TWS-EES-13-01-90-113

Yucca Mountain Project

Monthly Activity Report

January 1990

9003190318 - Part 2

This work was supported by the Yucca Mountain Project Office as part of the Civilian Radioactive Waste Management Program. This Project is managed by the US Department of Energy, Nevada Operations Office.

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YMPO AUDIT CHECKLIST NO. 90-1-01

N-QA-044
12/88

(1) Organization Los Alamos National Laboratory

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
1-1	QAP/88-9, Rev. 3 Para. 1.0	The organizational structure, lines of communication, authority and duties of persons and organizations performing activities affecting quality shall be clearly established and delineated in writing. These activities affecting quality include both the performing functions of attaining quality objectives and the QA functions.			
	LANL QAPP, Rev. 4.3 Section 1.0	1. Verify that organizational structure, lines of communication, authority, and duties of persons and organizations performing activities affecting quality are clearly established and delineated in writing.			

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1-2	QAP/88-9, Rev. 3 Para. 2.0 LANL QAPP, Rev. 4.3, Para. 1.2	The persons and organizations performing QA functions shall have sufficient authority, access to work areas, and organizational freedom to identify quality problems; to initiate, recommend, provide solutions through designated channels; to verify implementation of the solutions; and to assure that further processing, delivery, installation, or use is controlled until proper disposition of a nonconformance, deficiency, or unsatisfactory condition has occurred. This includes the ability to stop (or cause to be stopped) unsatisfactory work through established channels. Such persons or organizations shall have direct access to responsible management at a level where appropriate action can be effected and shall report to a management level at which this required authority and organizational freedom are provided, including sufficient independence from cost and schedule.			
	TWS-QAS-QP-01.2, Rev. 0, Para. 6.2 through 6.4.13	1. If stop work action has been initiated by QA, verify that all the requirements cited on the left have been or are followed.			

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1-3	QAP/88-9, Rev. 3 Para. 2.1 LANL QAPP, Rev. 4.3 Para. 1.2.1.1	The person responsible for directing and managing the overall NNWSI Project Participant QA program shall be identified and have appropriate organizational position, responsibilities, and authority to exercise proper control over the QA program. This person shall have appropriate management and QA knowledge and experience and shall be at the same or higher organizational level as the highest line manager responsible for performing activities affecting quality and sufficiently independent from cost and schedule. 1. Verify the above requirements through the the review of individual records and formal interview during the audit.			

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1-4	QAP/88-9, Rev. 3, Para. 2.2 LANL QAPP, Rev. 4.4 Table 1-1	Authority for the resolution of disputes involving quality arising from a difference of opinion between QA personnel and others shall be identified. This authority shall include the ability of QA personnel to elevate the resolution of disputes to progressively higher organization levels through established channels including the WMPO PQM, if the dispute cannot be resolved within the organization. 1. Verify through personnel interviews the acknowledgement of this method to resolve disputes involving quality.			

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1-5	QAP/88-9, Rev. 3, Para. 2.3	Because of the many variables involved, such as the number of personnel, the type of activity being performed, and the location or locations at which the activities are to be performed, the organizational structure for executing the QA program may take various forms provided that the persons and organizations assigned to QA functions have the required authority and organizational freedom. The QA responsibilities of all organizational elements depicted on organization charts shall be described.			
	LANL QAPP, Rev. 4.3 Para. 1.2, Fig. 1-1 and Table 1-1	1. Verify that the QA responsibilities of all organizational elements depicted on organization charts are described in procedures or instructions.			

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1-6	QAP/88-9, Rev. 3 Para. 4.1	The external interfaces between organizations and the internal interfaces between organizational units and changes thereto shall be documented. All interface responsibilities shall be defined and documented.			
	TWS-QAS-QP-01.1, Rev. 1, Para. 6.1-6.8	1. Verify that all internal interface responsibilities are defined and documented in procedures or instructions. 2. Verify that interfaces are being identified on Interface Description Forms. 3. Verify that interfaces with Los Alamos Service Groups and Subcontractors as defined in Interface Control Documents.			
2-1	NNWSI/88-9, Rev. 3, Sec. II, Paras. 4.1, 4.2	Management assessments are to be conducted at least annually for determining (1) the effectiveness of the system and management controls that are established to achieve and assure quality , and (2) the adequacy of resources and personnel provided to the QA program... Management above or outside the QA organization shall be responsible for the management assessment activity.			
	TWS-QAS-QP-02.4 Rev. 0, Paras. 6.1, 6.2, 6.3, and 6.4	Verify that annual assessments of the LANL QA Program have been performed by: 1. Developing an assessment plan which addressed as a minimum the items specified in Para. 6.1.			

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		2. Issuing an Assessment Report			
		3. Evaluation and implementation of recommendations			
		4. Documentation of follow-up actions			
				(9) Auditor Signature	(10) Date

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2-1 (cont'd)		NOTE: QP-02.4 does not describe what "annual" means or when "annual" is required. NOTE: QP-02.4, Para. 7.1 does not provide for "follow up" documentation (Para. 6.4) to be part of the assessment report package. NOTE: QP-02.2, Para. 6.6 (Action 30) provides for an annual assessment of training effectiveness; the assessment may be included in the trend analysis and/or management assessment reporting.			

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2-2	NNWSI/88-9, Rev. 3, Sec. II, Para. 5.1	All NNWSI Project participants shall establish requirements for the selection, indoctrination, and training of personnel performing or verifying activities that affect quality. The requirement shall establish position descriptions that set forth the minimun personnel qualifications and provide for appropriate indoctrination or training or both prior to initiation of activities that affect quality.			
	TWS-QAS-QP-02.5, Rev. 0, Para. 5.0, Attachment 2	Verify that position descriptions have been prepared by the following LANL managers and supervisors for personnel specified in Para. 5.0 as being under their supervision: 1. TPO 2. Project Leader 3. Technical Coordinators 4. Principal Investigators 5. Training Coordinator 6. Contractor YMP Supervisor 7. QA Liaison (QAL) 8. QA Project Leader (QAPL)			

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2-3	NNWSI/88-9, Rev. 3, Sec. II, Para. 5.1	In addtion to the following requirements for indoctrination and training, personnel performing activities that specifically require certification by applicable codes and standards (e.g., Lead Auditor,...etc.) shall be certified in accordance withthe detailed requirements specified in Appendix C, D, or F as applicable.			
	TWS-QAS-QP-18.3, Rev. 1, Paras. 6.3.3 Attachment 1	Verify that LANL personnel certified as Lead Auditors accumlated 10 credits under the scoring system specified by NQA-1, Appendix 2A-3, and a copy of Attachment 1 "Record of Lead Auditor Qualification" is on file.			

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2-4	NNWSI/88-9, Rev. 3, Sec. II, Para. 5.1.	Minimum education requirements shall be established and documented in position descriptions for each position involved in the performance of activities that affect quality.			
	TWS-QAS-QP-02.5, Rev. 0, Para. 6.1	The YMP Supervisor prepares a Position Description form (Attachment 2) for YMP positions under his supervision. Verify that Position Desciptions have been prepared in accordance with Para. 6.1 by at least six supervisors for at least two position under his command.			

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2-5	NNWSI/88-9, Rev. 3 Sect. II, Para. 5.1.2	Personnel selected shall have education and experience commensurate with the minimum requirements specified in the position descriptions. Relevant education and experience shall be verified. This verification shall be documented. The initial capabilities of an individual shall be based upon an evaluation of their education, experience and training and compared to those established for the position. Evaluations shall be documented by managers or supervisors responsible for the activities to be performed.			
	TWS-QAS-QP-02.5, Rev. 0, Rev. 0, Para. 6.2 and 6.3	Verify that the supervisors or Personnel Department representative verified the details presented by the propsective employee on the Personnel Qualification Evaluation form particularly education and experience. Also that the supervisior compared the position description requirements with the prospective employee's information presented on the Personnel Qualification Evaluation form.			

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2-6	NNWSI/88-9, Rev. 3, Sect. II, Para. 5.1.3	Prior to assigning personnel to perform activities affecting quality, they shall be indoctrinated as to the purpose, scope, methods of implementation, and applicability of the following documents (including changes thereto), as a minimum, as they relate to the work to be accomplished. Indoctrination may be accomplished by the use of a mandatory reading list, by group classroom presentations, by video presentation, or other instructional methods.			
	TWS-QAS-QP-02.6, Rev. 0, Para. 5.0 and 7.0	Verify that the TPO, QAPL, Project Leader, Technical Coordinator, PI, Training Coordinator and the Contractor YMP Supervisor ensured that orientation was provided for YMP personnel under his supervision. Review the records resulting from the indoctrination program conducted.			

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2-7	NNWSI/88-9, Rev. 3, Sec. II, Para. 5.1.3	Prior to assigning personnel to perform activities affecting quality, they shall be indoctrinated as to the purpose, scope, methods of implementation, and applicability of the following documents:			
	TWS-QAS-QP-02.6, Rev. 0 Rev. 2., Para. 6.1	Verify LANL personnel have received documented indoctrination in the following documents as required (including changes thereto): 1. Federal Regs and Orders 10CFR50 Appendix B 10CFR60 10CFR960 40CFR191 DOE Order 5700.6B 2. Industry Standards ANSI/ASME NQA-1 3. Project Level Documents Site Characterization Plan System Engineering Management Plan Configuration Management Plan Quality Assurance Plan etc. 4. LANL QAPP 5. LANL QPs and DPs			

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2-8	NNWSI/88-9, Rev. 3 Sect. II, Para. 5.1.4	Prior to assigning personnel to perform quality affecting activities training if needed, shall be conducted to gain the required proficiency. The training (in-depth instruction) shall include the principles, techniques, and requirements of the activity. Such in-depth instruction may be internal or external classroom sessions, classroom sessions supplemented by hands-on workshops, on-th-job training, other instruction methods, or combinations therof.			
	TWS-QAS-QP-02.7, Rev. 0, Para. 5.0 and 7.0	Verify that the TPO, QAPL, Project Leader, Technical Coordinator, PI, Training Coordinator, Records Coordinator and the Contractor YMP Supervisor ensured that training was provided for YMP personnel under his supervision by identifying the evidence of the training being satisfactorily completed. Review records of training efforts expended.			

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(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
2-9	NNWSI/88-9, Rev. 3 Sect. II, Para. 5.1.4	Prior to assigning personnel to perform quality affecting activities training, if needed, shall be conducted to gain the required proficiency. The training (in-depth instruction) shall include the principles, techniques, and requirements of the activity. Such in-depth instruction may be internal or external classroom sessions, classroom sessions supplemented by hands-on workshops, on-the-job training, other instruction methods, or combinations thereof.			
	TWS-QAS-QP-02.7, Rev. 0, Sect. II, Para. 6.0	Verify that the QAPL and PI provided the Records Coordinator with the level of training as required for each QP and DP, respectively. Verify that the Records Coordinator has listed the level of training as required for each QP and DP in the QAM Table of Contents and updates the listing when changes are provided by the QAPL and the PI.			

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2-10	NNWSI/88-9, Rev. 3 Sect. II, Para. 5.1.4	Prior to assigning personnel to perform quality affecting activities training if needed, shall be conducted to gain the required proficiency. The training (in-depth instruction) shall include the principles, techniques, and requirements of the activity. Such in-depth instruction may be internal or external classroom sessions, classroom sessions supplemented by hands-on workshops, on-th-job training, other instruction methods, or combinations thereof.			
	TWS-QAS-QP-2.7, Rev. 0 Para. 6.3	Verify that Reading Acknowledgement forms were provided to YMP employees by the YMP Supervisor and that the documents were read and the form was completed and returned to the YMP Supervisor. In addition, was required action taken to result in the documents being filed in the QAS training files.			

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2-11	NNWSI/88-9, Rev. 3 Sect. II, Para. 5.1.4	Prior to assigning personnel to perform quality affecting activities training if needed, shall be conducted to gain the required proficiency. The training (in-depth instruction) shall include the principles, techniques, and requirements of the activity. Such in-depth instruction may be internal or external classroom sessions, classroom sessions supplemented by hands-on workshops, on-th-job training, other instruction methods, or combinations therof.			
	TWS-QAS-QP-02.7, Rev. 0, Para. 6.2 and 6.4	Determine how the YMP Supervisor ensures that a YMP employee under his supervision receives required training, additional training or refresher training. Trace the steps taken until a Training Classroom Attendee List is filed in the QAS Training File.			

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2-12	NNWSI/88-9, Rev. 3 Sect. II, Para. 5.1.5 and 5.1.6.4	After the initial personnel qualification evaluation, the job proficiency of personnel who perform activities affecting quality shall be evaluated and documented at least annually. Proficiency evaluations may be performed in conjunction with periodic or day-to-day employee performance evaluations. Proficiency evaluations shall be performed by managers or supervisors who have responsibility for the activities being performed or verified.			
	TWS-QAS-QP-02.9, Rev. 0 Para. 6.1	Verify that YMP supervisors conduct an annual evaluation of their personnel which occurred during the quarter of the calendar year. Review a sample quantity of Personnel Proficiency Evaluation Forms.			

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2-13	NNWSI/88-9, Rev.3 Sect. II, Para. 5.1.6	Records of personnel qualification evaluations, indoctrination, training, and proficiency evaluations shall be retained as lifetime QA records. These records shall include, as a minimum, the items listed below: o Personnel Qualification Evaluation Records o Indoctrination Records o Training Records o Proficiency Evaluation Records			
	TWS-QAS-QP-02.5, 02.6, 02.7 & 02.9, Para. 7.0	Verify that the above documents have been placed in the group's Resident Files.			
3-1	NNWSI/88-9, Rev. 3, Sec. III, Paras. 1.1.1, 1.1.2, Appendix K AP-1.10Q TWS-QAS-QP-03.3, Rev. 0, Para. 5.1, 6.1 CR No. 068 CR No. 108	The scientific investigation planning document shall contain a level of detail which would enable an independent reviewer to determine the appropriate QA level to be applied to the investigator for site characterization activities. The purpose and key milestones of study plans is decribed in the SCP. The format and content of study plans shall meet the requirements of Appendix K to NNWSI/88-9. Verify LANL study plans have been prepared by certified authors in the format and content of Attachment 1 to QP-03.3. NOTE: Technical review of study plans is to be performed per QP-03.2. See Q 3-2. NOTE: Detailed technical procedures (DP) are prepared in accordance with QP-05.2. Coordinate with auditor responsible for Criterion V regarding			

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		procedure adequacy.			
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3-2	NNWSI/88-9, Rev. 3, Sec. III, Para. 1.3.1, AP-1.10Q TWS-QAS-QP-03.2, Rev. 0, Para. 6.2 CR No. 071	The responsible Participating Organization shall conduct a technical review of the scientific investigation planning document. This review shall be performed by any qualified individual(s) other than those who developed the original planning document....the results of this technical review, and the resolution of any comments by the reviewer or reviewers, shall be documented, and shall become a part of the QA Records. Verify technical reviews have been performed for the study plans reviewed under Q #3-1, by qualified, independent, reviewers and review comments have been resolved to the satisfaction of the reviewer. NOTE: QP-03.2, Para. 6.2.4 and Attachment 3, allows the TPO to accept a document even if the reviewer does not agree with comment resolution. NOTE: QP-03.16 also provides for "Technical Review" as a design related activity (Para. 4.2 and 6.2). Para. 2.0 is confusing regarding the applicability of QP-03.16 and QP-03.2 for technical reviews.			

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3-2 (cont)		NOTE: QP-03.5 provides for independent technical review of completed and terminated notebooks and logbooks, but does not reference QP-03.2. See Q #3-5. NOTE: Followup and verify corrective action to SDR 464 (audit 89-7). NOTE: Review conditions described by Observations 89-7-09 and 89-7-10, including subsequent procedure revisions. NOTE: AP-1.10Q, Rev. 4, requires QA review by the participant.			
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3-3	NNWSI/88-9, Rev. 3, Sec. II, Paras. 1.3.3, 4.0; Appendix J (NUREG-1297) TWS-QAS-QP-03.7, Rev. 0, Paras. 6.4, 6.5, 6.6 CR No. 106	1. A peer review of the scientific investigation planning document will be conducted when deemed necessary by the WMPO. 2. All Participating Organizations and NTS Support Contractors shall institute a peer review process, when applicable, to provide adequate confidence in the work being reviewed. Verify peer reviews are conducted in accordance with a peer review plan and comments and recommendations of the peer review report have been acceptably resolved or have been documented as unresolved in the final report of the work reviewed.			

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3-4	NNWSI/88-3(SEMP), Para. 4.2.5.3 AP-5.13Q, Para. 3.1 TWS-QAS-QP-02.3, Rev. 0 CR No. 092	Readiness Review is a documented comparison of readiness status to readiness criteria. It occurs at a meaningful transition point for a Yucca Mountain Project activity. Verify readiness reviews have been conducted prior to starting project activities under the control of Scientific Investigation Plans (SIPs) or Study Plans (SPs) to assure availability of personnel, procedures, and equipment to perform the described activities, and that that review is appropriately documented: o Readiness Review Notice o Readiness Review Panel Selection Record o Readiness Review Checklist o Readiness Review Comment Record o Readiness Review Record Memorandum (Report) See NOTES, next page.			

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3-4 (cont'd)		NOTE: Readiness Reviews, per AP-5.13Q, are not addressed by NNWSI/88-9, Project QA Plan, but derive from NNWSI/88-3, Project Systems Engineering Management Plan (SEMP). (See NNWSI/88-9, Sec. II, Para. 1.0, last sentence, 2nd paragraph) NOTE: QP-02.3 does not reference either NNWSI/88-3 (SEMP) or AP-5.13Q. NOTE: Check if a Readiness Review was conducted to assure readiness to receive this audit (90-1). NOTE: Review conditions described by Observations 89-7-01 and 89-7-02			

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3-5	NNWSI/88-9, Rev. 3, Sec. III, Para. 1.6.3	Scientific notebooks along with other appropriate documents may be used to document scientific investigations and experiments. In such cases, this documentation shall be sufficient such that another qualified scientist can use the notebook to retrace or repeat the experiment and achieve the same results without recourse to the PI.			
	TWS-QAS-QP-03.5, Rev. 0, Paras. 6.1, 6.3, 6.4, 6.5, 6.6, 6.8 CR No. 074	Verify the Resident File Custodian (RFC) controls and maintains status of laboratory and field notebooks, logbooks, and similar documents by assignment of a unique identification number and data entries are properly made and authenticated by the experimenters. NOTE: QP-03.5 provides for an independent technical review of completed or terminated notebooks and logbooks, but does not reference QP-03.2 for the performance of such reviews. See Q #3-2.			

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3-6	NNWSI/88-9, Rev. 3, Sec. III, Paras. 2.2.1, 5.0 Appendix B AP-5.2Q AP-5.3Q AP-5.18Q TWS-QAS-QP-03.14 Rev. 1, Para. 6.1, 6.2	Applicable design input ... shall be identified, documented, and their selection reviewed and approved by the responsible design organization and the responsible QA oganization. The design input shall be specified and approved on a timely basis and to the level of detail necessary to permit the design activity to be carried out in a correct manner and to provide a consistent basis for making design decisions, accomplishing design verification measures, and evaluating design changes. Verify design inputs for the Technical Data Base (TDB), Site & Engineering Properties Data Base (SEPDB), Interactive Graphics Information System (IGIS), Reference Information Base (RIB), and the ESF Basis for Design (BFD) have been accepted by technical review and QA review. NOTE: QP-03.14, Rev. 1 (effective 10/12/89) consists of less than one page of procedural requirements. NOTE: QP-03.14, Rev. 1 provides for "technical review" in accordance with QP-03.16 instead of QP-03.2.			

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3-7	NNWSI/88-9, Rev. 3, Sec. III, Para. 2.4,	Design control measures shall be applied to verify the adequacy of design and verification shall be performed in a timely manner. The responsible design organization shall identify and document the verification method used, the results of the verification, and the verifier.			
	AP-5.14Q	Design verification shall be accomplished by one or a combination of the following: design reviews, alternate calculations, qualification testing, or peer review.			
	TWS-QAS-QP-03.16, Rev.4	Verify design reviews are conducted by a qualified Design Review Team who did not participate in the technical activity to be reviewed, and that the review is appropriately documented: o Design Review Notice o Design Review Team Selection Record o Design Review Package o YMP Review Sheets (Comment Sheets) o Review Record Memorandum (Report) o Reviewers Qualifications (if not a certified LANL YMP reviewer) NOTE: LANL procedures for design verification do not address alternate calculations or qualification testing. NOTE: YMP Review Sheet and Reviewer Qualification forms in QP-03.16 are not quite the same as QP-03.2			

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3-8	NNWSI/88-9, Rev. 3, Sec. III, Paras. 2.6.1, 2.6.2	1. Internal and external design interfaces shall be identified and controlled and design efforts shall be coordinated among and within responsible design organizations.			
	AP-5.19Q	2. Design information transmitted across interfaces shall be documented and controlled. Transmittals shall identify the status of the design information or document provided and, where necessary, identify incompleted items which require further evaluation, review, or approval.			
	TWS-QAS-QP-03.15, Rev. 1, Para. 6.1 TWS-QAS-QP-01.1 Rev. 1, Para. 6.1	Verify Memoranda of Understanding (MOU) have been prepared between LANL and other Project participants that delineate responsibilities and detailed requirements for transmitting design information across organizational boundaries. NOTE: MOUs, per QP-03.15, appear to cover only external interfaces; identify the basis for control of internal interfaces between LANL groups. NOTE: QP-03.15 addresses "Project participants"; identify the controls placed on subcontractors NOTE: QP-01.1 also requires preparation of Interface Identification Forms per AP-5.19Q, but does not provide for the "ESF Interface Control Document Identification" or the "Interface Control Log". NOTE: Followup and verify corective action to SDR 460 (Audit 89-7)			

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3-9	NNWSI/88-9, Rev. 3, Sec. III, Para. 3.1	Where commercial auxiliary software is used all available documentation from the software supplier shall be obtained. It is recognized that source code is generally not availble and controls are limited to unique version identification and user-related manuals.			
	TWS-QAS-QP-03.1, Rev. 0, Paras. 3.3, 3.4, 3.9, 8.0, 9.0, 10.0 (TWS-QAS-QP-03.12)	Verify users manuals have been obtained and are available for commercial auxiliary software and manifest product software (MPS).			
		NOTE: QP-03.12 (Auxiliary, Commercial and Utility Software) has not been issued yet.			
	CR No. 055	NOTE: Review LANL Measures for Control of Users manuals and other supplier documentation, identification and notification to users of program errors or limitations, unique version identification, and access control to preclude unauthorized modification of source codes.			
		NOTE: Neither Para. 8.0 nor Table 2-1 of QP-03.1 require users manuals for Commercial Software (CS) or Manifest Product Software (MPS).			

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3-10	NNWSI/88-9, Rev. 3, Sec. III, Para. 3.1, 3.2, 3.3 Appendix H	Each organization participating in the NNWSI Project shall prepare a description of their software design, test, and configuration management system... Software shall be placed under calibration management as each baseline element is approved....			
		Computer programs developed and/or modified shall be documented in accordance with the applicable elements of NUREG-0856....			
	TWS-QAS-QP-03.1, Rev. 0, Paras. 7.1, 7.2 Table 2-1 (TWS-QAS-QP-03.10) (TWS-QAS-QP-03.11)	Verify Scientific and Engineering Software (SES) has been qualified and documented by the following records:			
	CR No. 055	o Software Requirements and Design Specifications			
		o Software V&V Plan			
		o Software V&V Report			
		o Users Manual			
		o Model Description			
		o Software Summary Form			
		o Checklist for Determining Code Status			
		o Listing of Controlled Codes			
		o Authorized Changes			

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3-10 (cont'd)		NOTE: QP-03.10 (Software Configuration) and QP-03.11 (Scientific and Engineering Software) have not been issued yet.			
		NOTE: Review status of YMPO approval of LANL Software QA Plan.			
		NOTE: QP-03.1, Para. 13.0 does not identify referenced procedures by number; therefore some procedures cannot be correctly identified.			
		NOTE: QP-03.1 provides for SRDS, SVVP, SVVR, Users Manual and Model Description to require a technical review, but does not specifically reference QP-03.2. See Q #3-2.			
4-1	YMP/88-9, Rev. 3, Sec. IV, Para. 2.1	Procurement issued at all tiers of procurement shall include provisions for the items listed below, as deemed necessary by the purchaser:			
		2.1.1 SCOPE OF WORK A statement of the scope of the work to be performed by the supplier shall be in the procurement documents.			
		2.1.2 TECHNICAL REQUIREMENTS Technical requirements shall be specified in the procurement documents. Where necessary, these requirements shall be specified by reference to specific drawings, specifications, codes, standards, regulations, procedures, or instructions, including revisions thereto			

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		that describe the items or services to be furnished. The procurement documents shall provide for identification of test, inspection, and acceptance requirements of the purchaser for monitoring and evaluating the supplier's performance.			

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		2.1.3 QA REQUIREMENTS 2.1.3.1 Procurement documents shall require that the supplier have a documented QA program that implements either portions or all of the requirements of this document. Quality Assurance Program Plans (QAPPs) and documents of subcontractors for Quality Assurance Level I purchases shall be reviewed and approved by the procuring Project participant. Those which do not adequately define QA requirements, as judged by the QA representative of the Project participant, shall be corrected prior to initiation of activities specified by the purchase order or contract. The extent of the program required shall depend upon the type and use of the item or services being procured. The procurement documents shall require the supplier to incorporate appropriate QA program requirements in subtier procurement documents. 2.1.3.2 In developing QA requirements for test and other equipment, consideration should be given to whether proper performance of that equipment can be determined during or after its use (i.e., whether failure or malfunction of the equipment can be detected.)			

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		2.1.4 RIGHTS OF ACCESS At each tier of procurement, the procurement documents shall provide for access to the suppliers' facilities and records for inspection or audit by the purchaser, appropriate WMPO personnel, or other WMPO authorized representative. WMPO access to subtier contractor facilities shall be arranged by the contracting organization.			
		2.1.5 DOCUMENTATION REQUIREMENTS The procurement documents at all tiers shall identify the documentation required to be submitted to the purchaser. The time of submittal shall also be established. If the purchaser requires the supplier to maintain specific QA records, then the retention times and disposition requirements shall be specified in accordance with Section XVII of this QA Plan.			
		2.1.6 NONCONFORMANCE The procurement documents shall prescribe the purchaser's requirements for reporting and approving disposition of nonconformances.			

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		2.1.7 SPARE AND REPLACEMENT PARTS The procurement documents shall require the identification of appropriate spare and replacement parts or assemblies and the appropriate delineation of the technical and quality related data that are required for ordering these parts or assemblies. The technical and quality requirements shall be equal to or better than the original. If QA or technical requirements of the original item cannot be determined, then an engineering evaluation shall be conducted by qualified individuals to establish the requirements. The evaluation shall consider the interchangeability, function, and safety of the item. The evaluation shall be documented.			
	QP-04.1, Rev. 2 Para. 6.1	Review purchase requests issued since 4/89 for QA Level I and II and verify that they contain the following descriptions: o A scope of work description; o The technical requirements for the work, including technical specifications or catalog number reference; o QA program requirements consistent with the applicable provisions of the LANL QAPP; o A right of access provision; o Subcontracting requirements; o Documentation requirements; o Nonconformance provisions; and o Applicable regulatory and design requirements, design or site investigation bases, and other requirements to assure adequate quality.			

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4-2	YMP/88-9, Rev. 3, Sec. IV, Para. 2.2	A review of the procurement documents and changes thereto shall be made to assure that documents transmitted to the prospective supplier or suppliers include appropriate provisions to assure that items or services will meet the specified requirements. The review shall be performed and documented prior to contract award. Procurement document reviews shall be performed by personnel who have access to pertinent information and who have adequate understanding of the requirements and intent of the procurement documents. The review shall include, as a minimum, the cognizant technical organization and QA organization. The review by the QA organization shall assure that the following requirements are met: o QA requirements are correctly stated, inspectable, and controllable. o There are adequate acceptance and rejection criteria. o Procurement documents have been prepared, reviewed, and approved in accordance with this QA Requirements document.			

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	QP-04.1, Rev. 2, Para. 6.6	Verify that the QAL completes the QA Level Assignment and Commercial-Grade Checklist for each PR and marks the QA Level and "YMP" on the PR and signs and dates the PR.			
	QP-04.1, Rev. 2, Para. 6.7	Verify that any exceptions taken and changes made by a bidder are discussed by the buyer with the requester and the QAL.			
	QP-04.1, Rev. 2, Para. 6.9	Verify that before the final authorization is given to MAT to award a QA Level I or II noncommercial-grade subcontract, the requester and a QA representative review the final procurement documents, including all changes and sign the Final Authorization for MAT to Award Subcontract.			

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4-3	YMP/88-9, Rev. 3, Sec. IV, Para. 2.3	Procurement document changes shall be subject to the same degree of control as utilized in the preparation of the original documents. Changes that are made as a result of the bid evaluation or precontract negotiations shall be incorporated into the procurement documents. The review of such changes and their effects shall be completed and documented prior to contract award. Review of changes shall include the following considerations: o Appropriate content shall be included in procurement documents as required by Paragraph 2.1 of this section. o Additional or modified design or site investigation criteria shall be determined. o Analysis of exceptions or changes requested or specified by the supplier and determination of the effects such changes may have on the intent of the procurement documents or quality of the item or service to be furnished.			
	QP-04.1, Rev. 2, Para. 6.8	Verify that both the requester and the MAT buyer document their review and concurrence on all procurement changes. Verify that this documentation is placed with the PR in the group Resident File and in the MAT buyer's file.			
4-4	YMP/88-9, Rev. 2, Sec. IV, Para. 2.4	Participating Organizations and NTS Support Contractors shall forward to the SAIC/T&MSS Project QA Department (QA Verification Division Manager), a copy of purchase documents, and changes thereto, as issued, when purchases involve Quality Assurance Level I items or services. Only those purchase documents which identify			

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		the vendor, describe the scope of work, and detail when work is to start are required to be submitted to the SAIC/T&MSS Project QA Department.			
		Verify that QA Level I purchase documents are sent to the SAIC/T&MSS Project QA Department (QA Verification Division Manager).			
	QP-04.1, Rev. 2, Para. 6.13	Verify that for each QA Level I and II order, the QAPL sends the procurement documents that identify the vendor, describe the scope of work, and specify work start date to the following address: Yucca Mountain Project Office Project Quality Manager P.O. Box 98518 Las Vegas, NV 89193-8518			
5-1	NNWSI/88-9, Rev. 3 Section V, Para. 1.0	Activities affecting quality shall be prescribed by and performed in accordance with documented instructions, procedures, or drawings, of a type appropriate to the circumstances except as noted in Paragraph 3.0 of this Section.			
	TWS-QAS-QP-05.1, Rev. 3, Para. 1.0	o Verify that activities affecting quality are prescribed and performed by documented instructions and procedures including quality administrative procedures (QPs) developed in accordance with TWS-QAS-QP-05.1 o Identify what documented instructions or procedures, excluding QP's, describe activities that affect quality. What procedures define the preparation of these items.			

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5-2	NNWSI/88-9, Rev. 3 Section V, Para. 1.0	Activities affecting quality shall be prescribed by and performed in accordance with documented instructions, procedures, or drawings, of a type appropriate to the circumstances except as noted in Paragraph 3.0 of this Section.			
	TWS-QAS-QP-05.2, Rev. 2, Para. 1.0	Verify that Los Alamos subcontractors who perform activities affecting quality do so in accordance with detailed technical procedures which comply with TWS-QAS-OP-05.2.			

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5-3	NNWSI/88-9, Rev. 2 Section V, Para. 1.0	These documents shall include or reference appropriate quantitative or qualitative acceptance criteria for determining that prescribed activities have been satisfactorily accomplished.			
	TWS-QAS-QP-05.1, Rev. 3, Para. 7.0	Select ten QPs at random and verify that any qualitative or quantitative acceptance criteria required to determine that the prescribed activities were satisfactorily accomplished are included or referenced in the basic document.			

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5-4	NNWSI/88-9, Rev. 3, Section V, Para. 1.0	These documents shall include or reference appropriate quantitative or qualitative acceptance criteria for determining that prescribed activities have been satisfactorily accomplished.			
	TWS-QAS-QP-05.2, Rev. 2, Para. 10.0	Select eight Detailed Procedures (DPs) and repeat the action specified by Audit Item 5-3.			

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5-5	NNWSI88/9, Rev. 3, Sect. V, Para. 3.0 TWS-QAS-QP-05.1, Rev. 3, Para. 7.0	Instruction and procedures shall include section which identifies the QA records which are generated during implementation of the document. o Review the documents selected for item 5-3 and verify that the QA records and/or record packages to be generated through the use of the documentation are identified as section of the document.			

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5-6	NNWSI88/9, Rev. 3 Section V, Para. 1.0	Instruction and procedures shall include a section which identifies the QA records which are generated during implementation of the document.			
	TWS-QAS-QP-05.2, Rev. 2, Para. 6.3.8.2	Repeat the action specified for Audit Item No. 5-5 reviewing the documents selected for Audit Item No. 5-4.			

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5-7	NNWSI/88-9, Rev. 3 Section V, Para. 1.0	If plans are used in lieu of procedures, the these plans shall also include or reference appropriate acceptance criteria and identify the QA records which are generated.			
	TWS-QAS-QP-05.1, Rev. 3, Paras. 6.1.3.8 and 7.0	If plans were used, verify that appropriate acceptance criteria and required QA records were specified.			

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5-8	NNWSI/88-9, Rev. 3 Section V, para. 2.0	An independent review of all instruction, procedures, plans and drawings shall be performed by the originating organization to assure technical adequacy and inclusion of appropriate quality requirments.			
	TWS-QAS-QP-05.1 Rev. 3, Paras. 6.2 and 6.3	o Review the documents selected for item 5-3 and verify that the preparer identified independent technical and QA reviewers including the Los Alamos YMP Records Coordinator, and appropriated QA Liaisons (QAL), QAS Staff and Los Alamos Project Participants to review the document. o Review the review sheets (QAP-03.2 Attachment 4) or equivalent for adequate reviews. Do they contain the optional or mandatory notation? o Did the preparer resolve all review sheets and return to the reviewer.			

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5-9 Ref.: Observation 89-7-14	NNWSI/88-9, Rev. 3 Section V, Para. 2.0 TWS-QAS-QP-05.2, Rev. 2, Para. 7.0	An independent review of all instruction, procedures, plans and drawings shall be performed by the originating organization to assure technical adequacy and inclusion of appropriate quality requirements. o Review the DPs selected for Audit item 5-4 and verify that the preparer submitted draft DPs for technical review to one or more qualified individuals not involved in preparing the DP and the groups QAL for QA review. o Review the review sheets for adequate reviews. o Did and how did the preparer resolve all review sheets and notified the reviewer.			

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5-10	NNWSI/88-9, Rev. 3 Section V, Para. 3.0	The participating Organization shall prepare instructions for the control of scientific notebooks, plans and the other documentation that will be used in scientific investigations. When scientific notebooks are used to document scientific investigations, the requirements of Section III, Para. 1.6 shall prevail over the requirements of this Section. Scientific notebooks shall be collected, controlled, stored, and maintained as QA records in accordance with procedures which meet the requirements of Section XVIII of this document.			
	NNWSI/88-9, Rev. 3 Section III, Para. 1.6	Verify/determine if Los Alamos has prepared instructions for the control of scientific notebooks. Verify if Scientific notebooks are used to document scientific investigation, the requirements of Section III, Para. 1.6. prevail over the requirements of Section XVII. (Check with auditor responsible for Section III).			

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5-11	NNWSI/88-9, Rev. 3 Section V, Para. 4.0	Each Participating Organization and Nevada Test Site (NTS) Support Contractor shall maintain and provide the YMPO PQM and the SAIC/T&MSS Project Quality Assurance Department Manager with controlled distribution of all implementing procedures, plans and instructions used for QA Level I and II activities.			
	LANL YMP QAPP, Rev. 4.3, Section 6 "Document Control"	"The LANL shall issue to the PQM controlled copies of all LANL implementing procedures, plans, instructions, and the QAPP used for QA Level I and II activities." Ascertain that the PQM is provided with a controlled copy of all implementing precedures, plans, and instruction used for QA Level I and II activities.			

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5-11	NNWSI/88-9, Rev. 3 Section V, Para. 1.0	Activities affecting quality shall be prescribed by and performed in accordance with documented instructions, procedures, or drawings, of a type appropriate to the circumstances except as noted in Para. 3.0 of this Section.			
	TWS-QAS-QP-05.2 Rev. 2, Para. 6.3.8.1	Review the DP's selected for Audit Item 5-4 and verify that they addressed the applicable handling, shipping and storage requirements for special equipment as specified in the QAPP Section 13. If no special requirements are to be addressed include a statemment to that effect.			

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5-12	NNWSI/88-9, Rev. 3 Section V, Para. 1.0	Activities affecting quality shall be prescribed by and performed in accordance with documented instructions, procedures, or drawings, of a type appropriate to the circumstances except as noted in Para. 3.0 of this Section.			
	TWS-QAS-QP-05.2 Rev. 2, Para. 6.3.8.3	o Review the DP's selected for Audit Item 5.4 and verify that they specify the training necessary for using the DP using the guidance provided by TWS-QAS-QP-02.1 & TWS-QAS-QP-02.2 o Review documentation verifying that Los Alamos Project personnel who use DPs were adequately trained and if required certified.			

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5-13	NNWSI/88-9, Rev. 3 Section V, Para. 1.0	Activities affecting quality shall be prescribed by and performed in accordance with documented instructions, procedures, or drawings, of a type appropriate to the circumstances except as noted in Para. 3.0 of this Section.			
	TWS-QAS-QP-05.2 Rev. 2, Para. 6.3.8.4	Review the DP's selected for Audit Item 5-4 verify that if applicable QAPP calibration procedures were addressed. Was reference made to the instrumentation which was to be calibrated more than once during the activities.			

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5-14	NNWSI/88-9, Rev. 3 Section V, Para. 1.0	Activities affecting quality shall be prescribed by and performed in accordance with documented instructions, procedures, or drawings, of a type appropriate to the circumstances except as noted in Para. 3.0 of this Section.			
	TWS-QAS-QP-05.2 Rev. 2, Para. 6.3.7	o Review the DP's selected for Audit Item 5-4 and verify the requirements of Para. 6.3.7 were specified as applicable			

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5-15 Ref.: SDR 465	LANL-YMP-QAPP, Rev. 4.4 Para. 3.1.6.1	States in part "DPs used for scientific investigation shall provide for the following as appropriate: o Acceptance and rejection limits and criteria including required levels of precision and accuracy."			
	TWS-QAS-QP-05.2, Rev. 2, Para. 6.3.7.6	States in part "include criteria (e.g. post-requisite and find condition) for ensuring that that DPs have been performed correctly."			
	TWS-QAS-QP-05.2, Rev. 2, Para. 6.3.7.6 CR No. 124	Provide acceptance and rejection limits and criteria including levels of precision and accuracy. Include criteria for ensuring that DPs have been performed correctly. Review the below listed DPs and select four additional DPs and verify that the above requirements are specified in each document: TWS-EES-DP-54, Rev. 1 TWS-EES-DP-102, Rev. 1 TWS-EES-DP-114, Rev. 1 TWS-EES-DP-124, Rev. 0 TWS-INC-DP-27, Rev. 0			
6-1	NNWSI QAP/88-9, Rev. 3 Section VI, Para. 1.2 LANL YMP QAPP, Rev. 4.4, Para. 6.2	Implementation of document control shall provide for the following: o Identification of documents to be controlled. o Identification of assignment of responsibility for preparing, reviewing, approving, and issuing documents. o Review of documents for technical adequacy, completeness, correctness, and inclusion of appropriate quality requirements, prior to			

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		approval and issuance. o A method for the removal or marking of obsolete or superseded documents to prevent inadvertent use. o A method for assuring that the correct and applicable documents are available at the location where they are to be used. o A master list or equivalent to identify the correct and updated revisions of documents. o Coordination of interface documents. Verify the above listed items are provided for in the implementing procedures.			

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6-2	NNWSI QAP/88-9, Rev. 3, Section V, Para. 2.1 LANL YMP QAPP, Rev. 4.4, Para. 6.3 TWS-QAS-QP-05.1, Rev. 3, Para. 6.5 TWS-QAS-QP-05.2, Rev. 2, Para. 8.2	Changes to documents, other than those defined below as minor changes are considered as major changes and shall be reviewed and approved by the same organization that performed the original review and approval, unless other organizations are specifically designated by the organization responsible for the document. Verify/determine if major changes have been reviewed and approved by the same organizations that performed the original review and approval.			

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6-3	NNWSI QAP/88-9, Rev. 3, Section VI, Para. 3.1 LANL YMP QAPP, Rev. 4.4, Para. 6.4 TWS-QAS-QP-06.1, Rev. 1, Para. 6.4.1	A master list or equivalent used to identify the correct, current and updated versions of documents shall be submitted to the WMPO PQM and the SAIC/T&MSS Project Quality Assurance Department Manager. Verify that the master distribution lists for controlled documents are maintained by the QAS.			

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6-4	LANL YMP QAPP, Rev. 4.4, Para. 6.4	Procedures, plans, and instructions for QA Level I and II activities shall be accessible for review in the area where the activity is performed.			
	TWS-QAS-QP-06.1 Rev. 1, Para. 6.3 & 6.5	Verify that LANL personnel have current procedures, plans, or instructions necessary to perform their activities.			
7-1	YMP/88-9, Rev. 3 Sec. VII, Para. 1.2	SOURCE EVALUATION AND SELECTION 1.2.1 SELECTION OF SUPPLIERS The selection of suppliers shall be based on evaluation of their capability to provide items or services in accorance with the requirements of the procurement documents before the award of contract. 1.2.2 SOURCE EVALUATION AND SELECTION MEASURES Procurement source evaluation and selection measures shall be implemented by the purchaser and shall provide for identification of the purchaser's organizational responsibilities for determining supplier capability.			

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		1.2.3 MEASURES FOR EVALUATION AND SELECTION OF PROCUREMENT SOURCES Measures for evaluation and selection of procurement sources, and the results thereof, shall be documented and shall include one or more of the following items: o Evaluation of the supplier's history of providing an identical or similar product that performs satisfactorily in actual use. The supplier's history shall reflect current capability. o Supplier's current quality assurance records supported by documented qualitative and quantitative information that can be objectively evaluated. o Supplier's technical and quality capability as determined by a direct evaluation of their facilities and personnel and the implementation of his QA program.			

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	QP-04.3, Rev. 1, Para. 6.3	Verify that the QAL documents the qualification process used and the outcome in a brief summary report to the requester. Verify that the QAL sends duplicate copies of the report to the QAS for the AVL file and to the RPC. Verify that the QAL's report states, as a minimum, the following: o method(s) used in attempting to qualify the supplier o item or service to be procured o requirements considered o identity of any documents and records reviewed o deficiencies that must be resolved before a contract is awarded o recommendation on qualification of the supplier Verify that the QAL signs and dates the report. Verify that tha QAS adds each supplier designated as fully or conditionally qualified to the AVL.			

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	QP-04.3, Rev. 1,	Verify that the AVL lists the following information: o supplier's name and address, o product or service to which the approval applies, including any special processes, o date of qualification, o method of qualification, o comments and conditions, and o evaluator's name. Verify that the QAS group sends a copy of the AVL, at each update, to all Resident File Custodians and to the RPC.			

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	QP-04.3, Rev. 1,	Verify that the QA Project Leader or his designee reviews the AVL annually.			
7-2	YMP/88-9, Rev. 3, Sec. VII, Para. 1.3.1	Bid evaluation shall determine the extent of conformance to the procurement documents. This evaluation shall be performed by individuals or organizations designated to evaluate the following subjects, as applicable to the type of procurement: o Technical Considerations o QA Requirements o Supplier's Personnel o Supplier's Production Capabilities o Supplier's Past Performance o Alternates o Exceptions			
	QP-04.1, Rev. 2, Para. 6.7	Verify that the MAT buyer evaluates all bids for technical and QA requirements with the requester. (How is this documented ?) Verify that any exceptions taken and changes made by a bidder are discussed by the buyer with the requester and the QAL. (How is this documented ?) Verify that the buyer prepares a PO that contains the contract specifications of the PR and includes any changes authorized by the requester. Verify that the buyer sends a copy of the PO to the requester's group, where the RFC places it with the PR in the group Resident File.			

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7-3	YMP/88-9, Rev. 2, Sec. VII, Para. 1.3.2	Before the award of the contract, the purchaser shall resolve or obtain commitments to resolve unacceptable quality assurance conditions resulting from the bid evaluation.			
	QP-04.1, Rev. 2, Para. 6.8	Verify that the requester and the MAT buyer incorporate into the procurement documentation any changes made as a result of bid evaluations or precontract award negotiations. Verify that the requester reviews any changes, evaluates possible effects, and documents any findings with a dated signature, showing acceptance. Verify that the requester discusses changes with the QAL before MAT awards the contract. Verify that both the requester and the buyer document their review and concurrence on all procurement changes.			

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7-4	YMP/88-9, Rev. 2, Sec. VII, Para. 1.4.1	The purchaser of items and services shall establish measures to interface with the supplier. The measures shall include the following: o Documentation of the understanding between purchaser and supplier of the provisions and specifications of the procurement documents. o Requiring the supplier to identify planning techniques and processes to be utilized in fulfilling procurement document requirements. o Reviewing supplier documents that are generated or processed during activities fulfilling procurement document requirements. o Identifying and processing necessary change information. Measures to control changes in procurement documents shall be established, implemented and documented in accordance with the requirements of this QA plan. o Establishing methods of document information exchange between purchaser and supplier.			
	QP-04.1, Rev. 2, Para. 6.4	Verify that the requester has included interface measures in the PR's.			

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7-5	YMP/88-9, Rev. 2, Sec. VII, Para. 1.4.2.1	The purchaser of items and services shall establish measures to verify supplier's performance, as deemed necessary by the purchaser. The measures shall establish the extent of source surveillance and inspection activities. Note: When a Participating Organization, or Nevada Test Site (NTS) Support Contractor, utilizes another Participating Organization or NTS Support Contractor for YMP activities for which they are responsible, the user organization shall initiate a request to YMPO to conduct a YMPO surveillance of the organization performing the work. The surveillance shall be conducted to determine that the item or activity is being produced or performed in accordance with the user organization's requirements. These surveillances may utilize NTS Support Contractor or Participant Organization personnel as technical advisors. The extent of verification activities, including planning, shall be a function of the relative importance, complexity, and quantity of the item or service procured and the supplier's quality performance. Verification activities shall be accomplished by qualified personnel assigned to check, inspect, audit, or witness the supplier's activities. These verification activities shall be conducted as early as practicable. However, the purchaser's verification activities shall not relieve the supplier of their responsibilities for verification of quality achievement.			
	QP-04.1, Rev. 2, Para. 6.4	Verify that the requester has addressed verification activities for items and/or services in the PR.			

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7-6	YMP/88-9, Rev. 2, Sec. VII, Para. 1.4.2.2	Activities performed to verify conformance to requirements of procurement documents shall be recorded.			
	QP-04.1, Rev. 2, Para. 6.11.3	Verify that the requester documents the method by which the item was evaluated for conformance to the procurement document requirements, documents the outcome of the evaluation and acceptance, and places the information with the procurement document package in the group Resident File.			
	QP-04.2, Rev. 2, Para. 6.1	Verify that the requester documents acceptance of the results of a procured service by checking the appropriate "accept" box(es) on the acceptance form, making comments, and signing and dating the form.			

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7-7	YMP/88-9, Rev. 2, Sec. VII, Para. 1.6.1.1	When a certificate of conformance is used, the following minimum criteria shall be met: o The certificate shall identify the purchased material or equipment, such as by the purchase order number. o The certificate shall identify the specific procurement requirements met by the purchased material or equipment, such as codes, standards, or other specifications. This may be accomplished by including a list of the specific requirements or by providing at the point of receipt, a copy of the purchase order and the procurement specifications or drawings, together with a suitable certificate. The procurement requirements identified shall include any approved changes, waivers, or deviations applicable to the subject material or equipment. o The certificate shall identify any procurement requirements that have not been met, together with an explanation and the means by which to resolve the nonconformances. o The certificate shall be attested to by a person who is responsible for this QA function and whose function and position are described in the purchaser's or supplier's QA program. o The certification system, including the procedures to be followed in filling out a certificate and the administrative procedures for the review and approval of the certificates, shall be described in the purchaser's or supplier's QA program.			

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		o Means shall be provided to verify the validity of supplier certificates and the effectiveness of the certification system, such as during the performance of audits of the supplier or independent inspection or test of the items. Such verification shall be conducted by the purchaser at intervals commensurate with the supplier's past quality performance.			
	QAPP, Rev. 4.3 Para. 7.1.7.1	If a certificate of conformance is requested, verify that the procurement documents specify the conditions for a certificate of conformance that are listed in para. 7.1.7.1 of the LANL QAPP.			

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7-8	YMP/88-9, Rev. 3, Sec. VII, Para. 1.6.1.3	When receiving inspection is used, purchased items shall be inspected as necessary to verify their conformance to specified requirements, by taking into account source verification and audit documentation and the demonstrated quality performance of the supplier. Receiving inspection shall be performed in accordance with established procedures and inspection instructions to verify by objective evidence such features as proper configuration; identification, dimensional, physical, and other characteristics; freedom from shipping damage, and cleanliness. Receiving inspection shall be coordinated with review of supplier documentation when procurement documents require such documentation to be furnished prior to receiving inspection. Receiving inspection associated with engineered items shall be planned, performed, and documented in accordance with the requirements specified in Section X, Para. 2.1, 4.0, 4.1, 6.1, 9.0, and 9.1 of this document. Personnel selected to receipt inspection activities shall have the experience or training commensurate with the scope, complexity, or special nature of the activities. When required, personnel shall also be indoctrinated as to the technical objectives and requirements of the applicable codes and standards and the QA program elements that are applicable.			

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	QP-04.1, Rev. 2, Para. 6.11.3	Verify that the requester documents the method by which the item was evaluated for conformance to the procurement document requirements, documents the outcome of the evaluation and acceptance, and places the information with the procurement document package in the group Resident File.			
	QP-04.1, Rev. 2, Para. 6.11.5	Verify that receiving inspection and service acceptance records are reviewed by the QAS staff as part of the audit and survey program.			

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7-9	YMP/88-9, Rev. 3, Sec. VII, Para. 1.6.1.4	When post-installation testing is used, post-installation test requirements and acceptance documentation shall be established mutually by both the purchaser and the supplier.			
	QP-04.1, Rev. 2, Para. 6.11.3	Verify that the requester documents the method by which the item was evaluated for conformance to the procurement document requirements, documents the outcome of the evaluation and acceptance, and places the information with the procurement document package in the group Resident File.			

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7-10	YMP/88-9, Rev. 3, Sec. VII, Para. 1.7.1	In certain cases involving procurement of services only, such as third party inspections, engineering, and consulting; and installation, repair, overhaul, or maintenance work, the purchaser shall accept the service by any combination of the following methods: o Technical verification of data produced. o Surveillance, audit, or both, with regard to the activity. o Review of objective evidence for conformance to the procurement document requirements such as certifications, stress reports, etc.			
	QP-04.2, Rev. 2, Para. 6.1	Verify that the requester documents acceptance of the results of a procured service by checking the appropriate "accept" box(es) on the acceptance form, making comments, and signing and dating the form.			

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7-11	YMP/88-9, Rev. 2, Sec. VII, Para. 1.8	CONTROL OF SUPPLIER NONCONFORMANCES 1.8.1 METHODS The purchaser and supplier shall establish and document methods for disposition of items and services that do not meet procurement requirements. These methods shall include the following provisions: 1.8.1.1 EVALUATION Provisions for evaluation of nonconforming items. 1.8.1.2 SUBMITTAL Provisions for submittal of nonconformance notice to purchaser by supplier as directed by the purchaser. These submittals shall include supplier recommended disposition (e.g., use-as-is or repair) and technical justification. Nonconformances to the procurement requirements or purchaser approved documents, which consist of one or more of the items listed below shall be submitted to the purchaser. Approval of the recommended disposition shall be in accordance with documented procedures.			

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		o Technical or material requirement is violated. o Requirement in supplier documents, which has been approved by the purchaser, is violated. o Nonconformance cannot be corrected by continuation of the original manufacturing process or by rework. o The item does not conform to the original requirement even though the item can be restored to a condition such that the capability of the item to function is unimpaired. 1.8.1.3 DISPOSITION Provisions for purchaser disposition of supplier recommendation. 1.8.1.4 VERIFICATION Provisions for verification of the implementation of the disposition.			

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		1.8.1.5 RECORDS MAINTENANCE Provisions for maintenance of records of nonconformances that are submitted by the supplier.			
	QP-04.1, Rev. 2, Para. 6.1	Verify that the requester has included provisions for the resolution of nonconformances in the statement of work of the PR's.			

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7-12	YMP/88-9, Rev. 3, Sec. VII, Para. 2.1.1	Where the commercial-grade item is to be used as an integral part of the designed facility, it shall be identified in an approved design or design out-put document. An alternate commercial-grade item may be supplied if the cognizant organization provides verification that the alternate commercial-grade item will perform the intended function and will meet the requirements applicable to both the replaced item and its application.			
	QP-04.1, Rev. 2, Para. 6.1	Verify that for commercial-grade procurements, the requester provides the technical information required for the PR and any necessary supporting information.			

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7-13	YMP/88-9, Rev. 2, Sec. VII, Para. 2.1.3	Commercial-grade items shall be identified in the purchase order by the manufacturer's published product description (e.g., the catalog number).			
	QP-04.1, Rev. 2, Para. 6.3	Verify that the requester identifies the item on the PR using the supplier's catalog number and product description and indicates the appropriate supplier(s).			
		Verify that the QAL reviews and completes the QA Level Assignment and Commercial-Grade Checklist, marks on the PR a QA level assignment of "QA Level I (or II), Commercial Grade", signs and dates the PR, and marks it "YMP".			

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7-14	YMP/88-9, Rev. 2, Sec. VII, Para. 2.1.4	After receipt of a commercial-grade item, the purchaser shall determine that the following conditions have been met: o Damage was not sustained during shipment. o The item received was the item ordered. o Inspection, testing, or both, is accomplished by the purchaser, in accordance with written procedures, to ensure conformance with the manufacturer's published requirements. If applicable, acceptance of the item may be accomplished via the calibration program in accordance with the requirements of Section XII of this QA plan. o Documentation, as applicable to the item, was received and is acceptable			
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	QP-04.1, Rev. 2, Para. 6.11.2	Verify that the requester performs any testing needed to ensure that the item conforms with manufacturer's published specifications. Verify that the requester uses one of the following forms to document receiving inspection and acceptance: o a MAT-14 Receiving Report o a Delivery Sheet o a YMP Receiving Inspection Report Verify that the requester signs or initials and dates the MAT-14 Receiving Report or completes, signs, and dates one of the other forms and places the original in the group Resident File with the other documents on that procurement.			
8-1	NNWSI/88-9, Rev. 3, Sect. 8, Part A, Paras. 1.1.1, & 1.1.2 AP-6.2Q AP-6.3Q AP-6.4Q AP-6.6Q TWS-QAS-QP-08.1, Rev. 1 Paras. 6.1, 6.2.1	Procedures shall be developed and implemented to assure that sample collection methods, techniques, and related equipment produce the intended sample. Storage methodology shall be developed and implemented to assure that the samples are maintained in predetermined physical conditions commensurate with their intended purpose. Samples intended for long term storage shall receive appropriate treatment to assure that they do not degrade during storage. Verify detailed Technical Procedures have been prepared and approved to meet the technical objectives and interface controls of referenced AP-X.XQs and of related study plans. NOTE: QP-08.1 does not define "long term storage" required by NNWSI/88-9, Sect. VIII, Part B, Para. 1.1.2.			

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8-2	NNWSI/88-9, Rev. 3, Sect. 8, Part B, Paras. 1.0 & 1.1 AP-6.3Q TWS-QAS-QP-08.1, Rev. 1	Physical identification shall be used to the maximum extent possible. Where physical identification cannot be placed on the sample, appropriate alternative identification methods shall be described and used. Samples shall be identified by placing the identification on the sample, on their (sic) container or on records traceable thereto. Verify LANL investigators identify field samples using bar code labels provided by the Sample Management Facility (SMF) and submit a copy of the sample collection report form (identified in AP-6.3 Q) within 30 days of collection. NOTE: QP-08.1 requires LANL investigators to be trained and certified to AP-6.3Q before being allowed to collect field samples. NOTE: See LANL procedure TWS-EES-DP-114, Rev. 1 for collection and identification of rock varnish samples (WBS 1.2.3.2.5).			

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8-3	NNWSI/88-9, Rev. 3, Sect. VIII, Part B, Para. 1.1.5	Measures shall be taken to maintain sample identification while in storage. These measures shall be consistent with the planned duration and conditions of storage and shall describe actions to taken where samples may have a maximum life expectancy while in storage.			
	TWS-QAS-QP-08.1, Rev. 1, Para. 6.3	Verify LANL samples are stored under physical conditions which protect against loss of identification, loss of traceability, and damage or deterioration of the samples. NOTE: QP-08.1 does not describe measures for physical security of the samples such as locked containers and access to authorized personnel only, or measures for physical segregation of like samples.			
12-1	NNWSI/88-8, Rev. 3 Sect. V, Para. 1.0	Activities affecting quality shall be prescribed by and performed in accordance with documented instructions, procedures, or drawings, of a type appropriate to the circumstances			
	TWS-QAS-QP-12.1, Rev. 4 Para. 4.7, 6.3	Verify the technical procedures for calibration of M&TE identify measurement equipment and standards to be used; required parameter, range, and accuracy; and acceptable tolerance of each characteristic being measured. NOTE: QP-12.1 does not identify specific calibration requirements to be included in the technical procedures. NOTE: Review identification and control of analytical standards used to check or adjust laboratory equipment to assure original certification and traceability is not compromised.			

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12-2	NNWSI/88-8, Rev. 3 Sect. XII, Para. 2.2	The method and interval of calibration for each item shall be defined, based on the type of equipment, stability characteristics, required accuracy, precision, intended use, degree of useage, and other conditions that affect measurement control.			
	TWS-QAS-QP-12.1, Rev. 4 Para. 6.2	Verify PIs have specified the calibration interval for calibrated equipment on the M&TE Calibration Record. NOTE: QP-12.1, Para. 5.3 and 6.5 provide for QAS notification to responsible QALs of equipment due calibration within the next month.			

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12-3	NNWSI/88-8, Rev. 3 Sect. XII, Para. 2.2	Measuring and test equipment shall be calibrated against certified equipment having known valid relationships to the National Bureau of Standards (now NIST) or other nationally recognized standards.... Calibrating standards shall have equal or greater accuracy than equipment being calibrated.			
	TWS-QAS-QP-12.1, Rev. 4 Para. 4.6, 6.3	Verify the calibration standards identified on the M&TE Calibration Records are traceable to NIST with known levels of accuracy and that the standards have a greater accuracy than the equipment being calibrated or the PI has documented the basis for use of an equal accuracy standards. NOTE: QP-12-1 allows use of lower accuracy calibration standards if justified by the PI. NOTE: MIL-STD-45662A requires justification for accuracy ratio less than 4:1. NOTE: See YMPO Surveillance Report YMP-SR-90-018, SDR 490 and 491, and Observations YMP-SR-018-01 through -09.			

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12-4	NNWSI/88-8, Rev. 3 Sect. XII, Para. 1.1	Measures shall be established to ensure that tools, gages, instruments, and other measuring and test equipment used in activities that affect quality are properly controlled, calibrated, and adjusted at specified periods to maintain accuracy within required limits.			
	TWS-QAS-QP-12.1, Rev. 4	Verify M&TE Calibration Records or Calibration Certificates documenting completed M&TE calibration include: o Equipment description and unique indentification number. o Equipment location o Calibration interval o Capacity (range) and required accuracy (tolerance). o Calibration standard used including specific identification o Calibration procedure used, including revision o Range of instrument calibration o Accuracy before and after calibration o Calibration date o New calibration due date o Signature, location, phone of person performing calibration NOTE: See related Q 12-1, 12-2, 12-3			

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		NOTE: QP-12.1 also provides for a master inventory list of M&TE to be maintained by QAS. See Surveillance Observation YMP-SR-90-018-04.			

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12-5	NNWSI/88-8, Rev. 3 Sect. XII, Para. 2.3	Measuring and test equipment must be labeled, tagged, or otherwise documented in a fashion which indicates the due date of the next calibration and to provide traceabliity to calibration data.			
	TWS-QAS-QP-12.1, Rev. 4 Para. 6.4	Verify controlled M&TE is labeled or tagged to indicate calibration status.			

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12-6	NNWSI/88-8, Rev. 3 Sect. XII, Para. 2.3	If measuring and test equipment is found to be out of calibration, an evaluation shall be made and documented of the validity of previous results obtained and the acceptability of items previously inspected, tested or data gathered since the last calibration. Devices that are out of calibration shall be tagged or segregated and shall not be used until they have been recalibrated.			
	TWS-QAS-QP-12.1, Rev. 4 Para. 4.6, 6.3	Verify out of calibration interval M&TE is tagged "DO NOT USED FOR YMP" and that out of tolerance M&TE is evaluated for impact to data obtained with the equipment since the last valid calibration. NOTE: QP-12.1 only requires a deficiency report to be prepard if data has been obtained using the equipment.			
13-1	NNWSI/88-9, Rev. 3, Sec. 13, Para. 1.0	Measures shall be established to control the packaging, handling, storage, shipping, cleaning, and preservation of material and equipment to prevent damage, loss, or deterioration. Handling storage, and shipping of items shall be conducted in accordance with established work and inspection instructions, drawings, specifications, shipment instructions, or other pertinent documents or procedures specified for use in conducting the activity. 1. Verify that there is a procedure in place to deal with handling, shippings, and storage requirements for material and equipment. 2. Verify that handling, storage, and shipping of items is conducted in accordance with procedures, instructions or other pertinent documents required to conduct the activity.			

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13-2	NNWSI/88-9, Rev. 3, Sect. 13, Paras. 1.1 and 1.2 LANL YMP QAPP, Rev. 4.4, Paras. 13.2 and 13.3	When required for particular items, special equipment (e.g., containers, shock absorbers, and accelerometers) and special protective environments (e.g., an inert gas atmosphere, specific moisture content levels, and temperature levels) shall be specified and provided, and their existence shall be verified. When they are required for critical, sensitive, perishable, or exceptionally expensive articles, specific procedures for handling, storage, packaging, shipping, and preservation shall be used.			
	TWS-QAS-QP-13.1, Rev. 2, Para. 6.1	1. Verify that M&TE is handled per manufacturer's recommendations or following a specific procedure if the PI so directs. Any special requirements are documented by the PI or experimenter in the laboratory notebook, in a DP or in a memo to the group Resident File. 2. Verify the equipment used in research and development activities is identified and any special handling storage or shipping procedures are noted by the experimenter following the procedures described in QP-03.5. 3. Verify that requirement used in DP is specified in the particular DP and any special handling, storage or shipping practices are also documented in the DPs.			

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13-3	NNWSI/88-9, Rev. 3, Para. 1.3 LANL YMP QAPP Rev. 4.4, Sect. 13, Paras. 13.4 and 13.5 TWS-QAS-QP-13.1, Rev. 2, Paras. 6.2 and 6.3	Special handling tools and equipment shall be utilized and controlled as necessary to ensure safe and adequate handling. Special handling tools and equipment shall be inspected and tested in accordance with procedures and at specified time intervals to verify that the tools and equipment are maintained adequately. 1. Verify that the PI hand carry the instrument or have it packed and shipped to a service organization for calibration. If handling and shipping are required, verify that the PI makes the necessary arrangements to prevent damage or loss in transit. 2. Verify that the PI explains to the users the special handling, storage or shipping requirements of equipment or items.			

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13.4	NNWSI/88-9, Rev. 4, Para. 1.5 LANL YMP QAPP, Rev. 4.4, Sect. 13, Para. 13.6 TWS-QAS-QP-13.1, Rev. 2, Para. 6.3	Instructions for marking and labeling for packaging, shipment, handling, and storage of items shall be established as necessary to adequately identify, maintain, and preserve the item, including indication of the presence of special environments or the need for special controls. 1. Verify that marking and labeling instructions for packaging, shipment, handling and storage of items are specified in LANL DPs or in memos to the group Resident File prepared by the PI and containing specific instructions to adequately identify, maintain, and preserve the item. 2. Verify that marking requirements for special environments or special controls are specified in LANL DPs or memos containing specific instructions.			
15-1	NNWSI 88-9, Rev. 3, Sect. 15, Para. 1.0	Measures shall be established to control items that do not conform to requirements, to prevent their inadvertent installation or use. These measures shall include documented procedures for identification, documentation, evaluation, segregation (when practical), disposition, and notification to affected organizations. 1. Verify that documented procedures prescribe measures to control nonconforming items. 2. Verify that nonconformance control measures are implemented in accordance with procedures.			

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15-2	NNWSI QAP-88-9, Rev. 3, Sect. 15, Para. 1.1.1	Identification of nonconforming items shall be made by marking, tagging, or other methods that shall not adversely affect the end use of the item. The identification shall be legible, easily recognizable, and shall contain the nonconfomance report number: The nonconformance report number shall be a sequential number preceded by an organizational acronym (e.g., LLNL-1, USGS-6, etc.). If tags are used, they shall be securely attached to avoid loss during handling.			
	TWS-QAS-QP-15.2, Rev. 0 Para.6.2.1 & 6.4.1.3	Identify the following: 1. Nonconforming items are identified in accordance with above requirements.			

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15-3	NNWSI 88-9, Rev. 3, Sect. 15, Para. 1.2.1	Each NNWSI Project participant shall maintain a nonconformance control log to track nonconforming items. This log shall contain the following information: o The nonconformance report number. o A brief description of the nonconforming condition. o Identification of the person or organization responsible for determining and carrying out the nonconformance disposition. o The status of each nonconformance report (open or closed).			
	TWS-QAS-QP-15.2, Rev. 0 Paras. 5.2, 5.2.1, 6.2.1 and Attachment 2	1. Verify that NCR log is controlled by the QAPL and contains the above information.			

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15-4	NNWSI 88-9, Rev. 3, Sec. 15, Para. 1.3.1 and 1.3.2	When practical, nonconforming items shall be segregated by placing them in a clearly identified and designated hold area until they are dispositioned properly. When segregation is impractical or impossible because of physical conditions, such as size, weight, or access limitations other precautions shall be employed to preclude inadvertent use of a nonconforming item.			
	TWS-QAS-QP-15.2, Rev. 0, Para. 6.4.1.4	1. Verify that the nonconforming items are segregated and identified when practical.			

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15-5	NNWSI QAP-88-9, Rev. 3, Sect. 15, Para. 1.4.1	Nonconforming characteristics shall be reviewed and recommended dispositions of nonconforming items shall be proposed and approved in accordance with documented procedures. Further processing, delivery, installation, or use of a nonconforming item shall be controlled pending an evaluation and an approved disposition by authorized personnel. Distribution of nonconformance documentation shall be to all affected organizations.			
	TWS-QAS-QP-15.2, Rev. 0, Paras. 6.4.1 thru 6.5.2	Verify that the process of dispositioning NCRs is per the procedure requirements.			

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15-6	NNWSI QAP-88-9, Rev. 3, Sect. 15, Para. 1.4.6	The action taken to correct the nonconforming item shall be verified and documented. Repaired or reworked items shall be reexamined in accordance with applicable procedures and with the original acceptance criteria, unless the nonconforming item disposition has established aternate acceptance criteria.			
	TWS-QAS-QP-15.2, Rev. 0, Paras. 6.7.3, 6.7.4 and 6.7.5	1. Verify that the YMP Supervisor notifies the QAPL in writing when corrective actions are complete. 2. Verify that the QAPL verifies that disposition has been accomplished within 30 calendar days of the YMP Supervisor's notification letter or memrandum. 3. Verify that a revised NCR is issued when a different method than the proposed disposition was used.			

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15-7	NNWSI QAP-88-9, Rev. 3, Sect. XV, Para. 3.0	Nonconformance reports shall be periodically analyzed by the QAS organization to show quality trends and to help identify root causes of nonconformances. Results shall be reported to upper management for review and assessment. 1. Verify that a trend analysis program is in place.			

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15-8	NNWSI QAP-88-9, Rev.3 Sect. XV, Para. 1.4.5	In those cases where the responsible organization proposes a disposition of "repair", WMPO shall approve the proposed disposition prior to implementation. In the case of a proposed disposition of "use-as-is", the NCR shall be forwarded to WMPO for approval after all actions necessary to support technical justification of the disposition have been completed. The appropriate WMPO Branch Chief and the WMPO PQM shall approve NCR dispositions involving "repair" or "use-as-is" determination and conditional release recommendations. 1. Verify that documented procedures describe the forwarding of NCRs with proposed dispositions of "repair" or "use-as-is" to the Project Office for approval.			

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15-9	NNWSI QAP-88-9, Rev. 3, Sect. XV, Para. 4.0	Copies of nonconformance reports for items shall be sent to the WMPO PQM and the SAIC/T&MSS Project QA Department (QA Engineering Division Manager) by the originating organization upon issuance and upon closure. The original nonconformance reports shall be sent to the WMPO for approval as required by Para. 1.4.5 of this section. 1. Verify that copies of deficiency documents for items are transmitted to the Project Office QA upon issue and closure.			
16-1	NNWSI/88-9, Rev. 3, Sec. XVI, Para. 1.0 LANL YMP QAPP, Rev. 4.4 Para. 16.1	The Corrective Action System shall ensure that conditions adverse or potentially adverse to quality are identified promptly and corrected as soon as practical. Verify that LANL has established a corrective action system which ensures that repetitive nonconformances and/or conditions adverse to quality, including supplier nonconforming activities and services, are identified promptly, documented on corrective action reports, and corrected as soon as practical.			

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16-2	NNWSI/88-9, Rev. 3, Sec. XVI, Para. 1.1	For significant conditions adverse to quality, the identification, cause, and corrective action taken to prevent recurrence shall be documented and reported to immediate management and upper levels of management for review and assessment.			
	LANL YMP QAPP Rev. 4.4, Sec. 16 Para. 16.2	Verify that upon discovering or receiving notification that a significant condition adverse to quality exists, LANL ensures that: a. immediate action has been taken to remedy the specific condition(s); b. any root cause has been determined; c. controls are reviewed, implemented, monitored, and revised, if necessary; and d. affected managers at all levels are notified of the adverse condition(s) and of additional training, if necessary, to improve conditions or to avoid similar occurences.			
	TWS-QAS-QP-15.2, Rev. 0	Verify that significant conditions adverse to quality are documented and reported to immediate management and upper levels of management for review and assessment.			

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16-3	NNWSI/88-9, Rev. 3, Sect. XVI, Para. 1.2 LANL YMP QAPP, Rev. 4.4, Sect. XVI, Para. 16.3	The QA organizations shall document concurrence of the adequacy of proposed corrective actions to assure that QA requirements will be satisfied. Follow-up action shall be taken by the QA organization to verify proper implementation of this corrective action and to close out the corrective action. The organization responsible for implementing the corrective action shall assure that the corrective action is completed in a timely manner. Failure to properly complete corrective action steps in in a timely manner may result in a stop work order.			
	TWS-QAS-QP-15.0, Rev. 0	Verify that the QAPL:			
	Para. 6.5.2	a. Approves the proposed disposition within 15 calendar days of the date the YMP Supervisor's signature on the proposed disposition.			
	Para. 6.7.4.2	b. Verifies that the deficiency was corrected adequately, met the completion date, and met the quality requirements.			
	Para. 6.7.4.3	c. Documents the method of verification.			
	Para. 6.8.1.4	d. Prepares a records package that includes the DR, its attachments, and related correspondence and forwards copies to the originator, the YMP Supervisor of the responsible organization, the QAPL Resident File and to the RPC.			

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16-4	NNWSI/88-9, Rev. 3 Sect. XVI, Para. 1.1	Corrective action reports shall be periodically analyzed by the QA organization to show quality trends and the results reported to upper management for review and assessment.			
	LANL YMP QAPP, Rev. 4.4, Para. 16.4	Verify that the QA organization periodically analyzes corrective action reports to establish quality trends. The results are reported to the TPO and QAPL for review and assessment. Copies of corrective action reports are to be sent to the PQM by the QAPL upon issue and closure.			
17-1	NNWSI/88-9, Rev. 3, Sec. XVII, Para. 1.2.2 AP-1.7Q, Rev. 2, Sec. 5.1.2, 5.1.4	Sufficient records shall be specified, prepared and maintained to furnish documented evidence of activities that affect quality.			
	QP-17.3, Rev. 0, Sec. 6.3, 6.4, and 6.5	Verify the existence, maintenance and use of the list of records and record packages that identified QA records; and the list of types of QA records and QA record packages. Do the lists include at least the following? o Operating Logs o Results of Reviews o Inspections o Tests o Monitoring of Work Performance o Audits o Material Analyses o Qualifications of personnel o Procedures			

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17-2	NNWSI/88-9, Rev. 3, Sec. XVII, Paras. 1.2.3 and 6.0	Requirements and responsibilities for record transmittal, distribution, retention, maintenance, and disposition of QA records shall be established and documented.			
	AP-1.7Q, Rev. 2, General	Records shall be controlled from the time they are complete until the time they are stored in a permanent storage facility.			
	LANL YMPO QAPP, Rev. 4.4, Sec. 17.2	Responsibilities and methods for record transmittal, distribution, retention, maintenance, retrievability, and status of QA records shall be specified in the QPs.			
	QP-17.3, Rev. 0, Sec. 6.3, 6.4, and 6.5, Exhibit 3	Verify the existence and effectiveness of controls on individual records and record packages from generation to disposition. Compare a sample record package with the Table of Contents of the Exhibit 3 document for the package.			

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17-3	NNWSI/88-9, Rev. 3, Sec. XVII, Para. 1.2.3 and 6.0	Requirements and responsibilities for record transmittal, distribution, retention, maintenance, and disposition of QA records shall be established and documented.			
	AP-1.7Q, Rev. 2, Sec. 3.13, 5.5.1.8, 5.5.3, 5.5.5, and 5.7.2	Records shall be controlled from the time they are complete until the time they are stored in a permanent storage facility.			
	LANL YMPO QAPP, Rev. 4.4, Sec. 17.2	Responsibilities and methods for record transmittal, distribution, retention, maintenance, retrievability, and status of QA records shall be specified in the QPs.			
	QP-17.3, Rev. 0, Sec. 6.1, 6.3.5, 6.4.5, 6.4.6, and 6.5.4	Verify the existence and effectiveness of controls on: a. Corrected Records b. Special Processed Records (Magnetic tapes, negatives, etc.) c. One of a Kind Records (Oversized maps, drawings, etc.) from Generation to Disposition			

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17-4	NNWSI/88-9, Rev. 3, Sec. XVII, Para. 1.3	The procedure that defines the implementation of the record system for each organization shall identify measures to be implemented for the preservation and safe-keeping of the records before storage and for the prevention of delays between record completion and storage at the Project Record Center.			
	AP-1.7Q, Rev. 2, Sec. 5.9.1 and 5.9.2.1				
	QP-17.3, Rev. 0, Sec. 6.2, 6.3, 6.4, and 6.5	Verify that records are protected from degradation until disposition after the RPC has inspected and accepted the corresponding microfilm.			

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17-5	NNWSI/88-9, Rev. 3, Sec. XVII, Para. 1.3	The procedure that defines implementation of the record system for each organization shall identify measures to be implemented for the preservation and safe-keeping of the records before storage and for the prevention of delays between record completion and storage at the Project Record Center.			
	AP-1.7Q, Rev. 2, Sec. 5.5.4.1 and 5.7.3				
	QP-17.3, Rev. 0, Sec. 6.3.4, 6.4.5, and 6.5.6	Verify that records flow without delays between the originator, the Resident File, and the CRF.			

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17-6	NNWSI/88-9, Rev. 3, Sec. XVII, Para. 2.1.1 AP-1.7Q, Rev. 2, Sec. 5.5.1.12, 5.5.4.1, 5.7.1, 5.7.2.4, Appendix A QP-17.3, Rev. 0, Para. 6.1, 6.3.2, 6.4.2, 6.5.2, and 6.5.7	Documents that are designated to become records shall be legible, identifiable, accurate, complete, reproducible, microfilmable, and appropriate to work accomplished. Verify that documents submitted by the Records Processing Center (RPC) to the Central Records Facility (CRF) had been reviewed and inspected and were considered legible, identifiable, accurate, complete, reproducible, microfilmable, and appropriate to work accomplished.			

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17-7	NNWSI/88-9, Rev. 3, Sec. XVII, Para. 2.1.1	Documents that are designated to become records shall be legible, identifiable, accurate, complete, reproducible, microfilmable, and appropriate to the work accomplished.			
	AP-1.7Q, Rev. 2, Sec. 5.5.1.12, 5.7.1, 5.7.2.4				
	QP-17.3, Rev. 0, Sec. 6.3.2, 6.4.4	Verify the methods and controls for assigning Best Available Copy status to a record for processing the BAC into the system.			

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17-8	NNWSI/88-9, Rev. 3, Sec. XVII, Para. 2.1.1 QP-17.3, Rev. 0, Sec. 6.3.2	Documents that are designated to become records shall be.....complete.....to work accomplished. Verify that the requirements of Section 6.3.2 are met by the originator. Is a checklist completed which indicates that all of the criteria were met?			

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17-9	NNWSI/88-9, Rev. 3, Sec. XVII, Para. 3.1 and 3.2	Documents shall be considered valid records only if stamped, initialed or signed and dated by authorized personnel or otherwise authenticated in accordance with approved procedures. These records may be originals or reproduced copies. Authentication may take form of a statement by the responsible individual or organization. Handwritten signatures are not required if the document is clearly identified as a statement by reporting individual or organization.			
	AP-1.7Q, Rev. 2, Sec. 5.1.3, 5.5.1.1, 5.5.7.4 and 5.7.1.8	Each organization shall maintain a list which contains the signature and initials of the personnel authorized to authenticate records.			
	QAP-17.3, Rev. 0, Sec. 6.3.3, 6.4.5, and 6.5.10	Verify that QA records and QA records packages were considered valid and authenticated by authorized personnel. Verify that a list of signatures and initials is maintained.			

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17-10	NNWSI/88-9, Rev. 3, Sec. XVII, Para. 4.1	Each organization that is responsible for the receipt of records shall designate a person or organization to be responsible for receiving the records and for organizing and implementing a system of receipt control. Each receipt control system shall be structured to permit a current and accurate assessment of the status of records during the receiving process.			
	AP-1.7Q, Rev. 2, Sec. 5.1.2, 5.1.4, 5.5.7.1, 5.5.4.1, 5.5.4.2, 5.7.1, 5.7.2, 5.7.3	Verify that the receipt control system used includes the following minimum requirements: 1. A method for designating the required records. 2. A method for identifying the records received. 3. Procedures for receipt and inspection of incoming records.			
	QP-17.3, Rev. 0, Sec. 6.3.4, 6.4.2, 6.4.4, 6.5	4. A method for submittal of completed records to the storage facility without unnecessary delay.			

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17-11	NNWSI/88-9, Rev. 3, Sec. XVII, Para. 4.1	Each organization that is responsible for the receipt of records shall designate a person or organization to be responsible for receiving the records and for organizing and implementing a system of receipt control. Each receipt control system shall be structures to permit a current and accurate assessment of the status of records during the receiving process.			
	AP-1.7Q, Rev. 2, Sec. 5.7.1, QP-17.3, Rev. 0, Sec. 6.5.2	Verify that the RPC inspection complies with requirements in AP-17.Q, Section 5.7.1.			

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17-12	NNWSI/88-9, Rev. 3, Sec. XVII, Para. 4.2	The individual or organization responsible for receiving records shall provide protection from damage, deterioration or loss during the time that the records are in their possession.			
	QP-17.3, Rev. 0, Sec. 6.2	Verify that required protection is provided (refer to item 17-18). Who plus how does one identify a list or damaged record, and who monitors the corrective action in order to meet the 90 days time limit.			

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17-13	NNWSI/88-9, Rev. 3, Sec. XVII, Para. 5.1, 5.2	Records or indexing systems or both shall provide sufficient information to permit identification between the record plus the items or activities to which it applies. Records shall be clearly identified by a unique number or other designation which is directly traceable to controlling programmatic information The records shall be indexed and the indexing system or systems shall include as a minimum the location of the record within the records system or systems.			
	QP-17.3, Rev. 0, Para. 6.0, 6.1, 6.3.2, 6.4.1, 6.4.2,	Verify that adequate records identification system is established and is being implemented.			

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17-14	NNWSI/88-9, Rev. 3, Sec. XVII, Para. 6.0	Temporary storage, preservation, safe keeping, and retrievability of completed records shall be in accordance with the requirements applicable to the permanent storage of records.			
	AP-1.7Q, Rev. 2, Sec. 5.13				
	QP-17.3, Rev.0, Sec. 6.0, 6.5.8	Verify that records are retrievable.			

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17-15	NNWSI/88-9, Rev. 3, Sec. XVII, Para. 6.2	Before the records are stored, a written storage procedure shall be prepared and responsibility assigned for enforcing the requirements of that procedure. As a minimum, this procedure shall include the following: o A description of the storage facility. o The filing system to be used. o The method for verifying that the records received are legible and are in agreement with the transmittal document. o The method of verifying that the records are those designated (see Paragraph 4.1 of this section). o The rules governing access to and control of the files. o the method for maintaining control of and accountability for records removed from the storage fac o A method for filing supplemental information.			
	AP-1.7Q, Rev. 2, General				
	QP-17.3, Rev. 0, Sec. 6.2, 6.4.1, 6.4.4, 6.5.2, 6.5.11	Verify that these characteristics are addressed in the storing of records at the Resident File, the RPC, and CRM-			

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17-16	NNWSI/88-9, Rev. 3, Sec. XVII, Para. 7.0	Records shall be stored in a manner approved by the organization or organizations responsible for storage. In order to preclude deterioration of the records, the following requirements shall apply:			
	AP-1.7Q, Rev. 2, Sec. 5.9.1 and 5.9.2.1	o Provisions shall be made in the storage arrangement to prevent damage from moisture, temperature, and press			
		o Records shall be firmly attached in binders or placed in folders or envelopes for storage in steel file cabinets or on shelving in containers.			
		o Provisions shall be made for special processed records(e.g., radiographs, photographs, negatives, microfilm,magnetic material, etc.) to prevent damage from excessive light, stacking, electromagnetic fields, temperature, and humidity.			
	QP-17.3, Rev. 0, Sec. 6.2, 6.4.1, and 6.3.4	Verify that the storage areas meet the minimum requirements that preclude record deterioration.			

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17-17	NNWSI/88-9, Rev. 3, Sec. XVII, Para. 8.1	Measures shall be established to preclude the entry of unauthorized personnel in the storage area. These measures shall guard against larceny and vandalism.			
	AP-1.7Q, Rev. 2, Sec. 5.10.1, 5.10.7				
	QP-17.3, Rev. 0, Sec. 6.4.1, 6.5.11	Verify the basis upon which persons are granted authorized access to the record storage areas. Are the requirements of AP-1.7Q, Paragraph 5.10.2 abided by?			

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17-18	NNWSI/88-9, Rev. 3, Sec. XVII, Para. 8.2	Measures shall be taken to provide for replacement, restoration, or substitution of lost or damaged records. Those measures shall be accomplished within 90 days following determination that either a record has been lost or a record has been damaged to a degree that it is no longer complete or legible.			
	AP-1.7Q, Rev. 2, Sec. 5.11				
	QP-17.3, Rev. 0, Sec. 6.2, 6.5.9	Verify that methods are established by which lost/damaged records are replaced, restored, or substituted within 90 days.			

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17-19	NNWSI/88-9, Rev. 3, Sec. XVII, Para. 9.0	Records may be corrected in accordance with written procedures that provide for appropriate review or approval by the originating organization. The correction shall include the date and the identification of the person authorized to issue correction and shall not obliterate the corrected data.			
	QP-17.3, Rev. 0, Sec. 6.1, 6.3.5	Verify that all corrections were made by the organization. Were corrections made in accordance with Sections 6.1 and 6.3.5?			

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17-20	NNWSI/88-9, Rev. 3, Sec. XVII, Paras. 10.1 and 10.2.3	Records shall be stored in facilities constructed and maintained in a manner that minimizes the risk of damage or destruction from natural disasters, such as winds, floods, or fires; environmental conditions such as high and low temperatures and humidity; and infestation of insects, mold, or rodents. If storage at dual facilities for each record is provided, then the facilities shall be at locations sufficiently remote from each other to eliminate the change of exposure to a simultaneous hazard.			
	AP-1.7Q, Rev. 2, Sec. 5.9.1.1				
	QP-17.3, Rev. 0, Sec. 6.2, 6.4.1, 6.4.5, 6.5.5	Verify that responsibilities and methods are established and implemented for dual storage of records once they are submitted to the Resident File until the corresponding microfilm is inspected and accepted by the RPC. Look for evidence of dual-filing by the CRF and RPC before microfilming is completed.			

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17-21	NNWSI/88-9, Rev. 3, Sec. XVII, Para. 11.2 QP-17.3, Rev. 0, Sec. 6.5.11	The list shall be maintained that designates those personnel who shall have access to the files. Verify that a list has been established and what method is uded to maintain it current.			

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17-22	NNWSI/88-9, Rev. 3, Sec. XVII, Sec. 12.2	The custodian shall inventory the submittals, acknowledge receipt, and process these records in accordance with this document on the procedures implementing this document.			
	QP-17.3, Rev. 0, Sec. 6.5.5	Who is the custodian for the Central Records Facility? Verify that an inventory of submittals is maintained current and review evidence of signed receipt acknowledging by CRF that records have been received from RPC.			
18-1	QAP/88-9, Rev. 3, Sect. XVIII, Paras. 1.1.2 and 1.2	Each Participating Organization shall conduct internal (covering their entire QAPP, on an annual basis) and external (direct subcontractor) audits of activities under its direct control. These audits will be scheduled, planned, conducted, and reported as described in their respective QAPPs. External and internal audit schedules, dates, and changes thereto, shall be sent to the SAIC/T&MSS Project QA Department (QA Verification Division Manager). Audit schedules shall identify the date of the audit, the activities to be audited, and the requirements to which the activities are to be audited. Audits shall be scheduled at a frequency commensurate with the status and importance of the activity and shall be initiated early enough to assure effective QA. Each NNWSI Project Participant shall perform or arrange for annual evaluations of suppliers. This evaluation shall be documented.			
	TWS-QAS-QP-18.1, Rev. 2, Para. 6.1	1. Verify that applicable sections of the QAPP have been audited annually. 2. Verify that audit schedules have been developed, revised as required and copies of them have been sent to the YMPO.			

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		3. Verify that annual evaluations of suppliers have been made and documented.			
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18-2	QAP/88-9, Rev. 3, Sect. XVIII, Para. 1.3.1	The auditing organization shall develop and document an audit plan for each audit. This plan shall identify the audit scope, requirements, audit personnel, activities to be audited, organizations to be notified, applicable documents, schedule, and written procedures or checklists.			
	TWS-QAS-QP-18.1, Rev. 2, Paras. 6.3 and 6.3.6	1. Verify that audit plan(s) developed contain the above requirements plus procedure requirements.			

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18-3	QAP/88-9, Rev. 3, Sect. XVIII, Para. 1.4	Audits shall be performed in accordance with written procedures using checklists as early in the life of the activity as practical and shall be continued at intervals consistent with the schedule for accomplishing the activity. Elements that have been selected for audit shall be evaluated against specified requirements including a review of corrective actions taken on deficiencies in the area being audited that were identified during previous audits. Objective evidence shall be examined to the depth necessary to determine if these elements are adequate for effective control and to determine whether or not they are being implemented effectively.			
	TWS-QAS-QP-18.1, Rev. 1, Paras. 6.3.3.2 and 6.5.2	1. Verify the use of checklists during audits performed and type of documented evidence reviewed. 2. Verify evaluation of corrective actions of deficiencies identified during previous audits.			

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18-4	QAPP/88-9, Rev. 3, Sect. XVIII, Para. 1.5	The audit report shall be signed by the audit team leader and should be issued within 30 calendar days. This report shall include the following information, as appropriate: o Description of the audit scope. o Identification of the auditors. o Identification of persons contacted during audit activities. o Summary of audit results, including a statement of the effectiveness of the QA program elements that were audited. o Description of each reported adverse audit finding in sufficient detail to enable corrective action to be taken by the audited organization.			
	TWS-QAS-QP-18.1, Rev. 2, Paras 6.6.7 and 6.6.8.2	1. Verify that audit report is issued within time limits, contained in above requirements. 2. Verify copies of audit report have been sent to the TPO and Records Processing Center (RPC).			

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18-5	QAP/88-9, Rev. 3, Sec. XVIII, Para. 1.6	Management of the audited organization or activity shall investigate adverse audit findings; determine root cause; schedule corrective action, including measures to prevent recurrence; and, within thirty calendar days of receipt of the audit report, notify the appropriate organizations in writing of action taken or planned. The adequacy of audit responses shall be evaluated by or for the auditing organization.			
	TWS-QAS-QP-15.2, Rev. 0, Paras. 6.4 and 6.5.2	1. Verify that audit responses to adverse audit findings are sent back to QA within time limits. 2. Verify that those responses address the above requirements. 3. Verify that copies of the accepted responses are sent to the TPO and the RPC.			

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18-6	QAP/88-9, Rev. 3, Sect. XVIII, Paras. 1.7 & 1.0	Follow-up action shall be taken to determine whether or not corrective action has been accomplished as scheduled and shall be verified by the auditing organization. An analysis of audit results shall be performed by the QA organization to identify quality trends. The results of the analysis shall be reported to responsible management for review, assessment, and appropriate action.			
	TWS-QAS-QP-15.2, Rev. 0, Paras. 6.7 through 6.8	1. Verify that the auditing organization performs follow-up of audit finding(s). 2. Verify that the implementation of corrective action for potential quality problems (observations) is checked. 3. Verify that trend analysis of audit results are performed by QA and reported to appropriate management.			

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18-7	QAP/88-9, Rev. 3, Sect. XVIII, Para. 1.8.1 and 1.8.2	As a minimum, audit records shall include the following: o Identification of the organization(s), activities, or items audited and the individual(s) contacted during the audit(s). o Description of any deficiencies, nonconformances, and potential quality problems identified. o Audit plans, audit reports, written replies, and the record of completion of corrective action, and close-out of the audit. Records of personnel qualifications for Auditors and Lead Auditors performing audits shall be established and maintained by the employer. Records for each Lead Auditor shall be maintained and updated annually.			
	TWS-QAS-QP-18.1, Rev. 2, Paras. 6.6.4.2 and 7.0	1. Verify that audit records are maintained.			
	TWS-QAS-QP-18.3 Rev. 1, Paras. 6.5 and 7.0	2. Verify that Auditors and Lead Auditors records are maintained and updated annually.			

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18-8	QAP/88-9, Rev. 3, Section XVIII, Paras. 2.0 and 2.1	The NNWSI Project audit program shall be supplemented by independent surveillance activities. The purpose of a surveillance is to monitor or observe items or activities to verify conformance to specified requirements. These surveillances shall be conducted by LANL and shall be either scheduled or implemented on a random basis. Surveillances are to be performed to written checklists or surveillance plans whenever practical. The documentation shall identify characteristics, methods and acceptance criteria shall provide for recording objective evidence of results, and accuracy of the equipment necessary to perform surveillance.			
	TWS-QAS-QP-18.2, Rev. 1, Paras. 6.1 through 6.3	1. Verify surveillances are scheduled. 2. Verify the use of checklists plus recording objective evidence on them. 3. Verify that accuracy of the equipment used during the surveillance is recorded.			

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18-10	QAP/88-9, Rev. 3 Sect. XVIII, Para. 2.2	Surveillance personnel shall not report directly to the immediate supervisors who are responsible for the work being surveilled.			
	TWS-QAS-QP-18.2, Rev. 1, Para. 6.2.2.1	Verify the independence of personnel performing surveillance.			

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18-9	QAP/88-9, Rev. 3, Sect. XVIII, Paras. 2.0 and 2.3	All deficiencies, nonconformances, and potential quality problems identified during surveillances are to be documented and monitored until verification of effective corrective action is made. As a minimum, surveillance records shall identify the following: o Item or activity. o Date of surveillance. o Name of individual performing the surveillance. o Identification of the organization(s), activities, or items surveilled, including the name or names of personnel contacted. o Description of any deficiencies, nonconformances, and potential quality problems identified during the surveillance. Nonconformances shall be handled in accordance with the requirements of Sect. XV or XVI, as applicable. o Surveillance criteria. o Equipment used during the surveillance. o Results. o Acceptance statement.			

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18-9 (cont.)					
	TWS-QAS-QP-18.2, Rev. 0 Paras. 6.7 and 6.8	1. Verify that discrepant items are monitored until corrective action is made.			
	TWS-QAS-QP-18.2, Rev. 0 Paras. 6.4.4.2	2. Verify that surveillance records do contain the above requirements.			

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18-11	QAP/88-9, Rev. 3, App. F, Para. 1.2.2	Prospective Lead Auditors shall have training to the extent necessary to ensure their competence in auditing skills. Training in the following areas shall be given based upon management evaluation of the particular needs of each prospective Lead Auditor: o Knowledge and understanding of this document, 10 CFR Part 60, and other nuclear and/or DOE related codes, standards, regulations, and regulatory guides, as applicable to the NNWSI Project. o General structure of Quality Assurances programs and applicable elements as defined in this document. o Auditing techniques of examining, questioning, evaluating, and reporting; methods of identifying and following up on corrective action items; and closing out audit findings. o Audit planning in the functions related to quality for the following activities; site characterization (scientific investigations), design, purchasing, fabrication, handling, shipping, storage, cleaning, erection, installation, inspection, testing, statistics, nondestructive examination, maintenance, repair, operation, modification of nuclear facilities or associated components, and safety aspects of the nuclear facility. o On-the-job training to include applicable elements of the audit program.			
	TWS-QAS-QP-18.3, Rev. 1, Para. 6.1.3	1. Verify training in accordance with above requirements is performed and documented.			

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18-12	QAP/88-9, Rev. 3, App. F, Paras. 1.2.3, 1.2.4 and 1.4.2	The prospective Lead Auditor shall have participated in a minimum of five Quality Assurance audits within a period of time not to exceed three years prior to the date of qualification. One of the audits shall be a nuclear Quality Assurance audit that shall be made within the year prior to qualification. The prospective Lead Auditor shall pass an examination that shall evaluate his comprehension of and ability to apply the body of knowledge identified in Item 18-11. The test may be oral, written, practical, or any combination of the the three types. If any portion of the examination is oral, written documentation of the oral examination questions/ content shall be maintained. Copies of the objective evidence regarding the type or types and content of the examination or examinations shall be retained by the employer.			
	TWS-QAS-QP-18.3, Rev. 1, Paras. 6.2 and 6.3.3	1. Verify that LA are qualified based on amount of audits as described above. 2. Verify that LA have been evaluated through an examination. 3. Verify that documented evidence of such examination is available.			

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18-13	QAP/88-9, Rev. 3, App. F, Paras. 1.3.1 and 1.5	Lead Auditors shall maintain their proficiency through regular and active participation in the audit process; review and study of codes, standards, procedures, instructions, and other documents related to quality assurance program and program auditing; and participation in training programs. Based on annual assessment, management may extend the qualification, require retraining, or require requalification. These evaluations shall be documented. Each Lead Auditor shall be certified by his employer as being qualified to lead audits. As a minimum, this certification shall document the following: o Employer's name. o Lead Auditor's name. o Date of certification or recertification. o Basis of qualification (i.e., education, experience, communication skills, training, examination, etc.). o Signature of employer's designated representative who is responsible for such certification.			
	TWS-QAS-QP-18.3, Rev. 1, Paras. 6.5 and 7.2	1. Verify that LA maintain their proficiency as described above. 2. Verify LA certification(s).			

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	(Marty Mitchell) Criteria 8 & 12				
	Technical General				
T-1		What equipment is being used in this activity?			
T-2		What procedures control the calibration of these items?			
				(9) Auditor Signature	(10) Date

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T-3		Where are the calibration records?			
T-4		Verify that the calibration information required by the procedure is recorded in the experimental or other records.			

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T-5		Is all equipment for measuring and test calibrated?			
T-6		How is this calibration traceable to the experimental data?			

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T-7		What is done when a recalibration is not within calibration limits?			
T-8		What assurances are there that all data from the period in question has been identified?			

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T-9		Why and how were the parameters to be calibrated on each unit determined?			
T-10		How (what form) is data reported?			

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T-11		What units are associated with the data?			
T-12		What parameters/variables are involved in data reduction?			

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T-13		What calculations are used in data reductions?			
T-14		How are samples and standards identified?			

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T-15		What information associated with the samples accompanies the data?			
T-16		What is done to assure that samples are not mixed up during analysis?			
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T-17		What control are in place to assure that identity is not lost when a sample is cut or split?			
	WBS 1.2.3.2.1.1.1				
T-18		Of the equipment used by this technical area, which units are in the control of the group and which are operated by others?			
				(9) Auditor Signature	(10) Date

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T-19		What other project groups use these instruments?			
T-20		Which units are operator calibrated?			

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(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-21		For what types of analysis is the SEM used?			
T-22		What parameters are calibrated on the SEM?			

(9) Auditor Signature (10) Date.

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(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-23		Why? (reference question T-22)			
T-24		For what types of analysis is the XRD used? Compound identification, Lattice parameter, etc.			
				(9) Auditor Signature	(10) Date

YMPO AUDIT CHECKLIST NO. 90-01-02

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(1) Organization Los Alamos National Laboratory (2) Page 13 of 24

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-25		What parameters are calibrated on the XRD?			
T-26		Why? (reference question T-25)			

(9) Auditor Signature (10) Date

YMPO AUDIT CHECKLIST NO. 90-01-02

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(1) Organization Los Alamos National Laboratory (2) Page 14 of 24

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-27		For what types of analysis is the XRF used? What types of samples? What types of standards are used?			
T-28		How are standards identified and maintained?			

(9) Auditor Signature (10) Date

YMPO AUDIT CHECKLIST NO. 90-01-02

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(1) Organization Los Alamos National Laboratory (2) Page 15 of 24

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-29		What type of computer control is used for instrument control?			
T-30		What type of computer data reduction is used?			

(9) Auditor Signature (10) Date

YMPO AUDIT CHECKLIST NO. 90-01-02

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(1) Organization Los Alamos National Laboratory

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-31		How are matrix effects dealt with?			
	WBS 1.2.3.2.5				
T-32		For what types of analysis is the SEM or microprobe used in the rock varnish activity?			
				(9) Auditor Signature	(10) Date

YMPO AUDIT CHECKLIST NO. 90-01-02

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(1) Organization Los Alamos National Laboratory (2) Page 17 of 24

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-33		What are the variables in the instruments operating parameters?			
T-34		Why are these conditions chosen?			

(9) Auditor Signature (10) Date

YMPO AUDIT CHECKLIST NO. 90-01-02

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(1) Organization Los Alamos National Laboratory (2) Page 18 of 24

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-35		What computer programs are used for instrument control and data reduction?			
T-36		How are sample geometry and matrix effects dealt with?			

(9) Auditor Signature (10) Date

YMPO AUDIT CHECKLIST NO. 90-01-02

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(1) Organization Los Alamos National Laboratory (2) Page 19 of 24

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-37		What are the varnish thicknesses and structure?			
T-38		How does this effect operating parameters and data analysis? Is chemical migration a problem?			

(9) Auditor Signature (10) Date

YMPO AUDIT CHECKLIST NO. 90-01-02

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(1) Organization Los Alamos National Laboratory

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-39		What is done in the ESR analysis?			
T-40		What is the sample holder configuration?			

(9) Auditor Signature (10) Date

YMPO AUDIT CHECKLIST NO. 90-01-02

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(1) Organization Los Alamos National Laboratory (2) Page 21 of 24

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
	WBS 1.2.3.4.1.3				
T-41		For what types of samples is the Laser Raman unit used?			
T-42		What are the data needs for accuracy and precision?			
				(9) Auditor Signature	(10) Date

YMPO AUDIT CHECKLIST NO. 90-01-02

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(1) Organization Los Alamos National Laboratory (2) Page 22 of 24

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-43		What are the instrumental variable associated with laser power?			
T-44		What is the size of the analytical area sampled?			

(9) Auditor Signature (10) Date

YMPO AUDIT CHECKLIST NO. 90-01-02

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(1) Organization Los Alamos National Laboratory (2) Page 23 of 24

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-45		How is data stored and reduced?			
T-46		How are the samples controlled in the laboratory?			

(9) Auditor Signature (10) Date

YMPO AUDIT CHECKLIST NO. 90-01-02

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(1) Organization Los Alamos National Laboratory

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-47		What calibrations are planned for the PAS?			

(9) Auditor Signature

(10) Date

YMPO AUDIT CHECKLIST NO. 90-1-03

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(1) Organization Los Alamos National Laboratory (2) Page 1 of 14

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
	(Marty Mitchell) Technical General	I. The following are generic question concerning qualifications and training of technical staff.			
T-1		What are the duties of the individuals interviewed?			
T-2		What procedures govern the experiments?			

(9) Auditor Signature (10) Date

YMPO AUDIT CHECKLIST NO. 90-1-03

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(1) Organization Los Alamos National Laboratory (2) Page 2 of 14

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-3		What procedures are used by each individual interviewed?			
T-4		Is the person knowledgeable of the activities in the procedure investigated?			

(9) Auditor Signature (10) Date

YMPO AUDIT CHECKLIST NO. 90-1-03

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(1) Organization Los Alamos National Laboratory (2) Page 3 of 14

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
		o What are the methods used?			
		o What is the sequence of events described			

(9) Auditor Signature (10) Date

YMPO AUDIT CHECKLIST NO. 90-1-03

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(1) Organization Los Alamos National Laboratory

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
		o What are the requirements for documentation?			
		o What are the accept/reject conditions?			

(9) Auditor Signature (10) Date

YMPO AUDIT CHECKLIST NO. 90-1-03

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(1) Organization Los Alamos National Laboratory (2) Page 5 of 14

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-5		Is the individual formally trained in the procedure?			
T-6		Does the training of the technical staff appear adequate to conduct the experiment?			
				(9) Auditor Signature	(10) Date

YMPO AUDIT CHECKLIST NO. 90-1-03

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(1) Organization Los Alamos National Laboratory

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-7		How does the lead person analyze or evaluate the data produced?			
		II. Generic question for the area of experimental documentation.			
T-8		Is the scientific notebook procedure used?			

(9) Auditor Signature (10) Date

YMPO AUDIT CHECKLIST NO. 90-1-03

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(1) Organization Los Alamos National Laboratory (2) Page 7 of 14

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-9		Does the scientific notebook procedure require checking, review, and verification?			
T-10		Verify that this has been done in accordance with the procedure.			

(9) Auditor Signature (10) Date

YMPO AUDIT CHECKLIST NO. 90-1-03

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(1) Organization Los Alamos National Laboratory (2) Page 8 of 14

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-11		Does this appear adequate to control/verify the activity?			
T-12		Verify that assumptions and experimental variables are identified in the notebooks?			
				(9) Auditor Signature	(10) Date

YMPO AUDIT CHECKLIST NO. 90-1-03

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(1) Organization Los Alamos National Laboratory

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-13		When work described is not done using a technical implementing procedure, is the detail sufficient to repeat or evaluate the method and results?			
T-14		When the work described is also controlled by a technical implementing procedure, verify that the entries are in accordance with the requirements of the procedure.			

(9) Auditor Signature (10) Date

YMPO AUDIT CHECKLIST NO. 90-1-03

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(1) Organization Los Alamos National Laboratory

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-15		How is data rejection indicated in the entries?			
T-16		Is instrument calibration included in the notebooks?			

(9) Auditor Signature

(10) Date

YMPO AUDIT CHECKLIST NO. 90-1-03

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(1) Organization Los Alamos National Laboratory (2) Page 11 of 14

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-17		How are calibrations before and after an experiment identified in the notebooks?			
T-18		Is this adequate to assure that as found conditions that are out of calibration can be traced to the data collected?			

(9) Auditor Signature (10) Date

YMPO AUDIT CHECKLIST NO. 90-1-03

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(1) Organization Los Alamos National Laboratory (2) Page 12 of 14

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-19		When this condition occurs what is done in the laboratory?			
T-20		Verify that precision and accuracy requirements are met in the experimental documentation?			

(9) Auditor Signature (10) Date

YMPO AUDIT CHECKLIST NO. 90-1-03

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(1) Organization Los Alamos National Laboratory (2) Page 13 of 14

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-21		How were these established?			
T-22		What will the data be used for?			

(9) Auditor Signature (10) Date

YMPO AUDIT CHECKLIST NO. 90-1-03

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(1) Organization Los Alamos National Laboratory (2) Page 14 of 14

(3) AUDIT ITEM NO.	(4) QUALITY ELEMENT & REFERENCE	(5) STANDARD QUALITY REQUIREMENTS AUDIT GUIDELINES	(6) RESULTS S, X, N/A	(7) SUMMARY OF INVESTIGATION	(8) PERSON CONTACTED
T-23		Does this appear reasonable in the light of data requirements for the activity?			

(9) Auditor Signature (10) Date

ORIGINAL
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YMPO STANDARD DEFICIENCY REPORT

N-QA-038
4/89

Completed by Originating QA Organization

1 Date 11/17/89 | 2 Severity Level ☐ 1 ☒ 2 ☐ 3 | Page 1 of 3

3 Discovered During: Audit 89-7

3a Identified By: M. Diaz

4 SDR No. 460 Rev. 0

5 Organization: Los Alamos Nat'l Lab

6 Person(s) Contacted: R. Herbst, H. Nunes

7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)
(Checklist Item 1-1)
NNWSI/88-9, Rev. 2, Para. 1.0, states "The organizational structure, lines of communication, authority, and duties of persons and organizations performing

9 Deficiency
Contrary to the requirements in Item 8 above, the responsibility and authority of each subcontractor for interface controls are not defined and documented in a procedure. Additionally, TWS-QAS-QP-01.1, Rev. 0, does not provide suffi-

10 Recommended Action(s): ☒ Remedial ☐ Investigative ☒ Corrective
Identify the remedial action(s) to be taken to correct the deficiencies noted in block 9. Identify the cause of the condition and the planned action to

Aprvl.

11 QAE/Lead Auditor/Date: 11/30/89

12 Division Manager/Date: 12-1-89

13 Project Quality Mgr./Date: 12/1/89

Completed by Organization in Block 5

14 Remedial/Investigative Action(s)

15 Effective Date 2/16/90

Refer to Page 3 of 3

16 Cause of the Condition & Corrective Action to Prevent Recurrence

17 Effective Date 2/16/90

Refer to Page 3 of 3

18 Signature/Date: 1/12/90

Comp. by Orig. QA Org.

19 Response Accepted	QAE/Lead Auditor/Date 2/21/90	Division Manager/Date 2/21/90	Project Quality Mgr./Date 2/21/90
20 Corrective Action Verif. Satisfactory	QAE/Lead Auditor/Date	Division Manager/Date	Project Quality Mgr./Date

21 Remarks Response letter TWS-EES-13-01-90-065 PLUS AMENDED RESPONSE letter TWS-EES-13-02-90-033.

22 QA CLOSURE	QAE/Lead Auditor/Date	Division Manager/Date	PQM/Date

ENCLOSURE

8 Requirement (continued)

activities affecting quality shall be clearly established and delineated in writing. These activities affecting quality include both the performing functions of attaining quality objectives and the QA functions."

LANL QAPP, Rev. 4.4, Para. 1.4, states "When more than one LANL subcontractor organization is involved in activities affecting quality, the responsibility and authority of each organization for interface, as well as changes thereto, shall be clearly established and documented and any shared responsibilities shall be defined and documented. To support these interfaces, required interface documentation shall be defined in the administrative procedures. The YMP administrative procedures (APs) shall provide the implementing interface controls used by LANL. A LANL QP shall describe the methods of conducting and documenting interorganizational interfaces."

9 Deficiency (continued)

cient details describing the methods of conducting and documenting interorganizational interfaces.

10 Recommended Actions (continued)

prevent recurrence.

14 Remedial/Investigative Action(s)

Remedial actions: Revise the QAPP, Section 1.4, Interface Between Organizations, and the administrative implementing procedure, QP-01.1, R1, Procedure for Interface Control, to eliminate ambiguity.

Investigative actions: None Required.

16 Cause of the Condition & Corrective Action to Prevent Recurrence

Cause: An ambiguous QAPP requirements statement and further, inadequate direction in the implementing procedure over how to identify an interface and establish the appropriate controls.

Corrective Action to Prevent Recurrence: Refer to the remedial action stated above.

ATTACHMENT

Responses to the below listed SDRs are amended or clarified as indicated.

SDR 460-Amendment

1. Change Block 14-Remedial/Investigative Action(s) to read as follows:

   "Remedial Action-QP01.1 will be revised to detail the methods for conducting and documenting organizational interfaces and to define responsibilities and authority for subcontractor interface controls. In addition, Figure 1-1 of the QAPP will be updated to correctly identify current LANL Subcontractors and Participating Groups."

   "Investigative Action-None Required."

2. Change Block 16-Cause of Condition & Corrective Action to Prevent Recurrence to read as follows:

   "Cause-QP01.1, Rev. 0 did not adequately detail methods for conducting and documenting organizational interfaces or define responsibilities and authority for subcontractor interface controls."

   " Corrective Action to Prevent Recurrence-See Remedial Action stated above."

SDR 462-Amendment

1. Change Block 14-Remedial/Investigative Action(s) to read as follows:

   "Remedial Action-A new procedure, QP02.5-Procedure for the Selection of Personnel, will be issued to provide a format for position descriptions to document equivalent education and experience requirements that may be used to evaluate an individuals capabilities in lieu of specified formal education. All LANL position descriptions will be rewritten in compliance with this format. In addition, QP02.5 will provide a method for responsible supervision to further evaluate and document an individuals capabilities and acceptability for any position even though they do not comply with the equivalents specified in position descriptions. In these instances justification for acceptance of the individual must be documented. The two individuals identified in Block 9 will be evaluated in accordance with the requirements of QP02.5 and the status of their acceptability documented."

   "Investigative Action-See Remedial Action stated above."

[illegible] 2/2/[illegible]-TWS-ES-13-02-90-[illegible]

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YMPO STANDARD DEFICIENCY REPORT

N-QA-038
4/89

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1 Date 11/16/89 | 2 Severity Level ☐ 1 ☒ 2 ☐ 3 | Page 1 of 23

3 Discovered During: AUDIT 89-7

3a Identified By: S. L. Crawford

4 SDR No. 461 Rev. 0

5 Organization: Los Alamos Nat'l Lab

6 Person(s) Contacted: K. Foster

7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)
(Q#2-5) TWS-QAS-QP-02.1, Rev. 1, Para. 6.5, step 16, requires a record of personnel indoctrination and training to be entered on a Project Certification Form. Step 17 requires the individual to sign the

9 Deficiency
An individual (Co-PI, Dynamic Transport Column experiments, and Technical Reviewer, Batch Sorption Studies) was certified 5/26/89 to four (4) Quality Procedures that do not exist:

10 Recommended Action(s): ☒ Remedial ☒ Investigative ☒ Corrective
Identify the remedial action(s) to be taken to correct the deficiencies noted in block 9. Investigate the program, process, activities, or documentation to

Aprvl.

11 QAE/Lead Auditor/Date	12 Division Manager/Date	13 Project Quality Mgr./Date
S Dunn 11/30/89	Wade Hedges 12-1-89	[illegible] 12/1/89

Completed by Organization in Block 5

14 Remedial/Investigative Action(s)

15 Effective Date 2/16/90

Refer to Page 3 of 3

16 Cause of the Condition & Corrective Action to Prevent Recurrence

17 Effective Date 2/16/90

Refer to Page 3 of 3

18 Signature/Date HDMenas 1/12/90

Comp. by Orig. QA Org.

	QAE/Lead Auditor/Date	Division Manager/Date	Project Quality Mgr./Date
19 Response Accepted	[illegible] 2/22/90	S Dunn 2/22/90	[illegible] 2/22/90
20 Corrective Action Verif. Satisfactory	QAE/Lead Auditor/Date	Division Manager/Date	Project Quality Mgr./Date

21 Remarks
① Ref. SDR response ltr., Herbst to Horton, dtd. 1/4/90

22 QA CLOSURE	QAE/Lead Auditor/Date	Division Manager/Date	PQM/Date

8 Requirement (continued)

certification acknowledging receipt and understanding of indoctrination and training. Step 19 requires the individual's supervisor to sign the certification accepting the indoctrination and training for the individual's qualification.

9 Deficiency (continued)

TWS-QAS-QP-03.10
TWS-QAS-QP-03.11
TWS-QAS-QP-03.12
TWS-QAS-QP-03.13

10 Recommended Actions (continued)

determine the extent and depth of similar deficient conditions listed as examples on the SDR. Identify these deficiencies and provide the measures required to correct them. Identify the cause of the condition and the planned corrective action to prevent recurrance.

14 Remedial/Investigative Action(s)

Remedial Actions: The record of the individual noted in Block #9 will be corrected.

Investigative actions: All LANL personnel files will be reviewed and corrected as necessary for similar and other noted deficiencies.

16 Cause of the Condition & Corrective Action to Prevent Recurrence

Cause of the condition: The training matrices were prepared by listing procedures that were in preparation, in anticipation of needed training. The procedures in Block #9 were never approved for use. The procedures were incorrectly copied from the matrices.

Corrective Action to Prevent Recurrence: The procedure QP-02.1, Training, will be revised (or change request issued) to replace the YMP Certification form with a new form that does not require the listing of the procedures to which personnel have been trained.

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N-QA-038
4/89

YMPO STANDARD DEFICIENCY REPORT

1/12/90

Completed by Originating QA Organization

1 Date 11/16/89

2 Severity Level ☐ 1 ☒ 2 ☐ 3 Page 1 of 23

3 Discovered During Audit 89-7

3a Identified By A. I. Arceo, S. L. Crawford

4 SDR No. 462 Rev. 0

5 Organization Los Alamos Nat'l Lab

6 Person(s) Contacted L. Hersman, K. Foster

7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)
(Q #2-3). LANL-YMP-QAPP, Rev. 4.4, para. 2.5.1 provides "The initial capabilities of an individual shall be based on an evaluation of his education, experience, and training and compared to those established for the

9 Deficiency
The qualification record files of the following two individuals did not satisfy the minimum education requirements identified in the applicable position descriptions nor had supervisors documented the basis for accepting

10 Recommended Action(s): ☒ Remedial ☒ Investigative ☒ Corrective
Identify the remedial action(s) to be taken to correct the deficiencies noted in block 9. Investigate the program, process, activities, or documentation,

Aprvl.

11 QAE/Lead Auditor/Date S Dana 11/30/89

12 Division Manager/Date [illegible] 12-1-89

13 Project Quality Mgr./Date [illegible] 12/1/89

Completed by Organization in Block 5

14 Remedial/Investigative Action(s)

15 Effective Date 2/16/90

Refer to Page 3 of 3

16 Cause of the Condition & Corrective Action to Prevent Recurrence

17 Effective Date 2/16/90

Refer to Page 3 of 3

18 Signature/Date [illegible] 1/12/90

Comp. by Orig. QA Org.

19 Response Accepted	QAE/Lead Auditor/Date [illegible] 2/22/90	Division Manager/Date S Dana 2/22/90	Project Quality Mgr./Date [illegible] 2/22/90
20 Corrective Action Verif. Satisfactory	QAE/Lead Auditor/Date	Division Manager/Date	Project Quality Mgr./Date

21 Remarks
① Ref SDR response, Herbst to Horton, dtd. 1/11/90 and Response Clarifications and Amendments thr., Herbst to Horton, dtd. 2/12/90 (TWS-13-02-90-33)

22 QA CLOSURE	QAE/Lead Auditor/Date	Division Manager/Date	PQM/Date

Ltr. dtd 1/11/90 - TWS-EF-13 01-90-005

8 Requirement (continued)

position."

TWS-QAS-QP-02.1, Rev. 1, Para. 6.2, Step 9, requires "Supervisors are responsible for determining and documenting that the personnel selected have relevant experience commensurate with the minimum requirements specified in the position description." Para. 6.3, Step 10, requires supervisors to "...verify resumes of employees or potential employees for accuracy and conformance to position description requirements, by reviewing the Project resume against the position description, and document verification of relevant education and experience by signing and dating the Project Resume Form...."

9 Deficiency (continued)

"equivalent experience" in lieu of the stated formal education requirements.

o Project Leader (EES-13)	Required: MS or equivalent Actual: BS ChE
o Lab Technician (LS-2)	Required: BS or equivalent Actual: No degree

10 Recommended Actions (continued)

to determine the extent and depth of similar deficient conditions listed as examples on the SDR. Identify these deficiencies and provide the measures required to correct them. Identify the cause of the condition and the planned corrective action to prevent recurrance.

14 Remedial/Investigative Action(s)

Remedial actions: A change request will be issued to QP-02.1, Training, stipulating a format for equivalent education and experience in lieu of the stipulated basic education and experience requirements stated on the position description. The two position descriptions noted in Block #9 of the SDR will be rewritten in this new format to document the basis for accepting the equivalent experience of each individual.

Investigative actions: All LANL position descriptions will be rewritten in the revised format to record the basis for accepting the equivalent experience.

16 Cause of the Condition & Corrective Action to Prevent Recurrence

Cause of the Condition: The procedure, QP-02.1, as written did not require any supervisor to record the basis for acceptance of equivalent experience in lieu of stated formal education. The supervisor simply stated his acceptance of the qualifications of the LANL staff member by signing the YMP Resume Forms.

Corrective Action to Prevent Recurrence: The procedure change noted in Block #14 will provide the mechanism by which LANL supervisor decisions involving equivalent experience in lieu of formal education will be documented. This will provide uniformity throughout the LANL project for documenting these decisions.

ATTACHMENT

Responses to the below listed SDRs are amended or clarified as indicated.

SDR 460-Amendment

1. Change Block 14-Remedial/Investigative Action(s) to read as follows:

   "Remedial Action-QP01.1 will be revised to detail the methods for conducting and documenting organizational interfaces and to define responsibilities and authority for subcontractor interface controls. In addition, Figure 1-1 of the QAPP will be updated to correctly identify current LANL Subcontractors and Participating Groups."

   "Investigative Action-None Required."

2. Change Block 16-Cause of Condition & Corrective Action to Prevent Recurrence to read as follows:

   "Cause-QP01.1, Rev. 0 did not adequately detail methods for conducting and documenting organizational interfaces or define responsibilities and authority for subcontractor interface controls."

   " Corrective Action to Prevent Recurrence-See Remedial Action stated above."

SDR 462-Amendment

1. Change Block 14-Remedial/Investigative Action(s) to read as follows:

   "Remedial Action-A new procedure, QP02.5-Procedure for the Selection of Personnel, will be issued to provide a format for position descriptions to document equivalent education and experience requirements that may be used to evaluate an individuals capabilities in lieu of specified formal education. All LANL position descriptions will be rewritten in compliance with this format. In addition, QP02.5 will provide a method for responsible supervision to further evaluate and document an individuals capabilities and acceptability for any position even though they do not comply with the equivalents specified in position descriptions. In these instances justification for acceptance of the individual must be documented. The two individuals identified in Block 9 will be evaluated in accordance with the requirements of QP02.5 and the status of their acceptability documented."

   "Investigative Action-See Remedial Action stated above."

[illegible] 2/12/90 - TWS-EES-13-02-90-0[illegible]

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N-QA-038
4/89

Completed by Originating QA Organization

1 Date 11/27/89 | 2 Severity Level ☐ 1 ☒ 2 ☐ 3 | Page 1 of 23

3 Discovered During: LANL Audit 89-7
3a Identified By: S. L. Crawford
4 SDR No. 463 Rev. 0

5 Organization: Los Alamos Nat'l Lab
6 Person(s) Contacted: R. Oblad, R. Morley
7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)
(Checklist Item 3-7) TWS-QAS-QP-03.15, para. 6.3 and 6.4 provide for review of design documents. LANL letter TWS-EES-1-09-89-16, 9/8/89 transmitted the Integrated Data System (IDS) Functional Requirements Document (FRD) for review

9 Deficiency
1. The FRD, as reviewed, and subsequently, as issued (10/04/89, TWS-EES-13-10-89-004) contained numerous errors and inconsistent structure in the logic elements of the IDS that was not identified by the

10 Recommended Action(s): ☒ Remedial ☐ Investigative ☒ Corrective
Identify the remedial action(s) to be taken to correct the deficiencies noted in block 9. Identify the cause of the condition and the planned action to

Aprvl.

11 QAE/Lead Auditor/Date: 12/1/89
12 Division Manager/Date: 12-1-89
13 Project Quality Mgr./Date: 12/1/89

Completed by Organization in Block 5

14 Remedial/Investigative Action(s)
15 Effective Date: 2/16/90
Refer to Page 3 of 3

16 Cause of the Condition & Corrective Action to Prevent Recurrence
17 Effective Date: 2/16/90
Refer to Page 3 of 3

18 Signature/Date: HPNunes 1/12/90

Comp. by Orig. QA Org.

	QAE/Lead Auditor/Date	Division Manager/Date	Project Quality Mgr./Date
19 Response Accepted	2/22/90	2/22/90	2/22/90
20 Corrective Action Verif. Satisfactory			

21 Remarks
① Ref. SDR response, Herbst to Horton, dtd 1/11/90 and Response Clarification and Amendments ltr, Herbst to Horton, dtd 2/12/90 (TWS-13-02-90-33)

22 QA CLOSURE	QAE/Lead Auditor/Date	Division Manager/Date	PQM/Date

8 Requirement (continued)

per QP-03.15, para. 6.3. The transmitted letter requested the reviewers to assure:

1. The FRD is correct.
2. The FRD is consistent with the ESF SDRD.
3. The FRD is concisely and logically structured.
4. The FRD fulfils its purpose adequately to start Title II design.
5. The FRD complies with the LANL QA plan.

9 Deficiency (continued)

design review process. (See attached List of Discrepancies)

2. The FRD referenced the design input source as the ESF SDRD, Benchmark #5 draft. Although, that was the issued version at the time of FRD preparation, Benchmark #6 changes had been approved by DOE/HQ (02/21/89) issued by YMPO (08/07/89) for incorporation into the SDRD. The changes of Benchmark #6 impacted the list of DOE orders in para. 2.2 of the FRD.

3. It is noted that QP-03.15, Rev. 0, was the correct procedure for design review at the time of FRD review; subsequently, QP-03.15, Rev. 1, 10/12/89 directs design reviews to be performed in accordance with QP-03.16, Rev. 0, 10/12/89.

10 Recommended Actions (continued)

prevent recurrence.

14 Remedial/Investigative Action(s)

Remedial Action(s): The current Functional Requirements Document (FRD) will be corrected to reflect the noted discrepancies in the SDR attachment, pages 1 and 2. The text will be amended to reflect current versions of the Department of Energy (DOE) orders, YMP Benchmark #6, that will govern the work. Upon completion of these revisions, the document will be technically reviewed to assure that any corrections do not impact the technical content of the document.

Investigative Action(s): None required.

16 Cause of the Condition & Corrective Action to Prevent Recurrence

Cause of the Condition: In appropriate use of QP-03.16, Procedure for TMO Review of Design Information. Implementing procedure, QP-03.2, Procedure for Preparation and Technical and Policy Review of Technical Information Products, should have been used prior to issue of the FRD.

Corrective Action to Prevent Recurrence: Modify QP-03.16, Procedure for TMO Review of Design Information, to require use of QP-03.2 prior to release of technical information.

LANL AUDIT 89-7

LIST OF DISCREPANCIES
INTEGRATED DATA SYSTEM (IDS) FUNCTIONAL REQUIREMENTS DOCUMENT (FRD)

	PAGE	REFERENCE	DISCREPANCY
1.	2	para 2.2	DOE Order 1330 Draft is 1330.1B Draft per SDRD BM6.
2.	2	para 2.2	DOE Order 1450.1C, listed in SDRD BM5 and BM6, is not listed in the FRD.
3.	2	para 2.2	DOE Order 5310.1A is not listed in SDRD BM5 or BM6 and DOE Order 5300.1B, listed in SDRD BM6, is not listed in the FRD.
4.	11	fig. 3.2.1	Element 1.1.1.5 is identified as "IDS Installation Tests" on logic tree, but "IDS Installation Checks" on page 12.
5.	13	fig.3.2.1	Element 1.1.1.6 and 1.1.1.7 are identified as "System Configuration" and "Instrument Configuration" on logic tree, but "System Configuration Input" and "Instrument Configuration Input" on page 11 (fig. 3.2.1) and page 12.
6.	17	fig. 3.2.4	Element 1.2.1.2 is identified as "Verify" on logic tree, but "Protect" on page 15 (fig. 3.2.3) and page 16.
7.	19	fig. 3.2.5	Element 1.2.1.2 is identified as "Verify" on logic tree; same as comment 6 above.
8.	20	para 3.2.5	"Test Controls" is identified as element 1.1.3, a part of element 1.1, "ACQUIRE"; fig. 3.1.2 (page 5) and fig. 3.2.5 (page 19) show the elements as 1.2 "PROCESS" and 1.2.3 "Test Controls."
9.	22	para. 3.2.6	Paragraph "Store" is a 2nd level element; previous paragraphs and figures are 3rd level elements. The paragraph title should be "IDS Data Archive". A new paragraph 3.2.7, "On-Line" should be inserted.
10.	22	para. 3.2.6	"STORE" is identified as element 1; the correct element designation is 1.3.
11.	24	para. 3.2.7	Paragraph "Distribute" is a 2nd level element; same as comment 9.

12.	25	fig. 3.2.8	Figure does not include 5th level elements 1.5.1.1.1, 1.5.1.1.2, 1.5.1.2.1, 1.5.1.2.2, 1.5.1.2.3; 5th level elements are presented on fig. 3.2.3 (page 15), fig. 3.2.4 (page 17), and fig. 3.2.5 (page 19).
13.	26	para. 3.2.8	"Malfunction Alarm" and subelements are identified as 1.5.1.4, 1.5.1.4.1, etc. The correct elements designations are 1.5.1.2, 1.5.1.2.1, etc.
14.	27	fig. 3.2.9	Figure does not include 5th level elements 1.5.2.3.1, 1.5.2.3.2; same as comment 12 above.
15.	28	para. 3.2.9	"Instrument Malfunction Alarm" subelements are identified as 1.5.2.4.1 and 1.5.2.4.2; the correct element designations are 1.5.2.3.1 and 1.5.2.3.2
16.	29	fig. 3.2.10	Element 1.6.3.2 is identified as "Provide Data I/O Terminals"; para. 3.2.10 (page 30) identifies the element title as "Provide Data I/O Terminals and Remote Access."
17.	30	para. 3.2.10	Paragraph "Operate" is a 2nd level element; same as comment 9 above.
18.	30	para. 3.2.10	"Maintenance and Operations" and subelements are identified as 1.6.4, 1.6.4.1, etc. The correct element designations are 1.6.3, 1.6.3.1, etc. Also "Maintenance and Operations" should be italicized.
19.	49	Appdx. B	"National Bureau of Standards" (NBS) should be "National Institute of Standards and Technology" (NIST). NIST was correctly identified on pages 12 and 16.
20.	52	Appdx. E	"NBS" should be "NIST"; same as comment 19 above.

SDR 463-Clarification

1. Add the following to Block 16-Cause of Condition & Corrective Action to Prevent Recurrence:

   "Training will be provided to reviewers to identify the relationship of QP03.2 and QP03.16 and emphasize appropriate use of these procedures during the review process."

SDR 464-Amendment

1. Change Block 16-Cause of Condition and Corrective Action to Prevent Recurrence to read as follows:

   "Cause-Study plans were not checked after changes(additions) were made to ensure changes did not impact technical content. These changes were made at the verbal direction of the Project Office."

   "Corrective Action to Prevent Recurrence-Remaining Study Plans will be checked by Technical Reviewers to ensure any changes or additions do not impact technical content of the Study Plans prior to submittal to the Project Office."

SDR 465-Amendment

1. Change Block 14-Remedial\Investigative Action(s) to read as follows:

   "Remedial Action-The DPs listed in Block 9 of the SDR will be reviewed and corrected as necessary to address acceptance and reject criteria or limits."

   "Investigative Action-All remaining DPs will be reviewed to ensure that acceptance and reject criteria or limits are adequately addressed in these procedures. Corrections to remaining DPs will be made as necessary."

SDR 466-Amendment

1. Change Corrective Action to Prevent Recurrence in Block 16 to read as follows:

   "All manual holders will be retrained in QP06.1 document control requirements. During the following quarter,the LANL QAS will verify from a random sample of QA Manuals that a 95% confidence level for the manuals has been achieved. In addition, an overview of QA Manuals for

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N-QA-038
4/89

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1 Date 11/14/89 | 2 Severity Level ☐ 1 ☒ 2 ☐ 3 | Page 1 of 23

3 Discovered During: Audit-89-7
3a Identified By: S.L. Crawford
4 SDR No. 464 Rev. 0

5 Organization: Los Alamos Nat'l Lab
6 Person(s) Contacted: R. Herbst, various PI's
7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)
(Q#3-1, 3-2) YMP AP-1.10Q, Rev. 0, paras. 5.1.2 and 5.1.5 require project participants to perform a technical review of SCP study plans prior to submittal to the Project Office. LANL TWS-QAS-QP-03.3, Rev. 0, para 6.2.1,

9 Deficiency
Several study plans, submitted to the Project Office subsequent to the effective date of AP-1.10Q, had been technically reviewed in a different form and content than the version actually submitted to the Project Office. No

10 Recommended Action(s): ☒ Remedial ☐ Investigative ☒ Corrective
Identify the remedial action to be taken to correct the deficiencies noted in block 9. Identify the cause of the condition and the planned action to

Aprvl.

11 QAE/Lead Auditor/Date: 11/30/89
12 Division Manager/Date: 12-1-89
13 Project Quality Mgr./Date: 12/1/89

Completed by Organization in Block 5

14 Remedial/Investigative Action(s)
15 Effective Date 2/16/90
Refer to Page 3 of 3

16 Cause of the Condition & Corrective Action to Prevent Recurrence
17 Effective Date 2/16/90
Refer to Page 3 of 3

18 Signature/Date: 1/12/90

Comp. by Orig. QA Org.

	QAE/Lead Auditor/Date	Division Manager/Date	Project Quality Mgr./Date
19 Response Accepted	2/22/90	2/22/90	2/22/90
20 Corrective Action Verif. Satisfactory			

21 Remarks
① Ref. SDR response, Herbst to Horton, dtd. 1/4/90 and response clarification and amendments via, Herbst to Horton (TWS-13-02-90-33)

22 QA CLOSURE	QAE/Lead Auditor/Date	Division Manager/Date	PQM/Date

8 Requirement (continued)

requires study plans to be "...reviewed technically according to QPS-3.02..."

9 Deficiency (continued)

check or review was documented to assure that changes occurring between the technical review and submission to the Project Office either did not impact technical content of the study plan or that an additional review of the changes for technical adequacy was performed.

It is noted that all study plans having technical reviews performed prior to AP-1.10Q (and prior to QP-03.3) have already been submitted to the Project Office. Only three (3) LANL study plans remain to be submitted.

10 Recommended Actions (continued)

prevent recurrance.

14 Remedial/Investigative Actions

Remedial Action: The Project Office and DOE/Headquarters have already conducted additional reviews. No further remedial action is required.

Investigative Action: The SDR does not specify what the difference in format and content was, but we conclude that the difference was 1) the addition of a QA appendix, and 2) the addition of a brief abstract. For ongoing studies, the appendix includes quality assurance level assignments (QALAs) and a matrix. The QALAs were already reviewed and approved by the Project Office, no additional review was required. The QA appendix does not provide any new information-- it is a summary of information that is readily available from other sources. The abstract is a short (1-3 paragraph) summary of the existing technical content of the study plan and does not change the technical content of the plans.

The subject study plans have all undergone additional screening, technical, management, and quality assurance reviews at both the Project Office and DOE/HQ. Any problems associated with the additions would have been identified during these reviews.

16 Cause of Condition & Corrective Action to Prevent Recurrence

Cause of Condition: Compliance with verbal direction from the Project Office.

Corrective Action to Prevent Recurrence: Require LANL staff to obtain written confirmation of verbal direction from the Project Office.

SDR 463-Clarification

1. Add the following to Block 16-Cause of Condition & Corrective Action to Prevent Recurrence:

   "Training will be provided to reviewers to identify the relationship of QP03.2 and QP03.16 and emphasize appropriate use of these procedures during the review process."

SDR 464-Amendment

1. Change Block 16-Cause of Condition and Corrective Action to Prevent Recurrence to read as follows:

   "Cause-Study plans were not checked after changes(additions) were made to ensure changes did not impact technical content. These changes were made at the verbal direction of the Project Office."

   "Corrective Action to Prevent Recurrence-Remaining Study Plans will be checked by Technical Reviewers to ensure any changes or additions do not impact technical content of the Study Plans prior to submittal to the Project Office."

SDR 465-Amendment

1. Change Block 14-Remedial\Investigative Action(s) to read as follows:

   "Remedial Action-The DPs listed in Block 9 of the SDR will be reviewed and corrected as necessary to address acceptance and reject criteria or limits."

   "Investigative Action-All remaining DPs will be reviewed to ensure that acceptance and reject criteria or limits are adequately addressed in these procedures. Corrections to remaining DPs will be made as necessary."

SDR 466-Amendment

1. Change Corrective Action to Prevent Recurrence in Block 16 to read as follows:

   "All manual holders will be retrained in QP06.1 document control requirements. During the following quarter,the LANL QAS will verify from a random sample of QA Manuals that a 95% confidence level for the manuals has been achieved. In addition, an overview of QA Manuals for

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1 Date 11-17-89 | 2 Severity Level ☐ 1 ☒ 2 ☐ 3 | Page 1 of 23

3 Discovered During Audit 89-7 | 3a Identified By M. J. Mitchell | 4 SDR No. 465 Rev. 0

5 Organization Los Alamos Nat'l Lab | 6 Person(s) Contacted R. Herbst, H. Nunes | 7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)
(Checklist Item N/A)
LANL-YMP-QAPP, Rev. 4.4, Para. 3.1.6.1, states in part "DPs used for scientific investigations shall provide for the following as appropriate:

9 Deficiency
Many DPs do not address acceptance and rejection criteria or limits or the applicability of this subject to the work covered by the DP. Examples of this condition include:

10 Recommended Action(s): ☒ Remedial ☒ Investigative ☒ Corrective
Identify the remedial action(s) to be taken to correct the deficiencies noted in block 9. Investigate the program, process, activities, or documentation to

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11 QAE/Lead Auditor/Date S Dam 11/30/89 | 12 Division Manager/Date 12-1-89 | 13 Project Quality Mgr./Date 12/1/89

Completed by Organization in Block 5

14 Remedial/Investigative Action(s)
Refer to Page 3 of 3

15 Effective Date 2/16/90

16 Cause of the Condition & Corrective Action to Prevent Recurrence
Refer to Page 3 of 3

17 Effective Date 2/16/90

18 Signature/Date HPHunes 1/12/90

Comp. by Orig. QA Org.

	QAE/Lead Auditor/Date	Division Manager/Date	Project Quality Mgr./Date
19 Response Accepted	S Dam 2/21/90	S Dam 2/21/90	[illegible]
20 Corrective Action Verif. Satisfactory	QAE/Lead Auditor/Date	Division Manager/Date	Project Quality Mgr./Date

21 Remarks ① See ltr., Herbst to Horton, dtd 9/12/90, SDR Response Clarifications & Amendments and SDR response ltr, Herbst to Horton, dtd. 1/11/90.

22 QA CLOSURE	QAE/Lead Auditor/Date	Division Manager/Date	PQM/Date

8 Requirement (continued)

o Acceptance and rejection limits and criteria, including required levels of precision and accuracy."

TWS-QAS-QP-05.2, Rev. 2, Para. 6.3.7.6 states in part "Include criteria (eg., postrequisites and final conditions) for ensuring that DPs have been performed correctly."

9 Deficiency (continued)

TWS-EES-DP-54, Rev. 1
TWS-EES-DP-102, Rev. 1
TWS-EES-DP-114, Rev. 1
TWS-EES-DP-124, Rev. 0
TWS-INC-DP-27, Rev. 0

10 Recommended Actions (continued)

determine the extent and depth of similar deficient conditions listed as examples on the SDR. Identify the deficiencies and provide the measures required to correct them. Identify the cause of the condition and the planned corrective action to prevent recurrance.

14 Remedial/Investigative Action(s)

Investigative Actions: Review the following Dps for incorporation of accept reject criteria: DP 54, R1; DP102, R1; DP 114, R0; DP 124, R0; DP 27, R1. Of note, two procedures in Block 9 of the SDR reference the wrong revision number: TWS-EES-DP-114, Rev. 1, is actually Rev. 0, and TWS-INC-DP-27, Rec. 0, is actually Rev. 1. Further, review all remaining technical implementing procedures.

Remedial Action: Issue a change request to each of the above five referenced procedures to add an accept reject criteria section.

16 Cause of the Condition & Corrective Action to Prevent Recurrence

Cause of the Condition: The implementing procedure,QP-05.2, Preparation of a Detailed Technical Procedure, failed to adequately instruct the preparer on inclusion of accept/reject criteria limits.

Corrective Action to Prevent Recurrence: Issue a change request to QP-05.2, R1, incorporation the requirement for a specific section stating the accept/rejection criteria and limits. Modify other detailed technical procedures, as necessary, to include accept reject criteria limits.

SDR 463-Clarification

1. Add the following to Block 16-Cause of Condition & Corrective Action to Prevent Recurrence:

   "Training will be provided to reviewers to identify the relationship of QP03.2 and QP03.16 and emphasize appropriate use of these procedures during the review process."

SDR 464-Amendment

1. Change Block 16-Cause of Condition and Corrective Action to Prevent Recurrence to read as follows:

   "Cause-Study plans were not checked after changes(additions) were made to ensure changes did not impact technical content. These changes were made at the verbal direction of the Project Office."

   "Corrective Action to Prevent Recurrence-Remaining Study Plans will be checked by Technical Reviewers to ensure any changes or additions do not impact technical content of the Study Plans prior to submittal to the Project Office."

SDR 465-Amendment

1. Change Block 14-Remedial\Investigative Action(s) to read as follows:

   "Remedial Action-The DPs listed in Block 9 of the SDR will be reviewed and corrected as necessary to address acceptance and reject criteria or limits."

   "Investigative Action-All remaining DPs will be reviewed to ensure that acceptance and reject criteria or limits are adequately addressed in these procedures. Corrections to remaining DPs will be made as necessary."

SDR 466-Amendment

1. Change Corrective Action to Prevent Recurrence in Block 16 to read as follows:

   "All manual holders will be retrained in QP06.1 document control requirements. During the following quarter,the LANL QAS will verify from a random sample of QA Manuals that a 95% confidence level for the manuals has been achieved. In addition, an overview of QA Manuals for

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1 Date 11/17/89 | 2 Severity Level ☐ 1 ☒ 2 ☐ 3 | Page 1 of 23

3 Discovered During: Audit 89-7

3a Identified By: F. Ruth/ J. Hadden

4 SDR No. 466 Rev. 0

5 Organization: Los Alamos Nat'l Lab

6 Person(s) Contacted: K. Foster

7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)
(Checklist Item 6-4)
TWS-QAS-QP-06.1, Rev. 1, Para. 6.5, states "The holder of a controlled document removes and destroys obsolete documents in accordance with directions

9 Deficiency
A random sample of the 59 controlled manuals were reviewed in accordance with the latest revision of the table of contents, dated October 13, 1989, to determine if all appropriate procedures had been removed or marked superceded

10 Recommended Action(s): ☒ Remedial ☒ Investigative ☒ Corrective
Identify the remedial action(s) to be taken to correct the deficiencies noted in block 9. Investigate the program, process, activities or documentation, to

Aprvl.

11 QAE/Lead Auditor/Date: S Dana 11/30/89

12 Division Manager/Date: 12-1-89

13 Project Quality Mgr./Date: 12/1/89

Completed by Organization in Block 5

14 Remedial/Investigative Action(s)

15 Effective Date 2/16/90

Refer to Page 3 of 3

16 Cause of the Condition & Corrective Action to Prevent Recurrence

17 Effective Date 2/16/90

Refer to Page 3 of 3

18 Signature/Date: 1/12/90

Comp. by Orig. QA Org.

19 Response Accepted	QAE/Lead Auditor/Date: S Dana 2/21/90	Division Manager/Date: S Dana 2/21/90	Project Quality Mgr./Date
20 Corrective Action Verif. Satisfactory	QAE/Lead Auditor/Date	Division Manager/Date	Project Quality Mgr./Date

21 Remarks ① See Ltr., Herbst to Horton, dtd 2/12/90, SDR Response Clarification & Amendment and SDR response Ltr, Herbst to Horton, dtd. 1/11/90.

22 QA CLOSURE	QAE/Lead Auditor/Date	Division Manager/Date	PQM/Date

File: LTR 1/11/90 - TWS-EES-13-01-90-005

8 Requirement (continued)

given in the receipt acknowledgement form. If the holder of a controlled document prefers to keep obsolete revisions, he may do so, but he must mark "superceded," "obsolete," or a similar expression on the cover page of the outdated version and note this action on the receipt acknowledgement form."

9 Deficiency (continued)

or obsolete as required. During the review, procedures were found which should have been removed or marked obsolete. In one case (#90), one procedure was missing from the manual.

Note: The following is a list of the controlled manuals that were reviewed and all discrepancies discovered during the review were corrected during the audit:

#4
#5
#27
#40
#48
#50
#85
#86
#90

10 Recommended Actions (continued)

determine the extent and depth of similar deficient conditions listed as examples on the SDR. Identify these deficiencies and provide the measures required to correct them. Identify the cause of the condition and the planned corrective action to prevent recurrence.

14 Remedial/Investigative Action(s)

Remedial Actions: No action is required because the manuals referenced in Block 9 of the SDR were corrected during the audit.

Investigative Actions: All controlled manual holders will be directed to review their controlled copies and verify in writing that it is complete and up to date with the correct revisions and change requests.

16 Cause of the Condition & Corrective Action to Prevent Recurrence

Cause of the Condition: Failure of the copy holders to update their manuals as instructed by the controlled distribution system.

Corrective Action to Prevent Recurrence: All manual holders will be retrained in QP-06.1, Document Control. The LANL QAS will verify a random sample of QA Manuals each calendar quarter to achieve a 95% confidence level.

SDR 463-Clarification

1. Add the following to Block 16-Cause of Condition & Corrective Action to Prevent Recurrence:

   "Training will be provided to reviewers to identify the relationship of QP03.2 and QP03.16 and emphasize appropriate use of these procedures during the review process."

SDR 464-Amendment

1. Change Block 16-Cause of Condition and Corrective Action to Prevent Recurrence to read as follows:

   "Cause-Study plans were not checked after changes(additions) were made to ensure changes did not impact technical content. These changes were made at the verbal direction of the Project Office."

   "Corrective Action to Prevent Recurrence-Remaining Study Plans will be checked by Technical Reviewers to ensure any changes or additions do not impact technical content of the Study Plans prior to submittal to the Project Office."

SDR 465-Amendment

1. Change Block 14-Remedial\Investigative Action(s) to read as follows:

   "Remedial Action-The DPs listed in Block 9 of the SDR will be reviewed and corrected as necessary to address acceptance and reject criteria or limits."

   "Investigative Action-All remaining DPs will be reviewed to ensure that acceptance and reject criteria or limits are adequately addressed in these procedures. Corrections to remaining DPs will be made as necessary."

SDR 466-Amendment

1. Change Corrective Action to Prevent Recurrence in Block 16 to read as follows:

   "All manual holders will be retrained in QP06.1 document control requirements. During the following quarter,the LANL QAS will verify from a random sample of QA Manuals that a 95% confidence level for the manuals has been achieved. In addition, an overview of QA Manuals for

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proper document control will be performed by the QAS each calendar quarter. The requirements for this overview will be documented in a change to QP06.1."

SDR 467-Clarification

1. Add the following to Block 16-Cause of Condition and Corrective Action to Prevent Recurrence:

   "Cause-It was intended to issue semi-annual Trend Reports rather than quarterly Trend Reports as required by QP16.2."

   "Corrective Action to Prevent Recurrence-QP16.2 will be revised to specify issuance of semi-annual Trend Reports rather than quarterly reports."

SDR 468-Amendment

Block 14-Remedial/Investigative Action(s)

"Remedial-Review generic deficiencies identified in Block 9 for the corrective action process as well as those identified for specific CARs. The QAPL will then determine what remedial action is appropriate for each identified deficiency."

"Investigative-Review all CARs Issued to date for indication of deficient conditions such as those described in Block 9 of the SDR. Document and report the results of this review to the QAPL so that corrective action determined to be necessary may be initiated."

Block 16-Cause of Condition & Corrective Action to Prevent Recurrence

"Cause-Personnel error and procedural inadequacies."

"Corrective Action to Prevent Recurrence-The Corrective Program procedures will be revised to restructure the program. As a result, program requirements not previously addressed will specified. After revision, training of all personnel involved in the Corrective Action Program will be performed with additional training provided to personnel involved with program implementation and administration."

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YMPO STANDARD DEFICIENCY REPORT

N-QA-038
4/89

Completed by Originating QA Organization

1 Date 11/17/89 | 2 Severity Level ☐ 1 ☐ 2 ☒ 3 | Page 1 of 3

3 Discovered During: Audit 89-7

3a Identified By: M. Diaz

4 SDR No. 467 Rev. 0

5 Organization: Los Alamos Nat'l Lab

6 Person(s) Contacted: P. Goulding

7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)
(Checklist Item 15-7)
NNWSI/88-9, Rev. 2, Section XV, Para. 3.0, states "Nonconformance reports shall be periodically analyzed by the QAS organization to show quality trends

9 Deficiency
Contrary to the above requirements, there is no documentation to show that a trend report has been issued on NCRs since the effective date of 6/20/89 of the procedure.

10 Recommended Action(s): ☒ Remedial ☐ Investigative ☐ Corrective
Identify the remedial actions to be taken to correct the deficiency(ies) noted in block 9.

Aprvl.

11 QAE/Lead Auditor/Date: 11/30/89

12 Division Manager/Date: 12-1-89

13 Project Quality Mgr./Date: 12/1/89

Completed by Organization in Block 5

14 Remedial/Investigative Action(s)

15 Effective Date 2/16/90

Refer to Page 3 of 3

16 Cause of the Condition & Corrective Action to Prevent Recurrence

17 Effective Date 2/16/90

Refer to Page 3 of 3

18 Signature/Date: 1/12/90

Comp. by Orig. QA Org.

19 Response Accepted	QAE/Lead Auditor/Date: 2/21/90	Division Manager/Date: 2/21/90	Project Quality Mgr./Date: 2/22/90
20 Corrective Action Verif. Satisfactory	QAE/Lead Auditor/Date	Division Manager/Date	Project Quality Mgr./Date

21 Remarks RESPONSE LETTER TWS-EES-13-01-90-065 PLUS AMENDED RESPONSE LETTER TWS-EES-13-02-90-033.

22 QA CLOSURE	QAE/Lead Auditor/Date	Division Manager/Date	PQM/Date

8 Requirement (continued)

and to help identify root causes of nonconformances. Results shall be reported to upper management for review and assessment." TWS-QAS-QP-16.2, Rev. 0, Para. 5.2, states "The Quality Assurance Support group generates trending data on a quarterly basis, beginning in January, and delivers these data to the QAPL." TWS-QAS-QP-16.2, Rev. 0, Para. 8.0, states "An approved quarterly trending report is the criterion that demonstrates satisfactory compliance with this QP."

14 Remedial/Investigative Action(s)

Remedial Actions: Issue a final trending report to cover Calendar Year 1989. The report will incorporate data from audit findings, SDRs, CARs and NCRs issued during the calendar year with recommendations for improvements to the quality program based upon the QAPL's review of the Trend Analysis Report.

Investigative actions: None required, the remedial action above covers all issued involved in trending.

16 Cause of the Condition & Corrective Action to Prevent Recurrence:

None required.

proper document control will be performed by the QAS each calendar quarter. The requirements for this overview will be documented in a change to QP06.1."

SDR 467-Clarification

1. Add the following to Block 16-Cause of Condition and Corrective Action to Prevent Recurrence:

   "Cause-It was intended to issue semi-annual Trend Reports rather than quarterly Trend Reports as required by QP16.2."

   "Corrective Action to Prevent Recurrence-QP16.2 will be revised to specify issuance of semi-annual Trend Reports rather than quarterly reports."

SDR 468-Amendment

Block 14-Remedial/Investigative Action(s)

"Remedial-Review generic deficiencies identified in Block 9 for the corrective action process as well as those identified for specific CARs. The QAPL will then determine what remedial action is appropriate for each identified deficiency."

"Investigative-Review all CARs Issued to date for indication of deficient conditions such as those described in Block 9 of the SDR. Document and report the results of this review to the QAPL so that corrective action determined to be necessary may be initiated."

Block 16-Cause of Condition & Corrective Action to Prevent Recurrence

"Cause-Personnel error and procedural inadequacies."

"Corrective Action to Prevent Recurrence-The Corrective Program procedures will be revised to restructure the program. As a result, program requirements not previously addressed will specified. After revision, training of all personnel involved in the Corrective Action Program will be performed with additional training provided to personnel involved with program implementation and administration."

Ltr cited 2/12/90 - TVA-EIS-13-02-90-033

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4/89

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1 Date 11-17-89 | 2 Severity Level ☒ 1 ☐ 2 ☐ 3 | Page 1 of 3

3 Discovered During Audit 89-7 | 3a Identified By A. I. Arceo | 4 SDR No. 468 Rev. 0

5 Organization Los Alamos Nat'l Lab | 6 Person(s) Contacted P. Goulding/H. Nunes | 7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)
(Checklist Items 16-1, 16-2, 16-3, and 16-4) NNWSI/88-9, Rev. 2, Section XVI, Para. 1.0, and LANL-YMP-QAPP, Rev. 4.4, Para. 16.1, state "The corrective Action System shall ensure that conditions adverse or potentally adverse to

9 Deficiency
Contrary to the requirements stated above:

1. Actions to prevent recurrence of significant conditions were not

10 Recommended Action(s): ☒ Remedial ☒ Investigative ☒ Corrective
Identify the remedial action(s) to be taken to correct the deficencies noted in block 9. Investigate the program, process, activities, or documentation to

Aprvl.

11 QAE/Lead Auditor/Date	12 Division Manager/Date	13 Project Quality Mgr./Date
11/30/89	12-1-89	12/1/89

Completed by Organization in Block 5

14 Remedial/Investigative Action(s) | 15 Effective Date 2/16/90

Refer to Page 4 of 4

16 Cause of the Condition & Corrective Action to Prevent Recurrence | 17 Effective Date 2/16/90

Refer to Page 4 of 4

18 Signature/Date 1/12/90

Comp. by Orig. QA Org.

	QAE/Lead Auditor/Date	Division Manager/Date	Project Quality Mgr./Date
19 Response Accepted	A. I. Arceo 2/21/90	2/21/90	2/21/90
20 Corrective Action Verif. Satisfactory			

21 Remarks Response clarification, letter R.J. Herbst to Horton dated 2/12/90
Responses to SDRs, letter R.J. Herbst to Horton dated 1/11/90

22 QA CLOSURE	QAE/Lead Auditor/Date	Division Manager/Date	PQM/Date

8 Requirement (continued)

quality are identified promptly and corrected as soon as practical." NNWSI/88-9, Rev. 2, Section XVI, Para. 1.1, and LANL-YMP-QAPP, Rev. 4.4, Para. 16.2, state "For significant conditions adverse to quality, the identification, cause, and corrective action taken to prevent recurrence shall be documented and reported to immediate management and upper levels of management for review and assessment... Upon discovering or receiving notification that a significant condition adverse to quality or unusual occurrence exists, each NNWSI Project Participant shall ensure that:

- o Immediate actions have been taken to remedy the specific condition(s).
- o Causative factors have been determined.
- o Controls have been reviewed, implemented, monitored, and revised, if necessary.
- o Affected managers at all levels have been notified of adverse condition(s) and of lessons to be learned to improve conditions or avoid similar occurrences."

NNWSI/88-9, Rev. 2, Section XVI, Para. 1.2, and LANL-YMP-QAPP, Rev. 4.4, Para. 16.3, state "The QA organization shall document concurrence of the adequacy of proposed corrective actions to assure that QA requirements will be satisfied. Follow-up action shall be taken by the QA organization to verify proper implementation of this corrective action and to close out the corrective action. The organization responsible for implementing the corrective action shall assure that the corrective action is completed in a timely manner." NNWSI/88-9, Rev. 2, Sec. XVI, Para, 1.3, and LANL-YMP-QAP Rev. 4.4, Para. 16.4, state "The QA organization shall periodically analyze corrective action reports to establish quality trends. The results shall be reported to the TPO and QAPL for review and assessment." TWS-QAS-QP-16.1, Rev. 1, Para. 6.3, states "A copy of the CAR Log is sent to the RPC annually in the first quarter of the calendar year."

9 Deficiency (continued)

indicated on the CARs reviewed (CAR Nos. 043; 043, Rev. 1; 044; 046; 055, and 055, Rev 1).

2. Verification of corrective action implementation was not documentated on the CAR other than the signature of the person who performed the verification. There were no references as to what was performed (survey, desk survey, or audit) or documents reviewed to verify corrective action implementation.

3. CARs were revised; however QP-16.1, Rev. 1, does not provide for revisions to CARs.

4. CARs and CAR Log do not provide information as to why the CARs were revised. The CAR Log showed that the CARs were voided, but in reality,

9 Deficiency (continued)

the CARs were revised (CAR No. 043, 046, and 055).

5. The CAR Log was not sent to the RPC as required by QP-16.1, Rev. 1.

6. The form used for CAR does not reflect all the information required by the example form in QP-16.1, Rev. 1.

7. Some CARs (043, 044, and 055) were not completed in a timely manner.

8. CARs were not analyzed to establish quality trends.

9. Corrective Action Reports were issued to identify procedural noncompliance instead of "...significant breakdown in the QA Program or repeated nonconformances." Procedural noncompliance should be identified in another deficiency reporting system and when it becomes repetitive, then a CAR should be written.

10 Recommended Actions (continued)

determine the extent and depth of similar deficient conditions listed as examples on the SDR. Identify these deficiencies and provide the measures required to correct them. Identify the cause of the condition and the planned corrective action to prevent recurrance.

14 Remedial/Investigative Action(s)

Remedial Actions: For the deficiency reported in Block 9, point #9, transmit a copy of the NCR Log for calendar years 1988 and 1989 to the RPC.

Investigative Actions: Each open CAR and NCR will be evaluated against the deficiencies noter in Block 9, points 1 through 9, revsied as necessary and written documentation of the review will be placed in the CAR and NCR files.

16 Cause of the Condition & Corrective Action to Prevent Recurrence

Cause of the Condition: Personnel error and procedural inadequacies.

Corrective Action to Prevent Recurrence: Revise the entire deficiency reporting system, QP-15.1 and QP-16.1. Retrain personnel to the revised deficiency reporting system.

proper document control will be performed by the QAS each calendar quarter. The requirements for this overview will be documented in a change to QP06.1."

SDR 467-Clarification

1. Add the following to Block 16-Cause of Condition and Corrective Action to Prevent Recurrence:

   "Cause-It was intended to issue semi-annual Trend Reports rather than quarterly Trend Reports as required by QP16.2."

   "Corrective Action to Prevent Recurrence-QP16.2 will be revised to specify issuance of semi-annual Trend Reports rather than quarterly reports."

SDR 468-Amendment

Block 14-Remedial/Investigative Action(s)

"Remedial-Review generic deficiencies identified in Block 9 for the corrective action process as well as those identified for specific CARs. The QAPL will then determine what remedial action is appropriate for each identified deficiency."

"Investigative-Review all CARs Issued to date for indication of deficient conditions such as those described in Block 9 of the SDR. Document and report the results of this review to the QAPL so that corrective action determined to be necessary may be initiated."

Block 16-Cause of Condition & Corrective Action to Prevent Recurrence

"Cause-Personnel error and procedural inadequacies."

"Corrective Action to Prevent Recurrence-The Corrective Program procedures will be revised to restructure the program. As a result, program requirements not previously addressed will specified. After revision, training of all personnel involved in the Corrective Action Program will be performed with additional training provided to personnel involved with program implementation and administration."

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N-QA-038
4/89

Completed by Originating QA Organization

1 Date 11/17/89 | 2 Severity Level ☐ 1 ☒ 2 ☐ 3 | Page 1 of 23

3 Discovered During: Audit 89-7

3a Identified By: M. Diaz

4 SDR No. 469 Rev. 0

5 Organization: Los Alamos Nat'l Lab

6 Person(s) Contacted: E. Cole/P. Tillery

7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)
(Checklist Item 18-5-1)
TWS-QAS-QP-18.1, Rev. 1, Para. 6.6.1, states in part "If any findings have been identified, a response is sent to the audit team leader within 20 working

9 Deficiency
Contrary to the requirements cited above, audit report LANL-YMP-89-02 contains the following deficiencies:

10 Recommended Action(s): ☒ Remedial ☒ Investigative ☒ Corrective
Identify the remedial action(s) to be taken to correct the deficiencies noted in block 9. Investigate the program, process, activities or documentation to

Aprvl.

11 QAE/Lead Auditor/Date: S. Dana 11/30/89

12 Division Manager/Date: 12-1-89

13 Project Quality Mgr./Date: 12/1/89

Completed by Organization in Block 5

14 Remedial/Investigative Action(s)

15 Effective Date 2/16/90

Refer to Page 3 of 3

16 Cause of the Condition & Corrective Action to Prevent Recurrence

17 Effective Date 2/16/90

Refer to Page 3 of 3

18 Signature/Date: HP James 1/12/90

Comp. by Orig. QA Org.

19 Response Accepted	QAE/Lead Auditor/Date: Mario for 2/21/90	Division Manager/Date: S. Dana 2/21/90	Project Quality Mgr./Date: [illegible]
20 Corrective Action Verif. Satisfactory	QAE/Lead Auditor/Date	Division Manager/Date	Project Quality Mgr./Date

21 Remarks: RESPONSE LETTER TWS-EES-13-01-90-065.

22 QA CLOSURE	QAE/Lead Auditor/Date	Division Manager/Date	PQM/Date

8 Requirement (continued)

days of the audit report." Para. 6.7.1 states in part "The status of audit findings for the current year shall be updated monthly by the QAS and reported to the QAPL." LANL-YMP-QAPP, Rev. 4.4, Para. 16.1, states in part "The corrective action system shall ensure that conditions adverse to quality shall be identified promptly, documented on corrective action reports, and correctedas soon as practical."

9 Deficiency (continued)

1. The audit report was issued on July 11, 1989. However, a response was not issued until October 6, 1989, 63 days after the due date.

2. Status of the audit findings was not reported to the QAPL as required.

3. A corrective action report was never issued. However, the affected audit team leader was aware of the situation but did not take any action to identify it nor to document it.

10 Recommended Actions (continued)

determine the extent and depth of similar deficient conditions listed as examples on the SDR. Identify these deficiencies and provide the measures required to correct them. Identify the cause of the condition and the planned corrective action to prevent recurrence.

14 Remedial/Investigative Action(s)

Remedial Action: None required for the deficiencies reported in Block 9, points 1 through 3. The QAPL is now aware of the audit finding status for LANL audit 89-02, and has notified the TPO, reference letter TWS-EES-13-12-89-003.

Investigative Action: Review the past LANL audit reports for calendar year 1988 and 1989 for a similar deficiency and prepare a summary report for the QAPL.

16 Cause of the Condition & Corrective Action to Prevent Recurrence

Cause of the Condition: Follow-up actions were not documented by the audit team leader. Further, personnel did not follow the audit procedure and issue the audit status finding report. Subsequently no CAR was issued due to a lack of written documentation.

Corrective Action to Prevent Recurrence: The LANL audit procedure, QP-18.1, will be revised to provide more explicit instructions regarding follow-up actions undertaken by the audit team leader and issue of a monthly audit finding status report. The LANL audit staff will be retrained to the new procedure upon its issue.

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Completed by Originating QA Organization

1 Date 11/17/89 | 2 Severity Level ☐ 1 ☒ 2 ☐ 3 | Page 1 of 23

3 Discovered During: Audit 89-7

3a Identified By: M. Diaz

4 SDR No. 470 Rev. 0

5 Organization: Los Alamos Nat'l Lab

6 Person(s) Contacted: E. Cole/P. Tillery.

7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)
(Checklist Items 18-2, 18-3-1)
NNWSI/88-9, Rev. 2, Section XVIII, Para. 1.3.1, states in part "Audit plans shall identify organizations to be notified,...applicable documents."

9 Deficiency
Contrary to the requirements cited above:

1. Audit plans do not identify organizations to be notified and the appli-

10 Recommended Action(s): ☒ Remedial ☒ Investigative ☒ Corrective
Identify the remedial action(s) to be taken to correct the deficiencies noted in block 9. Investigate the program, process, activities or documentation, to

Aprvl.

11 QAE/Lead Auditor/Date: S. Dana 11/30/89

12 Division Manager/Date: [signature] 12-1-89

13 Project Quality Mgr./Date: [signature] 12/1/89

Completed by Organization In Block 5

14 Remedial/Investigative Action(s)

Refer to Page 3 of 3

15 Effective Date 2/16/90

16 Cause of the Condition & Corrective Action to Prevent Recurrence

Refer to Page 3 of 3

17 Effective Date 2/16/90

18 Signature/Date: HPAlmes 1/12/90

Comp. by Orig. QA Org.

	QAE/Lead Auditor/Date	Division Manager/Date	Project Quality Mgr./Date
19 Response Accepted	[signature] for 2/21/90	S. Dana 2/21/90	[signature] 2/28/90
20 Corrective Action Verif. Satisfactory	QAE/Lead Auditor/Date	Division Manager/Date	Project Quality Mgr./Date

21 Remarks RESPONSE LETTER TWS-EES-13-01-90-065 PLUS AMENDED RESPONSE LETTER TWS-EES-13-02-90-033.

22 QA CLOSURE	QAE/Lead Auditor/Date	Division Manager/Date	PQM/Date

TWS-EES-13-01-90-065

8 Requirement (continued)

TWS-QAS-QP-18.1, Rev. 1, Para. 6.4.2, states in part "Auditors document their investigations, observations, and names of personnel interviewed on the audit checklist." NNWSI/88-9, Rev. 2, Section XVIII, Para. 1.4, states in part "Objective evidence shall be examined to the depth necessary to determine if these elements are adequate for effective control and to determine whether or not they are being implemented effectively."

9 Deficiency (continued)

cable documents to be used during the audit.

2. Numerous audit checklists do not contain the documented evidence reviewed during the audit.

3. Checklists do not contain qualitative or quantitative criteria to determine whether or not the objective evidence examined during the audit is acceptable to the scope and requirements of the audit.

10 Recommended Actions (continued)

determine the extent and depth of similar deficient conditions listed as examples on the SDR. Identify these deficiencies and provide the measures required to correct them. Identify the cause of the condition and the planned corrective action to prevent recurrence.

14 Remedial/Investigative Action(s)

Remedial Actions: Refer to investigative actions stated below.

Investigative Actions: Review the audit records for proper notification, completed checklists, appropriate document references, and qualitative and quantitative statements for acceptance. Results of each audit reviewed will be reported to the QAPL.

16 Cause of the Condition & Corrective Action to Prevent Recurrence

Cause of the Condition: Audit direction contained within the implementing procedure was inadequate.

Corrective Action to Prevent Recurrence: Revise the audit procedure to incorporate clear guidance on audit documentation. The audit staff will be trained to the revised procedure upon its issue.

SDR 470-Clarification

1. Change the last sentence of the response in Block 14 addressing Investigative Actions to read as follows:

   "Results of each audit reviewed will be documented and reported to the QAPL who will initiate needed additional corrective action."

Responses to SDRs 461, 469, and 471 are considered to be acceptable.

Ltr dtd 2/14/90 - TWS-EES-13-02-90-033

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YMPO STANDARD DEFICIENCY REPORT

Completed by Originating QA Organization

1 Date 11/16/89 | 2 Severity Level ☐ 1 ☒ 2 ☐ 3 | Page 1 of 23

3 Discovered During: Audit 89-7
3a Identified By: S.L. Crawford
4 SDR No. 471 Rev. 0

5 Organization: Los Alamos Nat'l Lab
6 Person(s) Contacted: K. Foster
7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)
(Q #2-2) LANL-YMP-QAPP, Rev. 4.4, para. 2.5 provides "Position descriptions shall establish minimum personnel qualifications and the necessary indoctrination or training or both before a person starts work on activities

9 Deficiency
TWS-QAS-QP-02.1, Rev.1, para. 4.2 and para 6.1, step 5, do not require position descriptions to identify needed indoctrination or training. Position descriptions do not generally identify training and indoctrination

10 Recommended Action(s): ☒ Remedial ☐ Investigative ☒ Corrective
Identify the remedial action(s) to be taken to correct the deficiencies noted in block 9. Identify the cause of the condition and the planned action to

Aprvl.

11 QAE/Lead Auditor/Date: S. Dana 11/30/89
12 Division Manager/Date: 12-1-89
13 Project Quality Mgr./Date: 12/1/89

Completed by Organization in Block 5

14 Remedial/Investigative Action(s)
Refer to Page 3 of 3

15 Effective Date 2/16/90

16 Cause of the Condition & Corrective Action to Prevent Recurrence
Refer to Page 3 of 3

17 Effective Date 2/16/90

18 Signature/Date: 1/12/90

Comp. by Orig. QA Org.

	QAE/Lead Auditor/Date	Division Manager/Date	Project Quality Mgr./Date
19 Response Accepted	2/22/90	S. Dana 2/22/90	2/22/90
20 Corrective Action Verif. Satisfactory			

21 Remarks
① Ref. SDR response ltr, Herbst to Hoeton, dtd. 1/11/90

22 QA CLOSURE	QAE/Lead Auditor/Date	Division Manager/Date	PQM/Date

8 Requirement (continued)

that affect quality."

9 Deficiency (continued)

requirements; training matrices, per QP-02.2 are not attached to certifications, resumes, or position descriptions, to show required training prior to annual certification.

10 Recommended Actions (continued)

prevent recurrance.

14 Remedial/Investigative Action(s)

Remedial actions: Procedure QP-02.1 will be changed to add the indoctrination and training requirements to each position description. All LANL position description will be revised to include this needed information and the files updated in accordance with the change.

Investigative actions: None required, the above actions involve all the LANL personnel files.

16 Cause of the Condition & Corrective Action to Prevent Recurrence

Cause of the condition: Implementing procedure did not require the inclusion of indoctrination and training requirements as a part of the position description.

Corrective action to prevent recurrence: A change request to the implementing procedure QP-02.1, Procedure for Personnel Selection, Indoctrination, and Qualification, will be issued requiring that position descriptions include applicable indoctrination and training information.

Monthly Activity Report
January 1990

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LOS ALAMOS NATIONAL LABORATORY
YUCCA MOUNTAIN PROJECT

Monthly Activity Report
January 1990

WBS 1.2.1
Project Title: Systems

The objective of this task is to integrate systems with the Geologic Repository Program and describe the Yucca Mountain Project Mined Geologic Disposal System and to evaluate the performance of the natural, engineered barrier, and total systems for meeting regulatory standards.

ACTIVITIES AND ACCOMPLISHMENTS:

Performance Assessment

K. Eggert and G. Zyvoloski attended a PACE Working Group 1 meeting in Las Vegas, on January 25. The group finalized the problem definition for the WG1 PACE expected case transport problems. K. Eggert presented a set of Kd values (supplied by A. Meijer) to be used for the problems and discussed the modeling approach that our task will use. G. Zyvoloski presented results for preliminary gas phase transport calculations at Yucca Mountain.

K. Eggert, G. Zyvoloski, G. Valentine, and K. Campbell met with project participants at Sandia on January 30. The group looked at Bob Glass's hydrologic experiments and discussed the data base for the PACE problems, geostatistical treatment of data gathered at Yucca Mountain, and cooperative efforts for flow-field calculations.

Technical Data Advisory Group (TDAG)

The TDAG met in Denver on January 26-27. The agenda consisted of a presentation and demonstration by the SAIC Golden staff on PARATRAC, a tool to track site characterization parameters and links with Performance Measures as defined in the Site Characterization Plan. The TDAG discussed a recent NRC interaction on technical data. The NRC wants the Data Catalogue on-line and some scientists representing the NRC wanted the Project's raw data even before the Project's analysis and reports. The meeting with Headquarters was also discussed. DOE wants the Technical Data Management system linked with PRoMIS, a project management information system.

The Technical Data Management Plan will be out for review in March, and three associated administrative procedures will be revised in June. Working groups will be formed around surface-based test prioritization to develop data input to the RIB.

Los Alamos presented the developed PACS schedule for the Min/Pet tasks. The link between the WBS structure and the SCP structure was shown. The link with the Long Range plan was pointed out. The milestones associated with the activities represented in the PACS schedule were described, and the milestone specifically designated as SEPDB submissions were shown. The TDAG lead from the DOE was interested in this way of scheduling and tracking data and data submissions. The TDAG lead was looking for a way to make the data flow in the DOE system without creating a data management schedule.

A presentation in the Instrument Data Acquisition System (IDAS) supporting the USGS's surface-based monitoring tasks was presented. The presentation was informative and well presented. The IDAS seems to be an impressive result of good planning, thought, and design.

WBS 1.2.3.2.1.1.1
Project Title: Mineralogy of Transport Pathways

The purpose of this activity is to define the important mineralogic and geochemical variables along transport pathways at Yucca Mountain in support of performance assessment and to evaluate the impact of repository construction on natural waste transport barriers.

ACTIVITIES AND ACCOMPLISHMENTS:

Studies of fracture-coating minerals in the Topopah Spring Member (drill cores USW G-1, G-2, and GU-3) are continuing. Scanning electron microscope (SEM) examination of samples from USW G-2 was completed, and a few samples remain to be analyzed by x-ray diffraction (XRD). The presence of stilbite with clinoptilolite and mordenite in fractures and lithophysal cavities above the vitrophyre makes USW G-2 very different from USW G-4. Study of fracture coatings from USW GU-3 has just begun, but this core also appears to be very different from USW G-4. Drusy quartz appears to be the dominant fracture mineral above the vitrophyre in USW GU-3. These differences in Topopah Spring Member fracture mineralogy between cores suggest considerable variability in unsaturated-zone fracture mineralogy across Yucca Mountain.

The development of trace-mineral separation methods has begun on samples UE-25a#1 (1153.2-1153.9), from the devitrified Topopah Spring Member, and UE-25a#1 (1478.1-1478.7), from the clinoptilolite-rich zeolitized tuff of Calico Hills. Magnetic and density methods will be used.

Studies of calcite deposition within fractures and faults of the Topopah Spring Member are on hold until software QA applications for the electron microprobe are resolved.

Data analysis of prototype sampling (Solitario Canyon) data by Group A-1 is on hold pending resolution of software QA problems. January was spent reformulating standard geostatistical inference procedures in terms of a Bayesian solution to an inverse problem. This approach is extremely useful in formalizing the decision analysis problem that underlies the design of sampling plans for both the Exploratory Shaft and a limited drilling plan. A talk was presented outlining some of these results, together with some of last year's simulation work, at Sandia National Laboratory on January 30 at a meeting arranged by EES-5.

S. Bolivar attended the January 9 meeting of the Sample Overview Committee. Discussions included SNL's capabilities in using the GIS to provide geologic information for the site (stratigraphic levels, contacts, etc.), the Apache Leap sample requests, the Surface Based Investigation Plan report, and borehole contamination.

A letter report by S. Levy and B. Carlos, "Preliminary Descriptions of Gel Fracture Fillings from Ranier Mesa, Nevada Test Site," is included in the appendix. This Level III milestone report was completed in November 1989.

PLANNED WORK:

Develop Exploratory Shaft Sampling plan using data from the Solitario Canyon outcrop; re-examine revised XRD data to develop "prior" models in terms of which proposed drilling plans can be evaluated; work on image analysis methods to generate porosity distribution maps and in trace-mineral analysis; develop statistical methods, especially the development of tools for handling compositional data; further develop methods for simulating spatially distributed mineralogic compositions for use in performance assessment models such as TRACR3D; evaluate trace-mineral separates from tuff samples at Yucca Mountain; continue examination and analysis of fracture-coating minerals in the Topopah Spring Member, and analyze fracture coatings, USW GU-3.

PROBLEM AREAS:

Issuance of a stop-work order on tasks using modified software has halted analyses using electron microprobe, XRF, quantitative XRD, and contracted INAA methods. A report on manganese minerals in the Tiva Canyon Member of the Paintbrush Tuff from USW G-4 will be delayed until 3 months after the stop-work on the electron microprobe is lifted. It is likely that no chemical analyses of fracture minerals will be included in the report on fracture coatings in the Topopah Spring Member. Delays will also be felt immediately in the report on calcite in fractures, which can not be completed until 2 months after the stop work on the electron microprobe is lifted. Statistical analysis of data is on hold until the stop-work order on software is lifted.

BIBLIOGRAPHY:

K. Campbell
Sampling for Site Characterization of a Potential Waste Repository Mathematical Geology (Journal)
Withdrawn due to improved theoretical developments.

B. Carlos
Manganese-oxide Minerals in Fractures of the Crater Flat Tuff in Drill Core USW G-4
LA-series report
IS-11 editing.

MILESTONE PROGRESS:

3120
1/90
Calcite in Fractures
Delayed because of stop work order on software.

3132
2/90
Tiva Fracture Mineralogy in USW G-4
Delayed because of stop work order on software.

3133
9/90
Summary: Topopah Fracture Mineralogy
New report.

3134
12/90
Trace Mineral Separations
Writing 3% complete.

3135
10/90
Review of Yucca Mountain Mineralogy
Writing 10% complete.

3136
10/90
Review of Erionite at Yucca Mountain
Writing 5% complete.

3137
Mineralogy of Calico Hills for Adit Development
New report.

T503
6/91
Statistical Analysis, Topopah Spring Member
Writing 5% complete; on hold pending software QA resolution.

WBS 1.2.3.2.1.1.2
Project Title: Mineralogic and Geochemical Alteration

The objective of this task is to characterize past and present natural alteration processes that have affected the potential geologic repository and to predict future effects of natural and repository-induced alteration.

ACTIVITIES AND ACCOMPLISHMENTS:

Hydrogenic deposit sample HD-15-3, a laminated sample from Trench 14, was studied by scanning electron microscope (SEM) analysis of backscattered-electron images and of x-ray maps. Relative proportions of authigenic opal and calcite are inferred from the data; the overall ratio of opal to calcite is approximately 1:4, although the relative abundances vary greatly from lamella to lamella within the sample. This work was done under the stop work order and is therefore designated as QALA III work.

A sample of bedrock breccia from Busted Butte was also studied by SEM. The authigenic-mineral-cemented breccia contains clasts of crushed-tuff-matrix breccia recycled from an older breccia. Some of the clasts have coatings containing fragments of acicular calcite not found elsewhere in the *in situ* breccia cement. It is possible that the clasts acquired the coats during one or more earlier cycles of erosion, deposition, and cementation and were subsequently re-eroded and deposited in their present-day location.

Six subsamples of HD-42 were analyzed by x-ray diffraction to investigate possible correlations between mineralogy and isotopic composition (determined by the USGS). All six subsamples have authigenic components consisting dominantly of opal-A and calcite. There is no apparent correlation between $^{87}Sr/^{86}Sr$ ratios and authigenic mineralogy. However, there is a correlation between detrital feldspar abundance and Rb content.

Preparation of secondary mineral samples for K/Ar and Ar/Ar dating continued. Some samples were split, with one split subjected to dialysis. When both dialyzed and undialyzed splits are analyzed for isotopic abundances and potassium content, it should be possible to determine whether loosely-bound potassium (i.e., potassium that can be removed by dialysis) has a significant effect on the age determination.

D. Cowan and V. Priest, of the University of Missouri, have obtained an electron spin resonance (ESR) date for drusy quartz void fillings from the Tiva Canyon tuff in Trench 14. The age derived from measurement of paramagnetic superoxide defects (produced by alpha recoil) is 8.6 - 2.9 m.y. The large estimated uncertainty mostly reflects the difficulty of measuring the fast- neutron flux to which the sample is exposed in the process of determining the natural radiation dose. ESR measurements were also made of an unidentified paramagnetic defect produced by gamma radiation damage. It is estimated that this defect was saturated (i.e., reached the maximum abundance that the crystal lattice can contain) about 7 m.y. ago; this date represents an independently derived minimum age for the sample.

Long-term vitrophyre dehydration experiments continued. Revisions to the alteration history study plan were completed and submitted to the Los Alamos program office.

PLANNED WORK:

D. Vaniman and S. Levy will present the results of work on hydrogenic deposit studies to the NRC in Las Vegas next month. The presentations by USGS and LANL researchers will be followed by a one-day field trip to hydrogenic deposit study sites. Research on hydrogenic deposit samples will continue.

G. WoldeGabriel will perform isotopic analysis of secondary mineral samples to determine the K/Ar and Ar/Ar systematics.

Preparations are underway for the quality assurance audit scheduled for March 1990.

PROBLEM AREAS:

Research efforts continue to be retarded while quality assurance concerns are addressed.

BIBLIOGRAPHY:

D. Bish
Thermal Stability of Zeolitic Tuff from Yucca Mountain, Nevada
International High-Level Radioactive Waste Management Conference, April 1990
Submitted to Project Office 1/11/90.

MILESTONE PROGRESS:

No milestone due in next three months.

WBS 1.2.3.2.1.2
Project Title: Stability of Minerals and Glasses

The objective of this activity is to produce a model for past and future mineral alteration in Yucca Mountain. The model is intended to explain 1) natural mineral evolution resulting from the transformation of metastable mineral assemblages to more stable assemblages and 2) the effects of a repository emplacement.

ACTIVITIES AND ACCOMPLISHMENTS:

The smectite/illite milestone report includes results of a Monte Carlo model for the smectite/illite transition that accounts for the ordering observed in I/S as a function of illite content. The model indicates that intermediate I/S can exist at equilibrium and that I/S behaves thermodynamically as a solid solution. Therefore, some I/S may have reached equilibrium and be indicative of their conditions of formation independent of the history of the sample. However, the state of order of many I/S indicates that they have not reached equilibrium. In particular, I/S that could be at equilibrium are not observed with < 55% illite layers.

It is proposed that pure smectite is stable only at $a_{SiO_{2(aq)}}$ above cristobalite saturation, and that at $a_{SiO_{2(aq)}}$ defined by quartz saturation only, I/S with illite contents > 50 - 55% can be at equilibrium. Most of the variation in equilibrium illite content between 50% and 100% can probably be produced by temperature variation between 25° and 200°C. Decrease in a_{H_2O} due to the presence of highly saline brines would tend to lower the temperature needed to produce a given percentage of illite layers.

Hardware for the data acquisition system has been installed in the hydrothermal lab, and its performance is being tested.

PLANNED WORK:

When the milestone is completed, our primary effort will be directed toward study plan comment resolution. Work will continue in support of achievement of a fully qualified QA program as needed. We will also continue to test the data acquisition system.

MILESTONE PROGRESS:

Work on the smectite/illite transition milestone is 95% complete and will be ready for technical review in February.

WBS 1.2.3.2.5
Project Title: Postclosure Tectonics

The objective of these volcanism studies is to determine the hazards of future volcanic activities with respect to siting a high-level radioactive waste repository at Yucca Mountain.

ACTIVITIES AND ACCOMPLISHMENTS:

Verification of comment resolution for Study Plan 8.3.1.8.5.1, Characterization of Volcanic Features, is in progress with assistance from SAIC. Several sets of comments have been verified, and signatures obtain from reviewers.

The contract for thermoluminescence (TL) dating with S. Forman of the University of Colorado was resubmitted to the University after technical review and addition of expanded quality assurance (QA) requirements.

A paper, "Basalt Volcanic Episodes of the Yucca Mountain Region," was completed for the International High Level Waste Management meeting in Las Vegas in April.

A draft response to a nonconformance report on the use of volcanism field notebooks was completed and is in review by the volcanism QAL. Two notebooks were upgraded to comply with QP-3.5 and the revised volcanism field procedure (DP-65).

A draft revision of the procedure for volcanism field studies (DP-65) was completed and is in review by the volcanism QAL. The procedure has been expanded to include sections on descriptions of methods for conducting the field studies of geomorphology of volcanic landforms and the development of soils on volcanic deposits and alluvial deposits associated with volcanic deposits.

A Memorandum of Understanding was completed for work conducted with the U.S. Geological Survey.

A letter was sent by the volcanism QAL to the EES-13 program office providing suggestions for needed changes to QP-04.1 and QP-04.3 to allow procurement of analytical services on a commercial grade basis.

The manuscript on the geomorphology of the Lathrop Wells volcanic center (first author S. Wells, University of New Mexico) was revised and returned to *Geology*. It is now scheduled for publication.

A new technician at the University of New Mexico received QA training during the month. She will be trained to the appropriate volcanism DP's in preparation for starting work on the volcanism task.

A QA software audit was conducted for investigators at the University of New Mexico on January 11.

Stereoscopic aerial photographic analysis was completed on EG&G photographs (1:5000) of the Sleeping Butte volcanic centers (Little Black Peak center and Hidden Cone).

Neon and helium isotopic ratios were measured for a sample of the Ql4 lava from the Lathrop Wells volcanic center. The ratios were consistent within analytical error, suggesting that there are no problems in the sample with loss of helium by diffusion.

PLANNED WORK:

The uranium-thorium (U-Th) disequilibrium isotopic data for Lathrop Wells sample LW-89-3-21-2 have been evaluated. We have decided to measure the Th isotopic ratios despite having only about a 5% spread in Th/U ratios in separated phases. This will allow age discrimination for the sample of about 40 ka. It may be sufficient to test current working models of the age of the lava units at the Lathrop Wells center.

Helium and neon isotopic ratios will be analyzed for the Ql4 lava for samples ranging in size from rock chunks to separated olivine.

Finalize the manuscript by Crowe, Fredrich (DOE), and Dobson (DOE) for the Waste Management '90 meeting at Tucson in March.

Permission has been obtained from the Air Force to conduct field geologic mapping at the Sleeping Butte volcanic centers. The work will be completed during the beginning of February and reported in the February monthly report.

BIBLIOGRAPHY:

B. Crowe
Basaltic Volcanic Episodes of the Yucca Mountain Region
International High-Level Radioactive Waste Management Conference
Submitted to the Project Office 1/24/90.

B. Crowe, C. Fredrich, and D. Dobson
Strategy for Resolution of Volcanic Risk Assessment for the Yucca Mountain Site
Waste Management 90
In preparation.

MILESTONE PROGRESS:

Letter report on feasibility of U/Th, helium, and TL dating is scheduled for June 1991. The report is on schedule. The TL part of the report may be delayed if there are further delays in the emplacement of the contract with the University of Colorado.

A level II milestone to produce a preliminary geologic map of the Sleeping Butte volcanic centers is scheduled for June 1991. It is on schedule.

A level II milestone report on the status of geochronology studies at the Lathrop Wells volcanic center is scheduled for January 1991. It is on schedule.

A level II milestone report on the geochemistry of the Lathrop Wells volcanic center is scheduled for January 1991. The completion of this milestone is dependent on development of a QA software plan for the EES-1 analytical equipment and permission to obtain commercial grade trace element data from Washington University.

WBS 1.2.3.3.1.2.2 and 1.2.3.3.1.2.5
Project Title: Water Movement Tracer Tests and Diffusion Tests in the ESF

The objective of the water movement tracer tests is to obtain measurements of chlorine isotope distributions to help quantify the percolation of precipitation in the unsaturated zone. The objective of the diffusion tests in the ESF is to determine *in situ* the extent to which the nonsorbing tracers diffuse into the water-filled pores of the Topopah Spring welded unit.

ACTIVITIES AND ACCOMPLISHMENTS:

A request for cuttings from the Yucca Mountain Project's Phase 1e prototype drilling at Apache Leap, Arizona, was submitted to the Sample Overview Committee. Analysis of the cuttings for ^{36}Cl would be valuable for establishing the procedures to be used with Yucca Mountain samples. The Sample Overview Committee approved the request and forwarded it to M. Blanchard; however, the drilling that was supposed to start on January 22 has been postponed at Headquarter's request.

Comment resolutions were verified for Study Plan 8.3.1.2.2.7, Hydrochemical Characterization of the Unsaturated Zone. This verification completed action item NN1-1990-0611.

An abstract of a technical paper about ^{36}Cl work was prepared and sent to coauthors at Hydro Geo Chem and at the University of Rochester for their comments. The technical presentation is planned for an accelerator mass spectrometry meeting in April.

Comments from the technical review of procedure TWS-INC-DP-84 are being addressed, and comment resolution is expected to be completed early next month.

PLANNED WORK:

The next ^{36}Cl accelerator mass spectrometry run at the University of Rochester's tandem accelerator is planned for February 11-21, the first ^{36}Cl run since September. Analyses of about ten samples from this task should be done during this run.

MILESTONE PROGRESS:

Milestones have not been scheduled for this fiscal year.

WBS 1.2.3.3.1.3.1
Project Title: Testing of C-Hole Sites with Reactive Tracers

Experiments will be conducted at the C-well complex (holes UE25c#1, UE25c#2, and UE25c#3) and in other wells in the vicinity of Yucca Mountain. Reactive tracers will be used to characterize retardation and transport properties on a scale larger than that currently used in laboratory experiments.

ACTIVITIES AND ACCOMPLISHMENTS:

Efforts continued on completing the milestone for Finite Element Heat-Mass code (FEHMN). We are authorized to complete this work under the current software stop work order. If any differences are found in the verification simulations, we will simply report the results without making any changes in source code. The final runs were to test the coupling of heat transfer and fluid convection heat transfer using an analytical solution for heat transfer in a wellbore. Fortunately, FEHMN agreed with the analytical solution, and no further work on this verification simulation is required.

Work began in assisting G. Cort with the new quality procedure (QP) for data management in software: Z. Dash and B. Robinson will write this QP. The plan is to devise a system for managing the creation and storage of computer-generated data using the concept of standardized input and output. This will facilitate the interchangeability of data files throughout the project and be useful for documenting the heritage of data generated by computer codes.

A technical progress report has been submitted by H. Fuentes to fulfill the obligations of the UTEP contract. It is currently being reviewed.

PLANNED ACTIVITIES:

Complete the milestone on FEHMN.

Rewrite detailed technical procedures to conform with the requirements of YMP 88-9, R2, and write the QP on data management.

BIBLIOGRAPHY:

B. D. Newman, H. R. Fuentes, and W. L. Polzer
An Evaluation of Lithium Sorption Isotherms and Their Application to Groundwater Transport
Groundwater (Journal)
Revision to Project Office 1/11/90.

W. L. Polzer, M. G. Rao, and H. R. Fuentes
The Use of the Modified Freundlich Isotherm to Estimate Thermodynamic Equilibrium Properties of Ion Exchange Adsorption of Radionuclides on Volcanic Tuff. Part I. Theoretical Development
Environmental Science and Technology (Journal)
In technical review.

W. L. Polzer and H. R. Fuentes
The Use of the Modified Estimate Thermodynamic Equilibrium Properties of Ion Exchange Adsorption of Radionuclides on Volcanic Tuff. Part II. Experimental
Environmental Science and Technology (Journal)
In preparation.

B. A. Robinson
FRACNET - Fracture Network Model for Water Flow and Solute Transport
LA-series report
In preparation.

MILESTONE PROGRESS:

R529
9/30/89
Evaluation of Preliminary Application of FEHMN to Yucca Mountain
Delayed.

Level III report
12/31/89
SORBEQ Documentation
Delayed due to stop work order on software.

WBS 1.2.3.4.1.1
Project Title: Groundwater Chemistry

The goal of this investigation is to provide conceptual and mathematical models of the groundwater chemistry at Yucca Mountain. These models will explain the present groundwater composition in relation to interactions of minerals and groundwater and will be used to predict groundwater compositions as a result of anticipated and unanticipated environments.

ACTIVITIES AND ACCOMPLISHMENTS:

Draft of the study plan for Study 8.3.1.3.1.1 is in technical review. One LANL reviewer is still commenting, and the text will be revised after the reviewer's comments are received.

Data from J. Kerrisk and A. Ogard (Groundwater Chemistry Along Flow Paths Between a Proposed Repository Site and the Accessible Environment, LA-10188-MS, 1984) were submitted to the Data Manager at Los Alamos for submission to the SEPDB.

Staff attended the Technical Information Exchange meeting on Geologic Structures and Hydrochemistry of Yucca Mountain in Las Vegas on January 29-31. Representatives from LANL, USGS, DOE/YMP and SKB (Swedish Nuclear Fuel and Waste Management Company) also attended.

PLANNED ACTIVITIES:

Submit Study Plan for Project Office review.

Begin collaboration with USGS to show the sensitivity of different groundwater composition parameters. Information from this collaboration will be important to development of conceptual models of groundwater chemistry at Yucca Mountain.

Review quality assurance material as requested in support of February 16 deadline for the audit response.

BIBLIOGRAPHY:

C. Dicke and H. Fuentes
Modeling of Sr Surface Complexation and Migration
Groundwater (Journal)
In preparation.

MILESTONE PROGRESS:

No milestone reports are scheduled in the next three months.

WBS 1.2.3.4.1.2.1 and 1.2.3.4.1.2.3
Project Title: Sorption

The objective of the sorption and precipitation task is to provide sorption coefficients for elements of interest in order to be able to predict radionuclide movements from the repository to the accessible environment.

ACTIVITIES AND ACCOMPLISHMENTS:

The experiments involving pure mineral separates contacted with neptunium (Np)-spiked J-13 water are still in progress. The solutions resulting from the experiments are being counted for gamma activity. The first set of technetium (Tc) sorption experiments involving pure mineral separates and J-13 water has been completed. The samples are being counted, and sorption coefficients will be reported next month.

Several geochemical computer codes useful in modeling sorption reactions have either been acquired or ordered: the codes of interest include PHREEQE, MINTEQ, MINEQL, HYDRAQL, and FITEQL. These codes will be evaluated, and one will be chosen for use in modeling the pure mineral sorption experiments.

The Stanford group is continuing with the Np/hematite sorption experiments as a function of pH.

PLANNED WORK:

Continue the study of Np sorption on pure minerals in J-13 water, Tc sorption studies on pure minerals, and development of modeling capabilities for the interpretation and integration of sorption data.

BIBLIOGRAPHY:

A. Meijer
YMP Far-Field Sorption Studies and Data Needs
LA-series report (approved milestone T419)
At press.

WBS 1.2.3.4.1.2.2
Project Title: Biological Sorption and Transport

The purpose of this research is to determine whether microbial activity can influence the movement of plutonium in tuff. Because fluids are used extensively in the exploration of locations for a nuclear repository, of special interest are those microorganisms capable of utilizing drilling fluids as growth substrates.

ACTIVITIES AND ACCOMPLISHMENTS:

As discussed in last month's report, significant improvement in siderophore production has been achieved by adjusting the relative concentrations of several media constituents, most notably that of iron. Since the amount of iron was reduced in the medium, the amount of siderophore has increased dramatically, averaging over 33 mg per run (crude sample). Work has continued on improving the production of siderophore.

PLANNED WORK:

Further develop techniques to purify siderophore, and begin colloidal agglomeration experiments.

WBS 1.2.3.4.1.3
Project Title: Solubility Determination

The objective of the solubility determination task is to determine the solubilities and speciation of important waste elements under conditions characteristic of the repository and along flow paths from the repository into the accessible environment.

ACTIVITIES AND ACCOMPLISHMENTS:

Hobart attended the NWTRB meeting at LLNL on January 18.

Staff prepared for the LANL internal review of the Solubility Task scheduled for February 8, and those involved in the Solubility Task prepared presentations for the review.

H. Nitsche submitted a comprehensive package of his program's software and requested a conditional exception from Stop Work Order No. SW/LA-001. The stop work order was lifted by G. Cort. A new ^{239}Pu stock solution to be used in the UE25p#1 experiment at 60° was prepared. Work continues on the new solubility cells.

The preparation of the following detailed technical procedures is in progress:

- Determining UV-VIS-IR Absorption and Diffuse Reflectance Spectra.
- X-Ray Powder Diffraction Analysis for Solubility (YMP-LBL-DP03).
- Sodium Concentration Determination in Radionuclide Solutions (YMP-LBL-DP05).

New commercial preamplifiers for photoacoustic signal processing were delivered and are being tested and incorporated into the system. These amplifiers have a larger bandwidth and more versatile frequency-filtering capabilities than those used previously, and they should provide enhanced noise reduction in photoacoustic data acquisition.

Work continues on optimizing data-collection routines, and we are retaining an emphasis on "full" photoacoustic waveform analysis. Recent efforts have focused on using the flexibility of the digital oscilloscope to provide variable selection of early and late time portions of the waveform for establishment of baseline and signal respectively, while ignoring the intermediate (low signal content) time portion. The instrumental components of the CMR photoacoustic facility have been integrated, and the system has been configured to begin bona fide data collection for Pu^{4+} speciation in carbonate media. These activities will begin as soon as the stop work order related to software quality assurance is resolved.

PLANNED WORK:

H. Nitsche plans to repeat the 60° C experiments with ^{243}Am and neodymium-spiked ^{241}Am.

Planned work will include identifying groundwater compositions that more closely resemble those expected in the unsaturated (vadose) zone at the Yucca Mountain site. We will continue work on a number of detailed procedures due this fiscal year.

Hobart, Morris, Clark, Nitsche, Tait, and Palmer will present talks at the LANL internal review of the Solubility Task at Los Alamos on February 8.

According to the SKB/DOE Bilateral Information Exchange Treaty, D. Hobart is expected to attend the next joint meeting in Sweden in June 1990.

Work will continue on the preliminary experiments with Pu^{4+} to assess system performance with the existing photoacoustic detection apparatus. While we anticipate continued modifications of the data collection routines to enhance system performance (likely for another 8-12 months), we will also attempt to establish the appropriate documentation and protocols so that the existing system can be used to begin to collect site characterization data.

WBS 1.2.3.4.1.4
Project Title: Dynamic Transport Process

The objective of the dynamic transport process task are to determine the rate of radionuclide movement along the potential flow paths to the accessible environment and to examine the effect of diffusion, adsorption, dispersion, anion exclusion, sorption kinetics, and colloid movements in the flow geometries and hydrologic conditions that are expected to exist along the flow path to the accessible environment in the scenarios to be used for performance assessment.

ACTIVITIES AND ACCOMPLISHMENTS:

No progress reported.

BIBLIOGRAPHY:

N. Patera, D. Hobart, A. Meijer, and R. Rundberg
Chemical and Physical Processes of Radionuclide Migration at Yucca Mountain Nevada
Radioanalytical Chemistry (Journal)
Returned to author for revisions 9/18/89.

I. R. Triay, R. S. Rundberg, A. J. Mitchell, M. A. Ott, D. E. Hobart, and P. D. Palmer
Size Determinations of Pu Colloids Using Autocorrelation Photon Spectroscopy
Migration '89 proceedings
In internal review.

WBS 1.2.3.4.1.5.1
Project Title: Retardation Sensitivity Analysis

The objectives of the retardation sensitivity analysis task are to construct a geochemical/geophysical model of Yucca Mountain and to use this model to examine the physical and chemical controls on radionuclide transport along flow paths to the accessible environment.

ACTIVITIES AND ACCOMPLISHMENTS:

Analysis of Physical/Chemical Processes

FEHMN/FEHMSN. Three papers were prepared and submitted for the conference proceedings for the International High-Level Radioactive Waste Management Conference, April 8-12, in Las Vegas.

QA and Programmatic

K. Birdsell met with G. Cort, C. Watson, and D. Hines to discuss "A Validation Methodology for Performance-Assessment Models," the methodology developed by the Validation Oversight Group. Cort will use the methodology to develop LANL's quality assurance strategy for validation.

The TRACRN Model Description and User's Manual is being prepared in LAMS format.

BIBLIOGRAPHY:

K. Birdsell, K. Campbell, K. Eggert, and B. Travis
Simulation of Radionuclide Retardation at Yucca Mountain Using a Stochastic Mineralogical/Geochemical Model
IHLRWMC
Submitted to Project Office 1/24/90.

S. Kelkar and G. Zyvoloski
Modeling of Coupled Heat-Mass-Stress Effects in Geologic Media
IHLRWMC
Submitted to Project Office 1/24/90.

G. Zyvoloski
Simulation of Heat Transfer in the Unsaturated Zone
International High-Level Radioactive Waste Management Conference (IHLRWMC)
Submitted to Project Office 1/24/90.

K. Birdsell and B. Travis
Results of the COVE2a Benchmarking Calculations Run with TRACR3D (approved milestone R749)
LAMS report
In preparation.

WBS 1.2.3.4.1.5.2
Project Title: Geochemical Field Tests for Validation

The purpose of this activity is to test the validity of the laboratory geochemistry data generated by the Geochemistry Test Program and to test the geochemical transport modules. Five subtasks constitute this activity: 1) natural analogs, 2) large block test, 3) caisson test, 4) unsaturated zone geochemistry field test, and 5) radionuclide migration studies at the Nevada Test Site.

ACTIVITIES AND ACCOMPLISHMENTS:

Natural Analogs

No significant action.

Large Block Tests

No significant action.

Anthropogenic Analogs

No significant action.

Caisson Tests

No significant action.

Geochemistry Field Tests

Emphasis has been on reviewing the current or anticipated needs of Los Alamos participants in terms of the purpose of this study. Any proposed test will need to include as many different aspects as possible to utilize the data in various studies in the Geochemistry Test Program. For example, a test to examine sorption processes may also include colloid transport and matrix diffusion. More discussion will be required to determine a logical approach to this effort as more data are collected in laboratory experiments, and testing requirements of the various projects become apparent.

PLANNED WORK:

A presentation to the principal investigators integration group is planned to present various strategies and ideas for this study and to continue discussion.

WBS 1.2.5
Project Title: Regulatory and Institutional

The purpose of this task is to coordinate the regulatory and institutional Project requirements within the Los Alamos programmatic structure. The focus of this coordination effort is on the integration of the technical work within the regulatory and institutional framework.

Site Characterization Plan

No action.

Semi-annual Progress Report

No action.

Study Plans

The status of the study plans is as follows.

Water Movement Test, R3 (8.3.1.2.2.2). Approved by Project Office and DOE/HQ; sent to NRC and State of Nevada.

Diffusion Test in the Exploratory Shaft, R0 (8.3.1.2.2.5). Abstract and SCP-based network submitted to Project Office 5/25/89 and to DOE/HQ 6/30/89.

Testing of the C-Hole Sites With Reactive Tracers, R1 (8.3.1.2.3.1.7). Revision 2, which incorporates DOE/HQ and Project Office comments, was submitted to DOE/HQ 11/16/89.

Mineralogy, Petrology, and Chemistry of Transport Pathways, R3 (8.3.1.3.2.1). A Study Plan Assessment was developed for this study and transmitted to DOE/HQ on 6/22/89.

History of Mineralogy and Geochemical Alteration at Yucca Mountain, R0 (8.3.1.3.2.2). A comment resolution meeting was held on May 31, 1989, for DOE/HQ comments.

Kinetics and Thermodynamics of Mineral Evolution and Conceptual Model of Mineral Evolution, R0 (8.3.1.3.3.2; 8.3.1.3.3.3). DOE/HQ review comments were received 11/1/89.

Sorption Studies and Sorption Modeling, R0 (8.3.1.3.4.1; 8.3.1.3.4.3). AP-1.10Q and DOE/HQ review comments were received 10/13/89.

Biological Sorption and Transport, R1 (8.3.1.3.4.2). Project Office AP-1.10Q review comments were received 11/13/89.

Dissolved Species Concentration Limits, and Colloid Formation and Stability, R0 (8.3.1.3.5.1; 8.3.1.3.5.2). Undergoing Los Alamos QP3.2 technical review.

Dynamic Transport Column Experiments, R0 (8.3.1.3.6.1). Project Office AP-1.10Q review comments were received 11/7/89.

Diffusion, R0 (8.3.1.6.2). Project Office AP-1.10Q review comments were received 11/7/89.

Probability of Volcanic Eruption Penetrating the Repository, R0 (8.3.1.8.1.1). Submitted to DOE/HQ (4/19/89).

Effects of Volcanic Features, R0 (8.3.1.8.1.2). In preparation.

Characterization of Volcanic Features, R0 (8.3.1.8.5.1). Review comments were incorporated and the revision was submitted to DOE/HQ 1/02/90.

Retardation Sensitivity Analysis, R0 (8.3.1.3.7.1). Project Office AP-1.10Q comments received 6/28/89.

Ground Water Chemistry Modeling, R0 (8.3.1.3.1.1). In preparation.

WBS 1.2.6
Project Title: Exploratory Shaft Management and Planning

These exploratory shaft (ES) tasks will address the issues and information needs associated with the feasibility of storing high-level nuclear waste in a geologic repository at Yucca Mountain.

ACTIVITIES AND ACCOMPLISHMENTS:

The focus of this office has shifted from planning ESF tests and prototype testing to the ESF Alternatives Study. This study will culminate in a comprehensive report and recommendations to the YMPO on the preferred option for excavation and location of the ESF.

Testing schedules are being updated to reflect the new schedule for the start of the ESF design (March 1, 1991). We began verifying the SDRD testing appendices. Staff participated in an NWTRB meeting with the USGS on geologic mapping. We are also continuing ongoing activities, such as completing the ESF Test Descriptions Document, Test Support Requirements Document, ESF Test Implementation Plan, and Annual Report on Prototype Testing.

Two papers were completed for the ANS International High-Level Radioactive Waste Management Conference in Las Vegas, April 1990. Two more papers are being prepared, one for an International Conference on Unique Underground Structures to be held in Denver, and one for a conference of the Shaft and Tunnel Institute in Las Vegas.

Review comments on the draft of the ESF Test Description Document are being incorporated, and editing and revisions are almost complete. The document will be transmitted to the test organizations for their input prior to finalization for the YMPO and test organization review as a Revision 0 draft.

PLANNED WORK:

Meet with Swedish waste management personnel to discuss YMPO work.

The following work will be started: complete report on Tracer Injection System; develop baseline for the tracers to be used in the ESF; and prepare a report on the management and planning of Prototype Testing, including lessons learned from the testing performed in G-Tunnel.

The following work will continue: support YMP ESF Alternatives Study, including technical lead activities for ESF testing issues and impacts; revise the ESF Test Descriptions Document; verify SDRD, appendices B and C; and prepare the Engineering Management Plan.

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H. Kalia, R. Oliver, A. Girdley
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Submitted to Project Office 1/05/90.

WBS 1.2.6.9.3
Project Title: Exploratory Shaft Integrated Data System

The integrated data system (IDS) is part of the supporting facilities for the Exploratory Shaft Facility (ESF). The IDS supports the data acquisition needs of the ESF test program by providing a central facility to automatically measure and control aspects of the ESF tests. The primary purpose of the IDS is to assist the principal investigators (PIs) in acquiring high-quality test data in a uniform, controlled fashion and to transfer those data to the PIs' organizations for data management and analysis.

ACTIVITIES AND ACCOMPLISHMENTS:

A close-out QA audit of EG&G has been completed. Records and equipment have been transferred to LANL for storage and reassignment within the Project.

Work has been initiated to prepare an RFP to obtain a contractor to design and develop the IDS. The strategy will be to issue an RFP that will identify qualified proposers by focusing on qualifications including past projects and quality assurance programs strict enough to pass NQA-1 requirements. The selected contractor will begin Title II design by March 1991 as required by the Project schedule.

The Functional Requirements Document is under revision to incorporate readiness review findings and to correct items observed in YMP Audit 89-7.

PLANNED WORK:

Support the ESF Alternates Study and revise IDS elements of the SDRD as required. Revise the Functional Requirements Document. Prepare and issue an RFP to obtain a contractor for the design and development of the IDS.

WBS 1.2.9.1.4
Project Title: Records Management

The objective of this task is to manage records and documents related to the licensing of a geologic repository for the disposal of high-level radioactive waste. The requirements are to support the development, implementation, and maintenance of a comprehensive, automated, and integrated information management system.

ACTIVITIES AND ACCOMPLISHMENTS:

No progress reported.

WBS 1.2.9.3
Project Title: Quality Assurance

The Quality Assurance Program provides quality assurance support to Los Alamos Yucca Mountain Project (YMP) participants. This support is designed to ensure that the YMP efforts of Los Alamos will provide admissible data and evidence for the repository licensing process.

ACTIVITIES AND ACCOMPLISHMENTS:

The biweekly meetings to correct the reported standard deficiencies noted during the Project Office audit continued.

The internal LANL control groups reviewed the responses to the observations and deficiencies before the letters were sent to the Project Office. Working groups assigned to resolve the deficiencies continued their efforts, and their goal remains at completing all needed actions by February 16, 1990. Procedures were identified that require revision, and drafts were completed for the new deficiency system, training and qualification program, and interface controls. These drafts were issued for review, and comment meetings are scheduled for February 5-6.

Work on the first internal Stop Work Order No. SWO-LA01 continued. Three new LANL staff are preparing the Software QA Plan and are working to lift the stop work order. Staff continue to install the needed hardware to establish the hardware portion of the Software QA Plan and its code control and testing features.

Work on the second internal Stop Work Order No. SWO-LA02 began. The stop work will be hinged on the completion of annual evaluations with the revised position descriptions and personnel qualification statements; all groups and subcontractors are affected. The submitted documents will be reviewed and accepted by the QA staff prior to the stop work being lifted.

PLANNED WORK:

LANL staff will continue resolving the standard deficiency reports. Training to any revisions will be a second priority to ensure that the ongoing research efforts are in compliance with the revised LANL QA program.

Efforts to resolve the internal deficiency reports and the standard deficiency reports will be increased to meet the YMPO-directed completion date. Additional staff will prepare the needed revisions and conduct the required internal reviews. The personnel certification and training files will be reviewed and corrected to ensure that personnel are properly certified and trained and the supporting documents are available.

APPENDIX

ATTACHMENTS AND LEVEL III MILESTONE REPORTS

Yucca Mountain Project
Level III Milestone R756 Letter Report
QA Level III
TWS-EES-1-10-89-25
31 October 1989

PRELIMINARY DESCRIPTIONS OF GEL FRACTURE FILLINGS FROM RAINIER MESA, NEVADA TEST SITE

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INTRODUCTION

This report contains descriptions of two gel samples collected from fractures in tunnels at Rainier Mesa. Gels are a type of material found in both natural and artificial chemical systems. With regard to the geologic environments considered in this report, the term "gel" is used to denote a semisolid colloid-water system with the macroscopic appearance and behavior of a jelly or paste. Colloids are the particulate material in the gel and also exist independent of gels (Yariv and Cross 1979). Natural gels and colloidal material have been found in a variety of aqueous geologic environments. Gels have been collected in areas of active zeolitic alteration within saline alkaline lakes and warm spring discharge areas (Eugster and Jones 1968; Mariner and Surdam 1970), but the role of gels and colloids in zeolitic burial diagenesis is not well known. The samples described in this report may be the only gels ever collected <u>in situ</u> from a thick terrigenous tuff deposit undergoing ground-water alteration.

This study, undertaken as an exploratory shaft prototype test for the Yucca Mountain Project (YMP), addresses a need to know whether gels might play a role in radionuclide transport and retardation at Yucca Mountain, a potential nuclear waste repository site about 40 km southwest of Rainier Mesa in southern Nevada. Fluid gels have not yet been found in material from Yucca Mountain, although material that may originally have been gel or colloids, now crystallized, has been observed in core samples of altered

tuff (Levy 1984). The use of water in drilling operations is not conducive to the preservation of fluid gels in recovered drill core. In the absence of hard data on gel abundance and distribution at Yucca Mountain, it is difficult to predict the potential role of this material in radionuclide transport. This study is a preliminary effort to identify some generic criteria for assessing the relative importance of natural gels as indicators of active geochemical and transport processes and as agents of radionuclide transport and retardation. More information about gel and colloid distribution may be forthcoming when samples from underground workings at Yucca Mountain become available for analysis.

THE POTENTIAL SIGNIFICANCE OF GELS FOR ALTERATION HISTORY AND RADIONUCLIDE TRANSPORT

The apparently recent formation of gels within rock fractures at Rainier Mesa is an example of an active geochemical process, and any movement of such gels within the fractures would be an active transport process. As described below, it is not clear whether the colloidal gel constituents include only crystalline material or also amorphous material in the process of crystallization. The existence of amorphous material at Yucca Mountain would be a potential indicator of active alteration within the pyroclastic rocks. Even if the fracture-filling gels were to contain only crystalline material, their presence would indicate active transport along fluid flow paths.

Studies have been formulated to investigate the formation and behavior of radionuclide-bearing colloids and the sorption of radionuclides on natural colloids. The potential role of naturally-occurring colloids has not yet been addressed or defined by any formal YMP position. A preliminary study by Ogard (1987) of particulate content in well J-13 water found a sediment concentration of about 2.7×10^{-5} g/l for particles smaller than 10 micrometers. Although Ogard (1987) specifically distinguishes particulates from colloids, colloidal particles are commonly defined as particles smaller than 10 micrometers (Yariv and Cross 1979). A simple calculation suggests that the particulate concentration measured in J-13 water would not represent an important contribution to radionuclide transport, relative to transport in solution, based on sorption ratios for Yucca Mountain

tuffaceous materials (Ogard 1987). However, a particulate content of about 10^{-2} g/l or greater could account for at least 10% of the transport for some radionuclides.

SAMPLE COLLECTION

The two gel samples examined in this study were collected from tunnel exposures at Rainier Mesa as part of geologic investigations in support of Defense Nuclear Agency (DNA) activities (Fig. 1). One sample was collected by H. Claassen in 1971 during the mapping of T-Tunnel drift U12t.02 at Rainier Mesa (Levy, Carlos, and Claassen 1986). The sample designation, U12t.02 Sta 19+24, indicates that the sample was collected 1924 ft inward from the drift opening. The material had the consistency of a gel and was oozing from a fracture in the wall of the drift. About 100 ml of the gel were collected in a sample jar and stored at room temperature. The material being studied is the dried residue of the original sample. Approximately one-half cubic centimeter of material is available for these studies. Subsamples of the material have been given individual letter designations and subjected to a variety of tests.

Sample MIEC-2 was collected by DNA personnel from a fracture in N-Tunnel in 1988. At the time of collection, the sample was semi-transparent and had the consistency of a paste. The sample was stored in a non-watertight plastic bag; consequently, no measurement has been made of the water content.

GEOLOGIC SETTING

The exact character of the T-Tunnel wall rock in the vicinity of the gel-filled fracture is not known. The sample location lies within tunnel beds unit 3 of the Miocene Indian Trails Formation, described as thin-bedded reworked ash-fall tuff, tuffaceous sandstone, and ash-fall tuff (Fig. 2). These rocks are zeolitized to silicified (W. H. Lee, USGS, memorandum, 30 July 1971). The description is consistent with the geologic character of sand-size rock inclusions in the dried gel residue, but it is not certain that these inclusions came from the wall rock in the immediate vicinity of the collection point.

The drift is about 1300 ft below the surface of the mesa. Water flowed at 1-2 gpm during construction from a fault located at 19+20; the flow ceased after about one week. Tuffaceous rock (including tunnel bed unit 3) below the Paintbrush Tuff is generally saturated (J. R. Ege, USGS memorandum, March 1972), but the regional potentiometric surface is about 1000 ft below the drift (Waddell and others 1984).

N-Tunnel is also located within the tunnel beds described above. The wall rock adjacent to the gel-containing fracture has not been characterized in detail.

THIN SECTION, U12t.02 STA 19+24b

This fragment of the sample was prepared as a polished thin section. The following descriptions and discussions are based on examination with the petrographic microscope, the scanning electron microscope (SEM), and the electron microprobe.

Microscopic Description

Most of the sample residue consists of detrital rock and mineral fragments. These fragments may have been naturally entrained in the gel or may have become incorporated during tunnel construction or subsequent sampling. Detrital grains, up to about 1.5 mm across, include zeolitized nonwelded tuff, devitrified tuff (lithic inclusions in nonwelded tuff?), and individual phenocrysts of quartz and feldspar.

Textural criteria must be used to distinguish between detrital material and possible gel products, which constitute a volumetrically small proportion of the dried sample. Some crystalline gel products are likely to be indistinguishable, on a mineralogic basis alone, from common tuff alteration products that are constituents of the detrital grains. In general, gel products should be interstitial to detrital grains and should form coatings on the grains; however, these criteria may not necessarily distinguish between gel products and very fine-grained detritus or material precipitated from solution. Evidence of *in situ* crystallization, especially of localized crystallization in an amorphous or cryptocrystalline material, may help identify a relict gel. Because a gel could consist of only smectite

and water, without amorphous material amenable to crystallization, there might be no evidence of crystallization in the suspected gel residue. In such a case, if the sample contains substantially greater amounts of possible gel products (e.g., smectite) than the wall rock, that fact may be indirect evidence for the operation of eluvial transport processes (i.e., preferential aqueous transport of colloidal material).

Smectite is the most abundant interstitial and clast-coating material in this sample. The larger detrital clasts and clasts of secondary origin have layered smectite coatings up to about 50 µm thick (Figs. 3 and 4). Smectite and other possible gel products tend to be segregated from each other, with variable textural relations. In places where clasts have more than one kind of coating, smectite is typically the outermost coating. The smectite coatings have a laminated texture, in which individual crystals are not distinguishable at 1350x magnification.

There are several areas where smectite is not the outermost coating; in these areas, smectite is overlain by or interlayered with very finely fibrous or massive material. This material is most readily recognized in areas where it is segregated from detrital constituents. Figure 4 shows such an area. Where individual crystals are discernible, the material consists of net-like aggregates of fibrous crystals less than 20 µm long. The net-like texture is very common, even where the material is too fine-grained to show individual fibers at 3000x magnification. Examination of other sample fragments suggests that the fibrous mineral may be locally more abundant as a surface coating than smectite. The areas occupied by the fibrous mineral in thin section seem to be mainly spaces created by the separation of larger detrital grains from adjacent fine-grained detrital material and by the formation of short, wide cracks in the fine-grained material. There may be some fibrous mineral within the fine-grained material, but is not easily recognizable in such a mixture.

In addition to the smectite and the fibrous material, there are one or more varieties of probable gel constituents present as discrete fragments and as fringes or coatings on altered tuff grains. This material is texturally variable. In SEM images, the texture varies from featureless and massive to spongy, granular, or faintly fibrous. The color in plane-polarized light varies from colorless to medium pink-brown.

A common feature of the gel consists of irregular round silica particles (individual particles are about 2 to 5 μm across) in sparse to dense aggregates within the otherwise semi-featureless gel. The densest aggregates are also the largest, up to >150 μm across. Silica particles commonly delineate a variety of relict textural boundaries within the gel. The most prominent of such features are the lines of silica particles that appear to mark the locations of relict fractures where brittle gel cracked and the fractures were filled with more fluid gel (Fig. 5). Cross-cutting relationships indicate multiple episodes of fracturing, with little or no development of silica particles along the youngest fractures. In addition to fracturing, some of the gel fragments were deformed in a plastic manner (Fig. 6).

Silica-particle concentrations have also preserved the shapes of cavities left in the gel by dissolved crystals or fragments of some kind (Fig. 7). The cavities are narrow and elongate, mostly about 25 to 100 μm long. After the original material dissolved, the cavities were infilled with gel. Some silica-outlined features do not appear to be strictly either relict fractures or ghost crystals (Fig. 8). These could be dissolved crystal cavities that were later modified by fracturing.

The gel fragments also contain a few irregularly-shaped, crystal-lined cavities, ranging in size from about 10 to 50 μm. Locally, this type of cavity is concentrated within the boundaries of infilled ghost crystals (Fig. 9). There are also crystal-lined cavities in the finely fibrous and massive material described above. Individual cavity-lining crystals are mostly less than 1 μm. Mineral phases, tentatively identified by morphology and qualitative energy-dispersive x-ray emission spectra, include silica, barite, Cu-Fe sulfides or sulfates, and prismatic crystals, possibly zeolites. Elongate prismatic or fibrous crystals up to 5 μm long seem to be characteristic of cavities within the fibrous and massive material (Fig. 10). Some of the elongate crystals have been coated with silica (Fig. 11).

Electron Microprobe Data, U12t.02 Sta 19+24b

Microprobe data for silica-rich gel products and smectite (verified by x-ray data, below) are shown in Table I. The 5-μm rastered electron beam was operated at a 15 nA sample current. The areas to be analyzed were

selected for minimal contamination with other material, based on SEM examination. The surfaces of fibrous materials and some silica-rich gels were judged insufficiently dense to analyze.

Analysis A1-1 represents a silica-rich gel fragment. The low analysis total probably results from high water content and low material density. The analysis of a round silica particle within a gel fragment (A1-2) has a much higher total, possibly because it is denser, less hydrous, and more highly crystalline than the featureless A1-1 fragment. The smectite (A1-3 and -4) has a moderately iron-rich composition, with potassium as the main exchangeable cation.

Surface Feature Study, U12t.02 Sta 19+24c,e

In addition to the SEM study of this sample in thin section, two easily separable subsamples were mounted and carbon-coated for SEM study of surface features. Both fragments are coated with either smectite or the fibrous to massive, probably zeolitic, material described from thin section.

At low magnification, the surface coatings and underlying clastic character of subsample c are clearly visible (Fig. 12). The semi-detached portion of the subsample on the right is coated primarily with fibrous material, in contrast to the more smectite-rich coating on the rest of the subsample. Figures 13 and 14, from the right-hand portion, show fibrous minerals in apparent growth positions and smooth, massive-appearing material. The qualitative energy-dispersive x-ray spectra for both the fibrous minerals and the massive material display Si:Al peak ratios typical of zeolites. The fibrous material contains much more Ca than K, whereas Ca content is greater than or subequal to K in the massive material.

Smectite is probably the most abundant surface coating on subsample e. Energy-dispersive x-ray spectra of the surface have Si:Al peak ratios typical of clays, with K predominant over Ca and Na, and Fe is present. These results are compatible with the microprobe analyses of smectite in thin section (Table I).

X-RAY DIFFRACTION RESULTS

U12t.02 Sta 19+24

A small powder sample, designated U12t.02 Sta 19+24c, was scanned from 2° to 70° two-theta. In addition, subsample e was ground for x-ray diffraction upon completion of SEM study and scanned from 2° to 36° two-theta. The major phases identified include smectite (undifferentiated), clinoptilolite, alkali feldspar, and quartz. No positive identification was made of either cristobalite or amorphous material. Mordenite might be present, but overlap with other mineral peaks prevented a definite identification.

As described above, the solidified sample consists largely of detrital material. All the feldspar in the x-ray diffraction pattern is assumed to be detrital. At least some of the quartz is detrital (e.g., phenocrysts). The thin section U12t.02 Sta 19+24b contains about 5 to 10 vol % of probable authigenic silica (or hydrated silica), identified by energy-dispersive x-ray spectra. X-ray diffracted beam intensities for samples of pure amorphous opal are so low (Vaniman, Bish, and Chipera 1988) that 10 vol % silica is probably undetectable in a sample with well-crystallized feldspar, quartz, and smectite.

MIEC-2

A dried sample of the translucent, jelly-like portion of sample MIEC-2 consists entirely of smectite (D. Krier, Los Alamos, personal communication 1988). The sample as collected also contained fragments of presumed wall rock that were not x-rayed.

DISCUSSION

This study of two gel samples from fractures in Rainier Mesa tuffs suggests that smectite is at present the principal or sole gel-forming disperse phase, with water as the dispersing medium. It is not known whether this is generally true for Rainier Mesa or for Yucca Mountain. For the purpose of this discussion, all gel constituents identified at Rainier

Mesa are considered as potential participants in radionuclide transport.

Evidence of In Situ Crystallization

Because the presumed gel products are mineralogically indistinguishable from secondary minerals in altered tuff clasts, they must be identified by textural criteria. In situ crystallization refers to minerals that were forming from amorphous or less crystalline material within a gel at the time of collection or that formed after collection. The recognition of evidence for crystallization of amorphous material is important because this process represents a distinct potential mechanism by which radionuclides could be incorporated into geologic materials.

There is no textural evidence either for or against in situ crystallization of smectite from amorphous material. The layered smectite coatings on various clasts in the dried T-Tunnel sample resemble illuviated clay coatings on detrital grains in sedimentary rocks. Illuviation is the aqueous transport of particulate material within a porous rock and does not imply any in situ crystallization.

The finely fibrous material in the T-Tunnel sample, possibly mordenite with silica and other zeolites was at least partly formed by in situ crystallization or deposition. The cavity-lining crystals within this material certainly formed in place. The sprays of fibrous crystals in Figs. 13 and 14 appear to be in undisturbed growth position. Whether this material was originally a gel is not certain. Crystallization could have taken place solely by precipitation from solution or by direct alteration of glassy material, although textural relations make these alternatives seem unlikely.

The silica-rich materials show strong textural evidence of having evolved by consolidation and partial crystallization of amorphous material. The complex fragmental character of this material suggests that it represents a gel older than the smectitic gel or that it is a product of early segregation from an originally more heterogeneous gel. The silica-rich gel fragments may be disrupted remnants of an earlier fracture filling or they may have been derived from the wall rock matrix in areas of active alteration, or both.

Implications for Yucca Mountain

Radionuclide Transport

The Rainier Mesa gel samples came from perched water zones where active rock alteration may be taking place. The available information for Yucca Mountain suggests that perched water zones may be much less common than at Rainier Mesa. Fluid gels may also be less common at Yucca Mountain if there is a true association between gels and perched water. Nevertheless, any perched water zones that exist might be important as segments of preferred fluid flow paths in the unsaturated zone. Zones of transient water storage that are not saturated at present may be identifiable by the presence of residual or dried gels.

Although no measurements of particulate content were made for the N-Tunnel gel, the smectite content probably exceeded the estimated value of 10^{-2} g/l above which particulate sorption could account for at least 10% of radionuclide transport for certain species (Ogard 1987). Given that smectitic gel materials probably have a significant sorption capacity, their potential importance would be a function of abundance and location with respect to fluid flow pathways.

Alteration History and Paleohydrology

The presence of gels or dried gels in the subsurface above the regional water table may be an indicator of transient or former perched water zones or higher former positions of the water table where alteration has taken place. If this association is valid, then gels may be useful in reconstructing the paleohydrology of the mountain. Drill cores and material from the exploratory shaft will be examined for evidence of gels, dried gels, or other accumulations of colloidal material. The exploratory shaft and associated drifts may represent the best opportunity to search for gels at Yucca Mountain.

The fragmental silica-rich gels from T-Tunnel in Rainier Mesa may be of value in understanding the early stages in the evolution of secondary silica minerals during diagenesis at Yucca Mountain. Secondary silica in zeolitized rocks at Yucca Mountain displays a variety of textural

characteristics and degree of crystallinity. Some of the differences are systematic changes with depth that are probably related to changes in temperature and water chemistry. This preliminary study of the T-Tunnel dried gel suggests that authigenic siliceous materials formed during early stages of diagenesis may exhibit a very wide variety of textures that is not preserved in more completely altered rocks. These differences may provide a guide to identifying zones of recent or arrested alteration.

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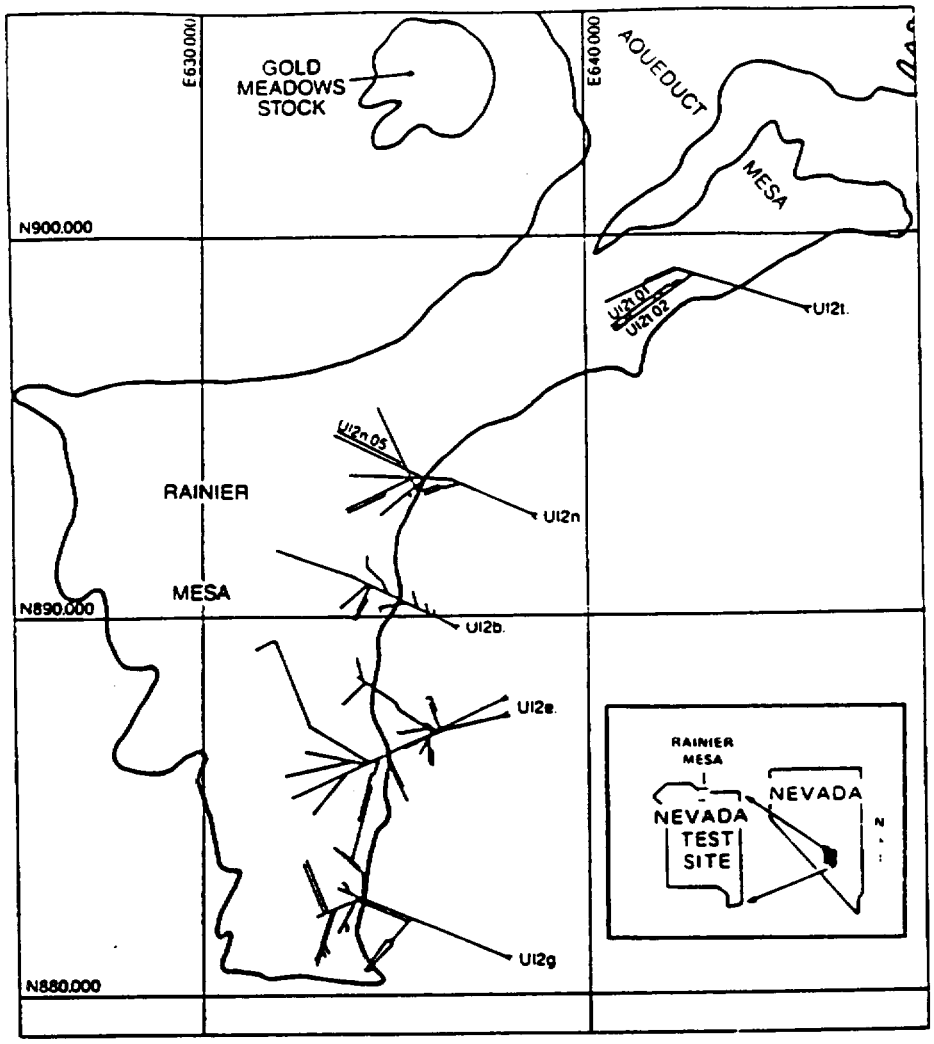
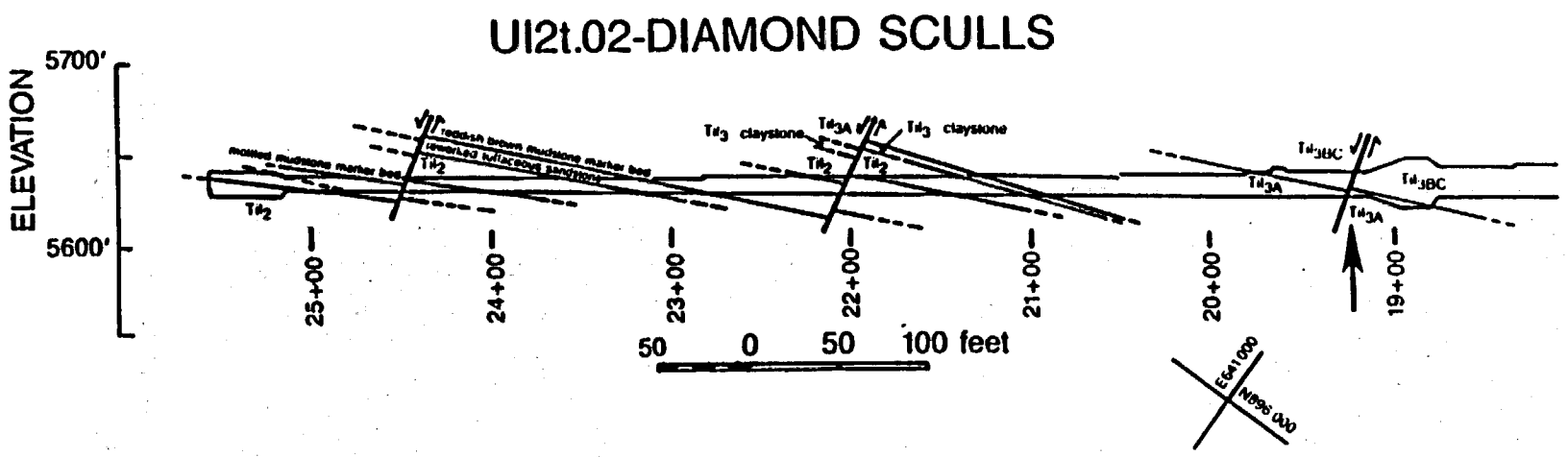


Fig. 1. Plan view of Rainier Mesa, showing locations of T-Tunnel (U12t) and N-Tunnel (U12n). Inset shows location of Rainier Mesa.



Tf3BC — Reworked ash-fall tuff, tuffaceous sandstone and ash-fall tuff, variegated colors, thin-bedded, zeolitized to silicified

Tf3A — Ash-fall tuff, grayish-orange, moderate reddish-brown, locally sandy texture, lower part is very fine-grained sediment, zeolitized

Geology by W.H. Lee, D.L. Hoover, Walter Danichik, and E.N. Hienrichs, USGS, 1969-71

Fig. 2. Geology of U12t.02 drift. Large arrow shows approximate collection site for U12t.02 Sta 19+24 gel sample.

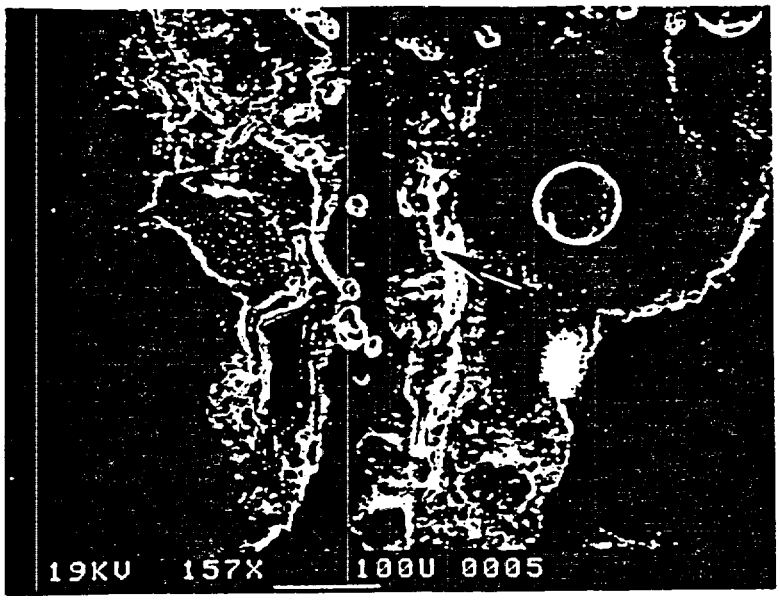


Fig. 3. U12t.02 Sta 19+24b, back-scattered electron (BSE) image. Arrow highlights area enlarged in Fig. 4.

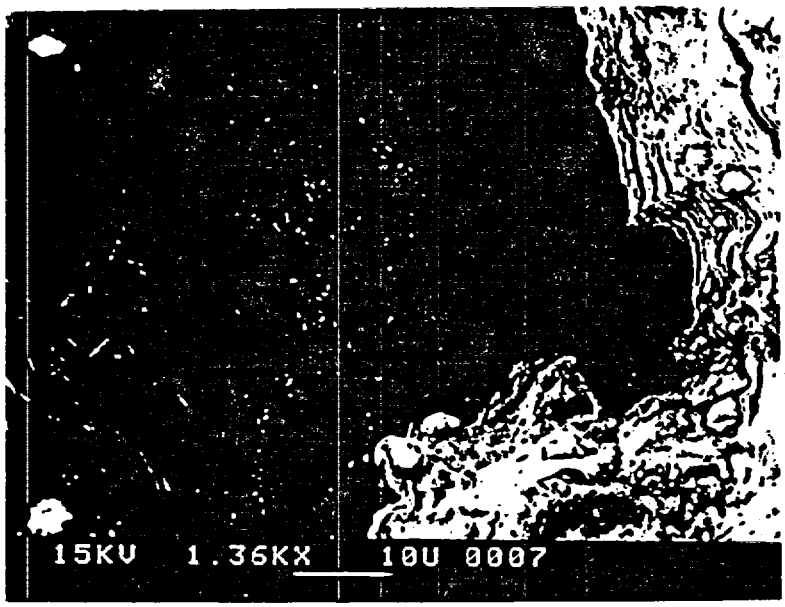


Fig. 4. U12t.02 Sta 19+24b, BSE image. Light-colored, layered smectite at right of image is juxtaposed against dark massive to fibrous material.

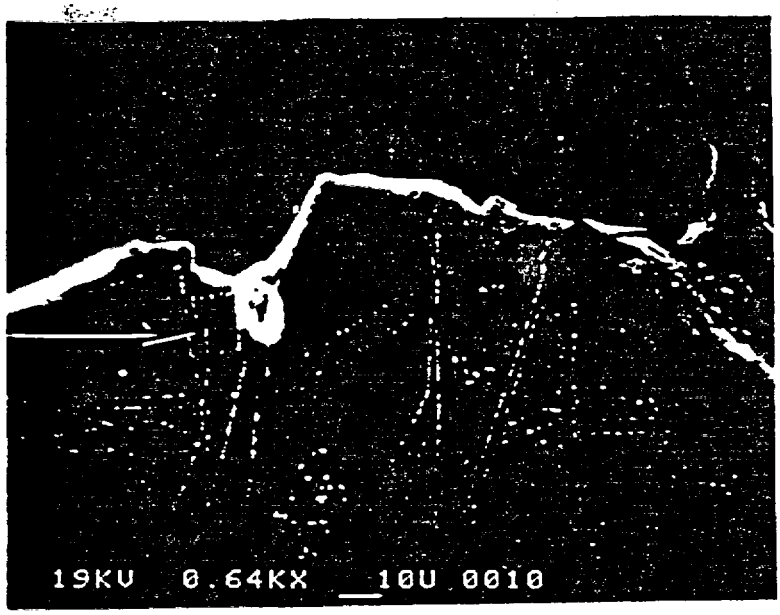


Fig. 5. U12t.02 Sta 19+24b, BSE image. Evidence of fracturing in gel, with positions of fractures and fragment boundaries approximately delineated by light-colored silica particles. Arrow shows displacement along a fracture with no silica particles.

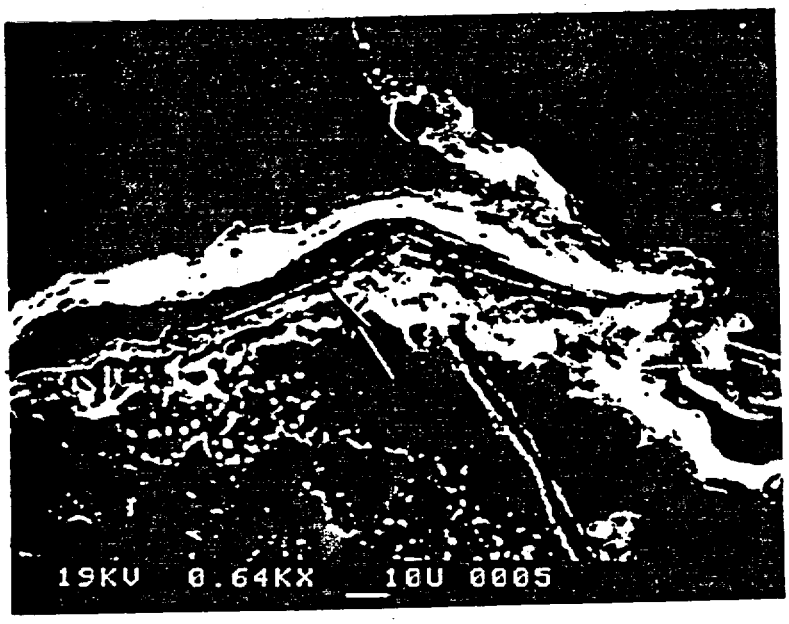


Fig. 6. U12t.02 Sta 19+24b, BSE image. Possible plastic deformation of a gel fragment, shown by arrow.

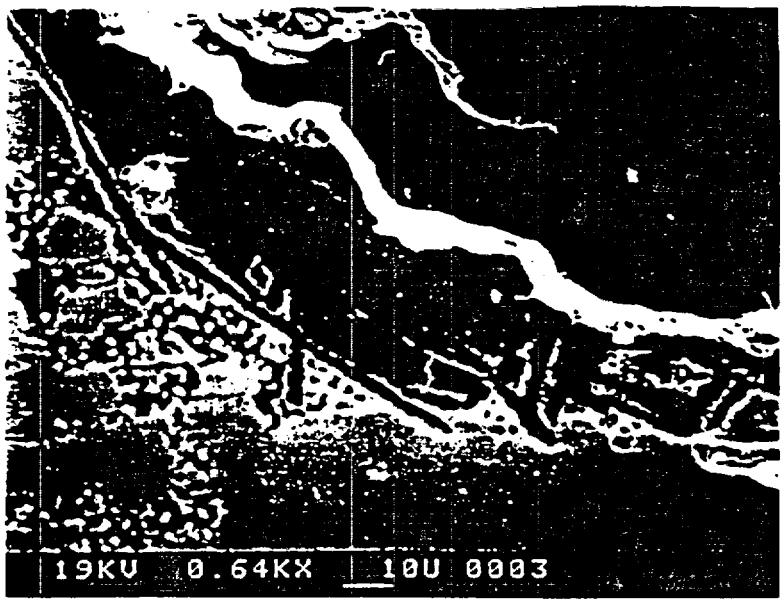


Fig. 7. U12t.02 Sta 19+24b, BSE image. Dark, elongate ghost crystals, with outlines preserved by surrounding light-colored silica particles.

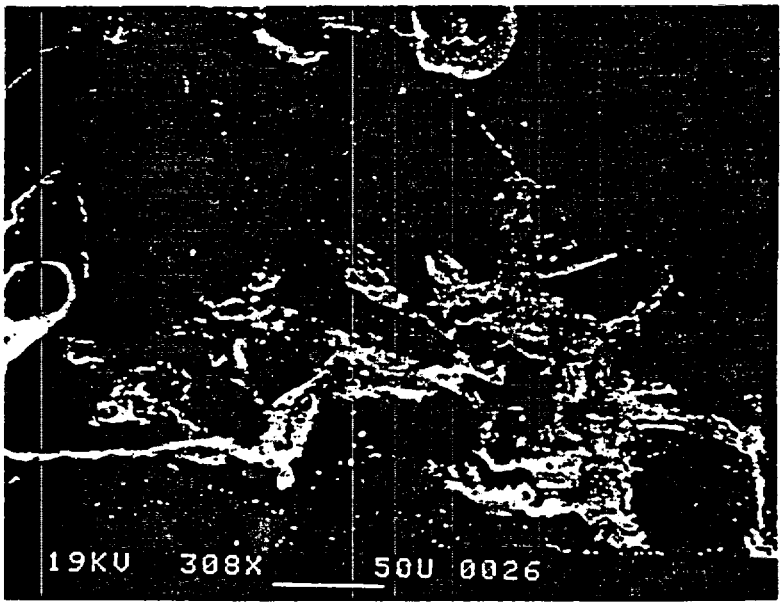


Fig. 8. U12t.02 Sta 19+24b, BSE image. Silica-outlined features of possible mixed origin.

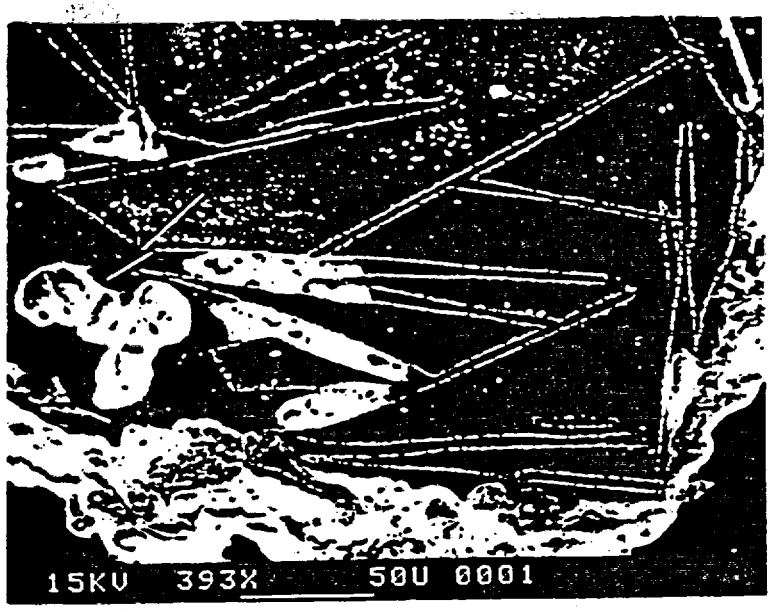


Fig. 9. U12t.02 Sta 19+24b, BSE image. Crystal-lined cavities in gel fragment (one is marked by arrow).

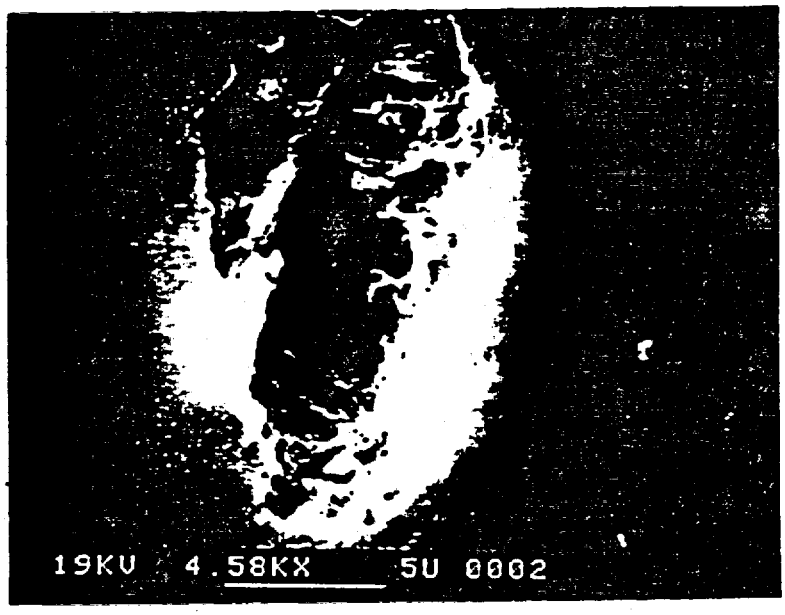


Fig. 10. U12t.02 Sta 19+24b, BSE image. Prismatic crystals (zeolite?) in cavity within fibrous to massive material.

Fig. 11. U12t.02 Sta 19+24b, BSE image. Silica coatings on fibrous crystals within cavity.

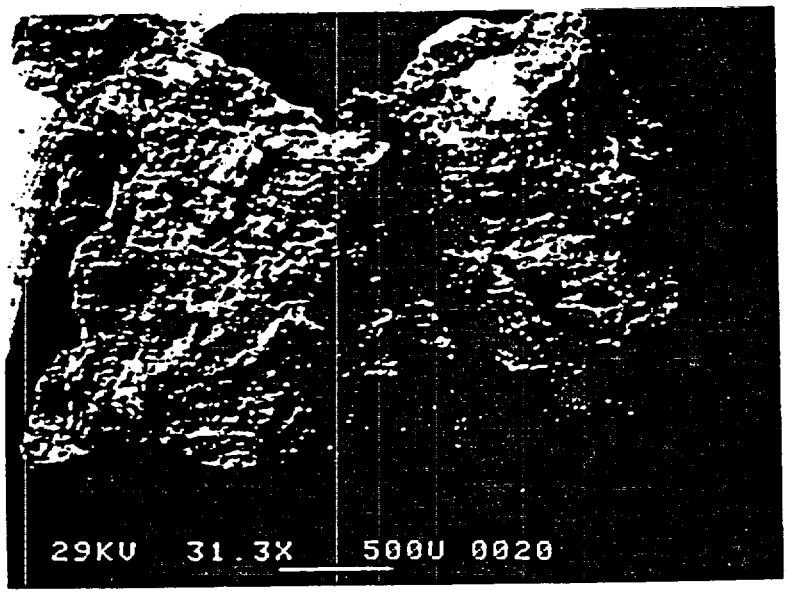


Fig. 12. U12t.02 Sta 19+24c, secondary electron image. Surface coatings on subsample c.

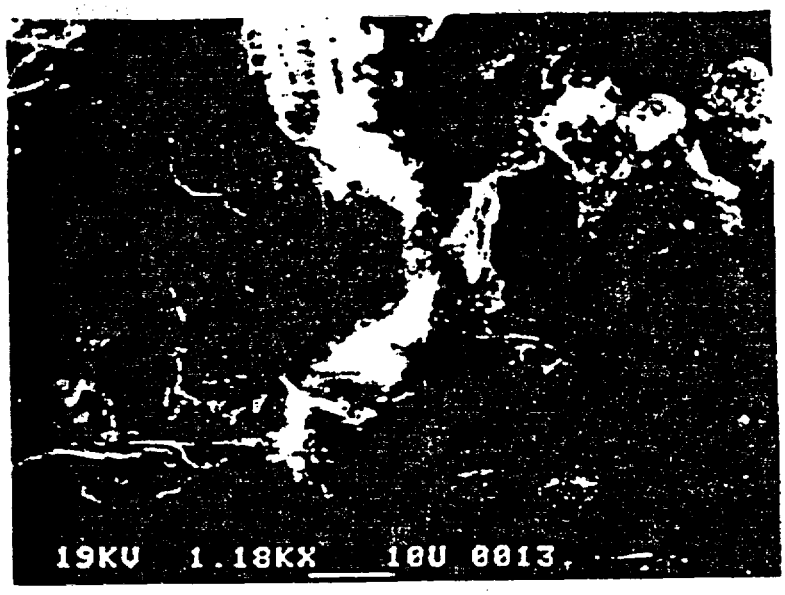


Fig. 13. U12t.02 Sta 19+24c, secondary electron image. Fibrous minerals in apparent growth position.

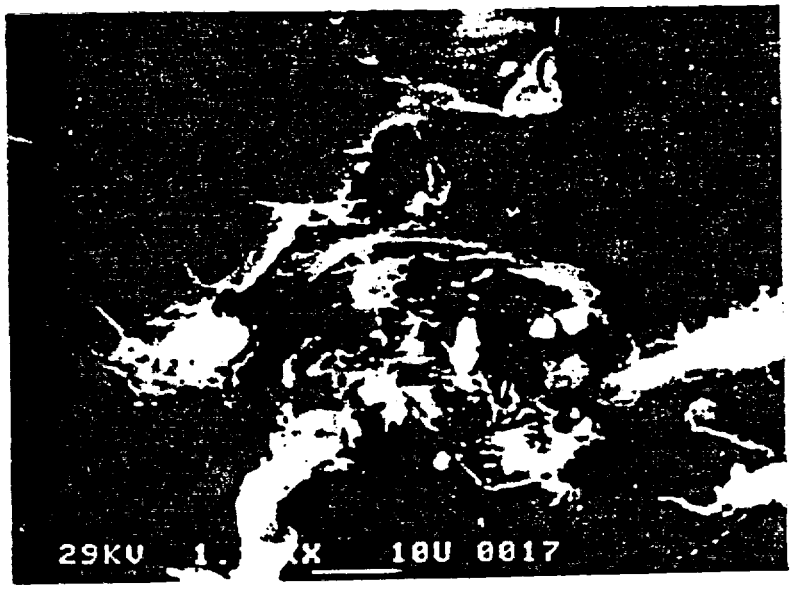


Fig. 14. U12t.02 Sta 19+24c, secondary electron image. Fibrous minerals in apparent growth position.

TABLE I

Silica-Rich Gel and Smectite Analyses, U12t.02 Sta 19+24b

	silica-rich gel products		smectite	
	A1-1	A1-2	A1-3	A1-4
Weight percent				
SiO_2	20.8	85.8	55.4	57.5
TiO_2	0.00	0.08	0.14	0.22
Al_2O_3	3.18	2.27	23.8	24.2
FeO	0.13	0.14	3.2	3.4
MnO	0.00	0.00	0.15	0.23
MgO	0.00	0.00	1.19	1.15
CaO	0.36	0.18	0.55	0.63
Na_2O	0.42	0.47	0.58	0.54
K_2O	0.45	0.66	3.48	3.00
Total	25.3	89.6	88.5	90.9

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TWS-EES-13-12-89-069

Yucca Mountain Project

Monthly Activity Report

December 1989

This work was supported by the Yucca Mountain Project Office as part of the Civilian Radioactive Waste Management Program. This Project is managed by the US Department of Energy, Nevada Operations Office.

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December 1989

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LOS ALAMOS NATIONAL LABORATORY
YUCCA MOUNTAIN PROJECT

Monthly Activity Report
December 1989

WBS 1.2.1
Project Title: Systems

The objective of this task is to integrate systems with the Geologic Repository Program and describe the Yucca Mountain Project Mined Geologic Disposal System and to evaluate the performance of the natural, engineered barrier, and total systems for meeting regulatory standards.

ACTIVITIES AND ACCOMPLISHMENTS:

Performance Assessment

A performance assessment meeting was held in Las Vegas on December 13, and the participants' role in the performance assessment calculational exercise (PACE) was discussed. Los Alamos participation was requested by Sandia. It was noted that an important first step toward PA integration was made with the Sandia visit to Los Alamos group EES-5. Another meeting is planned with more focus on the planned PACE problems.

A performance assessment/Technical Integration Group meeting was also held in Las Vegas on December 14.

Technical Data Advisory Group (TDAG)

A TDAG meeting was held in Las Vegas on December 8, at which the future role of the TDAG in data management was discussed. A tour of the records processing center at SAIC and a presentation of a management system, PRoMISE, were on the agenda.

WBS 1.2.3.2.1.1.1
Project Title: Mineralogy of Transport Pathways

The purpose of this activity is to define the important mineralogic and geochemical variables along transport pathways at Yucca Mountain in support of performance assessment and to evaluate the impact of repository construction on natural waste transport barriers.

ACTIVITIES AND ACCOMPLISHMENTS:

Work is continuing on fracture coatings in the Topopah Spring Member, with emphasis on samples from USW GU-2. Information obtained from scanning electron microscope (SEM) examination of the fracture coatings is being combined with mineral identification by x-ray diffraction (XRD) analysis. Most of the samples from USW GU-2 have now been analyzed using SEM and XRD, and samples from USW GU-3 were prepared for analysis. Results of core studies from several drill holes will be combined in a report on the distribution of fracture-coating minerals in the Topopah Spring Member of the Paintbrush Tuff.

Cathodoluminescence work began for the study of calcite in fractures. The work is focused on determining whether this technique is worth developing for use on calcite as well as opal in laminated deposits from Trench 14. Results so far for calcite from the Topopah Spring Member and from a vein at Devil's Hole show no detectable cathodoluminescence; however, calcite as well as opal in laminated deposits from Trench 14 shows variable but faint luminescence. Because this technique is likely to provide some useful information for LANL YMP work, a procedure will be written.

SEM work continued on alteration coronas around oxide microphenocrysts of the Topopah Spring Member. Thirty-two samples from USW G-4 were selected for thin-sectioning to increase the sample density and stratigraphic control in developmental studies (1) to assess the variability and properties of the potential host rock and (2) to examine the distributions and abundances of trace minerals that may contribute significantly to retardation by sorption.

PLANNED WORK:

Develop Exploratory Shaft Sampling plan using data from the Solitario Canyon outcrop. Evaluate revised XRD data using multivariate methods. Work on image analysis methods to generate porosity distribution maps and in trace-mineral analysis. Develop statistical methods, especially the tools for handling compositional data. Simulate spatial distribution of compositional data for use in transport models such as TRACRN. Evaluate trace-mineral separates from tuff samples at Yucca Mountain. Continue examination and analysis of fracture-coating minerals in the Topopah Spring Member.

PROBLEM AREAS:

The stop work order halted analyses using electron microprobe, x-ray fluorescence, quantitative XRD, and contracted INAA methods. The order will affect (1) a report on manganese minerals in the Tiva Canyon Member of the Paintbrush Tuff from USW G-4 (delayed for three months after the stop-work order is lifted); the report on calcite in fractures (delayed for two months after the stop-work on the electron microprobe is lifted); the report on fracture coatings in the Topopah Spring Member (no chemical analyses of fracture minerals will be included); and statistical analysis of data.

BIBLIOGRAPHY:

K. Campbell
Sampling for Site Characterization of a Potential Waste Repository
Mathematical Geology (Journal)
Submitted to Project Office 11/06/89.

MILESTONE PROGRESS:

R623 (Level III report)
6/90
Manganese Oxide Minerals in Fractures of the Crater Flat Tuff in Drill Core USW G-4
Submitted to Project Office 11/13/89.

Level III report
1/90
Calcite in Fractures
In preparation; writing 50% complete.

Level III report
6/90
Statistical Analysis, Topopah Spring Member
In preparation; writing 5% complete.

Level III report
8/90
Trace Minerals
In preparation.

New report
10/90
Review of Yucca Mountain Mineralogy
In preparation; writing 10% complete.

New report
10/90
Review of Erionite at Yucca Mountain
In preparation; writing 5% complete.

WBS 1.2.3.2.1.1.2
Project Title: Mineralogic and Geochemical Alteration

The objective of this task is to characterize past and present natural alteration processes that have affected the potential geologic repository and to predict future effects of natural and repository-induced alteration.

ACTIVITIES AND ACCOMPLISHMENTS:

D. Bish completed the paper "Thermal Stability of Zeolitic Tuff from Yucca Mountain, Nevada" for the First International High-Level Radioactive Waste Management Conference. He also completed his annual examination of zeolites and smectites used in long-term heating experiments that have been going on for four years. Samples that had previously undergone structural collapse showed no further collapse during the past year. Na-smectite has not been affected by 200°C heating.

Scanning electron microscope (SEM) study of hydrogenic deposit samples continued, and both bedrock breccias and volcanic ash-bearing fault fillings were examined. Because of the software stop work order, only direct SEM images are acceptable as Level I data. A large amount of time was spent this month providing input to the new software QA plan.

The internal letter report "Evaluation of the Feasibility of Applying $^{40}Ar/^{39}Ar$ and Rb/Sr Dating Techniques to Clays and Zeolites" by G. WoldeGabriel has been completed and is attached to the Appendix. This literature review suggests that $^{40}Ar/^{39}Ar$ dating of fine-grained materials like Yucca Mountain clays may be less reliable than K/Ar dating, but could be appropriate for authigenic feldspars. No examples were found in the literature of Rb/Sr dating of secondary minerals as young as the presumed ages of Yucca Mountain alteration products. However, the technique might work for a secondary mineral assemblage around 11 m.y. old if all the secondary minerals had equilibrated with each other.

PLANNED WORK:

Characterization of the hydrogenic deposit samples will continue. We intend to prepare papers for inclusion . a USGS bulletin covering the hydrogenic deposits around Yucca Mountain. Revision of QA procedural citations in the Alteration History study plan will be completed.

There are a number of quality assurance issues that need to be resolved soon to avoid impact on ongoing work. We need to establish acceptable documentation for work done by Los Alamos personnel using university analytical equipment and for university personnel doing small research projects for LANL. K/Ar dating of

secondary minerals from Yucca Mountain will be the most heavily affected in this area. QA qualification of software is also expected to be a major activity.

PROBLEM AREAS:

The software stop work order will prevent the following work from being accomplished: x-ray diffraction, electron microprobe, SEM, x-ray spectroscopy, image analysis, and any analytical work or data reduction that requires software. This could result in a three- to four-month delay in work requiring software support.

BIBLIOGRAPHY:

D. Bish
Thermal Stability of Zeolitic Tuff from Yucca Mountain, Nevada
International High-Level Radioactive Waste Management Conference, April 1990
Submitted to Project Office 9/08/89.

MILESTONE PROGRESS:

Level III
12/89
Evaluation of the Feasibility of Applying $^{40}Ar/^{39}Ar$ and Rb/Sr Dating Techniques to Clays and Zeolites
Complete and included in Appendix.

WBS 1.2.3.2.1.2
Project Title: Stability of Minerals and Glasses

The objective of this activity is to produce a model for past and future mineral alteration in Yucca Mountain. The model is intended to explain 1) natural mineral evolution resulting from the transformation of metastable mineral assemblages to more stable assemblages and 2) the effects of a repository emplacement.

ACTIVITIES AND ACCOMPLISHMENTS:

We have continued preparing the software quality assurance (QA) plan and responding to audit findings by making the accept/reject criteria in some detailed procedures more easily identifiable.

We received DOE/HQ comments on this task's study plan. Some of the comments that require the most attention concern the importance of clay minerals and their transformations in Yucca Mountain. We agree with this observation, and current work on the smectite/illite transition forms an important starting point for this understanding.

We have not completed the smectite/illite milestone report. We have made important progress in clarifying data from the literature, which made additional computational work necessary. The computations were exempted from the software stop order presently in force at Los Alamos, and the results reported will be clearly identified as not having been verified, validated, or otherwise subjected to the controls of a YMPO-approved quality program.

Current work points to control of the smectite/illite (I/S) transformation by both temperature and aqueous silica activity. It seems probable that pure or nearly pure smectite is stable only at elevated silica activity, probably only near or above cristobalite saturation. When silica activity drops to quartz saturation, I/S with compositions near 50% illite probably become stable at low temperature. As the temperature increases, more illite-rich I/S appears to become stable.

PLANNED WORK:

Work will continue to achieve a fully qualified QA program and to prepare the milestone report on the smectite/illite transition.

MILESTONE PROGRESS:

Work on the smectite/illite transition milestone is behind schedule, but major questions have been resolved.

WBS 1.2.3.2.5
Project Title: Postclosure Tectonics

The objective of these volcanism studies is to determine the hazards of future volcanic activities with respect to siting a high-level radioactive waste repository at Yucca Mountain.

ACTIVITIES AND ACCOMPLISHMENTS:

Study Plan 8.3.1.5.8.1, Characterization of Volcanic Features, has been revised and submitted to DOE/LV. The revision was based on review comments by DOE/LV, SAIC, YMP participants, and DOE/HQ.

Uranium-thorium (U-Th) mass spectrometric analysis was completed for a second sample of a lava flow from the Lathrop Wells volcanic center (Q13 lava, northeast of the main cone). We experienced the same problems encountered with a previous sample. The analytical measurements were successful, but we were unable to separate mineral phases with differing U/Th ratios.

Helium (He) was extracted from a second sample of the Lathrop Wells volcanic center (Q13 lava, northeast of the main cone). The analytical measurements were successful, and the rock yielded $^3He/^4He$ ratios that are about the same as the measured ratios for the Q15 lavas.

The source of the anomalous sodium (Na) values for x-ray fluorescence (XRF) analysis of basaltic volcanic rocks has been identified. We have classified existing chemical data from the Los Alamos XRF laboratory as QA Level III because of the combination of analytical problems with Na and the current concerns with the QA controls on software for the XRF instrumentation.

PLANNED WORK:

Field work will be conducted at the Sleeping Butte volcanic centers as soon as field escorts can be arranged with the Air Force.

We will evaluate the U-Th data to determine how to proceed with future work. The technique currently looks very promising but may not be feasible for very-fine-grained basaltic rocks like the lavas of the Lathrop Wells center.

Evaluation of existing He isotopic data suggests the addition of neon analysis may be appropriate to provide a cross check of the potential effects of He loss by diffusion and sample variability from erosion or depositional cover.

We are now starting revisions of Study Plan 8.3.1.8.1.1, Probability of Magmatic Disruption of the Repository.

Two papers are in preparation describing volcanism studies: one for Waste 90 for the Tucson meeting, and one for the April meeting in Las Vegas.

MILESTONE PROGRESS:

The milestone schedule for volcanism studies continues to be on hold until the revised versions of Study Plan 8.3.1.8.1.1 and 8.3.1.8.5.1 are completed for submission to the NRC.

WBS 1.2.3.3.1.2.2 and 1.2.3.3.1.2.5
Project Title: Water Movement Tracer Tests and Diffusion Tests in the ESF

The objective of the water movement tracer tests is to obtain measurements of chlorine isotope distributions to help quantify the percolation of precipitation in the unsaturated zone. The objective of the diffusion tests in the ESF is to determine *in situ* the extent to which the nonsorbing tracers diffuse into the water-filled pores of the Topopah Spring welded unit.

ACTIVITIES AND ACCOMPLISHMENTS:

The results of the ^{36}Cl studies at Yucca Mountain that pertain to matrix and fracture flow in the unsaturated zone were presented to the U. S. Nuclear Waste Technical Review Board meeting in Denver on December 11-12. Preparations included a rehearsal in Las Vegas on December 4-5.

We provided information about the role of the University of Rochester's accelerator mass spectrometer in analyzing Yucca Mountain Project samples for ^{36}Cl. This information was requested for a speech that C. Gertz will make at the University of Rochester.

Diffusion Test staff traveled to G-Tunnel on December 18 to remove the prototype diffusion test equipment, a trip necessitated by the closure of G-Tunnel. The control panels and the packers were placed in temporary storage at the NTS Los Alamos warehouse, in case the decision to close G-Tunnel is rescinded.

The Los Alamos representative on the Sample Overview Committee transmitted the requirements from the December 5 committee meeting that are necessary for obtaining samples from the Project Office Phase 1c Prototype Drilling at Apache Leap for ^{36}Cl analyses. The requirements are (1) a letter of approval from the Los Alamos Technical Project Officer indicating support of this work, (2) a proposal justifying the work, and (3) AP-6.4Q specimen removal request sheets for submission to the Sample Overview Committee. U. Clanton refused an informal request to store the Yucca Mountain Project cuttings for this ^{36}Cl work inside the Sample Management Facility in Area 25 at the NTS, but he would permit them to be stored outside in Area 25. Because weathering can degrade the value of the cuttings for ^{36}Cl analysis, a trip to Tucson on December 19 resulted in the possibility of using University of Arizona storage facilities for these Yucca Mountain Project samples.

PLANNED WORK:

Los Alamos procedure TWS-INC-DP-84 will be revised following receipt of the technical review and the quality assurance liaison comments.

WBS 1.2.3.3.1.3.1
Project Title: Testing of C-Hole Sites with Reactive Tracers

Experiments will be conducted at the C-well complex (holes UE25c#1, UE25c#2, and UE25c#3) and in other wells in the vicinity of Yucca Mountain. Reactive tracers will be used to characterize retardation and transport properties on a scale larger than that currently used in laboratory experiments.

ACTIVITIES AND ACCOMPLISHMENTS:

Efforts continued on completing the milestone report for FEHMN. There is still a need to determine final problems to be included as verification.

A review of all detailed technical procedures (DP) in EES-15 was initiated to determine if the requirements of YMP 88-9, R2, are being met. Of particular concern are the accept/reject criteria, accuracy and precision requirements, and scope of the DP. Documentation will be supplied for those items that were not included in the DP, but are listed as being applicable. This was not done during the last iteration of DP preparation.

Reactive Tracer Testing staff met with Devin Galloway (USGS), Mark Pabst (US Bureau of Reclamation), Klaus Stetzenbach (Univ. of Nevada, Las Vegas), and Kenzi Karasaki (Lawrence Berkeley) at the WIPP site near

Carlsbad, NM, on December 12-13 to discuss packer design for the C-Wells field tests. The U.S. Bureau of Reclamation is doing packer design and development for the USGS for the C-Wells. WIPP was selected as the meeting site to review the experiences of INTERA, Inc., in conducting convergent flow tracer tests. George Saulnier, Wayne Stensrud, and Gerry Grisak represented INTERA. After presentation by INTERA on their tests, D. Galloway and M. Pabst made informal presentations on the planned C-Well tests. Several ideas were discussed, but no final design was suggested.

PLANNED ACTIVITIES:

Continue working on the milestone report on FEHMN, review DPs for requirements and increase documentation, and support achievement of a qualified QA program.

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H. Fuentes, W. Polzer, E. Essington, and B. Newman
Characterization of Reactive Tracer for C-well Field Experiments I: Electrostatic Sorption Mechanism, Lithium
LA-series report (LA-11691-MS)
Published and distributed.

B. D. Newman, H. R. Fuentes, and W. L. Polzer
An Evaluation of Lithium Sorption Isotherms and Their Application to Groundwater Transport
Groundwater (Journal)
Returned to author for revisions 12/04/89.

W. L. Polzer, M. G. Rao, and H. R. Fuentes
The Use of the Modified Freundlich Isotherm to Estimate Thermodynamic Equilibrium Properties of Ion Exchange Adsorption of Radionuclides on Volcanic Tuff. Part I. Theoretical Development
Environmental Science and Technology (Journal)
In technical review.

W. L. Polzer and H. R. Fuentes
The Use of the Modified Estimate Thermodynamic Equilibrium Properties of Ion Exchange Adsorption of Radionuclides on Volcanic Tuff. Part II. Experimental
Environmental Science and Technology (Journal)
In preparation.

MILESTONE PROGRESS:

R529
9/30/89
Evaluation of Preliminary Application of FEHMN to Yucca Mountain
Delayed.

Level III report
12/31/89
SORBEQ Documentation
Delayed due to stop work order on software.

WBS 1.2.3.4.1.1
Project Title: Groundwater Chemistry

The goal of this investigation is to provide conceptual and mathematical models of the groundwater chemistry at Yucca Mountain. These models will explain the present groundwater composition in relation to interactions of minerals and groundwater and will be used to predict groundwater compositions as a result of anticipated and unanticipated environments.

ACTIVITIES AND ACCOMPLISHMENTS:

Additional review comments on draft of the Study Plan for Study 8.3.1.3.1.1 are being resolved, and text is being revised.

Data from J. Kerrisk and A. Ogard, "Groundwater Chemistry Along Flow Paths Between a Proposed Repository Site and the Accessible Environment," LA-10188-MS (1984) was compiled and will be submitted to the SEPDB.

PLANNED ACTIVITIES:

Submit Study Plan for YMPO review after revisions and submit Kerrisk and Ogard (1984) data on groundwater chemistry to SEPDB.

Attend Site Structures and Hydrochemistry meeting in Las Vegas, January 29-31 as part of Technical Exchange Program between DOE and SKB.

Review quality assurance (QA) material as requested in support of February 16 deadline for the audit response.

MILESTONE PROGRESS:

No milestone reports are scheduled in the next three months.

WBS 1.2.3.4.1.2.1 and 1.2.3.4.1.2.3
Project Title: Sorption

The objective of the sorption and precipitation task is to provide sorption coefficients for elements of interest in order to be able to predict radionuclide movements from the repository to the accessible environment.

ACTIVITIES AND ACCOMPLISHMENTS:

Experiments involving pure mineral separates contacted with neptunium (Np)-spiked J-13 water have continued, and the results will be reported next month. Another set of experiments has been initiated to investigate the sorption behavior of technetium (Tc) on pure mineral phases appropriate to the Yucca Mountain site. Pure mineral separates have been contacted with J-13 water spiked with Tc-95 (using a ratio of 20 ml of solution to 1 g of solid).

An overview of the sorption program was presented to the Nuclear Waste Technical Review Board in a meeting in Denver on December 11-12. A "dry-run" of the presentation was given in Las Vegas on December 4-5.

The Stanford group has initiated a set of experiments involving the sorption of Np onto hematite as a function of pH. Hematite was synthesized in the laboratory. The adsorption edge appears to lie between pH = 6-7.

PLANNED WORK:

Continue the study of Np sorption on pure minerals in J-13 water, Tc sorption studies on pure minerals, and development of a thermodynamic framework for the interpretation and integration of sorption data.

BIBLIOGRAPHY:

A. Meijer
YMP Far-Field Sorption Studies and Data Needs
LA-series report (approved milestone T419)
At press.

WBS 1.2.3.4.1.2.2
Project Title: Biological Sorption and Transport

The purpose of this research is to determine whether microbial activity can influence the movement of plutonium in tuff. Because fluids are used extensively in the exploration of locations for a nuclear repository, of special interest are those microorganisms capable of utilizing drilling fluids as growth substrates.

ACTIVITIES AND ACCOMPLISHMENTS:

As indicated in last month's report, it was felt that the siderophore was not completely purified. During this past month, several HPLC gradients were used in an attempt to separate those absorption peaks containing siderophore and contaminants. The rate of the gradient, from 100% acetonitrile to 100% water was decreased at the time the siderophore was being eluted. This technique resulted in limited success, in that there was some separation of the peaks.

More promising results came from a modification of the growth medium. At the suggestion of Dr. David Updegraff, the Pseudomonas sp. was grown in medium that did not contain an addition of iron because it was felt that the iron level in the medium was great enough to repress the production of the siderophore. Two runs were performed, and both yielded larger volumes of siderophore. Although increasing the volume of siderophore does not increase its purity, we can then be more selective when collecting fractions from the HPLC (i.e., collect smaller volumes from a specific region of a siderophore peak) and obtain purer samples of significant volume.

During the past summer, several colloidal agglomeration experiments were performed. Because of the volume of data generated, no statistical analysis of the data was performed. We are currently editing the data so that the appropriate statistical analysis can be performed. This has involved deleting large amounts of unwanted information (common to image analysis systems), entering the data in an ASCII file, and selecting an appropriate statistical analysis for the data.

PLANNED WORK:

Further develop techniques to purify siderophore.

WBS 1.2.3.4.1.3
Project Title: Solubility Determination

The objective of the solubility determination task is to determine the solubilities and speciation of important waste elements under conditions characteristic of the repository and along flow paths from the repository into the accessible environment.

ACTIVITIES AND ACCOMPLISHMENTS:

Solubility Task staff attended the Nuclear Waste Technical Review Board Meeting on December 11-12 in Denver, Colorado. D. Hobart presented a talk on "Waste Element Solubility at Elevated Temperatures: Colloid Formation, Characterization, and Stability." Solubility Task staff also attended the International Chemical Congress of the Pacific Basin Societies Meeting in Honolulu, Hawaii, December 18-22. H. Nitsche was the co-organizer for a symposium entitled "The Chemical Behavior of Radioactive Substances in the Environment." D. Hobart served as chairman of the opening session of this symposium.

H. Nitsche worked on documentation to ensure conditional release of the software that controls the pH-stat instrument (which monitors all of his long-term solubility experiments). He has also prepared a paper, "Solubility Studies of Transuranium Elements for Nuclear Waste Disposal: Principals and Overview," for the published proceedings of Migration '89.

The following DPs are in progress:

- Determining UV-VIS-IR Absorption and Diffuse Reflectance Spectra.

- X-Ray Powder Diffraction Analysis for Solubility (YMP-LBL-DP03).
- Sodium Concentration Determination in Radionuclide Solutions (YMP-LBL-DP05).

Installation and testing of the large-frame argon ion laser system have been completed. The new optical table for the wavelength calibration spectrophotometer has also been delivered and installed. The spectrophotometer is expected to be delivered shortly. This system will be used to very precisely determine the wavelength accuracy of the pulsed dye laser used in the photothermal spectroscopy system. Finally, a new class of piezoelectric transducers was ordered and received. These new transducers are based on very thin films of an organic polymer and possess useful properties such as the ability to immerse them directly in a solution.

We are continuing instrumentation development activities while awaiting a resolution of the stop work order related to software. Recent experimental work has focused on preliminary data acquisition of aqueous Pu^{4+} spectra in dilute mineral acid media to test instrumentation sensitivity and identify the appropriate pulsed laser dyes for investigating Pu^{4+} speciation.

PLANNED WORK:

Identify groundwater compositions that more closely resemble those expected in the unsaturated (vadose) zone at Yucca Mountain. We will also continue work on the DPs due this fiscal year.

According to the SKB/DOE Bilateral Information Exchange Treaty, D. Hobart is expected to attend the next joint meeting in Sweden in June.

Work will continue on the preliminary experiments with Pu^{4+} to assess system performance with the existing photoacoustic detection apparatus. We also hope to begin implementing the photothermal detector apparatus. We are expecting to receive new preamplifiers in January, the final hardware components required for the system.

MILESTONE PROGRESS:

None.

WBS 1.2.3.4.1.4
Project Title: Dynamic Transport Process

The objective of the dynamic transport process task are to determine the rate of radionuclide movement along the potential flow paths to the accessible environment and to examine the effect of diffusion, adsorption, dispersion, anion exclusion, sorption kinetics, and colloid movements in the flow geometries and hydrologic conditions that are expected to exist along the flow path to the accessible environment in the scenarios to be used for performance assessment.

ACTIVITIES AND ACCOMPLISHMENTS:

The same tuff column (made with Topopah Spring Member tuff) utilized for tritium elution was used to study the retardation of cesium-137, strontium-85 and barium-133. Before injection of the sorbing tracers into the tuff column, batch sorption coefficients for these tracers were obtained. One gram of the tuff was crushed and contacted with 20 ml of a solution containing the sorbing tracers for 11 days. After equilibration, the phases were separated and the amount of tracer in each phase was determined. The sorption coefficient K_d for each tracer (defined as the amount of tracer per gram of the solid phase divided by the amount of tracer per ml of solution phase) was calculated. The sorption coefficients obtained were used to calculate the retardation factor utilized for fitting the measured elution curves. Equation 1 was used for this calculation, where ρ is the dry bulk density of the tuff in the column.

$$R_f = 1 + K_d \rho_b \qquad (1)$$

The most dramatic consequence of the time dependent dispersion (discussed in the November monthly report) is the effect on the prediction of breakthrough times for sorbing tracers. As discussed, the apparent dispersion D parallel to the assumed one-dimensional flow through the column is given by Eq. 2.

$$D_A = D_1 + D_o t^n \qquad (2)$$

If the conventional Advection-Dispersion Equation is employed to predict the breakthrough of strontium, the expected breakthrough in the solid tuff column would be at approximately 1.5 years, based on the strontium sorption coefficient calculated using the batch sorption technique. The actual breakthrough, shown in Fig. 1, occurs within a few weeks of the start of the experiment. This is a discrepancy of 2 orders of magnitude. If the dispersion is given a time dependence, the strontium elution curve can be fit with the measured batch sorption coefficient. The strontium elution required a dispersion with a dependence on time of a power less than one (n = 0.4). Figure 2 shows the dispersivity as a function of time used to fit the tritium and the strontium elutions. Although in this case, the value of the tritiated water dispersion extrapolated to the times relevant for the strontium elution would provide a conservative value for the dispersion, this is not necessarily true in all cases.

The distribution of residual radioactivity in the tuff column after elution was measured by sectioning the column. The concentration of strontium, cesium, and barium as a function of distance from the column inlet was measured. The distribution measured is nonuniform. The most localized tracers are the most strongly sorbed tracers because these tracers have not eluted to a significant extent. The heterogeneous distribution of sorbing minerals may be partially responsible for the reduced retardation. Dispersivities for the sorbing tracers are significantly greater than dispersivities for tritiated water in the same tuff column.

The observation of time-dependent dispersion in laboratory scale migration experiments provides new insight into the effect of heterogeneity on the retardation of sorbing radionuclides. In order to calculate time dependence, a priori, a statistical characterization of the spatial distribution of sorbing minerals and the distribution of hydraulic conductivity in the system studied must be made. Time-dependent dispersion is even more important as the scale of the hydrologic system increases to field scales. Consequently, this observation points to the need for a more detailed characterization of the hydrologic and geochemical properties of Yucca Mountain tuff to predict dispersion in the potential repository.

PLANNED WORK:

Continue solid rock column experiments, rock beakers experiment (see February monthly report), and transport work with pure minerals.

PROBLEM AREAS:

The SPEX fluorometer is being repaired, and the autocorrelation photon spectroscopy system is being set up.

BIBLIOGRAPHY:

N. Patera, D. Hobart, A. Meijer, and R. Rundberg
Chemical and Physical Processes of Radionuclide Migration at Yucca Mountain Nevada
Radioanalytical Chemistry (Journal)
Returned to author for revisions 9/18/89.

I. R. Triay, R. S. Rundberg, A. J. Mitchell, M. A. Ott, D. E. Hobart, and P. D. Palmer
Size Determinations of Pu Colloids Using Autocorrelation Photon Spectroscopy
Migration '89 proceedings
In internal review.

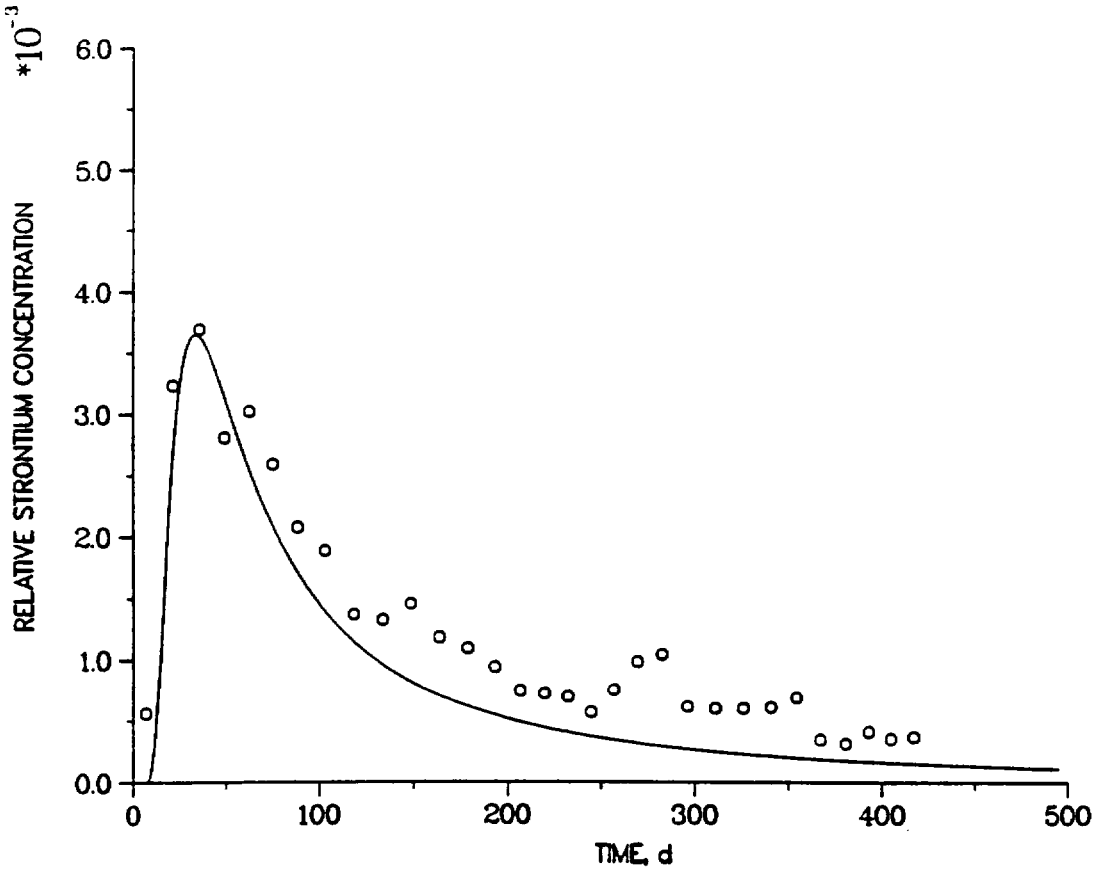

Figure 1: Fit (solid line) to strontium elution measured (o) through an intact tuff column using time-dependent dispersion.

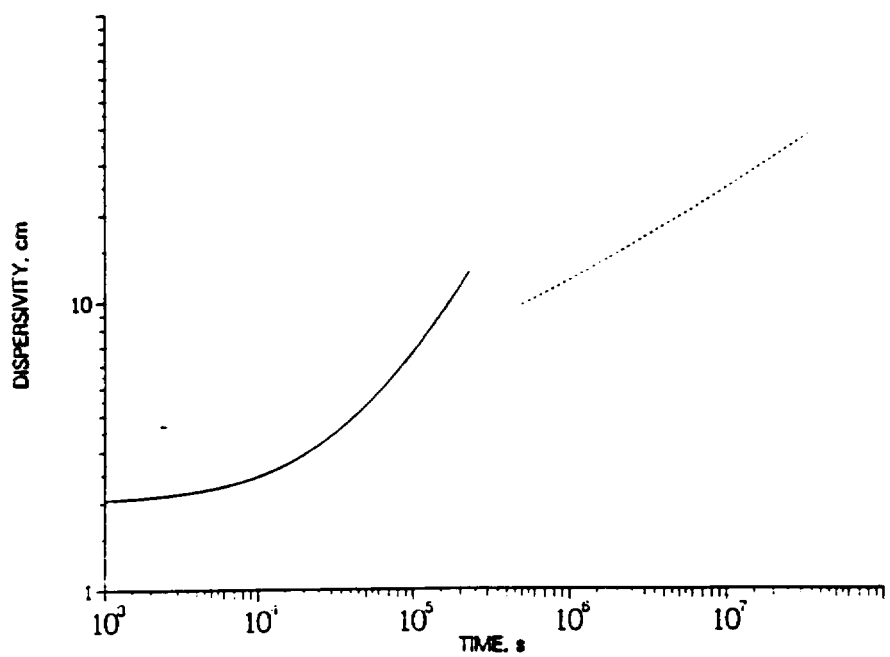

Figure 2: Dispersivity as a function of time used to fit the intact tuff column data for the tritiated water elution (solid line) and for the strontium elution (broken line).

WBS 1.2.3.4.1.5.1
Project Title: Retardation Sensitivity Analysis

The objectives of the retardation sensitivity analysis task are to construct a geochemical/geophysical model of Yucca Mountain and to use this model to examine the physical and chemical controls on radionuclide transport along flow paths to the accessible environment.

ACTIVITIES AND ACCOMPLISHMENTS:

Analysis of Physical/Chemical Processes

FEHMN/FEHMSN. The vapor-phase transport portion of FEHMN has been tested, and additional capabilities were added. The first application has been directed to explaining the large velocities observed in wells UZ-6 and UZ-6S at the top of Yucca Mountain. A match with the 2-d results of Kip (1987) has been achieved. Three-dimensional results are underway. This work is being done so that the code has the capability of calculating vapor-phase transport and unsaturated flow for the PACE problems.

COLLOID TRANSPORT - Two new boundary conditions were added to CTCN. The code is being used to simulate the Dynamic Transport task's experiments with colloid transport in fractures.

Geochemical/Geophysical Model

Three-dimensional transport calculations with spatially distributed sorption coefficients are being run. Six different realizations of Kd distributions for cesium (Cs) and technetium (Tc) were supplied by K. Campbell. Under a recharge rate of 0.1 mm/yr, Cs transport from the repository was simulated to 10,000 yr, and Tc transport was simulated to 5,000 yr. Little difference resulted from the various Kd realizations for the transport of Cs because of Cs's very high sorption coefficients. The transport of Tc was more strongly dependent on the realization of the Kd distribution. These results will be quantified by calculating the cumulative breakthrough to the water table. These calculations will be included as expected case scenarios for the PACE problems.

QA and Programmatic

A file containing 3-D spatially distributed Kd's for Cs and Tc was generated for distribution to PACE participants. This file contains one realization for these parameters. Average values for units from the TSw2 down to the Bullfrog for these two radionuclides are also included. We will work with A. Meijer to generate average values for a whole suite of radionuclides for PACE participants to use.

BIBLIOGRAPHY:

K. Birdsell et al.
Preliminary Integrated Calculations of Radionuclide Cation and Anion Transport at Yucca Mountain Using a Geochemical Model
FOCUS 89
Approved 12/22/89.

K. Birdsell
TRACRN User's manual
LA-Series report (approved milestone T421)
In preparation.

WBS 1.2.3.4.1.5.2
Project Title: Geochemical Field Tests for Validation

The purpose of this activity is to test the validity of the laboratory geochemistry data generated by the Geochemistry Test Program and to test the geochemical transport modules. Five subtasks constitute this activity: 1) natural analogs, 2) large block test, 3) caisson test, 4) unsaturated zone geochemistry field test, and 5) radionuclide migration studies at the Nevada Test Site.

ACTIVITIES AND ACCOMPLISHMENTS:

Natural Analogs

No significant action.

Large Block Tests

No significant action.

Anthropogenic Analogs

No significant action.

Caisson Tests

No significant action.

Geochemistry Field Tests

A meeting was held with the Principal investigator Integration Group (PiIG) and Science and Engineering Associates (SEA) on December 20. The purpose of the meeting was to present the calculational effort supporting various geochemistry field test designs. The calculational results were presented in a draft document, and technical discussions were held regarding the results and implications toward the field test designs we should consider.

The current AECL interaction on the Large Block Test and Natural Analog Task was discussed as well as the status of the INTRAVAL Program. EES-5 is maintaining interactions with INTRAVAL and INC with AECL.

Next quarter, the PiIG will meet to discuss the needed integration of Los Alamos YMP staff for a successful field testing program. E. Springer is assigned as PI for the development of the field testing strategy, which includes all tasks.

WBS 1.2.5
Project Title: Regulatory and Institutional

The purpose of this task is to coordinate the regulatory and institutional Project requirements within the Los Alamos programmatic structure. The focus of this coordination effort is on the integration of the technical work within the regulatory and institutional framework.

ACTIVITIES AND ACCOMPLISHMENTS:

Site Characterization Plan

No significant action.

Semi-annual Progress Report

No significant action.

Study Plans

The status of the study plans is as follows.

Water Movement Test, R3 (8.3.1.2.2.2). Approved by Project Office and DOE/HQ; sent to NRC and State of Nevada.

Diffusion Test in the Exploratory Shaft, R0 (8.3.1.2.2.5). Abstract and SCP-based network submitted to Project Office 5/25/89 and to DOE/HQ 6/30/89.

Testing of the C-Hole Sites With Reactive Tracers, R1 (8.3.1.2.3.1.7). Revision 2, which incorporates DOE/HQ and Project Office comments, was submitted to DOE/HQ 11/16/89.

Mineralogy, Petrology, and Chemistry of Transport Pathways, R3 (8.3.1.3.2.1). A Study Plan Assessment was developed for this study and transmitted to DOE/HQ on 6/22/89.

History of Mineralogy and Geochemical Alteration at Yucca Mountain, R0 (8.3.1.3.2.2). A comment resolution meeting was held on May 31, 1989, for DOE/HQ comments.

Kinetics and Thermodynamics of Mineral Evolution and Conceptual Model of Mineral Evolution, R0 (8.3.1.3.3.2; 8.3.1.3.3.3). DOE/HQ review comments were received 11/1/89.

Sorption Studies and Sorption Modeling, R0 (8.3.1.3.4.1; 8.3.1.3.4.3). AP-1.10Q and DOE/HQ review comments were received 10/13/89.

Biological Sorption and Transport, R1 (8.3.1.3.4.2). Project Office AP-1.10Q review comments were received 11/13/89.

Dissolved Species Concentration Limits, and Colloid Formation and Stability, R0 (8.3.1.3.5.1; 8.3.1.3.5.2). Undergoing Los Alamos QP3.2 technical review.

Dynamic Transport Column Experiments, R0 (8.3.1.3.6.1). Project Office AP-1.10Q review comments were received 11/7/89.

Diffusion, R0 (8.3.1.6.2). Project Office AP-1.10Q review comments were received 11/7/89.

Probability of Volcanic Eruption Penetrating the Repository, R0 (8.3.1.8.1.1). Submitted to DOE/HQ (4/19/89).

Effects of Volcanic Features, R0 (8.3.1.8.1.2). In preparation.

Characterization of Volcanic Features, R0 (8.3.1.8.5.1). A Comment Resolution Meeting for Project Office and DOE/HQ comments was held July 11-12, 1989.

Retardation Sensitivity Analysis, R0 (8.3.1.3.7.1). Submitted to Project Office 12/14/89. Project Office AP-1.10Q comments received 6/28/89.

Ground Water Chemistry Modeling, R0 (8.3.1.3.1.1). In preparation.

WBS 1.2.6
Project Title: Exploratory Shaft Management and Planning

These exploratory shaft (ES) tasks will address the issues and information needs associated with the feasibility of storing high-level nuclear waste in a geologic repository at Yucca Mountain.

ACTIVITIES AND ACCOMPLISHMENTS:

Work emphasis has shifted from coordinating test activities to supporting the Alternates Study for the construction of the Exploratory Shaft Facility (ESF). Los Alamos is involved in preparing input for the eight tasks identified in the Implementation Plan. We participated in meetings with Sandia and SAIC to define work scopes, schedules, and task definitions, and the Los Alamos staff was trained on Sandia QA procedures.

Preparation continued at a reduced level on the Test Support Requirements Document (TSRD); to date, support requirements have been determined on all tests in the Shaft. Review comments on the draft of the Exploratory Shaft Test Descriptions Document (ESTDD) are being incorporated, and revisions are almost

complete. In January, the document will be transmitted to various organizations for review. We continued to prepare the annual report for the prototype testing in G-Tunnel. All activities at G-Tunnel have been terminated and YMP equipment has been removed and stored at Area 25.

The draft of the Engineering Management Plan is undergoing internal Los Alamos review. Work continued on the preparation of the Health and Safety Plan (ESHIP) for the Test Manager's Office. Papers were completed for the International High-Level Radioactive Waste Management Conference in Las Vegas in April. An abstract will be prepared for the Shaft and Tunneling Institute to discuss the testing and construction-related issues of the ESF.

Work continued to complete the ESF testing networks. Our goal is to complete networks for each of the ESF tests, as they now have been defined. Any changes to the testing logic based on the Alternates Study will be incorporated.

PLANNED WORK:

Effort will be concentrated to support the Alternates Study. Work will be initiated to verify the SDRD input. Develop presentation material for the meeting on the ESF and Prototype Testing information exchange with the Swedish Waste Management Program (SKB).

The following work will continue: prepare the ESTDD and the TSRD; prepare the ESHIP; prepare change request for changes in testing needs to update the SDRD; and prepare the Engineering Management Plan.

WBS 1.2.6.9.3
Project Title: Exploratory Shaft Integrated Data System

The integrated data system (IDS) is part of the supporting facilities for the Exploratory Shaft Facility (ESF). The IDS supports the data acquisition needs of the ESF test program by providing a central facility to automatically measure and control aspects of the ESF tests. The primary purpose of the IDS is to assist the principal investigators (PIs) in acquiring high-quality test data in a uniform, controlled fashion and to transfer those data to the PIs' organizations for data management and analysis.

ACTIVITIES AND ACCOMPLISHMENTS:

Work continued to phase out EG&G's role in the design of the IDS. EG&G is reassigning staff, and all procured equipment is being inventoried for appropriate disposition.

Work continued for the development of the Configuration Management Plan for the IDS.

PLANNED WORK:

Completely phase out EG&G by January. Support the ESF Alternates Study. Develop responses to the Readiness Review audit. Revise the Functional Requirements Document. Prepare an inventory of all the of the IDS equipment procured for YMP. Initiate work to develop the IDS component reliability analysis.

WBS 1.2.9.1.4
Project Title: Records Management

The objective of this task is to manage records and documents related to the licensing of a geologic repository for the disposal of high-level radioactive waste. The requirements are to support the development, implementation, and maintenance of a comprehensive, automated, and integrated information management system.

ACTIVITIES AND ACCOMPLISHMENTS:

Two fireproof safes have been delivered to the Records Processing Center (LATA), and several others were delivered to groups for protection and storage of records and one-of-a-kind items.

We are searching the Records Information System (RIS) and Site Characterization Plan Reference Manual for accession numbers for several references being cited in three reports by W. Polzer, B. Newman, and M. Ebinger.

A demonstration was given by G. Ortiz to RPC personnel (LATA) to introduce and explain the basic ways to use the 3M Microfilm Reader Printer to retrieve a project record from microfilm. G. Ortiz also provided information and recommendations on the RIS to D. Williams (LATA).

Comments on QP-17.3, R0 were returned and resolved by K. Foster (LATA).

We met with Lee Carpenter, the new Project Records Administrator, and Don Helton, from the Project Office, on December 13. Discussions included the Records Management Plan, Administrative AP-1.7Q, and requirements in general. The visit was beneficial because we were able to express our concerns and ideas about records management. It was also suggested that a Task Force be set up to review the draft Records Management Plan.

PLANNED WORK:

Work continues in processing records into the RIS and implementing QP-17.3.

WBS 1.2.9.3
Project Title: Quality Assurance

The Quality Assurance Program provides quality assurance support to Los Alamos Yucca Mountain Project (YMP) participants. This support is designed to ensure that the YMP efforts of Los Alamos will provide admissible data and evidence for the repository licensing process.

ACTIVITIES AND ACCOMPLISHMENTS:

We began the biweekly meetings to correct the reported standard deficiencies noted during the November audit. The goal for the working groups is to complete all needed actions by February 16, 1990. Responses to the deficiency reports were drafted and discussed. A number of procedures and the entire LANL deficiency reporting system will be revised to address reported deficiencies.

Two internal LANL control groups were established: one examining all LANL policy issues that arise from correcting the reported deficiencies, and one providing long-term solutions to identified issues resulting from closure of the deficiency reports.

The work-closure efforts at Edgerton, Germeshausen & Grier (EG&G) were audited to ensure that the needed documents were completed and turned over to Los Alamos staff for submittal to the Records Processing Center.

Work on internal Stop Work Order No. SWO-LA01 continued. Additional LANL staff are being directed to prepare the Software Quality Assurance Plan and lift the stop work order. The Project Office continued its surveillance of the LANL software program through December.

PLANNED WORK:

LANL staff will continue resolving the standard deficiency reports. Training to any revisions will be a second priority to ensure that the ongoing research efforts are in compliance with the revised LANL QA program.

Efforts to resolve the internal deficiency reports and the standard deficiency reports will be increased to meet the YMPO-directed completion date. Additional staff will prepare the needed revisions and conduct the required internal reviews. The personnel certification and training files will be reviewed and corrected to ensure that personnel are properly certified and trained and the supporting documents are available.

APPENDIX

ATTACHMENTS AND LEVEL III MILESTONE REPORTS

EVALUATION OF THE FEASIBILITY OF APPLYING $^{40}Ar/^{39}Ar$ AND Rb/Sr DATING TECHNIQUES TO CLAYS AND ZEOLITES

Giday WoldeGabriel
Geology/Geochemistry, EES-1/D462
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This report reviews, using published literature, the feasibility of applying $^{40}Ar/^{39}Ar$ and Rb/Sr methods to date alteration minerals from the Yucca Mountain Project (YMP). A number of illite or illite/smectite clays from the site have already been dated by the K/Ar method (Aronson and Bish, 1987). The use of the three methods simultaneously could produce very reliable time constraints on various geological processes in an area.

Temporal events of geological processes in different environments have been documented by isotope dating techniques using the K/Ar, Rb/Sr, and the U, Th-Pb methods that are based on the radioactive decay of ^{40}K, ^{87}Rb, ^{235}U, ^{238}U, and ^{232}Th isotopes (JΣger, 1979). The $^{40}Ar/^{39}Ar$ dating method is a recently developed analytical variation of the conventional K/Ar technique. The K/Ar technique depends on several assumptions, the most important of which is that no loss of potassium and radiogenic ^{40}Ar nor any gain of extraneous ^{40}Ar and potassium has occurred since the initial crystallization of the rock or mineral phase being dated (Dalrymple and Lanphere, 1969; Faure, 1977). The $^{40}Ar/^{39}Ar$ method described in detail by Merrihue and Turner (1966) and Mitchell (1968) can overcome some of these limitations because in ideal circumstances internal systematics in the data may identify samples that have lost a component of their radiogenic argon, samples with extraneous radiogenic argon, and samples that were closed with respect to potassium and radiogenic argon since their crystallization.

The K/Ar method is widely used to date potassium-bearing minerals of plutonic, metamorphic, and volcanic origin (Dalrymple and Lanphere, 1969). Moreover, fine-grained rocks through their contained illite, illite/smectite, and glauconite minerals of the mica group provide a good K/Ar clock that can be used to constrain the age of burial diagenesis in sedimentary environments (Weaver and Wampler, 1970; Aronson and Hower, 1976; Odin, 1982; Aronson and Burtner, 1983). Authigenic potassium-bearing clay minerals (illite, illite/smectite) from hydrothermally altered environments can also be used to constrain the age of alteration and mineralization thereby unravelling the geologic history of hydrothermal deposits (Bonhomme et al., 1983; Eberl et al., 1987; Sillitoe, 1988; WoldeGabriel and Goff, 1989). Internally consistent and concordant K/Ar illite ages of diagenetic minerals from sedimentary basins and hydrothermally altered zones suggest that the fine-grained clays (0.1 - 2 mm) are able to retain radiogenic argon at temperatures normally encountered during burial diagenesis and even after hydrothermal alteration (Bonhomme et al., 1983; Aronson and Lee, 1984; Glasmann, 1987; WoldeGabriel and Goff, 1989). For example, Aronson and Lee (1984) reported that the ages of clay-size separates of illite/smectite from a potassium-bentonite immediately adjacent to an intrusion were concordant and matched the hornblende K/Ar age of the intrusion, whereas similar clays from a shale adjacent to the K-bentonite gave discordant ages much greater than the age of the stock suggesting that detrital illite retains significant radiogenic argon even close to an igneous contact. Data from the Continental Scientific Drilling Project core holes in the Valles caldera of the Jemez Mountains support the above suggestion whereby hydrothermal clays of different Plio-Pleistocene ages retained their radiogenic argon at current core hole temperatures of up to 300°C (WoldeGabriel and Goff, 1989). Hence, the progressive changes in the mineralogy of layer silicate minerals in relation to temperature variations and fluid interactions during burial and diagenesis in a sedimentary basin, hydrothermal alteration, and contact metamorphism can be monitored by illite and illite/smectite clays because of the strong evidence of their ability to retain radiogenic argon.

$^{40}Ar/^{39}Ar$ Method

In principle the K/Ar geochronology can be enhanced by the $^{40}Ar/^{39}Ar$ dating technique because of the ability of the latter to discriminate among samples that have lost, gained, or retained their radiogenic argon since their crystallization (Dallmeyer, 1979). The theory and analytical techniques used in the $^{40}Ar/^{39}Ar$ and K/Ar dating methods are generally similar (Merrihue and Turner, 1966; Mitchell, 1968; Dalrymple and Lanphere, 1971). However, in the K/Ar method, the chemical analysis of potassium is required, whereas in the $^{40}Ar/^{39}Ar$ technique, the age determination is measured as a function of ^{39}Ar which is produced from 39K by neutron activation.

In order to be useful for dating by the $^{40}Ar/^{39}Ar$ method, minerals and rocks must be relatively coarse in grain size because during irradiation the newly formed ^{39}Ar can recoil out of the fine grains through cracks, intergranular boundaries or expandable layers (Turner and Cadogan, 1974; Huneke and Smith, 1976; Seidemann, 1978). According to experiments on fine glass by Huneke and Smith (1976), 9% and 2.45% of the total ^{39}Ar

recoils, respectively, out of H3 mm and 15 mm glass grains. They determined a mean depth of 0.1 mm in which ^{39}Ar is depleted from the surfaces of glass grains. This is higher than the expected ^{39}Ar recoil distance of 0.08 mm reported by Turner and Cadogan (1974). Hence, anomalous age patterns can result for very fine grains from ^{39}Ar recoil transfer during neutron irradiation and differential Ar retention during stepwise Ar extraction at successively higher temperatures.

Several case studies are known concerning the dating of fine-grained minerals (illite, illite/smectite, glauconite, glass) by the $^{40}Ar/^{39}Ar$ method. Geologically significant and concordant ages were reported using K/Ar and $^{40}Ar/^{39}Ar$ on altered glassy volcanic rocks (Walker and McDougall, 1982) and illite clays of hydrothermal origin (Bray et al., 1987). On the contrary, anomalous and discordant ages were obtained on glauconites (Yanase et al., 1975; Foland et al., 1984) and illites (Halliday, 1978).

In the study by Bray et al. (1987), hydrothermal illites associated with uranium mineralization yielded concordant ages by the two argon techniques of 1321; 44 Ma (K/Ar) and 1301; 5 Ma ($^{40}Ar/^{39}Ar$) which is good evidence that no ^{39}Ar-recoil transfer occurred in the illites during irradiation (Bray et al., 1987). There is a continuum in nature between fine-grained illite and coarser-grained sericite. Because the clay size fraction of the irradiated samples was not reported by the authors, it is possible that these illites tended toward being sericites whose average grain diameter might have exceeded the expected ^{39}Ar recoil distance of 0.08 mm (Turner and Cadogan, 1974). The age concordance does not concur with the results of Huneke and Smith (1976) who reported 2.45% and 9% loss of the total ^{39}Ar from 15 mm and 3 mm glass grains.

Unlike the above-cited concordant results, Halliday (1978) reported that step-heating of illitic clay concentrates indicated major losses of ^{39}Ar (32-45%) and ^{40}Ar (25-35%) during irradiation. For glauconite the percent of ^{39}Ar loss ranges from 16.6% to 80%, resulting in ages higher than the K/Ar values by 15% to 40% (Yanase et al., 1975; Foland et al., 1984). However, contrary to the suggestion by Halliday (1978), radiogenic ^{40}Ar was not lost during the glauconite irradiation (Foland et al., 1984).

The available information on ^{39}Ar recoil transfer disfavors the use of $^{40}Ar/^{39}Ar$ for fine-grained minerals (clays). However, coarse authigenic minerals (K-feldspar) from a diagenetic environment could be dated by the $^{40}Ar/^{39}Ar$ method and compared with the K/Ar ages obtained on the finer clay or other mineral fractions from the same sample.

Rb/Sr Dating Method

The Rb/Sr method has been successfully applied to date magmatic, metamorphic, and diagenetic (sedimentation) processes (Faure and Powell, 1972; JΣger, 1979; Morton, 1983, 1985). The Rb/Sr method has an advantage over K/Ar and U/Pb dating because Rb and Sr are so geochemically different that phases of varying Rb/Sr ratio from the same rock can yield much information about the geochemical history of the rock. Moreover, Lee and Brookins (1978) suggested the daughter isotope (^{87}Sr) from the decay of 87Rb remains fixed within the rock during a subsequent disturbance unlike radiogenic ^{40}Ar from 40K. The successful application of the Rb/Sr method to sedimentary rocks depends on careful mineralogical examination of minerals that have isotopically equilibrated in a sedimentary environment (Clauer, 1979; 1982; Morton, 1983).

Rb-rich minerals (lepidolite, muscovites, biotite, or potassium feldspar) of pre-Tertiary rocks are generally sufficiently enriched in radiogenic ^{87}Sr to give reliable data (Faure and Powell, 1972). However, the application of Rb/Sr method to Tertiary rocks is limited by the long half life of 87Rb (48.8 x 109 years) which results in a small increase of radiogenic ^{87}Sr. Moreover, common strontium contains about 7% ^{87}Sr and if the dated rocks or minerals contain abundant common strontium, the small amount of radiogenic ^{87}Sr from the decay of 87Rb becomes difficult to identify (JΣger, 1979). As a result minerals with high Rb/Sr ratios have to be used. According to JΣger (1979), for Tertiary rocks the most ideal minerals for Rb/Sr dating, in order of decreasing Rb/Sr ratios, are biotite, phengite, muscovite, chlorite (when formed from biotite), K-feldspar, and minerals that concentrate Sr preferentially over Rb (plagioclase, apatite, fluorite, epidote, and garnet). Clauer (1979) documented the use of Rb/Sr in dating diagenetic processes. He emphasized the importance of preliminary mineralogical study and applying the Rb/Sr method to samples from well-known stratigraphic sedimentary levels. A major problem in the Rb/Sr method is in knowing the isotopic composition of the initial Sr present in the rock and all its phases. This is especially the case for diagenetic phases which may have grown in pore water whose isotopic composition differed from that of the rock. Morton (1985) reported such a study for a thick shale section in the Gulf Coast. He was able to obtain illite/smectite of varying Rb/Sr ratio. The linear correlation of $^{87}Sr/^{86}Sr$ with $87Rb/^{86}Sr$ suggested that the illite/smectite throughout the shale section formed in a common in

situ diagenetic event. The slope of the line and the intercept provided both the age and the isotopic composition of the initial strontium. Part of Mortons's success seems to have stemmed from a pretreatment saturation of the illite/smectite with NH^{4+}, which eliminated much of the common Sr from the illite/smectite. Meaningful analytical data were also reported on diagenetically altered minerals which had equilibrated with pore water and remained chemically closed under sedimentary conditions (Morton, 1985). The application of the Rb/Sr method to hydrothermal minerals is not widespread. This isochron method could be applicable to alteration minerals (illite, authigenic feldspars, epidote, chlorite, smectite) from volcanic rocks provided the strontium of these minerals isotopically equilibrated during alteration.

An advantage of igneous systems is the relative absence of detrital contaminants which can cause a wide range of initial $^{87}Sr/^{86}Sr$. In addition to the Gulf Coast study, Morton (1985) reported that Rb/Sr age data on illite clays from Paleozoic shales record the initial interaction with hydrothermal fluids migrating from a tectonic zone.

Procedures in the Rb/Sr Method

In order for diagenetic or alteration processes to be dated by the Rb/Sr method, alteration minerals need to be identified from a sedimentary or hydrothermal environment and need to be separated, free from detrital components. A suite of cogenetic minerals is needed that formed authigenically at the time of alteration and equilibrated their isotopic composition with the environment and each other so that the slope of the isochron will be well defined. Careful mineralogical examination and mineral separation is necessary to discriminate detrital from authigenic minerals. Moreover, minerals contain adsorbed or loosely bound exchangeable Rb and Sr, and samples are routinely pre-treated with chemicals to remove the contaminant Rb and Sr (Clauer, 1982; Morton, 1983). Again, the problem of detrital phases is minimized in working with altered igneous rocks, but primary igneous or volcanic phases and xenoliths should be avoided.

Once the mineralogical characterization and cleaning of the samples is accomplished, the amount of common strontium ($^{87}Sr/^{86}Sr$ - initial strontium) in the sample must to be determined. The contribution of common ^{87}Sr is subtracted from the total amount of radiogenic and common ^{87}Sr in a sample. As an approximation, in many cases the initial strontium from ocean water or mantle rocks is substituted for samples with unknown common strontium ratio. For older samples or those with very high Rb/Sr ratios the resulting age may not be sensitive to this assumed value. But the age is very sensitive in the case of young and/or low Rb/Sr phases. It is much safer to measure the isotopic composition of common strontium if several samples from a diagenetic or hydrothermal environment can be analyzed because of the uncertainty in an assumed value of common strontium (JΣger, 1979). The results of such analyses give both the age and ratio of the initial strontium provided the minerals were equilibrated in the alteration environment.

Several studies document the application of the Rb/Sr dating method to diagenetic and mineralization processes. Lee and Brookins (1978) used the Rb/Sr method to delineate the age of provenance area, sedimentation, and uranium mineralization in the Morrison Formation of the Grants mineral belt of New Mexico. The time of closure of the Rb/Sr system for the zeolite phillipsites in an ocean floor volcano-sedimentary deposit was established by Rb/Sr dating resulting in a mid-Miocene age (14.7 m.y.) (Clauer, 1982). Moreover, Morton (1985) applied the Rb/Sr method to date the diagenesis, source-material age, and strata-bound mineralization in the Tertiary and Paleozoic sedimentary shales from the Gulf Coast and west Texas, respectively. Morton's Gulf Coast study (1983) in which a burial diagenetic event was proposed to have occurred about 25 m.y. ago represents the youngest clay diagenetic process yet dated. Based on the available literature, the Rb/Sr method can be applied to authigenic minerals from hydrothermal alteration zones or deposits. The ideal goal for investigating a young rock (Neogene) would be to analyze different phases with varying Rb/Sr ratios. A high-precision mass spectrometer capable of measuring the $^{87}Sr/^{86}Sr$ to about 5 decimal places would be needed, along with pre-treatment procedures similar to those employed by Morton in order to get reliable results.

A theoretical isochron for an 11 m.y. old sample is plotted with initial $^{87}Sr/^{86}Sr$=0.7082 (comparable to mid-Tertiary marine Sr) and Rb/Sr ratios (26.1, 67.1) obtained from the Tertiary Gulf Coast illite/smectite clays (Morton, 1983). The age uncertainty in an 11-m.y. old sample (e.g. clay) is estimated by utilizing the error associated with a precise $^{87}Sr/^{86}Sr$ measurement made on a 12-m.y. old marine limestone (0.708880;60) by De Paolo and Ingram (1985) (Fig. 1). Based on this estimate a Rb/Sr isochron age of 11-m.y. old clay (e.g. Yucca Mountain authigenic clay) with as broad a range of Rb/Sr ratios as the Gulf Coast clays would have an age uncertainty of 0.2-0.6 m.y. However, if the range of Rb/Sr ratios were narrow (e.g. 30-40), then the error (uncertainty) associated with an 11-m.y. old clay would be higher (0.8 m.y.).

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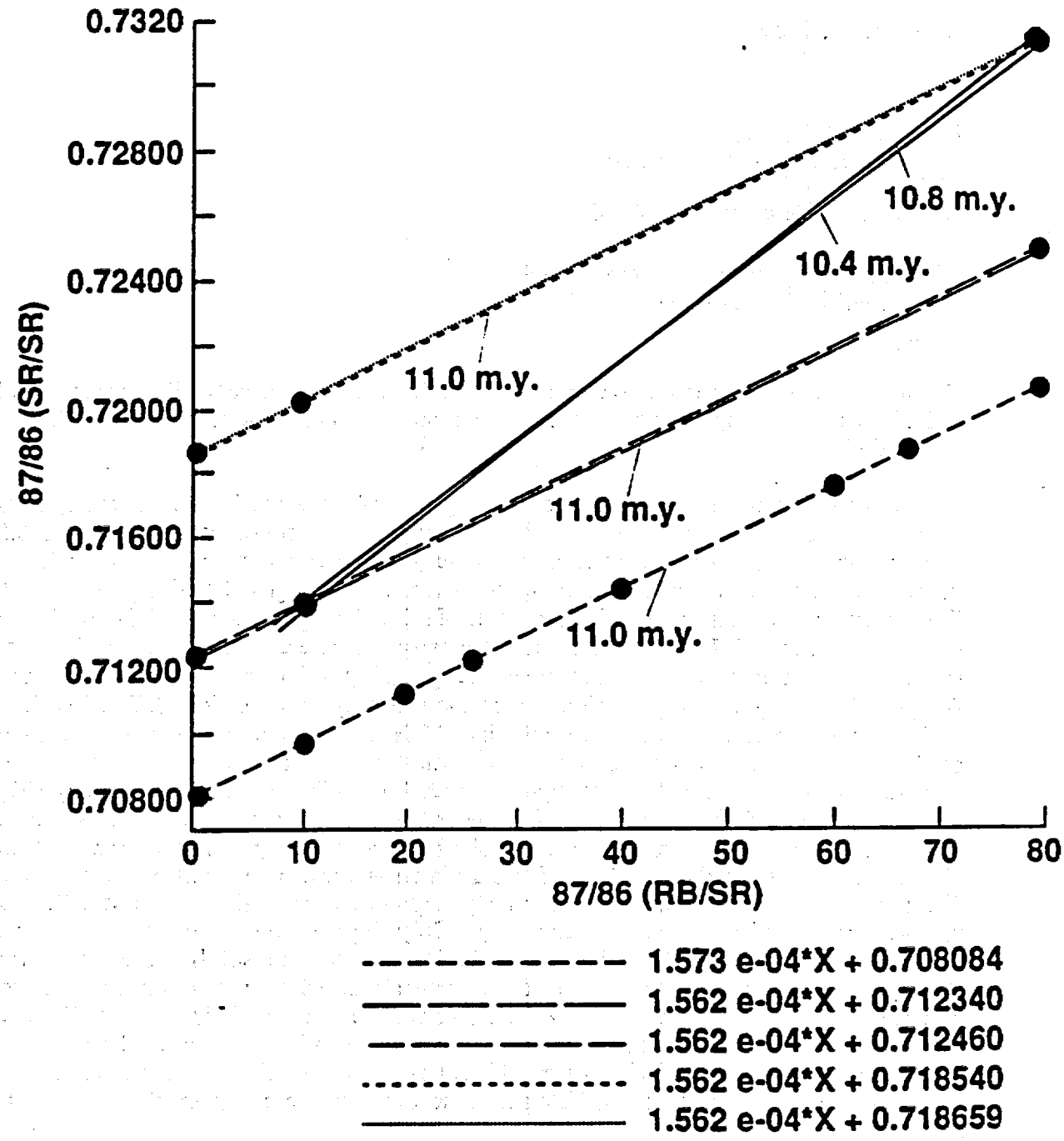

Figure 1. A theoretical Rb/Sr isochron age and associated uncertainty (error) of an 11 m.y. old clay obtained using an initial 87Sr/86Sr ratio of 0.7082 and Rb/Sr ratios of Tertiary clays from the Texas Gulf Coast.

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December 1, 1989

Dr. David E. Hobart
Los Alamos National Laboratory
Mail Stop G-739
Los Alamos, New Mexico 87545

RE: Letter Report for November 1989
YMP-LBL-LR14, R0

Dear Dave:

During the reporting period, we continued working on the project "Determination of Solubilities and Complexation of Waste Radionuclides Pertinent to Disposal at Yucca Mountain."

Our x-ray diffractometer is now working again. We analyzed all nine precipitates from the UE25p#1 experiments at 25°C. The neptunium solids at pH 6, 7, and 8.5 were identified as sodium-neptunium-carbonates and their patterns showed relative good agreement with the Soviet literature pattern of $Na_{0.6}NpO_2(CO_3)_{0.8} \times 2.5H_2O$. We identified the americium solid formed at pH 6 as hexagonal $AmOHCO_3$, while the solids formed at pH 7 and 8.5 are not yet clearly identified. Preliminary analyses of the powder patterns indicate that they are probably mixtures of $AmOHCO_3$ and $Am_2(CO_3)_3 \times nH_2O$. The plutonium solids showed only two identical diffraction lines each indicating a low degree of crystallinity. This is of course not surprising in light of the results of chemical dissolution experiments which we performed on these precipitates. When we treated the precipitates with 1 M HCl, we could not see any CO_2 bubbles coming off which indicates that the solids contained any carbonate. Gamma spectroscopy of these filtered (0.22 μm) solutions showed only ^{241}Am present and no ^{239}Pu. The ^{241}Am is the daughter of ^{239}Pu which is present in small amounts in the ^{239}Pu stock solution. Then, the remaining precipitates were boiled with 6M HCl and the precipitates did not dissolve completely. Only the addition of NaF and continued boiling dissolved them. This is a clear indication that the solids were polymeric Pu(IV). Figure 1 shows the spectra of the three dissolved solutions and one can see that even the NaF did not completely depolymerize the Pu(IV). This is especially true for the pH 7 solid. The spectra, however, have no quantitative bearing, because the amounts of solids, HCl and NaF were different and not controlled for each dissolution test. We are currently preparing KBr pellets to examine the solids by FTIR spectroscopy.

We begun preparing a new ^{239}Pu-stock solution to be used in the UE25p#1 experiments at 60°C. As I reported earlier (NNWSI-LBL-LR-33, R0, July 28, 1988 and YMP-LBL-LR6, R0, March 28, 1989), the previously prepared stock solution contained a whitish-pink translucent solid which floated on top of the solution. We are still unable to identify this rather mysterious solid and decided to not pursue its origin any further.

From November 6–10, 1989, I attended the Second International Conference on "Chemistry and Migration Behavior of Actinides and Fission Products in the Geosphere" at Monterey, California, U.S.A. I presented an invited lecture titled "Solubility Studies of Transuranium Elements for Nuclear Waste Disposal: Principles and Overview," which was well received by the audience.

If you have any questions, please call me.

Best regards,

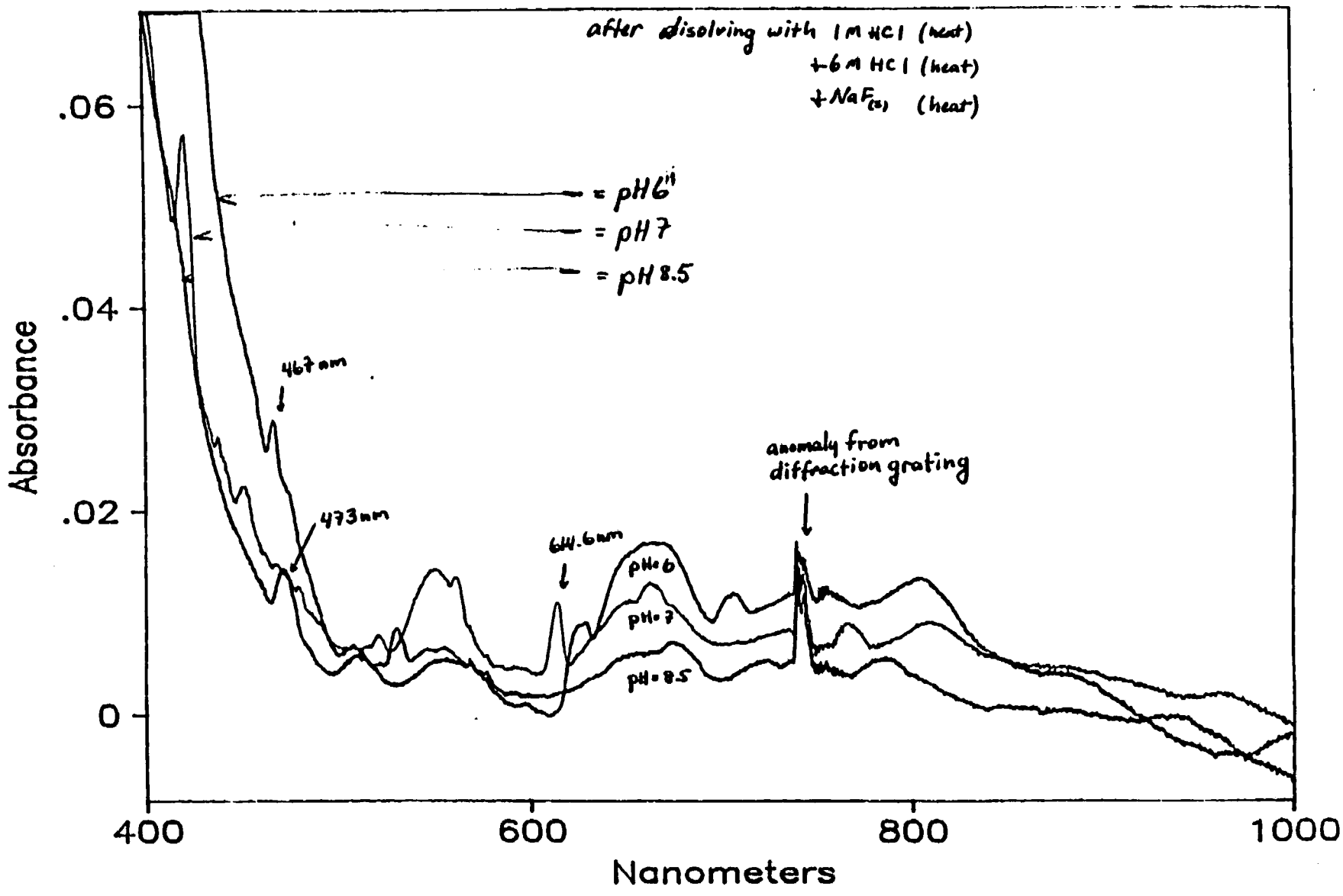
Heino

Heino Nitsche
Principal Investigator
Geochemistry Group
Earth Sciences Division

Total Spectrum

Pu(IV) polymer spectra

after disolving with 1M HCl (heat)
+6M HCl (heat)
+NaF(s) (heat)



PU SPEC 400–1100 AUTO

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11/16/89

14:14

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

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TWS-EES-13-11-89-090

Yucca Mountain Project

Monthly Activity Report

November 1989

This work was supported by the Yucca Mountain Project Office as part of the Civilian Radioactive Waste Management Program. This Project is managed by the US Department of Energy, Nevada Operations Office.

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Monthly Activity Report
November 1989

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Los Alamos
Yucca Mountain Project

LOS ALAMOS NATIONAL LABORATORY
YUCCA MOUNTAIN PROJECT

Monthly Activity Report
November 1989

WBS 1.2.1
Project Title: Systems
Principal Investigator: J. Canepa

The objective of this task is to integrate systems with the Geologic Repository Program and describe the Yucca Mountain Project Mined Geologic Disposal System and to evaluate the performance of the natural, engineered barrier, and total systems for meeting regulatory standards.

ACTIVITIES AND ACCOMPLISHMENTS:

Performance Assessment

J. Canepa attended a performance assessment/Technical Integration Group meeting held November 3 in Las Vegas. Work scope was discussed in light of preliminary budget allocations.

Technical Data Advisory Group

No action.

WBS 1.2.3.2.1.1.1
Project Title: Mineralogy of Transport Pathways
Principal Investigator: D. Vaniman

The purpose of this activity is to define the important mineralogic and geochemical variables along transport pathways at Yucca Mountain in support of performance assessment and to evaluate the impact of repository construction on natural waste transport barriers.

ACTIVITIES AND ACCOMPLISHMENTS:

Personnel participated in the Project Office audit of LANL activities on November 13-17.

Studies were made of the calcite fault filling in a sample of tuff from drill core USW GU-3, at a depth of 482 feet. This sample contains at least three generations of calcite: (1) calcite deposited along the wall of the fault and subsequently sheared by fault movement; (2) coarse (about 0.5 mm) calcite spar deposited after fault movement; and (3) fine-grained calcite deposited on top of the coarse spar. Energy-dispersive traverses during scanning electron microscope (SEM) analysis show no systematic variation in Mg content between calcites of these three generations. Further studies will be done using fluorescence, cathodoluminescence, and electron microprobe methods.

The goal of this study is to compare this type of fault-filling calcite with the calcites that occur in near-surface faults (e.g., in Trench 14) with very different habits and mineral associations but similar

compositions. An understanding of the depositional environments of these two calcite-forming locations will reveal much about the near-surface transport and deposition processes at Yucca Mountain.

Work continued on the statistical analysis of INAA, petrographic, and x-ray diffraction data from samples of the Topopah Spring member collected along Solitario Canyon. Results of this study will be used to define variability in the host rock and to determine adequate sampling methods.

PLANNED WORK:

Develop exploratory shaft sampling plan using data from the Solitario Canyon outcrop.

Evaluate revised x-ray diffraction data using multivariate methods.

Work on image analysis methods to generate porosity distribution maps and in trace-mineral analysis.

Develop statistical methods, especially tools for handling compositional data.

Simulate spatial distribution of compositional data for use in transport models such as TRACR3D.

Evaluate trace-mineral separates from tuff samples at Yucca Mountain.

PROBLEM AREAS:

None.

BIBLIOGRAPHY:

K. Campbell
Sampling for Site Characterization of a Potential Waste Repository
Mathematical Geology (Journal)
Completed internal reviews.

MILESTONE PROGRESS:

Level III report
1/90
Calcite in Fractures
Writing 30% complete.

Level III report
6/90
Statistical Analysis, Topopah Spring Member
Writing 5% complete.

Level III report
8/90
Trace Minerals

New report
10/90
Review of Yucca Mountain Mineralogy
Writing 5% complete.

New report
10/90
Review of Erionite at Yucca Mountain
Writing 5% complete.

WBS 1.2.3.2.1.1.2
Project Title: Mineralogic and Geochemical Alteration
Principal Investigator: S. Levy

The objective of this task is to characterize past and present natural alteration processes that have affected the potential geologic repository and to predict future effects of natural and repository-induced alteration.

ACTIVITIES AND ACCOMPLISHMENTS:

Most of the effort this month was directed toward preparation for and participation in the DOE quality assurance audit. Draft contracts for FY 90 work were prepared. The procedure for interface control was reviewed, and comments sent to the quality assurance staff.

S. Levy and D. Vaniman participated in a joint field collection trip with the USGS for the hydrogenic deposits study. Outcrop sites at southern Yucca Mountain, southern Crater Flat, and Amargosa Valley were visited and sampled. The thermoluminescent dosimeters emplaced at Trench 14 and Busted Butte in August to measure natural *in situ* radiation were removed. The dosimeter study is part of the electron spin resonance dating technique used to date secondary minerals.

The letter report "Bedrock Breccias Along Fault Zones" by S. Levy is complete and included in the Appendix. A draft letter report by G. WoldeGabriel on the feasibility of Ar/Ar and Rb/Sr dating of Yucca Mountain clays and other secondary minerals is undergoing informal review.

PLANNED WORK:

Petrographic and SEM study of hydrogenic deposit samples will continue. Radiation dosimeters removed from Trench 14 and Busted Butte will be sent to K. Tanaka for measurement.

PROBLEM AREAS:

Results of the quality assurance audit and an upcoming software QA audit are expected to delay ongoing and planned research and data reduction. The magnitude of the delay is not known at this time. A funding shortfall is expected to delay contract work on apatite annealing studies.

MILESTONE PROGRESS:

T431 (Level III)
Bedrock Breccias Along Fault Zones
Complete (see Appendix).

WBS 1.2.3.2.1.2
Project Title: Stability of Minerals and Glasses
Principal Investigator: C. Duffy

The objective of this activity is to produce a model for past and future mineral alteration in Yucca Mountain. The model is intended to explain 1) natural mineral evolution resulting from the transformation of metastable mineral assemblages to more stable assemblages and 2) the effects of a repository emplacement.

ACTIVITIES AND ACCOMPLISHMENTS:

Much of our effort has been directed toward quality assurance activities. This task was audited during the Project Office audit, which discussed our Software Quality Assurance Plan, and during a computer software surveillance.

PLANNED WORK:

Work will continue to achieve a fully qualified QA program and to prepare a milestone report on the smectite/illite transition.

PROBLEM AREAS:

None.

MILESTONE PROGRESS:

Work on the smectite/illite transition milestone is behind schedule; however, major questions have been resolved.

WBS 1.2.3.2.5
Project Title: Postclosure Tectonics
Principal Investigators: B. Crowe and F. Perry

The objective of these volcanism studies is to determine the hazards of future volcanic activities with respect to siting a high-level radioactive waste repository at Yucca Mountain.

ACTIVITIES AND ACCOMPLISHMENTS:

B. Crowe participated in a tectonics field trip with the NRC on November 2. An overview of the field relations of the basaltic volcanic rocks of Crater Flat was presented at a stop at Steves Pass in southwest Crater Flat.

A two-day field trip with the NWTRB was held November 20-21 to review the volcanism studies. Los Alamos participants and contractors included B. Crowe, F. Perry, S. Wells, and L. McFadden. The first day of the field trip was conducted by helicopter with field stops at the Lathrop Wells center, Crater Flat, Sleeping Butte, and Piaute Ridge. Fly-overs were conducted over Black Mountain, Pahute Mesa, and Buckboard Mesa. The second day was spent in the Cima Volcanic field. Overview discussions were held concerning the evolution of continental basaltic volcanic fields, and selected stops were made to illustrate how geomorphic, field, and soils studies are used to study the eruptive history of basaltic volcanic centers.

B. Crowe participated in the Project Office audit of the volcanism task at Los Alamos the week of November 13 and concluded in Las Vegas on November 27.

New mineral and groundmass separates of the Ql3 lava at the Lathrop Wells volcanic center have been obtained using the new Franz separator.

Crushing and melting in triplicate were completed for olivine separated from the Ql5 lava (150 to 250 micron fraction) from the Lathrop Wells volcanic center. We reproduced extractions of cosmogenic ^{3}He within error limits of about 15%.

The Series 151 Image Processor has been received and is being assembled and tested.

PLANNED WORK:

Mass spectrometric measurements of the isotopic composition of U and Th will be completed for the Lathrop Wells during December.

Helium-3 measurements will be obtained for different size fractions of olivine to test for loss of helium by diffusion.

The image processor will be used to develop procedures for digitizing geologic maps to calculate volumes of volcanic units for Yucca Mountain region volcanic rocks.

BIBLIOGRAPHY:

B. Crowe and F. Perry
Volcanic Probability Calculations for the Yucca Mountain Site: Estimation of Volcanic Rates
FOCUS 89 proceedings
Approved 11/20/89.

MILESTONE PROGRESS:

The milestone schedule for volcanism studies continues to be on hold until the revised versions of Study Plan 8.3.1.8.1.1 and 8.3.1.8.5.1 are completed for submission to the NRC.

WBS 1.2.3.3.1.2.2 and 1.2.3.3.1.2.5
Project Title: Water Movement Tracer Tests and Diffusion Tests in the ESF
Principal Investigator: A. E. Norris

The objective of the water movement tracer tests is to obtain measurements of chlorine isotope distributions to help quantify the percolation of precipitation in the unsaturated zone. The objective of the diffusion tests in the ESF is to determine *in situ* the extent to which the nonsorbing tracers diffuse into the water-filled pores of the Topopah Spring welded unit.

ACTIVITIES AND ACCOMPLISHMENTS:

The draft of a procedure for collecting cuttings from air-core drill holes was completed this month. The next steps in the approval process are the technical and quality assurance reviews.

A. Norris participated in the YMP field trip at Superior, Arizona, to select sites for prototype air coring. The two locations that were chosen are each less than 5 miles from the University of Arizona/U. S. Nuclear Regulatory Commission's Apache Leap site in Arizona. Projected ^{36}Cl unsaturated flow studies at this location are of interest to Prof. S. Davis of the University of Arizona's Hydrology Department. Arrangements for his collaboration in this study are being made.

A. Norris presented a talk, "^{36}Cl Studies of Water Movements for the Yucca Mountain Project," on November 3 for the project direct and the technical project officers. He also provided information to the DOE/YMP QA software audit team about the use of software.

The PI received training in the following QA procedures:

TWS-QAS-QP-13.1,R2 Procedure for Handling, Storing, and Shipping Equipment
TWS-QAS-QP-15.1,R1 Procedure for Nonconformances
TWS-QAS-QP-17.3,R0 Procedure for LANL YMP Records Management

PLANNED WORK:

The talk "Chlorine Isotope Studies" will be presented next month to the U. S. Nuclear Waste Technical Review Board.

MILESTONE PROGRESS:

No level II milestone reports are scheduled this fiscal year, and the remaining level III milestone report will be completed soon.

WBS 1.2.3.3.1.3.1
Project Title: Testing of C-Hole Sites with Reactive Tracers
Principal Investigator: E. Springer

Experiments will be conducted at the C-well complex (holes UE25c#1, UE25c#2, and UE25c#3) and in other wells in the vicinity of Yucca Mountain. Reactive tracers will be used to characterize retardation and transport properties on a scale larger than that currently used in laboratory experiments.

ACTIVITIES AND ACCOMPLISHMENTS:

W. Polzer attended the Migration '89 Conference and presented a paper titled "Experiences of Fitting Batch Sorption Experiments for Radionuclides on Tuffs."

The study plan for this activity was submitted to Headquarters by the Project Office for approval.

All personnel participated in the Project Office audit conducted November 13-17 at Los Alamos.

We met with D. Galloway, the USGS principal investigator for the C-Wells project, on November 21. Items discussed included packer design and USGS plans. It was agreed that Los ALamos needed to provide input on design of the packer system, so a meeting was scheduled between USGS; US Bureau of Reclamation (USBR), who is designing and building the packers for the USGS; University of Nevada at Las Vegas; and Los Alamos at Carlsbad, New Mexico on December 12-13. (The meeting will also include discussions with personnel involved with well testing for the WIPP site and their experiences.) It was also suggested that hydraulic testing of the existing C-Wells should be conducted and analyzed before the location of the new well is determined.

The technical portion of detailed technical procedure for the polarograph (DP 324) was completed, but questions concerning procedures during the audit may delay its final completion.

The stop work order on November 22 has stopped all efforts related to the documentation of SORBEQ. Initial planning activities of laboratory experiments using geochemical codes has also stopped until conditions are met to lift the stop work order. One task not affected is the completion of the milestone for FEHMN, and these efforts will continue. However, if the documentation does not comply with requirements in the new Software Quality Assurance Plan, then it will have to be redone.

PLANNED ACTIVITIES:

Continue work on completing the milestone on FEHMN.

Detailed technical procedures will be reviewed based on comments made during the audit for features such as accept/reject criteria and on strengthening documentation requirements. We will also participate as needed to implement a fully qualified QA program.

PROBLEM AREAS:

The results of the Project Office audit indicated that the QA program at Los Alamos was inadequate. Rather than risk any data, laboratory experiments for the tracer characterization and identification phase will not begin until the QA program is accepted.

BIBLIOGRAPHY:

H. Fuentes, W. Polzer, E. Essington, and B. Newman
Characterization of Reactive Tracer for C-well Field Experiments I: Electrostatic Sorption Mechanism, Lithium
LA-series report
Final report to IS-11.

B. Newman, H. Fuentes, and W. Polzer
An Evaluation of Lithium Sorption Isotherms and Their Application to Groundwater Transport
Groundwater (Journal)
Submitted to EES-13 for policy review.

W. Polzer and H. Fuentes
Experiences of Fitting Isotherms to Data From Batch Sorption Experiments for Radionuclides on Tuffs
Migration '89
Presented.

W. Polzer, M. Rao, and H. Fuentes
The Use of the Modified Freundlich Isotherm to Estimate Thermodynamic Equilibrium Properties of Ion Exchange Adsorption of Radionuclides on Volcanic Tuff. Part I. Theoretical Development
Environmental Science and Technology (Journal)
In technical review.

W. Polzer and H. Fuentes
The Use of the Modified Estimate Thermodynamic Equilibrium Properties of Ion Exchange Adsorption of Radionuclides on Volcanic Tuff. Part II. Experimental
Environmental Science and Technology (Journal)
In preparation.

MILESTONE PROGRESS:

R529
9/30/89
Evaluation of Preliminary Application of FEHMN to Yucca Mountain
Delayed 30 days.

Level III report
12/31/89
SORBEQ Documentation
Delayed due to stop work on software.

WBS 1.2.3.4.1.1
Project Title: Groundwater Chemistry
Principal Investigator: M. H. Ebinger

The goal of this investigation is to provide conceptual and mathematical models of the groundwater chemistry at Yucca Mountain. These models will explain the present groundwater composition in relation to interactions of minerals and groundwater and will be used to predict groundwater compositions as a result of anticipated and unanticipated environments.

ACTIVITIES AND ACCOMPLISHMENTS:

Review comments on the draft of Study Plan for Study 8.3.1.3.1.1 were resolved, and text is being revised.

PLANNED ACTIVITIES:

Complete the Study Plan revision and submit for Project Office review.

Submit J. Kerrisk's work on reaction path modeling and groundwater chemistry to the Science and Engineering Project Data Base (SEPDB) and/or the Reference Information Base (RIB).

PROBLEM AREAS:

None.

BIBLIOGRAPHY:

C. D. Dicke and H. R. Fuentes
Modeling of Sr Surface Complexation and Migration
Groundwater (Journal)
Project Office approved (milestone T422).

MILESTONE PROGRESS:

No milestone reports are scheduled in the next three months.

T422
C. D. Dicke
Interim Report: Sorption Characteristics of Sorbing Tracers Using MINEQL Preliminary Ion Exchange Modeling of Strontium in Clinoptilolite
Approved 11/20/89.

WBS 1.2.3.4.1.2.1 and 1.2.3.4.1.2.3
Project Title: Sorption
Principal Investigator: A. Meijer

The objective of the sorption and precipitation task is to provide sorption coefficients for elements of interest in order to be able to predict radionuclide movements from the repository to the accessible environment.

ACTIVITIES AND ACCOMPLISHMENTS:

We continued our studies of Np sorption on pure mineral separates. Our initial experiments with Np in a pH 8.5 buffer solution and pure mineral separates are being followed up with experiments involving pure mineral separates contacted with Np-spiked J-13 water. The mineral separates have been pre-conditioned with J-13 water. After pre-conditioning, the phases were separated, and a second aliquot of J-13 water, spiked with Np, was contacted with each of the mineral separates. This set of experiments will be completed in late December or early January.

Another set of experiments has been initiated to investigate the sorption behavior of Tc on pure mineral phases appropriate to the Yucca Mountain site. For these experiments, pure mineral separates are being pre-conditioned with a pH 8.5 buffer solution (using a ratio of 20 ml of solution to 1 g of solid). This pH is chosen as one pertinent to the Yucca Mountain site.

The sorption program was part of a week long audit by the Yucca Mountain Project Office in November. Our study plan, notebooks, quality assurance procedures, and facilities were included in the audit.

An outline was submitted for a presentation to the Nuclear Waste Technical Review Board Meeting to be held in Denver in early December. A "dry-run" of our presentation was given in Las Vegas on November 28.

LANL personnel involved in the sorption program attended the quality assurance session for software held at Los Alamos in November.

The Stanford group has completed a set of experiments involving the sorption of Np onto goethite as a function of pH. These experiments were carried out mainly to establish the technique in anticipation of experiments to be carried out involving Np sorption on hematite.

PLANNED WORK:

Continue the study of Np sorption on pure minerals in J-13 water, Tc sorption studies on pure minerals, and development of thermodynamic framework for the interpretation and integration of sorption data.

PROBLEM AREAS:

None.

BIBLIOGRAPHY:

A. Meijer, I. Triay, S. Knight, M. Cisneros
Sorption of Radionuclides on Yucca Mountain Tuffs
FOCUS 89 proceedings
Approved 11/20/89.

A. Meijer
YMP Far-Field Sorption Studies and Data Needs
LA-series report (approved milestone T419)
At press.

WBS 1.2.3.4.1.2.2
Project Title: Biological Sorption and Transport
Principal Investigator: L. Hersman

The purpose of this research is to determine whether microbial activity can influence the movement of plutonium in tuff. Because fluids are used extensively in the exploration of locations for a nuclear repository, of special interest are those microorganisms capable of utilizing drilling fluids as growth substrates.

ACTIVITIES AND ACCOMPLISHMENTS:

During the week of November 6-10, I attended the Migration '89 meetings in Monterey, California, and presented a paper titled "Effects of Microorganisms on the Transport of Actinide Elements."

The week of November 13-17 was spent participating in the DOE audit.

Several analyses have been performed on the siderophore to determine its purity and structure.

1. Twenty milligrams of siderophore were sent to Galbraith Labs for carbon, nitrogen, and hydrogen analysis. The C:N:H content was 38.15%, 12.03%, and 5.92%, respectively.

2. A Fourier transformed infrared spectrophotometry (FTIR) analysis of the siderophore was performed. The results clearly suggest the presence of amide linkages.

3. More detailed high pressure liquid chromatographic (HPLC) analysis of the siderophore suggest the presence of amino acids.

4. Subsequent amino acid analysis clearly indicates the presence of amino acid residues.

These analyses indicate that the siderophore is a peptide (or protein). However, it was also determined during the HPLC work that the siderophore has not yet been purified. We are currently developing techniques to purify this compound.

PLANNED WORK:

Further develop techniques to purify siderophore.

PROBLEM AREAS:

None.

WBS 1.2.3.4.1.3
Project Title: Solubility Determination
Principal Investigator: D. Hobart

The objective of the solubility determination task is to determine the solubilities and speciation of important waste elements under conditions characteristic of the repository and along flow paths from the repository into the accessible environment.

ACTIVITIES AND ACCOMPLISHMENTS:

D. Hobart, D. Morris, and H. Nitsche attended the Second International Conference on "Chemistry and Migration Behavior of Actinides and Fission Products in the Geosphere" at Monterey, California, from November 6-10. H. Nitsche presented a lecture "Solubility Studies of Transuranium Elements for Nuclear Waste Disposal: Principles and Overview."

The Solubility Determination Task was audited during the second week of November, and no findings were involved with this task.

H. Nitsche continued work on the determination of solubilities and complexation of waste radionuclides pertinent to disposal at Yucca Mountain. Nine precipitates were analyzed from the UE25p#1 experiments. The neptunium solids were identified as sodium-neptunium-carbonates, the americium was hexagonal $AmOHCO_3$, and the plutonium solids are suspected to be polymeric Pu(IV). Nitsche is also preparing a new ^{239}Pu stock solution for further experiments.

PLANNED WORK:

We will continue work on a number of detailed procedures which are due this fiscal year.

D. Hobart and Clark will attend the International Chemical Congress of the Pacific Basin Societies Meeting in Honolulu, Hawaii the week of December 18.

According to the SKB/DOE Bilateral Information Exchange Treaty, D. Hobart will go to Sweden in June 1990 to attend the next meeting.

PROBLEM AREAS:

None.

BIBLIOGRAPHY:

D. Hobart et al.
Formation, Characterization, and Stability of Pu(IV) Colloid
FOCUS 89 proceedings
Approved 11/21/89.

MILESTONE PROGRESS:

None.

WBS 1.2.3.4.1.4
Project Title: Dynamic Transport Process
Principal Investigator: I. Triay and R. Rundberg

The objective of the dynamic transport process task are to determine the rate of radionuclide movement along the potential flow paths to the accessible environment and to examine the effect of diffusion, adsorption, dispersion, anion exclusion, sorption kinetics, and colloid movements in the flow geometries and hydrologic conditions that are expected to exist along the flow path to the accessible environment in the scenarios to be used for performance assessment.

ACTIVITIES AND ACCOMPLISHMENTS:

The retardation of radionuclides in columns made of intact tuff is important for the evaluation of the Yucca Mountain site. The hydraulic and mineralogic heterogeneity of the natural tuff samples leads to a very complex transport mechanism. Modern stochastic models, capable of calculating the transport of conservative tracers in heterogeneous aquifers, predict increasing dispersion with time.

The transport of solutes in porous media is often considered a Fickian diffusive process described by the advection-dispersion equation, as given in Eq. 1.

$$\mathrm{div}(D \ \mathrm{grad}\ C - UC) = \epsilon R_f \frac{\partial c}{\partial t} , \qquad (1)$$

where D is the dispersion tensor, C is the concentration of solute, U is the Darcy's velocity vector, ϵ is the effective porosity, and R_f is the retardation factor. The dispersion tensor represents the diffusion and hydrodynamic dispersion.

The transport of radionuclides through intact tuff in our column experiments is approximated by one-dimensional flow through porous media. Tritium was eluted through a column made of densely welded intact tuff from the Topopah Spring member of Yucca Mountain. This tuff sample consists of feldspar, cristobalite, quartz, smectite, calcite, mica, and hematite. The length of the column was 4.71 cm, the diameter was 1.66 cm, the pore volume was 1.59 ml, the porosity was 0.156, the flow rate was 1.32×10^{-5} ml/s, and the dead volume was 1.1 ml. The elution curves, shown in Fig. 1, cannot be fit to the conventional advection-dispersion equation. To fit the elution data, time dependent dispersion was invoked. The time dependence of the apparent dispersion D_A, parallel to the direction of the flow, was approximated by the power law expression given in Eq. 2.

$$D_A = D_I + D_O t^n . \qquad (2)$$

The best fit obtained for the elution of the tritiated water corresponds to a value of the exponent n (in Eq. 2) of 1.0.

Two presentations were made at the 2nd International Conference on Chemistry and Migration Behavior of Actinides and Fission Products in the Geosphere (Migration '89) in Monterey, California, on November 6-10: "Size Determinations of Pu Colloids Using Autocorrelation Photon Spectroscopy" by I. R. Triay, R. S. Rundberg, A. J. Mitchell, M. A. Ott, D. E. Hobart, and P. D. Palmer; and "Observation of Time Dependent Dispersion in Laboratory Scale Experiments with Intact Tuff Columns" by R. S. Rundberg, I. R. Triay, M. A. Ott, and A. J. Mitchell.

PLANNED WORK:

Continue solid rock column experiments, rock beakers experiment (see February's monthly report), and transport work with pure minerals.

Report on the analysis of sorbing tracers eluted through intact tuff columns.

PROBLEM AREAS:

The SPEX fluorometer is being repaired and the autocorrelation photon spectroscopy system is being set up (see October's monthly report).

BIBLIOGRAPHY:

N. Patera, D. Hobart, A. Meijer, and R. Rundberg
Chemical and Physical Processes of Radionuclide Migration at Yucca Mountain Nevada
Radioanalytical Chemistry (Journal)
Returned to author for revisions 9/18/89.

I. R. Triay, R. S. Rundberg, A. J. Mitchell, M. A. Ott, D. E. Hobart, and P. D. Palmer
Size Determinations of Pu Colloids Using Autocorrelation Photon Spectroscopy
Migration '89 proceedings
In internal review.

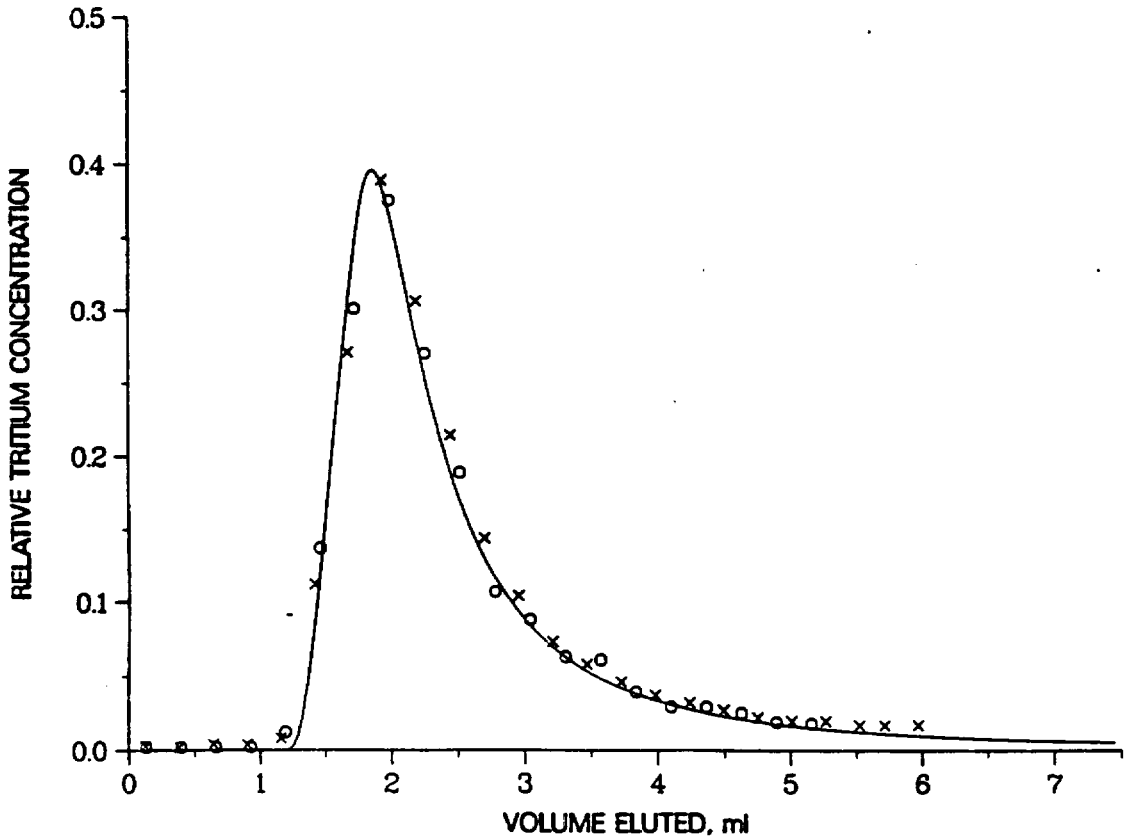

Figure 1. Comparison of predicted (solid line) and measured (o and x) duplicate tritium elutions through an intact tuff column; fit obtained with time-dependent dispersion.

WBS 1.2.3.4.1.5.1
Project Title: Retardation Sensitivity Analysis
Principal Investigator: K. Eggert

The objectives of the retardation sensitivity analysis task are to construct a geochemical/geophysical model of Yucca Mountain and to use this model to examine the physical and chemical controls on radionuclide transport along flow paths to the accessible environment.

ACTIVITIES AND ACCOMPLISHMENTS:

Analysis of Physical/Chemical Processes

S. Kelkar and G. Zyvoloski met with Devin Galloway, USGS, to discuss modeling coupled stress and flow fields at Yucca Mountain.

Team members met with R. Barnard, G. Barr, R. Glass, and M. Wilson from Sandia. A cooperative modeling effort is being initiated to develop 2- and 3-dimensional flow fields for use in Sandia's Ground Water Travel Time Task and for Retardation Sensitivity Analysis calculations. We also discussed ideas for validation experiments of common interest.

Geochemical/Geophysical Model

B. Travis presented the paper "Simulation of Radionuclide Retardation at Yucca Mountain Using a Stochastic Mineralogic/Geochemical Model" at the Migration '89 Meeting in Monterey, California, November 6-10. He presented a movie of results from 3-dimensional transport calculations run with TRACRN and of analogous particle tracking calculation. K. Eggert also attended the meeting.

Further 3-dimensional transport calculations are being run with TRACRN to study the effects of spatial variability in sorption coefficients on radionuclide migration.

QA and Programmatic

Team members attended quality assurance training on Records Management, QP-17.3.

K. Birdsell attended an INTRAVAL meeting for US participants in Berkeley, California, November 14-16. Participants discussed their modeling efforts on Phase 1 INTRAVAL cases and planning of experiments for inclusion as Phase 2 cases.

MILESTONE PROGRESS:

Milestone T421, the approved TRACRN manual, is undergoing final editing in preparation for printing as a LAMS report.

WBS 1.2.3.4.1.5.2
Project Title: Geochemical Field Tests for Validation
Principal Investigator: J. A. Canepa

The purpose of this activity is to test the validity of the laboratory geochemistry data generated by the Geochemistry Test Program and to test the geochemical transport modules. Five subtasks constitute this activity: 1) natural analogs, 2) large block test, 3) caisson test, 4) unsaturated zone geochemistry field test, and 5) radionuclide migration studies at the Nevada Test Site.

ACTIVITIES AND ACCOMPLISHMENTS:

Natural Analogs

No action.

Large Block Tests

No action.

Anthropogenic Analogs

No action.

Caisson Tests

No action.

SEA Contract

A report summarizing the results of scoping calculations for three field test designs was completed and is in the final stages of preparation.

SEA met with Everett Springer on November 17 to discuss results of the scoping calculations and field test objectives.

Work continued on the study plan, including considerable revision to the earlier version submitted in September. The emphasis of the study plan has been changed to place more emphasis on gaining an understanding of fundamental processes (such as dispersion, fracture flow, and fracture-matrix interaction) and resulting effects of radionuclide transport than was previously the case. Less emphasis is being placed on using results of the field test for model validation, since whether or not it will be suitable is uncertain.

SEA attended the quality assurance training on LANL YMP Records Management on November 30.

PLANNED WORK:

Work on the field test study plan will continue and the report on the scoping calculations will be submitted in December.

WBS 1.2.5
Project Title: Regulatory and Institutional
Principal Investigator: J. A. Canepa

The purpose of this task is to coordinate the regulatory and institutional Project requirements within the Los Alamos programmatic structure. The focus of this coordination effort is on the integration of the technical work within the regulatory and institutional framework.

ACTIVITIES AND ACCOMPLISHMENTS:

Site Characterization Plan

No action.

Semi-annual Progress Report

No action.

Study Plans

The status of the study plans is as follows.

Water Movement Test, R3 (8.3.1.2.2.2). Approved by Project Office and DOE/HQ; sent to NRC and State of Nevada.

Diffusion Test in the Exploratory Shaft, R0 (8.3.1.2.2.5). Abstract and SCP-based network submitted to Project Office 5/25/89 and to DOE/HQ 6/30/89.

Testing of the C-Hole Sites With Reactive Tracers, R1 (8.3.1.2.3.1.7). Revision 2, which incorporates DOE/HQ and Project Office comments, was submitted to DOE/HQ 11/16/89.

Mineralogy, Petrology, and Chemistry of Transport Pathways, R3 (8.3.1.3.2.1). A Study Plan Assessment was developed for this study and transmitted to DOE/HQ on 6/22/89.

History of Mineralogy and Geochemical Alteration at Yucca Mountain, R0 (8.3.1.3.2.2). A comment resolution meeting was held on May 31, 1989, for DOE/HQ comments.

Kinetics and Thermodynamics of Mineral Evolution and Conceptual Model of Mineral Evolution, R0 (8.3.1.3.3.2; 8.3.1.3.3.3). DOE/HQ review comments were received 11/1/89.

Sorption Studies and Sorption Modeling, R0 (8.3.1.3.4.1; 8.3.1.3.4.3). Undergoing Project Office AP-1.10Q review (1/30/89).

Biological Sorption and Transport, R1 (8.3.1.3.4.2). Project Office AP-1.10Q review comments were received 11/13/89.

Dissolved Species Concentration Limits, and Colloid Formation and Stability, R0 (8.3.1.3.5.1; 8.3.1.3.5.2). Undergoing Los Alamos QP3.2 technical review.

Dynamic Transport Column Experiments, R0 (8.3.1.3.6.1). Project Office AP-1.10Q review comments were received 11/7/89.

Diffusion, R0 (8.3.1.6.2). Project Office AP-1.10Q review comments were received 11/7/89.

Probability of Volcanic Eruption Penetrating the Repository, R0 (8.3.1.8.1.1). Submitted to DOE/HQ (4/19/89).

Effects of Volcanic Features, R0 (8.3.1.8.1.2). In preparation.

Characterization of Volcanic Features, R0 (8.3.1.8.5.1). A Comment Resolution Meeting for Project Office and DOE/HQ comments was held July 11-12, 1989.

Retardation Sensitivity Analysis, R0 (8.3.1.3.7.1). Submitted to Project Office 12/14/89. Project Office AP-1.10Q comments received 6/28/89.

Ground Water Chemistry Modeling, R0 (8.3.1.3.1.1). In preparation.

WBS 1.2.6
Project Title: Exploratory Shaft Management and Planning
Principal Investigator: H. Kalia

These exploratory shaft (ES) tasks will address the issues and information needs associated with the feasibility of storing high-level nuclear waste in a geologic repository at Yucca Mountain.

ACTIVITIES AND ACCOMPLISHMENTS:

The Project Office audited the IDS readiness review.

We worked on several documents this month. Preparation of the Test Support Requirements Document (TSRD) continued. Support requirements have been determined for all tests in the Exploratory Shaft, and requirements are being developed for the tests in the main test level. Review comments are being incorporated into the Exploratory Shaft Test Descriptions Document (TDD). We continued to prepare the Annual Report for the Prototype Testing. We reviewed the Project Preliminary Safety Analysis Report (PSAR) and the draft of the Engineering Management Plan. We prepared input for a joint proposal with Sandia on field testing activities. We supported the prerequisites (readiness review) list for the ESF tests, which will identify the requirements to be met prior to conducting the tests in the ESF, and prepared input for the implementation plan (developing networks and resource requirements).

The following work continued: prepare the ESF testing networks; prepare the Health and Safety Plan for the Test Manager's Office; track the progress of test procedures for the ESF; and update Prototype testing schedules and networks.

PLANNED WORK:

Work will begin to phase down the G-Tunnel Prototype Testing and to prepare the ESF Test Plan.

The following work will continue: prepare the TDD and TSRD; prepare the Environmental Health and Safety Implementation Plan (EHSIP) for ESF testing; prepare change requests; support the alternative design studies, WIT-4, and the Long-Range Plan; and prepare the Engineering Management Plan.

PROBLEM AREAS:

None.

BIBLIOGRAPHY:

H. Kalia, A. Girdley, and R. Oliver
Prototype Testing for the Yucca Mountain Project
International High-Level Radioactive Waste Management Conference (IHLRWMC), April 1990
Submitted to Project Office 9/20/89.

H. Kalia
Role of Underground Testing to Determine Suitability of Yucca Mountain as a Potential Repository Site
IHLRWMC
Submitted to Project Office 9/20/89.

H. Kalia, K. Bujard, R. Oliver, and S. Francis
Exploratory Shaft Facility (ESF) Prototype Test Management
IHLRWMC
Submitted to Project Office 10/30/89.

WBS 1.2.6.9.3
Project Title: Exploratory Shaft Integrated Data System
Principal Investigator: H. N. Kalia

The integrated data system (IDS) is part of the supporting facilities for the Exploratory Shaft Facility (ESF). The IDS supports the data acquisition needs of the ESF test program by providing a central facility to automatically measure and control aspects of the ESF tests. The primary purpose of the IDS is to assist the principal investigators (PIs) in acquiring high-quality test data in a uniform, controlled fashion and to transfer those data to the PIs' organizations for data management and analysis.

ACTIVITIES AND ACCOMPLISHMENTS:

A readiness review was conducted to determine EG&G's readiness to start the IDS Title II design. Preliminary results indicate that EG&G is not ready to start the Title II design. Work was initiated to phase out EG&G's role for the design of the IDS.

The development of the Configuration Management Plan for the IDS continued, as did the preparation of the IDS network.

PLANNED WORK:

EG&G is developing a phase down plan. All EG&G activities are to be terminated by the end of January 1990. IDS activities (i.e., supporting the ESF alternate study, responding to the QA audit, and finalizing the Functional Requirements Document) will be internalized by Los Alamos.

Initiate work to develop IDS component-reliability analysis.

PROBLEM AREAS:

None.

WBS 1.2.9.1.4
Project Title: Records Management
Principal Investigator: G. Ortiz

The objective of this task is to manage records and documents related to the licensing of a geologic repository for the disposal of high-level radioactive waste. The requirements are to support the development, implementation, and maintenance of a comprehensive, automated, and integrated information management system.

ACTIVITIES AND ACCOMPLISHMENTS:

The week of November 13, the Project Office Quality Assurance (QA) Department conducted an audit of the LANL QA Program. During that time, effort was concentrated on audit questions and answers regarding records retrieval, storage, and protection; database queries; log information; one-of-a-kind storage; and records identification. Many of the questions on records management were derived from Administrative Procedure 1.7Q and the YMP QAP, YMP/88-9, R2.

During the week of November 27, a DOE QA Software Surveillance team conducted a survey of the LANL YMP Software QA Program. Questions were related to protection (backups) and storage (environmental conditions) of the software being developed at Los Alamos. Also during that week, K. Foster (LATA) conducted QA training to Quality Procedure TWS-QAS-QP-17.3, R0, LANL YMP Records Management.

Donna Williams (LATA) is the new Records Assistant for the Records Processing Center (RPC).

PROBLEM AREAS:

None.

PLANNED WORK:

Don Helton and Lee Carpenter, the new Yucca Mountain Project Records Administrator, are scheduled to visit Los Alamos on December 13.

WBS 1.2.9.3
Project Title: Quality Assurance
Principal Investigator: H. P. Nunes

The Quality Assurance Program provides quality assurance support to Los Alamos Yucca Mountain Project (YMP) participants. This support is designed to ensure that the YMP efforts of Los Alamos will provide admissible data and evidence for the repository licensing process.

ACTIVITIES AND ACCOMPLISHMENTS:

The weekly meetings to prepare for the Project Office audit continued. The Project Office conducted its Los Alamos audit from November 13-17 and concluded at the LANL Test Manager's Office November 27-28. At the conclusion of the audit, the DOE concluded that the LANL QA Program was not sufficient to allow for its acceptance and use on the Yucca Mountain Project. Additional work is needed in reviews, procedural directions, training records, and the corrective action system. LANL EES-13 staff have begun the process of making the needed corrections to the QA program.

Work at Edgerton, Germeshausen & Grier (EG&G) was directed to stop by January 31, 1990. The EG&G will concentrate on completing records and turning all in-process work over to LANL.

The LANL QAPL issued Stop Work Order No. SWO-LA01 on November 22. The stop work was directed at software or software development. The Project Office conducted a surveillance on the LANL software program November 28-30.

PLANNED WORK:

LANL staff will participate in resolving the standard deficiency reports issued as a result of the Project Office Audit No. 89-7. Training of the Los Alamos staff to any revisions will be a second priority to assure that the ongoing research efforts are in compliance with the revised LANL QA program.

Efforts to resolve the internal deficiency reports and the standard deficiency reports will be increased to meet the Project Office-directed completion date. Additional staff will be assigned to track and close the outstanding standard deficiency reports. These efforts will include the needed corrections to the LANL training and certification files.

APPENDIX

ATTACHMENTS AND LEVEL III MILESTONE REPORTS

WBS 1.2.3.2.1.1.2

BEDROCK BRECCIAS ALONG FAULT ZONES

Schon S. Levy

INTRODUCTION

The hydrogenic deposits study is principally concerned with investigating the origin or origins of authigenic laminated calcite-silica deposits along the Bow Ridge and other faults in the vicinity of Yucca Mountain. A variety of depositional environments and fluid sources has been proposed for these deposits. Two of the main calcite-silica study areas--Trench 14 and western Busted Butte--also include exposures of material described in the hydrogenic deposits study plan as silica-cemented breccia. The origin of this material is also subject to multiple interpretations. Although secondary-silica cementation is a highly visible feature of the breccias, silica is neither the sole nor, in many cases, the most abundant cementing agent. The best distinguishing aspect of the breccias is the predominance of locally derived tuffaceous clasts over authigenic calcite-silica cement, ooids, or related material. This distinction may have genetic significance, but mainly serves as a useful field recognition criterion.

The goal of this preliminary study is to identify and describe the various attributes of bedrock breccias. This is the initial step in determining the particular genetic significance of the bedrock breccias and the specific rock characteristics that contain the significant information.

BEDROCK AND BRECCIA ZONE CHARACTERISTICS

The two bedrock units most affected by brecciation are the Topopah Spring and the Tiva Canyon Members of the Paintbrush Tuff. Both of these units are widespread and well-exposed in the Yucca Mountain area and have been extensively studied. The general characteristics of these units at the hydrogenic deposit study sites are summarized below.

At western Busted Butte, the brecciated bedrock exposed along ravines is Topopah Spring tuff. The brecciated part of the unit is densely welded devitrified tuff, including both lithophysal and non-lithophysal portions. The thickness of tuff affected by brecciation is at least 100 m.

Bedrock breccias at Trench 14 and nearby trenches along the Bow Ridge fault are mostly restricted to the Tiva Canyon Member. The Tiva Canyon Member at Trench 14 is a densely welded, devitrified tuff, with sparse-to-abundant lithophysal cavities. The vertical exposures of Tiva Canyon tuff in the trenches are up to about 4 m, and exposures along trench walls are up to 10-m long. This fairly limited exposure nevertheless reveals at least two distinct lithologic subunits of the tuff that have been juxtaposed by faulting. The stratigraphically higher subunits are distinguished from the lower by a higher phenocryst content. Secondary distinguishing characteristics of the stratigraphically highest material (now downdropped within the fault zone) include a deeper red color, high vesicularity, and abundant lithophysae.

TEXTURAL CLASSIFICATION

The bedrock breccias have been provisionally divided into two textural categories based primarily on differences in the composition and abundance of matrix materials and authigenic minerals. The two categories are crushed-tuff matrix breccia and authigenic-mineral-cemented breccias. Both varieties are present at Exile Hill and Busted Butte. This report describes the petrographic characteristics of the two breccia varieties in thin section and scanning electron microscope (SEM) images. Field identification and classification can be difficult, and the following descriptions are intended in part to make it easier.

Crushed-Tuff Matrix Breccia

The crushed-tuff matrix breccias at Busted Butte have been less affected by later rebrecciation than the similar breccias at Exile Hill. For this reason, most of the preliminary characterization of this breccia type is based on the study of Busted Butte samples. The descriptions that follow are summarized from petrographic and SEM examination.

DTV 2.1

As the name suggests, crushed-tuff matrix breccia consists of tuff clasts in a matrix of finely crushed tuff. The clasts are composed of lithologically homogenous Topopah Spring tuff and chunks of vapor-phase crystals (mostly tridymite) broken from lithophysal cavities in the tuff. Most tuff clasts are subangular to subrounded. Individual particles of crushed tuff are as small as 2 microns across. There is considerable variation in grain size distribution within the matrix. Small domains (about 500 microns across) exist in which the grain size range is about 2 to 20 microns. More commonly, the size range is from about 5 to 500 microns. The degree of brecciation has been influenced on a local scale by pre-existing microtextures in the devitrified tuff. Parts of the tuff with a dense texture have been resistant to fine crushing, whereas areas with a more open and porous texture have undergone much greater comminution.

The crushed-tuff matrix breccias contain small amounts of authigenic minerals as fracture and pore fillings. Silica, calcite, and sepiolite have been tentatively identified as the principal or sole authigenic minerals. The mineral identifications have not yet been confirmed by x-ray diffraction. In sample DTV2.1, silica has filled fractures and pores adjacent to fractures. Some areas of fine-grained crushed tuff matrix are strongly cemented by silica. In the smaller fractures and pores, silica has the form of a simple isopach cement. The texture of silica fillings in larger fractures is more complex, including botryoidal textures. No evidence has yet been found for physical replacement of tuffaceous material by silica. The field term "silicified tuff" has been applied to the bedrock breccias, but preliminary results indicate that "silicification" has been limited to pore-filling cementation.

In addition to silica, calcite is also a fracture- and pore-filling mineral in the crushed-tuff matrix breccias. The calcite in sample DTV2.1 appears to be younger than the silica because it has filled the central voids of silica-lined pores.

Sepiolite in sample DTV2.1 is present as fillings in pores, but has not been observed as a fracture filling. The pore fillings are common in some parts of the rock and absent elsewhere. The fillings are very porous, plumose aggregates of thin, elongate sepiolite ribbons. Individual ribbons are about 1 micron thick. Some of the densest aggregates identified by SEM were analyzed by electron microprobe. Analysis totals for the best of these analyses (Table I) are lower than the totals for denser aggregates in the authigenic-mineral-cemented breccias and the laminated calcite-silica deposits. Nevertheless, the analyses clearly reveal variations in the Al content of this texturally homogenous material.

Age relations between sepiolite, silica, and calcite in sample DTV2.1 are ambiguous because sepiolite is generally not in direct contact with the other two authigenic minerals. In those parts of the breccia matrix where sepiolite is the dominant pore filling and silica is a minor isopach cement, the silica-lined pores contain little or no sepiolite in the remaining void space. The simplest explanation of this relationship may be that silica was the earlier-deposited material, and silica-lined pores were effectively sealed off from later sepiolite deposition.

Crushed-Tuff Matrix Breccias in Trench 14

Exposures of crushed-tuff matrix breccias at Trench 14 are mostly restricted to recycled clasts of bedrock and breccia matrix within the authigenic mineral-cemented breccias described below. The crushed-tuff matrix in clasts from samples TR14-3A-SSL and TR14-3B-SSL resembles the Busted Butte breccia samples. It has not been possible to distinguish authigenic minerals deposited in the original tuff-matrix breccia from later-deposited cements in the Trench 14 material. Trench 14B, north of Trench 14, contains tuff-matrix breccia that has been less affected by later rebrecciation. Field examination of this material indicates substantial deposition of pore-filling silica.

Authigenic-Mineral-Cemented Breccias

The principal cements in the authigenic-mineral-cemented breccias (hereafter referred to as cemented breccias) are calcite and silica. Following the definition of breccia given in the introduction, cemented breccias include only rocks in which tuffaceous clasts are more abundant than cement and other authigenic material; however, field exposures show a complete gradation from tuffaceous clast-dominated breccias to laminated calcite-silica fault fillings or soil-column calcite-silica deposits containing mostly authigenic material.

The authigenic-mineral-cemented breccias are texturally more heterogeneous than the crushed-tuff matrix breccias. Clasts in the cemented breccias are mostly recycled from the crushed-tuff matrix breccias, as indicated by the distinctive clasts of crushed-tuff matrix. Many clasts of tuff and crushed tuff have banded coatings of carbonate. Clasts composed wholly or in part of crushed-tuff matrix are usually rounded and have very indistinct

boundaries owing to calcite deposition in the pores of the breccia matrix. Authigenic mineral clasts include ooids, sepiolite pods, and banded calcite-silica material. Most of the authigenic clasts appear to have formed in place, but some have been broken and redeposited. Plant remains are common. Three examples of this textural group are described in detail below. Sample TR14-3A-SSL, in which authigenic material predominates over tuffaceous clasts, is also briefly described.

TR14-3B-SSL

The clasts of Tiva Canyon tuff and crushed-tuff matrix are locally grain-supported. In places, clasts of crushed-tuff matrix recycled from older breccias have broken down sufficiently to create a local matrix of fine-grained material. There is only minor development of distinct carbonate coatings on the tuffaceous clasts. Some tuff clasts have discontinuous coatings of very fine-grained calcite about 0.02 mm thick.

The authigenic carbonate cementing material is very fine-grained, vesicular, and highly fractured. Fracture traces are commonly discontinuous, and fracture boundaries have been modified by later authigenic-mineral deposition, deformation, and, perhaps, recrystallization. The discontinuous fracture segments resemble vesicles. Many fractures locally run along the boundaries of tuff clasts and cut through tuffaceous clasts along the boundaries between tuff and crushed-tuff matrix. Some fractures and vesicles contain residual void space, but most have been completely filled. Silica is the most abundant fracture- and vesicle-filling material, and silica-coated carbonate root casts are common within the fractures. Other fracture- and vesicle-filling materials include sparry and acicular calcite and a possible mixture of sepiolite and minor silica (see next paragraph). Acicular calcite is older than silica where the two fillings are found together, and sparry pore-filling calcite is younger. The sepiolite-silica fracture fillings are mostly in discrete pods of material scattered along the relict fracture traces.

Individual sepiolite pods are commonly elongate and aligned subparallel to the relict fracture traces along which the pods lie. The material in the pods has a platy to fibrous texture, locally with an overall elongate fabric matching the elongation of the pods themselves. This kind of fabric could be a product of tectonic shear associated with fault movement, but it could also be produced by nontectonic mechanisms. Shear in surficial deposits can be produced by shrinking and swelling caused by wetting and drying or freezing and thawing. Other processes capable of producing alignment include illuviation of particulate sepiolite and plant root invasion and growth. It is possible that sepiolite with a texture like the open, plumose sepiolite aggregates in DTV2.1 could be converted to a denser texture with an aligned fabric by compaction or any of the processes mentioned above.

Microprobe analyses of the pods (Table I) show higher Si and lower Mg contents than would be expected for pure sepiolite (close to the Si/Mg values for DTV 2.1). There is SEM evidence for infiltration of younger silica along the margins of some pods. If the bulk of the material in the pods is interspersed sepiolite and silica, however, the two phases are texturally unresolvable at 1.75 kx magnification (or 2.31 kx in TR14-3A-SSL).

HD-74-2

Subsample HD-74-2 is a portion of a sample collected from a breccia deposit cut by the fault scarp crossing a ravine at Busted Butte. The fault scarp appears to be aligned with prominent carbonate-filled fractures in adjacent sand ramps. This subsample was cut into a series of slabs, from which three thin sections were prepared. Electron microprobe and SEM studies have not yet been done for this material; therefore, no information about sepiolite distribution or composition is available.

Breccia clasts include Topopah Spring tuff and crushed tuff matrix, all with carbonate coatings. The clasts are generally grain-supported, although they may have been locally forced apart by the formation of the carbonate coatings. Many of the carbonate coatings appear to be made in part of root casts (described in detail below). Coalescence of the carbonate coatings among adjacent clasts has produced a fine-grained carbonate cement with an overall vesicular texture. The vesicular pores have been filled with silica.

The calcite that coats tuffaceous clasts and roots is very fine-grained. In local areas up to several centimeters across, the tuffaceous clasts have coatings of sparry calcite instead of or in addition to fine-grained calcite. Sparry calcite also fills fractures within the tuff clasts and intergranular space between clasts. Most of the spar crystals are less than 0.1 mm across, but a few poikilitic crystals (enclosing tuffaceous clasts) up to 5 mm across are also present. Textural relations indicate that the sparry calcite mostly predates the finer-grained calcite and the silica.

There are three textural varieties of silica, based on the appearance of the material in thin section. Some vesicles are partly lined by spherulitic silica, with individual spherulites about 0.01 mm across. A few root casts have sparse coatings of spherulitic silica, as well. Most of the silica pore fillings have a fibrous texture in which the fibers (<0.05 mm long) are aligned perpendicular to pore walls. The innermost parts of some pores are filled with aggregates of botryoidal silica.

Plant remains, mostly root casts, are abundant. The forms of the roots are preserved by coatings of fine-grained calcite with infillings tentatively identified as silica. Carbonate root coatings with diameters less than 0.01 mm are the most abundant type of root cast. The largest root casts observed in thin section have diameters of about 0.2 mm. There is some textural evidence that most of the roots penetrated the breccia before authigenic-mineral cementation was very far advanced. Many of the root casts are concentrated along or within the carbonate coatings on tuffaceous clast surfaces, which were rendered increasingly inaccessible as cementation progressed. The silica-filled vesicles also contain root casts, although not in concentrated masses like those that surround some clasts. In areas where the silica pore fillings have a moderate development of acicular texture, the root casts have radiaxial coatings of silica crystals indicating that the roots or root casts acted as substrates for silica crystallization. This does not necessarily mean that the roots or root casts predate silica deposition, but at the least it indicates that the roots penetrated the pores when the silica was in a less crystalline condition, possibly a gel. The breccia is now cemented so tightly that little root penetration is possible.

Although the rock unit this sample represents has been described as a fault breccia and is cut by a fault scarp, there is little or no textural evidence of *in situ* brecciation in the portion of the sample that has been examined. The tuffaceous clasts are recycled from an older breccia of tectonic origin, but post-depositional fracturing of the clasts has been very minor. Similarly, the authigenic cements show few signs of breakage and recementation compared to the Trench 14 samples. Further study will be required to determine whether this deposit is truly a fault breccia or something more akin to a colluvial breccia or simple alluvium cemented by authigenic minerals.

TR14-3C-SSL

This sample may represent a distinct subcategory of authigenic-mineral-cemented breccia. Subvertical fracture zones up to a few centimeters across are present in the Tiva Canyon tuff within about one metra of the main fault trace. Most breccia fragments within these fracture zones are thin, elongate, and highly angular, with very little fine-grained material. The textures of the authigenic mineral fracture fillings in sample TR14-3C-SSL include laminated calcite-silica-sepiolite deposits similar to the thick laminated fillings in the main fault zone, as well as ooids, coated grains, and sepiolite-silica pods. Sparry calcite fracture fillings, with individual crystals up to 0.2 mm, are also present. Cross cutting of earlier fractures (and fillings) by later ones is common. For example, an ooid-rich fracture filling has been cut and offset by several fractures that were filled by laminated deposits.

TR14-3A-SSL

This rock contains abundant carbonate-coated grains and carbonate ooids. Tuffaceous clasts make up less than 50% of the rock volume. The coated grains include fine-grained and sparry calcite, devitrified tuff, vapor phase minerals and drusy quartz from the tuff, and sepiolite-silica masses (analyses, Table I). The most common pore-filling cement surrounding the clasts is probably a silica-sepiolite mixture, with sparry calcite as a locally more abundant cement. Carbonate root casts less than 0.02 mm in diameter are common. There is also an irregular, elongate zone about 1 cm wide that contains what may be organic matter from a larger root. Fractures and fracture fillings are similar to those in TR14-3B-SSL.

FIELD RELATIONS OF BRECCIAS

At Trench 14, the crushed-tuff matrix breccias occupy an incompletely exposed zone, at least several meters wide, that contains the Bow Ridge fault trace as defined by the prominent laminated calcite-silica fracture fillings. The cemented breccias are more localized within and adjacent to the calcite-silica fault fillings. Samples TR14-3A, -3B, and -3C were all collected within about one metra of each other, illustrating the short-range variability in the cemented breccias.

Exposures along a ravine on the western side of Busted Butte indicate that the crushed-tuff-matrix breccia zone is at least 100 m wide. The lower boundary of the breccia zone is concealed by alluvium, and the three-dimensional geometry of the zone has not been determined. The degree of brecciation is not uniform within the breccia zone; severely brecciated intervals ranging in width from a few centimeters to several meters are separated by up to several meters of unbrecciated rock. The cemented breccia deposit represented by sample

HD-74-2 is exposed at the bottom of the ravine along a break in slope marked by a north-south-trending fault scarp. This site is the lowest rock exposure not covered by alluvium. No cemented breccia exposures of any great extent have been observed anywhere else in the ravine.

PRELIMINARY CONCLUSIONS

Field and textural relations suggest that the crushed-tuff matrix breccias are older than the authigenic-mineral-cemented breccias at each site studied. If this is correct, the early history of deformation can be partly reconstructed by mapping the distribution of the crushed-tuff matrix breccias. One distinguishing characteristic of these breccias -- the absence of plant remains -- may mean that the breccias formed at some depth below the root zone and have subsequently been exposed at the surface by erosion. The minor authigenic-mineral cementation also appears to have occurred when the breccia was below the root zone or otherwise inaccessible to root penetration. The evolution of the cemented breccias seems to have taken place in the near surface, as indicated by abundant plant remains in the authigenic cement. Microscopic study has revealed considerable textural heterogeneity, of which the most important may be differences in tectonic imprint. Cemented breccia samples from Trench 14 show moderate tectonic effects, whereas a sample from Busted Butte shows none even though the rocks superficially resemble each other in the field.

TABLE I

Microprobe Analyses of Sepiolite and Mg-Rich Authigenic Materials

	DTV2.1		TR14-3B-SSL		TR14-3A-SSL	
	B1E-4	B1F-2	J-1	K-1	A-3	X-2
Weight Percent						
SiO_2	49.5	49.7	75.6	68.4	62.4	63.9
TiO_2	0.00	0.00	0.03	0.06	0.00	0.00
Al_2O_3	0.61	2.44	0.13	0.23	0.26	0.54
Fe_2O_3	0.08	<0.05	<0.04	<0.03	0.00	0.00
MnO	0.00	0.00	0.00	<0.03	0.00	0.00
MgO	19.8	19.5	10.07	13.1	16.8	17.0
CaO	0.04	0.06	0.05	0.09	0.08	0.11
Na_2O	<0.05	0.00	0.00	0.00	<0.03	0.04
K_2O	0.05	0.08	0.00	<0.03	<0.02	0.04
Total	70.1	71.8	85.9	81.9	79.5	81.6
Si/Mg (molecular)	1.68	1.71	5.03	3.49	2.50	2.53

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TWS-EES-13-10-89-091

Yucca Mountain Project

Monthly Activity Report

October 1989

This work was supported by the Yucca Mountain Project Office as part of the Civilian Radioactive Waste Management Program. This Project is managed by the US Department of Energy, Nevada Operations Office.

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Monthly Activity Report
October 1989

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Los Alamos
Yucca Mountain Project

LOS ALAMOS NATIONAL LABORATORY
YUCCA MOUNTAIN PROJECT

Monthly Activity Report
October 1989

WBS 1.2.1
Project Title: Systems
Principal Investigator: J. Canepa

The objective of this task is to integrate systems with the Geologic Repository Program and describe the Yucca Mountain Project Mined Geologic Disposal System and to evaluate the performance of the natural, engineered barrier, and total systems for meeting regulatory standards.

ACTIVITIES AND ACCOMPLISHMENTS:

Performance Assessment

No action.

Technical Data Advisory Group (TDAG)

The TDAG met in Los Alamos on October 26. The meeting agenda consisted of discussing current action items, establishing priorities to submit data to the technical data bases, and general comments and positions from the participants on Technical Data Management. Los Alamos reiterated its position that the Central Records Facility (CRF) is not the tool for accessing data and therefore, the requirements as written in the draft AP 5.1Q to submit the raw, reduced and interpreted data to the CRF on a quarterly basis is improper.

The afternoon session of the TDAG meeting was a tour of EES-1 to show how B. Carlos obtains, documents, and reports fracture mineralogy data. It was felt that this was a useful demonstration to the TDAG although no issues were resolved. The TDAG minutes reported by G. Heitland of SAIC are in the Appendix.

WBS 1.2.3.2.1.1.1
Project Title: Mineralogy of Transport Pathways
Principal Investigator: D. Vaniman

The purpose of this activity is to define the important mineralogic and geochemical variables along transport pathways at Yucca Mountain in support of performance assessment and to evaluate the impact of repository construction on natural waste transport barriers.

ACTIVITIES AND ACCOMPLISHMENTS:

A database was started for chain-structure clays relevant to the involvement of clay minerals along potential transport pathways at Yucca Mountain. This database will include compositional data on sepiolites and palygorskites for comparison with those chain-structure clays that occur at Yucca Mountain. Preliminary data suggest that chain-structure clays occur only at relatively shallow depths at Yucca Mountain (approximately 100 m or less); so far, sepiolite has been found only near the surface, whereas palygorskite has been found only in fractures within this shallow depth interval. If there is a transition from sepiolite to palygorskite with depth, it may provide information on pathways of near-surface alteration and

deposition. The question of sepiolite deposition is also related to the problem of genesis of the hydrogenic deposits that are being studied from Trench 14. Studies of these minerals will help to tie together the transport pathways and alteration history/hydrogenic deposit investigations.

A more detailed stratigraphic study of the Topopah Spring Member has been planned based on samples from drill core USW G-4. A more detailed study is possible because of the high sample density used for fracture mineralogy investigations of this drill core; splits will be made from the samples used for fracture mineralogy. The results of the more detailed Topopah stratigraphic study will be applicable to sampling strategies to be used throughout the Topopah Spring Member in the nearby exploratory shaft and will provide a data set to be compared with samples from the shaft. This comparison may be used to corroborate data from drill core USW G-4.

PLANNED WORK:

Continue work on QA program development and participate in the DOE audit of LANL activities.

Develop Exploratory Shaft Sampling plan using data from the Solitario Canyon outcrop.

Evaluate revised x-ray diffraction data using multivariate methods.

Work on image analysis methods to generate porosity distribution maps and in trace-mineral analysis.

Statistical methods development, especially the development of tools for handling compositional data.

Simulate spatial distribution of compositional data for use in transport models such as TRACR3D.

Evaluate trace-mineral separates from tuff samples at Yucca Mountain.

PROBLEM AREAS:

None.

BIBLIOGRAPHY:

K. Campbell
Sampling for Site Characterization of a Potential Waste Repository
Mathematical Geology (Journal)
Being revised following internal review.

WBS 1.2.3.2.1.1.2
Project Title: Mineralogic and Geochemical Alteration
Principal Investigator: S. Levy

The objective of this task is to characterize past and present natural alteration processes that have affected the potential geologic repository and to predict future effects of natural and repository-induced alteration.

ACTIVITIES AND ACCOMPLISHMENTS:

Additional samples were selected from material on hand for K/Ar dating. Zeolitized tuff samples from near the top of the pervasively zeolitized rocks and deeper within the zeolitized section will be prepared for analysis. A report on the feasibility of Ar/Ar and Rb/Sr dating of Yucca Mountain clays is in draft form.

Work on samples from hydrogenic deposits continued. Additional microprobe analyses of sepiolite were collected from a sample of Trench 14 bedrock breccia. Another Trench 14 sample containing Mg-rich material (it was probed last month and found to be too high in Si to be pure sepiolite) was examined by scanning electron microscope. There is some indication that masses of sepiolite may have been infiltrated by Si-depositing solutions. Material separated from various

spring deposits was x-rayed as part of a continuing effort to characterize hydrogenic minerals from a variety of depositional environments.

Four samples of the Topopah Spring vitrophyre (from drill core USW G-4, 1330 feet depth) have been held in ovens since July 27, 1987. The temperatures used for this long-term dry heating are 50°, 100°, 200°, and 400°C. For the first year of heating, all samples indicated incremental water loss with time. However, after 18 months, all samples began to indicate seasonal oscillations in water content, with greater weight losses in winter than in summer. These recent weight variations appear to correlate well with room humidity at the times of sample weighing, suggesting that the heating glasses have developed a short-term sensitivity to ambient humidity. More data will be collected to determine whether the humidity sensitivity increases or decays with prolonged heating.

We helped D. Norman, New Mexico Tech, prepare a research proposal for submission to the DOE/NMSU Waste Management Education Research Consortium. This program will provide funds to researchers at three New Mexico universities to do research on waste management problems. Highest priority is to be given to proposals that involve collaborative work with Los Alamos or other selected research facilities in New Mexico. Professor Norman is proposing to examine fluid inclusion gases in secondary minerals from a variety of depositional environments around the Nevada Test Site and other areas. The goal is to investigate whether there are systematic differences in gases from minerals of pedogenic, phreatic, warm spring, cold spring, and other origins.

Preparation for the DOE Tiger Team visit was a major activity this month.

Work continued on study plan revision.

PLANNED WORK:

The DOE quality assurance audit will be a major effort.

Ongoing work includes preparing samples for K/Ar dating and characterizing hydrogenic deposit samples. A joint hydrogenic deposits sample-collection trip with the USGS is tentatively planned for the end of November. At that time, the natural radiation dosimeters placed at Trench 14 and Busted Butte in August (for electron spin resonance dating) will be removed.

PROBLEM AREAS:

None.

BIBLIOGRAPHY:

S. Levy and J. O'Neil
Moderate-Temperature Zeolitic Alteration in a Cooling Pyroclastic Deposit
Chemical Geology, 76, 321-326 (1989)
Printed.

MILESTONE PROGRESS:

A Level III milestone report "Progress Report on Analysis of Thermogravimetry Data" by L. Brown and D. Bish is attached in the Appendix.

R756 (Level III)
10/31/89
S. Levy and B. Carlos
Preliminary Descriptions of Gel Fracture Fillings from Rainier Mesa, Nevada Test Site
Submitted to EES-13.

T431 (Level III)
S. Levy
Bedrock Breccias Along Faults
90% written.

WBS 1.2.3.2.1.2
Project Title: Stability of Minerals and Glasses
Principal Investigator: C. Duffy

The objective of this activity is to produce a model for past and future mineral alteration in Yucca Mountain. The model is intended to explain 1) natural mineral evolution resulting from the transformation of metastable mineral assemblages to more stable assemblages and 2) the effects of a repository emplacement.

ACTIVITIES AND ACCOMPLISHMENTS:

Our major effort is directed toward preparing a milestone report on the smectite/illite transition.

PLANNED WORK:

Work will continue to achieve a fully qualified QA program and to complete the milestone report on the smectite/illite transition.

PROBLEM AREAS:

None.

MILESTONE PROGRESS:

Work on the smectite/illite transition milestone is behind schedule.

REFERENCES:

Bethke, C. M., and S. P. Altaner (1986), "Layer-by-layer Mechanism of Smectite Illitization and Application to a New Rate Law," *Clays and Clay Minerals*, 34, 136-145.

WBS 1.2.3.2.5
Project Title: Postclosure Tectonics
Principal Investigators: B. Crowe and F. Perry

The objective of these volcanism studies is to determine the hazards of future volcanic activities with respect to siting a high-level radioactive waste repository at Yucca Mountain.

ACTIVITIES AND ACCOMPLISHMENTS:

An informal presentation on volcanism studies was made at the DOE/NRC meeting on the tectonics program in Las Vegas on October 31. Information was presented by B. Crowe, Los Alamos, and F. Perry, UNM.

Two days of field work were completed to examine the Mt. Jackson dome complex, located east of Stonewall Mountain, Nevada. Mt. Jackson is the youngest of a series of northeast-trending dome complexes (tephra and lava deposits), and its morphology is consistent with an age of 3 Ma. Mt. Jackson is located 100 kilometers northwest of the Yucca Mountain exploration block. The rhyolite was recently dated at about 3 Ma and represents the youngest site of silicic volcanism in the Yucca Mountain region. A second site of major coalesced dome complexes was examined in the Grapevine Mountains. This site is probably significantly older than the Mt. Jackson domes and may underlie the Timber Mountain tuff.

Olivine separates by size fraction were obtained from sample LW 89-3-21-1, a sample of the Ql5 lava from the Lathrop Wells center. Helium-3 was successfully extracted from the sample, and a cosmogenic He-3 signal obtained. Based on this work, we have set up a series of steps to follow that, if successful, would demonstrate the feasibility of using cosmogenic He-3 as a geochronology technique.

Major element analyses of tephra from the Lathrop Wells volcanic center were received from the x-ray fluorescence (XRF) laboratory. Ash grain mounts were prepared for samples of the pyroclastic surge deposits northwest of the Lathrop Wells scoria cone for electron probe and PIXE analysis. Basalt samples were submitted for analysis of Na by atomic absorption to cross check existing Na analysis by XRF.

B. Crowe attended the scientific workshop convened by the USGS in Death Valley the week of October 23.

A summary abstract was prepared for the International High-Level Radioactive Waste conference in Las Vegas in April.

K-Ar age determinations were received for the Sleeping Butte volcanic center from the USGS.

PLANNED WORK:

Revisions are continuing on Study Plan 8.3.1.8.5.1, Characterization of Volcanic Features. A revised section was added on the Mt. Jackson rhyolite, and we are waiting for revisions on sections for soils, thermoluminescence, and paleomagnetic studies.

The two day field trip with a subcommittee of the Nuclear Waste Technical Review Board has been confirmed for November 20-21.

BIBLIOGRAPHY:

B. Crowe and F. Perry
Volcanic Probability Calculations for the Yucca Mountain Site: Estimation of Volcanic Rates
FOCUS 89 proceedings
Submitted to Project Office 9/18/89.

MILESTONE PROGRESS:

The milestone schedule for volcanism studies continues to be on hold until the revised versions of Study Plan 8.3.1.8.1.1 and 8.3.1.8.5.1 are completed for submission to the NRC.

A level III milestone report by F. Perry, S. Wells, and L. McFadden, "Activities at the University of New Mexico in Support of the Volcanism Program for the Yucca Mountain Project, Fiscal Year 1989," is in the Appendix.

WBS 1.2.3.3.1.2.2 and 1.2.3.3.1.2.5
Project Title: Water Movement Tracer Tests and Diffusion Tests in the ESF
Principal Investigator: A. E. Norris

The objective of the water movement tracer tests is to obtain measurements of chlorine isotope distributions to help quantify the percolation of precipitation in the unsaturated zone. The objective of the diffusion tests in the ESF is to determine *in situ* the extent to which the nonsorbing tracers diffuse into the water-filled pores of the Topopah Spring welded unit.

ACTIVITIES AND ACCOMPLISHMENTS:

Dr. B. Scanlon, an hydrologist at the University of Texas who is characterizing water flow at a potential low-level nuclear waste site southeast of El Paso, requested a collaboration at the Texas site involving the use of ^{36}Cl water tracer techniques being developed for Yucca Mountain. The collaboration would give the Yucca Mountain Project the opportunity to use ^{36}Cl measurements in conjunction with an extensive hydrologic investigation to help validate the results of the ^{36}Cl data, and the University of Texas would acquire data that could give information unobtainable by other means. Dr. Scanlon was referred to U. Clanton in the Yucca Mountain Project Office to pursue the formal approval process.

A technical review of a U. S. Geological Survey study plan was performed at the request of the Yucca Mountain Project Office (action item #NN1-1989-3045).

The Yucca Mountain Project Manager requested a talk about the work in this task be given at the TPO meeting on November 3. Viewgraphs for this talk were prepared.

The PI received training in the following quality assurance procedures:

- AP 1.10Q Preparation, Review, and Approval of SCP Study Plans
- AP 6.3Q Interaction of Participants and Outside Interests with YMP Sample Management
- AP 6.4Q Procedure for the Submittal, Review, and Approval of Requests for YMP Geologic Specimens
- TWS-QAS-QP-01.1, R1 Procedure for Interface Control
- TWS-QAS-QP-08.1, R1 Procedure for Identification and Control of Samples
- TWS-QAS-QP-08.2, R1 Procedure for Control of Data
- TWS-QAS-QP-12.1, R3 Procedure for Control of Measuring and Test Equipment

Procedure TWS-QAS-QP-17.3, R0, Procedure for LANL YMP Records Management, was reviewed prior to its issuance.

An addendum to the Prototype Diffusion Test Criteria Letter was completed to cover the G-Tunnel work required to air core six additional 200-foot holes. This work will be done in conjunction with the Los Alamos Prototype Air Coring Test - Phase II.

The PI attended the Exploratory Shaft Test Coordination meeting on October 12.

PLANNED WORK:

Additional samples will be collected from G-Tunnel for ^{36}Cl analyses to help determine the background of ^{36}Cl in the drifts.

The sites for the first two of the 200-foot air-cored holes in G-Tunnel will be selected next month during a trip to the Nevada Test Site. The selection will be made during an on-site meeting with M. O'Brien of FSN and M. Ray and J. Newsom of the Los Alamos Prototype Air-Coring Test.

BIBLIOGRAPHY:

A. E. Norris
The Use of Chlorine Isotope Measurements to Trace Water Movements
FOCUS 89 proceedings
Approved 10/17/89.

MILESTONE PROGRESS:

No level II milestone reports are scheduled this fiscal year, and the remaining level III milestone report will be completed soon.

WBS 1.2.3.3.1.3.1
Project Title: Testing of C-Hole Sites with Reactive Tracers
Principal Investigator: E. Springer

Experiments will be conducted at the C-well complex (holes UE25c#1, UE25c#2, and UE25c#3) and in other wells in the vicinity of Yucca Mountain. Reactive tracers will be used to characterize retardation and transport properties on a scale larger than that currently used in laboratory experiments.

ACTIVITIES AND ACCOMPLISHMENTS:

Detailed technical procedures on the Zeta Sizer (particle size analyzer) were being completed following acceptance of the equipment. This will be important in analyzing for the polystyrene microspheres so it is not needed for the next round of experiments dealing with lithium on individual minerals. The polarograph has not provided the accuracy and precision for lithium in water similar to J-13, so this effort will be directed towards the ion chromatograph.

A planning meeting was held with personnel from EES-4 for FY 90 activities. A major task will be the construction of a three-dimensional mesh for FEHMN to begin preliminary design of the proposed field tracer test. One immediate need is to determine the concentration of the tracer for injection so laboratory experiments can be designed to provide data within the desired concentration range. Also, the transport module for the dual-porosity media must be developed and verified. The code SORBEQ will be documented, and a milestone produced.

Verification simulations for FEHMN are continuing, and documentation is being written.

PLANNED ACTIVITIES:

Continue to work on detailed technical procedures for the remaining equipment and train personnel to existing procedures.

A Project Office audit will be conducted beginning November 13.

Complete the milestone on FEHMN.

PROBLEM AREAS:

None.

BIBLIOGRAPHY:

H. Fuentes, W. Polzer, E. Essington, and B. Newman
Characterization of Reactive Tracer for C-well Field Experiments I: Electrostatic Sorption Mechanism, Lithium
LA-series report
Final submitted to IS.

B. D. Newman, H. R. Fuentes, and W. L. Polzer
An Evaluation of Lithium Sorption Isotherms and Their Application to Groundwater Transport
Groundwater (Journal)
In technical review.

W. L. Polzer and H. R. Fuentes
Experiences of Fitting Isotherms to Data From Batch Sorption Experiments for Radionuclides on Tuffs
Migration '89 proceedings
Submitted to Project Office 9/13/89.

W. L. Polzer, M. G. Rao, and H. R. Fuentes
The Use of the Modified Freundlich Isotherm to Estimate Thermodynamic Equilibrium Properties of Ion Exchange Adsorption of Radionuclides on Volcanic Tuff. Part I. Theoretical Development
Environmental Science and Technology (Journal)
In technical review.

MILESTONE PROGRESS:

R529
9/30/89
Evaluation of Preliminary Application of FEHMN to Yucca Mountain
Delayed 30 days.

WBS 1.2.3.4.1.1
Project Title: Groundwater Chemistry
Principal Investigator: M. H. Ebinger

The goal of this investigation is to provide conceptual and mathematical models of the groundwater chemistry at Yucca Mountain. These models will explain the present groundwater composition in relation to interactions of minerals and

groundwater and will be used to predict groundwater compositions as a result of anticipated and unanticipated environments.

ACTIVITIES AND ACCOMPLISHMENTS:

Draft of the Study Plan for Study 8.3.1.3.1.1 was reviewed by D. Vaniman, and comments are being resolved.

Attended Technical Integration Group meeting, October 26, in Las Vegas, NV.

PLANNED ACTIVITIES:

Continue resolution of comments and revise draft of Study Plan as comments are received.

Submit Study Plan for Project Office review by end of November pending resolution of comments from LANL review.

PROBLEM AREAS:

None.

BIBLIOGRAPHY:

C. D. Dicke and H. R. Fuentes
Modeling of Sr Surface Complexation and Migration
Groundwater (Journal)
In comment resolution.

MILESTONE PROGRESS:

No milestone reports are scheduled in the next three months.

T422
C. D. Dicke
Interim Report: Sorption Characteristics of Sorbing Tracers Using MINEQL Preliminary Ion Exchange Modeling of Strontium in Clinoptilolite
Submitted to Project Office 6/2/89.

WBS 1.2.3.4.1.2.1 and 1.2.3.4.1.2.3
Project Title: Sorption
Principal Investigator: A. Meijer

The objective of the sorption and precipitation task is to provide sorption coefficients for elements of interest in order to be able to predict radionuclide movements from the repository to the accessible environment.

ACTIVITIES AND ACCOMPLISHMENTS:

We have completed the americium (Am) sorption experiments. The americium Kd's are as follows:

Mineral	Kd (ml/g)	Average Kd	pH
Romanechite (Mn oxide)	3.25E+05	3.26E+05	7.98
3.28E+05		7.98	
Clinoptilolite (Zeolite)	3.95E+03	4.82E+03	8.23
5.69E+03		8.20	

The rather high sorption coefficient for Am on the manganese oxide romanechite indicates this type of oxide will be a "key mineral" for Am sorption in rocks units such as those found in Yucca Mountain.

The work on technetium (Tc) sorption experiments on pure mineral phases has continued. The first set of experiments failed because of a pH buffering problem. A new set of mineral samples is currently being pre-equilibrated with J-13 water. Our supply of Tc is currently exhausted, so we will prepare another batch in November.

The water/rock ratio experiments are continuing. Solutions resulting from the last batch of experiments are being analyzed for cation and anion composition.

The Stanford Group has continued the experiments on the sorption of uranyl ion onto goethite with and without carbonate. The results obtained are consistent with Langmuir and Hsi (1985) and are inconsistent with Tripathy (1983).

PLANNED WORK:

Continue the study of Am, neptunium, and Tc sorptive behavior using synthetic and natural ground waters and pure minerals.

PROBLEM AREAS:

None.

BIBLIOGRAPHY:

A. Meijer, I. Triay, S. Knight, and M. Cisneros
Sorption of Radionuclides on Yucca Mountain Tuffs
FOCUS 89 proceedings
Submitted to Project Office 9/18/89.

MILESTONE PROGRESS:

Milestone reports have been delayed due to completing other submitted papers, quality assurance activities in preparation for the November audit, and Study Plan comment resolution.

REFERENCES:

Langmuir, D., and C-K Hsi, "Adsorption of Uranyl onto Ferric Oxihydroxides: Application of the Surface Complexation Site-binding Model", Geochimica Cosmo. Acta, V. 49, pp. 1931-1941, 1985.

Tripathy, V. J., "Uranium (VI) Transport Modeling: Geochemical Data and Submodels," Ph.D. Dissertation, Stanford University (December 1983).

WBS 1.2.3.4.1.2.2
Project Title: Biological Sorption and Transport
Principal Investigator: L. Hersman

The purpose of this research is to determine whether microbial activity can influence the movement of plutonium in tuff. Because fluids are used extensively in the exploration of locations for a nuclear repository, of special interest are those microorganisms capable of utilizing drilling fluids as growth substrates.

ACTIVITIES AND ACCOMPLISHMENTS:

None reported.

WBS 1.2.3.4.1.3
Project Title: Solubility Determination
Principal Investigator: D. Hobart

The objective of the solubility determination task is to determine the solubilities and speciation of important waste elements under conditions characteristic of the repository and along flow paths from the repository into the accessible environment.

ACTIVITIES AND ACCOMPLISHMENTS:

D. Hobart returned from the USSR after attending the ACTINIDES-89 Conference in Tashkent. We have been working on two manuscripts with I. Triay that will be published in the Migration '89 proceedings.

H. Nitsche reports that the solubility experiments for Np(V), Pu(IV), and Am(III) in UE25p\#1 groundwater at 25° C and pH values of 6, 7, and 8.5 are completed. (The Letter Report is in the Appendix.) Filter saturation was required prior to performing the phase separations for these data. For americium at pH 6 and 7, the measurements were corrected for filter absorption losses. At pH 8.5, no filter loss was detected because the relatively high carbonate concentration in this groundwater at pH 8.5 favored the formation of low-charged carbonate complexes.

The following detailed procedures are in progress:

- Determining UV-VIS-IR Absorption and Diffuse Reflectance Spectra
- X-Ray Powder Diffraction Analysis for Solubility (YMP-LBL-DP03)
- Sodium Concentration Determination in Radionuclide Solutions (YMP-LBL-DP05)

The large-frame argon ion laser system (Spectra Physics Model 2045) has been delivered and partially installed. This system will be used for a variety of purposes including wavelength calibration, Raman and emission studies, and as a variable wavelength, continuous-wave laser source to serve as a probe beam in photothermal spectroscopy applications. The installation should be completed in November.

Work continues on the construction of the low-noise preamplifier circuits. A preliminary version was tested and found to work quite well (signal-to-noise enhancement of 20% over the commercial amplifier in use). However, reproducible performance continues to be a problem. The circuit design is presently undergoing re-evaluation. A fast photodiode detector assembly has been successfully incorporated into the photoacoustic spectrometer (PAS) system. This assembly enables real-time monitoring of the energy of incident excitation laser pulse. The data acquisition code has been updated to use this capability to establish a very sensitive accept/reject criterion for every PAS waveform acquisition cycle. Thus, spurious data resulting from abnormal excitation laser pulses is rejected.

PLANNED WORK:

We will continue work on the detailed procedures that are due this fiscal year.

D. Hobart, D. Morris, and H. Nitsche will attend the Migration '89 Meeting in Monterey, California, the week of November 6.

According to the SKB/DOE Bilateral Information Exchange Treaty, D. Hobart will go to Sweden in June 1990 to attend the next meeting.

Work on the preamplifier circuits will continue. The positive results obtained thus far encourage us to pursue this project as a means of significantly improving the ultimate sensitivity of the technique. We also plan to incorporate the additional required optical elements to enable us to carry out dual channel data acquisition in a parallel cell configuration.

PROBLEM AREAS:

H. Nitsche reported several problems this month. The x-ray diffractometer was inoperable because the new x-ray tube was defective; however, a spare has been located. In addition, the repeat experiments in J-13 water at 60° C are not completed, [the solubility cells of polyetheretherketone (PEEK) were required to replace teflon, which was found to absorb americium colloids thereby making the earlier solubility measurements meaningless] which may delay the next milestone report on J-13 groundwater. H. Nitsche also reports problems with sodium determination of the UE25p\#1 steady-state solutions. The ion-specific electrode showed non-Nerstian behavior and required replacement.

BIBLIOGRAPHY:

D. Hobart et al.
Formation, Characterization, and Stability of Pu(IV) Colloid
FOCUS 89 proceedings
Submitted to Project Office 8/17/89.

MILESTONE PROGRESS:

All milestone reports will be completed on time. A Level III milestone report "Interim Progress Report: Actinide Speciation by Photoacoustic Spectroscopy" by D. Morris, C. Tait, and W. Woodruff is attached in the Appendix.

WBS 1.2.3.4.1.4
Project Title: Dynamic Transport Process
Principal Investigator: I. Triay and R. Rundberg

The objective of the dynamic transport process task are to determine the rate of radionuclide movement along the potential flow paths to the accessible environment and to examine the effect of diffusion, adsorption, dispersion, anion exclusion, sorption kinetics, and colloid movements in the flow geometries and hydrologic conditions that are expected to exist along the flow path to the accessible environment in the scenarios to be used for performance assessment.

ACTIVITIES AND ACCOMPLISHMENTS:

We continued our investigation of Yucca Mountain tuffs to act as a natural filter for particulate matter. The fluorometer used to analyze the fluorescent colloids of known sizes was moved to a new location (see Problem Areas).

The study of the sorption of radionuclides as a function of time using beakers made of Yucca Mountain tuffs is still in progress (see schedule given in February's monthly report). We are in the process of investigating radionuclide migration using columns made with crushed pure minerals.

The size of Pu(IV) colloids has been analyzed using autocorrelation photon spectroscopy (APS). Table 1 shows the most probable diameters of Pu colloids prepared by dilution, peptization, and oxidation of Pu(III). The results obtained using constrained regularization to analyze the autocorrelation function are reported. These Pu colloids were prepared by the Speciation Task.

Dilution of a well-characterized Pu(IV) stock solution using distilled water yields colloids in the range of 2-6 nm in diameter. Peptization yielded a mixture of Pu colloids with two different sizes. Auto-oxidation of Pu(III) yielded the largest single-size Pu colloid measured. The stability of Pu colloid #2 was tested by measuring the size of the colloid as a function of time. A small change in the size of the colloid was observed in the period from 20 to 223 days. The fact that the most probable diameter determined was smaller at the shorter time could be explained by numerical dispersion; the average diameter of the particles analyzed using regularization increased by a factor of 1.1 from day 20 to day 223.

Several Pu colloids were placed in contact with groundwater obtained from the J-13 well of the Nevada Test Site. The APS analysis of the Pu colloids in J-13 water was unsuccessful. The reason for the failure of the analysis could be the formation of very large pseudocolloids outside the range of the APS system.

We have continued sorption experiments with tuff from Calico Hills G4-1501 to support our transport work using this material.

All our grinding equipment was moved to a new area and re-installed.

All personnel were trained to the procedure for identification and control of samples, AP 6.4Q, and AP 6.3Q.

PLANNED WORK:

Continue solid rock column experiments, rock beakers experiment, and transport work with pure minerals.

Prepare and analyze Pu colloids in synthetic groundwaters (with the same chemical composition as J-13 water but without the particulate impurities).

Two papers will be presented at the 2nd International Conference on Chemistry and Migration Behavior of Actinides and Fission Products in the Geosphere (Migration '89) in Monterey, California, November 6-10: "Size Determinations of Pu Colloids Using Autocorrelation Photon Spectroscopy" by I. R. Triay, R. S. Rundberg, A. J. Mitchell, M. A. Ott, D. E. Hobart, and P. D. Palmer and "Observation of Time Dependent Dispersion in Laboratory Scale Experiments with Intact Tuff Columns" by R. S. Rundberg, I. R. Triay, M. A. Ott, and A. J. Mitchell.

PROBLEM AREAS:

The SPEX fluorometer has been moved to a new area; the microcomputer driving the system is not working correctly, and it has been sent back to SPEX. We do not know when we will be able to resume our filtration studies.

The APS system has also been moved to a new area and needs to be set up, which is a time consuming process. Consequently, we anticipate our Pu colloid work to be delayed a few months.

BIBLIOGRAPHY:

N. Patera, D. Hobart, A. Meijer, and R. Rundberg
Chemical and Physical Processes of Radionuclide Migration at Yucca Mountain, Nevada
Radioanalytical Chemistry (Journal)
Returned to author for revisions 9/18/89.

R. Rundberg, A. Mitchell, M. Ott, J. Thompson, and I. Triay
Laboratory Studies of Radionuclide Migration in Tuff
FOCUS 89 proceedings
Submitted to EES-13.

MILESTONE PROGRESS:

None.

Table I. Size Determination of Pu Colloids

Pu(IV) Colloid	Method of Preparation	Molarity[a]	pH	Age[b] days	Diameter(s)[c] nm
1	Dropwise addition of Pu(IV) stock[d] to distilled water	0.01	1.3	223	3.7
2	Dropwise addition of Pu(IV) stock to distilled water; heated at 75-80°C for 4.5 hours	0.01	1.3	20 223	6.4 5.7
3	Pu(IV) stock taken to near dryness and 0.001 M HCl added to form colloid	0.015	1.6	216	3.0
4	Dropwise addition of Pu(IV) stock to distilled water and aging at room temperature	0.003	2	606	2.6
5	Dropwise addition of Pu(IV) stock to distilled water at 70°C	0.003	1.65	45	2.1
6	Pu(IV) in 0.5 M HNO_3 diluted to 0.08 M acid followed by near neutralization using 1 M NaOH	0.008	1.7	14	1.5
7	Pu(IV) stock added to 0.7 M $NaHCO_3$ with stirring; precipitate washed with water and peptized in 0.02 M HNO_3 at 80°C for 2.5 hr and then centrifuged and suspended in 0.01 M HNO_3	0.05	2	26	14. & 370
8	Slow auto-oxidation[e] of Pu(III) at pH 4	0.006	2.8	227	32.
9	50-50 mixture of #5 and #8 by volume				1.5 & 33.

Notes:
(a) Moles of Pu, as monomer, per liter
(b) Age at the time of the APS determination
(c) Most probable diameter; Analyzed using Regularization
(d) Typical stock was about 1 M in Pu and 3-4 M in HCl
(e) Alpha induced and/or air oxidized

WBS 1.2.3.4.1.5.1
Project Title: Retardation Sensitivity Analysis
Principal Investigator: K. Eggert

The objectives of the retardation sensitivity analysis task are to construct a geochemical/geophysical model of Yucca Mountain and to use this model to examine the physical and chemical controls on radionuclide transport along flow paths to the accessible environment.

ACTIVITIES AND ACCOMPLISHMENTS:

Analysis of Physical/Chemical Processes

FEHMN/FEHMSN. Coding has been completed on new 1 DOF solver for solving large matrices by defining active and passive nodes and using a robust solver on the active nodes and an easy method (i.e., SOR) on the passive nodes. It is currently being tested in FEHMN.

FEHMN code verification and preparation of the new user's manual continues.

The coupled heat/mass/stress code is now working in the mass/stress node. The coding for the heat/mass/stress is complete. Verification runs are in progress against the few analytical solutions available in this field.

The coupled mass/2-dimensional stress module for FEHMSN is being tested with example problems. It is being modified to simulate the "local pore pressure" assumption so that published semi-analytical results can be used for verification.

The coupled heat/2-dimensional stress module is being programmed.

COLLOID TRANSPORT. The 2-dimensional version of CTCN is fully operational. This is the extended version with optional fourth- or second-order spatial differencing for the derivatives and an additional option of directional differencing for the flux terms.

Three test problems were run and compared with published solutions.

Work is being done on the 3-dimensional case, and different methods from those used in MOL1D to treat boundary conditions are being explored.

Software Requirements and Design Specifications (SRDS) have been completed for CTCN.

Transport Models and Related Support

Animated color graphics capabilities were developed to visualize the migration of radionuclide plumes calculated with TRACRN.

A particle-tracking code is being used to calculate migration of technetium based on a velocity field calculated with TRACRN. This solution will be compared with an analogous finite-difference transport solution to examine the effects of numerical dispersion.

Further 3-dimensional transport calculations are being run with TRACRN to study the effects of spatial variability in sorption coefficients. The grid representing the stratigraphy was corrected to develop a more realistic flow field.

QA and Programmatic

Team members are addressing comments received on the Study Plan for the Retardation Sensitivity Analysis task.

The resident file is being reviewed for compliance with procedures.

Software summary forms have been completed for HDOCN, TRACRN, and FEHMSN.

PLANNED WORK:

Analysis of Physical/Chemical Processes

FEHMN/FEHMSN. Three-dimensional calculations will be performed for moisture flow in unsaturated zones with natural convection.

BIBLIOGRAPHY:

S. Kelkar and G. Zyvoloski
Modeling of Coupled Heat-Mass-Stress Effects in Geological Media
International High-Level Radioactive Waste Management Conference, Las Vegas, Nevada, April 1990
Approved 10/17/89.

G. Zyvoloski
Simulation of Heat Transfer in the Unsaturated Zone
IHLRWMC
Approved 10/18/89.

K. Birdsell, K. Eggert, B. Travis, and K. Campbell
Simulation of Radionuclide Retardation at Yucca Mountain Using a Stochastic Mineralogical/Geochemical Model
IHLRWMC
Submitted to Project Office 10/30/89.

K. Birdsell et al.
Preliminary Integrated Calculations of Radionuclide Cation and Anion Transport at Yucca Mountain Using a Geochemical Model
IHLRWMC
Submitted to Project Office 10/31/89.

MILESTONE PROGRESS:

Milestone T421, the approved TRACRN manual, is undergoing final editing in preparation for printing as a LAMS report.

WBS 1.2.3.4.1.5.2
Project Title: Geochemical Field Tests for Validation
Principal Investigator: J. A. Canepa

The purpose of this activity is to test the validity of the laboratory geochemistry data generated by the Geochemistry Test Program and to test the geochemical transport modules. Five subtasks constitute this activity: 1) natural analogs, 2) large block test, 3) caisson test, 4) unsaturated zone geochemistry field test, and 5) radionuclide migration studies at the Nevada Test Site.

ACTIVITIES AND ACCOMPLISHMENTS:

Natural Analogs

Interactions with the Project Office and the AECL continues in order to focus the technical plan for the natural analog work at Cigar Lake. Interactions with Don Livington occurred regarding the use of natural isotopes as analogs.

Large Block Tests

Interactions with the Project Office and the AECL continues in order to focus the technical plan for large block tests.

Anthropogenic Analogs

A meeting on the environmental restoration plan for DP site, area T was attended by Yucca Mountain Project personnel. The intent of the meeting was to bring an interdisciplinary team together and discuss the waste site, become familiar with the regulations and discuss the objective of the site characterization plan that is to be written.

Caisson Tests

No action.

SEA Contract

SEA attended the Exploratory Shaft Test Coordination meeting in Los Alamos on October 12. At the meeting, they made a presentation of the SEA borehole instrumentation and fluid sampling system. An overview of the Los Alamos technical program was given by the Project Leader for Site and Regulatory Investigations. Emphasis was placed on the Los Alamos Field Test Validation Plan (SCP 8.3.1.3.7.2).

On October 27, SEA met with the Project Leader to discuss progress on the subcontract, future directions, and goals. Preparation of a study plan for field-scale testing in the Calico Hills was identified as the highest priority objective.

Work on phase one of the scoping calculations has continued and is near completion. Phase one incorporates the basic components of three field test designs for several homogeneous, isotropic media with characteristics of vitric and zeolitic tuff. A report on the results is in progress.

PLANNED WORK:

A report on phase one of the scoping calculations will be submitted shortly. No additional work on these calculations is planned at this time, pending review by Los Alamos YMP personnel. SEA hopes to have the report reviewed by PIs to provide feedback that will aid in integration of the field test with other Los Alamos YMP activities.

WBS 1.2.5
Project Title: Regulatory and Institutional
Principal Investigator: J. A. Canepa

The purpose of this task is to coordinate the regulatory and institutional Project requirements within the Los alamos programmatic structure. The focus of this coordination effort is on the integration of the technical work within the regulatory and institutional framework.

ACTIVITIES AND ACCOMPLISHMENTS:

Site Characterization Plan

A meeting of the Integration Group on the approach to resolving the NRC comments on the SCP was held this month. The comments on Geochemistry were distributed to affected principal investigator for comment resolution. A completion or resolution of the comments is planned prior to the Christmas holidays.

Semi-annual Progress Report

The Los Alamos Biannual Status Report (BSR) was prepared, reviewed and submitted to the Project Office for inclusion in the Project BSR. The Project BSR will be sent to DOE/HQ as input to the Semi-annual Progress Report.

Study Plans

Sorption Studies and Sorption Modeling, R0 (8.3.1.3.4.1; 8.3.1.3.4.3). Project Office AP-1.10Q and DOE/HQ review comments were received 10/13/89.

Regulatory Interactions

An interaction with the Nuclear Waste Technical Review Board (NWTRB) is planned for December 11-12. The topic on the 12th will be geochemistry.

WBS 1.2.6
Project Title: Exploratory Shaft Management and Planning
Principal Investigator: H. Kalia

These exploratory shaft (ES) tasks will address the issues and information needs associated with the feasibility of storing high-level nuclear waste in a geologic repository at Yucca Mountain.

ACTIVITIES AND ACCOMPLISHMENTS:

We continued preparing the Test Support Requirements Document (TSRD) and the Annual Report for the Prototype Testing performed in the G-Tunnel. We began incorporating review comments into the Exploratory Shaft Test Descriptions Document (TDD) and reviewed the Project Preliminary Safety Analysis Report (PSAR). We reviewed papers on ESF and prototype testing for the International High-Level Radioactive Waste Management Conference.

We continued preparing the ESF testing networks and tracking the progress of test procedures for ESF tests. We began preparing the Engineering Management Plan for the Test Manager's Office. We supported the prerequisites (readiness review) list for the ESF tests, which will identify the requirements to be met before ESF tests are conducted. We prepared input for a joint proposal with Sandia on field testing activities in support of ESF and repository construction methods.

We attended several meetings: a meeting to discuss technical aspects of alcove blasting in the G-Tunnel, the Interface Control meeting, and an Exploratory Shaft Test Coordination meeting in Los Alamos, a trip to the Sample Management Facility to see G-4 core, and the YMP QAP Design Control Review.

PLANNED WORK:

Work will be initiated to prepare the ESF Test Plan.

The following work will continue: support and coordinate the prototype testing effort; update the Prototype Testing budget for support contractors (FSN, REECo and H&N); plan and implement readiness reviews for the prototype tests; develop ESF design documents; prepare the TDD and TSRD; develop detailed logic networks for the ESF testing; prepare the Environmental Health and Safety Implementation Plan (ESHIP) for ESF testing; support the alternative design studies; develop the joint proposal between Sandia and Los Alamos; prepare change requests for testing; support WIT-4, Long Range Planning, and other integration activities; prepare the Engineering Management Plan; and prepare the Health and Safety Plan for the Test Manager's Office.

PROBLEM AREAS:

None.

BIBLIOGRAPHY:

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Exploratory Shaft Facility (ESF) Prototype Test Management
IHLRWMC
Submitted to Project Office 10/30/89.

WBS 1.2.6.9.3
Project Title: Exploratory Shaft Integrated Data System
Principal Investigator: H. N. Kalia

The integrated data system (IDS) is part of the supporting facilities for the Exploratory Shaft Facility (ESF). The IDS supports the data acquisition needs of the ESF test program by providing a central facility to automatically measure and control aspects of the ESF tests. The primary purpose of the IDS is to assist the principal investigators (PIs) in acquiring high-quality test data in a uniform, controlled fashion and to transfer those data to the PIs' organizations for data management and analysis.

ACTIVITIES AND ACCOMPLISHMENTS:

A readiness review was conducted to determine EG&G's readiness to start IDS Title II design. The readiness review report is being prepared.

EG&G submitted the draft IDS Task Plan.

We continued to assess the availability of commercial databases for the IDS. Information and experience gained from Climax and the WIPP site will also be utilized in developing this information.

Work also continued on developing the Configuration Management Plan for the IDS, preparing the IDS network, and integrating the IDS with ESF design-/construction-related activities.

PLANNED WORK:

EG&G will complete any outstanding IDS quality assurance procedures and personnel training.

The following work will continue: develop software and hardware QA procedures; prepare the IDS Configuration Management Plan, Data Interface Documents, and Hardware Configuration Plan; develop an IDS network to completion of ESF testing; and integrate this network with the ESF design and construction network, as well as, with the testing networks..

We will initiate work to identify IDS operational requirements including resources and budgets and to develop IDS component reliability analysis and information on commercially available software.

PROBLEM AREAS:

None.

WBS 1.2.9.1.4
Project Title: Records Management
Principal Investigator: G. Ortiz

The objective of this task is to manage records and documents related to the licensing of a geologic repository for the disposal of high-level radioactive waste. The requirements are to support the development, implementation, and maintenance of a comprehensive, automated, and integrated information management system.

ACTIVITIES AND ACCOMPLISHMENTS:

The procedure for records management, QP 17.3, was distributed to the QA liaisons (QALs) for review and comment. This procedure combined QP 17.1 and 17.2 to eliminate the redundant requirements and definitions.

Work continues at the RPC with processing and transferring records to the Central Records Facility and preparing for the upcoming quality assurance audit.

PROBLEM AREAS:

None.

WBS 1.2.9.3
Project Title: Quality Assurance
Principal Investigator: H. P. Nunes

The Quality Assurance Program provides quality assurance support to Los Alamos Yucca Mountain Project (YMP) participants. This support is designed to ensure that the YMP efforts of Los Alamos will provide admissible data and evidence for the repository licensing process.

ACTIVITIES AND ACCOMPLISHMENTS:

Monthly meetings were changed to weekly meetings to prepare for the Project Office audit. Thirty-nine quality procedure revisions were completed. Following the audit, the Quality Group will begin biweekly meetings to discuss issues and actions to improve the quality program. Only software procedures remain to be formally issued and the training conducted.

The Edgerton, Germeshausen & Grier (EG&G) QA Program Plan has been completed, and they are preparing the corresponding procedures to implement the approved quality program. Copies of the completed procedures are in the LANL review process.

The Project Office procedure surveillances were concluded.

PLANNED WORK:

LANL staff will participate in the Project Office Audit No. 89-7. Training of the Los Alamos staff will be a second priority to ensure the start of the ongoing research efforts in accordance with the revised LANL QAPP.

Efforts to resolve the internal deficiency reports and the standard deficiency reports have been increased. Additional staff have been assigned to track and close the outstanding standard deficiency reports, nonconformance reports, and corrective actions reports. These efforts will allow for the timely closure of issues associated with the start of Title II IDS design efforts or the LANL Test Manager's Office activities.

APPENDIX

ATTACHMENTS AND LEVEL III MILESTONE REPORTS

TECHNICAL DATA ADVISORY GROUP
OCTOBER 26, 1989

NOTES

1. Technical Data Management Priorities for FY90

Don Livingston stated the #1 priority for technical data management for FY90 is the compilation of pre-existing data for submittal to the Project Technical Data Base and the Reference Information Base. The Project has been delinquent in capturing data in the TDB and RIB. This effort will require cooperation by all Project participants. The Project must prioritize the data to determine which data should be processed first. It was suggested we use the letter from B. Barton that established priorities of getting data into the records system, if it can be applied to the TDB and RIB. The Waste Package design and Performance Assessment needs for data must be included in this prioritization.

A revised Technical Data Management Plan and implementation of new requirements is also high priority for the Project Office.

The discussion included input from participants on their perspective of priorities and needs. For the qualification process of existing data, the Project needs to establish a date when all data collected subsequent to that date will meet 10CFR60 Subpart G requirements. Along with the qualification process, we need to establish applications of data to determine the qualification process. It was suggested that AP-5.9Q be tested by selecting different types of data and subjecting it to the process defined in that procedure.

The Project must define/clarify if participants have acceptance controls on the use of technical data.

The Project should develop a workshop for the usage, access, and content of the TDB and RIB.

Los Alamos is planning to have Work Products for submittals to the TDB and RIB. This should begin in FY91. They felt it was difficult to comply with AP-5.1Q due to complexity of technical data.

From a quality assurance perspective, the Project must work with data to anticipate problems. It is important to test the system, including AP-5.9Q. During the characterization phase, how will previous data effect quality studies (we must have input acceptance criteria and address qualification of data).

Holmes & Narver expressed concerns about data needs for ESF Title II Design. Data needs include 2 ft. intervals for topography, soils data, bin weather data, and additional flood data.

The USGS plans on regular, ongoing submittals to the TDB and RIB. They requested clarification on the types of data to be submitted to the RIB. Their Water Resources Division is in good shape for making submittals to the TDB. The Geologic Division has had severe budget cuts and is therefore behind schedule.

They need feedback from users on their needs and there is a general lack of understanding on how to use the TDB and RIB. The USGS does not plan on using a large amount of manpower to qualify existing data. Existing data will be used as corroborating data. New data that is collected will meet 10CFR60 Subpart G requirements and will be used for licensing.

FSN stated that designers need site-specific data/information, not data from many miles away. The A/Es do not have the technical staff to do the interpretations/analyses of technical data. Interface control should be responsible for determining these analyses.

LLNL plans on making submittals to the TDB. RIB submittals should be a Project function (Project Policy review). They have modified their QAPP to require the PI to make submittals to the TDB, which will be similar to the SNL Appendix. They will have difficulty implementing AP-5.1Q due to some contractual problems. LLNL felt the Project should focus on developing the index/Data Catalog.

HQs suggested the Project have an interaction set up between Paratrac and TRIMS, with representation included at a future TDAG meeting.

As an aside, it was determined that each participants TDAG representative be the focal point for TDB and RIB submittals.

SEPDB data and RIB data will be flagged for data collected under a 10CFR60 Subpart G program.

2. Technical Data Management Plan Annotated Outline

An annotated outline for the revised Technical Data Management Plan was distributed to all TDAG members. It was requested that comments be returned to Gail Heitland by Wednesday, Nov. 1. There was a brief discussion on the revised TDMP. Configuration management tracking should be applied to the RIB. However, it should not be the responsibility of the SEPDB Administrator to evaluate if changes to the SEPDB impacts participants. The Quarterly Report prepared by the SEPDB Administrator should identify changes/updates to the SEPDB. It will then be the responsibility of the user to determine impacts.

3. Data Compilations

Data compilations for both pre-existing data and data outside the Project were discussed. The Project must establish areas and prioritize. The Project should examine the types of analyses to be done, schedule, and data needs, especially in the area of waste package requirements needs and performance assessment needs. Within the area of performance assessment needs, the responsibility for identifying needs and submittals could be the Performance Assessment Working Groups. The Performance Assessment Working Group scheduled for Nov. 3 could discuss SEPDB/RIB needs. It was felt it would be easier to implement SEPDB submittals rather than RIB submittals because the SEPDB isn't "user" driven and does not require Project Office approval. The Project Office felt that the Project should use Work Plans for identifying SEPDB/RIB submittals.

4. Data Qualification

October 1989
WBS 1.2.1

Bruce Foster briefed the TDAG member on the data qualification task force effort currently underway. Data collected prior to an approved program meeting 10CFR60 Subpart G requirements that will be used to support licensing, Items Important to Safety, or Items Important to Waste Isolation, must be qualified. AP-5.9Q is the project procedure to qualify existing data. It was based upon NuReg 1298 requirements. In summary, there are four ways to qualify data: 1)equivalent QA program, 2) corroborating data, 3) confirmatory testing, and 4) peer review. The task force has recommended a phased approach. As data is used in various activities/designs (focus on ESF Title II), that data should be qualified through AP-5.9Q. The approach is as follows: the best available data will be used in design, the A/E should identify data used to support IITS and ITWI, the identified data should be submitted to AP-5.9Q, a process for qualifying data will be recommended in accordance with AP-5.9Q, and finally a recommendation will be made that the data is qualified/nonqualified. This same approach could be applied to other areas outside ESF Title II design.

Los Alamos
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memorandum

TO: Richard J. Herbst, EES-13, MS J521
DATE: Oct. 30, 1989
FROM: Lee F. Brown, INC 4
David L. Bish, EES-1
MAIL STOP/TELEPHONE: J568/7-4761
SYMBOL: INC-4-ICON-89-475

SUBJECT: Level III Milestone -- Progress Report on Analysis of Thermogravimetry Data, 7/1/89-9/30/89

Summary: A method is developed for estimating the pre-exponential factor for desorption from thermogravimetry data taken at different heating rates. Knowing the pre-exponential factor, the desorption site-energy distribution (SED) can be calculated with reasonable accuracy by inverting the Fredholm integral equation describing the thermogravimetry process. The SED is calculated for several cation-exchanged samples of natural zeolites representative of those from the Yucca Mountain vicinity.

- -

Introduction: In order to understand the effects of exchangeable-cation composition on the thermal behavior of zeolites, it would be particularly useful to determine the distributions of energies possessed by sorption sites in zeolites currently being tested by thermogravimetry. The desorption of sorbed substances from zeolites by thermogravimetry may be modeled by the equation

$$\frac{r_{sorp}}{\beta} = \frac{d\theta_{sr}}{dT} = -\frac{1}{\beta}\int_{E_{min}}^{E_{max}} A(E)\theta(E,T)e^{-E/RT}\eta(E)dE \quad , \qquad (1)$$

which is a Fredholm integral equation of the first kind. During a thermogravimetric experiment, the mass of the sample is measured as a function of time, while the sample is heated at β degrees per unit time. The loss in mass of the sample is caused by desorption of sorbed material, and from the mass measurements the quantity $d\theta_{sr}/dT$ is obtained. It was shown in the last quarter's progress report (INC-4-ICON-89-324) that if the pre-exponential factor $A(E)$ is known, the site-energy distribution (SED) for the given sample, $\eta(E)$, can be calculated by inversion of Eq. (1). The problem of determining $A(E)$ was, however, not satisfactorily solved.

Determination of pre-exponential factor for dehydration of clinoptilolites: In the previous progress report unsuccessful attempts toward the goal of obtaining the pre-exponential factor were discussed. The process of temperature-programmed desorption (TPD) is mathematically equivalent to that of thermogravimetry. In the analysis of TPD spectra, there are well-established methods for determination of the pre-exponential factor for desorption if the desorption is assumed to be from an energetically uniform surface. This assumption reduces Eq. (1) to

$$\frac{d\theta}{dT} = -\frac{A}{\beta}\,\theta e^{-E/RT} \quad , \tag{2}$$

in which E is the uniform desorption activation energy. The temperature at which the desorption rate is a maximum is the temperature at which the second differential $d^2\theta/dT^2$ is equal to zero. Differentiating Eq. (2), setting it equal to zero, then carrying out some manipulation yields

$$(A/\beta)\exp(-E/RT_p) = E/RT_p^2 \quad . \tag{3}$$

If two or more spectra at different heating rates are available (which would then have different T_p's), the system of implicit equations with unknowns E and A may be solved for these unknowns. The solution may also be carried out graphically. A simple plot of $\ln(\beta/T_p^2)$ vs. $1/T_p$ should give a straight line, and the values of E and A can be determined from the slope and intercept of this line.

It was decided to explore the applicability of this concept to TPD from a nonuniform surface with a continuous SED. The derivative of the desorption rate with respect to temperature is

$$\frac{dr_{sorp}}{\beta dT} = \frac{d^2\theta_{RT}}{dT^2} = -\frac{1}{\beta}\int_{E_{min}}^{E_{max}} A(E)\left[\frac{d\theta(E,T)}{dT}\cdot e^{-E/RT} + \frac{E}{RT^2}\cdot\theta(E,T)e^{-E/RT}\right]\eta(E)dE \quad . \tag{4}$$

At the peak temperature, $T = T_p$ and the second derivative equals zero. Setting Eq. (4) equal to zero, then substituting the left-hand side (LHS) of Eq. (2) into Eq. (4) for $-(A/\beta)[\theta(E,T_p)\exp(-E/RT_p)]$, gives

$$\int_{E_{min}}^{E_{max}} \left[-\frac{A(E)}{\beta}\,e^{-E/RT_p} + \frac{E}{RT_p^2}\right]\left[\frac{d\theta(E,T_p)}{dT}\right]\eta(E)dE = 0 \quad . \tag{5}$$

An approximate approach to extracting a pre-exponential factor can be obtained by reasoning that the sites of energy significantly lower than some average energy have mostly emptied by the time the peak temperature has been reached, and so their rate $d\theta(E,T_p)/dT$ is negligible at the peak temperature. Analogously, sites whose desorption energy is significantly higher than this average energy have not begun to empty yet, and so their sorption rate $d\theta(E,T_p)/dT$ is also negligible. This means that only over a narrow range, δE, is any contribution made to the integral in Eq. (5). If this narrow range is approximated by a delta function, then the portion of the LHS of Eq. (5) which is within the first set of brackets must equal zero at the peak temperature. If the sum of the terms within this set of brackets equals zero, a minor manipulation results in Eq. (3). This says that Eq. (3) is approximately valid for heterogeneous surfaces, with E being the postulated average energy. This in turn means that an approach identical with that for obtaining the pre-exponential factor for TPD from uniform surfaces can be used for obtaining the pre-exponential factor for TPD from heterogeneous surfaces. This would be valid for pre-exponential factors which are independent of the sorption activation energy. If the

pre-exponential factor is a function of the activation energy, then the pre-exponential factor obtained in this fashion would be the value for the average energy postulated above.

The possibility of applying this approach to substances with continuous SEDs was investigated. For a hypothetical three-peaked SED, synthetic TPD spectra at three heating rates were computed assuming a pre-exponential factor of 10^{13} s^{-1}. Plots of $\ln(\beta/T_p^2)$ vs. $1/T_p$ were constructed for the three peaks in each spectrum; three straight lines were obtained, in agreement with the prediction. From the slopes and the intercepts of these straight lines, site energies corresponding to each of the peaks as well as the pre-exponential factors were determined assuming the validity of Eq. (3). The results are shown in Table 1. The numerical experiments show that, even for a multi-peaked SED, it is possible to estimate the pre-exponential factor to within about an order of magnitude. Thus Eq. (3) is applicable even to a multi-peaked SED, confirming the reasoning behind the application of Eq. (3) to TPD experiments with substances possessing nonuniform surfaces.

This procedure can therefore be used for the thermogravimetric analysis of natural zeolites from the Yucca Mountain vicinity. With this goal, thermogravimetric data were collected for Ca-exchanged clinoptilolite samples. Five different heating rates ranging from 1.25 K/min to 20 K/min were used. For each experiment, the data showed one prominent peak in the plot of $d\theta/dT$ vs. T. Figure 1 shows the plot of $\ln(\beta/T_p^2)$ vs. $1/T_p$ for these experiments. With one exception (β = 5 K/min), the points form a straight line. The value of the pre-exponential factor was estimated to be 1.6×10^6 s^{-1}.

<u>Site-energy distributions for different clinoptilolites</u>: Thermogravimetric data for several clinoptilolites were collected with DuPont Model 1090 and Model 951 TGA systems. The derivative TGA spectra were computed from raw data by numerical differentiation. A Fortran code was employed to invert Eq. (1) using the method of regularization. The pre-exponential factor used was 1.58×10^6 s^{-1}, the value found for the Ca-exchanged clinoptilolite and reported above.

The input TGA spectra usually contained about 70-80 data points. The energy range from 0 to 300 kJ/mol was analyzed with a grid size of 625 kJ/mol. After SEDs were extracted from the TGA spectra, Eq. (1) was used to synthesize TGA spectra from the calculated SEDs. The synthesized spectra were then compared with the experimental spectra. Figures 2 and 3 show a typical comparison, that for Ba-exchanged clinoptilolite. Three calculated SEDs are shown in Fig. 2, each calculated from the same TGA spectrum but using a different value of the regularization smoothing parameter (α). The spectra calculated to result from identical TGA experiments on materials with the SEDs from Fig. 2 are presented in Fig. 3 and compared there with the experimental spectrum. The curve which results from using the SED calculated with an α of 10^4 apparently best fits the experimental TGA curve.

Figures 4 and 5 present the SEDs obtained from the TGA spectra from different clinoptilolites. Figure 4 shows the SEDs from three alkali-

metal-exchanged materials, and Fig. 5 shows the SEDs from four alkaline-earth-exchanged materials. Apparently the curves from the Na and Mg-exchanged clinoptilolites show some similarities, as do the curves from the K and Ca-exchanged materials. Sodium and magnesium are adjacent in the periodic table, as are potassium and calcium. Further analysis will be carried out here.

Future work: Additional analysis and interpretation of the calculated SEDs will be carried out. It is believed that an iterative procedure applied to Eq. (5) coupled with TGA or TPD spectra from different heating rates can give pre-exponential factors more accurately than the approximate method developed here. This possibility will be pursued. It is believed that the second derivative of the TGA data can be used to estimate the energy dependence of the pre-exponential factor. This possibility will also be pursued. The possibility of readsorption affecting the TGA data will be analyzed in the coming months. If readsorption is found to affect the results, then methods of compensating for this influence will be investigated.

Nomenclature:

A	pre-exponential factor, s^{-1}.
E	desorption activation energy, J/mol.
r_{sorb}	rate of sorption, fractional coverage/s.
R	gas constant, J/(mol)(K).
T	temperature, K.
α	regularization smoothing parameter, dimensionless
β	heating rate, K/s.
η	site-energy distribution function, where $\eta(E)dE$ is the fraction of all sites with desorption activation energies between E and $E + dE$.
$\theta(E,T)$	fractional coverage of sites with desorption activation energy E at temperature T.
θ_{gr}	gross fractional coverage of all sorption sites.

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CMR-4 (2), MS A150

Table 1

Pre-exponential Factors and Average Peak Energies Obtained for Desorption from a Nonuniform Surface

Site-energy distribution:

$$\eta(E) = 0.6885 \times 10^{-5}\left[e^{-1.25 \times 10^{-9}(E-150)^2} + e^{-1.50 \times 10^{-9}(E-230)^2} + e^{-1.25 \times 10^{-9}(E-300)^2}\right]$$

	From plots	True
Pre-exponential factor, s^{-1}:		
Peak 1	1.105×10^{14}	1×10^{13}
Peak 2	2.367×10^{13}	1×10^{13}
Peak 3	2.689×10^{13}	1×10^{13}
Peak energies, kJ/mol:		
Peak 1	166	150
Peak 2	233	230
Peak 3	304	300

Figure 1. Plot derived from TGA desorption-rate peak temperatures at different heating rates.

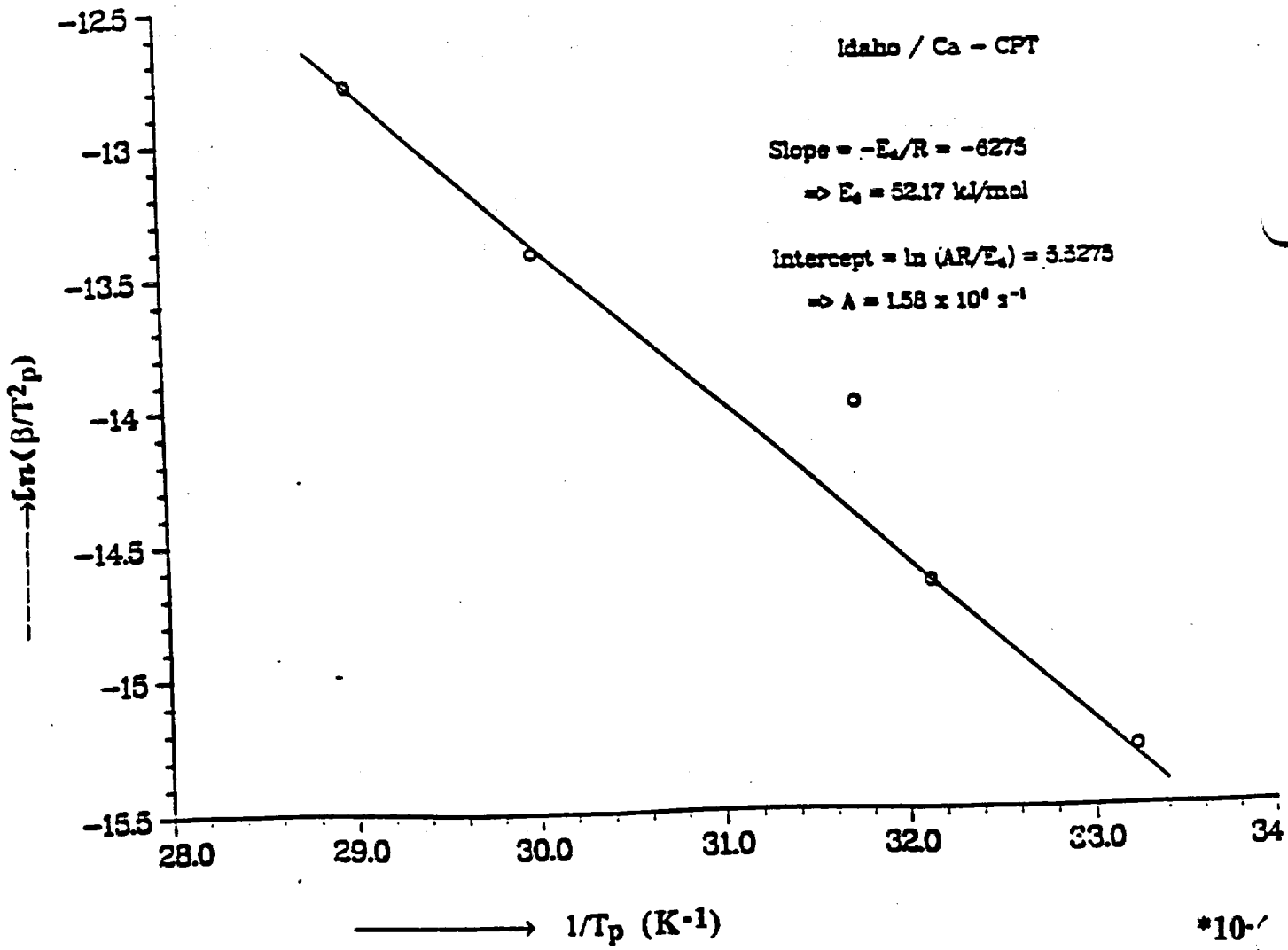


Figure 1

Figure 2. Site-energy distributions for a clinoptilolite calculated by regularization using different smoothing parameters.

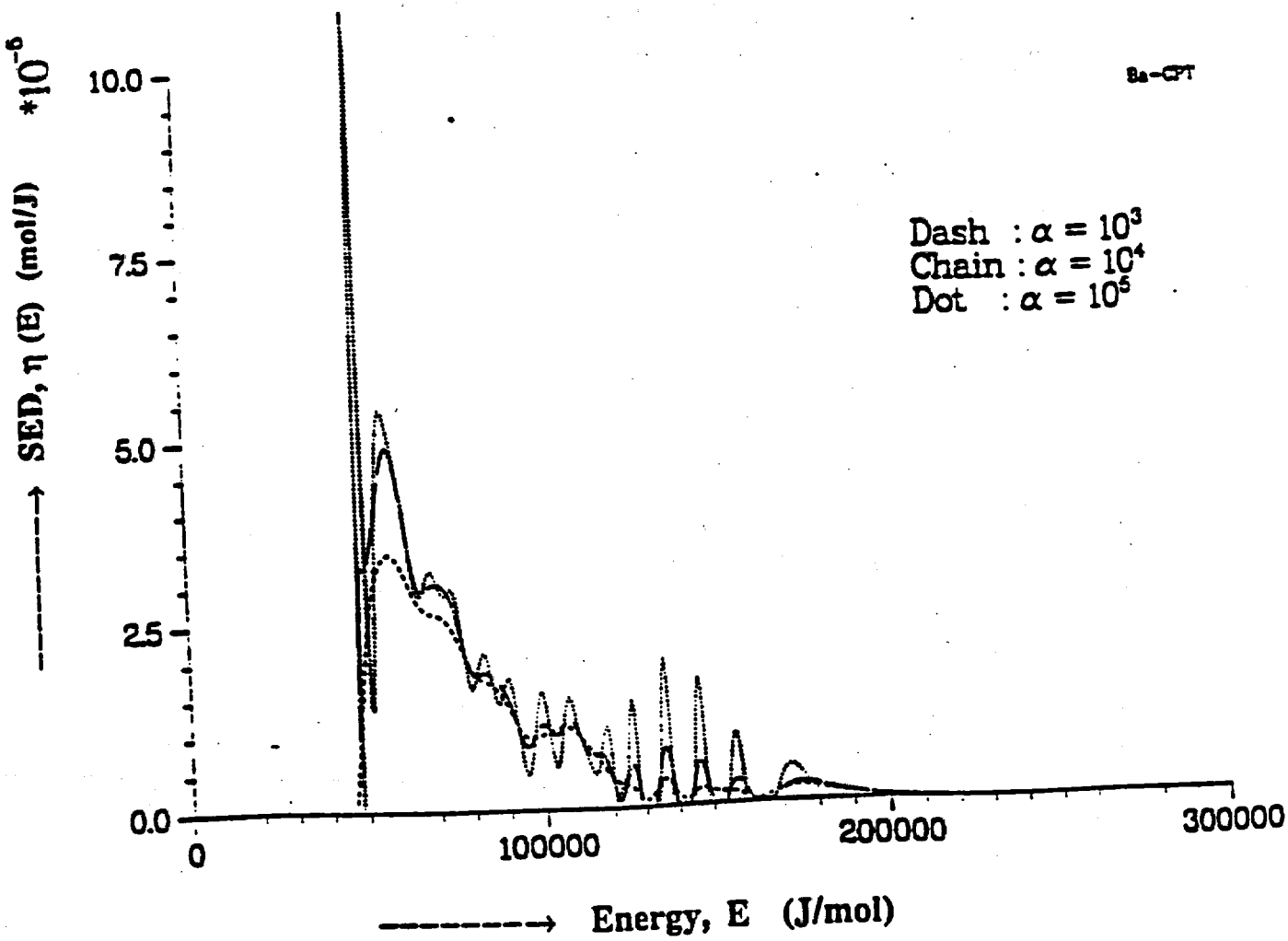


Figure 3. TGA desorption-rate spectra using a clinoptilolite. The plots compare spectra calculated from SED's obtained by regularization using different smoothing parameters with the experimentally-obtained spectrum.

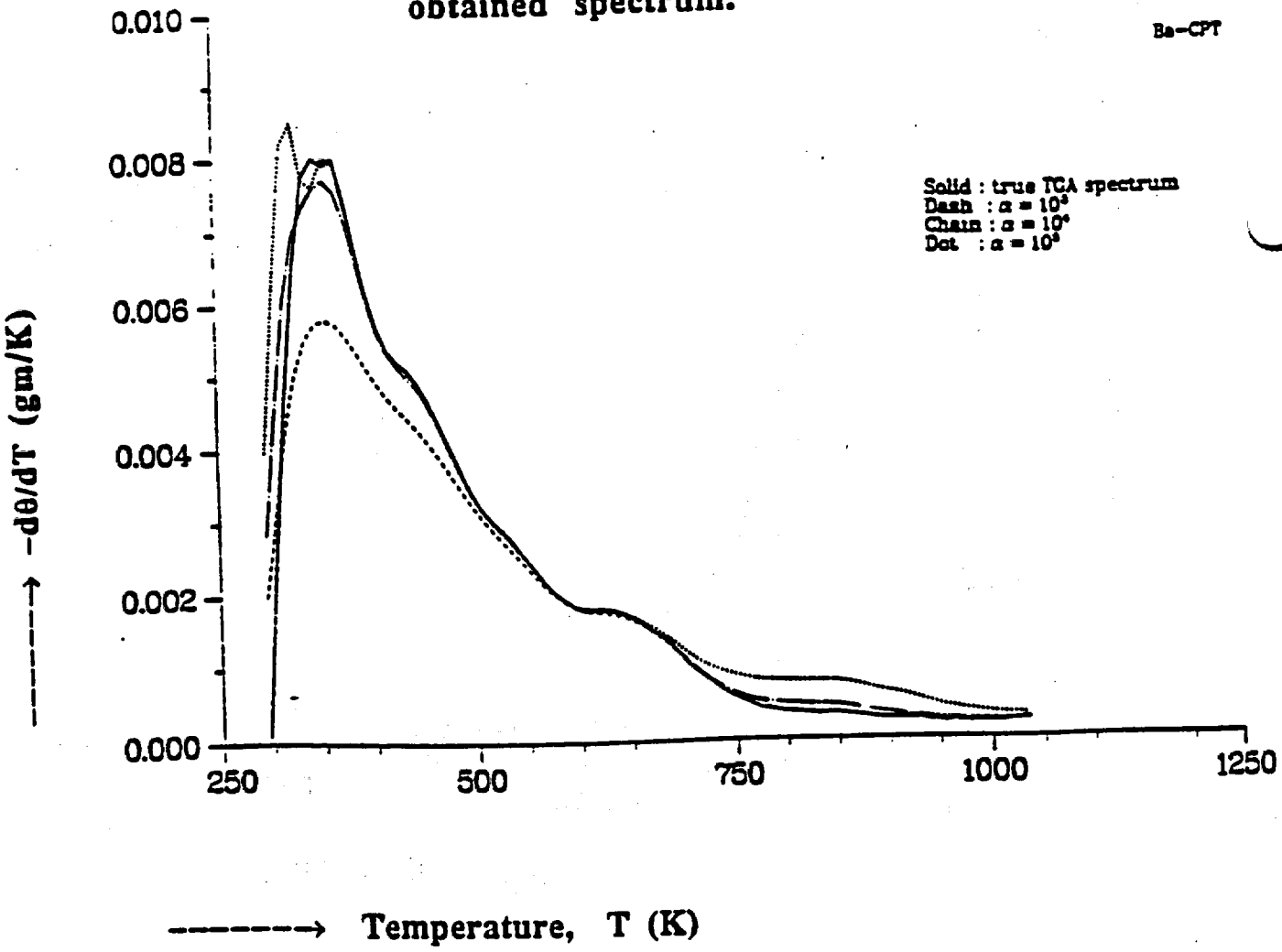


Figure 4. Site-energy distributions calculated for different clinoptilolites from TGA desorption-rate spectra.

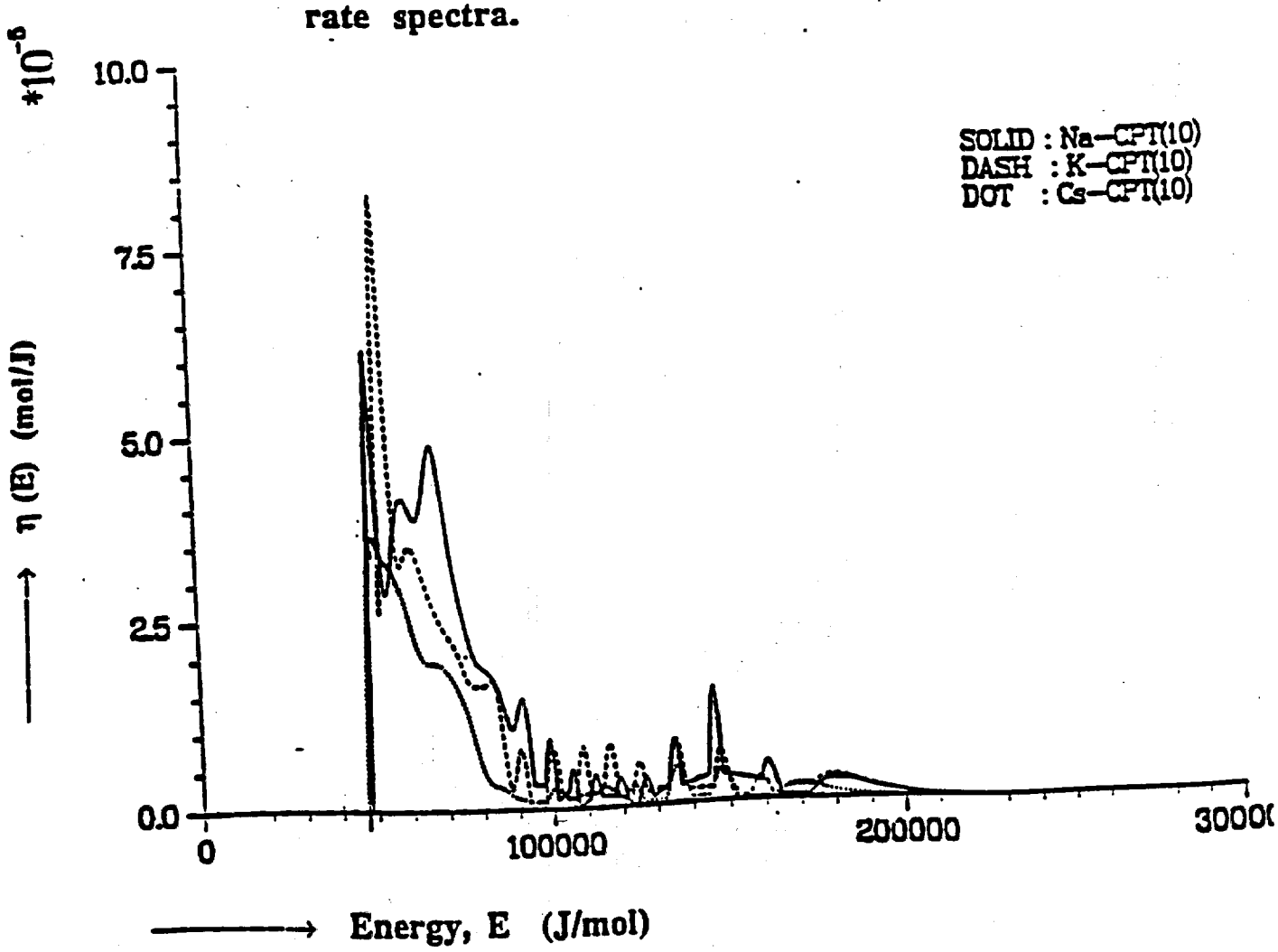
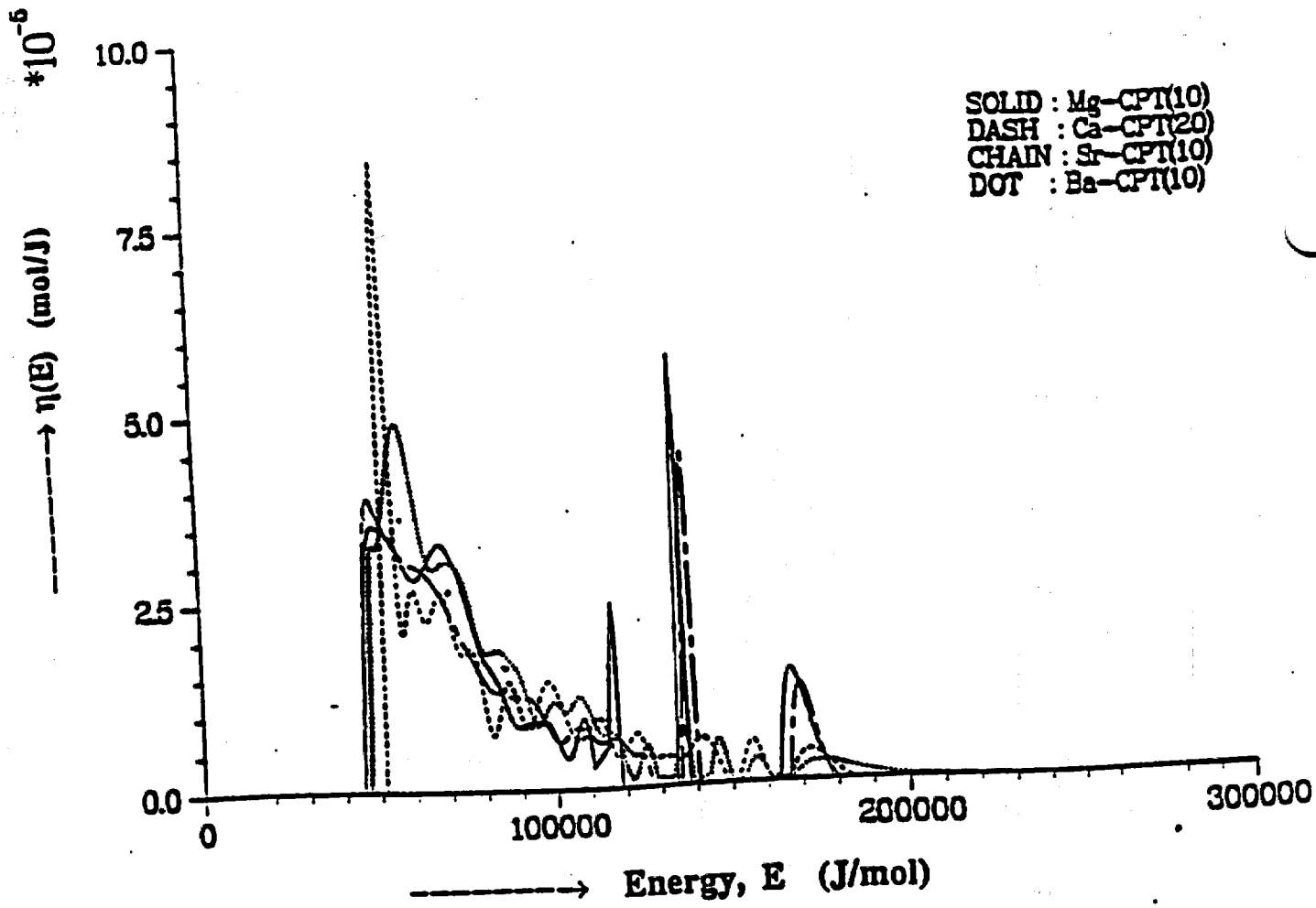


Figure 5. Site-energy distributions calculated for different clinoptilolites from TGA desorption-rate spectra.



ACTIVITIES AT THE UNIVERSITY OF NEW MEXICO IN SUPPORT OF THE VOLCANISM PROGRAM FOR THE YUCCA MOUNTAIN PROJECT, FISCAL YEAR 1989

October 1989
WBS 1.2.3.2.5

F.V. PERRY
S. G. WELLS
L. D. McFADDEN

This report provides a summary of the progress during fiscal year 1989 for studies at the Department of Geology of the University of New Mexico in support of the volcanism task for the Yucca Mountain Project. This task is attempting to determine the hazards of future volcanism with respect to location of a facility for geologic disposal of high-level radioactive waste at Yucca Mountain. Los Alamos National Laboratory has the primary responsibility for the volcanism work (B.M. Crowe, Principal Investigator).

Work for the volcanism task is supported through studies by F.V. Perry of the University of New Mexico and by Neotec, Inc., and Geoprofile, Inc. Planned activities for this work include:

1. Development of detailed technical procedures for the Quality Assurance requirements of the Yucca Mountain project.

2. Field studies of geomorphic parameters of volcanic features.

3. Field and laboratory studies of soil formation of volcanic features.

4. Petrologic and geochemical studies of Quaternary volcanic centers of the Yucca Mountain region.

progress during fiscal year 1989 for activities 2 and 3 was delayed because of limited land access and failure to obtain air quality permits to construct trenches at the Quaternary volcanic centers of the Yucca Mountain region.

DEVELOPMENT OF DETAILED TECHNICAL PROCEDURES FOR QUALITY ASSURANCE REQUIREMENTS

One detailed procedure was completed and is incorporated in the Los Alamos Quality Assurance Plan:

1. Preparation of Powders from Rock, Cinder, and Ash Samples (TWS-N5-DP-605, R0)

Three other detailed procedures submitted to the project have been delayed considerably in review and implementation:

1. Procedure for Soil Field Studies

2. Procedure for Geomorphic Field Studies

3. Procedure for Volcanism Field Studies (revision)

GEOMORPHIC AND SOILS STUDIES OF QUATERNARY VOLCANIC CENTERS OF THE YUCCA MOUNTAIN REGION

Several field trips to the Crater Flat/Lathrop Wells cinder cones were conducted to develop strategy for the trenching of volcanic materials. The trenches will enable development of the chronology of eruptive activity at these cinder cones based on soil stratigraphic and morphologic data. Field trips to the Cima volcanic field in southeastern California were conducted to observe the nature of surficial deposits and features associated with the "A" cone, the youngest known cinder cone in the field, and to investigate the nature of soil development in tephra and

colluvium related to this cone. The Lunar Crater volcanic field in central Nevada was visited to assess its usefulness as a geomorphic analogue to cinder cones of the Crater Flat/Lathrop Wells field.

Two volcanism meetings were attended at the Project office in Las Vegas to discuss the results of previous research and to discuss major goals of research consistent with the tasks of the volcanic hazards studies.

We participated in a field trip involving representatives from the NRC, DOE, LANL, and the State of Nevada to review studies of late Cenozoic volcanism in Nevada and California relevant to the volcanic hazards studies.

A talk entitled "Polycyclic Volcanism: A Common Eruption Mechanism of Small Volume Basaltic Volcanic Centers of the Southern Great Basin, USA" and a poster entitled "Geomorphic and Pedologic Criteria for Recognizing Polycyclic Volcanism at Small Basaltic Centers in the Western USA" were presented at the General Assembly of the International Association of Volcanology and Geochemistry of the Earth's Interior in Santa Fe (Appendix 1). A talk entitled "Geomorphic and Pedologic Evidence for Polygenetic Volcanism in Late Quaternary Cinder Cones: Examples from Cima Volcanic Field, California and Crater Flat/Lathrop Wells Volcanic Field, Nevada" was presented at the Annual Meeting of the Geological Society of America in Denver (Appendix 1).

PETROLOGIC AND GEOCHEMICAL STUDIES OF QUATERNARY VOLCANIC CENTERS OF THE YUCCA MOUNTAIN REGION

Geochemical sampling of two Quaternary polycyclic centers, the Lathrop Wells volcanic center and the "A" cone in the Cima field, began this year. Fifty seven samples, including flow material, bombs, and tephra, were collected from these centers. Sample sites from the Lathrop Wells center are shown in Appendix 2.

A sample preparation laboratory was completed at UNM and a

detailed procedure, "Preparation of Powders from Rock, Cinder, and Ash Samples" was prepared and approved in May. Fifty two samples have been processed in this laboratory and submitted for XRF analysis at the EES-1 XRF laboratory in Los Alamos. The first XRF results (for 20 samples) were returned in September.

The basalt compositions at Lathrop Wells determined by XRF are more hypersthene-normative than previous analyses determined by electron microprobe (Vaniman et al., 1982). The XRF analyses indicate that the Lathrop Wells basalts contain 10-15% normative hypersthene, plotting well away from the Di-Ol join in the Di-Hy-Ol ternary field. In contrast, analyses determined by electron microprobe straddle the Di-Ol join and are both hypersthene and nepheline normative. The difference in normative hypersthene is due to consistently lower Na in the XRF analyses compared to the microprobe analyses. This problem has been discussed with the XRF technician and it is possible (but not certain) that the XRF Na analyses are low for one or more reasons. One possibility is Na volatilization during the disk fusion process. Another possibility is hydration of the disk surfaces prior to analysis. In the latter case, repolishing of the disk surface immediately before analysis may resolve the problem. If repolishing has no effect, we plan to check the Na content of these samples with an independent technique such as atomic absorption. It is important to resolve this problem because the alkalinity and normative composition of these basalts is an important parameter in assessing the geochemical evolution of basaltic fields.

The major-element XRF analyses suggest that polycyclic volcanic centers may originate by more than one mechanism. Basalts from the "A" cone at Cima have K_2O and P_2O_5 concentrations (incompatible elements during basalt crystallization) that vary co-linearly, indicating that the basalts could be related by fractionation of a single batch of parental magma (Figure 1). In this case, the amount of fractionation needed to derive the most evolved basalt from the most primitive basalt is about 6%. In

contrast, the K_2O and P_2O_5 concentrations of basalts from Lathrop Wells indicate that more than one magma with different initial K_2O/P_2O_5 ratios (i.e., separate partial melts) is represented (Figure 2). These hypotheses are also consistent with plots of MgO versus P_2O_5 (a compatible element versus an incompatible element) which again suggest a single magma batch at Cima and multiple magma batches at Lathrop Wells (Figures 3 and 4). As more major-element, trace-element, and isotopic data is collected, these hypotheses will be tested and refined.

Samples of basaltic ash from exposures at the Lathrop Wells center were collected for attempted correlation with ashes in fault trenches west of Yucca Mountain. Successful correlation of ashes will constrain the timing of movement on these faults. Glass from two ash units at Lathrop Wells and from one ash from trench CF-1 was analyzed by electron microprobe. It was determined that glass compositions can be obtained that are relatively free from crystal contamination, but that all glass is inherently heterogeneous to some extent. Statistical techniques are being used to determine whether glass compositions can discriminate and correlate different ashes.

Work was completed on two papers: "Isotopic Evidence on the Structure and Origin of Subcontinental Lithospheric Mantle in Southern Nevada", published in the Journal of Geophysical Research, 94, 7885-7898, and "Volcanic Probability Calculations for the Yucca Mountain Site: Estimation of Volcanic Rates", submitted to the American Nuclear Society.

Figure 1
Cima "A" Cone

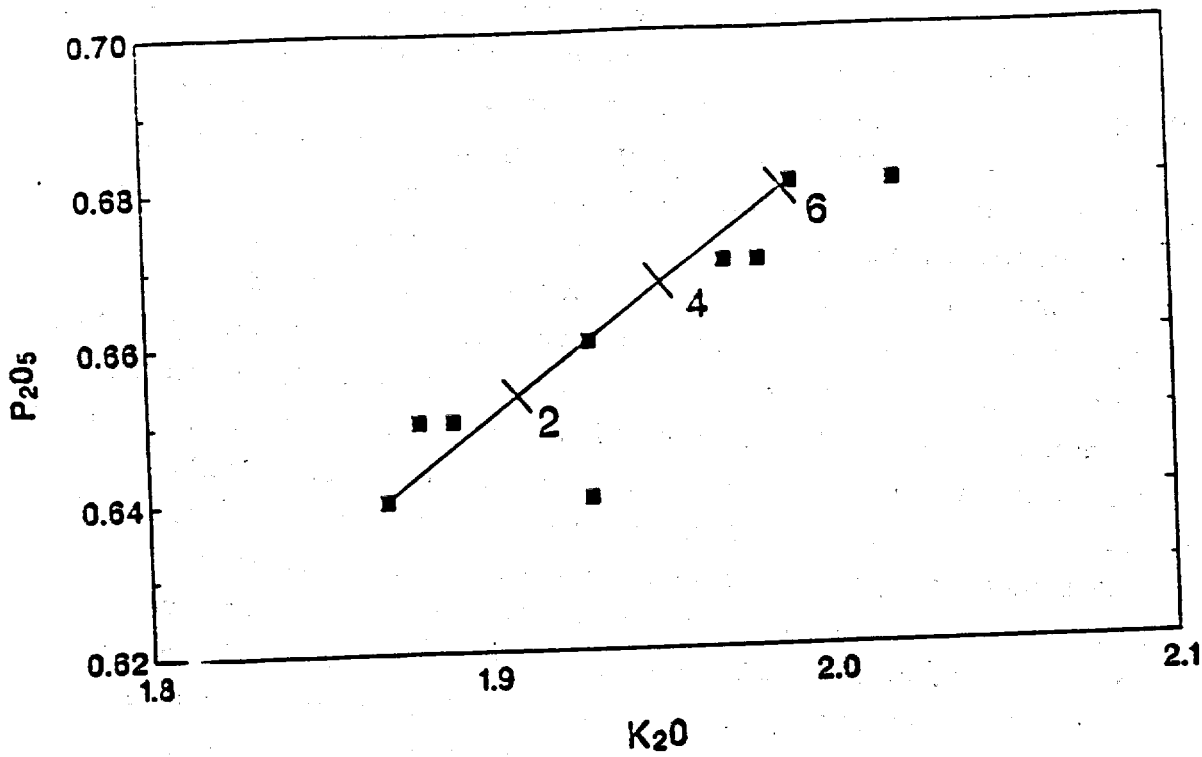


Figure 2
Lathrop Wells

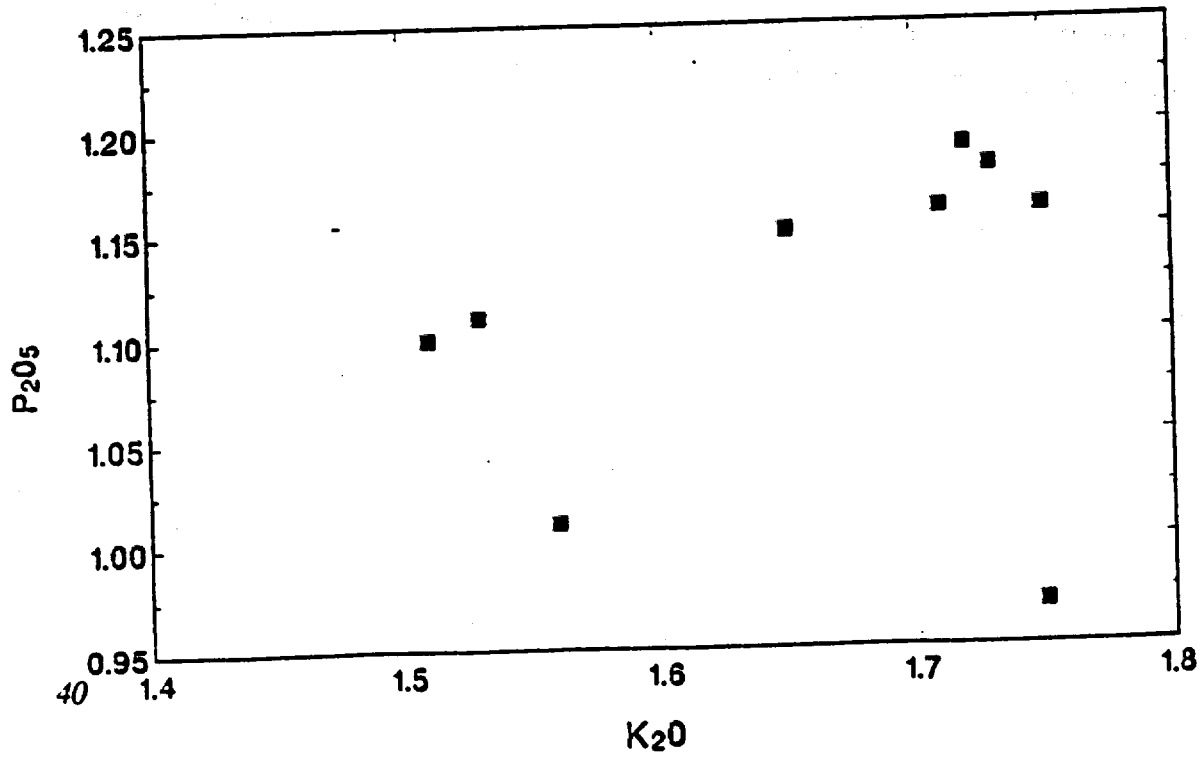


Figure 3
Cima 'A" Cone

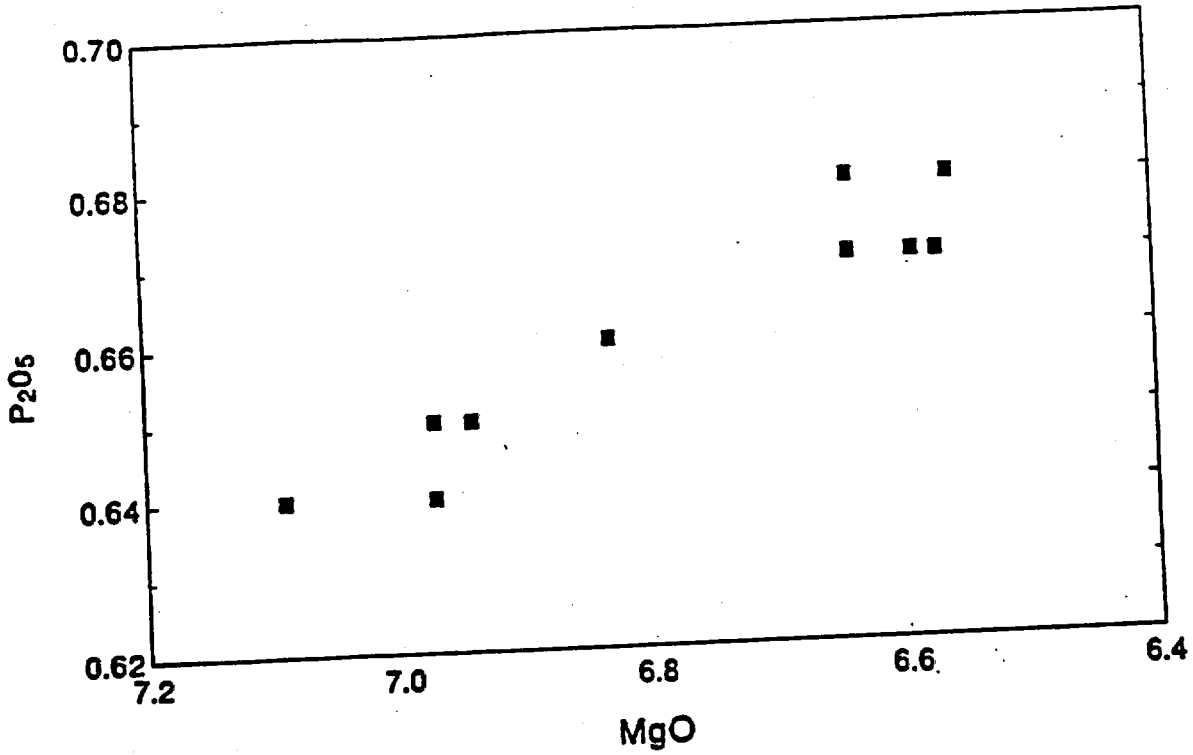
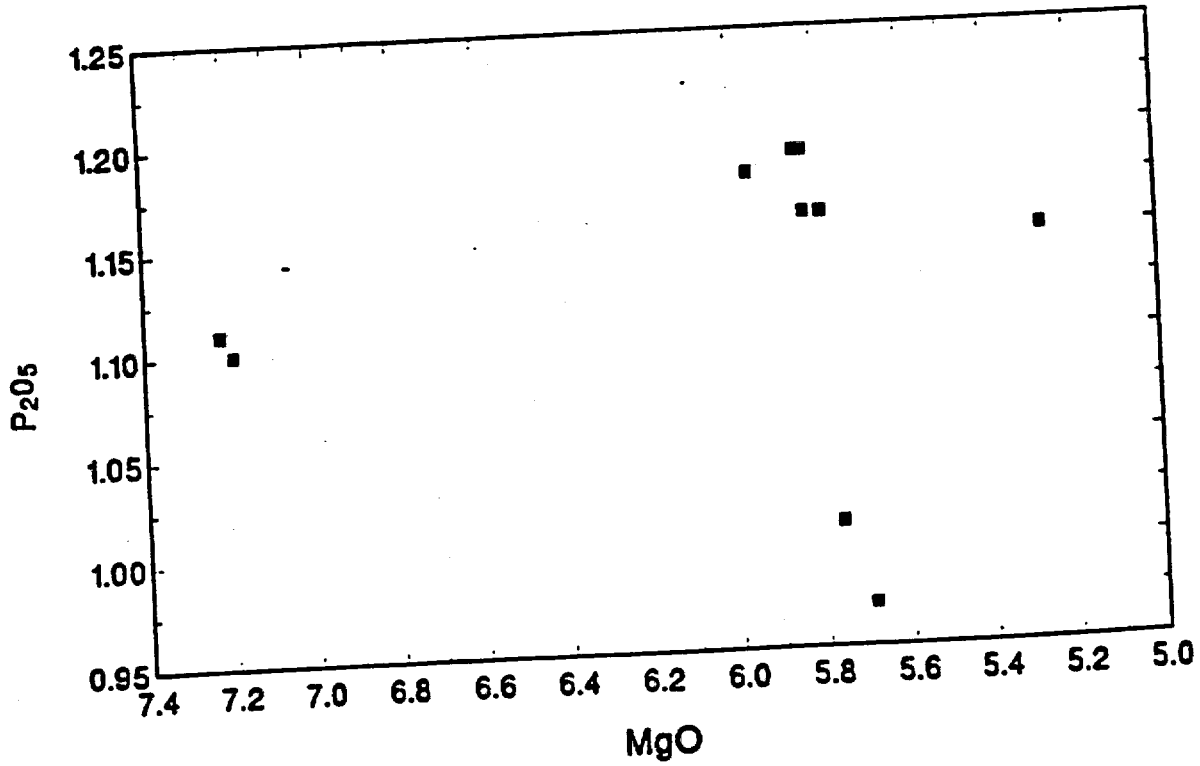


Figure 4
Lathrop Wells



Appendix 1

POLYCYCLIC VOLCANISM: A COMMON ERUPTION MECHANISM OF SMALL VOLUME BASALTIC VOLCANIC CENTERS OF THE SOUTHERN GREAT BASIN, USA

B. CROWE[1], B. TURRIN[4], S. WELLS[3], L. McFADDEN[3], C. RENAULT[3], F. PERRY[3], C. HARRINGTON[1], and D. CHAMPION[2]
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Small volume (<1 km^3) basaltic volcanic centers consisting of scoria cones and associated lava flows are inferred traditionally to form during a short duration (months to years) eruptive episode (monogenetic centers). Detailed studies of alkali basalt (hawaiite) centers in the southern Great Basin indicate that eruptions of these centers are much more complex. These studies are based on field mapping (scale 1:4000), analysis of progressive degradation, the degree of soil formation and the development of rock varnish on cone and lava surfaces, measurement of the paleomagnetic pole position of volcanic units, and conventional K-Ar age determinations. Examination of basalt centers of the southern Great Basin using these techniques shows that: (1) many, perhaps most, of the centers exhibit brief periods of eruptive activity separated by longer periods of inactivity; (2) small volume basalt centers may erupt intermittently over time spans of 10^3 to 10^5 yrs; and (3) there is a general decline in volume and increase in the ratio of scoria/lava in succeeding eruptions.

We classify the basalt centers as polycyclic and distinguish them from polygenetic centers. Polygenetic volcanoes are characterized by eruptions over time spans of 10^5 to 10^6 yrs, with eruption volumes of >1 to <10 km^3. There may be significant variation in the composition of magma of polygenetic centers. These centers are inferred to develop above a maintained, shallow sub-volcanic reservoir. Polycyclic behavior, in contrast, is associated with small volume (<1 km^3) basalt centers that exhibit intermittent eruptive activity separated by long periods of inactivity. The magma eruption rates of these centers are low ($<10^6$ m^3 yr^{-1}) and the erupted magmas are of uniform composition. The magma supply rate is too small to maintain a chamber in the shallow crust for the lifetime of the volcano. The repeated eruptions must be derived from ascent of individual pulses of magma from a deep crustal chamber or mantle source.

The frequency of occurrence of polycyclic volcanic centers is being investigated. Polycyclic eruptive patterns have been documented at Quaternary volcanic centers in the Crater Flat and Cima volcanic fields (Turrin and Renne, 1987; Renault et al., 1988); it has been recognized, based on preliminary studies, at other Quaternary centers (Lunar Crater and Sleeping Butte volcanic fields). We infer that it may be a common eruption mechanism of other basaltic centers of the southern Great Basin. The recognition of polycyclic volcanism has three significant impacts. (1) Past petrological studies of these centers are incomplete. They are based on sampling lavas which represent only part of the eruptive units. (2) The ascent of an initial pulse of basalt magma may create a preferential pathway through the shallow crust. This pathway controls the site of ascent of future magma until it is sealed by the regional stress field. (3) Polycyclic eruption patterns of basalt centers must be considered for volcanic hazard studies.

GEOMORPHIC AND PEDOLOGIC CRITERIA FOR RECOGNIZING POLYCYCLIC VOLCANISM AT SMALL BASALTIC CENTERS IN THE WESTERN U.S.A.

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Albuquerque, NM 87131

Studies of geomorphic degradation and soil development of volcanic landforms at small (< 1 km^3) basaltic centers in southern Nevada and California indicate that (1) eruptive history is more complicated than previously recognized and (2) multiple basaltic lava and scoria eruptions from single vents are intermittent with periods inactivity lasting 10^3 to 10^5 years. This style of repeated eruptions is classified as polycyclic (Crowe et al., this volume), and the timing of multiple events from a single vent must be deciphered in order to understand the ascent history of individual pulses of magma. We propose four geomorphic and pedologic criteria for recognizing polycyclic volcanism which are based upon detailed studies at the Cima and Crater Flat volcanic fields in California and Nevada, respectively.

1. Pyroclastic-fall units separated by a buried soil indicates that a period of surface stability and concomitant soil development have occurred on the volcanic units prior to a second eruption which buries the soil with tephra.
2. Degradation of scoria cones by small debris-flow and channelized-flow processes produce debris aprons at the base of the cone and require at least 10^3 years to form. When these apron deposits are overlain by pyroclastic-fall deposits, long-term cone erosion and volcanic inactivity has preceded a second eruption.
3. Debris aprons, which only occur below cone slopes showing debris-flow and channel-flow erosion, indicate long-term erosion. Thus the occurrence of debris aprons below cone slopes which show no signs of erosion indicates that a younger pyroclastic-fall unit has buried the older, eroded cone slope.
4. Several morphometric parameters of a scoria cone are sensitive to cone age. Cone slope angle decreases with time as the ratio of apron length to total cone length and apron height to total cone height increase with time. These parameters can be used to recognize polycyclic volcanism where several overlapping cinder cones of significantly differing age occur within a vent area.

The timing between multiple eruptions is provided by the degree of soil development. Soils associated with these volcanic landforms are formed primarily in eolian sands and silts which mantle and fill voids in the scoria and lava. The primary pedogenic horizons of these soils include a strongly developed vesicular A horizon, a thin cambic B or an oxidized C horizon, and a stage I secondary calcium carbonate horizon. Such soil development appears to require 10^3 years. Soils associated with increasingly older ages of volcanic landforms are usually characterized by systematic changes in B horizon thickness and secondary carbonate morphology.

These geomorphic and pedologic criteria not only provide field techniques for recognizing the polycyclic nature of scoria cones but are useful in understanding the complexities of strombolian eruptions and enhancing geologic mapping of volcanic centers where radiogenic dates are unavailable and field relations are unclear. Geomorphic and pedologic studies are ongoing in an attempt to refine the four criteria, improve the accuracy of assessing the time intervals between eruptions, and determine the regional extent of polycyclic volcanism in the western U.S. Preliminary observations suggest polycyclic volcanism has occurred at numerous other centers in California and Nevada as well as centers in New Mexico.

№ 12418

ER DISCHARGE WITHIN A GLACIATED STRATO-VOLCANO: WHAT HAPPENS TO SURFACE RUNOFF?

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ssivity of glaciated volcanoes is closely associated with the ce of groundwater located in the vicinity of hot, near-surface tic intrusions. To investigate this problem as it relates to St. Helens volcano, glacier mass balance and isotopic (D and ^{18}O) techniques were applied to study water discharge paths in the dy River Basin of Washington State. Between 1979 and 1983 the iation, surface water discharge and isotopic composition of snow, r ice, rain, surface streams and springs were monitored at Shoe- glacier and at lower elevations of the volcano. Results indicate only ten percent of the total meltwater produced during the summer discharged as surface water. The remainder is discharged through ground or is stored within the ice and rock masses on the volcano. ifically, isotopic measurements indicate the water in Moss Springs ginates as meteoric water (probably snow) deposited at high eleva- s on the volcano. This water apparently traveled within porous ined aquifers located at the base of layered andesite flows that ur at Moss Springs. Although a significant portion (50%) of the mer meltwater is accounted for by this discharge path, both isotopic mass balance data imply that a significant amount of water (on the der of 1 m^3/sec.) was regularly discharged into the porous summit ifer prior to 1980. This water would have contributed to the explosi- ity of Mount St. Helens during the May, 1980 eruption.

№ 8013

PACTS OF ACIDIC EMISSIONS FROM NEVADO DEL RUIZ VOLCANO, COLUMBIA, ON ATURE AND AGRICULTURAL ECOSYSTEMS.

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ission of acid gases and thermal waters from Nevado del Ruiz volcano s increased in concert with the November 13, 1985 eruption. This study amines the downwind and downstream effects of these emissions on alpine ecosystems on the slopes of the volcano (4100m) and on coffee plantations at lower elevations (1500m). Rain, soils, soil solutions, and streams are sampled between January and July, 1987.

Precipitation falling high on the volcano is usually acidified; how- ever, rain reaching the distal coffee plantations seldom is acidic. The urce of the acids is hydrogen chloride and sulfur dioxide from the enus vent. Sulfur dioxide is the dominant gas, but hydrogen chloride s most responsible for acidification of rain falling on the slopes of e volcano. With distance from the vent, the chloride/sulfate ratio ases exponentially.

Throughfall chemistry in the coffee plantations shows a dramatic esponse to occasional acid rain events. A base exchange process on cof- e plant leaves is triggered. For each Equivalent of hydrogen ion in ain, over 23 Equivalents of potassium ion are leached from the leaf.

Nonetheless, the plantation soils appear relatively unaffected by cidic deposition. In contrast, the alpine soils on the volcano exhibit ow pHs, high sulfate and chloride concentrations in soil solutions, and igh extractable sulfate. These factors indicate that these soils re- ceive significant acid loading.

The streams flowing off the volcano are apparently acidified by sul- uric acid in thermal waters discharging into the streams. The acidity f these streams decreased and silica concentrations increased down- stream. Stream water composition is controlled by thermal water dis- charges, equilibrium dissolution of amorphous silica glass, and non- equilibrium leaching of soil and ash.

№ 2275

EOMORPHIC AND PEDOLOGIC EVIDENCE FOR POLYCYCLIC VOLCANISM IN LATE QUATERNARY CINDER CONES: EXAMPLES FROM CIMA VOLCANIC FIELD, CALIFORNIA AND CRATER FLAT/LATHROP WELLS VOLCANIC FIELD, NEVADA

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Polygenetic volcanism (multiple eruption cycles from a single vent) has been proposed for the Quaternary Cima volcanic field (CVF) of California by Turrin and Renne (1987) on the basis of K-Ar dating and paleomagnetic analyses. We propose that geomorphic/pedologic studies provide an effective technique for establishing the frequency and timing of multiple eruptive events at single vents within basaltic volcanic fields at CVF and at Crater Flat/Lathrop Wells (CF/LWV) in Nevada. Cinder cones degrade and form debris aprons which consists of reworked cinder accumulations at the base of the cone. Stripping of airfall tephra from cone slopes by debris- and channelized flow processes are episodic over time and are strongly influenced by lithologic variations of the cinder cone. The presence of buried soils in stratigraphic sequences of debris apron and airfall deposits indicate the complexity of volcanic eruptions and cone-slope degradation processes. Surface and buried soils within the debris aprons and airfall deposits of the 15 Ka "A" cone of the CVF indicates a minimum of three eruptive events separated by a sufficient amount of time to allow soil development and cone-slope degradation. The characteristic profiles of these soils are Ao-Bw/Ab-Btkb-Bk, suggesting a minimum of a few thousand years between eruptive events. Immediately adjacent to the "A" cone, a deeply degraded cone slope with a well-developed soil profile is buried by the much younger tephra of the "A" cone; the degree of soil development suggest a period of 10^5 years between the older and younger cone building events. Similar geomorphic and pedologic relations exist on other cinder cones within the CVF which are < 300 Ka, indicating a long-term trend of polycyclic volcanism. The < 23 Ka Lathrop Wells vent within the CF/LWV displays a similar complex sequence of airfall deposits separated by weakly developed soils indicating that late Quaternary polycyclic volcanism is not restricted to the CVF. We conclude that geomorphic/pedologic studies provide critical data necessary for understanding the eruptive history of Quaternary basaltic centers which is important for deciphering age and field relations among flows and cones and for adequately evaluating volcanic hazards.

№ 4172

HAZARD IMPLICATIONS OF JOINT-CONTROLLED BASALTIC VOLCANISM IN SOUTHWESTERN UTAH

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Post-5-m.y.-old basaltic rocks form scattered exposures within a 60 x 140-km northeast-trending belt in southwestern Utah and a broad area of adjacent northwestern Arizona. Many flows are surmounted by cinder cones or mounds, and many of those show conspicuous alinement, suggesting that their locations are structurally controlled. Eight alinements of Quaternary basaltic centers are identified in the Cedar City 1° x 2° quadrangle in southwestern Utah. They include from 3 to 28 centers, range in length from 2.5 to 11.5 km, and trend either northeast or northwest. Petrogenetic evidence for magma derivation from lithospheric mantle and lack of evidence for magma residence in crustal chambers suggest channelways that extend through the crust. The alined centers do not lie along mapped faults of parallel trend despite the presence of such faults near some centers. A generally similar relationship has been noted for northwestern Arizona. Alined and unalined centers near major mapped faults show a preference for localization on the footwall block with lava commonly pouring across the fault scarp. The general avoidance of mapped faults as conduits suggests either that those faults (1) are unsuitable because their damage zones have physical properties that preclude magma transmissivity, (2) do not penetrate deeply enough to tap magmas, or (3) have normal stresses whose magnitudes preclude opening at ambient magmatic pressures. On the basis of direct and indirect field evidence, the alinements reflect control by steep joints. An absence of syravolcanic shear or permanent dilatation (generally no coeval dikes) indicates low strain or zero strain associated with the volcanic process. A paucity of evidence for syravolcanic mineralization along prevolcanic fractures at or near the eruptive centers indicates little or no hydrothermal discharge or disturbance of ground-water systems by the volcanic process. As a consequence, a low level of hazard associated with syravolcanic geopressuring of ground-water systems can be inferred. Also, unless it is assumed that the eruptive process drives shear displacement of faults that are spatially separated from the eruptions, syravolcanic faulting does not appear to be a hazard.

TUESDAY, NOVEMBER 1, 1988

Poster Session II

SESSION 39, 8:00 a.m.

Tectonics/Geophysics I: General Tectonics

№ 13791

PROPAGATING MAFIC DIKE SWARMS IN THE DECCAN VOLCANICS, HOT SPOT TRACK AND INTRAPLATE RIFTING

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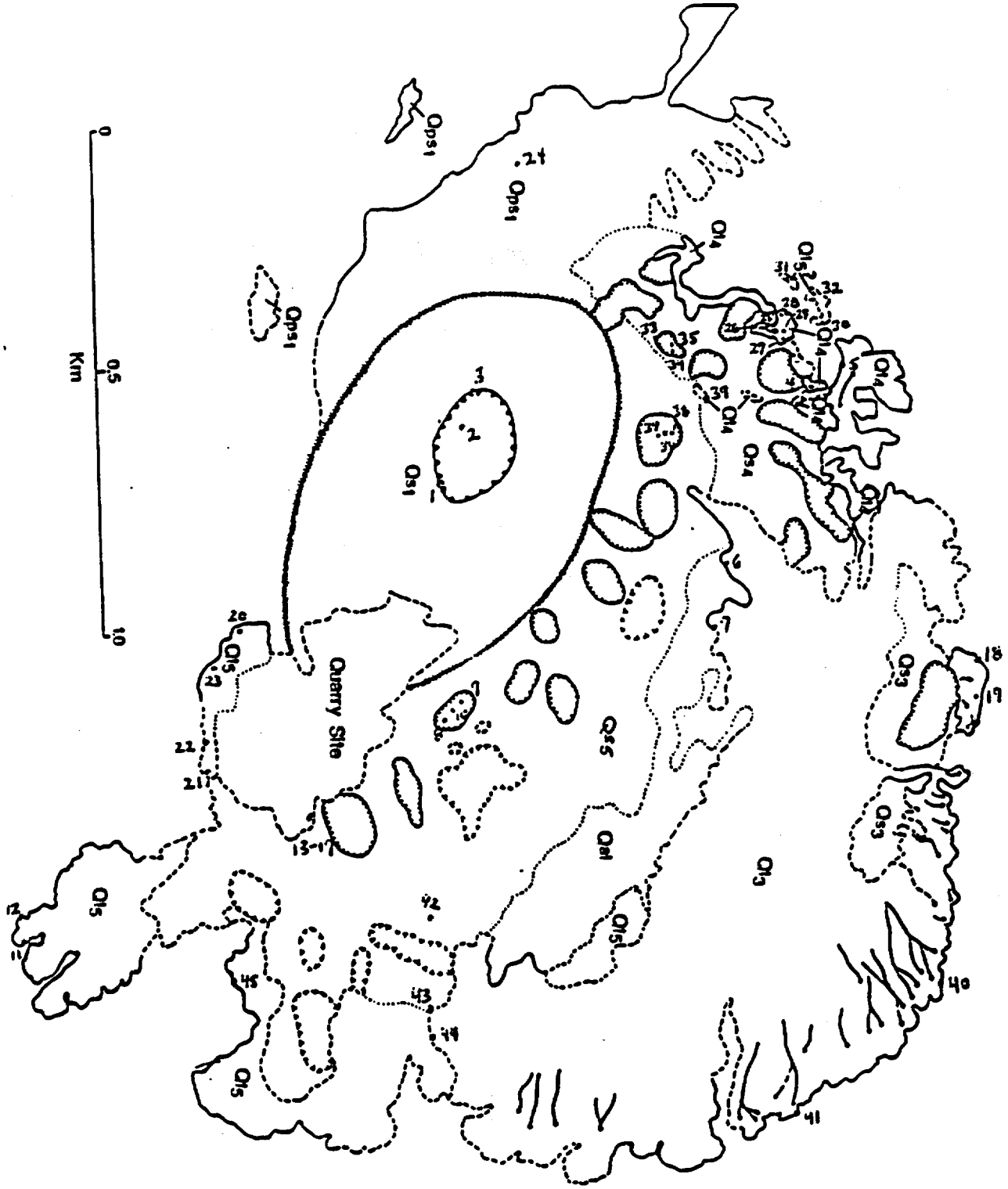
Studies of several hundred mafic dikes and dike swarms in the Deccan volcanics show that major dikes and dike swarms trend primarily E-W to ENE-WSE and NS to NW-SE. They are several meters to tens of kilometers long, segmented en echelon or arcuate. E-W to ENE-WSW dolerite dikes and dike swarms, carbonatite plugs and dikes, and alkaline intrusives at the western part of the Deccan volcanics are confined exclusively within the E-W trending mid-plate Precambrian Narmada-Tapti-Son lineament belt. The N-S to NW-SE basalt-dolerite, gabbro and picritic dikes parallel the Cambay graben in the north, and faults, fractures and the Panvel flexural axis along the west coast of India. Many centers of radial and radial-concentric dikes align N-S to NW-SE paralleling the Kurduvadi-Koyna lineament (rift) zone. The association of thermal springs, high heat flow, and gravity anomalies with several centers of radial and radial-(arc) concentric dikes, and the mechanics of the origin of the radial and radial-concentric dikes indicate that these are possible sites for upper crustal, subcaldera magma reservoirs as well as important eruptive centers for Deccan volcanism. Like the Deccan lavas, these dikes are essentially tholeiitic. A positive correlation of high gravity, high heat flow and high seismicity with areas of

Appendix 2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Olxs
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Lawrence Berkeley Laboratory
1 Cyclotron Road Berkeley, California 94720
(415) 486-4000 • FTS 451-4000
October 1989
WBS 1.2.3.4.1.3

November 2, 1989

Dr. David E. Hobart
Los Alamos National Laboratory
Mail Stop G-739
Los Alamos, New Mexico 87545

RE: Letter Report for September and October 1989
YMP-LBL-LR12, R0, YMP-LBL-LR13, R0

Dear Dave:

During the reporting period, we continued working on the project "Determination of Solubilities and Complexation of Waste Radionuclides Pertinent to Disposal at Yucca Mountain."

We finished the solubility experiments of NpO_2^+, Pu^{4+}, and Am^{3+} in UE25p#1 groundwater at 25°C and pH values of 6, 7, and 8.5. The results are summarized in Table 1. Figures 1 to 9 show the solution concentrations as a function of equilibrium time. We also conducted tests to determine how much solution is required to saturate the filters used to separate the solid from the solution. Filter saturation is necessary to avoid sorption on the filter material. From the americium experiments, we suspected that the fixed amount of 200 µL was not sufficient. Figures 10 to 12 shows filtrations americium experiments; the concentration is depicted as a function of filtered volume. As you can see from Figures 10 and 11, a volume larger than 500 µL was required for saturation. The amount seems also to depend on the running time of the experiments. At day 12 about 1500 µL was sufficient while at the other days about 2500 µL were necessary. This is not surprising because the dominant solution species might have changed with time thus having different sorption characteristics. Therefore we corrected our routine measurements for americium at pH 6 and 7 by the amount which was lost by filter sorption (Figure 12). The corrected values are shown in Figures 7 and 8. The americium solution at pH 8.5 did not show any filter sorption. Rather stable and low-charge carbonate complexes that formed already during the early stages of the experiment may sorb much less than the higher charged Am^{3+}. The relatively high CO_3^{2-} concentration of UE25p#1 water will favor the complex formation. We also tested the filter sorption for the Np and Pu solution as shown in Figures 13 and 14, respectively. We could not find any volume effect and therefore the routine separations are satisfactory.

We had several problems during the last two months. The x-ray diffractometer was inoperable until last week, because the new replacement x-ray tube was defective. It is very difficult to get another replacement because the tube is not manufactured any more. The supplier finally located another spare tube and it is being sent now.

Table 1. Results of Solubility Experiments of NpO_2^+, Pu^{4+}, Am^{3+} in UE25p#1 at 25°C

	pH	conc./M	days since start when steady state was reached
Np	6.0 ± 0.1	$(2.88 \pm 0.63) \times 10^{-3}$	1 – 86
	7.1 ± 0.1	$(4.7 \pm 1.1) \times 10^{-5}$	57 – 106
	8.5 ± 0.1	$(6.98 \pm 0.59) \times 10^{-6}$	71 – 106
Pu	6.0 ± 0.1	$(8.28 \pm 0.35) \times 10^{-7}$	75 – 118
	7.1 ± 0.1	$(4.46 \pm 0.36) \times 10^{-7}$	75 – 126
	8.5 ± 0.1	$(1.01 \pm 0.14) \times 10^{-6}$	40 – 109
Am	6.0 ± 0.1	$(3.1 \pm 1.1) \times 10^{-7}$	40 – 110
	7.1 ± 0.1	$(3.2 \pm 1.6) \times 10^{-7}$	62 – 123
	8.5 ± 0.1	$(3.10 \pm 0.76) \times 10^{-7}$	62 – 104

I still could not start the repeat experiments in J-13 water at 60°C because I do not have the new solubility cells made from polyetheretherketone (PEEK). The only mechanical technician who was able to fabricate these delicate cells became sick several months ago and I could not find an adequate replacement. I think, I found somebody capable of doing the job now. Given the development work involved, this will take at least another six weeks. This effects my milestone for J-13 water. There are two possibilities to solve the problem. One is to deliver the milestone as planned by December 31, 1989 and leave the americium part at 60°C out and add it in March 1989 before the final YMP review. The other possibility is to move the entire milestone to March 31, 1989. What do you suggest and prefer?

We also had problems with the sodium determination of the UE25p#1 steady-state solutions. The ion specific sodium electrode showed non-Nerstian response and needed replacement. There was an initial problem with the supply, but we now have a replacement and the sodium determinations are on the way.

If you have any questions, please call me.

I am looking forward to seeing you at the "Migration 89" Conference and to discuss further details there.

Best regards,

Heino

Heino Nitsche
Principal Investigator
Geochemistry Group
Earth Sciences Division

APPROACH OF UE-25p#1 WATER SOLUTION OF Np (V)
AT pH 6 TO EQUILIBRIUM AT 25 DEGREES

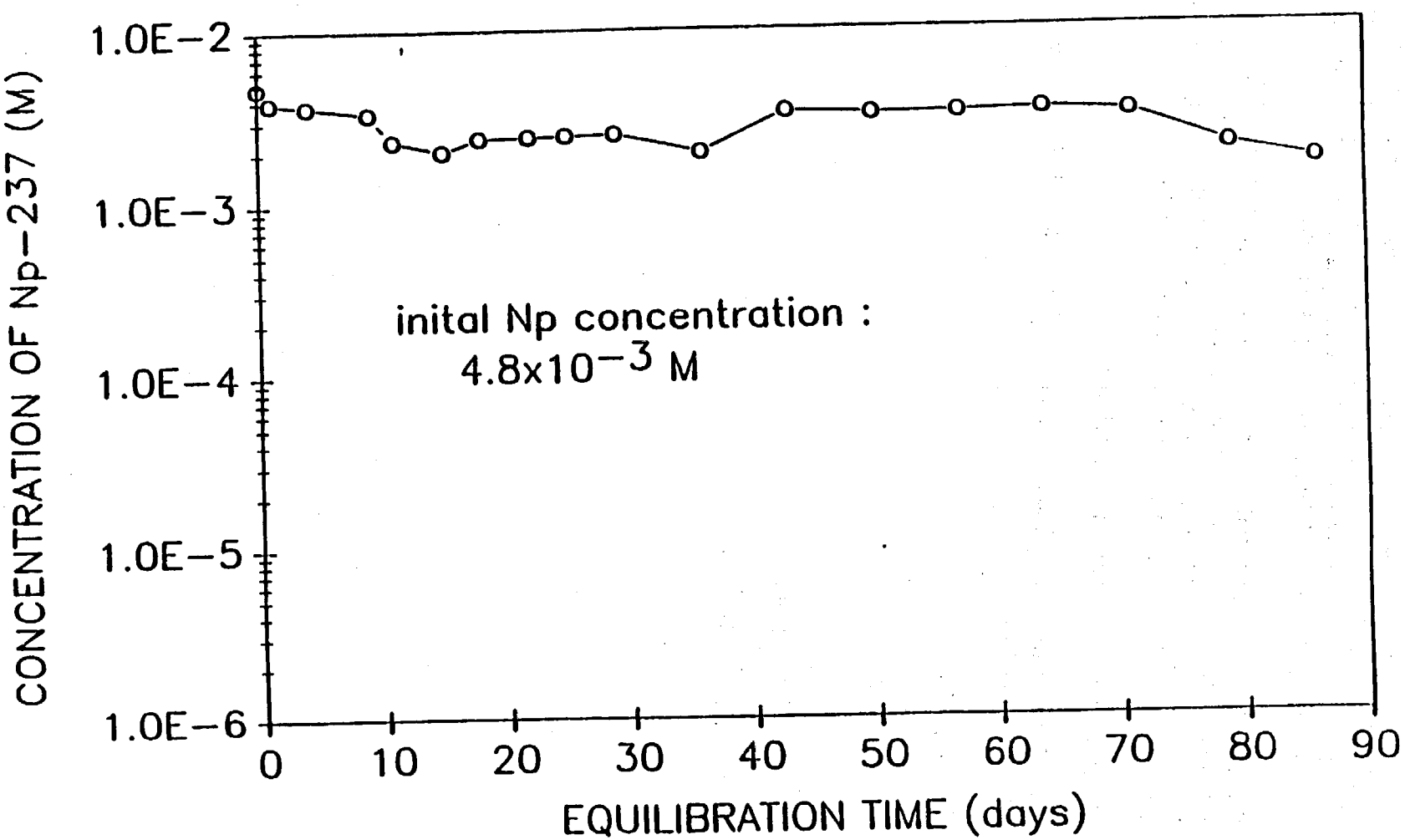

FIG. 1

APPROACH OF UE-25p#1 WATER SOLUTION OF Np (V)
AT pH 7 TO EQUILIBRIUM AT 25 DEGREES

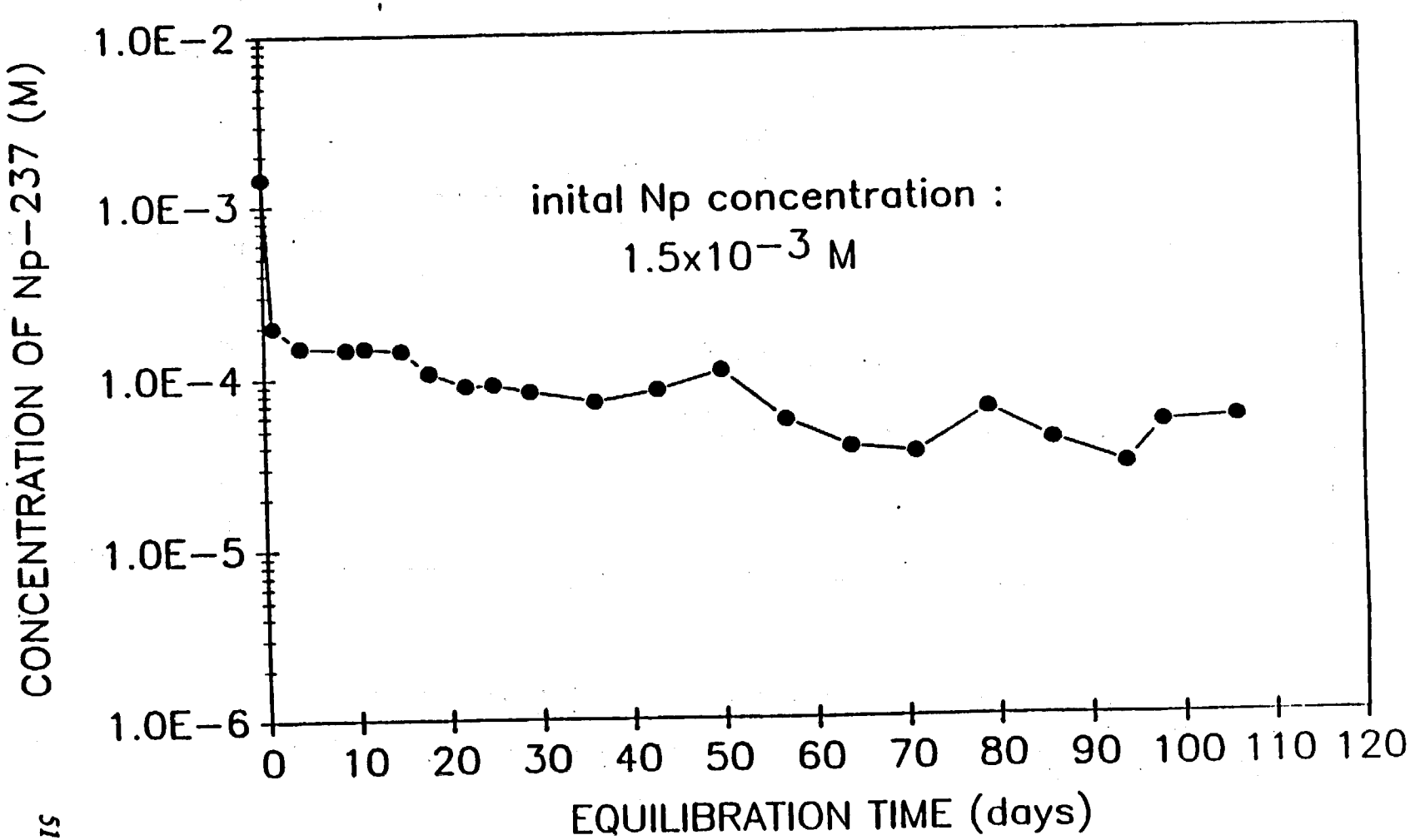

FIG.2

APPROACH OF UE-25p#1 WATER SOLUTION OF Np(V) AT pH 8.5 TO EQUILIBRIUM AT 25 DEGREES

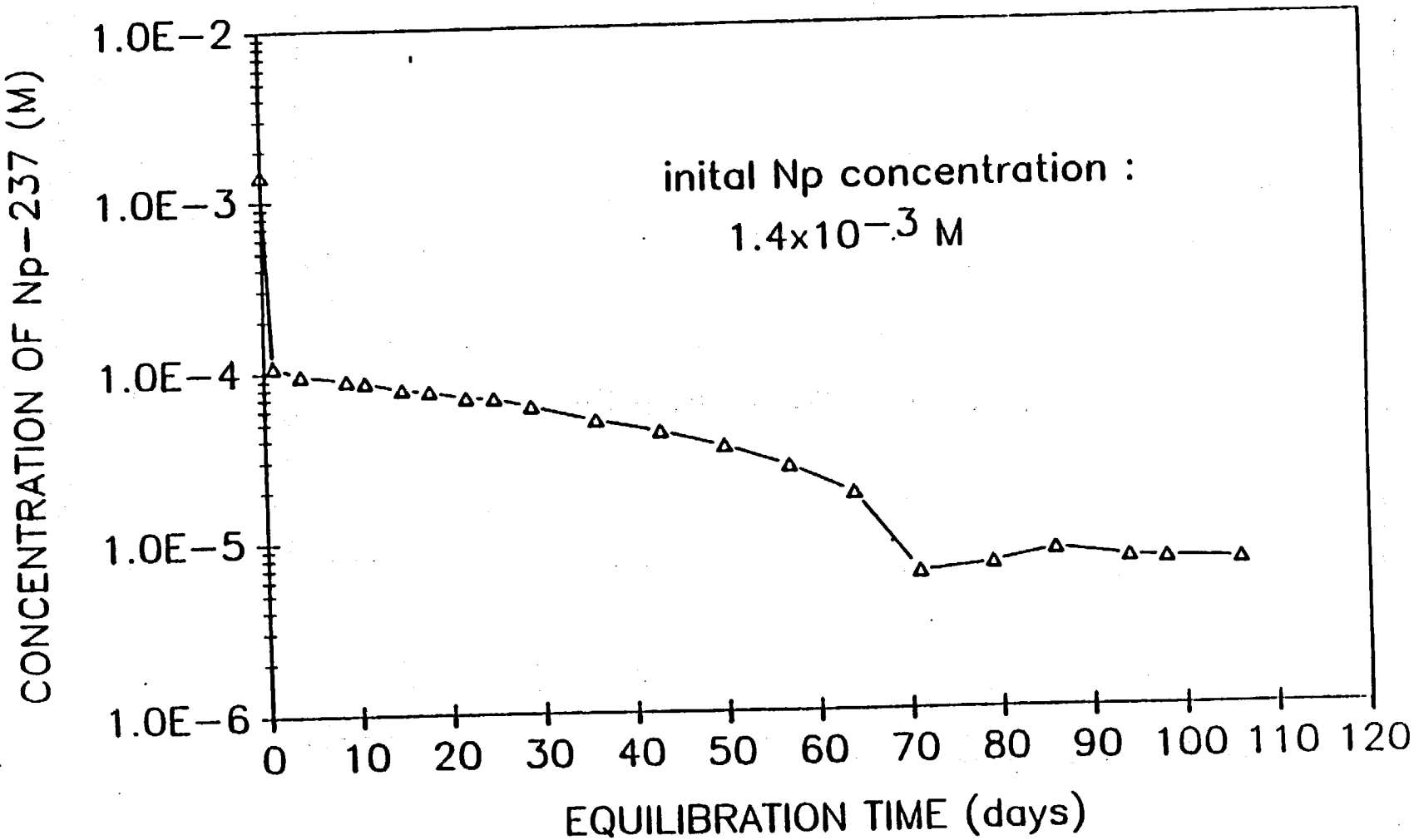

FIG. 3

APPROACH OF UE-25p#1 WATER SOLUTION OF Pu(IV)
AT pH 6 TO EQUILIBRIUM AT 25 DEGREES

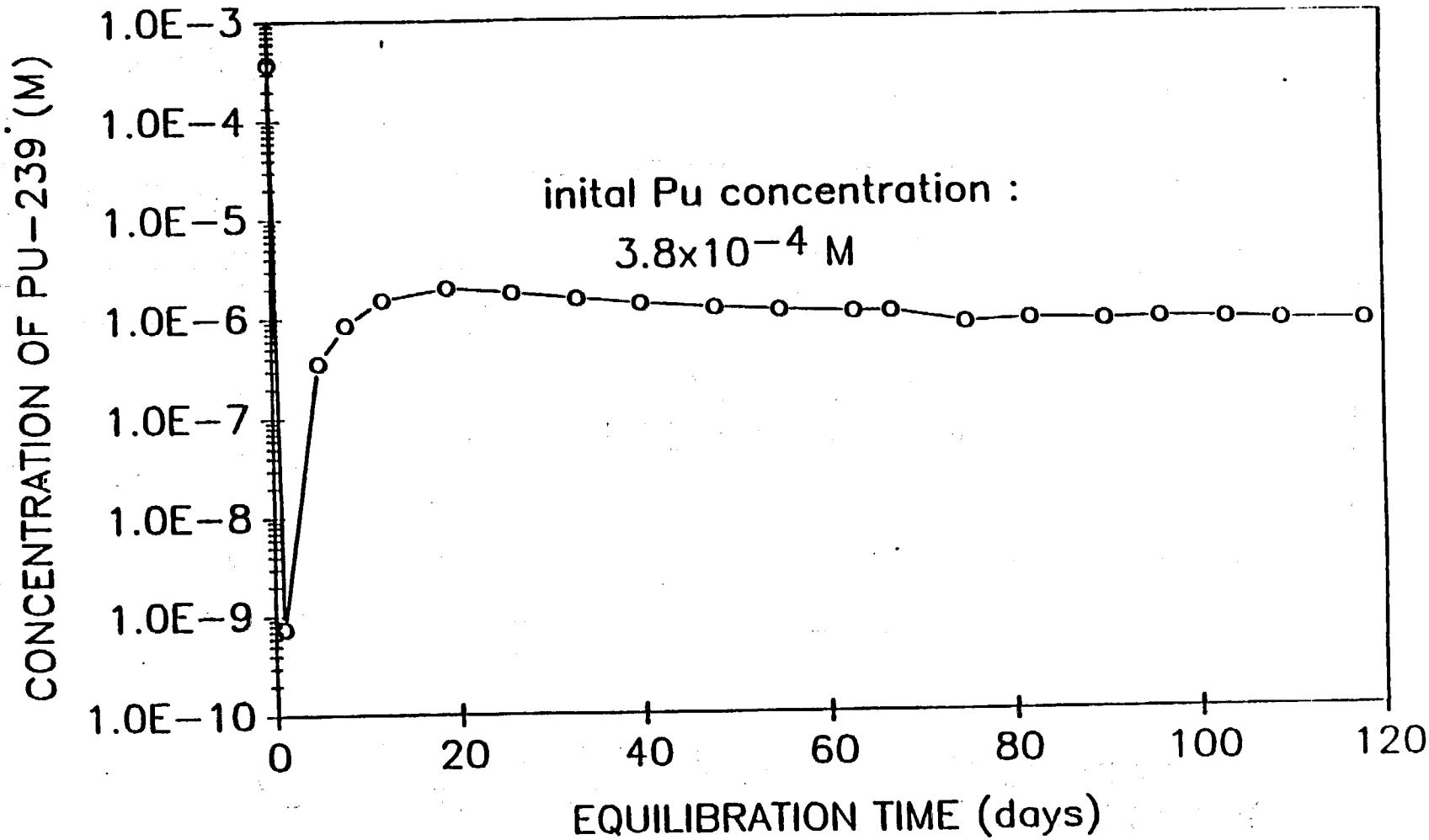

FIG. 4

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APPROACH OF UE-25p#1 WATER SOLUTION OF Pu(IV)
AT pH 7 TO EQUILIBRIUM AT 25 DEGREES

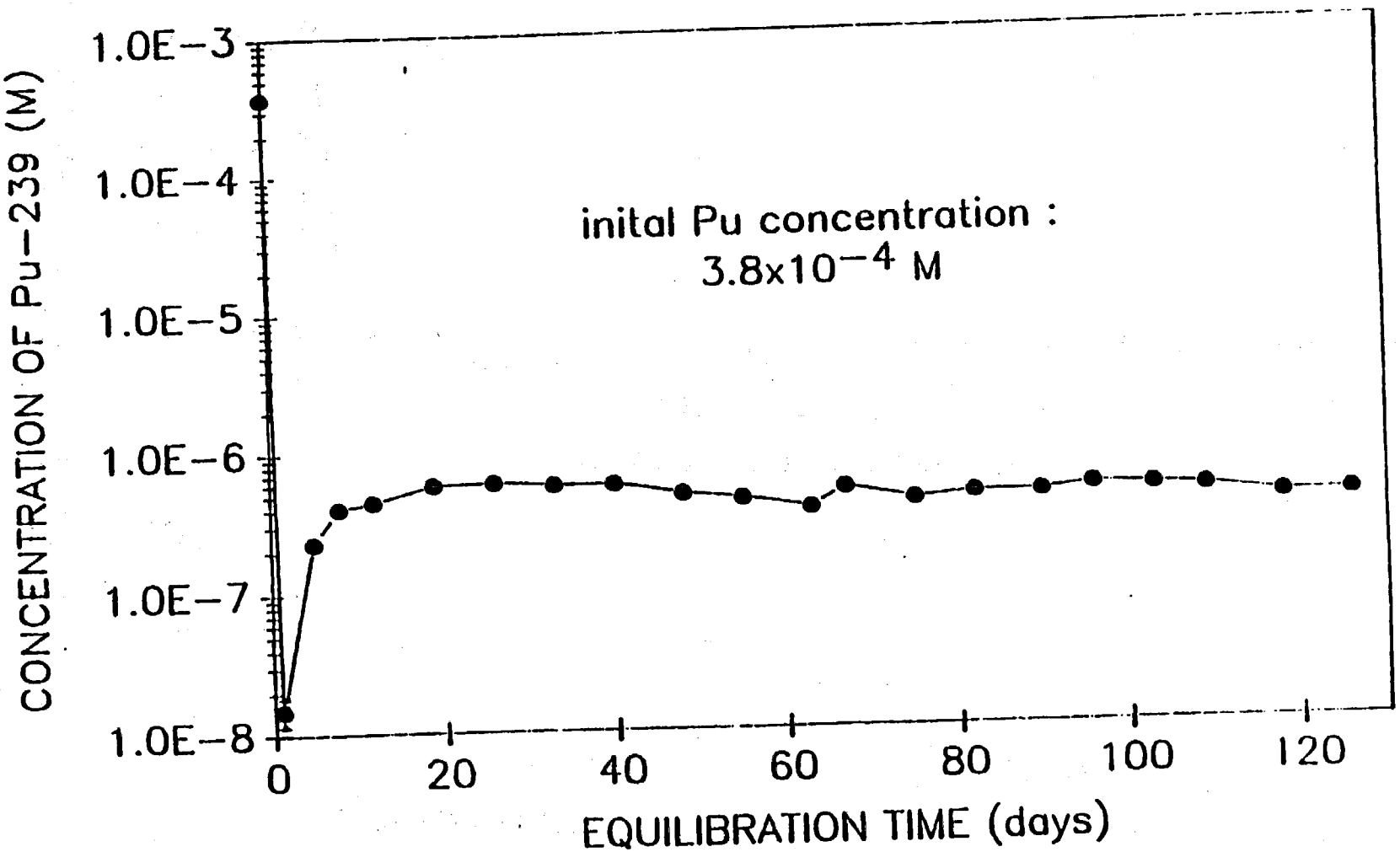

FIG. 5

APPROACH OF UE-25p#1 WATER SOLUTION OF Pu(IV)
AT pH 8.5 TO EQUILIBRIUM AT 25 DEGREES

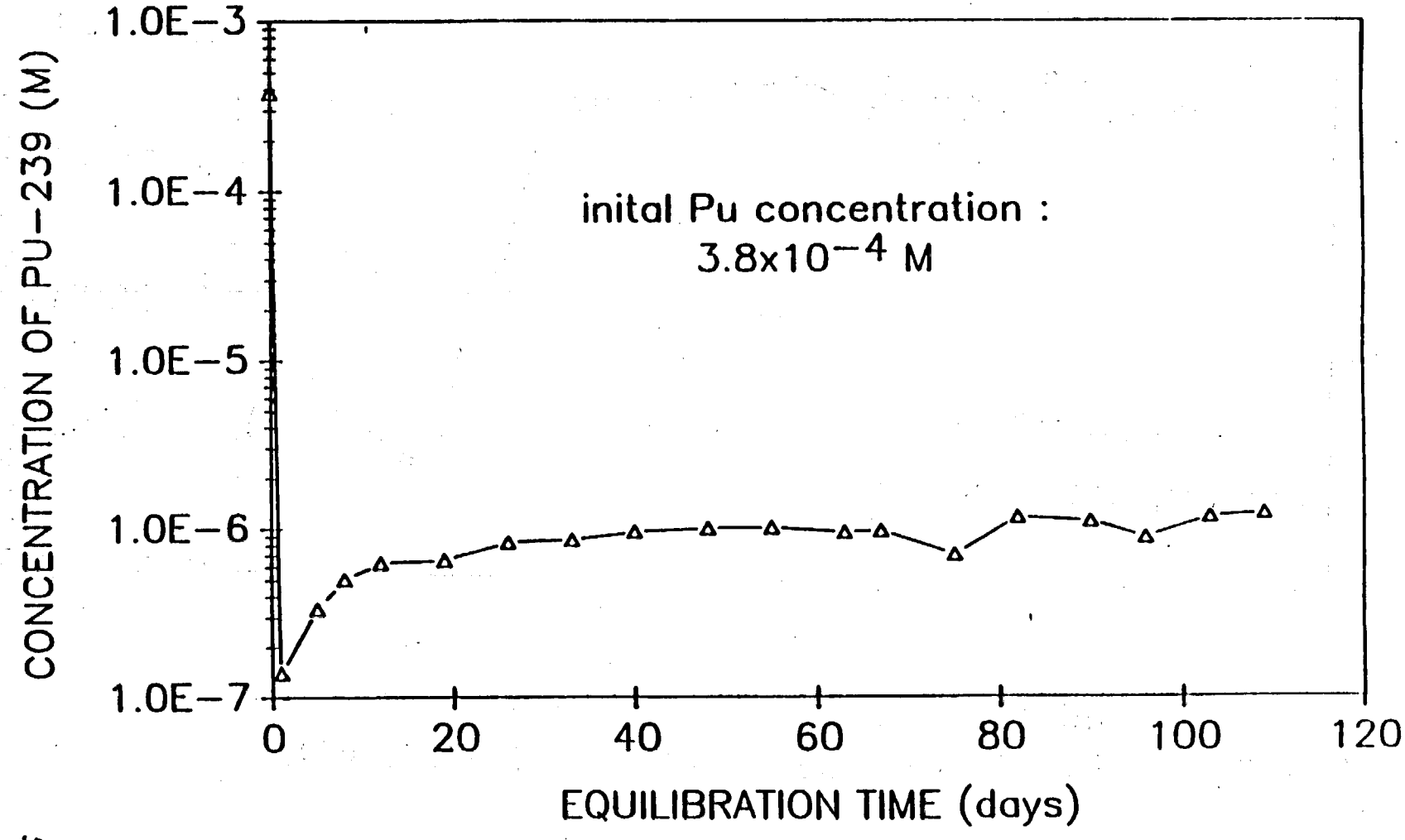

FIG. 6

APPROACH OF UE-25p#1 WATER SOLUTION OF Am (III)/Nd
AT pH 6 TO EQUILIBRIUM AT 25 DEGREES

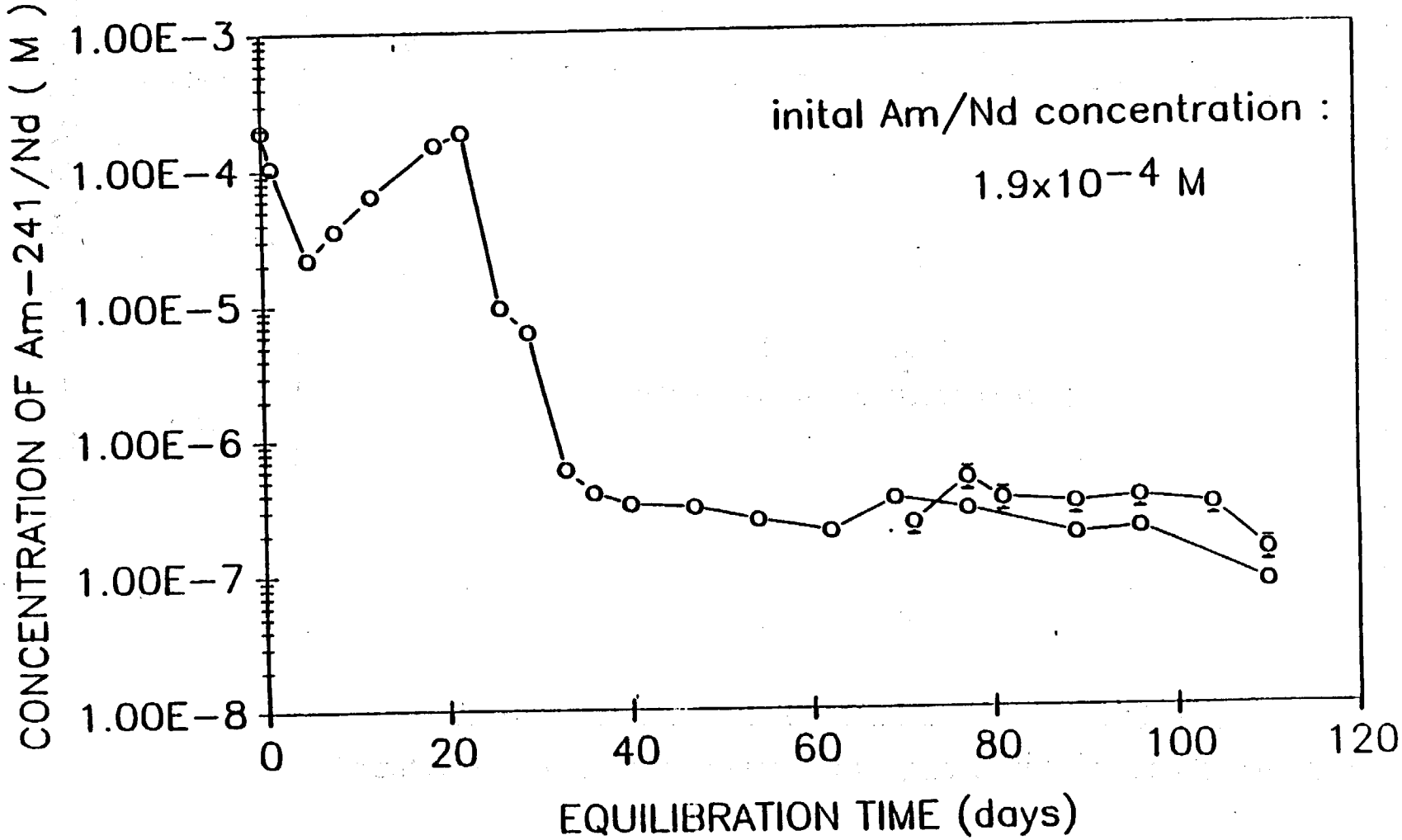

FIG 7

APPROACH OF UE-25p#1 WATER SOLUTION OF Am (III)/Nd
AT pH 7 TO EQUILIBRIUM AT 25 DEGREES

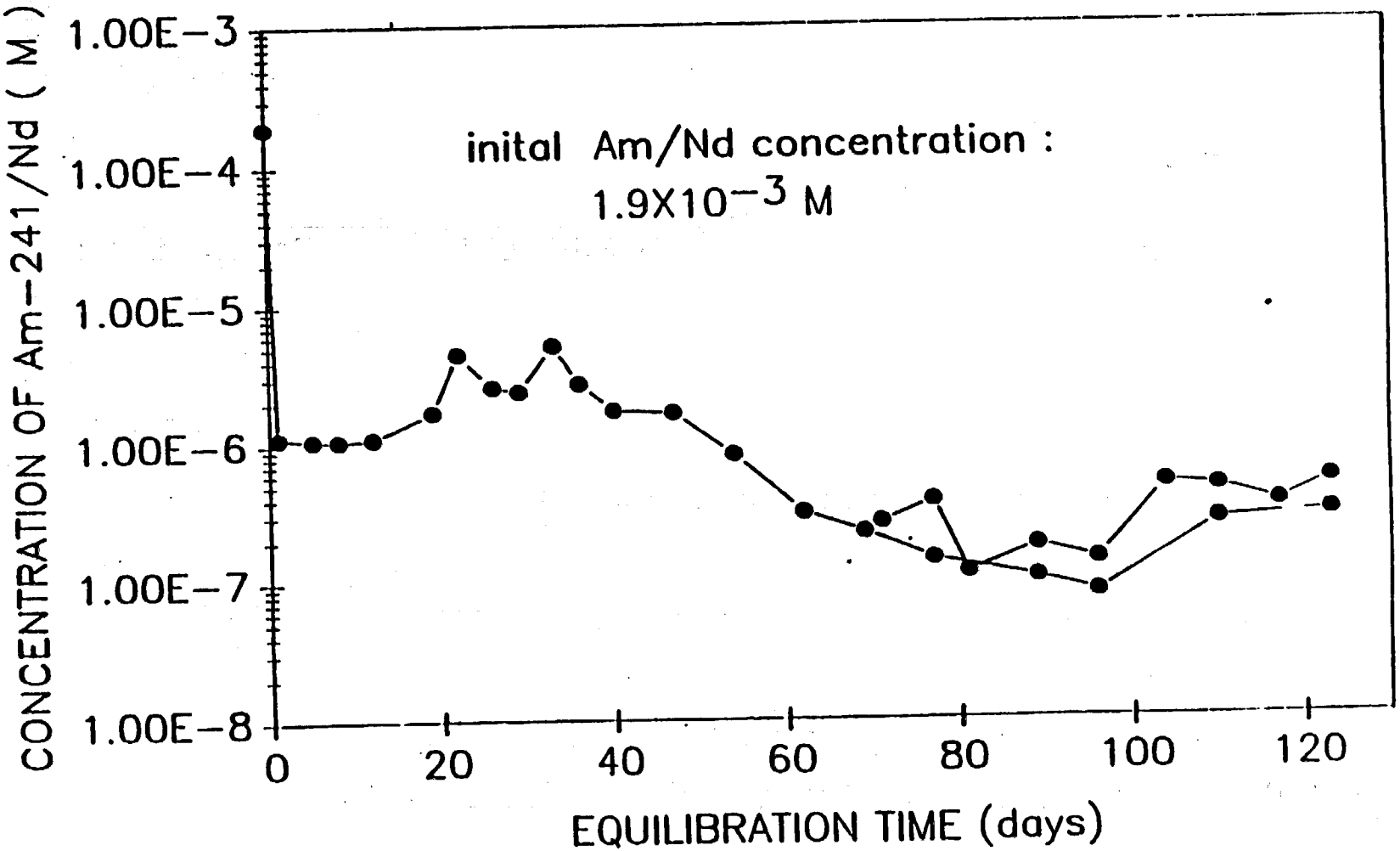

FIG 5

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APPROACH OF UE-25p#1 WATER SOLUTION OF Am (III)/Nd
AT pH 8.5 TO EQUILIBRIUM AT 25 DEGREES

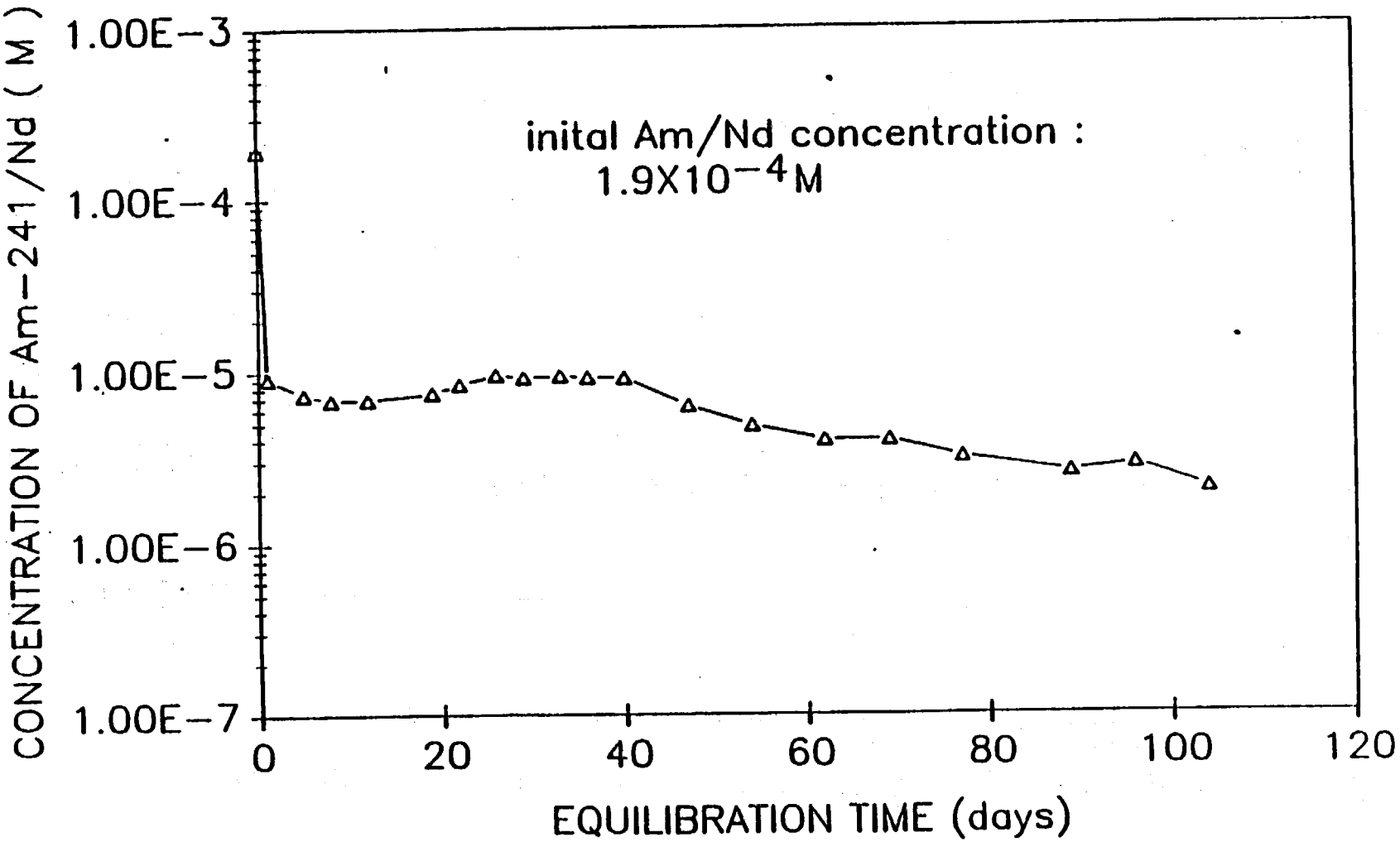

FIG. 9

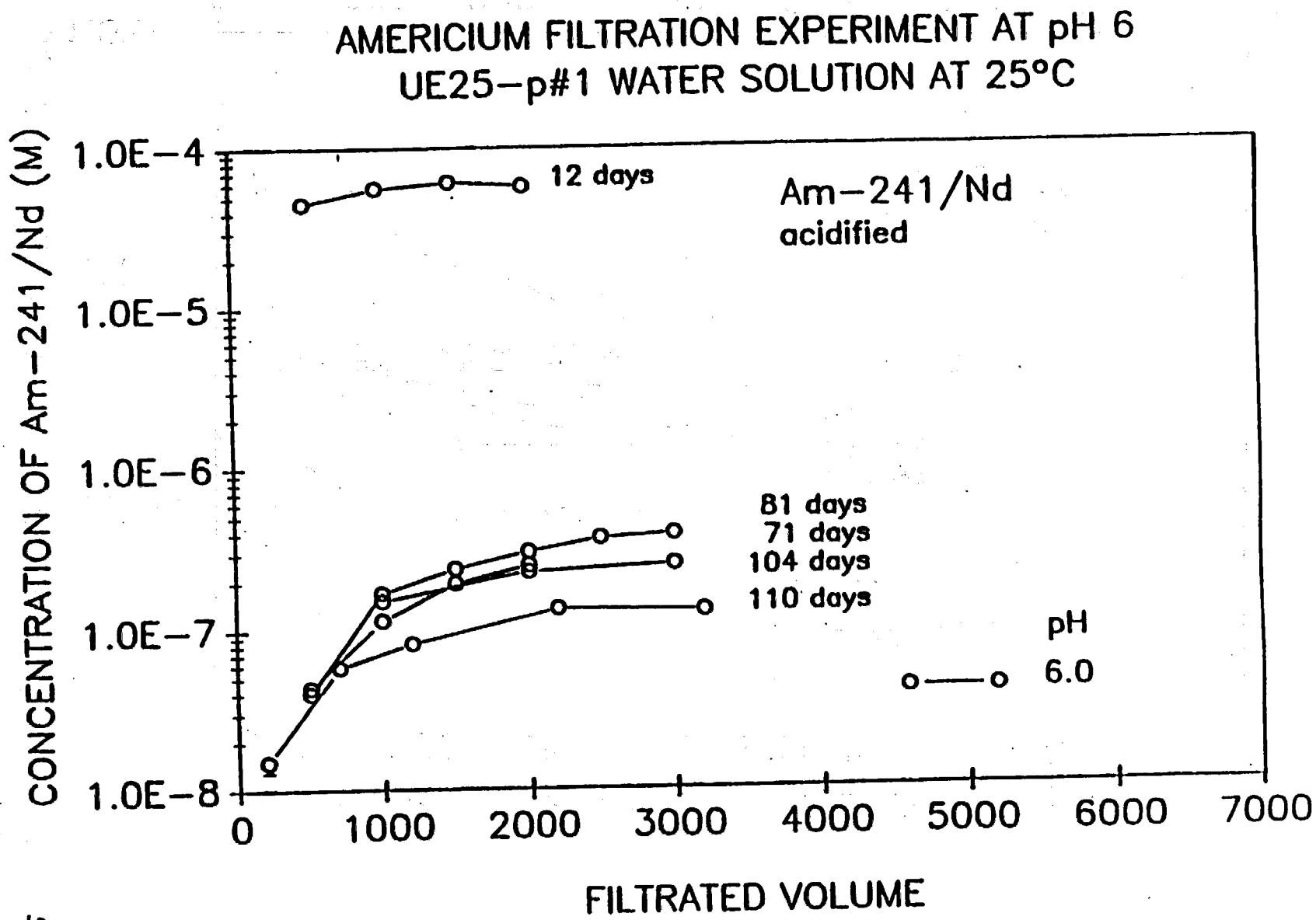
AMERICIUM FILTRATION EXPERIMENT AT pH 6
UE25–p#1 WATER SOLUTION AT 25°C
CONCENTRATION OF Am–241/Nd (M)
1.0E–4
1.0E–5
1.0E–6
1.0E–7
1.0E–8
0
1000
2000
3000
4000
5000
6000
7000
FILTRATED VOLUME
12 days
Am–241/Nd
acidified
81 days
71 days
104 days
110 days
pH
6.0

FIG. 15

AMERICIUM FILTRATION EXPERIMENT AT pH7
UE25–p#1 WATER SOLUTION AT 25°C

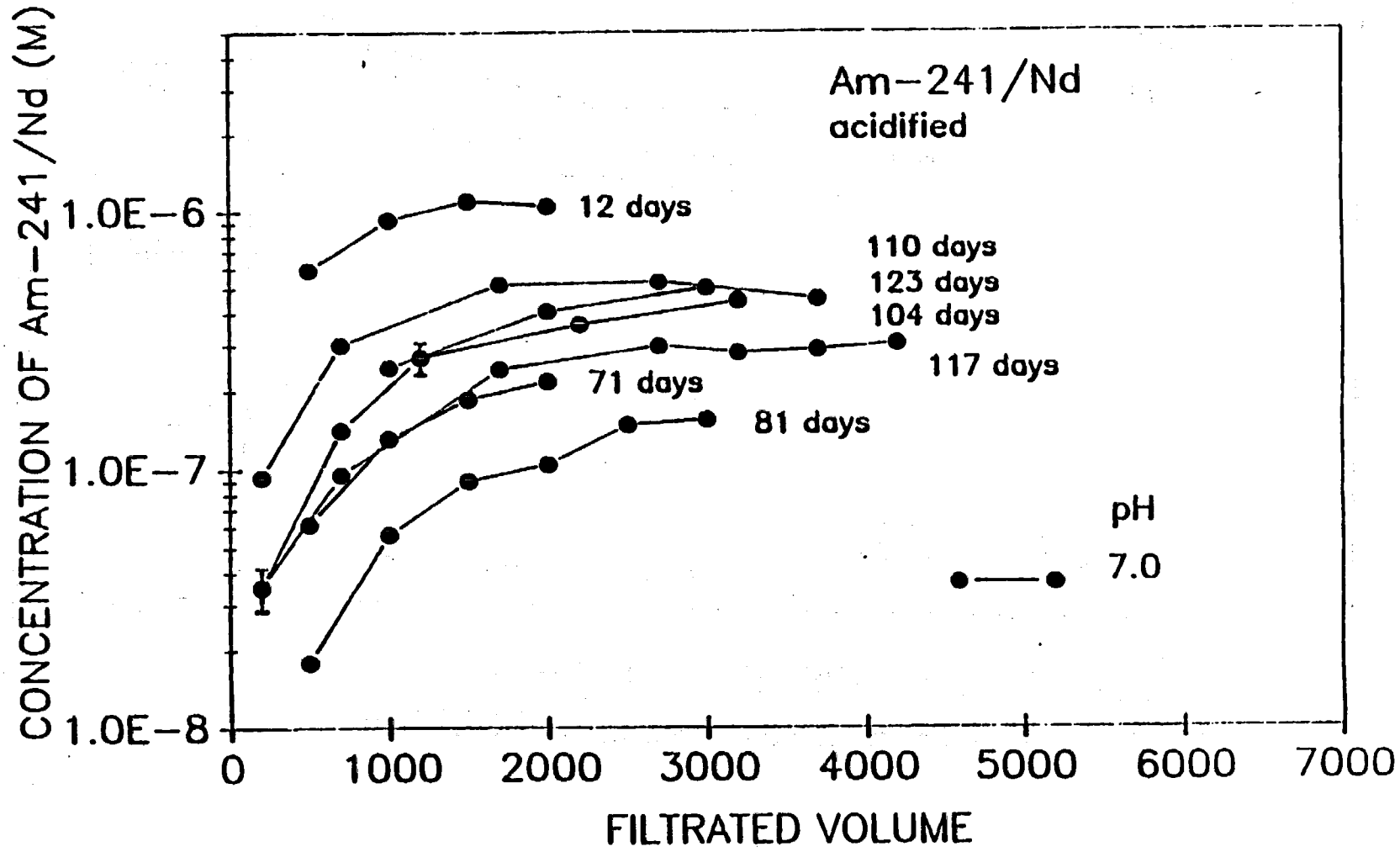

FIG. 11

AMERICIUM FILTRATION EXPERIMENT AT pH 8.5
UE25–p#1 WATER SOLUTION AT 25°C

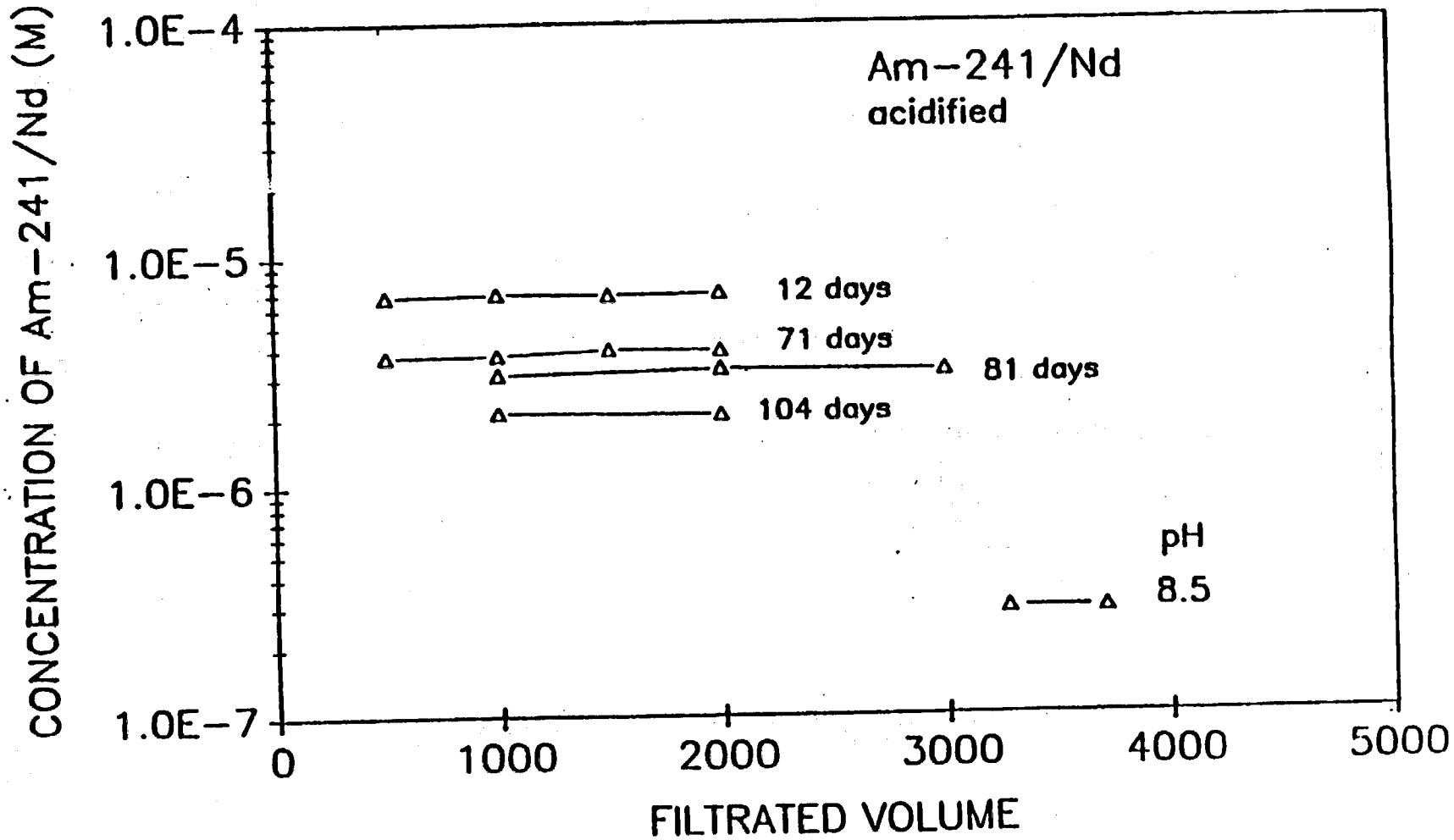

FIG. 12

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NEPTUNIUM FILTRATION EXPERIMENT

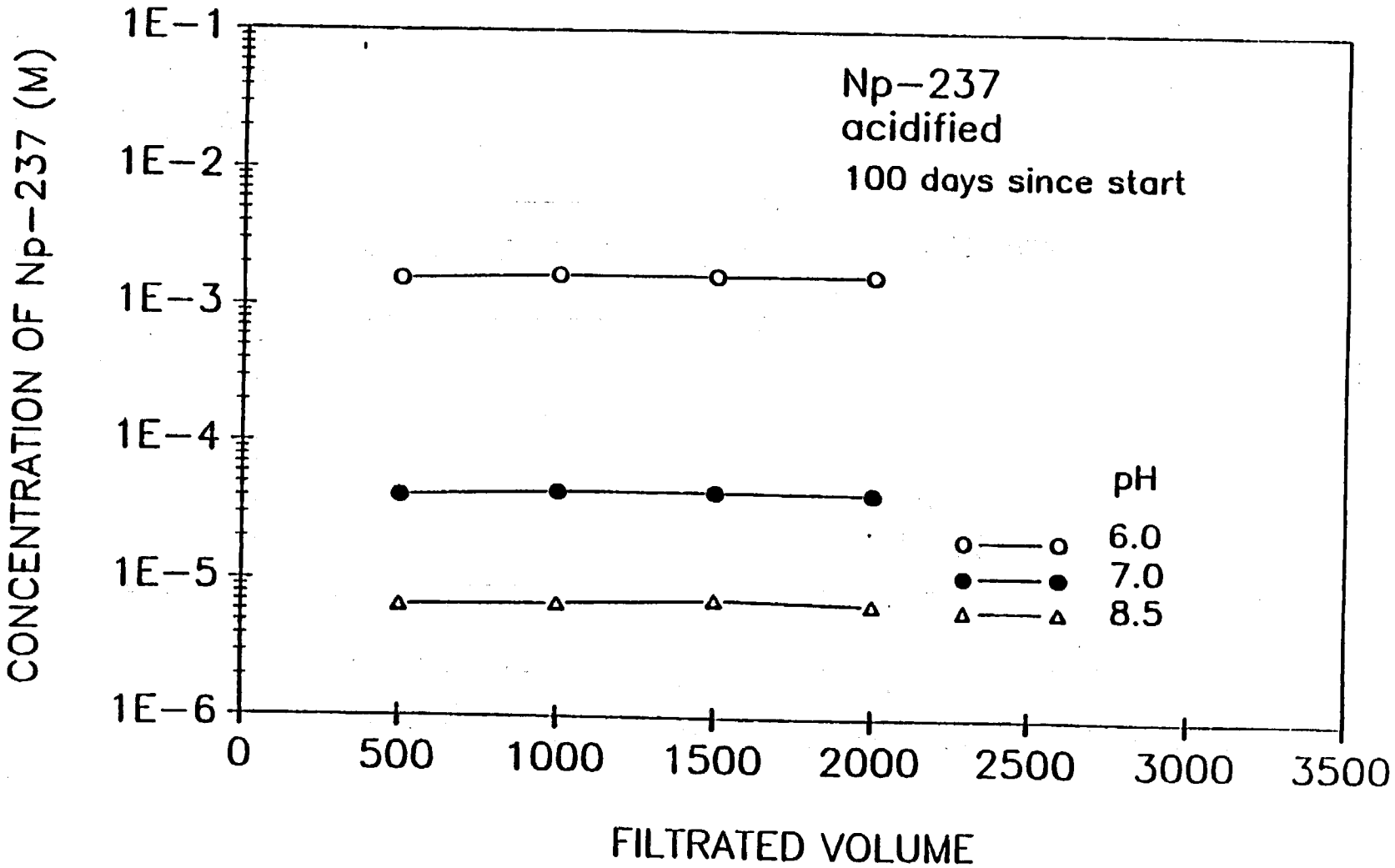

FIG. 13

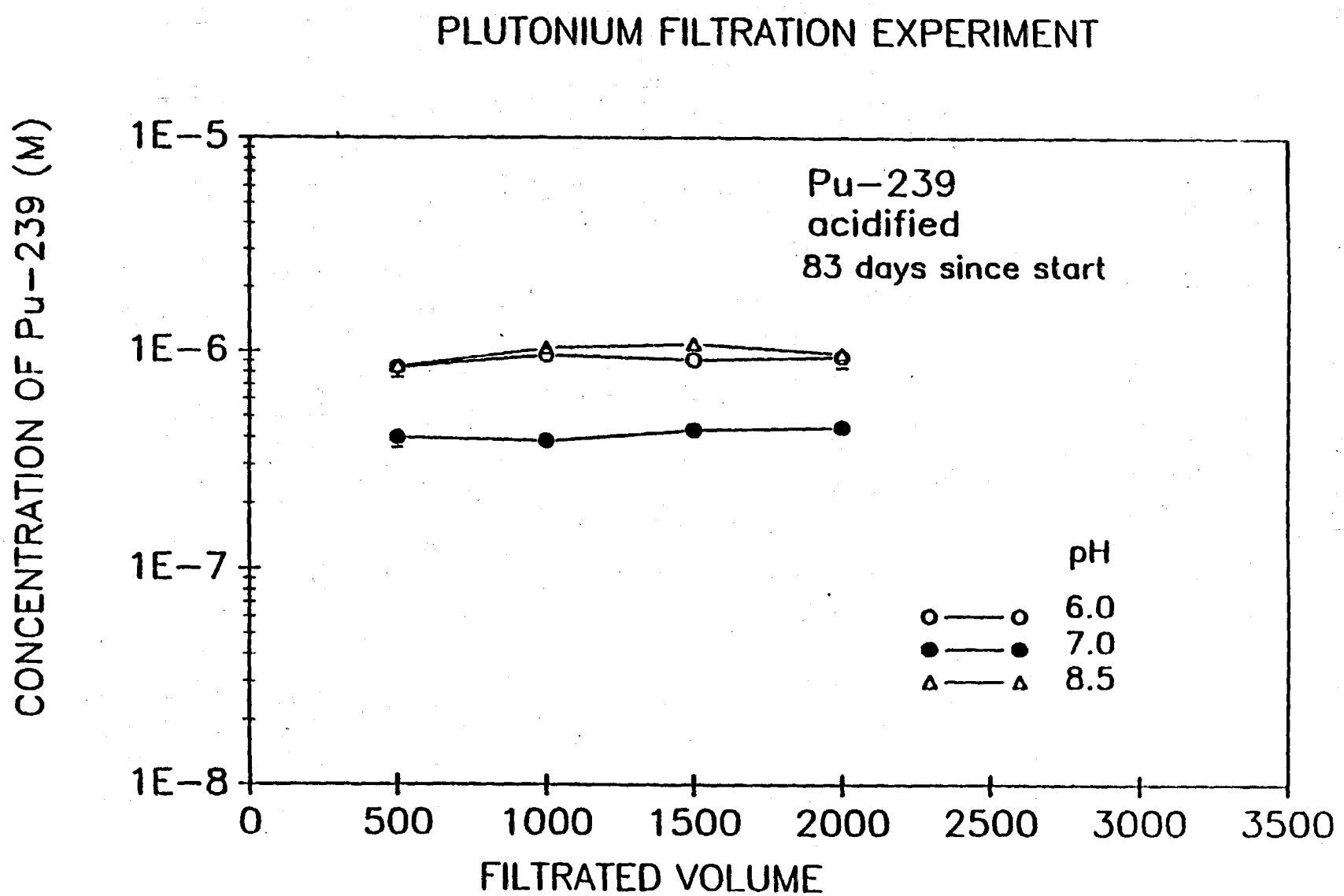
PLUTONIUM FILTRATION EXPERIMENT
Pu-239
acidified
83 days since start
pH
6.0
7.0
8.5
CONCENTRATION OF Pu-239 (M)
1E-5
1E-6
1E-7
1E-8
0
500
1000
1500
2000
2500
3000
3500
FILTRATED VOLUME

FIG. 14

October 1989
WBS 1.2.3.4.1.3

INTERIM PROGRESS REPORT: ACTINIDE SPECIATION BY PHOTOACOUSTIC SPECTROSCOPY*

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Los Alamos, New Mexico, 87545 USA

1. INTRODUCTION

One of the critical issues related to site characterization and performance assessment for the ~~proposed~~ potential high-level nuclear waste repository at Yucca Mountain is the behavior of actinides and other waste radionuclides under pertinent environmental conditions. An understanding of the chemical and physical properties of the actinides must begin with a detailed knowledge of the aqueous solution chemistry (speciation and reactivity) of the actinide complexes of simple inorganic ligands prevalent in the local environmental groundwaters. However, to specify completely actinide behavior, consideration must also be given to the sorption of these complexes on mineral matrices, to the formation of colloidal species, and to the influences of sorption and colloid formation on transport properties. Knowledge of total actinide concentration alone in groundwaters or sorbed onto mineral matrices can frequently be misleading because the chemical and physical behavior of the various species of an element can differ greatly. The nature of the actinide species strongly influences processes such as solubility, adsorption, ion exchange, and diffusion. Thus, speciation directly affects actinide transport in the far-field environment. A molecular-level understanding of actinide speciation and reactivity in the groundwaters and at the groundwater-mineral matrix interfaces is vital to the ultimate site-characterization objective of assessing the transport of the waste

* Applicable logbook or notebook references for satisfying Yucca Mountain Project Quality Assurance requirements can be found in Appendix A. A list of pertinent data files is or will be stored in the Los Alamos ~~Reference~~ Records Processing Center.

radionuclides in subsurface environments. This implies an urgent need for methods to determine actinide speciation and reactivity under chemical conditions existing at the proposed site.

Recent advances in laser technology and sophisticated detection methods have made available several spectroscopic probes which possess the requisite sensitivity and the molecular-level specificity for the direct determination of actinide speciation under environmental groundwater conditions. The most promising of these laser spectroscopic probes are photothermal spectroscopy, which includes both photoacoustic spectroscopy (PAS) and photothermal deflection spectroscopy (PDS), and laser-induced fluorescence spectroscopy (LIF). A brief description of these methods as they apply to actinide speciation can be found in a previous report [1].This report describes our recent progress in developing a photothermal spectroscopy capability (both PAS and PDS) for the Yucca Mountain Project to study all important aspects of actinide speciation. This work is principally in support of the Solubility Determination Task (WBS 1.2.3.4.1.3.3.1.1 ~~2.3.4.1.4.A~~) which is responsible for characterizing actinide speciation in the groundwaters found at the proposed repository site. However, because of the unique capabilities of these spectroscopic methods to investigate solid samples and interfaces between solids and solutions, they should also be of great benefit to the ongoing work in the Sorption Task (1.2.3.4.1.3.4 ~~WBS 2.3.4.1.5.A~~) and the Dynamic Transport Task (WBS 1.2.3.4.1.3.6 ~~2.3.4.1.6.A~~).

please use SCP numbers

2. SYSTEM STATUS

The existing PAS task definition calls for a two-year phase-in period for the acquisition, assembly, and testing of all the spectroscopic system components and integration of these components to provide a complete system. A schematic representation of the complete system as it is currently planned is given in Figure 1. As noted in the previous progress report [1], the heart of this system is a Q-switched Nd:YAG laser system (Spectra Physics Model DCR-3G-10) with the full compliment of harmonic generating crystals, a pulsed dye laser (Spectra Physics Model PDL-2), and a wavelength extender unit (Spectra Physics Model WEX-1b). There ~~is~~ are also commercially available

frequency shifting devices for possible future extension to the infrared region of the spectrum. These components are used to produce the tunable wavelength excitation pulses needed to generate the photothermal spectra. This laser excitation system has several advantages over excimer-based laser systems typically employed for photothermal studies of actinide speciation. The advantages include better operating stability and reliability, better spatial characteristics in the beam profile, and a reduction in electrical noise that can interfere with the photothermal signal. The acoustic pulses generated by the high-powered laser pulse typically have frequency components in the megahertz range, thereby readily enabling the application of standard noise reduction schemes. For example, low frequency noise (e.g., 1/f noise and 60 Hz noise) can be eliminated simply by filtering. Moreover, signal and noise (principally scattering) that reach the detector at different times can be separated by gating techniques. Furthermore, the inclusion of a fast, versatile digital oscilloscope allows for full waveform analysis, thus increasing signal to noise relative to boxcar averaging.

All of the commercially available components illustrated in Figure 1 have now been acquired and installed. The detector housing/cell holder assembly shown in Figure 2 has been designed and fabricated in-house for preliminary spectral data acquisition using photoacoustic signal detection. The active element in this detector is a lead-zirconate-titanate (PZT) pressure transducer obtained from Vernitron (PZT5A). This detector/cell holder design provides good acoustic coupling between the sample and the PZT, and the metal casing of the PZT housing offers shielding to minimize electrical noise pickup and also to protect the PZT from physical damage. The high sensitivity/low noise preamplifier unit for processing the photoacoustic PZT signal is currently under in-house construction. It is based on an existing design for photoacoustic spectroscopy applications [2]. The only major component remaining to be acquired is a monochromator for wavelength calibration of the pulsed excitation laser system. A double monochromator with photomultiplier detection has been chosen for this purpose to provide the widest possible calibration range and ease of operation. This unit can also be used for laser-induced fluorescence studies when necessary. Delivery and installation of this unit is anticipated by the beginning of calendar year 1990.

For preliminary system analysis and testing, we have chosen to focus solely on photoacoustic methods of signal detection for spectral data acquisition. While all components are presently on hand for detection using photothermal deflection methods, this capability has not yet been integrated into the total system. Our efforts have been concentrated in two areas described in more detail below. These are (1) software and interface development to generate an integrated network between the signal collection and processing hardware (i.e., the peripheral instruments) and the host computer, and (2) preliminary system performance assessment and optimization of the system geometry and optical layout. We have also recently initiated work on more sophisticated methods of waveform analysis and on testing of instrumental sensitivity and spectral reproducibility. In the process of preliminary system testing, a minor complication was detected which has bearing on the status of the system. Namely, low-frequency acoustic vibrations associated with audible instrumental noise and background building vibrations were found to be transmitted to the PZT detector. This results in baseline jitter in the PAS waveform and a subsequent reduction in averaged signal strength. We are currently minimizing this effect by placing the detector housing/cell holder assembly on pieces of felt to minimize acoustic coupling between the optical table and the PZT. A mini ("desktop") floating optical bench (Newport Corporation model TXM-1) has been ordered to compensate more completely for this problem.

3. SOFTWARE DEVELOPMENT*

To have practical application, photothermal spectroscopic methods must generate data under full computer control of the instrumentation. To do so, it is necessary to develop an interface between the host Apple MacIntosh II computer and the peripheral data acquisition and processing instrumentation. The easiest way to accomplish this, and also the one which most utilizes commercially available hardware/software, involves the use of an IEEE-488 general purpose interface bus (GPIB). All of the instruments needed to scan

* The software described in this report is not in full compliance with Yucca Mountain Project Quality Assurance requirements.

the spectrum and record data, including the dye laser monochromator driver, boxcar averager, and digital oscilloscope, already contain the necessary hardware/firmware to accept and generate GPIB commands and data strings. To implement the GPIB interface bus and protocol with the MacIntosh II computer, an IEEE interface board (MacII488) with direct GPIB output was obtained from IOTech, Inc. Software included with this interface board (MacDriver488, Version 1.3) allows for interpretation and processing of macro commands from a high-level language (e.g., BASIC) to control the bus. We are using Microsoft QuickBasic (Version 1.0) as the high-level programming environment to string together macro commands for peripheral control and for data file collection and management. For data file plotting and postprocessing, we are again taking advantage of an existing powerful commercial software package, CricketGraph (Version 1.2).

It should be emphasized at this point that computer code development is in a very preliminary stage. The primary goal has been to develop working routines for peripheral control and communication so that rudimentary data acquisition and total system performance assessment can commence. We expect computer code development to remain an ongoing part of this activity, particularly as we focus on improved waveform analysis schemes and more efficient data collection and processing algorithms. Attainment of "controlled" status for most of the instrumentation control and data acquisition routines will likely require 12-18 months. In developing the peripheral interface routines, we are endeavoring to make the computer code as modular as possible. For example, the code for communicating with the digital oscilloscope or the dye laser scan controller will ultimately be separate program units that can be incorporated into any source program. Preliminary versions of the interface routines have been developed successfully thus far for communication and control of (1) the Spectra-Physics MCI dye-laser motor control interface unit, (2) the Hewlett-Packard Model 54111D digital oscilloscope, and (3) the Stanford Research Systems Model SR245 computer interface module. This latter unit is a multipurpose analog-to-digital converter which digitizes the boxcar integrator signal and the laser power meter signal.

Two primary source programs based on these interface routines have emerged thus far. The first generates a photoacoustic spectrum by scanning

the pulsed excitation laser over a wavelength range of interest and signal averaging on a selected portion of the photoacoustic waveform using the Stanford Research Systems Model 250 boxcar integrator. The second source program obtains the PAS waveform (i.e., signal vs time) from the Hewlett-Packard 54111D at a selected wavelength. This program is intended primarily as a diagnostic tool for characterization of system performance. Development of one additional data acquisition source program was initiated very recently. This program will generate a photoacoustic spectrum, again by scanning the exciting laser over a wavelength range of interest. In this case, however, an arbitrarily large portion of the PAS waveform is signal averaged by the digital oscilloscope. It is then transferred to the computer for subsequent rectification and integration (both in real time). The advantage of this approach over conventional boxcar averaging of only a selected small portion of the waveform is that the signal content of a much larger portion of the waveform is accessed. Improvements in signal-to-noise resulting from this approach are currently being explored. Finally, a related data processing code is currently under development that generates the Fourier transform of the PAS waveforms. In the frequency domain, the high frequency noise can be identified and mathematically filtered more readily. Inverse transformation results in a smoothed waveform which can then be rectified and integrated as above to generate enhanced signal-to-noise characteristics.

4. PRELIMINARY EXPERIMENTAL RESULTS

A. Experimental

For the preliminary system performance assessment studies, Nd^{3+} has been chosen as the spectroscopic analyte. This lanthanide ion is an excellent spectroscopic and chemical mimic of the actinide ions that have been identified for speciation characterization in the Yucca Mountain Project. In particular, Nd^{3+} has a cluster of weak *f-f* transitions with narrow bandwidths in the range from 490 nm to 540 nm. This is approximately the same spectral region and similar spectral band properties that will be probed when carrying out speciation studies of two of the more important radionuclide systems, Pu^{4+} and Am^{3+}. Further, neodymium offers the advantage of posing no radiological

hazard. Thus, solutions can be prepared and handled without containment precautions.

Solutions of ~0.1 M Nd^{3+} were prepared in two ways: (1) by slow dissolution of Nd_2O_3 (Fordomes Trading Co.) in 0.5 M HCl, and (2) by dissolution of $NdCl_3 \cdot nH_2O$ (Alfa Products) in 0.1 M KCl. More dilute solutions of Nd^{3+} (10 mM to 0.1 mM) for photoacoustic spectral acquisition were prepared by serial dilution of the 0.1 M Nd^{3+} solution in 0.1 M KCl with additional 0.1 M KCl. Initial investigations of the effect of filtration on photoacoustic signal were done using 200 nm pore size disposable nylon membrane filters (Corning).

As noted above, our preliminary work has focused on using photoacoustic detection of the electronic absorption spectra. We have also confined our efforts to single excitation beam experiments thus far with signal acquisition from a single sample cell and PZT detector..Thus, any background signal attributable to water absorption, scattering, electrostriction, etc. has been either ignored because it is negligible or corrected by acquiring separate spectra for analyte solution and pure H_2O. Ultimately, the system configuration will utilize dual-beam excitation of both sample and reference solutions (or single beam excitation of sample and reference solutions in series) so that background signals can be nulled during data acquisition. These background correction methods are expected to improve further the sensitivity limits of the spectroscopic techniques.

All PAS data presented here were obtained using Coumarin 500 dye (tuning range 485 nm to 545 nm) in the pulsed dye laser. Typical laser energies at the sample were 5 - 30 mJ/pulse. The exciting beam was weakly focused on the sample cell using a 500 mm focal length lens. The PAS spectra were obtained using a Stanford Research Systems Model SR250 Boxcar Averager. Signal averaging was typically 10 - 100 laser pulses per wavelength interval. The PAS waveforms were obtained on a Hewlett-Packard Model 54111D Digital Oscilloscope operating in the averaging mode with 64 averages per waveform typical. PZT signal amplification was done only with a Princeton Applied Research Corp. Model 113 Preamplifier typically operating in the amplification range 200 - 2000. Conventional transmission-type electronic

absorption spectra were obtained on a Perkin-Elmer Lambda 9 Spectrophotometer operating in the absorbance mode.

B. Results and Discussion

The photoacoustic waveforms obtained for a 1 m$\underline{M}$ Nd^{3+} solution at three different wavelengths within the absorption band envelope between 490 nm and 540 nm are shown in Figure 3a. The conventional absorption spectrum for a 0.1 $\underline{M}$ Nd^{3+} solution is given in Figure 3b to indicate the points within the absorption band at which the photoacoustic waveforms in Figure 3a were collected. Note that as the excitation wavelength is tuned from the wing of the absorption band (495 nm) into resonance with the absorption peaks at 512 nm [molar absorptivity (ϵ) =1.6 $\underline{M}^{-1}cm^{-1}$] and 522 nm ($\epsilon$=4.0 $\underline{M}^{-1}cm^{-1}$), the only significant change in the photoacoustic waveform is an increase in the amplitude of the peaks. Further, the increased peak amplitudes in the waveform exactly track the increase in Nd^{3+} solution absorbance. This demonstrates that the photoacoustic signal is linearly proportional to absorbance in this concentration range as predicted by theory [3]. The photoacoustic spectrum that results for this 1 m$\underline{M}$ Nd^{3+} solution when the boxcar averager is set to integrate, for example, the waveform peak occurring between 8 µs and 14 µs is shown in Figure 4a. Again, the conventional absorption spectrum of a 0.1 $\underline{M}$ Nd^{3+} solution has been included for comparison. Note that the spectral fidelity of the PAS spectrum with respect to the conventional spectrum (obtained at 100 times greater concentration) is excellent. All spectral features, including the weak shoulders at 505 nm and 525 nm, are present in the PAS spectrum, and the relative peak intensities are the same in both spectra. The slight degradation in spectral resolution in the PAS spectrum is attributable to the difference in wavelength increment between the two spectra; 0.4 nm/pt for the PAS spectrum versus 0.05 nm/pt for the conventional spectrum.

It is noteworthy that the PAS spectrum for 1 m$\underline{M}$ Nd^{3+} shown in Figure 4a represents a performance capability that already surpasses that of conventional transmission spectrophotometers. The peak absorbance at 522 nm corresponds to an optical density of ~4 x 10^{-3}/cm for a 1 m$\underline{M}$ Nd^{3+} solution. Thus, even using a 10-cm path length cell, the *maximum* absorbance for this solution measured using a conventional spectrophotometer would be only 0.04;

a value that is approaching the signal-to-noise limit of transmission instruments. Because the actinides have significantly larger molar absorptivities than the lanthanides, the quality of the PAS spectrum illustrated in Figure 4a can be expected for actinide concentrations much lower than 1 m$\underline{M}$. For example, Pu^{4+} has an absorption band at ~485 nm in aqueous carbonate solutions with $\varepsilon \cong 80$ $\underline{M}^{-1}cm^{-1}$ [4]. Thus, a Pu^{4+} spectrum similar in quality to that shown in Figure 4a can be expected for a 5 x 10^{-5} $\underline{M}$ Pu^{4+} solution. This is without background correction or more sophisticated waveform analysis, and with only minimal signal averaging (~15 laser pulses per wavelength increment) on a small portion of the photoacoustic waveform.

To date, the lowest concentration of Nd^{3+} for which we have attempted to acquire spectral data is 0.1 m$\underline{M}$. At this concentration, a significant background signal was detected in the unfiltered solution. Thus, a separate spectrum was obtained for an unfiltered deionized H_2O sample to use for background correction. These raw spectral data and the corrected spectrum are shown in Figure 5. The signal averaging in this spectrum is only ~15 laser pulses per wavelength increment (0.4 nm). Nonetheless, all salient spectral features are still present.

We have subsequently determined that a significant portion of the background signal can be removed by filtering the solutions through 200 nm pore size filters. This is clearly illustrated for the 0.1 m$\underline{M}$ Nd^{3+} solution in the photoacoustic waveforms shown in Figure 6. Note that for the unfiltered solution (Figure 6a), the change in the peak amplitudes on going from the baseline (495 nm) to the absorbance maximum (522 nm) is relatively small. In contrast, for the filtered solution (Figure 6b), this change is much larger and should enable a much better signal-to-noise ratio. A very low resolution scan (1 nm/pt) has been collected to verify this. The fact that filtration is so effective in decreasing the background signal indicates that the background signal shown in Figure 5 is attributable principally to light scattering rather than H_2O absorption. This is encouraging because it suggests that additional analyte dilution will be possible before interference from H_2O absorption becomes a limiting constraint.

5. PLANNED WORK

A. Technique Development

Instrumentation and related system development work will continue during the next year. Principal emphasis will be given to integrating the photothermal deflection method of detection into the existing system. This method of detection is theoretically more sensitive than photoacoustic detection using PZT transducers [3], and is inherently less noisy because high levels of electronic signal amplification are not required. As noted above, all components needed to implement this detection method are already on hand. We also expect to have the high-sensitivity/low-noise preamplifier units integrated into the photoacoustic detection instrumentation. This, too, should afford significant improvements in sensitivity and noise reduction. We will continue to work on improving the optical design and layout of the system. Efforts here will include (1) establishment of a dual-beam optical path so that sample and reference data can be collected simultaneously, (2) optimization of beam focusing optics to provide well defined excitation volumes in the sample cells, and (3) general improvements in beam steering and focusing optic designs and geometries to maximize the laser energy delivered to the sample cells and reduce the interferences from scattered light.

Software development work will include further efforts to devise more sophisticated total waveform analysis routines. It is clear that simple boxcar averaging methods discard an enormous amount of signal content. Our goal is to maximize the signal content that is processed to arrive at the analytical result while minimizing or rejecting noise. Simple waveform integration routines based on data collection with the digital oscilloscope and more complex routines, such as Fourier-transform smoothing, are currently under development and should be implemented in a short time. We will also endeavor to maximize the efficiency of all algorithms in an effort to decrease data acquisition time.

B. Analytical Studies

We will continue to use model spectroscopic analytes, principally Nd^{3+}, for system development and performance assessment. The experimental convenience afforded by these models relative to the radiologically hazardous actinides greatly reduces the amount of time required to carry out the system performance analyses. Efforts here will focus on establishing the ultimate sensitivity limits of the technique by both photoacoustic and photothermal deflection detection modes. We will also establish experimental protocols for subsequent work with the actinides and determine the necessary procedures to ensure reproducibility in data acquisition. Initial photothermal spectroscopic studies of the actinides should be initiated in October, 1989. Some minor modifications to the sample cell configuration and cell/detector interfaces are expected to be necessary to meet radiological containment and safety criteria. Actual speciation studies should begin by the end of calendar 1989. Our intention is to begin these studies using Pu^{4+} in carbonate media.

ACKNOWLEDGEMENT

The authors express their gratitude to Dr. Ernest Bryant of this Laboratory for providing the design concept for the PZT detector housing and overseeing its construction, and for much helpful discussion.

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FIGURE CAPTIONS

Figure 1. Block diagram of the photothermal spectroscopy system.

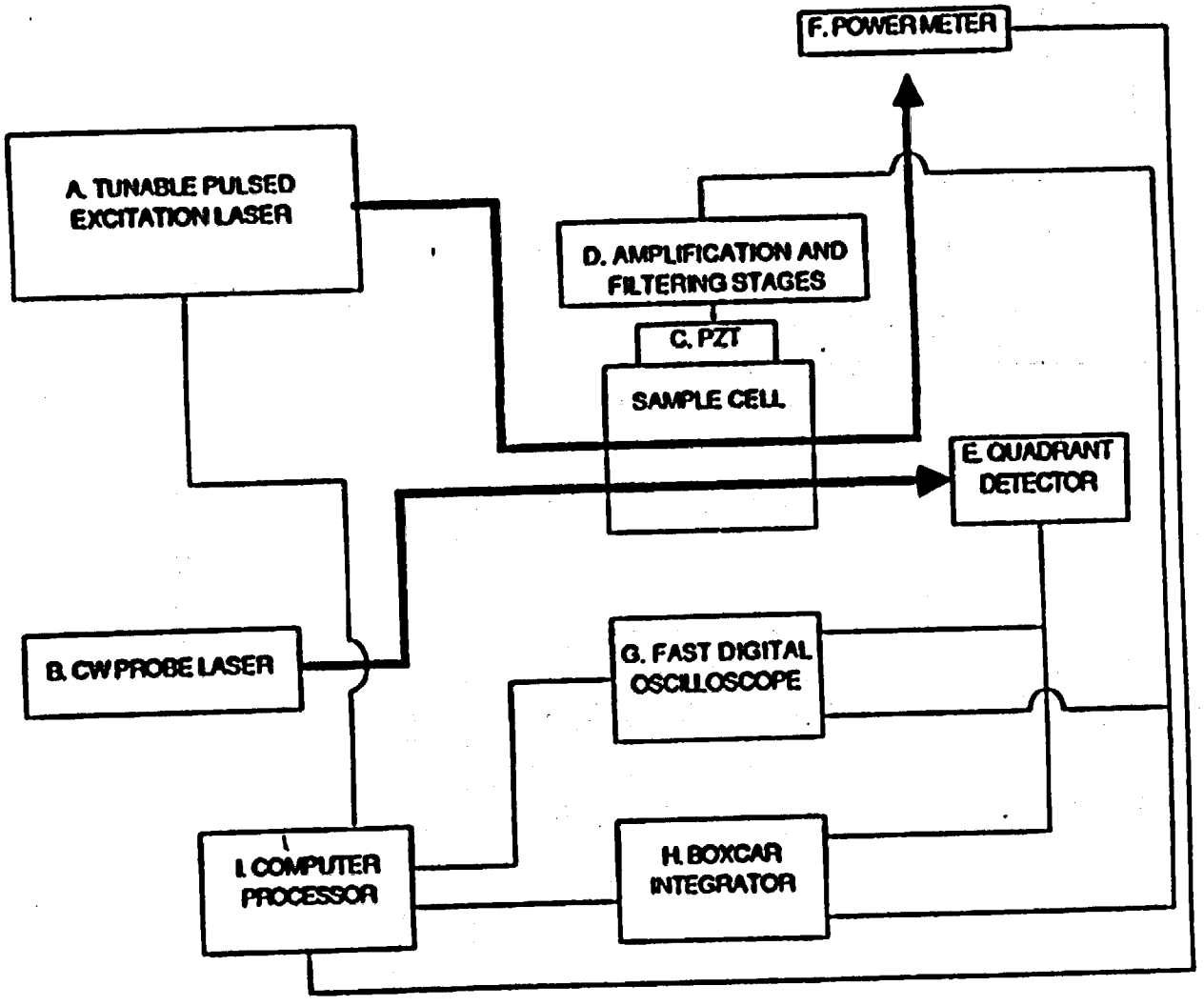
Figure 2. Schematic diagram of the PZT detector housing/cell holder assembly.

Figure 3. (a) Photoacoustic waveforms obtained for 1 m<u>M</u> Nd^{3+} in 0.1 <u>M</u> KCl at the wavelengths indicated. (b) Conventional absorption spectrum of 0.1 <u>M</u> Nd^{3+} in dilute HCl indicating the positions within the absorption bands at which the waveforms in (a) were collected.

Figure 4. (a) Photoacoustic spectrum of 1 m<u>M</u> Nd^{3+} in 0.1 <u>M</u> KCl.
(b) Conventional absorption spectrum of 0.1 <u>M</u> Nd^{3+} in dilute HCl.

Figure 5. Raw spectral data and background-corrected photoacoustic spectrum of 0.1 m<u>M</u> Nd^{3+} in 0.1 <u>M</u> KCl.

Figure 6. Photoacoustic waveforms obtained at indicated wavelengths for (a) an unfiltered solution and (b) a filtered solution of 1 m<u>M</u> Nd^{3+} in 0.1 <u>M</u> KCl. Filtration was done with a 200-nm pore size filter.



A. Spectra Physics DCR-3G/PDL-2/WEX/RS-1 Tunable Pulsed Nd:YAG/Dye Laser System

B. Coherent Model 200 HeNe Laser or other suitable cw laser

C. Vernitron Lead Zirconate Titanate Piezo-electric Transducer

D. In-house constructed low-noise preamplifier and Princeton Applied Research Model 113 Preamplifier or other suitable amplifier

E. United Detector Technology Model 431 X-Y Position Sensitive Detector

F. Scientech Laser Energy Meter and/or Opto-Electronics Fast Photodiode Detector

G. Hewlett Packard Model 54111D Oscilloscope

H. Stanford Research Systems Gated Integrator/Boxcar Averager

I. Apple Macintosh II Computer

October 1989
WBS 1.2.3.4.1.3

Figure 1

October 1989
WBS 1.2.3.4.1.3

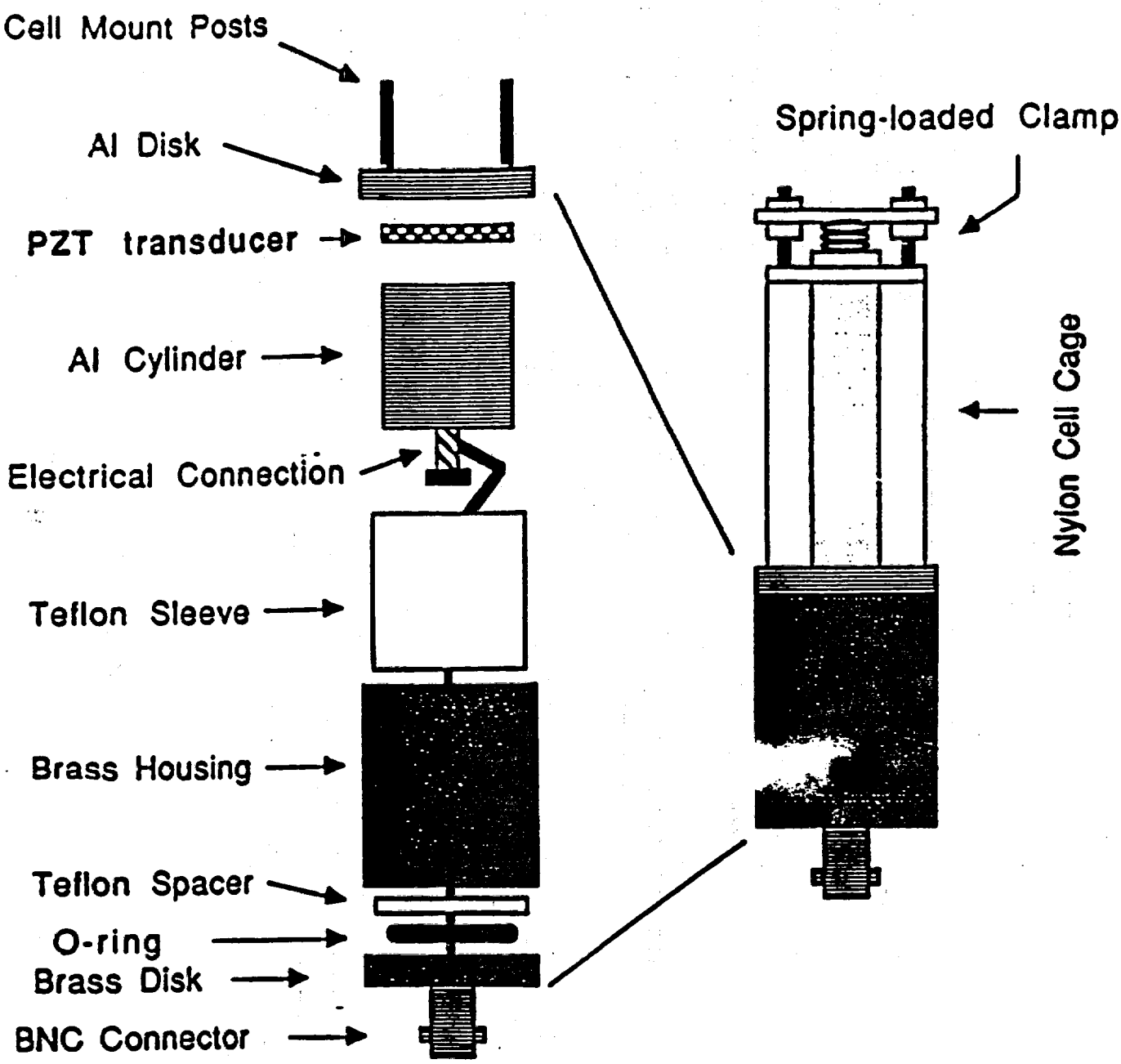
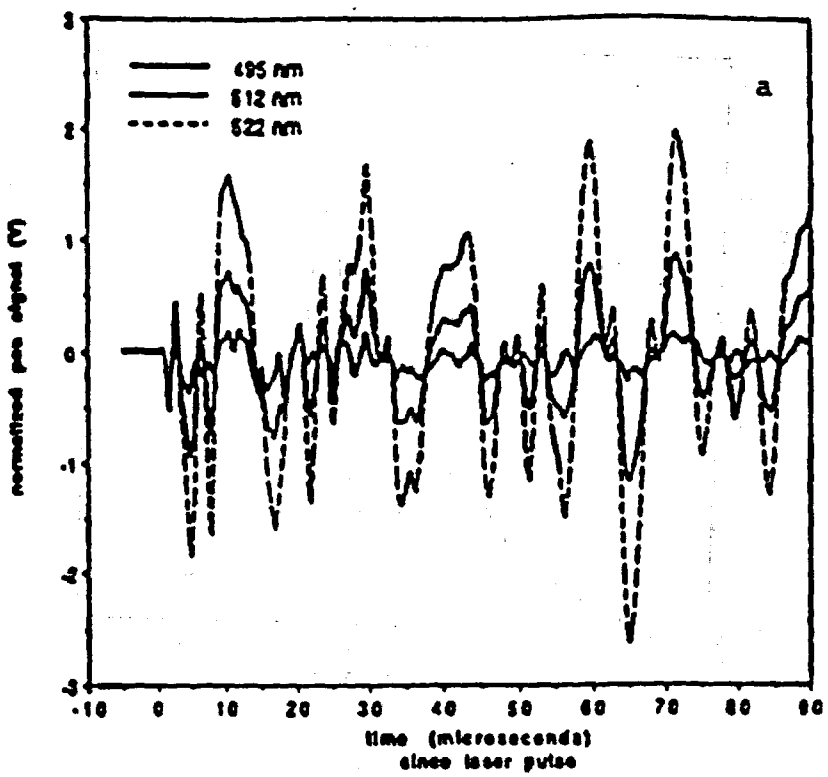


Figure 2


495 nm
512 nm
522 nm
a
normalized pos digital (V)
time (microseconds)
since laser pulse

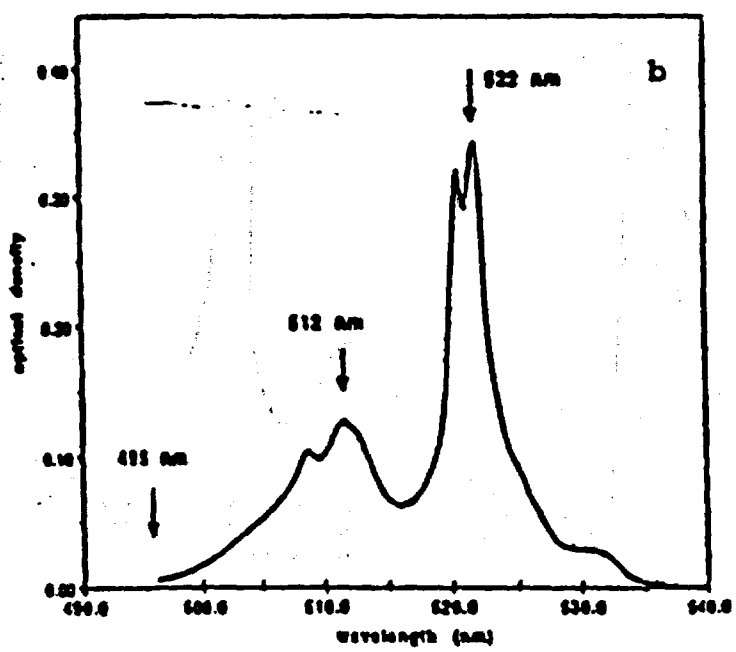
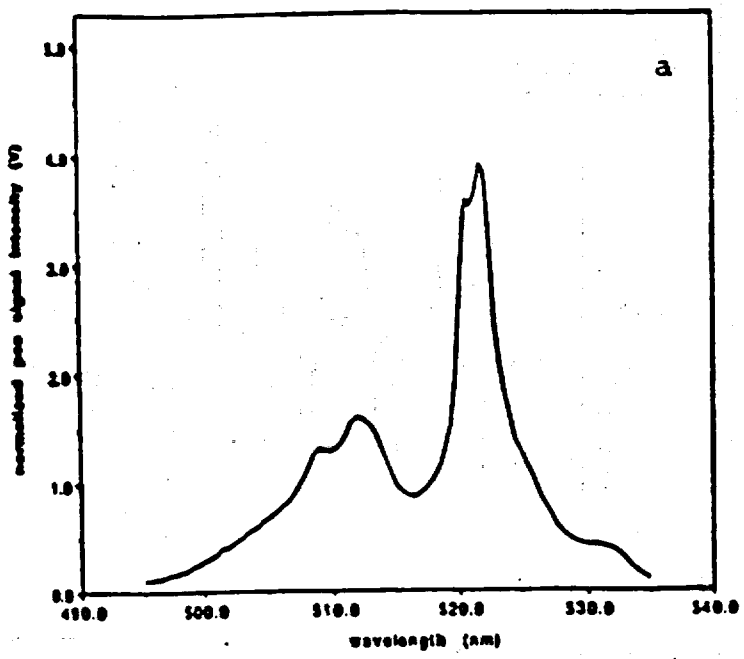

522 nm
b
512 nm
495 nm
optical density
wavelength (nm)

Figure 3


a
normalized peak signal intensity (%)
1.0
2.0
3.0
4.0
5.0
0.0
490.0
500.0
510.0
520.0
530.0
540.0
wavelength (nm)

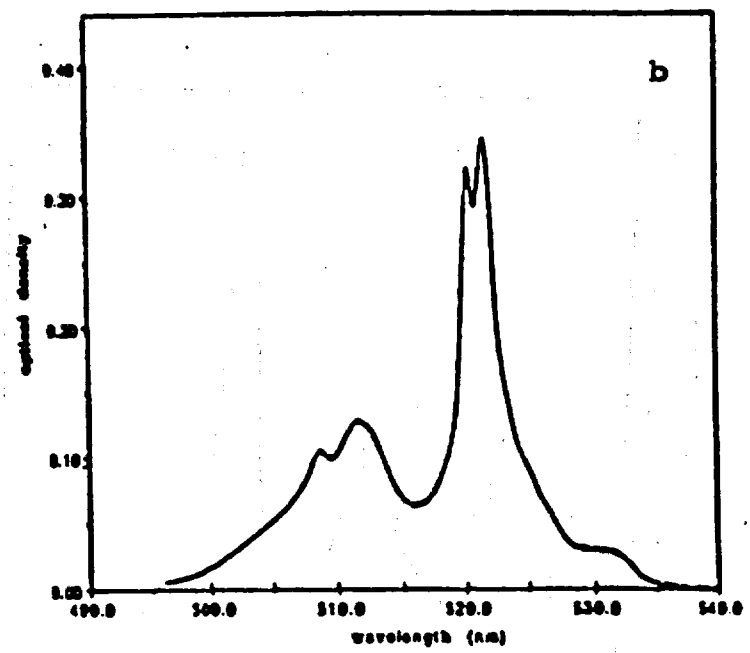

b
optical density
0.40
0.30
0.20
0.10
0.00
490.0
500.0
510.0
520.0
530.0
540.0
wavelength (nm)

Figure 4

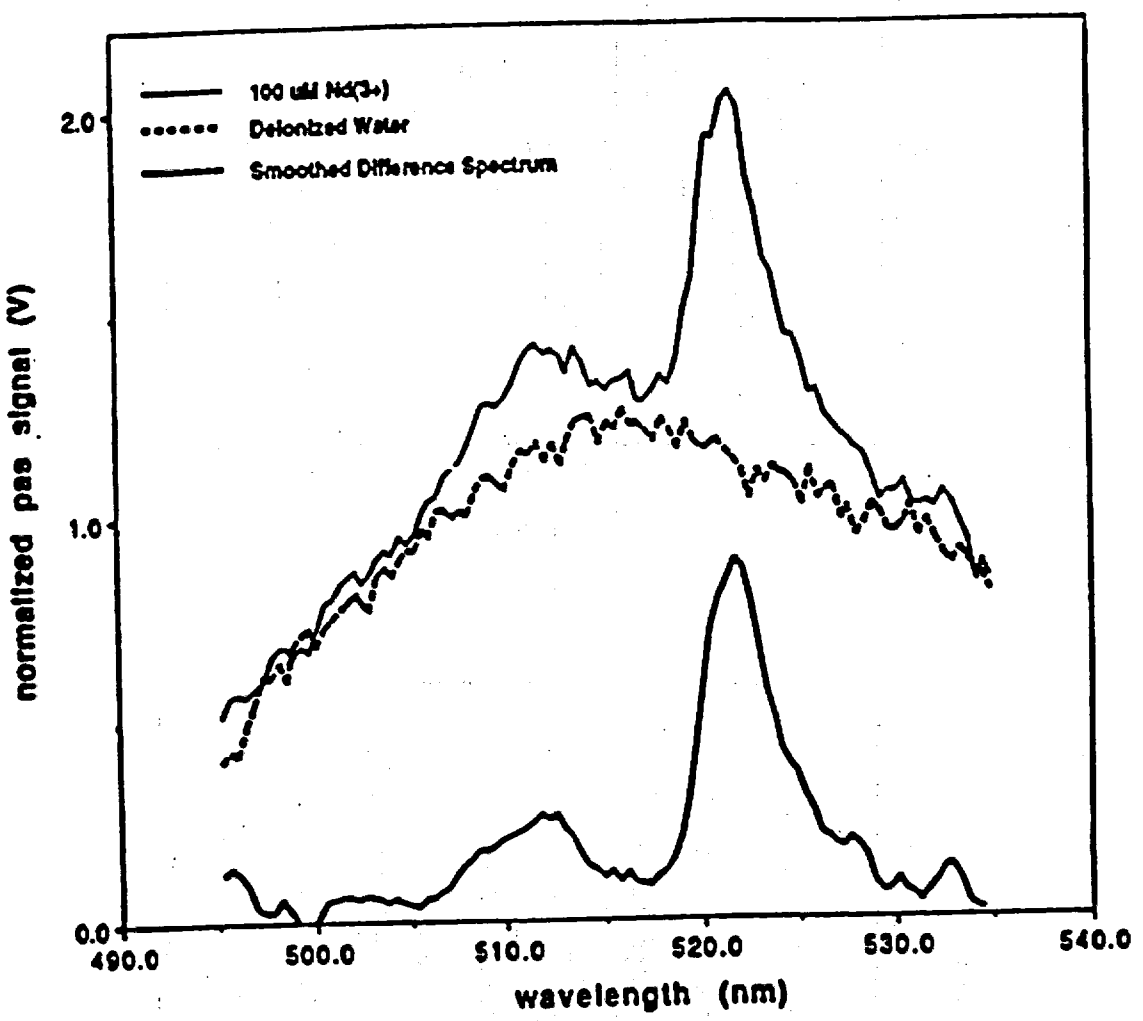
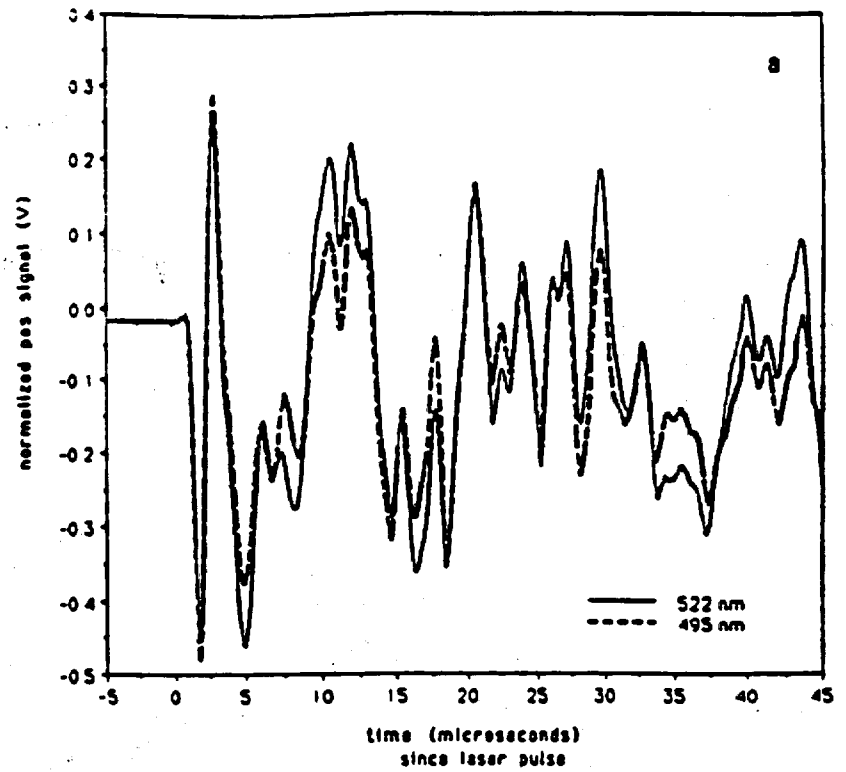

100 uM Nd(3+)
Deionized Water
Smoothed Difference Spectrum
2.0
1.0
0.0
normalized pas signal (V)
490.0
500.0
510.0
520.0
530.0
540.0
wavelength (nm)

Figure 5


a
522 nm
495 nm
normalized pas signal (V)
time (microseconds)
since laser pulse

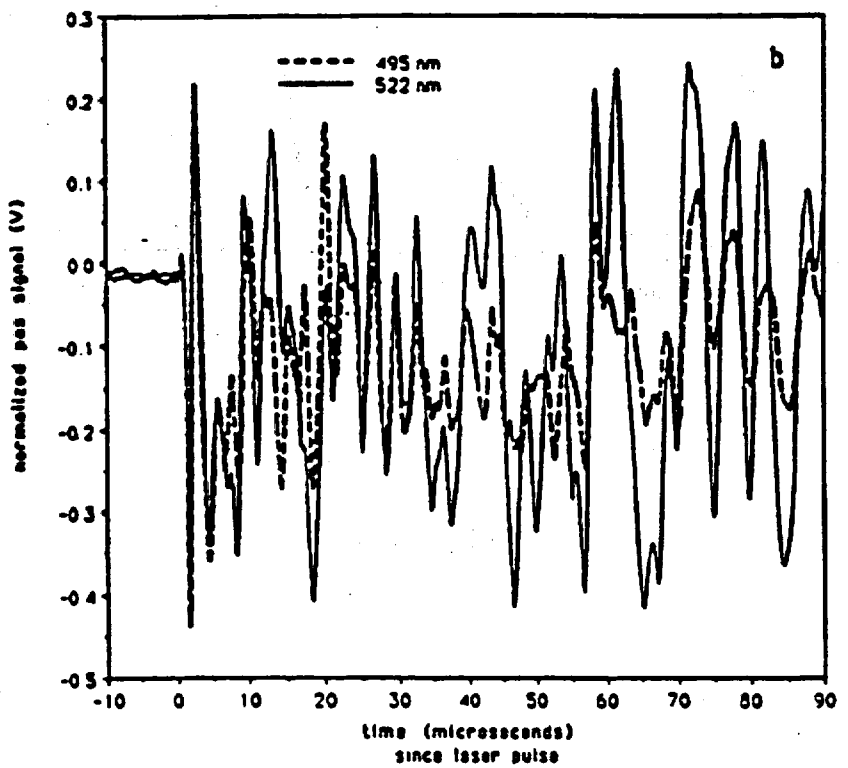

b
495 nm
522 nm
normalized pas signal (V)
time (microseconds)
since laser pulse

Figure 6

APPENDIX A: NOTEBOOKS

Data in this report can be found in the following notebooks: TWS-INC11-7/86-8 and TWS-INC7-7/89-2.

The activity that this report documents is assigned a Quality Assurance Level of I.

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