UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

Reply to:

1050 East Flamingo Road
Suite 319
Las Vegas, Nevada 89119
Tel: (702) 388-6125
FTS: 598-6125

M E M O R A N D U M

DATE: February 13, 1990

FOR: John J. Linehan, Director, HLPD, Division of High-Level Waste Management, M/S 4 H 3

FROM: Paul T. Prestholt, Sr. OR - YMP PTP

SUBJECT: YMP Site Report for the months of December, 1989 and January, 1990

I. GEOLOGY-GEOPHYSICS

A. The prototype drilling program scheduled to take place at the Apache Leap, Arizona site is on hold. Discussions between the Yucca Mountain Project (YMP) and OCRWM are being conducted to decide which of a number of alternative drilling programs will take place. It may be that the decision will be made to wait until the Lang 250 rig is completed in April or May. If the decision is made to use the Lang 250, the rig will have to be broken down into 3 loads. The rig is too large to take over the highway (too heavy for bridges?) fully assembled.

B. Procedures for the drill hole G-4 core qualification program are being written. No actual work on core is taking

place. Since this activity will be conducted under a full QA program, the procedures have to go through a full review before work on the core can start. The schedule is dependent on the time it will take to review the procedures.

C. Some months ago, this office requested the results of a reflection seismic survey that was conducted at the proposed surface facility site near Exile Hill. The survey was conducted by Charles B. Reynolds and Associates for Sandia National Laboratories, a participant in the Yucca Mountain Project. The survey was conducted in August, 1985.

The Project has determined that there are serious problems with the data collection and interpretation. There are no current plans to use the results of this seismic survey. A copy of the report was provided for information only. Copies of the report have been sent to Dr. N. K. Stablein and Dr. A. Ibrahim.

D. This office was asked to find out where the geotechnical data that has been collected at the Test Site for the weapons program is to be found. There is a library in the Nevada Operations Office Building on Highland Ave. that keeps this data. The library is outside the security area and is open to the public.

II. HYDROLOGY - There are no new activities to report.

III. GEOCHEMISTRY

Enclosed are copies of the November and December LANL Project status reports.

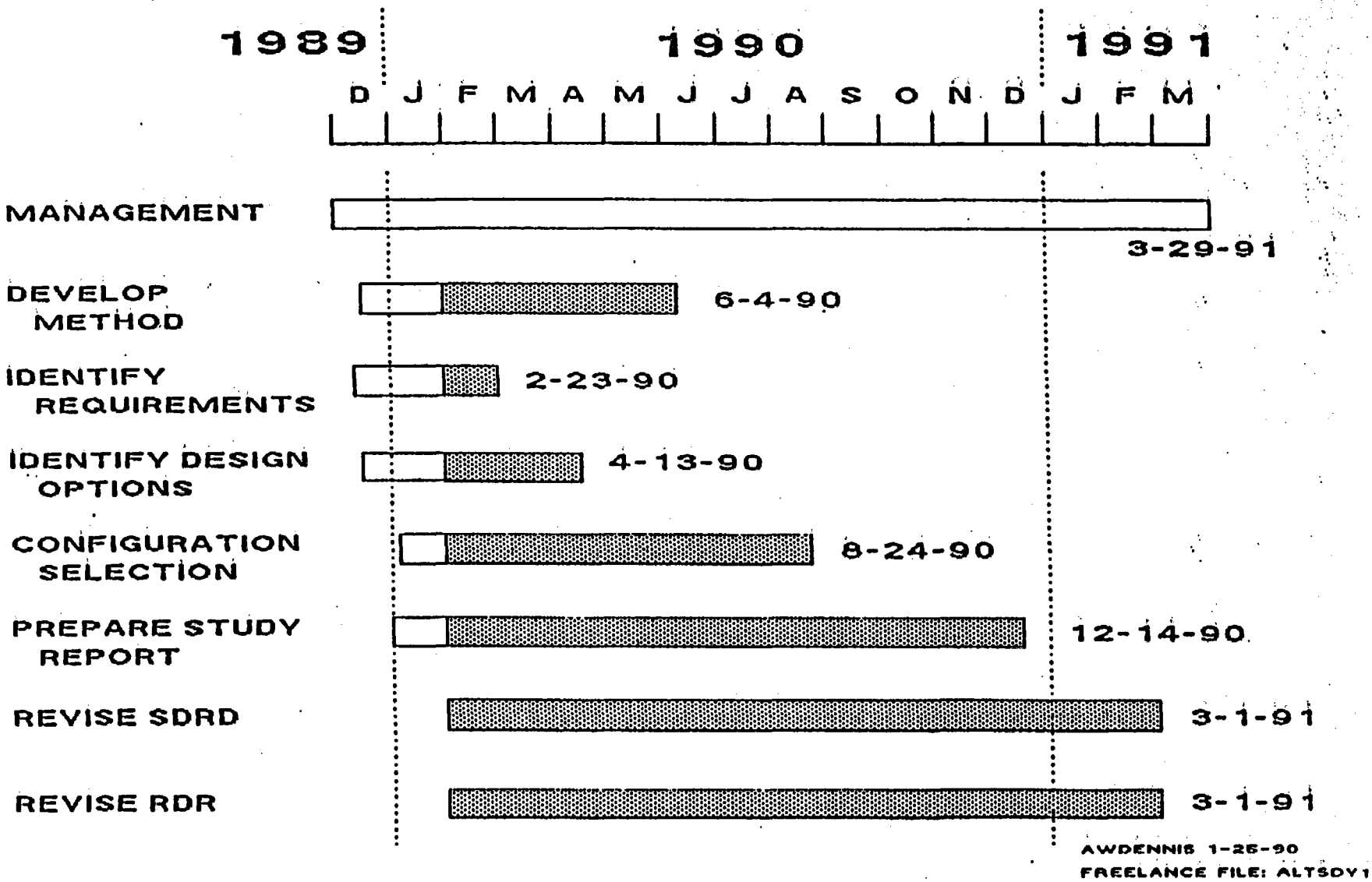
IV. REPOSITORY ENGINEERING

A. Enclosed is an updated presentation on the ESF Alternative Study by Dr. Tom Hunter, SNL TPO. Attached is a new ESF alternative studies schedule that was included in Dr. Hunter's presentation and a summary statement of the purpose of the ESF Alternative Studies activity. (See IV A & IV B inserted)

U.S. DEPARTMENT OF ENERGY

YUCCA MOUNTAIN PROJECT

ESF ALTERNATIVE STUDIES SCHEDULE



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INSERT IV-A

U.S. DEPARTMENT OF ENERGY

YUCCA MOUNTAIN PROJECT

SUMMARY

- THE ESF ALTERNATIVE STUDY IS REEVALUATING THE ESF/REPOSITORY CONFIGURATION TO ESTABLISH A DESIGN BASIS FOR ESF FINAL (TITLE II) DESIGN
- THE CURRENT CONFIGURATION FOR THE ESF HAS TWO CONVENTIONALLY MINED SHAFTS. THE CURRENT REPOSITORY DESIGN HAS TWO ADDITIONAL SHAFTS AND TWO RAMPS FOR ACCESS
- PREVIOUS STUDIES HAVE EXAMINED THE ESF LOCATION, CONSTRUCTION METHOD, AND ACCESS TYPE. THE STUDIES DID NOT SPECIFICALLY ADDRESS THE PERFORMANCE REQUIREMENTS OF THE NRC, NOR EMPHASIZE INTEGRATION WITH THE REPOSITORY, AND WERE NOT DONE UNDER THE CURRENT QA PROGRAM
- THE ALTERNATIVE STUDY WILL EVALUATE A RANGE OF ALTERNATIVES OF SHAFTS, RAMPS, CONSTRUCTION METHODS, AND LOCATIONS
- FOR REPOSITORY AND ESF REGULATORY, OPERATIONAL, AND SITE CHARACTERIZATION REQUIREMENTS WILL BE ADDRESSED AS OBJECTIVES FOR A DECISION PROCESS EMPLOYING A DECISION AIDING METHODOLOGY
- THE ALTERNATIVE STUDY INCLUDING THE DECISION METHODOLOGY WILL BE PERFORMED UNDER A SUPPORTING QA PROGRAM AND WILL INCLUDE SEVERAL PROJECT PARTICIPANTS AND THE DOE

INSERT IV-B

B. The Yucca Mountain Project is still planning to have a formal review by the NRC staff and the State of Nevada of the (old) ESF Title II Design Package I. The proposed date is April 11. The purpose of the review is to demonstrate that the Title II design control process was implemented.

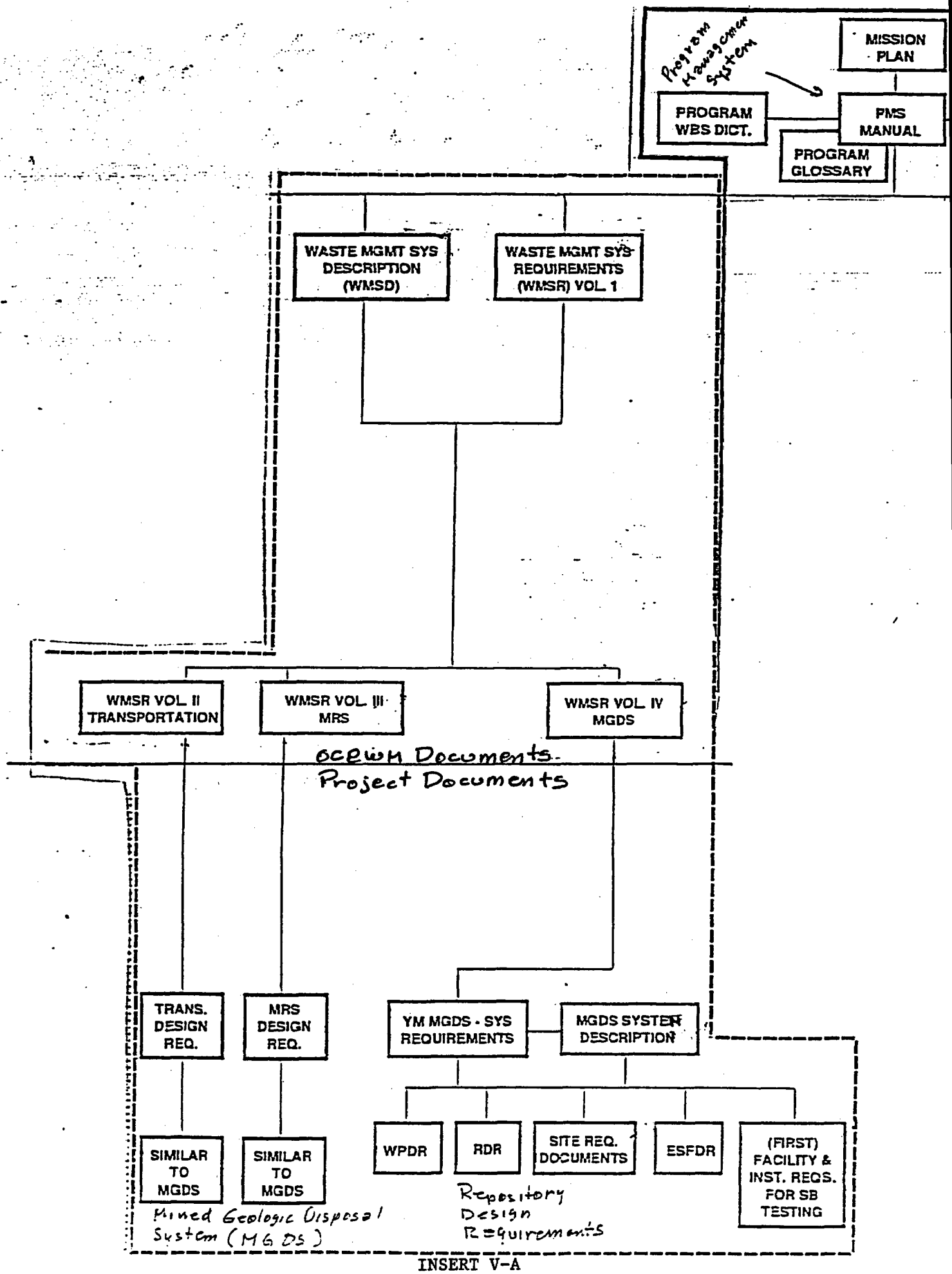
V. LICENSING AND DOE-NRC INTERACTIONS

A. The recommended OCRWM technical document hierarchy.

The technical document hierarchy starts with the Mission Plan and the Program Management System (PMS) Manual. These two documents are common to both the technical and management document hierarchy. Next below are the Waste Management Systems Description (WMSD) and the Waste Management Systems Requirements (WMSR) Volume I. Next are WMSR Volume II, Transportation; WMSR Volume III, Monitored Retrievable Storage; and WMSR Volume IV, Mined Geological Disposal System (MGDS) (see insert V-A).

The above documents are OCRWM produced and are generally generic in nature. With some exceptions they relate to any geologic medium. Each of these documents has an accompanying rational document. The WMSD and the WMSR Volume I supercede the Waste Management System Requirements and Descriptions (SRD) document and are the highest level of technical baseline documents for the waste management system.

The purpose of WMSR Volume I is: "To identify the requirements that the waste management system must fulfill and the major functions it must perform in order to achieve the Program objectives, specify performance levels that must be achieved, and define the controlled interfaces of the system and the system-elements. It also defines the system-elements, i.e., the transportation system (Volume II), the monitored retrievable storage facility (Volume III), and the mined geologic disposal system (Volume IV), and allocates each system-level requirement to one or more of these elements."


Program Management System
MISSION PLAN
PROGRAM WBS DICT.
PMS MANUAL
PROGRAM GLOSSARY
WASTE MGMT SYS DESCRIPTION (WMSD)
WASTE MGMT SYS REQUIREMENTS (WMSR) VOL 1
WMSR VOL II TRANSPORTATION
WMSR VOL III MRS
WMSR VOL IV MGDS
Program Documents
Project Documents
TRANS. DESIGN REQ.
MRS DESIGN REQ.
YM MGDS - SYS REQUIREMENTS
MGDS SYSTEM DESCRIPTION
SIMILAR TO MGDS
SIMILAR TO MGDS
WPDR
RDR
SITE REQ. DOCUMENTS
ESFDR
(FIRST) FACILITY & INST. REQS. FOR SB TESTING
Mined Geologic Disposal System (MGDS)
Repository Design Requirements

INSERT V-A

"The requirements allocated in Volume I to each system will be expanded in Volumes II, III, and IV. These Volumes (II, III, and IV) shall expand the requirements specified in Volume I; they specify how the system requirements are to be performed at the program level, and shall include regulatory and licensing requirements imposed on each system element and criteria reflecting policy and system inegration decisions."

WMSR Volumes I and IV are in the review cycle and may be released in the next couple of months. Volumes II and III may be out late this year. The Project doesn't expect major changes to Project documents (SDRD, RDR, etc.) to be necessary because of the WMSR.

B. ProMIS, a comprehensive project information system.

The NRC-DOE Technical Exchange on Data Management that was held on January 9 presented a reasonably complete outline of DOE's current plans for management and control of the technical data collected during the investigation of Yucca Mountain as a possible high-level nuclear waste repository. What was not presented was the way DOE is going to deal with the entire range of project management-administrative information that include:

- traditional areas of management
- references to technical data
- retrieval of results from technical tasks

ProMIS is designed to do this job.

ProMIS is an integrated project information system that is designed to produce:

- consistent information
- uniform reporting
- uniform user interfaces
- efficient resource use

Development of the Project Management Information System (ProMIS) is seen as a two step activity that is projected to take about 13 months. Step one develops the overall "Information Management System Plan" (IMSP). The IMSP includes:

- Information Resource Management (IRM) resources baseline
- IRM long range plans
- IRM work authorization
- Status report and reviews
- IRM change control
- IRM quality assurance
- IRM program reviews

Step two consists of:

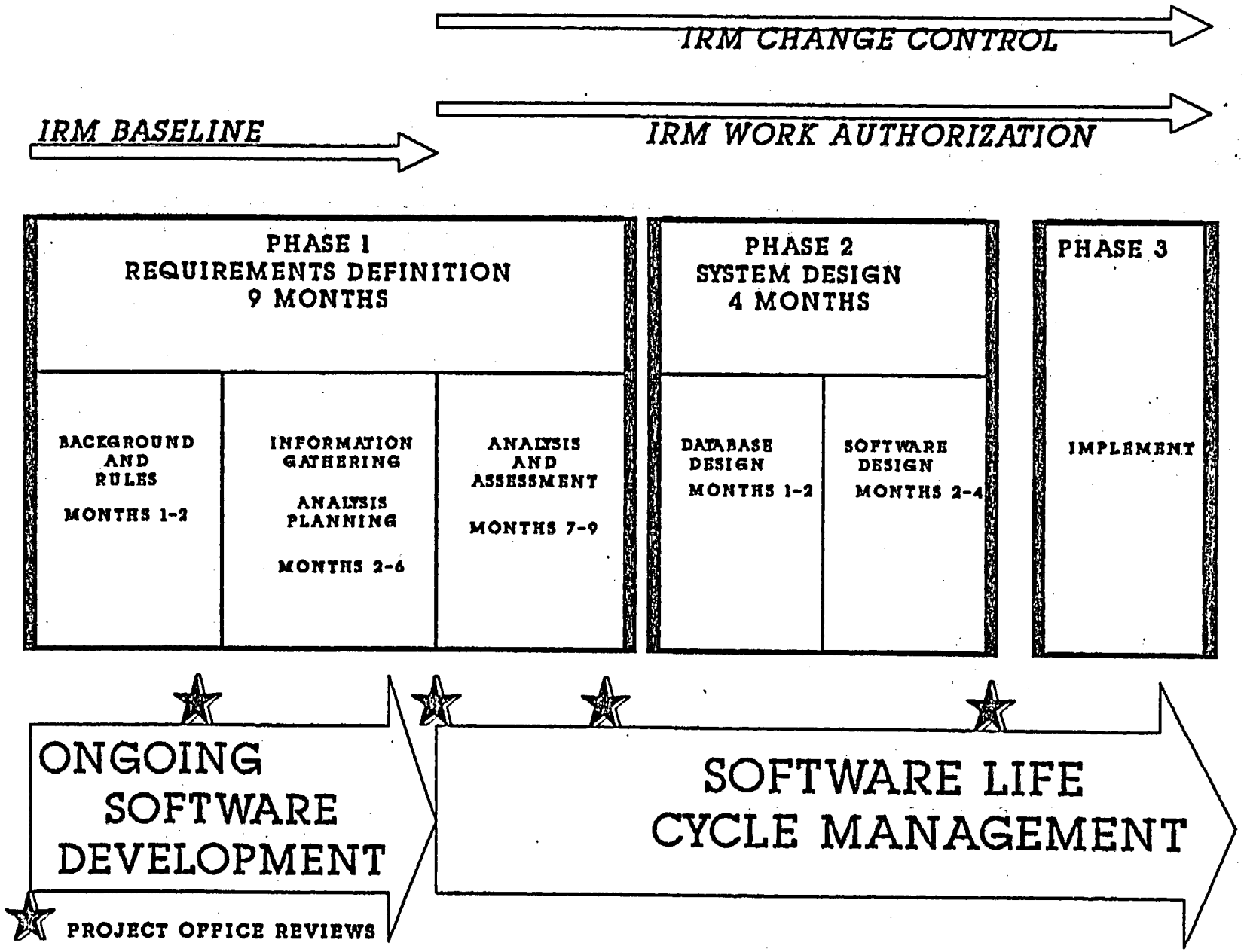
- Implementation of the IMSP
- Identify functional management information requirements
- Establish the IRM baseline
- Analyze and design a comprehensive project information system

Insert V-B is a proposed schedule for this effort.

Over the six years that this office has functioned in Las Vegas, we have seen a number of efforts by the DOE Yucca Mountain Project to get a handle on data management with spotty success. The SEPDB and RIB have been in existence for several years but efforts to obtain cooperation throughout the Project to get data into these data bases has been difficult. The ability to find specific pieces of data and to obtain data for staff use has been difficult, even when the data set requested is a number of years old.

The review of the present efforts by the DOE Yucca Mountain Project to manage data was undertaken with some skepticism. However, if the present effort continues to receive the support

INSERT V-B


IRM CHANGE CONTROL
IRM BASELINE
IRM WORK AUTHORIZATION
PHASE 1
REQUIREMENTS DEFINITION
9 MONTHS
PHASE 2
SYSTEM DESIGN
4 MONTHS
PHASE 3
BACKGROUND AND RULES
MONTHS 1-2
INFORMATION GATHERING
ANALYSIS PLANNING
MONTHS 2-6
ANALYSIS AND ASSESSMENT
MONTHS 7-9
DATABASE DESIGN
MONTHS 1-2
SOFTWARE DESIGN
MONTHS 2-4
IMPLEMENT
ONGOING SOFTWARE DEVELOPMENT
SOFTWARE LIFE CYCLE MANAGEMENT
PROJECT OFFICE REVIEWS

and funding by management that it now enjoys, it has a chance of success. Management support includes the requirement that the participants (USGS, SNL, LANL, LLNL and engineering support) cooperate fully.

C. For some time, the Yucca Mountain Project Office (YMPO) has been having trouble getting participant technical staff to review NRC Technical Positions. There are several reasons for this:

- Often, review comments are not forwarded to the NRC staff by DOE-Hq. There are instances where comments have been edited (supposedly by DOE-Hq staff) to eliminate some comments or to change comments.

- NRC doesn't respond to those comments that are sent to the staff by DOE-Hq.

- The Technical Positions are never finalized, and are often referenced by the staff even though they are still in draft form.

An example of a YMPO review of a staff document that worked well was the finalization of NUREG 1318. DOE staff commented on the draft version, there were interactions between staffs concerning the comments and consequently, the DOE staff has no quarrel with the finalized document.

There was the comment that NRC Technical Positions are too general in nature and that they are little help to the DOE investigator. This may be a view held by some DOE investigators but it is not the view of YMPO management or licensing staff.

In general, the YMPO staff consider NRC staff comments on DOE activities to be technically sound and professional.

D. In the future, when badging staff for NTS visits, it will be necessary for naturalized citizens to have the original (not copies) naturalization documents with them. The naturalization documents may not be asked for, but if they are and the individual doesn't have them, access to the Test Site can be denied.

E. A change in the YMPO management structure now has Wendy Dixon's division responsible for environmental concerns, socio-economic activities and transportation.

Vince Iorii, DOE-YMPO, will manage the Project Management Information System (ProMIS). In addition, Vince Iorii's organization will be responsible for Project Integration.

VI. STATE OF NEVADA INTERACTIONS - None to report.

VII. GENERAL

A. The following is a list of the personnel actions taken by the Yucca Mountain Project participants as a consequence of the budget cuts.

F&S: transferred 13 persons out of their YMP organization; laid off 14 persons.
H&N: transferred 21 persons out of their YMP organization; laid off 19 persons.
LANL: transferred 9 persons out of their YMP organization; laid off 6 persons.
LLNL: transferred 54 persons out of their YMP organization; laid off 14 persons.
REECo: transferred 9 persons out of their YMP organization; laid off 1 person.
SNL: transferred 21 persons out of their YMP organization; laid off 2 persons.
SAIC: laid off 17 persons.
USGS: transferred 22 persons out of their YMP organization; laid off 15 persons.

B. Meetings attended:

- 12-4-89 Meeting with Carl Gertz - discussed new DOE organization and QA
- 12-4-89 Meeting with Dave Dobson - discussed study plan schedule
- 12-21-89 Meeting with Carl Gertz - discussed QA activities
- 1-5-90 Meeting with Carl Gertz - discussed DOE organization changes, Apache Leap prototype drilling program (Uel Clanton was present) and QA
- 1-8-90 Meeting with Leo Little - discussed Alternative Studies Plan, review by NRC and State of the Title II, Package 1 to be held in April, and WMSR Volumes I, II, III and IV.
- 1-22-90 Meeting with John Linehan in office
- 1-22-90 Meeting with Carl Gertz, John Linehan present
- 1-22-90 Meeting with Leo Little, John Linehan present
- 1-23-90 Meeting with John Linehan in office
- 1-23-90 Meeting with Dave Dobson and Uel Clanton - discussed Apache Leap drilling program, study plan schedules, Calico Hills investigation, the Coyote Wash TAR and the geophysics White Paper
- 1-24-90 Meeting with SAIC representatives who were investigating problems within the SAIC QA organization

There are no new issues that this office has identified that have not been brought to management's attention.

cc: With enclosures: K. Stablein, M/S 4 H3, J. E. Latz
Without enclosures: C. P. Gertz, R. E. Loux, M. Glora, G. Cook, D. M. Kunihiro, K. Turner, R. E. Browning, M/S 4 H3; R. Bernero, M/S 7 A4; H. Thompson, M/S 17 G21; H. Denton, M/S 17 F2; S. Gagner, M/S 2 G5; L. Kovach, M/S NLS260

Enclosures: LANL November Project Status Report; LANL Monthly Activity Report - December 1989; Borehole Prospectus - Modification Phase 1e Prototype Drilling; Technical & Management Support Services Project; ProMIS info.; ESF Alternative Study, T.Hunter, 2/2/90; 8.3.1.5.2.1 Characterization of Quaternary Regional Hydrology (Paleohydrology)

Los Alamos
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

WBS #: 1.2.9
QA: N/A

Y.M.P.

December 15, 1989

TWS-EES-13-12-89-055

Mr. Carl P. Gertz, Project Manager
Yucca Mountain Project Office
US Department of Energy
P.O. Box 98518
Las Vegas, NV 89193-8518

Dear Mr. Gertz:

SUBJECT: NOVEMBER PROJECT STATUS REPORT

Attached is the November Project Status Report for Los Alamos' participation in the Yucca Mountain Project.

Sincerely,

R. J. Herbst

ABC/em

Attachment: a/s

McConville ACTION: Norelli/Williams
Prater cc: Dobson/Dyer
cc: Fridrich/Newman
cc: Gawell/Carlile
cc: Waters/Hughes
cc: Dymmel/Clanton
w/o encl cc: Jones/EST.BC
Cloninger cc: Levich/Rocar
Simmons cc: Gilray-Mac
Mukherjee cc: Bjersted+
Svemar
Roberson
White, R
Maxwell
McDonald

REC'D IN WMPO 12/21/89

Cy w/attachment:

R. Bullock, FSN, Las Vegas, NV
J. C. Calovini, H&N, Las Vegas, NV
V. J. Cassella, HQ/Washington, DC
C. Garvin, SAIC, Las Vegas, NV
L. Hayes, USGS, Denver, CO
T. Hunter, SNL, Albuquerque, NM
R. F. Pritchett, REECo, Las Vegas, NV
L. Jardine, LLNL, Livermore, CA
R. E. Lowder, MACTEC, Las Vegas, NV
J. Nelson, SAIC, Las Vegas, NV
T. Petrie, DOE/YMPO, Las Vegas, NV
M. Cloninger, DOE/YMPO, Las Vegas, NV
U. Clanton, DOE/YMPO, Las Vegas, NV
D. Dobson, DOE/YMPO, Las Vegas, NV
J. Robson, DOE/YMPO, Las Vegas, NV
V. Iorii, DOE/YMPO, Las Vegas, NV
J. Waddell, SAIC, Las Vegas, NV
J. Peck, SAIC, Las Vegas, NV
K. Beall, SAIC, Las Vegas, NV
J. Younker, SAIC, Las Vegas, NV
I. Cottle, SAIC, Las Vegas, NV
J. Treadwell, SAIC, Las Vegas, NV
A. B. Caughran, IS-11, MS J521
R. J. Herbst, EES-13, MS J521
J. A. Canepa, EES-13, MS J521
W. Myers, EES-DO, MS D446
K. A. West, EES-13, MS J521
RPC File (2), MS J521
TWS-EES-13, MS J521
CRM-4 (2), MS A150

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1.2.1 SYSTEMS

No significant action to report.

1.2.3.2 GEOLOGY

MAJOR ACCOMPLISHMENTS:

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) course (about 0.5 mm) calcite spar deposited after fault movement; and (3) fine-grained calcite deposited on top of the course spar.

Mineralogy and Geochemical Alteration staff 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.

SIGNIFICANT MEETINGS:

The volcanism staff 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 US Nuclear Waste Technical Review Board was also held on November 20-21 to review the volcanism studies. 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.

PLANNED WORK:

A. Norris will present a talk on "Chlorine Isotope Studies" to the US Nuclear Waste Technical Review Board.

1.2.3.3 HYDROLOGY

MAJOR ACCOMPLISHMENTS:

A paper titled "Experiences of Fitting Batch Sorption Experiments for Radionuclides on Tuffs" was presented at the Migration '89 Conference.

The C-Hole Reactive Tracers Staff met with D. Galloway, the USGS principal investigator for the C-Wells project, on November 21. Discussion included packer design and USGS plans.

SIGNIFICANT MEETINGS:

A. Norris presented a talk, "^{36}Cl Studies of Water Movements for the Yucca Mountain Project," on November 3 for the Project management and technical project officers.

PLANNED WORK:

The talk "Chlorine Isotope Studies" will be presented to the U.S. Nuclear Waste Technical Review Board next month.

1.2.3.4 GEOCHEMISTRY

MAJOR ACCOMPLISHMENTS:

The following presentations were made at the Migration '89 conference: "Solubility Studies of Transuranium Elements for Nuclear Waste Disposal: Principles and Overview;" "Effects of Microorganisms on the Transport of Actinide Elements;" and "Simulation of Radionuclide Retardation at Yucca Mountain Using a Stochastic Mineralogic/Geochemical Model," which included a movie of results from 3-dimensional transport calculations run with TRACRN and of analogous particle tracking calculations. A poster session, "Sorption of Americium in Tuff and Pure Minerals Using Synthetic and Natural Ground Waters," was also presented.

Work continued 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 were suspected to be polymeric Pu(IV).

A set of experiments has been initiated to investigate the sorption behavior of technetium on pure mineral phases appropriate to the Yucca Mountain site.

A set of experiments involving the sorption of neptunium onto goethite as a function of pH has been completed. These experiments were carried out mainly to establish the technique in anticipation of experiments involving neptunium sorption on hematite.

SIGNIFICANT MEETINGS:

Retardation Sensitivity Analysis staff met with D. Galloway, USGS, to discuss modeling coupled stress and flow fields at Yucca Mountain. Staff also 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 for retardation sensitivity analysis calculations. Discussions also included ideas for validation experiments of common interest.

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 experiments for inclusion as Phase 2 cases.

1.2.5 REGULATORY AND INSTITUTIONAL

Study Plans

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.

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.

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

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.

1.2.6 EXPLORATORY SHAFT

MAJOR ACCOMPLISHMENTS:

The Project Office audited the IDS readiness review.

Staff reviewed the Project Preliminary Safety Analysis Report and the draft of the Engineering Management Plan.

A readiness review was conducted to determine EG&G's readiness to start the IDS Title II design. However, work was initiated to phase out EG&G's role in IDS design.

PLANNED WORK:

Work will begin to phase down the G-Tunnel Prototype Testing and to prepare the ESF Test Plan.

EG&G is developing a phase down plan. All EG&G activities are to terminate at the end of January 1990.

1.2.9 PROJECT MANAGEMENT

MAJOR ACCOMPLISHMENTS:

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. Los Alamos staff have begun the process of making the needed corrections to the QA program.

The LANL Quality Assurance Program Leader issued Stop Work Order No. SWO-LA01 on November 22. The stop work was directed at software and software development.

WBS No: 1.2.9
QA: N/A

Los Alamos

Los Alamos National Laboratory
Los Alamos New Mexico 87545

ACTION Ympo
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January 22, 1990

TWS-EES-13-01-90-085

David C. Dobson, DOE/YMP, Las Vegas, NV
Donald E. Livingston, DOE/YMP, Las Vegas, NV
Thomas W. Bjerstedt, DOE/YMP, Las Vegas, NV
Carolyn Rutland, DOE/YMP, Las Vegas, NV
Paul Cloke, SAIC, Las Vegas, NV

LOS ALAMOS MONTHLY ACTIVITY REPORT - DECEMBER 1989

Attached is a copy of the Los Alamos Monthly Activity Report for December 1989; Julie Canepa requested that I place you on our distribution list. This report is an internal document that we produce to describe our technical work in greater detail than the Project Office monthly report allows.

If you would like previous issues of these reports or would like to be removed from our distribution list, please call me at FTS 843-0916.

Thank you.

Sincerely,

Alison B. Caughran

Alison B. Caughran

ABC/em

Attachment: a/s

Cy w/o attach:
A. B. Caughran, IS-11, MS J521
J. A. Canepa, EES-13, MS J521
TWS-EES-13 File, MS J521
RPC (2), MS M321
CRM-4, MS A150

ACTION Dobson/Livingston
C Bjerstedt/Morley
C ~~Dale~~ Dyer
C Newbury/Waters
C ESF, BC/Levich
C Gilray-NRC
C Mulchey
C Svenard/Roberson
CC White/Maxwell
CC McDonald/Lorenz
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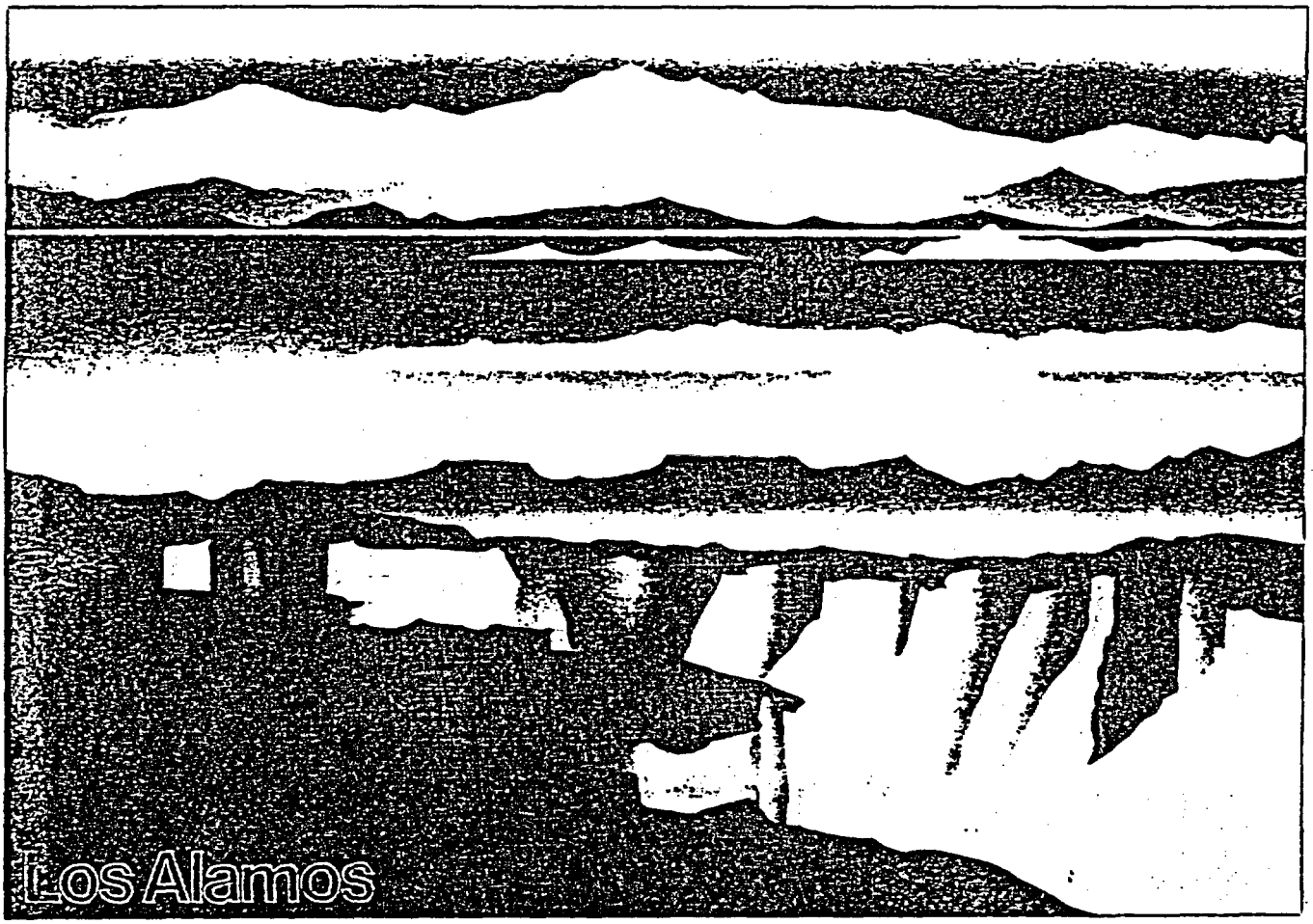
TWS-EES-13-12-89-069

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.

Monthly Activity Report
December 1989

CONTENTS

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 of 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 in 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 "Ar/"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.

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 (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 [illegible]oncentration 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.

$$D_A = D_l + D_o t^n \quad (2)$$

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.

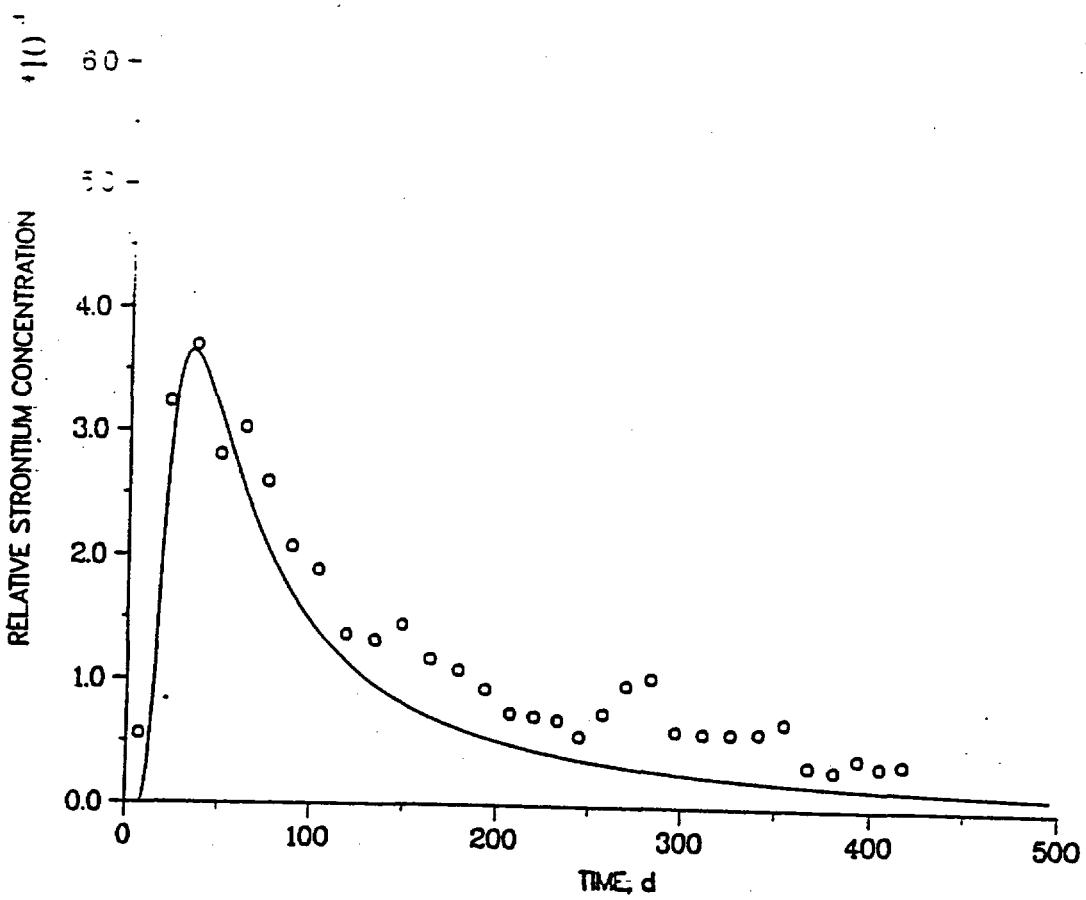


Figure 1: Fit (solid line) to strontium elution measured (o) through an intact tuff column using time-dependent dispersion.

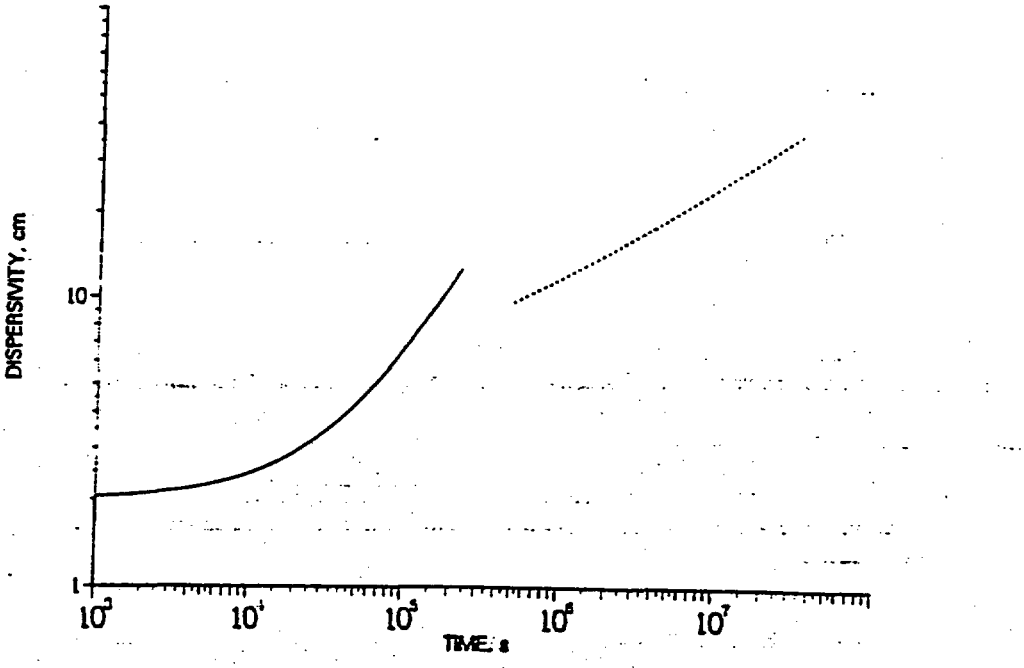


Figure 2: Dispersivity as a function of time used to fit the intact tuff column data for the tritiated water elution (solid line) and for the strontium elution (broken line).

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

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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 Buttner, 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^+, 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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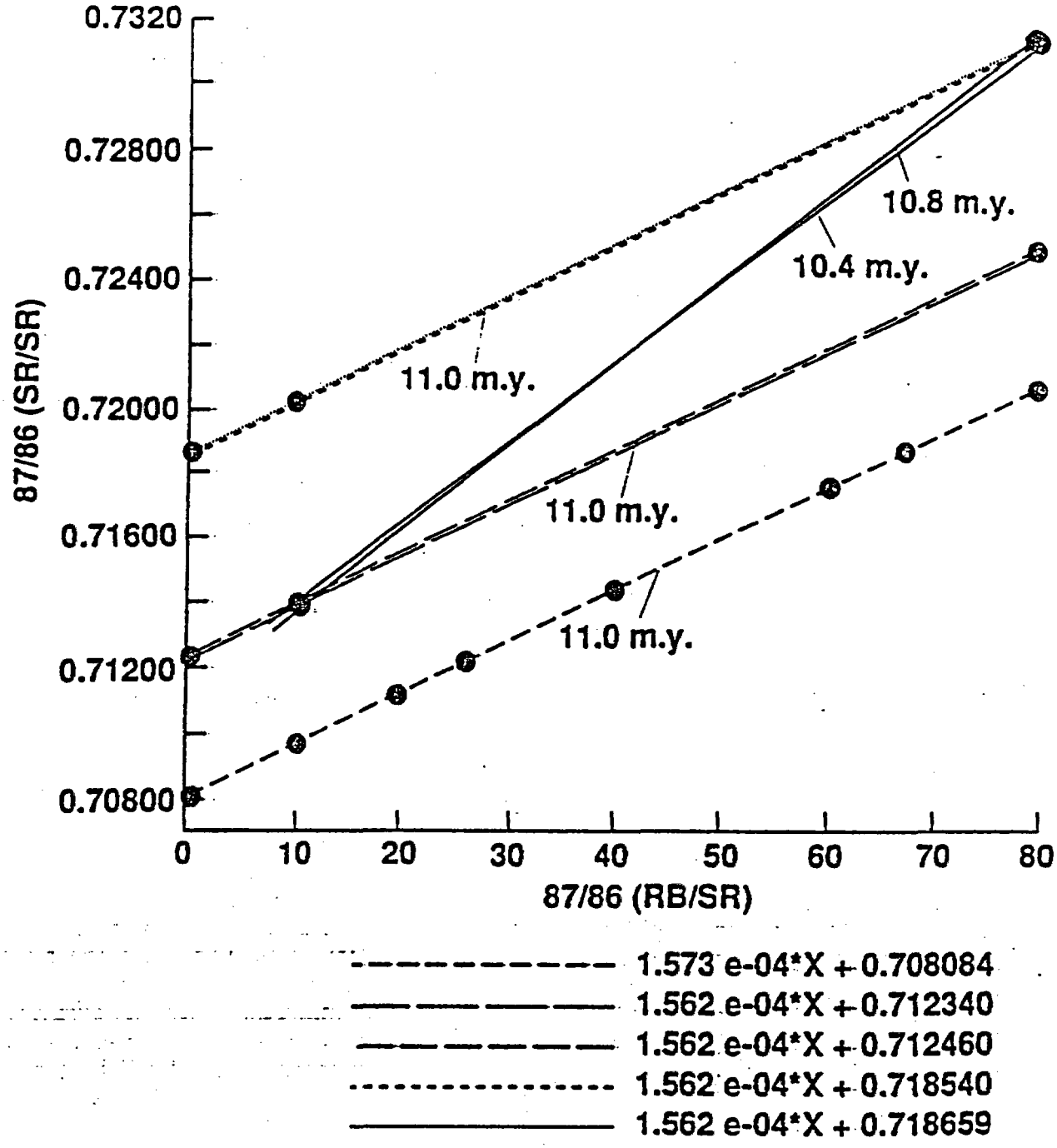


Figure 1. A theoretical Rb/Sr isochron age and associated uncertainty (error) of an 11 m.y. old clay obtained using an initial 87Sr/86Sr ratio of 0.7082 and Rb/Sr ratios of Tertiary clays from the Texas Gulf Coast.

Lawrence Berkeley Laboratory
1 Cyclotron Road Berkeley, California 94720
(415) 486-4000 • FTS 451-4000

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.

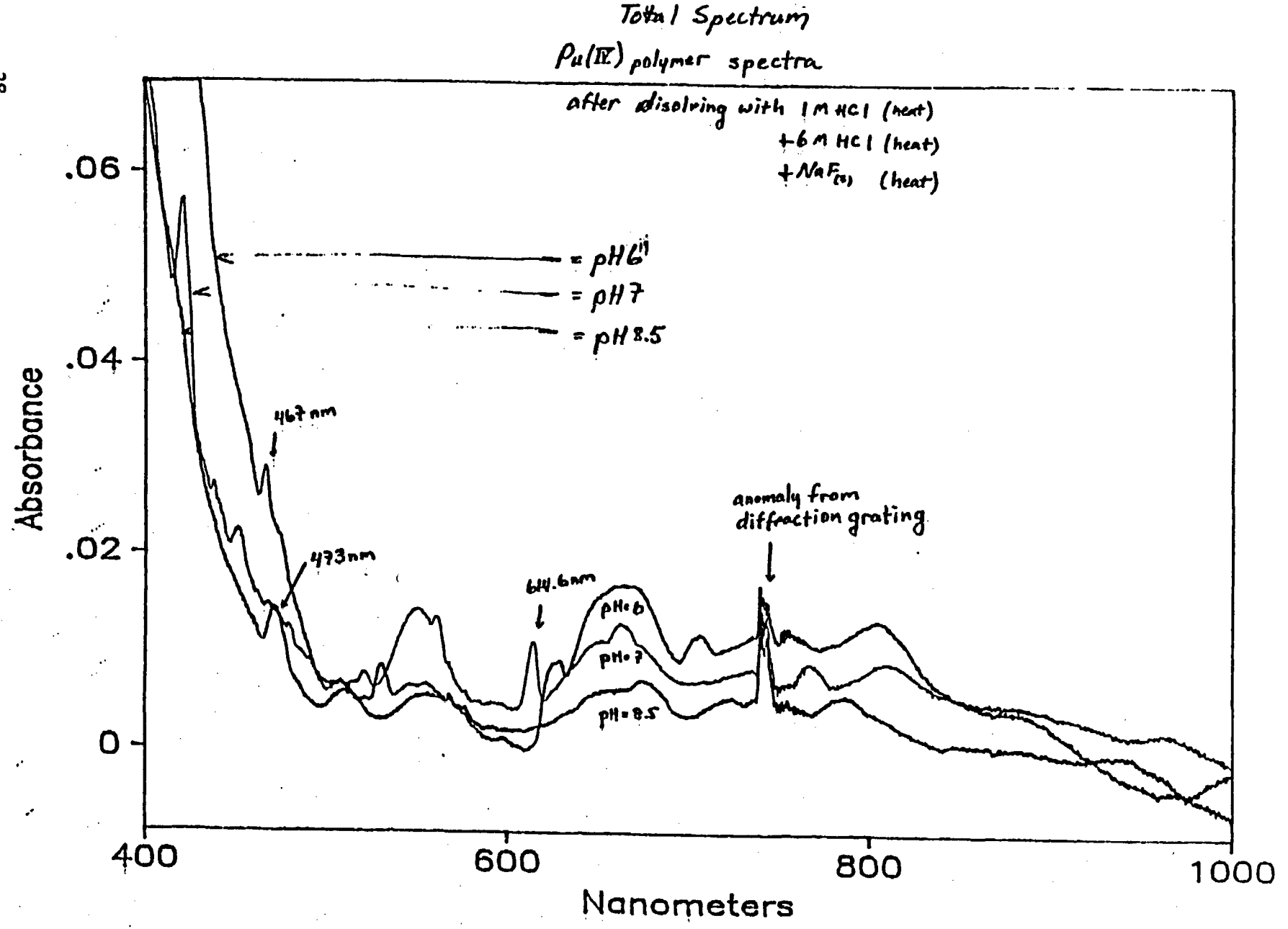
From November 6–10, 1989, I attended the Second International Conference on "Chemistry and Migration Behavior of Actinides and Fission Products in the Geosphere" at Monterey, California, U.S.A. I presented an invited lecture titled "Solubility Studies of Transuranium Elements for Nuclear Waste Disposal: 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



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Res= .3

11/16/89

14:14

Paul Cloke, SAIC, Las Vegas, NV

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

STEVE BROCOUM
JEFF KIMBALL
RAY WALLACE

Two areas have begun to firm up as we approach drilling at Apache Leap, Az.:

1. The area appears to be wetter than first thought. Information obtained from retired mining company employees, drilling contractors, etc. within the last week indicate that boreholes located 0.25, 0.50 and 2.0 miles distant encountered multiple perched water zones.

2. The cost estimates/cost for activities outlined in the December prospectus continue to increase as the drilling date approaches. We have a budget problem.

I need to know if you have a problem with the new prospectus. I need to officially turn on Lang, REECo, etal. if we are to start the week of January 21, 1990.

Uel Clanton

BOREHOLE PROSPECTUS - MODIFICATION
PHASE 1e PROTOTYPE DRILLING

Proposed modifications to the original Borehole Prospectus are listed and discussed below. These changes reflect the latest information and are proposed by Project Office to insure that, at least, limited objectives of the Phase 1e program are met in the event water is found to be a controlling factor during drilling at Apache Leap.

Proposed Modifications:

- The 6-1/4" site investigation holes will not be drilled.
- The second drillsite will not be investigated at this time.
- The first hole drilled will be the 12-1/4", continuously cored below the surface casing beginning at approximately 20' to a total depth of 1100".
- Should water be encountered which cannot be grouted off (situation of extensive fracturing filled with water) the 12-1/4" hole will be hammer drilled from the last grouting attempt to 1100' and 9-5/8" casing will be set as a temporary protective string.
- The 8" hole will then be drilled from 1100' to 1700' to determine drilling/coring rates with the 8" system.
- Should the 8" drilling objectives (bit life, trip times, coring/drilling rates) be fulfilled prior to reaching 1700', the 8" hole will be deepened to 1700' using the hammer drill. Should the hammer be used, one bottomhole core will be attempted prior to abandoning the hole.

Significant Points for Justification of Modifications:

- There is a high probability that the top 350' of the Volcanic Tuff is dry, based on offset core hole information.
- There is a high probability that the interval from 1100' to 1900' is dry, again based on offset core hole information.
- There is one major perched water zone of undetermined thickness between 700' and 1000', based on mine shaft and offset core hole information.
- Current information on the second drillsite, combined with known structural uncertainties the area, indicates that the chances of finding improved drilling conditions at the second site are poor.
- An estimated 355K will be expended in equipment and additional drillpipe to reach 1700' and mobilization by the time the rig is on location, prior to drilling any holes. A minimum of 200K in drilling cost would be required to simply prove that the site does or does not have significant water, demobilize, and reclaim the site.

Costs:

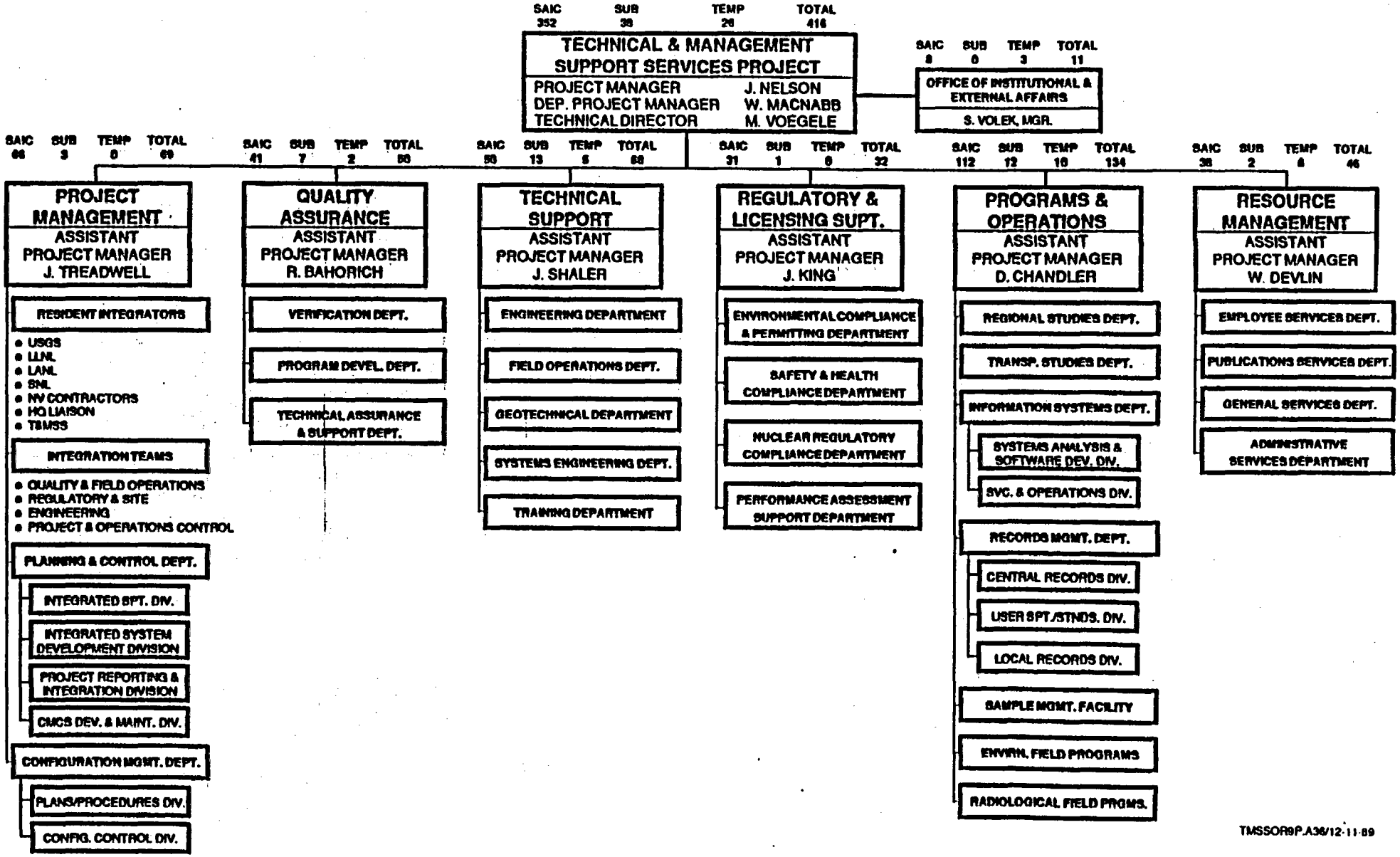
- The following costs are for a combination 12-1/4"/8" borehole:

580K	Drilling
260K	Equipment and mobilization
100K	Standby to beginning of drilling
940K	Total

All other options for additional logging, drilling additional boreholes, etc., will be significantly more expensive.

Achievable objectives:

- The following objectives should still be achievable from the Combo Hole:
  - Drilling/Coring rates for 12-1/4" and 8" boreholes.
  - Trip times for both borehole sizes.
  - A limited logging program (TV, gyro, caliper).
  - An 8" hole would be available below 1100' for USGS packer testing.
  - Design adequacy of the 8" and 12-1/4" core-through bits will be determined to establish the need for a fully developed bit design program.
  - Effectiveness of our cementing programs.



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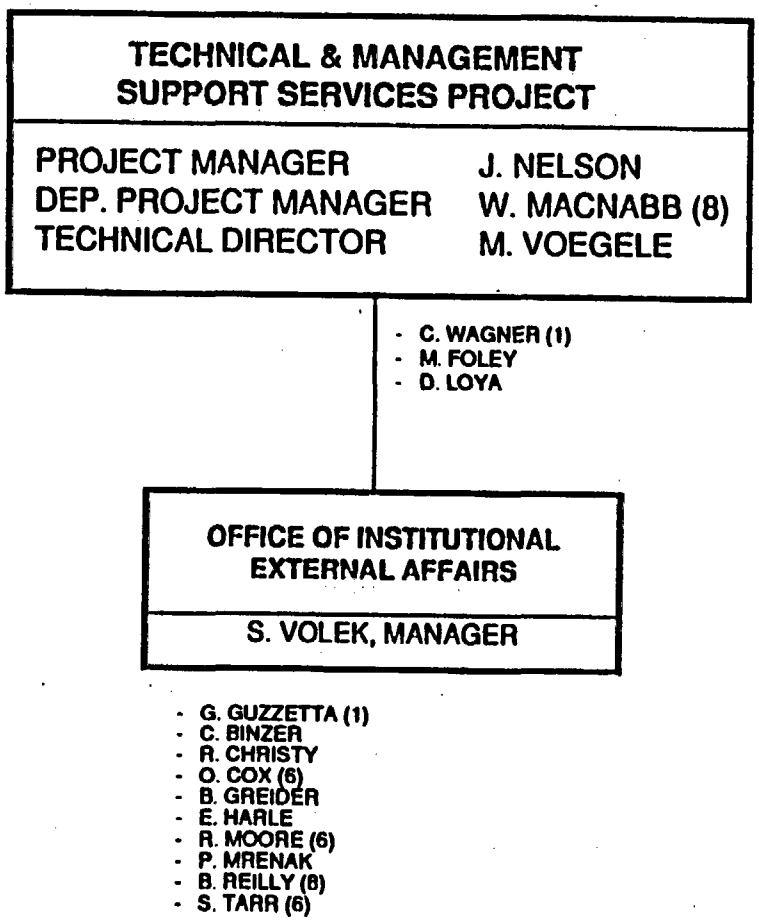

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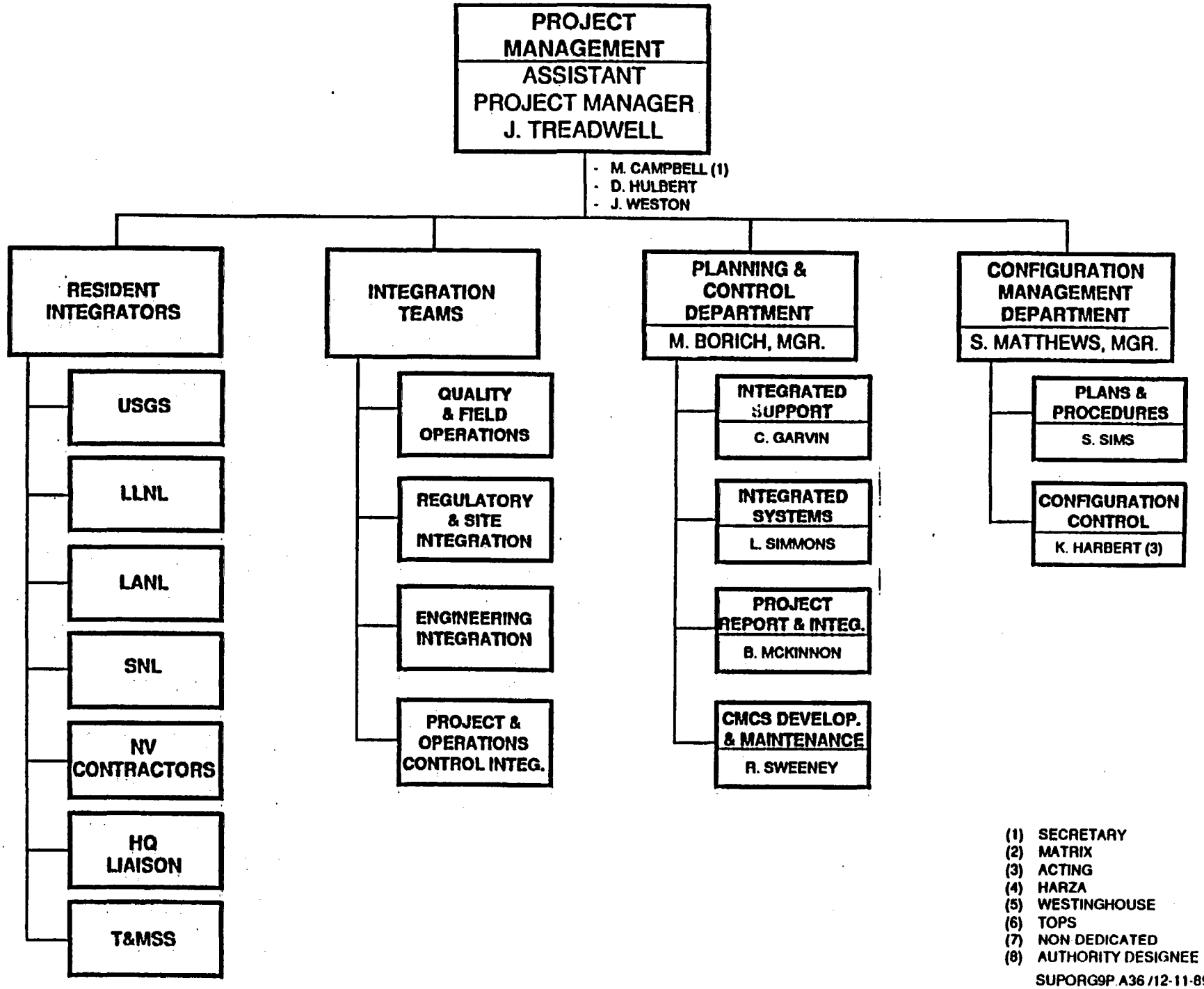
PROJECT MANAGEMENT
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- M. CAMPBELL (1)
- D. HULBERT
- J. WESTON
RESIDENT INTEGRATORS
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SNL
NV CONTRACTORS
HQ LIAISON
T&MSS
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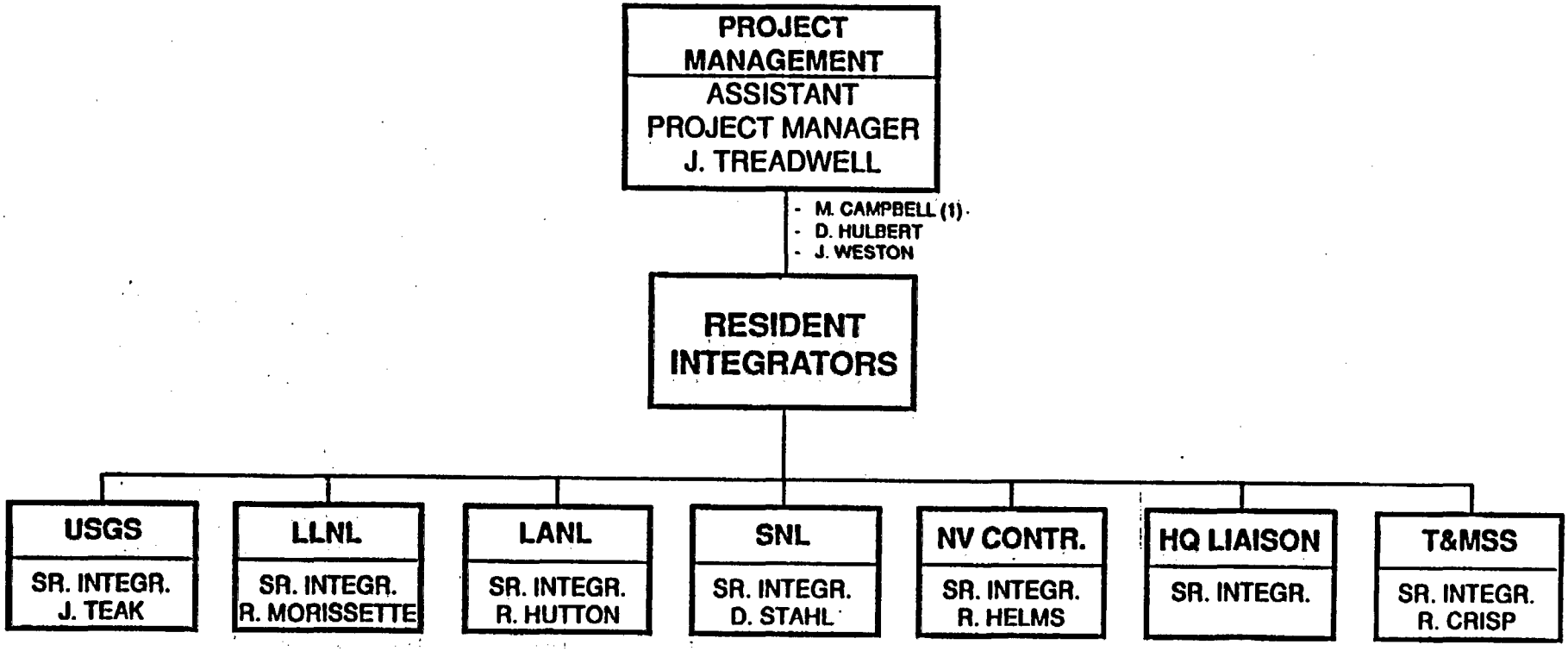
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R. HELMS
HQ LIAISON
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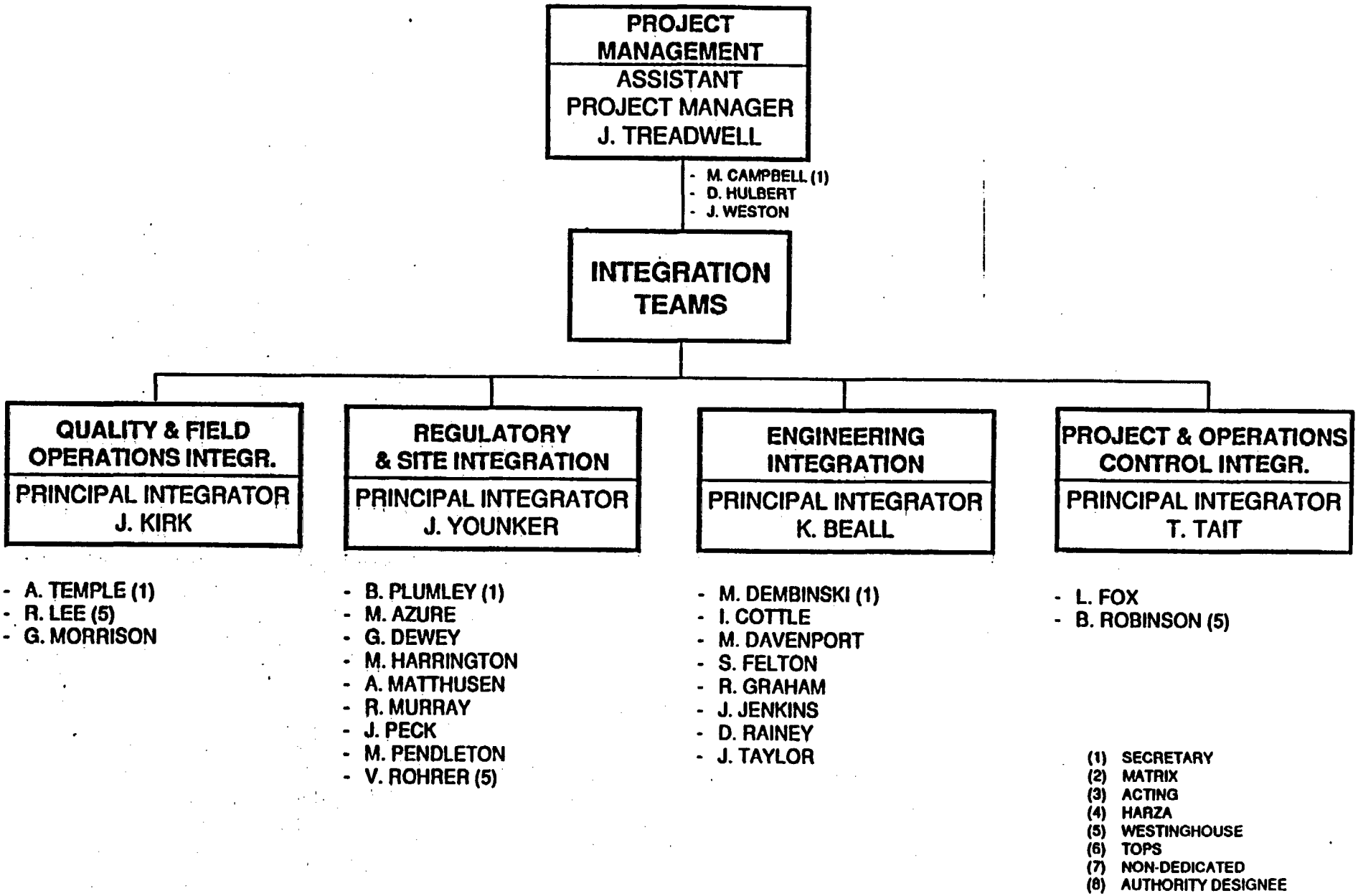
T&MSS
SR. INTEGR.
R. CRISP



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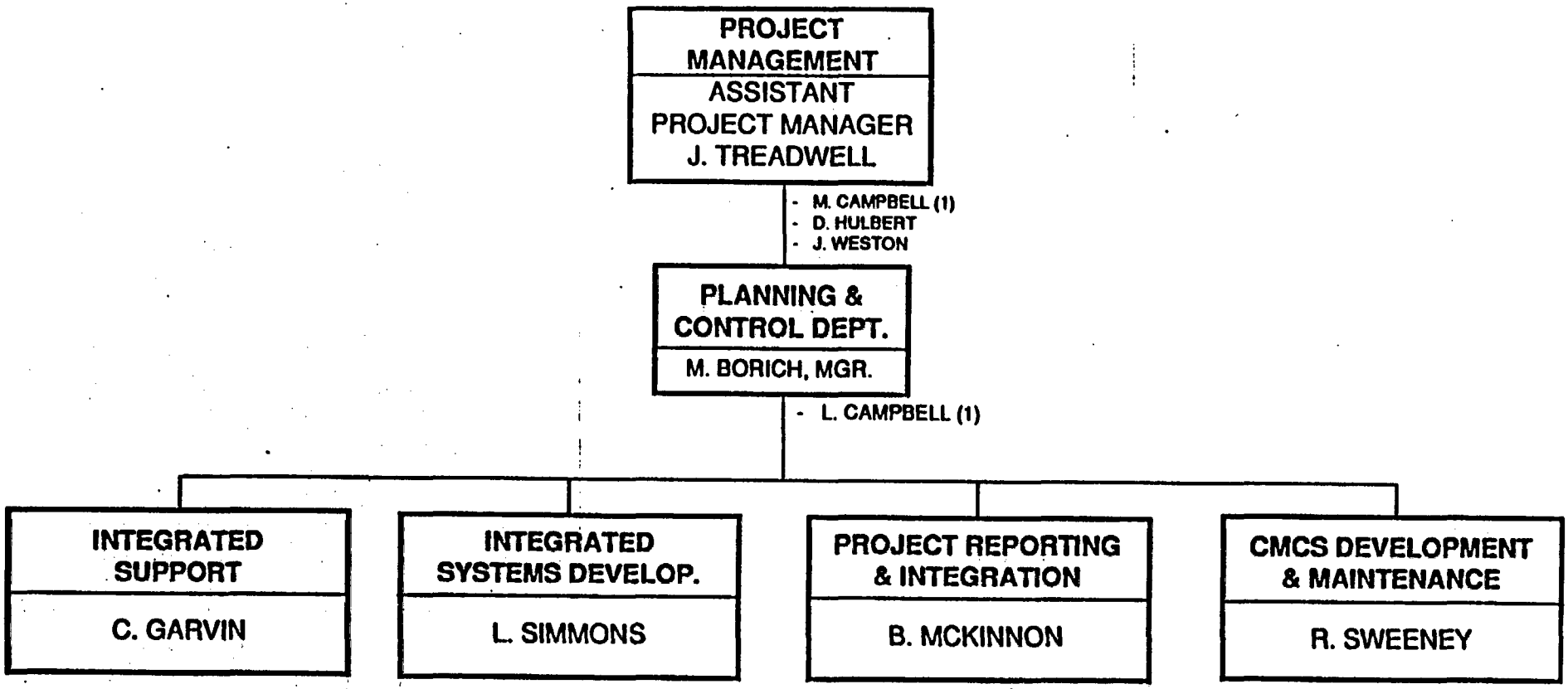

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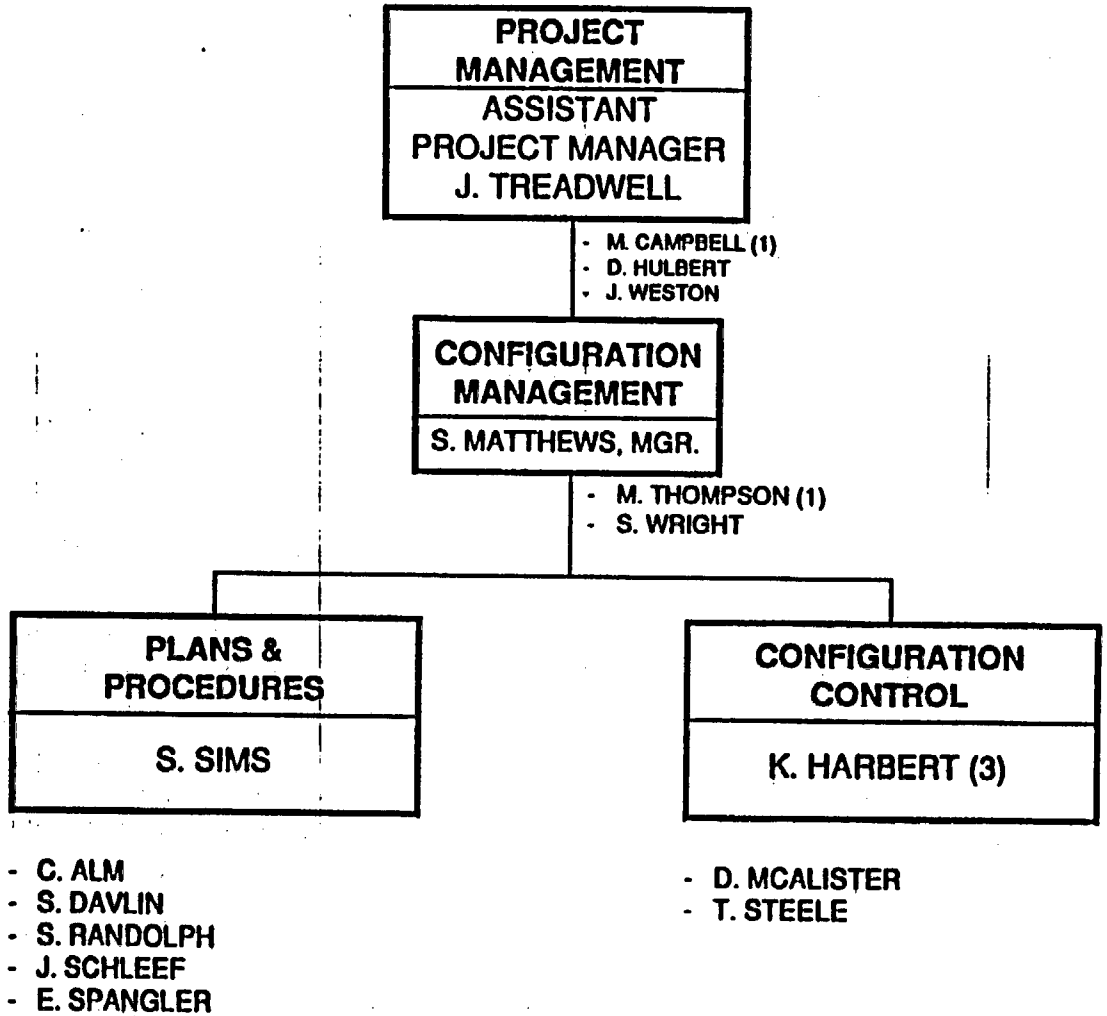

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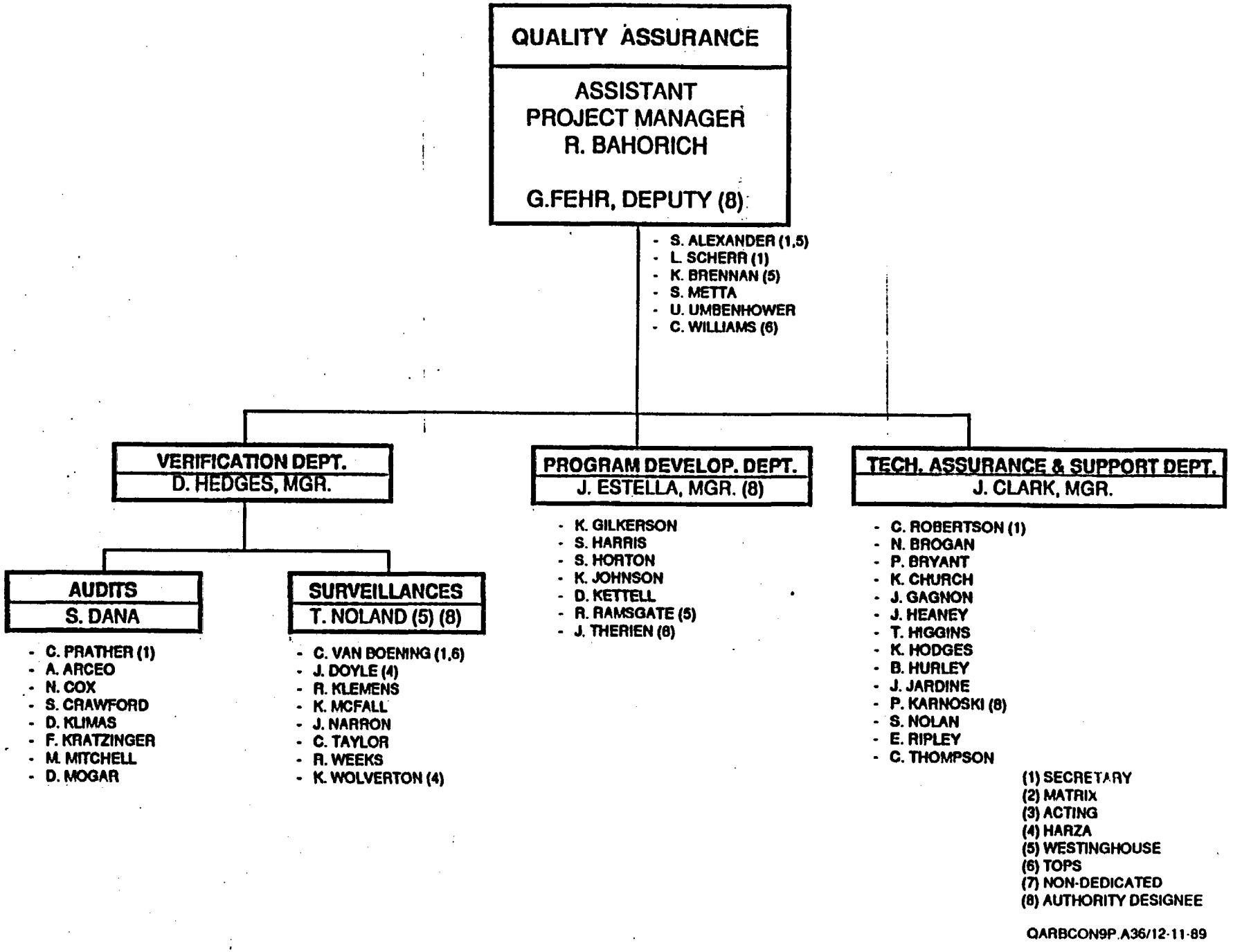
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- S. ALEXANDER (1,5)
- L. SCHERR (1)
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- C. PRATHER (1)
- A. ARCEO
- N. COX
- S. CRAWFORD
- D. KLIMAS
- F. KRATZINGER
- M. MITCHELL
- D. MOGAR
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- J. DOYLE (4)
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- R. WEEKS
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- C. ROBERTSON (1)
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- T. HIGGINS
- K. HODGES
- B. HURLEY
- J. JARDINE
- P. KARNOSKI (8)
- S. NOLAN
- E. RIPLEY
- C. THOMPSON
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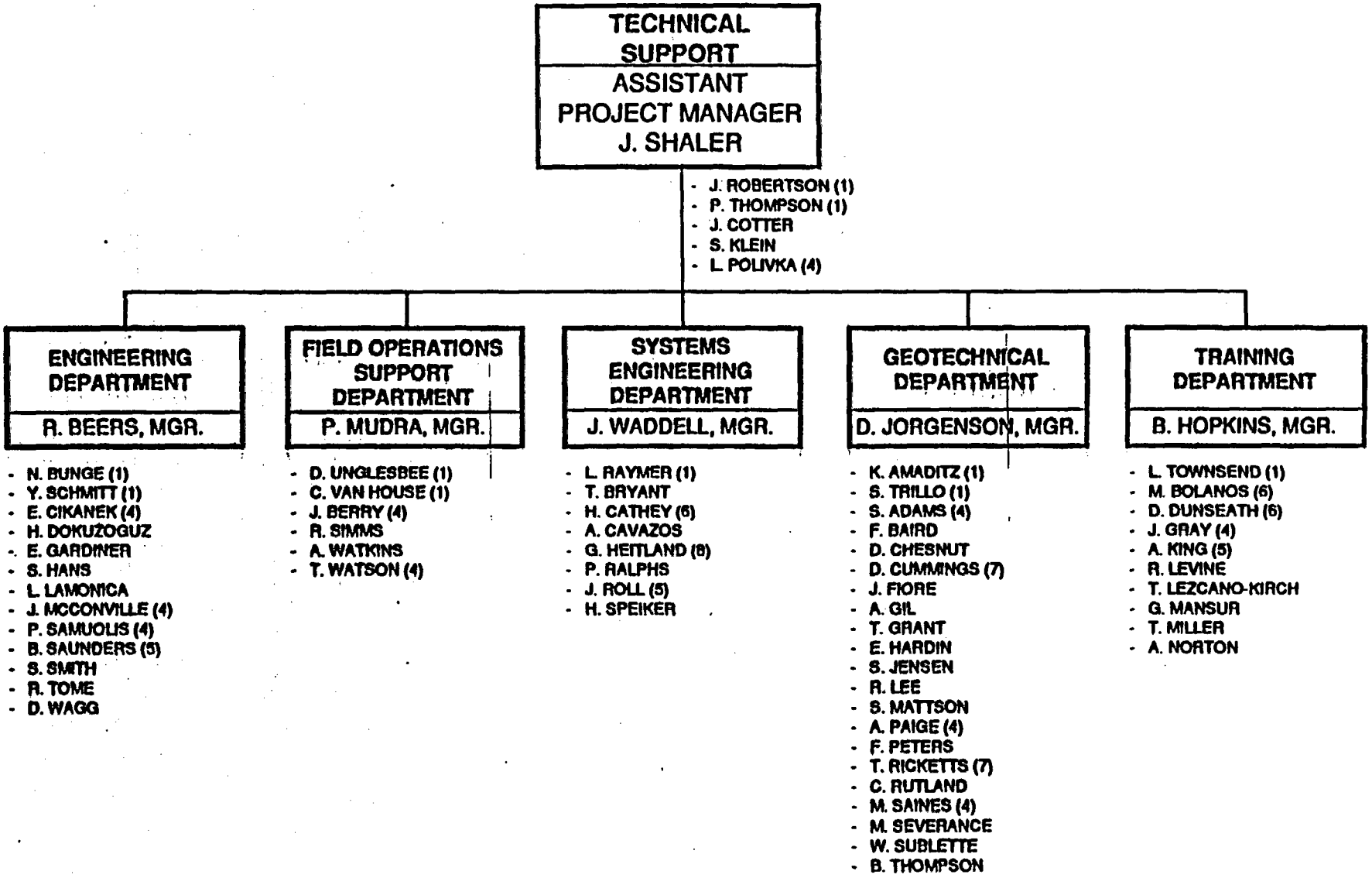

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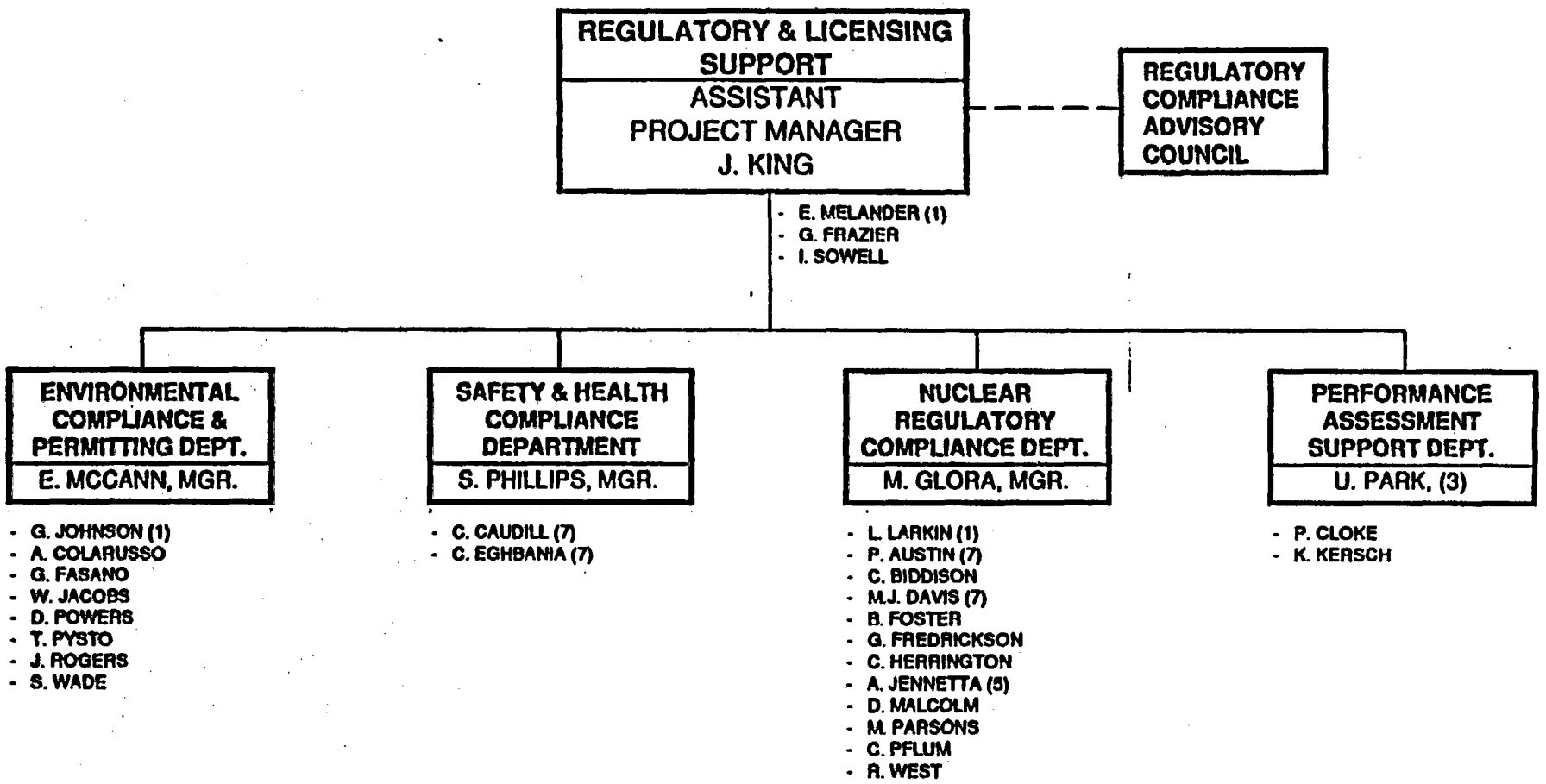

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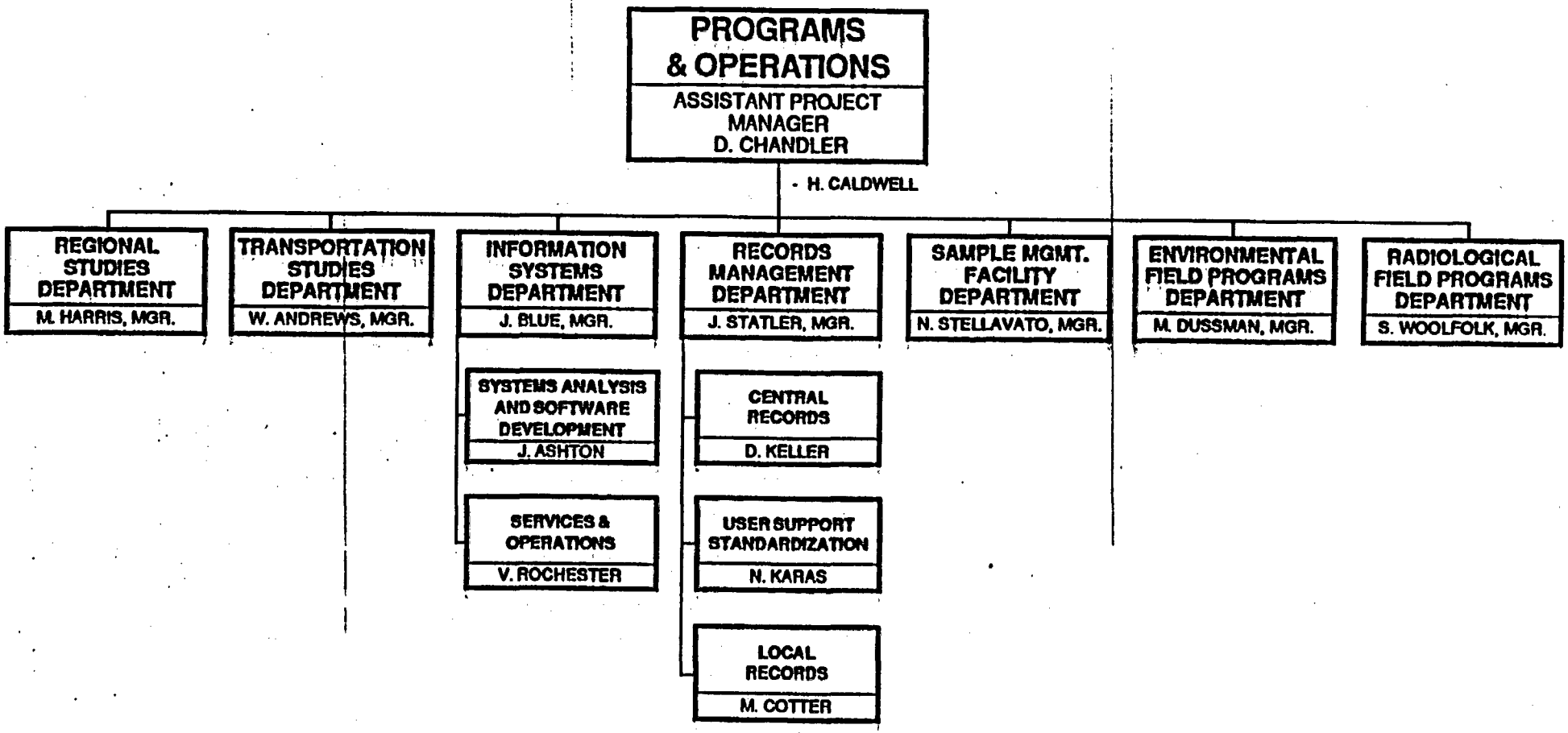

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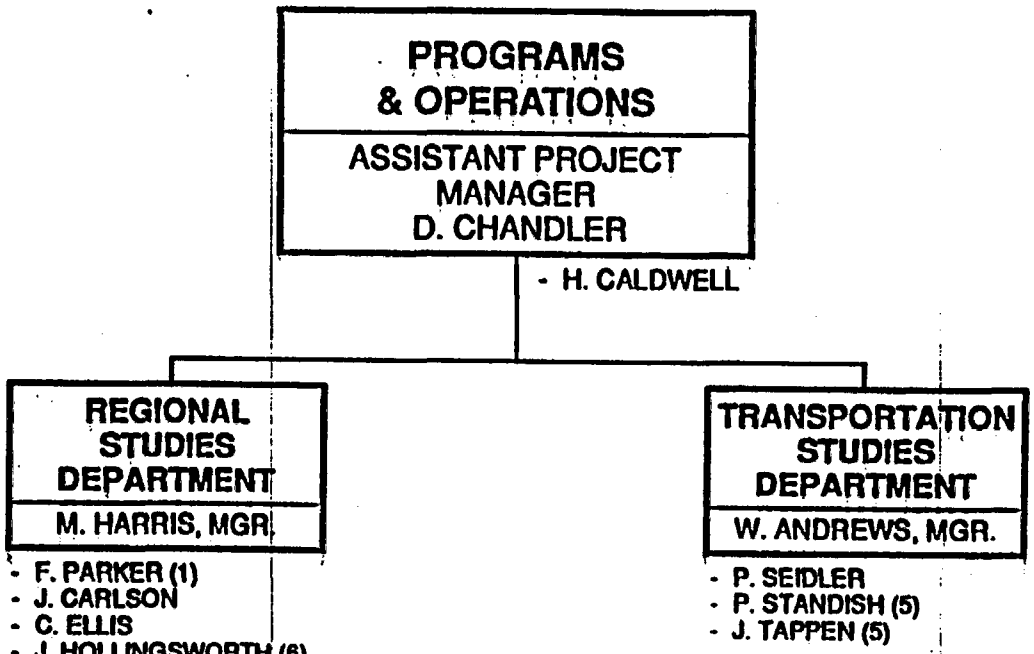

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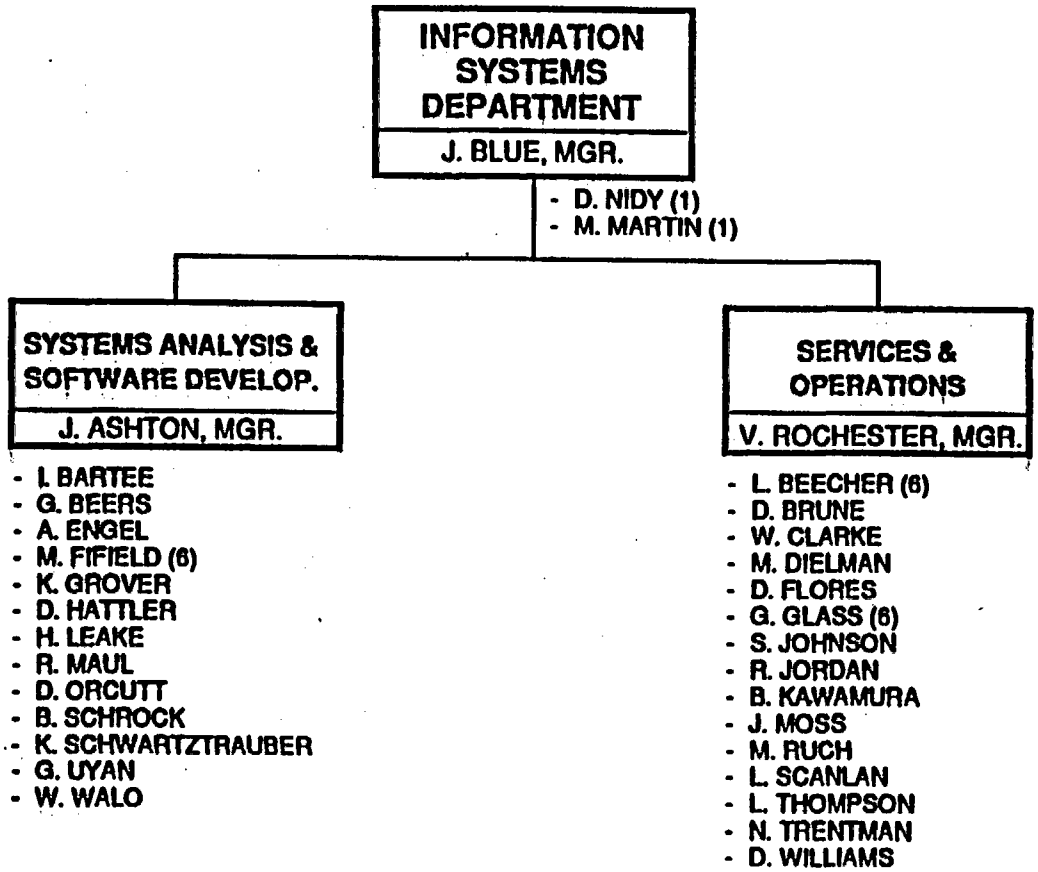

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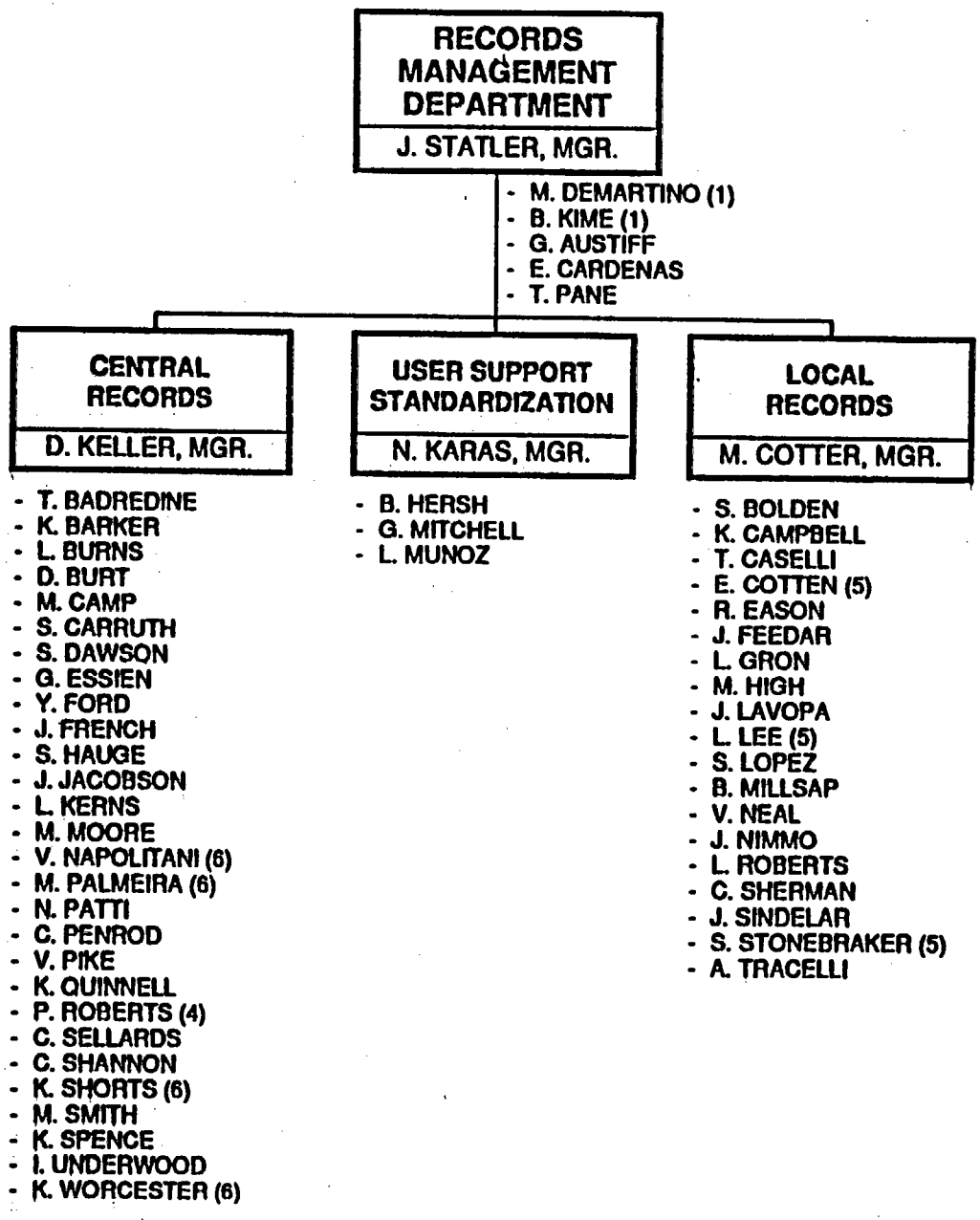

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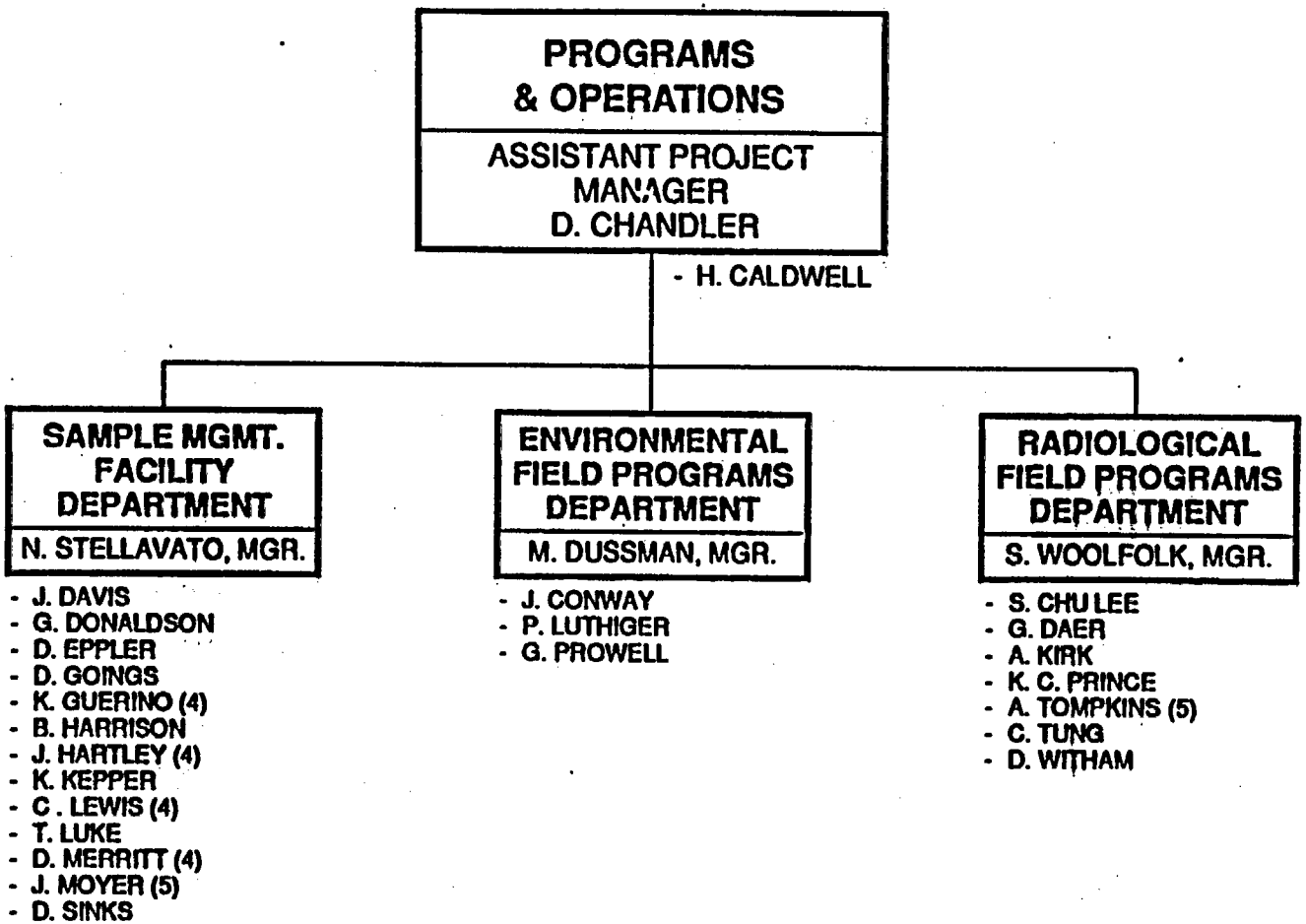

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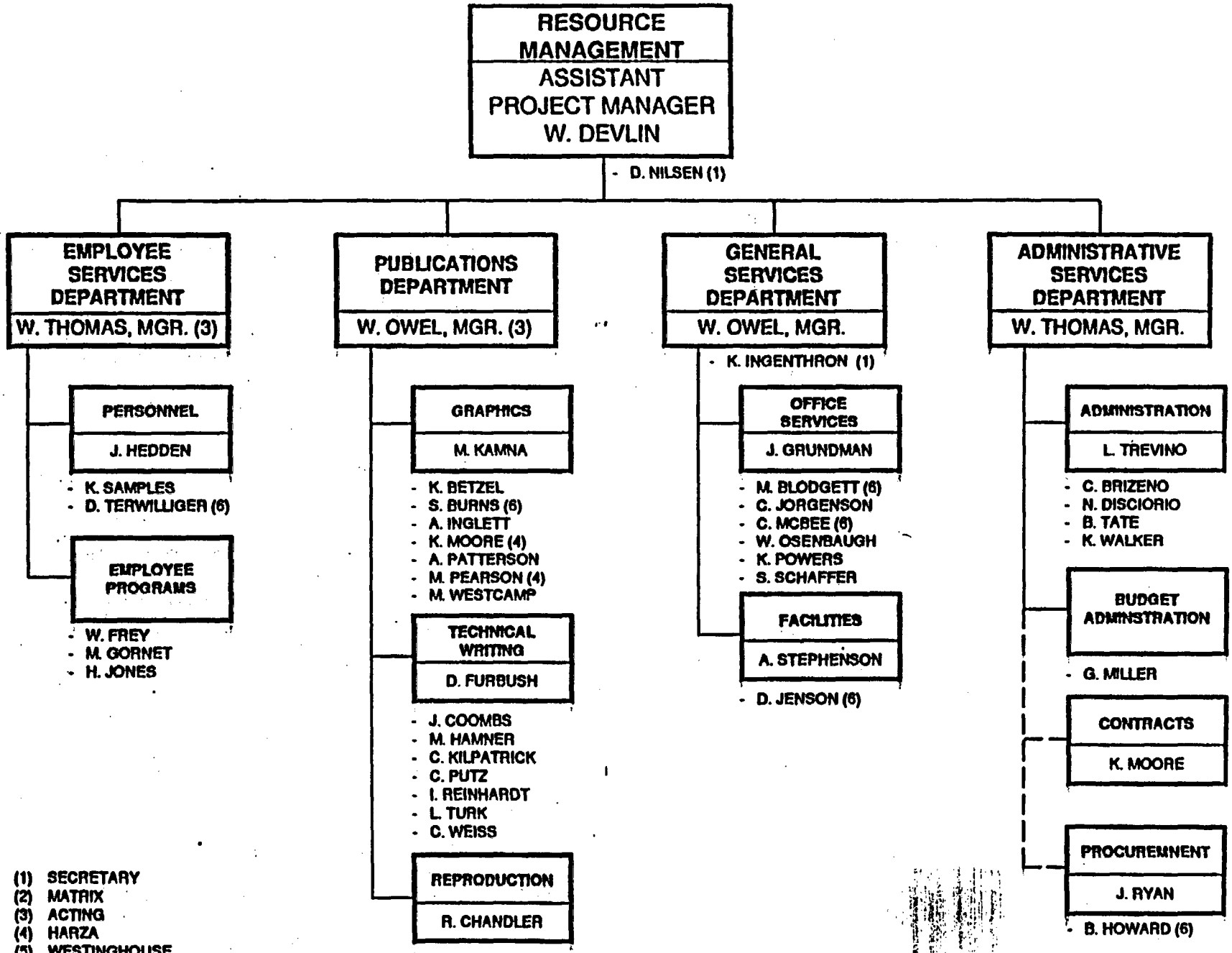

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"PRELIMINARY DRAFT"

OVERALL REQUIREMENT:

"A comprehensive Project Information System"
(Gertz Ltr 11/88)

INFORMATION ONLY

ProMIS

"PRELIMINARY DRAFT"

STEP ONE: DEVELOP OVERALL INFORMATION MANAGEMENT SYSTEM PLAN (IMSP)

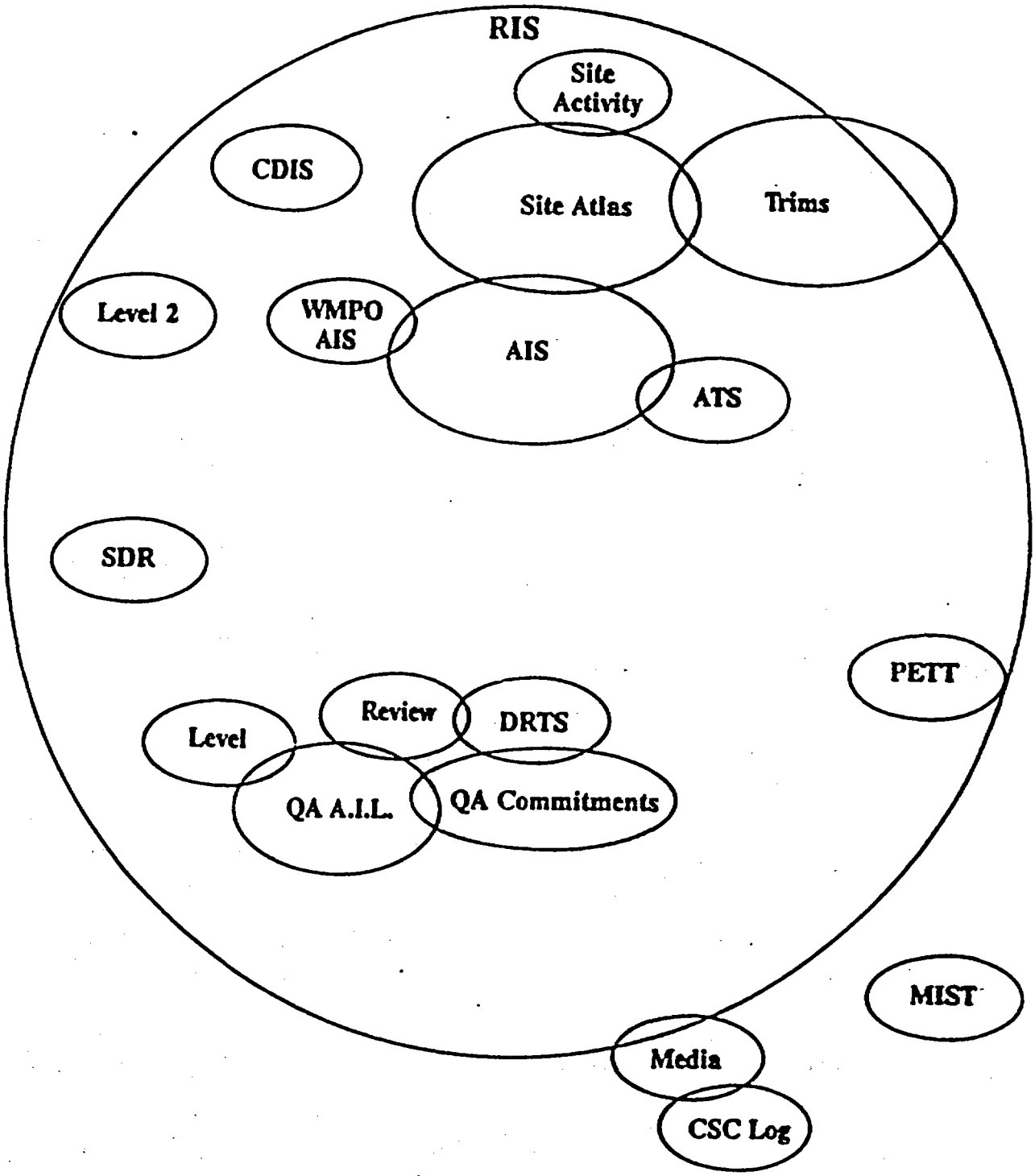
- IRM Resources Baseline
- IRM Long Range Plans
- IRM Work Authorization
- Status Report and Reviews
- IRM Change Control
- IRM Quality Assurance
- IRM Program Reviews

EXISTING CONDITIONS

- Normal Growth Patterns
- No Established Baselines
- Poorly Defined Operating Procedures
- No Established Software Development Life Cycle

RESULTING SITUATION

- Numerous Standalone Systems
- Overlapping Requirements
- Duplicated Data Bases
- Inefficient Use of Hardware & Software Resources
- Cross-correlation of Data Not Possible
- Management Decisions Difficult to Make


RIS
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QA A.I.L.
QA Commitments
MIST
Media
CSC Log

STEP TWO:

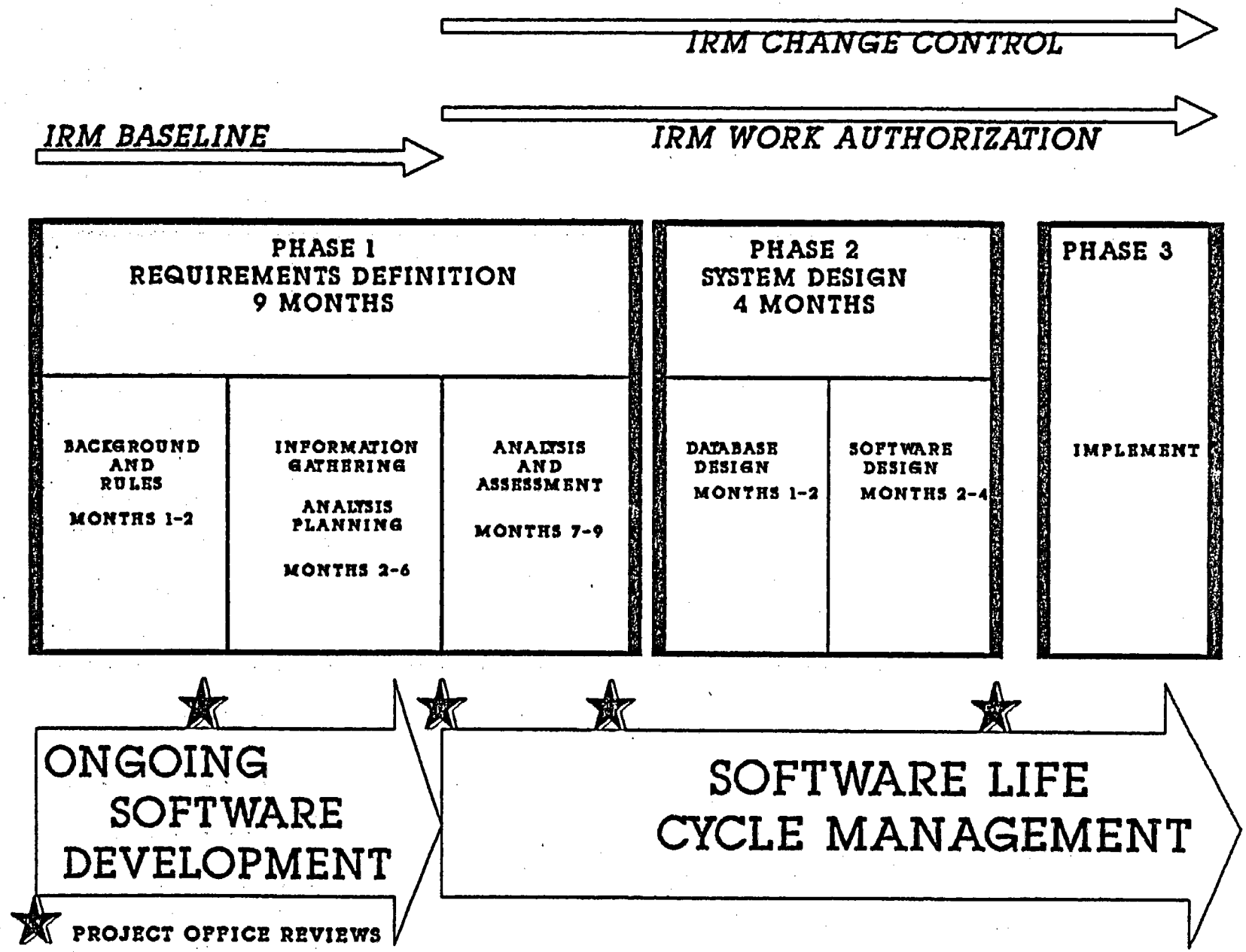
- Implement the Information Management System Plan.
- Identify functional management information requirements.
- Establish the Information Resources Management (IRM) Baseline.
- Analyze & design a comprehensive project information system.

STEP TWO:

Requirements, Analysis, & Design (RAD)

of the Project Management Information System

ProMIS


IRM CHANGE CONTROL
IRM BASELINE
IRM WORK AUTHORIZATION
PHASE 1
REQUIREMENTS DEFINITION
9 MONTHS
PHASE 2
SYSTEM DESIGN
4 MONTHS
PHASE 3
BACKGROUND AND RULES
MONTHS 1-2
INFORMATION GATHERING
ANALYSIS PLANNING
MONTHS 2-6
ANALYSIS AND ASSESSMENT
MONTHS 7-9
DATABASE DESIGN
MONTHS 1-2
SOFTWARE DESIGN
MONTHS 2-4
IMPLEMENT
ONGOING SOFTWARE DEVELOPMENT
SOFTWARE LIFE CYCLE MANAGEMENT
PROJECT OFFICE REVIEWS

PHASE 1
MONTHS 1-2

BACKGROUND AND RULES

ACTIVITIES:

Analyze YMP Environment

Identify Development Constraints

Define Standards and Guidelines

DELIVERABLES:

Software Development Plan

PHASE 1
MONTHS 2-6

INFORMATION GATHERING / ANALYSIS PLANNING

ACTIVITIES:

Interview Current and Potential Users

Investigate Existing Systems

Gather Candidate Requirements

Define Requirements Selection Criteria

DELIVERABLES:

IRM Baseline (for existing systems)

Work Authorization "Gate"

Preliminary Requirements Document

PHASE 1
MONTHS 7-9

ANALYSIS AND ASSESSMENT

ACTIVITIES:

Evaluate Requirements Specifications

DELIVERABLES:

Final Requirements Documents
(IRM Baseline Requirements)

PHASE 2
MONTHS 1-2

DATABASE DESIGN

ACTIVITIES:

Design the Physical
Database Structure

DELIVERABLES:

Database Design Document

PHASE 2
MONTHS 2-4

SOFTWARE DESIGN

ACTIVITIES:

Design the Physical Structure
of the IMS System

DELIVERABLES:

Software Design Document

REQUIREMENTS FOR SUCCESSFUL IMPLEMENTATION OF ProMIS

Approval of the IMSP

Approval of the Concept

Approval of the SQAP

Commitment of Resources

FUTURE OF INFORMATION MANAGEMENT AT YMP

WITH RAD

Temporary disruption of information system support

Clearly defined IRM Baseline

Uniform Reporting System

Enhanced Quality & Change Control

Consumption of fewer resources per request

Ability to respond to requests for data

WITHOUT RAD

Continous, slow, unstructured and expensive system support

Indeterminate IRM Baseline

Redundant and incompatible data bases

Ineffective Change Control System (no defined baseline for evaluation)

Exponentially increasing resources requirements

Unable to satisfy data requirements

RESOURCE REQUIREMENTS

- ESTIMATED RESOURCES
  - Four FTEs dedicated to RAD

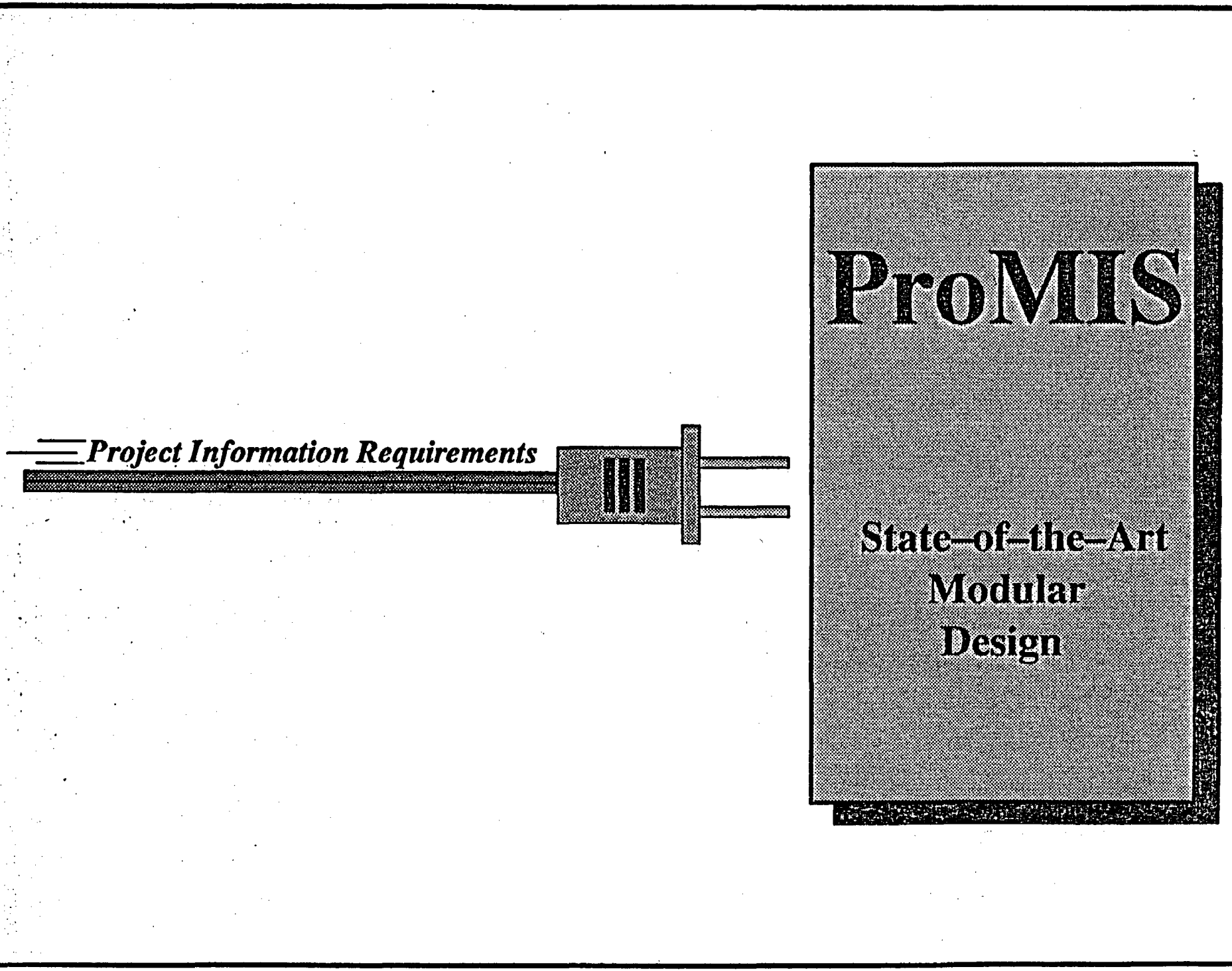
    3 Systems Analyst
    1 Computer Scientist
    1 Data Administrator
  - Technical Writers & Specialized Engineers
  - YMP personnel to provide on-going support
  - Equipment & Software: $40K

Overall Cost of 13-month RAD effort: $685K

RESOURCE REQUIREMENTS

- PERSONAL MANAGEMENT INVOLVEMENT
  - Adherence to IMSP
  - Management support of schedules
  - Timely provision of guidance and feedback
  - Personal involvement
  - Appointment of appropriate management contacts
  - Assignment of priority to ProMIS activities

"The real problem, in my opinion, is that most American organizations have not yet made a fundamental commitment to quality and productivity over the entire life cycle of the system."


Project Information Requirements
ProMIS
State–of–the–Art
Modular
Design

EXISTING CONDITIONS

- Normal Growth Patterns
- No Established Baselines
- Poorly Defined Operating Procedures
- No Established Software Development Life Cycle

RESULTING SITUATION

- Numerous Standalone Systems
- Overlapping Requirements
- Duplicated Data Bases
- Inefficient Use of Hardware & Software Resources
- Cross–correlation of Data Not Possible
- Management Decisions Difficult to Make

YUCCA MOUNTAIN PROJECT IRM APPROACH

- Information Management Systems Plan
- Identify Functional Requirements (RAD)
- Establish IRM Baseline (RAD)
- Analyze and Design (RAD ⟶ ProMIS)

DEVELOP OVERALL INFORMATION MANAGEMENT SYSTEM PLAN (IMSP)

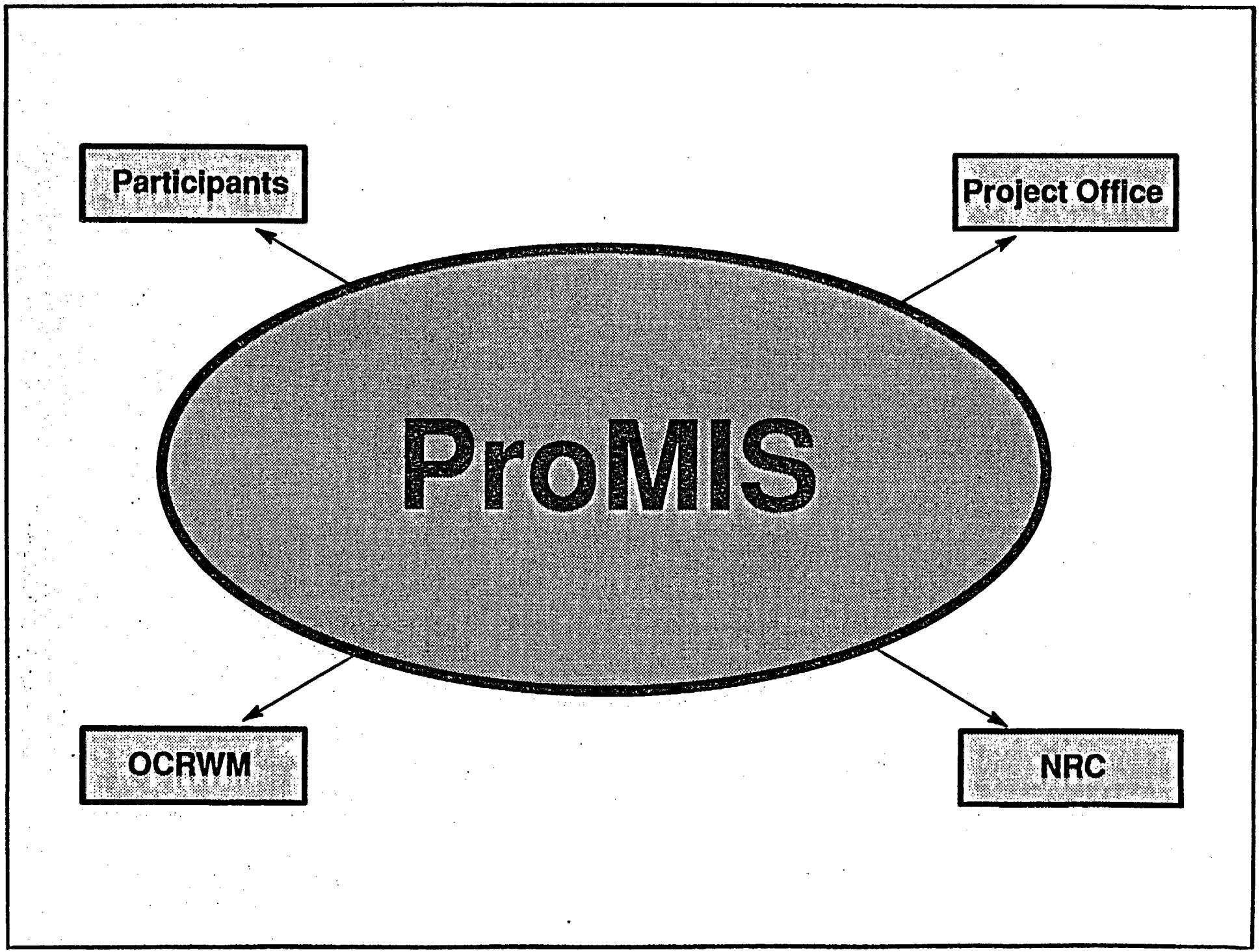
- IRM Resources Baseline
- IRM Long Range Plans
- IRM Work Authorization
- Status Report and Reviews
- IRM Change Control
- IRM Quality Assurance
- IRM Program Reviews

ProMIS

". . . a comprehensive Project information system . . ."

Carl P. Gertz, Yucca Mountain Project Manager, September 1989

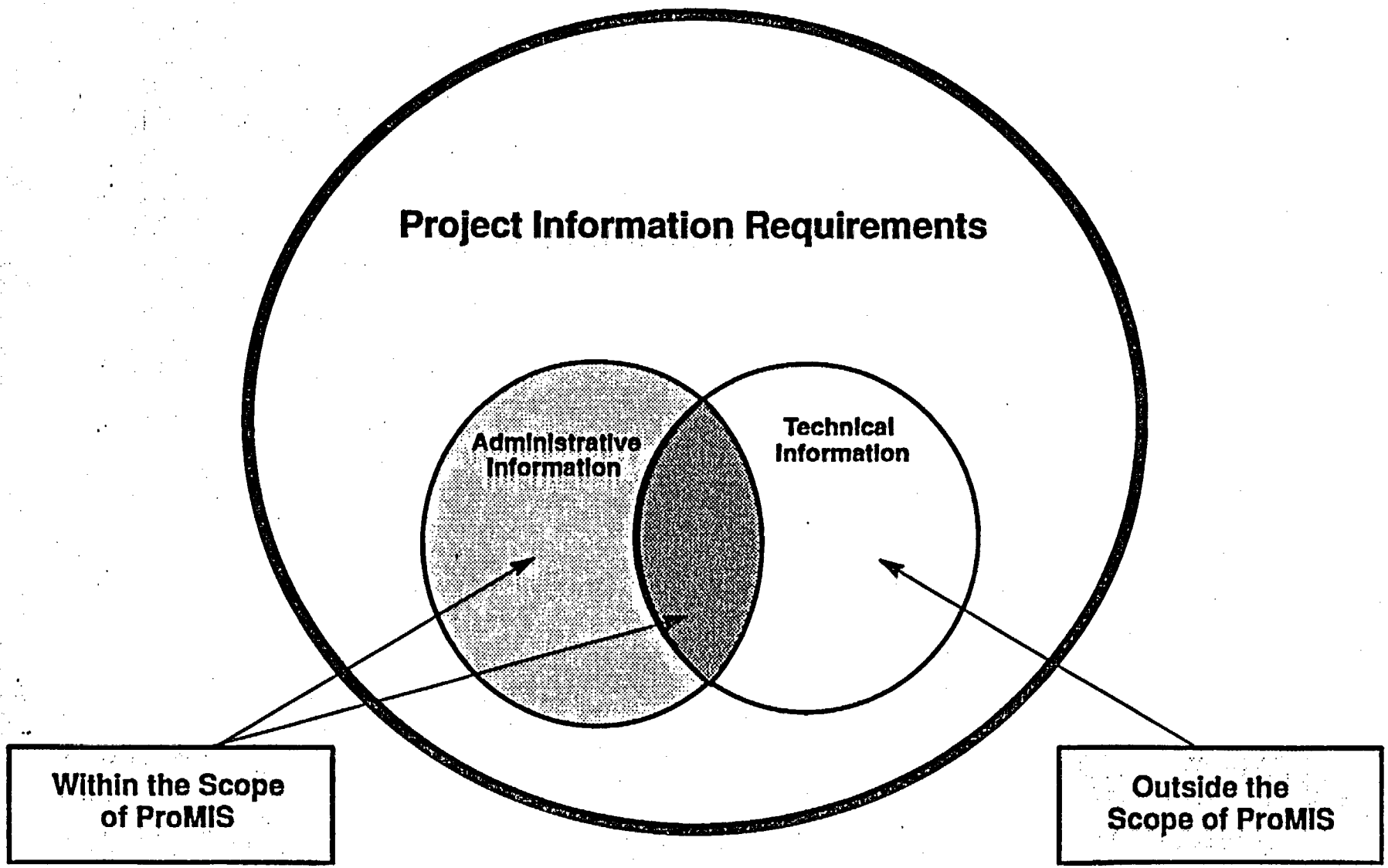
- **Integrated Project Systems**
- **Consistent Information**
- **Uniform Reporting**
- **Uniform User Interfaces**
- **Efficient Resource Use**


Participants
Project Office
ProMIS
OCRWM
NRC

SCOPE

- **Entire Range of Project Management/Administrative Information**
  - **Traditional Areas of Management**
  - **References to Technical Data**
  - **Retrieval of Results from Technical Tasks**

SIMPLIFIED YUCCA MOUNTAIN PROJECT INFORMATION MODEL

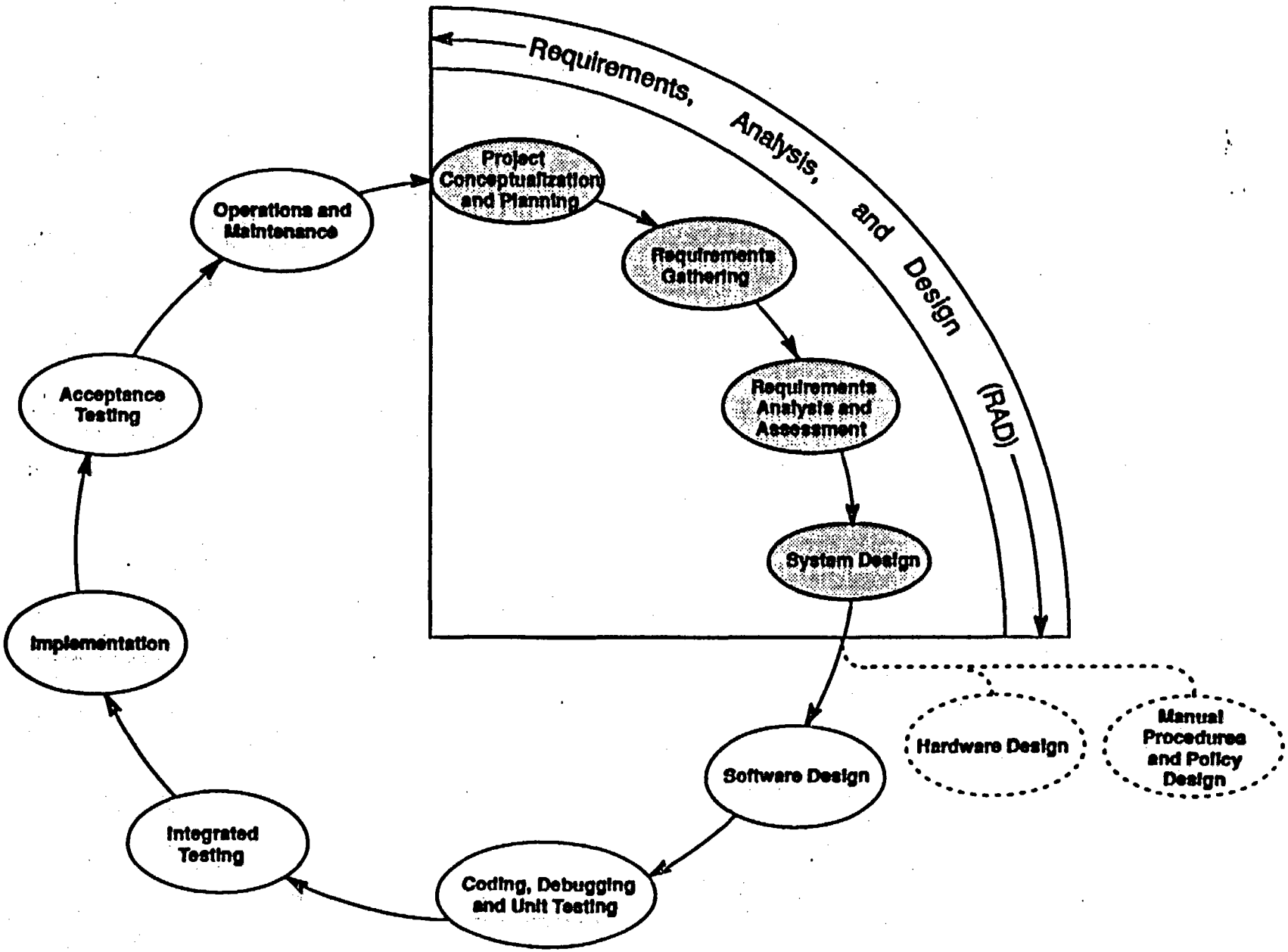


RAD

ProMIS Requirements, Analysis, and Design

- Flow of Information
- Information Requests
- Critical Project Factors
- Implement

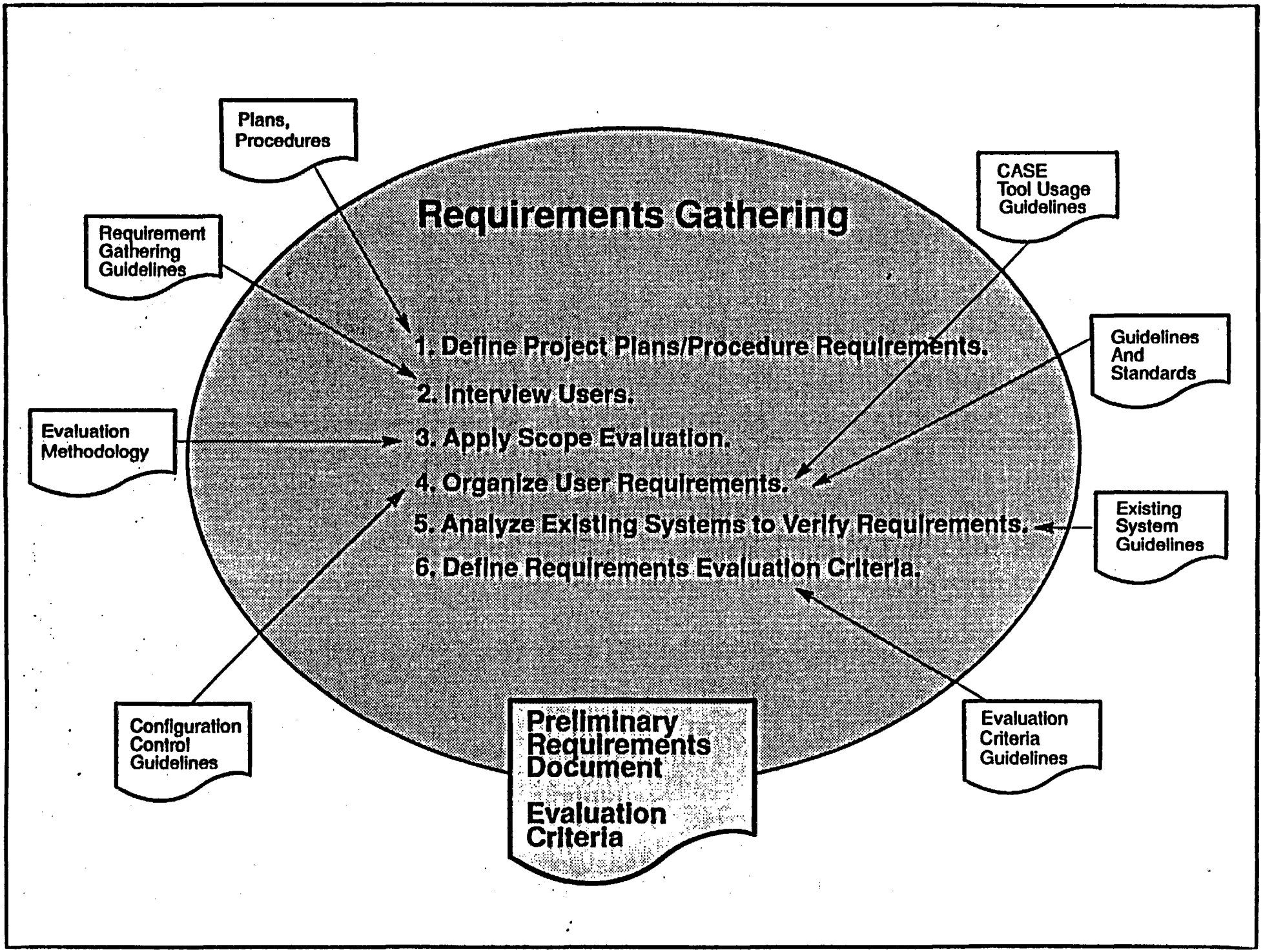
RAD PORTION OF PROMIS LIFE CYCLE

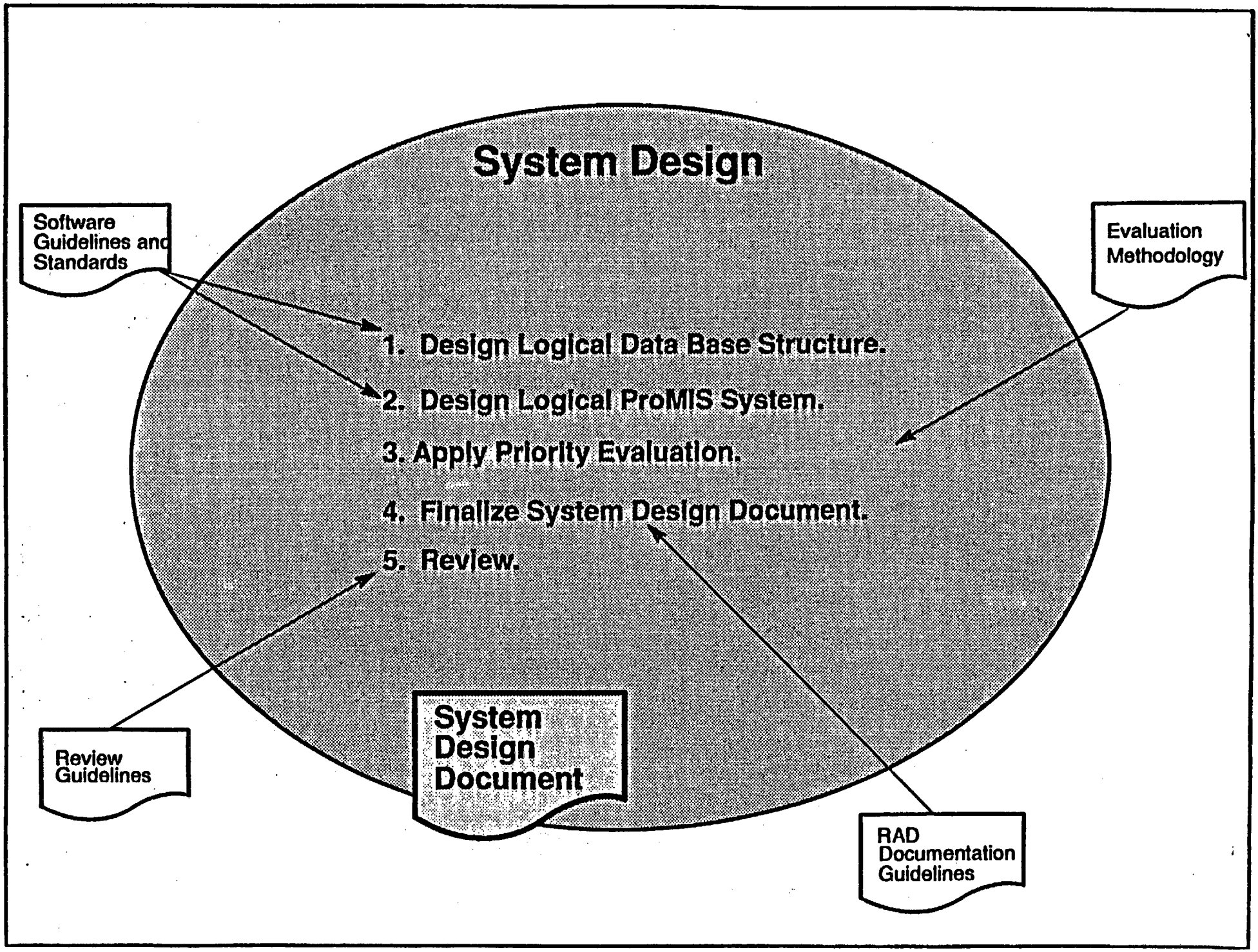



Project
Conceptualization and Planning
(Background and Guidelines)
1. Define RAD Work Definition Structure. (WBS)
2. Analyze Project Organization, Information Requirements, Current Information Systems, . . .
3. Define Project Environmental Constraints.
4. Standards/Conventions.
5. RAD Task Guidelines.
6. Yucca Mountain Project Information Model.
RAD Planning Document
Guidelines and Standards

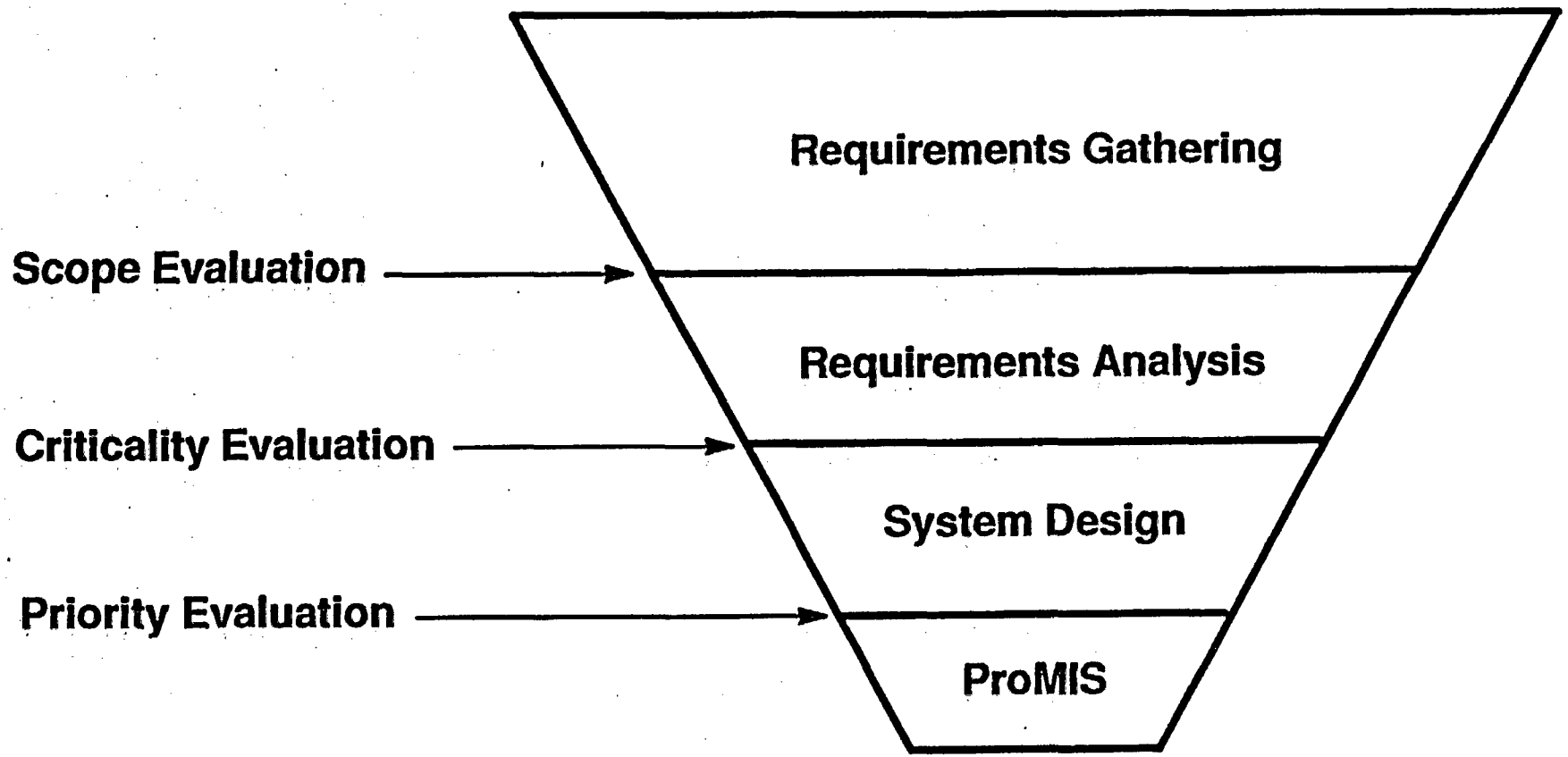
RAD PLANNING DOCUMENT

- A Living Document
- Controlled Baseline
- Background and Guidelines
- Uniformity of Products
- Increased Productivity
- Facilitates Task Startup


Plans, Procedures
Requirement Gathering Guidelines
Evaluation Methodology
Configuration Control Guidelines
CASE Tool Usage Guidelines
Guidelines And Standards
Existing System Guidelines
Evaluation Criteria Guidelines
Requirements Gathering
1. Define Project Plans/Procedure Requirements.
2. Interview Users.
3. Apply Scope Evaluation.
4. Organize User Requirements.
5. Analyze Existing Systems to Verify Requirements.
6. Define Requirements Evaluation Criteria.
Preliminary Requirements Document
Evaluation Criteria

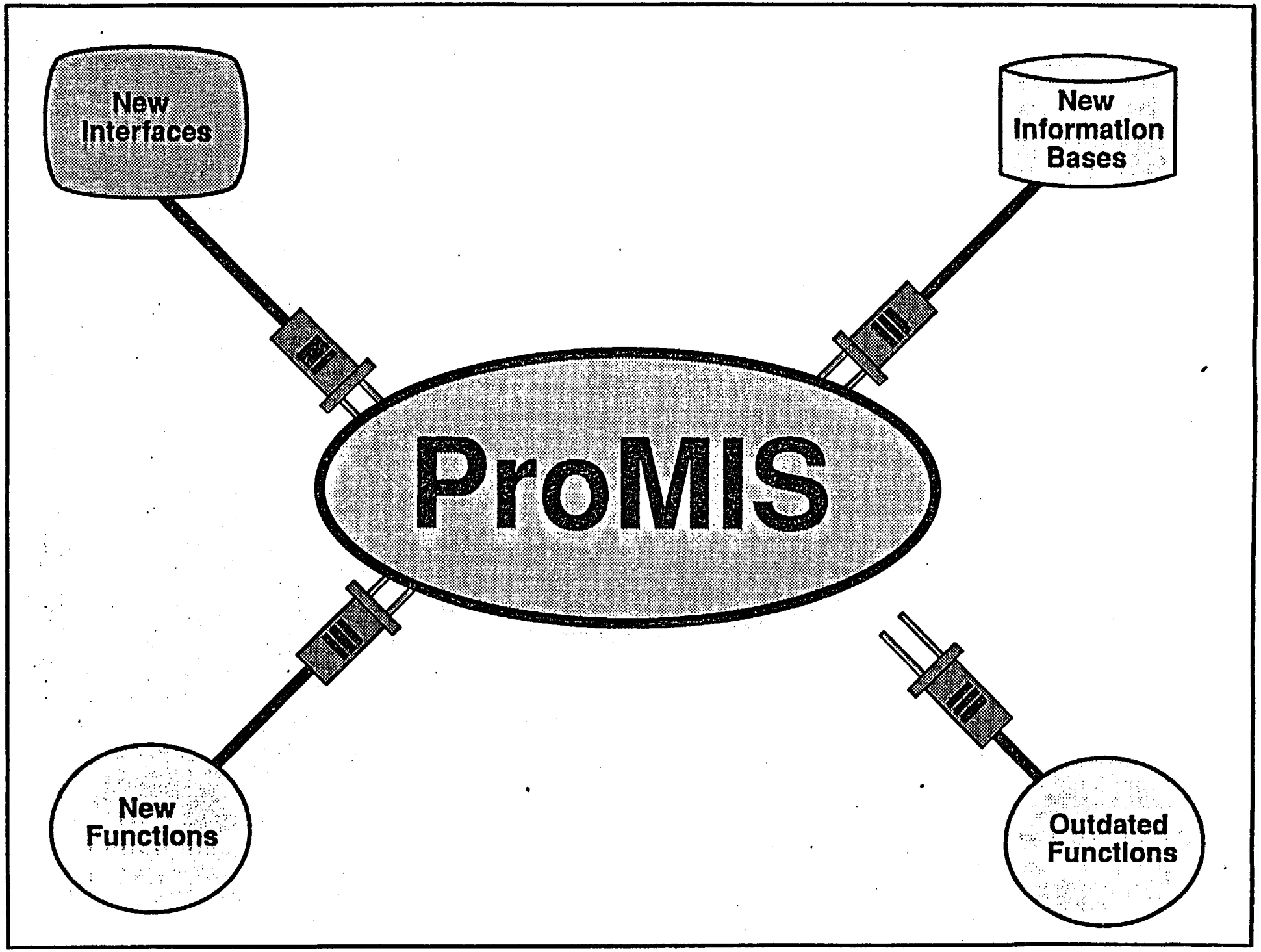

System Design
Software Guidelines and Standards
Evaluation Methodology
1. Design Logical Data Base Structure.
2. Design Logical ProMIS System.
3. Apply Priority Evaluation.
4. Finalize System Design Document.
5. Review.
System Design Document
Review Guidelines
RAD Documentation Guidelines

REQUIREMENTS EVALUATION FUNNEL



RAD TEAM AND SPAN OF PARTICIPANT INVOLVEMENT

RAD TEAM / RAD ACTIVITIES	RAD PLANNING	REQUIREMENTS GATHERING	EVALUATION GATES DEFINITION	REQUIREMENTS ANALYSIS	DATA SOURCE DEFINITION	DATABASE DESIGN	SYSTEM DESIGN	REVIEWS	GENERAL CONSULTATION
RAD Manager	X	X	X	X	X	X	X	X	X
Background Team	X							X	
Interview Team		X			X			X	
Evaluation Team (Analysts)				X				X	
Data Base Design Team (Database Analysts)						X	X	X	
System Design Team (Systems Analysts)						X	X	X	
Project Office	X	X	X				X	X	X
Project Integrators		X	X	X					X
RAD Representative	X	X	X		X		X	X	X
Participant Management	X	X	X					X	X
Users		X			X		X	X	


New Interfaces
New Information Bases
ProMIS
New Functions
Outdated Functions

ESF ALTERNATIVE STUDY

PRESENTED BY

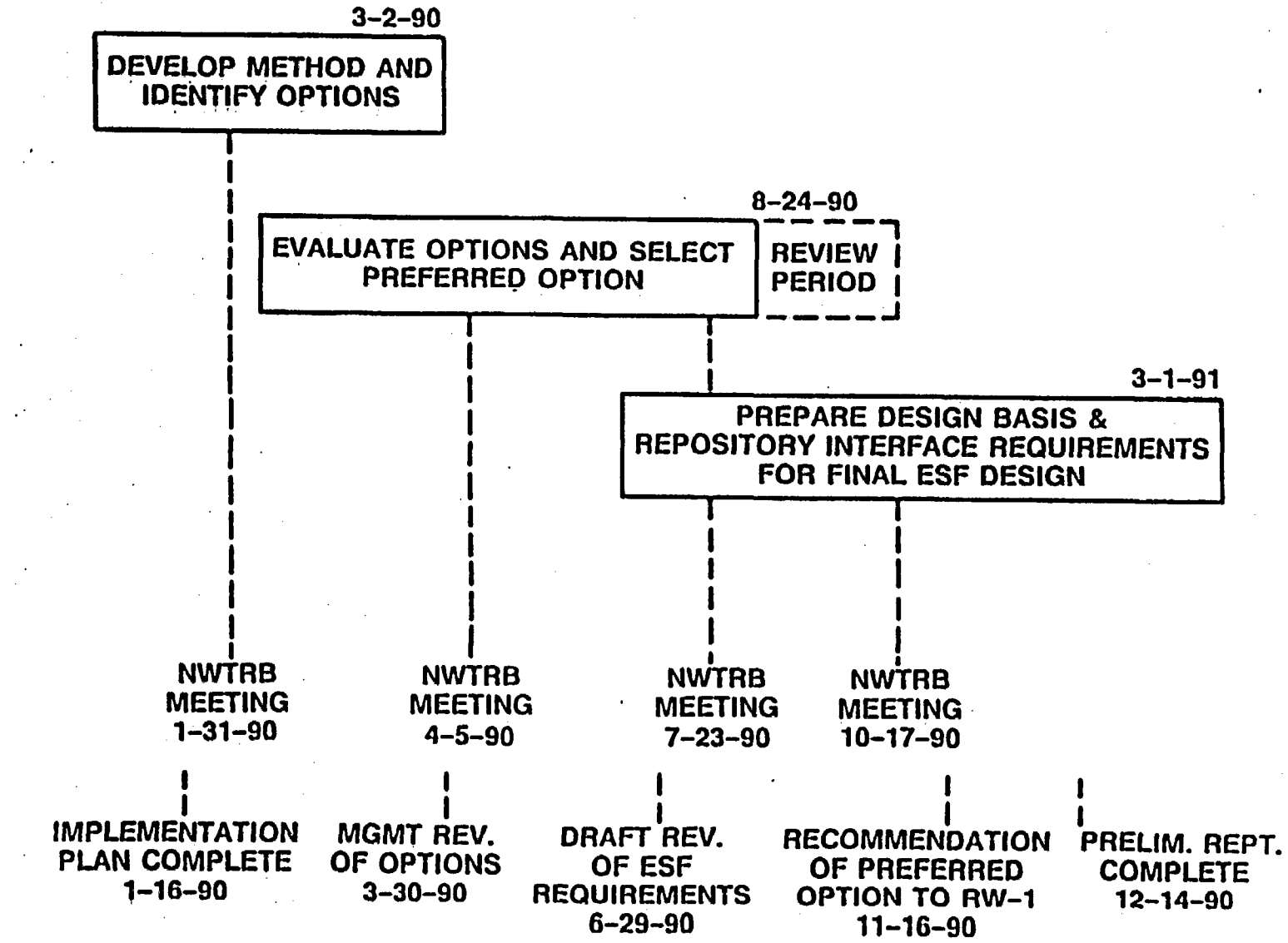
TOM HUNTER
SANDIA NATIONAL LABORATORIES

FEBRUARY 2, 1990

U.S. DEPARTMENT OF ENERGY

YUCCA MOUNTAIN PROJECT

ESF ALTERNATIVE STUDY



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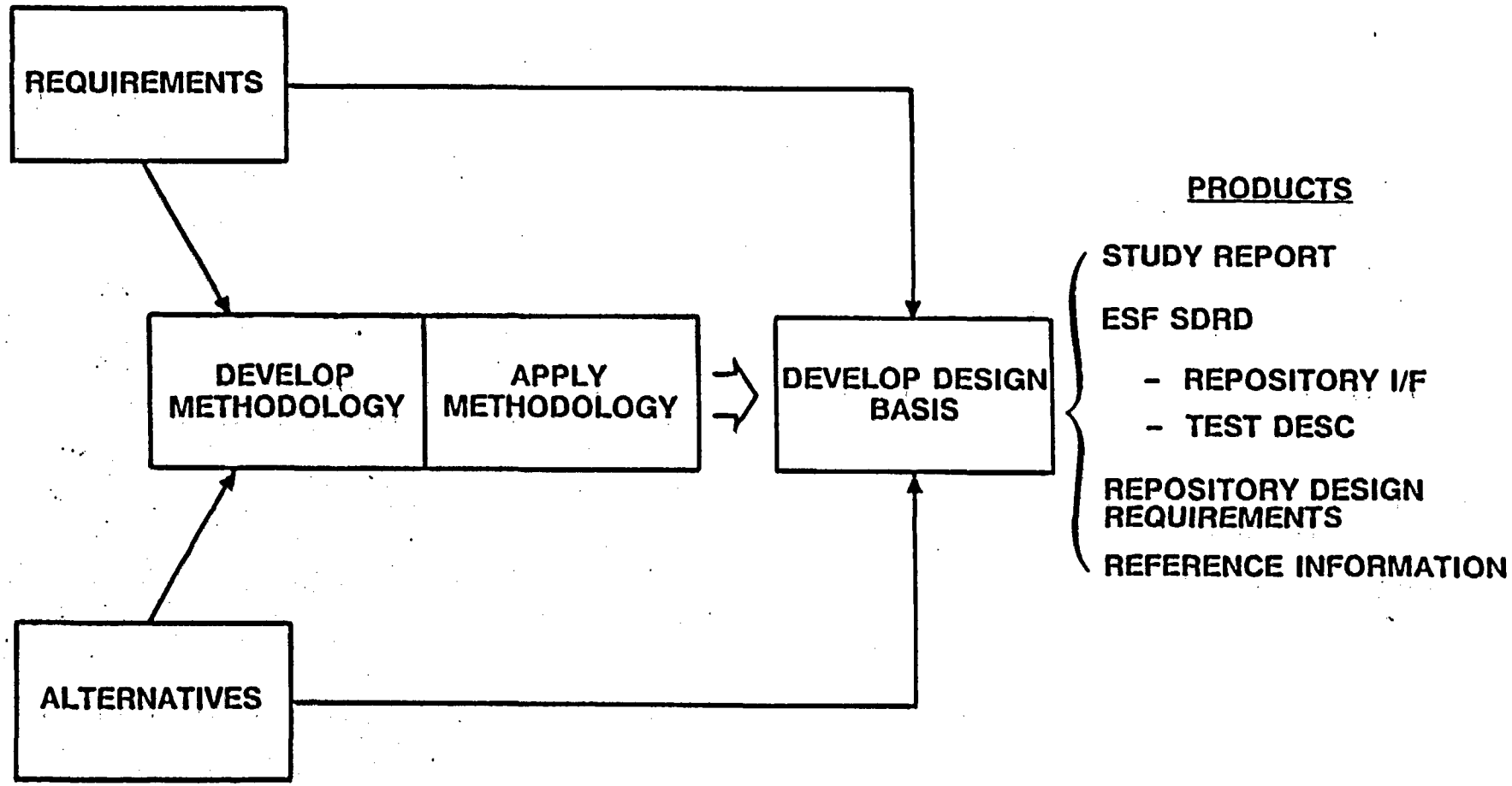
ESF ALTERNATIVES STUDY



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REQUIREMENTS

REGULATORY

- MINIMIZE ADVERSE IMPACTS
- EVALUATE DESIGN ALTERNATIVES

OPERATIONAL

- ACCESS
- VENTILATION
- ESF USES IN REPOSITORY
- CONSTRUCTION EFFICIENCY

CHARACTERIZATION

- PROVIDE FOR SCP ESF TESTS
- EVALUATION OF OTHER SITE FEATURES
- FLEXIBILITY FOR EXPANSION
- REPRESENTATIVE OF SITE

BASIS FOR OBJECTIVES IN METHODOLOGY

OBJECTIVES MAY BE COMPETING

SEEK A BALANCE

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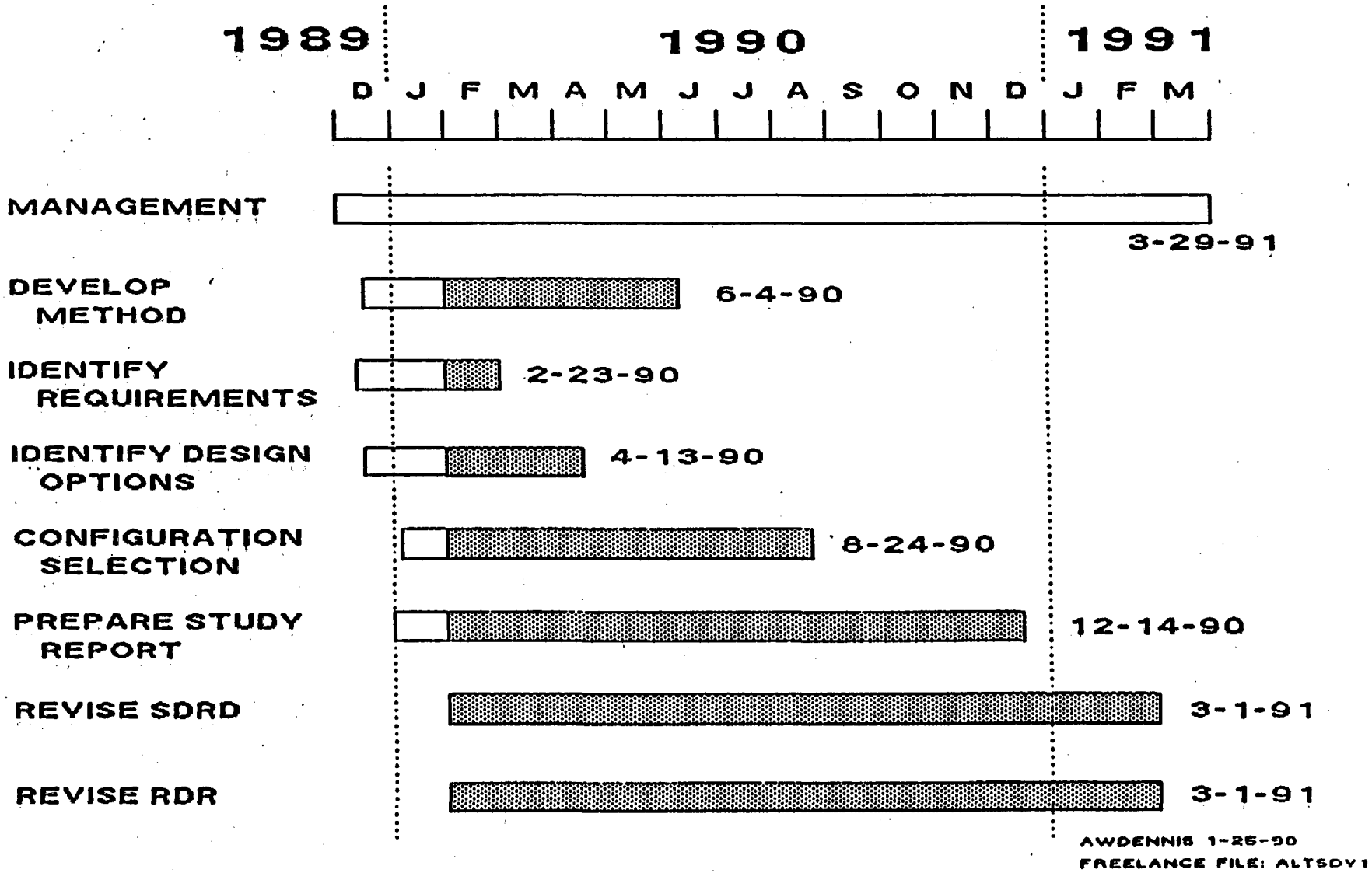
ESF ALTERNATIVE STUDIES SCHEDULE



AWDENNIS 1-26-90
FREELANCE FILE: ALTSDY1

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YUCCA MOUNTAIN PROJECT

ELEMENTS OF THE DECISION PROCESS

FORMALIZED DECISION-AIDING METHODOLOGY

DIRECT INCORPORATION OF 10 CFR PART 60 REQUIREMENTS

INTEGRATED REPOSITORY AND ESF CONFIGURATION

QA CONTROLLED PROCESS

INDEPENDENT REVIEW

WELL-ESTABLISHED BASIS FOR PREFERRED ESF/ REPOSITORY DESIGN

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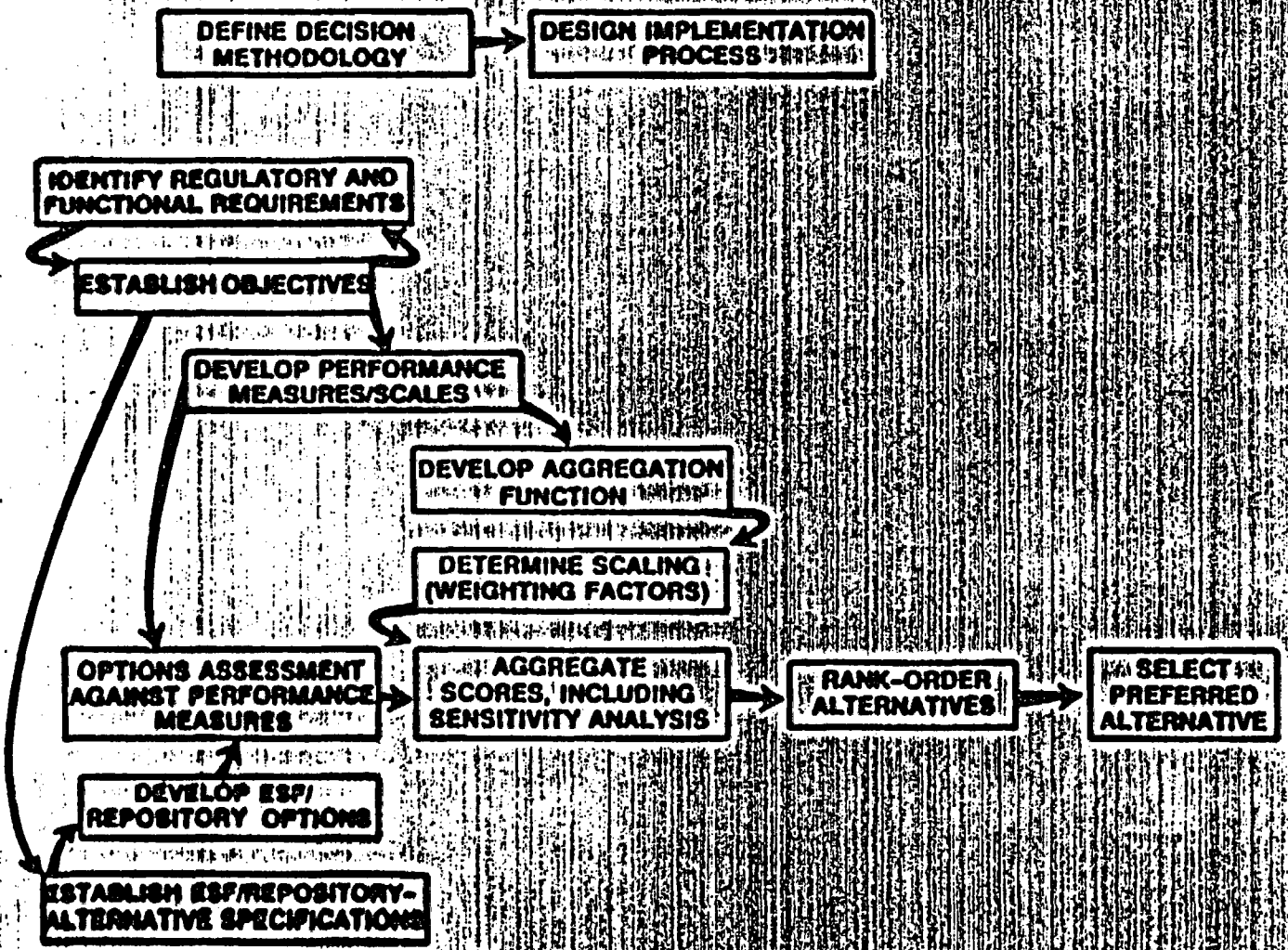
DECISION METHODOLOGY



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YUCCA MOUNTAIN PROJECT

PRELIMINARY DEVELOPMENT OF OBJECTIVES HIERARCHY

- OBJECTIVES WILL CONSIDER
  - SITE CHARACTERIZATION
  - PERFORMANCE IMPACTS
  - COMBINED ESF/REPOSITORY FUNCTIONS
- SPECIFIC OBJECTIVES WILL INCLUDE CONSIDERATION OF
  - POSTCLOSURE RADIOLOGICAL IMPACTS ON HEALTH AND SAFETY
  - PRECLOSURE RADIOLOGICAL AND NONRADIOLOGICAL IMPACTS ON HEALTH AND SAFETY
  - SOCIOECONOMIC IMPACTS
  - ENVIRONMENTAL IMPACTS
  - COST (AND SCHEDULE) IMPACTS
  - IMPACTS ON SITE CHARACTERIZATION ACTIVITIES
  - IMPACTS ON REPOSITORY CONSTRUCTION AND OPERATION
  - IMPACTS ON EXPECTED LICENSABILITY OF REPOSITORY

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YUCCA MOUNTAIN PROJECT

EXAMPLE FACTORS RELATED TO OBJECTIVES

OBJECTIVE	FACTORS
SITE CHARACTERIZATION	▪ FEASIBILITY TO PERFORM TESTS ▪ INTERFERENCE BETWEEN AND AMONG TESTS ▪ IMPACT OF CONSTRUCTION TECHNIQUES ▪ REPRESENTATIVENESS OF CHARACTERIZATION

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YUCCA MOUNTAIN PROJECT

METHODOLOGY WILL INCLUDE

1. EXPERT PANELS
2. INDEPENDENT REVIEW
3. PILOT STUDY

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ESF/REPOSITORY ALTERNATIVES

CHARACTERISTICS OF ALTERNATIVES

1. LOCATION AND NUMBER OF ACCESSES
2. ACCESS METHOD AND SIZES
3. CONSTRUCTION METHOD
4. TEST AREA CONFIGURATION
5. FUNCTIONS WITH REPOSITORY

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YUCCA MOUNTAIN PROJECT

APPROACH TO DEFINING ALTERNATIVES

REVIEW PRIOR ALTERNATIVES

GUIDANCE BASED ON:

- CURRENT REPOSITORY CONCEPTUAL DESIGN
- CONSTRAINTS

NUMEROUS ALTERNATIVES LIKELY

- CONSIDER OPTIONS FOR THIS MAJOR REPOSITORY COMPONENT
- SCREEN DOWN TO REPRESENTATIVE FEW

PREFERRED ALTERNATIVE WILL BE DEVELOPED AS DESIGN BASIS

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EXAMPLE COMBINATIONS FOR PILOT STUDY

1. SCP/CDR (2 SHAFTS)
2. CDR MODIFIED (1 RAMP, 1 SHAFT)
3. TBM LAYOUT (NORTHERN ESF LOCATION)
4. TBM LAYOUT (SOUTHERN ES)

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SUMMARY

- THE ESF ALTERNATIVE STUDY IS REEVALUATING THE ESF/REPOSITORY CONFIGURATION TO ESTABLISH A DESIGN BASIS FOR ESF FINAL (TITLE II) DESIGN
- THE CURRENT CONFIGURATION FOR THE ESF HAS TWO CONVENTIONALLY MINED SHAFTS. THE CURRENT REPOSITORY DESIGN HAS TWO ADDITIONAL SHAFTS AND TWO RAMPS FOR ACCESS
- PREVIOUS STUDIES HAVE EXAMINED THE ESF LOCATION, CONSTRUCTION METHOD, AND ACCESS TYPE. THE STUDIES DID NOT SPECIFICALLY ADDRESS THE PERFORMANCE REQUIREMENTS OF THE NRC, NOR EMPHASIZE INTEGRATION WITH THE REPOSITORY, AND WERE NOT DONE UNDER THE CURRENT QA PROGRAM
- THE ALTERNATIVE STUDY WILL EVALUATE A RANGE OF ALTERNATIVES OF SHAFTS, RAMPS, CONSTRUCTION METHODS, AND LOCATIONS
- FOR REPOSITORY AND ESF REGULATORY, OPERATIONAL, AND SITE CHARACTERIZATION REQUIREMENTS WILL BE ADDRESSED AS OBJECTIVES FOR A DECISION PROCESS EMPLOYING A DECISION AIDING METHODOLOGY
- THE ALTERNATIVE STUDY INCLUDING THE DECISION METHODOLOGY WILL BE PERFORMED UNDER A SUPPORTING QA PROGRAM AND WILL INCLUDE SEVERAL PROJECT PARTICIPANTS AND THE DOE

8.3.1.5.2.1 CHARACTERIZATION OF QUATERNARY REGIONAL HYDROLOGY (PALEOHYDROLOGY)

.1 -- Regional paleoflood evaluation

.2 -- Quaternary unsaturated zone hydrochemical analysis

.3 -- Evaluation of point discharge areas

.4 -- Analog recharge studies
a) chloride ion model
b) arid zone geochemistry

.5 -- *Studies of calcite and opaline silica vein deposits (Hydrogenic Deposits)*

CONTRIBUTING ORGANIZATIONS TO PALEOHYDROLOGY

A. USGS/WRD
   1. NHP
   2. Nevada District
   3. CSM
   4. UNM

B. USGS/GD
   1. BIG
   2. BP&S
   3. BRG

C. LANL

SCIENTIFIC APPROACH

a) Field work

b) Mineralogy

c) Geochemistry

d) Fluid Inclusions

e) Geochronology

f) Tracer Isotopes

g) Stable Isotopes

h) Paleontology

I) Hydrology

j) Data Integration

STATEMENT OF PROBLEM

1. Do any hydrogenic deposits or hydrothermal data have significant implications for repository performance?
   A) Stability of waste package?
   B) Travel time to biosphere?

2. Do any hydrogenic deposits have potential economic implications?

HYDROGENIC DEPOSITS

1. Minerals and mineraloids precipitated from water.

2. Types identified around Yucca Mountain:
   a) Calcite and opaline silica
   b) Bedrock breccias
   c) Drusy quartz and other vug fillings

MODES OF ORIGIN FOR HYDROGENIC DEPOSITS

1. **Pedogenic: Deposited by meteoric waters as part of the soil-forming process.**
2. **Cold springs: Groundwater of deep or shallow origin moved along fractures.**
3. **Hydrothermal springs: Water heated by any of several mechanisms & moved up fractures.**
4. **Seismic springs: Hot or cold waters moved along faults as a direct result of faulting.**

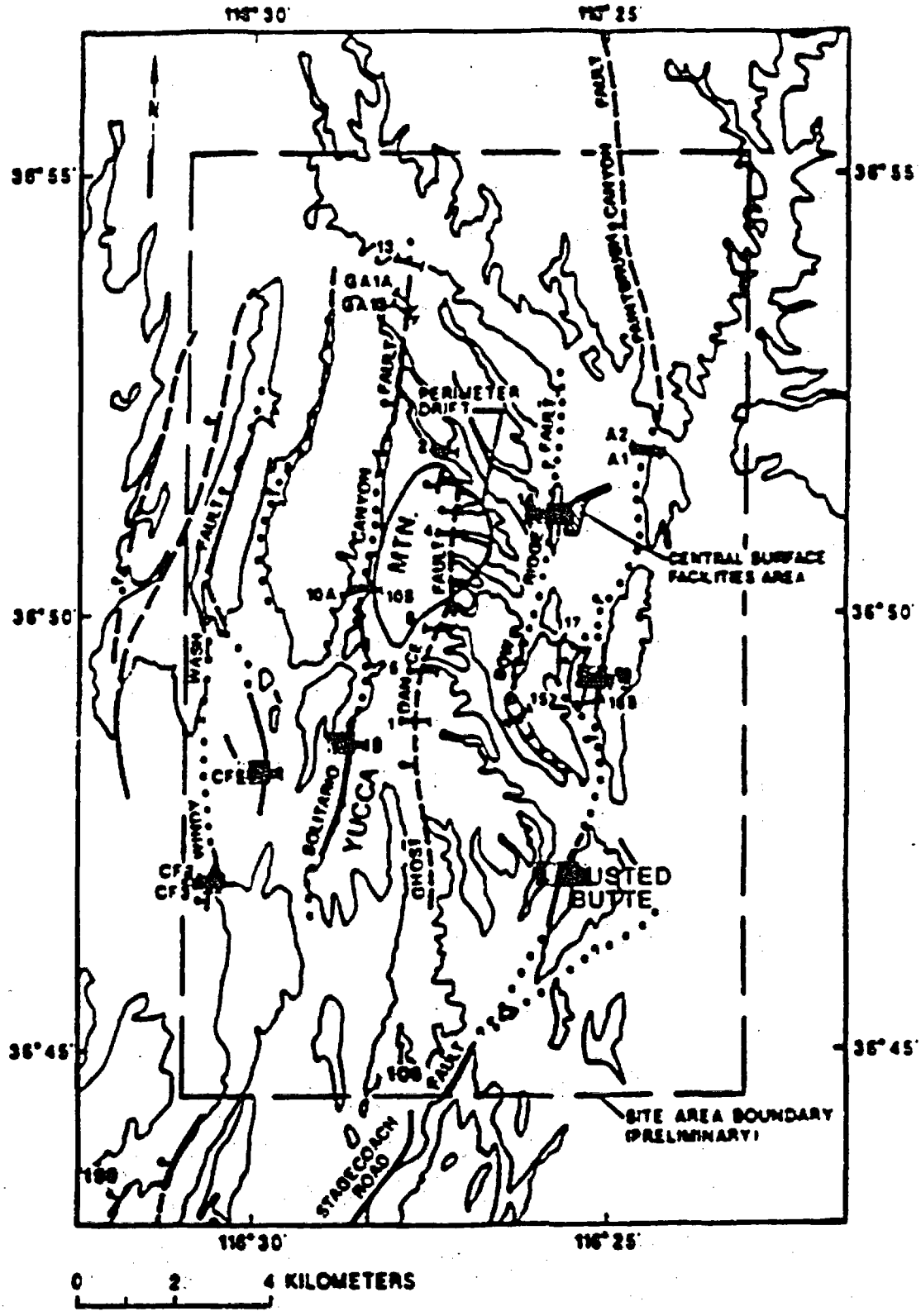
BEDROCK BRECCIAS

2 Categories:

1) Crushed-tuff-matrix breccia

2) Authigenic mineral-cemented breccia

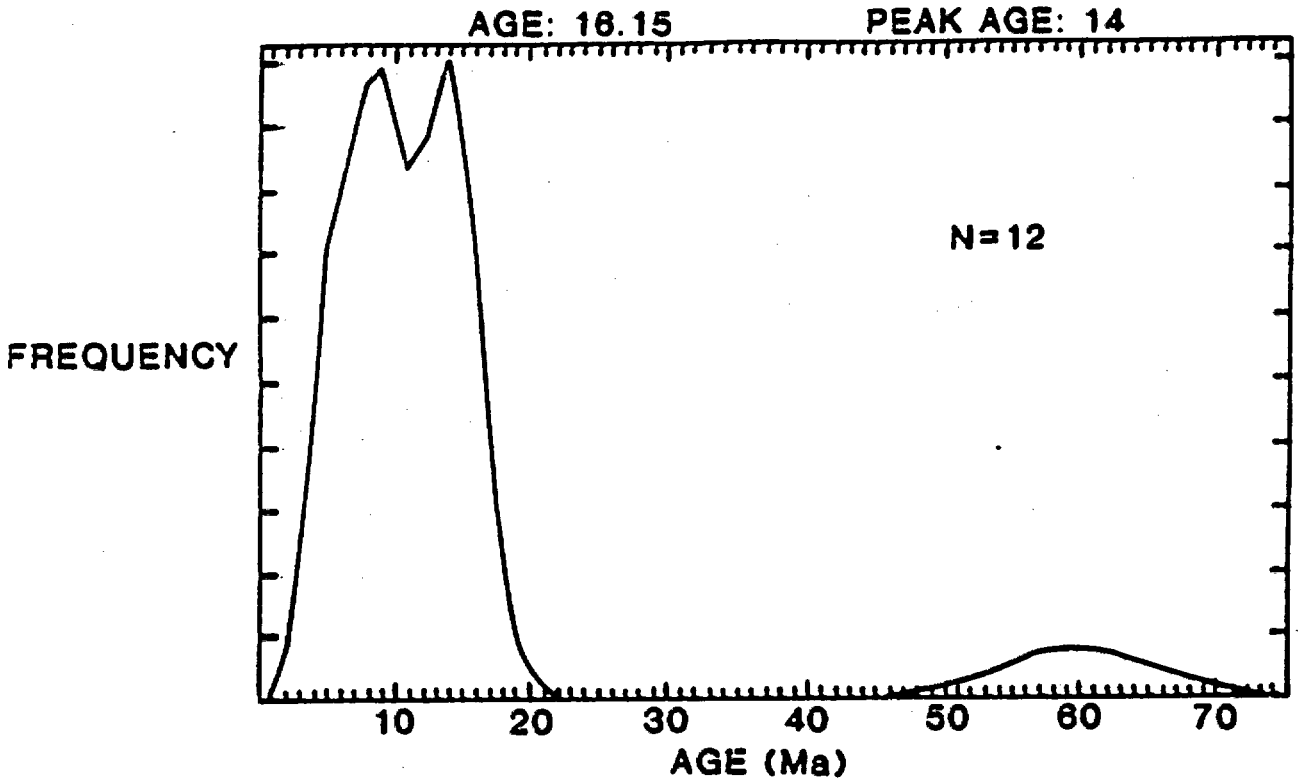
[PICTURE OF CRUSHED-TUFF-MATRIX BRECCIA FOLLOWS.]



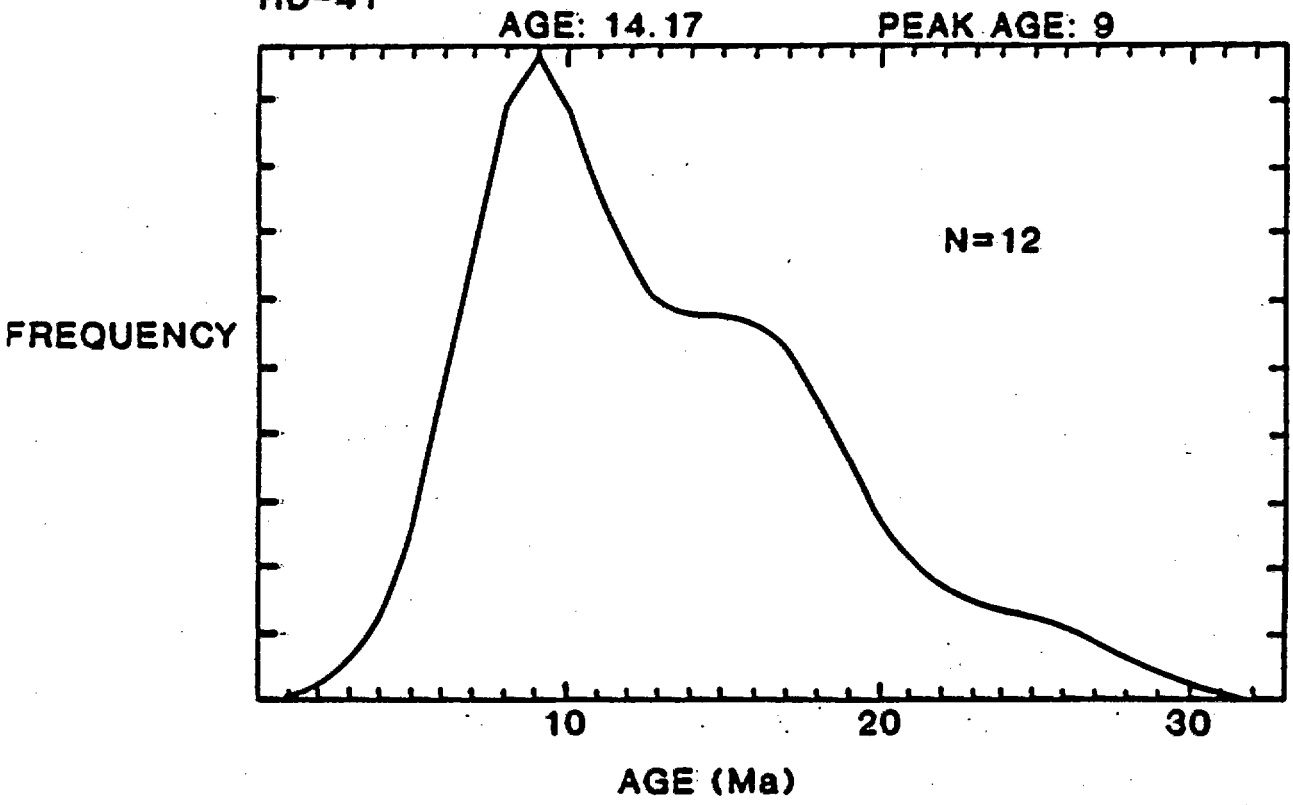
[PICTURE OF SOUTH WALL OF TRENCH 14 FOLLOWS.]

FISSION-TRACK ZIRCON AGES

BUSTED BUTTE HD-74

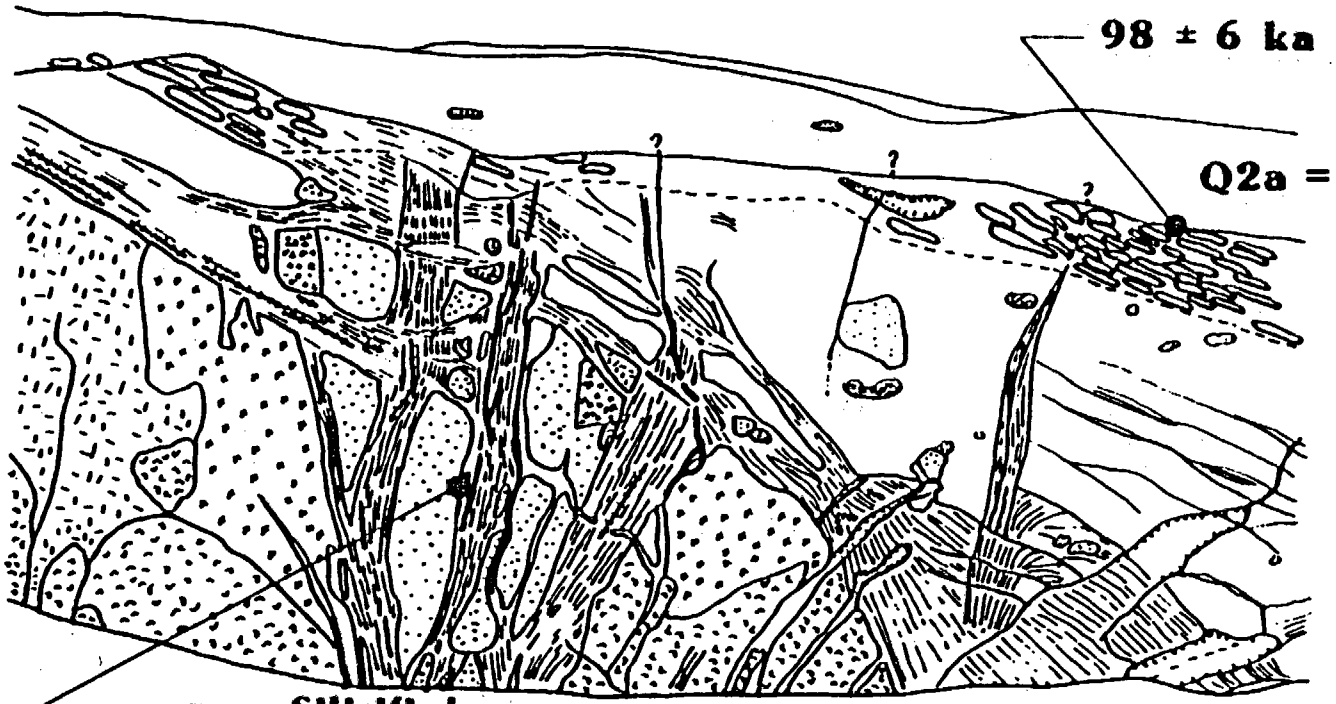


TRENCH 14
HD-41



DEC -8 1989

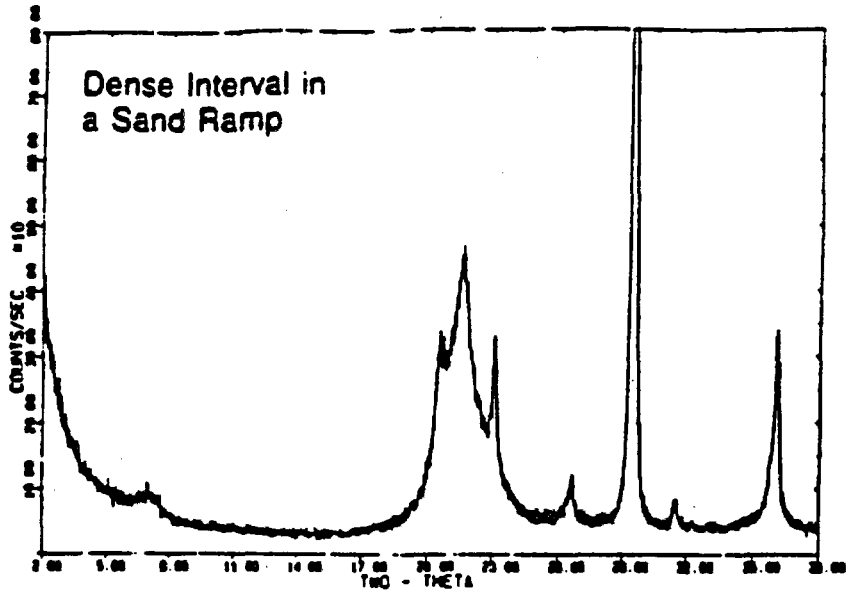
Trench 14, South Wall

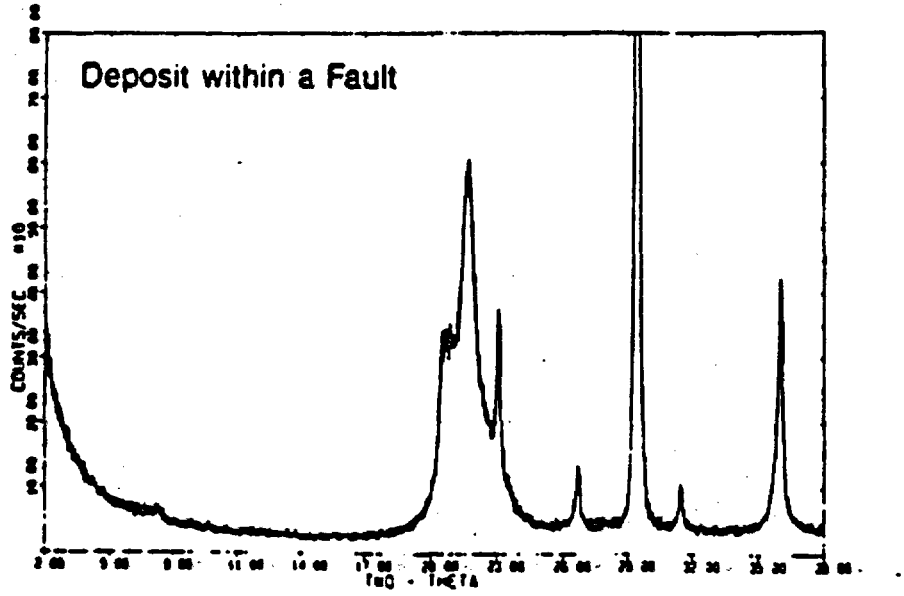


From E.M. Taylor

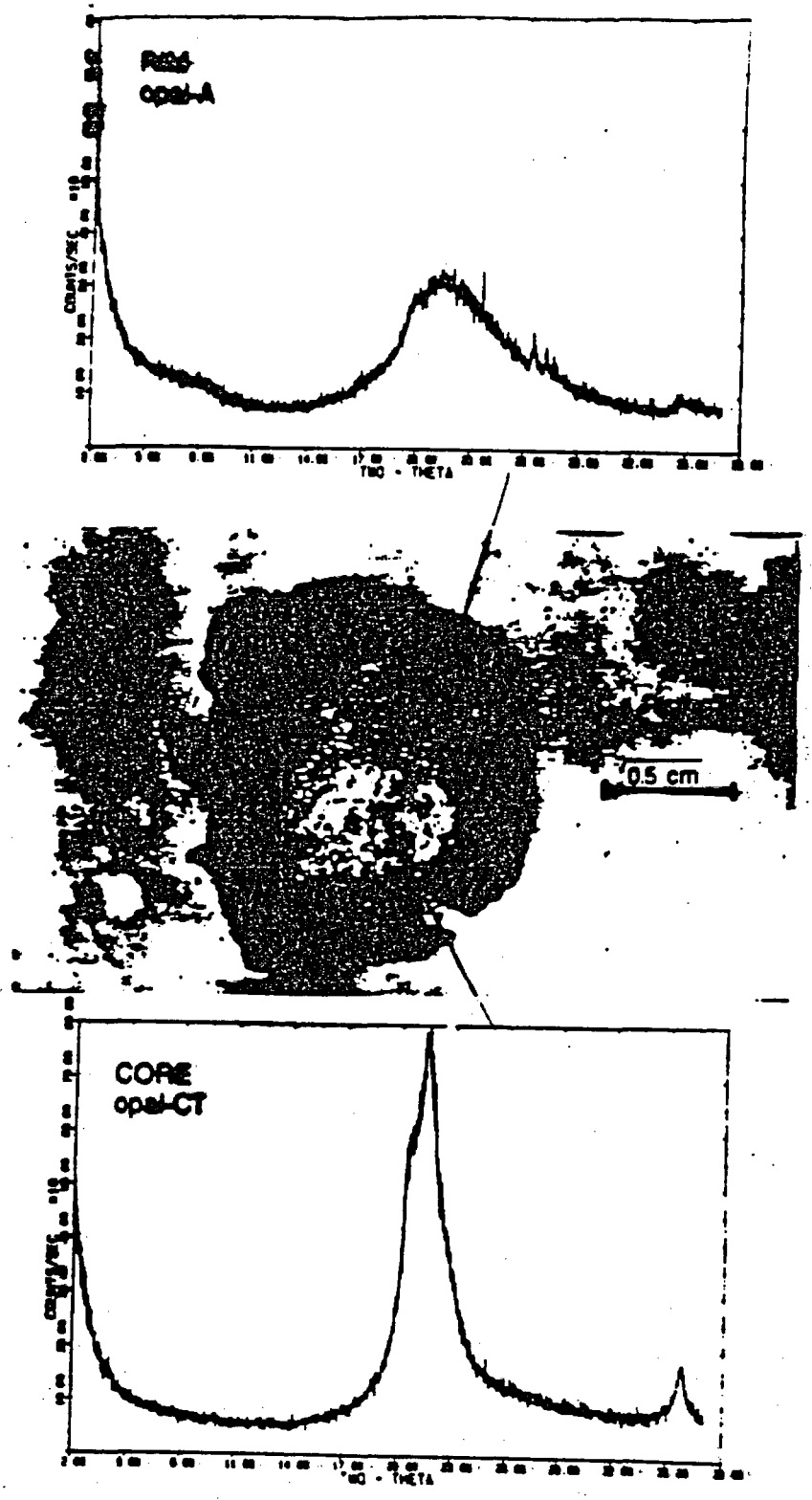
ASSOCIATIONS AND ASSEMBLAGES

	CALCITE	OPAL A	OPAL CT	OPAL C	QUARTZ	SEPIOLITE	CRYPTOMELANE	SULFUR PHASES
HYDROTHERMAL VEINS	X			X	X		X	
WARM SPRINGS		X						X
COLD SPRINGS AND SEEPS	X		X		X	X		
SOILS	X		X					
SAND RAMPS	⊗	⊗	⊗			⊗		
FAULTS	⊗	⊗	⊗			⊗		





[DETAILED PICTURE OF LAMINATED VEIN SHOWING AREAS STUDIED BY THIN SECTION AND PHOTOMICROGRAPH OF ROOT CROSS SECTION FOLLOW.]



"BEST AVAILABLE COPY"

OSTRACODE STUDIES

- Two soil and six vein samples of carbonate from Trench 14 are apparently devoid of ostracodes and mollusks
- Two samples from Busted Butte yield same preliminary results
- Saturated residence time for the area of carbonate deposition must have been less that 2 months.
- Need to look for horizontal areas within veins at Trench 14 and Travertine Point

[PICTURE OF OSTRACODA FOLLOWS.]

CHRYSOPHYTE CYSTS

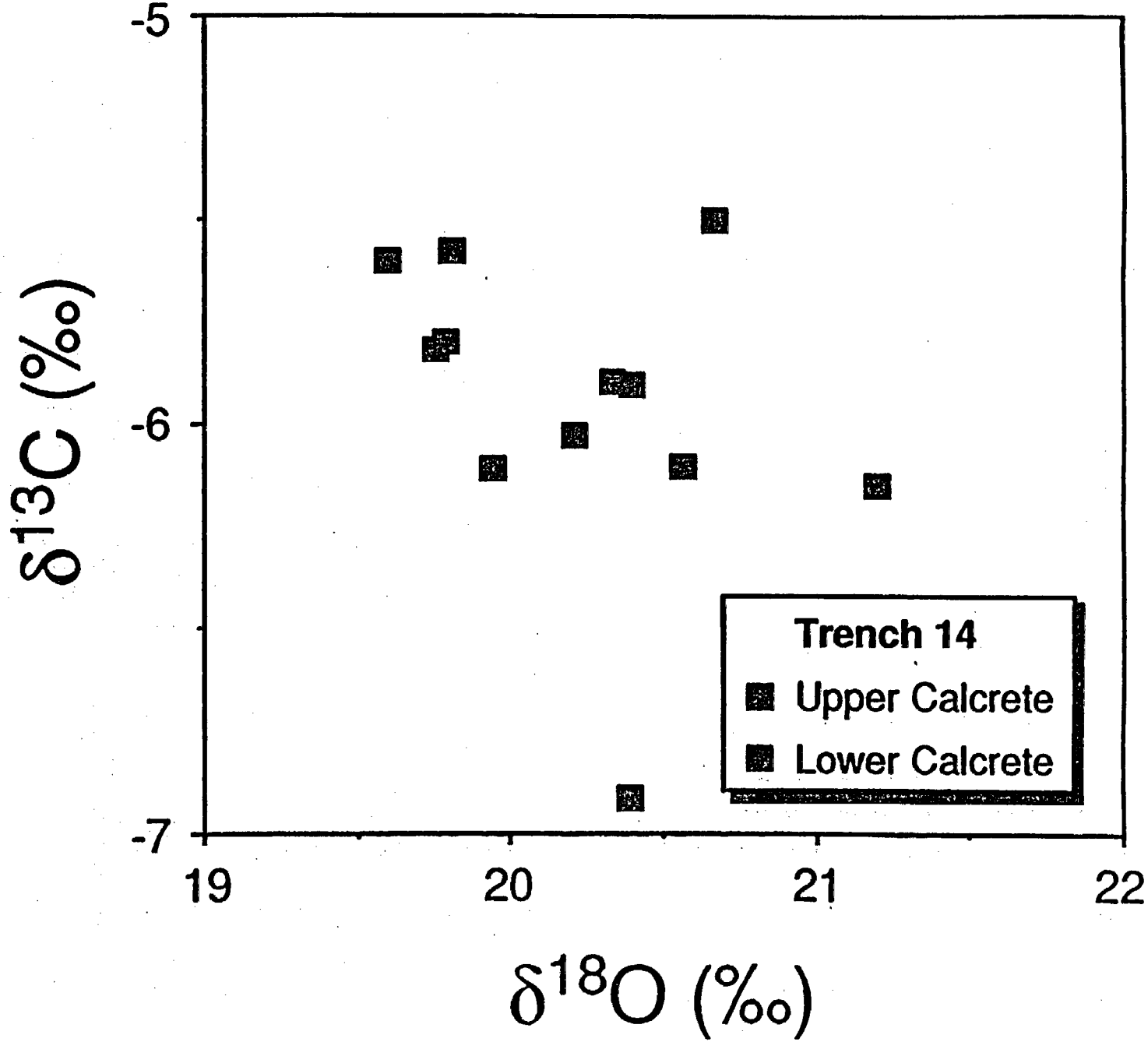
- Opaline silica
- Resting stages of certain chrysophyte algae
- Quite small (2.5-2.0 μm in diameter)
- Wide morphological range
- Hundreds of different forms
- In the modern environment, cysts are far more common in places where relatively dilute surface waters are entering the hydrologic system (recharge areas) than in places where relatively concentrated groundwater is emerging from the hydrologic system (discharge areas).

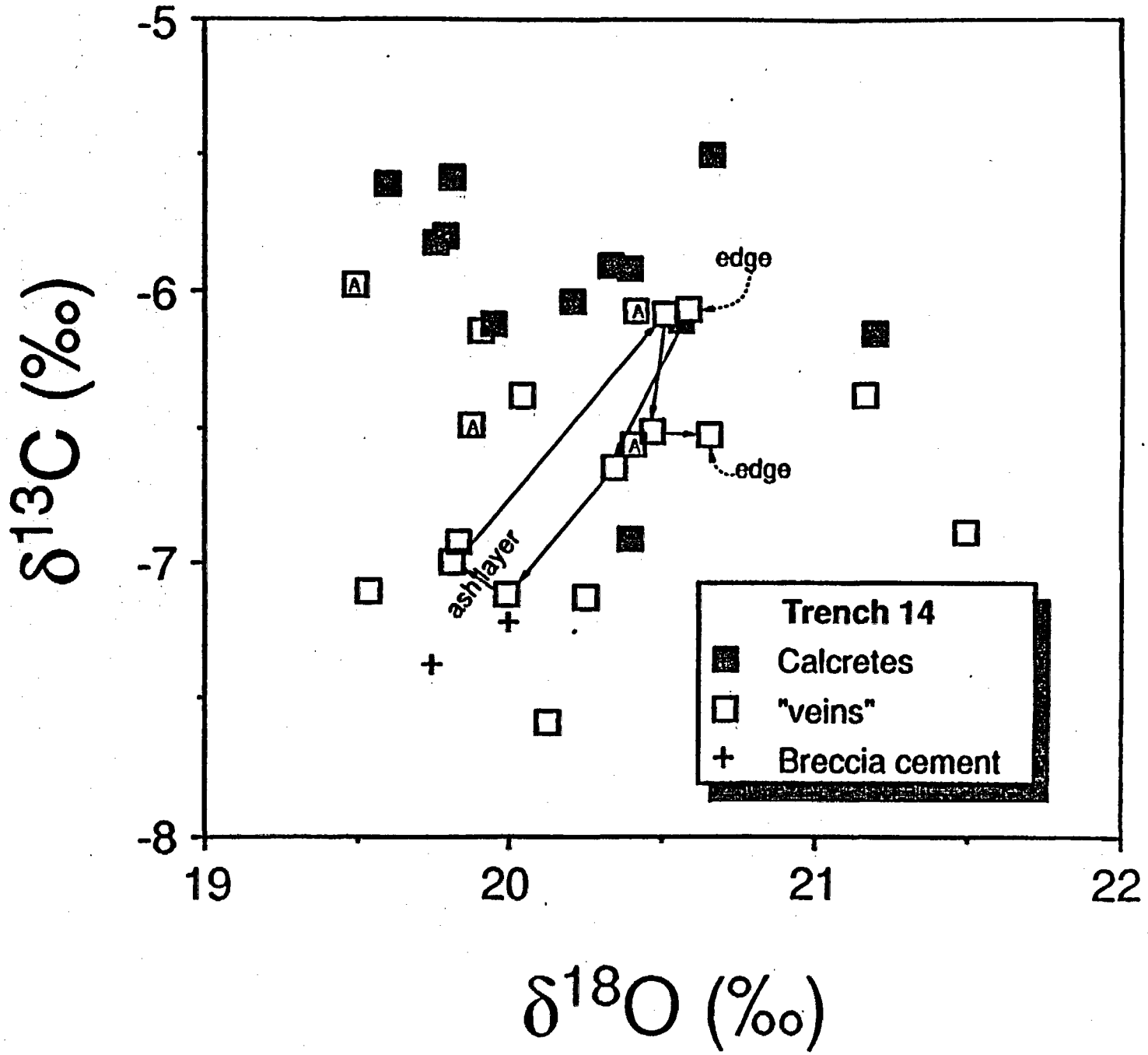
[TWO PICTURES OF CHRYSOPHYTE CYSTS FOLLOW.]

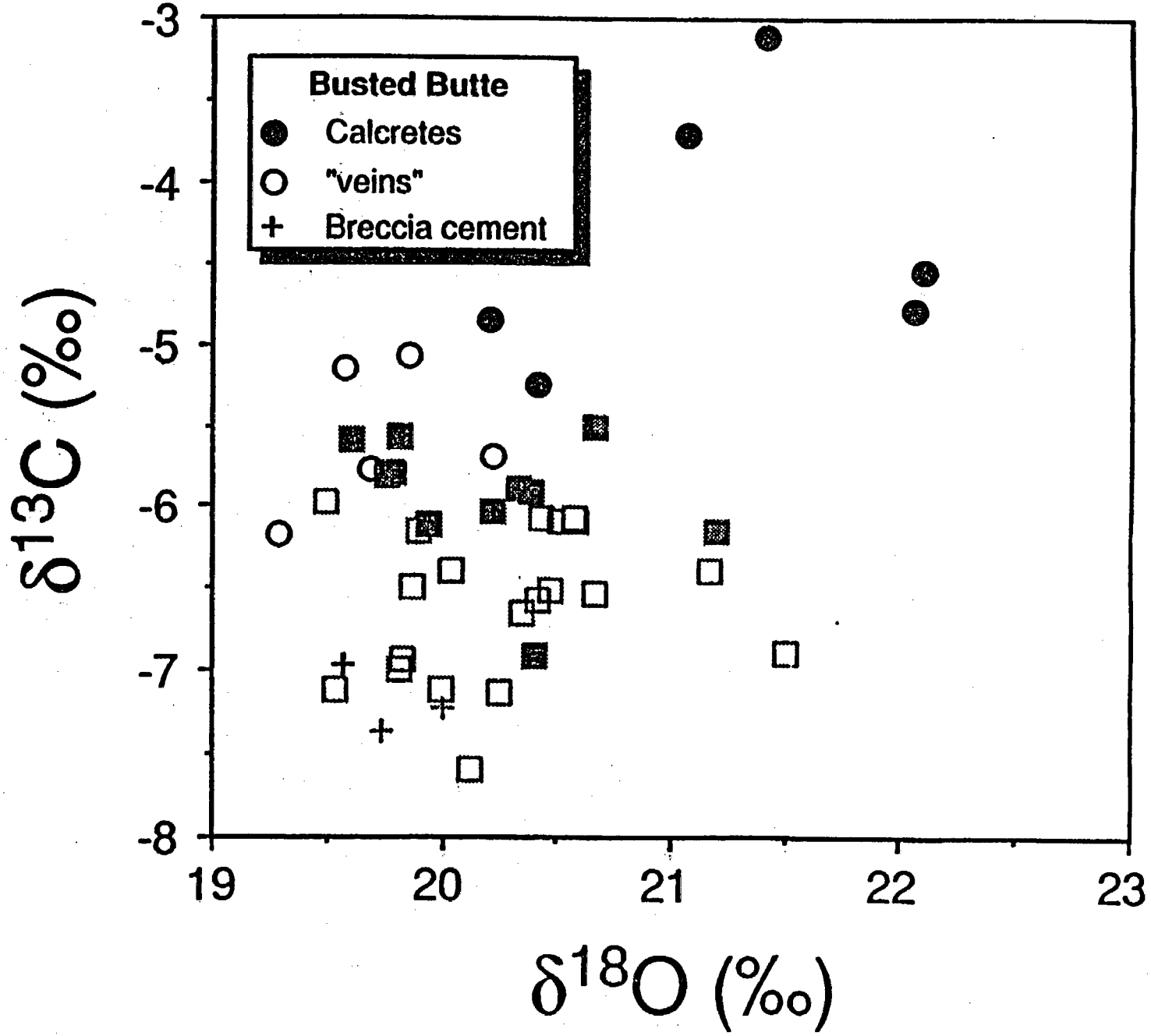
DEC

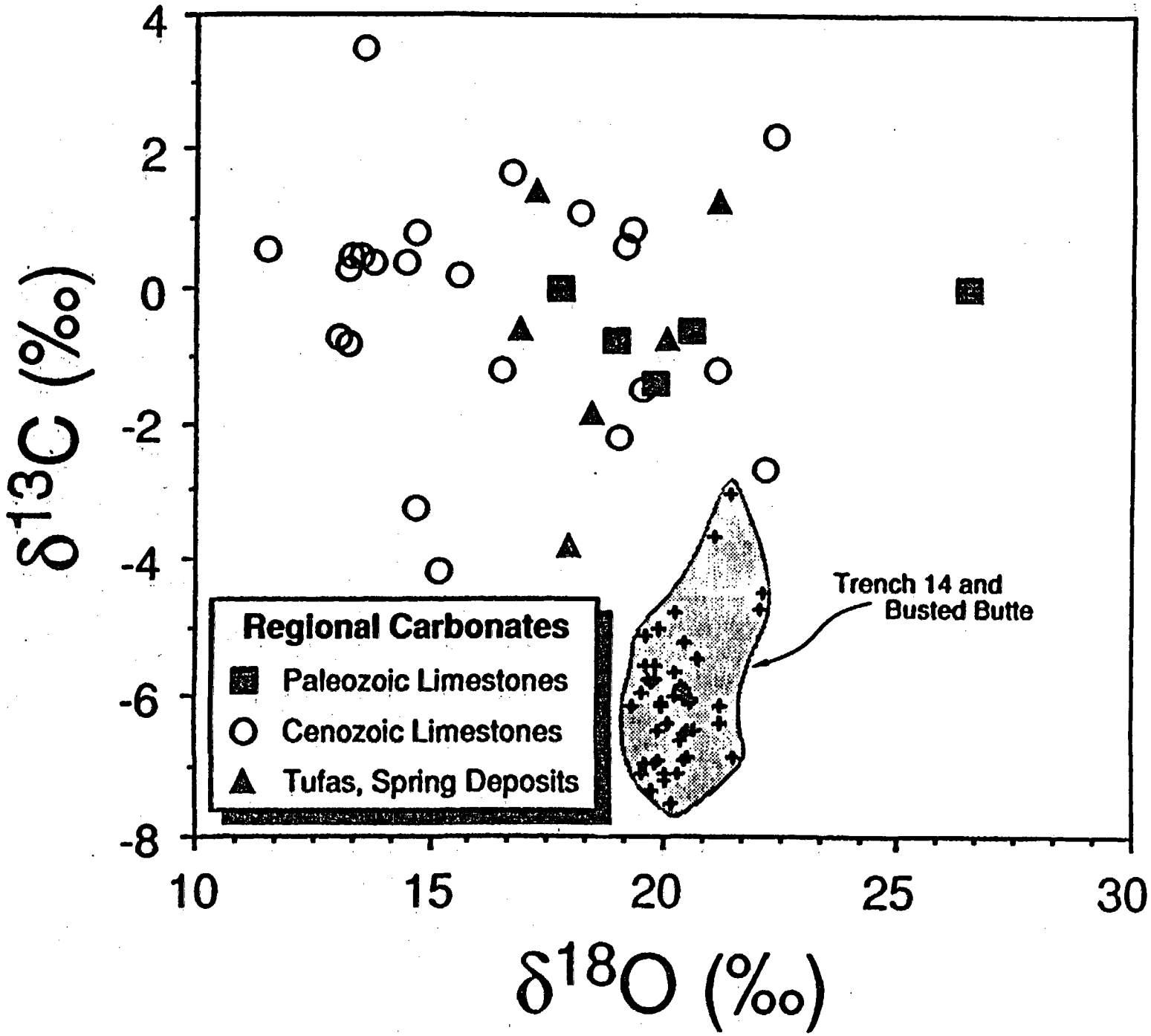
CHRYSOPHYTE CYSTS

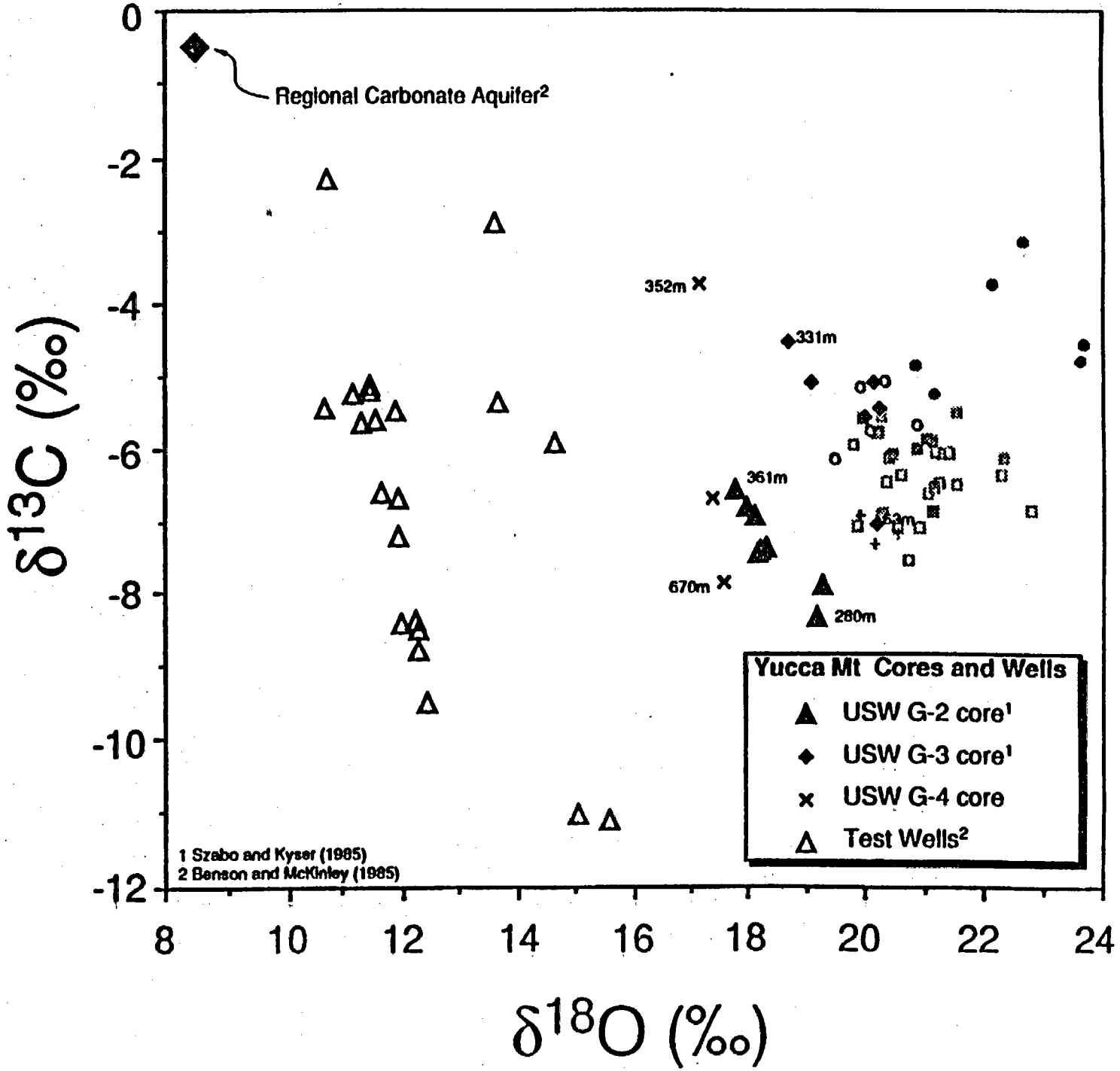
- None found in 4 samples of soil
- None found in 4 samples of calcite-silica veins and 1 sample of volcanic ash.
- Two samples of calcite-silica veins have rare cysts
- Rare cysts have been found in dried mud from Trench1.

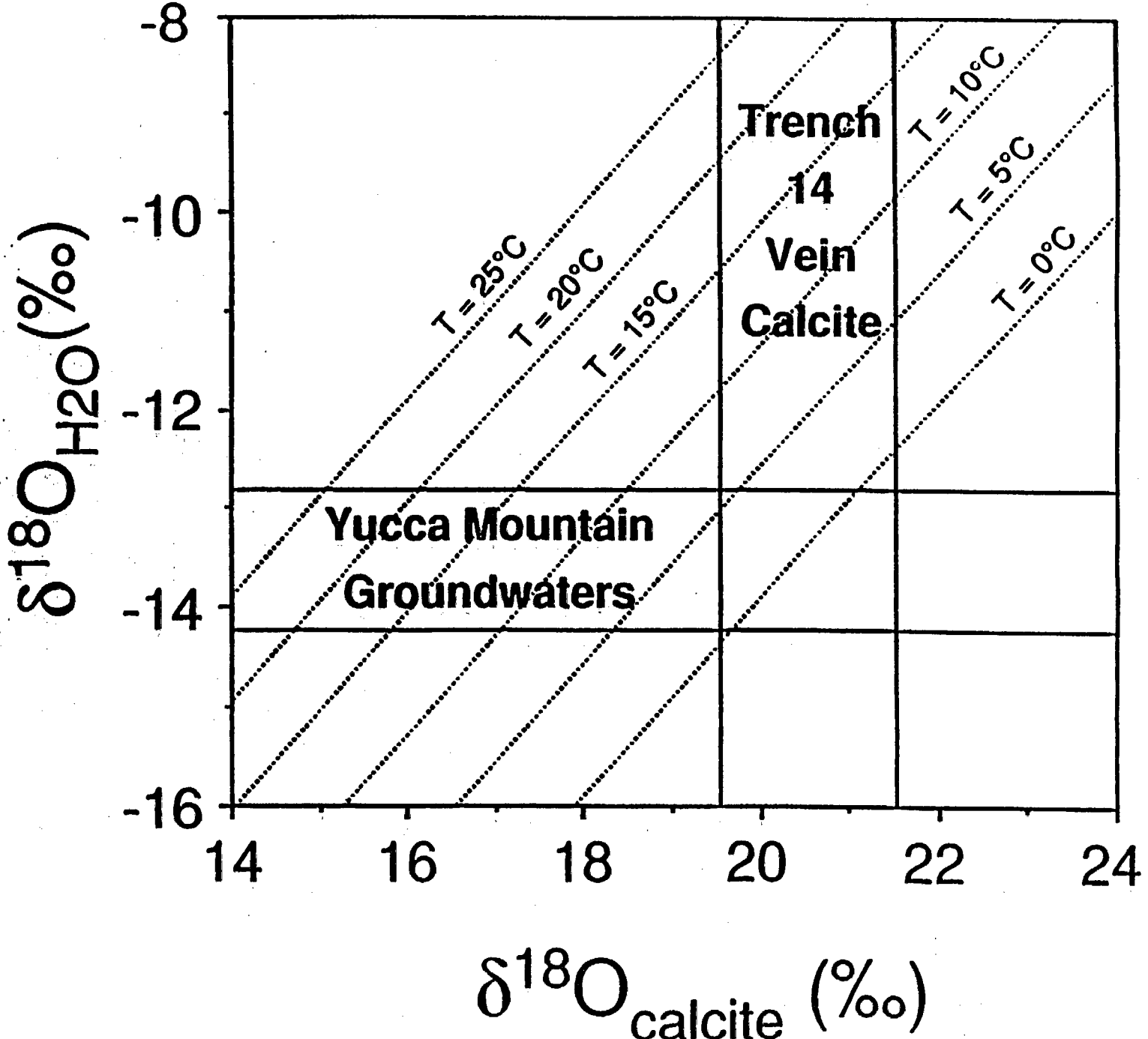

-5
-6
-7
19
20
21
22
δ13C (‰)
δ18O (‰)
Trench 14
Upper Calcrete
Lower Calcrete


-5
-6
-7
-8
19
20
21
22
δ13C (‰)
δ18O (‰)
edge
edge
ash layer
A
Trench 14
Calcretes
"veins"
Breccia cement

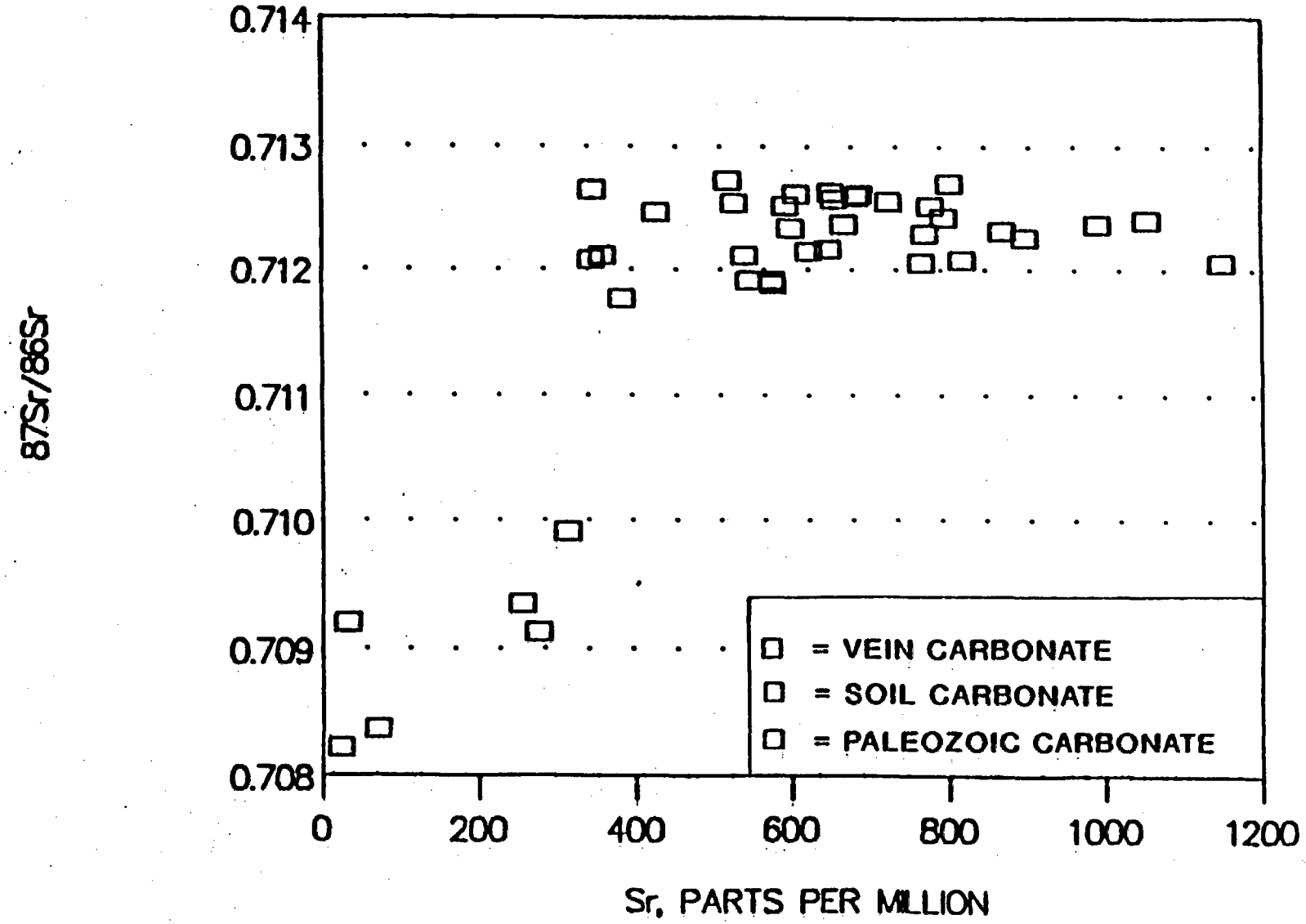

Busted Butte
Calcretes
"veins"
Breccia cement
-3
-4
-5
-6
-7
-8
19
20
21
22
23
δ13C (‰)
δ18O (‰)


4
2
0
-2
-4
-6
-8
10
15
20
25
30
δ13C (‰)
δ18O (‰)
Regional Carbonates
Paleozoic Limestones
Cenozoic Limestones
Tufas, Spring Deposits
Trench 14 and
Busted Butte

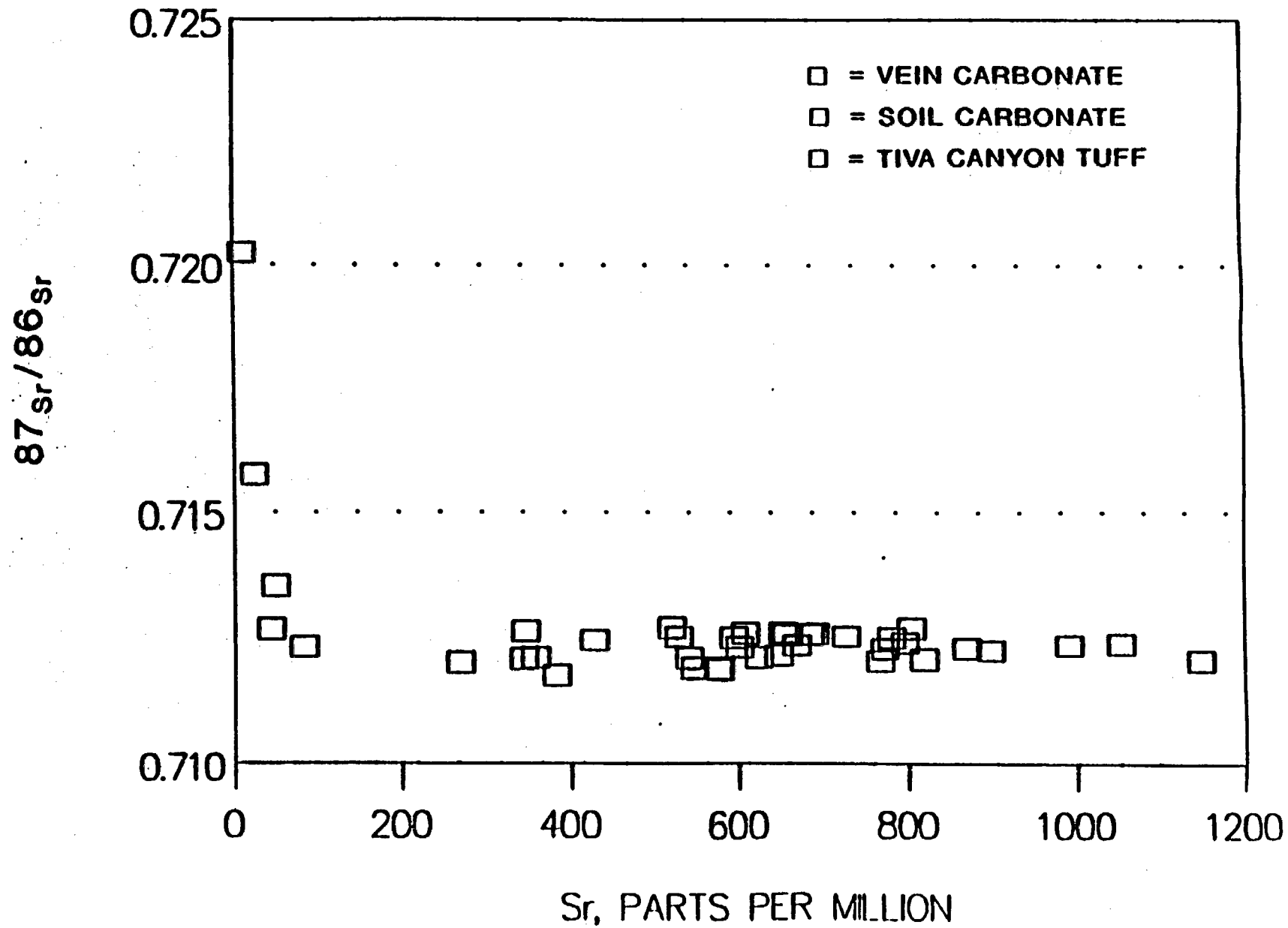

Regional Carbonate Aquifer²
352m
331m
361m
670m
280m
Yucca Mt Cores and Wells
USW G-2 core¹
USW G-3 core¹
USW G-4 core
Test Wells²
1 Szabo and Kyser (1985)
2 Benson and McKinley (1985)
δ¹³C (‰)
δ¹⁸O (‰)
0
-2
-4
-6
-8
-10
-12
8
10
12
14
16
18
20
22
24

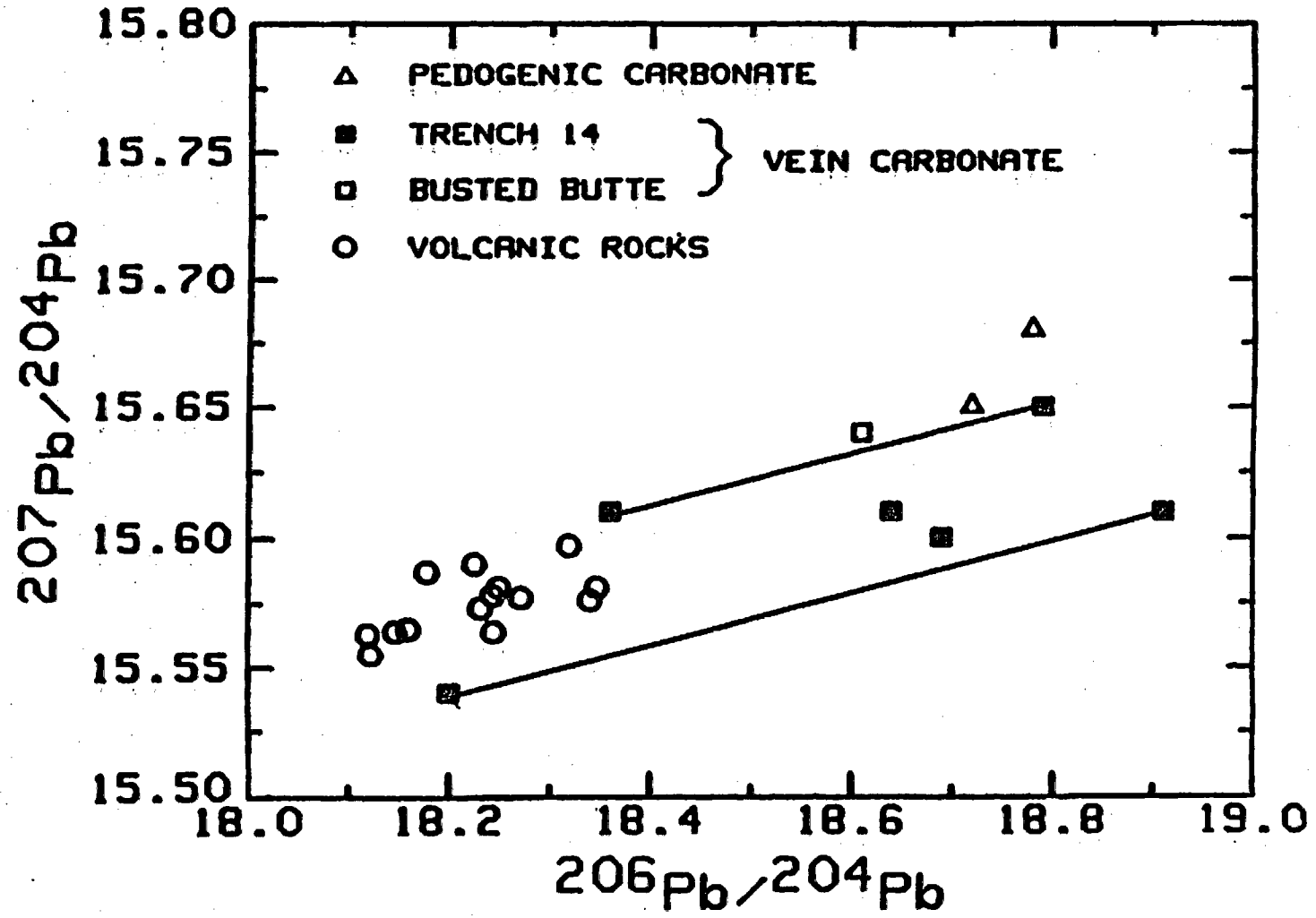

-8
-10
-12
-14
-16
14
16
18
20
22
24
$\delta^{18}O_{H2O}$(‰)
$\delta^{18}O_{calcite}$ (‰)
T = 25°C
T = 20°C
T = 15°C
T = 10°C
T = 5°C
T = 0°C
Trench 14 Vein Calcite
Yucca Mountain Groundwaters

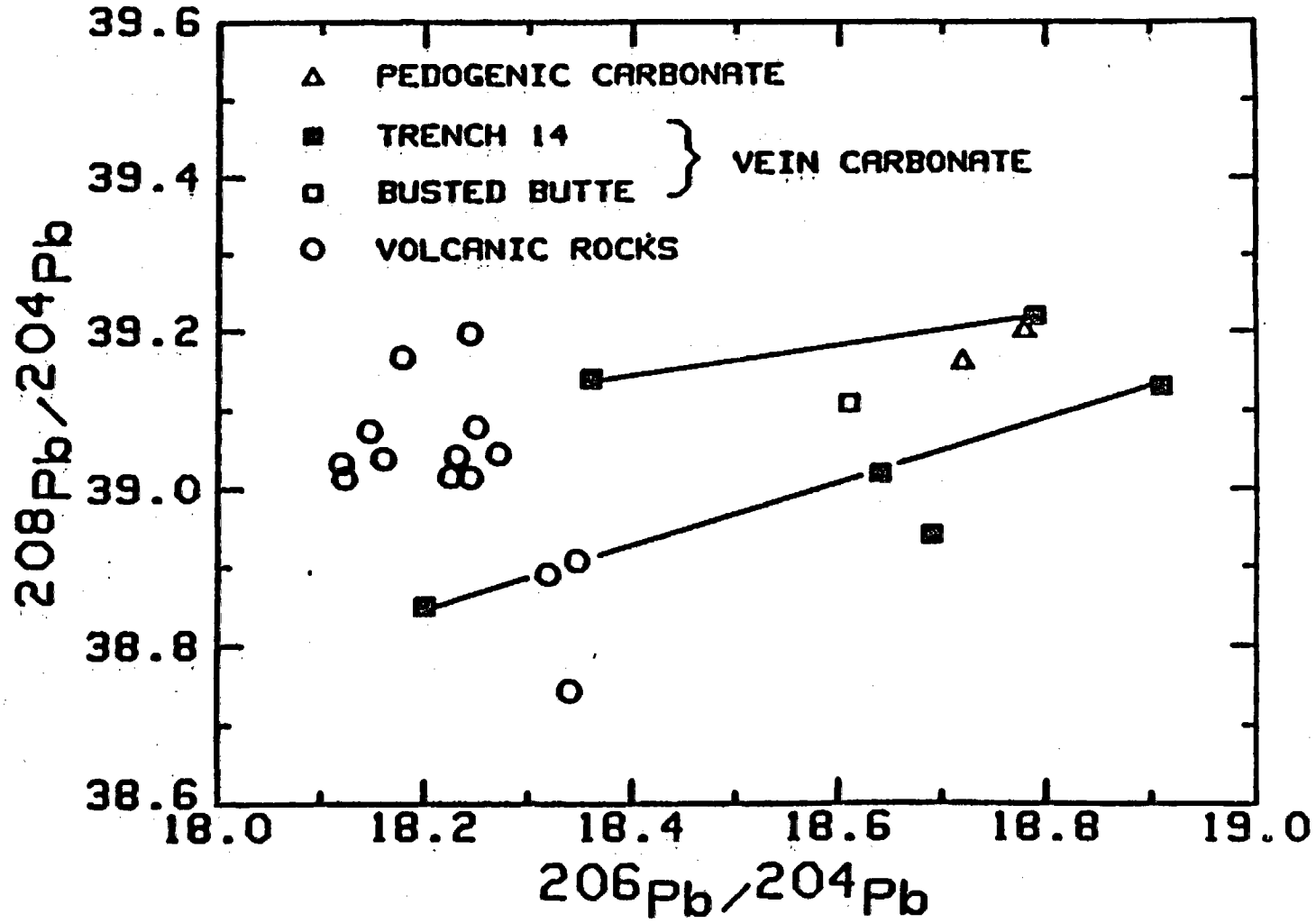
TIVA CANYON TUFF
TRENCHES 14 AND 14A

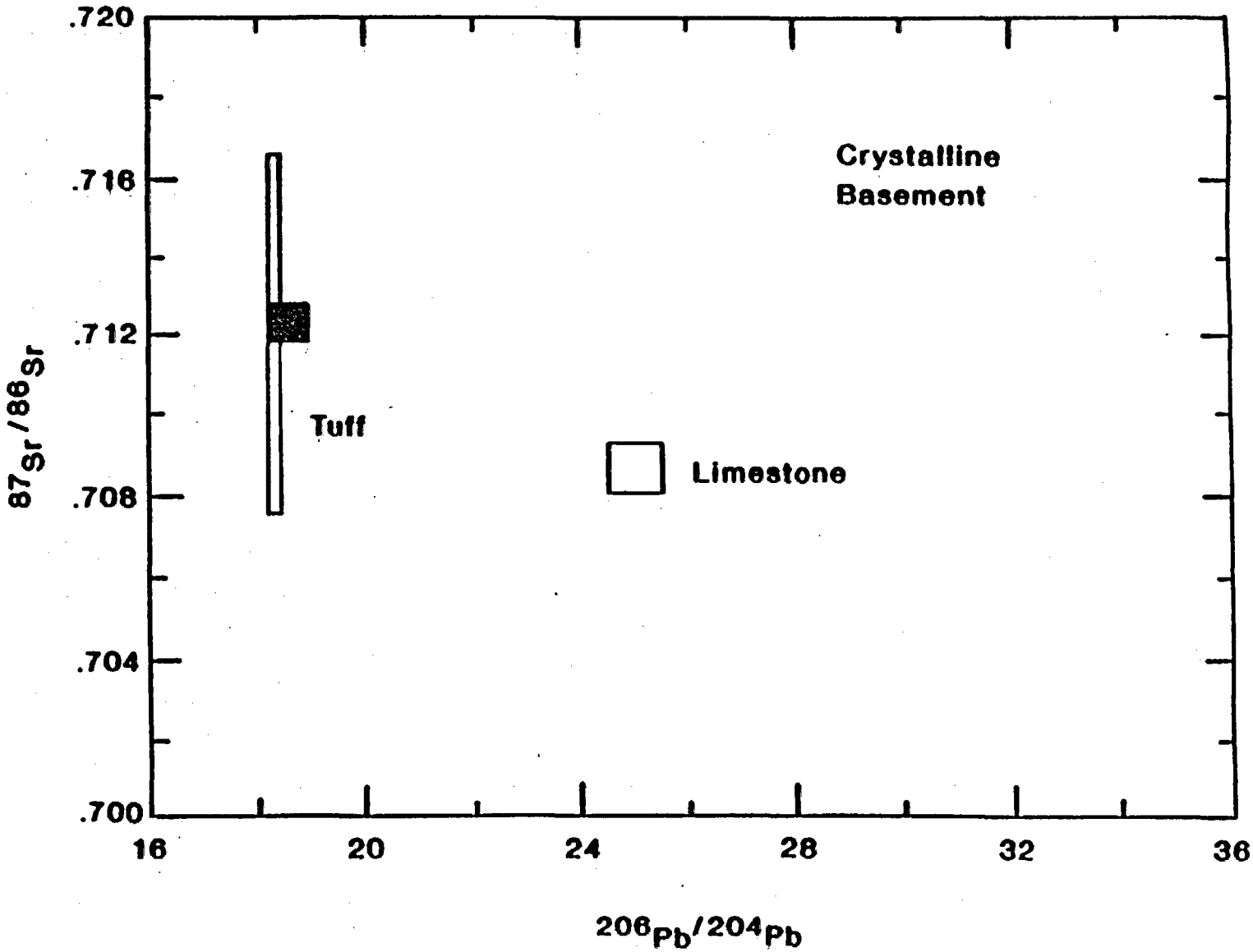


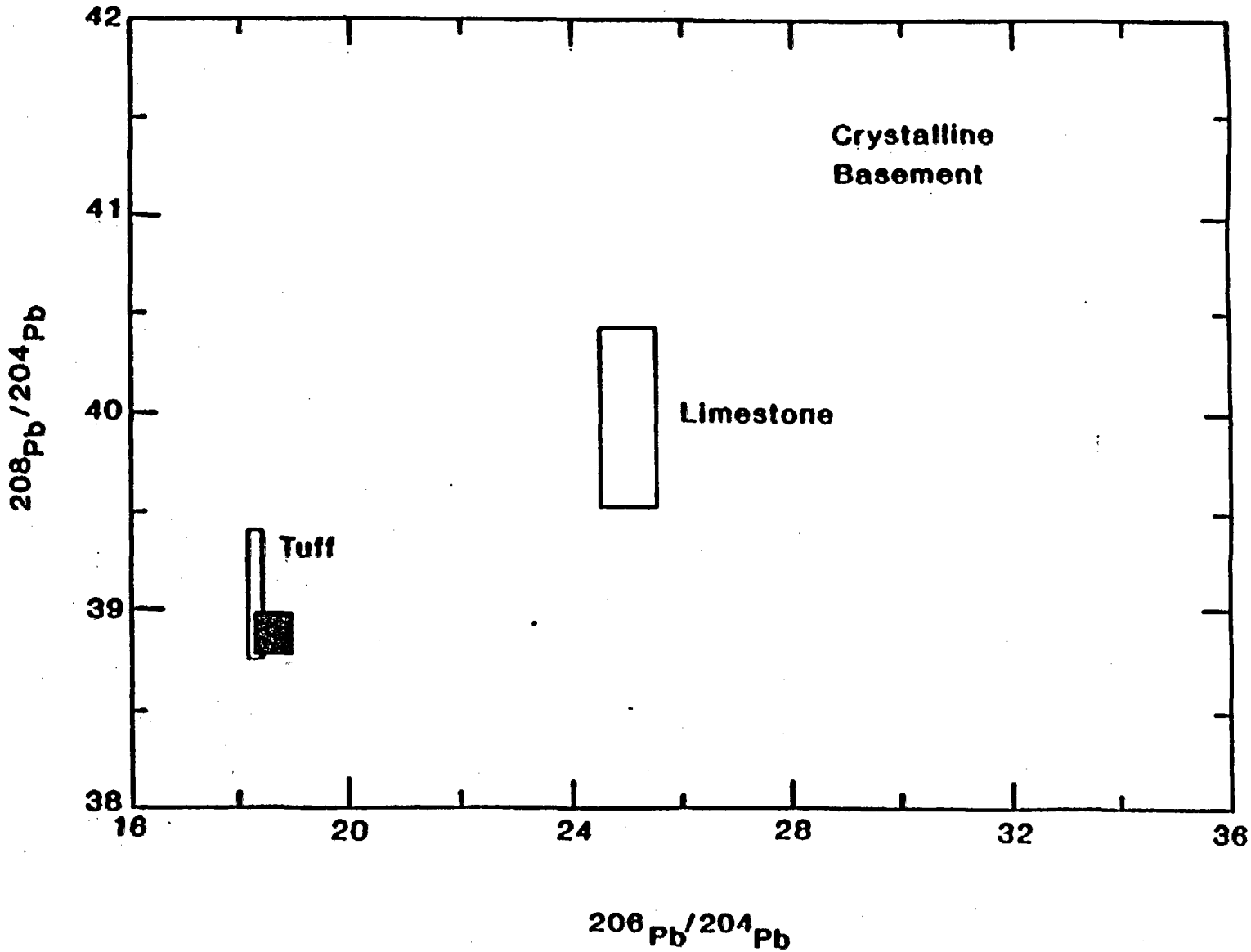
TIVA CANYON TUFF
TRENCHES 14 AND 14A

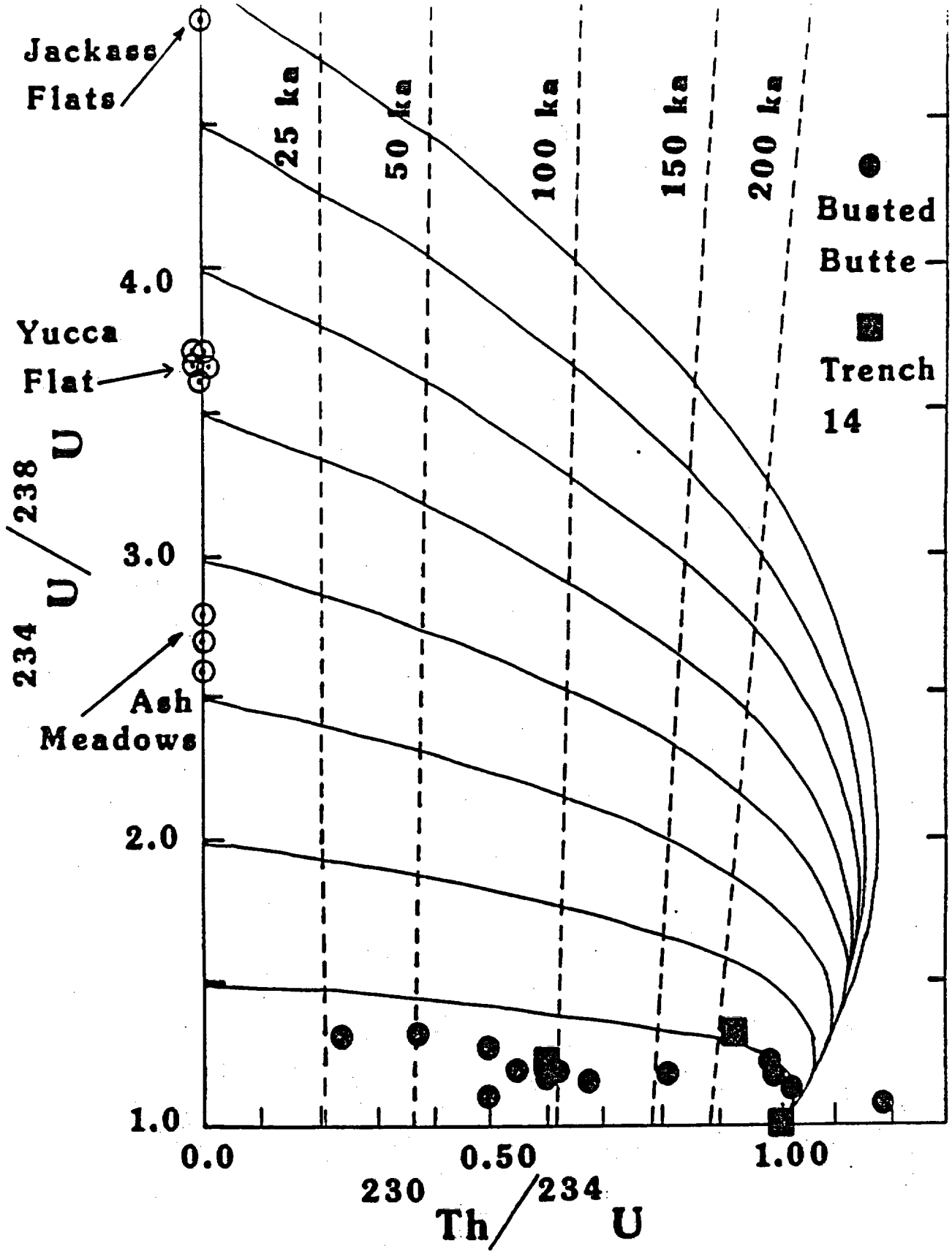



15.80
15.75
15.70
15.65
15.60
15.55
15.50
18.0
18.2
18.4
18.6
18.8
19.0
$^{207}Pb/^{204}Pb$
$^{206}Pb/^{204}Pb$
PEDOGENIC CARBONATE
TRENCH 14
BUSTED BUTTE
VEIN CARBONATE
VOLCANIC ROCKS

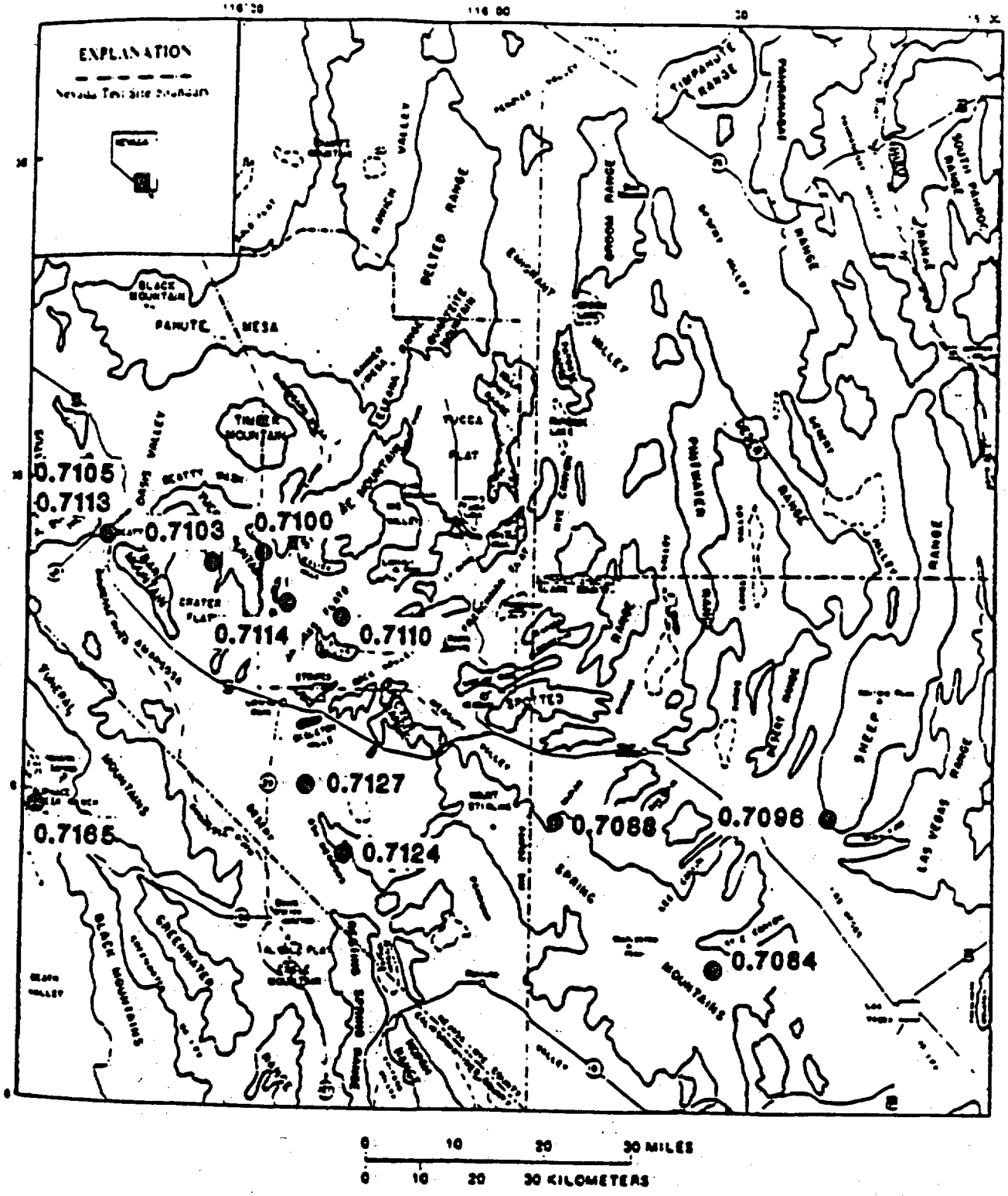

PEDOGENIC CARBONATE
TRENCH 14
BUSTED BUTTE
VEIN CARBONATE
VOLCANIC ROCKS
39.6
39.4
39.2
39.0
38.8
38.6
18.0
18.2
18.4
18.6
18.8
19.0
208Pb/204Pb
206Pb/204Pb


.720
.716
.712
.708
.704
.700
$^{87}Sr/^{88}Sr$
16
20
24
28
32
36
$^{206}Pb/^{204}Pb$
Crystalline
Basement
Tuff
Limestone


42
41
40
39
38
16
20
24
28
32
36
Crystalline
Basement
Limestone
Tuff
208Pb/204Pb
206Pb/204Pb


Jackass Flats
25 ka
50 ka
100 ka
150 ka
200 ka
Busted Butte
Trench 14
4.0
Yucca Flat
3.0
234 U / 238 U
Ash Meadows
2.0
1.0
0.0
0.50
1.00
230 Th / 234 U

DEC - 8 1989


EXPLANATION
0.7105
0.7113
0.7103
0.7100
0.7114
0.7110
0.7127
0.7165
0.7124
0.7088
0.7096
0.7084
0 10 20 30 MILES
0 10 20 30 KILOMETERS