See Pocket 11 for encl

Preliminary

Evaluation of the Geologic Relations and Seismotectonic Stability of the Yucca Mountain area, Nevada Nuclear Waste Site Investigation (NNWSI)

Proposal submitted to

Nevada Nuclear Waste Project Office

State of Nevada

by

Center for Neotectonic Studies

Mackay School of Mines
University of Nevada - Reno

June 1986

James V. Taranik, Dean
Mackay School of Mines

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8703007188

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To: M. Blackford - from: Burt Slemmons, MD Univ. of Nevada

Packet II

Rec'd 9/23/86 as encl. to (Preliminary) Evaluation of the Geologic Relations NNWSI (dated June, 1986) 102

INTRODUCTION

(continued)

This is a proposal to initiate a geological, seismological, tectonic and geochemical review of the seismotectonic and geologic setting of the Nevada Nuclear Waste Storage Investigations Project (NNWSI) area at Yucca Mountain, Nevada. Review and related research will be conducted by faculty at the Mackay School of Mines and Nevada Bureau of Mines and Geology at the University of Nevada in Reno (UNR). The work will be coordinated by the Center for Neotectonic Studies, and carried out by the several Principal Investigators. Their work will be divided into the Tasks that are individually described in the following proposal. In brief, the main tasks will include review and evaluations that will be carried out by the Principal Investigators as listed below:

Task 1: John Bell; Associate Engineering Geologist, Nevada Bureau of Mines and Geology, for the Quaternary Geology and Active Fault Assessments.

Task 2: Frank W. Dickson; Professor of Geochemistry, for Geochemical Assessments.

Task 3: Donald C. Noble; Professor of Geology, for Volcanic Geology, Stratigraphy, Petrology, and Possible Hydrothermal Alteration and Mineralization Assessments.

Task 4: Keith Priestley; Associate Professor of Geology and Research Seismologist; William A. Peppin; Research Seismologist, Edward J. Corbett; Research Seismologist, and Ute R. Vetter; Research Seismologist.

Task 5: Richard A. Schweickert; Professor of Geology, for Neotectonic and Tectonic Investigations.

Task 6: James V. Taranik; Professor of Geology, for Remote Sensing Assessments.

Task 7: Robert Watters; Professor of Geological Engineering, for Geotechnical and Rock Mass Assessments.

The primary purpose of the proposed work will be to review data submitted from a variety of governmental agencies, consultants, and other researchers. The review will include collection of confirmatory and verification data and assessment of the research needed to fill essential gaps. The review will provide an independant assessment that will be focussed on technical evaluations.

The goal of our study is to evaluate the seismotectonic stability and geologic suitability, and mineral resource assessment of the proposed repository and will include all essential aspects, with the exception of hydrogeological studies, which will be evaluated by the Desert Research Institute. The review will include collation of data to establish maximum or

maximum credible earthquake values for each of the main active faults or seismotectonic structures. The regional effort will be to determine the presence or absence of detachment and listric faults, domains of tilted fault blocks, depths and character of possible detachment and listric structures, and interrelationships of the Walker Lane and Las Vegas shear zones to the Basin and Range faults. The faults will be evaluated to determine the sense of displacement, activity, approximate recurrence intervals and interrelationships of focal mechanisms, direct stress measurements, and geodetic changes. Low-sun angle aerial photographs, radar and Thematic Mapper imagery, and all types of available aerial photography will be interpreted for a synoptic analysis.

The analysis will include geologic compilation of all relevant geological, seismological, and tectonic literature, analysis of various types of imagery, preparation of fault and lineament maps and evaluation of analyses that have been made for the site and adjoining region. The field work will include examination of geologic, fault and geomorphic features. Review will include site visits to examine exploratory trenches, drill core, geologic maps, geophysical and geochronologic interpretations, make hydrothermal and mineral assessments and participate in meetings, workshops, and conferences. Field work will be mainly for general or synoptic evaluations of major geologic units, structures, geomorphic features, exploratory trenches and geochemical and geophysical characteristics.

The general part of the proposed work will also provide a complete library of essential publications, aerial photographs, and make available for the various Task staffs any general information that is needed for the geologic, seismotectonic, and remote sensing studies of the site and adjoining area.

The Center for Neotectonic Studies will provide a general umbrella for contact and liason, and will coordinate the activities of each Task group to assure that all deadlines are met. The detailed investigations will be semi-independent for each Task and each Task group will have its own assigned scope of work and will meet any deadlines or milestones that are designated for each Task or Subtask. Although a small budget is included for the general operation of the Center for Neotectonics Studies, the main budget will be allocated to the several Tasks.

The budget estimates are for a six month basis, from July 1, 1986 to December 31, 1986. The scope of the work can be increased by assignment of supplemental Tasks or Subtasks.

Individual task reports and reviews will be made by each task leader and will be submitted by the Center for Neotectonic Studies to Mr. Carl Johnson, Nevada Nuclear Waste Project Office. Each individual on the project will submit trip and progress reports for quarterly deadlines. Work to be accomplished after December 31, 1986 will be authorized on future contracts to extend the review process.

The general products to be delivered will include technical documents to be reviewed as needed and technical status reports by discipline that will assess the current state of knowledge in eahc subject area. These will be summarized in the final report, to be submitted at the end of December.

Invoicing will be in two parts with one-half of the fixed contract financing due at September 30, 1986 and an additional one-half to be paid by the state on December 31, 1986. A progress report for each Task is due for the first period, July 1-September 30, 1986 and a final report will be prepared after December 31, 1986. Each report is to be completed within a month of these two dates.

The contract will be for a fixed amount, with the estimated budget for each task and the general contract indicated within the appropriate sections of the proposal.

ESTIMATED GENERAL BUDGET, JULY 1, 1986 TO DECEMBER 31, 1986

Personnel	
Professional Labor	
David B. Slemmons, Director, Center for Neotectonic Studies	n.c.
Non-Professional Staff	
One Graduate Research Assistant, Half-time during the academic year and full-time for two summer months, budgeted amount assumes that the RA will be started in the fall	4,000
Student Hourly Assistants, including secretarial, drafting, computer, geological, analysis and other assistance, 1200 hour, estimated @$7.00/hr.	8,400
Non-Professional Labor Subtotal	12,400
Fringe Benefits, @ 1.2 percent	149
Total Non-Professional Labor plus benefits	12,549
Labor Subtotal	12,549
Materials and Services	
Supplies and Services: including cost of publications, library searches, postage, general supplies, etc.	500
Imagery, photo-enlargements, etc.	10,000
Copying and communication charges	400
Stipend	1,100
Tuition fees, $42/credit, 30 credits	1,260
Computer Time, 2 hours, @$200/hr	400
Software	500
Visiting Lecturers	1,000
Materials Subtotal	15,160

Travel	
Per diem, 30 days, estimated $50/day	1,500
University vehicle, personal, or rental car, estimated @30/days, @$30/day	900
Air travel or equivalent cost	
5 trips to Las Vegas, $150 each	750
3 trips to Menlo Park, @$100 each	300
3 trips to Denver, @200 each	600
1 trip to national meeting (probably GSA in San Antonio)	500
Travel Subtotal	4,550
Direct Costs Subtotal	32,259
Indirect Costs, @ 27 percent of Direct Costs less tuition ($32,259-1260 = 30,999)	8,370
Equipment	
Miscellaneous, including expansion of memory in PC AT, storage cabinets, file cabinets, etc.	2,000
Copy machine (model to receive prior State approval	5,000
Total Cost for July 1, 1986 to December 31, 1986	47,629

Task 1

Review of Quaternary Geology and Evaluation of Potential for Undetected Quaternary Faults At and Near Yucca Mountain

A Proposal for the Period July 1 to December 31, 1986

Principal Investigator: John W. Bell
Nevada Bureau of Mines and Geology

RATIONALE

In reviewing the 1984 "U.S. Department of Energy Draft Environmental Assessment for the Proposed High-level Nuclear Waste Site at Yucca Mountain", numerous major deficiencies were noted in the tectonics studies (see my detailed comments in the 1985 State of Nevada Comments, v. II). These included:

- -- Structure-tectonics of the Walker Lane
- -- Potential for strike-slip movement
- -- Potential for undetected fault scarps
- -- Lineament analysis
- -- Geomorphic analyses of faults
- -- Integration of structural and Quaternary geology relationships
- -- Probabilistic estimates of potential for large earthquakes and surface faulting
- -- Explosion-induced faulting

These deficiencies are critical to the evaluation of the post-closure favorable condition which requires that tectonic processes have less than one chance in 10,000 of leading to a loss of waste isolation over the next 10,000 years. Several of these deficiencies were also recently noted and recommended for further study by a review panel of experts in seismology and tectonics (SAIC,1985). DOE is now preparing a Seismic/Tectonic Position Paper which will assign probabilistic estimates to various tectonic scenarios; such an evaluation, however, is fruitless without an adequate and accurate data base.

Previous work suggests that the potential for tectonic activity is substantially greater than acknowledged by DOE in the Draft EA. Seismic data suggest that north-northeast-trending faults are susceptible to slip in the current stress field, and that such faults at Yucca Mountain may also be tectonically

stressed to near tha rupture point (Rogers and others, 1983; Healy and others, 1984; Stock and others, 1985). A reconnaissance-level review of Quaternary deposits and exploratory trenches in Crater Flat and on the Bow Ridge fault by the Principal Investigator revealed several potentially critical relationships, including:

1) Recurrent movement on the Windy Wash, Solitario Canyon, and Bow Ridge faults, with the last movements having displacements of 30 cm or less, and possibly being Holocene age.
2) A number of unmapped alluvial fault scarps and lineaments that may have significant structural implications.
3) A lack of detail in the published Quaternary stratigraphic and pedologic mapping suggesting that very young unmapped deposits are present which may be faulted.

Taken together, the geologic and seismic data suggest that the potential for significant seismicity and renewed movement on faults exists and should be considered (U.S. Geological Survey, 1984).

OBJECTIVE

In order for the State of Nevada to adequately and objectively assess the probability that tectonic processes may lead to a loss of waste isolation during the next 10,000 years, the Nevada Bureau of Mines and Geology proposes the following 6 month preliminary review and monitoring program. In brief, we propose to: first, review and evaluate available Quaternary geologic data; and second, evaluate the potential for undetected active faults through the use of available photography.

PROPOSED 6 MONTH PROGRAM

I. Quaternary Geology-- Preliminary Assessment

1. Review and annotate all literature pertaining to the Quaternary geology of the Yucca Mountain area, including surficial geology, pedology, archeology, paleoclimatology, age-dating, trenching, and geomorphology.
2. Conduct reconnaissance-level field review of stratigraphic controls and relationships by investigation of selected stratigraphic sites.
3. Provide a preliminary evaluation of the present adequacy of the Quaternary stratigraphic controls being used for structural-tectonic assessment.

II. Tectonics-- Preliminary Analysis of Selected Fault Zones

1. Review and annotate all literature pertaining to the structural-tectonic setting of Yucca Mountain.
2. Acquire existing aerial photography for the site vicinity (56 km radius).
3. Analyze selected aerial photographs, focussing on a number of the most critical faults: the Paintbrush Canyon, Bow Ridge, Ghostdance, Solitario Canyon, Windy Wash, and Yucca Wash faults.

PROPOSED 6 MONTH BUDGET

	Cost
Personnel	
John W. Bell, Engineering Geologist	[redacted]
H.F. Bonham, Geologist	[redacted]
Quaternary Geologist/ Research Assoc.	[redacted]
Hourly student labor	[redacted]
Draftsperson/Secretary	[redacted]
Consultants	
Outside reviewers in soils and Quaternary geology	
10 days @$500/day	5000
10% travel expenses	500
Equipment and Supplies	
Aerial photographs	15,000
Reports and maps	500
Stereoscope	1000
Microcomputer	6000
Maintenance	300
Drafting supplies 6 mos. @$100/mo.	600
Field supplies 6 mos. @$100/mo.	600
Office supplies	500
Xerox, phone, postage 6 mos. @$100/mo.	600

Travel In-state	
University of Nevada vehicle $150/mo.; 10,000 mi @$.25/mi	3400
Per diem 50 days @55/day	2750
10 r.t. to Las Vegas	1000
Travel Out-of-state	
2 r.t. to G.S.A.	1000
meeting costs	400
10 days per diem @$75/day	750
2 r.t. to U.S.G.S.-Denver	1000
10 days per diem @$75/day	750
Rental car 20 days @$40/day	800
ESTIMATED DIRECT COST	**$79,432**
INDIRECT COST (27% of all direct costs except equipment)	**$19,475**
TOTAL ESTIMATED COST	**$98,907**

The above estimated costs are itemized for internal project purposes only. The final contract is to be performed on a fixed-cost basis.

TASK 2: GEOCHEMICAL ASSESSMENTS

Frank W. Dickson, Principal Investigator

Putting radioactive waste underground injects man-made chemical and physical disturbances of the natural configurations of rocks and contained fluids. The predictions of travel times of deleterious substances under various conditions to the biosphere requires understanding the rules whereby elements are mobilized, transported, and retained in various places by the natural processes. Geochemistry is the branch of earth sciences specifically concerned with such processes, causing assessments by geochemists of appropriate background to be vital to planning, developing, and monitoring storage sites. The prediction of geochemical processes can be done only in the geologic contexts of specific proposed sites, and then with the help of additional studies in the field and in the laboratory. The Nuclear Regulatory Commission has made it clear that an important factor they will use in judging the suitability of proposed sites is the extent to which the geochemical processes are understood.

The following geovhemical issues are of concern to the Yucca Mountain repository site:

1. The geochemical characteristics of rocks and grounwarwes, in and adjacent to the site, as a baseline for predicting and detecting changes induced by man, from chemical, isotopic and mineralogic studies of surface and borehole material.

2. The geochemical processes by which the rocks have interacted with groundwaters in the recent geologic past, from alteration effects of rocks correlated with associated pore water compositions and experimental studies of analogous rock-water systems, as a base to predict future changes.

3. Mineral and hazardous waste solubilities under repository conditions, during the various statges of repository development and operation, from known data and from experimental designed to provide specific data on unanswered questions, to predict travel times from the site to the boundaries, under normal and worst-case conditions.

The following sub-tasks will be undertaken by F.W.Dickson:

1. Review published records.

2. Establish status of unpublished work through communicating with individuals currently doing studies.

3. Attend technical meetings relevant to Task 2.

4. Receive, catalogue and store written material.

The budget requested for Task 2 makes provisions for the above sub-tasks.

The budget lists estimated costs of the assessment work in geochemistry during the initial period of the grant, July 1 through December 31, 1986. The following activities are planned:

1. Gaining an up-to-date overview of accomplished and planned work from published documents;

2. Getting current through telephone conversations and visits with individuals at institutions where work is being done;

3. Establish a center where all written records on geochemical aspects will be lodged and available according to State policy;

4. With help from a part-time student assistant, compile and process data, file, keep records, and maintain correspondence.

5. Attend meetings and workshops concerned with waste storage at Yucca Mountain and other proposed sites.

ESTIMATED BUDGET FOR TASK 2, JULY 1 TO DECEMBER 31, 1986

Personnel	
Professional Labor	
F.W. Dickson, Professor and P.I., [redacted]	[redacted]
Professional Labor plus Benefits	[redacted]
Non-Professional Labor	
Student Assistant, 520 hrs. estimated @ $7/hour	3,640
Fringe Benefits, @ 1.2 percent	44
Labor Subtotal	14,726
Materials and Services Subtotal: Miscellaneous office supplies, maps, etc.	200
Travel	
Per Diem, 20 days @ $50/day	1,000
University vehicle, 20 days @ $30/day	600
Air Travel or equivalent cost	
1 trip to national meeting	600
2 trips, local and Las Vegas	350
Registration Fees (est.)	200
Travel Subtotal	2,750
Direct Costs Subtotal	17,676
Indirect Costs, 27% of direct costs	4,773
Total Cost of Task 2 for July 1, 1986 to December 31, 1986	22,449

TASK 3: REVIEW OF STUDIES IN VOLCANIC GEOLOGY, STRATIGRAPHY, PETROLOGY, AND POSSIBLE HYDROTHERMAL ALTERATION AND MINERALIZATION ASSESSMENTS.

Donald C. Noble, Principal Investigator

The Yucca Mountain Repository is sited in rhyolitic tuffs of the Paintbrush Formation of middle Miocene age (Byers, et al., 1976). Most of the volcanic sequence consists of densely welded devitrified ash-flow tuff, although dense glassy welded tuff (vitrophyre), and partially welded to nonwelded tuff, both glassy and vapor-phase crystallized, are also present. These variants, which result largely from differences in the rate of cooling and overburden pressure of the ash flows immediately after deposition, exhibit markedly different chemical and physical behavior. For example, tuff that is glassy reacts much more readily with groundwater than does tuff that has undergone primary devitrification or vapor-phase crystallization and certain reaction products, specifically zeolites, possess a demonstrated affinity for a number of radionuclides. Structural behavior is also affected: for example, porous glassy beds - particularly those in which the glass has altered to clay - are commonly zones of slippage.

It is my understanding that some evidence suggestive of hydrothermal activity at the Yucca Mountain site has been recognized. This would not be too surprising, since the site is located in close proximity to several large collapse calderas of Neogene age. In addition, it has recently been recognized in several localities within the Great Basin that economically significant precious-metal mineralization may be related to basin-and-range faults rather than to high-level magmatic activity. Finally, it is clearly pertinent that an important active gold property (the Sterling mine) is located to the west on the east flank of Bare Mountain, and the general Beatty-Rhyolite-Bare Mountain area has been a site of appreciable mineral interest over the past few years.

A thorough review of the field and laboratory studies and other information pertinent to understanding the stratigraphy, petrology, mineralogy, and chemical composition of the volcanic rocks that host the proposed repository will be carried out. The review will encompass:

1. Comprehensive review of the pertinent literature, both published papers and open-file reports.

2. On-site inspection of the volcanic rocks, both in outcrop and drill-core, to evaluate the accuracy of identifications and interpretations made by previous investigators.

3. Discussion with selected staff personnel of the U.S.G.S., L.A.S.L., etc., who have carried out research studies that bear on those aspects of the Yucca Mountain site to be evaluated.

The attached budget includes funds for fifty days of work by this investigator within the period from July 1, 1986 to December 31, 1986. Funds are also included for part-time assistance by a graduate student, particularly in carrying out examinations of drill core and field examinations of rock outcrops. Funds are included for travel to the Nevada Test Site, Denver, Menlo Park, and Los Alamos, and for miscellaneous expenses, including telephone, reproduction, computer, and other office expenses.

His efforts will be coordinated with Eugene Smith at UNLV for regional volcanic assessments.

ESTIMATED BUDGET FOR TASK 3

Personnel	
Professional Labor	
Donald C. Noble, Principal Investigator	[redacted]
[redacted]	
Total Professional Labor plus Benefits	[redacted]
Non-Professional Labor	
Student Hourly Assistants, estimated at 250 hours @ $7.00/hr	1,750
Fringe Benefits, @ 1.2 percent	210
Total Non-Professional Labor plus Benefits	1,960
Labor Subtotal	14,074
Materials and Services: including telephone, reproduction, use of computer, and other materials and services	600
Travel	
Per diem, 20 days, estimated at $50	1,000
University vehicle, personal, or rental car 20 days, estimated at $30	600
Air travel or equivalent cost	
Las Vegas (five trips, including student assistant)	750
Menlo Park (two trips)	100
Denver (one trip)	200
Travel Subtotal	2,650
Direct Costs Subtotal	17,324
Indirect Costs, @ 27.0 percent	4,677
Total Cost of Task 3 from July 1, 1986 to December 31, 1986	22,001

TASK 4: SEISMOLOGICAL ASSESSMENTS INCLUDING REVIEW OF THE U.S. GEOLOGICAL SURVEY DATA.

Four professionals at the Seismological Laboratory will participate in this project: Ed Corbett, William Peppin, Keith Priestley, and Ute Vetter. Individuals, as named below, will be the task leaders, responsible for seeing to reporting requirements, coordinating work efforts, and disseminating information (e.g., pertinent documents) to co-participants. The research assistant will participate as needed to support the three tasks.

Task 4a: Comprehensive Summary of the Seismological Literature Pertinent to the Yucca Mountain site.

Task Leader: Keith Priestley, with Ed Corbett, William Peppin, and Ute Vetter co-participants.

The complex geological situation of the repository site poses a host of difficult questions, the answers to which may be critical in understanding how current seismicity relates to the geology. For example, Yucca Mountain is near the Death Valley seismic zone, dominated by recent tectonic activity along trending faults. And yet activity near the repository site appears to be confined to NE-trending faults with no evidence for activity on NW-trending faults at all. The catalog of recent earthquakes will play a key role in determining if the faults near the repository site are active today. Another conflict is that all of the focal mechanisms of recent events show north-south, right-lateral strike-slip motion, while many of the trends showing concentrations of microearthquakes trend to the northeast. One of us (URV) has extensive experience in studies of earthquake focal mechanisms. She will participate in what will be a main goal of the literature review: to determine to what extent the recent seismological record pertains to the hazard at Yucca Mountain occasioned by large earthquakes in the vicinity. In this region of relatively low present-day seismicity, the relationship between the tectonics leading to the larger earthquakes may be poorly related to the information coming to us from microearthquake characterization.

An in-depth review of released reports and published journal articles covering the topics of seismicity, strong ground motion, and seismic structure relevant to the siting of a high-level nuclear waste repository at Yucca Mountain, Nye County, Nevada, will be undertaken. Considerations that will be incorporated into the review are:

1. Objective and methodology of each report,

2. Source and quality of data used in each report,

3. Reasonableness and acceptability of conclusions to the scientific community,

4. Adequacy of the investigation from the State's perspective, and

5. A discussion of alternative methodologies.

The product of this task will be a written summary of the current state of knowledge of seismicity, strong ground motion studies, and seismic structure of the Yucca Mountain region. Additionally, we will initiate a computer-resident data base summarizing the articles and literature pursuant to the repository siting problem, as exhaustive as the resources in the proposal can reasonably permit.

Task 4b: Assessment of U.S.G.S. Seismological Data Base and Methodology Used in its Assembly.

Task leader: William Peppin, with Ed Corbett, Keith Priestley, and Ute Vetter as co-participants.

The U.S.G.S. have been operating a 53-station network of short-period seismographs in a 100-km region surrounding Nevada Test Site and Yucca Mountain since 1978. Since 1981 this data has been recorded digitally using a system almost identical to that at UNR. One of us (EJC) has full experience in the use of such a system and manipulation of the data produced. Therefore, in order to familiarize ourselves with the possible problems associated with the catalog of earthquakes assembled by the USGS, some 1,500 epicenters, we propose to spend two days in Golden to become acquainted first-hand with the procedure used by the USGS in collecting and analyzing these data. Several investigators have described some serious potential problems with the USGS data set. These include:

1. Methods used to locate the earthquakes,

2. The methods used for earthquake magnitude calculations,

3. Velocity models used in the computational algorithm, and most importantly,

4. The overall quality and homogeneity of the catalog and archived seismographic data. This last item is particularly important because of two major sources of contamination: local quarry blasts and afterevents induced by underground nuclear detonations. Workers at the Sandia National Laboratory in Albuquerque have reported an extremely high (25%) incidence of erroneous entries in the USGS catalog (M. Somerville, personal communication, 1986). If this is true, the catalog would be useless from the point-of-view of NRC standards, or for use in providing confident assessment of seismic activity on the important faults near the repository site. The magnitude question is also important because it has been long noted that this network reports magnitudes significantly lower than those calculated at UNR, U.C. Berkeley, and the USGS-operated National Earthquake Information Center. Since assessment of seismic risk

is made on the basis of seismic flux which depends on magnitude data, the correctness of magnitude calculations could become a critical issue.

The main purpose of this task is to provide an overall assessment of the procedures used by the USGS to prepare their earthquake catalogs. We will obtain all of their earthquake catalogs, published or on computer tape, so that we can make a preliminary assessment of their coverage and thoroughness during various time periods. We also propose to investigate a single swarm of earthquakes (such as the one near Sarcobatus Flat northwest of Yucca Mountain) using a master-event location scheme. The reasons for studying a single swarm in detail are first to become acquainted intimately with the USGS standard data acquisition and processing procedures, second, to test their location methods on a sample of reasonable size, and third to determine if some of the "lineups" of epicenters which have been reported are real (i.e., truly trend in the direction reported). This effort will involve the transfer of appropriate data files from Golden to Reno and application of existing master-event software. Two of us (WAP and EJC) have extensive experience in use of master-event location techniques. With regard to the magnitude question, we will thoroughly acquaint ourselves with scientific methods used by the USGS and assumptions made; further, we will compile some initial documentation on how much the USGS magnitudes differ from those reported by other sources.

-- The product of this task will be a report describing our investigations of these problems.

Task 4c: Analysis of the Post-1982 U.S.G.S. seismic refraction data collected in the vicinity of Yucca Mountain.

Task leader: Keith Priestley.

With funding from the NNWSI program, we are completing analysis of the seismic refraction data collected by the U.S.G.S. in the vicinity of Yucca Mountain, for the period 1980-1982 (Figure 2). We are also assembling the data set of seismic refraction recordings of the U.S.G.S. since 1982. The results obtained by the U.S.G.S. using these data has not yet been released. These data, which involve approximately 2000 additional seismograms, will be incorporated into our analysis of the seismic structure of the Yucca Mountain region.

The data will be compiled, and a preliminary interpretation will be described in a report as the product of this task.

Estimated Budget for Task 4, July 1 to December 31, 1985

Personnel	
Professional Labor	
William A. Peppin, P.I., Research Seismologist,	[redacted]
Keith F. Priestley, P.I., Research Seismologist,	
Edward J. Corbett, P.I., Research Seismologist	
Ute R. Vetter, Research Seismologist,	
[redacted]	[redacted]
Total Professional Labor plus benefits	[redacted]
Non-professional Labor	
Graduate Research Fellow, 50% @ $9,818/yr	4,909
Fringe Benefits, 1.2%	59
	$ 4,968
Labor subtotal	$ 22,621
Travel	
2 trips to Golden, Colorado, airfare plus lodging, per diem and car rental	1020
Trip to Menlo Park (USGS), air fare plus 5 days per diem	435
2 trips to Las Vegas	300
	$ 1,755
Materials and Services	
Computer time on PDP 11/70 for 6 mo @$500/mo(est)	3,000
Report preparation and graphics costs	2,000
Telephone, copying, postage, etc.	570
Digital computer tapes, 10 @ $18	180
Tuition for Graduate Research Fellow, 1 semester	1,100
Stipend for Graduate Research Fellow	504
	$ 7,354
Total Direct Cost (TDC)	31,730
Indirect Costs	
Off-campus rate, 27% @ $30,630	8,270
Total Estimated Costs	40,000

TASK 5: NEOTECTONIC AND TECTONIC FRAMEWORK ASSESSMENT

Richard A. Schweickert, Principal Investigator

A clear understanding of the tectonic and neotectonic framework of the Yucca Mountain area is an important element in the assessment of the seismotectonic behavior and seismic potential of the region. The area is structurally complex, and many aspects of the tectonic and neotectonic framework are controversial. Important questions concern the relative importance and timing of a) northwest-trending, right-lateral structures of the Walker Lane belt, b) northeast-trending, left-lateral structures, c) block tilting related to detachment faults, and d) volcano-tectonic structures. Many of the investigators who have published results on the area have committed many years of time and effort to their research. While they may be highly qualified and knowledgeable about the region, some may have acquired biases toward certain favored hypotheses they have developed, as is common in scientific disciplines.

It is highly desirable for the State of Nevada to have impartial, noninvolved scientists conduct in depth reviews of released reports on all aspects of the structural, tectonic, and neotectonic development of the region. Field examination of critical structural and tectonic features must also be made. In addition, subsidiary studies of special problems or areas may be necessitated by the review process, either to clarify controversial points or to obtain supplemental data on key problems or areas that have not, in the judgment of our staff, received adequate attention.

Support is requested for a Master's level Graduate Research Assistant and hourly student support to assist in the collection and analysis of relevant documents, and to participate in additional studies of special problems. Each review will be documented by a report that will be submitted to the state.

Criteria to be employed in the reviews are:

1. Objectives and methodology of the study.
2. Source(s) and reliability of data.
3. Assumptions and interpretive approaches.
4. Reasonableness and degree of confidence in conclusions.
5. Adequacy of investigation from perspective of the State of Nevada.
6. Recommendations of alternative methodologies and suggestions for further research.

The reviews may include individual reports or groups of reports for generic or topical reviews.

ESTIMATED BUDGET FOR TASK 5

Personnel	
Professional Labor	
Richard A. Schweickert, Principal Investigator, one summer month [redacted]	
[redacted]	
Total Professional Labor plus Benefits [redacted]	
Non-Professional Labor	
Graduate Research Assistant, 4-1/2 months @ $889/mo, plus one one summer month @ $1778/mo.	5,778
Student hourly assistance: 500 hrs. @ $7.00/hr.	3,500
Total Non-Professional Labor	9,278
Fringe Benefits for Non-Professional Labor @ 1.2 percent	111
Labor Subtotal	14,259
Materials and Services	
Miscellaneous Expenses, including communications, copying, cost of publications, shipping, phone, etc.	500
Tuition, 15 cr. @ $42	630
Stipend	1,100
Materials and Services Subtotal	2,230
Travel	
Per diem, 30 days @ $50/day	1,500
University vehicle, 30 days @ 30/day	900
Air travel or equivalent cost	
4 trips from Reno to NTS	600
1 trip, Reno to USGS (Menlo Park)	200
1 trip, Reno to USGS (Denver)	400
2 trips, Reno to Scientific Conference	1,000
Travel Subtotal	4,600

Direct Cost Subtotal	21,089
Indirect Costs, @ 27 percent	5,524
Total Cost of Task 5 from July 1, 1986 to December 31, 1986,	26,613

TASK 6: REMOTE SENSING ASSESSMENTS

Dr. James V. Taranik, Principal Investigator

BACKGROUND

Previous studies using Landsat Thematic Mapper data have revealed straight alighnments of drainage in the Nevada Test Site and proposed Nuclear Repository that have been interpreted as structural discontinuities in the volcanic rock sequences, Walker, 1986. These structural discontinuities have localized development of stream drainages that developed in late Pleistocene and perhaps Holocene time. Although displacements along these features may be minor, the structural discontinuities may extend far into the subsurface, perhaps into the water table. These disconuities could provide pathways for infiltration of groundwater, and minor displacements could occur along the features during an earthquake. Work by Walker, 1986 has documented minor displacements along fractures and joints sets that are parallel to the alighnments of linear landscape features mapped from imagery. However, significant offsets along these features were not documented and therefore the structural discontinuities should not be mapped as major faults.

OBJECTIVES OF TASK 6

1. To utilize state-of-the-technology aerospace remote sensing data and techniques to delineate landscape features in the Nevada Test Site and the Nuclear Repository.

2. To conduct field studies to determine if delineated landscape features represent structural discontinuities.

3. To evaluate structural discontinuities interpreted from aerospace remote sensing imagery and documented through field analysis to determine if the structural discontinuities could act as conduits for groundwater recharge and groundwater flow in the Nuclear Repository.

APPROACH FOR TASK 6

Several state-of-the-technology data sets now exist for the study area and important new aerospace remote sensing data is now being acquired. The following approach is recommended:

1. Acquire the following data sets over the study area:

   a. Multitemporal Landsat Thematic Mapper Data. At least four seasons are recommended. One scene is currently on hand at UNR and three additional scenes should be acquired (Winter, Spring and Summer).

   b. French SPOT stereo panchromatic data should be acquired. This data set will require two scenes at 10 meter panchromatic resolution. The observation geometry is being defined by a study currently underway at UNR.

APPROACH FOR TASK 6 (CONTINUED)

c. Analyze the Landsat TM and SPOT data using the VAXII/780 IDIMS system at UNR.

d. Manufacture images on precision photo reproduction equipment. Estimated cost:

e. Interpret precision images at 1:50,000 scale to delineate landscape features.

f. Field check of interpretation.

g. Prepare preliminary and final reports.

The expected results will include:

1. Systematic evaluation of linear landscape features discovered by Walker, 1986 using higher resolution aerospace remote sensing data.

2. Systematic evaluation of the geologic and hydrologic significance of any structural discontinuities in the Nuclear Repository area.

ESTIMATED BUDGET FOR TASK 6, JULY 1, 1986 TO DECEMBER 31, 1986

Personnel	
Professional Labor	
James, V. Taranik, Principal Investigator, [redacted]	
[redacted]	
Professional Labor plus Benefits	[redacted]
Non-Professional Labor	
Student assistants, 40 hours, @ estimated $7.00/hr	280
VAX/IDIMS operator, 40 hours, @ $10.00/hr	400
Fringe Benefits, @ 1.2 percent	8
Non-Professional Labor plus Benefits	688
Labor Subtotal	4,450
Materials and Services	
Imagery	28,762
Miscellaneous supplies, communications and services	400
Supplies Subtotal	29,162
Travel	
Las Vegas, 2 people	300
Per diem, 24 days, @$50/day	1,200
Car rental, 20 days, @30/day	600
Miscellaneous field expenses, film, etc.	200
Travel Subtotal	2,300
Direct Costs Subtotal	35,912
Indirect Costs, @ 27 percent	9,696
Total Cost for Task 6, July 1, 1986 to December 31, 1986	45,608

TASK 7: GEOCHEMICAL AND ROCK MASS ASSESSMENT

Robert Watters, Principal Investigator

The stability of large underground openings in rock is controlled by the orientation, spacing, continuity and shear strength of discontinuities (planes of weakness, e.g. joints), the in-situ virgin stress state and seismicity. The uniaxial strength and moduli values of unjointed rock is of lesser importance where planes of weakness are numerous in the rock mass. The rock mass at Yucca Mountain is traversed by intersecting discontinuities, in conjunction with a highly variable rock lithology (welded tuff) with wide ranges in intact strength.

The proposed investigation will concentrate on reviewing and critically appraising the geotechnical information which has been developed by the U.S.G.S., Sandia labs, and other agencies. Specifically the following areas will be reviewed:

a) Televiewer logs of boreholes and in situ stress measurements.

b) Geotechnical reports on the Data baseline for rock mass elastic properties, shear behavior on discontinuities, tensile and unconfined compressive strength, and other material properties.

c) Site visit(s) to inspect and check rock core and geotechnical rock core borehole logs.

d) Reports and plots on rock fracture data.

e) General information on the project.

The final product will be a report that answer the current knoweledge of geotectonic infraction.

ESTIMATED BUDGET FOR TASK 7, JULY 1, 1986 TO DECEMBER 31, 1986

Personnel	
Professional Labor	
Robert J. Watters, Principal Investigator, [redacted]	
Fringe Benefits, [redacted]	
Professional Labor plus Benefits	[redacted]
Non-Professional Labor	
Student Assistant, 225 hours @ $7.00/hour	1,575
Fringe Benefits, @ 1.2 percent	19
Total Non-Professional Labor	1,594
Labor Subtotal	10,691
Travel	
Per diem, 25 days @ $60/day	$1,500
Car rental, 20 days @ $30/day	600
Air Travel, 5 trips including student assistants, @ $150/trip to Test Site	750
Menlo Park, one trip	100
Denver, one trip	200
Albuquerque, one trip	300
National Meeting	500
Travel Subtotal	3,950
Materials, Services, and Communications	400
Direct Costs Subtotal	15,041
Indirect Costs, @ 27 Percent	4,061
Total Cost of Task 7 from July 1, 1986 to December 31, 1986	$19,102

ESTIMATED BUDGET TOTAL - ALL TASKS

General Budget	111,298	+372	47,629 ~~$40,969~~	177,29
Task 1 - Quaternary Geology, Active Faulting	250,000	230 %	$98,907	250,000
Task 2 - Geochemical	65,000	300 %	$22,449	65,000
Task 3 - Volcanic Geology, Stratigraphy, Petrology, Hydrothermal Alteration and Mineralization	84,000	750 %	22,001 ~~$21,829~~	168,000
Task 4 - Seismological, Part I	25,000-50,000 ?	550 %	48,800 ~~$28,306~~	500,000
Task 5 - Neotectonic and Tectonic	131,000	550	$26,613 ~~529~~	146,000
Task 6 - Remote Sensing	90,000	180	45,608 ~~$40,396~~	90,000
Task 7 - Geotechnical and Rock Mass	50,000±	750	$19,102	150,000
Task 8 - Seismological, Part II			~~$20,494~~	—
TOTAL ESTIMATED BUDGET		+ 500 ?	$318,981	1,594,000

RESUMES OF PROFESSIONAL STAFF OF THE CENTER FOR NEOTECTONIC STUDIES

David B. Slemmons, Director, Center for Neotectonic Studies

John Bell, Principal Investigator, Quaternary Geology and Active Faults Assessments (Task 1)

Frank W. Dickson, Principal Investigator, Geochemical Assessments (Task 2)

Donald C. Noble, Principal Investigator, Volcanic Geology, Stratigraphy, Petrology, and Possible Hydrothermal Alteration and Mineralization Assessments (Task 3)

Keith F. Priestley, Principal Investigator, Seismological Assessments (Task 4)

Richard A. Schweickert, Principal Investigator, Neotectonic and Tectonic Assessments (Task 5)

James Taranik, Principal Investigator, Remote Sensing Assessments (Task 6)

Bob Watters, Principal Investigator, Geotechnical and Rock Mass Assessments (Task 7)

William A. Peppin, Principal Investigator, Seismic Data Base Assessments (Task 8)

Edward J. Corbett, Principal Investigator, Seismic Data Base Assessments (Task 8)

Ute R. Vetter, Principal Investigator, Seismic Data Base Assessments (Task 4)

David B. Slemmons, Director
Center for Neotectonic Studies
Mackay School of Mines
University of Nevada - Reno
Reno, Nevada 89557

EDUCATION: B.S., Economic Geology, 1947, and Ph.D. in Geology, 1950, University of California, Berkeley, California.

PROFESSIONAL HISTORY: Assistant Professor to Professor, University of Nevada, Reno, 1951 to present.
Visiting Assist. Professor to Professor, University of California, Berkeley, Summer Sessions, 1952-1962.
Principal Investigator, or Co-Principal Investigator on Research Grant and Contracts on seismology, active faulting, seismic regionalization, late Cenozoic volcanism, geothermal energy and environmental geology.
Chairman, Department of Geology-Geography, Mackay School of Mines, University of Nevada, 1966-1970.
Program Director for Geophysics, National Science Foundation, 1970 to 1971.

CONSULTING EXPERIENCE: Consulting services and contracts with industry and the federal government in geology, engineering geology, earthquake hazard and risk assessment for nuclear reactors, dams and waste disposal facilities. Work includes service with the United States Atomic Energy Commission, Nuclear Regulatory Commission, Corps of Engineers, Lawrence Livermore Laboratory, and Los Alamos Scientific Laboratory.

HONORS AND AWARDS: G.K. Gilbert Award in Seismic Geology, Carnegie Institute of Washington, 1962; Listed in Dictionary of International Biography, World Who's Who in Science; Who's Who in America; Who's Who in Technology, Who's Who in the West; Who's Who in the World, and American Men and Women of Science. Delegate to Second and Third U.S.-Japan Conferences on Earthquake Prediction: 1966 and 1969.

OFFICES AND APPOINTMENTS: Board of Directors, Seismol. Soc. America, 1969-1970; Chairman, Cordilleran Section, Geological Society of America, 1971-1972; Associate Editor, Geol. Soc. Amer., 1971-1973; Member, Commission on Safety of Dams, National Research Council, 1977-1978 Chairman, Geophysics Division, Geol. Soc. America.

PUBLICATIONS: Author or Co-Author of more than 100 scientific papers and abstracts in fields of seismology, earthquake hazard assessment, geology, mineralogy, tectonics and geothermal energy.

SELECTED BIBLIOGRAPHY, DAVID B. SLEMMONS

Slemmons, D.B., 1956, Geological setting for the Fallon-Stillwater earthquake of 1954: Bull. Seismol. Soc. Amer., v. 46, p. 4-9.

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Slemmons, D.B., 1966, Cenozoic volcanism of the Central Sierra Nevada, California: in Geology of Northern California, Bailey, E.H. (ed.), Calif. Div. Mines and Geology Bull. 190, p. 199-208.

Slemmons, D.B., 1967, Pliocene and Quaternary crustal movements of the Basin-and-Range Province, U.S.A., in Sea Level Changes and Crustal Movements of the Pacific, 11th Pac. Sci. Cong., Tokyo, 1966, Symp. 19: Osaka City Univ. Jour. of Geoscience, v. 10, Art. 1-11, p. 91-103.

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Slemmons, D.B., 1972, Microzonation for surface faulting: Intl. Conf. on Microzonation for Safer Construction Research and Application, v. 1, p. 347-361.

Cluff, L.S. and Slemmons, D.B., 1972, Wasatch fault zone - features defined by low-sun angle aerial photography: in Hilpert, L.S. (ed.), Environmental Geology of the Wasatch Front, 1971, Utah Geol. Assoc. Publ. 1, p. G1-G9.

Slemmons, D.B., 1977, Faults and earthquake magnitude: State-of-the-art for assessing earthquake hazards in the United States: U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, Misc. Paper S-73-1, Report 6, 166 p.

Slemmons, D.B. and McKinney, R., 1977, Definitions of the term "active fault": U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, Misc. Paper S-77-8, 17 p.

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Ch. 2 - Slemmons, D.B. and Stroh, J.M., Introduction, p. II-1 to II-5.
Ch. 3 - Stroh, J.M. Slemmons, D.B. and Whitney, R.A., Environmental geology, p. III-1 to III-34.

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RESUME

JOHN W. BELL

EDUCATION:	B.A., 1968, Augustana College, Rock Island, Illinois Major: Geology
	M.S., 1974, Arizona State University, Tempe, Arizona Specialization: Quaternary geology. Thesis: Environmental Geology of the Fairbanks Area, Alaska; includes folio of maps showing surficial geology, permafrost, foundation, ground water, and resource material conditions.
EXPERIENCE:	
1976 to present	Engineering Geologist (tenured faculty). Nevada Bureau of Mines and Geology, University of Nevada-Reno. Responsibilities include: research on geologic and engineering geologic subjects throughout the State of Nevada; public service through dissemination of research data to the public; coordination and research for the Bureau's Urban and Engineering Geology Program.
1973 to 1976	Staff Geologist. ERTEC, Inc. (formerly Fugro, Inc.), Long Beach, California. Quaternary/Engineering Geologist on nuclear power plant site investigations in Arizona and California; experience in geomorphology, alluvial and soil stratigraphy, surficial and subsurface geology, geochronology, and exploratory drilling and trenching.
1972 to 1974	Geologist/Engineering Geologist (WAE). U.S. Geological Survey, Alaskan Geology Branch, Menlo Park, California. Thesis and publication of maps funded by the U.S. Geological Survey.
1972	Consulting Geologist. Arizona Atomic Energy Commission, Phoenix, Arizona. Geology of the Yuma area.
1969 to 1971	U.S. Army Surveyor. Included service in Vietnam.
1968	Geology Technician. Kennecott Copper Corp. Salt Lake City, Utah. Geology of open-pit copper mine.
PROFESSIONAL AFFILIATIONS	Geological Society of America; Association of Engineering Geologists; Seismological Society of America; Sigma Xi; Registered Geologist No. 3425, State of California.

John W. Bell

Publication List

Bell, E. J., Trexler, D. T., and Bell, J. W. (1978) Computer-simulated composite earthquake hazard model for the Reno, Nevada area: Proceedings of Second International Conference on Microzonation, San Francisco, California, p. 471-483.

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_____ (1975b) Late Cenozoic geology along the Gila River near Gillispie Dam, central Arizona: Geological Society of America Abstracts, v. 7, no. 3, p. 340-341.

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_____ (1975a) Map showing distribution of permafrost in the Fairbanks D-2 NW quadrangle, Alaska: U.S. Geological Survey Map MF-668A.

_____ (1975b) Map showing ground water conditions in the Fairbanks D-2 NW quadrangle, Alaska: U.S. Geological Survey Map 668B.

_____ (1975c) Map showing construction materials in the Fairbanks D-2 NW quadrangle, Alaska: U.S. Geological Survey Map 668C.

_____ (1975d) Map showing foundation conditions in the Fairbanks D-2 NW quadrangle, Alaska: U.S. Geological Survey Map 668D.

_____ (1975e) Map showing distribution of permafrost in the Fairbanks D-2 NE quadrangle, Alaska: U.S. Geological Survey Map MF-670A.

_____ (1975f) Map showing ground water conditions in the Fairbanks D-2 NE quadrangle, Alaska: U.S. Geological Survey Map MF-670B.

_____ (1975g) Map showing construction materials in the Fairbanks D-2 NE quadrangle, Alaska: U.S. Geological Survey Map MF-670C.

_____ (1975h) Map showing foundation conditions in the Fairbanks D-2 NE quadrangle, Alaska: U.S. Geological Survey Map MF-670D.

_____ (1975i) Map showing distribution of permafrost in the Fairbanks D-2 SE quadrangle, Alaska: U.S. Geological Survey Map MF-669A.

_____ (1975j) Map showing ground water conditions in the Fairbanks D-2 SE quadrangle, Alaska: U.S. Geological Survey Map MF-669B.

_____ (1975k) Map showing construction materials in the Fairbanks D-2 SE quadrangle, Alaska: U.S. Geological Survey Map MF-669C.

_____ (1975l) Map showing foundation conditions in the Fairbanks D-2 SE quadrangle, Alaska: U.S. Geological Survey Map MF-669D.

_____ (1975m) Map showing distribution of permafrost in the Fairbanks D-1 SW quadrangle, Alaska: U.S. Geological Survey Map MF-671A.

_____ (1975n) Map showing ground water conditions in the Fairbanks D-1 SW quadrangle, Alaska: U.S. Geological Survey Map MF-671B.

_____ (1975o) Map showing construction materials in the Fairbanks D-1 SW quadrangle, Alaska: U.S. Geological Survey Map MF-671C.

_____ (1975p) Map showing foundation conditions in the Fairbanks D-1 SW quadrangle, Alaska: U.S. Geological Survey Map MF-671D.

Péwé, T. L., Bell, J. W., Forbes, R. B., and Weber, F. R. (1975a) Geological map of the Fairbanks D-2 NW quadrangle, Alaska: U.S. Geological Survey Map I-907.

_____ (1975b) Geologic map of the Fairbanks D-2 NE quadrangle, Alaska: U.S. Geological Survey Map I-950.

_____ (1976a) Geologic map of the Fairbanks D-2 SW quadrangle, Alaska: U.S. Geological Survey Map I-829A.

_____ (1976b) Geologic map of the Fairbanks D-2 SE quadrangle, Alaska: U.S. Geological Survey Map I-942.

Péwé, T. L., Bell, J. W., Williams, J. R., and Paige, R. A. (1976) Geologic map of the Fairbanks D-1 SW quadrangle, Alaska: U.S. Geological Survey Map I-949.

Trexler, D. T. and Bell, J. W. (1980) Earthquake hazards map, Carson City quadrangle: Nevada Bureau of Mines and Geology Map 1Ai.

_____ (1980) Earthquake hazards map, South Lake Tahoe quadrangle: Nevada Bureau of Mines and Geology Map 2Ai.

Frank W. Dickson
Task 2 - Geochemistry

Current Position: Professor, Dept. of Geological Sciences, UNR (50%), and President, Dickson Resources Company (50%), Sparks, Nevada.

[redacted]

Former Positions Relevant to Task 2: Faculty member and Chairman, Departments of Geology at the University of California, Riverside (13 years) and at Stanford University (10 years). Research Scientist, Oak Ridge National Laboratory, Tennessee (4 years).

Degrees: Bachelors in Geology (1950) and in Chemistry (1953); PhD in Geology (1955), at University of Calfornia, Los Angeles.

Honors and Awards: Guggenheim Fellow, 1962-63; Fulbright Scholar, 1962-63 and 1964; Member of Phi Beta Kappa, Scholastic Honorary, Sigma Xi, Science Honorary, and Phi Lambda Upsilon, Chemistry Honorary.

Professional Experience: Co-worker on U. S. Geological Survey projects on lithium, mercury, and gold; Consultant to Companies and Governmental Agencies in applied geochemistry (Exploration for ore deposits; Underground storage of radioactive waste).

Licensed Geologist, State of California.

Member of 10 Professional Organizations, including the Geological Society of America, Society of Economic Geologists, Geochemical Society, Mineralogical Society of America, Society of Exploration Geochemists, American Institute for Mining and Metallurgical Engineering, International Association on Genesis of Ore Deposits.

Research Support: National Science Foundation, Ore genesis, Mineral Solubilities, Rock-Solution Interactions; Joint NSF and Japan Society for Promotion of Science; Electric Power Research Institute; U. S. Geological Survey.

Present Research: Field and Laboratory studies on the origin of Carlin-type gold deposits and related subjects.

Research Approach: Laboratory investigations of chemical systems that bear on the origin of mineral deposits, geothermal system processes, rock alteration and changes in solution chemistry during rock-solution interactions. Designed special equipment to study corrosive systems to 500°C and 2000 bars. Measured solubilities of sulfide and gangue minerals, reacted basalt and rhyolite with seawater, and basalt, andesite, and rhyolite with water and sodium chloride solutions.

Applications of Research: Applied to chemical process problems in the upper earth's crust, such as ore genesis, evolution of hot springs, changes in rocks and solution caused by activities of man (hazardous waste storage).

Publications: More than 75 articles in professional journals, most of which are experimental or field applications of the experimental result. A selected set of representative publications is listed below.

Selected Publications of F. W. Dickson

Dickson, F.W. and Tunell, George, 1958, Equilibria of red HgS (cinnabar) and black HgS (metacinnabar) and their saturated solutions in the systems HgS-Na_2S-H_2O and HgS-Na_2S-Na_2O-H_2O from 25° to 75°C at 1 atmosphere pressure, Am. J. Sci., v. 256, p. 654-679.

Dickson, F.W., Blount, C.W., and Tunell, George, 1963, Use of the hydrothermal solution equipment to determine the solubility of anhydrite in water from 100°C to 275°C and from 1 bar to 1000 bars pressure, Am. J. Sci., v. 261, p. 61-78.

Dickson, F.W., 1964, Solubility of cinnabar in Na_2S solutions at 50°C to 250°C and 1 bar to 1800 bars with geologic applications, Econ. Geol., v. 59, p. 625-635.

Bowser, C.J. and Dickson, F.W., 1966, Chemical zonation of the borates of Kramer, California, in Rau, J.L. (ed.), Second Symposium on Salt, Northern Ohio Geological Society, p. 122-132.

Dickson, Frank W. and Tunell, George, 1968, Mercury and antimony deposits associated with active hot springs in the western United States; Graton-Sales Vol., A.I.M.E., John D. Ridge, editor, p. 1673-1701.

Blount, C.W. and Dickson, F.W., 1969, The solubility of anhydrite ($CaSO_4$) in NaCl-H_2O from 100° to 450°C and 1 to 1000 bars, Geochim. Cosmochim. Acta, v. 33, p. 227-245.

Blount, C.W. and Dickson, F.W., 1973, Gypsum-Anhydrite equilibrium in systems $CaSO_4$-H_2O and $CaSO_4$-NaCl-H_2O, Amer. Min., v. 58, p. 323-331.

Learned, R.E., Tunell, George, and Dickson, F.W., 1974, Cinnabar, stibnite and saturated solution equilibria in the system HgS-Sb_2S_3-Na_2S-H_2O at 150°-250°C and 100 bars, with implications on ore genesis, Jour. Research, U.S. Geol. Surv., v. 2, p. 457-466.

Radtke, A.S. and Dickson, F.W., 1974, Genesis and vertical position of fine-grained disseminated replacement-type gold deposits in Nevada and Utah, U.S.A. IAGOD Proc. 4th Symposium, 1974, Varna, Bulgaria, v. 1, p. 71-78.

Dickson, F.W., Radtke, A.S., Weissberg, B.G., and Heropoulous, Chris, 1975, Solid solutions of antimony, arsenic, and gold in stibnite (Sb_2S_3), orpiment (As_2S_3), and realgar (As_2S_2), Econ. Geology, v. 70, no. 3, p. 591-594.

Radtke, A.S. and Dickson, F.W., 1975, Carlinite, Tl_2S, a new mineral from Nevada, Am. Mineralogist, v. 60, nos. 7 and 8, p. 559-565.

Bischoff, James L. and Dickson, Frank W., 1975, Sea water-basalt interaction at 200°C and 500 bars: Implications for origin of sea-floor heavy metal deposits and regulations of sea water chemistry, Earth and Planetary Science Letters, v. 25, p. 385-387.

Seyfried, W.D., Jr., Bischoff, J.L., and Dickson, F.W., 1975, Basalt-seawater interactions from 25°C to 300°C and from 1 to 500 bars: Implications for origin of sea-floor heavy metal deposits and regulation of sea water chemistry, Earth and Planetary Science Letters, v. 25, p. 385-387.

Dibble, Walter E., Jr. and Dickson, Frank W., 1976, The behavior of lithium in experimental rock-water interaction studies, U.S. Geol. Surv. Prof. Paper 1005, p. 142-147.

Dickson, F.W. and Radtke, A.S., 1977, The unique mineralogy of Hg-As-Sb-Tl sulfides at the Carlin gold deposit, Nevada, and implications as to the origin of the deposit, Mineralog. Soc. America - Friends of Mineralogy, 3rd Joint Symposium, Crystal Growth and Habit, Tucson, Arizona, February 1977, p. 13-14.

Sakai, H. and Dickson, F.W., 1978, Experimental determination of the rate and equilibrium fractionation factors of sulfur isotope exchange between sulfate and sulfide in slightly acid solutions at 300°C and 1000 bars, Earth and Planetary Science Letters, v. 39, p. 151-161.

Dickson, F.W., Rye, R.O., and Radtke, A.S., 1979, The Carlin gold deposit as a product of rock water interactions, Internatl. Assoc. Genesis Ore Deposits (IAGOD), 5th Symposium, Snowbird, Utah, Proc., v. 11, p. 101-109.

Dickson, F.W., Radtke, A.S., and Peterson, J.A., 1979, Ellisite, Tl_3AsS_3, a new mineral from the Carlin gold deposit Nevada, and associated sulfide and sulfosalt minerals, Am. Mineralogist, v. 64, p. 701-707.

Radtke, A.S., Rye, R.O., and Dickson, F.W., 1980, Geology and stable isotope studies of the Carlin gold deposit, Nevada, Econ. Geol., v. 75, p. 641-672.

Dickson, F.W., 1981, Association of organic matter with epithermal ore deposits, in "Conference on the Geochemistry of Organic Matter in Ore Deposits", Carnegie Inst. Wash., Geophys. Lab., Warrenton, Virginia, p. 35-37.

Dickson, F.W., and Potter, J.M., 1981, Rock-brine chemical correlations, EPRI, AP-2258, Project 653-2, Final Report, 72 p.

Seki, Y., F. W. Dickson, J. G. Liou, Y. Oki, H. Sakai, and T. Hirano, 1986, Geochemical prediction of impending catastrophic inflow of seawater during construction of the undersea part of the Seikan Tunnel, Japan, J. Applied Geochem., v. 1, p.___-____.

Donald C. Noble, Principal Investigator, Task 3

[redacted]

EDUCATION: B.S. Geology, Cornell University, 1958
M.S. Geology, Stanford University, 1961
Ph.D. Geology, Stanford University, 1962

PROFESSIONAL HISTORY: Geologist, U.S. Geological Survey, 1962-1966. Duties included stratigraphic, structural, petrographic, and geochemical studies of Cenozoic rocks, southern Great Basin.
Asst. Professor of Geology, Harvard University, 1966-1971.
Visiting Professor, Research Associate, Adjunct Professor, Mackay School of Mines/Nevada Bureau of Mines and Geology, 1972-1975.
Assoc. and Full Professor of Geology, Michigan Technological University, 1975-1980 (with tenure).
Prof. of Geology, Mackay School of Mines, University of Nevada-Reno, 1980-present (with tenure).
In addition: Guest investigator, Branch of Isotope Geology, U.S. Geological Survey; W.A.E., U.S. Geological Survey; Geological Engineer, Lawrence Berkeley Laboratory, Univ. Calif.; Consultant, Cia. de Minas Buenaventura, S.A., Mauricio Hochschild y Cia., Ltda., S.A., and other organizations.

Scientific and professional work has involved studies of Cenozoic volcanic rocks and mineral deposits in both the Great Basin of the Western United States and the Central Andes of South America. A special emphasis has been on the stratigraphy, petrology, and geochemistry of large-volume rhyolitic ash-flow sheets of the type in which the Yucca Mountain repository facility is sited. From 1962 to 1966 he worked on the Nevada Test Site and Northern Nellis Bombing and Gunnery Range as one of the team of geologists who worked out the Cenozoic volcanic stratigraphy, caldera geology, and geochemistry of the Test Site - Nellis area. A number of studies have involved the loss and gain of a variety of minor elements on eruption, cooling and primary crystallization, and during contact with groundwater and on base- and precious-metal mineralization hosted by volcanic rocks.

PROFESSIONAL ORGANIZATIONS: Member of the Geological Society of America, the Society of Economic Geologists, A.I.M.E., the Sociedad Geologica del Peru, and a Fellow of the Mineralogical Society of America.

PUBLICATIONS: More than 100 published scientific papers. Selected publications of studies particularly pertinent to the volcanic geology, petrology and geochemistry at the Yucca Mountain site include:

Ekren, E.B., Anderson, R.E., Rogers, C.L. and Noble, D.C., 1971, Geology of Northern Nellis Air Force Base Bombing and Gunnery ange, Nye County, Nevada: U.S. Geol. Survey Prof. Paper 651, 91 p.

McKee, E.H. and Noble, D.C., 1986, Tectonic and magmatic development of the Great Basin during late Cenozoic time: Modern Geol., v. 10, p. 39-49.

Noble, D.C., in ms, Mobility of antimony during the crystallization of peralkaline silicic volcanic rocks.

Noble, D.C. and Christiansen, R.L., 1974, Black Mountain volcanic center, in Guidebook to the geology of four Tertiary volcanic centers in central Nevada: Nev. Bur. Mines and Geol. Report 19, p. 22-26.

Noble, D.C., Smith, V.C. and Peck, L.C., 1967, Loss of halogens from crystallized and glassy silicic volcanic rocks: Geochim. et Cosmochim. Acta, v. 31, p. 215-233.

Noble, D.C., Vogel, T.A., Weiss, S.A., Erwin, J.W., McKee, E.H. and Younker, L.W., 1984, Stratigraphic relations and source areas of ash-flow sheets of the Black Mountain and Stonewall Mountain volcanic centers, Nevada: Jour. Geophys. Res., v. 89, p. 8593-8602.

Rosholt, J.N., Prihana, and Noble, D.C., 1971, Mobility of uranium and thorium in glassy and crystallized volcanic rocks: Econ. Geology, v. 66, p. 1061-1069.

Stuart, E.J., Bornhorst, T.J., Rose, W.I. Jr. and Noble, D.C., 1983, Distribution and mobility of uranium and thorium in the Soldier Meadow Tuff, northwestern Nevada: Econ. Geology, v. 78, p. 353-358.

Vogel, T.A., Ryerson, R.A., Noble, D.C. and Younker, L.W., Evidence for magma mixing and phenocryst disequilibrium within pumice from an ash-flow sheet, Black Mountain volcanic center, southern Nevada: (submitted to Journal of Geology).

KEITH F. PRIESTLEY

EDUCATION: B.S., University of Washington, 1969 (Oceanography).
B.S., University of Washington, 1969 (Geology).
M.S., University of Washington, 1971 (Geophysics).
Ph.D., University of Nevada, 1974 (Geophysics).

EXPERIENCE: Research Assistant, Dept. Geology, 1969-1970, Research Assistant, Dept. Civil Engineering, 1971, University of Washington, Seattle, WA.
Graduate Research Fellow, Seismological Laboratory, University of Nevada, Reno, NV, 1971-1974.
Post-doctoral fellow, Dept. Geodesy and Geophysics, University of Cambridge, Cambridge, England, 1974-1975.
St. Peter's College, Gore, New Zealand, 1975-1976.
Assistant Professor, Seismological Laboratory, University of Nevada, Reno, NV 1976-1979.
Visiting Research Associate, Institute of Geophysics and Planetary Physics, Scripps Institute of Oceanography, University of California-San Diego, La Jolla, CA, 1979 to present.
Senior Lecturer, Dept. Geology, University of Otaga, Dunedin, New Zealand, 1980-1982.
Assistant Professor, Seismological Laboratory, University of Nevada, Reno, NV, 1982-1984, Associate Professor, 1984 to present.

MEMBERSHIP: American Geophysical Union, Seismological Society of America, New Zealand Geophysical Society, Royal Society of New Zealand.

BIBLIOGRAPHY:

Koizumi, C.J., Ryall, A. and Priestley, K.F., 1973, Evidence for a high-velocity lithospheric plate under northern Nevada: Bull. Seismol. Soc. America, v. 63, p. 2135-2144.

Priestley, K.F., 1974, Crustal strain measurements in Nevada: Bull. Seismol. Soc. America, v. 64, p. 1319-1328.

Priestley, K.F., 1975, Possible premonitory strain changes associated with an earthquake swarm near Mina, Nevada: Pure and Applied Geophysics, v. 113, p. 251-256.

Ryall, A. and Priestley, K.F., 1975, Seismicity, secular strain and maximum magnitude in the Excelsior Mountains area, western Nevada and eastern California: Bull. Geol. Soc. America, v. 86, p. 1585-1592.

Priestley, K.F. and Brune, J.N., 1978, Surface waves and the structure of the Great Basin of Nevada and western Utah: Jour. Geophys. Res., v. 83, p. 2265-2272.

Reichle, M.S., Preistley, K.F., Brune, J.N. and Orcutt, J.A., 1980, The 1978 Oaxaca earthquake source mechanism analysis from digital data: Geofisich Internacional, v. 17, p. 295-301.

Priestley, K.F., Orcutt, J.A. and Brune, J.N., 1980, Higher mode surface waves and the structure of the Great Basin of Nevada and western Utah: Jour. Geophys. Res., v. 85, p. 7166-7174.

Priestley, K.F. and Orcutt, J.A., 1982, Extremal travel time inversion of explosion seismology data from the eastern Snake River Plain, Idaho: Jour. Geophys. Res., v. 87, p. 2634-2642.

Preistley, K.F. and Brune, J.N., 1982, Shear wave structure of the southern volcanic plateau of Oregon and Idaho and the northern Great Basin of Nevada from surface wave dispersion: Jour. Geophys. Res., v. 87, p. 2671-2675.

Priestley, K.F., Ryall, A. and Fezie, G., 1982, Crust and upper mantle structure in the northwest Basin and Range Province: Bull. Seismol. Soc. Amer., v. 72, p. 911-923.

Priestley, K.F. and Davey, F.J., 1983, Crustal structure of Fiordland, southwestern New Zealand, from seismic refraction measurements: Geology, v. 11, p. 660-663.

Priestley, K.F. and Chavez D.E., 1985, Magnitude bias in the Great Basin and its implications for explosion magnitude versus yield estimates: Geophys. Res. Letters, v. 12, p. 573-576.

Priestley, K.F., Brune, J.N. and Anderson, J.G., 1985, Surface wave excitation and source mechanisms of the Mammoth Lakes earthquake sequence: Jour. Geophys. Res., v. 90, p. 11,177-11,185.

Chavez, D.E. and Priestley, K.F., 1985, ML observations in the Great Basin and Mo versus ML relationships for the 1980 Mammoth Lakes, CA earthquake sequence: Bull. Seismol. Soc. Amer., v. 75, p. 1583-1598.

Priestley, K.F., 1985, Source mechanism, surface wave excitation, and mb-Ms analysis of the Mammoth Lakes earthquakes: in, The VELA Program, A Twenty-Five Year Review of Basic Research, Ed. Ann U. Kerr, Executive Graphic Services, 964 p.

Priestley, K.F. and Masters, T.G., Source mechanism of the September 19, 1985 Michoacan earthquake and its implications: Geophys. Res. Letters, in press.

Chavez, D.E. and Priestley, K.F., Measurement of frequency dependent Lg attenuation in the Great Basin: Geophys. Res. Letters, in press.

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Reno, Nevada 89557

EDUCATION

B. S. with Distinction and Honors, 1967, and Ph. D. in Geology, 1972, Stanford University, Stanford, California

PROFESSIONAL HISTORY

Exploration geologist, Texaco Inc., Los Angeles, California, 1971-72
Assistant Professor of Geology (temporary), California State College, Sonoma, Rohnert Park, California: Fall, 1972-73
Geologist, U. S. Geological Survey, Menlo Park, California, Spring, 1973
Lecturer in Geology, California State University, San Jose, San Jose, California, Spring, 1973
Visiting Assistant Professor of Geology, California State University, San Francisco, San Francisco, California, Summer, 1973
Assistant Professor of Geology, Columbia University, New York, N. Y., 1973-78
Associate Professor of Geology, Columbia University, New York, N. Y., 1978-82
Member of Senior Staff, Lamont-Doherty Geological Observatory of Columbia University, 1973-82
Professor of Geology, University of Nevada--Reno, Reno, Nevada, 1982-present
Adjunct Professor of Geology, Columbia University, New York, N. Y., 1982-present

HONORS AND AWARDS

Honorary International Minerals and Chemical Corporation--Louis Ware Fellow, 1967; National Science Foundation Fellow, Stanford University, 1968-71; Roy Angus MacDiarmid Award, Stanford University, 1971; listed in American Men and Women in Science; Who's Who in American Science; recipient of 11 National Science Foundation Research Grants, 1976-84, and 2 U. S. Geological Survey Research Grants, 1978-81.

PUBLICATIONS

Author or coauthor of more than 30 scientific papers and 30 abstracts in fields of stratigraphy, structure, tectonics, plate tectonics, and petrology.

Selected recent papers on tectonics include:

Batten, R. L. and Schweickert, R. A., 1981, The lost Pacifica continent: a mobilistic speculation: Discussion: Vicariance Biogeography Symposium, American Museum of Natural History, Columbia University Press, p. 359-366.

Schweickert, R. A., 1981, The relative importance of plate movement, eustasy, and climate in controlling major biogeographic changes since the early Mesozoic: Discussion: Vicariance Biogeography Symposium, American Museum of Natural History, Columbia University Press, p. 331-334.

Schweickert, R. A., Bogen, N. L., Girty, G. H., Hanson, R. E., and Merguerian, C., 1984, Timing and structural expression of the Nevadan orogeny, Sierra Nevada, California: Geol. Soc. America Bull., v. 95, p. 967-979.

Bogen, N. L., Kent, D. V., and Schweickert, R. A., 1985, Paleomagnetism of Jurassic rocks in the western Sierra Nevada metamorphic belt and its bearing on the structural evolution of the Sierra Nevada block: Jour. Geophys. Res., v. 90, p. 4627-4638.

Bogen, N. L. and Schweickert, R. A., 1985, Magnitude of Cenozoic extension across the Basin and Range province: constraints from paleomagnetism: Earth and Planet. Sci. Lett., v. 75, p. 93-100.

Nelson, K. D., Zhu, T. F., Gibbs, A., Harris, R., Oliver, J. E., Kaufman, S., Brown, L., and Schweickert, R. A., 1986, COCORP deep seismic reflection profiling in the northern Sierra Nevada mountains, California: Tectonics, v. 5, p. 321-334.

RESUME

April 23, 1986

JAMES V. TARANIK, Ph. D.

[redacted]

Current Employment: Since 1982, Dean of Mackay School of Mines and Professor of Geology and Geophysics at the University of Nevada-Reno. Supervises three academic departments: Chemical and Metallurgical Engineering, Geological Sciences (including geology, geochemistry, geophysics, geological engineering and hydrology/hydrogeology academic programs) and Mining Engineering. Oversees the Mackay Mineral Resources Research Institute, Nevada Bureau of Mines and Geology, State Seismological Laboratory, and the Cooperative Institute for Aerospace Science and Terrestrial Applications. Teaches and directs research in the applications of aerospace technology to mineral and energy exploration, engineering and environmental geology, and hydrology/hydrogeology.

Previous Professional Experience:

1979 - 1982 Chief, Non-Renewable Resources Branch (Senior Executive Service, ES-4), Office of Space Science and Applications, NASA Headquarters, Washington, D. C. Developed NASA's research program in Geological Applications for the decade of the 1980's. Directed the development of advanced instrumentation for aerospace remote sensing including Thermal Infrared Multiband Scanner, Large Format Camera, Shuttle Multispectral Infrared Radiometer, and Shuttle Imaging Radar. Program Scientist for first payload of scientific experiments flown on the Shuttle.

1975 - 1978 Principal Remote Sensing Scientist, Earth Resources Observation Systems Data Center, U. S. Geological Survey. Developed the U. S. Department of Interior's research and applications programs in aerospace remote sensing for mineral resources, civil works and geohydrology. Developed procedures for computer processing, analysis and interpretation of Landsat data. Developed training courses for Government personnel and international scientists at EDC. Also, Adjunct Professor of Geology, University of South Dakota.

1971 - 1974 Chief of Remote Sensing, Iowa Geological Survey. Developed one of the first state remote sensing laboratories to serve federal and state agencies in Iowa. Also, Adjunct Professor of Geology at the University of Iowa and Visiting Professor of Civil Engineering at Iowa State University.

1964 - 1974 Commissioned Officer (Active Duty and Reserves), U. S. Army Corps of Engineers and Military Intelligence Branches. Geologist for U. S. Army Engineer Command Headquarters, Vietnam. Strategic Military Intelligence Officer, Assistant Chief of Staff for Intelligence, Washington, D. C. Served to rank of Captain, USAR.

SPECIAL ASSIGNMENTS

- NASA Principal Investigator:
  - Science Team Member and Investigator for Shuttle Imaging Radar-B, Shuttle mission 41-G and SIR-B follow-on studies (1983 - Present). $95,000 3-year grant with $50,000 follow-on proposal submitted.
  - Landsat AO Thematic Mapper Investigations Program (1985 - 1988), Goddard Space Flight Center. $308,000 3-year grant.
  - Airborne Imaging Spectrometer Program (1985 - 1987), Jet Propulsion Laboratory, California Institute of Technology. $80,000 2-year grant.
  - Thermal Infrared Multispectral Scanner Program. Research Proposal being resubmitted for $50,000 in 1986. Data on hand.
  - NASA University Affairs Grant submitted 1986. $100,000 per year.
- International Science Committee member, French SPOT Satellite Program, CNES and SPOT Image. Principal Investigator, SPOT PEPS Program. Investigator for SPOT-C sensor definition study (1984 - Present).
- Chairman, Working Groups for International Society of Photogrammetry and Remote Sensing:
  - Working Group on Instruments for Remote Sensor Data Reduction (76-80).
  - Working Group on Non-Renewable Resources Applications (1980-84, 84-88).
- Chairman, NASA Multispectral Imaging Science Working Group (1981-82).
- Team Leader, NASA Radar Geology Research Program Study (1981-82).
- Team Member, NASA Earth Observations System Synthetic Aperature Radar Working Group (1985-Present). Earth Observations System Platform.
- Science Team Observer, NASA Shuttle Imaging Radar-C Science Plan.
- Chairman, NASA/EOSAT Thermal Infrared Working Group, 1985-86. Science definition of multiband thermal sensor for Landsat-7.
- NASA Headquarters Program Scientist:
  - OSTA-1 Shuttle Payload: Directed team of 25 investigators during instrument development, payload integration, mission simulations, mission flight operations, and science data analysis and reporting. First scientific payload flown on the Shuttle.
  - Heat Capacity Mapping Mission Satellite (HCMM): Directed team of 38 scientific investigators for the duration of science data acquisition and analysis.
  - Magnetic Field Mapping Satellite Mission (Magsat): Coordinated initial scientific investigations and initial science data distribution.

SPECIAL ASSIGNMENTS (Continued)

- Member, Civil Operational Remote Sensing Satellite Advisory Committee, U. S. Department of Commerce (1982-84). Chairman, Working Group on Commercialization of Land and Weather Satellites (1983-84).
- Director, Board of Directors, Geosat Committee (1983 - Present).
- Director, Board of Directors, Alhambra Mines Incorporated and General Minerals of America (1984-86).
- Director, Board of Directors, Newmont Gold Incorporated (1986 - Present).
- Executive, Federal Executive Reserve, Emergency Minerals Management Service, U. S. Bureau of Mines (1986 - Present).
- Member, NASA Space Applications Advisory Committee for remote sensing of earth, its atmosphere and its oceans.
- Member, Editorial Advisory Board of Global Metallogeny. Member of Working Group 3, Commission on Tectonics of Ore Deposits, International Association on the Genesis of Ore Deposits (IAGOD).
- Academician, International Academy of Astronautics, Corresponding member for Engineering Sciences.
- Member of Certification Board for Professional Photogrammetrists, American Society of Photogrammetry and Remote Sensing.
- President, American Institute of Professional Geologists, Nevada Section (1985, 1986).

CONSULTING EXPERIENCE

Consultant, Atlantic Richfield Company, Plano Research Center 1983, 1984.

Consultant, Santa Barbara Research Center, Hughes Aircraft Corp. 1984. Advanced Earth Observations Multispectral Linear Array Sensor Design for Landsat Program.

Consultant, Earth Observations Satellite Corporation, 1986. Chairman Thermal Infrared Working Group for Landsat-7 sensor definition.

Consultant, Marathon Oil Company, Denver Research Center, 1984, 1985.

Consultant, Tenneco Minerals Company, Denver, Colorado 1986.

Consultant, TRW/Rockwell, Manned Space Platform External Advisory Group, Phase-B Program Definition, Earth Observations 1985-87.

PROFESSIONAL REGISTRATION

Certified Professional Geologist, #2669
American Institute of Professional Geologists

Certified Photogrammetrist, A.S.P. #372
American Society of Photogrammetry and Remote Sensing

EDUCATION

Stanford University, B.S. Geology, minor in theoretical earth science.

Colorado School of Mines, Ph.D. Geology, minor geophysics and mathematics.

HONORS AND AWARDS

Academician, International Academy of Astronautics, 1984
NASA Exceptional Scientific Achievement Medal, 1982
U. S. Geological Survey Special Achievement Award, 1978
NASA Group Achievement Award, 1982
Who's Who in Frontiers of Science and Technology, 1985
Who's Who in Aviation and Aerospace, 1983
Who's Who in America, continuously since 1980
American Men and Women of Science, since 1976
Sigma Xi, 1971
Fellow, Geological Society of America, 1978
Fellow, American Association for the Advancement of Science, 1984
Fellow, Explorers Club, New York, 1985
Bronze Star Medal, Vietnam, 1967
U. S. Army Reserve Components Achievement Medal, 1976

MEMBERSHIPS, IN ADDITION TO THOSE LISTED ABOVE

Senior Member:
American Astronautical Society
American Institute for Aeronautics and Astronautics

Member:
American Geophysical Union
Society of Exploration Geophysicists
Society of Mining Engineers of AIME
Institute of Electrical and Electronic Engineers
American Association of Petroleum Geologists
Rocky Mountain Association of Geologists
Society of Economic Paleontologists and Mineralogists

PUBLICATIONS

Over 75 publications in the scientific literature dealing with geology, geophysics and the applications of aerospace remote sensing technology to the study of the earth.

Publications:

Taranik, J. V. and Cording, E. J., 1967, Laterite and its engineering properties: United States Army Corps of Engineers materials studies, USAECV Special Study 11, 29 p.

Taranik, J. V., 1967, A summary of geologic information on the Mekong Terrace of South Vietnam: United States Army Corps of Engineers, USAECV Special Study 12, 19 p.

Taranik, J. V., 1967, Military engineering in the Mekong delta of Vietnam: United States Army Corps of Engineers, USAECV Special Study 13, 24 p.

Taranik, J. V., 1972, Permian-Pennsylvanian stratigraphy and structural evolution of the Shrine Pass-Breckenridge area, Colorado: Quarterly, Colorado School of Mines, v. 67, no. 4 (Abstract).

Taranik, J. V., Stratigraphic and structural evolution of Breckenridge area, Central Colorado: Ph.D. dissertation, Colorado School of Mines, v. 67, no. 4 (Abstract).

De Voto, R. H., Peel, F. A., and Taranik, J. V., 1972, Late Paleozoic tectonism in Central Colorado: Am. Assoc. Petroleum Geologists Bull., v. 56, no. 3 (Abstract).

Tuthill, S. J., Taranik, J. V., and Hoyer, B. E., 1972, Thermal remote sensing on the Mississippi River in Iowa: Am. Inst. Chemical Engineers Symposium series, v. 69, no. 129, p. 391-400.

Tuthill, S. J. and Taranik, J. V., 1972, Remote sensing a tool for state planning-management in Iowa: Proc. 8th International Symposium on Remote Sensing of the Environment, Ann Arbor, Michigan, p. 11-20.

Taranik, J. V., 1972, Photographic detection of electromagnetic radiation: Proc. Seminar in Applied Remote Sensing, Iowa Geol. Survey, Public Information Circular no. 3, p. 59-75.

Hoyer, B. E., and Taranik, J. V., 1972, Multispectral photography and flood-plain analysis in Iowa: Geol. Society of America, Central Section, v. 5, no. 4, p. 321 (Abstract).

Taranik, J. V., 1973, Remote sensing, a new tool for industrial minerals exploration: 8th Industrial Minerals Conference, published by Iowa Geological Survey, p. 99-108.

Hoyer, B. E., and Taranik, J. V., 1972, Aerial flood mapping southwestern Iowa: Iowa Geol. Survey, Prelim. Report 1. 12 p.

Taranik, J. V., and Tuthill, S. J., 1973, Remote sensing data, a basis for monitoring systems design: U. S. Environmental Protection Agency, Proceedings, 2nd Conf. on Environmental Quality Sensors, Las Vegas, Nevada, p. V-17-V-31.

Hardy, R. L., and Taranik, J. V., 1973, Getting it all together in earth mapping education: Proc. Symposium on Management and Utilization of Remote Sensing Data, Sioux Falls, South Dakota, Am. Society of Photogram., Falls Church, Virginia, p. 501-512.

Hoyer, B. E., Hallberg, G. R., and Taranik, J. V., 1973, Seasonal multispectral flood inundation mapping in Iowa: Proc. Symposium on Management and Utilization of Remote Sensing Data, Sioux Falls, South Dakota, Am. Society of Photogram., Falls Church, Virginia, p. 130-141.

Hoyer, B. E., Anderson, R. R., and Taranik, J. V., 1974, Resource development, land-and-water use management, 11-County region South-Central Iowa: Iowa Geol. Survey, Misc. Map Series 4 with explanatory text.

Hoyer, B. E., Hallberg, G. R., and Taranik, J. V., 1974, Summary of multi-spectral flood inundation mapping: Iowa Geol. Survey, Public Information Circular 7, 57 p.

Anderson, R. R., Hoyer, B. E., and Taranik, J. V., 1974, A guide to imagery of Iowa: Iowa Geol. Survey, Public Information Circular 7, 178 p.

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Omit p 62

HONORS AND AWARDS

Listed in 14th Edition American Men and Women of Scienced:
Member Society of Sigma XI.

PROFESSIONAL AFFILIATIONS

International Society of Rock Mechanics,
International Society of Engineering Geology,
Association of Engineering Geologists,
Fellow Geological Society,
Member Institution of Civil Engineers
Member Society of Mining Engineers of A.I.M.E.
Member American Society of Civil Engineers

SELECTED PUBLICATIONS PERTINENT TO YUCCA MOUNTAIN INVESTIGATION

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Present Position

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Education

University of California, Berkeley
PhD Geophysics, 1974
MA Geophysics, 1969
BA Geophysics, 1967

Summary of Pertinent Qualifications

Dr. Peppin has participated in studies involving the NNWSI for the last two years, first as a subcontractor to URS/John A. Blume and Associates, Engineers and second at the request of Carl Johnson as a Research Seismologist at UNR. He is familiar with many of the seismotectonic issues involved, having given a detailed analysis to the State of one of the major recent studies.

Work Experience

Summer, 1964 to December, 1964: Laboratory Technician at the University of California Forest Products Laboratory at Richmond. Operated a gas chromatograph and helped design methods for separating certain valuable chemicals from pulp liquors.

November, 1967 to February, 1968: Seismology Consultant, Woodward-Clyde and Associates. Worked on the preparation of a catalog of historic earthquakes in the vicinity of Lake Maracaibo.

August, 1967 to June 1974: Research Assistant at the University of California, Berkeley (Geophysics). Worked for G. H. Curtis in the Potassium-Argon lab doing mineral separation and argon extraction and for T. V. McEvilly on seismic discrimination and source studies.

September 1974 to June 1976: Assistant Professor and Research Seismologist, University of Nevada at Reno. Taught courses in seismology and in geophysics and did research in seismic discrimination.

Summer 1976 to March 1980: Physicist and Consulting Physicist, Lawrence Livermore National Laboratory, Livermore California. Worked on a computer program to do seismic wave propagation and on various aspects of seismic discrimination; designed and executed a field program at Site 300

to record surface chemical explosions.

Summer 1976 to summer 1978: Acting Director, Seismological Laboratory, University of Nevada at Reno. Taught courses in seismology, geophysics, and computing; oversaw operations of Lab including performance of Lab personnel on grants and contracts.

Summer 1978 to May 1981: Research Seismologist. Taught courses as above and did research funded by NSF and the Air Force Office of Scientific Research on seismic discrimination and source theory. Did fieldwork to obtain digital seismic records at Mammoth Lakes.

May 1981 to July 1984: Senior Seismologist, URS/John A. Blume and Associates, Engineers. Supported projects as needed, including two major ones in which I produced synthetic seismograms and extensive software support for a data acquisition effort in South Carolina.

February 1984 to present: Research Seismologist, Seismological Laboratory, Mackay School of Mines. Assigned to work on the digital data bases now available for the Mammoth Lakes sequence.

July 1984 to present: Senior Seismologist, QEST Consultants. Work as a subcontractor to URS/Blume on siting of the waste repository in southern Nevada and on programming for QEST.

Professional Societies

American Geophysical Union

Publications

Chandra, U., Peppin, W. A. and Adams, R. D., 1970. *Registration of Earthquakes, Bulletin of the Seismographic Stations*, University of California, Berkeley.

McEvilly, T. V. and Peppin, W. A., 1973. Source characteristics of earthquakes, explosions, and afterevents, *Geophys. J. R. A. S.*, 31, 67.

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Education

California Institute of Technology, Pasadena
PhD Geophysics (Seismology), 1984

University of California, Berkeley
MS Geological Engineering, 1977
BS Engineering Geoscience, 1973

Work Experience

January 1984 to present: Seismological Laboratory, Mackay School of Mines, University of Nevada, Reno: Research Seismologist--research on local seismicity with emphasis on the Mammoth Lakes region; managing routine analysis of local earthquakes using on-line recording system.

June 1977 to September 1983: Division of Geological & Planetary Sciences, California Institute of Technology: Graduate Research Assistant--teaching assistant for geophysics classes; field assistant for aftershock studies of Imperial Valley and Mammoth Lakes; computer programmer for locating earthquakes, seismicity studies, and digital data processing.

January to April 1977 & July to September 1976: Woodward-Clyde Consultants: Staff Geologist (part-time)--Worked on siting and fault studies in central California.

October 1975 to June 1976: Department of Civil Engineering, University of California: Teaching Assistant--for classes in geological engineering.

August 1973 to March 1975: Woodward-Clyde Consultants, Oakland, California: Staff Geologist--worked on siting studies for nuclear power plants in California and on fault hazard studies in Nicaragua.

July to September 1972: Department of Engineering Geoscience, University of California: Engineering Aide--worked on electroresistivity study of the San Andreas Fault.

Professional Societies

American Geophysical Union
Geological Society of America
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Publications

Corbett, E.J., D.M. Martinelli, and K.D. Smith (1985). Aftershock locations of the November 23, 1984 Round Valley, California earthquakes, *EOS, Trans.*

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Smith, K.D., D.M. Martinelli, and E.J. Corbett (1985). Focal mechanisms of the November 23, 1984 Round Valley, California earthquakes, *EOS, Trans. Amer. Geophys. Union*, 66, 952.

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Cockerham, R.S., A.S. Ryall, and E.J. Corbett (1980). The Mammoth, California, earthquakes of 1980, *Trans. Amer. Geophys. Union* 61, 1041.

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INTERPRETOR, VEB Geophysik Leipzig, East Germany, Feb. 1966-Aug. 1966
SCIENCE ASSOCIATE, Institute of Geophysics, D2000 Hamburg, 1967-1968
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POSTDOCTORATE FELLOWSHIP, California Institute of Tech. Seism., 1979-1980
VISITING RES. ASSOC., Hawaii Inst. of Geophys., Jan. 1981-June 1981

PROFESSIONAL SOCIETIES

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European Geophysical Society (EGS)
American Geophysical Union
Seismological Society of America

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