NRCGEOL 86-2
March 3, 1986

TO: D. Chung

FROM: H. L. McKague

SUBJECT: Trip Report for Workshop on Calcite-Silica Deposits
February 28, 1986

The workshop on the calcite-silica vein filling was held at SAIC's Las Vegas Offices. Thirty people were in attendance; a list is appended. This was a much larger group than was expected, and affected the outcome of the meeting. Initial expectations by SAIC, USGS and LANL were that a small working group would discuss the regulatory implications of the calcite-silica deposits and formulate a working plan. Instead, the work to date was reviewed, the current plans for future work discussed, and input for other additional tasks was requested.

Introduction

The meeting was chaired by Max Blanchard, who made the introductory remarks. Following these, Jerry Szymanski showed viewgraphs of temperature logs and discussed his concerns that the logs indicate upwelling of hotter water which could result in an upward bulge in the water table. He believes the Wahmonie area is an analog. It should be noted that there are other interpretations of these logs. In addition, these logs should be carefully used as they were not run with the express purpose of determining the geothermal gradient. At the 1983 workshop in Denver J. Sass (USGS) discussed the geothermal gradient in central Nevada and the anomalous low gradient in the vicinity of NTS. Sass attributed this to the complex hydrology allowing cooler surface water to descend deeper, in effect lowering the geothermal gradient.

The current state of work being done on calcite-silica deposits was addressed by Uel Clanton (SAI), Joe Downey 9USGS), Emily Taylor (USGS), John Whitney (USGS) and Dave Vaniman (LANL).

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Summarizing the discussion:

The material in Trench 14 is believed to be of pedogenic origin. The vein deposit results from runoff from the rock surface on the upthrown side of the fault to the east and percolation down the fault. Evidence offered for a pedogenic origin included (1) inclusion of basaltic ash from either the .27 or 1.4 m.y. eruptions in Carter Flat (2) gradation of the vein deposit into a well developed caliche horizon down slope to the west, (3) isotope data that supported a low temperature origin, (4) similarities to deposit a Busted Butte, and (5) the occurrence of sepiolite in veins and in the obvious pedogenic K horizon.

Briefly commenting on each of these.

1. The basaltic ash could have been entrained by fault movement and could have originated in either a deposition in spring environment, or as a soil. If it originated as settlement in a spring deposit the spring activity must have been very low or inactive. May support pedogenic origin but does not eliminate spring origin.

2. Very critical - I would like to see this clearly demonstrated. Should be included in next NRC/DOE workshop field trip.

3. Not definitive - more work being done.

4. Again a critical line of evidence. The Busted Butte exposure is considered by the USGS as a close analogue. Because it is exposed in a gully within the sandramps there is more vertical exposure. A trip to this location should be included on the DOE/NRC workshop.

5. The presence of sepiolite has recently been identified as a small, but persistent component in the soil mineralogy of several desert areas. At trench 14 it has been found in both the vein deposit and the K horizon down scope. The genesis of this mineral needs to be better understood. The question of whether the mineral forms in both the vein and the soil as a result of the same origin for the starting material,

i.e. carbonate, or because the same process worked on two similar materials, each of which had different origin needs to be answered.

The USGS and LANL described their planned work on the carbonate-silica veins for the USGS. This includes: (1) deepen Trench 14, (2) add a backhoe trench between Trenches 14 and 14a, (3) put a new trench in across valley, west of Trench 14, (4) additional isotope work to establish vertical and horizontal variations within Trench 14, (5) attempt to match laminations across fault zone, (6) establish a hydrology scenario for the deposits, (7) examine spring deposits in Oasis Valley where there are both high and low temperature spring deposits, (8) evaluate data from similar deposits in literature, and (9) clean up the Busted Butte exposure and do additional mapping and sample collection there. LANL is going to study: (1) origin of the drusy quartz, which is thought to be high temperature, and (2) the slickensides in the bedrock of Trench 14 and 14a.

The meeting was open and cordial, with a full discussion of most points. Comments by observers at the end of the meeting were similar. Most agreed that while a pedogenic origin was very promising, other alternatives had not been ruled out and that the data should be looked at with an open mind. They also agreed that this problem should be addressed in a timely fashion.

In summary, I believe those favoring a pedogenic origin clarified their case; however, the issue is still very much open.

Handouts are attached.

HLMcK:be

Att:

cc: K. Knauss
B. Slemmons

Attendees
Calcite-Silica Deposits Workshop
Las Vegas, Nevada
February 28, 1986

Name	Organization	Phone No.
Kevin Knauss	LLNL	(415) 422-1372
Keff Wagoner	LLNL	" 422-1374
Larry McKague	LLNL	" 422-6494
Bill Twenhofel	SAIC	(303) 237-0780
Paul Prestholt	NRC	FTS 598-6125
John Whitney	USGS	FTS 776-1246
Bill Wilson	USGS	FTS 776-5044
Torrence Gerlach	SNLA	FTS 844-5929
Terry Grant	SAIC	702-295-0067
Brad Myers	USGS	FTS 776-1274
Mike Glora (part time)	SAIC	FTS 575-1463
Forrest Peters	SAIC	" 575-1350
Jim Danna	SAIC	" 575-1418
John Rotert	DOE	" 575-1588
Joe D'Lugosz	DOE	" 575-1862
Dave Vaniman	LANL	" 843-1165
John Stuckless	USGS	" 776-7886
Schon Levy	LANL	" 843-9504
Bill Dudley	USGS	" 776-4920
Bob Raup	USGS	" 776-1273
Dan Muhs	USGS	" 776-4722
Emily Taylor	USGS	" 776-1141
Heather Huckins	F&S	" 295-6519
Joe Downeg	USGS	" 236-5195
Uel S. Clanton	DOE	" 5575-1589
Donald E. Livingston	DOE-WMPO	" 295-1490
Steve Mattson	SAIC	" 295-1204
Max Blanchard	DOE-WMPO	" 575-1091
Carl Johnson	State Nevada	" 885-3744
Jean L. Younker	SAIC	" 575-1461
Jerry Szymanski	SAIC	

WORKSHOP ON CALCITE-SILICA DEPOSITS

FEBRUARY 28, 1986

VUE GRAPHS USED BY MAX BLANCHARD

SUGGESTED AGENDA

8:00a.m. Purpose of meeting M. Blanchard, WMPO

Discussion of possible regulatory implications of calcite-silica deposits

10:30 Informal summaries of what is known about the deposits (USGS, LANL, LLNL, WMPO)

- o field occurrences
- o isotope geology
- o geochronology
- o mineralogy

12:00 lunch

1:00 Discussion of ongoing and planned activities to resolve remaining questions (USGS, LANL)

1:45 Future activities of working group (all)

FEB. 28, 1986

WORKSHOP ON CALCITE-SILICA DEPOSITS NEAR YUCCA MOUNTAIN

o PURPOSE---DEVELOP UNDERSTANDING OF POTENTIAL REGULATORY/LICENSING ISSUES RELATED TO DEPOSITS

---DISCUSS PLANS AND ONGOING WORK RELATED TO NATURE AND ORIGIN OF DEPOSITS

---DEVELOP GROUP CONSENSUS THAT PLANS AND ONGOING WORK WILL ADEQUATELY RESOLVE REGULATORY/LICENSING QUESTIONS

REGULATORY IMPLICATIONS OF CALCITE-SILICA DEPOSITS NEAR YUCCA MOUNTAIN

- POSSIBLE REGULATORY IMPLICATIONS RESULT FROM TWO CONSIDERATIONS
  - (1) MINERALS ARE WATER DEPOSITED
  - (2) SUBSTANTIAL QUANTITIES OF WATER MAY BE INVOLVED

- THE EXTENT OF THE REGULATORY IMPLICATIONS IS DIFFICULT TO EVALUATE AT THIS TIME SINCE
  - (1) THERE IS A LACK OF SPECIFICITY IN THE REGULATIONS
  - (2) THE "INTENT" OF THE REGULATIONS HAS YET TO BE CLARIFIED IN THE COURTS THROUGH HEARINGS
    - -- CONTENTIONS
    - -- CONFLICTING DOCUMENTS AND INTERPRETATIONS

REGULATORY IMPLICATIONS

EVALUATION OF THE DEPOSITS POTENTIALLY AFFECTS 3 PERFORMANCE OBJECTIVES

- 10CFR60.112 - OVERALL SYSTEM PERFORMANCE
  - --EPA RELEASE LIMITS CONSIDERING BOTH ANTICIPATED AND UNANTICIPATED EVENTS

- 10CFR60.113 - PERFORMANCE OF BARRIERS AFTER CLOSURE
  - --RELEASE RATE OF ANY RADIONUCLIDE SHALL NOT EXCEED 1 PART IN 100,000 PER YEAR OF THE INVENTORY AT 1000 YEARS (FOR ANTICIPATED PROCESSES AND EVENTS)
  - --CONTAINMENT WITHIN WASTE PACKAGES WILL BE ESSENTIALLY COMPLETE FOR 300-1000 YEARS (FOR ANTICIPATED PROCESSES AND EVENTS)

REGULATORY IMPLICATIONS

- 10CFR60.21 - CONTENT OF APPLICATION

  --EVALUATION OF PERFORMANCE OF GEOLOGIC REPOSITORY SYSTEM AFTER CLOSURE.....
  FOR ANTICIPATED AND UNANTICIPATED PROCESSES AND EVENTS

- 10CFR60.122 - SITING CRITERIA

  --FAVORABLE CONDITIONS

  NATURE AND RATES OF ....HYDROGEOLOGIC.....PROCESSES WITHIN THE QUATERNARY PERIOD WOULD NOT...AFFECT... THE ABILITY TO ISOLATE....

  --POTENTIAL ADVERSE CONDITIONS

  POTENTIAL FOR CHANGES IN HYDROLOGIC CONDITIONS THAT WOULD AFFECT THE MIGRATION OF RADIONUCLIDES.....

REPOSITORY SITE SELECTION
10 CFR 960

FOR SITE COMPARISONS TO SUPPORT RECOMMENDATION OF SITES FOR DEVELOPMENT OF REPOSITORIES

- 10CFR960.3 IMPLEMENTATION GUIDELINES

  960.3-1-5 ...THE SITES SHALL BE COMPARED BY MEANS OF EVALUATIONS THAT EMPHASIZE THE PERFORMANCE OF NATURAL BARRIERS AT THE SITE ....(BASED ON EXPECTED CONDITIONS OVER 100,000 YEARS)

REPOSITORY SITE SELECTION
10 CFR 960

- 10CFR960.4-2-1(B)(2) FAVORABLE CONDITION: NATURE AND RATES OF HYDROLOGIC PROCESSES DURING QUATERNARY PERIOD WOULD, IF CONTINUED.....FAVORABLY AFFECT .....ISOLATE THE WASTE DURING THE NEXT 100,000 YEARS.

- 10CFR960.4-2-1(C)(1) POTENTIALLY ADVERSE CONDITION: EXPECTED CHANGES IN GEOHYDROLOGIC CONDITIONS ----....SUFFICIENT TO SIGNIFICANTLY INCREASE TRANSPORT OF RADIONUCLIDES.....

- 10CFR960.4-2-7(A) QUALIFYING CONDITION: THE SITE SHALL BE LOCATED IN A GEOLOGIC SETTING WHERE FUTURE TECTONIC PROCESSES OR EVENTS WILL NOT BE LIKELY TO LEAD TO RADIONUCLIDE RELEASES .....

EVALUATION OF REGULATORY IMPLICATIONS

IN ORDER TO DETERMINE THE REGULATORY IMPLICATIONS OF THE DEPOSITS, THE FOLLOWING QUESTIONS MUST BE ADDRESSED:

(1) WHAT IS THE ORIGIN OF THE DEPOSITS?

---PEDOGENIC OR DEEP??

(2) WHAT IS THE GEOCHRONOLOGY OF THE DEPOSITS?

(3) ARE THE PROCESSES/EVENTS TO BE "ANTICIPATED OR UNANTICIPATED" OVER THE TIME FRAMES OF INTEREST?

ONCE THE ABOVE INFORMATION IS OBTAINED, THE REGULATORY IMPLICATIONS OF THE DEPOSITS CAN BE EVALUATED

- EPA RELEASE LIMIT (I.E. SYSTEM PERFORMANCE OBJECTIVE)
- 300-1000 YEAR WASTE PACKAGE
- 10^{-5} RELEASE FROM ENGINEERED BARRIER SYSTEM

CRITERIA FOR DISTINGUISHING PEDOGENIC VS. NON-PEDOGENIC $CaCO_3$ and OPALINE SiO_2

FROM EMILY TAYLOR (USGS).

FACTOR	HIGH TEMPERATURE NON-PEDOGENIC	LOW TEMPERATURE NON-PEDOGENIC	PEDOGENIC	WHAT IS OBSERVED AT NTS?	ORIGIN
1. Geomorphology, spatial arrangements	Isolated points at or near springs, downslope of fractures or faults in bedrock or surficial deposits		Follow topography and geomorphic surfaces, laterally persistent	Laterally persistent	Pedogenic
2. Physical characteristics of $CaCO_3$	Stratiform, mound or drapped strata; commonly displaying vegetative molds and vugs; crosscuts depositional features, may preserve bedding		Laminar layers underlain by bedrock or a plugged horizon	Laminar plates	Pedogenic
3. Location of initial $CaCO_3$ deposition	Random orientation, gravels remain in contact		Deposition on the underside of gravel, gravel is "jacked" apart	$CaCO_3$ on the underside of gravel	Pedogenic
4. Change in amount of $CaCO_3$ with depth	No systematic change, uniform deposition		Decreases with depth below a maximum level near top	Decrease with depth below a maximum	Pedogenic
5. Stratification in thin or polished section	Poorly stratified		Well stratified	Well stratified	Pedogenic
6. $CaCO_3$ - percent, crystallinity and associated minerals	Coarse sparry calcite crystals, microsparite and sparite; crystals >99.5% pure; impurities related to changes in depositional environment		Microcrystalline, micrite; commonly $MgCO_3$ and opaline SiO_2 present	Microcrystalline with opaline SiO_2	Pedogenic
7. Opaline SiO_2 - percent, crystallinity and associated minerals	>85% Opal-C	Sicrete >85% Opal-A	Duripan, no minimum percentage Opal-CT	Opal-CT	Pedogenic

CRITERIA FOR DISTINGUISHING PEDOGENIC VS. NON-PEDOGENIC $CaCO_3$ and OPALINE SiO_2

FACTOR	HIGH TEMPERATURE / LOW TEMPERATURE NON-PEDOGENIC	PEDOGENIC	WHAT IS OBSERVED AT NTS?	ORIGIN
8. Ca:Mg ratio and clay mineralogy	No systematic depletion of Mg overtime compared to $CaCO_3$ precipitation	Progressive depletion of Mg in secondary $CaCO_3$ and formation of Mg-rich clays	Mg concentration to be determined; formation of Mg-rich sepiolite	Pedogenic
Isotopic Composition				
9. $^{18}O/^{16}O$	Systematic change with distance from fault and with depth down the fault	No change with distance from or down major fault	To be determined	
10. δD vs $\delta^{18}O$ in opaline SiO_2	Shift in $\delta^{18}O$ values away from meteoric water line	Hypothesized: no shift away from meteoric water line	To be determined	
11. $^{13}C/^{12}C$				
12. Sr/Pb				

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PROGRAM: Geochemical Sensitivity Analysis FIN#: A-1756

CONTRACTOR: Sandia National Laboratories BUDGET PERIOD: 10/01/85 - 9/30/86

DRA PROGRAM MANAGER: W. R. Kelly BUDGET AMOUNT: 265K

CONTRACT PROGRAM MANAGER: R. M. Cranwell FTS PHONE: 844-8368

PRINCIPAL INVESTIGATOR: M. D. Siegel FTS PHONE: 846-5448

PROJECT OBJECTIVES

The objective of this project is to provide technical assistance to the NRC in determining the sensitivity of far-field performance assessment calculations to uncertainties in geochemical and hydrological input data and in the representation of geochemical processes in transport models. In Task I, the error in model calculations of integrated radionuclide discharge due to speciation, kinetic and sorption effects will be evaluated. In Task II, the potential importance of organic molecules and colloids will be examined. SNLA will assist the NRC in determining how geochemical processes should be represented in transport models under Task III. Short-term technical assistance will be carried out under Task IV.

ACTIVITIES DURING FEBRUARY 1986

Task I. Uncertainty in Integrated Radionuclide Discharge

- Conceptual Models for Sites

A draft description of the conceptual models of the hydrology of hypothetical basalt and bedded salt sites was written during this month. These descriptions will be a starting point for collaboration with the hydrological data base compilation and hydrological sensitivity analyses being conducted by other NRC contractors (Nuclear Waste Consultants).

A review of previous efforts to rank radionuclides according to their importance in HLW disposal was initiated during February. The result of this review will be a letter report which will later be included in the introductory sections of the final report for this project.

~~$160331 0365~~ 6pp.

• Solubility/Speciation Effects

Data for minerals found in basaltic geological settings were added to the Aqueous Solutions Data Base. In addition, data on aqueous species were updated and corrected during this month. A draft report summarizing the status of the ASD and potential uses in sensitivity analyses is in preparation.

Malcolm Siegel attended the USGS computer modeling course "Geochemistry for Ground-Water Systems," in Denver, Colorado on February 26 to March 7, 1986.

• Sorption Effects

A complete first draft of a report describing the application of the Stanford Generalized Model for Adsorption to radionuclide sorption was received during February. The document is under review at SNLA and will be sent to the NRC after necessary revisions are made. A preliminary list has been compiled of geochemical systems for which the effects of fluid composition on theoretical Kd's can be modeled. (See Attachment 1.) The systems which are most relevant to HLW disposal will be selected for modeling at SNLA and Stanford University.

• Kinetic and Dynamic Effects

The final version of the paper "Approximate Methods to Calculate Radionuclide Discharges for Performance Assessment of HLW Repositories in Fractured Rock" was completed and is appended as Attachment 2.

A user's manual, user-friendly interface, and a well-documented source code for the chemical transport simulator TRANQL are nearly complete. It is anticipated that the code will be transferred to SNLA during March.

Other Activities

A revised Schedule 189 for this project was prepared during February and approved by the NRC. Under this new Schedule, a new task, "Transfer of Sensitivity Analysis Tools," has been added to the Geochemical Sensitivity Analysis project.

Trips

• M. Siegel (6431) attended the U.S. Geological Survey course "Geochemistry for Ground-Water Systems" at the USGS National Training Center in Denver, Colorado on February 24 - March 7, 1986. The course dealt with computer models developed by the USGS to model the chemistry of ground waters. The program emphasized four major topics: 1) thermodynamic basis for

geochemical models, 2) major rock/water reactions, 3) use of the USGS codes WATEQF, BALANCE and PHREEQE, and 4) case studies illustrating the application of the codes to ground-water systems studied by the USGS.

Allocation of Resources

Task I. 100%

A-1756
1646.010
February 1986

THIS IS AN ESTIMATE ONLY AND MAY NOT MATCH THE INVOICES SENT TO NRC BY SANDIA'S ACCOUNTING DEPARTMENT.

		Current Month	Year-to-Date
I.	Direct Manpower (man-months of charged effort)	1.4	5.1
II.	Direct Loaded Labor Costs	14.0	54.0
	Materials and Services	1.0	1.0
	ADP Support (computer)	0.0	1.0
	Subcontracts	16.0	23.0
	Travel	1.0	4.0
	Other	-1.0	0.0
	TOTAL COSTS	31.0	83.0

Other = rounding approximation by computer

III. Funding Status

Prior FY Carryover	FY86 Projected Funding Level	FY86 Funds Received to Date	FY86 Funding Balance Needed
None	265K	115K	150K

ATTACHMENT I

REPORT ON GEOCHEMICAL SCENARIOS

ADSORBATE+	ADSORBENTS*	SOLUTION VARIABLES‡
UO_2^{2+}	α-FeOOH, am-$Fe(OH)_3$	P_{CO_2}, Ca^{2+}, EDTA, pH
Pu	α-FeOOH	P_{CO_2}, Ca^{2+}, EDTA, pH
Np	am-$Fe(OH)_3$	P_{CO_2}, Ca^{2+}, EDTA, pH
Ni^{2+}	SiO_2, α-FeOOH, am-$Fe(OH)_3$, α-Al_2O_3	EDTA, pH
SeO_3/SeO_4	α-FeOOH, am-$Fe(OH)_3$, α-Al_2O_3	pH
Pb^{2+}	α-FeOOH, am-$Fe(OH)_3$, α-Al_2O_3, SiO_2	pH, EDTA, P_{CO_2}, Ca^{2+}
Cd^{2+}	am-$Fe(OH)_3$, α-Al_2O_3, TiO_2, SiO_2	P_{CO_2}, Ca^{2+}, Cl^-, EDTA, pH
Zn^{2+}	α-FeOOH, am-$Fe(OH)_3$, α-Al_2O_3, SiO_2	P_{CO_2}, Ca^{2+}, EDTA, pH
Cu^{2+}	α-FeOOH, am-$Fe(OH)_3$, α-Al_2O_3, TiO_2, SiO_2	P_{CO_2}, Ca^{2+}, EDTA, pH

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* In every case where more than one solid (adsorbent) is available, it is possible to model transitions from one solid to another. Total surface area can be varied.

‡ P_{CO_2} is intended to represent several different possible modes of representing total carbonate in the system.

\+ The total concentration of adsorbate can be varied in the simulations if needed.