DOE/NV/10461--T45

EVALUATION OF THE GEOLOGIC RELATIONS AND SEISMOTECTONIC STABILITY OF THE YUCCA MOUNTAIN AREA NEVADA NUCLEAR WASTE SITE INVESTIGATIONS (NNWSI)

PROGRESS REPORT

SEPTEMBER 30, 1992

CENTER FOR NEOTECTONIC STUDIES
MACKAY SCHOOL OF MINES
UNIVERSITY OF NEVADA, RENO

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Prepared by C. H. Jones

1 October 1991 to 30 September 1992

Introduction

This report provides a summary of progress for the project "Evaluation of the Geologic Relations and Seismotectonic Stability of the Yucca Mountain Area, Nevada Nuclear Waste Site Investigation (NNWSI)." This progress report was preceded by the progress report for the year from 1 October 1990 to 30 September 1991. Initially the report will cover progress of the General Task, followed by sections describing progress of the other ongoing Tasks which are listed below.

Task 1 — Quaternary Tectonics
Task 3 — Mineral Deposits, Volcanic Geology
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General Task

Staff

Steven G. Wesnousky, Project Director, Craig H. Jones, Research Associate, Ingrid Ramos and Gloria Sutherland, Secretaries.

The General task continued to coordinate project activities to meet general deadlines and responsibilities. The central office provided general secretarial support and network and computer support. Computer capabilities continued to expand. Dr. Wesnousky has also represented NWPO at a number of meetings with the NRC and other federal agencies during the year.

Technical Activities

Research activities conducted by the general task have focused on the tectonics of the Yucca Mountain region. Research conducted by Dr. Jones has focused on the seismological and tectonic framework of the entire lithosphere. Because Yucca Mountain lies near the boundary between two very different extensional regimes to the north and south, general tectonic study of both regions will improve understanding of the Yucca Mountain site.

The first project represents the completion of a project by Dr. Jones; work during the past year has centered about satisfying peer review for publication. In this experiment, seismometers were deployed in the high Sierra Nevada of southern California in 1988. Teleseisms and regional earthquake arrival times recorded by this network were used to examine the crustal and upper mantle structure beneath the southern Sierra. The results, presently in a manuscript in review, have proven quite controversial: While extension in the upper crust has accommodated over 250 km of motion in the Basin and Range, it appears from this work (when placed in context for the entire region) that the downward continuation of that deformation actually lies under the Sierra Nevada to the west. This deformation is inferred to have warmed and thinned the anti-buoyant mantle lithosphere, thus causing the Sierra Nevada to rise. Such a model has important implications in the Yucca Mountain area, because Death Valley's deformation lies only a few miles to the southwest. Understanding the lithosphere-scale tectonics of the region should improve the framework for systematically examining the Yucca Mountain site; this work complements the earlier study of Dr. Zhang, who described, without providing a tectonic explanation, the evolution of faulting in the Death Valley area through time.

The second project is something of an outgrowth of the first; Dr. Jones combined with other scientists representing other subdisciplines (Wernicke, Farmer, and Walker) to write a single paper that attempts to integrate geological, geochemical, and geophysical observation. This paper was completed during the past year and is in press in *Tectonophysics* at the present writing. Dr. Jones has been responsible for the geophysical study and the overall compilation and preparation of the manuscript. Although the paper contains considerable review, new work in the geophysical section explores the variation in the style of deformation through the Basin and Range by taking seismic velocity profiles of the crust that have been obtained in the past few years and converting them into density structures. Armed with the density of the crust, one can infer how much of the variation in elevation seen through the Basin and Range is due to variations in density in the crust; what remains is probably due to variations in the mantle. Results of this study that bear on Yucca Mountain directly are that to the north, extensional deformation in the mantle probably lies under the central part of the Basin and Range, while to the south, deformation in the upper mantle lies under the western flank of the Basin and Range. This implies that a major lithospheric boundary lies near the Yucca Mountain area; this boundary might be responsible for the diffuse band of seismicity that crosses the Basin and Range at this latitude. These results will be important when interpreting results from a 3-d velocity structure study discussed below. Some additional work might be started in the coming year to expand this analysis to the entire western U.S. and quantify the uncertainties in the techniques used will be quite useful in evaluating the inferences from this study.

A third project is a continuation of work undertaken at Caltech with Drs. Leslie Sonder (Dartmouth College) and Steven Salyards (New Mexico State University), which in turn was inspired by earlier work of Nelson and Jones (1987). Paleomagnetic samples have been gathered in Miocene sediments near Lake Mead in order to understand the mechanics that accompany the creation of "oroflexes," which are great bends in the earth's crust adjacent to large strike-slip faults. These bends are best understood through paleomagnetic work, which can constrain the exact amount of bending. Earlier work by Nelson and Jones documented the presence of an oroflex in the Las Vegas Range northwest of Las Vegas; that study lacked the spatial resolution to understand the mechanical underpinnings of the deformation and also could not constrain the age of deformation. The present study should solve both problems, for the young sediments in the Lake Mead area are well exposed and have not been as deformed as the sedimentary rocks in the Las Vegas Range. Although the study is still proceeding, data to date do clearly show that the oroflex does extend to the southeast and formed within the past 15-20 m.y.. This same structure or one analogous to it might extend into Yucca Mountain, where similar paleomagnetic rotations have been observed by USGS scientists over the past few years. Completion of this work should provide insight into structures that might be present in Yucca Mountain itself, including, possibly, the presence of large, subhorizontal decollements. Data collected in the past year have led to the presentation of this work at professional meetings and a manuscript is in preparation for submission early in 1993.

A fourth project conducted by Dr. Wesnousky and Dr. Jones investigates the physical parameters that control the partitioning of slip between a vertical fault and an adjacent dipping fault through the use of a simple model. The model was improved and expanded for use on fault systems within continents from models originally developed to understand analogous phenomena observed at plate boundaries. This model was initially applied to the San Andreas fault and it indicates that the slip rate along the San Andreas should vary as a function of the geometry of the adjacent dipping faults. It also provides some insights into the variation of physical characteristics of the faults that control the strength of the fault. A manuscript was published *Science*. Continuation of this work into the Basin and Range has begun and some initial results are to be presented at the fall meeting of the American Geophysical Union. Within the Basin and Range, several faults exhibit similar behavior: one large, vertical fault will tend to be strike-slip, while an adjacent fault might have oblique-slip on its dipping surface. Such fault systems include the Death Valley and Owens Valley fault systems. The latter fault system has been inferred to have slipped in different ways at different times in the past because of changes in the stress field in the Owens Valley area. We have found by extending our analysis to this area that this conclusion is unwarranted; this style of faulting is compatible with a single stress system. Implications from this work include evaluating the likely amount of variation in the stress field both in space and time; as such, it will have implications for evaluating the potential for changes in the stress regime and changes in the activity of faulting in the Yucca Mountain area.

A fifth project represents a collaboration of Dr. Jones with Dr. Steven Roecker (Rensselaer Polytechnic Institute) and Dr. Joan Gomberg (USGS Golden) on the seismic velocity structure of southern Nevada. During this year a new collection of arrival times were picked by a student of Roecker's with guidance from Gomberg. In the coming year this dataset will be used to determine a 3-dimensional velocity structure for southern Nevada. In addition, the Little Skull Mountain earthquake sequence from the summer of 1992 should provide additional constraints on the velocity structure in the immediate vicinity of Yucca Mountain. Dr. Jones assisted in deployment of portable seismometers from UNR after the mainshock and is beginning to gather data necessary for 3-d inversions from this earthquake sequence. Overall, the determination of the lateral variations in seismic velocity both improve the locations of earthquakes in the area and provide insight into lateral changes in earth structure reflecting subsurface geology.

Papers and preprints:

Jones, C. H., and S. G. Wesnousky, Variations in strength and slip rate along the San Andreas Fault system, *Science, 256*, 83-86, 1992.

Magistrale, H., H. Kanamori, and C. H. Jones, Forward and inverse three-dimensional P-wave velocity models of the southern California crust, *J. Geophys. Res., 97*, 14115-14135, 1992.

Jones, C. H., B. P. Wernicke, G. L. Farmer, J. D. Walker, D. S. Coleman, L. W. McKenna, and F. V. Perry, Variations across and along a major continental rift: An interdisciplinary study of the Basin and Range Province, western USA, *Tectonophysics* (part II of the Proceedings of the Geodynamics of Rifting Symposium held in Glion-sur-Montreux, Switzerland, 4-11 November 1990), *213*(?) in press, 1992.

Jones, C. H., H. Kanamori, and S. W. Roecker, Missing Roots and Mantle "Drips:" Regional P_n and Teleseismic Arrival Times in the Southern Sierra Nevada and Vicinity,

California, resubmitted to *J. Geophys. Res.*, August 1992; (in review).

Review and Meeting Activities

Date	Investigator	Meeting or Review
12-4-91	Wesnousky	Provided Review if NRC Staff technical position on investigations to identify fault displacement and seismic hazards at a geologic repository.
12-17-91	Wesnousky	Attended ACNW working group meeting in Bethesda, MD on concerns related to seismic and faulting investigations for a geologic repository
1-22-92	Wesnousky	Attended NWTRB meeting of the Panel on Structural Geology & Geoengineering in Irvine, CA.
12-28-92	Wesnousky	Provided detailed review of DOE study plan for effects of Local site Geology on Surface and Subsurface Motions (Study Plan 8.3.2.27.3.4)
3-1-92	Wesnousky	Provide NWPO a review of the DOE sponsored 'peer-reviewed' reports regarding the hypothesis that hydrologic and tectonic processes are coupled and responsible for carbonate deposits in and around Yucca Mountain
4-2-92	Wesnousky	Present summary of ongoing NWPO-supported Seismology and Neotectonic studies at Yucca Mountain to the Nevada Commission on Nuclear Projects- in Las Vegas
9-14 to 19-92	Wesnousky	Attend meetings in Las Vegas sponsored by the NWTRB and NRC concerning issues and progress in studies on Volcanism and Neotectonics at Yucca Mountain

PROGRESS REPORT

Task 1 Quaternary Tectonics

1 October 1991 to 30 September 1992

John W. Bell
Principal Investigator

Craig M. dePolo
Co-Investigator

SUMMARY OF ACTIVITIES CONDUCTED DURING THE CONTRACT PERIOD

During the contract period, the following activities were conducted by Task 1:

* J.W. Bell reviewed the final draft of the Nuclear Regulatory Commission Staff Technical Position (STP) on "The Identification of Fault Displacement and Seismic Hazards at a Geologic Repository" and submitted a two-page report to the Nevada Nuclear Waste Project Office.

* J.W. Bell and C.M. dePolo reviewed the Department of Energy Study Plan 8.3.1.17.3.1 "Relevant Earthquake Sources" and submitted a five-page report to the Nevada Nuclear Waste Project Office.

* J.W. Bell reviewed the Department of Energy "Outline for Topical Report on Erosion Rates at Yucca Mountain Geologic Setting: Methodology and Results" and submitted a three-page report to the Nevada Nuclear Waste Project Office.

* J.W. Bell participated in a three-day field review related to the Technical Review Board review of the volcanic hazard issue and the DOE/NRC site visit to Midway Valley.

* J.W. Bell and F.F. Peterson revised the manuscript "Late Quaternary Geomorphology and Soils in Crater Flat, Next to Yucca Mountain, Southern Nevada: A Reinterpretation" for resubmission to *Quaternary Research.*

* A.R. Ramelli completed the manuscript "Quaternary Fault Interconnection and Possible Distributive Behavior at Yucca Mountain, Southern Nevada" and submitted it to *Geology.*

* R. I. Dorn of Arizona State University provided a new rock varnish data set for previously analyzed Crater Flat samples and performed alkalinity analyses of rock varnish microlaminations on Crater Flat samples.

* A. Sarna-Wojcicki of the U.S. Geological Survey submitted the results of petrographic and microprobe chemical analyses for volcanic tephra samples from the Cedar Mountain area.

* J.W. Bell presented the paper "Tephras and Late Holocene Alluvial-fan Deposition in West-central Nevada: Is There a Connection?" at the 1991 Annual Meeting of the Geological Society of America in San Diego.

* C.M. dePolo presented the paper "The 1932 Cedar Mountain Earthquake: An Example of Active Tectonism in the Walker Lane" and led a one-day field trip at a symposium on the Structure, Tectonics, and Mineralization of the Walker Lane sponsored by the Geological Society of Nevada.

* C.M. dePolo investigated the surface faulting associated with the June 28, 1992 Landers earthquake (M7.4) in southern California.

* The geologic map of the Crater Flat 7½-minute quadrangle was completed by UNLV and NBMG investigators (J. Faulds, E.I. Smith, A.R. Ramelli, and J.W. Bell). The lower portion of the adjoining quadrangle to the north (East of Beatty 7½-minute) will be added and the composite map published by the Nevada Bureau of Mines and Geology.

* The bedrock geology of the Mina 7½-minute quadrangle was received from John Oldow of Rice University. The surficial geology (already completed) will be added by J.W. Bell and the map will be published by the Nevada Bureau of Mines and Geology.

* The causative fault(s) associated with the June 29, 1992 Little Skull Mountain earthquake (M5.6) was analyzed by J.W. Bell and C.M. dePolo. Based on focal mechanisms, either the Mine Mountain or Cane Springs fault systems are likely sources for the earthquake, and a low-sun-angle aerial photographic mission over the epicentral area was planned; the photography will be flown during the early part of the next contract period.

* J.W. Bell reviewed trenches excavated by M. Machette of the U.S. Geological Survey across the 1915 Pleasant Valley earthquake (M7.6) fault zone, including the evidence for temporal clustering on the fault zone.

* J.W. Bell led a one-day field trip for about 15 DOE and Woodward-Clyde personnel to trenches excavated across the Genoa fault in northern Nevada.

TECHNICAL REPORT

Crater Flat Allostratigraphy

Refinement and revision of Crater Flat Quaternary stratigraphy continued during the contract period and consisted of several activities: revision of the rock varnish (RV) cation-leaching curve; sample comparison of RV manganese:iron microlaminations; correlation of Crater Flat allostratigraphic units with regional chronologies.

Rock Varnish Chemistry Data

A complete compilation of all previous RV analytical data was prepared by Dr. Ronald I. Dorn for all Crater Flat samples and is attached as Appendix A. Recent criticism of Dr. Dorn's Crater Flat data by Bierman and Gillespie (1991) is addressed in our study in two ways. First, the Bierman and Gillespie (1991) conclusion that the U.C. Davis cation-ratio (CR) data set (analyses of Dorn's samples) is flawed has no merit based on both analytical procedure and on duplicate data sets. Cahill (1992) states that the Bierman and Gillespie (1991) data set was produced on entirely different laboratory equipment than Dorn's data, thus making the Bierman and Gillespie (1991) conclusions irrelevant. Second, only some of the early Crater Flat samples were analyzed by the PIXE system, and all samples were additionally analyzed by wavelength dispersive microprobe (Dorn, 1992). In order to address the Bierman and Gillespie (1992) comment that Dr. Dorn has not published all specific chemical analysis data, a complete compilation of this data is provided here (Table 1; Appendix A).

Rock Varnish Cation-leaching Curve

The cation-leaching curve for Crater Flat (Figure 1) has evolved since Dorn (1988a); revised calibration points have been added by Dr. Dorn during this contract period. The Lathrop Wells basalt flow K-Ar calibration point was dropped because recent studies (e.g., Wells *et al.*, 1990a; Zreda *et al.*, 1991; Wells *et al.*, 1992; Zreda *et al.*, in press) indicate the history of the eruptive center still needs to be resolved. The CR of $<2\mu m$ dust was viewed as unnecessary, because a ^{14}C age of ~ 1300 yr BP is available for calibrating all but the youngest site; CFP-41 with the youngest CR is $<<1300$ yr BP, with a provisional age of $\sim 300 \pm 200$ yr BP based on an extension of the curve. We also use the most recent K-Ar dating results for basalt flows in Crater Flat from Smith *et al.*(1990). We note that CR's for the Early Black Cone, Yucca, and Solitario allostratigraphic units fall between the ^{14}C and K-Ar calibration points. The CR's used as calibration points in Table 1 are averages (with 1 standard deviation) of four or more individual measurements. The CR ages reported for each site in Table 1 are averages (with 1 standard deviation) of four to fifteen separate CR ages. (The complete PIXE and microprobe analyses data sets are attached as Appendix A).

Table 1. Results of Rock Varnish Analyses

Allostratigraphic Unit (This Study)	Sample	^{14}C AMS Date (yr B.P.; lab #)	K+Ca/Ti (Avg ±1σ)	Calculated Cation Ratio Age (yrs B.P.)
Crater Flat	CFP-41	–	9.17±0.25	300±200
	JWB-36	1,320±70 (ETH 5264)	7.94±0.17	1,100±400
Little Cones	CFP-2	6,645±245 (ETH 3197)	6.47±0.13	
	JWB-38	8,425±70 (ETH 5268)	6.37±0.13	
	CFP-26	10,180±270 (ETH 3187)	6.13±0.09	
	JWB-41	11,135±105 (ETH 5270)	5.99±0.13	
Late Black Cone	CFP-33	17,280±370 (ETH 3191)	5.75±0.06	
	CFP-31	–	5.67±0.15	19,000±4,000
	JWB-39	19,660±240 (ETH 4483)	5.68±0.15	
	CFP-27	25,700±360 (ETH 3188)	5.42±0.12	
	CFP-35	26,970±375 (ETH 3192)	5.34±0.15	
	CFP-36	28,920±400 (ETH 3190)	5.32±0.07	
	CFP-32	30,320±460 (ETH 3189)	5.14±0.07	
Early Black Cone	CFP-37	–	3.98±0.19	159,000±38,000
	CFP-29	>40,120 (ETH 5259)	3.98±0.32	168,000±75,000
	JWB-42	–	3.90±0.11	176,000±25,000
	JWB-20	–	3.79±0.11	200,000±29,000
Yucca	CFP-39	–	3.29±0.11	375,000±53,000
	CFP-38	–	3.29±0.11	373,000±50,000
Solitario	JWB-43	–	3.17±0.10	433,000±54,000
	CFP-40	–	2.95±0.10	572,000±66,000
	JWB-40	–	2.84±0.09	660,000±71,000
Little Cones basalt	Smith *et al.*, 1990	770,000±40,000	2.63±0.08	
Red Cone basalt	"	950,000±80,000	2.62±0.12	
Black Cone basalt	"	1,090,000±120,000	2.53±0.06	

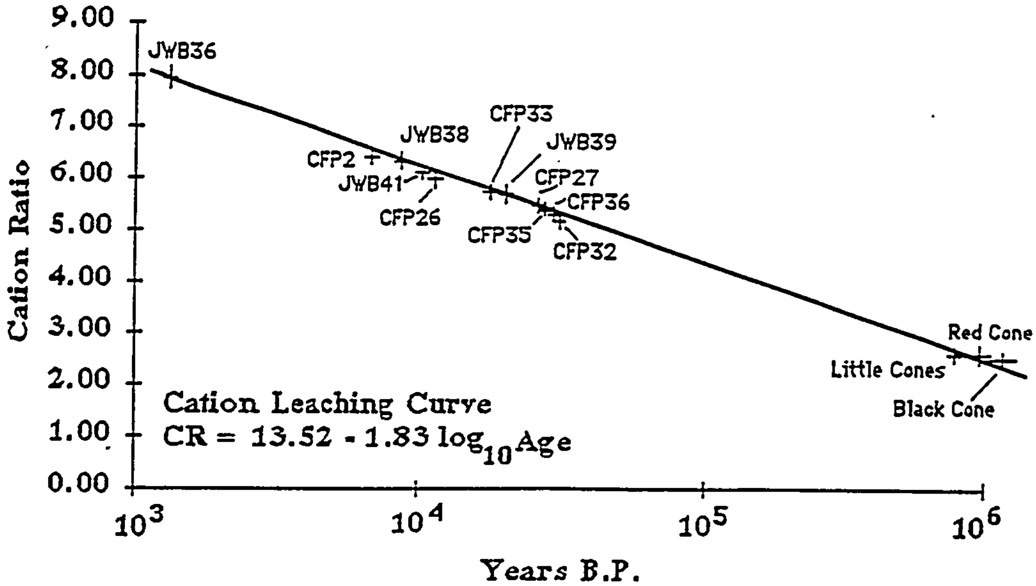

Figure 1. Rock varnish cation leaching curve for Crater Flat. Calibration is based on ^{14}C rock varnish dates on allostratigraphic surfaces and on K/Ar dates on basaltic cones (Smith *et al.*, 1990).

Microlamination Alkalinity Data

During the contract period, Dr. Dorn provided new RV alkalinity data that support correlation of samples and corroborate previously estimated numerical ages. Manganese:iron ratios on microlaminations are indicators of alkalinity fluctuations during the late Quaternary (Dorn, 1988b, 1990; Jones, 1991). The sequence of microlaminations observed in Crater Flat samples is consistent with other evidence when evenly layered subaerial varnishes are used (*cf.*, Dorn, 1990; Krinsley *et al.*, 1990). Selected Crater Flat samples were examined by wavelength dispersive microprobe, and several trends are evident on Figure 2. Younger varnishes have fewer Mn:Fe layers than older varnishes. Crater Flat and Little Cones varnishes are only Mn-poor, reflecting a period of enhanced alkalinity (Jones, 1991) during the Holocene. Late Black Cone varnishes show a basal layer of reduced alkalinity, probably corresponding with a more moist late Pleistocene period in the Nevada Test Site area (Spaulding, 1985; Claassen, 1986). Early Black Cone, Yucca, and Solitario varnishes show progressively more complex sequences.

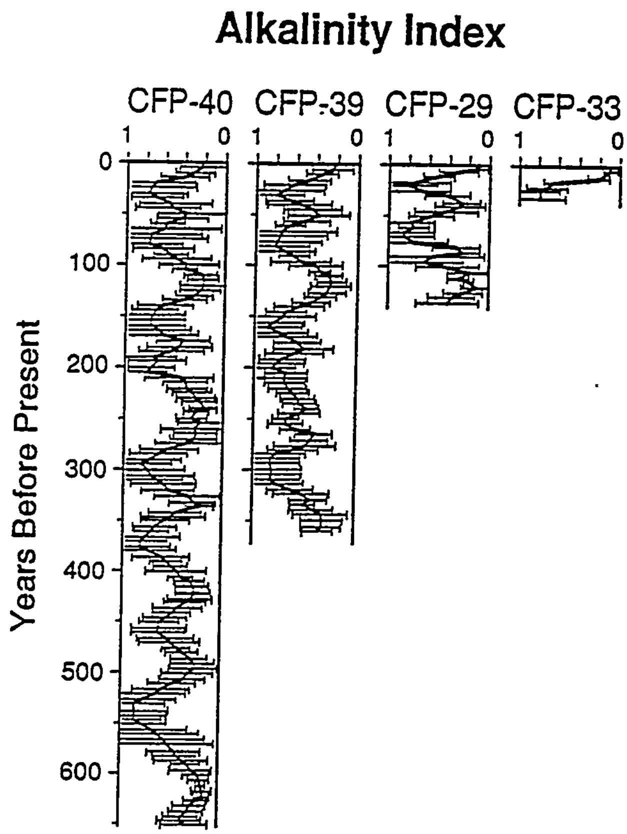

Figure 2. Averaged electron microprobe analyses (wavelength dispersive mode) of Mn:Fe microlaminations on the different Crater Flat stratigraphic units. As in Dorn (1990) the alkalinity index represents normalized Mn:Fe values. Zero is the lowest ratio (highest alkalinity) and 1 is the highest ratio (lowest alkalinity). Years before present (in 10^3) is derived by normalizing depth to the ^{14}C or cation ratio age. Alkalinity index values were regressed for every 5,000 years. The central line indicates the average alkalinity index values of 20 transects across layered varnishes from five different rocks, and bars represent 2 standard deviations.

Regional Correlation of Quaternary Stratigraphic Units

Similar Quaternary stratigraphic sequences have been described in the southern Nevada, Colorado River, Death Valley, and Mojave Desert regions. Although the Crater Flat units are more limited in extent and restricted to a single piedmont, a correlation of these sequences based on stratigraphic order and similarities in reported distinguishing characteristics, such as geomorphic character, soils, and estimated numerical age (Table 2), provides supporting evidence for the concept of regional climatic control of arid alluvial deposition (Bull, 1991) and an additional test of the Hoover *et al.* (1981) chronology.

TABLE 2. Comparison of Crater Flat Alluvial Chronology With Other Chronologies in the Region (Listed ages are ka).

Crater Flat (this study)	Lower Colorado River (Bull,1991)	Las Vegas and Indian Springs Valleys (Quade, 1986; Quade and Pratt, 1989)	S. Death Valley (Dorn, 1988b)	East-central Mojave (Wells *et al.*, 1990b)
Modern 0	Q4b 0	Modern 0	Modern 0	Modern (Qf9) 0
Crater Flat <.4->1.5	Q4a 0.1-2 Q3c 2-4 Q3b 4-8	Unit G 0.4.0 Unit F 4.0-8.0	Q3b3 0.5-2.5 Q3b2 2.0-4.5	Qf8 <0.3->0.7 Qf6,7 2-8
Little Cones 7-11	Q3a 8-12	Unit E 8.6-14.0	Q3b1 6-11	Qf5 8-15
Late Black Cone 17-30	Q2c 12-70	Unit D 15-30	Q3a 13-50	Qf4 <34->45
Early Black Cone 130-190	Q2b 70-200	Unit C >30 Unit B >40	Q2b 110-130 Q2a 140-190	Qf3 >47->130 Qf2 <160->320
Yucca >360-370	Q2a 400-740	Unit A	Q1b 400-650	
Solitario >450->740	Q1 >1200	Unit A	Q1 >650->800	Qf1 <3800

Most striking in this regional correlation is the evidence for widespread alluviation in the southern Basin and Range during the late Wisconsin pluvial (interstadial) and during the transition from the late Wisconsin maximum pluvial to the arid Holocene-- a concept discussed in detail by Bull (1991). Our Late Black Cone unit in Crater Flat is similar in stratigraphic order and soil morphology to unit Q2c (12-70 ka) of Bull (1991) in the lower Colorado River region; in both cases, the units contain the youngest well-developed Bt (argillic) and Bk (stage II-III) horizons in the stratigraphic section, a characteristic indicative of development under the more moist conditions of the late Wisconsin pluvial period (Nettleton *et al.*, 1975). We note that the Hoover *et al.* (1981) chronology *does not include* a similar late Wisconsin unit.

Cedar Mountain Allostratigraphy

As discussed in previous reports (Bell *et al.*, 1990, 1991), allostratigraphic relations in the 1932 Cedar Mountain earthquake area consist of seven units (Fig. 3). Studies conducted during this contract period included the refinement of the numerical ages of these units based on chemical microprobe analyses of 16 volcanic ashes and on 15 radiocarbon dates collected during the period. The results of the microprobe and radiocarbon analyses (Tables 3,4) indicate that additional age constraints can be placed both on recency and recurrence of faulting associated with the Cedar Mountain and adjacent fault zones.

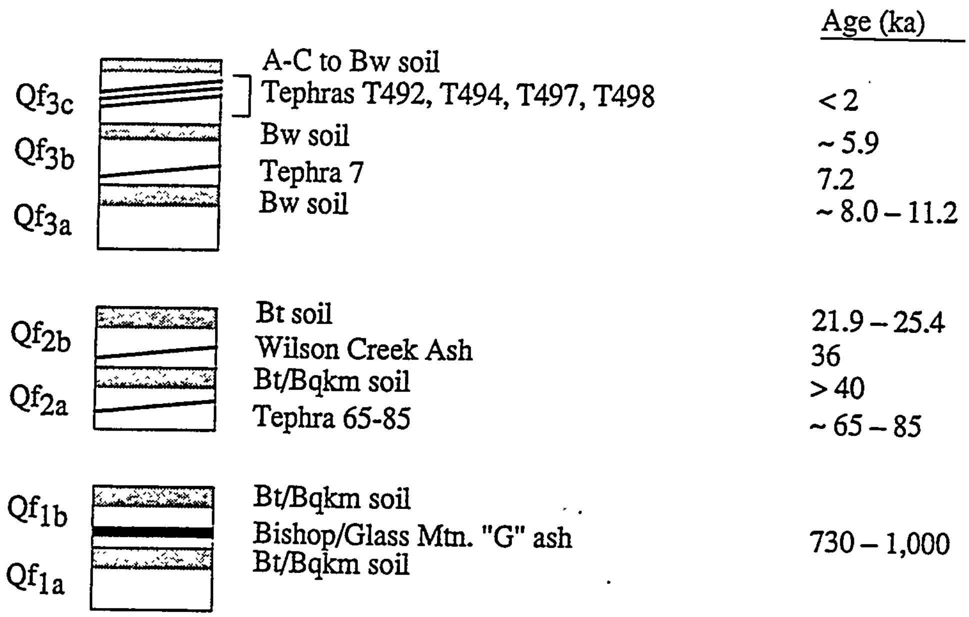

Figure 3. Cedar Mountain area allostratigraphy showing units, soil stratigraphic relations, tephras, and estimated numerical ages.

Volcanic ash analyses

The sixteen volcanic ash samples were submitted to Andrei Sarna-Wojcicki of the U.S. Geological Survey in December 1990, and the written report containing the analytical results and identifications were received in June 1992 (Appendix B). Three sets of Mono Craters ashes are identified here on the basis of glass shard chemistry: a Holocene set, a latest Pleistocene set, and an older Pleistocene set. Positive identification and differentiation of a number of the Holocene

Table 3. Identification and age of tephras from the Cedar Mountain and related areas; results from report of Andrei Sarna-Wojcicki (Appendix B).

Ash sample	Unit	Best Age Estimate (yrs)	Remarks
BS-1	Qf3c	1950±110, or 890±40	Similar to BS-9, -11, -12, -16
BS-2	Qf3c	~900, or 1950±110	Very similar to BS-7, -11, -12
BS-3	Qf2a	60,000-100,000	Previously reported as 65-85 ka
BS-4	Qf3c	1000-2000	Similar to BS-5
BS-5	Qf3c	1780-1960, possibly 7200	Similar to BS-1
BS-6	Qf2b	36,000	Wilson Creek Bed 19
BS-7	Qf3c	900 or 1780	Similar to BS-1, -5
BS-9	Qf3b	7200	Good match with Mono Lake ash
BS-11	Qf3c	900-3750	BS-11 through BS-16 all similar
BS-12	Qf3c	900-3750	"
BS-13	Qf3c	900-3750	"
BS-14	Qf3c	900-3750	"
BS-15	Qf3c	900-3750	"
BS-16	Qf3c	900-3750	"
BS-16	Qf3c	900-3750	"
BS-17	Qf2b	36,000	Wilson Creek Bed 19
Wassuk 1	Qfy	900-3750	Similar to BS-11

Table 4. Cedar Mountain Area ^{14}C Results

Sample	Date (yrs)	Lab #	Stratigraphic position
BS-1	995±110	GX-17250	6 cm below ash BS-23
BS-2	535±150	GX-17251	6 cm above ash BS-23
BS-3	1260±145	GX-17252	Disturbed zone
BS-4	435±110	GX-17253	30 cm above ash BS-25
BS-5	790±105	GX-17254	6 cm above ash BS-25
BS-6	1025±65	GX-17255	6 cm below ash BS-25
BS-7	1110±110	GX-17256	6 cm above ash BS-24
BS-8	1550±110	GX-17257	15 cm below ash BS-24
BS-9	1605±120	GX-17566	Immediately below ash BS-2
WR-3	Modern	GX-17568	
WR-4	685±135	GX-18127	Immediately below ash WR-6
WR-5	Modern	GX-18128	
WR-6	1230±125	GX-18129	60 cm below ash WR-7
WR-7	440±130	GX-18130	1 m above ash WR-7
11-Mile-1	2585±165	GX-17567	Av below Turupah Flat ash

ashes are problematic because of the close similarity in glass shard chemistry and variable degrees of hydration. Nevertheless, general groupings of the Holocene tephras are possible.

The Holocene age tephras can be divided into those of mid-Holocene (~7200 yrs) and late Holocene age (900-3750 yrs) based on correlation with other dated tephras in the western U.S.

(Sarna-Wojcicki *et al.*, 1988). In each case, however, several previously dated Mono Craters ashes are similar enough in composition to result in more than one possible correlation and age. This is large part due to the multiple eruptive sequences at Mono Craters all of which had generally similar glass chemistry. The late Holocene set, in particular, has significant uncertainties not resolved by the chemical comparisons. Many of these ashes are similar in composition to both the mid- and late Holocene Mono Craters sets.

Previous measurements of refractive indices of these ashes (Bell *et al.*, 1991) indicates that seven of the ashes analyzed here have refractive indices similar to that of the Turupah Flat ash (1.5-1.6 ka) of Davis (1978): BS-1, -4, -5, -11, -13, -15, -16. Bracketing radiocarbon ages at the Weber Dam locale of Davis (1978) were listed in previous reports (Bell *et al.*, 1991): 1455$\pm$140 and 1550$\pm$130 yrs. The age estimates for these samples in Table 3 are thus consistent with correlation to the Turupah Flat ash. In addition, a radiocarbon date of 1605$\pm$120 yrs was obtained from charcoal immediately beneath ash BS-2, an age also consistent with Sarna-Wojcicki's estimate of 900-1950 yrs.

Since submission of these original 16 samples, an additional 13 tephras from the Cedar Mountain area and 7 samples from the Walker Lake area have been collected. Although these have not been analyzed for glass chemistry, many have been examined for refractive index and glass morphology properties, and several have been dated by radiocarbon (Table 4). The ^{14}C results suggest that most, if not all, of these additional tephras are similar in age to those discussed above. During the next contract period, a more comprehensive analysis of trace element chemistry will be undertaken utilizing xray fluorescence (XRF) in order to develop more positive evidence for differentiations and correlations.

Two older, pre-Holocene tephras can be positively identified in the Cedar Mountain area. Samples BS-6 and -17 are chemically similar to the Wilson Creek Beds 16, 17 and 19, with the closest match being bed 19 which is about 36 ka old (Benson *et al.*, 1990). This ash is present in unit Qf2b in the Cedar Mountain region (Fig. 3), and it is overlain by geomorphic surfaces which have yielded ^{14}C AMS rock varnish ages ranging between about 21-25 ka (Bell *et al.*, 1991). An older Pleistocene tephra is present within Qf2a deposits (Fig. 3) that is correlative with an unnamed Mono Craters ash found in the Mono and Walker Lake areas (Sarna-Wojcicki *et al.*, 1988). This ash is on the order of 60-100 ka based on extrapolated sedimentation rates; it was previously estimated to be on the order of 65-85 ka (Sarna-Wojcicki, verbal communication, 1988).

Radiocarbon analyses

Fifteen samples were submitted for ^{14}C analysis during the contract period, and the results are listed in Table 4. Nine of the samples were from the immediate Cedar Mountain region and six of the samples were from outcrops of volcanic ash in the Walker Lake and Dixie Valley areas. The latter ashes are likely correlative with some or all of the Cedar Mountain ashes and provide additional constraints on the Cedar Mountain allostratigraphy. All of the samples either closely underlie or overlie a tephra, and thus provide tight constraints on tephra ages. All of the ages are latest Holocene, consistent with the results of Sarna-Wojcicki discussed above.

Refined ages of allostratigraphic units

Figure 3 lists the revised ages of the previously defined allostratigraphic units in the Cedar Mountain region; revisions are based on incorporation of tephra analyses conducted during this contract period. The principal differences in these refined ages compared to those reported in Bell *et al.* (1991) are related to the occurrence of the sequence of late Holocene tephras in unit Qf3c, the unnamed mid-Holocene 7.2 ka tephra in unit Qf3b, and the Wilson Creek Bed 19 (36 ka) in unit Qf2b. Of particular importance is the observation that the independently derived tephra ages are very consistent with the rock varnish ages estimated for the geomorphic surfaces of the same units. For example, a series of ^{14}C AMS varnish dates from four Qf2b surfaces range in age from 21.9-25.4 ka, ages which are younger (as expected) than the underlying volcanic ash. Additional rock varnish dating during the next contract period will provide further verification of these age relationships and the rock varnish dating procedure.

1932 Cedar Mountain Earthquake

Research continued on the 1932 Cedar Mountain earthquake, the principal relative comparison earthquake for the Yucca Mountain site. A surface rupture map was completed at a scale of 1:24,000, seismicity of the Cedar Mountain region was examined, a new kinematic model for the earthquake is being developed, surface rupturing from a large strike-slip earthquake in California (1992 Landers Earthquake, M7.5) was examined for similarities with the ground rupture associated with the Cedar Mountain event, and a working model for earthquakes along the Walker Lane was developed in light of these two earthquakes.

Surface rupture studies

A new surface rupture map has been completed and digitized (Fig. 4). This effort consisted of enlarging surface rupture maps from Gianella and Callaghan (1934) to 1:24,000 scale and transferring them to the topographic maps. New ruptures mapped by dePolo were transferred from various scale aerial photographs to these maps as well. The result gives us a better picture of the actual geometry and location of the surface breaks. This in turn has allowed a better estimate of the cross-strike width of faulting and emphasizes the northerly trends of surface ruptures in northern Monte Cristo and southern Stewart Valleys. This latter point has strongly influenced the formation of a new kinematic model for the southern part of this event.

Gianella's and Callaghan's field notes have been scrutinized as part of this process as well.

There are surface breaks mentioned in these notes that never made it to their final published maps, some which have important tectonic significance. For example, ruptures are reported in Gianella's notes just north of Stewart Springs (eastern Stewart Valley on the flank of Cedar Mountain) and through the springs itself. The rupture through the springs extends distinctly beyond the springs, suggesting that it was indeed a tectonic surface rupture, and not just a liquefaction or other effect of saturated ground. This becomes even more significant when considered along with a rupture mentioned in a letter from Gianella the Mr. Spencer (who I believe lived in the town of Gilbert in southern Monte Cristo Valley at the time), dated January 13, 1933. This paragraph is so significant that we reproduce it in its entirety here:

> "I learned today that Norman Annette found a crack south of Stewart Springs. He went up a wash about a mile or so beyond the Simon road and said that he traced it to within half a mile of the springs while the man with him, who owns a prospect out there, traced it in the other direction for a distance of a mile. This runs nearly N-S and may be a continuation of the ones we found on the Simon Road."

The Simon road is roughly 3 1/4 miles south of Stewart Springs. The breaks mentioned in this letter never made the map (with exception of the small break in the Simon road itself. This opens the possibility that there was intermittent, but semicontinuous rupture from Gianella and Callaghan's rupture numbers "17" and "18", through rupture "16", near rupture "13" and possibly beyond to the north. This will become an important consideration for the kinematic modeling.

Unmapped ruptures are now suspected to have occurred south of Gianella and Callaghan's rupture number "20" and north of new strike-slip breaks mapped during this project. A field trip is planned to investigate this area for ground disturbance. If breaks are found, this will extend the main surface rupture zone in Monte Cristo Valley to the north. At this point in their field work, Gianella and Callaghan were overwhelmed with surface breaks and were only noting those that crossed the roads, and were not walking them out to any extent.

Unfortunately, neither original photographs or originally sketched maps have been recovered from Gianella's or Callaghan's archives. This is a bit surprising. Sketch maps from the event must have existed, or it would have been hard to produce the maps presented in their published papers, unless they simply "faked" the details. The details are so realistic looking, however, that this is unlikely the case. Perhaps a deeper dig into the archives is warranted. More photographs were taken than are presented in their publications according to their notes.

Seismicity

After the surface ruptures were digitized, Diane dePolo of the University of Nevada, Reno Seismological Laboratory searched the UNR catalog for seismicity surrounding the breaks (Figs. 5, 6). The towns of Gabbs, Luning, and Mina were added for reference. Two plots are shown

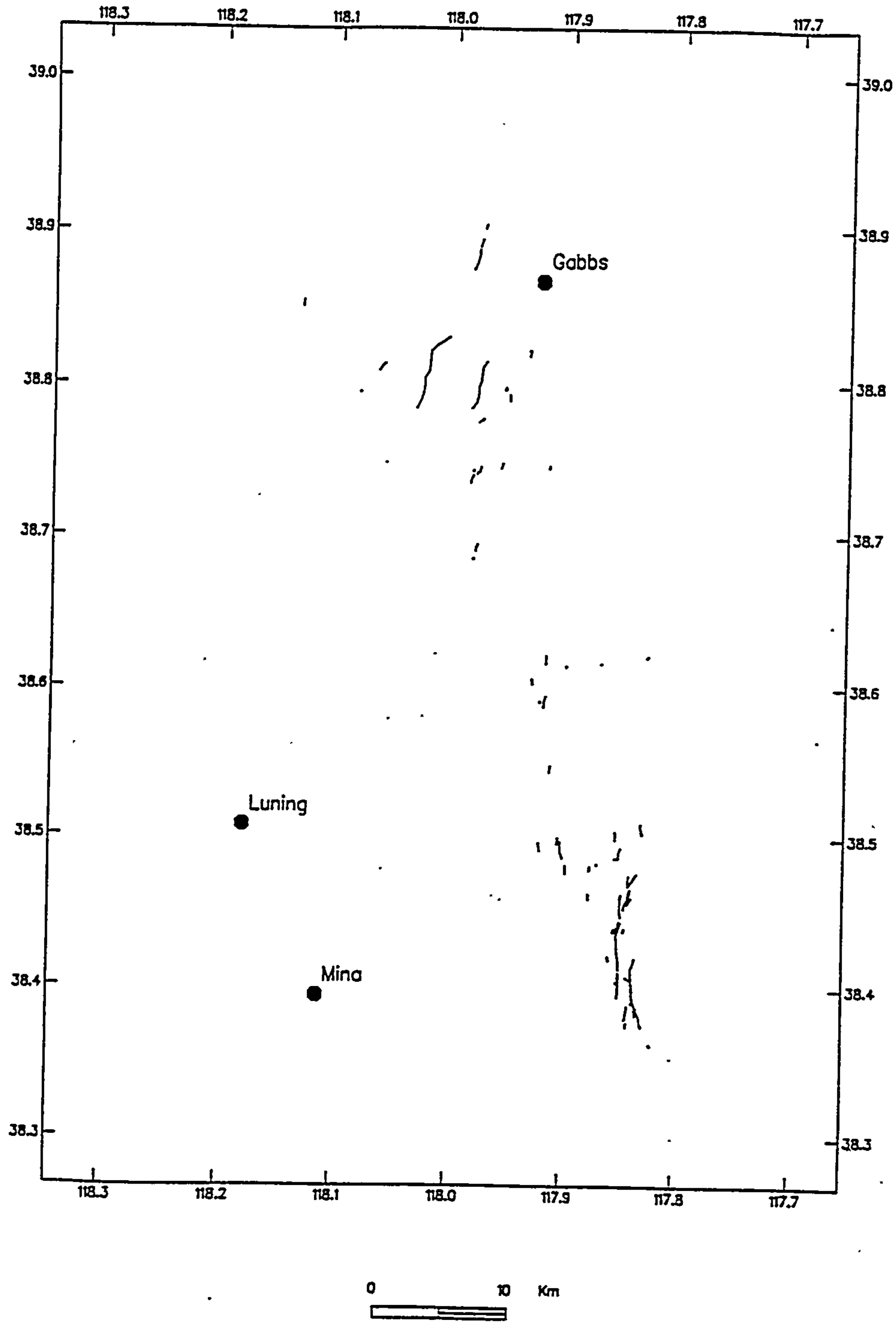

Figure 4. Digitized surface ruptures associated with the 1932 Cedar Mountain earthquake.

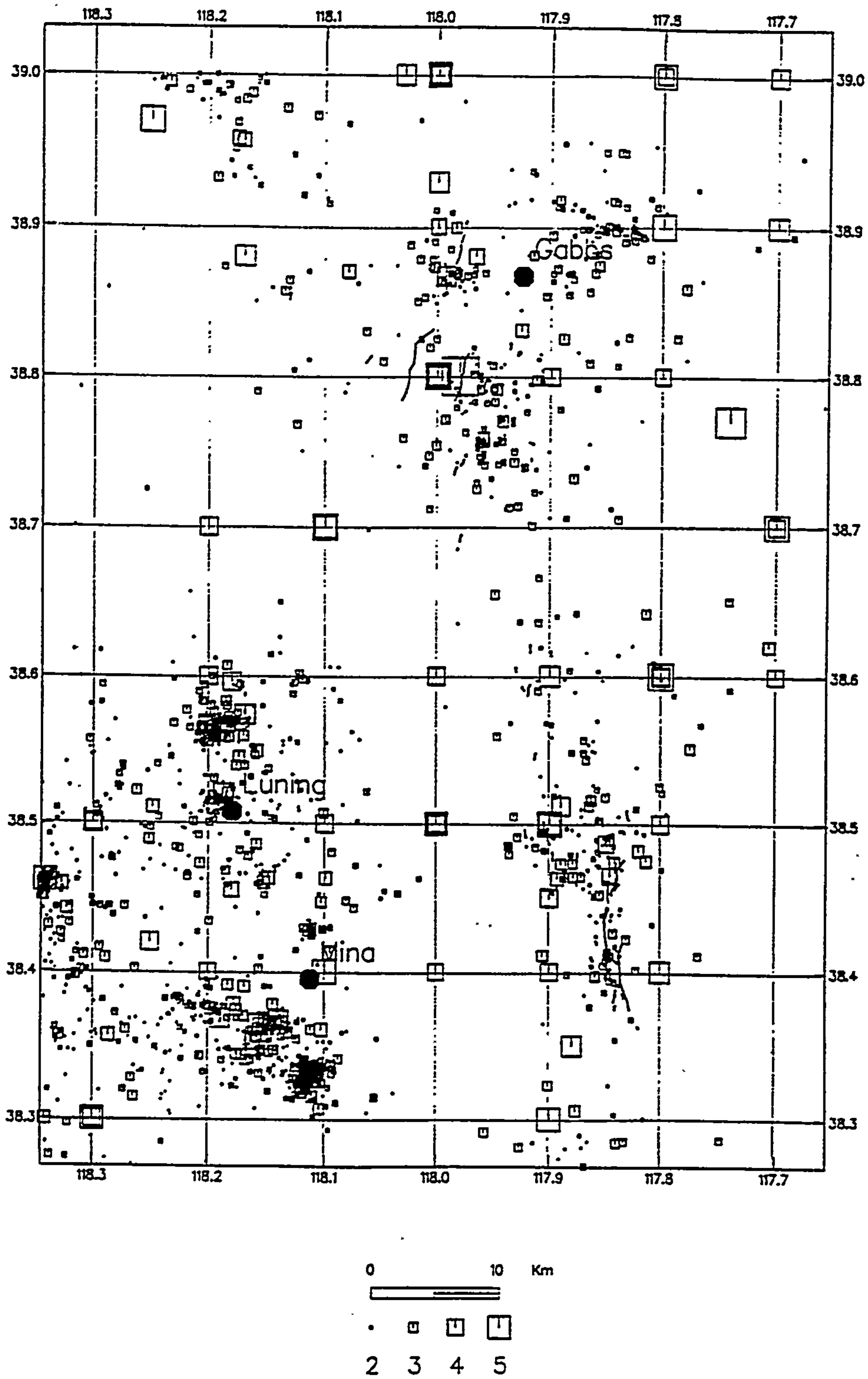

Figure 5. Seismicity catalogued in the 1932 Cedar Mountain earthquake area by the UNR Seismological Laboratory for the period 1932-June 1992. Surface ruptures are shown on the base map.

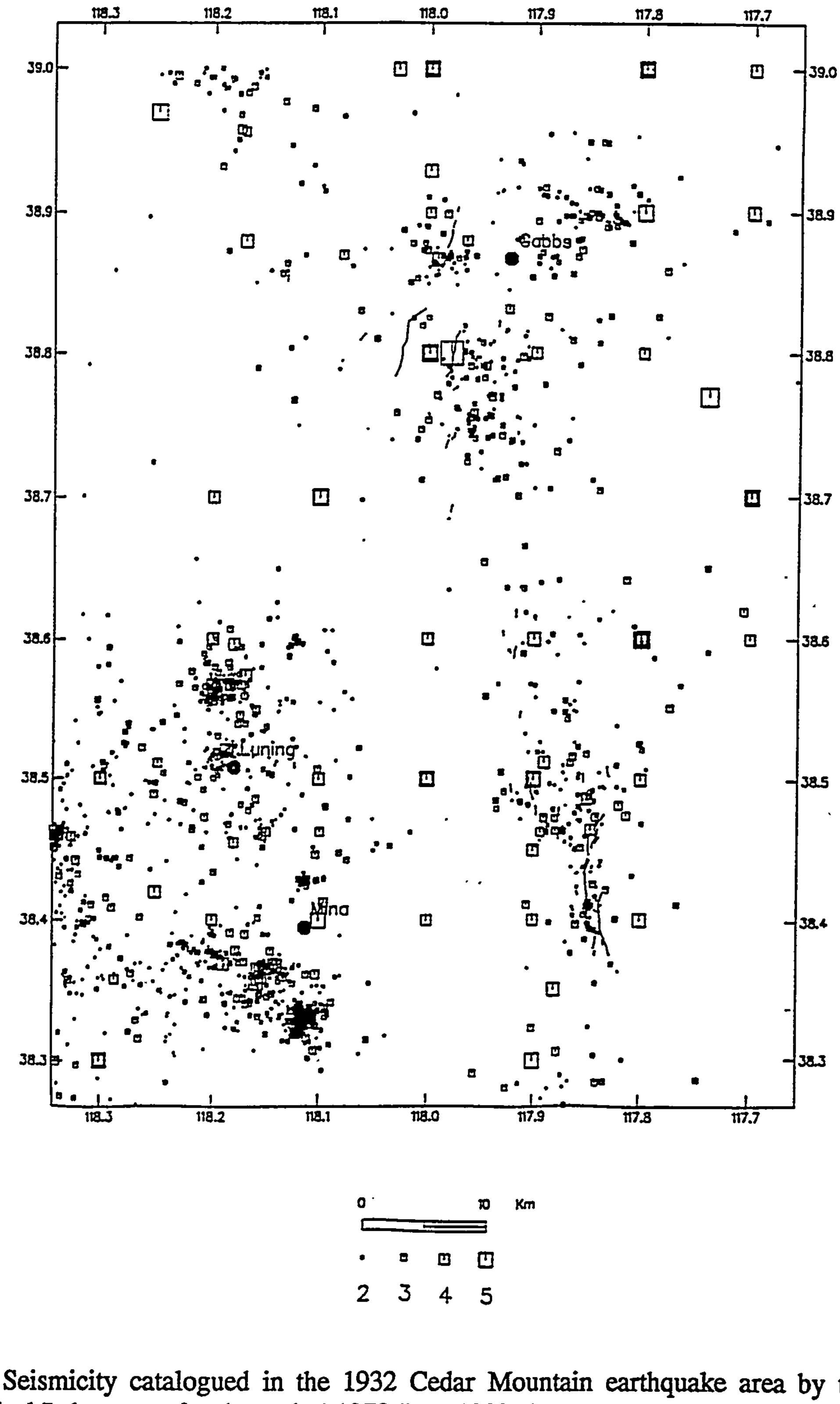

Figure 6. Seismicity catalogued in the 1932 Cedar Mountain earthquake area by the UNR Seismological Laboratory for the period 1970-June 1992. Some general groupings of seismicity can be seen. The surface ruptures are shown on the base map.

here, one for the time period 1932 to June 1992, and the other, for the time period that there has been more local monitoring, 1970 to June 1992.

Although the post-1932 seismicity map is clearly incomplete, it shows all the data that is available for the aftershocks in UNR's catalog. The difficulties of locating earthquakes in this area prior to 1970 is evident in the many magnitude 4 and 5 events located on the tenth of a degree latitude and longitude intersections. Contrasting the seismicity in the immediate area around the surface ruptures with the seismicity of small earthquake swarms near Mina and Luning, demonstrates that most of the aftershocks are missing. The areas around the surface breaks should be as black and much more extensive with earthquakes as these swarms.

The post-1970 data still must be viewed as somewhat fuzzy in the locations of the earthquakes, but offers the best opportunity to spatially associate earthquakes with the ruptures. Several groupings of seismicity are apparent on Figure 6. In general, as pointed out by Doser (1988), there are two groups of aftershocks, one associated with the northern ruptures, and one associated with the southern. The southern group of epicenters cluster around the surface ruptures rather tightly, several being located directly along rupture 23 A. There also seems to be a lot of activity in the northern part of Monte Cristo Valley and the southern part of Stewart Valley. In this region, there are several folds that were probably involved in the surface deformation. These folds are intimately associated with surface faulting and presently form small hills in the landscape. Most of the seismicity at the northern end is from the center of the surface ruptures, and to the east. There is some seismicity immediately southeast of the epicenter that is distributed in nature. A small pocket of seismicity is also located near rupture 3A in Gabbs Valley. Seismicity northwest of the surface rupture area is probably related to the 1954 Fairview Peak earthquake.

Kinematic models

A second kinematic model is being considered for the 1932 Cedar Mountain earthquake, although more work must be done to substantiate it. Initially, Gianella and Callaghan thought that the earthquake must be deep to give such a scattered pattern of surface ruptures. In its simplest form, this could involve a single, north-northwest-trending rupture at depth, that distributes and splays towards the surface. As discussed previously, however, Doser (1988) found evidence for multiple ruptures in the teleseismic P waves from this event, both located more toward the northern half of the surface rupture area. If the southern Stewart Valley and Monte Cristo Valley surface ruptures are interpreted to be primary surface ruptures, this might suggest that there were two other multiple events in addition to Doser's, both northerly trending. Such a model is consistent with the inferred regional stress regime. The consideration of this second kinematic model has come about from the new mapping of surface breaks by Task 1, plotting the breaks at a large scale, and incorporating Gianella and Callaghan' notes and correspondence.

Similarities with the 1992 Landers Earthquake

There are several similarities between the 1992 Landers earthquake and the 1932 Cedar Mountain earthquake including involvement of multiple faults, rupturing across valleys and along different ranges, rupturing multiple geometric and structural segments, and a dominant strike-slip nature.

Observations of the fresh surface ruptures from the Landers event are invaluable to the studies of the Cedar Mountain earthquake. Many of the same geomorphic features whose remnants can be seen from the 1932 earthquake occurred during the Landers earthquake. Of particular note are the occurrence of many swell features. These were almost always related to small left-steps between the main fault breaks. In the area of the Cedar Mountain surface breaks, we have delineated some ruptures based on the occurrence of an alignment of swells and disrupted pavement, and little else. Although these have always been fairly confidently interpreted as true indicators of surface rupture, there is no doubt now. Also in abundance along the Landers earthquake rupture were "moletracks", similar to the "molehill ridges" mentioned by Gianella and Callaghan (1934).

Implications for the Walker Lane

Commonly, a rather simplistic view of an earthquake along a single fault has been envisioned for the seismic hazard of the Walker Lane. Perhaps this is true for several cases. But earthquakes such as the 1923 Cedar Mountain earthquake and the more recent 1992 Landers earthquake in Mojave Desert, California remind us that these major earthquakes (magnitude 7+) can be complicated involving multiple geometric and structural segments of the same fault zone, or different fault zones.

An interesting aspect of the large strike-slip faults of the Walker Lane is that their activity, both in recency and geomorphic expression, is highly variable along their strike. What the previously mentioned earthquakes suggest as a possible explanation for this phenomenon is that parts of different strike-slip faults could be involved in the same major event. Such an event could either be characteristic, with some repeat history, or a random, triggered event. Such multiple fault events should be considered as a possible model for earthquake behavior in the contemporary Walker Lane.

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Appendix A

Chemical Analyses of Rock Varnish Samples

Appendix 1: Chemical analyses of rock varnish used in the paper. Electron microprobe measurements made by JEOL superprobe with wavelength dispersive mode. Samples were prepared and analyzed according to Dorn et al. (1990).
PIXE measurements have also been made on the some of the same samples analyzed by the electron microprobe. The PIXE results have been normalized to 100%. Zero is listed where PIXE values were not reported for an element or it was below limit of detection.

Site & Subsamples	CR	CR Age ± 1 Sigma	MgO	Al2O3	SiO2	P2O5	SO3	K2O	CaO	TiO2	MnO	Fe2O3	BaO	Total
Red Cone	2.62±0.12													
Red Cone_a	2.57	Used in Calibration	0.86	14.40	45.11	1.21	0.35	1.15	0.32	0.77	9.28	7.75	0.24	81.44
Red Cone_b	2.80	Used in Calibration	0.99	11.41	36.01	0.89	0.10	0.99	0.35	0.64	8.34	6.78	0.12	66.62
Red Cone_c	2.60	Used in Calibration	0.55	10.80	33.89	0.44	0.12	0.80	0.29	0.56	7.01	5.83	0.12	60.41
Red Cone_d	2.53	Used in Calibration	1.06	12.37	38.11	2.41	0.07	0.93	0.21	0.61	7.19	5.98	0.09	69.03
Little Cone	2.63±0.08													
Little_a	2.73	Used in Calibration	0.51	17.10	26.94	2.62	0.15	1.59	0.58	1.06	10.55	12.55	0.14	73.79
Little_b	2.55	Used in Calibration	0.35	13.45	22.19	3.60	0.24	1.00	0.40	0.73	6.85	8.00	0.26	57.07
Little_c	2.63	Used in Calibration	1.33	15.63	23.50	1.95	0.07	1.44	0.72	1.08	8.74	10.49	0.11	65.06
Little_d	2.67	Used in Calibration	0.50	13.66	23.15	3.62	0.05	1.41	0.63	1.01	8.80	10.09	0.07	62.99
Little_e	2.55	Used in Calibration	0.91	13.23	22.19	4.01	0.15	1.51	0.56	1.08	9.58	11.32	0.13	64.67
Black Cone	2.53±0.06													
Black_a	2.54	Used in Calibration	0.68	14.18	28.56	0.70	0.00	2.34	0.52	1.53	10.77	12.42	0.18	71.88
Black_b	2.60	Used in Calibration	0.43	19.10	37.17	0.25	0.02	2.69	0.54	1.69	12.48	13.12	0.13	87.62
Black_c	2.46	Used in Calibration	0.22	17.51	35.45	1.33	0.15	2.21	0.49	1.49	10.83	12.90	0.18	82.76
Black_d	2.51	Used in Calibration	0.33	17.11	32.44	1.05	0.05	2.13	0.41	1.38	8.92	9.76	0.07	73.65
CFP 2	6.47±0.13													
CFP_2_a	6.35	Used in Calibration	0.88	21.15	27.95	1.27	0.15	4.18	1.03	1.11	21.01	18.58	0.17	97.48
CFP_2_b	6.47	Used in Calibration	0.95	25.05	30.35	0.67	0.07	4.83	1.03	1.23	21.40	13.07	0.05	98.70
CFP_2_c	6.59	Used in Calibration	0.80	15.70	20.80	0.38	0.10	3.90	0.86	0.98	18.93	17.17	0.09	79.71
CFP_2_d	6.32	Used in Calibration	0.71	15.54	22.47	0.38	0.02	3.63	0.85	0.96	19.18	17.07	0.00	80.81
CFP_2_e	6.60	Used in Calibration	0.91	20.91	28.44	1.03	0.00	4.92	1.00	1.22	22.37	18.11	0.00	98.91

Site & Subsamples	CR	CR Age ± 1 Sigma	MgO	Al2O3	SiO2	P2O5	SO3	K2O	CaO	TiO2	MnO	Fe2O3	BaO	Total
CFP 26	6.13±0.09													
CFP_26_a	6.06	Used in Calibration	1.27	19.62	28.33	2.05	0.00	3.77	0.72	1.01	8.33	13.11	0.05	78.26
CFP_26_b	6.25	Used in Calibration	1.99	18.03	27.47	1.55	0.00	3.84	0.69	0.99	8.52	12.30	0.06	75.44
CFP_26_c	6.07	Used in Calibration	1.90	16.55	47.84	1.08	0.15	4.16	0.84	1.12	5.29	7.79	0.18	86.90
CFP_26_d	6.14	Used in Calibration	1.01	14.23	42.03	2.45	0.17	3.76	0.75	1.00	4.81	6.94	0.21	77.36
CFP 33	5.75±0.06													
CFP_33_a	5.74	Used in Calibration	0.91	9.32	52.60	2.09	0.15	2.79	0.64	0.81	4.00	8.05	0.15	81.51
CFP_33_b	5.82	Used in Calibration	1.94	9.88	46.73	1.12	0.00	2.48	0.98	0.79	3.16	7.09	0.00	74.17
CFP_33_c	5.69	Used in Calibration	1.66	12.66	54.81	1.55	0.00	2.12	1.13	0.75	2.91	6.64	0.06	84.29
CFP_33_d	5.73	Used in Calibration	1.96	13.38	57.21	1.83	0.15	2.70	1.15	0.89	3.50	7.32	0.17	90.26
CFP 27	5.42±0.12													
CFP_27_a	5.38	Used in Calibration	1.79	20.12	40.61	1.08	0.17	3.40	1.00	1.10	10.04	10.17	0.22	89.70
CFP_27_b	5.24	Used in Calibration	1.46	12.48	29.40	3.12	0.55	2.72	0.83	0.91	8.69	9.30	0.61	70.07
CFP_27_c	5.46	Used in Calibration	1.36	15.92	31.77	2.38	0.07	2.79	1.11	0.95	8.00	8.75	0.07	73.17
CFP_27_d	5.45	Used in Calibration	1.88	13.07	31.89	1.70	0.00	3.07	1.33	1.07	8.35	9.19	0.00	71.55
CFP_27_e	5.56	Used in Calibration	2.04	12.12	29.04	1.99	0.00	1.06	0.40	0.35	7.71	8.37	0.05	63.13
CFP 35	5.34±0.15													
CFP_35_a	5.26	Used in Calibration	1.06	14.66	27.51	2.98	0.10	3.49	1.89	1.34	17.76	13.13	0.14	84.06
CFP_35_b	5.27	Used in Calibration	1.39	14.13	22.66	1.79	0.10	3.86	1.35	1.32	17.38	12.55	0.17	76.70
CFP_35_c	5.21	Used in Calibration	0.81	16.51	25.38	2.57	0.22	3.92	1.57	1.40	17.49	15.36	0.32	85.55
CFP_35_d	5.58	Used in Calibration	1.28	16.78	22.46	2.73	0.40	3.36	1.20	1.09	14.08	10.11	0.41	73.90
CFP_35_e	5.37	Used in Calibration	1.74	15.83	22.25	0.99	0.00	3.72	1.31	1.25	15.54	10.50	0.17	73.30
CFP 36	5.32±0.07													
CFP_36_a	5.23	Used in Calibration	2.89	21.56	31.92	0.66	0.00	3.97	1.99	1.50	18.07	15.06	0.03	97.65
CFP_36_b	5.26	Used in Calibration	2.45	10.68	27.79	0.80	0.00	1.40	1.00	0.59	11.01	12.94	0.10	68.76
CFP_36_c	5.39	Used in Calibration	1.29	8.85	24.67	0.41	0.17	1.30	0.67	0.48	10.79	13.49	0.17	62.29
CFP_36_d	5.32	Used in Calibration	2.11	16.88	25.04	0.37	0.00	2.99	1.31	1.07	15.46	14.05	0.02	79.30
CFP_36_e	5.39	Used in Calibration	0.88	16.23	23.46	0.78	0.25	2.17	1.11	0.80	10.46	13.08	0.29	69.51

Site & Subsamples	CR	CR Age ± 1 Sigma	MgO	Al2O3	SiO2	P2O5	SO3	K2O	CaO	TiO2	MnO	Fe2O3	BaO	Total
CFP 32	5.14±0.07													
CFP_32_a	5.09	Used in Calibration	1.26	16.58	24.36	1.33	0.12	2.35	1.75	1.04	15.14	12.46	0.12	76.51
CFP_32_b	5.14	Used in Calibration	1.43	19.14	27.61	1.44	0.25	2.32	1.88	1.05	16.38	11.11	0.27	82.88
CFP_32_c	5.20	Used in Calibration	0.95	20.28	27.80	2.84	0.32	2.37	1.60	0.99	13.99	10.75	0.31	82.20
CFP_32_d	5.04	Used in Calibration	1.69	19.09	29.67	1.81	0.00	1.68	0.54	0.59	13.84	9.98	0.00	78.89
CFP_32_e	5.21	Used in Calibration	0.93	20.13	29.20	1.23	0.07	1.79	0.63	0.62	14.57	9.43	0.12	78.72
CFP 40	2.95±0.10	572,000 ± 66,000												
CFP_40_a	2.92	591,088	0.56	19.04	26.83	1.05	0.52	1.28	0.42	0.78	11.93	11.39	0.17	73.97
CFP_40_b	2.92	588,223	0.95	15.11	22.21	0.44	0.80	1.40	0.48	0.86	12.95	12.15	1.02	68.37
CFP_40_c	2.93	581,508	0.86	17.15	25.57	0.66	0.55	1.60	0.73	1.05	11.77	10.24	0.88	71.06
CFP_40_d	3.12	461,333	0.81	19.75	27.81	0.73	0.15	1.74	0.70	1.04	11.70	9.57	0.39	74.39
CFP_40_e	2.86	640,003	0.22	18.15	27.05	0.88	0.00	1.61	0.37	0.94	15.63	14.25	0.06	79.16
CFP 38	3.29±0.11	373,000 ± 50,000												
CFP_38_a	3.31	360,009	1.18	28.35	39.73	0.60	0.12	2.30	0.83	1.26	4.01	11.61	0.07	90.06
CFP_38_b	3.23	399,985	0.90	21.28	35.33	0.66	2.15	2.38	1.15	1.44	2.86	11.98	2.54	82.67
CFP_38_c	3.19	422,094	0.99	28.18	43.43	0.34	1.27	2.84	1.93	1.94	3.21	9.95	2.28	96.36
CFP_38_d	3.44	308,345	0.91	35.37	35.84	0.62	0.00	3.65	1.90	2.12	2.29	11.85	0.00	94.55
CFP 39	3.29±0.11	375,000 ± 53,000												
CFP_39_a	3.27	380,379	1.06	19.87	27.03	1.08	0.12	1.59	0.71	0.93	13.95	11.09	0.13	77.56
CFP_39_b	3.15	443,765	2.17	18.44	27.73	0.34	0.07	1.60	0.68	0.96	14.19	12.62	0.05	78.85
CFP_39_c	3.31	360,589	0.98	19.83	30.61	0.48	0.22	2.01	0.75	1.11	14.07	11.06	0.25	81.37
CFP_39_d	3.42	315,941	1.81	18.66	29.85	0.34	0.40	1.98	0.80	1.08	14.23	15.29	0.31	84.75
JWB 20	3.79±0.11	200,000 ± 29,000												
JWB_20_a	3.81	192,613	1.14	15.34	28.35	0.78	0.32	2.52	0.91	1.20	16.86	13.67	0.25	81.34
JWB_20_b	3.80	194,862	1.41	16.05	28.33	0.37	0.17	2.14	0.60	0.97	13.49	10.61	0.20	74.34
JWB_20_c	3.60	250,665	1.71	19.57	32.82	0.30	0.05	2.64	0.92	1.32	17.47	14.50	0.07	91.37
JWB_20_d	3.89	175,118	1.82	17.06	35.28	0.34	0.00	1.74	1.61	1.10	11.92	11.57	0.00	82.44
JWB_20_e	3.83	187,792	1.06	16.08	36.92	0.37	0.30	1.96	1.22	1.08	11.71	9.07	0.15	79.92

Site & Subsamples	CR	CR Age ± 1 Sigma	MgO	Al2O3	SiO2	P2O5	SO3	K2O	CaO	TiO2	MnO	Fe2O3	BaO	Total
CFP 29	3.98±0.32	168,000 ± 75,000												
CFP_29_a	4.22	116,299	0.93	17.04	38.22	0.48	0.05	2.77	1.43	1.31	7.76	16.80	0.00	86.79
CFP_29_b	4.22	115,732	1.26	20.84	36.98	0.69	0.17	2.59	0.84	1.09	5.30	15.09	0.12	84.97
CFP_29_c	4.12	130,592	1.92	23.34	33.95	2.18	0.12	2.28	0.66	0.96	4.90	15.84	0.11	86.26
CFP_29_d	3.86	182,798	0.81	23.87	33.50	1.42	0.07	2.33	0.68	1.05	5.07	10.30	0.15	79.25
CFP_29_e	3.48	292,089	1.08	17.66	25.29	0.76	0.00	2.35	0.52	1.12	8.03	19.82	0.07	76.70
CFP 37	3.98±0.19	159,000 ± 38,000												
CFP_37_a	4.12	131,924	0.85	14.00	22.54	0.89	0.00	2.25	1.02	1.05	16.31	13.85	0.00	72.76
CFP_37_b	4.12	130,625	1.34	23.11	29.93	1.19	0.15	2.36	1.00	1.08	16.59	13.94	0.21	90.90
CFP_37_c	4.12	131,845	0.90	15.50	30.38	0.92	0.15	2.45	0.70	1.03	13.91	10.34	0.16	76.44
CFP_37_d	3.75	208,203	1.24	17.17	30.21	0.57	0.20	2.41	0.65	1.10	14.37	12.08	0.12	80.12
CFP_37_e	3.81	192,630	0.83	15.04	29.50	0.66	0.20	2.29	0.59	1.02	13.01	10.22	0.12	73.48
JWB_YM36-V2	7.94±0.17													
a C-14 Calibration	8.19	Used in Calibration	1.18	14.85	22.85	0.55	0.10	1.35	1.41	0.43	21.00	13.87	0.07	77.66
b Site	8.19	Used in Calibration	0.86	15.66	25.37	0.50	0.25	1.65	1.06	0.43	25.93	14.53	0.15	86.39
c	8.07	Used in Calibration	0.95	15.80	24.39	0.78	0.10	1.65	1.47	0.50	19.68	13.45	0.05	78.82
d	8.09	Used in Calibration	1.16	14.85	22.81	0.60	0.75	1.41	0.97	0.38	16.75	15.22	0.45	75.35
e	7.82	Used in Calibration	2.52	18.61	27.83	0.66	0.00	1.75	0.73	0.42	17.03	18.89	0.00	88.44
f	7.82	Used in Calibration	1.36	17.50	25.31	1.01	0.00	1.53	1.97	0.56	15.65	19.55	0.00	84.44
g	7.65	Used in Calibration	0.99	20.63	30.06	0.57	0.12	2.00	0.99	0.52	15.32	13.75	0.00	84.95
h	7.95	Used in Calibration	1.33	16.95	23.88	1.17	0.02	2.24	1.62	0.63	15.40	10.77	0.00	74.01
i	7.86	Used in Calibration	0.78	17.59	24.77	0.73	0.55	1.67	1.25	0.48	22.00	13.85	0.45	84.12
j	7.77	Used in Calibration	2.60	15.09	29.05	0.48	0.25	1.52	1.50	0.50	19.25	18.34	0.19	88.77
k	7.88	Used in Calibration	1.24	17.46	22.57	1.26	0.05	1.99	1.33	0.55	18.96	18.96	0.07	84.44
l	8.00	Used in Calibration	1.06	16.51	25.52	0.64	0.32	1.73	1.79	0.57	18.68	14.76	0.25	81.83

Site & Subsamples	CR	CR Age ± 1 Sigma	MgO	Al2O3	SiO2	P2O5	SO3	K2O	CaO	TiO2	MnO	Fe2O3	BaO	Total
JWB_YM41	5.99±0.13													
a	5.83	Used in Calibration	0.91	17.29	27.17	0.53	0.22	1.61	1.22	0.63	20.69	13.25	0.26	83.78
b	5.92	Used in Calibration	1.86	17.61	22.44	1.26	0.00	1.83	1.02	0.63	18.96	12.17	0.00	77.78
c	6.10	Used in Calibration	1.06	16.02	34.70	2.18	0.11	1.74	1.34	0.65	13.87	11.19	0.14	83.00
d	6.02	Used in Calibration	1.08	15.61	21.24	1.28	0.00	1.70	1.71	0.72	22.13	13.60	0.00	79.07
e	5.90	Used in Calibration	2.59	19.39	27.64	0.76	0.00	1.88	0.69	0.58	16.08	13.94	0.11	83.66
f	5.75	Used in Calibration	1.09	15.78	24.90	0.78	0.00	1.87	1.23	0.70	20.00	13.19	0.00	79.54
g	6.11	Used in Calibration	2.42	19.12	26.76	0.87	0.10	1.67	0.73	0.52	17.38	13.72	0.13	83.42
h	6.20	Used in Calibration	0.63	17.19	23.70	1.01	0.27	1.20	0.97	0.45	21.10	15.28	0.47	82.27
i	6.01	Used in Calibration	1.23	18.21	29.29	0.57	0.07	1.65	1.13	0.60	17.76	14.46	0.05	85.02
j	6.06	Used in Calibration	1.04	13.26	16.02	1.67	0.25	0.98	1.72	0.55	19.51	12.20	0.22	67.42
k	5.98	Used in Calibration	0.85	13.83	33.78	0.94	0.92	1.47	1.06	0.55	17.39	12.67	0.97	84.43
l	5.94	Used in Calibration	1.09	14.98	26.64	1.83	0.10	0.95	1.18	0.45	20.93	12.48	0.11	80.74
JWB_YM38	6.37±0.13													
a	6.32	Used in Calibration	1.96	17.06	40.73	1.58	0.37	1.75	1.62	0.68	9.53	9.58	0.38	85.24
b	6.31	Used in Calibration	1.11	17.57	26.04	0.78	0.17	1.84	1.51	0.68	15.63	14.39	0.15	79.87
c	6.48	Used in Calibration	1.54	20.69	30.46	1.10	0.00	2.48	1.04	0.72	12.23	13.45	0.00	83.71
d	6.54	Used in Calibration	1.11	18.10	22.72	1.72	0.05	1.59	1.20	0.55	23.58	11.11	0.06	81.79
e	6.67	Used in Calibration	1.19	15.36	29.03	1.12	0.50	2.20	1.80	0.77	20.71	8.02	0.41	81.11
f	6.24	Used in Calibration	1.76	16.36	22.16	1.12	0.00	1.64	0.99	0.55	24.38	9.85	0.06	78.87
g	6.32	Used in Calibration	1.31	13.02	26.86	2.13	0.15	0.90	2.17	0.59	28.67	15.07	0.18	91.05
h	6.40	Used in Calibration	1.39	20.39	26.06	2.15	0.05	2.04	1.18	0.66	17.57	11.81	0.06	83.36
i	6.29	Used in Calibration	1.04	13.53	24.22	2.45	0.12	1.07	1.78	0.56	21.02	19.61	0.10	85.50
j	6.24	Used in Calibration	0.7	15.54	22.11	2.57	0.32	0.64	1.79	0.47	22.1	12.82	0.32	79.38
k	6.36	Used in Calibration	1.59	16.48	21.67	2.57	0.37	1.54	1.90	0.68	20.21	13.22	0.40	80.63
l	6.29	Used in Calibration	1.16	18.42	29.48	0.85	0.22	1.81	1.47	0.67	20.46	4.70	0.23	79.47

Site & Subsamples	CR	CR Age ± 1 Sigma	MgO	Al2O3	SiO2	P2O5	SO3	K2O	CaO	TiO2	MnO	Fe2O3	BaO	Total
JWB_YM39	5.68±0.15													
a ADJACENT TO	5.82	Used in Calibration	1.58	15.55	19.94	1.33	0.00	1.47	1.25	0.60	27.88	9.74	0.09	79.43
b TRENCH CF 8	5.44	Used in Calibration	1.21	15.30	19.02	1.86	0.07	0.99	1.60	0.59	27.80	9.15	0.12	77.71
c	5.49	Used in Calibration	1.48	15.66	19.60	1.19	0.00	1.42	1.05	0.58	27.50	9.65	0.00	78.13
d	5.90	Used in Calibration	1.71	15.89	20.71	1.26	0.00	1.48	1.29	0.60	26.56	9.69	0.00	79.19
e	5.85	Used in Calibration	0.91	9.92	16.34	0.89	0.15	1.60	1.78	0.73	37.61	2.53	0.18	72.64
f	5.74	Used in Calibration	1.67	15.80	20.32	1.33	0.00	1.46	1.12	0.58	26.34	10.02	0.00	78.64
g	5.48	Used in Calibration	1.19	15.04	23.68	0.89	0.35	1.70	1.61	0.77	30.18	4.70	0.41	80.52
h	5.55	Used in Calibration	1.74	16.25	21.37	1.19	0.12	1.57	1.09	0.62	25.17	9.62	0.16	78.90
i	5.67	Used in Calibration	1.79	17.27	26.06	2.41	0.30	1.88	1.67	0.80	16.19	13.41	0.34	82.12
j	5.57	Used in Calibration	1.96	16.44	23.92	1.22	0.00	1.19	1.22	0.55	17.51	14.67	0.00	78.68
k	5.61	Used in Calibration	2.32	16.74	23.02	0.92	0.00	2.28	1.28	0.83	22.74	9.12	0.00	79.25
l	5.71	Used in Calibration	0.95	11.79	12.92	2.34	0.10	0.65	1.46	0.45	32.54	12.34	0.15	75.69
m	5.74	Used in Calibration	1.14	14.47	26.96	0.41	0.50	1.94	1.74	0.82	28.39	4.12	0.31	80.80
n	5.77	Used in Calibration	1.34	14.70	19.40	1.99	0.25	1.13	1.81	0.63	25.72	14.61	0.30	81.88
o	5.89	Used in Calibration	1.81	16.99	21.82	1.26	0.00	1.78	1.17	0.65	19.91	11.64	0.00	77.03
JWB_YM36-V1		1,100 ± 400												
a NOT THE	8.33	672	1.34	18.80	27.70	0.39	0.10	1.61	1.82	0.52	25.61	3.97	0.07	81.93
b CALIBRATION S	8.23	762	0.86	12.77	20.39	0.69	0.15	1.54	1.50	0.47	37.03	3.52	0.17	79.09
c SWALE LOCALE	8.31	689	1.11	10.62	23.39	1.24	0.46	1.18	0.88	0.32	23.35	6.78	0.38	69.71
d	8.02	991	1.04	16.36	26.49	0.64	0.20	1.63	1.16	0.45	29.96	3.27	0.14	81.34
e	7.80	1,306	0.93	14.89	25.07	0.89	0.22	1.73	1.50	0.53	30.20	3.89	0.23	80.08
f	7.87	1,196	0.98	12.19	18.53	0.78	0.25	1.77	1.62	0.55	38.48	2.97	0.25	78.37
g	7.64	1,596	1.13	16.85	19.70	1.51	0.12	1.58	1.61	0.53	26.88	9.25	0.15	79.31
	7.74	1,408	0.90	12.41	19.23	0.50	0.15	1.48	1.85	0.54	36.45	2.30	0.15	75.96
i	7.89	1,167	1.31	17.52	21.35	1.72	0.00	1.78	1.41	0.52	24.11	10.18	0.00	79.90
j	8.03	979	1.36	17.70	23.75	1.26	0.05	2.29	1.62	0.63	21.65	10.84	0.07	81.22
CFP-41-V1	9.17±0.25	300 ± 200												
a PETERSON	9.25	212	1.19	16.19	20.88	1.40	0.05	1.93	1.90	0.53	15.74	17.58	0.00	77.39
b PEDON 13	8.68	434	0.88	12.77	21.37	0.60	0.17	1.70	1.43	0.47	12.92	17.29	0.14	69.74
c	9.36	185	1.04	15.79	26.43	0.32	0.12	1.57	1.85	0.47	12.33	13.24	0.15	73.31
d	9.23	218	1.13	18.56	24.61	0.34	0.07	1.54	2.08	0.50	12.73	14.64	0.07	76.27
e	9.36	185	0.83	15.87	24.15	0.50	0.27	1.70	1.30	0.42	12.92	19.26	0.25	77.47
f	9.15	241	1.21	16.61	20.77	1.26	0.15	1.71	1.47	0.45	18.35	17.28	0.12	79.38

Site & Subsamples	CR	CR Age ± 1 Sigma	MgO	Al2O3	SiO2	P2O5	SO3	K2O	CaO	TiO2	MnO	Fe2O3	BaO	Total
CFP-31-V1	5.67±0.15	19,000 ± 4,000												
a PETERSON	5.63	19,797	1.64	18.29	19.28	1.55	0.08	1.04	1.09	0.48	22.85	11.89	0.10	78.288
b PEDON 14	5.77	16,613	2.45	18.18	28.58	1.22	0	1.35	1.02	0.53	18.21	9.31	0.00	80.85
c	5.53	22,440	0.93	14.61	19.54	2.75	0.27	0.93	1.43	0.53	26.87	9.34	0.24	77.44
d	5.92	13,766	2.22	18.04	25.72	0.87	0.12	1.61	0.98	0.57	19.07	8.76	0.13	78.09
e	5.48	23,890	1.67	19.2	21.09	1.88	0.17	1.22	0.9	0.5	18.23	10.45	0.20	75.511
f	5.60	20,556	1.13	15.63	23.25	1.53	0.07	1.58	1.69	0.75	24.66	8.96	0.07	79.32
g	5.61	20,300	0.98	16.14	22.72	1.79	0.00	1.47	1.83	0.75	29.92	3.00	0.00	78.60
h	5.79	16,201	0.71	11.26	23.95	2.2	0.23	0.98	1.59	0.55	24.22	10.84	0.17	76.70
JWB_YM40	2.84±0.09	660,000 ± 71,000												
a ADJACENT TO	2.77	712,386	1.81	15.66	28.54	0.99	0.47	1.08	0.66	0.82	17.33	15.79	0.48	83.63
b TRENCH CF 1	2.87	628,501	2.22	19.05	34.27	0.34	0.25	0.73	0.69	0.63	15.07	13.05	0.22	86.52
c	2.95	568,563	0.85	15.81	25.03	1.31	0.05	0.74	1.01	0.74	19.80	14.06	0.09	79.49
d	2.75	730,461	1.09	11.47	22.04	0.94	0.07	0.82	0.41	0.59	24.86	13.63	0.13	76.05
e	2.77	712,386	0.27	12.64	24.37	1.05	0.36	0.88	0.55	0.67	18.99	14.56	0.29	74.63
f	2.93	582,989	1.01	19.18	29.81	1.28	0.00	0.83	0.73	0.68	15.32	9.81	0.00	78.65
g	2.72	758,438	1.43	18.46	25.12	0.99	0.00	0.75	0.46	0.58	23.07	12.14	0.04	83.04
h	2.92	590,339	0.61	16.67	24.73	1.56	0.12	0.84	0.58	0.63	23.83	12.66	0.15	82.38
i	2.84	652,573	1.96	17.86	29.61	0.44	0.05	1.02	0.67	0.77	17.59	17.12	0.07	87.16

Site & Subsamples	CR	CR Age ± 1 Sigma	MgO	Al2O3	SiO2	P2O5	SO3	K2O	CaO	TiO2	MnO	Fe2O3	BaO	Total
JWB_YM42	3.90±0.11	176,000 ± 25,000												
a EARLY BLACK	3.69	224,983	1.26	16.78	27.88	0.55	0.10	1.02	1.08	0.72	17.68	10.03	0.15	77.25
b CONE SURFACE	3.77	203,527	1.24	17.18	23.92	1.05	0.00	1.17	0.89	0.70	21.49	11.50	0.00	79.14
c NEAR	3.89	175,118	0.83	11.53	23.80	1.10	0.12	1.12	1.08	0.72	21.14	10.01	0.17	71.62
d	3.92	168,658	1.11	13.56	23.34	0.37	0.12	1.20	0.65	0.62	21.10	13.07	0.15	75.29
e	3.90	172,938	0.18	12.74	25.60	0.41	0.10	0.95	0.96	0.62	21.32	12.00	0.12	75.00
f	4.02	148,799	1.11	12.51	24.75	0.76	0.77	1.29	0.46	0.58	18.85	14.60	0.80	76.48
g	4.08	138,023	0.90	13.91	26.04	0.82	0.40	1.24	0.70	0.62	28.34	13.40	0.58	86.95
h	3.88	177,326	1.23	17.69	28.69	0.50	0.42	1.17	1.01	0.72	22.20	9.79	0.45	83.87
i	3.85	184,117	1.87	19.08	27.55	2.22	1.07	1.36	0.79	0.73	17.86	10.52	1.17	84.22
j	3.95	162,437	1.41	12.88	23.17	0.55	0.07	1.26	0.77	0.67	22.42	13.07	0.09	76.36
JWB_YM43	3.17±0.10	433,000 ± 54,000												
a	3.16	437,038	0.86	16.21	26.98	0.82	0.15	1.07	0.85	0.78	29.57	12.99	0.15	90.43
b	3.25	390,437	1.03	11.62	20.47	2.89	0.37	1.15	0.50	0.67	21.48	13.59	0.29	74.06
c	3.07	489,201	0.63	14.45	22.01	0.53	0.10	1.31	0.35	0.73	28.82	11.89	0.12	80.94
d	3.13	453,776	0.48	16.82	20.33	2.77	0.87	1.22	0.78	0.83	24.82	10.85	0.99	80.76
e	3.02	520,825	2.85	15.35	24.05	0.27	0.07	1.03	0.40	0.63	27.26	16.25	0.08	88.24
f	3.21	410,501	1.18	15.33	27.18	0.53	0.27	1.07	0.57	0.67	22.03	12.52	0.25	81.60
g	3.36	340,173	1.01	15.53	27.26	1.03	0.25	1.05	1.16	0.83	20.80	12.69	0.27	81.88
h	3.22	405,390	0.96	14.38	21.24	0.50	1.55	1.18	0.47	0.68	20.42	14.78	1.56	77.72
i	3.13	453,776	0.91	12.34	17.97	0.69	0.02	1.19	0.64	0.77	29.11	12.92	0.00	76.56

PIXE RESULTS

Sample	PIXE CR	Al	Si	Ca	K	Ti	V	Mn	Fe	Ni	Cu	Zn	Pb	Mg	Sr	Ba
Red Cone_a	2.61	12.89	50.48	1.95	0.90	1.09	0.25	17.40	14.13	0.10	0.00	0.11	0.69	0.00	0.00	0.00
Red Cone_b	2.68	12.21	47.81	1.84	1.16	1.12	0.27	18.84	15.80	0.06	0.07	0.12	0.69	0.00	0.00	0.00
Red Cone_c	2.48	13.06	50.43	1.65	0.98	1.06	0.24	17.17	14.37	0.05	0.00	0.11	0.88	0.00	0.00	0.00
Red Cone_d	2.54	13.82	51.63	1.92	0.77	1.06	0.19	16.20	13.62	0.10	0.04	0.09	0.56	0.00	0.00	0.00
Little_a	2.73	16.12	32.35	2.75	1.73	1.64	0.14	20.54	23.77	0.00	0.00	0.18	0.80	0.00	0.00	0.00
Little_b	2.55	16.40	33.45	2.30	1.53	1.50	0.15	18.15	21.11	0.18	0.00	0.15	0.75	4.32	0.00	0.00
Little_c	2.54	17.18	32.21	2.57	2.25	1.90	0.19	19.44	23.34	0.00	0.04	0.14	0.74	0.00	0.00	0.00
Little_d	2.66	14.29	30.25	2.68	2.05	1.78	0.16	20.04	23.78	0.04	0.06	0.26	0.84	3.77	0.00	0.00
Little_e	2.57	14.92	30.88	2.94	1.92	1.89	0.15	21.26	24.71	0.15	0.09	0.15	0.91	0.00	0.00	0.00
Black_a	2.56	13.53	33.48	4.13	1.62	2.25	0.18	20.75	22.87	0.19	0.04	0.22	0.73	0.00	0.00	0.00
Black_b	2.57	13.73	33.89	3.85	1.36	2.03	0.14	19.24	21.61	0.15	0.00	0.17	0.77	3.04	0.00	0.00
Black_c	2.49	14.70	36.27	3.48	1.37	1.95	0.11	18.04	20.06	0.04	0.05	0.14	0.00	3.77	0.00	0.00
Black_d	2.41	16.38	37.87	3.67	1.18	2.01	0.19	17.47	20.29	0.00	0.00	0.19	0.76	0.00	0.00	0.00
CFP_2_a	6.34	13.97	23.20	5.30	2.25	1.19	0.29	29.26	23.68	0.00	0.00	0.00	0.85	0.00	0.00	0.00
CFP_2_b	6.57	15.32	23.44	5.86	2.15	1.22	0.23	27.98	23.18	0.00	0.02	0.00	0.60	0.00	0.00	0.00
CFP_2_c	6.57	12.53	20.69	5.89	2.26	1.24	0.26	31.02	25.27	0.00	0.00	0.00	0.84	0.00	0.00	0.00
CFP_2_d	6.46	12.17	22.10	5.56	2.26	1.21	0.25	30.88	25.54	0.00	0.04	0.00	0.00	0.00	0.00	0.00
CFP_2_e	6.60	13.14	22.33	6.13	2.18	1.26	0.21	29.64	24.40	0.00	0.07	0.09	0.56	0.00	0.00	0.00

Sample	PIXE CR	Al	Si	Ca	K	Ti	V	Mn	Fe	Ni	Cu	Zn	Pb	Mg	Sr	Ba
CFP_26_a	6.02	16.84	30.26	6.25	2.06	1.38	0.17	14.96	24.35	0.00	0.00	0.00	0.64	3.10	0.00	0.00
CFP_26_b	6.24	15.53	29.53	6.37	1.99	1.34	0.11	15.21	23.34	0.00	0.04	0.00	0.71	5.84	0.00	0.00
CFP_26_c	6.08	13.57	48.23	6.55	2.32	1.46	0.00	8.83	18.29	0.00	0.00	0.12	0.63	0.00	0.00	0.00
CFP_26_d	6.12	13.02	47.47	6.66	2.27	1.46	0.09	9.02	19.32	0.00	0.00	0.00	0.68	0.00	0.00	0.00
CFP_33_a	5.79	8.47	59.38	4.86	1.92	1.17	0.07	7.51	16.08	0.00	0.00	0.11	0.43	0.00	0.00	0.00
CFP_33_b	5.82	10.03	58.23	4.53	3.04	1.30	0.10	6.69	15.45	0.00	0.00	0.10	0.54	0.00	0.00	0.00
CFP_33_c	5.65	11.46	62.81	3.26	2.95	1.10	0.00	5.47	12.90	0.00	0.00	0.06	0.00	0.00	0.00	0.00
CFP_33_d	5.67	11.31	60.17	3.89	3.03	1.22	0.08	6.04	13.85	0.00	0.00	0.08	0.33	0.00	0.00	0.00
CFP_27_a	5.40	15.25	38.76	4.78	2.51	1.35	0.17	15.72	16.15	0.00	0.06	0.15	0.68	4.42	0.00	0.00
CFP_27_b	5.20	12.66	36.41	4.96	2.69	1.47	0.16	18.20	18.27	0.00	0.00	0.10	0.00	5.09	0.00	0.00
CFP_27_c	5.46	15.27	38.05	4.64	3.27	1.45	0.13	15.90	16.32	0.00	0.05	0.12	0.00	4.81	0.00	0.00
CFP_27_d	5.33	13.53	40.21	5.24	3.82	1.70	0.00	17.25	17.59	0.00	0.00	0.17	0.49	0.00	0.00	0.00
CFP_27_e	5.51	13.39	39.86	5.22	3.27	1.54	0.00	17.48	18.52	0.00	0.00	0.22	0.49	0.00	0.00	0.00
CFP_35_a	5.28	11.63	27.80	4.72	4.15	1.68	0.00	29.43	19.56	0.00	0.04	0.19	0.80	0.00	0.00	0.00
CFP_35_b	5.28	11.80	22.96	5.33	3.43	1.66	0.32	29.08	22.35	0.00	0.06	0.15	0.00	2.86	0.00	0.00
CFP_35_c	5.19	12.77	24.00	5.16	3.56	1.68	0.35	27.41	21.65	0.00	0.02	0.15	0.00	3.25	0.00	0.00
CFP_35_d	5.42	15.41	25.81	5.55	3.40	1.65	0.30	26.96	20.74	0.00	0.06	0.13	0.00	0.00	0.00	0.00
CFP_35_e	5.35	13.77	24.16	5.85	3.52	1.75	0.29	28.23	22.24	0.00	0.03	0.16	0.00	0.00	0.00	0.00
CFP_36_a	5.27	14.17	26.54	4.49	3.78	1.57	0.22	24.84	19.99	0.00	0.00	0.15	0.50	3.75	0.00	0.00
CFP_36_b	5.27	10.34	33.81	2.03	2.71	0.90	0.17	22.22	27.08	0.00	0.00	0.11	0.64	0.00	0.00	0.00
CFP_36_c	5.17	9.56	32.53	2.13	1.90	0.78	0.16	23.33	29.51	0.00	0.00	0.10	0.00	0.00	0.00	0.00
CFP_36_d	5.22	14.58	26.54	4.36	3.26	1.46	0.32	27.28	21.98	0.00	0.08	0.15	0.00	0.00	0.00	0.00
CFP_36_e	5.39	15.19	27.28	3.39	3.02	1.19	0.27	20.32	25.77	0.00	0.02	0.13	0.00	3.41	0.00	0.00

Sample	PIXE CR	Al	Si	Ca	K	Ti	V	Mn	Fe	Ni	Cu	Zn	Pb	Mg	Sr	Ba
CFP_32_a	5.04	15.12	26.94	3.14	4.02	1.42	0.24	27.91	20.94	0.00	0.10	0.16	0.00	0.00	0.00	0.00
CFP_32_b	5.18	15.53	27.21	2.86	3.82	1.29	0.36	26.28	19.39	0.00	0.00	0.12	0.63	2.51	0.00	0.00
CFP_32_c	5.21	16.60	28.66	3.38	4.02	1.42	0.26	24.37	20.32	0.00	0.06	0.17	0.74	0.00	0.00	0.00
CFP_32_d	5.09	18.11	34.04	2.78	1.55	0.85	0.13	26.15	15.62	0.00	0.06	0.11	0.60	0.00	0.00	0.00
CFP_32_e	5.20	18.16	32.20	2.86	1.77	0.89	0.14	26.69	16.55	0.00	0.00	0.11	0.63	0.00	0.00	0.00
CFP_40_a	2.94	17.69	31.10	2.17	1.30	1.18	0.20	23.04	22.05	0.07	0.16	0.21	0.83	0.00	0.00	0.00
CFP_40_b	2.95	15.17	26.99	2.41	1.45	1.31	0.65	26.13	23.36	0.00	0.08	0.18	0.99	0.00	0.00	1.29
CFP_40_c	2.80	16.54	30.36	2.45	1.95	1.57	0.60	23.04	21.58	0.13	0.13	0.15	0.77	0.00	0.00	0.73
CFP_40_d	3.01	17.80	31.10	2.61	1.84	1.48	0.59	21.62	20.88	0.19	0.05	0.15	1.18	0.00	0.00	0.51
CFP_40_e	2.93	14.39	26.55	2.46	1.00	1.18	0.14	25.99	23.36	0.10	0.09	0.18	0.00	4.56	0.00	0.00
CFP_38_a	3.22	20.47	35.29	2.80	1.74	1.41	0.26	5.72	25.49	0.00	0.07	0.22	0.94	5.58	0.00	0.00
CFP_38_b	3.39	19.92	40.45	3.92	3.30	2.13	0.00	5.39	20.52	0.05	0.00	0.22	0.00	0.00	0.00	4.09
CFP_38_c	3.31	21.12	41.36	3.40	3.94	2.22	0.00	5.07	19.36	0.00	0.14	0.09	0.00	0.00	0.00	3.29
CFP_38_d	3.32	23.37	29.07	4.02	3.64	2.31	0.00	3.14	34.39	0.07	0.00	0.00	0.00	0.00	0.00	0.00
CFP_39_a	3.21	17.28	29.61	2.29	1.79	1.27	0.31	25.03	21.46	0.03	0.11	0.15	0.67	0.00	0.00	0.00
CFP_39_b	3.27	16.24	29.83	2.51	1.80	1.32	0.34	25.59	21.44	0.06	0.06	0.13	0.68	0.00	0.00	0.00
CFP_39_c	3.30	15.64	29.49	2.69	1.77	1.35	0.23	22.48	22.32	0.11	0.00	0.11	0.67	3.13	0.00	0.00
CFP_39_d	3.46	14.73	29.09	2.82	1.92	1.37	0.16	23.24	22.90	0.12	0.04	0.12	0.73	2.75	0.00	0.00
JWB_20_a	3.91	12.81	28.85	3.65	2.29	1.52	0.34	28.13	21.55	0.00	0.00	0.16	0.70	0.00	0.00	0.00
JWB_20_b	3.63	15.32	31.95	3.50	1.76	1.45	0.35	25.46	19.39	0.00	0.03	0.15	0.63	0.00	0.00	0.00
JWB_20_c	3.71	14.42	30.17	3.59	2.09	1.53	0.34	26.81	20.14	0.00	0.07	0.18	0.66	0.00	0.00	0.00
JWB_20_d	3.69	14.50	37.69	3.30	2.09	1.46	0.10	20.87	19.17	0.00	0.08	0.12	0.61	0.00	0.00	0.00
JWB_20_e	3.85	12.47	37.69	2.66	2.84	1.43	0.10	20.12	18.60	0.00	0.07	0.11	0.70	3.22	0.00	0.00

Sample	PIXE CR	Al	Si	Ca	K	Ti	V	Mn	Fe	Ni	Cu	Zn	Pb	Mg	Sr	Ba
CFP_29_a	4.09	14.09	39.48	3.74	3.34	1.73	0.00	13.23	23.55	0.05	0.00	0.13	0.66	0.00	0.00	0.00
CFP_29_b	4.03	15.41	32.81	3.15	1.77	1.22	0.00	7.80	29.29	0.00	0.00	0.15	0.00	8.40	0.00	0.00
CFP_29_c	3.95	20.24	34.86	3.29	1.65	1.25	0.00	8.28	29.71	0.03	0.00	0.16	0.52	0.00	0.00	0.00
CFP_29_d	3.82	20.59	34.36	3.18	1.60	1.25	0.00	8.25	30.58	0.00	0.06	0.13	0.00	0.00	0.00	0.00
CFP_29_e	3.80	16.72	29.82	4.58	1.76	1.67	0.27	15.87	29.01	0.00	0.09	0.19	0.00	0.00	0.00	0.00
CFP_37_a	4.10	12.15	23.44	3.17	2.45	1.37	0.27	28.00	24.75	0.00	0.00	0.19	0.97	3.24	0.00	0.00
CFP_37_b	4.02	16.82	28.00	2.95	2.16	1.27	0.33	25.52	22.06	0.00	0.00	0.12	0.77	0.00	0.00	0.00
CFP_37_c	3.99	14.07	33.97	3.96	1.94	1.48	0.17	25.08	18.55	0.00	0.00	0.15	0.63	0.00	0.00	0.00
CFP_37_d	3.90	14.75	32.00	3.81	1.73	1.42	0.16	25.70	19.72	0.00	0.00	0.11	0.61	0.00	0.00	0.00
CFP_37_e	3.92	13.97	33.58	3.95	1.77	1.46	0.18	24.59	18.44	0.00	0.00	0.09	0.64	1.33	0.00	0.00

Appendix B

Petrographic and Chemical Analyses of Volcanic Tephra

United States Department of the Interior

GEOLOGICAL SURVEY

TAKE PRIDE IN AMERICA

Geologic Division; Branch of Western Regional Geology
Tephrochronology Project; MS 975; 345 Middlefield Road
Menlo Park, CA 94025; Tel. 415 329-4930; FTS 459-4930;
FAX: 415 329-4936 or FTS 459-4936

June 29, 1992

John Bell
Nevada Bureau of Mines and Geology
University of Nevada,
Reno, NV 89557

Dear John:

Here are the results of our analyses of your 16 tephra samples that you submitted to us in January of last year. Samples JB-BS-4 through -7 were analyzed last June, and samples JB-BS-9 through -17, and JB-WA-1, were analyzed last October. Samples JB-BS-1 through -3 somehow slipped through the cracks, and were not analyzed until last week. I have given you results of the earlier analyses on two different occasions via the telephone. This letter is a written evaluation of the analyses as a follow-up to our phone conversations, and for citation if you wish to publish the data, and a first report on samples -1 through 3. I'm sorry it has taken so long to finish these; part of the problem was that I was away out of the country for most of last summer and we lost some continuity in our work.

Petrographic Characteristics:

The samples were examined initially by Elmira Wan in our Tephrochronology Lab before any treatment was begun, to check if isotropic glass shards were present; a brief petrographic description was made at that time. Subsequent observations were made on the various processed fractions during sample preparation as warranted. Because the samples were small, all available material was processed (for future reference, you may want to collect larger samples, as this makes a big difference in ease of processing). Petrographic descriptions by Elmira are enclosed on copies of the lab notes. A few words of explanation about abbreviations used in the notes:

WS - wet sieved

HCl - treated with 10% HCl (to get rid of carbonate coating or cement)

HF - treated with 8% HF (to etch outside of shard; get rid of hydrated or altered exterior)

Numbers below HCl or HF refer to number of seconds sample was treated with acid.

BW - bubble-wall shard.

BWJ - bubble-wall junction shard.

Mesh sizes used in sieving samples are for nylon screens. The sizes differ from metal screens.

100 mesh has openings of about 150 microns.

200 mesh has openings of about 80 microns.

325 mesh has openings of about 40 microns.

Chemistry of glass shards based on probe analysis:

JB-BS-1 contains very homogenous glass, as indicated by variations from shard to shard. Only silica seems somewhat variable, and that is probably a result of variation in hydration from shard to shard. The total for this sample is high, 97.4%, indicating that the glass is not very hydrated. Closest matches are with young, near surface layers erupted from the Mono Craters, and with pumice from the Panum tuff ring (material sampled 1.5 m below the surface - KRL82282A(P)). The chemically most similar dated tephra layer to -1 is OD-ML-65CM, a sample of Owen Davis' from Mono Lake, the uppermost of a sequence of Holocene ash layers; the date is essentially at the level of the ash, a radiocarbon age of 1950 $\pm$ 110. Samples of yours similar to this one are JB-BS-2, -4, -5, -7, -12, -15, and 16. Samples -2, -7, -11, and -12 have somewhat more iron than -1. Another similar sample, BL-RSA-4 of Scott Anderson from Barrett Lake, has an interpolated age from radiocarbon dates of about 950 yrs B.P. Yet another good match with -1 and several of your other samples in this batch (-9, -11, -12 through -16, and JB-WA-1) is sample 3-30-82-1 of Scott Stine's, a "proto Panum" ash overlying a radiocarbon date of 890 $\pm$40 in Lee Vining Creek.

JB-BS-2 is likewise similar to late Holocene tephra layers erupted from the Mono Craters, including one of a sequence from Barrett Lake, BL-RSA-2, estimated to be about 900 yrs B.P. It totals a high 98%, thus is little hydrated. It is similar again to tephra from the Panum Crater tuff ring, the matrix ash from 1.5 m below the surface (KRL82282A), as opposed to the pumice, and a late Holocene ash layer in Yosemite Valley, in lake deposits formed behind a terminal or recessional moraine near Bridalvail Falls (YOS-1). Sample -2 is also chemically similar to an early Holocene tephra layer at Crooked Meadow, except that the latter is more hydrated than -2. Closest matches to -2 in this batch are -12, -7, -11 (all with slightly higher iron content), and -1.

JB-BS-3 is a moderately hydrated, homogenous tephra (K is slightly variable). The total of 94.9% indicates about 5 % water in the glass. This tephra, of probable early Mono Craters provenance, matches well with tephra layers in Walker Lake (WL 3-7-2.66, WLC-85-2(11.34M), WL-5-19-0.27M, WLC-85-2(13.65M),*WL5-19 78.19m, and in Mono Lake (KRL71082(CII), that are late Pleistocene in age and roughly bracketed between about 60 and 100 Ka. The age control is obtained from a sedimentation-rate curve in Walker Lake constrained by radiocarbon ages on the young end, uranium-series ages in the middle and lower parts, and some direct and indirect tephra correlations to dated source units (Sarna-Wojcicki and others, USGS OFR 88-548, and a later unpublished revision of this report).

JB-BS-4 is a fairly homogenous, poorly hydrated (about 3.5% water) tephra similar to -5 and other Mono Craters tephra layers in the age range of about 1000 to 2000 yrs. B.P. See notes to -1, above.

JB-BS-5 is a fairly homogenous tephra with about 3.5% water. It matches most closely with late Holocene tephra layers erupted from Mono Craters such as -1 (above), and SL-103 and SL-115.5 (Swamp Lake; about 1780 and 1960 yrs B.P., respectively), but also with KRL82182(A-1), an older but more hydrated Mono Craters tephra layer from Crooked Meadow, about 7200 yrs B.P.

JB-BS-6 is a very homogenous tephra layer that is moderately hydrated (about 6.5% water). This is more typical of late Pleistocene or older tephra layers. Closest matches are with the lowest tephra layers in the Wilson Creek Beds of Ken Lajoie, Ash Beds 16, 17, and 19. The closest match (similarity coefficient of 0.998 amd 0.991 for the six elements used) is to ash bed 19 (KRL7982-19B and 679-340), extrapolated to be about 36 Ka, according to Ken (see Benson and others, 1990, Paleo., Paleo., Paleo. v.78, 241-286). There are also correlative beds in Walker Lake, and your sample -17.

JB-BS-7 is another poorly hydrated (about 3.25%) fairly homogenous (except for K) tephra, similar to late Holocene Mono

Craters tephra layers. The closest match is to surface ash at Putnam Dome (North)(KRL-91882A') and Crater Mt (Russell), ash from the pit (KRL91882B), as well as dated late Holocene layers from Barrett Lake (BL-RSA-2, about 900 yrs. B.P., and SL-103, about 1780 yrs. B.P.).

Samples JB-BS-9, -11, -12, -13, -14, -15, -16, and JB-WA-1 are all very similar to one another. They are relatively homogenous, weakly hydrated (range from 1.5 to 2.5%), except for -9, which is moderately hydrated (4.7%). Closest matches fall into two categoried for these: 1) mostly late Holocene tephra layers of Mono Craters provenance, in the range of about 900 to 3750 yrs B.P., but 2) KRL82182(A1) shows-up as a persistant good match for many of these, and as the best for -9, the most hydrated one of the bunch. This is an early Holocene layer, interpolated from Ken Lajoie's radiocarbon dates to be about 7200 yrs. B.P.

JB-BS-17, as mentioned above, matches the oldest ash layers in the Wilson Creek Beds (see comments on your sample -6).

I compared your two samples from a previously submitted set, 1-JWB-1-CM-2 and -3, to see if any new good matches appeared since the last evaluation. The best match is (still) with KRL-71082(II-3), a tephra layer recently exposed on the causeway between Negit Island and the north shore during a recent anthropogenic lowstand of Mono Lake; this layer, according to Ken Lajoie who sampled it, is part of a sequence of about eight or more beds interbedded with "older", deformed lake beds. The set of beds are of two types, one set similar to your sample -6, a putative early Mono Craters set of tephra layers, the other similar to rhyolites erupted from Mammoth Mountain, in the age range of 50 to 100 Ka. These age constraints, plus additional ones from a sedimentation rate curve in Walker Lake based on various age constraints (Sarna-Wojcicki and others, 1988, revised, as above), suggest that these units are in the age range of 60 to 100 Ka. The manganese was not determined for the Mono causeway samples because one of the spectrometers was not working at the time.

Interpretation:

The differences among tephra layers derived from the Mono Craters are small. I think, however, that we can distinguish three sets of Mono Craters and Mono Craters-like ash layers without too much difficulty; these are a Holocene set, a latest Pleistocene set (13-

36 Ka)(some of your samples correlate with the oldest of these), and an older late Pleistocene set (about 60 to 100 Ka).

When we attempt to distinguish between Holocene Mono Craters tephra layers we are basically splitting hairs; I'm not sure such distinctions are valid--at least not on the basis of electron-probe analysis alone. I think we can safely say that the large group of your samples (all except -3, -6, and -17) are Holocene. I suspect that most of these, with the possible exception of -9, are late Holocene, and that the latter might be early Holocene, based on its greater degree of hydration. A problem I see here is that the more distal tephra layers, being finer grained, may hydrate more rapidly than the proximal coarse-grained tephra of equivalent age. Further analysis of the Holocene tephra of Mono Craters source by XRF and other techniques may help us to distinguish them with greater certainty. I was hoping that radiocarbon ages would help to sort these layers out, but it looks to me like there are systematic errors of about 1000 years in Holocene sets of layers sampled from different sites (for example, sets from peat deposits at Crooked Meadow, and from lake deposits in Barrett Lake and Walker Lake).

I hope these data are useful to you. I am sending a copy of this letter to Ken Lajoie, because he is closely involved in investigations of the Mono Craters tephra layers and has provided us with much of the age control and reference samples.

Sincerely,

Andrei Sarna-Wojcicki

Andrei M. Sarna-Wojcicki

P.S.: Your 1-st sample, CMT-3, submitted way back when, still matches best with Bishop-like tephra layers such as the Bishop ash bed, Mono Glass Mt. ash beds B and G, and the Bailey ash bed, all in the age range of 0.75 - 1.2 Ma. The iron is more like the older ash beds than like the Bishop.

A.

~~color~~ N8 - 5YR 8/1
Very lt. gray - ~~white~~ pinkish gray

DISAGGREGATION
H20 Spray

WS	HCl	HF
✓	60	15

(Benton Spring Ash #1, Dunlap Canyon, nr. mouth, NV, 38°24'48"N., 118°4'12" W.)
- Processed entire spl. Spl. is a fine-grained pumiceous ash dominated by blocky, subangular, hydrated, highly vesicular (elongated spindle, tubular & irreg. bubble-type), and ribbed shards (mostly straight, few slightly wavy). (There are a few % feldspars.) Compound grains are also abundant. Altered/heavily coated mat'l makes-up ~6-7% of spl. There is a slight surficial coating on most of the glass so first → ACIDS

* Upon examination of [-200 +325], the decision to process this size fraction for probe also was made as most of the grains are less hydrated/vesicular and contain far fewer microliths/microphenocrysts than the [-100 +200] size.

- Good clean-up of both fractions. [-100 +200] has in add'n to mostly vesicular + compound shards, a fair # of acicular ones. The same can be said for the [-200 +325] fraction (albeit this size has a fair amt. of platy shards). Both portions contain a few % feldspars, altered mat'l, etc. However, because ~~of small~~ the remaining amts. of residue are so small (<.09 grams), processing was stopped at this pt. Samples are good enough for probe. → PROBE NEXT

DONE FOR PROBE 5/1/91

388 JB-BS-2

COLOR NB DISAGGREGATION

WHITE Very lt. gray H2O spray

WS	HCl	HF
✓	60	20

(Benton Spring Ash #2, Dunlap Cyn., NV 38°24'54"N, 118°3'18"W.) Entire spl. processed.
- Spl. similar to JB-BS-1 a fine-grained, unconsolidated pumiceous ash. Glass makes up ~85% of sample, altered mat'l, feldspars and heavies = the rest. Grains are slightly coated w/ FeO_3. First step = ACIDS.
[-200 +325] fraction also similar to JB-BS-1. Shards make-up ~92%, feldspars ~5-6%, remaining grains (heavies [hornblende, biotite, pyroxene(?), dk. shards], altered ≤2%). → ACIDS AL80
— Nice clean-up of both portions. Still a fair amt. of grungy mat'l in each plus unwanted xtls but deemed by CEM as good enough for probe → PROBE NEXT

DONE FOR PROBE 5/1/91

~~color~~ N8 – 5YR 8/1
Very Lt. Pinkish ~~white~~ gray

DISAGGREGATION
H_2O spray

WS	HCl	HF	TUBE
✓	60	15	///

(Benton Spring Ash #3, NV, 38°25'36"N, 118° 4'24" W.) Entire spl. processed.
Another fine-grained, pumiceous tephra. At the [-100 +200] size, shards are highly vesicular (elongated conical, spindle and irreg. bubble-type), hydrated, mostly ribbed and blocky, sub & /or compound. Feldspars (~8%), Biotites (~8%) and ➝zircons, pyroxenes hornblendes (<1%) make up ~17-18% of spl. At [200 +325] better glass is observed (i.e., most of the shards are ribbed, platy w/ few vesicles and little or no hydration). The % minerals is halved (~8-9%). Will process finer fraction for probing instead of [-100 +200]. To remove dirt → ACIDS 1ST
– Nice clean-up after acids. To drop unwanted xtls → TUBE NEXT
– Fair tubing. All of heavies removed, some of feldspars → TUBE AGAIN
– Good tubing. Many feldspars dropped out → TUBE AGAIN
– Spl. still has ~5% feldspars but good enough for probe for now → PROBE NEXT

DONE FOR PROBE 5/2/91

182 JB-BS-4

COLOR 10 YR 8/2 DISAGGREGATION

VERY PALE ORANGE H2O Spray

WS	HCl	HF
√	60	10

(Benton Spring Ash #4, NV, 38°25'43"N. 118°4'24" W.) Entire spl. processed.
- A fair amt. of good glass in a very tiny spl. Mostly pumiceous + vesicular. Biotite, zircons, feldspars, pyroxene (?), and magnetite also present. Give a quick acid bath to clean up for probe → ACIDS 1ST *
- Acids removed most of coating, devitrified and altered mat'l. Still contains minerals but not enough spl. to process further. Good enough for probe.
→ PROBE NEXT

* med. + fine fractions wet-sieved together to make [-100+325]

DONE FOR PROBE 5/2/91

COLLN NO. DISAGGREGATION

WHITE H2O Spray

WS	HCl	HF
✓	60	20

(Benton Spring Ash #5, NV 38°25'49"N, 118°3'54"W.) Processed entire spl.
– Mostly good glass, a fair amt. of grungies, few feldspars (~4%). Acid wash to remove surficial coating → ACIDS 1ST *.

- GOOD CLEAN-UP OF SPL. AFTER ACIDS. STILL A FEW % GRUNGIES AND MINERALS BUT NOT ENOUGH SPL. TO PROCESS ANY FURTHER SO SUBMITTED FOR PROBE
→ PROBE NEXT

* med. + fine fraction wet-sieved together to make [-100+325].

DONE FOR PROBE 5/2/91

184 JB-BS-6

COLOR ~5YR 8/1 DISAGGREGATION

~~white~~ Lt. Pinkish Gray H2O spray

WS	HCl	HF
√	60	10

(Benton Spring Ash #6. NV, 38°29'47" N, 118°3'29" W.) Entire spl. processed.

- Highly vesicular, pumiceous spl. that is moderately to heavily coated. Spl. also contains a few % compounds, feldspar, biotite, hornblende + magnetite; clean up w/ a short acid bath → ACIDS 1ST.

- Good clean-up of spl. Lots of good glass to work w/ even though spl. is diluted w/ a fair amt. of altered mat'l + xtls.* Good enough for probe → PROBE NEXT

* med + fine fractions combined to make [-100 +325].

DONE FOR PROBE 5/7/91

COLOR 5YR 8/1 DISAGGREGATION

Pinkish gray H_2O Spray

W.S	HCl	HF
✓	60	10

(Benton Spring Ash #7, Dunlap Cyn., NV, 38°24'54"N, 118°3'24"W.) Entire spl. processed.

- Mostly ribbed glass, some platy, some compound. Vesicular shards are hydrated, irregular bubble-type or elongated conical, spindly; a lot of dirty mat'l present → ACID 1ST.

BE EX - Good clean-up!* As described above w/ still a few coated/altered grains. In addtn, hornblende, biotite, etched pyroxene(?), and feldspar present in rel. small #'s. Too small a spl. to continue processing so → PROBE NEXT

- Combined med + fine fractions to make [-100 +325].

DONE FOR PROBE 5/7/91

JB-85-9

COLOR 5 YR 8/1 DISAGGREGATION

Pinkish gray H2O Spray

WS	HCl	HF
/	60	10

(Benton Spring Ash #9, NV, 38°26'48" N, 117°59'38" W.) Entire spl. processed.
- Spl. contains an abundant amt. (~75%) good, strongly vesiculate, hydrated, ribbed &/or webby, and sometimes compound glass. A few microlitic shards were observed. BW's + BWJ's were also few in #. Shards containing vesicles have those that are cylindrical, conical, spindle and irreg. bubble-type. Minerals observed in ash were = feldspar, zircon, biotite, + hornblende. Lithic fragments are sparse, as are altered grains + brown shards. There is a slight to mod. coating on grains. A quick acid wash will render this spl. good enough for probe so → ACIDS 1ST
- Nice clean-up. Spl. is too small to process any further. Submit to CEM at this point for analysis → PROBE NEXT

DONE FOR PROBE 10/1/91

Color: 10 YR 8/2 DISAGGREGATION

Very pale orange H_2O spray

WS	HCl
✓	60

(Benton Spring Ash #11. NV, 38°27'18"N, 117°59'6"W.) Entire spl. processed. Vfg. spl. contains abundant (~90%) good glass. Almost all of the shards contain microcrystallites. However, these vary in amt. from sparse to abundant. Vesicles w/in shards are mostly cylindrical, but spindle-shaped, conical and irreg. bubble-type are present also. Minerals observed incl. feldspar, hornblende, apatite, calcite, + biotite. Lithic fragments are rare. To clean off the slight surficial coating of $CaCO_3$ found on some of the grains, an HCl treatment will be given 1st before submitting spl. to probe → HCl FIRST

– Nice clean-up. All traces of $CaCO_3$ remove. Too small a spl. to process any further → PROBE NEXT

DONE FOR PROBE 10/1/91

189 JB-BS-12

Color 5YR 8/1 — DISAGGREGATION

Pinkish gray — H2O spray

WS	HCl	HF
✓	60	10

(Benton Spring Ash #12. NV, 38° 26' 16" N, 118° 1' 43" W.) Entire spl. processed.
- Another vfg spl. containing ~90% glass: 10% minerals + altered or lithic fragments. Most of the shards are ribbed, a few are platy; bw's + bwj's are rare in either of these morphotypes. Shards w/ vesicles have those that are usu. hydrated tubular, altho' spindle-shaped and irreg. bubble-types are commonly observed. Microxtlites + microphenocrysts are often found in a number of shards also. Minerals observed incl.: feldspar, biotite, magnetite, hornblende, ilmenite & hypersthene. $CaCO_3$ is present as a coating. To clean up → AGIOS 1ST
- Decent acid wash. Still a small amt. of cement on grains but spl. is clean enough for probe analysis. Too small to warrant any further processing. Submit for probe → PROBE NEXT

DONE FOR PROBE 10/1/91

JB-BS-13

COLOR 5YR 8/1
PINKISH GRAY

DISAGGREGATION
H_2O Spray

WS	HCl	HF
✓	60	15

(Benton Spring Ash #13. NV, 38°26' 18" N, 118° 1' 43" W.) Entire spl. processed.
– Vfg spl. containing ~ 90% mostly ribbed shards and ~ 10% minerals, etc.
Platy/blocky shards are also common. Many of these shards are ~~also~~ moderately vesiculate, hydrated, and compound. Microxtllites + phenocrysts are common. The most prevalent vesicle shape is conical, followed by spindle, tubular + irreg. bubble-type. Minerals occurring incl. feldspar biotite, magnetite, poss. ilmenite, and calcite. $CaCO_3$ is found on many of of the surfaces. To remove the carbonate → ACIDS 1ST
– Still a trace of coating left but overall, a good clean-up. There is a fair amt. of good mat'l to work w/. Too small a spl. to continue processing further. Submit to PROBE → PROBE NEXT

DONE FOR PROBE 10/1/91

00002

JB-85-14

COLOR 5YR 8/1

Pinkish gray

DISAGGREGATION

H2O spray

WS	HCl	HF
√	60	10

(Benton Spring Ash #14, NV, 38°26'18"N, 118°1'43" W) Entire spl. processed
- Vfg spl contains ~95% good glass : ~5% misc. xtls, lithic frags., etc. However, Much of this glass is compound and contains xtllites + microphenocrysts. Shards are commonly blocky, some are ribbed and very few are platy. Most are moderately vesiculate, and may or may not be hydrated. The most common vesicle morph is elongated spindle, though irreg. bubble-types are also prevalent. Minerals in spl. incl.: calcite, feldspar, magnetite, biotite, hornblende, and possibly apatite. There is a slight coating of FeO_3 + $CaCO_3$ on the grain surfaces so the 1st step will be acid washes → ACIDS 1ST

— Spl. completely cleaned. Percentages have changed to ~85-90% glass : 15% xtls. Oxyhornblende is the only new mineral observed. Sample can use more processing but not enough residue to warrant extra work - submit to CEM for probe analysis → PROBE NEXT

DONE FOR PROBE 10/1/91

JB-85-15

COLOR 5 YR 8/1
Pinkish gray

DISAGGREGATION
H_2O Spray

WS	HCl	HF
✓	60	10

(Benton Spring Ash #15, NV, 38°26'18" N, 118° 1' 27" W.) Entire spl. processed.
— Vfg spl. w/ mostly blocky, compound shards. Ribbed shards are relatively common tho'. Glass is moderately veciculate; vesicles may or may not be hydrated, and are predominantly spindle-shaped or conical. Irreg. b-t's were present in smaller numbers. Minerals make up ~5-6% of spl. and include mostly feldspars, some biotite and calcite. There is a slight coating on the grains so to remove this → ACIDS 1ST
— Spl. looks better after acid wash. No Δ's in %'s Altho' ilmenite (?) was observed after process. Again spl. is too small to continue w/ further processing; good enough for probe however so → PROBE NEXT

DONE FOR PROBE 10/1/91

000004

JB-BS-16

COLOR 5YR 8/1
Pinkish gray

DISAGGREGATION
H2O spray

WS	HCl	HF
/	60	10

(Benton Spring Ash #16. NV, 38°27'36"N, 117°58'27"W). Entire spl. processed.

- Vfg, moderately to strongly vesiculate, blocky +/or ribbed shards dominate in this ash spl. Vesicles are mostly hydrated and spindle-shaped; a few tubular + irreg. b-t are present also. Additionally, there are sparse conical vesicles. Compound grains were commonly observed as were a few % shards w/ bw's + bwjs. Minerals incl.: feldspars, biotite, hornblende, magnetite, calcite and orthopx.
To remove slight residual coating → ACIDS 1ST

- Nice clean-up. Spl. ratios are ~80% glass : ~15% xtls : ~5% altered grains. There is not enough residue to continue w/ additional processing. However, enough good mat'l to probe so → PROBE NEXT

DONE FOR PROBE - 10/2/91

JB-BS-17

COLOR 5 YR 8/1
Pinkish gray

DISAGGREGATION
H2O spray

WS	HCl	HF
✓	60	10

(Benton Spring Ash #17. NV, 38°27'35"N, 117°58'24" W.) Entire spl. processed - vfg spl. is composed of mostly moderately to strongly vesiculate, ribbed + pumiceous shards. Vesicles are hydrated for the most part and are usu. spindle-shaped. (A few of these "spindles" are arcuate) The remaining vesicles are usu. irreg. bubble-type. A fair # of shards contain xtllites and microphenocrysts. There is a slight surficial coating on many of the grains. Minerals observed: feldspars, calcite, hornblende, magnetite, and biotite. To clean-up spl. → Acids 1st —

his
js.
Thor
gh

DONE FOR PROBE 10/2/91

JB-WA-1

COLOR 5 YR 8/1
Pinkish gray

DISAGGREGATION
H_2O spray

WS	HCl	HF
✓	60	15

(Wassuk Ash #1. Reese River Cyn., NV, 38°48'30"N, 118°47'30"W) Entire spl. processed.

DONE FOR PROBE 10/2/91

SAMPLE: T226-6 J[illegible]-1

PT	BEAM COUNTS	NA COUNTS	9 SD	MG COUNTS	8 SD	AL COUNTS	3 SD	SI COUNTS	7 SD	K COUNTS	2 SD	CA COUNTS	6 SD	TI COUNTS	5 SD	MN COUNTS	1 SD	FE COUNTS	4 SD
1	14582	2516	50	159	13	14138	119	26910	164	8649	93	970	31	26	5	100	10	618	25
2	14589	2673	111	168	6	14923	555	28278	967	9147	352	933	26	37	8	90	7	575	31
3	14594	2627	81	142	13	14857	436	28015	726	9343	358	966	20	27	6	106	8	607	23
4	14600	2611	66	147	12	14824	367	27962	604	9245	309	985	22	21	7	110	9	653	32
5	14604	2616	57	152	10	14816	324	28420	594	9299	282	1016	30	19	7	87	10	626	29
6	14602	2640	53	172	12	14823	293	27985	532	9043	255	1025	34	24	6	102	9	605	26
7	14597	2708	60	171	12	14900	275	27924	485	9131	233	981	31	23	6	88	9	578	27
8	14587	2787	79	193	16	14941	263	27987	450	9119	216	964	29	16	6	91	9	659	31
9	14572	2631	74	157	16	14817	246	27415	455	8746	238	957	29	32	7	87	9	626	29
10	14565	2567	74	163	15	14574	241	26753	557	8972	227	968	27	30	6	106	9	603	28
11	14563	2550	75	164	14	14472	245	27186	557	9005	216	984	26	27	6	91	9	601	27
12	14555	2726	77	129	16	15022	248	27288	545	9069	206	959	25	26	6	81	9	633	26
13	14548	2622	74	184	17	14990	246	27509	524	9185	200	970	24	27	6	101	9	563	29
14	14546	2785	81	158	16	14939	240	27236	516	9031	192	1027	27	28	5	93	9	570	30
15	14550	2618	79	159	16	14671	233	27608	497	9148	187	958	27	31	5	91	9	595	29
16	14551	2637	76	181	16	14617	229	27731	481	9062	180	995	26	26	5	92	8	546	32
17	14548	2676	74	204	19	14905	224	28264	490	9171	176	967	25	36	6	99	8	555	33
18	14548	2639	72	166	18	15000	224	28522	515	9129	171	951	25	18	6	95	8	621	32
19	14547	2600	71	202	20	14838	218	28027	506	9008	167	997	25	22	6	94	8	624	32
20	14547	2628	69	188	20	15041	219	28269	506	9474	185	1181	52	23	6	96	8	526	35

LINES DELETED: 1

AVE. BEAM CURRENT/SEC = 728

DATA REDUCED USING $R-AL: $GL9M

ON SPECIMEN: T226-6 JB-BS-1

$R-AL VERSION 1.0

OXIDE FORM.	WEIGHT% (OXIDE)	STD.DEV. (%)	HOMO. INDEX	FORMULA	K-RATIO	UNKN PEAK (COUNTS)	UNKN BKGD (COUNTS)	COUNTING TIME(SEC)	STD PEAK (COUNTS)	STD BKGD (COUNTS)	COUNTING TIME(SEC)	STANDARD FILENAME
NA2O	3.953	2.84	1.236	0.000	1.02731	2649.5	46.8	20.00	2579.8	46.2	20.00	%RGSC
MGO	0.019	133.04	1.542	0.000	0.00500	168.4	154.9	20.00	2859.9	155.1	20.00	%RGSC
AL2O3	12.482	1.18	1.288	0.000	0.95526	14840.5	249.1	20.00	15523.8	249.1	20.00	%5831
SIO2	~~76.919~~ 74.788	0.86	2.863	0.000	1.04418	27809.3	87.9	20.00	26636.5	87.9	20.00	%5831
K2O	4.604	1.62	1.634	0.000	1.26169	9122.5	139.9	20.00	7267.9	148.4	20.00	%RGSC
CAO	0.527	4.39	1.681	0.000	0.10288	988.7	181.6	20.00	8037.0	192.7	20.00	%RGSC
TIO2	0.060	66.60	1.123	0.000	0.00055	26.2	16.4	20.00	17895.8	23.7	20.00	%TIO2
MNO	0.041	61.10	0.783	0.000	0.00041	95.0	73.7	20.00	52602.4	137.9	20.00	%MN2O
FEO	0.933	5.63	1.478	0.000	0.14576	598.2	102.6	20.00	3509.7	109.8	20.00	%RGSC

97.406

TAL 99.537 NO. OXYGENS = 0 NO. ITERS. = 2 AVE. ATOMIC NO. = 11.18

SAMPLE ID: JB-BS-1 T226-6

Date of Analysis: 6/24/92

Raw Probe Data		Raw Probe Data (FeO to Fe2O3)	Recalculated to 100%	
SiO2	74.788		SiO2	76.70
Al2O3	12.482		Al2O3	12.80
FeO	0.933*1.1113=Fe2O3	1.037	Fe2O3	1.06
MgO	0.019		MgO	0.02
MnO	0.041		MnO	0.04
CaO	0.527		CaO	0.54
TiO2	0.060		TiO2	0.06
Na2o	3.953		Na2o	4.05
K2O	4.604		K2O	4.72
TOTAL(O)	97.406	TOTAL(N) 97.510	TOTAL(R)	99.99

20 Best Matches:

1	0.9966	6/8/91	SS-91-1-1 T232-2
2	0.9903		3-30-82-1, T43-3
3	0.9893	xx/xx/83	KRL82282A(P), T66-6
4	0.9891	5/2/85	WL CORE G 380cm T92-8
5	0.9890	8/7/91	SS-91-1-5 T232-6
6	0.9890	8/6/91	SS-91-1-SU T232-1
7	0.9889	6/13/91	JB-BS-4 T227-1
8	0.9888	8/7/91	SS-91-1-4 T323-5
9	0.9886	10/25/83	KRL-91882G, T66-11
10	0.9883		BO-16
11	0.9883	5/2/85	WL CORE G 370cm T92-7
12	0.9883	1/30/92	FLV-201-TO T249-5
13	0.9882	8/7/91	SS-91-1-Adgss
14	0.9878	6/24/87	OD-ML-65CM T143-7
15	0.9878	10/21/91	JB-BS-11 T241-2
16	0.9875	9/3/88	FLV-64-CS T170-7
17	0.9874	6/22/84	KRL-71082C (590) T58-1
18	0.9873	10/23/85	BL-RSA-4 T112-9
19	0.9860	11/25/86	KRL 860922 A T134-2
20	0.9859	12/20/90	FLV-159-CH T219-6

Elements used in the calculation are:

Na2o
Al2O3
SiO2
K2O
CaO
FeO

***** This sample has been added to the data base *****

Listing of 50 closest matches for COMP. NO. 2820 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 6/25/92

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2820	JB-BS-1 T226-6	6/24/92	76.70	12.80	1.06	0.02	0.04	0.54	0.06	4.05	4.72	99.99	1.0000
2	2557	SS-91-1-1 T232-2	6/8/91	76.57	12.92	1.07	0.02	0.04	0.54	0.06	4.05	4.72	99.99	0.9966
3	435	3-30-82-1, T43-3		76.62	12.93	1.06	0.02	0.05	0.54	0.07	4.13	4.59	100.01	0.9903
4	562	KRL82282A(P), T66-6	xx/xx/83	76.86	12.85	1.05	0.03	0.06	0.54	0.05	3.87	4.70	100.01	0.9893
5	1225	WL CORE G 380cm T92-8	5/2/85	76.82	12.79	1.06	0.04	0.04	0.56	0.06	4.00	4.65	100.02	0.9891
6	2562	SS-91-1-5 T232-6	8/7/91	76.97	12.65	1.08	0.03	0.04	0.54	0.07	3.98	4.65	100.01	0.9890
7	2558	SS-91-1-SU T232-1	8/6/91	76.74	12.86	1.09	0.04	0.04	0.54	0.05	3.95	4.68	99.99	0.9890
8	2567	JB-BS-4 T227-1	6/13/91	76.75	12.83	1.04	0.03	0.06	0.55	0.06	3.95	4.73	100.00	0.9889
9	2561	SS-91-1-4 T323-5	8/7/91	77.02	12.63	1.06	0.02	0.04	0.53	0.06	4.00	4.63	99.99	0.9888
10	682	KRL-91882G, T66-11	10/25/83	76.91	12.76	1.07	0.03	0.06	0.54	0.07	3.87	4.68	99.99	0.9886
11	760	BO-16		76.59	12.92	1.11	0.03	0.03	0.54	0.07	4.00	4.71	100.00	0.9883
12	1224	WL CORE G 370cm T92-7	5/2/85	76.83	12.82	1.09	0.04	0.04	0.54	0.05	3.95	4.65	100.01	0.9883
13	2717	FLV-201-TO T249-5	1/30/92	76.85	12.77	1.10	0.02	0.04	0.54	0.04	3.99	4.65	100.00	0.9883
14	2563	SS-91-1-Adgss	8/7/91	76.73	12.85	1.04	0.03	0.05	0.53	0.07	3.95	4.74	99.99	0.9882
15	1806	OD-ML-65CM T143-7	6/24/87	76.81	12.80	1.05	0.03	0.05	0.56	0.05	3.96	4.70	100.01	0.9878
16	2638	JB-BS-11 T241-2	10/21/91	76.55	12.80	1.10	0.02	0.08	0.54	0.06	4.16	4.68	99.99	0.9878
17	2060	FLV-64-CS T170-7	9/3/88	76.71	12.87	1.11	0.02	0.04	0.54	0.04	4.02	4.64	99.99	0.9875
18	1025	KRL-71082C (590) T58-1	6/22/84	76.91	12.71	1.08	0.02	0.00	0.53	0.05	3.95	4.74	99.99	0.9874
19	1418	BL-RSA-4 T112-9	10/23/85	76.83	12.79	1.08	0.04	0.04	0.55	0.06	3.96	4.65	100.00	0.9873
20	1680	KRL 860922 A T134-2	11/25/86	76.94	12.75	1.07	0.03	0.04	0.55	0.06	3.91	4.65	100.00	0.9860
21	2496	FLV-159-CH T219-6	12/20/90	77.01	12.76	1.08	0.03	0.03	0.54	0.05	3.94	4.57	100.01	0.9859
22	2570	JB-BS-7 T227-4	6/13/91	76.73	12.89	1.10	0.03	0.05	0.54	0.06	3.91	4.69	100.00	0.9859
23	2821	JB-BS-2 T226-7	6/24/92	76.56	12.91	1.12	0.02	0.04	0.53	0.08	4.04	4.72	100.02	0.9858
24	2716	FLV-200-LC T249-4	1/30/92	76.77	12.80	1.11	0.02	0.04	0.53	0.06	4.01	4.67	100.01	0.9858
25	2560	SS-91-1-3 t232-4	8/7/91	77.08	12.64	1.06	0.02	0.05	0.53	0.06	3.92	4.64	100.00	0.9858
26	681	KRL-91882A', T66-8	10/25/83	76.79	12.83	1.10	0.03	0.06	0.54	0.07	3.91	4.67	100.00	0.9858
27	1141	WL-2-3-1.94M T85-1	12/4/84	76.97	12.65	1.05	0.03	0.05	0.56	0.05	4.00	4.66	100.02	0.9858
28	2795	FLV-209-BC T254-6	4/14/92	76.36	13.11	1.09	0.03	0.06	0.55	0.07	4.01	4.73	100.01	0.9857
29	1034	WL 2-2-2.64, T78-7	08/18/84	77.06	12.62	1.06	0.03	0.05	0.55	0.06	3.86	4.71	100.00	0.9857
30	2568	JB-BS-5 T227-2	6/13/91	76.69	12.91	1.08	0.02	0.05	0.55	0.09	3.90	4.70	99.99	0.9856
31	431	YOS-1, T13-1		76.61	12.93	1.12	0.03	0.05	0.54	0.07	4.03	4.64	100.02	0.9856
32	1186	WALKER LAKE CORE G 380CM t89-1	2/28/85	76.98	12.79	1.08	0.02	0.05	0.54	0.05	3.86	4.64	100.01	0.9855
33	2643	JB-BS-16 T241-7	10/21/91	76.97	12.59	1.04	0.02	0.08	0.54	0.05	4.13	4.58	100.00	0.9854
34	2639	JB-BS-12 T241-3	10/21/91	76.51	12.85	1.11	0.03	0.08	0.54	0.05	4.16	4.67	100.00	0.9853
35	1142	WL-2-3-2.14M T85-2	12/4/84	76.97	12.69	1.06	0.03	0.05	0.56	0.06	3.96	4.63	100.01	0.9851
36	1310	WL 8-2B 172-174.5CM T99-10	7/1/85	76.90	12.74	1.05	0.02	0.05	0.56	0.07	3.91	4.71	100.01	0.9851
37	2236	SL-115.5 T186-3	2/28/89	76.76	12.91	1.07	0.03	0.04	0.55	0.06	3.84	4.73	99.99	0.9849
38	1409	KRL 82182 (A1) (599) T112-1	10/22/85	76.60	12.87	1.11	0.04	0.04	0.55	0.06	4.08	4.65	100.00	0.9846
39	2642	JB-BS-15 T241-6	10/21/91	76.59	12.83	1.08	0.03	0.07	0.54	0.04	4.23	4.59	100.00	0.9846
40	1948	WL-4-4 (12.25M) T162-2	5/14/88	76.87	12.86	1.09	0.02	0.05	0.54	0.06	3.80	4.72	100.01	0.9840
41	2493	FLV-156-SS T219-3	12/20/90	76.64	13.06	1.09	0.03	0.04	0.54	0.05	3.94	4.62	100.01	0.9839
42	2559	SS-91-1-2 T232-3	8/7/91	77.11	12.63	1.03	0.03	0.05	0.54	0.06	3.89	4.67	100.01	0.9838
43	570	KRL91982D, T66-10	xx/xx/83	76.81	12.89	1.08	0.03	0.05	0.53	0.06	3.90	4.65	100.00	0.9838
44	566	KRL91882B, T64-12	09/06/83	76.81	12.82	1.10	0.01	0.05	0.53	0.08	3.91	4.69	100.00	0.9835
45	680	KRL-82282B, T54-4	xx//xx/x	76.99	12.71	1.08	0.02	0.06	0.53	0.04	3.86	4.70	99.99	0.9835
46	1972	WL-4-58 (144.77m) T164-1	5/21/88	76.73	12.71	1.15	0.00	0.03	0.54	0.12	4.02	4.69	99.99	0.9834
47	1419	BL-RSA-5 T112-10	10/23/85	76.98	12.65	1.09	0.04	0.04	0.53	0.05	3.93	4.68	99.99	0.9834
48	2585	FLV-168-TC T229-3	6/14/91	76.89	12.90	1.05	0.03	0.05	0.54	0.06	3.74	4.74	100.00	0.9833
49	2718	FLV-202-D T249-6	1/30/92	76.79	12.79	1.06	0.02	0.04	0.58	0.07	3.96	4.68	99.99	0.9831
50	1757	OD-ML-10-405 CM T139-14	5/28/87	76.99	12.77	1.05	0.03	0.06	0.53	0.09	3.80	4.69	100.01	0.9830

SAMPLE: T226-7 JB-BS-2

	BEAM		9	MG	8	AL	3	SI	7	K	2	C.	6	TI	5	MN	1	FE	4
PT	COUNTS	COUNTS	SD	COUNTS	SD	COUNTS	SD	COUNTS	SD	COUNTS	SD	COUNTS	SD	COUNTS	SD	COUNTS	SD	COUNTS	SD
1	14564	2562	51	151	12	15320	124	27025	164	8959	95	1028	32	27	5	96	10	652	26
2	14563	2758	138	157	4	15294	19	27914	628	9064	74	932	68	24	2	108	9	652	0
3	14573	2672	98	181	15	15286	18	27290	456	9151	96	993	49	28	2	89	10	540	65
4	14577	2672	80	190	18	15043	129	27876	439	9363	172	988	40	31	3	96	8	602	53
5	14584	2670	69	150	18	14781	232	27748	393	9038	155	990	35	32	3	94	7	694	59
6	14591	2767	74	190	19	15100	208	27972	388	9195	142	966	32	24	3	88	7	596	54
7	14601	2735	71	162	18	15156	190	27985	378	9500	191	997	30	36	4	117	11	658	52
8	14602	2588	75	159	17	14718	231	27415	363	9147	177	941	32	30	4	101	10	654	49
9	14595	52	878	168	16	507	****	38607	****	142	****	170	271	16	6	62	15	92	185
10	14600	2612	831	160	15	15009	****	27732	****	9240	****	895	256	25	6	84	15	531	175
11	14593	2633	791	168	14	15078	****	28379	****	9219	****	989	245	34	6	90	14	636	167
12	14585	2708	759	171	14	15051	****	28402	****	9112	****	1012	235	38	6	108	14	639	161
13	14574	2649	729	166	13	14835	****	28608	****	9134	****	966	226	25	6	97	14	626	154
14	14564	2685	702	180	13	15089	****	28348	****	9198	****	998	218	19	6	87	13	601	149
15	14564	2634	678	162	13	14918	****	27903	****	9234	****	953	211	29	6	85	13	639	144
16	14555	2683	657	152	13	15073	****	27931	****	9216	****	959	204	30	6	89	13	641	140
17	14549	2644	637	187	13	15217	****	27790	****	8959	****	991	198	19	6	73	13	647	136
18	14541	2543	618	171	13	15171	****	28471	****	9036	****	973	192	23	6	85	13	619	132
19	14551	2717	602	167	13	15211	****	27944	****	9179	****	963	187	29	6	99	13	674	129
20	14544	2303	588	184	13	14617	****	26647	****	9323	****	988	182	27	6	105	13	432	131

LINES DELETED:

LINES DELETED: 2 9 20

AVE. BEAM CURRENT/SEC = 729

DATA REDUCED USING $B-AL: *GL9M

ON SPECIMEN: T226-7 JB-BS-2

$B-AL VERSION 1.0

OXIDE FORM.	WEIGHT% (OXIDE)	STD.DEV. (%)	HOMO. INDEX	FORMULA	K-RATIO	UNKN PEAK (COUNTS)	UNKN BKGD (COUNTS)	COUNTING TIME(SEC)	STD PEAK (COUNTS)	STD BKGD (COUNTS)	COUNTING TIME(SEC)	STANDARD FILENAME
NA2O	3.962	2.84	1.154	0.000	1.03044	2657.5	46.7	20.00	2579.8	46.2	20.00	%RGSC
MGO	0.019	130.45	1.001	0.000	0.00510	168.7	154.9	20.00	2859.9	155.1	20.00	%RGSC
AL2O3	12.665	1.17	1.380	0.000	0.96975	15062.2	249.5	20.00	15523.8	249.1	20.00	%5831
SIO2	77.270	0.86	2.567	0.000	1.04874	27930.5	87.9	20.00	26636.5	87.9	20.00	%5831
K2O	4.628	1.61	1.408	0.000	1.26822	9169.3	140.2	20.00	7267.9	148.4	20.00	%RGSC
CAO	0.519	4.44	0.978	0.000	0.10129	976.6	182.0	20.00	8037.0	192.7	20.00	%RGSC
TIO2	0.074	55.82	1.008	0.000	0.00067	28.5	16.5	20.00	17895.8	23.7	20.00	%TIO2
MNO	0.037	67.68	1.059	0.000	0.00036	93.0	73.9	20.00	52602.4	137.9	20.00	%MN2O
FEO	0.985	5.45	1.707	0.000	0.15397	626.4	102.9	20.00	3509.7	109.8	20.00	%RGSC

SAMPLE ID: JB-BS-2 T226-7 Date of Analysis: 6/24/92

Raw Probe Data		Raw Probe Data (FeO to Fe2O3)	Recalculated to 100%	
SiO2	75.129		SiO2	76.56
Al2O3	12.665		Al2O3	12.91
FeO	0.985*1.1113=Fe2O3	1.095	Fe2O3	1.12
MgO	0.019		MgO	0.02
MnO	0.037		MnO	0.04
CaO	0.519		CaO	0.53
TiO2	0.074		TiO2	0.08
Na2o	3.962		Na2o	4.04
K2O	4.628		K2O	4.72
TOTAL(O) 98.018		TOTAL(N) 98.128	TOTAL(R)	100.02

20 Best Matches:

1	0.9936	1/30/92	FLV-200-LC T249-4
2	0.9933		YOS-1, T13-1
3	0.9932		BO-16
4	0.9912	10/25/83	KRL82282A, T66-5
5	0.9909	9/3/88	FLV-64-CS T170-7
6	0.9907		DR-64
7	0.9907	1/30/92	FLV-199-BC T249-3
8	0.9889	6/8/91	SS-91-1-1 T232-2
9	0.9889	09/06/83	KRL91882B, T64-12
10	0.9889		HC-10
11	0.9886		BO-11
12	0.9885	10/23/85	BL-RSA-2 T112-7
13	0.9883		LD-12, T3,4
14	0.9880	10/21/91	JB-BS-12 T241-3
15	0.9877	10/22/85	KRL 82182 (A1) (599) T112-1
16	0.9877	5/21/88	WL-4-58 (144.77m) T164-1
17	0.9875		LD-12
18	0.9871		GS-32
19	0.9870	1/30/92	FLV-201-TO T249-5
20	0.9869	6/13/91	JB-BS-7 T227-4

Elements used in the calculation are:

Na2o
Al2O3
SiO2
K2O
CaO
FeO

***** This sample has been added to the data base *****

Listing of 50 closest matches for COMP. NO. 2821 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 6/25/92

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2821	JB-BS-2 T226-7	6/24/92	76.56	12.91	1.12	0.02	0.04	0.53	0.08	4.04	4.72	100.02	1.0000
2	2716	FLV-200-LC T249-4	1/30/92	76.77	12.80	1.11	0.02	0.04	0.53	0.06	4.01	4.67	100.01	0.9936
3	431	YOS-1, T13-1		76.61	12.93	1.12	0.03	0.05	0.54	0.07	4.03	4.64	100.02	0.9933
4	760	BO-16		76.59	12.92	1.11	0.03	0.03	0.54	0.07	4.00	4.71	100.00	0.9932
5	561	KRL82282A, T66-5	10/25/83	76.71	12.88	1.12	0.04	0.05	0.52	0.06	3.98	4.65	100.01	0.9912
6	2060	FLV-64-CS T170-7	9/3/88	76.71	12.87	1.11	0.02	0.04	0.54	0.04	4.02	4.64	99.99	0.9909
7	952	DR-64		76.57	13.01	1.13	0.03	0.05	0.53	0.07	3.90	4.70	99.99	0.9907
8	2721	FLV-199-BC T249-3	1/30/92	76.88	12.71	1.13	0.02	0.03	0.53	0.06	3.98	4.66	100.00	0.9907
9	2557	SS-91-1-1 T232-2	6/8/91	76.57	12.92	1.07	0.02	0.04	0.54	0.06	4.05	4.72	99.99	0.9889
10	566	KRL91882B, T64-12	09/06/83	76.81	12.82	1.10	0.01	0.05	0.53	0.08	3.91	4.69	100.00	0.9889
11	750	HC-10		76.27	13.21	1.15	0.03	0.03	0.53	0.07	4.00	4.70	99.99	0.9889
12	758	BO-11		76.35	13.11	1.12	0.03	0.04	0.55	0.09	4.00	4.70	99.99	0.9886
13	1416	BL-RSA-2 T112-7	10/23/85	76.78	12.85	1.12	0.04	0.03	0.54	0.06	3.90	4.68	100.00	0.9885
14	192	LD-12, T3,4		76.94	12.70	1.12	0.03	0.07	0.53	0.07	3.91	4.64	100.01	0.9883
15	2639	JB-BS-12 T241-3	10/21/91	76.51	12.85	1.11	0.03	0.08	0.54	0.05	4.16	4.67	100.00	0.9880
16	1409	KRL 82182 (A1) (599) T112-1	10/22/85	76.60	12.87	1.11	0.04	0.04	0.55	0.06	4.08	4.65	100.00	0.9877
17	1972	WL-4-58 (144.77m) T164-1	5/21/88	76.73	12.71	1.15	0.00	0.03	0.54	0.12	4.02	4.69	99.99	0.9877
18	701	LD-12		76.94	12.72	1.12	0.03	0.07	0.53	0.07	3.91	4.61	100.00	0.9875
19	788	GS-32		76.58	12.90	1.13	0.03	0.04	0.56	0.06	4.00	4.70	100.00	0.9871
20	2717	FLV-201-TO T249-5	1/30/92	76.85	12.77	1.10	0.02	0.04	0.54	0.04	3.99	4.65	100.00	0.9870
21	2570	JB-BS-7 T227-4	6/13/91	76.73	12.89	1.10	0.03	0.05	0.54	0.06	3.91	4.69	100.00	0.9869
22	1240	WL 4-2 3.29m T93-9	5/2/85	76.75	12.79	1.13	0.03	0.04	0.55	0.05	4.02	4.64	100.00	0.9869
23	560	KRL82282, T66-4	xx/xx/83	76.74	12.90	1.13	0.02	0.06	0.54	0.06	3.87	4.68	100.00	0.9865
24	1025	KRL-71082C (590) T58-1	6/22/84	76.91	12.71	1.08	0.02	0.00	0.53	0.05	3.95	4.74	99.99	0.9863
25	2558	SS-91-1-SU T232-1	8/6/91	76.74	12.86	1.09	0.04	0.04	0.54	0.05	3.95	4.68	99.99	0.9863
26	2638	JB-BS-11 T241-2	10/21/91	76.55	12.80	1.10	0.02	0.08	0.54	0.06	4.16	4.68	99.99	0.9863
27	972	DR-86		76.74	12.92	1.15	0.03	0.04	0.53	0.07	3.91	4.61	100.00	0.9859
28	2820	JB-BS-1 T226-6	6/24/92	76.70	12.80	1.06	0.02	0.04	0.54	0.06	4.05	4.72	99.99	0.9858
29	567	KRL91882-K-1, T64-13	09/06/83	76.93	12.82	1.11	0.01	0.05	0.53	0.07	3.88	4.60	100.00	0.9857
30	1419	BL-RSA-5 T112-10	10/23/85	76.98	12.65	1.09	0.04	0.04	0.53	0.05	3.93	4.68	99.99	0.9853
31	681	KRL-91882A', T66-8	10/25/83	76.79	12.83	1.10	0.03	0.06	0.54	0.07	3.91	4.67	100.00	0.9853
32	570	KRL91982D, T66-10	xx/xx/83	76.81	12.89	1.08	0.03	0.05	0.53	0.06	3.90	4.65	100.00	0.9850
33	2795	FLV-209-BC T254-6	4/14/92	76.36	13.11	1.09	0.03	0.06	0.55	0.07	4.01	4.73	100.01	0.9849
34	1224	WL CORE G 370cm T92-7	5/2/85	76.83	12.82	1.09	0.04	0.04	0.54	0.05	3.95	4.65	100.01	0.9845
35	757	BO-7		76.35	13.23	1.14	0.03	0.03	0.52	0.09	4.01	4.61	100.01	0.9843
36	783	GS-27		76.74	12.92	1.12	0.03	0.05	0.55	0.07	3.91	4.61	100.00	0.9842
37	753	BO-1		76.45	13.11	1.09	0.03	0.04	0.51	0.07	4.00	4.70	100.00	0.9841
38	1241	WL 4-2 3.31m T93-10	5/2/85	76.69	12.91	1.14	0.04	0.04	0.55	0.06	3.92	4.67	100.02	0.9840
39	971	DR-85		76.75	12.93	1.14	0.03	0.05	0.52	0.07	3.91	4.61	100.01	0.9840
40	2380	FLV-131-FC T203-4	4/16/90	77.18	12.43	1.12	0.01	0.04	0.54	0.06	3.93	4.68	99.99	0.9834
41	1029	KRL-99182K-1P (595) T58-6	6/22/84	76.79	12.72	1.13	0.03	0.00	0.54	0.05	3.91	4.83	100.00	0.9833
42	2493	FLV-156-SS T219-3	12/20/90	76.64	13.06	1.09	0.03	0.04	0.54	0.05	3.94	4.62	100.01	0.9827
43	2563	SS-91-1-Adgss	8/7/91	76.73	12.85	1.04	0.03	0.05	0.53	0.07	3.95	4.74	99.99	0.9825
44	2235	SL-103 T186-2	2/28/89	76.68	12.95	1.10	0.03	0.04	0.55	0.07	3.88	4.69	99.99	0.9825
45	1223	WL CORE G 180cm T92-6	5/2/85	76.64	12.88	1.11	0.04	0.05	0.57	0.06	3.99	4.67	100.01	0.9824
46	680	KRL-82282B, T54-4	xx//xx/x	76.99	12.71	1.08	0.02	0.06	0.53	0.04	3.86	4.70	99.99	0.9824
47	437	6A, T35-7		75.81	12.97	1.11	0.03	0.03	0.52	0.06	3.92	4.56	99.01	0.9824
48	564	KRL82782A, T64-11	09/06/83	76.99	12.75	1.09	0.01	0.06	0.53	0.08	3.90	4.59	100.00	0.9822
49	2562	SS-91-1-5 T232-6	8/7/91	76.97	12.65	1.08	0.03	0.04	0.54	0.07	3.98	4.65	100.01	0.9818
50	571	KRL91982F, T56-5	07/01/83	76.61	12.89	1.14	0.03	0.05	0.55	0.05	4.12	4.56	100.00	0.9818

SAMPLE: T226-8 JR-BS-3

PT	BEAM COUNTS	NA COUNTS	9 SD	MG COUNTS	8 SD	AL COUNTS	3 SD	SI COUNTS	7 SD	K COUNTS	2 SD	CA COUNTS	6 SD	TI COUNTS	5 SD	MN COUNTS	1 SD	FE COUNTS	4 SD
1	14542	2318	48	180	13	14766	122	26450	163	9272	96	1358	37	33	6	88	9	459	21
2	14551	2319	0	218	27	15056	205	27215	541	9366	66	1367	6	25	6	84	3	531	52
3	14560	2215	60	227	25	14877	146	27058	404	9979	384	1381	11	31	4	92	4	472	39
4	14572	2289	49	181	25	14335	307	27830	567	9199	357	812	279	29	3	87	3	464	34
5	14571	2328	46	210	22	15218	336	26912	501	9398	310	1337	246	27	3	81	4	506	31
6	14571	2334	45	224	21	15235	339	27176	450	9596	284	1398	228	30	3	104	8	495	28
7	14545	2298	41	194	20	14833	311	26539	463	9509	260	1348	210	26	3	109	10	454	29
8	14539	2399	51	227	20	14970	289	26781	438	9306	248	1337	195	24	3	89	10	497	27

LINES DELETED: 4

AVE. BEAM CURRENT/SEC = 728

DATA REDUCED USING $B-AL: *GL9M

ON SPECIMEN: T226-8 JR-BS-3

$B-AL VERSION 1.0

OXIDE FORM.	WEIGHT% (OXIDE)	STD.DEV. (%)	HOMO. INDEX	FORMULA	K-RATIO	UNKN PEAK (COUNTS)	UNKN BKGD (COUNTS)	COUNTING TIME(SEC)	STD PEAK (COUNTS)	STD BKGD (COUNTS)	COUNTING TIME(SEC)	STANDARD FILENAME
NA2O	3.466	2.95	1.136	0.000	0.89556	2315.8	46.8	20.00	2579.8	46.2	20.00	%RGSC
MGO	0.079	33.82	1.254	0.000	0.02096	211.6	154.9	20.00	2859.9	155.1	20.00	%RGSC
AL2O3	12.627	1.17	1.508	0.000	0.96535	14993.4	248.1	20.00	15523.8	249.1	20.00	%5831
SIO2	74.429	0.87	1.835	0.000	1.00902	26876.0	87.9	20.00	26636.5	87.9	20.00	%5831
K2O	4.788	1.60	2.500	0.000	1.31331	9489.2	139.1	20.00	7267.9	148.4	20.00	%RGSC
CAO	0.769	3.52	0.618	0.000	0.15047	1360.9	180.6	20.00	8037.0	192.7	20.00	%RGSC
TIO2	0.074	55.68	0.639	0.000	0.00067	28.3	16.3	20.00	17895.8	23.7	20.00	%TIO2
MNO	0.037	66.45	1.062	0.000	0.00037	92.6	73.2	20.00	52602.4	137.9	20.00	%MN2O
FEO	0.727	6.54	1.254	0.000	0.11351	487.9	101.9	20.00	3509.7	109.8	20.00	%RGSC

TOTAL 96.995 NO. OXYGENS = 0 NO. ITERS. = 2 AVE. ATOMIC NO. = 11.12

24-JUN-92 14:15:23

SAMPLE ID: JB-BS-3 T226-8 Date of Analysis: 6/24/92

Raw Probe Data		Raw Probe Data (FeO to Fe2O3)		Recalculated to 100%	
SiO2	72.367			SiO2	76.16
Al2O3	12.627			Al2O3	13.29
FeO	0.727*1.1113=Fe2O3		0.808	Fe2O3	0.85
MgO	0.079			MgO	0.08
MnO	0.037			MnO	0.04
CaO	0.769			CaO	0.81
TiO2	0.074			TiO2	0.08
Na2o	3.466			Na2o	3.65
K2O	4.788			K2O	5.04
TOTAL(O)	94.933	TOTAL(N)	95.014	TOTAL(R)	100.00

20 Best Matches:

1	0.9886	12/3/84	WL-5-19-0.27M T84-13
2	0.9857		DR-14
3	0.9843	7/2/91	EL-1-M T230-5
4	0.9824	5/2/85	WL 3-7 17.51m T93-8
5	0.9824	6/14/91	FLV-176-TC T229-8
6	0.9806	8/18/86	WLC-85-2 (13.65M) T128-2
7	0.9750	07/01/83	KRL71082(CII), T56-3
8	0.9748	08/18/84	WL 3-7-2.66
9	0.9746	5/15/88	WL-4-27 (69.77M) T163-9
10	0.9721	5/22/88	WL-5-16 (73.40m) T164-12
11	0.9712	5/15/88	WL-4-27 (68.59M) T163-8
12	0.9688	8/18/86	WLC-85-2 (11.34M) T128-1
13	0.9681	5/15/88	WL-4-26 (66.50M) T163-7
14	0.9678	5/22/88	WL-5-16 (73.62m) T164-14
15	0.9678	08/18/84	WL 4-26-3.06, T78-12
16	0.9670	3/6/86	6VI84-1-5.5M T117-13
17	0.9662	11/25/83	KRL71082F, T55-5
18	0.9659	6/22/84	KRL-71082 (II-4) (593) T58-4
19	0.9638		DR-12
20	0.9632	07/18/84	DSDP 36-10-2 SSA, T78-5

Elements used in the calculation are:

Na2o
Al2O3
SiO2
K2O
CaO
FeO

***** This sample has been added to the data base *****

Listing of 50 closest matches for COMP. NO. 2822 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 6/25/92

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2822	JB-BS-3 T226-8	6/24/92	76.16	13.29	0.85	0.08	0.04	0.81	0.08	3.65	5.04	100.00	1.0000
2	1137	WL-5-19-0.27M T84-13	12/3/84	76.42	13.19	0.85	0.07	0.05	0.82	0.09	3.67	4.84	100.00	0.9886
3	909	DR-14		76.37	13.21	0.87	0.08	0.06	0.80	0.10	3.60	4.90	99.99	0.9857
4	2595	EL-1-M T230-5	7/2/91	76.61	13.14	0.85	0.06	0.04	0.79	0.08	3.64	4.79	100.00	0.9843
5	1239	WL 3-7 17.51m T93-8	5/2/85	76.22	13.30	0.89	0.10	0.03	0.83	0.10	3.61	4.92	100.00	0.9824
6	2590	FLV-176-TC T229-8	6/14/91	76.53	13.22	0.85	0.07	0.06	0.82	0.10	3.44	4.91	100.00	0.9824
7	1571	WLC-85-2 (13.65M) T128-2	8/18/86	76.71	13.06	0.84	0.06	0.06	0.81	0.09	3.43	4.94	100.00	0.9806
8	546	KRL71082(CII), T56-3	07/01/83	76.09	13.39	0.90	0.08	0.03	0.83	0.09	3.74	4.85	100.00	0.9750
9	1037	WL 3-7-2.66	08/18/84	76.74	13.00	0.82	0.06	0.03	0.83	0.08	3.51	4.92	99.99	0.9748
10	1965	WL-4-27 (69.77M) T163-9	5/15/88	76.69	13.07	0.87	0.09	0.05	0.80	0.11	3.38	4.94	100.00	0.9746
11	1983	WL-5-16 (73.40m) T164-12	5/22/88	76.37	13.29	0.81	0.05	0.04	0.75	0.10	3.70	4.89	100.00	0.9721
12	1964	WL-4-27 (68.59M) T163-8	5/15/88	76.85	13.06	0.85	0.04	0.06	0.75	0.06	3.64	4.69	100.00	0.9712
13	1570	WLC-85-2 (11.34M) T128-1	8/18/86	76.89	12.97	0.84	0.04	0.05	0.75	0.08	3.54	4.85	100.01	0.9688
14	1963	WL-4-26 (66.50M) T163-7	5/15/88	76.67	13.24	0.84	0.04	0.04	0.73	0.07	3.66	4.70	99.99	0.9681
15	1985	WL-5-16 (73.62m) T164-14	5/22/88	76.34	13.31	0.83	0.06	0.03	0.73	0.10	3.47	5.13	100.00	0.9678
16	1039	WL 4-26-3.06, T78-12	08/18/84	76.97	12.78	0.86	0.04	0.05	0.73	0.06	3.65	4.87	100.01	0.9678
17	1480	6VI84-1-5.5M T117-13	3/6/86	76.73	13.08	0.87	0.06	0.05	0.74	0.08	3.55	4.85	100.01	0.9670
18	549	KRL71082F, T55-5	11/25/83	76.59	13.26	0.86	0.05	0.05	0.71	0.07	3.59	4.82	100.00	0.9662
19	1033	KRL-71082 (II-4) (593) T58-4	6/22/84	76.44	13.18	0.88	0.05	0.00	0.70	0.07	3.69	4.98	99.99	0.9659
20	907	DR-12		76.27	13.53	0.73	0.09	0.03	0.81	0.12	3.61	4.81	100.00	0.9638
21	1045	DSDP 36-10-2 SSA, T78-5	07/18/84	76.90	12.80	0.85	0.04	0.04	0.72	0.09	3.73	4.83	100.00	0.9632
22	1966	WL-4-30 (78.72M) T163-10	5/15/88	76.62	13.09	0.89	0.09	0.05	0.87	0.09	3.49	4.82	100.01	0.9629
23	1242	WL 4-26 66.33m T93-11	5/2/85	76.65	13.16	0.87	0.05	0.04	0.71	0.05	3.69	4.78	100.00	0.9625
24	696	RSCS2		77.33	12.80	0.89	0.01	0.00	0.81	0.05	3.50	4.60	99.99	0.9624
25	1243	WL 4-26 66.40m T93-12	5/2/85	76.71	13.12	0.83	0.05	0.04	0.71	0.06	3.70	4.78	100.00	0.9613
26	1958	WL-4-17 (39.81M) T162-12	5/15/88	76.91	12.98	0.84	0.04	0.05	0.72	0.05	3.70	4.70	99.99	0.9605
27	1040	WL 4-30-28M, T78-13	07/18/84	76.80	12.82	0.92	0.07	0.03	0.85	0.10	3.44	4.97	100.00	0.9603
28	1982	WL-5-13 (64.49m) T164-11	5/22/88	76.59	13.19	0.83	0.03	0.05	0.70	0.07	3.73	4.80	99.99	0.9597
29	1262	*WL 5-19 78.91m	5/29/85	77.29	12.54	0.79	0.06	0.05	0.84	0.08	3.62	4.73	100.00	0.9588
30	1979	WL-5-12 (61.28m) T164-8	5/22/88	76.51	13.26	0.87	0.04	0.05	0.70	0.07	3.76	4.75	100.01	0.9579
31	1261	*WL 4-30 78.77m t95-10	5/29/85	77.12	12.57	0.89	0.08	0.04	0.86	0.11	3.50	4.83	100.00	0.9579
32	1260	*WL 4-26 6a7.04m t95-7	5/29/85	77.27	12.59	0.84	0.04	0.05	0.74	0.06	3.73	4.70	100.02	0.9576
33	1136	WL-5-13-1.11M T84-12	12/3/84	76.59	13.09	0.89	0.04	0.06	0.71	0.07	3.74	4.82	100.01	0.9572
34	183	KRL7982-19B, T45-4		76.37	13.29	0.83	0.04	0.02	0.71	0.07	3.88	4.79	100.00	0.9569
35	1569	WLC-85-2 (10.65M) T127-14	8/18/86	76.61	13.40	0.87	0.03	0.06	0.70	0.05	3.52	4.76	100.00	0.9560
36	1257	*WL 4-26 66.68m	5/29/85	76.78	12.82	0.88	0.05	0.05	0.75	0.07	3.86	4.73	99.99	0.9554
37	2569	JB-BS-6 T227-3	6/13/91	76.39	13.29	0.83	0.04	0.06	0.71	0.06	3.88	4.74	100.00	0.9552
38	1300	WL 5-13 64.51M T99-15	07/01/85	77.18	12.74	0.88	0.04	0.06	0.73	0.07	3.53	4.78	100.01	0.9547
39	454	679-340, T31-2		76.57	13.20	0.84	0.03	0.03	0.70	0.07	3.84	4.71	99.99	0.9542
40	1977	WL-5-7 (50.91m) T164-6	5/21/88	76.58	13.13	0.93	0.04	0.05	0.71	0.08	3.54	4.94	100.00	0.9538
41	1258	*WL 4-26 66.79m t95-5	5/29/85	76.94	12.84	0.81	0.05	0.04	0.73	0.07	3.77	4.75	100.00	0.9535
42	545	KRL7982-17, T50-4	02/01/83	76.61	13.14	0.87	0.03	0.04	0.68	0.05	3.77	4.79	99.98	0.9530
43	1238	WL 2-7 21.02m T93-7	5/1/85	76.85	13.15	0.89	0.05	0.04	0.71	0.05	3.48	4.78	100.00	0.9523
44	1962	WL-4-25 (62.76M) T164-6	5/15/88	76.91	12.91	0.79	0.05	0.05	0.70	0.09	3.62	4.87	99.99	0.9522
45	495	IIB, T32-1		76.58	13.16	0.87	0.03	0.06	0.71	0.05	3.87	4.68	100.01	0.9517
46	1259	*WL 4-26 66.87m t95-6	5/29/85	77.01	12.69	0.88	0.04	0.04	0.73	0.09	3.81	4.71	100.00	0.9506
47	1956	WL-4-13 (33.32M) T162-10	5/15/88	76.98	12.91	0.86	0.04	0.04	0.65	0.06	3.60	4.85	99.99	0.9500
48	2644	JB-BS-17 T241-8	10/21/91	76.22	13.28	0.84	0.04	0.08	0.70	0.05	4.04	4.76	100.01	0.9498
49	1959	WL-4-18 (43.53M) T162-13	5/15/88	77.01	12.97	0.82	0.04	0.04	0.67	0.06	3.63	4.77	100.01	0.9496
50	1951	WL-4-8B (21.275M) T162-5	5/14/88	76.67	13.13	0.82	0.06	0.07	0.65	0.12	3.47	5.01	100.00	0.9489

SAMPLE: T227-1 JB-BS-4

PT	BEAM COUNTS	NA COUNTS	9 SD	MG COUNTS	8 SD	AL COUNTS	3 SD	SI COUNTS	7 SD	K COUNTS	2 SD	CA COUNTS	6 SD	TI COUNTS	5 SD	MN COUNTS	1 SD	FE COUNTS	4 SD
1	13535	2663	52	144	12	14337	120	25821	161	9458	92	916	30	18	4	106	10	596	24
2	13538	2725	43	150	4	14289	34	26114	207	8513	39	966	35	29	8	110	3	595	1
3	13536	2449	145	149	3	13483	480	24604	801	7878	352	872	47	27	6	102	4	553	25
4	13548	2570	120	168	10	14493	454	26183	734	9830	397	937	40	33	6	126	10	496	47
5	13547	2513	111	177	14	14330	401	26395	712	9178	483	1039	62	23	6	76	18	447	65
6	13544	4187	662	152	13	29858	****	18422	****	955	****	13854	****	11	8	87	18	219	143
7	13538	44	****	131	15	443	****	36553	****	136	****	166	****	15	8	64	21	104	194
8	13543	2597	****	148	14	14349	****	25776	****	8749	****	980	****	22	7	95	20	576	187
9	13544	2451	****	147	13	13846	****	24737	****	8254	****	979	****	27	7	97	18	591	181
10	13552	2644	1000	145	13	14066	****	25378	****	8518	****	985	****	26	7	99	17	630	179
11	13546	2641	950	145	12	14027	****	25463	****	8555	****	993	****	23	6	105	17	645	177
12	13546	2698	907	145	12	14077	****	25971	****	8470	****	936	****	24	6	101	16	587	170
13	13543	2724	870	145	11	14254	****	26081	****	8504	****	973	****	19	6	101	15	595	165
14	13568	2547	837	151	11	14226	****	25895	****	8628	****	938	****	26	6	97	15	622	161
15	13559	36	****	147	11	445	****	36549	****	135	****	162	****	22	6	84	15	91	191
16	13571	5496	****	105	15	27302	****	19901	****	709	****	8949	****	14	6	94	14	121	206
17	13565	2611	****	169	16	14560	****	26058	****	8708	****	1066	****	20	6	98	14	441	200
18	13564	2485	****	154	15	13816	****	25311	****	9424	****	994	****	28	6	92	13	476	194
19	13559	6516	****	130	15	25230	****	20458	****	394	****	6127	****	11	6	69	14	107	205
20	13562	6534	****	136	15	25351	****	21060	****	332	****	5928	****	21	6	64	16	122	213

LINES DELETED: 3 6 7 15 16 19 20

AVE. BEAM CURRENT/SEC = 677

DATA REDUCED USING $B-AL:

*GL9M

ON SPECIMEN: T227-1 JB-BS-4

$B-AL VERSION 1.0

OXIDE FORM.	WEIGHT% (OXIDE)	STD.DEV. (%)	HOMO. INDEX	FORMULA	K-RATIO	UNKN PEAK (COUNTS)	UNKN BKGD (COUNTS)	COUNTING TIME(SEC)	STD PEAK (COUNTS)	STD BKGD (COUNTS)	COUNTING TIME(SEC)	STANDARD FILENAME
NA2O	~~3.961~~ 3.81	2.86	1.717	0.000	1.02240	2613.0	47.6	20.00	2556.2	47.0	20.00	%RGSC
MGO	0.030	93.66	0.891	0.000	0.00783	152.9	134.8	20.00	2448.4	135.3	20.00	%RGSC
AL2O3	12.394	1.20	1.909	0.000	0.94468	14205.4	245.3	20.00	15024.3	246.7	20.00	%5831
SIO2	74.118	0.88	2.808	0.000	1.00366	25783.3	52.8	20.00	25689.8	53.2	20.00	%5831
K2O	4.564	1.66	2.481	0.000	1.25191	8599.4	135.2	20.00	6904.5	143.5	20.00	%RGSC
CAO	0.531	4.37	1.337	0.000	0.10408	977.0	172.8	20.00	7912.2	185.5	20.00	%RGSC
TIO2	0.055	69.11	0.863	0.000	0.00050	24.4	15.3	20.00	18243.6	25.1	20.00	%TIO2
MNO	0.055	47.22	1.128	0.000	0.00055	100.1	70.0	20.00	55217.4	137.4	20.00	%MN2O
FEO	0.905	5.79	2.975	0.000	0.14139	561.4	95.8	20.00	3397.2	104.0	20.00	%RGSC

TOTAL ~~96.612~~ 96.471 NO. OXYGENS = 0 NO. ITERS. = 2 AVE. ATOMIC NO. = 11.10

Listing of 25 closest matches for COMP. NO. 2567 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 06/18/92

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2567	JB-BS-4 T227-1	6/13/91	76.75	12.83	1.04	0.03	0.06	0.55	0.06	3.95	4.73	100.00	1.0000
2	1806	OD-ML-65CM T143-7	6/24/87	76.81	12.80	1.05	0.03	0.05	0.56	0.05	3.96	4.70	100.01	0.9934
3	2563	SS-91-1-Adgss	8/7/91	76.73	12.85	1.04	0.03	0.05	0.53	0.07	3.95	4.74	99.99	0.9933
4	1310	WL 8-2B 172-174.5CM T99-10	7/1/85	76.90	12.74	1.05	0.02	0.05	0.56	0.07	3.91	4.71	100.01	0.9915
5	562	KRL82282A(P), T66-6	xx/xx/83	76.86	12.85	1.05	0.03	0.06	0.54	0.05	3.87	4.70	100.01	0.9905
6	1418	BL-RSA-4 T112-9	10/23/85	76.83	12.79	1.08	0.04	0.04	0.55	0.06	3.96	4.65	100.00	0.9899
7	2236	SL-115.5 T186-3	2/28/89	76.76	12.91	1.07	0.03	0.04	0.55	0.06	3.84	4.73	99.99	0.9896
8	2568	JB-BS-5 T227-2	6/13/91	76.69	12.91	1.08	0.02	0.05	0.55	0.09	3.90	4.70	99.99	0.9895
9	1680	KRL 860922 A T134-2	11/25/86	76.94	12.75	1.07	0.03	0.04	0.55	0.06	3.91	4.65	100.00	0.9894
10	1036	WL 2-3-2.01, T78-9	08/18/84	77.05	12.74	1.05	0.02	0.04	0.55	0.05	3.82	4.67	99.99	0.9890
11	1034	WL 2-2-2.64, T78-7	08/18/84	77.06	12.62	1.06	0.03	0.05	0.55	0.06	3.86	4.71	100.00	0.9890
12	1225	WL CORE G 380cm T92-8	5/2/85	76.82	12.79	1.06	0.04	0.04	0.56	0.06	4.00	4.65	100.02	0.9883
13	1141	WL-2-3-1.94M T85-1	12/4/84	76.97	12.65	1.05	0.03	0.05	0.56	0.05	4.00	4.66	100.02	0.9881
14	1142	WL-2-3-2.14M T85-2	12/4/84	76.97	12.69	1.06	0.03	0.05	0.56	0.06	3.96	4.63	100.01	0.9876
15	2559	SS-91-1-2 T232-3	8/7/91	77.11	12.63	1.03	0.03	0.05	0.54	0.06	3.89	4.67	100.01	0.9873
16	2558	SS-91-1-SU T232-1	8/6/91	76.74	12.86	1.09	0.04	0.04	0.54	0.05	3.95	4.68	99.99	0.9872
17	2557	SS-91-1-1 T232-2	6/8/91	76.57	12.92	1.07	0.02	0.04	0.54	0.06	4.05	4.72	99.99	0.9863
18	1224	WL CORE G 370cm T92-7	5/2/85	76.83	12.82	1.09	0.04	0.04	0.54	0.05	3.95	4.65	100.01	0.9862
19	682	KRL-91882G, T66-11	10/25/83	76.91	12.76	1.07	0.03	0.06	0.54	0.07	3.87	4.68	99.99	0.9859
20	1684	SCHURZ-1 T134-6	11/25/86	77.01	12.64	1.09	0.03	0.05	0.55	0.05	3.94	4.64	100.00	0.9857
21	1025	KRL-71082C (590) T58-1	6/22/84	76.91	12.71	1.08	0.02	0.00	0.53	0.05	3.95	4.74	99.99	0.9855
22	2110	KRL-82982-F T174-14	10/28/88	76.85	12.91	1.02	0.02	0.05	0.56	0.09	3.84	4.66	100.00	0.9855
23	2795	FLV-209-BC T254-6	4/14/92	76.36	13.11	1.09	0.03	0.06	0.55	0.07	4.01	4.73	100.01	0.9855
24	2718	FLV-202-D T249-6	1/30/92	76.79	12.79	1.06	0.02	0.04	0.58	0.07	3.96	4.68	99.99	0.9854
25	1472	KRL 82182 (A-1) T117-3	3/6/86	76.80	12.75	1.10	0.03	0.04	0.55	0.07	3.87	4.77	99.98	0.9850

SAMPLE: T22?   JR-BS-5

PT	BEAM COUNTS	NA COUNTS	9 SD	MG COUNTS	8 SD	AL COUNTS	3 SD	SI COUNTS	7 SD	K COUNTS	2 SD	CA COUNTS	6 SD	TI COUNTS	5 SD	MN COUNTS	1 SD	FE COUNTS	4 SD
1	13546	2481	50	147	12	14541	121	26218	162	8586	93	1056	32	31	6	101	10	574	24
2	13542	2679	140	150	2	14623	58	26076	100	8486	71	1017	27	33	1	99	1	602	20
3	13540	2573	99	144	3	14415	105	25818	203	8617	69	988	34	19	8	111	6	625	26
4	13544	2303	160	135	6	12171	****	22558	****	7422	574	880	75	15	9	85	11	479	64
5	13546	2520	138	148	6	14452	****	25472	****	8563	513	1026	68	23	8	102	9	607	58
6	13542	2560	125	161	8	14309	944	25588	****	8679	480	970	61	29	7	127	14	571	52
7	13542	2472	116	133	9	13937	864	24794	****	8130	449	958	57	20	7	114	13	576	47
8	13545	2589	111	181	15	14450	811	25862	****	8377	416	998	53	28	6	104	12	592	44
9	13547	2608	107	164	15	14528	771	26053	****	8731	408	1018	51	83	20	98	12	678	53
10	13553	2545	101	138	15	13993	729	25351	****	8267	387	870	61	31	19	63	17	455	66
11	13557	2615	99	139	14	14581	704	25819	****	8838	392	941	59	27	18	104	16	570	62
12	13548	2597	96	123	16	14295	672	26015	997	8612	377	937	58	27	17	89	16	584	60
13	13545	2606	93	145	15	14262	644	25891	961	8614	365	980	55	26	17	96	15	563	57
14	13545	2592	91	150	15	14065	620	26057	936	8646	354	1016	54	34	16	108	15	612	56
15	13548	2660	91	154	14	14378	599	26114	914	8469	341	969	52	20	16	102	14	568	54
16	13547	2612	89	150	14	14056	580	25548	883	8671	333	986	51	24	15	97	14	608	53
17	13553	2576	87	141	13	14240	562	26006	861	8591	324	942	50	28	15	100	13	578	51
18	13553	2542	84	152	13	13669	559	25134	842	8175	323	855	56	24	14	106	13	418	62
19	13556	2532	82	156	13	14049	544	25459	819	8497	314	978	54	22	14	92	13	606	61
20	13552	2506	81	147	12	14099	529	25162	803	8461	305	869	57	34	14	91	13	435	67

LINES DELETED: 4 7 18

AVE. BEAM CURRENT/SEC =   677

DATA REDUCED USING $B-AL: $GL9M

ON SPECIMEN: T227-2 JR-BS-5

$B-AL VERSION 1.0

OXIDE FORM.	WEIGHT% (OXIDE)	STD.DEV. (%)	HOMO. INDEX	FORMULA	K-RATIO	UNKN PEAK (COUNTS)	UNKN BKGD (COUNTS)	COUNTING TIME(SEC)	STD PEAK (COUNTS)	STD BKGD (COUNTS)	COUNTING TIME(SEC)	STANDARD FILENAME
NA2O	~~3.910~~ 3.764	2.87	1.023	0.000	1.00911	2579.6	47.6	20.00	2556.2	47.0	20.00	%RGSC
MGO	0.024	116.25	1.020	0.000	0.00627	149.3	134.8	20.00	2448.4	135.3	20.00	%RGSC
AL2O3	12.487	1.20	1.714	0.000	0.95200	14313.8	245.4	20.00	15024.3	246.7	20.00	%5831
SIO2	74.158	0.88	1.920	0.000	1.00410	25794.6	52.9	20.00	25689.8	53.2	20.00	%5831
K2O	4.549	1.66	1.470	0.000	1.24769	8570.9	135.2	20.00	6904.5	143.5	20.00	%RGSC
CAO	0.529	4.38	1.633	0.000	0.10370	974.2	172.9	20.00	7912.2	185.5	20.00	%RGSC
TIO2	0.091	44.53	2.581	0.000	0.00083	30.5	15.3	20.00	18243.6	25.1	20.00	%TIO2
MNO	0.053	44.90	1.283	0.000	0.00053	99.0	70.0	20.00	55217.4	137.4	20.00	%MN2O
FEO	0.937	5.68	2.390	0.000	0.14641	578.0	95.9	20.00	3397.2	104.0	20.00	%RGSC

TOTAL ~~[illegible]~~ 96.597   NO. OXYGENS = 0   NO. ITERS. = 2   AVE. ATOMIC NO. = 11.10

Listing of 25 closest matches for COMP. NO. 2568 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 06/18/92

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2568	JB-BS-5 T227-2	6/13/91	76.69	12.91	1.08	0.02	0.05	0.55	0.09	3.90	4.70	99.99	1.0000
2	2235	SL-103 T186-2	2/28/89	76.68	12.95	1.10	0.03	0.04	0.55	0.07	3.88	4.69	99.99	0.9952
3	2236	SL-115.5 T186-3	2/28/89	76.76	12.91	1.07	0.03	0.04	0.55	0.06	3.84	4.73	99.99	0.9947
4	1418	BL-RSA-4 T112-9	10/23/85	76.83	12.79	1.08	0.04	0.04	0.55	0.06	3.96	4.65	100.00	0.9938
5	1680	KRL 860922 A T134-2	11/25/86	76.94	12.75	1.07	0.03	0.04	0.55	0.06	3.91	4.65	100.00	0.9937
6	2570	JB-BS-7 T227-4	6/13/91	76.73	12.89	1.10	0.03	0.05	0.54	0.06	3.91	4.69	100.00	0.9928
7	1244	WL 8-3A ASH A 64-66cm T93-13	5/2/85	76.97	12.80	1.08	0.03	0.05	0.55	0.05	3.86	4.60	99.99	0.9927
8	2558	SS-91-1-SU T232-1	8/6/91	76.74	12.86	1.09	0.04	0.04	0.54	0.05	3.95	4.68	99.99	0.9919
9	570	KRL91982D, T66-10	xx/xx/83	76.81	12.89	1.08	0.03	0.05	0.53	0.06	3.90	4.65	100.00	0.9916
10	681	KRL-91882A', T66-8	10/25/83	76.79	12.83	1.10	0.03	0.06	0.54	0.07	3.91	4.67	100.00	0.9912
11	682	KRL-91882G, T66-11	10/25/83	76.91	12.76	1.07	0.03	0.06	0.54	0.07	3.87	4.68	99.99	0.9910
12	1186	WALKER LAKE CORE G 380CM t89-1	2/28/85	76.98	12.79	1.08	0.02	0.05	0.54	0.05	3.86	4.64	100.01	0.9910
13	1472	KRL 82182 (A-1) T117-3	3/6/86	76.80	12.75	1.10	0.03	0.04	0.55	0.07	3.87	4.77	99.98	0.9909
14	1684	SCHURZ-1 T134-6	11/25/86	77.01	12.64	1.09	0.03	0.05	0.55	0.05	3.94	4.64	100.00	0.9905
15	1034	WL 2-2-2.64, T78-7	08/18/84	77.06	12.62	1.06	0.03	0.05	0.55	0.06	3.86	4.71	100.00	0.9903
16	783	GS-27		76.74	12.92	1.12	0.03	0.05	0.55	0.07	3.91	4.61	100.00	0.9902
17	1224	WL CORE G 370cm T92-7	5/2/85	76.83	12.82	1.09	0.04	0.04	0.54	0.05	3.95	4.65	100.01	0.9901
18	1228	WL 8-2B 130-134cm T92-12	5/2/85	77.03	12.81	1.08	0.04	0.04	0.55	0.04	3.77	4.63	99.99	0.9899
19	1621	BO-18 JOD	09/12/86	76.98	12.70	1.10	0.03	0.05	0.55	0.07	3.83	4.68	99.99	0.9899
20	562	KRL82282A(P), T66-6	xx/xx/83	76.86	12.85	1.05	0.03	0.06	0.54	0.05	3.87	4.70	100.01	0.9899
21	2795	FLV-209-BC T254-6	4/14/92	76.36	13.11	1.09	0.03	0.06	0.55	0.07	4.01	4.73	100.01	0.9896
22	2567	JB-BS-4 T227-1	6/13/91	76.75	12.83	1.04	0.03	0.06	0.55	0.06	3.95	4.73	100.00	0.9895
23	1948	WL-4-4 (12.25M) T162-2	5/14/88	76.87	12.86	1.09	0.02	0.05	0.54	0.06	3.80	4.72	100.01	0.9894
24	1416	BL-RSA-2 T112-7	10/23/85	76.78	12.85	1.12	0.04	0.03	0.54	0.06	3.90	4.68	100.00	0.9893
25	1241	WL 4-2 3.31m T93-10	5/2/85	76.69	12.91	1.14	0.04	0.04	0.55	0.06	3.92	4.67	100.02	0.9893

SAMPLE: T2 JB-BS-6

PT	BEAM COUNTS	NA COUNTS	9 SD	MG COUNTS	8 SD	AL COUNTS	3 SD	SI COUNTS	7 SD	K COUNTS	2 SD	CA COUNTS	6 SD	TI COUNTS	5 SD	MN COUNTS	1 SD	FE COUNTS	4 SD
1	13550	2378	49	143	12	14240	119	24667	157	8400	92	1143	34	34	6	91	10	482	22
2	13555	2469	64	169	18	14234	4	24718	36	8417	12	1137	4	16	13	84	5	441	29
3	13559	2476	54	146	14	14027	121	24499	114	8305	60	1142	3	27	9	99	7	408	37
4	13557	2508	56	164	13	14190	99	24566	98	8490	76	1316	88	26	7	112	12	453	31
5	13561	2447	48	162	12	14458	154	24388	132	8873	220	1180	76	28	6	99	10	419	29
6	13564	2584	68	138	13	14209	138	25015	217	8466	197	1117	73	24	6	103	10	477	30
7	13560	2465	62	160	12	14341	133	24692	199	8380	185	1210	68	21	6	92	9	454	28
8	13565	2501	58	184	15	14443	142	25038	230	8382	175	1233	66	33	6	107	9	451	26
9	13561	2492	55	162	14	14465	148	24963	233	8304	172	1227	64	19	6	99	9	462	25
10	13561	2429	54	150	14	14155	146	24855	223	8189	181	1144	62	19	6	108	9	480	25
11	13565	2232	89	186	16	14391	143	24920	218	8956	236	1127	61	28	6	94	8	473	25
12	13567	2418	86	170	15	14070	150	25054	225	8386	226	1145	59	20	6	92	8	452	23
13	13567	2564	88	157	14	14339	145	24677	218	8422	217	1154	57	33	6	105	8	433	23
14	13562	2400	86	157	14	14369	141	25416	271	8706	219	1125	56	29	6	109	8	446	22
15	13564	2531	85	154	14	14206	138	25106	271	8207	222	1119	56	26	6	108	8	435	22
16	13559	2459	82	166	13	14165	136	24678	265	8404	215	1176	54	24	5	100	8	455	21
17	13564	2280	91	188	14	14219	132	25192	271	8845	228	1366	71	21	5	99	8	488	22
18	13564	2384	89	144	15	14247	128	24916	264	8294	226	1189	69	24	5	78	9	466	22
19	13564	2484	87	155	14	14200	125	24920	257	8377	220	1168	67	29	5	108	9	466	22
20	13564	2412	85	142	14	14059	130	24797	250	8466	214	1145	66	20	5	89	9	460	21

LINES DELETED:

LINES DELETED: 5 11 14 17

AVE. BEAM CURRENT/SEC = 678

DATA REDUCED USING $B-AL: $GL9M

ON SPECIMEN: T227-3 JB-BS-6

$B-AL VERSION 1.0

OXIDE FORM.	WEIGHT% (OXIDE)	STD.DEV. (%)	HOMO. INDEX	FORMULA	K-RATIO	UNKN PEAK (COUNTS)	UNKN BKGD (COUNTS)	COUNTING TIME(SEC)	STD PEAK (COUNTS)	STD BKGD (COUNTS)	COUNTING TIME(SEC)	STANDARD FILENAME
NA2O	~~3.765~~ 3.630	2.90	1.187	0.000	0.96623	2472.1	47.7	20.00	2556.2	47.0	20.00	%RGSC
MGO	0.035	78.94	0.996	0.000	0.00935	156.3	134.7	20.00	2448.4	135.3	20.00	%RGSC
AL2O3	12.443	1.20	1.046	0.000	0.94609	14224.5	243.6	20.00	15024.3	246.7	20.00	%5831
SIO2	71.499	0.89	1.184	0.000	0.96620	24822.5	52.4	20.00	25689.8	53.2	20.00	%5831
K2O	4.476	1.67	0.953	0.000	1.21788	8368.1	134.0	20.00	6904.5	143.5	20.00	%RGSC
CAO	0.660	3.84	1.521	0.000	0.12964	1172.8	171.1	20.00	7912.2	185.5	20.00	%RGSC
TIO2	0.057	66.17	1.103	0.000	0.00052	24.6	15.1	20.00	18243.6	25.1	20.00	%TIO2
MNO	0.053	44.40	0.990	0.000	0.00053	98.3	69.1	20.00	55217.4	137.4	20.00	%MNO
FEO	0.700	6.75	0.902	0.000	0.10934	454.8	94.7	20.00	3397.2	104.0	20.00	%RGSC

TOTAL ~~[illegible]~~ 93.514 NO. OXYGENS = 0 NO. ITERS. = 9 AVE. ATOMIC NO. = 10.00

Listing of 25 closest matches for COMP. NO. 2569 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 06/18/92

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2569	JB-BS-6 T227-3	6/13/91	76.39	13.29	0.83	0.04	0.06	0.71	0.06	3.88	4.74	100.00	1.0000
2	183	KRL7982-19B, T45-4		76.37	13.29	0.83	0.04	0.02	0.71	0.07	3.88	4.79	100.00	0.9982
3	454	679-340, T31-2		76.57	13.20	0.84	0.03	0.03	0.70	0.07	3.84	4.71	99.99	0.9914
4	1243	WL 4-26 66.40m T93-12	5/2/85	76.71	13.12	0.83	0.05	0.04	0.71	0.06	3.70	4.78	100.00	0.9880
5	2644	JB-BS-17 T241-8	10/21/91	76.22	13.28	0.84	0.04	0.08	0.70	0.05	4.04	4.76	100.01	0.9879
6	495	IIB, T32-1		76.58	13.16	0.87	0.03	0.06	0.71	0.05	3.87	4.68	100.01	0.9878
7	1982	WL-5-13 (64.49m) T164-11	5/22/88	76.59	13.19	0.83	0.03	0.05	0.70	0.07	3.73	4.80	99.99	0.9874
8	182	KRL7982-16, T45-3		76.66	13.17	0.83	0.03	0.02	0.68	0.07	3.91	4.64	100.01	0.9861
9	1979	WL-5-12 (61.28m) T164-8	5/22/88	76.51	13.26	0.87	0.04	0.05	0.70	0.07	3.76	4.75	100.01	0.9838
10	1958	WL-4-17 (39.81M) T162-12	5/15/88	76.91	12.98	0.84	0.04	0.05	0.72	0.05	3.70	4.70	99.99	0.9815
11	1963	WL-4-26 (66.50M) T163-7	5/15/88	76.67	13.24	0.84	0.04	0.04	0.73	0.07	3.66	4.70	99.99	0.9814
12	572	KRL91982J, T64-14	09/06/83	76.90	12.98	0.83	0.02	0.05	0.67	0.06	3.85	4.65	100.01	0.9812
13	1242	WL 4-26 66.33m T93-11	5/2/85	76.65	13.16	0.87	0.05	0.04	0.71	0.05	3.69	4.78	100.00	0.9806
14	1258	*WL 4-26 66.79m t95-5	5/29/85	76.94	12.84	0.81	0.05	0.04	0.73	0.07	3.77	4.75	100.00	0.9795
15	2709	FLV-194-BC T246-3	12/12/91	76.50	12.97	0.88	0.05	0.05	0.72	0.06	4.00	4.75	99.98	0.9786
16	1974	WL-5-5 (36.93m) T164-3	5/21/88	76.69	13.09	0.83	0.03	0.05	0.66	0.06	3.79	4.82	100.02	0.9785
17	756	BO-5		76.29	13.42	0.90	0.04	0.06	0.70	0.08	3.80	4.71	100.00	0.9784
18	549	KRL71082F, T55-5	11/25/83	76.59	13.26	0.86	0.05	0.05	0.71	0.07	3.59	4.82	100.00	0.9782
19	1975	WL-5-6 (39.31m) T164-4	5/21/88	76.69	13.10	0.82	0.04	0.05	0.66	0.07	3.79	4.78	100.00	0.9780
20	1976	WL-5-6 (40.08m) T164-5	5/21/88	76.68	13.08	0.82	0.03	0.05	0.66	0.06	3.81	4.82	100.01	0.9772
21	1136	WL-5-13-1.11M T84-12	12/3/84	76.59	13.09	0.89	0.04	0.06	0.71	0.07	3.74	4.82	100.01	0.9770
22	1045	DSDP 36-10-2 SSA, T78-5	07/18/84	76.90	12.80	0.85	0.04	0.04	0.72	0.09	3.73	4.83	100.00	0.9770
23	545	KRL7982-17, T50-4	02/01/83	76.61	13.14	0.87	0.03	0.04	0.68	0.05	3.77	4.79	99.98	0.9765
24	2565	SS-91-1 high Ca SS	8/7/91	77.12	12.77	0.83	0.03	0.05	0.67	0.05	3.79	4.67	99.98	0.9762
25	1983	WL-5-16 (73.40m) T164-12	5/22/88	76.37	13.29	0.81	0.05	0.04	0.75	0.10	3.70	4.89	100.00	0.9742

SAMPLE ?-4 JR-BS-7

PT	BEAM COUNTS	NA 9 COUNTS	SD	MG 8 COUNTS	SD	AL 3 COUNTS	SD	SI 7 COUNTS	SD	K 2 COUNTS	SD	CA 6 COUNTS	SD	TI 5 COUNTS	SD	MN 1 COUNTS	SD	FE 4 COUNTS	SD
1	13563	5054	71	131	11	26887	164	20293	142	2221	47	8479	92	20	4	83	9	218	15
2	13558	2561	****	164	23	14404	****	25712	****	8565	****	1007	****	22	1	98	11	590	264
3	13562	2652	****	136	18	14477	****	25987	****	8413	****	950	****	35	8	83	9	570	210
4	13562	2550	****	143	15	14295	****	25461	****	8290	****	968	****	22	7	91	7	582	182
5	13567	2560	****	173	18	14268	****	25875	****	8671	****	982	****	32	7	97	7	533	159
6	13561	2727	1000	155	16	14534	****	26217	****	8671	****	962	****	21	6	91	6	555	144
7	13581	2508	933	143	15	13981	****	25566	****	8235	****	890	****	28	6	95	6	609	137
8	13588	2595	873	154	14	14265	****	26298	****	8477	****	1002	****	31	6	110	9	579	128
9	13588	2573	820	127	15	14618	****	26486	****	8723	****	929	****	29	5	107	9	551	120
10	13586	3402	791	167	16	32138	****	18016	****	475	****	16859	****	27	5	81	10	225	149
11	13586	2624	756	177	17	14182	****	25345	****	8485	****	860	****	33	5	89	9	764	162
12	13577	47	****	121	19	605	****	35257	****	158	****	169	****	23	5	67	12	111	195
13	13588	2656	****	163	18	14403	****	25418	****	8640	****	951	****	27	5	103	12	602	190
14	13593	2651	****	148	18	14096	****	25386	****	8342	****	1011	****	22	5	103	12	594	184
15	13591	2448	972	137	17	13924	****	25212	****	8253	****	932	****	29	5	123	14	557	178
16	13594	2652	939	147	17	14366	****	26246	****	8405	****	949	****	19	5	99	13	604	173
17	13593	2558	909	143	16	14133	****	25781	****	8318	****	984	****	20	5	90	13	626	170
18	13595	2572	882	145	16	14414	****	26136	****	8718	****	1034	****	12	6	93	12	523	165
19	13592	4223	931	138	16	29612	****	19084	****	1397	****	12845	****	12	6	77	13	250	172
20	13593	2440	909	164	16	14602	****	26526	****	9731	****	1015	****	19	6	116	13	607	169

LINES DELETED: 1 10 12 19

AVE. BEAM CURRENT/SEC = 679

DATA REDUCED USING $B-AL: .$GL9M

ON SPECIMEN: T227-4 JB-BS-7

$B-AL VERSION 1.0

OXIDE FORM.	WEIGHT% (OXIDE)	STD.DEV. (%)	HOMO. INDEX	FORMULA	K-RATIO	UNKN PEAK (COUNTS)	UNKN BKGD (COUNTS)	COUNTING TIME(SEC)	STD PEAK (COUNTS)	STD BKGD (COUNTS)	COUNTING TIME(SEC)	STANDARD FILENAME
NA2O	~~3.924~~ 3.783	2.87	1.579	0.000	1.01296	2589.3	47.6	20.00	2556.2	47.0	20.00	ZRGSC
MGO	0.027	102.80	1.144	0.000	0.00711	151.2	134.8	20.00	2448.4	135.3	20.00	ZRGSC
AL2O3	12.482	1.20	1.732	0.000	0.95175	14310.1	245.5	20.00	15024.3	246.7	20.00	Z5B31
SIO2	74.320	0.88	2.674	0.000	1.00639	25853.2	52.9	20.00	25689.8	53.2	20.00	Z5B31
K2O	4.542	1.66	3.837	0.000	1.24587	8558.6	135.3	20.00	6904.5	143.5	20.00	ZRGSC
CAO	0.523	4.42	1.508	0.000	0.10239	964.1	173.0	20.00	7912.2	185.5	20.00	ZRGSC
TIO2	0.058	65.85	1.265	0.000	0.00053	25.0	15.3	20.00	18243.6	25.1	20.00	ZTIO2
MNO	0.053	45.04	1.063	0.000	0.00052	93.9	70.1	20.00	55217.4	137.4	20.00	ZMN2O
FEO	0.961	5.59	2.242	0.000	0.15018	590.5	95.9	20.00	3397.2	104.0	20.00	ZRGSC

TOTAL ~~96.8??~~ 96.749 NO. OXYGENS = 0 NO. ITERS. = 2 AVE. ATOMIC NO. = 11.11

1? ... [illegible]

Listing of 25 closest matches for COMP. NO. 2570 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 06/18/92

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2570	JB-BS-7 T227-4	6/13/91	76.73	12.89	1.10	0.03	0.05	0.54	0.06	3.91	4.69	100.00	1.0000
2	681	KRL-91882A', T66-8	10/25/83	76.79	12.83	1.10	0.03	0.06	0.54	0.07	3.91	4.67	100.00	0.9984
3	2558	SS-91-1-SU T232-1	8/6/91	76.74	12.86	1.09	0.04	0.04	0.54	0.05	3.95	4.68	99.99	0.9960
4	566	KRL91882B, T64-12	09/06/83	76.81	12.82	1.10	0.01	0.05	0.53	0.08	3.91	4.69	100.00	0.9958
5	1416	BL-RSA-2 T112-7	10/23/85	76.78	12.85	1.12	0.04	0.03	0.54	0.06	3.90	4.68	100.00	0.9956
6	2235	SL-103 T186-2	2/28/89	76.68	12.95	1.10	0.03	0.04	0.55	0.07	3.88	4.69	99.99	0.9948
7	1224	WL CORE G 370cm T92-7	5/2/85	76.83	12.82	1.09	0.04	0.04	0.54	0.05	3.95	4.65	100.01	0.9943
8	2717	FLV-201-TO T249-5	1/30/92	76.85	12.77	1.10	0.02	0.04	0.54	0.04	3.99	4.65	100.00	0.9934
9	560	KRL82282, T66-4	xx/xx/83	76.74	12.90	1.13	0.02	0.06	0.54	0.06	3.87	4.68	100.00	0.9934
10	760	BO-16		76.59	12.92	1.11	0.03	0.03	0.54	0.07	4.00	4.71	100.00	0.9933
11	2568	JB-BS-5 T227-2	6/13/91	76.69	12.91	1.08	0.02	0.05	0.55	0.09	3.90	4.70	99.99	0.9928
12	2493	FLV-156-SS T219-3	12/20/90	76.64	13.06	1.09	0.03	0.04	0.54	0.05	3.94	4.62	100.01	0.9924
13	1948	WL-4-4 (12.25M) T162-2	5/14/88	76.87	12.86	1.09	0.02	0.05	0.54	0.06	3.80	4.72	100.01	0.9920
14	570	KRL91982D, T66-10	xx/xx/83	76.81	12.89	1.08	0.03	0.05	0.53	0.06	3.90	4.65	100.00	0.9919
15	2060	FLV-64-CS T170-7	9/3/88	76.71	12.87	1.11	0.02	0.04	0.54	0.04	4.02	4.64	99.99	0.9919
16	1290	WL 8-1B 92-94cm T99-1	07/01/85	76.99	12.72	1.11	0.02	0.06	0.54	0.07	3.84	4.65	100.00	0.9913
17	1947	WL-4-4 (10.83M) T162-1	5/14/88	76.86	12.94	1.10	0.04	0.06	0.54	0.06	3.77	4.64	100.01	0.9913
18	682	KRL-91882G, T66-11	10/25/83	76.91	12.76	1.07	0.03	0.06	0.54	0.07	3.87	4.68	99.99	0.9913
19	1186	WALKER LAKE CORE G 380CM t89-1	2/28/85	76.98	12.79	1.08	0.02	0.05	0.54	0.05	3.86	4.64	100.01	0.9912
20	783	GS-27		76.74	12.92	1.12	0.03	0.05	0.55	0.07	3.91	4.61	100.00	0.9907
21	1419	BL-RSA-5 T112-10	10/23/85	76.98	12.65	1.09	0.04	0.04	0.53	0.05	3.93	4.68	99.99	0.9906
22	1472	KRL 82182 (A-1) T117-3	3/6/86	76.80	12.75	1.10	0.03	0.04	0.55	0.07	3.87	4.77	99.98	0.9905
23	1621	BO-18 JOD	09/12/86	76.98	12.70	1.10	0.03	0.05	0.55	0.07	3.83	4.68	99.99	0.9902
24	952	DR-64		76.57	13.01	1.13	0.03	0.05	0.53	0.07	3.90	4.70	99.99	0.9898
25	1241	WL 4-2 3.31m T93-10	5/2/85	76.69	12.91	1.14	0.04	0.04	0.55	0.06	3.92	4.67	100.02	0.9896

SAMPLE: T241-1 JR-BS-9

PT	I COUNTS	NA COUNTS	9 SD	MG COUNTS	8 SD	[illegible] COUNTS	3 SD	SI COUNTS	7 SD	K COUNTS	SD	CA COUNTS	6 SD	TI COUNTS	5 SD	MN COUNTS	1 SD	[illegible] COUNTS	4 SD
1	14122	2444	[illegible]	127	11	13627	117	25617	160	8386	92	960	31	29	5	127	11	594	24
2	[illegible]	2517	52	143	11	13867	170	26275	465	8611	159	923	[illegible]	32	2	89	27	654	42
3	14128	2383	67	154	14	14244	311	26090	339	9135	[illegible]	983	30	27	3	100	20	480	88
4	14127	5572	****	160	14	27140	****	20990	****	706	****	8050	****	11	9	85	19	123	239
5	14124	2467	****	153	13	13825	****	26396	****	8671	****	947	****	24	8	114	17	602	[illegible]
6	14135	2514	****	132	[illegible]	14630	****	27034	****	9157	****	938	****	19	8	120	[illegible]	582	196
7	14138	2671	****	152	12	14416	****	27299	****	8958	****	925	****	32	9	113	16	602	182
8	14138	2375	****	132	12	13646	****	26297	****	8644	****	960	****	32	8	105	15	587	171
9	14132	2450	****	163	13	14212	****	26801	****	8995	****	918	****	30	7	109	14	580	161
10	14138	2474	983	141	13	14346	****	[illegible]	****	8834	****	979	****	23	7	101	13	604	153
11	14138	2466	937	161	13	[illegible]	****	25958	****	8799	****	911	****	22	7	99	13	594	146
12	14132	45	****	132	13	485	****	38274	****	161	****	162	****	12	7	74	15	89	192
13	14129	2493	****	140	12	13960	****	26253	****	8505	****	919	****	21	7	102	14	569	184
14	14124	46	****	127	13	508	****	38075	****	152	****	189	****	16	7	86	15	99	209
15	14119	2554	****	147	13	14315	****	26790	****	8573	****	929	****	30	7	101	14	609	204
16	14123	2604	****	159	13	21407	****	23364	****	21540	****	496	****	19	7	83	14	130	217
17	14112	33	****	128	17	480	****	38450	****	137	****	177	****	14	7	101	14	91	229
18	14113	2331	****	134	13	13846	****	26132	****	9273	****	874	****	23	7	102	14	541	223
19	14098	6098	****	157	13	24089	****	22422	****	2965	****	4056	****	22	7	81	14	160	227
20	14099	2569	****	138	13	13955	****	26397	****	8464	****	939	****	29	7	113	14	573	223

LINES DELETED: 4 12 14 17 19 16 3

AVE. BEAM CURRENT/SEC = 706

DATA REDUCED USING $B-AL! *GL9M

ON SPECIMEN: T241-1 JR-BS-9

$B-AL VERSION 1.0

OXIDE FORM.	WEIGHT% (OXIDE)	STD.DEV. (%)	HOMO. INDEX	FORMULA	K-RATIO	UNKN PEAK (COUNTS)	UNKN BKGD (COUNTS)	COUNTING TIME(SEC)	STD PEAK (COUNTS)	STD BKGD (COUNTS)	COUNTING TIME(SEC)	STANDARD FILENAME
NA2O	4.024	2.95	1.580	0.000	1.03512	2483.5	50.5	20.00	2400.2	49.7	20.00	%RGSC
MGO	0.011	236.92	0.943	0.000	0.00303	143.4	136.3	20.00	2469.5	136.9	20.00	%RGSC
AL2O3	12.331	1.21	2.636	0.000	0.93784	14039.5	245.7	20.00	14955.9	247.8	20.00	%5831
SIO2	72.929	0.87	3.110	0.000	0.98634	26501.7	53.5	20.00	26868.4	53.9	20.00	%5831
K2O	4.436	1.64	2.914	0.000	1.21735	8759.2	143.6	20.00	7230.1	152.8	20.00	%RGSC
CAO	0.524	4.57	0.862	0.000	0.10287	932.3	177.5	20.00	7528.9	191.2	20.00	%RGSC
TIO2	0.046	79.80	0.911	0.000	0.00042	26.6	18.2	20.00	19938.2	26.6	20.00	%TIO2
MNO	0.077	30.16	0.968	0.000	0.00077	107.2	63.8	20.00	56342.7	119.9	20.00	%MN2O
FEO	0.946	5.71	1.074	0.000	0.14776	591.7	104.6	20.00	3409.3	112.6	20.00	%RGSC

TOTAL 95.326 NO. OXYGENS = 0 NO. ITERS. = 2 AVE. ATOMIC NO. = 11.06

21-OCT-91 13:59:35

SAMPLE ID: JB-BS-9 T241-1

Data of Analysis: 10/21/91

Raw Probe Data		Raw Probe Data (FeO to Fe2O3)	R ulated to 100%	
SiO2	72.929		SiO2	76.42
Al2O3	12.331		Al2O3	12.92
FeO	0.946*1.1113=Fe2O3	1.051	Fe2O3	1.10
MgO	0.011		MgO	0.01
MnO	0.077		MnO	0.08
CaO	0.524		CaO	0.55
TiO2	0.046		TiO2	0.05
Na2o	4.024		Na2o	4.22
K2O	4.436		K2O	4.65
TOTAL(O)	95.326	TOTAL(N) 95.431	TOTAL(R)	100.00

20 Best Matches:

1	0.9319	10/22/85	KRL 82182 (A1) (599) T112-1
2	0.9862	07/01/83	KRL91982F, T56-5
3	0.9859	9/3/88	FLV-64-CS T170-7
4	0.9856		YOS-1, T13-1
5	0.9849	5/2/85	WL 4-2 3.29m T93-9
6	0.9846		3-30-82-1, T43-3
7	0.9843		BO-16
8	0.9842	2/28/89	SL-103 T186-2
9	0.9841	10/23/85	BL-RSA-4 T112-9
10	0.9840		BO-11
11	0.9829	6/8/91	SS-91-1-1 T232-2
12	0.9827		GS-27
13	0.9826	5/2/85	WL CORE G 370cm T92-7
14	0.9823	8/6/91	SS-91-1-SU T232-1
15	0.9822	6/13/91	JB-BS-7 T227-4
16	0.9822	11/25/86	SCHURZ-1 T134-6
17	0.9820	10/25/83	KRL-91882A", T66-8
18	0.9819	5/2/85	WL CORE G 180cm T92-6
19	0.9818	6/13/91	JB-BS-5 T227-2
20	0.9815		GS-32

Elements used in the calculation are:

Na2o
Al2O3
SiO2
K2O
CaO
FeO

***** This sample has been addad to the data base *****

Listing of 50 closest matches for COMP. NO. 2638 for elements: Na, Al, Si, K, Ca, Fe Date of Update: 10/22/91

	No	Sample Number	Date		Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,	. Cc
1	2638	JB-BS-9 T241-1	10/21/91	75.42	12.92	1.10	0.01	0.06	0.55	0.03	4.22	4.63	100.01	1.0000
2	2642	JB-BS-14 T241-5	10/21/91	76.55	12.82	1.11	0.02	0.07	0.55	0.06	4.20	4.62	100.00	0.9951
3	1439	KRL 82182 (A1) (599) T112-1	10/22/85	76.60	12.87	1.11	0.04	0.04	0.55	0.06	4.08	4.63	100.00	0.9913
4	2639	JB-BS-11 T241-2	10/21/91	76.55	12.80	1.10	0.02	0.08	0.54	0.06	4.16	4.68	99.99	0.9917
5	2640	JB-BS-12 T241-3	10/21/91	76.51	12.85	1.11	0.03	0.09	0.54	0.05	4.16	4.67	100.00	0.9912
6	2643	JB-BS-15 T241-6	10/21/91	76.59	12.83	1.08	0.03	0.07	0.54	0.04	4.23	4.59	100.00	0.9899
7	2641	JB-BS-13 T241-4	10/21/91	76.49	12.83	1.03	0.03	0.08	0.53	0.05	4.26	4.64	100.00	0.9877
8	571	KRL91982F, T56-5	07/01/83	76.61	12.89	1.14	0.03	0.05	0.55	0.03	4.12	4.56	100.00	0.9864
9	2050	FLV-64-CS T170-7	9/3/88	76.71	12.87	1.11	0.02	0.04	0.54	0.04	4.02	4.54	99.99	0.9859
10	431	YDS-1, T13-1		76.61	12.93	1.12	0.03	0.05	0.54	0.07	4.03	4.64	100.02	0.9858
11	1240	WL 4-2 3.29m T93-9	3/2/85	76.75	12.79	1.13	0.03	0.04	0.55	0.05	4.02	4.64	100.00	0.9849
12	2646	JB-WA-1 T242-1	10/21/91	76.77	12.70	1.09	0.02	0.07	0.53	0.06	4.19	4.57	100.00	0.9846
13	435	3-30-82-1, T43-3		76.62	12.93	1.06	0.02	0.05	0.54	0.07	4.13	4.59	100.01	0.9846
14	750	BO-16		76.59	12.92	1.11	0.03	0.03	0.54	0.07	4.00	4.71	100.00	0.9843
15	2236	SL-103 T186-2	2/28/89	76.68	12.95	1.10	0.03	0.04	0.55	0.07	3.68	4.69	99.99	0.9842
16	1418	BL-RSA-4 T112-9	10/23/85	76.83	12.79	1.08	0.04	0.04	0.55	0.06	3.56	4.65	100.00	0.9841
17	758	BO-11		76.35	13.11	1.12	0.03	0.04	0.55	0.09	4.00	4.70	99.99	0.9840
18	2558	SS-91-1-1 T232-2	6/8/91	76.57	12.92	1.07	0.02	0.04	0.54	0.06	4.05	4.72	99.99	0.9829
19	733	GS-27		76.74	12.92	1.12	0.03	0.05	0.55	0.07	3.91	4.61	100.00	0.9827
20	1224	WL CORE G 370cm T92-7	5/2/85	75.83	12.82	1.09	0.04	0.04	0.54	0.05	3.95	4.65	100.01	0.9826
21	2559	SS-91-1-SU T232-1	8/6/91	76.74	12.86	1.09	0.04	0.04	0.54	0.05	3.95	4.68	99.99	0.9823
22	2571	JB-BS-7 T227-4	6/13/91	75.73	12.89	1.10	0.03	0.05	0.54	0.06	3.91	4.69	100.00	0.9822
23	1684	SCHURZ-1 T134-6	11/25/86	77.01	12.64	1.09	0.03	0.05	0.55	0.05	3.94	4.64	100.00	0.9822
24	681	KRL-91882A", T66-8	10/25/83	76.79	12.83	1.10	0.03	0.06	0.54	0.07	3.91	4.67	100.00	0.9820
25	1223	WL CORE G 180cm T92-6	5/2/85	76.64	12.88	1.11	0.04	0.05	0.57	0.06	3.99	4.57	100.01	0.9819
26	2569	JB-BS-5 T227-2	6/13/91	76.69	12.91	1.08	0.02	0.05	0.55	0.09	3.90	4.70	99.99	0.9818
27	788	GS-32		76.58	12.90	1.13	0.03	0.04	0.56	0.06	4.00	4.70	100.00	0.9815
28	2494	FLV-156-SS T219-3	12/20/90	76.54	13.06	1.09	0.03	0.04	0.54	0.05	3.94	4.62	100.01	0.9811
29	1241	WL 4-2 3.31m T93-10	5/2/85	75.69	12.91	1.14	0.04	0.04	0.55	0.06	3.92	4.67	100.02	0.9809
30	1630	KRL 860922 A T134-2	11/25/86	76.94	12.75	1.07	0.03	0.04	0.55	0.06	3.91	4.65	100.00	0.9799
31	2170	KRL-82982-KP T178-5	12/6/88	76.70	13.01	1.11	0.02	0.06	0.55	0.06	3.81	4.67	99.99	0.9798
32	2563	SS-91-1-5 T232-6	8/7/91	76.97	12.65	1.08	0.03	0.04	0.54	0.07	3.98	4.65	100.01	0.9798
33	1225	WL CORE G 380cm T92-8	5/2/85	76.82	12.79	1.06	0.04	0.04	0.56	0.06	4.00	4.65	100.02	0.9797
34	1621	BO-18 JOD	09/12/86	76.98	12.70	1.10	0.03	0.05	0.55	0.07	3.83	4.68	99.99	0.9795
35	1472	KRL 82182 (A-1) T117-3	3/6/86	76.80	12.75	1.10	0.03	0.04	0.55	0.07	3.87	4.77	99.98	0.9790
36	1416	BL-RSA-2 T112-7	10/23/85	76.78	12.85	1.12	0.04	0.03	0.54	0.06	3.90	4.68	100.00	0.9786
37	1245	WL 8-3A ASH B 59.5-64.0cm T93-	5/2/85	77.00	12.70	1.10	0.03	0.06	0.56	0.04	3.89	4.61	99.99	0.9785
38	1244	WL 8-3A ASH A 64-66cm T93-13	5/2/85	75.97	12.80	1.08	0.03	0.05	0.55	0.05	3.86	4.60	99.99	0.9782
39	556	KRL91882B, T64-12	09/06/83	76.81	12.82	1.10	0.01	0.05	0.53	0.08	3.91	4.69	100.00	0.9781
40	1947	WL-4-4 (10.83M) T152-1	5/14/88	76.86	12.94	1.10	0.04	0.06	0.54	0.06	3.77	4.64	100.01	0.9776
41	551	KRL82282A, T66-5	10/25/83	76.71	12.88	1.12	0.04	0.05	0.52	0.06	3.58	4.65	100.01	0.9773
42	1229	WL 8-3A 14.5-20cm T92-13	5/2/85	77.03	12.78	1.09	0.03	0.04	0.55	0.06	3.78	4.63	99.99	0.9773
43	570	KRL91982D, T66-10	xx/xx/83	75.81	12.89	1.08	0.03	0.05	0.53	0.06	3.90	4.65	100.00	0.9770
44	1972	WL-4-58 (144.77m) T164-1	5/21/88	76.73	12.71	1.15	0.00	0.03	0.54	0.12	4.02	4.69	99.99	0.9770
45	1291	WL 8-1B 192-194cm T99-3	07/01/85	76.95	12.70	1.11	0.03	0.06	0.56	0.07	3.86	4.64	99.98	0.9770
46	1417	BL-RSA-3 T112-8	10/23/85	76.83	12.80	1.15	0.04	0.05	0.55	0.05	3.89	4.64	100.00	0.9769
47	1227	WL 8-2A 61-5-70.0cm T92-11	5/2/85	77.09	12.70	1.11	0.03	0.05	0.55	0.04	3.78	4.65	100.00	0.9768
48	2237	SL-115.5 T186-3	2/28/89	76.76	12.91	1.07	0.03	0.04	0.55	0.06	3.84	4.73	99.99	0.9768
49	550	KRL82282, T66-4	xx/xx/83	76.74	12.90	1.13	0.02	0.06	0.54	0.06	3.87	4.68	100.00	0.9767
50	2497	FLV-159-CH T219-6	12/20/90	77.01	12.76	1.08	0.03	0.03	0.54	0.05	3.94	4.57	100.01	0.9767

Listing of 25 closest matches for COMP. NO. 2637 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 06/18/92

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2637	JB-BS-9 T241-1	10/21/91	76.42	12.92	1.10	0.01	0.08	0.55	0.05	4.22	4.65	100.00	1.0000
2	2641	JB-BS-14 T241-5	10/21/91	76.55	12.82	1.11	0.02	0.07	0.55	0.06	4.20	4.62	100.00	0.9951
3	1409	KRL 82182 (Al) (599) T112-1	10/22/85	76.60	12.87	1.11	0.04	0.04	0.55	0.06	4.08	4.65	100.00	0.9919
4	2638	JB-BS-11 T241-2	10/21/91	76.55	12.80	1.10	0.02	0.08	0.54	0.06	4.16	4.68	99.99	0.9917
5	2639	JB-BS-12 T241-3	10/21/91	76.51	12.85	1.11	0.03	0.08	0.54	0.05	4.16	4.67	100.00	0.9913
6	2642	JB-BS-15 T241-6	10/21/91	76.59	12.83	1.08	0.03	0.07	0.54	0.04	4.23	4.59	100.00	0.9899
7	2682	JB-BS-9 T241-1	10/21/91	76.15	13.07	1.11	0.01	0.08	0.56	0.05	4.27	4.70	100.00	0.9893
8	2640	JB-BS-13 T241-4	10/21/91	76.49	12.83	1.08	0.03	0.08	0.53	0.06	4.26	4.64	100.00	0.9877
9	571	KRL91982F, T56-5	07/01/83	76.61	12.89	1.14	0.03	0.05	0.55	0.05	4.12	4.56	100.00	0.9862
10	2060	FLV-64-CS T170-7	9/3/88	76.71	12.87	1.11	0.02	0.04	0.54	0.04	4.02	4.64	99.99	0.9859
11	431	YOS-1, T13-1		76.61	12.93	1.12	0.03	0.05	0.54	0.07	4.03	4.64	100.02	0.9856
12	2717	FLV-201-TO T249-5	1/30/92	76.85	12.77	1.10	0.02	0.04	0.54	0.04	3.99	4.65	100.00	0.9850
13	1240	WL 4-2 3.29m T93-9	5/2/85	76.75	12.79	1.13	0.03	0.04	0.55	0.05	4.02	4.64	100.00	0.9849
14	2795	FLV-209-BC T254-6	4/14/92	76.36	13.11	1.09	0.03	0.06	0.55	0.07	4.01	4.73	100.01	0.9848
15	2645	JB-WA-1 T242-1	10/21/91	76.77	12.70	1.09	0.02	0.07	0.53	0.06	4.19	4.57	100.00	0.9848
16	435	3-30-82-1, T43-3		76.62	12.93	1.06	0.02	0.05	0.54	0.07	4.13	4.59	100.01	0.9846
17	760	BO-16		76.59	12.92	1.11	0.03	0.03	0.54	0.07	4.00	4.71	100.00	0.9843
18	2235	SL-103 T186-2	2/28/89	76.68	12.95	1.10	0.03	0.04	0.55	0.07	3.88	4.69	99.99	0.9842
19	1418	BL-RSA-4 T112-9	10/23/85	76.83	12.79	1.08	0.04	0.04	0.55	0.06	3.96	4.65	100.00	0.9841
20	758	BO-11		76.35	13.11	1.12	0.03	0.04	0.55	0.09	4.00	4.70	99.99	0.9840
21	2557	SS-91-1-1 T232-2	6/8/91	76.57	12.92	1.07	0.02	0.04	0.54	0.06	4.05	4.72	99.99	0.9829
22	783	GS-27		76.74	12.92	1.12	0.03	0.05	0.55	0.07	3.91	4.61	100.00	0.9827
23	1224	WL CORE G 370cm T92-7	5/2/85	76.83	12.82	1.09	0.04	0.04	0.54	0.05	3.95	4.65	100.01	0.9826
24	2558	SS-91-1-SU T232-1	8/6/91	76.74	12.86	1.09	0.04	0.04	0.54	0.05	3.95	4.68	99.99	0.9823
25	2570	JB-BS-7 T227-4	6/13/91	76.73	12.89	1.10	0.03	0.05	0.54	0.06	3.91	4.69	100.00	0.9822

Listing of 25 closest matches for COMP. NO. 2682 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 06/18/92

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2682	JB-BS-9 T241-1	10/21/91	76.15	13.07	1.11	0.01	0.08	0.56	0.05	4.27	4.70	100.00	1.0000
2	2637	JB-BS-9 T241-1	10/21/91	76.42	12.92	1.10	0.01	0.08	0.55	0.05	4.22	4.65	100.00	0.9893
3	2641	JB-BS-14 T241-5	10/21/91	76.55	12.82	1.11	0.02	0.07	0.55	0.06	4.20	4.62	100.00	0.9874
4	2639	JB-BS-12 T241-3	10/21/91	76.51	12.85	1.11	0.03	0.08	0.54	0.05	4.16	4.67	100.00	0.9851
5	1409	KRL 82182 (A1) (599) T112-1	10/22/85	76.60	12.87	1.11	0.04	0.04	0.55	0.06	4.08	4.65	100.00	0.9843
6	758	BO-11		76.35	13.11	1.12	0.03	0.04	0.55	0.09	4.00	4.70	99.99	0.9841
7	788	GS-32		76.58	12.90	1.13	0.03	0.04	0.56	0.06	4.00	4.70	100.00	0.9834
8	2638	JB-BS-11 T241-2	10/21/91	76.55	12.80	1.10	0.02	0.08	0.54	0.06	4.16	4.68	99.99	0.9832
9	2795	FLV-209-BC T254-6	4/14/92	76.36	13.11	1.09	0.03	0.06	0.55	0.07	4.01	4.73	100.01	0.9818
10	1223	WL CORE G 180cm T92-6	5/2/85	76.64	12.88	1.11	0.04	0.05	0.57	0.06	3.99	4.67	100.01	0.9816
11	760	BO-16		76.59	12.92	1.11	0.03	0.03	0.54	0.07	4.00	4.71	100.00	0.9803
12	2640	JB-BS-13 T241-4	10/21/91	76.49	12.83	1.08	0.03	0.08	0.53	0.06	4.26	4.64	100.00	0.9802
13	2642	JB-BS-15 T241-6	10/21/91	76.59	12.83	1.08	0.03	0.07	0.54	0.04	4.23	4.59	100.00	0.9801
14	571	KRL91982F, T56-5	07/01/83	76.61	12.89	1.14	0.03	0.05	0.55	0.05	4.12	4.56	100.00	0.9785
15	2060	FLV-64-CS T170-7	9/3/88	76.71	12.87	1.11	0.02	0.04	0.54	0.04	4.02	4.64	99.99	0.9784
16	431	YOS-1, T13-1		76.61	12.93	1.12	0.03	0.05	0.54	0.07	4.03	4.64	100.02	0.9783
17	2708	FLV-193-BC T246-2	12/12/91	76.75	12.61	1.16	0.04	0.06	0.56	0.06	4.11	4.65	100.00	0.9776
18	1240	WL 4-2 3.29m T93-9	5/2/85	76.75	12.79	1.13	0.03	0.04	0.55	0.05	4.02	4.64	100.00	0.9773
19	2235	SL-103 T186-2	2/28/89	76.68	12.95	1.10	0.03	0.04	0.55	0.07	3.88	4.69	99.99	0.9773
20	780	GS-21		76.41	13.12	1.13	0.03	0.05	0.58	0.06	4.01	4.61	100.00	0.9768
21	2169	KRL-82982-KP T178-5	12/6/88	76.70	13.01	1.11	0.02	0.06	0.55	0.06	3.81	4.67	99.99	0.9760
22	2557	SS-91-1-1 T232-2	6/8/91	76.57	12.92	1.07	0.02	0.04	0.54	0.06	4.05	4.72	99.99	0.9759
23	741	HC-1		76.76	12.83	1.11	0.02	0.03	0.58	0.06	3.91	4.71	100.01	0.9755
24	1291	WL 8-1B 192-194cm T99-3	07/01/85	76.95	12.70	1.11	0.03	0.06	0.56	0.07	3.86	4.64	99.98	0.9754
25	1225	WL CORE G 380cm T92-8	5/2/85	76.82	12.79	1.06	0.04	0.04	0.56	0.06	4.00	4.65	100.02	0.9752

Listing of 25 closest matches for COMP. NO. 2638 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 06/18/92

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2638	JB-BS-11 T241-2	10/21/91	76.55	12.80	1.10	0.02	0.08	0.54	0.06	4.16	4.68	99.99	1.0000
2	2639	JB-BS-12 T241-3	10/21/91	76.51	12.85	1.11	0.03	0.08	0.54	0.05	4.16	4.67	100.00	0.9974
3	2637	JB-BS-9 T241-1	10/21/91	76.42	12.92	1.10	0.01	0.08	0.55	0.05	4.22	4.65	100.00	0.9917
4	2641	JB-BS-14 T241-5	10/21/91	76.55	12.82	1.11	0.02	0.07	0.55	0.06	4.20	4.62	100.00	0.9915
5	2717	FLV-201-TO T249-5	1/30/92	76.85	12.77	1.10	0.02	0.04	0.54	0.04	3.99	4.65	100.00	0.9911
6	2642	JB-BS-15 T241-6	10/21/91	76.59	12.83	1.08	0.03	0.07	0.54	0.04	4.23	4.59	100.00	0.9905
7	2060	FLV-64-CS T170-7	9/3/88	76.71	12.87	1.11	0.02	0.04	0.54	0.04	4.02	4.64	99.99	0.9902
8	1409	KRL 82182 (A1) (599) T112-1	10/22/85	76.60	12.87	1.11	0.04	0.04	0.55	0.06	4.08	4.65	100.00	0.9902
9	760	BO-16		76.59	12.92	1.11	0.03	0.03	0.54	0.07	4.00	4.71	100.00	0.9894
10	2558	SS-91-1-SU T232-1	8/6/91	76.74	12.86	1.09	0.04	0.04	0.54	0.05	3.95	4.68	99.99	0.9889
11	681	KRL-91882A', T66-8	10/25/83	76.79	12.83	1.10	0.03	0.06	0.54	0.07	3.91	4.67	100.00	0.9887
12	431	YOS-1, T13-1		76.61	12.93	1.12	0.03	0.05	0.54	0.07	4.03	4.64	100.02	0.9886
13	2716	FLV-200-LC T249-4	1/30/92	76.77	12.80	1.11	0.02	0.04	0.53	0.06	4.01	4.67	100.01	0.9886
14	2645	JB-WA-1 T242-1	10/21/91	76.77	12.70	1.09	0.02	0.07	0.53	0.06	4.19	4.57	100.00	0.9885
15	1224	WL CORE G 370cm T92-7	5/2/85	76.83	12.82	1.09	0.04	0.04	0.54	0.05	3.95	4.65	100.01	0.9881
16	2570	JB-BS-7 T227-4	6/13/91	76.73	12.89	1.10	0.03	0.05	0.54	0.06	3.91	4.69	100.00	0.9881
17	2557	SS-91-1-1 T232-2	6/8/91	76.57	12.92	1.07	0.02	0.04	0.54	0.06	4.05	4.72	99.99	0.9880
18	2640	JB-BS-13 T241-4	10/21/91	76.49	12.83	1.08	0.03	0.08	0.53	0.06	4.26	4.64	100.00	0.9880
19	435	3-30-82-1, T43-3		76.62	12.93	1.06	0.02	0.05	0.54	0.07	4.13	4.59	100.01	0.9877
20	2562	SS-91-1-5 T232-6	8/7/91	76.97	12.65	1.08	0.03	0.04	0.54	0.07	3.98	4.65	100.01	0.9858
21	566	KRL91882B, T64-12	09/06/83	76.81	12.82	1.10	0.01	0.05	0.53	0.08	3.91	4.69	100.00	0.9857
22	1416	BL-RSA-2 T112-7	10/23/85	76.78	12.85	1.12	0.04	0.03	0.54	0.06	3.90	4.68	100.00	0.9855
23	1972	WL-4-58 (144.77m) T164-1	5/21/88	76.73	12.71	1.15	0.00	0.03	0.54	0.12	4.02	4.69	99.99	0.9852
24	1240	WL 4-2 3.29m T93-9	5/2/85	76.75	12.79	1.13	0.03	0.04	0.55	0.05	4.02	4.64	100.00	0.9849
25	1418	BL-RSA-4 T112-9	10/23/85	76.83	12.79	1.08	0.04	0.04	0.55	0.06	3.96	4.65	100.00	0.9841

Listing of 50 closest matches for COMP. NO. 2639 # elements: Na, Al, Si, K, Ca, Fe Date of Update: 10/22/91

	C.No	Sample Number	Date		Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total	#. Co
1	2639	JB-BS-11 T241-2	10/21/91	76.55	12.80	1.10	0.02	0.08	0.54	0.06	4.16	4.68	99.99	1.0000
2	2640	JB-BS-12 T241-3	10/21/91	76.51	12.85	1.11	0.03	0.08	0.54	0.05	4.16	4.67	100.00	0.9974
3	2638	JB-BS-9 T241-1	10/21/91	76.42	12.92	1.10	0.01	0.08	0.55	0.05	4.22	4.55	100.00	0.9917
4	2642	JB-BS-14 T241-5	10/21/91	76.55	12.82	1.11	0.02	0.07	0.55	0.06	4.20	4.62	100.00	0.9913
5	2643	JB-BS-15 T241-6	10/21/91	76.59	12.83	1.08	0.03	0.07	0.54	0.04	4.23	4.59	100.00	0.9905
6	2060	FLV-64-CS T170-7	9/3/88	76.71	12.87	1.11	0.02	0.04	0.54	0.04	4.02	4.64	99.99	0.9902
7	1409	KRL 82182 (A1) (599) T112-1	10/22/85	76.60	12.87	1.11	0.04	0.04	0.55	0.06	4.08	4.65	100.00	0.9902
8	750	BD-16		76.59	12.92	1.11	0.03	0.03	0.54	0.07	4.00	4.71	100.00	0.9894
9	2559	SS-91-1-SU T232-1	8/6/91	76.74	12.86	1.09	0.04	0.04	0.54	0.05	3.95	4.68	99.99	0.9889
10	681	KRL-91882A*, T66-8	10/25/83	76.79	12.83	1.10	0.03	0.06	0.54	0.07	3.91	4.67	100.00	0.9887
11	431	YDS-1, T13-1		76.61	12.93	1.12	0.03	0.05	0.54	0.07	4.03	4.64	100.02	0.9886
12	2646	JB-WA-1 T242-1	10/21/91	76.77	12.70	1.09	0.02	0.07	0.53	0.06	4.19	4.57	100.00	0.9885
13	1224	WL CORE G 370cm T92-7	5/2/85	76.83	12.82	1.09	0.04	0.04	0.54	0.05	3.95	4.65	100.01	0.9881
14	2571	JB-BS-7 T227-4	6/13/91	76.73	12.89	1.10	0.03	0.05	0.54	0.06	3.91	4.69	100.00	0.9881
15	2558	SS-91-1-1 T232-2	6/8/91	76.57	12.92	1.07	0.02	0.04	0.54	0.06	4.05	4.72	99.99	0.9880
16	2641	JB-BS-13 T241-4	10/21/91	76.49	12.83	1.08	0.03	0.08	0.53	0.06	4.26	4.64	100.00	0.9880
17	435	3-30-82-1, T43-3		76.62	12.93	1.06	0.02	0.05	0.54	0.07	4.13	4.59	100.01	0.9877
18	2563	SS-91-1-5 T232-6	8/7/91	76.97	12.65	1.08	0.03	0.04	0.54	0.07	3.98	4.65	100.01	0.9868
19	566	KRL91882B, T64-12	09/06/83	76.81	12.82	1.10	0.01	0.05	0.53	0.08	3.91	4.69	100.00	0.9857
20	1416	BL-RSA-2 T112-7	10/23/85	76.78	12.85	1.12	0.04	0.03	0.54	0.06	3.90	4.68	100.00	0.9855
21	1972	WL-4-58 (144.77m) T164-1	5/21/88	76.73	12.71	1.15	0.00	0.03	0.54	0.12	4.02	4.69	99.99	0.9852
22	1240	WL 4-2 3.29m T93-9	5/2/85	76.75	12.79	1.13	0.03	0.04	0.55	0.05	4.02	4.64	100.00	0.9849
23	1418	BL-RSA-4 T112-9	10/23/85	76.83	12.79	1.08	0.04	0.04	0.55	0.06	3.96	4.65	100.00	0.9841
24	2494	FLV-156-SS T219-3	12/20/90	76.64	13.06	1.09	0.03	0.04	0.54	0.05	3.94	4.62	100.01	0.9840
25	571	KRL91982F, T56-5	07/01/83	76.61	12.89	1.14	0.03	0.05	0.55	0.05	4.12	4.56	100.00	0.9840
26	1419	BL-RSA-5 T112-10	10/23/85	76.98	12.65	1.09	0.04	0.04	0.53	0.05	3.93	4.68	99.99	0.9833
27	2236	SL-103 T186-2	2/28/89	76.68	12.95	1.10	0.03	0.04	0.55	0.07	3.88	4.69	99.99	0.9832
28	2497	FLV-159-CH T219-6	12/20/90	77.01	12.76	1.08	0.03	0.03	0.54	0.05	3.54	4.57	100.01	0.9827
29	1230	WL 8-18 92-94cm T99-1	07/01/85	76.99	12.72	1.11	0.02	0.06	0.54	0.07	3.84	4.65	100.00	0.9826
30	682	KRL-91882G, T66-11	10/25/83	76.91	12.76	1.07	0.03	0.06	0.54	0.07	3.87	4.68	99.99	0.9825
31	2644	JB-BS-16 T241-7	10/21/91	76.97	12.59	1.04	0.02	0.08	0.54	0.05	4.13	4.58	100.00	0.9825
32	758	BD-11		76.35	13.11	1.12	0.03	0.04	0.55	0.09	4.00	4.70	99.99	0.9825
33	1196	WALKER LAKE CORE G 380CM t89-1	2/28/85	76.98	12.79	1.08	0.02	0.05	0.54	0.05	3.86	4.64	100.01	0.9825
34	550	KRL82282, T66-4	xx/xx/83	76.74	12.90	1.13	0.02	0.06	0.54	0.06	3.87	4.66	100.00	0.9823
35	1684	SCHURZ-1 T134-6	11/25/86	77.01	12.64	1.09	0.03	0.05	0.55	0.05	3.94	4.64	100.00	0.9821
36	2381	FLV-131-FC T203-4	4/16/90	77.18	12.43	1.12	0.01	0.04	0.54	0.06	3.93	4.68	99.99	0.9816
37	1521	BD-18 JOD	09/12/86	76.98	12.70	1.10	0.03	0.05	0.55	0.07	3.83	4.68	99.99	0.9815
38	1025	KRL-71082C (590) T58-1	6/22/84	76.91	12.71	1.08	0.02	0.00	0.53	0.05	3.95	4.74	99.99	0.9814
39	1223	WL CORE G 180cm T92-6	5/2/85	76.64	12.88	1.11	0.04	0.05	0.57	0.06	3.99	4.67	100.01	0.9813
40	561	KRL82282A, T66-5	10/25/83	76.71	12.88	1.12	0.04	0.05	0.52	0.06	3.98	4.65	100.01	0.9812
41	1948	WL-4-4 (12.25M) T162-2	5/14/88	76.87	12.86	1.09	0.02	0.05	0.54	0.06	3.80	4.72	100.01	0.9812
42	788	GS-32		76.58	12.90	1.13	0.03	0.04	0.56	0.06	4.00	4.70	100.00	0.9811
43	2569	JB-BS-5 T227-2	6/13/91	76.69	12.91	1.08	0.02	0.05	0.55	0.09	3.90	4.70	99.99	0.9811
44	1472	KRL 82182 (A-1) T117-3	3/6/86	76.80	12.75	1.10	0.03	0.04	0.55	0.07	3.87	4.77	99.98	0.9810
45	570	KRL91982D, T66-10	xx/xx/83	76.81	12.89	1.08	0.03	0.05	0.53	0.06	3.90	4.65	100.00	0.9807
46	1947	WL-4-4 (10.83M) T162-1	5/14/88	76.86	12.94	1.10	0.04	0.06	0.54	0.06	3.77	4.64	100.01	0.9805
47	192	LD-12, T3,4		76.94	12.70	1.12	0.03	0.07	0.53	0.07	3.91	4.64	100.01	0.9803
48	567	KRL91882-K-1, T64-13	09/06/83	76.93	12.82	1.11	0.01	0.05	0.53	0.07	3.88	4.60	100.00	0.9803
49	564	KRL82782A, T64-11	09/06/83	76.99	12.75	1.09	0.01	0.06	0.53	0.08	3.90	4.59	100.00	0.9802
50	1680	KRL 860922 A T134-2	11/25/86	76.94	12.75	1.07	0.03	0.04	0.55	0.06	3.91	4.65	100.00	0.9796

SAMPLE ID: JB-BS-11 T241-2

Date of Analysis: 10/21/91

Raw Probe Data		Raw Probe Data (FeO to Fe2O3)	Recalculated to 100%	
SiO2	75.463		SiO2	76.55
Al2O3	12.620		Al2O3	12.80
FeO	0.977*1.1113=Fe2O3	1.086	Fe2O3	1.10
MgO	0.023		MgO	0.02
MnO	0.080		MnO	0.08
CaO	0.533		CaO	0.54
TiO2	0.056		TiO2	0.06
Na2o	4.101		Na2o	4.16
K2O	4.612		K2O	4.68
TOTAL(O) 98.465		TOTAL(N) 98.574	TOTAL(R)	99.99

20 Best Matches:

1	0.9917	10/21/91	JB-BS-9 T241-1
2	0.9902	9/3/88	FLV-64-CS T170-7
3	0.9902	10/22/85	KRL 82182 (A1) (599) T112-1
4	0.9894		80-16
5	0.9889	8/6/91	SS-91-1-SU T232-1
6	0.9887	10/25/83	KRL-91882A", T66-8
7	0.9886		YOS-1, T13-1
8	0.9881	5/2/85	WL CORE G 370cm T92-7
9	0.9881	6/13/91	JB-BS-7 T227-4
10	0.9880	6/8/91	SS-91-1-1 T232-2
11	0.9877		3-30-82-1, T43-3
12	0.9858	8/7/91	SS-91-1-5 T232-6
13	0.9857	09/06/83	KRL918828, T64-12
14	0.9855	10/23/85	BL-RSA-2 T112-7
15	0.9852	5/21/88	WL-4-58 (144.77m) T164-1
16	0.9849	5/2/85	WL 4-2 3.29m T93-9
17	0.9841	10/23/85	BL-RSA-4 T112-9
18	0.9840	12/20/90	FLV-156-SS T219-3
19	0.9840	07/01/83	KRL91982F, T56-5
20	0.9833	10/23/85	BL-RSA-5 T112-10

Elements used in the calculation are:

Na2o
Al2O3
SiO2
K2O
CaO
FeO

***** This sample has been added to the data base *****

SAMPLE: T241-2 JR-BS-11

PT	I COUNTS	NA COUNTS	9 SD	MG COUNTS	8 SD	AL COUNTS	3 SD	SI COUNTS	7 SD	K COUNTS	SD	CA COUNTS	6 SD	TI COUNTS	5 SD	MN COUNTS	1 SD	FE COUNTS	4 SD
1	14133	2492	50	137	12	14368	120	27028	164	9171	96	919	30	27	5	91	10	604	25
2	14142	2515	17	164	19	13984	272	27208	127	8814	252	935	12	21	4	105	10	584	14
3	14143	2531	20	150	13	14404	233	26698	259	8819	205	926	8	39	9	95	7	540	33
4	14146	2608	50	149	11	14335	195	26927	213	8916	167	927	7	33	8	113	10	633	39
5	14148	2580	48	154	10	14399	178	27896	455	9098	163	960	16	11	11	127	14	673	50
6	14142	2615	51	133	11	14576	195	27592	445	9318	205	961	18	26	10	106	13	652	49
7	14139	2565	47	150	10	14505	188	27661	439	8923	191	939	17	21	9	141	18	629	45
8	14146	2301	101	153	10	14318	175	26923	426	10213	461	815	46	38	9	102	17	579	43
9	14139	41	834	130	11	515	****	38051	****	139	****	147	262	20	9	79	19	101	175
10	14139	2080	788	167	12	14152	****	26911	****	10965	****	854	247	30	9	102	18	436	169
11	14141	3255	809	200	19	31086	****	18585	****	1727	****	15598	****	42	9	84	18	411	165
12	14147	2680	778	151	18	14650	****	27473	****	9019	****	935	****	28	9	116	18	650	161
13	14146	2665	749	161	18	14807	****	27058	****	9185	****	946	****	37	9	106	17	608	156
14	14151	2680	725	146	17	14455	****	27893	****	8914	****	986	****	22	9	116	16	561	150
15	14149	2540	699	157	17	14183	****	28088	****	8978	****	952	****	21	9	121	16	589	145
16	14145	2471	676	144	16	14488	****	27780	****	9188	****	1023	****	27	8	113	16	592	140
17	14144	2556	655	163	16	14292	****	27289	****	8812	****	908	****	38	9	110	15	632	137
18	14148	2530	636	154	15	14434	****	27822	****	9126	****	990	****	34	8	82	16	610	134
19	14143	2484	618	148	15	14501	****	28006	****	9013	****	988	****	33	8	118	16	597	130
20	14143	2503	602	148	15	14406	****	27590	****	9110	****	942	****	30	8	104	15	621	127

LINES DELETED: 9 11 10

AVE. BEAM CURRENT/SEC = 707

DATA REDUCED USING $B-AL: *GL9M

ON SPECIMEN: T241-2 JR-BS-11

$B-AL VERSION 1.0

OXIDE FORM.	WEIGHT% (OXIDE)	STD.DEV. (%)	HOMO. INDEX	FORMULA	K-RATIO	UNKN PEAK (COUNTS)	UNKN BKGD (COUNTS)	COUNTING TIME(SEC)	STD PEAK (COUNTS)	STD BKGD (COUNTS)	COUNTING TIME(SEC)	STANDARD FILENAME
NA2O	4.101	2.93	1.826	0.000	1.06265	2548.2	50.4	20.00	2400.2	49.7	20.00	%RGSC
MGO	0.023	119.33	0.670	0.000	0.00609	150.6	136.4	20.00	2469.5	136.9	20.00	%RGSC
AL2O3	12.620	1.20	1.516	0.000	0.96344	14417.8	247.4	20.00	14955.9	247.8	20.00	%5831
SIO2	75.463	0.86	2.600	0.000	1.02232	27466.7	53.8	20.00	26868.4	53.9	20.00	%5831
K2O	4.612	1.62	3.396	0.000	1.26465	9095.1	144.7	20.00	7230.1	152.8	20.00	%RGSC
CAO	0.533	4.54	1.454	0.000	0.10427	944.3	179.2	20.00	7528.9	191.2	20.00	%RGSC
TIO2	0.056	67.45	1.450	0.000	0.00051	28.5	18.4	20.00	19938.2	26.6	20.00	%TIO2
MNO	0.080	29.32	1.316	0.000	0.00080	109.5	64.5	20.00	56342.7	119.9	20.00	%MN2O
FEO	0.977	5.61	1.388	0.000	0.15274	609.1	105.6	20.00	3409.3	112.6	20.00	%RGSC

TOTAL 98.465 NO. OXYGENS = 0 NO. ITERS. = 2 AVE. ATOMIC NO. = 11.16

21-OCT-91 14:15:28

SAMPLE: T` ` JR-BS-12

PT	BEAM COUNTS	NA COUNTS	9 SD	MG COUNTS	8 SD	AL COUNTS	3 SD	SI COUNTS	7 SD	K COUNTS	2 SD	CA COUNTS	6 SD	TI COUNTS	5 SD	MN COUNTS	1 SD	FE COUNTS	4 SD
1	14146	2489	50	168	13	14585	121	27408	166	10053	100	963	29	33	6	115	11	455	21
2	14146	2456	23	168	0	14511	52	27334	52	9979	759	920	40	22	8	103	8	633	126
3	14139	2632	94	145	13	21373	****	23547	****	21554	****	446	259	17	8	86	15	144	248
4	14142	2732	129	173	13	14843	****	27521	****	9114	****	986	244	27	7	111	13	573	218
5	14138	3511	476	201	20	31543	****	18570	****	851	****	15335	****	21	6	92	12	331	196
6	14150	2424	450	148	20	13822	****	26563	****	8064	****	957	****	27	6	102	11	565	184
7	14142	2645	412	143	21	14491	****	27400	****	9025	****	952	****	37	7	102	10	619	180
8	14136	2556	385	162	19	14392	****	27709	****	9112	****	916	****	21	7	133	14	606	173
9	14135	2641	361	151	18	14276	****	27936	****	9014	****	940	****	34	7	107	14	605	166
10	14132	2620	341	141	18	14308	****	27540	****	9076	****	984	****	32	7	108	13	625	161
11	14140	2216	352	143	18	14101	****	26773	****	8973	****	1047	****	27	6	103	12	513	153
12	14145	2499	338	148	18	14615	****	27555	****	8956	****	903	****	21	6	103	12	726	158
13	14146	2577	324	156	17	14619	****	27401	****	9193	****	933	****	27	6	125	12	657	155
14	14145	2562	312	136	17	14639	****	27589	****	9071	****	949	****	25	6	94	12	702	155
15	14150	2225	317	147	17	13678	****	26243	****	8967	****	756	****	20	6	95	12	441	152
16	14147	3135	335	158	16	18006	****	25486	****	12229	****	1040	****	28	6	110	12	405	151
17	14153	2598	325	155	16	14609	****	27729	****	9097	****	944	****	33	6	112	12	652	149
18	14156	2502	316	156	15	14678	****	27297	****	9885	****	840	****	30	6	123	12	594	145
19	14153	2541	308	161	15	14606	****	27424	****	9108	****	948	****	27	5	100	12	593	142
20	14150	2592	300	160	15	14373	****	27271	****	9087	****	943	****	23	5	105	11	653	140

LINES DELETED:
LINES DELETED: 3 5 16 15 18

AVE. BEAM CURRENT/SEC = 707

DATA REDUCED USING $B-AL: *GL9H

ON SPECIMEN: T241-3 JR-BS-12

$B-AL VERSION 1.0

OXIDE FORM.	WEIGHT% (OXIDE)	STD.DEV. (%)	HOMO. INDEX	FORMULA	K-RATIO	UNKN PEAK (COUNTS)	UNKN BKGD (COUNTS)	COUNTING TIME(SEC)	STD PEAK (COUNTS)	STD BKGD (COUNTS)	COUNTING TIME(SEC)	STANDARD FILENAME
NA2O	4.094	2.93	2.385	0.000	1.06053	2543.2	50.4	20.00	2400.2	49.7	20.00	%RGSC
MGO	0.029	96.33	0.892	0.000	0.00759	154.1	136.4	20.00	2469.5	136.9	20.00	%RGSC
AL2O3	12.653	1.20	2.103	0.000	0.96581	14452.5	247.3	20.00	14955.9	247.8	20.00	%5831
SIO2	75.324	0.86	2.103	0.000	1.02021	27410.2	53.9	20.00	26868.4	53.9	20.00	%5831
K2O	4.595	1.62	4.005	0.000	1.25990	9061.4	144.7	20.00	7230.1	152.8	20.00	%RGSC
CAO	0.534	4.54	1.342	0.000	0.10447	945.7	179.2	20.00	7528.9	191.2	20.00	%RGSC
TIO2	0.051	72.90	0.955	0.000	0.00047	27.7	18.4	20.00	19938.2	26.6	20.00	%TIO2
MNO	0.078	30.21	0.963	0.000	0.00077	108.0	64.5	20.00	56342.7	119.9	20.00	%MN2O
FEO	0.983	5.59	2.778	0.000	0.15357	611.8	105.5	20.00	3409.3	112.6	20.00	%RGSC

TOTAL 98.339 NO. OXYGENS = 0 NO. ITERS. = 2 AVE. ATOMIC NO. = 11.16

Listing of 25 closest matches for COMP. NO. 2639 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 06/18/92

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2639	JB-BS-12 T241-3	10/21/91	76.51	12.85	1.11	0.03	0.08	0.54	0.05	4.16	4.67	100.00	1.0000
2	2638	JB-BS-11 T241-2	10/21/91	76.55	12.80	1.10	0.02	0.08	0.54	0.06	4.16	4.68	99.99	0.9974
3	2641	JB-BS-14 T241-5	10/21/91	76.55	12.82	1.11	0.02	0.07	0.55	0.06	4.20	4.62	100.00	0.9931
4	2060	FLV-64-CS T170-7	9/3/88	76.71	12.87	1.11	0.02	0.04	0.54	0.04	4.02	4.64	99.99	0.9926
5	1409	KRL 82182 (Al) (599) T112-1	10/22/85	76.60	12.87	1.11	0.04	0.04	0.55	0.06	4.08	4.65	100.00	0.9926
6	2637	JB-BS-9 T241-1	10/21/91	76.42	12.92	1.10	0.01	0.08	0.55	0.05	4.22	4.65	100.00	0.9913
7	760	BO-16		76.59	12.92	1.11	0.03	0.03	0.54	0.07	4.00	4.71	100.00	0.9911
8	431	YOS-1, T13-1		76.61	12.93	1.12	0.03	0.05	0.54	0.07	4.03	4.64	100.02	0.9910
9	2716	FLV-200-LC T249-4	1/30/92	76.77	12.80	1.11	0.02	0.04	0.53	0.06	4.01	4.67	100.01	0.9897
10	2642	JB-BS-15 T241-6	10/21/91	76.59	12.83	1.08	0.03	0.07	0.54	0.04	4.23	4.59	100.00	0.9894
11	2717	FLV-201-TO T249-5	1/30/92	76.85	12.77	1.10	0.02	0.04	0.54	0.04	3.99	4.65	100.00	0.9892
12	681	KRL-91882A', T66-8	10/25/83	76.79	12.83	1.10	0.03	0.06	0.54	0.07	3.91	4.67	100.00	0.9876
13	2558	SS-91-1-SU T232-1	8/6/91	76.74	12.86	1.09	0.04	0.04	0.54	0.05	3.95	4.68	99.99	0.9876
14	435	3-30-82-1, T43-3		76.62	12.93	1.06	0.02	0.05	0.54	0.07	4.13	4.59	100.01	0.9872
15	1416	BL-RSA-2 T112-7	10/23/85	76.78	12.85	1.12	0.04	0.03	0.54	0.06	3.90	4.68	100.00	0.9872
16	2640	JB-BS-13 T241-4	10/21/91	76.49	12.83	1.08	0.03	0.08	0.53	0.06	4.26	4.64	100.00	0.9871
17	2557	SS-91-1-1 T232-2	6/8/91	76.57	12.92	1.07	0.02	0.04	0.54	0.06	4.05	4.72	99.99	0.9868
18	1224	WL CORE G 370cm T92-7	5/2/85	76.83	12.82	1.09	0.04	0.04	0.54	0.05	3.95	4.65	100.01	0.9868
19	2570	JB-BS-7 T227-4	6/13/91	76.73	12.89	1.10	0.03	0.05	0.54	0.06	3.91	4.69	100.00	0.9868
20	2645	JB-WA-1 T242-1	10/21/91	76.77	12.70	1.09	0.02	0.07	0.53	0.06	4.19	4.57	100.00	0.9866
21	571	KRL91982F, T56-5	07/01/83	76.61	12.89	1.14	0.03	0.05	0.55	0.05	4.12	4.56	100.00	0.9863
22	1240	WL 4-2 3.29m T93-9	5/2/85	76.75	12.79	1.13	0.03	0.04	0.55	0.05	4.02	4.64	100.00	0.9860
23	1972	WL-4-58 (144.77m) T164-1	5/21/88	76.73	12.71	1.15	0.00	0.03	0.54	0.12	4.02	4.69	99.99	0.9856
24	2682	JB-BS-9 T241-1	10/21/91	76.15	13.07	1.11	0.01	0.08	0.56	0.05	4.27	4.70	100.00	0.9851
25	758	BO-11		76.35	13.11	1.12	0.03	0.04	0.55	0.09	4.00	4.70	99.99	0.9844

Listing of 50 closest matches for COMP. NO. 2640 f-- elements: Na, Al, Si, K, Ca, Fe Date of Update: 10/22/91

	CANo	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total	Sim. Coef.
1	2640	JB-BS-12 T241-3	10/21/91	76.51	12.85	1.11	0.03	0.08	0.54	0.05	4.16	4.57	100.00	1.0000
2	2639	JB-BS-11 T241-2	10/21/91	76.55	12.80	1.10	0.02	0.08	0.54	0.06	4.16	4.68	99.99	0.9974
3	2642	JB-BS-14 T241-5	10/21/91	76.55	12.82	1.11	0.02	0.07	0.55	0.06	4.20	4.62	100.00	0.9931
4	2060	FLV-64-CS T170-7	9/3/88	76.71	12.87	1.11	0.02	0.04	0.54	0.04	4.02	4.64	99.99	0.9926
5	1439	KRL 82182 (A1) (599) T112-1	10/22/85	76.60	12.87	1.11	0.04	0.04	0.55	0.06	4.08	4.65	100.00	0.9926
6	2638	JB-BS-9 T241-1	10/21/91	76.42	12.92	1.10	0.01	0.08	0.55	0.05	4.22	4.65	100.00	0.9913
7	750	BO-16		76.59	12.92	1.11	0.03	0.03	0.54	0.07	4.00	4.71	100.00	0.9911
8	431	YOS-1, T13-1		76.61	12.93	1.12	0.03	0.05	0.54	0.07	4.03	4.64	100.02	0.9910
9	2643	JB-BS-15 T241-6	10/21/91	76.59	12.83	1.08	0.03	0.07	0.54	0.04	4.23	4.59	100.00	0.9894
10	681	KRL-91882A", T66-8	10/25/83	76.79	12.83	1.10	0.03	0.06	0.54	0.07	3.91	4.67	100.00	0.9876
11	2559	SS-91-1-SU T232-1	8/6/91	76.74	12.86	1.09	0.04	0.04	0.54	0.05	3.99	4.68	99.99	0.9876
12	435	3-30-82-1, T43-3		76.62	12.93	1.06	0.02	0.05	0.54	0.07	4.13	4.59	100.01	0.9872
13	1416	BL-RSA-2 T112-7	10/23/85	76.78	12.85	1.12	0.04	0.03	0.54	0.06	3.90	4.68	100.02	0.9872
14	2641	JB-BS-13 T241-4	10/21/91	76.49	12.83	1.08	0.03	0.08	0.53	0.06	4.26	4.64	100.00	0.9871
15	2558	SS-91-1-1 T232-2	6/8/91	76.57	12.92	1.07	0.02	0.04	0.54	0.06	4.05	4.72	99.99	0.9868
16	1224	WL CORE G 370cm T92-7	5/2/85	76.83	12.82	1.09	0.04	0.04	0.54	0.05	3.99	4.65	100.01	0.9866
17	2571	JB-BS-7 T227-4	6/13/91	76.73	12.89	1.10	0.03	0.05	0.54	0.06	3.91	4.69	100.00	0.9866
18	2646	JB-WA-1 T242-1	10/21/91	76.77	12.70	1.09	0.02	0.07	0.53	0.06	4.19	4.57	100.00	0.9866
19	571	KRL91982F, T56-5	07/01/83	76.61	12.89	1.14	0.03	0.05	0.55	0.05	4.12	4.56	100.00	0.9863
20	1240	WL 4-2 3.29m T93-9	5/2/85	76.75	12.79	1.13	0.03	0.04	0.55	0.05	4.02	4.64	100.00	0.9860
21	1972	WL-4-58 (144.77m) T164-1	5/21/88	76.73	12.71	1.15	0.00	0.03	0.54	0.12	4.02	4.69	99.99	0.9856
22	758	BO-11		76.35	13.11	1.12	0.03	0.04	0.55	0.09	4.00	4.70	99.99	0.9844
23	2563	SS-91-1-5 T232-6	8/7/91	76.97	12.65	1.08	0.03	0.04	0.54	0.07	3.98	4.65	100.01	0.9840
24	560	KRL82282, T66-4	xx/xx/83	76.74	12.90	1.13	0.02	0.06	0.54	0.06	3.67	4.63	100.00	0.9839
25	1223	WL CORE G 180cm T92-6	5/2/85	76.64	12.88	1.11	0.04	0.05	0.57	0.06	3.99	4.67	100.01	0.9837
26	1290	WL 8-1B 92-94cm T99-1	07/01/85	76.99	12.72	1.11	0.02	0.06	0.54	0.07	3.84	4.65	100.00	0.9837
27	566	KRL91882B, T64-12	09/06/83	76.81	12.82	1.10	0.01	0.05	0.53	0.08	3.91	4.69	100.00	0.9836
28	561	KRL82282A, T66-5	10/25/83	76.71	12.88	1.12	0.04	0.05	0.52	0.06	3.98	4.65	100.01	0.9836
29	2494	FLV-156-SS T219-3	12/20/90	76.64	13.06	1.09	0.03	0.04	0.54	0.05	3.94	4.62	100.01	0.9834
30	788	GS-32		76.58	12.90	1.13	0.03	0.04	0.56	0.06	4.00	4.70	100.00	0.9828
31	1418	BL-RSA-4 T112-9	10/23/85	76.83	12.79	1.08	0.04	0.04	0.55	0.06	3.96	4.65	100.00	0.9823
32	2381	FLV-131-FC T203-4	4/16/90	77.18	12.43	1.12	0.01	0.04	0.54	0.06	3.93	4.68	99.99	0.9820
33	783	GS-27		76.74	12.92	1.12	0.03	0.05	0.55	0.07	3.91	4.61	100.00	0.9819
34	557	KRL91882-K-1, T64-13	09/06/83	76.93	12.82	1.11	0.01	0.05	0.53	0.07	3.88	4.60	100.00	0.9819
35	2236	SL-103 T186-2	2/28/89	76.68	12.95	1.10	0.03	0.04	0.55	0.07	3.88	4.69	99.99	0.9819
36	1241	WL 4-2 3.31m T93-10	5/2/85	76.69	12.91	1.14	0.04	0.04	0.55	0.06	3.92	4.67	100.02	0.9818
37	192	LD-12, T3,4		76.94	12.70	1.12	0.03	0.07	0.53	0.07	3.91	4.64	100.01	0.9815
38	2497	FLV-159-CH T219-6	12/20/90	77.01	12.76	1.08	0.03	0.03	0.54	0.05	3.94	4.57	100.01	0.9809
39	1419	BL-RSA-5 T112-10	10/23/85	76.98	12.65	1.09	0.04	0.04	0.53	0.05	3.93	4.68	99.99	0.9807
40	2644	JB-BS-16 T241-7	10/21/91	76.97	12.59	1.04	0.02	0.08	0.54	0.05	4.13	4.56	100.00	0.9807
41	701	LD-12		76.94	12.72	1.12	0.03	0.07	0.53	0.07	3.91	4.61	100.00	0.9807
42	1136	WALKER LAKE CORE G 380CM t89-1	2/28/85	76.98	12.79	1.08	0.02	0.05	0.54	0.05	3.86	4.64	100.01	0.9806
43	2170	KRL-82982-KP T178-5	12/6/88	76.70	13.01	1.11	0.02	0.06	0.55	0.06	3.81	4.67	99.99	0.9805
44	952	DR-64		76.57	13.01	1.13	0.03	0.05	0.53	0.07	3.90	4.70	99.99	0.9803
45	1684	SCHURZ-1 T134-6	11/25/86	77.01	12.64	1.09	0.03	0.05	0.55	0.05	3.94	4.64	100.00	0.9803
46	570	KRL91982D, T66-10	xx/xx/83	76.81	12.89	1.08	0.03	0.05	0.53	0.06	3.90	4.65	100.00	0.9801
47	1226	WL 8-2A 28.5-33.0cm T92-10	5/2/85	77.00	12.77	1.12	0.03	0.05	0.54	0.06	3.76	4.66	99.99	0.9800
48	682	KRL-91882G, T66-11	10/25/83	76.91	12.76	1.07	0.03	0.06	0.54	0.07	3.87	4.68	99.99	0.9800
49	1948	WL-4-4 (12.25M) T162-2	5/14/88	76.87	12.86	1.09	0.02	0.05	0.54	0.06	3.80	4.72	100.01	0.9799
50	1947	WL-4-4 (10.83M) T162-1	5/14/88	76.86	12.94	1.10	0.04	0.06	0.54	0.06	3.77	4.64	100.01	0.9799

SAMPLE ID: JB-BS-12 T241-3

Date of Analysis: 10/21/91

Raw Probe Data		Raw Probe Data (FeO to Fe2O3)		Recalculated to 100%	
SiO2	75.324			SiO2	76.51
Al2O3	12.653			Al2O3	12.85
FeO	0.983*1.1113=Fe2O3		1.092	Fe2O3	1.11
MgO	0.029			MgO	0.03
MnO	0.078			MnO	0.08
CaO	0.534			CaO	0.54
TiO2	0.051			TiO2	0.05
Na2o	4.094			Na2o	4.16
K2O	4.595			K2O	4.67
TOTAL(O)	98.339	TOTAL(N)	98.448	TOTAL(R)	100.00

20 Best Matches:

1	0.9974	10/21/91	JB-BS-11 T241-2
2	0.9926	9/3/88	FLV-64-CS T170-7
3	0.9926	10/22/85	KRL 82182 (A1) (599) T112-1
4	0.9913	10/21/91	JB-BS-9 T241-1
5	0.9911		BO-16
6	0.9910		YDS-1, T13-1
7	0.9876	10/25/83	KRL-91882A", T66-8
8	0.9876	8/6/91	SS-91-1-SU T232-1
9	0.9872		3-30-82-1, T43-3
10	0.9872	10/23/85	BL-RSA-2 T112-7
11	0.9868	6/8/91	SS-91-1-1 T232-2
12	0.9868	5/2/85	WL CORE G 370cm T92-7
13	0.9868	6/13/91	JB-BS-7 T227-4
14	0.9863	07/01/83	KRL91982F, T56-5
15	0.9860	5/2/85	WL 4-2 3.29m T93-9
16	0.9856	5/21/88	WL-4-58 (144.77m) T164-1
17	0.9844		BO-11
18	0.9840	8/7/91	SS-91-1-5 T232-6
19	0.9839	xx/xx/83	KRL82282, T66-4
20	0.9837	5/2/85	WL CORE G 180cm T92-6

Elements used in the calculation are:

Na2o
Al2O3
SiO2
K2O
CaO
FeO

***** This sample has been added to the data base *****

SAMPLE: T241-4 JB-BS-13

PT	BEAM COUNTS	NA COUNTS	9 SD	MG COUNTS	8 SD	AL COUNTS	3 SD	SI COUNTS	7 SD	K COUNTS	2 SD	CA COUNTS	6 SD	TI COUNTS	5 SD	MN COUNTS	1 SD	FE COUNTS	4 SD
1	14162	2643	51	162	13	14575	121	27136	165	9039	95	922	30	28	5	100	10	619	25
2	14156	2628	11	142	14	14438	97	26921	152	9306	189	949	19	25	2	99	1	566	37
3	14153	2455	105	155	10	14094	248	25988	610	8747	280	928	14	46	11	108	5	593	26
4	14162	2579	95	170	12	14419	204	27003	523	9167	238	930	12	33	9	97	5	581	22
5	14171	2493	83	140	13	14240	188	27775	641	8909	218	893	21	43	9	112	6	613	22
6	14170	2580	74	163	12	14491	177	27407	601	9087	196	890	23	31	8	102	6	664	35
7	14173	2396	93	147	11	13646	320	25632	744	8500	272	901	22	25	8	101	5	578	33
8	14177	2574	87	133	13	14422	301	27272	724	9879	254	948	23	35	8	101	5	573	32
9	14167	2565	81	145	12	14333	282	27035	679	8896	228	904	23	36	7	119	7	610	31
10	14166	2570	77	165	12	14444	270	27823	702	9091	229	919	21	21	8	106	7	598	29
11	14167	2655	80	147	12	14208	258	27481	682	8936	218	939	21	34	8	105	6	580	28
12	14168	2624	78	160	12	13854	278	27016	650	8527	242	928	20	30	7	112	7	601	27
13	14161	39	704	153	11	503	****	38649	****	144	****	167	210	23	7	71	11	95	142
14	14169	2627	680	162	11	14316	****	27467	****	9050	****	936	203	19	8	131	13	625	137
15	14170	2638	659	160	11	14508	****	27143	****	8998	****	912	196	23	8	92	13	567	132
16	14165	2624	639	142	11	14472	****	27118	****	9046	****	936	190	29	8	120	13	582	128
17	14164	2580	620	149	10	14415	****	26989	****	8800	****	974	185	31	7	103	13	590	124
18	14159	46	822	150	10	531	****	38423	****	134	****	154	248	22	7	84	14	96	164
19	14174	2534	801	168	11	14061	****	27407	****	8922	****	929	242	30	7	110	13	558	159
20	14173	2567	782	166	11	14259	****	27375	****	8775	****	954	237	27	7	117	13	597	155

LINES DELETED: 13 18 3

AVE. BEAM CURRENT/SEC = 708

DATA REDUCED USING $B-AL:

*GL9M

ON SPECIMEN: T241-4 JB-BS-13

$B-AL VERSION 1.0

OXIDE FORM.	WEIGHT% (OXIDE)	STD.DEV. (%)	HOMO. INDEX	FORMULA	K-RATIO	UNKN PEAK (COUNTS)	UNKN BKGD (COUNTS)	COUNTING TIME(SEC)	STD PEAK (COUNTS)	STD BKGD (COUNTS)	COUNTING TIME(SEC)	STANDARD FILENAME
NA2O	4.161	2.92	1.257	0.000	1.07662	2581.0	50.5	20.00	2400.2	49.7	20.00	%RGSC
MGO	0.028	97.40	0.933	0.000	0.00750	153.8	136.3	20.00	2469.5	136.9	20.00	%RGSC
AL2O3	12.533	1.20	2.055	0.000	0.95548	14300.0	246.8	20.00	14955.9	247.8	20.00	%5B31
SIO2	74.715	0.86	2.907	0.000	1.01150	27176.5	53.7	20.00	26868.4	53.9	20.00	%5B31
K2O	4.530	1.63	2.188	0.000	1.24234	8936.9	144.4	20.00	7230.1	152.8	20.00	%RGSC
CAO	0.521	4.60	0.746	0.000	0.10201	927.1	178.7	20.00	7528.9	191.2	20.00	%RGSC
TIO2	0.061	62.55	1.105	0.000	0.00055	29.4	18.3	20.00	19938.2	26.6	20.00	%TIO2
MNO	0.077	30.55	0.982	0.000	0.00076	107.2	64.3	20.00	56342.7	119.9	20.00	%MN20
FEO	0.949	5.70	1.087	0.000	0.14835	594.3	105.3	20.00	3409.3	112.6	20.00	%RGSC

TOTAL 97.575 NO. OXYGENS = 0 NO. ITERS. = 2 AVE. ATOMIC NO. = 11.13

21-OCT-91 14:45:41

Listing of 50 closest matches for COMP. NO. 2641 * elements: Na, Al, Si, K , Ca, Fe Date of Update: 10/22/91

	No	Sample Number	Date		Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total	a. Gc
1	2641	JB-BS-13 T241-4	10/21/91	76.49	12.83	1.08	0.03	0.08	0.53	0.06	4.26	4.64	100.00	1.0000
2	2643	JB-BS-15 T241-6	10/21/91	76.59	12.83	1.08	0.03	0.07	0.54	0.04	4.23	4.59	100.00	0.9937
3	2646	JB-WA-1 T242-1	10/21/91	76.77	12.70	1.09	0.02	0.07	0.53	0.06	4.15	4.57	100.00	0.9905
4	2639	JB-BS-11 T241-2	10/21/91	76.55	12.80	1.10	0.02	0.08	0.54	0.06	4.16	4.68	99.99	0.9880
5	2638	JB-BS-9 T241-1	10/21/91	76.42	12.92	1.10	0.01	0.08	0.55	0.05	4.22	4.65	100.00	0.9877
6	2640	JB-BS-12 T241-3	10/21/91	76.51	12.85	1.11	0.03	0.08	0.54	0.05	4.16	4.67	100.00	0.9871
7	2642	JB-BS-14 T241-5	10/21/91	76.55	12.82	1.11	0.02	0.07	0.55	0.06	4.20	4.62	100.00	0.9861
8	435	3-30-82-1, T43-3		76.62	12.93	1.06	0.02	0.05	0.54	0.07	4.13	4.59	100.01	0.9854
9	570	KRL91982D, T66-10	xx/xx/83	76.81	12.89	1.08	0.03	0.05	0.53	0.06	3.90	4.65	100.00	0.9841
10	2558	SS-91-1-1 T232-2	6/8/91	76.57	12.92	1.07	0.02	0.04	0.54	0.06	4.05	4.72	99.99	0.9830
11	2562	SS-91-1-4 T323-5	8/7/91	77.02	12.63	1.06	0.02	0.04	0.53	0.06	4.00	4.63	99.99	0.9826
12	2563	SS-91-1-5 T232-6	8/7/91	76.97	12.65	1.08	0.03	0.04	0.54	0.07	3.98	4.65	100.01	0.9822
13	1224	WL CORE G 370cm T92-7	5/2/85	76.83	12.82	1.09	0.04	0.04	0.54	0.05	3.95	4.65	100.01	0.9820
14	2060	FLV-64-CS T170-7	9/3/88	76.71	12.87	1.11	0.02	0.04	0.54	0.04	4.02	4.64	99.99	0.9820
15	1025	KRL-71082C (590) T58-1	6/22/84	76.91	12.71	1.08	0.02	0.00	0.53	0.05	3.55	4.74	99.99	0.9819
16	1409	KRL 82182 (A1) (599) T112-1	10/22/85	76.60	12.87	1.11	0.04	0.04	0.55	0.06	4.08	4.65	100.00	0.9813
17	2559	SS-91-1-SU T232-1	8/6/91	76.74	12.86	1.03	0.04	0.04	0.54	0.05	3.95	4.68	99.99	0.9809
18	1419	BL-RSA-5 T112-10	10/23/85	76.98	12.65	1.09	0.04	0.04	0.53	0.05	3.93	4.68	99.99	0.9807
19	566	KRL91882D, T64-12	09/06/83	76.81	12.82	1.10	0.01	0.05	0.53	0.08	3.91	4.69	100.00	0.9807
20	1418	BL-RSA-4 T112-9	10/23/85	76.83	12.79	1.08	0.04	0.04	0.55	0.06	3.96	4.65	100.00	0.9806
21	564	KRL82782A, T64-11	09/06/83	76.99	12.75	1.09	0.01	0.06	0.53	0.08	3.90	4.59	100.00	0.9805
22	431	YDS-1, T13-1		76.61	12.93	1.12	0.03	0.05	0.54	0.07	4.03	4.64	100.02	0.9804
23	2561	SS-91-1-3 t232-4	8/7/91	77.08	12.64	1.06	0.02	0.05	0.53	0.06	3.92	4.64	100.00	0.9799
24	2497	FLV-159-CH T219-6	12/20/90	77.01	12.76	1.08	0.03	0.03	0.54	0.05	3.94	4.57	100.01	0.9796
25	1136	WALKER LAKE CORE G 380CM t89-1	2/28/85	76.98	12.79	1.08	0.02	0.05	0.54	0.05	3.86	4.64	100.01	0.9797
26	680	KRL-82282B, T54-4	xx//xx/x	76.99	12.71	1.08	0.02	0.06	0.53	0.04	3.86	4.70	99.99	0.9796
27	2644	JB-BS-16 T241-7	10/21/91	76.97	12.59	1.04	0.02	0.08	0.54	0.05	4.13	4.58	100.00	0.9793
28	2494	FLV-156-SS T219-3	12/20/90	76.64	13.06	1.09	0.03	0.04	0.54	0.05	3.94	4.62	100.01	0.9789
29	681	KRL-91882A*, T66-8	10/25/83	76.79	12.83	1.10	0.03	0.06	0.54	0.07	3.91	4.67	100.00	0.9785
30	551	KRL82282A, T66-5	10/25/83	76.71	12.88	1.12	0.04	0.05	0.52	0.06	3.58	4.65	100.01	0.9785
31	760	BD-16		76.59	12.92	1.11	0.03	0.03	0.54	0.07	4.00	4.71	100.00	0.9784
32	567	KRL91882-K-1, T64-13	09/06/83	76.93	12.82	1.11	0.01	0.05	0.53	0.07	3.88	4.60	100.00	0.9781
33	192	LD-12, T3,4		76.94	12.70	1.12	0.03	0.07	0.53	0.07	3.91	4.64	100.01	0.9777
34	2664	SS-91-1-Adgss	8/7/91	76.73	12.85	1.04	0.03	0.05	0.53	0.07	3.95	4.74	99.99	0.9774
35	2571	JB-BS-7 T227-4	6/13/91	76.73	12.89	1.10	0.03	0.05	0.54	0.06	3.91	4.69	100.00	0.9773
36	2488	FLV-149-CS T218-8	11/19/90	76.77	13.05	1.07	0.03	0.05	0.53	0.06	3.81	4.63	100.00	0.9771
37	701	LD-12		76.94	12.72	1.12	0.03	0.07	0.53	0.07	3.91	4.61	100.00	0.9765
38	682	KRL-91882G, T66-11	10/25/83	76.91	12.76	1.07	0.03	0.06	0.54	0.07	3.87	4.68	99.99	0.9765
39	1680	KRL 860922 A T134-2	11/25/86	76.94	12.75	1.07	0.03	0.04	0.55	0.06	3.91	4.65	100.00	0.9763
40	679	KRL-82182(A-4), T66-3	10/25/83	76.89	12.82	1.02	0.02	0.05	0.52	0.04	4.08	4.55	99.99	0.9763
41	1694	SCHURZ-1 T134-6	11/25/86	77.01	12.64	1.09	0.03	0.05	0.55	0.05	3.94	4.64	100.00	0.9763
42	2569	JB-BS-5 T227-2	6/13/91	76.69	12.91	1.08	0.02	0.05	0.55	0.09	3.50	4.70	99.99	0.9763
43	753	BD-1		76.45	13.11	1.09	0.03	0.04	0.51	0.07	4.00	4.70	100.00	0.9762
44	1225	WL CORE G 380cm T92-8	5/2/85	76.82	12.79	1.06	0.04	0.04	0.56	0.06	4.00	4.65	100.02	0.9762
45	1240	WL 4-2 3.29m T93-9	5/2/85	76.75	12.79	1.13	0.03	0.04	0.55	0.05	4.02	4.64	100.00	0.9761
46	571	KRL91982F, T56-5	07/01/83	76.61	12.89	1.14	0.03	0.05	0.55	0.05	4.12	4.56	100.00	0.9758
47	1244	WL 8-3A ASH A 64-66cm T93-13	5/2/85	76.97	12.80	1.08	0.03	0.05	0.55	0.05	3.86	4.60	99.99	0.9754
48	739	S-20		76.83	12.90	1.09	0.03	0.07	0.51	0.06	4.00	4.50	99.99	0.9753
49	684	KRL--92082D, T66-12	10/25/83	77.02	12.69	1.09	0.02	0.05	0.51	0.04	3.92	4.66	100.00	0.9752
50	559	KRL82182(bubble wall), T56-4	07/01/83	76.87	12.92	1.01	0.02	0.03	0.53	0.03	4.03	4.55	99.99	0.9750

Listing of 25 closest matches for COMP. NO. 2640 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 06/18/92

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2640	JB-BS-13 T241-4	10/21/91	76.49	12.83	1.08	0.03	0.08	0.53	0.06	4.26	4.64	100.00	1.0000
2	2642	JB-BS-15 T241-6	10/21/91	76.59	12.83	1.08	0.03	0.07	0.54	0.04	4.23	4.59	100.00	0.9937
3	2645	JB-WA-1 T242-1	10/21/91	76.77	12.70	1.09	0.02	0.07	0.53	0.06	4.19	4.57	100.00	0.9909
4	2638	JB-BS-11 T241-2	10/21/91	76.55	12.80	1.10	0.02	0.08	0.54	0.06	4.16	4.68	99.99	0.9880
5	2637	JB-BS-9 T241-1	10/21/91	76.42	12.92	1.10	0.01	0.08	0.55	0.05	4.22	4.65	100.00	0.9877
6	2639	JB-BS-12 T241-3	10/21/91	76.51	12.85	1.11	0.03	0.08	0.54	0.05	4.16	4.67	100.00	0.9871
7	2641	JB-BS-14 T241-5	10/21/91	76.55	12.82	1.11	0.02	0.07	0.55	0.06	4.20	4.62	100.00	0.9861
8	435	3-30-82-1, T43-3		76.62	12.93	1.06	0.02	0.05	0.54	0.07	4.13	4.59	100.01	0.9854
9	2707	FLV-192-BC T246-1	12/12/91	77.01	12.55	1.05	0.03	0.05	0.53	0.05	4.18	4.56	100.01	0.9846
10	570	KRL91982D, T66-10	xx/xx/83	76.81	12.89	1.08	0.03	0.05	0.53	0.06	3.90	4.65	100.00	0.9841
11	2716	FLV-200-LC T249-4	1/30/92	76.77	12.80	1.11	0.02	0.04	0.53	0.06	4.01	4.67	100.01	0.9836
12	2557	SS-91-1-1 T232-2	6/8/91	76.57	12.92	1.07	0.02	0.04	0.54	0.06	4.05	4.72	99.99	0.9830
13	2561	SS-91-1-4 T323-5	8/7/91	77.02	12.63	1.06	0.02	0.04	0.53	0.06	4.00	4.63	99.99	0.9826
14	2562	SS-91-1-5 T232-6	8/7/91	76.97	12.65	1.08	0.03	0.04	0.54	0.07	3.98	4.65	100.01	0.9822
15	1224	WL CORE G 370cm T92-7	5/2/85	76.83	12.82	1.09	0.04	0.04	0.54	0.05	3.95	4.65	100.01	0.9820
16	2060	FLV-64-CS T170-7	9/3/88	76.71	12.87	1.11	0.02	0.04	0.54	0.04	4.02	4.64	99.99	0.9820
17	1025	KRL-71082C (590) T58-1	6/22/84	76.91	12.71	1.08	0.02	0.00	0.53	0.05	3.95	4.74	99.99	0.9819
18	2717	FLV-201-TO T249-5	1/30/92	76.85	12.77	1.10	0.02	0.04	0.54	0.04	3.99	4.65	100.00	0.9814
19	1409	KRL 82182 (A1) (599) T112-1	10/22/85	76.60	12.87	1.11	0.04	0.04	0.55	0.06	4.08	4.65	100.00	0.9813
20	2558	SS-91-1-SU T232-1	8/6/91	76.74	12.86	1.09	0.04	0.04	0.54	0.05	3.95	4.68	99.99	0.9809
21	1419	BL-RSA-5 T112-10	10/23/85	76.98	12.65	1.09	0.04	0.04	0.53	0.05	3.93	4.68	99.99	0.9807
22	566	KRL91882B, T64-12	09/06/83	76.81	12.82	1.10	0.01	0.05	0.53	0.08	3.91	4.69	100.00	0.9807
23	1418	BL-RSA-4 T112-9	10/23/85	76.83	12.79	1.08	0.04	0.04	0.55	0.06	3.96	4.65	100.00	0.9806
24	564	KRL82782A, T64-11	09/06/83	76.99	12.75	1.09	0.01	0.06	0.53	0.08	3.90	4.59	100.00	0.9805
25	431	YOS-1, T13-1		76.61	12.93	1.12	0.03	0.05	0.54	0.07	4.03	4.64	100.02	0.9804

SAMPLE ID: JB-BS-13 T241-4 D of Analysis: 10/21/91

Raw Probe Data		Raw Probe Data (FeO to Fe2O3)		.lculated to 100%	
SiO2	74.715			SiO2	76.49
Al2O3	12.533			Al2O3	12.83
FeO	0.949*1.1113=Fe2O3		1.055	Fe2O3	1.08
MgO	0.028			MgO	0.03
MnO	0.077			MnO	0.08
CaO	0.521			CaO	0.53
TiO2	0.061			TiO2	0.06
Na2o	4.161			Na2o	4.26
K2O	4.530			K2O	4.64
TOTAL(O)	97.575	TOTAL(N)	97.681	TOTAL(R)	100.00

20 Best Matches:

1	0.9880	10/21/91	JB-BS-11 T241-2
2	0.9877	10/21/91	JB-BS-9 T241-1
3	0.9871	10/21/91	JB-BS-12 T241-3
4	0.9854		3-30-82-1, T43-3
5	0.9841	xx/xx/83	KRL91982D, T66-10
6	0.9830	6/8/91	SS-91-1-1 T232-2
7	0.9826	8/7/91	SS-91-1-4 T323-5
8	0.9822	8/7/91	SS-91-1-5 T232-6
9	0.9820	5/2/85	WL CORE G 370cm T92-7
10	0.9820	9/3/88	FLV-64-CS T170-7
11	0.9819	6/22/84	KRL-71082C (590) T58-1
12	0.9813	10/22/85	KRL 82182 (A1) (599) T112-1
13	0.9809	8/6/91	SS-91-1-SU T232-1
14	0.9807	10/23/85	BL-RSA-5 T112-10
15	0.9807	09/06/83	KRL91882B, T64-12
16	0.9806	10/23/85	BL-RSA-4 T112-9
17	0.9805	09/06/83	KRL82782A, T64-11
18	0.9804		YOS-1, T13-1
19	0.9799	8/7/91	SS-91-1-3 t232-4
20	0.9798	12/20/90	FLV-159-CH T219-6

Elements used in the calculation are:

Na2o
Al2O3
SiO2
K2O
CaO
FeO

***** This sample has been added to the data base *****

SAMPLE: T2'   JB-BS-14

PT	BEAM COUNTS	NA 9 COUNTS	SD	MG 8 COUNTS	SD	AL 3 COUNTS	SD	SI 7 COUNTS	SD	K 2 COUNTS	SD	CA 6 COUNTS	SD	TI 5 COUNTS	SD	MN 1 COUNTS	SD	FE 4 COUNTS	SD
1	14188	2553	51	149	12	14729	121	27530	166	9218	96	936	31	28	5	107	10	609	25
2	14182	2642	63	146	1	14335	278	27336	137	8917	212	928	6	24	3	95	9	614	4
3	14179	2548	53	156	5	14324	231	27451	98	9015	153	963	18	25	2	96	7	603	5
4	14178	45	****	134	9	473	****	38956	****	136	****	188	377	16	5	87	9	103	253
5	14181	2803	****	151	9	14946	****	27326	****	8771	****	1089	360	33	6	112	10	586	224
6	14185	2612	****	151	8	14344	****	27788	****	9090	****	969	327	25	6	90	10	644	209
7	14195	6479	****	146	7	23300	****	23011	****	2787	****	3041	882	18	6	84	11	159	235
8	14195	2572	****	127	10	14389	****	27817	****	9006	****	945	820	28	5	103	10	646	226
9	14189	2423	****	143	9	13878	****	27203	****	8755	****	1023	768	26	5	117	12	599	214
10	14186	2522	****	162	10	14492	****	27283	****	8989	****	934	726	39	7	101	11	622	205
11	14192	2634	****	166	11	14510	****	27595	****	9084	****	904	692	42	8	106	11	608	197
12	14191	2530	****	146	11	14229	****	27665	****	8901	****	896	662	27	7	90	11	620	190
13	14195	2575	****	163	11	14533	****	27383	****	8929	****	939	634	25	7	94	10	574	182
14	14198	2512	****	166	12	14732	****	27359	****	9119	****	932	611	37	7	95	10	623	176
15	14195	2557	****	142	11	14450	****	27575	****	9150	****	977	589	31	7	122	11	616	171
16	14202	2768	****	142	11	14626	****	27389	****	8949	****	822	571	25	7	103	11	453	167
17	14196	3955	****	175	12	28852	****	20042	****	1404	****	12818	****	23	7	85	11	440	163
18	14197	2601	****	151	12	14514	****	27829	****	8911	****	924	****	24	7	101	11	602	159
19	14201	2544	****	146	12	14279	****	27529	****	8917	****	946	****	22	7	111	11	614	156
20	14204	2548	****	150	12	14505	****	26995	****	9026	****	958	****	31	7	110	11	619	152

LINES DELETED: 4 7 16 17

AVE. BEAM CURRENT/SEC =   710

DATA REDUCED USING $B-AL: *GL9M

ON SPECIMEN: T241-5 JB-BS-14

$B-AL VERSION 1.0

OXIDE FORM.	WEIGHT% (OXIDE)	STD.DEV. (%)	HOMO. INDEX	FORMULA	K-RATIO	UNKN PEAK (COUNTS)	UNKN BKGD (COUNTS)	COUNTING TIME(SEC)	STD PEAK (COUNTS)	STD BKGD (COUNTS)	COUNTING TIME(SEC)	STANDARD FILENAME
NA2O	4.141	2.93	1.585	0.000	1.07342	2573.5	50.4	20.00	2400.2	49.7	20.00	%RGSC
MGO	0.024	114.09	0.822	0.000	0.00637	151.2	136.4	20.00	2469.5	136.9	20.00	%RGSC
AL2O3	12.649	1.20	2.006	0.000	0.96559	14449.3	247.4	20.00	14955.9	247.8	20.00	%5831
SIO2	75.509	0.85	1.403	0.000	1.02277	27479.0	53.8	20.00	26868.4	53.9	20.00	%5831
K2O	4.557	1.63	1.352	0.000	1.24944	8987.4	144.7	20.00	7230.1	152.8	20.00	%RGSC
CAO	0.540	4.51	1.516	0.000	0.10559	954.0	179.2	20.00	7528.9	191.2	20.00	%RGSC
TIO2	0.059	64.61	1.085	0.000	0.00054	29.0	19.4	20.00	19938.2	26.6	20.00	%TIO2
MNO	0.069	33.36	0.957	0.000	0.00069	103.4	64.5	20.00	56342.7	119.9	20.00	%MN2O
FEO	0.984	5.58	0.737	0.000	0.15375	612.4	105.6	20.00	3409.3	112.6	20.00	%RGSC

TOTAL   98.530   NO. OXYGENS = 0   NO. ITERS. = 2   AVE. ATOMIC NO. = 11.16

21-OCT-91 15:00:19

Listing of 25 closest matches for COMP. NO. 2641 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 06/18/92

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2641	JB-BS-14 T241-5	10/21/91	76.55	12.82	1.11	0.02	0.07	0.55	0.06	4.20	4.62	100.00	1.0000
2	2637	JB-BS-9 T241-1	10/21/91	76.42	12.92	1.10	0.01	0.08	0.55	0.05	4.22	4.65	100.00	0.9951
3	1409	KRL 82182 (A1) (599) T112-1	10/22/85	76.60	12.87	1.11	0.04	0.04	0.55	0.06	4.08	4.65	100.00	0.9934
4	2639	JB-BS-12 T241-3	10/21/91	76.51	12.85	1.11	0.03	0.08	0.54	0.05	4.16	4.67	100.00	0.9931
5	2638	JB-BS-11 T241-2	10/21/91	76.55	12.80	1.10	0.02	0.08	0.54	0.06	4.16	4.68	99.99	0.9915
6	2642	JB-BS-15 T241-6	10/21/91	76.59	12.83	1.08	0.03	0.07	0.54	0.04	4.23	4.59	100.00	0.9900
7	571	KRL91982F, T56-5	07/01/83	76.61	12.89	1.14	0.03	0.05	0.55	0.05	4.12	4.56	100.00	0.9892
8	1240	WL 4-2 3.29m T93-9	5/2/85	76.75	12.79	1.13	0.03	0.04	0.55	0.05	4.02	4.64	100.00	0.9884
9	2060	FLV-64-CS T170-7	9/3/88	76.71	12.87	1.11	0.02	0.04	0.54	0.04	4.02	4.64	99.99	0.9881
10	2682	JB-BS-9 T241-1	10/21/91	76.15	13.07	1.11	0.01	0.08	0.56	0.05	4.27	4.70	100.00	0.9874
11	2645	JB-WA-1 T242-1	10/21/91	76.77	12.70	1.09	0.02	0.07	0.53	0.06	4.19	4.57	100.00	0.9867
12	431	YOS-1, T13-1		76.61	12.93	1.12	0.03	0.05	0.54	0.07	4.03	4.64	100.02	0.9865
13	2640	JB-BS-13 T241-4	10/21/91	76.49	12.83	1.08	0.03	0.08	0.53	0.06	4.26	4.64	100.00	0.9861
14	783	GS-27		76.74	12.92	1.12	0.03	0.05	0.55	0.07	3.91	4.61	100.00	0.9849
15	2717	FLV-201-TO T249-5	1/30/92	76.85	12.77	1.10	0.02	0.04	0.54	0.04	3.99	4.65	100.00	0.9848
16	760	BO-16		76.59	12.92	1.11	0.03	0.03	0.54	0.07	4.00	4.71	100.00	0.9845
17	435	3-30-82-1, T43-3		76.62	12.93	1.06	0.02	0.05	0.54	0.07	4.13	4.59	100.01	0.9840
18	1418	BL-RSA-4 T112-9	10/23/85	76.83	12.79	1.08	0.04	0.04	0.55	0.06	3.96	4.65	100.00	0.9839
19	2716	FLV-200-LC T249-4	1/30/92	76.77	12.80	1.11	0.02	0.04	0.53	0.06	4.01	4.67	100.01	0.9839
20	758	BO-11		76.35	13.11	1.12	0.03	0.04	0.55	0.09	4.00	4.70	99.99	0.9836
21	1223	WL CORE G 180cm T92-6	5/2/85	76.64	12.88	1.11	0.04	0.05	0.57	0.06	3.99	4.67	100.01	0.9831
22	1684	SCHURZ-1 T134-6	11/25/86	77.01	12.64	1.09	0.03	0.05	0.55	0.05	3.94	4.64	100.00	0.9826
23	1224	WL CORE G 370cm T92-7	5/2/85	76.83	12.82	1.09	0.04	0.04	0.54	0.05	3.95	4.65	100.01	0.9824
24	788	GS-32		76.58	12.90	1.13	0.03	0.04	0.56	0.06	4.00	4.70	100.00	0.9822
25	2708	FLV-193-BC T246-2	12/12/91	76.75	12.61	1.16	0.04	0.06	0.56	0.06	4.11	4.65	100.00	0.9820

Listing of 50 closest matches for COMP. NO. 2642 f elements: Na, Al, Si, K , Ca, Fe Cate of Update: 10/22/91

	C.No	Sample Number	Date		Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total	x. Co
1	2642	JB-BS-14 T241-5	10/21/91	76.55	12.82	1.11	0.02	0.07	0.55	0.06	4.20	4.62	100.00	1.0000
2	2538	JB-BS-9 T241-1	10/21/91	76.42	12.92	1.10	0.01	0.08	0.55	0.05	4.22	4.65	100.00	0.9951
3	1439	KRL 82182 (A1) (599) T112-1	10/22/85	76.60	12.87	1.11	0.04	0.04	0.55	0.06	4.08	4.65	100.00	0.9934
4	2640	JB-BS-12 T241-3	10/21/91	76.51	12.85	1.11	0.03	0.08	0.54	0.05	4.16	4.67	100.00	0.9931
5	2639	JB-BS-11 T241-2	10/21/91	76.55	12.80	1.10	0.02	0.08	0.54	0.06	4.16	4.68	99.99	0.9912
6	2643	JB-BS-15 T241-6	10/21/91	76.59	12.83	1.08	0.03	0.07	0.54	0.04	4.23	4.59	100.00	0.9900
7	571	KRL91982F, T56-5	07/01/83	76.61	12.89	1.14	0.03	0.05	0.55	0.05	4.12	4.56	100.00	0.9892
8	1260	WL 4-2 3.29m T93-9	5/2/85	76.75	12.79	1.13	0.03	0.04	0.55	0.05	4.02	4.64	100.00	0.9884
9	2050	FLV-64-CS T170-7	9/3/88	76.71	12.87	1.11	0.02	0.04	0.54	0.04	4.02	4.64	99.99	0.9881
10	2646	JB-WA-1 T242-1	10/21/91	76.77	12.70	1.09	0.02	0.07	0.53	0.06	4.19	4.57	100.00	0.9867
11	431	YOS-1, T13-1		76.61	12.93	1.12	0.03	0.05	0.54	0.07	4.03	4.64	100.02	0.9865
12	2641	JB-BS-13 T241-4	10/21/91	76.49	12.83	1.08	0.03	0.08	0.53	0.06	4.26	4.64	100.00	0.9861
13	733	GS-27		76.74	12.92	1.12	0.03	0.05	0.55	0.07	3.91	4.61	100.00	0.9849
14	750	BO-16		76.59	12.92	1.11	0.03	0.03	0.54	0.07	4.00	4.71	100.00	0.9845
15	435	3-30-82-1, T43-3		76.62	12.93	1.06	0.02	0.05	0.54	0.07	4.13	4.59	100.01	0.9840
16	1418	BL-RSA-4 T112-9	10/23/85	76.83	12.79	1.08	0.04	0.04	0.55	0.06	3.96	4.65	100.00	0.9839
17	758	BO-11		76.35	13.11	1.12	0.03	0.04	0.55	0.09	4.00	4.70	99.99	0.9836
18	1223	WL CORE G 180cm T92-6	5/2/85	76.64	12.88	1.11	0.04	0.05	0.57	0.06	3.99	4.67	100.01	0.9831
19	1684	SCHURZ-1 T134-6	11/25/86	77.01	12.64	1.09	0.03	0.05	0.55	0.05	3.94	4.64	100.00	0.9826
20	1224	WL CORE G 370cm T92-7	5/2/85	76.83	12.82	1.09	0.04	0.04	0.54	0.05	3.99	4.65	100.01	0.9824
21	788	GS-32		76.58	12.90	1.13	0.03	0.04	0.56	0.06	4.00	4.70	100.00	0.9822
22	691	KRL-91882A", T66-8	10/25/83	76.79	12.83	1.10	0.03	0.06	0.54	0.07	3.91	4.67	100.00	0.9815
23	2236	SL-103 T186-2	2/28/89	76.68	12.95	1.10	0.03	0.04	0.55	0.07	3.88	4.69	99.99	0.9814
24	1241	WL 4-2 3.31m T93-10	5/2/85	76.69	12.91	1.14	0.04	0.04	0.55	0.06	3.92	4.67	100.02	0.9813
25	2559	SS-91-1-SU T232-1	8/6/91	76.74	12.86	1.09	0.04	0.04	0.54	0.05	3.95	4.68	99.99	0.9810
26	1416	BL-RSA-2 T112-7	10/23/85	76.78	12.85	1.12	0.04	0.03	0.54	0.06	3.90	4.68	100.00	0.9806
27	2494	FLV-156-SS T219-3	12/20/90	76.64	13.06	1.09	0.03	0.04	0.54	0.05	3.94	4.62	100.01	0.9804
28	1291	WL 8-1B 192-194cm T99-3	07/01/85	76.95	12.70	1.11	0.03	0.06	0.56	0.07	3.86	4.64	99.98	0.9804
29	1245	WL 8-3A ASH B 59.5-64.0cm T93-	5/2/85	77.00	12.70	1.10	0.03	0.06	0.56	0.04	3.89	4.61	99.99	0.9803
30	1417	BL-RSA-3 T112-8	10/23/85	76.83	12.80	1.15	0.04	0.05	0.55	0.05	3.69	4.64	100.00	0.9803
31	2571	JB-BS-7 T227-4	6/13/91	76.73	12.89	1.10	0.03	0.05	0.54	0.06	3.91	4.69	100.00	0.9802
32	2558	SS-91-1-1 T232-2	6/8/91	76.57	12.92	1.07	0.02	0.04	0.54	0.06	4.05	4.72	99.99	0.9801
33	1244	WL 8-3A ASH A 64-66cm T93-13	5/2/85	76.97	12.80	1.08	0.03	0.05	0.55	0.05	3.86	4.60	99.99	0.9801
34	2170	KRL-82982-KP T178-5	12/6/88	76.70	13.01	1.11	0.02	0.06	0.55	0.06	3.81	4.67	99.99	0.9800
35	1972	WL-4-58 (144.77m) T164-1	5/21/88	76.73	12.71	1.15	0.00	0.03	0.54	0.12	4.02	4.69	99.99	0.9797
36	557	KRL91882-K-1, T64-13	09/06/83	76.93	12.82	1.11	0.01	0.05	0.53	0.07	3.88	4.60	100.00	0.9797
37	1680	KRL 860922 A T134-2	11/25/86	76.94	12.75	1.07	0.03	0.04	0.55	0.06	3.91	4.65	100.00	0.9797
38	2563	SS-91-1-5 T232-6	8/7/91	76.97	12.65	1.08	0.03	0.04	0.54	0.07	3.98	4.65	100.01	0.9795
39	1227	WL 8-2A 61-5-70.0cm T92-11	5/2/85	77.09	12.70	1.11	0.03	0.05	0.55	0.04	3.78	4.65	100.00	0.9795
40	1225	WL CORE G 380cm T92-8	5/2/85	76.82	12.79	1.06	0.04	0.04	0.56	0.06	4.00	4.65	100.02	0.9795
41	1290	WL 8-1B 92-94cm T99-1	07/01/85	76.99	12.72	1.11	0.02	0.06	0.54	0.07	3.84	4.65	100.00	0.9794
42	2569	JB-BS-5 T227-2	6/13/91	76.69	12.91	1.08	0.02	0.05	0.55	0.09	3.90	4.70	99.99	0.9793
43	1621	BO-18 JOD	09/12/86	76.98	12.70	1.10	0.03	0.05	0.55	0.07	3.83	4.68	99.99	0.9792
44	1949	WL-4-4B (12.00M) T162-3	5/14/88	76.93	12.81	1.13	0.03	0.05	0.55	0.05	3.79	4.64	99.98	0.9791
45	1472	KRL 82182 (A-1) T117-3	3/6/86	76.80	12.75	1.10	0.03	0.04	0.55	0.07	3.87	4.77	99.98	0.9787
46	2497	FLV-159-CH T219-6	12/20/90	77.01	12.76	1.08	0.03	0.03	0.54	0.05	3.94	4.57	100.01	0.9786
47	561	KRL82282A, T66-5	10/25/83	76.71	12.88	1.12	0.04	0.05	0.52	0.06	3.98	4.65	100.01	0.9785
48	701	LD-12		76.94	12.72	1.12	0.03	0.07	0.53	0.07	3.91	4.61	100.00	0.9784
49	1229	WL 8-3A 14.5-20cm T92-13	5/2/85	77.03	12.78	1.09	0.03	0.04	0.55	0.06	3.78	4.63	99.99	0.9784
50	2644	JB-BS-16 T241-7	10/21/91	76.97	12.59	1.04	0.02	0.08	0.54	0.05	4.13	4.58	100.00	0.9783

SAMPLE ID: JB-BS-14 T241-5 D of Analysis: 10/21/91

Raw Probe Data		Raw Probe Data (FeO to Fe2O3)		Recalculated to 100%	
SiO2	75.508			SiO2	76.55
Al2O3	12.649			Al2O3	12.82
FeO	0.984	*1.1113=Fe2O3	1.094	Fe2O3	1.11
MgO	0.024			MgO	0.02
MnO	0.069			MnO	0.07
CaO	0.540			CaO	0.55
TiO2	0.059			TiO2	0.06
Na2o	4.141			Na2o	4.20
K2O	4.557			K2O	4.62
TOTAL(O)	98.530	TOTAL(N)	98.640	TOTAL(R)	100.00

20 Best Matches:

1	0.9951	10/21/91	JB-BS-9 T241-1
2	0.9934	10/22/85	KRL 82182 (A1) (599) T112-1
3	0.9931	10/21/91	JB-BS-12 T241-3
4	0.9915	10/21/91	JB-BS-11 T241-2
5	0.9892	07/01/83	KRL91982F, T56-5
6	0.9884	5/2/85	WL 4-2 3.29m T93-9
7	0.9881	9/3/88	FLV-64-CS T170-7
8	0.9865		YOS-1, T13-1
9	0.9861	10/21/91	JB-BS-13 T241-4
10	0.9849		GS-27
11	0.9845		BO-16
12	0.9840		3-30-82-1, T43-3
13	0.9839	10/23/85	BL-RSA-4 T112-9
14	0.9836		BO-11
15	0.9831	5/2/85	WL CORE G 180cm T92-6
16	0.9826	11/25/86	SCHURZ-1 T134-6
17	0.9824	5/2/85	WL CORE G 370cm T92-7
18	0.9822		GS-32
19	0.9815	10/25/83	KRL-91882A*, T66-8
20	0.9814	2/28/89	SL-103 T186-2

Elements used in the calculation are:

Na2o
Al2O3
SiO2
K2O
CaO
FeO

***** This sample has been added to the data base *****

SAMPLE: 12 JR-BS-15

PT	BEAM COUNTS	NA COUNTS	9 SD	MG COUNTS	8 SD	AL COUNTS	3 SD	SI COUNTS	7 SD	K COUNTS	2 SD	CA COUNTS	6 SD	TI COUNTS	5 SD	MN COUNTS	1 SD	FE COUNTS	4 SD
1	14205	2623	51	147	12	14711	121	26991	164	9059	95	945	31	26	5	98	10	611	25
2	14207	2660	26	156	6	14756	32	26852	98	8770	204	924	15	25	1	96	1	562	35
3	14207	52	****	132	12	524	****	38205	****	129	****	153	451	17	5	91	4	83	292
4	14214	2554	****	149	10	14167	****	27756	****	9043	****	931	390	26	4	107	7	611	257
5	14220	2539	****	143	9	14801	****	27766	****	9113	****	902	346	25	4	106	7	655	238
6	14208	2521	****	134	9	14463	****	27516	****	9011	****	935	316	38	7	80	10	610	217
7	14210	2508	953	133	9	14300	****	27878	****	8977	****	936	293	34	7	100	9	603	201
8	14215	2593	892	169	13	14319	****	28139	****	8873	****	940	275	23	6	118	11	609	188
9	14214	2662	846	142	12	14733	****	27420	****	9041	****	946	260	22	6	106	11	650	179
10	14214	2796	812	147	11	14590	****	27570	****	8830	****	1014	251	23	6	96	10	594	169
11	14211	2801	783	147	11	14704	****	27802	****	8546	****	1053	245	24	6	112	10	511	161
12	14204	2627	749	153	10	14383	****	27102	****	9077	****	967	235	26	5	109	10	567	154
13	14206	29	975	142	10	463	****	37844	****	137	****	169	300	17	6	78	12	100	194
14	14215	2515	940	142	10	14312	****	27596	****	9006	****	949	290	30	6	116	12	607	188
15	14219	2630	911	161	10	14520	****	27580	****	9029	****	932	281	35	6	102	12	593	182
16	14217	2581	884	161	10	14481	****	27986	****	8921	****	955	273	25	6	109	11	621	177
17	14222	2496	857	166	11	14727	****	27564	****	9047	****	859	264	26	6	110	11	645	173
18	14223	2525	833	167	12	14449	****	27831	****	9147	****	937	257	24	5	116	11	625	169
19	14218	2546	811	141	11	14266	****	27547	****	8988	****	983	251	21	5	96	11	758	172
20	14239	2626	792	166	12	14266	****	27820	****	8861	****	936	245	18	6	99	11	580	167

LINES DELETED: 3 13 19

AVE. BEAM CURRENT/SEC = 711

DATA REDUCED USING $B-AL: *GL9M

ON SPECIMEN: T241-6 JR-BS-15

$B-AL VERSION 1.0

OXIDE FORM.	WEIGHT% (OXIDE)	STD.DEV. (%)	HOMO. INDEX	FORMULA	K-RATIO	UNKN PEAK (COUNTS)	UNKN BKGD (COUNTS)	COUNTING TIME(SEC)	STD PEAK (COUNTS)	STD BKGD (COUNTS)	COUNTING TIME(SEC)	STANDARD FILENAME
NA2O	4.184	2.92	1.789	0.000	1.08616	2603.4	50.4	20.00	2400.2	49.7	20.00	%RGSC
MGO	0.025	108.44	0.927	0.000	0.00672	152.0	136.4	20.00	2469.5	136.9	20.00	%RGSC
AL2O3	12.698	1.20	1.669	0.000	0.96976	14510.7	247.5	20.00	14955.9	247.8	20.00	%5831
SIO2	75.829	0.86	2.091	0.000	1.02722	27598.2	53.8	20.00	26868.4	53.9	20.00	%5831
K2O	4.545	1.63	1.577	0.000	1.24582	8961.9	144.8	20.00	7230.1	152.8	20.00	%RGSC
CAO	0.534	4.54	1.350	0.000	0.10432	944.8	179.3	20.00	7528.9	191.2	20.00	%RGSC
TIO2	0.043	84.59	0.982	0.000	0.00040	26.3	18.4	20.00	19938.2	26.6	20.00	%TIO2
MNO	0.072	32.24	0.914	0.000	0.00072	104.9	64.6	20.00	56342.7	119.9	20.00	%MN2O
FEO	0.966	5.65	1.435	0.000	0.15093	603.2	105.6	20.00	3409.3	112.6	20.00	%RGSC

TOTAL 98.896 NO. OXYGENS = 0 NO. ITERS. = 2 AVE. ATOMIC NO. = 11.17

21-OCT-91 15:15:07

Listing of 25 closest matches for COMP. NO. 2642 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 06/18/92

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2642	JB-BS-15 T241-6	10/21/91	76.59	12.83	1.08	0.03	0.07	0.54	0.04	4.23	4.59	100.00	1.0000
2	2640	JB-BS-13 T241-4	10/21/91	76.49	12.83	1.08	0.03	0.08	0.53	0.06	4.26	4.64	100.00	0.9937
3	435	3-30-82-1, T43-3		76.62	12.93	1.06	0.02	0.05	0.54	0.07	4.13	4.59	100.01	0.9916
4	2645	JB-WA-1 T242-1	10/21/91	76.77	12.70	1.09	0.02	0.07	0.53	0.06	4.19	4.57	100.00	0.9910
5	2638	JB-BS-11 T241-2	10/21/91	76.55	12.80	1.10	0.02	0.08	0.54	0.06	4.16	4.68	99.99	0.9905
6	2641	JB-BS-14 T241-5	10/21/91	76.55	12.82	1.11	0.02	0.07	0.55	0.06	4.20	4.62	100.00	0.9900
7	2637	JB-BS-9 T241-1	10/21/91	76.42	12.92	1.10	0.01	0.08	0.55	0.05	4.22	4.65	100.00	0.9899
8	2639	JB-BS-12 T241-3	10/21/91	76.51	12.85	1.11	0.03	0.08	0.54	0.05	4.16	4.67	100.00	0.9894
9	2496	FLV-159-CH T219-6	12/20/90	77.01	12.76	1.08	0.03	0.03	0.54	0.05	3.94	4.57	100.01	0.9860
10	2643	JB-BS-16 T241-7	10/21/91	76.97	12.59	1.04	0.02	0.08	0.54	0.05	4.13	4.58	100.00	0.9856
11	2557	SS-91-1-1 T232-2	6/8/91	76.57	12.92	1.07	0.02	0.04	0.54	0.06	4.05	4.72	99.99	0.9856
12	2562	SS-91-1-5 T232-6	8/7/91	76.97	12.65	1.08	0.03	0.04	0.54	0.07	3.98	4.65	100.01	0.9848
13	2707	FLV-192-BC T246-1	12/12/91	77.01	12.55	1.05	0.03	0.05	0.53	0.05	4.18	4.56	100.01	0.9847
14	2060	FLV-64-CS T170-7	9/3/88	76.71	12.87	1.11	0.02	0.04	0.54	0.04	4.02	4.64	99.99	0.9846
15	1224	WL CORE G 370cm T92-7	5/2/85	76.83	12.82	1.09	0.04	0.04	0.54	0.05	3.95	4.65	100.01	0.9846
16	2717	FLV-201-TO T249-5	1/30/92	76.85	12.77	1.10	0.02	0.04	0.54	0.04	3.99	4.65	100.00	0.9840
17	1409	KRL 82182 (A1) (599) T112-1	10/22/85	76.60	12.87	1.11	0.04	0.04	0.55	0.06	4.08	4.65	100.00	0.9839
18	2558	SS-91-1-SU T232-1	8/6/91	76.74	12.86	1.09	0.04	0.04	0.54	0.05	3.95	4.68	99.99	0.9835
19	1418	BL-RSA-4 T112-9	10/23/85	76.83	12.79	1.08	0.04	0.04	0.55	0.06	3.96	4.65	100.00	0.9831
20	431	YOS-1, T13-1		76.61	12.93	1.12	0.03	0.05	0.54	0.07	4.03	4.64	100.02	0.9830
21	2493	FLV-156-SS T219-3	12/20/90	76.64	13.06	1.09	0.03	0.04	0.54	0.05	3.94	4.62	100.01	0.9829
22	1186	WALKER LAKE CORE G 380CM t89-1	2/28/85	76.98	12.79	1.08	0.02	0.05	0.54	0.05	3.86	4.64	100.01	0.9823
23	571	KRL91982F, T56-5	07/01/83	76.61	12.89	1.14	0.03	0.05	0.55	0.05	4.12	4.56	100.00	0.9820
24	681	KRL-91882A', T66-8	10/25/83	76.79	12.83	1.10	0.03	0.06	0.54	0.07	3.91	4.67	100.00	0.9811
25	760	BO-16		76.59	12.92	1.11	0.03	0.03	0.54	0.07	4.00	4.71	100.00	0.9810

Listing of 50 closest matches for COMP. NO. 2643 f elements: Na, Al, Si, K, Ca, Fe Date of Update: 10/22/91

I-No		Sample Number	Date	!	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total	Sim. Co
1	2643	JB-BS-15 T241-6	10/21/91	76.59	12.83	1.08	0.03	0.07	0.54	0.04	4.23	4.59	100.00	1.0000
2	2641	JB-BS-13 T241-4	10/21/91	76.49	12.83	1.08	0.03	0.08	0.53	0.06	4.26	4.64	100.00	0.9937
3	435	3-30-82-1, T43-3		76.62	12.93	1.06	0.02	0.05	0.54	0.07	4.13	4.59	100.01	0.9916
4	2646	JB-WA-1 T242-1	10/21/91	76.77	12.70	1.09	0.02	0.07	0.53	0.06	4.15	4.57	100.00	0.9910
5	2639	JB-BS-11 T241-2	10/21/91	76.55	12.80	1.10	0.02	0.08	0.54	0.06	4.16	4.69	99.99	0.9905
6	2642	JB-BS-14 T241-5	10/21/91	76.55	12.82	1.11	0.02	0.07	0.55	0.06	4.20	4.62	100.00	0.9900
7	2638	JB-BS-9 T241-1	10/21/91	76.42	12.92	1.10	0.01	0.08	0.55	0.05	4.22	4.65	100.00	0.9895
8	2640	JB-BS-12 T241-3	10/21/91	76.51	12.85	1.11	0.03	0.08	0.54	0.05	4.16	4.67	100.00	0.9894
9	2497	FLV-159-CH T219-6	12/20/90	77.01	12.76	1.08	0.03	0.03	0.54	0.05	3.94	4.57	100.01	0.9860
10	2644	JB-BS-16 T241-7	10/21/91	76.97	12.59	1.04	0.02	0.08	0.54	0.05	4.13	4.58	100.00	0.9856
11	2558	SS-91-1-1 T232-2	6/8/91	76.57	12.92	1.07	0.02	0.04	0.54	0.06	4.05	4.72	99.99	0.9856
12	2553	SS-91-1-5 T232-6	8/7/91	76.97	12.65	1.08	0.03	0.04	0.54	0.07	3.98	4.65	100.01	0.9848
13	2050	FLV-64-CS T170-7	9/3/88	76.71	12.87	1.11	0.02	0.04	0.54	0.04	4.02	4.64	99.99	0.9846
14	1224	WL CORE G 370cm T92-7	5/2/85	76.83	12.82	1.09	0.04	0.04	0.54	0.05	3.95	4.65	100.01	0.9846
15	1439	KRL 82182 (A1) (599) T112-1	10/22/85	76.60	12.87	1.11	0.04	0.04	0.55	0.06	4.08	4.65	100.00	0.9839
16	2559	SS-91-1-SU T232-1	8/6/91	76.74	12.86	1.09	0.04	0.04	0.54	0.05	3.95	4.68	99.99	0.9833
17	1418	BL-RSA-4, T112-9	10/23/85	76.83	12.79	1.08	0.04	0.04	0.55	0.06	3.96	4.65	100.00	0.9831
18	431	YOS-1, T13-1		76.61	12.93	1.12	0.03	0.05	0.54	0.07	4.03	4.64	100.02	0.9830
19	2494	FLV-156-SS T219-3	12/20/90	76.64	13.06	1.09	0.03	0.04	0.54	0.05	3.94	4.62	100.01	0.9829
20	1186	WALKER LAKE CORE G 380CM t89-1	2/28/85	76.98	12.79	1.08	0.02	0.05	0.54	0.05	3.86	4.64	100.01	0.9823
21	571	KRL91982F, T56-5	07/01/83	76.61	12.89	1.14	0.03	0.05	0.55	0.05	4.12	4.56	100.00	0.9820
22	681	KRL-91882A", T66-8	10/25/83	76.79	12.83	1.10	0.03	0.06	0.54	0.07	3.91	4.67	100.00	0.9811
23	750	BO-16		76.59	12.92	1.11	0.03	0.03	0.54	0.07	4.00	4.71	100.00	0.9810
24	1244	WL 8-3A ASH A 64-66cm T93-13	5/2/85	76.97	12.80	1.08	0.03	0.05	0.55	0.05	3.86	4.60	99.99	0.9808
25	570	KRL91982D, T66-10	xx/xx/83	76.81	12.89	1.08	0.03	0.05	0.53	0.06	3.90	4.65	100.00	0.9805
26	564	KRL82782A, T64-11	09/06/83	76.99	12.75	1.09	0.01	0.06	0.53	0.08	3.90	4.59	100.00	0.9805
27	2562	SS-91-1-4 T323-5	8/7/91	77.02	12.63	1.06	0.02	0.04	0.53	0.06	4.00	4.63	99.99	0.9798
28	2571	JB-BS-7 T227-4	6/13/91	76.73	12.89	1.10	0.03	0.05	0.54	0.06	3.91	4.69	100.00	0.9797
29	632	KRL-91882G, T66-11	10/25/83	76.91	12.76	1.07	0.03	0.06	0.54	0.07	3.87	4.68	99.99	0.9795
30	1680	KRL 860922 A T134-2	11/25/86	76.94	12.75	1.07	0.03	0.04	0.55	0.06	3.91	4.65	100.00	0.9795
31	1684	SCHURZ-1 T134-6	11/25/86	77.01	12.64	1.09	0.03	0.05	0.55	0.05	3.94	4.64	100.00	0.9788
32	2569	JB-BS-5 T227-2	6/13/91	76.69	12.91	1.08	0.02	0.05	0.55	0.09	3.90	4.70	99.99	0.9788
33	1225	WL CORE G 380cm T92-8	5/2/85	76.82	12.79	1.06	0.04	0.04	0.56	0.06	4.00	4.65	100.02	0.9787
34	1240	WL 4-2 3.29m T93-9	5/2/85	76.75	12.79	1.13	0.03	0.04	0.55	0.05	4.02	4.64	100.00	0.9787
35	1025	KRL-71082C (590) T58-1	6/22/84	76.91	12.71	1.08	0.02	0.00	0.53	0.05	3.95	4.74	99.99	0.9784
36	567	KRL91882-K-1, T64-13	09/06/83	76.93	12.82	1.11	0.01	0.05	0.53	0.07	3.68	4.60	100.00	0.9774
37	1419	BL-RSA-5 T112-10	10/23/85	76.98	12.65	1.09	0.04	0.04	0.53	0.05	3.93	4.68	99.99	0.9772
38	1416	BL-RSA-2 T112-7	10/23/85	76.78	12.85	1.12	0.04	0.03	0.54	0.06	3.90	4.68	100.00	0.9772
39	566	KRL918828, T64-12	09/06/83	76.81	12.82	1.10	0.01	0.05	0.53	0.08	3.91	4.69	100.00	0.9771
40	562	KRL82282A(P), T66-6	xx/xx/83	76.86	12.85	1.05	0.03	0.06	0.54	0.05	3.87	4.70	100.01	0.9764
41	679	KRL-82182(A-4), T66-3	10/25/83	76.89	12.82	1.02	0.02	0.05	0.52	0.04	4.08	4.55	99.99	0.9764
42	2490	FLV-155-CH T218-10	11/19/90	76.77	13.06	1.08	0.03	0.05	0.54	0.06	3.76	4.64	99.99	0.9764
43	2561	SS-91-1-3 t232-4	8/7/91	77.08	12.64	1.06	0.02	0.05	0.53	0.06	3.92	4.64	100.00	0.9763
44	1142	WL-2-3-2.14M T85-2	12/4/84	76.97	12.69	1.06	0.03	0.05	0.56	0.06	3.96	4.63	100.01	0.9762
45	783	GS-27		76.74	12.92	1.12	0.03	0.05	0.55	0.07	3.91	4.61	100.00	0.9762
46	1228	WL 8-2B 130-134cm T92-12	5/2/85	77.03	12.81	1.08	0.04	0.04	0.55	0.04	3.77	4.63	99.99	0.9762
47	1972	WL-4-58 (144.77m) T164-1	5/21/88	76.73	12.71	1.15	0.00	0.03	0.54	0.12	4.02	4.69	99.99	0.9762
48	680	KRL-82282B, T54-4	xx//xx/x	76.99	12.71	1.08	0.02	0.06	0.53	0.04	3.86	4.70	99.99	0.9760
49	1948	WL-4-4 (12.25M) T162-2	5/14/88	76.87	12.86	1.09	0.02	0.05	0.54	0.06	3.80	4.72	100.01	0.9759
50	554	KRL82182(A-3), T56-4	07/01/83	76.97	12.82	1.02	0.03	0.03	0.55	0.04	4.05	4.44	99.99	0.9758

SAMPLE ID: JB-BS-15 T241-6

Date of Analysis: 10/21/91

Raw Probe Data		Raw Probe Data (FeO to Fe2O3)		.culated to 100%	
SiO2	75.829			SiO2	76.59
Al2O3	12.693			Al2O3	12.83
FeO	0.966*1.1113=Fe2O3		1.074	Fe2O3	1.08
MgO	0.025			MgO	0.03
MnO	0.072			MnO	0.07
CaO	0.534			CaO	0.54
TiO2	0.043			TiO2	0.04
Na2o	4.184			Na2o	4.23
K2O	4.545			K2O	4.59
TOTAL(O)	98.896	TOTAL(N)	99.004	TOTAL(R)	100.00

20 Best Matches:

1	0.9937	10/21/91	JB-BS-13 T241-4
2	0.9916		3-30-82-1, T43-3
3	0.9905	10/21/91	JB-BS-11 T241-2
4	0.9900	10/21/91	JB-BS-14 T241-5
5	0.9899	10/21/91	JB-BS-9 T241-1
6	0.9894	10/21/91	JB-BS-12 T241-3
7	0.9860	12/20/90	FLV-159-CH T219-6
8	0.9856	6/8/91	SS-91-1-1 T232-2
9	0.9848	8/7/91	SS-91-1-5 T232-6
10	0.9846	9/3/88	FLV-64-CS T170-7
11	0.9846	5/2/85	WL CORE G 370cm T92-7
12	0.9839	10/22/85	KRL 82182 (A1) (599) T112-1
13	0.9835	8/6/91	SS-91-1-SU T232-1
14	0.9831	10/23/85	BL-RSA-4 T112-9
15	0.9830		YOS-1, T13-1
16	0.9829	12/20/90	FLV-156-SS T219-3
17	0.9823	2/28/85	WALKER LAKE CORE G 380CM t89-1
18	0.9820	07/01/83	KRL91982F, T56-5
19	0.9811	10/25/83	KRL-91882A", T66-8
20	0.9810		BO-16

Elements used in the calculation are:

Na2o
Al2O3
SiO2
K2O
CaO
FeO

***** This sample has been added to the data base *****

SAMPLE: T2 JR-BS-16

	BEAM	NA 9		MG 8		AL 3		SI 7		K 2		CA 6		TI 5		MN 1		FE 4	
PT	COUNTS	COUNTS	SD	COUNTS	SD	COUNTS	SD	COUNTS	SD	COUNTS	SD	COUNTS	SD	COUNTS	SD	COUNTS	SD	COUNTS	SD
1	14240	2454	50	133	12	13989	118	26211	162	8717	93	870	30	23	5	108	10	569	24
2	14239	1453	707	162	20	14104	81	26394	129	12027	****	1152	199	32	6	117	6	529	28
3	14244	6062	****	128	18	25166	****	21905	****	2418	****	5342	****	23	5	70	25	174	218
4	14247	2544	****	148	15	14468	****	27311	****	9083	****	894	****	23	4	102	20	572	193
5	14249	2576	****	142	13	14281	****	28190	****	8741	****	886	****	26	4	106	18	560	173
6	14243	2722	****	162	14	14706	****	26942	****	9230	****	933	****	29	4	101	16	343	164
7	14244	2471	****	141	13	14185	****	27899	****	8685	****	940	****	30	4	104	15	600	159
8	14244	2564	****	177	16	14438	****	27765	****	8842	****	934	****	30	4	110	14	603	154
9	14249	2537	****	153	15	14179	****	28110	****	8951	****	994	****	29	3	100	13	594	148
10	14249	2537	****	126	16	14233	****	27957	****	9206	****	878	****	20	4	104	12	854	178
11	14252	2412	****	149	16	13543	****	26921	****	8712	****	945	****	33	4	104	12	596	169
12	14252	2437	****	151	15	13843	****	26999	****	8499	****	1000	****	24	4	107	11	599	162
13	14251	2535	****	148	14	14064	****	27822	****	8887	****	931	****	18	5	120	12	566	156
14	14253	2528	****	161	14	14229	****	27947	****	8916	****	962	****	37	5	118	12	568	149
15	14252	2478	976	142	14	14170	****	26995	****	9076	****	952	****	32	5	113	12	544	144
16	14252	2552	944	135	14	14365	****	27512	****	9018	****	1005	****	27	5	114	11	590	140
17	14249	2518	914	155	13	13754	****	27108	****	8633	****	944	****	39	6	117	11	595	135
18	14251	5317	****	138	13	26697	****	21257	****	399	****	9200	****	16	6	78	13	151	163
19	14249	2531	****	171	14	14030	****	28373	****	8860	****	910	****	21	6	106	13	550	158
20	14245	2546	****	148	13	14190	****	27814	****	8815	****	920	****	31	6	113	12	556	154

LINES DELETED: 1 2 3 18

AVE. BEAM CURRENT/SEC = 712

DATA REDUCED USING $B-AL: $GL9M

ON SPECIMEN: T241-7 JR-BS-16

$B-AL VERSION 1.0

OXIDE FORM.	WEIGHT% (OXIDE)	STD.DEV. (%)	HOMO. INDEX	FORMULA	K-RATIO	UNKN PEAK (COUNTS)	UNKN BKGD (COUNTS)	COUNTING TIME(SEC)	STD PEAK (COUNTS)	STD BKGD (COUNTS)	COUNTING TIME(SEC)	STANDARD FILENAME
NA2O	4.071	2.94	1.360	0.000	1.05511	2530.4	50.4	20.00	2400.2	49.7	20.00	%RGSC
MGO	0.023	121.33	1.043	0.000	0.00598	150.3	136.4	20.00	2469.5	136.9	20.00	%RGSC
AL2O3	12.394	1.20	2.387	0.000	0.94643	14167.3	247.1	20.00	14955.9	247.8	20.00	%5831
SIO2	75.779	0.86	2.956	0.000	1.02744	27604.0	53.7	20.00	26868.4	53.9	20.00	%5831
K2O	4.505	1.63	2.176	0.000	1.23494	8884.6	144.6	20.00	7230.1	152.8	20.00	%RGSC
CAO	0.530	4.56	1.244	0.000	0.10360	939.1	179.0	20.00	7528.9	191.2	20.00	%RGSC
TIO2	0.052	71.89	1.107	0.000	0.00047	27.8	18.3	20.00	19938.2	26.6	20.00	%TIO2
MNO	0.079	29.75	0.607	0.000	0.00079	108.6	64.4	20.00	56342.7	119.9	20.00	%MN2O
FEO	0.923	5.80	3.961	0.000	0.14418	580.8	105.4	20.00	3409.3	112.6	20.00	%RGSC

TOTAL 98.355 NO. OXYGENS = 0 NO. ITERS. = 2 AVE. ATOMIC NO. = 11.15
21-OCT-91 15:29:05

Listing of 25 closest matches for COMP. NO. 2643 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 06/18/92

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2643	JB-BS-16 T241-7	10/21/91	76.97	12.59	1.04	0.02	0.08	0.54	0.05	4.13	4.58	100.00	1.0000
2	2707	FLV-192-BC T246-1	12/12/91	77.01	12.55	1.05	0.03	0.05	0.53	0.05	4.18	4.56	100.01	0.9920
3	435	3-30-82-1, T43-3		76.62	12.93	1.06	0.02	0.05	0.54	0.07	4.13	4.59	100.01	0.9914
4	2561	SS-91-1-4 T323-5	8/7/91	77.02	12.63	1.06	0.02	0.04	0.53	0.06	4.00	4.63	99.99	0.9861
5	2642	JB-BS-15 T241-6	10/21/91	76.59	12.83	1.08	0.03	0.07	0.54	0.04	4.23	4.59	100.00	0.9856
6	2559	SS-91-1-2 T232-3	8/7/91	77.11	12.63	1.03	0.03	0.05	0.54	0.06	3.89	4.67	100.01	0.9847
7	2645	JB-WA-1 T242-1	10/21/91	76.77	12.70	1.09	0.02	0.07	0.53	0.06	4.19	4.57	100.00	0.9846
8	2562	SS-91-1-5 T232-6	8/7/91	76.97	12.65	1.08	0.03	0.04	0.54	0.07	3.98	4.65	100.01	0.9845
9	679	KRL-82182(A-4), T66-3	10/25/83	76.89	12.82	1.02	0.02	0.05	0.52	0.04	4.08	4.55	99.99	0.9843
10	554	KRL82182(A-3), T56-4	07/01/83	76.97	12.82	1.02	0.03	0.03	0.55	0.04	4.09	4.44	99.99	0.9841
11	1141	WL-2-3-1.94M T85-1	12/4/84	76.97	12.65	1.05	0.03	0.05	0.56	0.05	4.00	4.66	100.02	0.9836
12	2496	FLV-159-CH T219-6	12/20/90	77.01	12.76	1.08	0.03	0.03	0.54	0.05	3.94	4.57	100.01	0.9835
13	1421	BL-RSA-7 T112-12	10/23/85	77.16	12.66	1.03	0.04	0.05	0.52	0.03	3.95	4.57	100.01	0.9833
14	559	KRL82182(bubble wall), T56-4	07/01/83	76.87	12.92	1.01	0.02	0.03	0.53	0.03	4.03	4.55	99.99	0.9825
15	2638	JB-BS-11 T241-2	10/21/91	76.55	12.80	1.10	0.02	0.08	0.54	0.06	4.16	4.68	99.99	0.9825
16	2560	SS-91-1-3 t232-4	8/7/91	77.08	12.64	1.06	0.02	0.05	0.53	0.06	3.92	4.64	100.00	0.9822
17	2557	SS-91-1-1 T232-2	6/8/91	76.57	12.92	1.07	0.02	0.04	0.54	0.06	4.05	4.72	99.99	0.9820
18	1142	WL-2-3-2.14M T85-2	12/4/84	76.97	12.69	1.06	0.03	0.05	0.56	0.06	3.96	4.63	100.01	0.9809
19	2567	JB-BS-4 T227-1	6/13/91	76.75	12.83	1.04	0.03	0.06	0.55	0.06	3.95	4.73	100.00	0.9808
20	2639	JB-BS-12 T241-3	10/21/91	76.51	12.85	1.11	0.03	0.08	0.54	0.05	4.16	4.67	100.00	0.9807
21	1225	WL CORE G 380cm T92-8	5/2/85	76.82	12.79	1.06	0.04	0.04	0.56	0.06	4.00	4.65	100.02	0.9802
22	2717	FLV-201-TO T249-5	1/30/92	76.85	12.77	1.10	0.02	0.04	0.54	0.04	3.99	4.65	100.00	0.9801
23	2563	SS-91-1-Adgss	8/7/91	76.73	12.85	1.04	0.03	0.05	0.53	0.07	3.95	4.74	99.99	0.9801
24	562	KRL82282A(P), T66-6	xx/xx/83	76.86	12.85	1.05	0.03	0.06	0.54	0.05	3.87	4.70	100.01	0.9801
25	2640	JB-BS-13 T241-4	10/21/91	76.49	12.83	1.08	0.03	0.08	0.53	0.06	4.26	4.64	100.00	0.9793

Listing of 50 closest matches for COMP. NO. 2544 ✓   elements: Na, Al, Si, K , Ca, Fe   Date of Update: 10/22/91

	C.No	Sample Number	Date	?	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total	.=. Cc
1	2544	JB-BS-16 T241-7	10/21/91	76.97	12.59	1.04	0.02	0.08	0.54	0.05	4.13	4.55	100.00	1.0000
2	435	3-30-82-1, T43-3		76.62	12.93	1.06	0.02	0.05	0.54	0.07	4.13	4.59	100.01	0.9914
3	2552	SS-91-1-4 T323-5	8/7/91	77.02	12.63	1.06	0.02	0.04	0.53	0.06	4.00	4.63	99.99	0.9843
4	2643	JB-BS-15 T241-6	10/21/91	76.59	12.83	1.08	0.03	0.07	0.54	0.04	4.23	4.53	100.00	0.9856
5	2560	SS-91-1-2 T232-3	8/7/91	77.11	12.63	1.03	0.03	0.05	0.54	0.06	3.85	4.67	100.01	0.9847
6	2646	JB-WA-1 T242-1	10/21/91	76.77	12.70	1.09	0.02	0.07	0.53	0.06	4.15	4.57	100.00	0.9846
7	2563	SS-91-1-5 T232-6	8/7/91	76.97	12.65	1.08	0.03	0.04	0.54	0.07	3.98	4.65	100.01	0.9845
8	579	KRL-82182(A-4), T66-3	10/25/83	76.89	12.82	1.02	0.02	0.05	0.52	0.04	4.08	4.55	99.99	0.9843
9	554	KRL82182(A-3), T56-4	07/01/83	76.97	12.82	1.02	0.03	0.03	0.55	0.04	4.09	4.44	99.99	0.9841
10	1141	WL-2-3-1.94M T85-1	12/4/84	76.97	12.65	1.05	0.03	0.05	0.56	0.05	4.00	4.66	100.04	0.9836
11	2497	FLV-159-CH T219-6	12/20/90	77.01	12.76	1.08	0.03	0.03	0.54	0.05	3.94	4.57	100.01	0.9835
12	1421	BL-RSA-7 T112-12	10/23/85	77.16	12.66	1.03	0.04	0.05	0.52	0.03	3.95	4.57	100.01	0.9833
13	559	KRL82182(bubble wall), T56-4	07/01/83	76.87	12.92	1.01	0.02	0.03	0.53	0.03	4.03	4.55	99.99	0.9829
14	2639	JB-BS-11 T241-2	10/21/91	76.55	12.80	1.10	0.02	0.08	0.54	0.06	4.16	4.68	99.99	0.9824
15	2561	SS-91-1-3 t232-4	8/7/91	77.08	12.64	1.06	0.02	0.05	0.53	0.06	3.92	4.64	100.00	0.9822
16	2558	SS-91-1-1 T232-2	6/8/91	76.57	12.92	1.07	0.02	0.04	0.54	0.06	4.05	4.72	99.99	0.9820
17	1142	WL-2-3-2.14M T85-2	12/4/84	76.97	12.69	1.06	0.03	0.05	0.56	0.06	3.96	4.63	100.01	0.9809
18	2568	JB-BS-4 T227-1	6/13/91	76.75	12.83	1.04	0.03	0.06	0.55	0.06	3.95	4.73	100.00	0.9808
19	2640	JB-BS-12 T241-3	10/21/91	76.51	12.85	1.11	0.03	0.08	0.54	0.05	4.16	4.67	100.00	0.9807
20	1225	WL CORE G 380cm T92-8	5/2/85	76.82	12.79	1.06	0.04	0.04	0.56	0.06	4.00	4.65	100.02	0.9802
21	2554	SS-91-1-Adgss	8/7/91	76.73	12.85	1.04	0.03	0.05	0.53	0.07	3.99	4.74	99.99	0.9801
22	562	KRL82282A(P), T66-6	xx/xx/83	76.86	12.85	1.05	0.03	0.06	0.54	0.05	3.87	4.70	100.01	0.9801
23	2641	JB-BS-13 T241-4	10/21/91	76.49	12.83	1.08	0.03	0.08	0.53	0.06	4.26	4.64	100.00	0.9793
24	1224	WL CORE G 370cm T92-7	5/2/85	76.83	12.82	1.09	0.04	0.04	0.54	0.05	3.95	4.65	100.01	0.9793
25	682	KRL-91882G, T66-11	10/25/83	76.91	12.76	1.07	0.03	0.06	0.54	0.07	3.87	4.68	99.99	0.9789
26	1684	SCHURZ-1 T134-6	11/25/86	77.01	12.64	1.09	0.03	0.05	0.55	0.05	3.94	4.64	100.00	0.9788
27	1680	KRL 860922 A T134-2	11/25/86	76.94	12.75	1.07	0.03	0.04	0.55	0.06	3.91	4.65	100.00	0.9788
28	2050	FLV-64-CS T170-7	9/3/88	76.71	12.87	1.11	0.02	0.04	0.54	0.04	4.02	4.64	99.99	0.9787
29	1418	BL-RSA-4 T112-9	10/23/85	76.83	12.79	1.08	0.04	0.04	0.55	0.06	3.96	4.65	100.00	0.9785
30	2642	JB-BS-14 T241-5	10/21/91	76.55	12.82	1.11	0.02	0.07	0.55	0.06	4.20	4.62	100.00	0.9783
31	1806	OD-ML-65CM T143-7	6/24/87	76.81	12.80	1.05	0.03	0.05	0.56	0.05	3.96	4.70	100.01	0.9783
32	1196	WALKER LAKE CORE G 380CM t89-1	2/28/85	76.98	12.79	1.08	0.02	0.05	0.54	0.05	3.86	4.64	100.01	0.9781
33	1034	WL 2-2-2.64, T78-7	08/18/84	77.06	12.62	1.06	0.03	0.05	0.55	0.06	3.86	4.71	100.00	0.9777
34	2559	SS-91-1-SU T232-1	8/6/91	76.74	12.86	1.09	0.04	0.04	0.54	0.05	3.95	4.68	99.99	0.9775
35	1036	WL 2-3-2.01, T78-9	08/18/84	77.05	12.74	1.05	0.02	0.04	0.55	0.05	3.82	4.67	99.99	0.9775
36	1439	KRL 82182 (A1) (599) T112-1	10/22/85	76.60	12.87	1.11	0.04	0.04	0.55	0.06	4.08	4.65	100.00	0.9773
37	554	KRL82782A, T64-11	09/06/83	76.99	12.75	1.09	0.01	0.06	0.53	0.08	3.90	4.59	100.00	0.9775
38	2342	FLV-67-HA T195-1	7/21/89	77.02	12.94	1.05	0.02	0.06	0.54	0.06	3.72	4.59	100.00	0.9769
39	1310	WL 8-2B 172-174.5CM T99-10	7/1/85	76.90	12.74	1.05	0.02	0.05	0.56	0.07	3.91	4.71	100.01	0.9769
40	1419	BL-RSA-5 T112-10	10/23/85	76.98	12.65	1.09	0.04	0.04	0.53	0.05	3.93	4.68	99.99	0.9766
41	431	YDS-1, T13-1		76.61	12.93	1.12	0.03	0.05	0.54	0.07	4.03	4.64	100.02	0.9767
42	2385	FLV-142-TC T203-8	4/16/90	77.51	12.24	1.03	0.00	0.06	0.51	0.08	3.98	4.60	100.01	0.9766
43	571	KRL91982F, T56-5	07/01/83	76.61	12.89	1.14	0.03	0.05	0.55	0.05	4.12	4.56	100.00	0.9766
44	2494	FLV-156-SS T219-3	12/20/90	76.64	13.06	1.09	0.03	0.04	0.54	0.05	3.94	4.62	100.01	0.9765
45	1244	WL 8-3A ASH A 64-66cm T93-13	5/2/85	76.97	12.80	1.08	0.03	0.05	0.55	0.05	3.86	4.60	99.99	0.9764
46	2638	JB-BS-9 T241-1	10/21/91	76.42	12.92	1.10	0.01	0.08	0.55	0.05	4.22	4.65	100.00	0.9764
47	1025	KRL-71082C (590) T58-1	6/22/84	76.91	12.71	1.08	0.02	0.00	0.53	0.05	3.95	4.74	99.99	0.9761
48	1420	BL-RSA-6 T112-11	10/23/85	77.08	12.78	0.97	0.02	0.04	0.53	0.04	3.97	4.56	99.99	0.9758
49	1757	OD-ML-10-405 CM T139-14	5/28/87	76.99	12.77	1.05	0.03	0.06	0.53	0.09	3.80	4.69	100.01	0.9757
50	1423	BL-RSA-9 T112-14	10/23/85	77.13	12.80	1.02	0.03	0.03	0.52	0.04	3.87	4.54	99.98	0.9756

SAMPLE ID: JB-BS-16 T241-7 — Date of Analysis: 10/21/91

Raw Probe Data		Raw Probe Data (FeO to Fe2O3)		Recalculated to 100%	
SiO2	75.779			SiO2	76.37
Al2O3	12.394			Al2O3	12.59
FeO	0.923*1.1113=Fe2O3		1.026	Fe2O3	1.04
MgO	0.023			MgO	0.02
MnO	0.079			MnO	0.08
CaO	0.530			CaO	0.54
TiO2	0.052			TiO2	0.05
Na2o	4.071			Na2o	4.13
K2O	4.505			K2O	4.58
TOTAL(O)	98.355	TOTAL(N)	98.458	TOTAL(R)	100.00

20 Best Matches:

1	0.9914		3-30-82-1, T43-3
2	0.9861	8/7/91	SS-91-1-4 T323-5
3	0.9856	10/21/91	JB-BS-15 T241-6
4	0.9847	8/7/91	SS-91-1-2 T232-3
5	0.9845	8/7/91	SS-91-1-5 T232-6
6	0.9843	10/25/83	KRL-82182(A-4), T66-3
7	0.9841	07/01/83	KRL82182(A-3), T56-4
8	0.9836	12/4/84	WL-2-3-1.94H T85-1
9	0.9835	12/20/90	FLV-159-CH T219-6
10	0.9833	10/23/85	BL-RSA-7 T112-12
11	0.9825	07/01/83	KRL82182(bubble wall), T56-4
12	0.9825	10/21/91	JB-BS-11 T241-2
13	0.9822	8/7/91	SS-91-1-3 t232-4
14	0.9820	6/8/91	SS-91-1-1 T232-2
15	0.9809	12/4/84	WL-2-3-2.14H T85-2
16	0.9808	6/13/91	JB-BS-4 T227-1
17	0.9807	10/21/91	JB-BS-12 T241-3
18	0.9802	5/2/85	WL CORE G 380cm T92-8
19	0.9801	8/7/91	SS-91-1-Adgss
20	0.9801	xx/xx/83	KRL82282A(P), T66-6

Elements used in the calculation are:

Na2o
Al2O3
SiO2
K2O
CaO
FeO

***** This sample has been added to the data base *****

SAMPLE: T24'-8 JR-RS-17

PT	BEAM COUNTS	NA COUNTS	9 SD	MG COUNTS	8 SD	AL COUNTS	3 SD	SI COUNTS	7 SD	K COUNTS	2 SD	CA COUNTS	6 SD	TI COUNTS	5 SD	MN COUNTS	1 SD	FE COUNTS	4 SD
1	14263	2428	49	163	13	14186	119	26470	163	9013	95	1150	34	27	5	107	10	447	21
2	14256	2342	61	145	13	14329	101	26300	120	9092	56	1103	33	22	3	96	8	437	7
3	14256	2301	65	160	10	14196	80	26468	97	8842	128	1135	24	29	4	102	5	472	18
4	14253	2347	53	157	8	14081	102	26430	80	8711	171	1098	25	28	3	130	15	450	15
5	14253	2407	52	154	7	14427	135	25846	265	9016	155	1064	34	29	3	117	13	470	15
6	14258	2378	46	157	6	14473	153	26014	265	8618	190	1126	31	30	3	103	12	457	14
7	14258	2374	42	152	6	13878	207	26152	245	8757	180	1099	29	18	4	93	13	442	13
8	14263	2395	40	158	6	14308	194	26517	247	8802	168	1121	27	29	4	93	13	518	26
9	14259	2445	45	166	6	14277	182	25993	249	8900	158	1132	26	23	4	106	12	482	25
10	14254	2295	50	174	8	14613	208	26017	246	9195	182	1288	60	28	4	100	11	494	26
11	14262	2219	66	155	8	14182	200	26045	239	8834	174	1239	66	31	4	105	11	510	28
12	14270	2518	78	146	8	14513	203	26440	238	8840	166	1125	63	21	4	88	11	456	27
13	14267	2417	76	164	8	14124	200	26025	234	8972	161	1136	60	21	4	109	11	477	26
14	14269	2294	76	182	10	14406	195	26845	282	9488	222	1332	77	25	4	92	11	501	26
15	14260	2322	74	168	10	14234	188	26018	279	8748	219	1059	78	27	4	109	11	466	25
16	14265	2436	74	178	11	14243	182	26288	269	8837	213	1187	76	21	4	101	10	456	25
17	14264	2327	72	147	11	14574	190	26201	261	8921	206	1118	74	30	4	93	10	489	24
18	14262	2287	73	154	11	14159	187	26570	265	8766	203	1117	72	28	4	112	10	480	24
19	14266	2236	76	156	11	14334	182	25807	277	9123	204	1113	71	22	4	109	10	476	23
20	14262	2434	76	158	10	14337	178	26112	271	8744	202	1091	70	40	5	108	10	473	22

LINES DELETED: 14 7

AVE. BEAM CURRENT/SEC = 713

DATA REDUCED USING $B-AL: *GL9M

ON SPECIMEN: T241-8 JR-RS-17

$B-AL VERSION 1.0

OXIDE FORM.	WEIGHT% (OXIDE)	STD.DEV. (%)	HOMO. INDEX	FORMULA	K-RATIO	UNKN PEAK (COUNTS)	UNKN BKGD (COUNTS)	COUNTING TIME(SEC)	STD PEAK (COUNTS)	STD BKGD (COUNTS)	COUNTING TIME(SEC)	STANDARD FILENAME
NA2O	3.826	2.99	1.625	0.000	0.98383	2363.0	50.6	20.00	2400.2	49.7	20.00	%RGSC
MGO	0.036	76.75	0.722	0.000	0.00960	158.7	136.3	20.00	2469.5	136.9	20.00	%RGSC
AL2O3	12.567	1.20	1.299	0.000	0.95631	14310.6	245.2	20.00	14955.9	247.8	20.00	%5B31
SIO2	72.135	0.87	1.496	0.000	0.97501	26197.8	53.3	20.00	26868.4	53.9	20.00	%5B31
K2O	4.501	1.63	1.643	0.000	1.23552	8887.4	143.2	20.00	7230.1	152.8	20.00	%RGSC
CAO	0.664	3.97	1.668	0.000	0.13036	1133.4	176.9	20.00	7528.9	191.2	20.00	%RGSC
TIO2	0.047	78.16	0.920	0.000	0.00043	26.7	18.1	20.00	19938.2	26.6	20.00	%TIO2
MNO	0.074	31.52	0.937	0.000	0.00073	104.8	63.6	20.00	56342.7	119.9	20.00	%MN2O
FEO	0.716	6.76	0.979	0.000	0.11178	472.8	104.2	20.00	3409.3	112.6	20.00	%RGSC

TOTAL 94.565 NO. OXYGENS = 0 NO. ITERS. = 2 AVE. ATOMIC NO. = 11.02

21-OCT-91 15:47:59

Listing of 25 closest matches for COMP. NO. 2644 for elements: Na, Al, Si, K , Ca, Fe Date of Update: 06/18/92

	C.No	Sample Number	Date	SiO2	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,R	Sim. Co
1	2644	JB-BS-17 T241-8	10/21/91	76.22	13.28	0.84	0.04	0.08	0.70	0.05	4.04	4.76	100.01	1.0000
2	454	679-340, T31-2		76.57	13.20	0.84	0.03	0.03	0.70	0.07	3.84	4.71	99.99	0.9882
3	2569	JB-BS-6 T227-3	6/13/91	76.39	13.29	0.83	0.04	0.06	0.71	0.06	3.88	4.74	100.00	0.9879
4	183	KRL7982-19B, T45-4		76.37	13.29	0.83	0.04	0.02	0.71	0.07	3.88	4.79	100.00	0.9876
5	1982	WL-5-13 (64.49m) T164-11	5/22/88	76.59	13.19	0.83	0.03	0.05	0.70	0.07	3.73	4.80	99.99	0.9819
6	1979	WL-5-12 (61.28m) T164-8	5/22/88	76.51	13.26	0.87	0.04	0.05	0.70	0.07	3.76	4.75	100.01	0.9815
7	182	KRL7982-16, T45-3		76.66	13.17	0.83	0.03	0.02	0.68	0.07	3.91	4.64	100.01	0.9814
8	2709	FLV-194-BC T246-3	12/12/91	76.50	12.97	0.88	0.05	0.05	0.72	0.06	4.00	4.75	99.98	0.9813
9	495	IIB, T32-1		76.58	13.16	0.87	0.03	0.06	0.71	0.05	3.87	4.68	100.01	0.9798
10	695	RSCS1		76.82	12.90	0.85	0.01	0.00	0.66	0.05	4.00	4.70	99.99	0.9787
11	1243	WL 4-26 66.40m T93-12	5/2/85	76.71	13.12	0.83	0.05	0.04	0.71	0.06	3.70	4.78	100.00	0.9779
12	756	BO-5		76.29	13.42	0.90	0.04	0.06	0.70	0.08	3.80	4.71	100.00	0.9753
13	545	KRL7982-17, T50-4	02/01/83	76.61	13.14	0.87	0.03	0.04	0.68	0.05	3.77	4.79	99.98	0.9747
14	1242	WL 4-26 66.33m T93-11	5/2/85	76.65	13.16	0.87	0.05	0.04	0.71	0.05	3.69	4.78	100.00	0.9743
15	1958	WL-4-17 (39.81M) T162-12	5/15/88	76.91	12.98	0.84	0.04	0.05	0.72	0.05	3.70	4.70	99.99	0.9740
16.	572	KRL91982J, T64-14	09/06/83	76.90	12.98	0.83	0.02	0.05	0.67	0.06	3.85	4.65	100.01	0.9739
17	1963	WL-4-26 (66.50M) T163-7	5/15/88	76.67	13.24	0.84	0.04	0.04	0.73	0.07	3.66	4.70	99.99	0.9739
18	1974	WL-5-5 (36.93m) T164-3	5/21/88	76.69	13.09	0.83	0.03	0.05	0.66	0.06	3.79	4.82	100.02	0.9727
19	1975	WL-5-6 (39.31m) T164-4	5/21/88	76.69	13.10	0.82	0.04	0.05	0.66	0.07	3.79	4.78	100.00	0.9722
20	549	KRL71082F, T55-5	11/25/83	76.59	13.26	0.86	0.05	0.05	0.71	0.07	3.59	4.82	100.00	0.9721
21	1976	WL-5-6 (40.08m) T164-5	5/21/88	76.68	13.08	0.82	0.03	0.05	0.66	0.06	3.81	4.82	100.01	0.9714
22	2711	FLV-196-BC T246-5	12/12/91	76.65	12.88	0.90	0.05	0.04	0.67	0.08	3.95	4.78	100.00	0.9714
23	1045	DSDP 36-10-2 SSA, T78-5	07/18/84	76.90	12.80	0.85	0.04	0.04	0.72	0.09	3.73	4.83	100.00	0.9707
24	1136	WL-5-13-1.11M T84-12	12/3/84	76.59	13.09	0.89	0.04	0.06	0.71	0.07	3.74	4.82	100.01	0.9706
25	1569	WLC-85-2 (10.65M) T127-14	8/18/86	76.61	13.40	0.87	0.03	0.06	0.70	0.05	3.52	4.76	100.00	0.9705

Listing of 50 closest matches for COMP. NO. 2645 f   Elements: Na, Al, Si, K, Ca, Fe   Date of Update: 10/22/91

C.No	Sample Number	Date		Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total,	s. Co
1 2645	JB-8S-17 T241-8	10/21/91	76.22	13.28	0.84	0.04	0.08	0.70	0.05	4.04	4.70	100.01	1.0000
2 454	679-340, T31-2		76.57	13.20	0.84	0.03	0.03	0.70	0.07	3.84	4.71	99.99	0.9882
3 2570	JB-8S-6 T227-3	6/13/91	76.39	13.29	0.83	0.04	0.06	0.71	0.06	3.88	4.74	100.00	0.9875
4 183	KRL7982-19B, T45-4		76.37	13.29	0.83	0.04	0.02	0.71	0.07	3.88	4.79	100.00	0.9876
5 1932	WL-5-13 (64.49m) T164-11	5/22/88	76.59	13.19	0.83	0.03	0.05	0.70	0.07	3.73	4.80	99.99	0.9819
6 1979	WL-5-12 (61.28m) T164-8	5/22/88	76.51	13.26	0.87	0.04	0.05	0.70	0.07	3.76	4.75	100.01	0.9815
7 182	KRL7982-16, T45-3		76.66	13.17	0.83	0.03	0.02	0.68	0.07	3.91	4.64	100.01	0.9814
8 495	IIB, T32-1		76.58	13.16	0.87	0.03	0.06	0.71	0.05	3.87	4.68	100.01	0.9798
9 695	RSCS1		76.82	12.90	0.85	0.01	0.00	0.66	0.05	4.00	4.70	99.99	0.9787
10 1243	WL 4-26 66.40m T93-12	5/2/85	76.71	13.12	0.83	0.05	0.04	0.71	0.06	3.70	4.78	100.00	0.9779
11 756	80-5		76.29	13.42	0.90	0.04	0.06	0.70	0.08	3.80	4.71	100.00	0.9753
12 545	KRL7982-17, T50-4	02/01/83	76.61	13.14	0.87	0.03	0.04	0.68	0.05	3.77	4.79	99.98	0.9747
13 1242	WL 4-26 66.33m T93-11	5/2/85	76.65	13.16	0.87	0.05	0.04	0.71	0.05	3.69	4.78	100.00	0.9743
14 1958	WL-4-17 (39.81M) T162-12	5/15/88	76.91	12.98	0.84	0.04	0.05	0.72	0.05	3.70	4.70	99.99	0.9740
15 572	KRL91982J, T64-14	09/06/83	76.90	12.98	0.83	0.02	0.05	0.67	0.06	3.85	4.65	100.01	0.9735
16 1953	WL-4-26 (66.50M) T163-7	5/15/88	76.67	13.24	0.84	0.04	0.04	0.73	0.07	3.66	4.70	99.99	0.9735
17 1974	WL-5-5 (36.93m) T164-3	5/21/88	76.69	13.09	0.83	0.03	0.05	0.66	0.06	3.79	4.62	100.02	0.9727
18 1975	WL-5-6 (39.31m) T164-4	5/21/88	76.69	13.10	0.82	0.04	0.05	0.66	0.07	3.79	4.76	100.00	0.9722
19 549	KRL71082F, T55-5	11/25/83	76.59	13.26	0.86	0.05	0.05	0.71	0.07	3.59	4.82	100.00	0.9721
20 1976	WL-5-6 (40.08m) T164-5	5/21/88	76.68	13.08	0.82	0.03	0.05	0.66	0.06	3.81	4.82	100.01	0.9714
21 1045	DSDP 36-10-2 SSA, T78-5	07/18/84	76.90	12.80	0.85	0.04	0.04	0.72	0.09	3.73	4.83	100.00	0.9707
22 1136	WL-5-13-1.11M T84-12	12/3/84	76.59	13.09	0.89	0.04	0.06	0.71	0.07	3.74	4.82	100.01	0.9706
23 1569	WLC-85-2 (10.65M) T127-14	8/18/86	76.61	13.40	0.87	0.03	0.06	0.70	0.05	3.52	4.76	100.00	0.9705
24 2566	SS-91-1 high Ca SS	8/7/91	77.12	12.77	0.83	0.03	0.05	0.67	0.05	3.79	4.67	99.98	0.9651
25 1033	KRL-71082 (II-4) (593) T58-4	6/22/84	76.44	13.18	0.88	0.05	0.00	0.70	0.07	3.69	4.98	99.99	0.9685
26 1258	*WL 4-26 66.79m t95-5	5/29/85	76.94	12.84	0.81	0.05	0.04	0.73	0.07	3.77	4.75	100.00	0.9686
27 574	KRL92082-A, T53-3	03/25/83	76.12	13.32	0.94	0.04	0.04	0.67	0.06	3.95	4.86	100.00	0.9673
28 455	679-409-6, T31-1		76.71	13.04	0.88	0.03	0.03	0.66	0.07	3.78	4.80	100.00	0.9667
29 191	LD-10, T40-2		76.71	13.04	0.91	0.04	0.03	0.68	0.07	3.80	4.71	99.99	0.9667
30 1959	WL-4-18 (43.53M) T162-13	5/15/88	77.01	12.97	0.82	0.04	0.04	0.67	0.06	3.63	4.77	100.01	0.9660
31 1257	*WL 4-26 66.68m	5/29/85	76.78	12.82	0.88	0.05	0.05	0.75	0.07	3.86	4.73	99.99	0.9658
32 588	PMR-1, T54-12	07/xx/83	77.00	12.77	0.86	0.13	0.07	0.72	0.13	3.88	4.44	100.00	0.9656
33 1259	*WL 4-26 66.87m t95-6	5/29/85	77.01	12.69	0.88	0.04	0.04	0.73	0.09	3.81	4.71	100.00	0.9652
34 1260	*WL 4-26 6a7.04m t95-7	5/29/85	77.27	12.59	0.84	0.04	0.05	0.74	0.06	3.73	4.70	100.02	0.9652
35 1983	WL-5-16 (73.40m) T164-12	5/22/88	76.37	13.29	0.81	0.05	0.04	0.75	0.10	3.70	4.89	100.00	0.9640
36 1964	WL-4-27 (68.59M) T163-8	5/15/88	76.85	13.06	0.85	0.04	0.06	0.75	0.06	3.64	4.69	100.00	0.9636
37 1962	WL-4-25 (62.76M) T164-6	5/15/88	76.91	12.91	0.79	0.05	0.05	0.70	0.05	3.62	4.87	99.99	0.9626
38 1039	WL 4-26-3.06, T78-12	08/18/84	76.97	12.78	0.86	0.04	0.05	0.73	0.06	3.65	4.87	100.01	0.9615
39 1238	WL 2-7 21.02m T93-7	5/1/85	76.85	13.15	0.89	0.05	0.04	0.71	0.05	3.46	4.78	100.00	0.9615
40 1978	WL-5-7 (51.83m) T164-7	5/21/88	75.54	13.66	0.98	0.07	0.05	0.68	0.14	4.01	4.87	100.00	0.9603
41 573	KRL91982-K, T64-15	09/06/83	76.84	13.01	0.90	0.02	0.05	0.66	0.06	3.70	4.75	99.99	0.9603
42 1570	WLC-85-2 (11.34M) T128-1	8/18/86	76.89	12.97	0.84	0.04	0.05	0.75	0.08	3.54	4.65	100.01	0.9598
43 1047	DSDP 36-10-2 SSA3, T78-5	07/18/84	77.04	13.17	0.81	0.02	0.06	0.67	0.03	3.50	4.69	99.99	0.9590
44 2596	EL-1-M T230-5	7/2/91	76.61	13.14	0.85	0.06	0.04	0.79	0.08	3.64	4.79	100.00	0.9589
45 1480	6VI84-1-5.5M T117-13	3/6/86	76.73	13.08	0.87	0.06	0.05	0.74	0.08	3.55	4.85	100.01	0.9583
46 1956	WL-4-13 (33.32M) T162-10	5/15/88	76.98	12.91	0.86	0.04	0.04	0.65	0.06	3.60	4.85	99.99	0.9567
47 1998	WL-5-57 (144.18m) T165-13	5/22/88	77.70	11.93	0.88	0.05	0.08	0.71	0.09	3.76	4.82	100.02	0.9563
48 2376	KRL880-604B T201-5	10/12/89	76.67	13.17	0.93	0.02	0.03	0.66	0.04	3.69	4.80	100.01	0.9562
49 180	KRL7982-11L, T44-8		76.76	13.01	0.92	0.02	0.03	0.63	0.04	3.89	4.70	100.00	0.9560
50 1985	WL-5-16 (73.62m) T164-14	5/22/88	76.34	13.31	0.83	0.06	0.03	0.73	0.10	3.47	5.13	100.00	0.9550

SAMPLE ID: JB-BS-17 T241-8 D of Analysis: 10/21/91

Raw Probe Data		Raw Probe Data (FeO to Fe2O3)	Recalculated to 100%	
SiO2	72.135		SiO2	76.22
Al2O3	12.567		Al2O3	13.28
FeO	0.716*1.1113=Fe2O3	0.796	Fe2O3	0.84
MgO	0.036		MgO	0.04
MnO	0.074		MnO	0.08
CaO	0.664		CaO	0.70
TiO2	0.047		TiO2	0.05
Na2o	3.826		Na2o	4.04
K2O	4.501		K2O	4.76
TOTAL(O)	94.565	TOTAL(N) 94.645	TOTAL(R)	100.01

20 Best Matches:

1	0.9882		679-340, T31-2
2	0.9879	6/13/91	JB-BS-6 T227-3
3	0.9876		KRL7982-198, T45-4
4	0.9819	5/22/88	WL-5-13 (64.49m) T164-11
5	0.9815	5/22/88	WL-5-12 (61.28m) T164-8
6	0.9814		KRL7982-16, T45-3
7	0.9798		IIB, T32-1
8	0.9787		RSCS1
9	0.9779	5/2/85	WL 4-26 66.40m T93-12
10	0.9753		BO-5
11	0.9747	02/01/83	KRL7982-17, T50-4
12	0.9743	5/2/85	WL 4-26 66.33m T93-11
13	0.9740	5/15/88	WL-4-17 (39.81M) T162-12
14	0.9739	09/06/83	KRL91982J, T64-14
15	0.9739	5/15/88	WL-4-26 (66.50M) T163-7
16	0.9727	5/21/88	WL-5-5 (36.93m) T164-3
17	0.9722	5/21/88	WL-5-6 (39.31m) T164-4
18	0.9721	11/25/83	KRL71082F, T55-5
19	0.9714	5/21/88	WL-5-6 (40.08m) T164-5
20	0.9707	07/18/84	DSDP 36-10-2 SSA, T78-5

Elements used in the calculation are:

Na2o
Al2O3
SiO2
K2O
CaO
FeO

This sample has been added to the data base

SAMPLE: T: JB-WA-1

PT	BEAM COUNTS	NA COUNTS	9 SD	MG COUNTS	8 SD	AL COUNTS	3 SD	SI COUNTS	7 SD	K COUNTS	2 SD	CA COUNTS	6 SD	TI COUNTS	5 SD	MN COUNTS	1 SD	FE COUNTS	4 SD
1	14276	2659	52	157	13	14569	121	27309	165	9014	95	895	30	27	5	108	10	627	25
2	14264	2653	5	185	20	14507	44	26973	238	8987	19	911	11	27	0	104	3	656	21
3	14274	2669	9	154	17	14522	32	27862	449	9035	24	844	35	27	0	107	2	493	87
4	14278	2506	77	136	20	14492	33	27821	428	9007	20	905	31	33	3	124	9	607	71
5	14270	2516	82	156	18	13725	358	26101	724	8357	293	908	28	31	3	99	9	577	62
6	14269	2388	114	141	17	13936	365	27063	650	8601	286	925	28	23	3	97	9	564	57
7	14265	2656	109	151	16	13907	363	27553	609	8856	261	909	26	23	4	109	9	568	52
8	14261	2464	109	149	15	14116	339	26927	575	8689	247	942	29	29	3	110	8	609	49
9	14258	2556	102	167	15	14177	317	28007	601	8722	233	949	30	31	3	106	8	581	46
10	14274	2478	100	143	14	14345	302	27126	569	8837	220	910	29	43	6	83	10	590	44
11	14278	2461	99	148	14	13407	379	26957	548	8361	249	945	29	21	6	108	10	660	47
12	14270	2566	94	157	13	14129	361	27485	527	8659	240	918	28	31	6	97	10	587	45
13	14268	2626	93	122	15	14491	358	27608	514	8975	237	948	28	29	6	111	10	639	45
14	14273	2363	103	142	15	13535	385	26505	537	8612	232	924	27	18	6	86	10	606	43
15	14276	2530	99	157	15	14242	372	27845	540	8794	224	969	30	23	6	108	10	604	41
16	14279	2372	105	153	14	13552	388	26504	557	8594	220	922	29	31	6	106	10	566	41
17	14269	2451	103	144	14	13801	383	27193	539	8822	214	899	28	25	6	105	9	549	41
18	14273	2585	101	142	13	14359	377	27322	523	8873	209	916	27	38	6	105	9	638	41
19	14283	2616	100	155	13	14707	392	27437	511	8673	204	941	27	26	6	108	9	641	41
20	14283	2558	98	156	13	14564	394	27897	518	9346	238	944	27	31	6	102	9	598	40

LINES DELETED: 5 6

AVE. BEAM CURRENT/SEC = 714

DATA REDUCED USING $B-AL: *GL9M

ON SPECIMEN: T242-1 JB-WA-1

$B-AL VERSION 1.0

OXIDE FORM.	WEIGHT% (OXIDE)	STD.DEV. (%)	HOMO. INDEX	FORMULA	K-RATIO	UNKN PEAK (COUNTS)	UNKN BKGD (COUNTS)	COUNTING TIME(SEC)	STD PEAK (COUNTS)	STD BKGD (COUNTS)	COUNTING TIME(SEC)	STANDARD FILENAME
NA2O	4.097	2.93	1.915	0.000	1.06034	2542.8	50.5	20.00	2400.2	49.7	20.00	%RGSC
MGO	0.024	115.74	1.082	0.000	0.00628	151.0	136.4	20.00	2469.5	136.9	20.00	%RGSC
AL2O3	12.428	1.20	3.338	0.000	0.94799	14190.0	246.9	20.00	14955.9	247.8	20.00	%5831
SIO2	75.144	0.86	2.774	0.000	1.01803	27351.8	53.7	20.00	26868.4	53.9	20.00	%5831
K2O	4.474	1.63	2.354	0.000	1.22660	8825.4	144.4	20.00	7230.1	152.8	20.00	%RGSC
CAO	0.517	4.62	0.931	0.000	0.10126	921.7	178.7	20.00	7528.9	191.2	20.00	%RGSC
TIO2	0.055	68.83	1.131	0.000	0.00050	28.2	18.3	20.00	19938.2	26.6	20.00	%TIO2
MNO	0.072	32.24	0.877	0.000	0.00072	104.6	64.3	20.00	56342.7	119.9	20.00	%MN2O
FEO	0.962	5.66	1.689	0.000	0.15036	601.0	105.3	20.00	3409.3	112.6	20.00	%RGSC

TOTAL 97.773 NO. OXYGENS = 0 NO. ITERS. = 2 AVE. ATOMIC NO. = 11.13
21-OCT-91 16:09:31

SAMPLE ID: JB-WA-1 T242-1 Dr of Analysis: 10/21/91

Raw Probe Data			Raw Probe Data (FeO to Fe2O3)	. lculated to 100%	
SiO2	75.144			SiO2	76.77
Al2O3	12.428			Al2O3	12.70
FeO	0.962*1.1113=Fe2O3		1.069	Fe2O3	1.09
MgO	0.024			MgO	0.02
MnO	0.072			MnO	0.07
CaO	0.517			CaO	0.53
TiO2	0.055			TiO2	0.06
Na2o	4.097			Na2o	4.19
K2O	4.474			K2O	4.57
TOTAL(O)	97.773	TOTAL(N)	97.880	TOTAL(R)	100.00

20 Best Matches:

1	0.9910	10/21/91	JB-BS-15 T241-6
2	0.9909	10/21/91	JB-BS-13 T241-4
3	0.9885	10/21/91	JB-BS-11 T241-2
4	0.9867	10/21/91	JB-BS-14 T241-5
5	0.9866	10/21/91	JB-BS-12 T241-3
6	0.9866	09/06/83	KRL82782A, T64-11
7	0.9859		3-30-82-1, T43-3
8	0.9848	10/21/91	JB-BS-9 T241-1
9	0.9846	10/21/91	JB-BS-16 T241-7
10	0.9846	10/23/85	BL-RSA-5 T112-10
11	0.9842	8/7/91	SS-91-1-4 T323-5
12	0.9841	12/20/90	FLV-159-CH T219-6
13	0.9831	8/7/91	SS-91-1-5 T232-6
14	0.9828	5/2/85	WL CORE G 370cm T92-7
15	0.9825	6/22/84	KRL-71082C (590) T58-1
16	0.9823		LD-12
17	0.9823	9/3/88	FLV-64-CS T170-7
18	0.9817	09/06/83	KRL91882-K-1, T64-13
19	0.9815	xx/xx/83	KRL91982D, T66-10
20	0.9815		LD-12, T3,4

Elements used in the calculation are:

Na2o
Al2O3
SiO2
K2O
CaO
FeO

***** This sample has been added to the data base *****

Listing of 50 closest matches for COMP. NO. 2646 # - elements: Na, Al, Si, K, Ca, Fe Date of Update: 10/22/91

	C.No	Sample Number	Date	?	Al2O3	Fe2O3	MgO	MnO	CaO	TiO2	Na2O	K2O	Total	#. Gc
1	2646	JB-WA-1 T242-1	10/21/91	76.77	12.70	1.03	0.02	0.07	0.53	0.05	4.15	4.57	100.00	1.0000
2	2643	JB-BS-15 T241-6	10/21/91	76.59	12.83	1.08	0.03	0.07	0.54	0.04	4.23	4.59	100.00	0.9916
3	2641	JB-BS-13 T241-4	10/21/91	76.49	12.83	1.08	0.03	0.08	0.53	0.06	4.26	4.64	100.00	0.9903
4	2639	JB-BS-11 T241-2	10/21/91	76.55	12.80	1.10	0.02	0.08	0.54	0.06	4.16	4.68	99.99	0.9865
5	2642	JB-BS-14 T241-5	10/21/91	76.55	12.82	1.11	0.02	0.07	0.55	0.06	4.20	4.62	100.00	0.9867
5	2640	JB-BS-12 T241-3	10/21/91	76.51	12.85	1.11	0.03	0.08	0.54	0.05	4.16	4.67	100.00	0.9866
7	564	KRL82782A, T64-11	09/06/83	76.99	12.75	1.09	0.01	0.06	0.53	0.08	3.90	4.59	100.00	0.9866
8	435	3-30-82-1, T43-3		76.62	12.93	1.06	0.02	0.05	0.54	0.07	4.13	4.59	100.01	0.9859
9	2638	JB-BS-9 T241-1	10/21/91	76.42	12.92	1.10	0.01	0.08	0.55	0.05	4.22	4.65	100.00	0.9848
10	2644	JB-BS-16 T241-7	10/21/91	76.97	12.59	1.04	0.02	0.08	0.54	0.05	4.13	4.58	100.00	0.9846
11	1419	BL-RSA-5 T112-10	10/23/85	76.98	12.65	1.09	0.04	0.04	0.53	0.05	3.93	4.68	99.99	0.9846
12	2552	SS-91-1-4 T323-5	8/7/91	77.02	12.63	1.06	0.02	0.04	0.53	0.06	4.00	4.63	99.99	0.9842
13	2497	FLV-159-CH T219-6	12/20/90	77.01	12.76	1.08	0.03	0.03	0.54	0.05	3.94	4.57	100.01	0.9841
14	2563	SS-91-1-5 T232-6	8/7/91	76.97	12.65	1.08	0.03	0.04	0.54	0.07	3.98	4.65	100.01	0.9831
15	1224	WL CORE G 370cm T92-7	5/2/85	76.83	12.82	1.09	0.04	0.04	0.54	0.05	3.95	4.65	100.01	0.9828
16	1025	KRL-71082C (590) T58-1	6/22/84	76.91	12.71	1.08	0.02	0.00	0.53	0.05	3.95	4.74	99.99	0.9825
17	701	LD-12		76.94	12.72	1.12	0.03	0.07	0.53	0.07	3.91	4.61	100.00	0.9823
18	2050	FLV-64-CS T170-7	9/3/88	76.71	12.87	1.11	0.02	0.04	0.54	0.04	4.02	4.64	99.99	0.9823
19	567	KRL91882-K-1, T64-13	09/06/83	76.93	12.82	1.11	0.01	0.05	0.53	0.07	3.88	4.60	100.00	0.9817
20	570	KRL91982D, T66-10	xx/xx/83	76.81	12.89	1.08	0.03	0.05	0.53	0.06	3.90	4.65	100.00	0.9815
21	192	LD-12, T3,4		76.94	12.70	1.12	0.03	0.07	0.53	0.07	3.91	4.54	100.01	0.9815
22	566	KRL91882B, T64-12	09/06/83	76.81	12.82	1.10	0.01	0.05	0.53	0.08	3.91	4.69	100.00	0.9814
23	2559	SS-91-1-SU T232-1	8/6/91	76.74	12.86	1.09	0.04	0.04	0.54	0.05	3.95	4.68	99.99	0.9813
24	1409	KRL 82182 (A1) (599) T112-1	10/22/85	76.60	12.87	1.11	0.04	0.04	0.55	0.06	4.08	4.65	100.00	0.9811
25	739	S-20		76.83	12.90	1.09	0.03	0.07	0.51	0.06	4.00	4.50	99.99	0.9809
26	2561	SS-91-1-3 t232-4	8/7/91	77.08	12.64	1.06	0.02	0.05	0.53	0.06	3.92	4.64	100.00	0.9807
27	571	KRL91982F, T56-5	07/01/83	76.61	12.89	1.14	0.03	0.05	0.55	0.05	4.12	4.56	100.00	0.9807
28	2494	FLV-156-SS T219-3	12/20/90	76.64	13.06	1.09	0.03	0.04	0.54	0.05	3.94	4.62	100.01	0.9803
29	431	YDS-1, T13-1		76.61	12.93	1.12	0.03	0.05	0.54	0.07	4.03	4.64	100.02	0.9803
30	1634	SCHURZ-1 T134-6	11/25/86	77.01	12.64	1.09	0.03	0.05	0.55	0.05	3.94	4.64	100.00	0.9802
31	680	KRL-822828, T54-4	xx//xx/x	76.99	12.71	1.08	0.02	0.06	0.53	0.04	3.86	4.70	99.99	0.9801
32	2558	SS-91-1-1 T232-2	6/8/91	76.57	12.92	1.07	0.02	0.04	0.54	0.06	4.05	4.72	99.99	0.9797
33	679	KRL-82182(A-4), T66-3	10/25/83	76.89	12.82	1.02	0.02	0.05	0.52	0.04	4.08	4.55	99.99	0.9792
34	1418	BL-RSA-4 T112-9	10/23/85	76.83	12.79	1.08	0.04	0.04	0.55	0.06	3.96	4.65	100.00	0.9791
35	684	KRL--92082D, T66-12	10/25/83	77.02	12.69	1.09	0.02	0.05	0.51	0.04	3.92	4.66	100.00	0.9791
36	681	KRL-91882A*, T66-8	10/25/83	76.79	12.83	1.10	0.03	0.06	0.54	0.07	3.91	4.67	100.00	0.9790
37	551	KRL82282A, T66-5	10/25/83	76.71	12.88	1.12	0.04	0.05	0.52	0.06	3.98	4.65	100.01	0.9787
38	760	BD-16		76.59	12.92	1.11	0.03	0.03	0.54	0.07	4.00	4.71	100.00	0.9782
39	1136	WALKER LAKE CORE G 380CM t89-1	2/28/85	76.98	12.79	1.08	0.02	0.05	0.54	0.05	3.86	4.64	100.01	0.9781
40	559	KRL82182(bubble wall), T56-4	07/01/83	76.87	12.92	1.01	0.02	0.03	0.53	0.03	4.03	4.55	99.99	0.9776
41	1240	WL 4-2 3.29m T93-9	5/2/85	76.75	12.79	1.13	0.03	0.04	0.55	0.05	4.02	4.64	100.00	0.9775
42	2571	JB-BS-7 T227-4	6/13/91	76.73	12.89	1.10	0.03	0.05	0.54	0.06	3.91	4.69	100.00	0.9775
43	437	6A, T35-7		75.81	12.97	1.11	0.03	0.03	0.52	0.06	3.92	4.56	99.01	0.9772
44	1072	WL-4-58 (144.77m) T164-1	5/21/88	76.73	12.71	1.15	0.00	0.03	0.54	0.12	4.02	4.69	99.99	0.9770
45	1421	BL-RSA-7 T112-12	10/23/85	77.16	12.66	1.03	0.04	0.05	0.52	0.03	3.95	4.57	100.01	0.9768
46	1760	OD-ML-6-135 CM T139-11	5/28/87	77.17	12.73	1.09	0.05	0.05	0.54	0.08	3.72	4.58	100.01	0.9766
47	1244	WL 8-3A ASH A 64-66cm T93-13	5/2/85	76.97	12.80	1.08	0.03	0.05	0.55	0.05	3.86	4.60	99.99	0.9765
48	1754	OD-QWP-34 CM T139-7	5/28/87	77.27	12.64	1.07	0.04	0.05	0.53	0.08	3.74	4.59	100.01	0.9765
49	1290	WL 8-1B 92-94cm T99-1	07/01/85	76.99	12.72	1.11	0.02	0.06	0.54	0.07	3.84	4.65	100.00	0.9764
50	2599	FLV-163-LC T230-8	7/2/91	77.28	12.61	1.08	0.02	0.04	0.51	0.06	3.94	4.47	100.01	0.9763

Appendix C

Paper and Field Guide Presented at Geological Society of Nevada
Symposium on Walker Lane

GEOLOGICAL SOCIETY OF NEVADA

WALKER LANE SYMPOSIUM

1992 SPRING FIELD TRIP #1 GUIDEBOOK

HAWTHORNE AREA-NORTHERN WALKER LANE

STRUCTURE AND TECTONICS

Northern Wassuk Range Faults

Walker Lake Area - Pine Nut Fault Zone

Santa Fe Mine - Isabella Tectonic Setting

Bettles Well Graben Tectonics

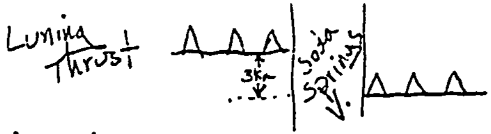
Cedar Mountain Fault Zone

Dicalite Summit Detachment Fault

Sheep Canyon Fault

SPECIAL PUBLICATION #14

April 25-26, 1992



50.7 Approximate trace of the northwest-trending Bettles Well strike-slip fault, which apparently merges with the Petrified Spring fault to the north. Together, these faults truncate the east end of the Bettles Well Valley half-graben and displace the east end of the graben about 3 km right-laterally to the southeast. This amount of displacement is equal to that of displaced Mesozoic structures across this fault.

52.3 Summit, elevation 6439', microwave tower to north.

53.1 Fork in road at power line, take right fork heading east into the southern Stewart Valley.

55.0 To the left of the road (east) and about 200 yards down the broad drainageway are fault scarps produced during the 1932 Cedar Mountain earthquake (Molinari, 1984, and references therein).

56.7 Water trough near cattle guard in fence. Looking to the west and south is an overview of the geology of the eastern Pilot Mountains. Of importance is the southerly displaced continuation of the Bettles Well half-graben now exposed at the Gun Metal mine. The half-graben has been displaced about 3 km south by the Bettles Well fault system. The eastern extent of the half-graben is obscured by range-front faults along the eastern Pilot Mountains. Scarps in alluvium can be seen in the valley fill east of the prominent pre-Tertiary exposures.

In the southeastern part of the Pilot Mountains, a large skarn tungsten deposit, the **Gunmetal mine**, was extensively explored and developed by Duval Corporation in the late 1970s. The original Gunmetal mine produced tungsten during WW II from generally low grade ores, which locally averaged 1% WO_3. An extensive exploration effort was conducted by Union Carbide in late 1970s-early 1980s (Grabher, 1984).

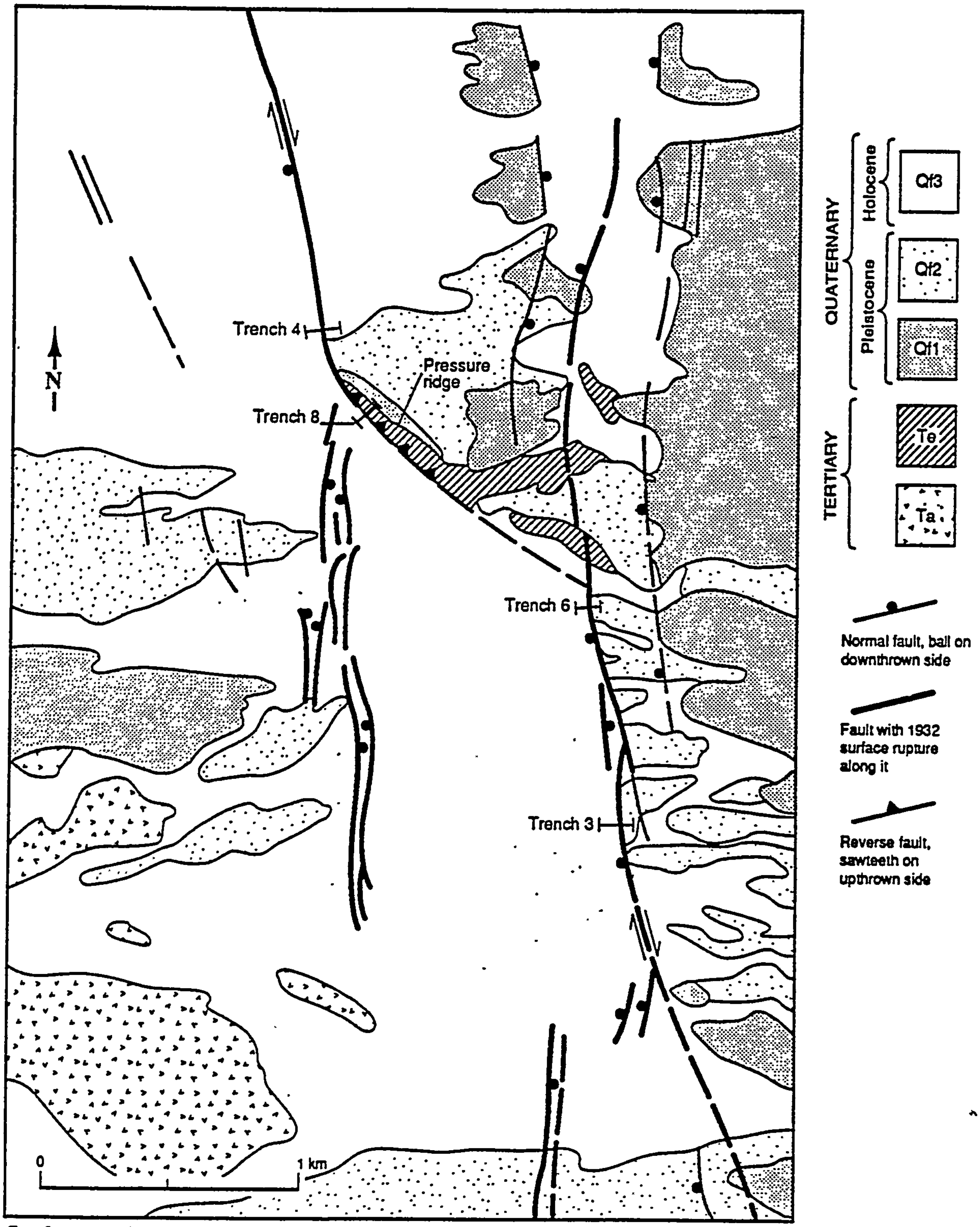
56.8 Fork in road, stay right and drive south.

58.4 Take track on left (east) to small hill with white trench dumps.

58.7 **STOP 11 - Craig dePolo, Figure 18.** Examine features of the **1932 Cedar Mountain earthquake** where **Trench #8** exposes upturned tuffaceous sediments.

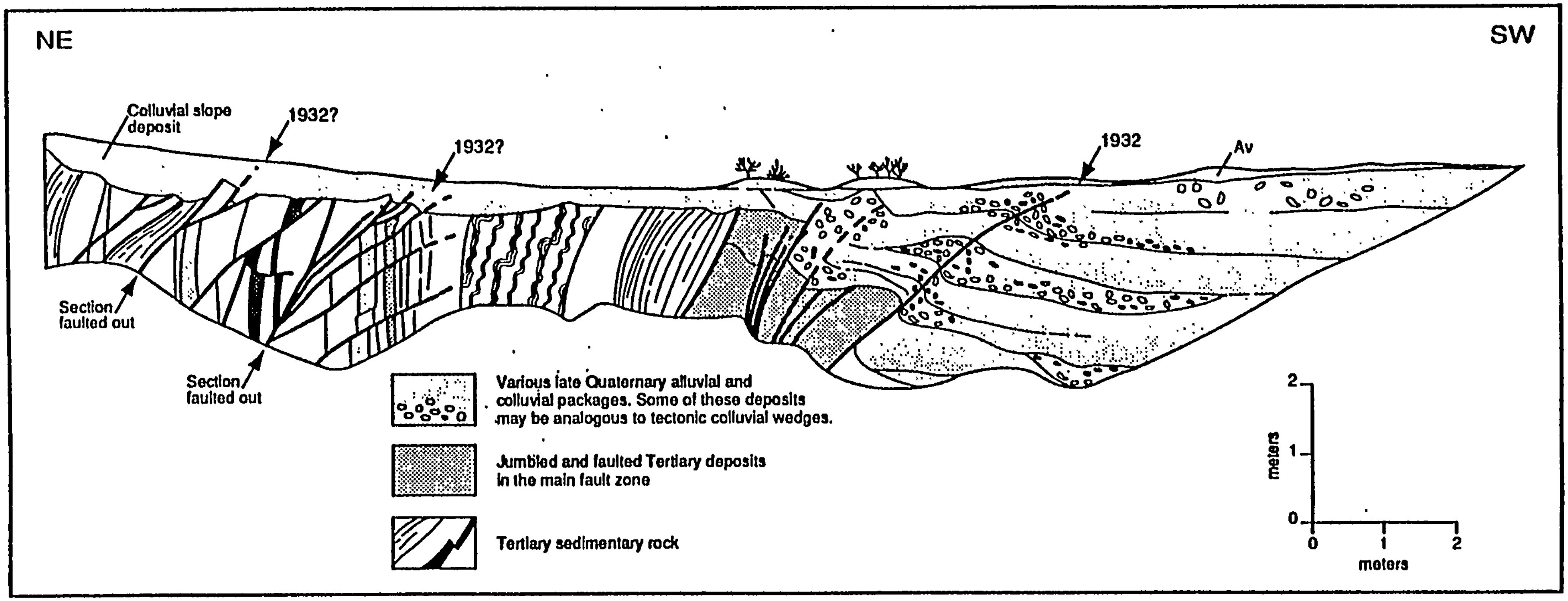
The Stewart-Monte Cristo fault zone, along which the 1932 Cedar Mountain earthquake occurred, is more than a kilometer wide in this area. The fault zone is dominantly right-lateral strike slip in nature. About 1 m of right-lateral displacement occurred in this area in 1932. The small hill at this location is a "pressure ridge" formed by compression at a left step in the fault zone (restraining bend). Due to a small amount of contraction, Tertiary sedimentary rocks with a veneer of Quaternary alluvium are pushed up forming the topographic high. Trench 8 was dug across a subtle scarp on the southern side of the hill (see figure 18 for faults and trench locations) and confirmed the contractional nature of the fault zone at this location.

The northern half of the trench revealed steeply to vertically tilted Tertiary sedimentary rocks cut by several reverse faults. The southern end of the trench exposes Quaternary gravels deposited by streams running along the southern edge of the pressure ridge, roughly perpendicular to the trench. These gravels are faulted and deformed towards the contact with the Tertiary sediments. The contact between the gravels and the Tertiary sediments is a fault zone with several episodes of movement represented. Most of the Tertiary units in the fault zone have been highly sheared and jumbled. Several reverse faults are present in the rest of the trench particularly in the hanging wall of the main (contact) fault zone, three of which offset the section exposed in the trench. Movement in 1932 may have occurred along the southernmost fault in the trench, and along two of the reverse faults cutting the Tertiary sediments. The southernmost fault deforms gravels very near the surface. In all cases the movement would have been minor. A simplified trench log is given in Figure 19.



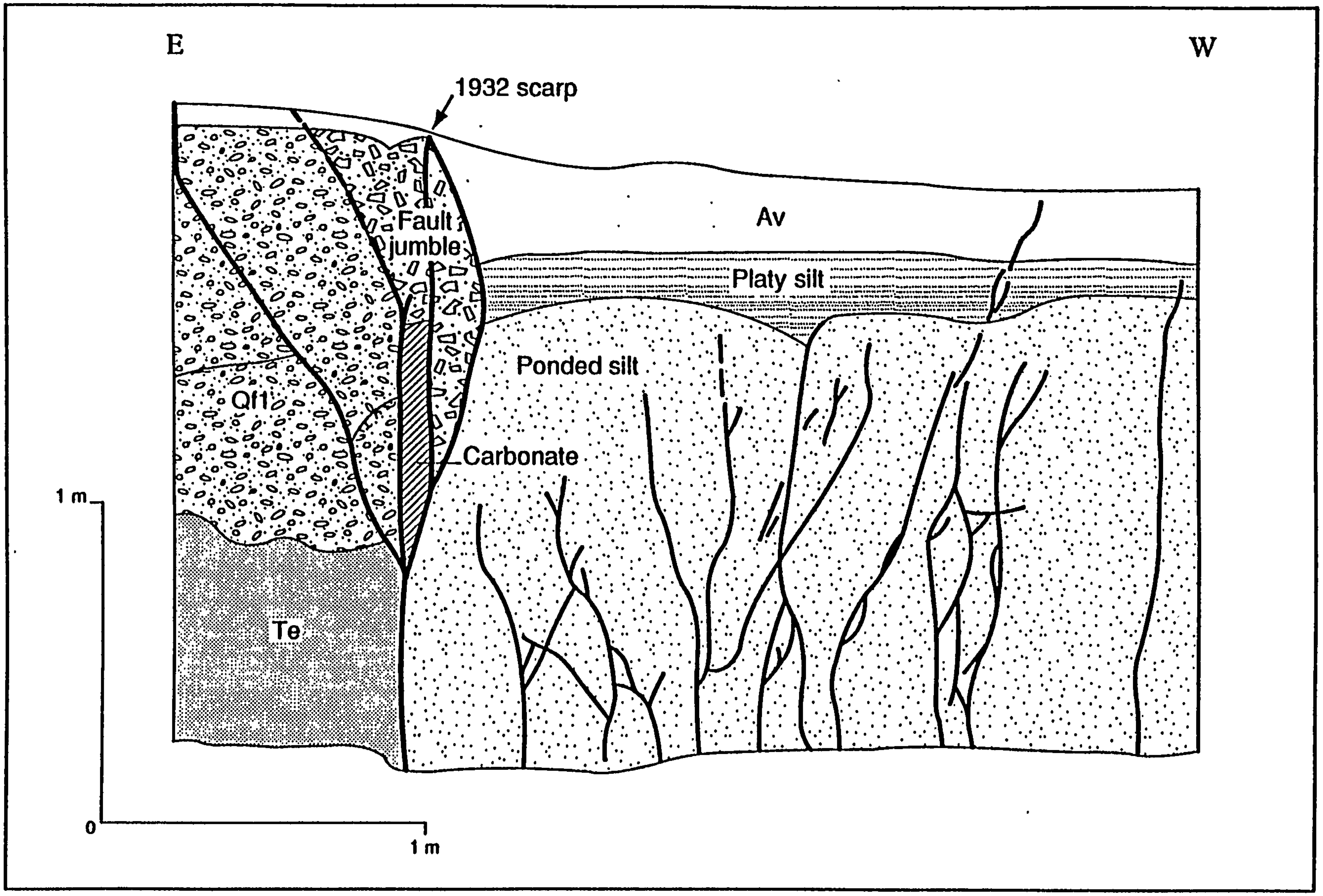
Surface geology of Monte Cristo Valley.

Figure 18.



Trench 8, east wall.

Figure 19.



Partial log of Cedar Mountain Trench 3A, cut back 80 cm from original face on south wall.

Figure 20.

58.9 Return to main road and turn left (south).

60.1 Turn left on track and drive east to trenches.

60.6 **STOP 12 - Craig dePolo, Figure 18.** Examine fault escarpment and **Trench #3.** Don't fall in!

This is one of the first trenches dug by the Nevada Bureau of Mines and Geology in the study of the 1932 Cedar Mountain earthquake. Originally a single trench, Trench 3 was expanded into an "H" shape to better establish stratigraphic relationships. One to two meters of right-lateral strike-slip displacement occurred at this location in 1932. The 30-cm high surface scarp from this event is still well preserved and can be traced out in either direction. **To preserve these ruptures for others to examine and for potential future scientific studies, please avoid walking on the scarp; this is especially important for large groups of people or when the ground is wet.**

Trench 3 exposes a vertical main fault that commonly splays into a flower structure near the surface, and several secondary faults on the "downthrown" side (see Figure 20). The backfacing nature of this scarp with respect to topography has ponded younger sediments against the fault. In some cases these packages of ponded alluvium appear to represent individual earthquake events.

The east side of the trench reveals ponded late Quaternary silts and gravels. The west side consists of tilted tertiary sediments, overlain by mid-Quaternary gravels (ash within these gravels has been identified as Bishop-aged ash; 0.7-1 Ma). The fault zone, especially in the flower structure, contains jumbled and sheared units from both sides of the fault. Carbonate has been deposited in a small mass in the fault zone, a fairly common occurrence along youthful faults in the Basin and Range province. Slickensides from the main fault plunge 6 to 9 degrees to the north supporting a large component of right-lateral strike-slip motion along this north-striking fault.

The stream to the immediate south of the trench has a right-lateral offset at the fault zone. The 1932 stream-offset can be seen, but is difficult to measure. The overall right-lateral jog in the stream is due to several late Pleistocene and Holocene offsets. This is a rare, well-developed lateral offset of a stream channel. Most streams have straightened their channels across the rupture. The particular example south of the trench appears to be well developed due to a limited catchment basin and significant lateral offsets per event.

61.1 Retrace route to main road and turn right (north) back to fork in road at mile 58.1.

63.9 Turn hard right at the road fork and proceed southeast and east across the southern Stewart Valley to the southern Cedar Mountains and Dicalite Summit area.

64.6 Crossing trace of Quaternary fault scarp from Stop 12.

64.9 Fork in road, bear left.

66.8 Cross main Stewart Valley wash.

70.8 Old bulldozer cut, trending east from the main Dicalite summit road, claim post and workings west of road.

The hills to the east are composed of Tertiary ash-flow tuff units that overlie locally discontinuous intermediate composition lavas (about 30 Ma) that thicken to the south (Whitebread and Hardyman, 1987).

dePolo

Geological Society of Nevada
Structure, Tectonics and Mineralization of the Walker Lane
A Short Symposium

April 24, 25, 26, 1992

AGENDA

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The 1932 Cedar Mountain Earthquake: An Example of Active Tectonism in the Walker Lane

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The 1932 Cedar Mountain earthquake (surface-wave magnitude 7.2) has an important bearing on the neotectonics of the western Great Basin because the event is the largest historical earthquake in the Walker Lane, had an unusually wide distribution of surface ruptures, consisted of multiple events, and precipitated the notion of the Walker Lane. Gianella and Callaghan (1934a) were the first to discuss the significance of the Cedar Mountain earthquake, strike-slip faulting in the western Great Basin, and topographic aspects associated with the Walker Lane.

The main shock of the 1932 earthquake occurred at 0610 UTC (2210 PST) on December 21 and had a felt area of 850,0000 km^2 (Coffman and von Hake, 1973). Considering the location of the epicenter in southern Gabbs Valley (Byerly, 1935) and the extension of surface ruptures for roughly 60 km to the south of the epicenter, it seems clear that this earthquake propagated to the south. Seismological studies conducted by Doser (1988) suggest the Cedar Mountain earthquake was a complicated, multiple event. Doser studied and modeled the teleseismic P-waves from this earthquake using seismograms recorded worldwide and found that it was comprised of at least two subevents. For the preferred northerly-striking nodal planes, both subevents were dominated by right-lateral strike-slip displacement and were subparallel to the Walker Lane. Doser noted that the better located aftershocks from the 1932 event cluster in two major areas, Gabbs Valley and northern Monte Cristo Valley, possibly highlighting the areas of the two major subevents.

The earthquake appears to have involved at least two major faults and many minor faults in the region. The two major faults involved are the Stewart-Monte Cristo Valley fault zone (Molinari, 1984) and an unmapped, subsurface fault below northern Stewart and Gabbs Valleys. Both of these ruptures were right-lateral strike-slip in nature. Other faults that were involved in the 1932 earthquake include normal faults on the west flank of Cedar Mountain, strike-slip faults in Stewart Valley, and normal faults in southern Gabbs Valley. The Stewart-Monte Cristo Valley fault zone is the easternmost member of the group of strike-slip faults in the central Walker Lane.

The zone of surface ruptures from the Cedar Mountain earthquake is approximately 60 km in length (end-to-end measurement) and 6 to 14 km wide (Gianella and Callaghan, 1934b). Surface ruptures were not confined to a mountain front or a single topographic feature, but rather were distributed broadly across three valleys and along short parts of adjacent mountain fronts. The longest and most continuous surface faulting was about 17 km in length and occurred along the Stewart-Monte Cristo Valley fault zone in northern Monte Cristo Valley. Right-lateral displacements along this fault zone ranged from a few centimeters to 2 m, and vertical displacements were as much as 0.5 m. Small-scale geomorphic features formed during the surface rupture include fault scarps, grabens, moletracks, swells and depressions, warped scarps (small surficial monoclines), and echelon-stepping breaks.

Trenching and Quaternary stratigraphic studies in Monte Cristo Valley have been conducted by the Nevada Bureau of Mines and Geology to determine the structural nature of the surface faulting and the paleoseismic history of the Stewart-Monte Cristo Valley fault zone. In trench exposures where significant lateral slip occurred, the fault planes are vertical and small scale (1 to 2 m) flower structures commonly exist near the surface. These structures, consisting of upward splaying fault traces and small reverse faults, appear to underlie surface expressions such as warped or ramped scarps, moletracks, and swells.

The ages of surfaces and deposits in Monte Cristo Valley have been estimated using tephrochronology, rock varnish radiocarbon dating, and soil development. From these ages and crosscutting relations of the surfaces and deposits with the faults, normal-right slip rates for the Stewart-Monte Cristo Valley fault zone of 0.2-0.5 mm/yr are estimated for the late Quaternary. The lateral to vertical displacement ratio ranges from 3:1 to 6:1 (dePolo and others, 1987). Studies thus far indicate that the most recent paleoseismic event prior to the 1932 earthquake probably occurred in early Holocene.

The 1932 Cedar Mountain earthquake underscores the importance of considering multiple source models when analyzing faults for seismic hazards in the Basin and Range province. It demonstrates the potential for small surface faults to reflect an earthquake larger than an analysis of a single fault would suggest, and for the potential involvement of subsurface faults that lack clear surface expression. Although many of the widely distributed surface ruptures from the 1932 event were probably secondary or sympathetic in nature, displacements ranged from a few centimeters to a decimeter or more at the surface, which can be a significant amount for some engineering projects. In southern Gabbs Valley, surface ruptures occurred along a group of subparallel northeast-striking normal faults, whereas the main subsurface rupture below appears to have been a northerly striking right-lateral fault. The complex nature of this event illustrates the need for considering such complexities when analyzing earthquake hazards in the Basin and Range province, especially for critical engineering facilities.

TASK 3: EVALUATION OF MINERAL RESOURCE POTENTIAL, CALDERA GEOLOGY, AND VOLCANO-TECTONIC FRAMEWORK AT AND NEAR YUCCA MOUNTAIN

REPORT FOR OCTOBER, 1991 - SEPTEMBER, 1992

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[1] Research Associate
[2] Co-principal Investigators and Professors of Geology

INTRODUCTION

This report summarizes the results of Task 3 work initially discussed in our monthly reports for the period October 1, 1991 through September 30, 1992, and contained in our various papers and abstracts, both published and currently in press or review (see appendices). Our work during this period has involved a) the continuation of studies begun prior to October, 1991, focussed mainly on aspects of the caldera geology, volcanic stratigraphy, magmatic activity, hydrothermal mineralization and extensional tectonics of the western and northwestern parts of the southwestern Nevada volcanic field (SWNVF), and b) new studies of the alteration and trace-metal geochemistry of subsurface rocks of Yucca Mountain utilizing drill hole samples obtained in late 1991 and early 1992.

UPDATE ON THE NATURE AND DISTRIBUTION OF SUBSURFACE ALTERATION IN YUCCA MOUNTAIN

During the past year, we have continued to investigate the nature and distribution of alteration in the subsurface of Yucca Mountain. This has been accomplished by the visual examination of intervals of core that were not previously inspected by our group, coupled with initial hand-specimen, polished-section and thin-section petrographic studies of core samples obtained primarily for chemical analyses. A graphical summary of alteration features is presented in Figure 1, which has been modified from our 1991 report based on our observations made during the period of this report.

Distribution, nature and origin of pyrite in tuffs and lavas of Yucca Mountain

One of our principal concerns has been to address questions about the distribution, nature, and origin of pyrite observed in various intervals of drill core from the volcanic rocks of Yucca Mountain by personnel Task 3, by Stephen B. Castor and the Nevada Bureau of Mines group, and by several previous workers of the U.S. Geological Survey and the national laboratories. In the volcanic rocks, pyrite is unevenly distributed in pyroclastic rocks, mainly occurring in the unwelded to partially welded, lithic-rich parts of the Tram Member of the Crater Flat Tuff and the Lithic Ridge Tuff, and in intercalated silicic lavas (Figure 1). Our view has been that the pyrite is simply one product of hydrothermal activity and its uneven distribution reflects the flow paths of fluids that had activities of reduced sulphur species sufficient to sulphidize iron-rich phases in the rock mass (Weiss et al., 1991). Castor et al. (1991; in review) believe most, or all, of the pyrite in the pyroclastic rocks is lithic material, and therefore consider the pyrite to *predate* deposition of the pyroclastic host rocks. Their hypothesis is that the "lithic" pyrite originated by hydrothermal alteration of rocks in the vent area(s) of the Tram Member and the Lithic Ridge Tuff. They speculate that during the eruptions of these pyroclastic rocks, pyrite and pyritic altered rock fragments were ripped from the vent walls and incorporated in the tuffs. Castor et al. (1991; in review) therefore propose that the pyrite in the pyroclastic rocks does not reflect *in situ* alteration within Yucca Mountain. Based on a number of lines of textural evidence and the near magmatic temperatures of the eruption, transport, deposition and initial cooling of the ash-flow sheets, we strongly disagree with the proposition that no *in-situ* addition of sulphur has occurred, although hydrothermally altered and pyritic rock fragments could provide evidence for earlier hydrothermal events.

In the subsurface of Yucca Mountain pyrite is most common and most widely distributed in the Tram Member of the Crater Flat Tuff (Figure 1), where it is present as disseminated grains composing <1% of the groundmass and as disseminated grains and veins in lithic fragments. Some lithic fragments contain as much as about 10% pyrite, and many are partly to completely replaced by varying proportions of albite, adularia, quartz and clay. Pyrite is also present both in lithic fragments and in the groundmass of the Lithic Ridge Tuff, although it is apparently less widely distributed (Figure 1) and less abundant. In lithic fragments and the groundmass of both ash-flow sheets, the disseminated pyrite consists of anhedral to subhedral, generally pitted and wormy to seived, or skeletal(?), individual crystals and granular aggregates of $\sim 5\ \mu m$ - $300\ \mu m$ in maximum dimension (Figures 2 and 3). In some grains pits and ophitic texture appear to result from the presence of numerous inclusions of altered groundmass, while other grains, mainly those smaller than about $10\ \mu m$ in diameter, are not uncommonly subhedral in shape and free of pits. Propylitically altered silicic lavas in USW-G2 contain disseminated pyrite grains having textures and morphology indistinguishable from those of the pyrite in the tuffs (Figure 4). Fractures, not uncommon in granular pyrite in the tuffs, are present in pyrite grains in the altered lavas as well. These observations demonstrate that the fragmentation and degassing processes of ash-flow eruptions are not required to produce the textures and morphology of the pyrite in the tuffs, since the pyrite in the lavas is clearly not lithic material. Instead, as is the case in the altered lavas, the observed pyrite textures in the tuffs more likely stem from precipitation and growth (± partial dissolution ?) from hydrothermal solutions.

Further textural evidence in support of the above argument includes the presence of partly sulphidized phenocrystic biotite in the Lithic Ridge Tuff (Figure 5a), and pyritic clay-altered pumice in the Tram Member (Figure 5b). It is difficult to imagine that this pyrite predated and survived the eruptions of each ash-flow unit. The features shown in Figure 5 were found only with careful examination of an initial, small number of sections that had been impregnated with epoxy prior to polishing, and, though not abundant, they may be more common than would be inferred from inspection of unpolished core or unimpregnated polished sections.

Another significant line of evidence arguing that the pyrite in tuff in Yucca Mountain is the result of *in situ* growth involves the similarity in texture and morphology of the pyrite in Yucca Mountain tuffs to that found in obviously hydrothermally altered porous ash-flow tuffs elsewhere. For example, in the Divide mining district the early Miocene Tonopah Summit Member of the Fraction Tuff contains as much as 1 - 3% pyrite where the unit has been affected by propylitic and phyllic alteration (Bonham and Garside, 1979). This pyrite has been considered by Bonham and Garside (1979) to comprise a common component of the hydrothermal mineral assemblage in the Divide district. Examination of samples from partially welded, pyritic ash-flow tuff of the Tonopah Summit Member shows that this hydrothermal pyrite is essentially identical in texture and morphology to the pyrite in volcanic rocks in Yucca Mountain (Figure 6), and in some hand-specimens tends to be more abundant in lithic fragments than in the groundmass. It should be noted that pyrite has not been described as a component of unaltered rocks of the Tonopah Summit Member (Bonham and Garside, 1979). Similarly, in areas of little or no alteration, pyrite has not been described as a component of the Lithic Ridge Tuff or members of the Crater Flat Tuff (e.g., Carr et al., 1986). We intend to obtain additional specimens of pyritic, porous ash-flow tuff from other paleohydrothermal systems (e.g., Round Mountain, NV) for comparison of pyrite textures with those of Yucca Mountain.

Finally, although traces of magmatic pyrrhotite, cubanite chalcopyrite, and Fe-Ni sulphides are not uncommon in volcanic rocks, they are found *only* as blebby inclusions in phenocrysts and dense glassy rock (vitrophyre) where they have been sufficiently encapsulated to prevent degassing of sulphur during eruption and primary cooling (e.g., Hildreth, 1977; Drexler, 1982; Whitney and Stormer, 1983; Keith et al., 1991). At the near magmatic temperatures associated with the eruption, deposition and primary cooling of the Yucca Mountain tuffs, "lithic" pyrite gains ripped from vent walls would have been rapidly heated and would have lost most or all of their sulphur. Although pyrite enclosed within altered rock fragments might retain their sulphur, it seems highly unlikely that unprotected pyrite grains only 5 μm to few 100's of μm in maximum dimension would survive such heating. Evidence for such degassing would include partial or total conversion of pyrite grains to iron oxides. Iron oxide coatings or rims are absent from much of the groundmass pyrite in the Yucca Mountain tuffs, arguing strongly against the idea that these grains are but remnants of originally larger, partially degassed "lithic" grains.

Within both the Lithic Ridge Tuff and the Tram Member of the Crater Flat Tuff of drill holes USW-G3, USW-G1and USW-G2, many lithic fragments are more strongly altered than the enclosing ash-flow tuff. Much of the groundmass of the tuffs consists of glass shards and small pumice fragments that have been altered to mixtures of clay, zeolites and opaline silica. The stronger alteration of many lithic fragments, the lack of observable pyrite veins cutting the matrix of tuffs, the truncation of quartz and pyrite veins by the margins of the lithic fragments, and the relatively rare presence of pyrite in clay-altered pumice clasts have led Castor et al. (1991; in review) to argue that essentially *all* pyrite, including that in the groundmass, originated by hydrothermal alteration of rocks in the vent area(s) of these two ash-flow units. Disseminated pyrite is also present in the pre-Lithic Ridge tuffs of UE25p-1 (S. I. Weiss, unpublished data, 1992), and in the lower parts of the Prow Pass and Bullfrog members in USW-G2 (Caporuscio et al., 1982). Are we to believe that this pyrite is of a "lithic" origin as well, in units not particularly rich in lithics, when its presence can be more easily explained by the passage of sulphidic fluids through the more permeable areas of the rock mass? There can be little doubt that altered lithic fragments provide important evidence for pre-Lithic Ridge and pre-Tram hydrothermal events. However, the *later* addition of pyrite is strongly supported by the textural, distribution and temperature considerations discussed above.

Other observations concerning the nature and distribution of subsurface rock alteration

Petrographic work on samples from the Yucca Mountain drill core is currently getting under way and systematic studies have not yet been carried out, but several observations merit discussion in this report. In USW G1 propylitic alteration of the pre-Tram silicic lavas was verified. Beneath these lavas, the alteration gap composed of unaltered Lithic Ridge Tuff, previously inferred from published reports (Figure 1) was confirmed. Another gap is present in USW G3 where the presence of unaltered tuffs beneath the Lithic Ridge was verified. These areas of apparently fresh rocks demonstrate, not surprisingly, that alteration and hydrothermal fluid flow were not vertically or laterally continuous over the depths and wide spacing of the drill holes.

Cursory examination of a small number of thin sections indicates that many of the lithic fragments in the Tram Member and the Lithic Ridge Tuff of drill holes UE25b-1H, USW G1 and USW G3 are more strongly altered than the enclosing tuffs. In the few sections of these units examined to date, sanidine, plagioclase and mafic phenocrysts are mainly unaltered, in contrast to the replacement of lithic fragments by combinations of albite, adularia, quartz, calcite and clay.

In USW G2, pyritic propylitic(?) alteration in the lower part of the Prow Pass Member of the Crater Flat Tuff dies out upward into weak argillic alteration, defined by the presence of clay-replaced feldspàr phenocrysts, associated with a zone of breccia veins at depths from 2873' to about 2975'. The breccia veins are irregular, anastomosing to planar structures filled with a mixture of cm- to mm-sized rock fragments, rock flour, very fine-grained silica and reddish to black iron and manganese oxides. Jigsaw textures, irregular pinchouts and the ranges of fragment size and shapes, and associated bleaching and argillic alteration of the welded tuff, suggest that the veins are hydrothermal in origin. Very similar breccia veins containing a matrix of extremely fine-grained iron-oxide, silica and fluorite (Figure 7) are present in iron-oxide stained, brecciated, moderately to densely welded, devitrified ash-flow tuff of the Crater Flat Tuff in drill holes UE25 C1, UE25 C2 and UE25 C3. Multiple stages of cross-cutting quartz, fluorite, and iron-manganese oxide veinlets are present within and cutting through the breccia veins. Fluorite also fills small cavities and is intergrown with montmorillonite in other small, irregular cavities. Spengler and Rosenbaum (1991) recognized that the brecciated rocks of the Crater Flat Tuff in the UE25 C holes form a tabular, shallowly west-dipping body of hydrologic significance, through which aqueous fluids have passed. Analyses of 7 samples from these brecciated rocks show the presence of anomalous concentrations of Mo, Sb, Bi and As (see below), demonstrating that such fluids have included metal-bearing solutions.

TRACE-METAL CHEMISTRY OF ROCKS FROM THE SUBSURFACE OF YUCCA MOUNTAIN

Samples from 41 intervals of core and rotary cuttings were analysed for precious metals and a broad suite of elements generally considered useful in indicating the presence of hydrothermal mineralization. These analyses were carried out to investigate the possible presence of metal and trace-element enrichments in the subsurface of Yucca Mountain that might be associated with undiscovered, potentially economic mineralization.

Methods

Samples were analyzed by highly sensitive inductively-coupled plasma emission spectrography (ICP-ES), graphite-furnace atomic absorption (GFAA) and hydride-generator atomic absorption (AA) methods carried out at MB Associates and the Nevada Mining Analytical Laboratory (Hg); the results are listed in Table 2. Blind duplicate analyses carried out in this and other studies indicate acceptable levels of precision for all of the elements determined (Table 2). In all but a few samples, ICP-ES measurements gave higher Hg values than were determined by AA measurements. Previous experience has shown that at low levels the AA determinations of Hg are more precise and probably more accurate than ICP-ES determinations (Weiss et al., 1991).

Special care was taken to avoid contamination of samples during preparation for the analyses. First, with the core enclosed in 50 mil plastic bags, representative fragments totalling about 60-100 grams were broken from each core interval using a clean, acid-treated hammer. Where veins or filled fractures were observed, selected fragments contained more wall-rock than vein material. Core fragments were inspected visually to avoid macroscopically visible drill-tool rubs, drilling lubricant and paint. Each core fragment was then scrubbed and rinsed with distilled water, using a nylon brush, to mechanically remove potential microscopic surface contaminants. After air drying, samples were crushed and pulverized to -200 mesh powders using carefully cleaned, small volume equipment not normally used for processing ores. Ceramic plates were used on a small rotary pulverizer. In addition to an initial mechanical and acid cleaning, both the crusher and pulverizer were cleaned between each sample using an abrasion flux of fresh, unmineralized, densely welded tuff of the Tiva Canyon Member having extremely low trace metal concentrations (e.g. Table 4 of Weiss et al., 1991; Table 2, sample 3SW-589 of this report). Sample powders were split and sealed in clean plastic and glass vials.

Rotary cuttings were inspected under a binocular microscope for the possible presence of drill-tool fragments, lubricants and other foreign material. Due to the small amounts of cuttings available for study (<50 grams for each 10' interval) and the sand-sized nature of most of the cuttings, some contamination with drill-tool and lubricant particles could not be avoided. Samples containing visible foreign material are noted in Table 2. As will be discussed below, the effects of this contamination on measured precious- and trace-metal contents are not likely to be significant. Cuttings were also pulverized to -200 mesh powders using ceramic plates and sealed in clean plastic and glass vials.

Results

Elemental abundances measured for fresh specimens of the Bullfrog Member of the Crater Flat Tuff and the Tiva Canyon Member of the Paintbrush Tuff ("fresh tuff reference samples", Table 2), together with analyses by similar methods of unaltered tuff given by

Castor et al. (1989), Connors et al. (1991a; in review), Weiss et al. (1991) and Castor and Weiss (1992) provide a limited, but useful indication of precious- and associated trace-metal contents to be expected in unaltered, silicic volcanic rocks in Yucca Mountain. Silicic rocks that have undergone cooling-related (primary) devitrification and weathering tend to have slightly larger contents of As and Au than those found in glassy rocks, but overall, precious- and associated trace-metal contents are extremely low. Based on the sources mentioned above, and our prior exploration experience, we expect concentrations in fresh silicic volcanic rocks to be approximately as follows:

Au	<1 ppb (most <0.3 ppb
Ag	<0.10 ppm
As	<6 ppm (most <2 ppm)
Bi	<0.10 ppm
Hg	<30 ppb (most <15 ppb)
Sb	<0.20 ppm
Se	<0.10 ppm
Te	<0.10 ppm
Mo	<2.0 ppm (most <1.0 ppm)
Tl	<0.50 ppm

In east-central Yucca Mountain, rotary cuttings from four 10' intervals of mineralized carbonate sedimentary rocks of drill hole UE25p-1 assigned to the Silurian Lone Mountain and Roberts Mountain formations (Carr et al., 1986), and containing disseminated pyrite and fragments of pyrite, quartz and fluorite veins were analysed. Sample 16963, from a depth of 5530'-5540' contains highly anomalous concentrations of Hg, Sb, Mo, Pb and Zn, and modestly anomalous concentrations of As, Bi, and Tl (Table 2). Gold and Ag are modestly enriched in 16963 with respect to the other three intervals of Silurian sedimentary rocks (Table 2), but are still relatively low in absolute value. Analysis of powder made from a second split from this interval (16963B) confirmed the first analysis and indicates that within this interval, the cuttings are not chemically homogenous. The data are inconsistent with contamination by drill-tool fragments and(or) lubricant owing to the clearly elevated *suite* of trace metals. Rather, the chemical data, together with the vein fragments in this interval, provide unequivocal evidence for the passage of metal-bearing, epithermal-type fluids through pre-Cenozoic rocks beneath Yucca Mountain. Although the anomalous metals in these sedimentary rocks could have been introduced prior to deposition of the overlying Miocene volcanic rocks, significantly elevated As (~14-63 ppm), Zn (125 ppm) and Sb (~1-2 ppm), and weakly elevated Mo (~2-3 ppm) and Hg (~50-135 ppb) are also present in several scattered intervals from tuffs of stratigraphic unit Tot of UE25p-1 (Table 2).

To the northwest of drill hole UE25p-1, an unusual association of modestly to very highly elevated Mo (as high as ~200 ppm) ± elevated Sb, As and Bi, is present in brecciated rocks of the Crater Flat Tuff in drill holes UE25 C2, UE25 C3, and probably in UE25 C1 as well (Table 2). Three lines of evidence indicate that the elevated Mo concentrations are unlikely to result from contamination by drilling tools, cutting tools or lubricants. First, sample 20069B (109 ppm Mo) was composed entirely of fragments broken from the interior of the core and having no surfaces cut by drilling or splitting tools. Second, the elevated Mo values are associated with elevated Sb, As and Bi contents, which are not likely to result from such contamination. Finally, the presence of drusy fluorite, and breccia veins with a matrix rich in iron oxide, provide direct evidence for the passage of fluoride- and metal-bearing fluids. These fluids passed through the tuffs after compaction, and apparently caused some or all of the brecciation, but their origin remains unclear.

Further to the north, significantly elevated concentrations of As (39-85 ppm) and Hg (~120-150 ppb) are found in strongly propylitically altered lavas of stratigraphic unit Tr1 in drill hole USW-G2 (Table 2). In the same drill hole, between 3420' and 3421' (sample 16871), a 0.5-2 mm thick fracture filled with manganese oxide and adjacent fresh, but iron-oxide stained tuff of the Bullfrog Member of the Crater Flat Tuff contains less As (18 ppm), but much greater amounts of Hg (~0.7 ppm) and Sb (~5 ppm).

As discussed previously, drill holes USW-G3, UE25B-1H, USW-G1 and USW-G2 encountered deep, but aerially widespread pyritic alteration in units of the Crater Flat Tuff and the Lithic Ridge Tuff. In drill holes USW-G1 and UE25B-1H nine samples from these pyritic rocks contain no distinctly elevated Au, Ag, Sb and Tl (Table 2). Arsenic concentrations are only 2-5 ppm higher than concentrations found in weathered devitrified rhyolitic ash-flow tuff. Modest Hg enrichment (~106 ppb) is present in only one of these 9 samples (sample 16860), but 8 samples contain marked enrichments of Bi, Se and Te. Further to the south in USW-G3, where less pyrite is present in the Lithic Ridge Tuff than is found in the Tram Member to the north, the pyritic rocks apparently contain less Bi, Se and Te, and slightly more Hg (Table 2). Selenium is a common element in many volcanic-hosted epithermal precious-metal deposits. Bismuth and Te are associated with magmatic-hydrothermal systems (i.e. porphyry and skarn deposits) and various types of epithermal vein systems. Trace amounts of these metals are commonly attributed to the input of magmatic fluids into hydrothermal systems.

From textural and temperature considerations discussed earlier, we believe that much or all of the pyrite formed after deposition of the tuffs by partial hydrothermal sulfidation of iron-bearing phenocrysts and other iron-bearing phases in the groundmass and lithic fragments. This pyritic alteration, or sulfidation, clearly represents a major enrichment of sulphur relative to fresh rhyolitic tuffs.

The chemical data given above, in combination with presently available information on subsurface alteration, veining, pyrite distribution, etc., are consistent with the passage of hydrothermal fluids through parts of Yucca Mountain and the movement and local, generally low-level accumulation of various combinations of elements (including As, Sb, Hg, Bi, Se, Te, Mo, Pb, Zn and Tl) commonly associated with hydrothermal mineralization. In many volcanic-hosted epithermal ore deposits, mineralization and associated trace-metal halos are restricted to narrow areas of high permeability that channeled large volumes of fluid flow. Commonly, rocks a few meters outside these channelways show little, if any, metal enrichments. This is true not only in vein systems, but in disseminated deposits as well. For example, in porous ash-flow tuff of the Round Mountain gold deposit, mineralizing fluids were guided in part by primary permeability enhanced and preserved by original vapor-phase crystallization, and fluid flow was restricted by lower permeability in porous glassy zones (Sander, 1990). Many of our sample are from porous, previously largely glassy tuff units which, upon alteration of shards and pumice to clays and zeolites, probably became relatively impermeable and conducted only small amounts of fluid flow. Therefore, many of our analyses may reflect the chemistry of zones of relatively small fluid flow. Our data do not rule out, or demonstrate the presence of, possible epithermal precious-metal mineralization between the widely spaced drill holes in Yucca Mountain.

MAJOR-ELEMENT CHEMISTRY OF THE MOUNT JACKSON DOME FIELD

In our 1990-1991 report (Weiss et al., 1991) we presented radiometric age data demonstrating that rhyolite domes of the Mount Jackson dome field were emplaced from about 6.8 Ma to 2.9 Ma. We have considered most rocks of the domes to be rhyolitic in composition, except for the intermediate composition, lower lava of Mount Jackson, based on field examination and reconnaissance-level hand-specimen and thin-section petrography (McKee et al., 1989; Noble et al., 1991a). During the period of this report we have obtained major- and minor-element chemical data from splits of the rocks used for the radiometric age determinations (Table 3 and Figure 8). These data show that chemically, the capping lavas are indeed high- to medium-silica subalkaline rhyolites, confirming our previous classification of these rocks. Two samples of the basal, less silicic lavas exposed on the west and southeast sides of Mount Jackson (samples MJ-W and MJ-SE, Table 3) have chemical compositions of trachydacite (Le Bas et al., 1986) or rhyodacite. Many of the rhyolites are highly evolved as shown by Rb/Sr ratios of >15 and low barium contents.

The linear alignments of the domes (Figure 8) and similarities in chemistry, petrography, and general morphology suggest that the entire dome field was produced by eruptions from a linear, high-angle fault controlled array of vents that were probably fed by a single magmatic system. If this is the case, the geometry and remarkably long-lived nature of the system (minimum of about 4 Ma) may reflect the influence of deep-seated faults or zones of weakness during a period of tectonic stability within the Goldfield segment of the Walker Lane belt.

PROGRESS IN RADIOMETRIC DATING STUDIES

Timing of Au-Ag mineralization, northern Bare Mountain

Much of the presently known Au-Ag mineralization in northern and eastern Bare Mountain is spatially associated with the silicic porphyry dikes of Bare Mountain and resulted from hydrothermal activity that occured at about 12.9 - 12.5 Ma during the main magmatic stage of the SWNVF (Noble et al., 1989; 1991a). This interpretation is based on age determinations of hydrothermal minerals from the Goldspar and Telluride mine areas and from the fact that the *ca.* 13.9 Ma silicic dikes are in most places strongly altered, locally contain elevated gold concentrations (e.g., Sterling mine area, Jackson, 1988) and host gold mineralization at the Mother Lode mine (Noble et al., 1989; Castor and Weiss, 1992).

Altered porphyry dikes have not been identified within or near the presently subeconomic Secret Pass disseminated gold deposit, but stratigraphic and structural relations permit a similar timing for gold mineralization there. Mineralization at Secret Pass is hosted by the Bullfrog Member of the Crater Flat Tuff and is truncated by the underlying Fluorspar Canyon - Tate's Wash fault (Greybeck and Wallace, 1991). Alteration affects rocks of the Bullfrog Member and the porous lower portion of the overlying Topopah Spring Member of the Paintbrush Tuff (Castor and Weiss, 1992), which has a radiometric age of about 12.8 Ma (cf. Marvin et al., 1970; Sawyer et al., 1990). Movement on the Fluorspar Canyon - Tate's Wash fault accomodated tilting of the hanging-wall section at Secret Pass after deposition of the Tiva Canyon Member of the Paintbrush Tuff, but prior to the deposition of nearby, flat-lying rocks of the 11.6 Ma Rainier Member of the Timber Mountain Tuff (Monsen et al., 1990). A strong argument can be made, therefore, that hydrothermal activity and mineralization at Secret Pass took place between about 12.9 Ma and 11.6 Ma.

The feasibilty of direct dating of the timing of hydrothermal activity at the Mother Lode mine remains under investigation. At the Mother Lode mine ore-grade disseminated Au-Ag mineralization is present within argillically altered porphyry dike rocks and adjacent tuffaceous sedimentary rocks (Noble et al. 1989; Castor and Weiss, 1992). Mineralized and altered dike and sedimentary rock samples containing abundant illitic mica (modestly-ordered interstratified illite-montmorillonite) have been sent to Los Alamos National Laboratory for evaluation for possible K-Ar dating.

PRIMARY LOW-LEVEL GOLD CONTENTS OF SILICIC VOLCANIC ROCKS: APPLICATIONS TO STUDIES OF YUCCA MOUNTAIN

A short journal paper summarizing the results of K.A. Connors work on the initial gold contents of silicic volcanic rocks was prepared and submitted to *Geology*. The principal points of the paper, entitled *The initial gold contents of silicic volcanic rocks* (Appendix A), are contained in the abstract as follows:

> Fresh silicic volcanic rocks have markedly lower initial gold contents than would be inferred from much of the geochemical literature. The great majority of 129 carefully selected glassy silicic volcanic rocks analyzed contain less than 1.0 ppb, and many contain only $\leq$ 0.1 to 0.3 ppb Au. Nonperalkaline rhyolites contain <0.1 to 0.7 ppb, mean 0.22 ppb Au; of these, highly evolved, high-silica subalkaline and peraluminous rhyolites have the lowest Au contents. Peralkaline and iron-rich subalkaline rhyolites have higher gold contents of 0.2 to 4.5 ppb, mean about 1 ppb. The mean of 23 relatively silicic intermediate rocks is 0.54 ppb Au, with tholeiitic andesites (icelandites) generally higher in gold than calc-alkalic types. Fundamental controls on the initial gold content of silicic volcanic rocks appear to be melt structure and petrologic affinity; regional setting is less important. High-silica, nonperalkaline rhyolite melts apparently do not readily accomodate gold, whereas crystal fractionation appears to increase the gold concentration in less-polymerized peral-

kaline melts. Bulk composition and melt structure, and the amount and timing of separation of vapor, mineral, and sulfide or metal melt phases, may largely determine the gold content of silicic magmas on eruption. Silicic and intermediate volcanic rocks, particularly high-silica nonperalkaline rhyolites, appear to be less favorable sources of gold for hydrothermal mineral deposits than crystallizing magmatic bodies or other, more gold-rich rock types. Although iron-rich rhyolites may have contributed to development of certain deposits, factors other than associated volcanic rock type appear to be more important in determining gold availability to hydrothermal systems.

A longer paper is presently being prepared for *Economic Geology* to more fully discuss the data, inferences and interpretive conclusions outlined above and in the text of Connors et al. (*in review*; Appendix A). Clearly, rocks and alluvium in silicic volcanic terranes such as Yucca Mountain should be very sensitive to the addition of small amounts of gold by groundwater and hydrothermal solutions owing to the very low initial gold contents of most rhyolites. Existing and future gold analytical data from Yucca Mountain must be evaluated and interpreted in the context of Connors' results, rather than average crustal abundance values or average volcanic rock values found in much of the geochemical literature. Low-level anomalies have the potential to delineate structural features and other paleohydrologic flow paths along which post-depositional addition of gold may have taken place.

UPDATE ON THE MIOCENE VOLCANIC STRATIGRAPHY AND STRUCTURAL GEOLOGY OF THE GOLD MOUNTAIN - SLATE RIDGE AREA

Most of our knowledge of the volcano-tectonic evolution of the Gold Mountain-Slate Ridge area (GMSR) has been outlined in abstracts and papers included with previous yearly reports (e.g., McKee et al., 1990; Noble et al., 1991a; 1991b; Worthington et al., 1991). During the past year Ted Worthington has nearly completed his masters thesis on the GMSR. In addition, we have obtained a new K-Ar age determination of 16.8 ± 0.5 Ma on biotite from the Tuff of Mount Dunfee, the stratigraphically oldest ash-flow unit recognized in the Gold Mountain-Slate Ridge area. This age determination confirms a previous age determination of 16.7 ± 0.4 Ma on biotite from the same unit in another locality (E.H. McKee, D.C. Noble and J. E. Worthington, unpublished data 1991-1992). Based on our past work in the GMSR and in collaboration with E. H. McKee and M. C. Reheis of the U.S. Geological Survey, we are currently preparing to lead a field trip entitled *Neogene Tectonism from the Southwestern Nevada Volcanic Field to the White Mountains, California* for the 1993 joint Cordilleran-Rocky Mountain Section meeting of the Geological Society of America.

UPDATE ON MINING AND MINERAL EXPLORATION

Even though precious metals prices have been relatively weak during the past year, strong exploration and mining efforts continued in the Beatty area of the SWNVF. Heap leaching continued at the presently closed Mother Lode gold mine. Considerable refractory gold mineralization remains at the Mother Lode mine, but is subeconomic at current gold prices. Exploratory drilling by U. S. Precious Metals continued near the mine and north of

Tarantula Canyon in eastern Bare Mountain. Further south in Bare Mountain, gold production continues at the Sterling mine, which is situated adjacent to Crater Flat. A new area of subsurface gold mineralization has reportedly been identified between the Sterling and Goldspar mines (J. Marr, pers. communication, 1992).

Gold production at the Lac Gold Bullfrog mine is projected to substantially exceed the 240,000 oz planned for 1992 due to better than expected grades in the open-pit mining area. Underground production is running just under the planned rate of 1000 tons per day from the decline at the north end of the open-pit. The decline encountered hot water (approx. 42° C), which is slowing underground production and requires pumping at a rate of about 15 gallons per minute. Lac Minerals Ltd is presently conducting exploratory drilling a short distance north of the mine.

Exploration for precious metals continued in the northern Bullfrog Hills. Pathfinder Resources began an exploratory drilling program in the Pioneer mine area and has completed a detailed geologic map of the northern Bullfrog Hills. This map is based primarily on lithology and does not incorporate the regional stratigraphic units recognized by Task 3 (Weiss and Connors, unpublished mapping, 1989-1990) or previous U.S. Geological Survey investigators such as Ransome et al. (1910), Cornwall and Kleinhampl (1964), and Maldonado and Hausback (1990).

HG Mining Inc. of Beatty, NV. continues production of cut stone products from ash-flow tuffs quarried in the Transvaal Hills and upper Oasis Valley area. Although conventional models predict little or no hydrocarbon resource potential, rigging began in June, 1992, for an attempt to re-enter and deepen the Coffer #1 wildcat oil well, which was originally drilled in Oasis Valley to a depth of 3880 feet in 1991.

REVIEWS, PRESENTATIONS AND PUBLICATIONS

Presentations

Noble presented to the Nevada Commission for Nuclear Projects an overview of Task 3's efforts and hypotheses to address the issue of undiscovered potential mineral resources in and near Yucca Mountain.

Publications

The following abstracts and articles resulting from Task 3 studies were produced and(or) published during the period covered by this report, and are contained in the appendices as follows:

Appendix A:

Connors, K., A., Noble, D. C., Bussey, S., D., and Weiss, S. I., (*in review*), The initial gold contents of silicic volcanic rocks, manuscript submitted to *Geology*, 1992, 14 p.

Appendix B:

Castor, S. B., and Weiss, S. I., 1992, Contrasting styles of epithermal precious-metal mineralization in the southwestern Nevada volcanic field, USA: *Ore Geology Reviews*, v. 7, p. 193-223.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The veins and disseminated pyrite present in altered lithic fragments suggest that hydrothermally altered rocks may have been present in the vent area(s) of the Lithic Ridge Tuff and the Tram Member of the Crater Flat Tuff. The locations of these vents are not known, but geophysical and other information has been used to propose that they may in part lie beneath northwestern Yucca Mountain (Carr et al., 1986). If this is correct, the lithic fragments may provide direct evidence for one or more previously unrecognized periods of hydrothermal activity in or very near Yucca Mountain. A more basic problem is to confidently determine if there has been, as we strongly suspect, a later *in-situ* addition of sulphur to rocks in Yucca Mountain. Sulphidic solutions are common in hydrothermal systems in volcanic rocks and have the capacity to transport significant quantities of precious metals. We believe that the groundmass pyrite in the tuffs, with its similarity in texture and morphology to that present in the pre-Lithic Ridge silicic lavas and other hydrothermally altered ash-flow tuff elsewhere, provides evidence for such a post-depositional addition of sulphur. Clearly, this process has affected the pre-Lithic Ridge silicic lavas in drill hole USW G2, the lowermost part of the pre-Lithic Ridge tuffs in drill hole UE25p-1 and the pre-Cenozoic carbonate rocks in UE25p-1. In the Lithic Ridge Tuff and portions of the Crater Flat Tuff this sulphidation may have been from the passage of fluids, perhaps at low water to rock ratios, that had little effect on the tuffs other than the destruction of glass and the weak development of laterally and vertically discontinuous propylitic assemblages. The uneven and discontinuous distribution of pyrite and veins and cavity in-fillings of quartz, calcite, fluorite and barite in Yucca Mountain would be consistent with irregular, highly channelized paleohydrology, a phenomena that is not uncommon in fossil hydrothermal systems known elsewhere. Much basic petrographic work is planned to better determine the identity and distribution of alteration minerals, and to ascertain that previous investigators did not confuse altered lithic material with primary, magmatic components of the ash-flow units. Also, as mentioned previously, further comparisons will be made between pyrite textures of Yucca Mountain tuffs and those of pyrite in hydrothermally altered, porous ash-flow tuffs elsewhere.

With regard to the chemical data in Table 2, it should be emphasized that the analysed samples were selected to test, on a reconnaissance basis, the trace-element and precious-metal contents of various types of alteration and paleo-fluid channelways, and represent only a few, widely spaced drill hole intervals. The current data set provides only a minimal glimpse of the nature of fluids that may have included cold as well as heated meteoric water. Although no significant Au or Ag concentrations were found, there can be little doubt that various combinations of trace-elements and metals, including Hg, As, Sb, Mo, Se, Te, Bi, Pb, Zn and Tl, are locally elevated relative to fresh rock concentrations. The remarkable Mo concentrations in rocks of the UE25 C holes (Table 2) are associated with breccia veins, fluorite, quartz and Fe-Mn oxide veinlets, and less enriched, but still highly elevated Sb, As and Bi. These accumulations reflect the movement of metal-bearing fluids and are sufficiently dispersed in the rock mass of Yucca Mountain to be detected by the few samples analyzed. In particular, mineralogic and chemical data from the pre-Cenozoic rocks of

UE25p-1 suggest the possible presence of deep base-metal and(or) precious-metal mineralization in the vicinity of the drill hole. Additional samples from UE25p-1, particularly those intervals adjacent to sample #16963, should be obtained for chemical analyses to better bracket the vertical extent of the highly anomalous metal and trace-element concentrations. Further geochemical work is clearly warranted and we intend to obtain additional analyses.

Another area of research planned for the coming year will be to investigate the precious-metals and trace-element contents of hydrothermally altered, but unmineralized, rocks from several silicic tuff-hosted epithermal mineral deposts. This would involve the same types of low-level, multi-element analyses reported in Table 2. If possible, we will obtain specimens from a number of deposits, including Round Mountain, Secret Pass, Rawhide, Paradise Peak and Wonder, Nevada, and perhaps Castle Mountain, California.

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Table 1. List of Core and Rotary Cuttings Samples from the Subsurface of Yucca Mountain Received by Task 3

Hole #	SMFSpecID	Depth Top	Depth Bot	Unit	Type	Alt?Type	Py?	Vns?	comments
UE25B-1H	16937	2110.0	2120.0	Tcp	chips	?			
UE25B-1H	16938	2130.0	2140.0	Tcp	chips	?			
UE25B-1H	16939	2140.0	2150.0	Tcp	chips	?			
UE25B-1H	16940	2240.0	2250.0	Tcp	chips	?			
UE25B-1H	16941	2280.0	2290.0	Tcp	chips	?			
UE25B-1H	17755	3184.7	3185.5	Tct	core		N	Y	cal ±? vns
UE25B-1H	17756	3195.3	3196.2	Tct	core			N	
UE25B-1H	17757	3208.3	3209.0	Tct	core			Y	cal vns
UE25B-1H	17758	3214.0	3214.7	Tct	core		N	N	
UE25B-1H	16847	3550.0	3550.8	Tct	core	Y	Y	N	
UE25B-1H	16848	3555.2	3556.0	Tct	core	Y	Y	Y	cal? vns
UE25B-1H	16849	3659.5	3660.2	Tct	core	Y	Y	Y	cal vns
UE25B-1H	16850	3675.0	3676.0	Tct	core	Y	Y	N	
UE25B-1H	16851	3695.0	3695.6	Tct	core	Y	Y	N	
UE25B-1H	16852	3771.2	3772.0	Tct	core	Y	Y	N	lithology similar to Round Mtn type II ore
UE25B-1H	16854	3773.0	3773.5	Tct	core	Y	Y	N	lithology similar to Round Mtn type II ore; photos of gdmss py ??
UE25B-1H	16855	3786.0	3786.8	Tct	core	Y	Y	N	
UE25B-1H	16856	3796.2	3796.7	Tct	core	Y	Y	Y	cal vns
UE25B-1H	16857	3821.8	3822.4	Tct	core	Y	Y	Y	dissem py in gdmass+py in lithics; minor py in cal vn.
UE25B-1H	16859	3825.0	3825.7	Tct	core	Y	Y	Y	good green fluor? + cal vein, poss. fluid incls.
UE25B-1H	16860	3935.9	3936.5	Tct??	core	?	N	Y	no py seen; cal±? vn
UE25B-1H	16861	3959.9	3960.6	Tlr	core	Y?	?	N	
UE25B-1H	16862	3985.7	3986.3	Tlr	core	Y, arg?	N	Y	cal vn
UE25B-1H	16863	3999.8	4000.6	Tlr	core	Y	N	N	
UE25 P1	16948	880.0	890.0	Tpt	chips	N	N	?	
UE25 P1	16949	900.0	910.0	Tpt	chips	N	N	?	
"E25 P1	16950	920.0	930.0	Tpt	chips	N	N	?	
.25 P1	16951	940.0	950.0	Tpt	chips	N	N	?	
UE25 P1	16952	2870.0	2880.0	Tct?	chips	?	N	?	
UE25 P1	16953	3120.0	3130.0	Tlr	chips	?	N	?	
UE25 P1	16954	3870.0	3880.0	Tot	chips	?	N	?	
UE25 P1	16955	3890.0	3900.0	Tot	chips	?	Y	?	alt volc frags, some w/py
UE25 P1	16956	3920.0	3930.0	Tot	chips	?	N	?	contam w/drill tool frags
UE25 P1	16957	3930.0	3940.0	Tot	chips	?	N	?	
UE25 P1	16958	4060.0	4070.0	Tot/Slm	chips	?	Y	?	mixed Tot/Slm
UE25 P1	16959	4080.0	4090.0	Tot+Pz	chips	?	Y	Y	mixed Tot(±py) + carb frags, occais. qtz, py vein frags.
UE25 P1	16960	4210.0	4220.0	Tot/Slm	chips	?	Y	?	mixed, 90% Tot w/sparse py
UE25 P1	16961	5490.0	5500.0	Slm	chips	?	N	Y	cal + fluor? vns
UE25 P1	16962	5510.0	5520.0	Srm	chips	?	N	Y	cal, fluor, qtz vn frags
UE25 P1	16963	5530.0	5540.0	Srm	chips	?	Y	Y	contam. w/drill frags; py vn/vug frags; fluor, qtz, cal vn frags
UE25 P1	16964	5550.0	5560.0	Srm	chips	?	Y?	Y	contam w/drill tool frags; dissem py; qtz, cal, fluor vn frags
USW G1	16898	3216.0	3217.0	Tct	core	?	Y	N	py in lithics only??
USW G1	16899	3219.5	3220.5	Tct	core	Y	Y	N	
USW G1	16900	3236.3	3237.1	Tct	core	Y	Y	N	
USW G1	16901	3250.3	3250.6	Tct	core	Y	Y	N	
USW G1	16903	3324.0	3224.9	Tct	core	Y	Y	N	
USW G1	16904	3368.2	3368.8	Tct	core	Y?	Y	N	
USW G1	16905	3372.0	3372.4	Tct	core	Y?	Y	Y	clear qtz vn, pyritic lithics + gdmss.
USW G1	16906	3384.0	3385.0	Tct	core	Y?	Y	N	
USW G1	16907	3392.3	3393.0	Tct	core	Y?	Y	N	py in gdmss too?, good one for TS
USW G1	16897	3393.0	3393.8	Tct	core	Y	Y	N	
USW G1	16908	3477.0	3478.0	Tct	core	Y?	Y	N	
USW G1	16909	3493.0	3494.0	Tct	core	Y?	Y	N	
USW G1	16910	3515.3	3516.0	Tct	core	Y?	Y	N	
USW G1	16911	5775.4	5776.4	Tot	core	Y?	N	N	good spec. for TS to check out alt.
USW G1	16912	5790.0	5791.0	Tot	core	Y?	N	N	

Table 1, continued

Hole #	SMFSpecID	Depth Top	Depth Bot	Unit	Type	Alt?Type	Py?	Vns?	comments
USW G1	16913	5823.0	5824.0	Tot	core	Y?	N	N	
USW G1	16914	5846.7	5847.7	Tot	core	Y?	N	N	xtal-rich, milky fldsp- get TS for alt check
USW G1	16915	5860.0	5861.0	Tot	core	Y?	N	N	
USW G1	16916	5879.8	5880.6	Tot	core	Y?	N	N	
USW G2	16864	1674.1	1675.1	Tpt	core	Y?	N	N	incipient alt?? in vit ??
USW G2	16865	1690.2	1690.8	Tpt	core	?	N	N	incipient argillic alt.??
USW G2	16866	1700.0	1700.6	Tpt	core	?	N	N	incipient arg. alt.?
USW G2	16867	2280.2	2280.8	Trc	core	?	N	Y	silica vns
USW G2	16868	2306.3	2307.2	Trc	core	?	N	N	
USW G2	16869	3105.0	3105.9	Tcp	core	?	N	Y	silica vns
USW G2	16870	3313.0	3313.5	Tcb	core	N	N	N	fresh? dense Tcb- possible baseline gc
USW G2	16871	3420.0	3421.0	Tcb	core	?	N	Y	Mnox-filled fracture/vein
USW G2	16872	3445.9	3447.1	Tcb	core	?	N	N	
USW G2	16873	3935.0	3935.7	Tct	core	Y	N	N	
USW G2	16874	3949.8	3950.5	Tct	core	Y?	N	N	
USW G2	16875	3968.0	3968.8	Tct	core	Y	N	N	
USW G2	16876	3985.0	3986.0	Tct	core	Y	N	N	arg. alt?, dark, pheno-rich subunit, lower Tct
USW G2	16877	3991.4	3992.4	Tct	core	Y?	N	N	arg. alt? propylitic?
USW G2	16878	4188.3	4189.0	Tr2	core	Y?	N	N	propylitic? alt. welded tuff
USW G2	16879	4198.4	4199.0	Tlr	core	?	N	Y?	clay/FeOx shear? bands, prev. glassy?
USW G2	16880	4202.0	4202.7	Tlr	core	?	N	N	prop. alt? prev. glssy dense ash-flow tuff
USW G2	16881	4204.4	4205.2	Tlr	core	?	N	N	propylitic alt?
USW G2	16882	4219.0	4219.7	Tlr	core	Y?	N	N	propylitic alt?
USW G2	16883	4277.3	4278.0	Tlr	core	Y?	N	N	propylitic alt?, py??
USW G2	16884	4291.3	4292.0	Tlr	core	Y?	N	N	
USW G2	16885	4305.0	4306.0	Tlr	core	Y?	N	N	
USW G2	16886	5207.0	5207.7	Tr1	core	Y?	Y?	N	
USW G2	16887	5232.9	5233.7	Tr1	core	Y	Y	Y	cal-silica-chlor vns, hydraulic/hydrothermal? brecc vns; sparse py
USW G2	16888	5254.0	5255.0	Tr1	core	Y	Y?	Y	
USW G2	16889	5260.0	5260.6	Tr1	core	Y	Y	Y	propyl. alt, cal-chlor-silica vns., sparse py
USW G2	16890	5263.0	5264.0	Tr1	core	Y,prop	N?	Y	fault shear surfaces,sheared cal+grnclay? vn
USW G2	16891	5644.0	5645.0	Tr1tuff	core	Y?prop	N	N	propylitic? alt welded tuff
USW G2	16892	5664.0	5665.0	Tr1tuff	core	Y?prop	N	N	propylitic? alt. welded tuff
USW G2	16893	5670.5	5671.3	Tr1	core	Y?prop	N	N	propylitic alt? lava
USW G2	16894	5684.3	5685.3	Tr1	core	Y?prop	N	Y	propylitic alt? lava; cal vns
USW G2	16895	5697.0	5698.0	Tr1	core	Y?prop	N	Y	cal vns
USW G2	16896	5711.9	5712.7	Tr1	core	Y?prop	N	Y	cal vns
USW G3	16930	4652.9	4654.5	Tlr	core	Y?prop	N	N	
USW G3	16932	4754.7	4755.5	Tlr	core	Y?prop	Y	N	py in lithics and gdms
USW G3	16933	4790.0	4790.7	Tlr	core	Y?prop	Y	N	v. sparse py in a few lithics; good match for Round Mtn type II ore
USW G3	16934	4805.0	4805.7	Tlr	core	Y?prop	Y	N	v. sparse py in a few lithics; good match for Round Mtn type II ore
USW G3	16935	4816.7	4817.1	Tlr	core	Y?prop	Y	N	v. sparse py in a few lithics; good match for Round Mtn type II ore
USW G3	16936	4828.0	4828.7	Tlr	core	Y?prop	?	N	
USW GU3	16924	1041.0	1041.7	Tpt	core	N	N	Y	cal vns
USW GU3	16927	1185.6	1186.2	Tpt	core	N	N	N	did not receive part of core interval with vein
USW GU3	16929	1229.4	1230.4	Tpt	core	N	N	N	fresh Tpt vit for possible baseline gc
USW H3	16942	3340.0	3350.0	??Tc?	chips	N	N	N	
USW H3	16943	3990.0	4000.0	??Tc?	chips	N	N	N	
UE25 A1	16917	2115.3	2115.9	Tcp	core	Y?	N	Y	yellow-green fracture coating; SEM-EDX shows no As, U or trace metals
UE25 A1	16918	2116.8	2117.2	Tcp	core	Y?	N	N	not what we requested, incipient alt. vit??
UE25 A1	16919	2123.0	2123.7	Tcp	core	Y?	N	Y	arg alt?; similar to Rawhide oxide ore; silica vns
UE25 A1	16920	2133.5	2134.0	Tcp	core	Y?	N	Y?	arg alt+clay-zeol-wad fracture filling; similar to Rawhide oxide ore
UE25 A1	16921	2187.4	2188.1	Tcp	core	Y?	N	N	silicified? glassy tuff??
UE25 A1	16922	2478.1	2478.7	Tcb	core	Y?	N	N	wk arg. alt plag, bio v. cx; strong v.p.??
UE25 A1	16923	2495.5	2496.1	Tcb	core	Y?	N	N	arg. alt? v.p., fault surfaces
UE25 A4	16944	359.4	360.2	Tpt	core	N	N	N	delicate carb xtals lining relict v.p. pums

Table 1, continued

Hole #	SMFSpecID	Depth Top	Depth Bot	Unit	Type	Alt?Type	Py?	Vns?	comments
UE25 A4	16945	366.3	366.7	Tpt	core	N	N	N	caliche in relict v.p. pums; contam w/coppery metallic drill lube
UE25 A4	16946	386.1	386.5	Tpt	core	N	N	N	fresh devit+v.p.; minor caliche
UE25 A4	16947	398.2	399.0	Tpt	core	N	N	Y	drusy cal vn and cal-cemented brecc, fault surface
UE25 C1	20064	2783.0	2784.0	Tc	core	arg?+Feox	N	Y	rubble zone frags containing hydraulic/hydrothermal? breccia veins
UE25 C2	20065	2688.1	2688.5	Tc	core	arg?+Feox	N	N	strong reddish Feox stain
UE25 C2	20066	2830.0	2840.0	Tc	chips	arg?	N	Y	bleached, Feox hydraulic/hydrothermal? breccia vns
UE25 C2	20067	2900.0	2910.0	Tc	chips	arg?	N	Y	breccia veins as in 20064; bleached, bio fresh
UE25 C3	20068	2900.1	2900.5	Tc	core	arg?+Feox	N	Y	breccia veins, clear calcite and dark grey calcite veins
UE25 C3	20069	2902.2	2903.0	Tc	core	arg?+Feox	N	Y	breccia vns, fluor cubes lining cavities, vfg qtz+fl? vns, no efferv.
UE25 C3	20070	2821.3	2821.6	Tc	core	arg?+Feox	N	N	bleached to mustard color

SMFSpecID = sample identification number assigned to each interval by staff of the Sample Management Facility, Area 25, Nevada Test Site.

Depth top and Depth Bot refer to the depth in feet from the surface to the top and bottom of each sample interval.

Srm = Roberts Mountain Formation, Slm = Lone Mountain Dolomite; Tot = pre-Lithic Ridge sequence of ash-flow and bedded tuffs, Tr1 = pre-Lithic Ridge silicic lavas, Tlr = Lithic Ridge Tuff; Tct, Tcb and Tcp = Tram, Bullfrog and Prow Pass members of the Crater Flat Tuff, respectively; Tc = Crater Flat Tuff undivided,; Tpc = Tiva Canyon Member of the Paintbrush Tuff.

py = pyrite, fluor = fluorite, cal = calcite, qtz = quartz, vns = veins, alt = altered, mod = moderately, dissem = disseminated, gdmss = groundmass, arg = argillic, carb = carbonate, v.p. = vapor phase, pums = pumice(s), brecc = breccia.

Table 2. Precious Metals and Indicator-Element Abundances in Core
Ag and Au values given in

Hole #	SMF ID#	Unit	Py?	Vns?	Comments	Ag	Au
UE25B-1H	16854	Tct	Y	N	lithology similar to Round Mountain type II ore.	38.0	0.492
UE25B-1H	16855	Tct	Y	N		34.5	0.233
UE25B-1H	16856	Tct	Y	Y	cal vns.	37.9	<0.200
UE25B-1H	16857	Tct	Y	Y	cal vns; dissem py in groundmass and in lithics; minor py in cal vn.	33.7	0.230
UE25B-1H	16859	Tct	Y	Y	cal + green to clear fluor?? vein, possible fluid inclusions.	34.1	0.596
UE25B-1H	16860	Tct?	N	Y	cal + green phase in vn; no py seen.	33.3	0.324
	YMX-2				(blind duplicate 16860)	40.1	1.10
UE25B-1H	16861	Tlr	?	N		28.6	<0.200
UE25B-1H	16862	Tlr	N	Y	cal vn.	33.6	0.230
UE25 P1	16954	Tot	N	?		41.1	0.360
UE25 P1	16955	Tot	Y	?	alt volc frags, some w/py.	27.1	<0.198
UE25 P1	16956	Tot	N	?	alt Tot, no py seen, contains drill tool fragments.	29.6	<0.197
UE25 P1	16958	Tot	Y	?	mixed Tot/Slm.	54.0	0.519
UE25 P1	16959	fault?	?	?		93.0	2.13
UE25 P1	16960	Tot/Slm	Y	?	mixed Tot/Slm, 90% Tot fragments contain sparse py.	29.8	<0.198
UE25 P1	16961	Slm	N	Y	cal + fluor? vns.	91.3	0.794
UE25 P1	16962	Srm	N	Y	cal+fluor?+qtz? vn fragments.	51.3	<0.196
	YMH-X5				(blind dup. 16962).	54.7	<0.199
UE25 P1	16963	Srm	Y	Y	contains drill tool fragments; py and fluor vn or vug fragments.	139.0	4.83
	16963B*				(powder from 2nd split of chips; 5 gram GXPL).	173.0	7
UE25 P1	16964	Srm	Y	Y	qtz, py, fluor? vns + dissem py, contains drill tool fragments.	49.2	0.328
USW G1	16904	Tct	Y	N		41.8	<0.196
USW G1	16905	Tct	Y	Y	clear qtz vn; pyritic lithics and groundmass.	39.1	2.72
USW G1	16907	Tct	Y	N	pyritic lithics and groundmass.	36.7	0.396
USW G1	16914	Tot	N	N	xtal-rich, milky feldspar phenocrysts.	33.3	0.327
USW G2	16871	Tcb	N	Y	Mn-ox filled fracture.	14.8	1.47
	16871				(second split of original powder)		
USW G2	16887	Tr1	Y	Y	propylitic alt, cal-chlor-silica vns., albitized feldspar phenos.	28.4	0.332
USW G2	16888	Tr1	N	Y	as above	26.2	<0.197
USW G2	16889	Tr1	Y	Y	as above	28.7	0.232
	YMX-1				(blind duplicate 16889)	34.9	1.14
USW G2	16890	Tr1	N	Y	fault surfaces, sheared cal+green clay? vn.	27.9	<0.198
USW G2	16895	Tr1	N	Y	cal vns.	43.0	0.360
USW G2	16896	Tr1	N	Y	cal vns.	38.6	<0.197
USW G3	16932	Tlr	Y	N	py in lithics and groundmass.	36.7	<0.198
	X-1				(blind duplicate 16932 for Hg by AA)		
USW G3	16933	Tlr	Y	N	very sparse py in few lithics; lithology similar to Round Mtn type II.	36.7	<0.194
USW G3	16934	Tlr	Y	N	v. sparse py in few lithics; good match for RM typeII ore.	40.2	0.328
USW G3	16935	Tlr	Y	N	v. sparse py in few lithics; good match for RM typeII ore.	41.3	0.329
USW G3	16936	Tlr	?	N		34.4	<0.199
UE25 C1	20064	Tc	N	Y	rubble zone fragments w/breccia veins.	8.5	<0.198
UE25 C2	20065	Tc	N	N	strong reddish Feox stain.	6.5	0.295
UE25 C2	20066	Tc	N	Y	bleached, Feox breccia vns.	12.4	<0.225
UE25 C2	20067	Tc	N	Y	bleached, breccia veins as in 20064; biotite fresh.	10.1	0.276
UE25 C3	20068	Tc	N	Y	breccia veins, clear calcite+dark grey calcite veins.	12.5	0.328
UE25 C3	20069	Tc	N	Y	breccia vns; fluor+montmorill. in cavities; vfg qtz+fluor? vns, no cal.	21.1	0.395
	20069R				(2nd analysis of powder from original split of 20069)	10.0	<0.199
	X-2				(blind duplicate 20069 for Hg by AA)		
	20069B				(powder from second split of 20069 excluding cut surfaces)	9.9	<0.199
	YMH-X4				(blind duplicate 20069B)	10.4	<0.198
UE25 C3	20070	Tc	N	N	bleached to mustard color.	4.5	0.261
	Fresh tuff reference samples						
BMCF-D		Tcb			mod. welded, devit; S end Yucca Mtn NW of Lathrop Wells cinder cone.	10.1	<0.199
3SW-589		Tpc			fresh, dense, devit, minor caliche in lithophys.; Exile Hill.	9.7	0.265
YMH-X3					(blind duplicate 3SW-589)	13.1	<0.198
X-3					(blind duplicate 3SW-589 for Hg by AA)		

SMF ID # denotes sample identification assigned to each interval by staff of Sample Management Facility, Area 25, Nevada Test Site; ID numbers beginning with YM and X were assigned by Task 3 to denote blind duplicates.

Srm = Roberts Mountain Formation, Slm = Lone Mountain Dolomite; Tot = pre-Lithic Ridge sequence of ash-flow and bedded tuffs, Tr1 = pre-Lithic Ridge silicic lavas, Tlr = Lithic Ridge Tuff; Tct, Tcb and Tcp = Tram, Bullfrog and Prow Pass members of the Crater Flat Tuff, respectively; Tc = Crater Flat Tuff undivided,; Tpc = Tiva Canyon Member of the Paintbrush Tuff.

and Rotary Cuttings Samples from the Subsurface of Yucca Mountain
ppb, all others given in ppm

As	Bi	Cd	Hg	HgAA	Sb	Se	Te	Cu	Mo	Pb	Zn	Tl
4.2	0.451	0.202	0.066	0.023	<0.05	0.355	0.208	2.8	0.38	13.5	37.4	<0.492
4.8	0.554	0.132	0.063	0.022	0.22	0.456	0.413	3.3	0.47	17.0	37.0	<0.500
7.8	0.442	0.118	0.068	0.037	0.23	0.416	0.428	3.5	0.33	15.8	38.4	<0.500
5.2	0.450	0.196	0.078	0.021	<0.05	0.556	0.268	3.2	0.69	14.1	38.2	<0.493
7.9	0.445	0.118	0.080	0.024	<0.05	0.464	0.202	3.1	0.27	16.5	39.7	<0.496
0.7	0.182	0.324	0.153	0.106	<0.05	<0.243	<0.049	5.8	0.23	7.7	54.1	<0.486
<0.75	0.167	0.355	0.142	nd	<0.15	<0.753	<0.151	6.5	0.41	7.9	53.2	<1.51
0.5	0.183	0.082	0.060	0.040	0.14	<0.250	0.112	2.4	0.23	8.7	41.4	<0.500
0.3	0.057	0.037	<0.020	<0.010	<0.05	<0.246	<0.049	0.9	<0.02	8.0	36.4	<0.493
5.2	0.156	0.320	0.140	0.120	<0.07	<0.338	<0.068	1.7	1.18	14.9	30.8	<0.675
2.7	0.154	0.089	0.053	0.038	0.42	<0.248	0.085	2.6	0.79	22.6	125	<0.495
3.4	0.105	0.082	0.039	0.022	0.52	<0.247	0.062	1.7	0.62	14.1	21	<0.493
47.8	0.123	0.127	0.092	0.061	1.84	<0.243	0.055	1.6	2.86	11.7	29.4	<0.487
63.2	0.051	0.253	0.129	0.136	0.39	<0.242	<0.048	1.4	1.32	5.6	42.5	<0.484
14.3	0.164	0.107	0.060	0.027	1.14	<0.247	0.157	1.4	0.82	13.0	21.5	<0.494
9.7	<0.050	0.035	0.056	0.046	1.35	0.268	<0.050	1.1	2.19	1.9	12.8	<0.496
3.7	<0.049	0.030	0.025	0.031	0.77	0.363	<0.049	0.8	1.92	2.3	11.7	<0.489
3.9	<0.050	0.031	0.031	nd	0.86	0.318	0.065	0.9	1.78	2.3	11.8	<0.498
25.9	1.92	0.469	0.585	nd	12.7	0.687	0.091	38.6	208	900	227	2.44
38.2	1.65	0.208	0.815	0.714	20.1	1.38	<0.526	64.9	286	1358	304	3.05
4.5	0.053	0.037	0.051	0.051	1.23	<0.246	<0.049	1.6	16.2	9.7	15	<0.492
8.0	0.340	0.079	0.073	0.023	0.15	0.404	0.439	4.3	0.37	16.1	21.2	<0.491
6.8	0.427	0.173	0.070	0.023	<0.05	0.526	0.206	3.9	0.64	18.3	37.9	<0.486
8.4	0.381	0.224	0.069	0.016	<0.05	0.687	0.325	4.7	0.68	15.0	37.4	<0.495
2.6	0.070	0.045	0.054	<0.010	<0.05	<0.245	<0.049	2.0	<0.02	10.1	57.3	<0.490
18	<0.049	0.416	0.649	0.786	5.31	<0.246	<0.049	1.7	0.46	9.5	36.8	<0.491
				0.681								
68.8	<0.050	0.100	0.192	0.118	<0.05	<0.249	<0.050	3.9	0.59	12.1	50.1	<0.498
85.2	0.064	0.119	0.220	0.152	0.40	<0.247	0.073	3.5	1.16	17.2	81.9	<0.493
47.1	0.081	0.126	0.220	0.123	<0.05	<0.248	<0.050	3.1	2.05	16.9	52	<0.497
50	<0.132	0.132	0.188	nd	<0.132	<0.66	<0.132	3.5	2.2	16.5	51.8	<1.32
38.6	<0.050	0.163	0.081	0.037	0.34	<0.248	0.067	3.7	0.18	22.3	86.8	<0.496
1.6	<0.049	0.092	0.061	0.016	0.17	<0.246	0.067	12.6	0.18	9.3	76.8	<0.491
0.5	<0.049	0.100	0.178	0.021	<0.25	<0.246	<0.049	11.2	<0.02	7.2	78.8	<0.492
1.5	0.196	0.153	0.078	0.046	<0.05	<0.248	<0.050	1.8	0.13	9.3	12.7	<0.496
				0.050								
1.3	0.152	0.071	0.091	0.063	0.11	<0.243	0.130	1.0	0.30	10.5	32.8	<0.486
1.2	0.268	0.215	0.110	0.079	<0.05	<0.246	<0.049	1.7	0.15	10.6	31.7	<0.492
1.1	0.177	0.144	0.111	0.066	<0.05	<0.247	<0.049	1.6	0.12	10.8	29.8	<0.493
1.1	0.179	0.077	0.053	0.046	0.24	<0.249	0.115	1.7	0.29	14.8	27.7	<0.498
18.1	0.106	0.119	0.042	0.033	15.1	<0.247	<0.049	0.8	1.25	9.9	40.6	<0.494
5.5	1.110	0.050	<0.020	0.017	<0.05	<0.246	0.083	0.5	<0.02	13.9	17.0	<0.491
22.4	0.122	0.057	0.026	0.018	3.72	<0.282	<0.056	0.6	8.83	6.2	9.3	<0.563
20.4	0.277	0.120	0.050	0.021	0.47	<0.345	<0.069	0.8	12.5	6.5	27.3	<0.689
77.4	0.163	0.292	0.075	0.062	1.49	<0.246	<0.049	0.6	0.98	10.9	39.1	<0.491
34.3	1.970	0.083	0.153	0.045	3.37	<0.247	0.134	0.5	193	11.1	20.8	<0.494
37.7	1.240	0.092	0.113	0.045	3.67	<0.249	0.188	0.7	207	11.3	23.6	<0.499
				0.050								
23	0.674	0.067	0.065	0.030	2.35	<0.248	0.090	0.4	110	9.2	19.3	<0.497
22.7	0.744	0.066	0.064	0.045	2.3	<0.248	0.107	0.6	109	9.0	19.1	<0.496
35.3	<0.049	0.063	0.041	0.058	4.67	<0.244	<0.049	0.7	0.29	2.8	12.8	<0.489
Fresh tuff reference samples												
5.3	<0.050	0.062	0.024	0.013	0.26	<0.249	0.055	1.0	1.36	2.0	47.9	<0.497
2.7	<0.050	0.037	<0.020	0.015	<0.05	<0.249	<0.050	1.4	0.89	4.9	49.0	<0.497
2.6	<0.049	0.044	0.023	0.014	0.12	<0.247	0.053	1.2	0.64	4.5	50.5	<0.495
				0.012								

Analyses by MB Associates, North Highland, CA, using inductively-coupled plasma emission spectrography for all elements except Au which was carried out by graphite furnace - atomic absorption spectrometry; * = 5 gram digestion, all other analyses used 15 gram digestion. Values as reported by MB Associates except Ag rounded to nearest ppb, As, Sb and Cu rounded to nearest 0.1 ppm, and Mo to nearest 0.01 ppm. Number of significant figure does not indicate precision or accuracy of analyses.

HgAA = analyses carried out by the Nevada Mining Analytical Laboratory using hydride<generator type atomic absorption methods, M. O. Desilets, analyst.

nd = not determined.

py = pyrite, fluor = fluorite, cal = calcite, qtz = quartz, vns = veins, alt = altered, mod = moderately, dissem = disseminated.

Table 3. X-Ray Fluorescence Analyses of Rocks of the Mount Jackson Dome Field
major elements given in weight percent, minor elements in ppm

Sample #	383A	383A*	383B	385	387	387*	MJ-SE	MJ-W	DWLJ-1
SiO_2	75.6	72.9	74.4	74.5	72.6	72.8	67.0	65.6	74.6
Al_2O_3	12.6	12.2	12.4	12.1	12.7	12.7	14.4	15.2	12.8
MgO	0.20	0.24	0.23	0.18	0.19	0.18	0.72	0.87	0.11
CaO	0.66	1.52	0.79	0.82	0.76	0.85	2.49	2.92	0.70
Na_2O	4.26	4.03	4.08	4.06	4.05	4.06	3.70	4.14	3.74
K_2O	4.48	4.53	4.56	4.25	4.85	4.83	4.16	3.77	4.55
P_2O_5	0.02	0.04	0.03	0.03	0.02	0.02	0.11	0.12	0.02
TiO_2	0.161	0.141	0.145	0.131	0.135	0.127	0.380	0.367	0.118
MnO	0.08	0.08	0.08	0.08	0.08	0.08	0.06	0.06	0.07
Fe_2O_3	0.97	0.83	0.87	0.84	0.92	0.87	2.13	2.30	0.58
Cr	-10	13	-10	-10	-10	-10	-10	-10	-10
Rb	172	189	187	316	157	159	138	95	237
Sr	-10	-10	-10	19	13	21	715	977	-10
Y	27	34	28	42	-10	16	14	-10	14
Zr	119	112	114	100	129	102	162	130	93
Nb	35	50	47	73	32	53	39	30	40
Ba	31	57	63	91	77	72	1230	1650	41
LOI(%)	0.85	2.65	2.10	2.80	2.95	3.00	2.90	2.95	2.20
SUM(%)	99.9	99.2	99.7	99.9	99.3	99.6	98.3	98.6	99.5

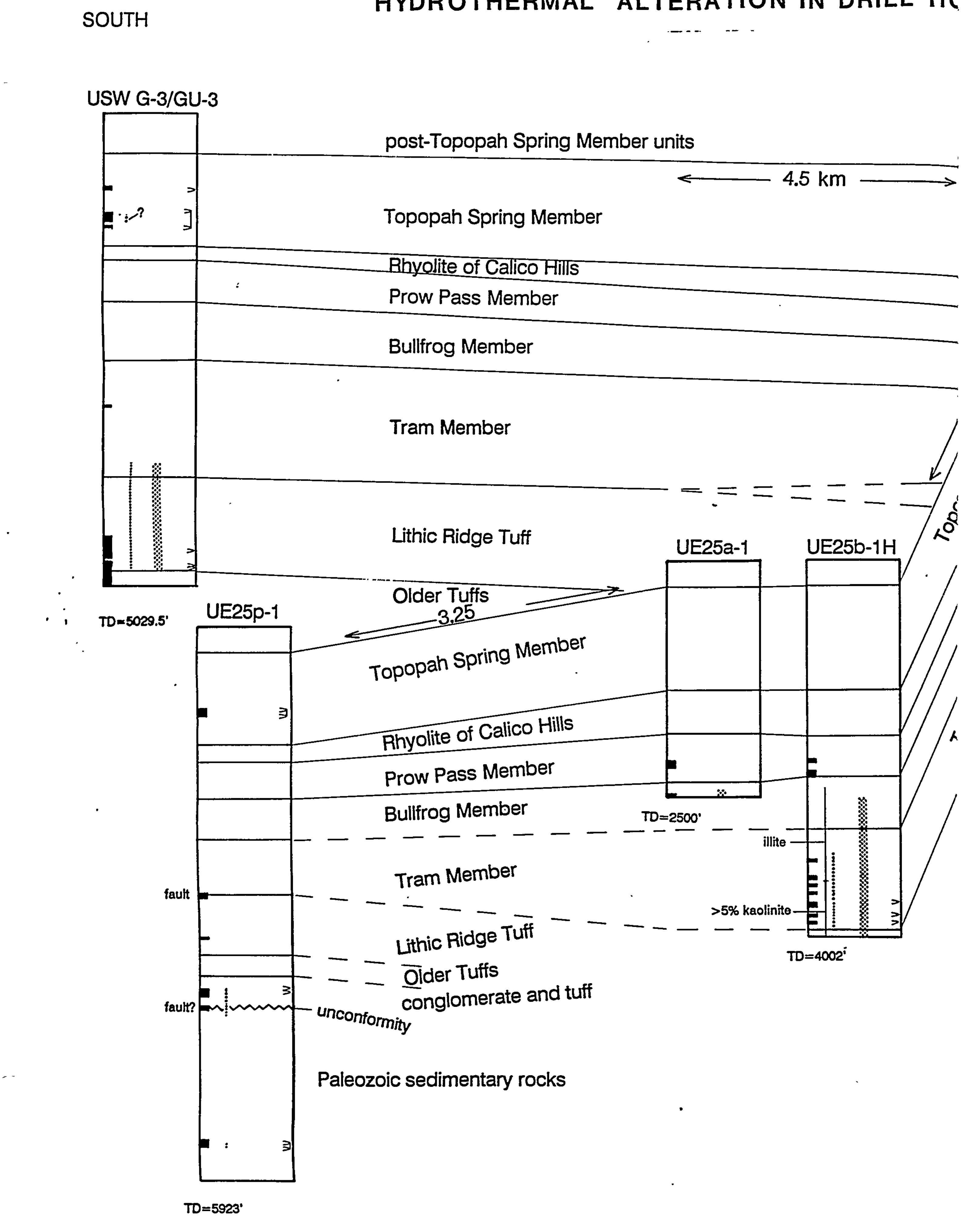
Analyses Recalculated "Anhydrous"

Sample #	383A	383A*	383B	385	387	387*	MJ-SE	MJ-W	DWLJ-1
SiO_2	76.2	74.9	76.0	76.6	74.8	75.1	69.0	67.6	76.3
Al_2O_3	12.7	12.5	12.7	12.4	13.1	13.1	14.8	15.7	13.1
MgO	0.20	0.25	0.23	0.19	0.20	0.19	0.74	0.90	0.11
CaO	0.67	1.56	0.81	0.84	0.78	0.88	2.57	3.01	0.72
Na_2O	4.30	4.14	4.17	4.18	4.17	4.19	3.81	4.27	3.82
K_2O	4.52	4.65	4.66	4.37	5.00	4.98	4.29	3.89	4.65
P_2O_5	0.02	0.04	0.03	0.03	0.02	0.02	0.11	0.12	0.02
TiO_2	0.162	0.145	0.148	0.135	0.139	0.131	0.392	0.378	0.121
MnO	0.08	0.08	0.08	0.08	0.08	0.08	0.06	0.06	0.07
Fe_2O_3	0.98	0.85	0.89	0.86	0.95	0.90	2.19	2.37	0.59
Cr	-10	13	-10	-10	-10	-10	-10	-10	-10
Rb	173	194	191	325	162	164	142	98	242
Sr	-10	-10	-10	20	13	22	737	1007	-10
Y	27	35	29	43	-10	16	14	0	14
Zr	120	115	116	103	133	105	167	134	95
Nb	35	51	48	75	33	55	40	31	41
Ba	31	59	64	94	79	74	1267	1701	42

See Figure 7 for sample locations. All samples contained small amounts of secondary carbonate minerals (caliche). To minimize the CaO contributed by caliche, most samples were crushed to -20 mesh and leached for 10 minutes with 5% acetic acid in a sonic cleaner. * indicates samples not leached in 5% acetic acid. Total iron as Fe_2O_3.

Analyses carried out by XRAL Ltd., using fused disk (lithium metaborate flux) X-ray fluorescence methods.

HYDROTHERMAL ALTERATION IN DRILL HO



LES IN YUCCA MOUNTAIN

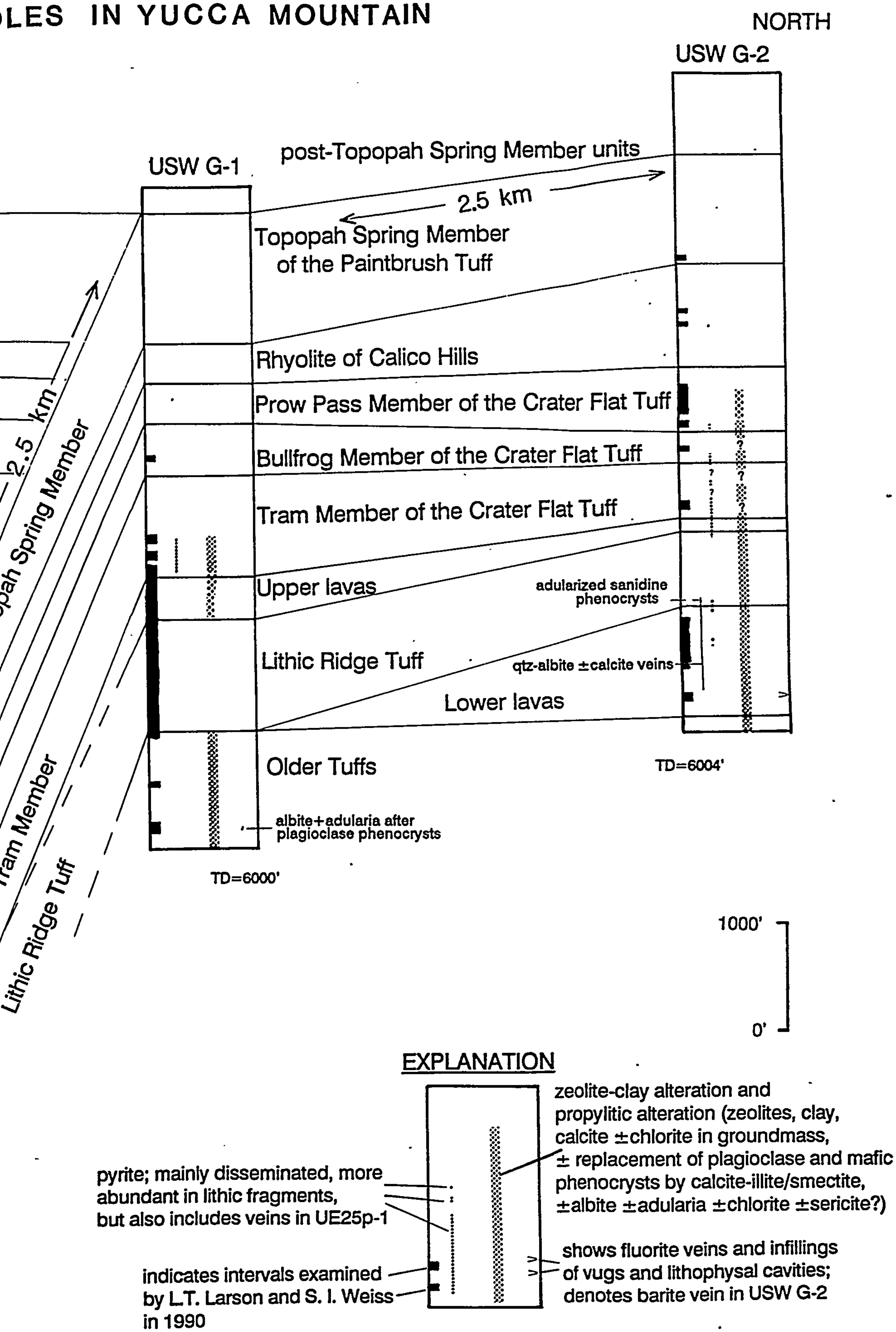


Figure 1. Subsurface stratigraphy and hydrothermal alteration features of deep drill holes in Yucca Mountain. Data from direct visual inspection by Task 3 and numerous published reports of the U. S. Geological Survey and the Los Alamos National Laboratory.

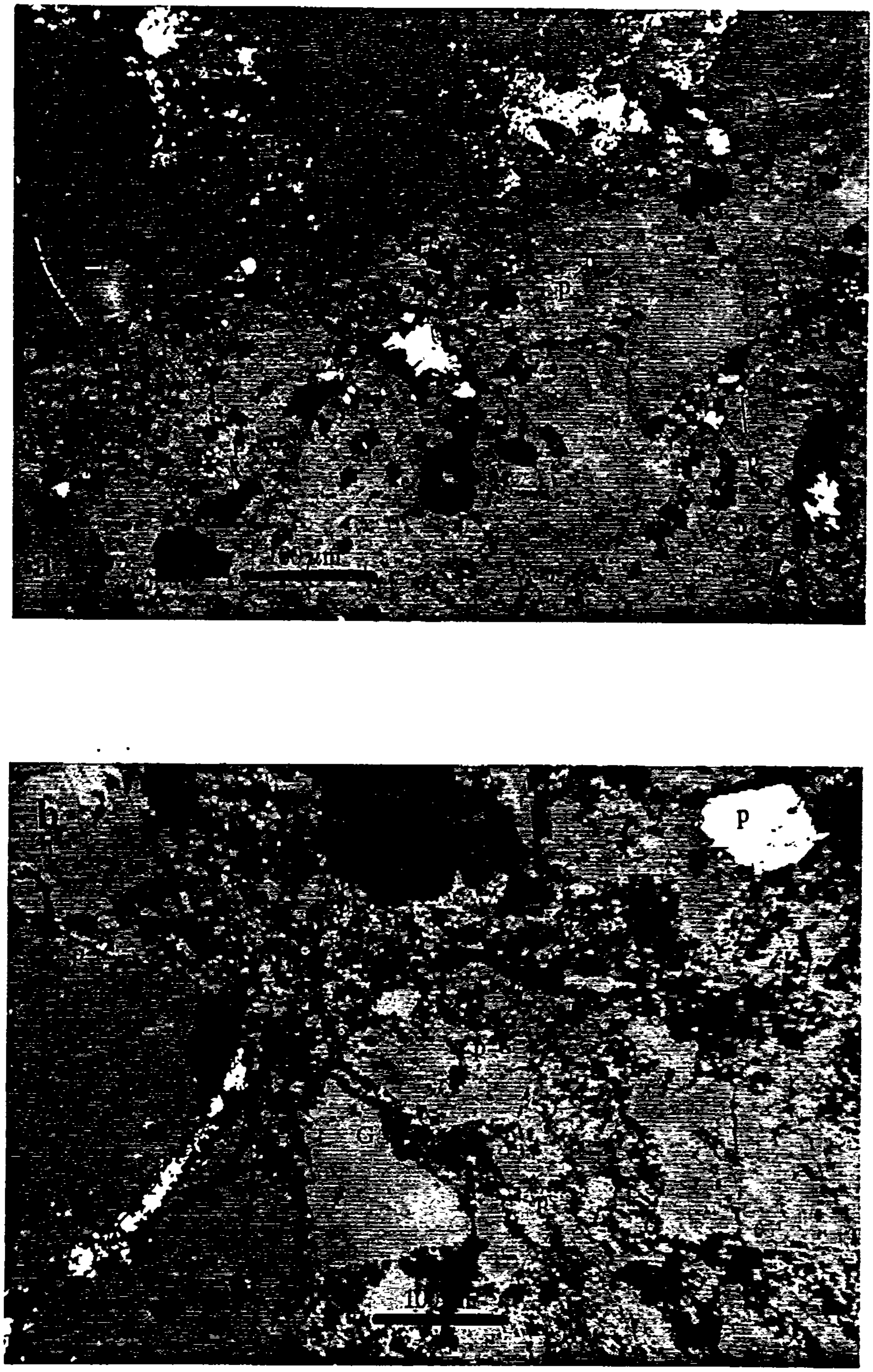
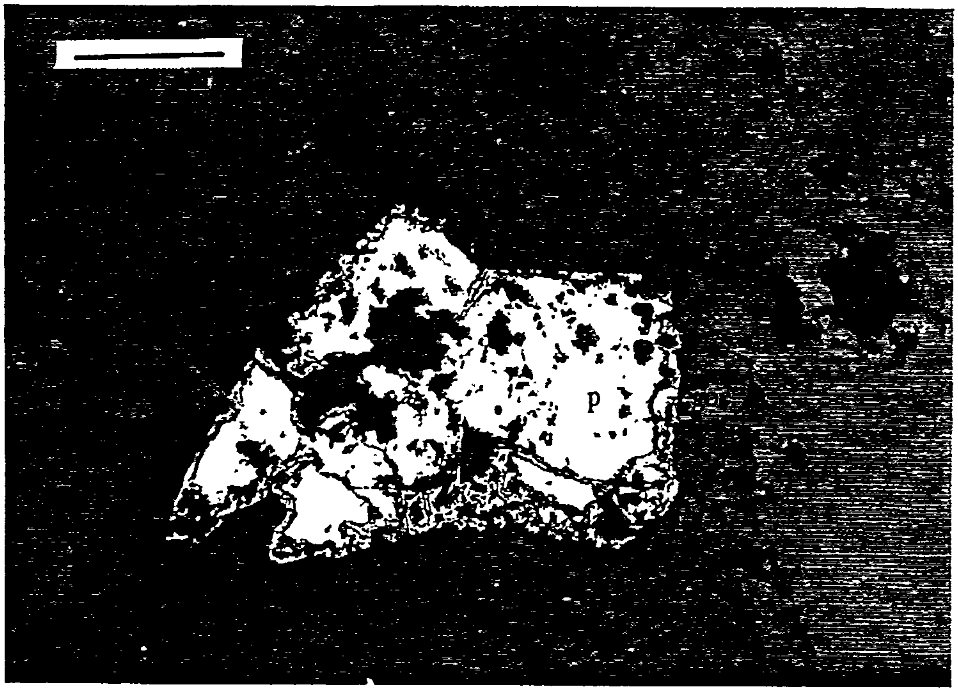


Figure 2. Pyrite in lithic fragments and groundmass of the Tram Member of the Crater Flat Tuff from drill hole UE25-B1H, SMF sample # 16954, including both disseminated and vein pyrite. p = pyrite, G = groundmass, L = lithic fragment.



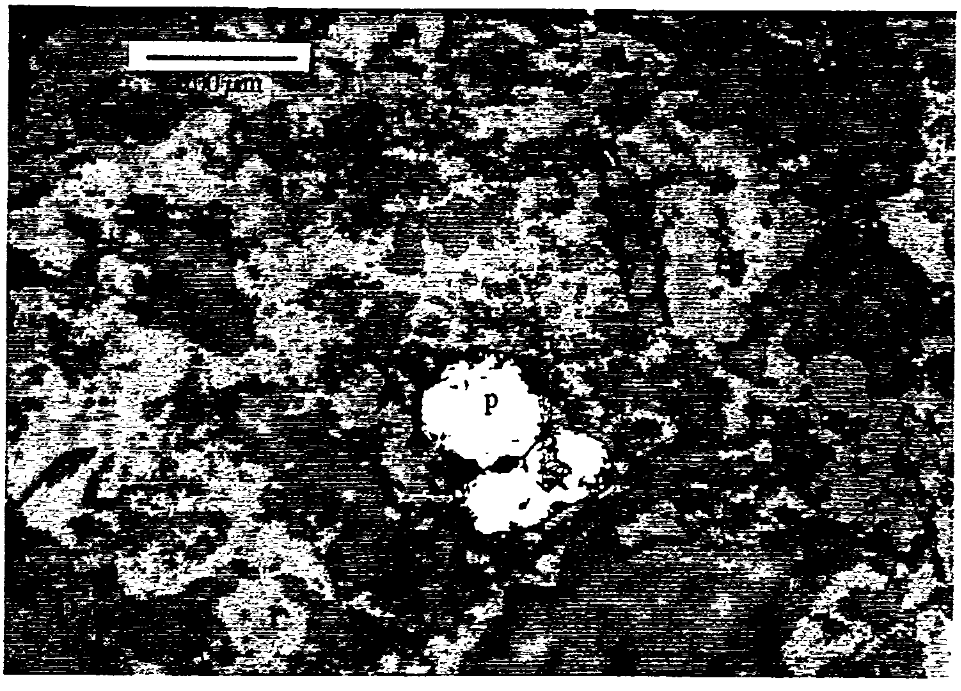


Figure 3. Poorly formed pyrite in the groundmass of the Lithic Ridge Tuff from drill hole USW-G3. a) SMF sample # 16935. b) SMF sample # 16932. p = pyrite, goe = goethite.

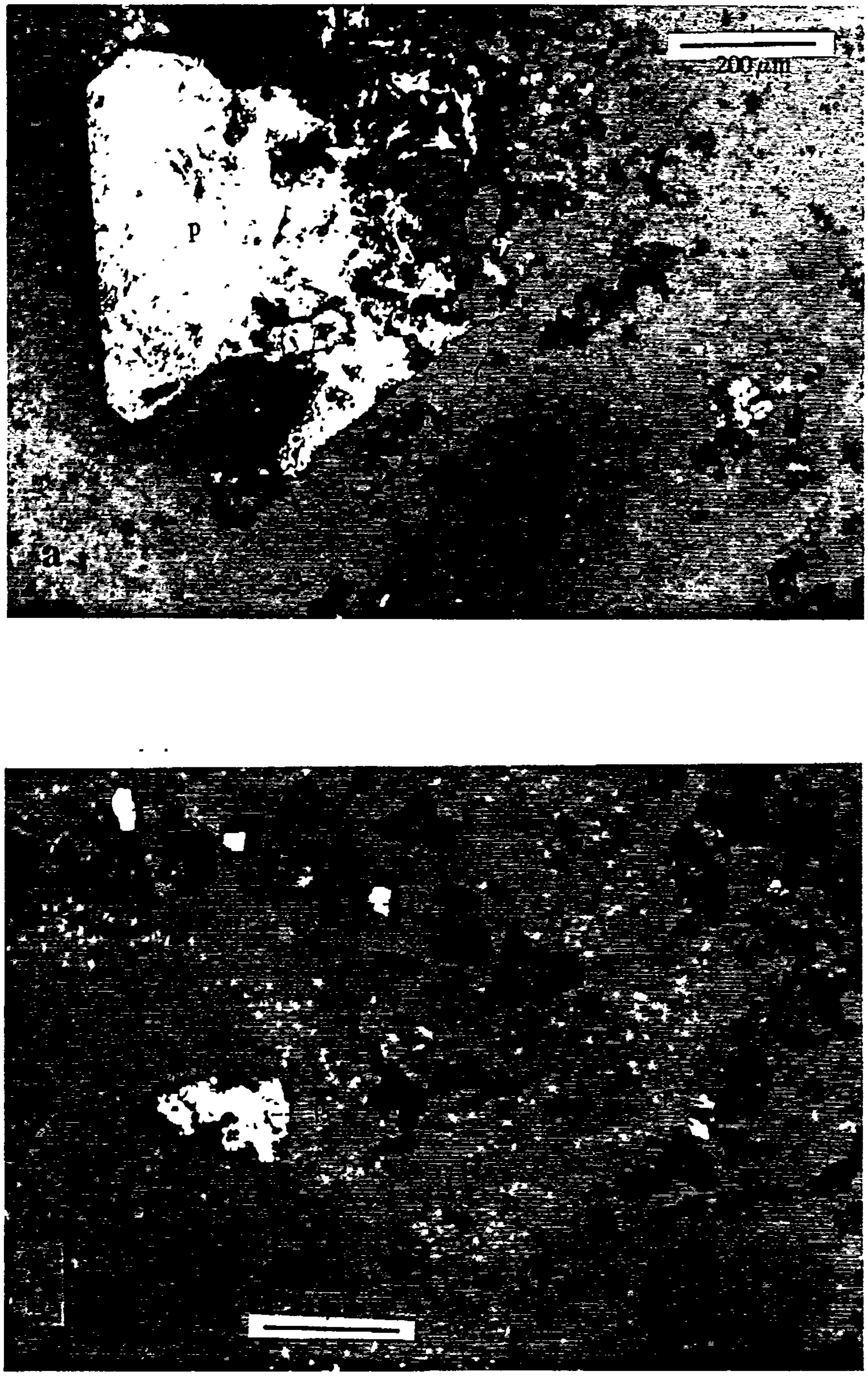


Figure 4. Disseminated pyrite in altered silicic lava from drill hole USW-G2, SMF sample # 16887. a) large, inclusion-bearing, pitted to seived, subhedral pyrite grain. b) small subhedral pyrite grains and larger, anhedral skeletal grain. p = pyrite

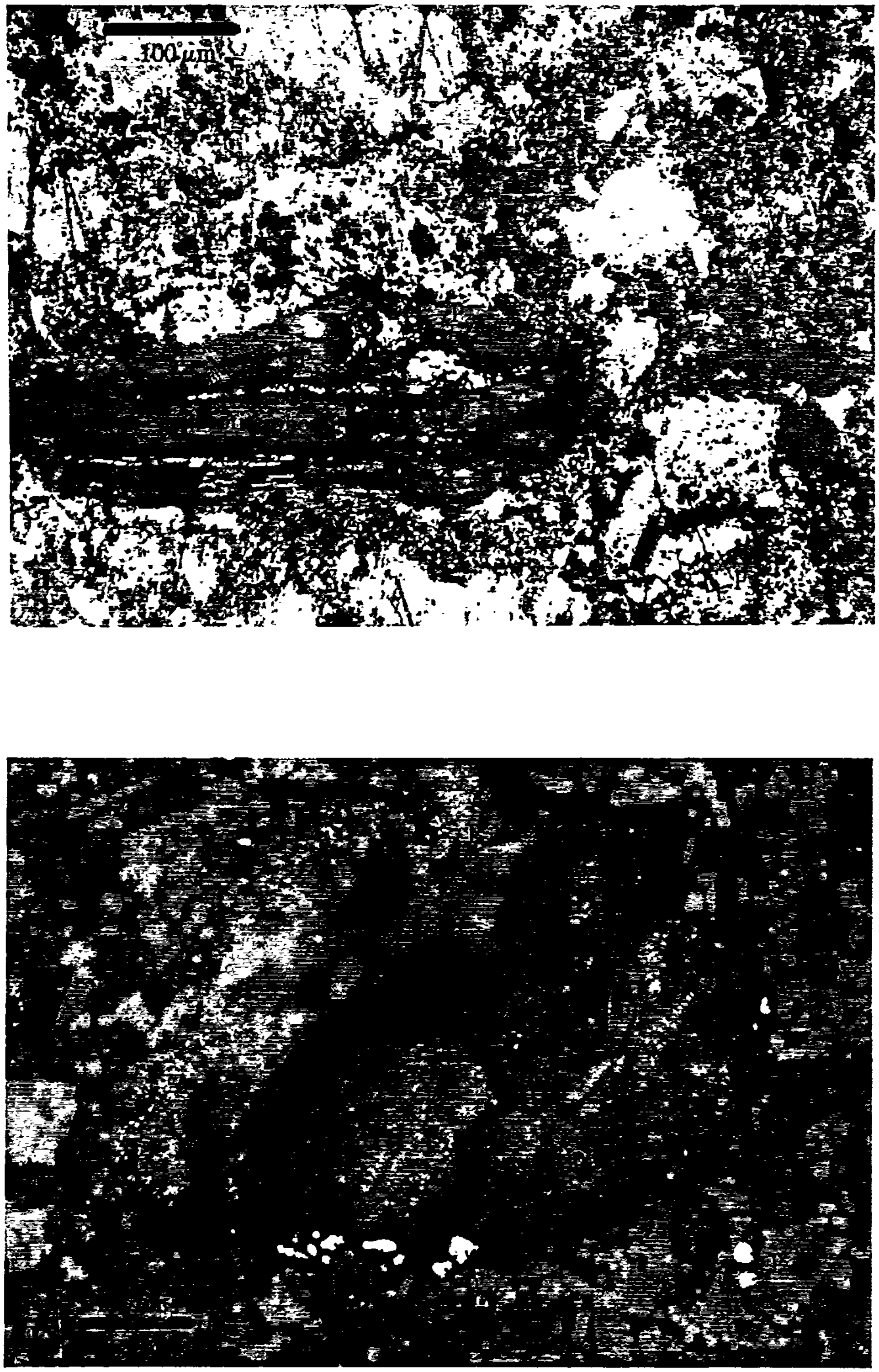


Figure 5. a) Partial sulphidation of biotite phenocryst in the Lithic Ridge Tuff from drill hole USW-G3, SMF sample # 16932. b) pyrite rimming and within clay altered pumice fragment in the Tram Member of the Crater Flat Tuff from drill hole UE25-B1H, SMF sample #16859. p = pyrite.

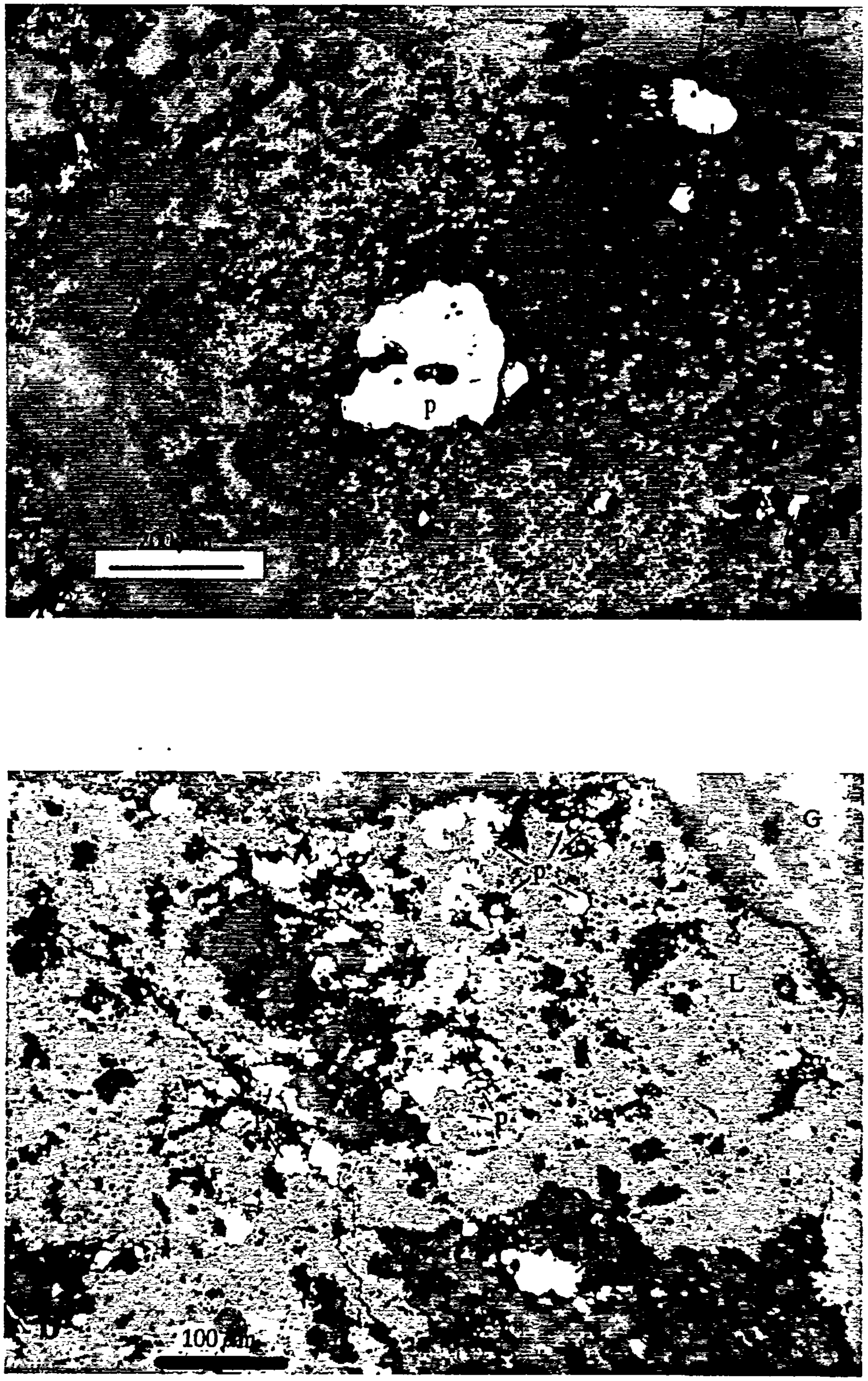


Figure 6. Pyrite in groundmass (a) and porous lithic fragment (b) of the Tonopah Summit Member of the Fraction Tuff (Bonham and Garside, 1979) from the Belcher Divide mine, Divide mining district, Esmeralda County, Nevada. Note anhedral, pitted and ophitic to wormy morphology of the pyrite. p = pyrite, G = groundmass, L = lithic fragment.

Figure 7. Oxidized Crater Flat Tuff with iron-oxide cemented breccia vein, SMF sample # 20069, drill hole UE25-C3.

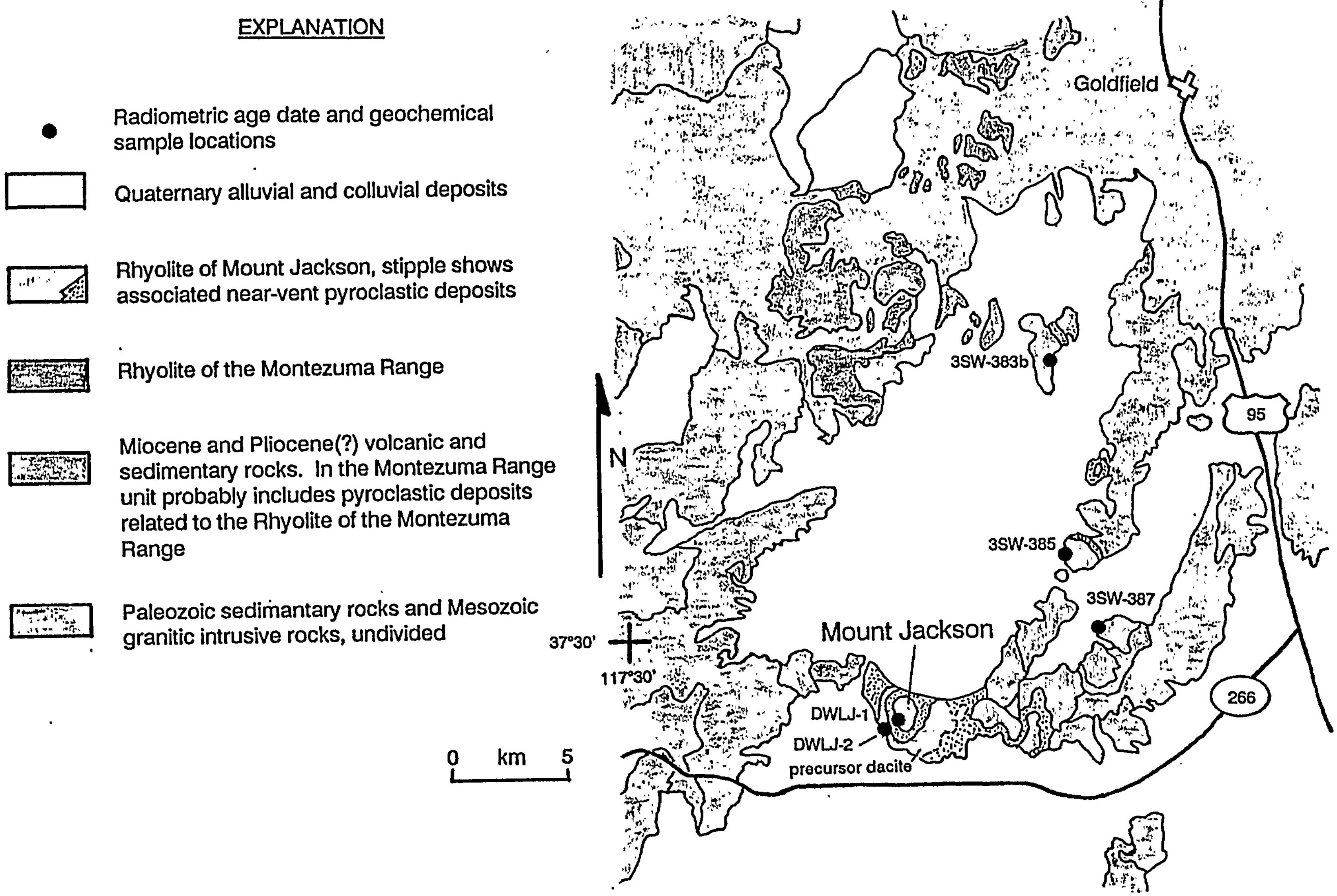


Figure 8. Simplified geologic map of the Mount Jackson dome field. Modified from Albers and Stewart (1972)

APPENDIX A

The initial gold contents of silicic volcanic rocks

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ABSTRACT

Fresh silicic volcanic rocks have markedly lower initial gold contents than would be inferred from much of the geochemical literature. The great majority of 129 carefully selected glassy silicic volcanic rocks analyzed contain less than 1.0 ppb, and many contain only $\leq$ 0.1 to 0.3 ppb Au. Nonperalkaline rhyolites contain <0.1 to 0.7 ppb, mean 0.22 ppb Au; of these, highly evolved, high-silica subalkaline and peraluminous rhyolites have the lowest Au contents. Peralkaline and iron-rich subalkaline rhyolites have higher gold contents of 0.2 to 4.5 ppb, mean about 1 ppb. The mean of 23 relatively silicic intermediate rocks is 0.54 ppb Au, with tholeiitic andesites (icelandites) generally higher in gold than calc-alkalic types. Fundamental controls on the initial gold content of silicic volcanic rocks appear to be melt structure and petrologic affinity; regional setting is less important. High-silica nonperalkaline rhyolite melts apparently do not readily accommodate gold, whereas crystal fractionation appears to increase the gold concentration in less-polymerized peralkaline melts. Bulk composition and melt structure, and the amount and timing of separation of vapor, mineral, and sulfide or metal melt phases, may largely determine the gold content of silicic magmas on eruption. Silicic and intermediate volcanic rocks, particularly high-silica nonperalkaline rhyolites, appear to be less favorable sources of gold for hydrothermal mineral deposits than crystallizing magmatic bodies or other, more gold-rich, rock types. Although iron-rich rhyolites may have contributed to development of certain deposits, factors other than associated volcanic rock type appear to be more important in determining gold availability to hydrothermal systems.

INTRODUCTION

There are remarkably few reliable data on the gold contents of fresh volcanic rocks in view of the importance of gold in the mineral industry, the intimate association of several types of gold deposits with high-level magmatic activity, the fact that many precious metal deposits are hosted by volcanic rocks, and the availability of analytical techniques for determining very low concentrations of gold. We have measured the gold contents of a variety of fresh, glassy volcanic rocks, most of silicic composition, with the principal objectives being to: 1) better define the range of initial gold contents, 2) determine if gold content is related to petrochemical type and degree of differentiation/evolution and, 3) determine if rocks of areas with different geologic setting and history have significantly different gold contents. Our findings bear on problems of geochemical exploration, the genesis of hydrothermal precious-metal deposits, and more general petrologic and geochemical questions.

The average gold content of felsic volcanic rocks is commonly given as between 2 and 4 ppb (Table 1). Work by Gottfried et al. (1972) and Bornhorst et al. (1986) suggests considerably lower values, of about 0.1 to 2.0 ppb, for generally fresh silicic and intermediate volcanic rocks. Our ongoing studies (Connors et al., 1990, 1991) have produced a body of data showing that rocks careful selected to represent *initial* gold contents typically contain less than 1 ppb Au, and in many cases 0.1 ppb or less.

Crocket (1991), who gives an average of 1.55 ppb for silicic volcanic rocks, based in large part on data sets that include numerous individual values much higher than any observed in the above studies, notes that "the lowest gold contents in felsic volcanics are from the western US localities (Gottfried et al., 1972), where averages of <1 ppb apply". Interestingly, these values of <1 ppb were common in the one study that carefully documents preparation and analysis. All other felsic volcanic suites included by Crocket are of pre-Cenozoic age, from the former Soviet Union, and give averages of >1 ppb Au. Indeed, rocks from one region have an average value of 9.6 ppb with a range of 1.5 to 22.5 ppb. Crocket (1991) suggests that the low gold contents found in the western U.S. may reflect regional variation or analytical bias at these very low gold concentrations. We believe that the average of 1.55 ppb given by Crocket (1991) is strongly influenced by the relatively high averages for suites of samples to which gold has been added by groundwater and/or hydrothermal solutions.

Sample Selection, Preparation and Analysis

Many factors influence the initial gold content of volcanic rocks. These include: 1) gold content of the original source material(s), 2) degree of partial melting and other aspects of magma generation, 3) magma differentiation, mixing and assimilation, and 4) magmatic outgassing at depth and on eruption with possible fractionation of gold into the vapor phase. These factors are presently difficult to quantify. Careful sample selection can, however, minimize or eliminate changes resulting from loss, migration, and/or addition of gold during primary crystallization, or later by circulating hydrothermal fluid or groundwater.

Glassy volcanic rocks, unlike plutonic and crystallized (devitrified) volcanic rocks, are essentially unaffected by circulating fluids during crystallization and cooling, and therefore more closely represent the composition of the magma upon eruption. Halogens and many other elements may be lost from silicic melts and volcanic rocks before, during or shortly after primary crystallization (e.g., Noble et al., 1967; Haffty and Noble, 1972; Stuart et al., 1983; Webster and Duffield, 1991). Studies of fumarolic gases and precipitates (e.g., Symonds et al., 1987; Anderson, 1991) suggest that gold and many other metals may be removed, transported by high-temperature magmatic gases, and concentrated in fumarolic encrustations, including those of "rootless" systems such as the hot pyroclastic flows of the Valley of Ten Thousand Smokes (Zies, 1929; Papike et al., 1991). Keays and Scott (1976) demonstrated that gold is largely lost from fresh, crystallized interiors of ocean-ridge basalt pillows relative to their glassy rims, suggesting crystallization makes gold readily available to solution mobilization. Moreover, devitrified and vapor-phase crystallized silicic volcanic rocks are more readily subject to the addition of various elements, presumably including gold, both during crystallization and from groundwater after crystallization, because of their porosity, the great surface area of the finely crystalline groundmass material and the presence of iron oxides, etc.

For these reasons we have used glassy rocks in preference to primarily crystallized (devitrified) specimens to minimize the effects of possible post-eruption loss and addition of gold. Nonhydrated glassy specimens, which have behaved as completely closed systems since cooling (Rosholt et al., 1971), were used wherever possible. Where such materials were not available, dense hydrated glassy rocks (vitrophyres) free of observable alteration were analyzed. Because of the ubiquity of gold in the home and laboratory, special care was taken to avoid contamination during sample collection and preparation.

Gold contents were determined by XRAL Activation Services, Inc. using procedures similar to those of Rowe and Simon (1968). Neutron activation was done prior to fire-assay collection of gold to eliminate contamination during the fire-assay procedure. Two grams of sample, instead of one as generally used, were analyzed to decrease the effects of sample inhomogeneity and to slightly lower the nominal detection limit of 0.1 ppb. Analyses of a single split of U.S.G.S. standard RGM-1 gave values of 0.61 and 0.67 ppb Au; these agree well with values of from 0.4 to 0.8, mean 0.6 ± 0.05 ppb for three runs on each of six splits of RGM-1 reported by Gottfried et al. (1972). Ten samples were run twice, and most results agreed within 0.1 ppb. A nonhydrated comendite glass analyzed 14 times between August, 1990, and January, 1992, yielded values of from 0.9 to 1.1 ppb Au. Petrochemical affinity was inferred from petrologic and major and minor element data.

RESULTS

A total of 129 samples of tuff and lava, largely from the Great Basin of the western United States, were analyzed. Most were from various centers in southern and northwestern Nevada. Samples also include rocks from the Long Valley and Little Walker volcanic centers, and various centers in the eastern Great Basin, as well as specimens from other regions, including Idaho, Colorado, Ethiopia, Mexico, Peru, and Japan.

Our data indicate that the great majority of silicic volcanic rocks have very low original gold contents (Fig. 1). Most contain considerably less than 1 ppb gold and many, particularly very highly evolved, high-silica subalkaline and peraluminous rhyolites, contain 0.1 ppb or less. Subalkaline high-Si rhyolites, which have low Ca and Fe, have extremely low gold contents, most between <0.1 and 0.3 ppb (Figs. 1A, 2A). The mean and median of 23 samples are about 0.2 ppb and the maximum is 0.6 ppb. Eight peraluminous (S-type and topaz) rhyolites also have uniformly very low gold contents of <0.1 to 0.5 ppb with mean and median values of 0.15 and 0.1 ppb, respectively (Fig. 1A, 2A). This suite includes samples from Spor Mountain and the Honeycomb Hills in west-central Utah (Christiansen et al., 1986) and aluminosilicate-bearing ash-flow tuff and Macusani glass from southeastern Perú (Noble et al., 1984), which contain very high contents of such elements as Li, Rb, Cs, F, Ta, and Nb, but only 0.1-0.2 ppb Au. Low- to medium-silica subalkaline rhyolites, which are less evolved and have higher Fe and Ca have only slightly higher gold contents of from <0.1 to 0.8, mean 0.26 ppb (Fig. 1B, 2B). Iron-rich subalkaline rhyolites (tholeiitic or ferrorhyolites - filled symbols on Fig. 1B) have generally higher gold contents of from 0.4 to 0.8 ppb.

Peralkaline rhyolites contain appreciably more gold. A suite of 37 samples ranges from 0.2 to 4.5, average 1.0 ppb Au (Fig. 1C). However, there is no obvious correlation between *degree* of peralkalinity and gold content. The highest gold values (4.5 and 3.2 ppb) obtained are from slightly peralkaline comendites, whereas pantellerite glasses from Ethiopia and southern Nevada, the highly peralkaline samples, contain only 0.2 ppb and 0.6 ppb Au, respectively.

The silicic rocks can be divided into distinct high- and low-gold groups (Fig. 3). The low-gold group includes subalkaline and peraluminous rhyolites with various silica contents and degrees of evolution (Fig. 3A), which have from <0.1 to 0.7 ppb, average 0.22 ppb Au. The high-gold group includes the peralkaline rhyolites and the iron-rich, nonperalkaline rhyolites and dacites, with Au contents between 0.2 and 4.5 ppb. More than 30 percent of the peralkaline rhyolites have gold contents of 1.0 to 4.5 ppb and 70 percent have 0.6 ppb or more Au. Even the average for the high-gold group of 0.96 ppb Au is much lower than the commonly cited average gold content of silicic volcanic rocks of 3-4 ppb. It should be specifically pointed out that our sampling has markedly overemphasized peralkaline rocks relative to their abundance in nature, and unweighted averaging of our entire data set would produce an overestimation of the average initial gold contents of salic volcanic rocks.

The mean and median of 0.54 and 0.4 ppb Au respectively for 23 relatively silicic intermediate rocks (Fig. 1D), are slightly higher than those for subalkaline and peraluminous silicic rocks. The higher gold concentrations are generally found in rocks with tholeiitic affinity, with iron-rich tholeiitic andesites (icelandites) being somewhat higher in gold than calc-alkalic types (Fig. 1D). Five specimens of icelandite from the McDermitt caldera complex (Wallace et al., 1980) and three specimens from the High Rock Canyon icelandite-ferrodacite field, northwestern Nevada, have a mean value of 0.8 ppb. Similar relatively high gold contents have been found in the Fe-rich differentiates of Tertiary basalts in Iceland (Zentilli et al., 1985).

Correlation Between Petrochemistry and Gold Content:

There is a general trend of increasing gold with increasing iron but iron content alone does not allow prediction of the gold content of a rock. A better correlation is obtained when both Ca and Fe are used. Figure 2 is the same type of plot used by Warshaw and Smith (1988), but with logarithmic axes to better display samples with low Fe and Ca. The diagrams show a distinct division between rock types, with a general increase in gold content with increasing FeO/CaO. The subalkaline and peraluminous rhyolites plot in the lower portion of the diagram, and the peralkaline rocks in the upper left, reflecting their higher iron contents and higher Fe/Ca ratios. Warshaw and Smith (1988) demonstrated a general trend of decreasing fO_2 with increasing FeO/CaO; the importance of low fO_2 in stabilizing gold in melts can be inferred from the higher gold contents of the peralkaline and tholeiitic subalkaline rocks. When evaluated in detail, relations may prove more complicated. For example, the compositionally complex Summit Lake Tuff in NW Nevada (Noble et al., 1970) shows no simple relationship between major element chemistry and gold content.

Regional Variations in Initial Gold Content

The gold contents of the silicic volcanic rocks analyzed in this study are consistently low, irrespective of geographical location. The gold contents of specimens from Colorado (0.5 and 0.1 ppb), Mexico (0.08 and 0.16 ppb), Peru (9 rocks with Au from 0.1 to 1.2, avg. 0.4 ppb), Japan (0.36 ppb) and Ethiopia (0.2 ppb) correspond well with samples of similar composition from the western U.S. (both this study and Gottfried et al., 1972). The data give no indication that the low gold concentrations seen in the western United States are a regional phenomena as suggested by Crocket (1991).

Sample suites from northwest Nevada and the Southwest Nevada volcanic field provide a measure of the influence of differences in regional geology on gold contents. Sr and Nd isotope data suggest that volcanic rocks in northwest Nevada have little or no crustal component (Tegtmeyer and Farmer, 1987) whereas volcanic rocks in southwest Nevada show evidence of a considerable crustal component (Farmer et al., 1991). The major differences between the average gold contents of rocks from the two regions (Fig. 4) are largely explained by the much higher ratio of peralkaline to nonperalkaline rhyolite in northwestern Nevada. We conclude that although regional setting may exert some subtle influence on gold content, the most important control appears to be petrologic affinity. Even in the NW Great Basin, where Neogene silicic volcanic rocks are closely associated in space and time, and probably genetically, with large volumes of continental flood basalts, which as a group appear to have higher gold contents than other basalts (Gottfried et al., 1973; Bird et al., 1991), four nonperalkaline rhyolites have gold contents of only 0.1, 0.2, 0.25, and 0.36 ppb. In our suite of silicic rocks, variations with regional setting are evident only in the dominance of particular petrologic types.

Controls on gold content

Our data suggest that the elevated gold contents of many peralkaline rocks is largely a function of the compatible behavior of gold in peralkaline melts, although mixing and perhaps wall rock assimilation may account for the higher than average gold concentrations of some samples. That significant amounts of gold can be carried in slightly peralkaline rhyolite melts is demonstrated by 15 specimens of aphyric, nonhydrated comendite obsidian from northwestern and southern Nevada that contain from 0.6 to 4.5 ppb Au. Also, densely welded, phenocryst-rich glassy tuff from the Soldier Meadow Tuff, NW Nevada (Korringa, 1973), contains 0.6 ppb Au, whereas nonhydrated glassy groundmass material from the rock contains 0.9 ppb Au.

The relatively high gold contents of the peralkaline rhyolites may reasonably be explained by retention of gold in the residual liquid during phenocryst separation in a manner similar to that generally accepted for the elevated Fe, Zr, REE, Nb, etc., contents of such rocks (e.g., Noble, 1968; Mahood and Hildreth, 1983). Zentilli et al. (1985) show that Au correlates positively with Y, Zr and other indicators of differentiation, and suggest that Au has been systematically partitioned into the evolving melt. Conversely, the extremely low gold contents of many high-silica nonperalkaline rhyolites would appear to require removal of the gold during differentiation (Tilling et al., 1973), and/or during degassing.

A fundamental control of the different gold contents of these two types of silicic rocks therefore appears to be melt structure. High-silica rhyolites, containing small amounts of Ca and Fe, are highly polymerized and a wide range of minor elements, apparently including gold, are not accommodated. Higher contents of network-modifying cations, particularly iron and alkalies in excess of that required to balance the aluminum present, as well as water and halogens, depolymerize silicate melts. This markedly reduces the partition coefficients of minor elements between the melt and the separating crystal (Drexler et al., 1983; Mahood and Hildreth, 1983) and presumably also immiscible melt phases. Gold content will be controlled by the amount and timing of separation of mineral phases capable of siting gold, such as Fe oxides, and of sulfide melt and perhaps liquid metal phases (Bornhorst and Rose, 1986; Bird et al., 1991), as well as by the degree to which gold is accommodated within the melt. Another major control may be volatile loss, which would effectively remove gold and other metals strongly partitioned into the vapor phase (e.g., Symonds et al., 1987; Lowenstern et al., 1991).

DISCUSSION AND CONCLUSIONS

Initial gold contents of silicic volcanic rocks, irrespective of geographical location, are lower than indicated in much of the geochemical literature. Fresh, glassy volcanic rocks typically have original gold contents much lower than the 4 ppb commonly quoted for igneous rocks. Average values range from about 0.15 ppb for peraluminous rhyolites to about 1.0 ppb for peralkaline rhyolites. Our results are much lower than those reported in the Russian literature (e.g., Korobeynikov, 1989) and average values given in geochemical texts and reviews (Table 1). These higher values reflect, we believe, the addition of small but significant amounts of gold to older and probably altered rocks. Indeed, it is likely that some of the Cenozoic silicic volcanic rocks analyzed by Gottfried et. al (1973) contain gold added by post-depositional processes.

Original gold content of silicic volcanic rocks appear to depend more on petrochemical type and degree of differentiation/evolution than on regional setting. Rocks with high Fe contents and Fe/Ca ratios have generally higher gold contents than rocks of more calc-alkalic character (Fig. 2). We speculate that this is largely due to differences in melt structure and fO_2 and the amount and timing of separation of crystal, liquid sulfide and metal (?), and volatile phases.

High-silica subalkaline rhyolites appear to be poor sources of gold for the formation of gold deposits. Very large volumes of rock would have to be leached by hydrothermal solutions.

Economic epithermal deposits in subalkaline silicic terranes would appear to require contributions of gold from other, more gold rich, igneous or sedimentary rocks and/or from known or inferred intrusive bodies that drove the hydrothermal systems.

Peralkaline silicic rocks, other iron-rich silicic and intermediate rocks, and mafic rocks (Gottfried et al., 1973) are more viable potential sources of gold. Mafic rocks and magmas are the only possible source material in deposits such as those on Lihir Island, Papua New Guinea (Moyle et al., 1990), and are attractive sources in continental areas with coeval large-volume basaltic magmatism (Noble et al., 1988). Certain deposits, for example Hog Ranch in northwestern Nevada, and prospects in the Challis volcanic field, Idaho, are associated in time and space with peralkaline rhyolite and ferrorhyolite (Harvey et al., 1986; Hardyman and Fisher, 1985; Hardyman and Noble, 1989). However, even the relatively gold-rich peralkaline rocks analyzed in this study contain very modest absolute concentrations of gold. The lack of an obvious preferential association of gold mineralization with volcanic fields dominated by peralkaline and subalkaline Fe-rich volcanic rocks, combined with the close association of Au$\pm$Ag mineralization with high-level magmatic (porphyry) systems, argues that factors such as contents of halogens, sulfur, water, etc., higher initial gold, and fO_2 conditions of magmas, are more important than volcanic rock type in controlling gold availability to hydrothermal systems in volcanic terranes. The common association of pronounced gold anomalies with intrusive related hydrothermal systems, the occurrence of hypogene porphyry ores containing $\geq$ 0.3 ppm Au, and evidence for the existence of metal-rich salic melts (e.g., Wilson 1978) all suggest the existence of atypical silicic to intermediate magmas with much higher gold contents. Indeed, silicic magmas may, in general, initially contain much higher concentrations of gold than observed in volcanic rocks, with a large fraction of this gold being removed, transported and possibly reconcentrated by magmatic degassing during and/or prior to eruption.

The very low initial gold content of most rhyolites make rocks and alluvium in silicic volcanic terranes very sensitive to the addition of small amounts of gold by groundwater as well as by hydrothermal solutions. Such terranes will be particularly amenable to ultra-low detection limit soil and rock geochemical surveys. Low-level anomalies have the potential to delineate structural features that may have controlled addition of gold by post-depositional processes that include upward migration as volatile complexes during primary cooling, and migration in surface and groundwater as well as by hydrothermal activity.

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ACKNOWLEDGEMENTS

Various aspects of this study were supported by the Geological Society of America, Mackay Minerals Research Institute, WAIIME, Nevada Nuclear Waste Project Office, and the U. S. Geological Survey Reno Field Office. Western Mining Corporation allowed access to samples and data from the Hog Ranch Mine, Eric Christiansen and Jeff Keith guided in sampling topaz rhyolites in west-central Utah, and Paul Lechler assisted with major-element analyses.

FIGURE CAPTIONS

Figure 1. Cumulative plots showing distribution of gold contents for different rock types. A: subalkaline high-silica rhyolite and peraluminous rhyolite (solid symbols), B: subalkaline low- to medium-silica rhyolite, C: peralkaline rhyolite, and D: rocks of intermediate composition. Solid symbols in 1B and 1D indicate iron-rich (tholeiitic) specimens.

Figure 2. Gold content as a function of Ca and Fe. A: high-silica rhyolites and peraluminous rhyolite, B: low- to medium-silica rhyolite and, C: peralkaline rhyolite.

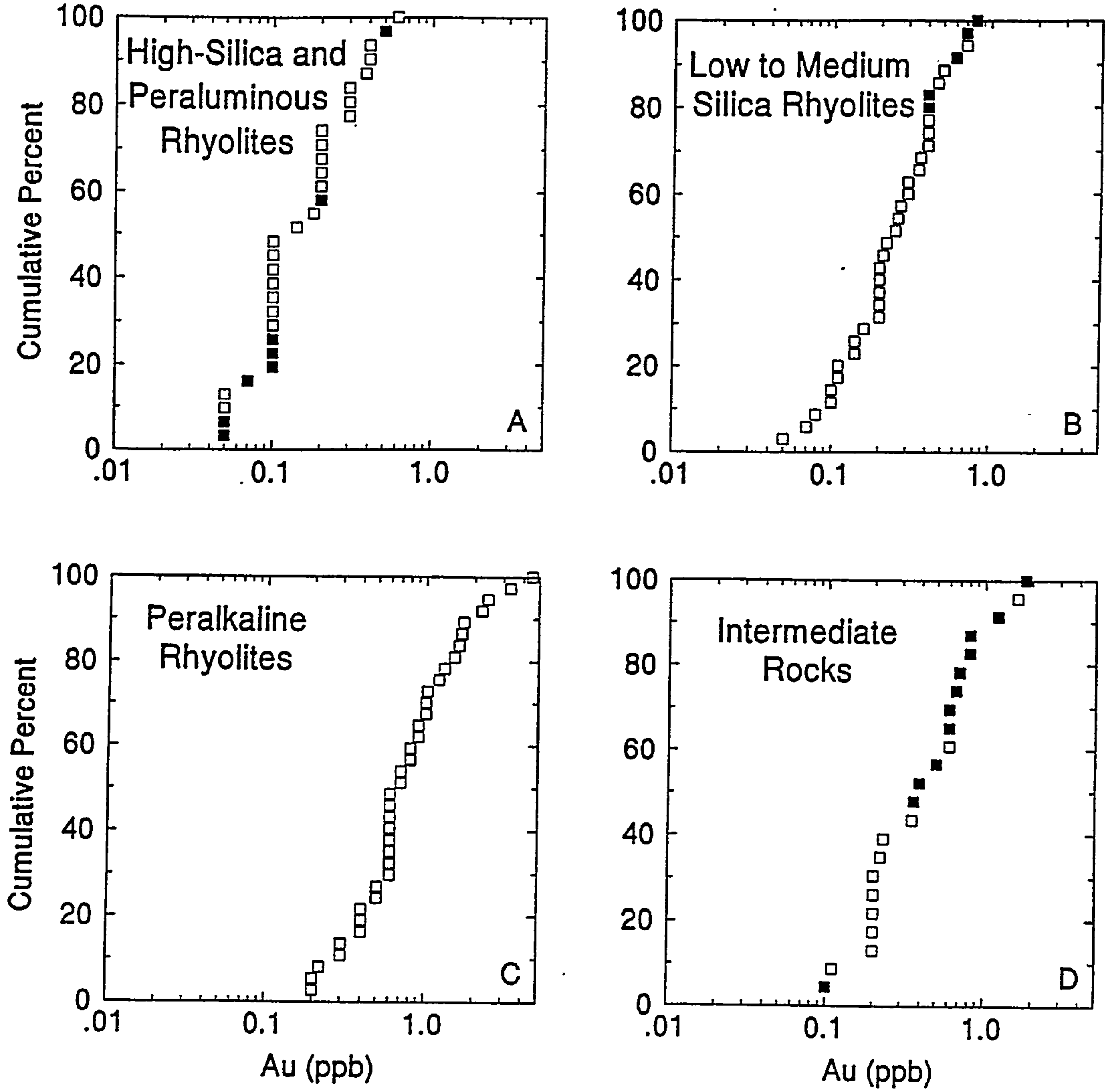
Figure 3. Histograms of samples from the 'low gold' and 'high-gold' groups of silicic volcanic rocks. A: low-Fe subaluminous and peraluminous rhyolite, B: peralkaline rhyolite, ferrorhyolite and ferrodacite.

Figure 4. Cumulative frequency diagram for all samples from northwest and southwest Nevada, showing a comparison of the distribution of gold contents for the two regions. Solid symbols indicate peralkaline samples, symbols with cross-bars represent intermediate composition samples.

Table 1 -- Average Gold Contents of Silicic Volcanic Rocks Given in Review Papers and Texts

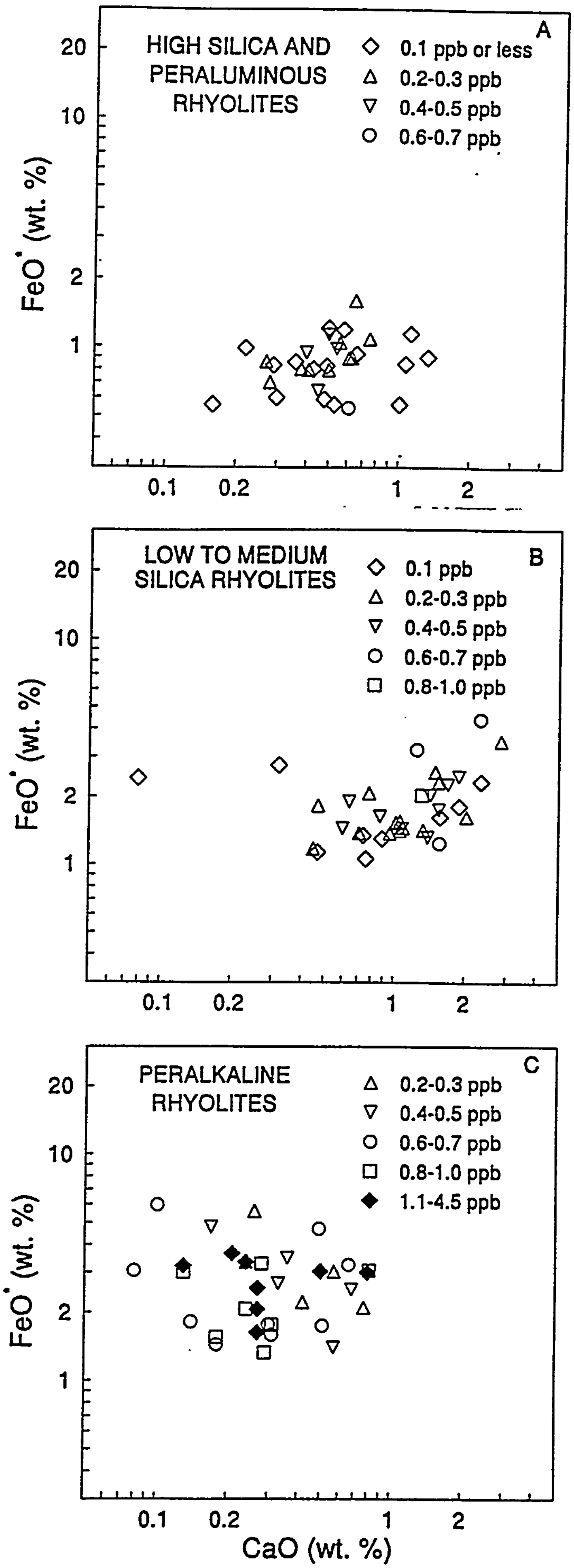
TABLE 1. AVERAGE GOLD CONTENTS OF SILICIC VOLCANIC ROCKS GIVEN IN REVIEW PAPERS AND TEXTS

Source and date	Rock Type/Suite	Au range, ppb	Au avg., ppb	No. of samples
Allman and Crocket (1978)	silicic volcanic rocks from various regions and averaged from various sources	1.0-3.5	1.8	11
		none given	1.79	2
		0.1-2.8	0.6	21
		0.4-5.5	2.3	4
Rose et al. (1979)	granitic	none given	2.3	??
Boyle (1979)	rhyolite, obsidian, etc.	0.1-113.0	3.7	372
Levinson (1980)	felsic igneous	none given	4.0	??
Romberger (1988)	rhyolite	0.5-3.5	1.5	188
Crocket (1991)	felsic volcanic rocks	none given	1.55	??



High-Silica and Peraluminous Rhyolites
A
Low to Medium Silica Rhyolites
B
Peralkaline Rhyolites
C
Intermediate Rocks
D
Cumulative Percent
Au (ppb)
100
80
60
40
20
0
.01
0.1
1.0

Figure 1.



HIGH SILICA AND PERALUMINOUS RHYOLITES
A
0.1 ppb or less
0.2-0.3 ppb
0.4-0.5 ppb
0.6-0.7 ppb
FeO* (wt. %)
LOW TO MEDIUM SILICA RHYOLITES
B
0.1 ppb
0.2-0.3 ppb
0.4-0.5 ppb
0.6-0.7 ppb
0.8-1.0 ppb
PERALKALINE RHYOLITES
C
0.2-0.3 ppb
0.4-0.5 ppb
0.6-0.7 ppb
0.8-1.0 ppb
1.1-4.5 ppb
CaO (wt. %)

Figure 2.

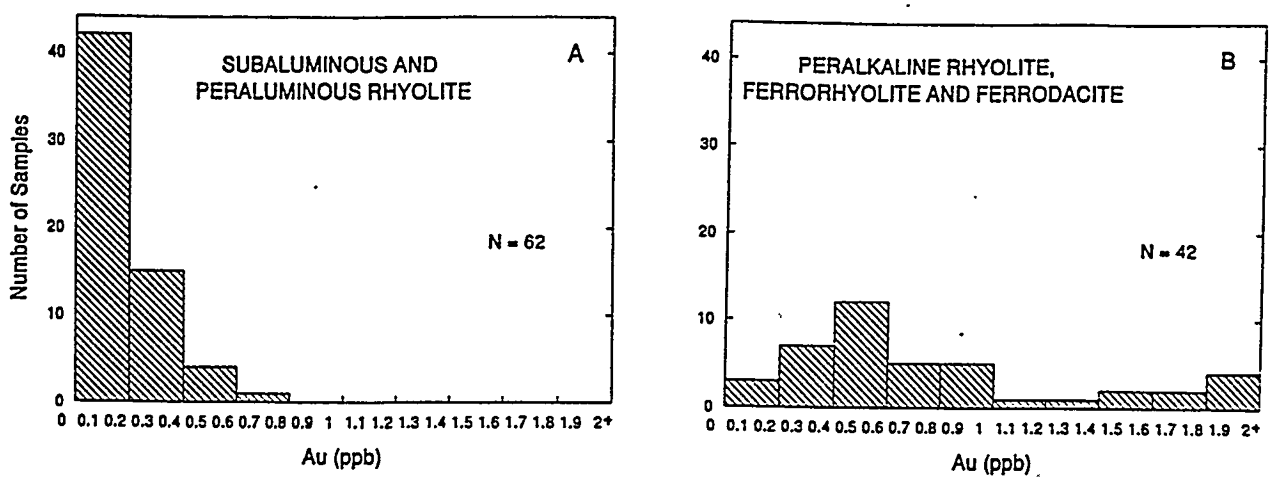


Figure 3.

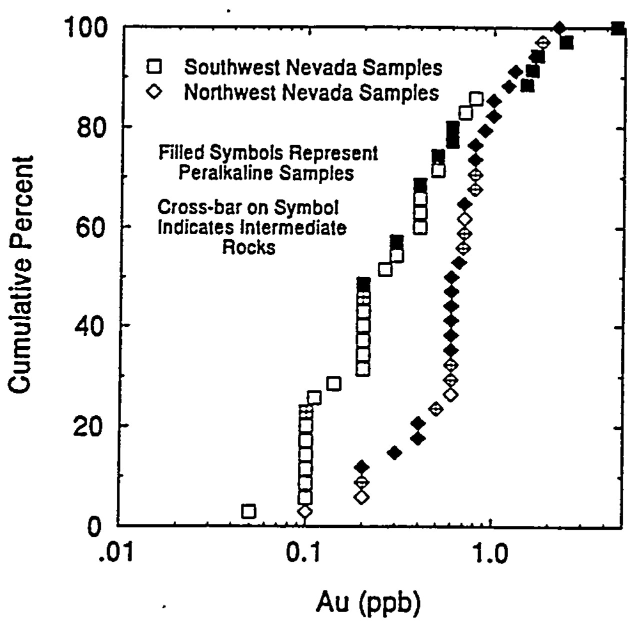


Figure 4.

YEARLY REPORT

YUCCA MOUNTAIN PROJECT

TASK 4

October 1, 1991 to Sept 30, 1992

James N. Brune

SUMMARY OF PROPOSED ACTIVITIES: We proposed to (1) Develop our data logging and analysis equipment and techniques for analyzing seismic data from the Southern Great Basin Seismic Network (SGBSN), (2) Investigate the SGBSN data for evidence of seismicity patterns, depth distribution patterns, and correlations with geologic features (3) Repair and maintain our three broad band downhole digital seismograph stations at Nelson, Nevada, Troy Canyon, Nevada, and Deep Springs, California (4) Install, operate, and log data from a super sensitive microearthquake array at Yucca Mountain (5) Analyze data from micro-earthquakes relative to seismic hazard at Yucca Mtn.

SUMMARY OF ACTIVITIES

(1) Continued activities to upgrade the CUSP data logging for eventual use on Yucca Mountain data.

(2) Maintained 3 broadband stations. Re-installed seismometers. Sent Nelson control unit to England for external repairs (after vault flooding). Received digitally recorded data.

(3) Continued to operate the 4-station microearthquake array at Yucca Mountain.

(4) Continued analysis of the Szymansky and Archambeau-Price reports.

(5) Attended workshops on seismic hazard in Santiago Chile and Mexico City.

(6) Began work on a system to estimate magnitudes from microearthquake data.

(7) Received and analyzed paper by Gomberg on the strain pattern in southern Nevada.

(8) Visited Univ. of California, San Diego, to discuss use of digital seismic arrays for seismic hazard and seismic source mechanism studies. Consulted with colleagues about future of proposed strain meter installation at Yucca Mountain.

(9) Attended meetings of Seismological Society of America, Santa Fe. Presented paper on precarious rocks at Yucca Mtn.

(10) Published paper on microearthquakes at Yucca Mountain, Nevada (see attached reprint).

(11) Investigated possible causes for bias in magnitude between Northern Nevada Network and SGBSN.

(12) Filtered selected SGBSN stations to duplicate Yucca Mtn. microearthquake response in order to check high frequency noise level of SGBSN stations.

(13) Made repairs on Nellis Boundary microearthquake station.

(14) Copied selected microearthquake records from Yucca Mtn. region.

(15) Studied microearthquakes triggered in southern Nevada region by Landers, CA, (see attached abstracts).

(16) Studied micro-earthquakes associated with Little Skull Mtn. earthquake.

(17) Studied rocks dislodged by Little Skull Mtn. earthquake.

PUBLICATIONS

Microearthquakes at Yucca Mountain, Nevada, James N. Brune, Walter Nicks, and Arturo Aburto, Bull. Seismol. Soc. Am., vol. 82, no. 1, 164-174, 1992.

Real Time Analog and Digital Data Acquisition through CUSP, William A. Peppin, Seis. Res. Lett., submitted 1991.

1992 AGU Abstracts:

Distribution of Precariously Balanced Rocks in Nevada and California: Correlation with Probability Maps for Strong Ground Motion by J. Brune.

Seismicity in Nevada Apparently Triggered by the Landers, California Earthquake, June 28, 1992 by J.G. Anderson, J. Louie, J. Brune, D. dePolo, M. Savage and G. Yu.

Remote Seismicity Triggered by the M 7.5 Landers, California, Earthquake of June 28, 1992 by J. Brune et al.

MEETINGS, WORKSHOPS

Gave invited papers at Santiago, Chile and Mexico City.

PROGRESS REPORT--OCTOBER 1, 1991 TO SEPTEMBER 30, 1992

TASK 5 Tectonic and Neotectonic framework of the Yucca Mountain Region

Personnel

Principal Investigator: Richard A. Schweickert

Research Associate: Mary M. Lahren, October 1, 1991 to March 31, 1991

Graduate Research Assistants:

a. Zhang, Y.--October, 1991-September, 1992

Part I. Highlights of major research accomplishments

a. Structural studies in Grapevine Mountains, Bullfrog Hills, and Bare Mountain

b. Acceptance for publication of manuscript submitted to Tectonics on Mesozoic thrust belt by S.J. Caskey and R. A. Schweickert

c. Publication of one abstract based upon research funded under Task 5: Zhang and Schweickert (1992).

d. Recognition of significance of pre-Middle Miocene normal and strike-slip faulting at Bare Mountain (Yang Zhang)

e. Compilation of map of Quaternary faulting in southern Amargosa Valley (M.M. Lahren)

f. Preliminary paleomagnetic analysis of Paleozoic and Cenozoic units at Bare Mountain (Yang Zhang, S. Gillette, and R. Karlin).

Part II. Research projects

This section highlights the research projects conducted by Task 5 personnel.

1. *Regional overview of structure and geometry of Mesozoic thrust faults and folds in the area around Yucca Mountain*; R. A. Schweickert.

The purpose of this study is to provide information about the deep structural geometry of Paleozoic units and their bounding faults, which is necessary both for understanding of Tertiary faults and for the correct formulation of regional hydrologic models. It has also provided evidence for a previously unknown strike-slip fault beneath Crater Flat, and for the existence of major pre-Middle Miocene extension in the NTS region. The study involves new field work in selected areas and a synthesis of structural relations in areas both east and west of Yucca Mountain, including the CP Hills-Mine Mountain area to the east, and Bare Mountain-Bullfrog Hills-Grapevine Mountains to the west.

2. *Kinematic analysis of low and high angle normal faults and strike-slip faults in the Bare Mountain area, study of metamorphic rocks, and comparison of structures with the Grapevine Mountains* Y. Zhang and R. Schweickert

The purpose of this study is to determine the timing and slip directions of high and low-angle normal faults exposed at Bare Mountain, which is a direct analogue of the deep structure beneath Yucca Mountain. This will provide better constraints on the displacement histories of the faults. In addition, metamorphic fabrics are being studied in metamorphic rocks in the northern parts of the mountain and traced to lower grade rocks in the southern part of the mountain. Finally, the development of these structures is compared with possible analogues in the Grapevine Mountains and the CP Hills to develop firm constraints on the deep structure beneath the Yucca Mountain area.

3. *Evaluation of pre-Middle Miocene structure of Grapevine Mountains and its relation to Bare Mountain.* R. Schweickert and M.M. Lahren

The goal of this project is to establish the Mesozoic and Cenozoic structural geometry and timing of deformation in the Grapevine Mountains, which developed in close proximity to the Bullfrog Hills and Bare Mountain areas, prior to post-10 Ma displacement on the Bullfrog Hills-Boundary Canyon detachment fault. This study is clarifying the significance of pre-Middle Miocene and possibly pre-Tertiary extension and detachment faulting on crustal structure in the area between the NTS and Death Valley, and beneath Yucca Mountain.

4. *Evaluation of paleomagnetic character of Tertiary and pre-Tertiary units in the Yucca Mountain region, as tests of the Crater Flat shear zone hypothesis and the concept of oroclinal bending.* S. Gillett, R. Karlin, Y. Zhang, and R. A. Schweickert.

Paleomagnetic data from various volcanic units at Yucca Mountain show that up to 30° of progressive north-to-south clockwise rotation has occurred since mid-Miocene. These studies are geographically relatively limited; one of the goals of this study is to expand the data base to various Paleozoic and Mesozoic units to understand the regional variations of magnitude and timing of rotations.

5. *Late Quaternary fault patterns in southern Amargosa Valley, Stewart Valley, and Pahrump Valley.* M.M. Lahren and R.S. Schweickert.

This project involves the compilation of all available data on the distribution and style of late Quaternary faults in the region, primarily from mapping by Donovan and Hoffard (M.S. Theses completed under Task 5) and USGS mapping. This compilation will reveal the nature of the late Quaternary structural setting of Yucca Mountain. Field checking of certain key areas is required.

6. *Tectonics and Neotectonics of the Pahranagat shear zone, Lincoln County, Nevada;* (R. Elwood and T. Reynolds, formerly supported here, have both left UNR but still plan to complete their studies).

The rationale for this study has been that the Pahranagat shear zone lies on trend with the Spotted Range - Mine Mountain structural zone, which is composed of seismically active, ENE-striking, sinistral faults, and which lies immediately south of Yucca Mountain. Studies of the Pahranagat shear zone have been undertaken to evaluate whether the two zones are parts of a related zone of crustal weakness that may be active.

In addition, the Pahranagat shear zone shows clear evidence that shortening occurs within the Basin and Range province. Such shortening may be manifest as thrust earthquakes and (or) as shortening through aseismic folding. Elwood's part of this project was completed in 1991, and her thesis report is in progress.

Part III.

Brief summaries of research results during FY 1992

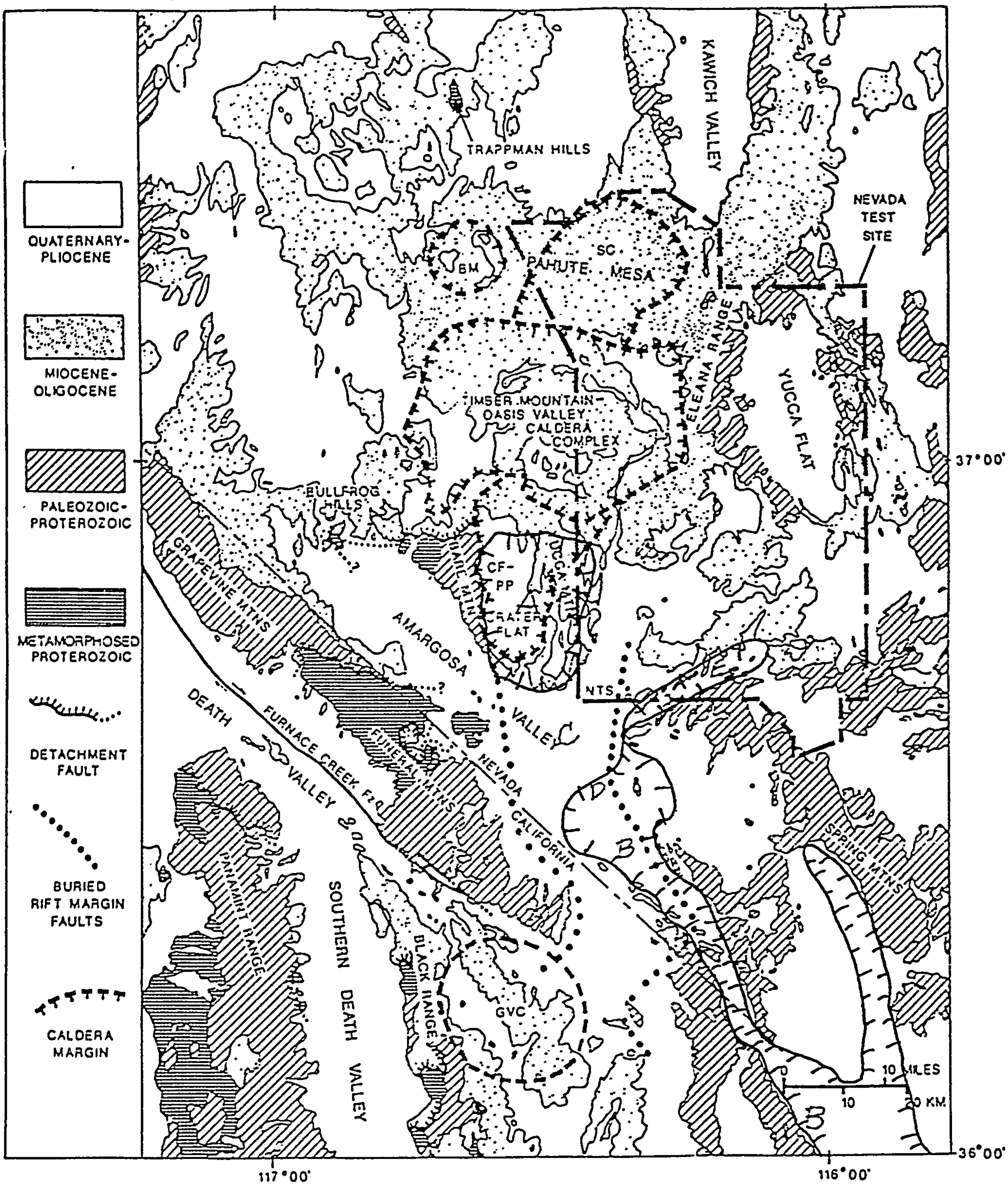
This section presents a summary of progress to date. Because these projects are long-term and field-intensive, the results are still preliminary, and should not be quoted without permission. Many of our interpretations are speculative.

1. Quaternary fault patterns and basin history of Pahrump and Stewart Valleys, Nevada and California. (See attached map, Figure 1).

Our map is preliminary and requires field checking in a number of areas, but it clearly indicates that Late Quaternary faults at Yucca Mountain (area A, Figure 1) lie along strike with an 80+ km-long, continuous zone of NNW-striking late Quaternary strike-slip and normal faults (B, Figure 1) in the southeastern part of Amargosa Valley and in Stewart and Pahrump Valleys, that represents the principal zone of late Quaternary fault movements in the area east of Death Valley. These faults are distinctly east of, and are not connected to, the Death Valley-Furnace Creek fault zone. These facts indicate that the fault patterns at Yucca Mountain are a manifestation of a regional strain pattern involving NW-trending strike-slip displacements and associated NS-striking normal faults. A 10-mile wide gap exists in this zone of surface faults between the southern end of Yucca Mountain and the southeastern end of Amargosa Valley (C, Figure 1), and this coincides with the area of late Holocene outwash from Forty-Mile Canyon to the northeast.

Near the northern end of the zone of faulting in southern Amargosa Valley (D, Figure 1), northeast-striking faults apparently related to the Rock Valley fault zone to the northeast (E, Figure 1), occur in association with north and northwest-striking faults. The interaction of northeast- and northwest-striking faults is not understood.

Our preliminary tectonic model is that normal faults in Crater Flat and at Yucca Mountain are related to a major late Quaternary pull-apart zone in the northwest-striking strike-slip system (see Figure 2).



Generalized geologic map of the Nevada Test Site region, showing relation of caldera complexes, Greenwater volcanic center, and rift zone to metamorphic rocks and detachment structures. BM—Black Mountain caldera; SC—Silent Canyon caldera; CF-PP—Crater Flat-Prospector Pass caldera complex; GVC—Greenwater volcanic center. Buried rift margin faults shown are based on presence of steep, linear gravity gradients.

Figure 1. Modified from Carr (1990). Zones of late Quaternary normal and strike slip faulting (A, B, D, and E) are outlined.

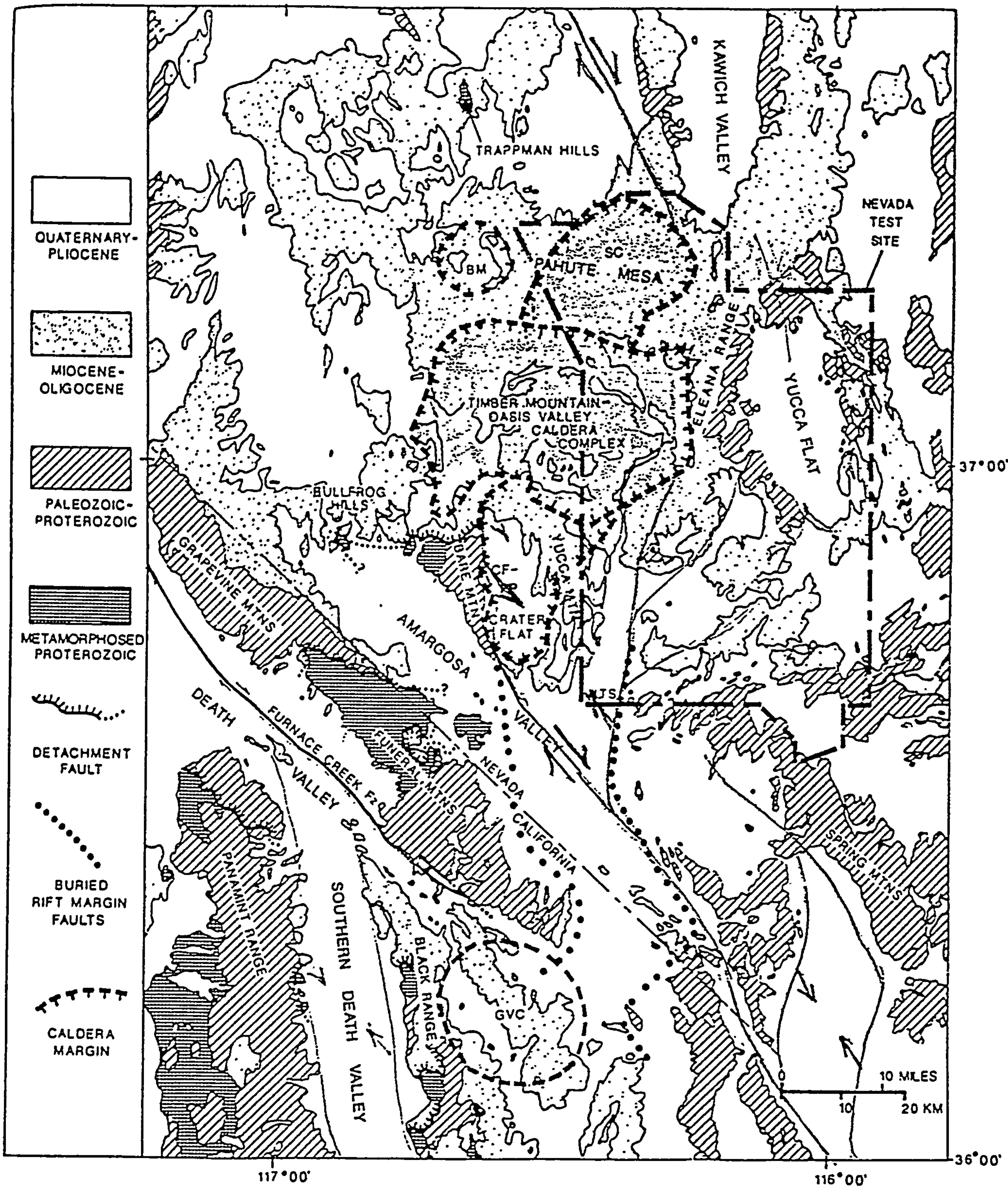


Figure 2. Modified from Carr (1990). Tectonic model of late Quaternary faulting in the Pahrump Valley-Yucca Mountain region. Yucca Mountain and Crater Flat are viewed as lying within a large right-step pullapart zone in a northwest-trending zone of right-lateral faulting. These features evolved since Middle Miocene time and are currently active.

2. *Regional overview of structure and geometry of Mesozoic thrust faults and folds in the area around Yucca Mountain.* R. A. Schweickert.

(See preprint by Caskey and Schweickert; Appendix 1).

3. *Evaluation of pre-Middle Miocene structure of Grapevine Mountains and its relation to Bare Mountain.* R. Schweickert and M.M. Lahren. (see Figure 3).

New field work and map-scale structural analysis has confirmed that the Oligocene Titus Canyon Formation unconformably overlaps a major detachment fault system related to the Titus Canyon fault (as mapped by Reynolds (1969))(Figure 3). We documented four localities in Titanothere and Titus Canyons and south of Daylight Pass in which conglomerate and sandstone of the Titus Canyon Formation lies in unmoved depositional contact on Cambrian rocks in upper and lower plate positions relative to the Titus Canyon fault. The basal conglomerate commonly contains highly polished 1-3m boulders of Zabriskie Quartzite in a sandy conglomerate matrix, all resting on Cambrian rocks. We also recorded kinematic indicators on several segments of the Titus Canyon fault that indicate top to the east displacements. Finally, in the lower part of Titus Canyon, we discovered that the Miocene Hall Canyon fault is a high-angle fault that cuts across the trace of the older, low-angle Titus Canyon fault.

As noted previously, the Titus Canyon fault (Figure 3) is a detachment fault that excises the upright limb of a major Mesozoic recumbent fold, the Titus Canyon anticline, and has a structural relation similar to that of the Wildcat Peak normal fault at the southern end of Bare Mountain, and the Conejo Canyon fault at the north end of Bare Mountain. The former excises the upright limb of a large recumbent anticline in the hangingwall of the Panama thrust (as mapped by Monsen and others (1990)).

The Titus Canyon fault is undated, but is pre-Titus Canyon Formation, and could even be of Late Cretaceous age. Existing data suggests that the Late Miocene Fluorspar Canyon-Bullfrog-Boundary Canyon detachment system (Figure 3) pulled apart and exposed elements of a much older detachment system, which includes the Titus Canyon fault, the lower detachment fault in the Bullfrog Hills, and the Conejo Canyon and Wildcat Peak faults at Bare Mountain. New work at Bare Mountain by Y. Zhang indicates that this older detachment system was largely

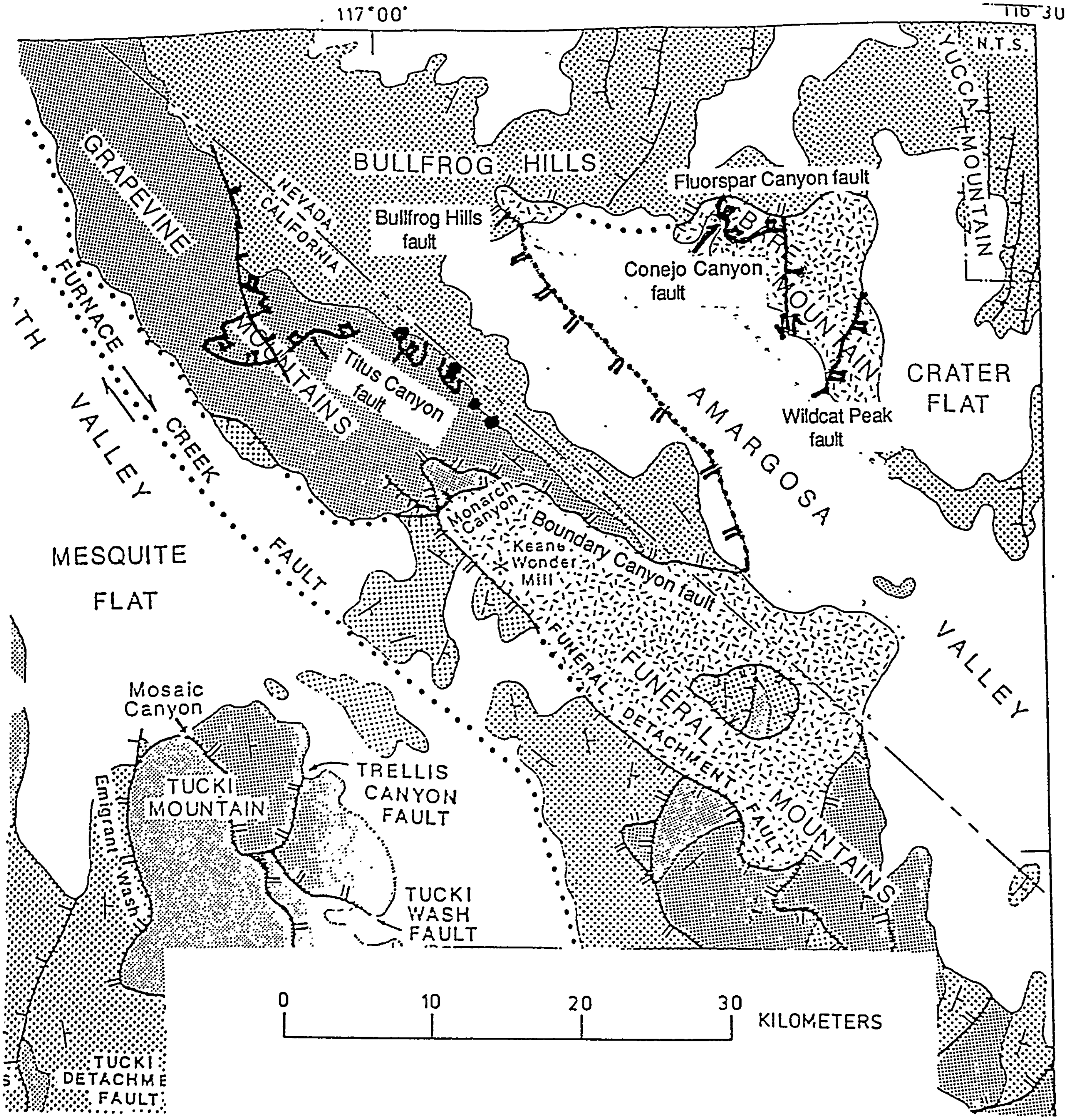


Figure 3. Modified from Hamilton (1988). Map showing post-10 Ma Boundary Canyon-Bullfrog Hills-Fluorspar Canyon detachment fault and remnants of Oligocene or older detachments, including Titus Canyon fault, Conejo Canyon fault, and Wildcat Peak fault. If the post-10 Ma detachment system were restored, the Titus Canyon fault would be located immediately west of Bare Mountain, and in close proximity to the Conejo Canyon and Wildcat Peak faults.

responsible for the exhumation of deep metamorphic rocks at northern Bare Mountain, Bullfrog Hills, and the Funeral Mountains, and that these metamorphic rocks were already exposed at high structural levels when ash flow tuffs of the Southwest Nevada Volcanic Field were erupted.

Structural relations in the western part of the Bullfrog Hills suggest that a portion of the Grapevine thrust is exposed where Ordovician carbonates rest upon Mississippian clastic rocks. To account for this segment of the Grapevine thrust, displacement on pre-Middle Miocene faults like the Titus Canyon fault must be invoked.

Implications of this study for Yucca Mountain are that pre-Middle Miocene detachment faults are very likely to occur beneath the volcanic section, and have probably disrupted and extended the Paleozoic section at depth. The combination of Mesozoic thrusts, pre-Middle Miocene detachment faults, and post-13 Ma faults at Yucca Mountain most likely indicates the impossibility of constructing accurate cross-sections of Paleozoic aquifers and aquitards beneath Yucca Mountain.

4. Kinematic analysis of low and high angle normal faults in the Bare Mountain area, and comparison of structures with the Grapevine Mountains Y. Zhang. (see Figure 4)(also see attached abstract by Zhang and Schweickert; Appendix 1).

A complete section of upper Precambrian through Mississippian sedimentary strata is well exposed at Bare Mountain. These rocks are involved in numerous folds, low- and high-angle faults, and strike-slip faults. Field relations indicate that many of these structures are pre-Middle Miocene in age. Thus, Bare Mountain provides an important window into the deep structures of Paleozoic rocks that lie beneath Yucca Mountain.

Research Activity

Two periods were spent in the field at Bare Mountain and vicinity, January 7 - 18 and June 1 - 7, 1992, respectively.

Structural mapping of fault-related structures at Bare Mountain was performed at a scale 1:24,000, incorporating published geologic maps of Bare Mountain. The northern part of Bare Mountain, which exposes complex structures, was selected as a key area for detailed mapping at scale of 1:12,000.

Field work also included reconnaissance in the Grapevine Mountains

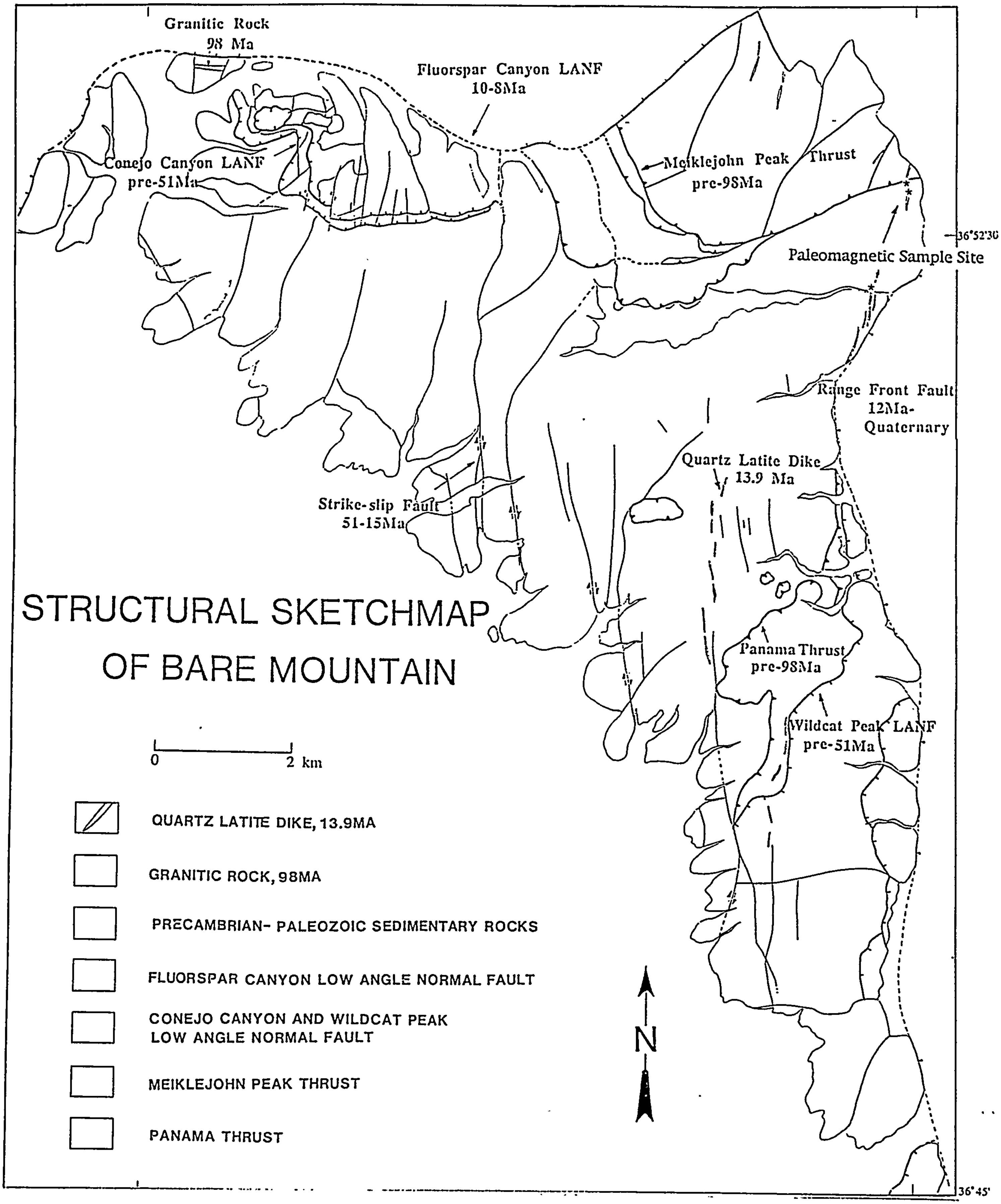


Figure 4. Structural sketchmap of Bare Mountain showing fault types, timing of faults and relations of various structures recognized at Bare Mountain.

of the Death Valley region with R.A. Schweickert and M.M. Lahren.

Samples of metamorphic rocks and fault rocks were collected for micro-structural analyses. Thin sections were made and were investigated for deformation styles. Both brittle and ductile deformation have been documented in various faults at Bare Mountain.

Samples also were collected from metamorphic rocks and diorite dikes that intruded Precambrian and Cambrian metasedimentary rocks for U-Pb and Ar-Ar geochronologic dating. Unfortunately, the sample of diorite cannot be dated by the U-Pb method because of a lack of zircon in the rocks. Other options will be tried with the sample.

Geologic map compilations and cross-section constructions on the basis of field data and air-photo information are approximately half complete. These maps and sections will show the structural patterns and Mesozoic and Cenozoic geologic history of Bare Mountain. Preliminary results are:

Summary

On the basis of structural studies at Bare Mountain, my main conclusions are listed below.

1. Pre-Tertiary thrusts exist at Bare Mountain (Figure 4), as shown by Monsen and others (1990). The Panama thrust is north-vergent and the Meiklejohn Peak thrust is south-vergent. North-vergent large scale folds occurring throughout the footwall of the Panama thrust and south-vergent folds in the footwall of the Meiklejohn Peak thrust are compatible with north-south shortening that resulted from Mesozoic deformation.

2. Two different ages of detachment faults have been distinguished at Bare Mountain. An older detachment fault (Conejo Canyon detachment fault) is exposed in the footwall of the Fluorspar Canyon detachment fault (7.5 - 10 Ma) in the northern part of Bare Mountain. The Conejo Canyon detachment fault was responsible for the denudation of amphibolite-facies metamorphic rocks at the northwestern end of Bare Mountain. Kinematic and structural data indicate that the Conejo Canyon detachment fault roots to the south. Still earlier high-angle faults, some possibly strike-slip faults, predate the Conejo Canyon fault. Published K-Ar ages from metamorphic rocks in the footwall of the Conejo Canyon detachment fault suggest that the unroofing and detachment faulting occurred in pre-Miocene times.

3. North-south striking and east-dipping oblique-slip faults became

active with most right oblique displacement prior to 14 Ma. Minor younger displacement has cut the 14 Ma dikes. These faults truncated both the Mesozoic thrust faults and the pre-Miocene detachment faults. Kinematic indicators indicate east-side-down oblique displacement on the larger faults, which further implies that rocks in the central part of Bare Mountain have been downdropped from the upper plate of the Conejo Canyon fault. If so, the Conejo Canyon fault roots at depth beneath the southern parts of Bare Mountain and the Wildcat Peak fault lies structurally above the Conejo Canyon fault. Some east-dipping faults are overlapped by 15 Ma volcanic rocks at the north end of Bare Mountain.

5. Evaluation of paleomagnetic character of Tertiary and pre-Tertiary units in the Yucca Mountain region, as tests of the Crater Flat shear zone hypothesis and the concept of oroclinal bending. S. Gillett, R. Karlin, Y. Zhang, and R. A. Schweickert.

Knowledge of the amount and sense of structural rotations is important for constraining kinematic models of tectonic deformation. Paleomagnetism is a powerful tool for identifying rotations about both horizontal axes (tilts) and vertical axes (oroclinal bending). Previous work at Bare Mountain (Monsen and others, 1990) revealed that north-south trending vertical quartz latite dikes (13.9 Ma) cut, or are cut by, a set of east-dipping faults that are dominant structures in the central part of Bare Mountain. The quartz latite dikes intruded Paleozoic rocks in various structural domains along the north - south extent of the range. Paleomagnetic study of the dikes is intended to constrain the sense of tilting and/or rotation of the domains separated by low angle faults.

Paleomagnetic data (Rosenbaum et al., 1991) from ash flow tuffs at Yucca Mountain demonstrated about 30 degrees of vertical axis rotation (clockwise) over the 25 km north-south extent of Yucca Mountain since emplacement of the Tiva Canyon member (about 13 Ma) of the Paintbrush Tuff. Paleomagnetic data from 13.9 Ma quartz latite dikes at Bare Mountain can provide a test of the oroclinal bending hypothesis.

Method and measurement

In January, 1991, paleomagnetic sampling of the following units was completed: the Lower Cambrian Carrara Formation at Carrara Canyon and Gold Ace Canyon at Bare Mountain, and in Striped Hills; Devonian rocks of Tarantula Canyon in Tarantula Canyon, at north end of Bare Mountain; 14 Ma dacite dikes at Tarantula Canyon; and the Middle Jurassic Sylvania pluton at Slate Ridge. All samples were collected with a portable rock drill and oriented with a brunton compass. In the laboratory, each sample was separated into 2 or 3 specimens (A,B, and C). NRM's have been measured on all samples of the quartz latite dikes. Specimen A was subjected to progressive alternating field demagnetization (measurements for AF demagnetization have not been completed). Specimen B was thermally demagnetized over Curie temperatures of the minerals or to 700° C. Specimen C from some of the samples was subjected to both AF and thermal demagnetization in order to compare the results from specimens A and B.

Specimens with strong magnetism were measured on a spinner magnetometer (usually for natural remanence and several early steps of demagnetization). Most of the specimens were measured on a cryogenic magnetometer.

Discussion

Demagnetization indicates magnetite and hematite carry most of the remanence in the dikes. A few samples contain pyrrhotite that loses magnetism at a low temperature range from 310° C to 330° C. Samples containing magnetite have blocking temperatures of about 580° C. A few samples have blocking temperatures as high as 620° C. This phenomenon probably indicates maghemite is the remanence carrier. Hematite is the dominant carrier of magnetization in the dikes. Blocking temperature in these samples is about 685° C.

Most samples have a remanence that comprises two or more components. On equal-area projections of directions, two concentrations are recognized, one a reversed direction in the west and another, also reversed, in the south portions, respectively. Two stable reversed Tertiary field has been recognized and have the potential to constrain structural movements. Remanences of the overprinting field with low blocking temperature are not difficult to differentiate from primary components and viscous components. Further measurements and analyses of the paleomagnetism of the dikes are continuing. This work will hopefully provide quantitative constraints on the timing and mode of deformation since 13.9 Ma at Bare Mountain.

6. Geology of Black Marble butte

Existing geologic maps show a NNW-striking high-angle fault along the eastern edge of Black Marble butte, at the southern tip of Bare Mountain, which separates Cambrian Bonanza King Formation on the west from the Timber Mountain Tuff to the east. If present, this fault could represent a NNW-striking strike-slip fault or a southern continuation of the Bare Mountain fault. However, our field studies suggest no fault is present in this location.

Near the southeastern end of Black Marble butte, a section of poorly indurated Cenozoic sandstones and crystal tuffs strikes northwest, dips northeast, and appears to lie unconformably upon Cambrian Bonanza King Formation. These strata dip eastward beneath basalts that underlie the Timber Mountain Tuff. If so, the Bonanza King represents either basement or large slide blocks in the pre-13 Ma stratigraphic section. If no fault is present in this location, the southern continuation of the Bare Mountain fault would have to pass west of Black Marble butte, through Steves Pass.

Part IV. Other activities of Task 5 personnel

1. Technical review of reports for the Center

None formally assigned; reviewed new publications by Snow (1992) and Wernicke (in press):

Snow, J.K., 1992, Large-magnitude Permian shortening and continental-margin tectonics in the southern Cordillera: Geol. Soc. America Bull., v. 104, p. 80-105.

Wernicke, B., 1991, Cenozoic extensional tectonics of the U.S. Cordillera, in Burchfiel, B.C., Lipman, P.W., and Zoback, M.L., eds., The Cordilleran orogen; Coterminus United States: Boulder, Colorado, Geol. Soc. America, The Geolopgy of North America, v. G3, in press.

2. Meetings attended in relation to the Yucca Mountain Project and the Center for Neotectonic Studies

a. Geological Society of America, National Meeting, San Diego, California, October, 21-24,1991 (attended by Schweickert, Lahren, and Zhang; see abstract by Zhang and Schweickert)

b. Premeeting fieldtrip, attended by Schweickert, October 17-20, 1991, to Chicago Pass, Death Valley, southern Nopah Range, Kingston Range, Winters Pass in the Mesquite Mountains, Providence Mountains, Soda Mountains, Marble Mountains, and Little Piute Mountains, southeastern California.

3. Field work

a. Structural mapping in Bare Mountain, Y. Zhang, January 7-10, June 1-7, 1992; Schweickert, Lahren, and Zhang, January, 11-14, 1992

b. Geologic mapping and structural analysis in Grapevine Mts., Bullfrog Hills, Bare Mountain, and Black Marble--Schweickert, Lahren, and Zhang, January, 14-17, 1992

4. Professional reports provided to NWPO

a. None

5. Abstracts published

a. Zhang, Y., and Schweickert, R.A., 1991, Structural analysis of Bare Mountain, southern Nevada (abs.): Geol. Soc. America Abs. with Programs, v. 23, p. A185-A186.

6. Papers accepted for publication in peer-reviewed literature

a. Caskey, S.J., and Schweickert, R.A., Mesozoic deformation in the Nevada Test Site region: Implications for the structural framework of the Cordilleran fold and thrust belt and Tertiary extension north of Las Vegas Valley: Tectonics; accepted for publication, 2/92.

7. Graduate theses supported by NWPO

a. Zhang, Y., in progress, Structural and kinematic analysis of Mesozoic and Cenozoic structures at Bare Mountain, Nye County, Nevada

Appendix I.

Abstracts and published papers

1. Caskey, S.J., and Schweickert, R.A., Mesozoic deformation in the Nevada Test Site region: Implications for the structural framework of the Cordilleran fold and thrust belt and Tertiary extension north of Las Vegas Valley: Tectonics, accepted for publication, 2/92. (preprint)

2. Zhang, Y., and Schweickert, R.A., 1991, Structural analysis of Bare Mountain, Southern Nevada (abs.): Geol. Soc. America Abs. with Programs, v. 23, p. A185.

University of Nevada, Reno
Center For Neotectonic Studies

Site Characterization of the Proposed Nuclear Waste Repository at Yucca Mountain

Task 8
Evaluation of Hydrocarbon Potential

Report of Investigations
Oct. 1991 through Sept. 1992

Principal Investigators:
Patricia H. Cashman
James H. Trexler, Jr.

EXECUTIVE SUMMARY

Task 8 is responsible for assessing the hydrocarbon potential of the Yucca Mountain vicinity. Our main focus is source rock stratigraphy in the NTS area in southern Nevada. (In addition, Trexler continues to work on a parallel study of source rock stratigraphy in the oil-producing region of east-central Nevada, but this work is not funded by Task 8.) As a supplement to the stratigraphic studies, we are studying the geometry and kinematics of deformation at NTS, particularly as these pertain to reconstructing Paleozoic stratigraphy and to predicting the nature of the Late Paleozoic rocks under Yucca Mountain.

Our stratigraphic studies continue to support the interpretation that rocks mapped as the "Eleana Formation" are in fact parts of two different Mississippian units. We have made significant progress in determining the basin histories of both units. These place important constraints on regional paleogeographic and tectonic reconstructions. In addition to continued work on the Eleana, we plan to look at the overlying Tippipah Limestone. Preliminary TOC and maturation data indicate that this may be another potential source rock.

We have set up a lab for extracting radiolaria and sponge spicules from siliceous rocks, and are in the process of setting up a lab to extract conodonts from calcareous rocks. This substantially improves our biostratigraphic dating capability, by increasing both the number of rock types we can date and the number of individual samples we can run. More dates tied to measured sections will allow us to refine the basin histories and will aid in regional correlation.

Our structural studies focus on understanding the distribution of Late Paleozoic rocks at NTS. The deformational history is complex, and detailed mapping is necessary to determine both the present surface distribution of Late Paleozoic sedimentary rocks and the geometry and kinematics of the various faults that offset them. Both are necessary in order to predict the subsurface distribution of potential source rocks.

INTRODUCTION

Our studies continue to concentrate on the stratigraphy of Late Devonian through Lower Pennsylvanian rocks at NTS, because these have the best potential to be hydrocarbon source rocks. Our work involves structural as well as stratigraphic studies: detailed stratigraphy will identify the extent of potential source rocks, and structural history controls both the maturation and the present structural position of these rocks.

This report summarizes new results of our stratigraphic and structural studies in southern Nevada. New to this year's report is a basin history for each unit (the 'eastern' and 'western' Eleana), and a separate section on biostratigraphy. Directions for future work are included where appropriate in each section. We conclude with a brief summary of implications of all the above for hydrocarbon potential in the NTS region.

STRATIGRAPHY

A. introduction

Our work this year supports the interpretation that rocks mapped as "Eleana Formation" at NTS are in fact two different, in part coeval, sedimentary units. The evidence for two separate units includes: (1) a fault contact wherever the two are adjacent; (2) different sandstone compositions between the two units; (3) paleocurrent directions which are internally consistent for each unit, but differ between the two units; (4) different depositional environments and basin histories; and (5) overlapping ages.

The following section will describe the internal stratigraphy of the 'eastern Eleana' and then the 'western Eleana'. These are followed by a comparison of the basin histories documented in each unit, and a discussion of the stratigraphic and structural implications of these histories.

B. Eastern Eleana

The **internal stratigraphy** of the 'eastern' Eleana documents a two-stage depositional history. Most of the section is mud interbedded with occasional thin, craton-derived, sand sheets. These were deposited on a west-facing continental platform or slope, and may also comprise parts of the distal Mississippian foreland basin. We have so far been unable to determine whether the mud came from the craton or the Antler allochthon. The mudstone and sandstone are unconformably overlain by limestone which represents the re-establishment of a carbonate platform in the area. Exposure of the 'eastern' Eleana is poor; our surface measured section is supplemented by several cores and well logs, including one complete core through

1000m of section. There is evidence for both soft-sediment and tectonic deformation in this core, suggesting that neither original thickness nor internal stratigraphy of the mudstone section can be determined reliably.

The 'eastern Eleana' section (see Red Canyon Wash measured section, Fig.s 1,2) is predominantly thick, siliciclastic mudstone; quartz arenite and calcareous mudstone are occasionally interbedded. Strong bioturbation of some horizons indicates that the water column was well oxygenated and well mixed at the time of deposition. However, euxinic horizons in both the siliciclastic and calcareous mudstones document a restricted basin at the time these were deposited. At present, we don't know whether the degree of oxygenation varied spatially, temporally, or both ... or whether an open or a restricted basin was more characteristic during deposition of the 'eastern 'Eleana'.

Primary **sedimentary structures** are generally absent in the mudstone, with the exception of local lamination or bioturbation. The quartz arenite contains both ripple and trough cross-lamination, indicating that sands were reworked by bottom currents. Paleocurrents determined from cross-lamination are variable, ranging from SE to WNW, but generally indicate sediment transport toward the south or west.

Sandstones from the 'eastern' Eleana are uniformly quartz arenites. The few (less than 2%) sand grains that are not quartz are stable, resistant grains like zircon and epidote. Sandstone compositions, therefore, support the paleocurrent evidence that the sediments were derived from the craton; there is no petrographic evidence of derivation from the Antler allochthon.

At the top of the section, quartz arenite beds are thicker and more common, and limestone is occasionally interbedded. These compositional changes indicate that clear-water, open marine conditions were established at this point in the local depositional history. Sedimentary structures in the quartzite suggest shallow-marine currents (possibly longshore), and wave reworking. These quartzites probably correlate with the Scotty Wash sand beds associated with the Chainman Shale to the northeast. Scotty Wash sandstones are petrographically identical, are of the same age (as well as they are presently constrained) and paleocurrents indicate a linked sand distribution system.

Prior to our work, the only **dates** for these rocks were from macrofossils high in the section (i.e., in the open marine deposits described above), and even these dates have undergone a recent revision. The lower (mudstone) part of the 'eastern Eleana' is difficult to date. Spores (dated for Task 8) suggest an Osagean - Meramecian (middle Mississippian) age for much of the mudstone section, but palynology on rocks of this age is not deemed reliable by many workers. The top of the Eleana was dated as Chesterian (latest Mississippian) (Gordon and Poole, 1968). Endothyrids dated for Task 8 were also latest Chesterian (Mamet, written comm., 1990). However, the

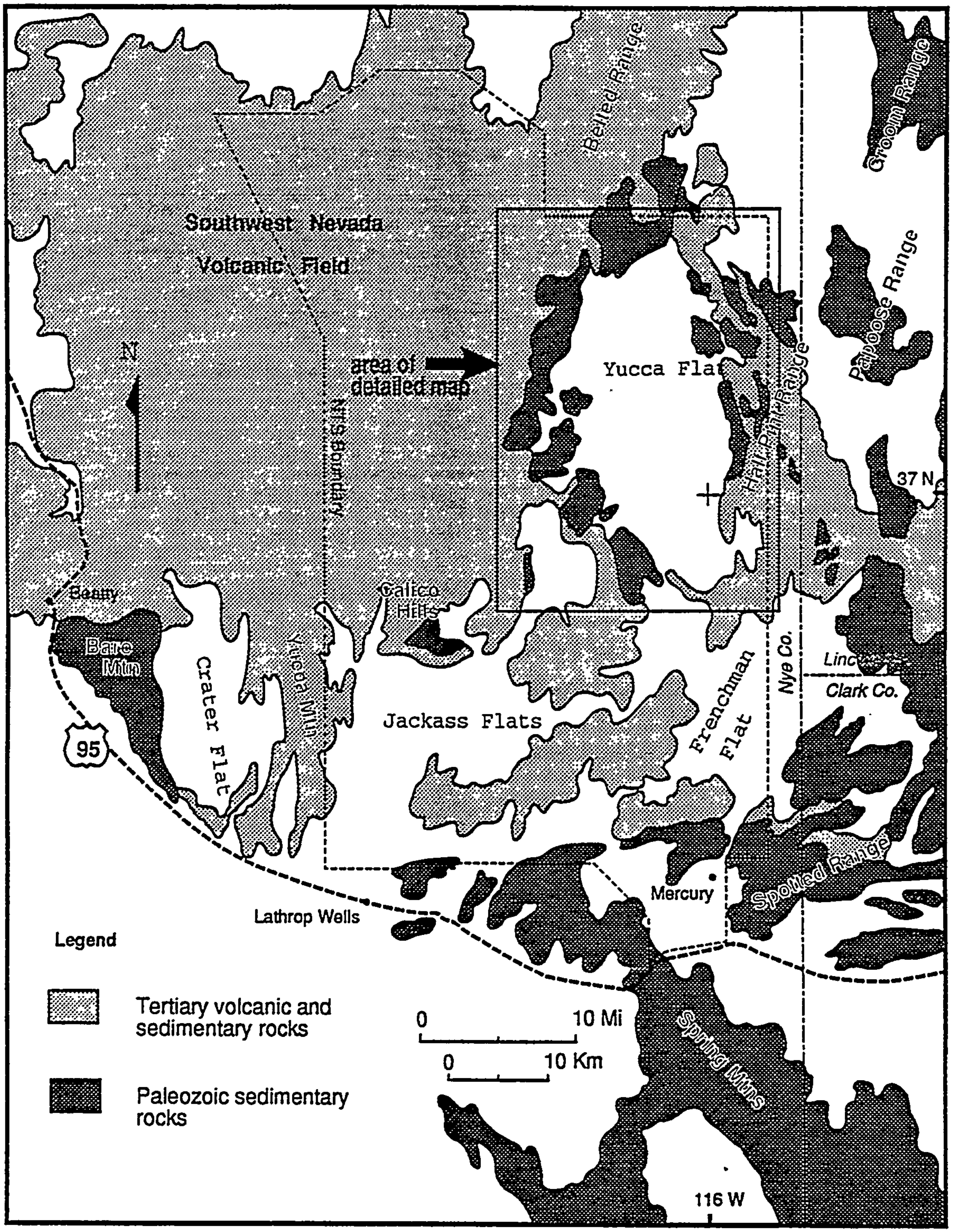


Figure 1(a): Location map, Nevada Test Site and vicinity, area of Fig. 1(b) shown.

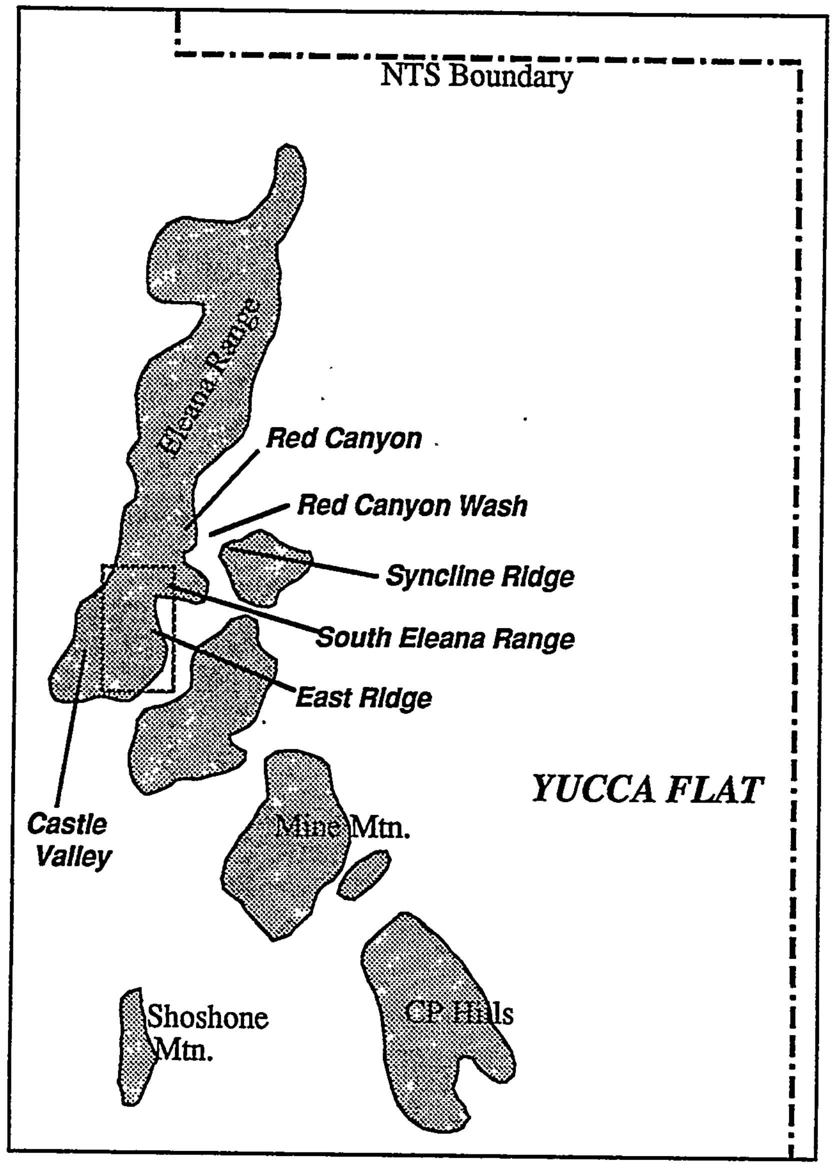


Figure 1b: Location map, Eleana Range and vicinity; area of Fig. 3 and locations of measured sections shown.

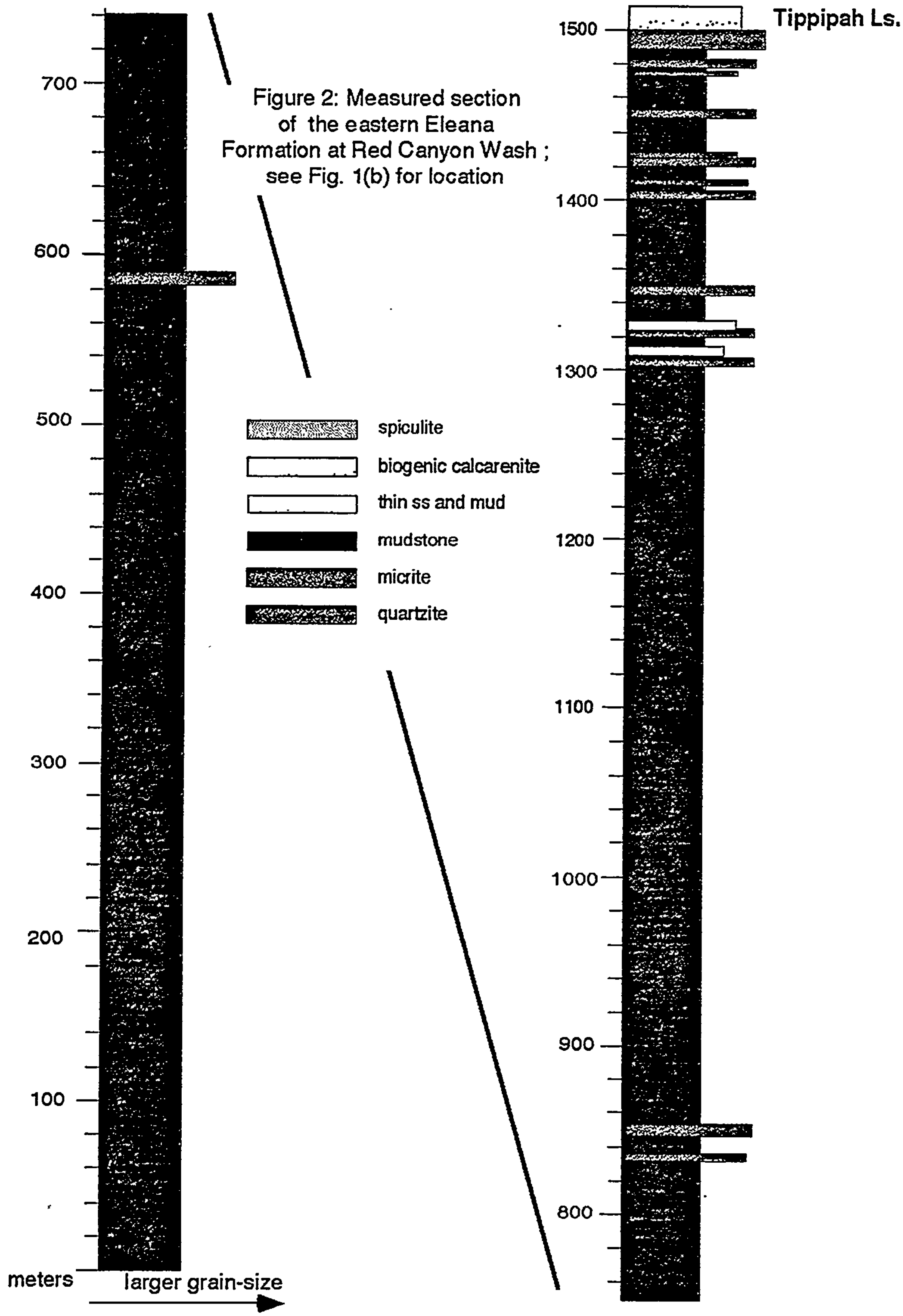


Figure 2: Measured section of the eastern Eleana Formation at Red Canyon Wash ; see Fig. 1(b) for location

ammonoid Homoceras (which defines the base of the Pennsylvanian) has recently been discovered in continuous section with upper Mississippian ammonoids within the uppermost Eleana (Titus and Manger, 1992). This moves the top of the Eleana section into the Pennsylvanian. (For a summary of all Task 8 age data see appendices 2 and 3).

The carbonate rocks of the **Tippipah Limestone** unconformably overlie the mudstone/sandstone/limestone section at the top of the 'eastern' Eleana with substantial erosional relief. For example, Titus and Manger, (1992) describe an ammonoid assemblage that occupies a 17m-thick shale section below orthoquartzites of the highest Eleana. This assemblage has been erosionally removed in similar basinal rocks just 16 km to the east. The flooding surface at the base of the Tippipah is therefore a sequence boundary, representing a transition from possibly subaerial to shallow marine conditions. Conodont dates consistently identify the base of the Tippipah as Lower Pennsylvanian (Morrowan) (Gordon and Poole, 1968). The shallow marine conditions that allowed the build-up of a Pennsylvanian carbonate platform differed from those prior to erosion in that there was a dramatic reduction in the amount of fine-grained siliciclastic detritus.

We haven't worked on the Tippipah yet, but the internal stratigraphy of the Tippipah Limestone is one of the topics we intend to investigate further in the next year. Reconnaissance has shown that chert pebble conglomerates with a carbonate matrix occur within the section. The chert pebbles clearly are reworked from older sedimentary rocks, but the depositional environment of such rocks (and the paleogeography at the time of deposition) is enigmatic. The geologic history recorded in the Tippipah is the last chapter in the 'eastern Eleana' tectonic story; in addition, maturation and TOC results on a few samples of Tippipah suggest that it may be a potential source rock.

C. Western Eleana

The **internal stratigraphy** of the 'western' Eleana also documents a two-stage tectonic and depositional history: the lower part is siliciclastic submarine fan deposits, the upper part is organic/detrital basin fill. The transition between the two is fairly abrupt, and represents an important Mississippian tectonic event. From the sections that we have measured so far, it appears that we may be seeing two different parts of the 'western Eleana' basin that have been structurally juxtaposed. This may ultimately prove very helpful in deciphering the Mississippian paleogeography as well as in improving our understanding of the 'western' Eleana.

The **submarine fan** basin fill comprises a fining-upward sequence of mid-fan to inner fan deposits. Our current interpretation of this setting is that it was a mid-fan channel complex, topographically constrained laterally and occupying an elongate trough. This is born out by the lack of dispersal of paleocurrent trends, and the general lack of fine-grained inter-channel deposits. The small and large-scale fining-thinning upward cycles observed in the measured section are consistent with channel fill and amalgamation as channels were alternately abandoned and reoccupied in the narrow fan system. Paleocurrents determined from these rocks are more consistent than those from the 'eastern' Eleana, and trend SSW to SW. These confirm a somewhat unusual fan geometry: the submarine fan may have occupied an elongate SSW-trending basin that was filled primarily by axial turbidity currents.

The **clast compositions** in the sandstones and conglomerates provide information about the source areas feeding the submarine fan. Limestone (+/- chert) and quartzite clasts were most probably derived from the older sedimentary rocks of the Paleozoic continental margin. These rocks must have been tectonically uplifted in order to be a source; paleocurrents suggest that this tectonic source was generally to the north of the 'western Eleana' basin. Vesicular basalt clasts were most probably derived from the Antler allochthon, although they could also have been derived from terranes to the west of it. At any rate, it is unlikely that these clasts were derived from the North American craton to the east. Phosphatic clasts (appendix 1) (+/- chert) were formed *in situ* or also were derived from the Antler allochthon and/or terranes to the west of it (e.g., those now in the northern Sierra); there is no known phosphatic source of pre-Mississippian age on the North American craton. We hope to be able to do more with these phosphatic clasts -- possibly finding diagnostic fossils associated with them -- to pinpoint their source.

Although the Eleana has generally been interpreted as part of the Antler foreland clastic wedge and thus correlative with the Diamond Peak and Chainman formations of central Nevada, there are no known units directly correlative to the 'western' Eleana. Identifying such unit(s) and determining their relative paleogeographic position(s) would go a long way toward resolving the obvious paleogeographic problems posed by our interpretation that rocks previously mapped as "Eleana" are in fact parts of two separate basins. As far as we know, coarse-grained rocks of the 'western Eleana' are found only at the Nevada Test Site and the adjacent Nellis Air Force Range. Finer-grained rocks of apparently similar composition (e.g., primarily chert-grain sandstones) and Mississippian age are mapped as "Eleana" at Bare Mountain and also occur in the El Paso Mountains (M. Carr, pers. comm. 1992) and in the northern Sierra (Harwood and others, 1991; M. Carr, pers. comm. 1992). At present, it is not known whether any of these are genetically related to each other or to the coarse submarine fan deposits of the 'western' Eleana; this is another direction for future work.

The **organic/detrital basin fill** depositionally overlies the submarine fan deposits, and contains a variety of rock types. The carbonates in this section are reworked bioclastic sands, often in graded beds. These sands are primarily crinoidal, but also include brachiopods, gastropods, corals, ammonoids, etc. This organic detritus comprises reworked Mississippian organisms, derived from a productive carbonate platform. The siliceous argillites and cherts contain some radiolaria, but are primarily spiculites. The sponge spicules originated in relatively shallow water (Murchey, 1990; B. Murchey, pers. comm., 1992) but are almost certainly reworked, because they occur in the graded beds. In many places, beds which contain coarse crinoid debris at the base grade up into spiculitic chert at the top, demonstrating that siliceous and carbonate reworked organic debris were transported and deposited simultaneously. Preliminary dating from the radiolaria supports a Mississippian (no older than Osage) age for these rocks (B. Murchey, pers. comm., 1992). Micrites, calcareous mudstones, and mudstones are intimately interbedded with the bioclastic limestones and cherts. Locally, these fine-grained rocks show extensive bioturbation, indicating a well-oxygenated water column.

The biogenic beds contain the **primary sedimentary structures** associated with submarine fan turbidites in an outer fan setting. Primary depositional mechanisms are turbidity flows and pelagic rain-out of suspended debris in the water column. Paleocurrent data from these rocks are limited, but suggest that transport was in part toward the east.

Sedimentary clasts (in addition to bioclastic debris) in the graded beds include chert and phosphate. The phosphatic clasts (see Appendix 1) may be primary phosphate nodules formed on a slope where upwelling currents enhanced biogenic productivity, or they may be reworked from older rocks. The chert clasts are presumably reworked material from the oceanic terranes to the west or northwest.

There are several similarities between rocks of the organic/detrital portion of the 'western' Eleana and the siliceous sedimentary rocks in the upper Paleozoic Havallah sequence of northern and central Nevada. Both contain sponge spicule-rich turbidites derived from a shallow source. Similar assemblages of radiolaria and sponge spicules occur in the two (B. Murchey, pers. comm., 1992). Several distinctive structural features in chert ("step boudins" with silica-sealed cracks, and asymmetric to overturned folds with thickening at the hinges) resemble those described in the Havallah (Snyder and Bruekner, 1983; Snyder and others, 1983; Bruekner and Snyder, 1985; Bruekner and others, 1987), and interpreted to be pre-lithification features. It is premature to propose a correlation between the two, but testing this idea will be another direction for future work. If the two units correlate, it will require significant revision of both structural and paleogeographic models!

So far, our **age control** on the 'western' Eleana is limited to the sediments from the upper (organic/detrital) part of the basin. (For a summary of all Task 8 age data see Appendices 2 and 3.) Endothyrids and calcareous algae from the lowest bioclastic limestone horizons consistently yield zone 16 (latest Meramec - earliest Chester) ages. We are provisionally using this information to date the shift from a siliciclastic-dominated sediment system to one that was fed primarily by an organically productive platform. Other potential dating methods for these rocks include radiolaria

Figure 3: Geologic map of the southern Eleana Range, showing the distribution of 'eastern' and 'western' Eleana Fm. See Fig. 1(b) for location

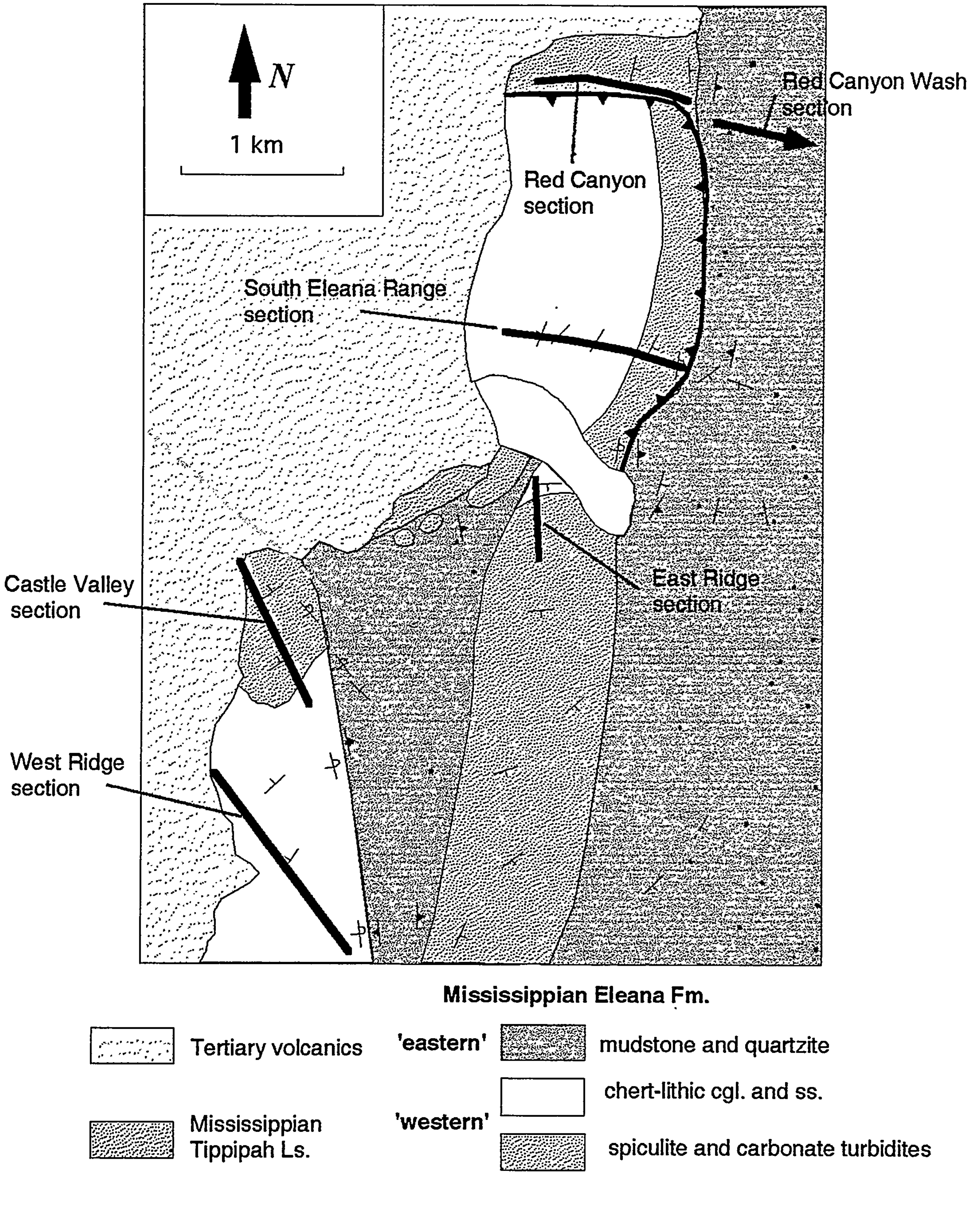


Figure 4: Measured section of the 'western' Eleana Fm. at West Ridge; see Fig.s 1(b) and 3 for location

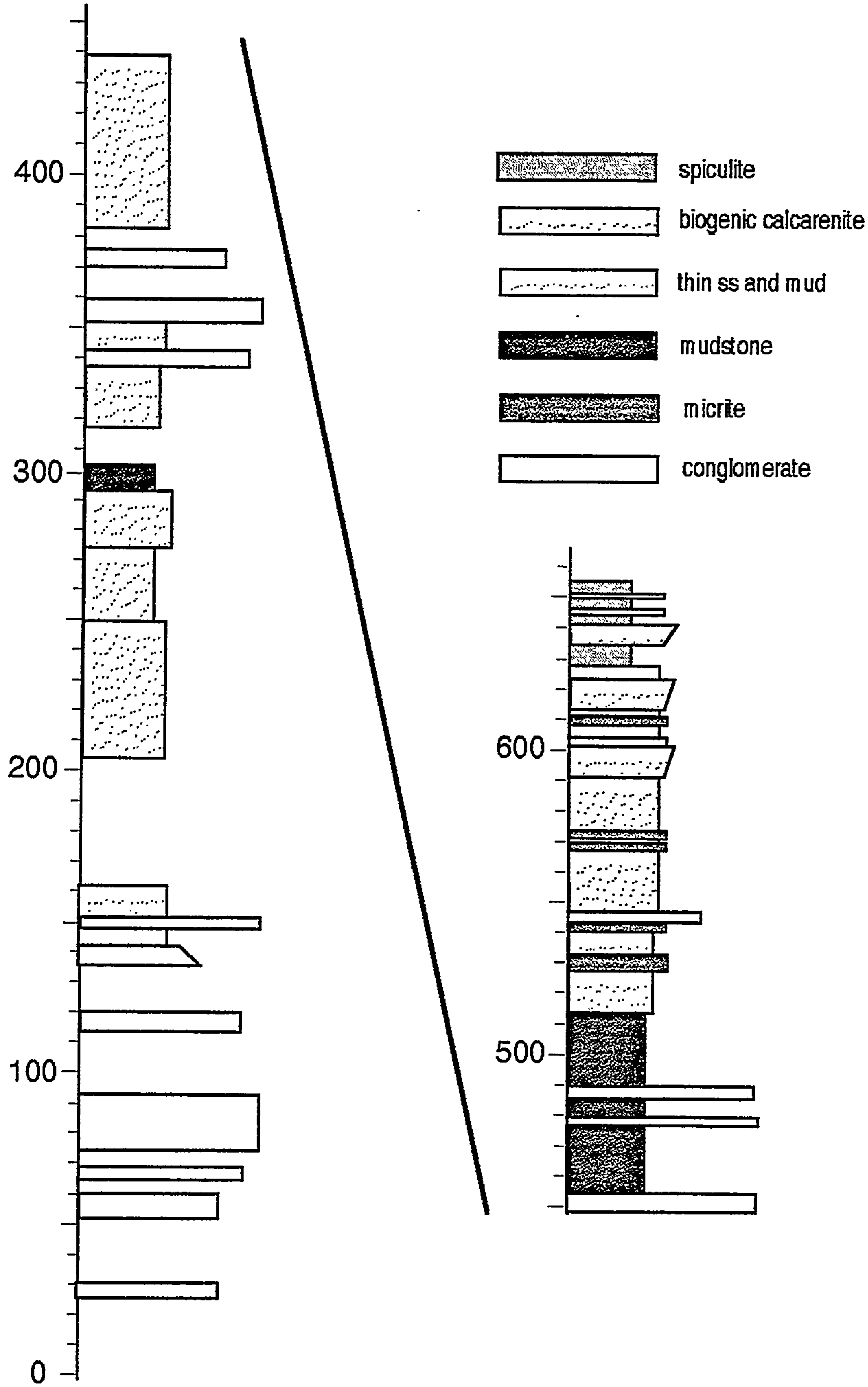
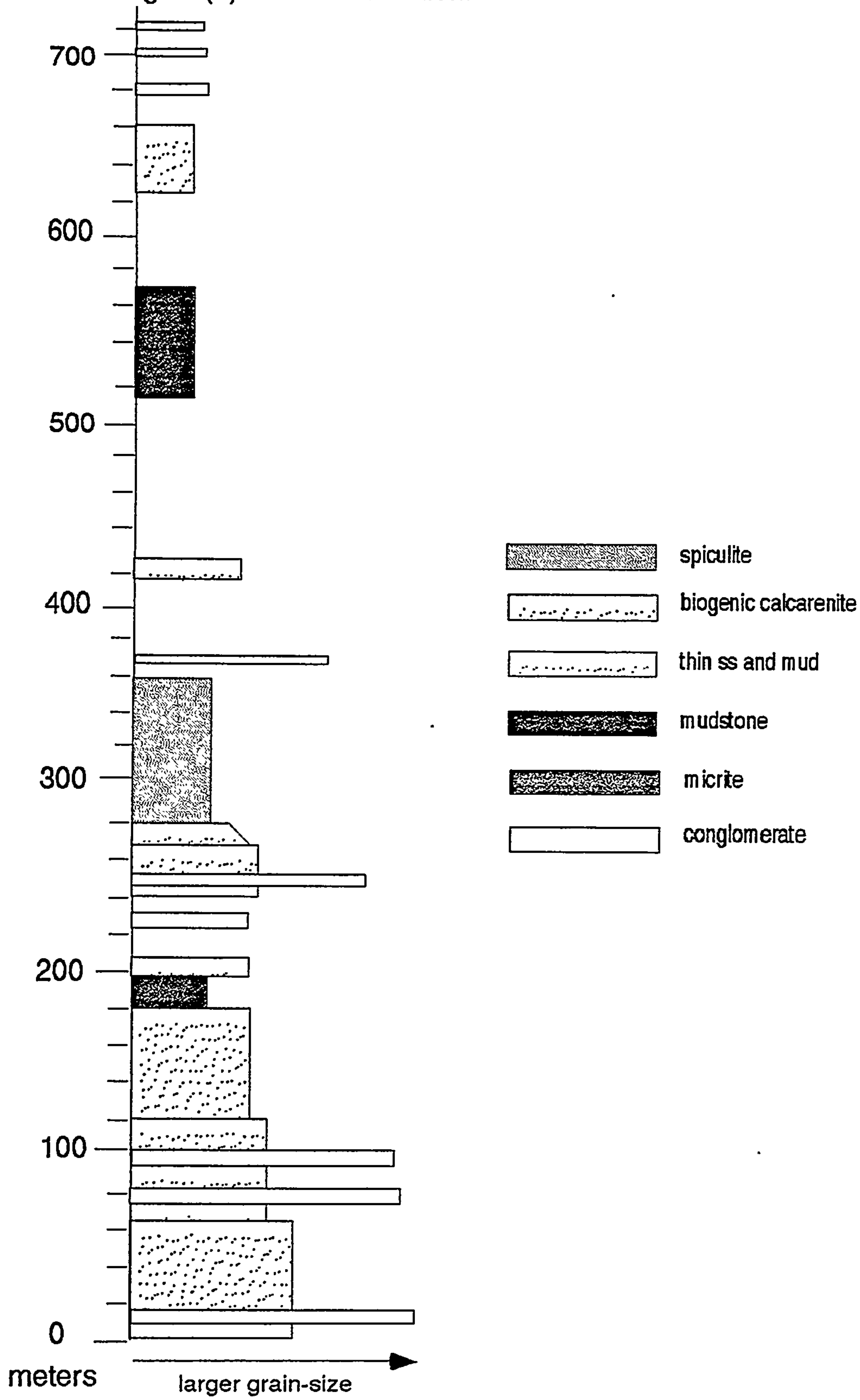


Figure 5: Measured section of the 'western' Eleana Fm. at Red Canyon; see Fig.s 1(b) and 3 for location.



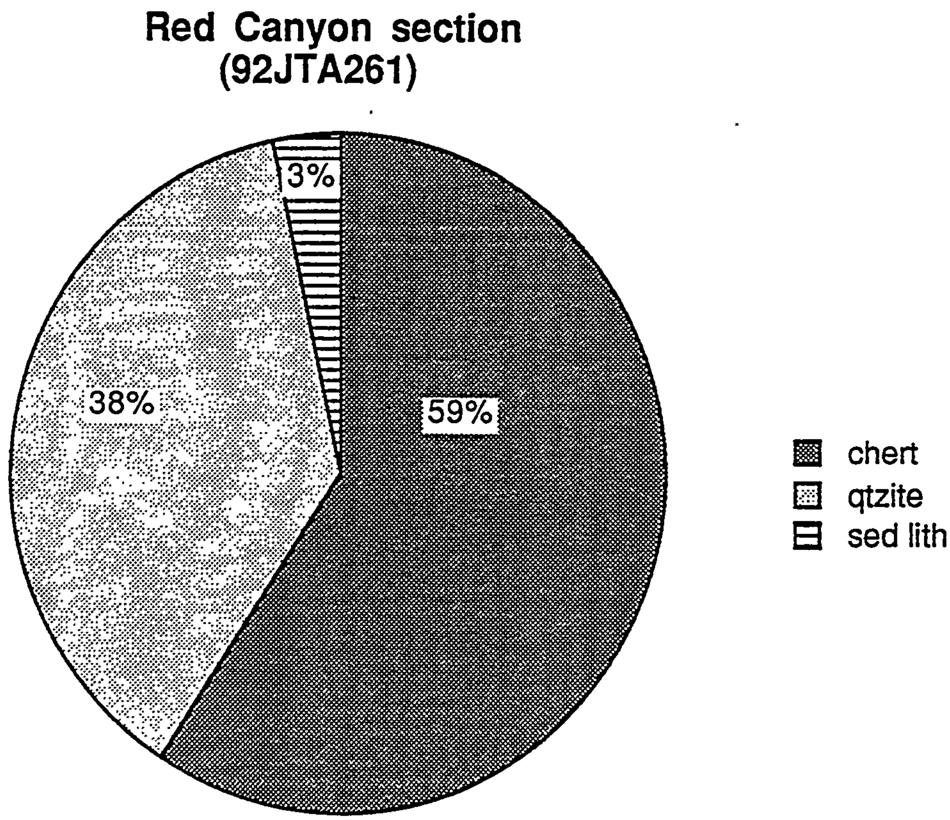


Figure 6: Pie diagram of conglomerate clast count (300 clasts) near the base of the Red Canyon measured section; "sed lith" clasts are fine-grained litharenite. Compare with Fig. 9.

Figure 7: Measured section of the 'western' Eleana Fm. in the southern Eleana Range; see Fig.s 1(b) and 3 for location.

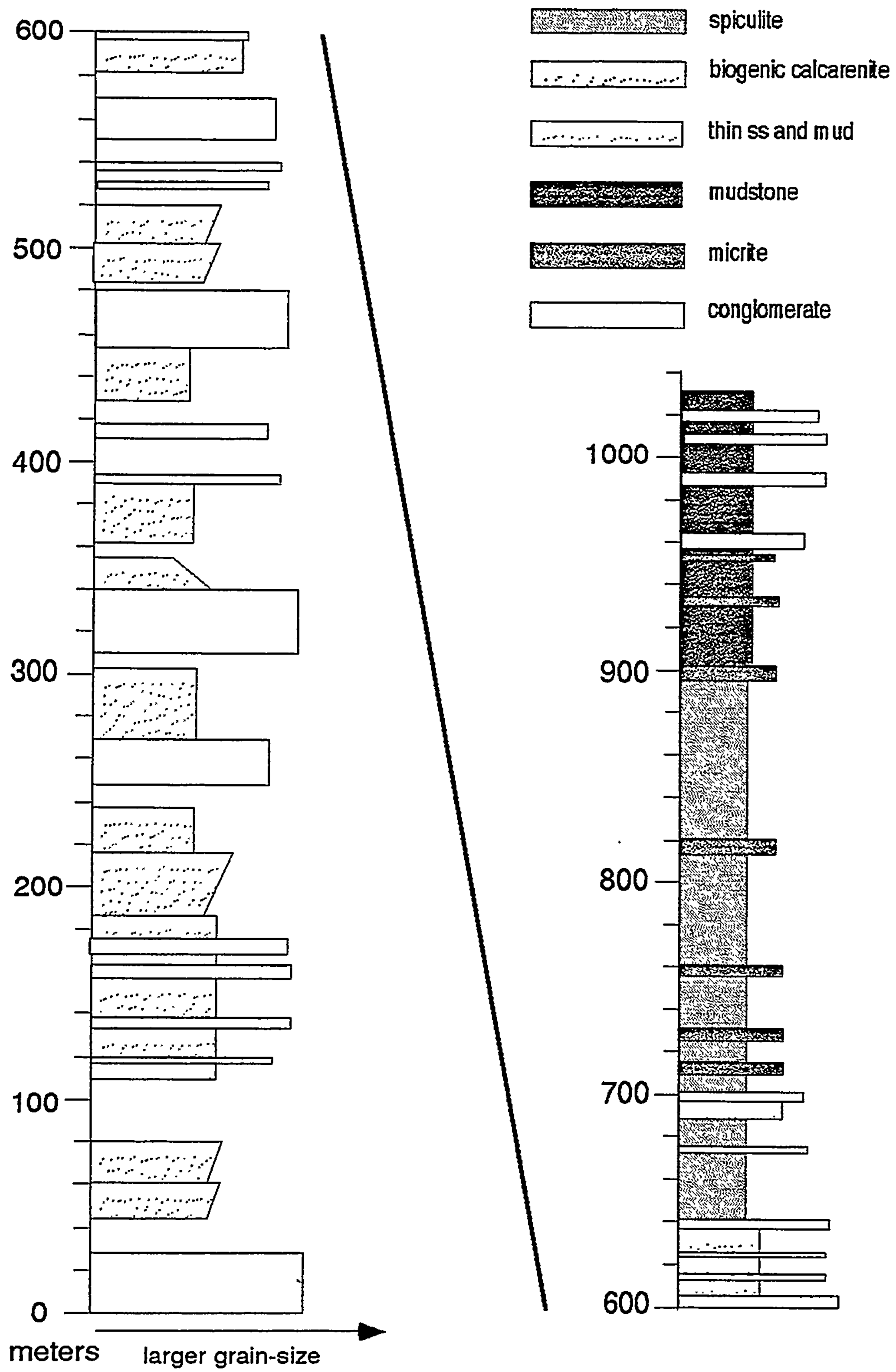
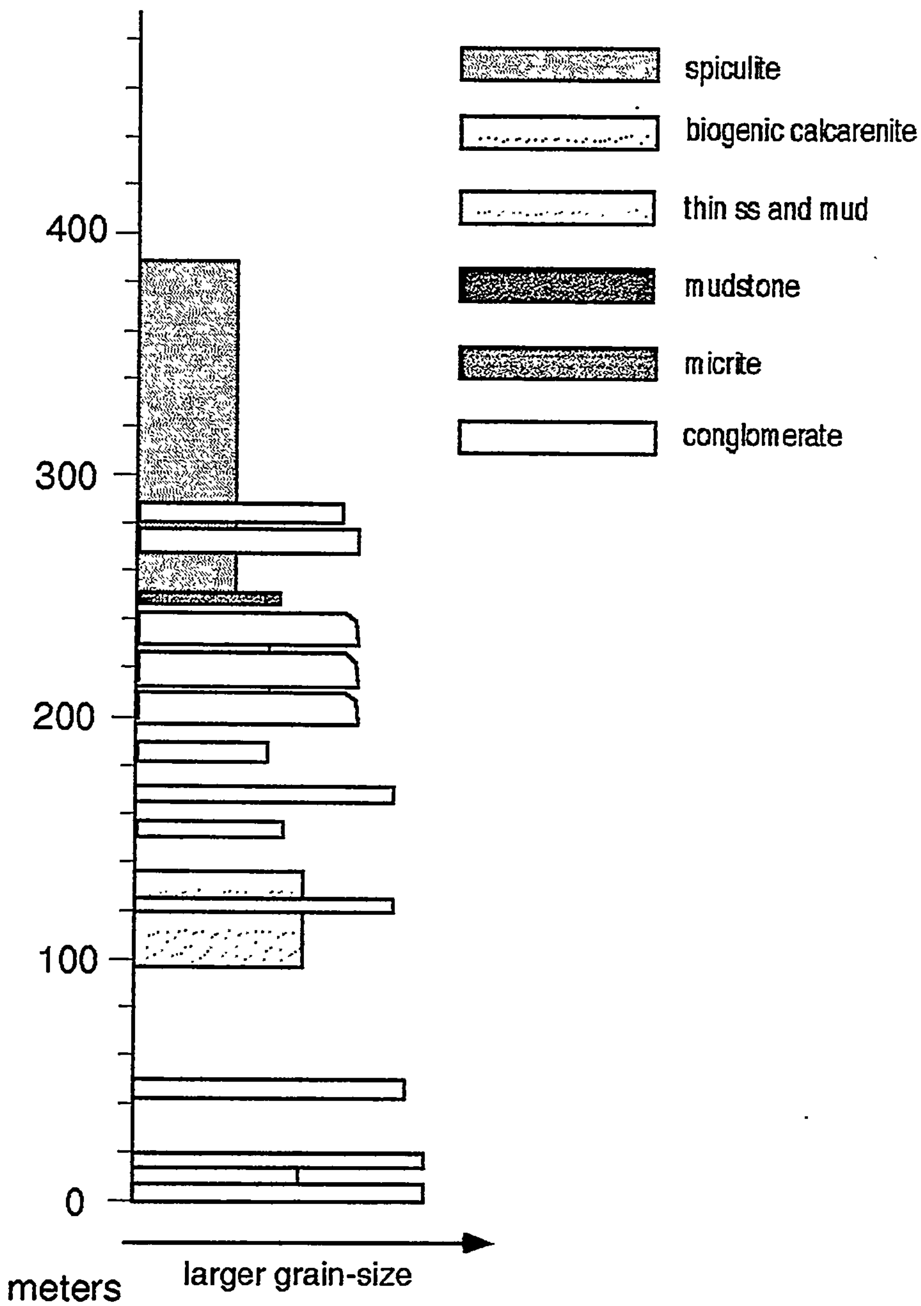
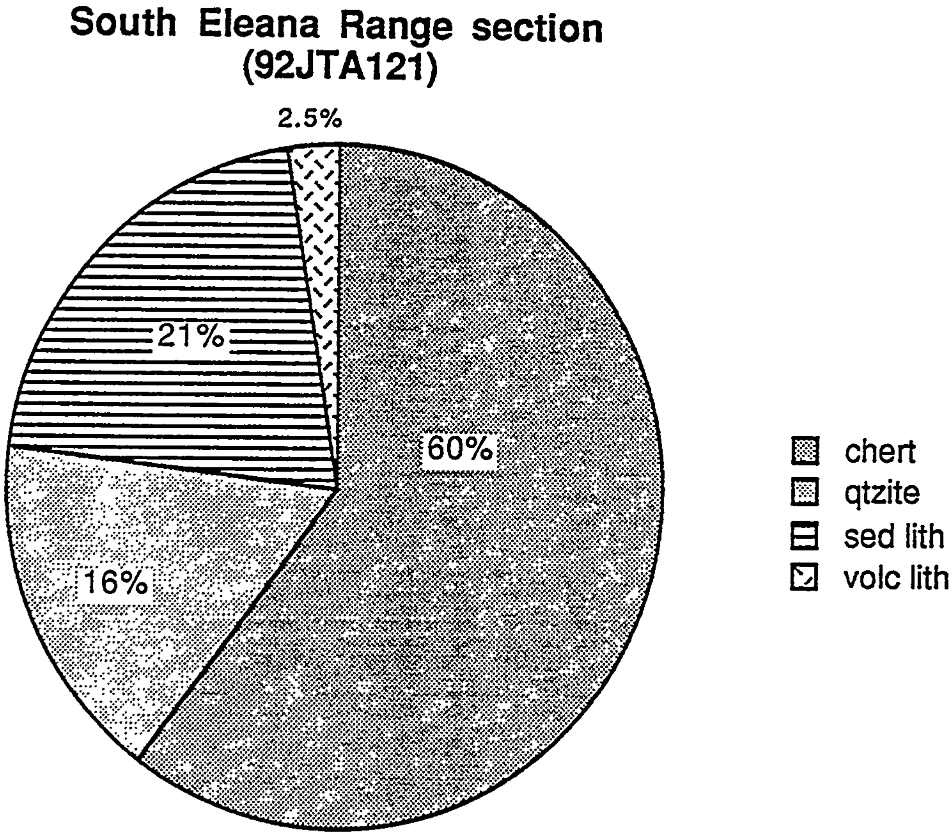


Figure 8: Measured section of the 'western' Eleana Fm. at East Ridge; see Fig.s 1(b) and 3 for location





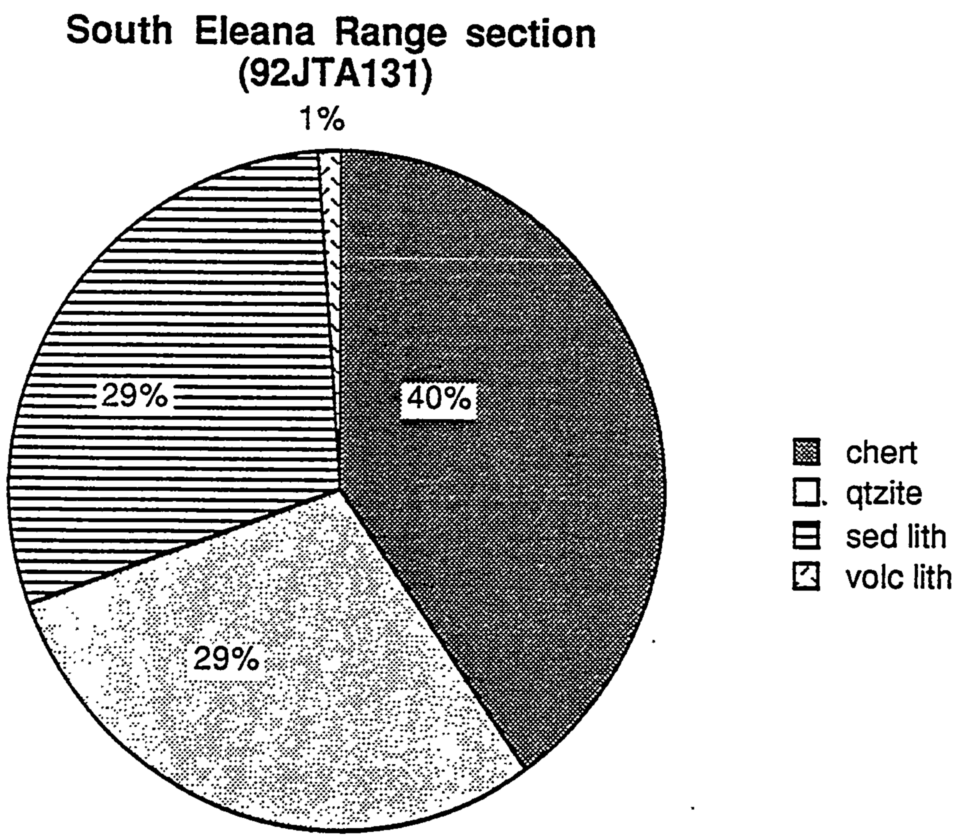


Figure 9: Pie diagrams of conglomerate clast counts (250 and 200 clasts) near the base of the Southern Eleana Range section. "sed lith" includes limestone, siltstone, and litharenite. Compare with Fig. 6.

and sponge spicules from the cherts, and conodonts from the limestones. In addition, it may be possible to date radiolaria and/or spicules from the phosphatic clasts which occur in both the submarine fan section and the organic/detrital section. Note that if the phosphatic clasts are reworked from an older oceanic terrane, ages from the phosphatic clasts would date the source terrane (and might aid in correlation), but would not date the Eleana!

The 'western Eleana' measured sections fall into two groups of similar stratigraphy. This suggests that we are seeing **two different parts of the 'western Eleana' basin**, now faulted together:

version 1: In some measured sections (e.g., West Ridge (Fig. 4) and Red Canyon (Fig. 5)), micrite and biogenic calcarenite immediately overlie the conglomerate and sandstone of the submarine fan deposits. There are at least 100 - 200m of these calcareous rocks before the appearance of siliceous sediments (chert and siliceous argillite containing radiolaria and sponge spicules). In the submarine fan deposits associated with these sections, conglomerates contain chert, quartzite and minor amounts of siliciclastic sedimentary rocks (Fig. 6).

version 2: In other measured sections, (e.g., Southern Eleana Range (Fig. 7) and East Ridge (Fig. 8)), 50m or more of siliceous sediment lies between the coarse clastics of the submarine fan and the first occurrence of micrite. In the one case we have with continuous section, there is another 120m of spiculite and occasional micrite before the first occurrence of biogenic calcarenite. In the submarine fan deposits associated with these sections, conglomerates contain chert, quartzite and siliciclastic sedimentary rocks, but also include basaltic volcanic and limestone clasts (Fig. 9).

It therefore appears that in *version 1* we are seeing a part of the basin that was relatively close to the productive Mississippian carbonate shelf, and received calcareous debris as soon as the clastic sedimentation ceased. In *version 2*, we are seeing a part of the basin that was either far from or separated from the carbonate source, and received only fine-grained material that was carried in suspension. Eventually, the coarse bioclastic material also made it to this part of the basin. The geographic separation of these two parts of the 'western' Eleana basin is also reflected in the submarine fan deposits in the lower parts of these sections: although the source terranes for the different parts of the submarine fan had many characteristics in common, the volcanic and limestone source(s) supplied only a limited part of the fan (i.e.,*version 2*).

D. Comparison of basin histories; implications

A comparison of the basin histories of the 'eastern' Eleana and 'western Eleana', as they are presently known from the measured sections (Fig. 10) and paleontologic data summarized above, shows that the Mississippian rocks at NTS do

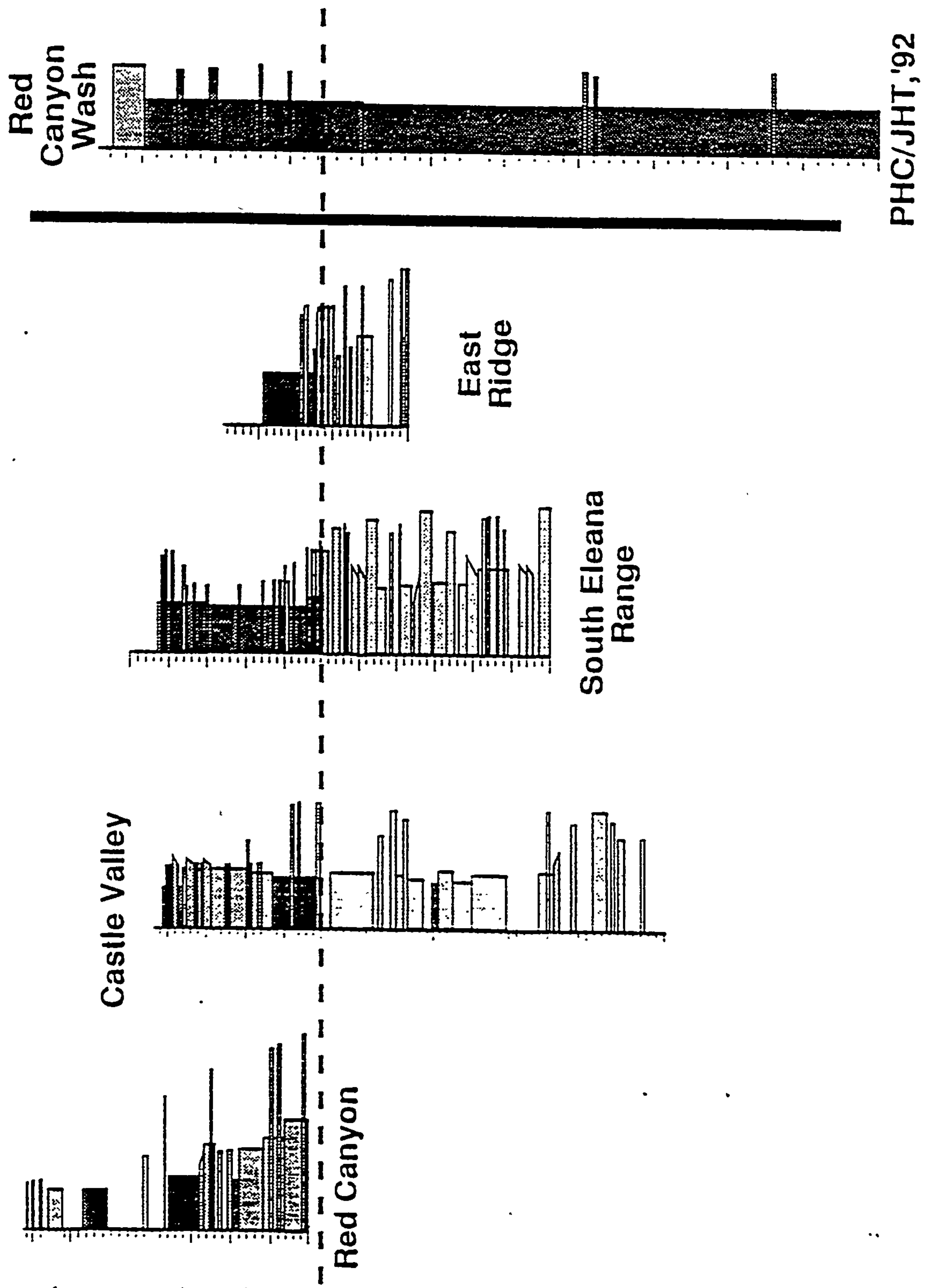


Figure 10: Comparison of measured sections. Datum (dashed) is Early Chester. Note that the 'eastern' Eleana Fm. shows no change at this time, but the 'western' Eleana sections record the change from submarine fan to pelagic, organic-detrital basin.

not reflect the evolution of a single simple basin. Rather, they record the development of two separate basins. Indirectly, this points to a poorly understood but significant structural juxtaposition of the two. The history of each basin will be summarized briefly below, followed by a discussion of the implications for tectonic/structural history.

The muddy sedimentary basin of the **'eastern' Eleana** was probably established on the Devonian carbonate margin of North America. We have not found the depositional base of unequivocal 'eastern' Eleana rocks. However, we are tentatively interpreting the fine-grained mudstone and limestone unit mapped as "Ml" on the Mine Mountain 7 1/2' quadrangle (Orkild, 1968), which depositionally overlies Devonian carbonates, to represent the base of the 'eastern' Eleana. This interpretation is based on Orkild's (1968) Mississippian age*, the presence of mudstone and quartz arenite and absence of chert and other lithic clasts (like the 'eastern', and unlike the 'western', Eleana), and the fact that "Ml" has never been mapped or described anywhere except in a single, 250ft thick exposure on the flank of Shoshone Mountain, in the Mine Mountain quadrangle. Mississippian rocks in nearby areas -- within and adjacent to the Mine Mountain quadrangle -- are either chert-bearing submarine fan deposits (which we interpret to be 'western' Eleana) or mudstone and quartz arenite shelf (?) deposits (which we interpret to be 'eastern 'Eleana). It is hard to justify a new and unique unit designation ("Ml") for a single exposure, when similar rocks with an established name crop out nearby, so we suggest that this unit may represent the lower 'eastern' Eleana.

The 'eastern' Eleana basin fill consists of prograding muds which were locally calcareous, and craton-derived quartz arenite. There is no evidence so far of any sediment source other than the craton. Sand dispersal was generally toward the south and west. The quartz sand beds became thicker and more common with time; limestone is interbedded with the quartz arenite at the top of the section. The limestone at the top of the section had been dated as late Chesterian (latest Mississippian) (Gordon and Poole, 1968) and on calcareous (Mamet, written comm.. to Task 8, 1990). However, the uppermost part of the section has recently been reinterpreted as earliest Pennsylvanian (Titus and Manger, 1992). The water in the 'eastern' Eleana basin was well oxygenated at some times and restricted at others; we don't yet understand the mechanism or know which was dominant.

The siliciclastic basin fill is erosionally truncated (Titus and Manger, 1992), so we do not see the top of the section. Although there was significant erosion on this

* The map explanation -- which is the only published description of "Ml" -- notes "common, well-preserved Devonian conodonts, probably reworked from the Devil's Gate Limestone". There is no explanation of why the conodonts are thought to be reworked or why the unit is interpreted to be Mississippian rather than Devonian. If "Ml" is Devonian, it may still represent the base of the 'eastern' Eleana ... it just pushes back the inception of siliciclastic deposition into Devonian time.

surface in the NTS area, there seems to be little section missing at Syncline Ridge because lower Pennsylvanian rocks occur both above and below the unconformity. The erosional surface was flooded in earliest Morrowan (Early Pennsylvanian) time, and a carbonate platform (the Tippipah Limestone) developed.

The **'western' Eleana** submarine fan also depositionally overlies Devonian carbonate. Clastic (Eleana) deposition appears to have started by Late Devonian time -- a Late Devonian conodont assemblage is described 160ft above the base of the Eleana clastic section (Rogers and Noble, 1969). We have not been allowed access to the area where the basal contact is exposed, but the stratigraphy is briefly described in the explanation on the Oak Spring Butte 7 1/2' quadrangle (Rogers and Noble, 1969). Based on this description and the coarse base of our measured sections, the submarine fan appears to have prograded quickly into the narrow foreland basin. The timing of this event is not well constrained, and the relationship of this clastic fan to the arrival of the Antler allochthon in central Nevada is not currently known. Because of the basin geometry, the direction of sediment transport, and nature of the basin fill, a simple peripheral foreland basin model such as is currently popular in central Nevada for this orogeny does not work here.

The submarine fan was active from Late Devonian to Late Mississippian (late Meramecian or early Chesterian) time. The fan appears to have developed in an elongate trough, with SSW-trending axial currents. Sediments in the fan were derived from tectonically uplifted older Paleozoic rocks, the Antler orogen, and possibly also from volcanic and/or oceanic terranes to the west of the Antler orogen. The submarine fan rocks we have observed were deposited in a channel-fill complex that is regressional overall. Submarine fan sedimentation tapered off by early Chesterian time, and slow subsidence of the basin continued without much external sedimentary input. Slow deposition of fine-grained organic debris (both calcareous and siliceous) was the dominant mode of sedimentation. The arrival of numerous bioclastic-rich turbidites signals the appearance of a significant "carbonate factory" upstream. This may be synchronous with the transgressive event suggested in central Nevada, where Diamond Peak siliciclastic sediments are overwhelmed by carbonate shelf limestone (Trexler and Cashman, 1991). Transgressive events should shut off siliciclastic sediment transport and enhance carbonate production in shelf areas. Note that the suggestion we made in an early Task 8 Progress Report -- that the change in sediment composition might be due to the emergence of the orogenic highland represented by the mid-Mississippian unconformity in the Diamond Mountains -- now appears to be incorrect, even though the two events occurred at about the same time. The unconformity in the Diamond Mountains represents uplift and emergence of marine sedimentary rocks; the change in sediment composition in the 'western Eleana' basin represents subsidence and flooding of the continental margin in the source area.

The obvious conclusion that can be drawn from these two basin histories is that the Latest Devonian and Mississippian rocks at NTS do not reflect a single, simple orogenic history (Fig. 10). Rather, they document sediment derived from different sources and deposited in different environments. Furthermore, they have been subjected to different syndepositional tectonic histories. Clastic deposition appears to have started at about the same time (Late Devonian) in both the 'eastern' and 'western' Eleana basins. A late Meramec or early Chester transgressive event is recorded in the 'western' Eleana. An Early Pennsylvanian erosion event, followed by Early Pennsylvanian flooding, is recorded in the 'eastern' Eleana.

STRUCTURAL GEOLOGY

Our work on the structure of the southern Eleana Range documents several superimposed deformations, and shows that detailed mapping is required throughout the area in order to understand the structure. Deformation events that pre-date the oldest Tertiary volcanic rocks in the area (the ca. 16 Ma Redrock Valley Tuff) include (1) possible pre-lithification (therefore Late Paleozoic) deformation in the upper part of the 'western' Eleana, (2) thrust faulting and associated overturned folding of probable Mesozoic age, and (3) the cryptic fault that juxtaposes 'eastern' and 'western' Eleana. Tertiary low-angle normal faulting obscures the earlier deformations, and makes structural reconstructions difficult. Structures typical of each of these events are described briefly below.

A possible **Late Paleozoic deformation** was pointed out to us by colleague Walt Snyder (Boise State University) when he visited NTS with us in December, 1991. Its existence is suggested by a distinctive mesoscopic deformational style that occurs locally in the upper part of the 'western Eleana'. Good examples of this deformation occur both north and south of the Pahute Mesa road where it crosses the ridge we informally call East Ridge -- between Syncline Ridge and the southern end of the Eleana Range (see Fig. 1b). Interbedded spiculitic chert, siliceous argillite and bioclastic turbidites are folded into asymmetric to overturned mesoscopic folds. Bedding thickens at some fold hinges, suggesting that the rock was not completely lithified when the folding occurred. These rocks also contain "step boudins" (or "step planes" and "solution boudins"), as described in the Havallah sequence rocks of the Golconda allochthon (Snyder and Bruekner, 1983; Snyder and others, 1983; Bruekner and Snyder, 1985; Bruekner and others, 1987). In these structures, bedding is extended by slip along multiple sub-parallel surfaces and rotation of the intervening blocks. The cracks are sealed with silica (not obvious quartz veins) that Snyder interpreted to be diagenetic (Snyder and Bruekner, 1983; Snyder and others, 1983; Bruekner and Snyder, 1985; Bruekner and others, 1987). Further documentation of this deformational event is important for two reasons: (1) If it exists, it provides another line of evidence that the rocks of the 'western' Eleana may be genetically related to the Havallah sequence of the Golconda allochthon. (2) If it exists, we must be careful not to confuse it with mesoscopic deformation produced by later structures (e.g., Mesozoic(?) thrusting).

We have mapped several structures in the southern Eleana Range that are unequivocally related to **Mesozoic(?) thrust faulting**. One of these is the large overturned fold south of Red Canyon in the lower (submarine fan) portion of the 'western' Eleana (just north of the uncolored area in Fig. 3). Overturned upper (biogenic/detrital) 'western Eleana' overlies 'eastern Eleana' along a sub-horizontal contact farther south in the Eleana Range. More mapping is needed to resolve the structural relationships between these two areas (uncolored area in Fig. 3). The geometry and extent of thrust faulting in the southern Eleana Range is particularly important to Task 8: It will constrain projections of structures toward the southwest (toward the poorly-exposed Calico Hills and then Yucca Mountain). It will also help us evaluate the applicability of "thrust play" models for creating hydrocarbon reservoirs at NTS.

The **fault juxtaposing 'eastern' and 'western' Eleana** is cryptic, and is best exposed in the southernmost Eleana Range (see the southwest quadrant of the geologic map, Fig. 3). Here, it is sub-vertical and strikes north-northwest. Several exposures farther north in the Eleana Range also indicate a north-striking, sub-vertical fault contact. It is not yet known whether this represents the original fault contact between the 'eastern' and 'western' Eleana, or a later (possibly reactivated) fault. Steep foliation characterizes the 'eastern' Eleana in the vicinity of the fault. In the 'western 'Eleana, the fault is at a relatively high angle to bedding, and a broad, overturned fold is sometimes -- but not always -- developed within 10 to 20 m of the fault. This folding suggests west-over-east reverse movement. Foliation, brecciation, and veining (quartz, calcite, or chalcedony) occur locally, adjacent to the contact. The fault juxtaposing 'eastern' and 'western' Eleana is potentially the most significant structure at NTS from a tectonic standpoint, yet the nature of this fault remains disappointingly enigmatic. Further mapping, particularly farther north along the front of the Eleana Range, may reveal better exposures of this feature.

Tertiary low-angle normal faulting is characterized by brecciation, iron staining, and polished or striated fault surfaces. Shattering -- with or without veining -- is typical near the base of the upper plate. Its distribution is irregular; it may extend tens of meters into the upper plate. Iron staining is common along the fault contact and in the lower plate in the vicinity of the contact. We have mapped low-angle faulting at several places in the southern Eleana Range; its presence has explained some anomalous map relationships (e.g., the "thrust slice" of Tippipah Limestone over Eleana mapped by Orkild (1963) in the Tippipah Spring quad (see geologic map, Fig. 3)). Jim Cole's detailed mapping at Mine Mountain (Cole and others, 1991) showed that both high- and low-angle normal faulting were active during Redrock Valley Tuff time (ca. 16 Ma). The tectonic transport due to low-angle faulting was toward the west and southwest. We don't yet know whether this is also true for the low-angle faulting in the southern Eleana Range, or how/whether Tertiary faulting in these adjacent areas might be related. Detailed mapping will be necessary to identify the low-angle faulting (let alone to determine the kinematics); it is vital that we do so, because of the potential for structural and stratigraphic misunderstandings if Tertiary faulting goes unrecognized!

BIOSTRATIGRAPHY

We have made great strides in biostratigraphic dating in the last year, increasing both the variety of techniques we can use and the number of samples we can analyze (at no increase in budget for biostratigraphic dating). In addition, we have curated all the samples -- they are now all stored, in numerical order by sample number, in the sample storage drawers in LMR 355A -- and put all sample information into a computer data base (see Appendices 2 and 3). Much of this has been possible because of student technician help.

With the recognition (in December, 1991) that the siliceous rocks in the upper 'western' Eleana were spiculites, came the possibility of getting both age and environmental information from these rocks. We have set up a lab for extracting **radiolaria and sponge spicules**, and have arranged for Bonny Murchey (USGS) to analyze the residues. She is able to date them, based primarily on radiolaria, and to make some interpretations about the depositional environment (especially paleobathymetry) based on the proportions of different kinds of sponge spicules. Preliminary results are in agreement with age determinations based on other methods. Our future sampling will be designed to take advantage of our new ability to date siliceous rocks.

We have not dated any additional samples using **endothyrids and calcareous algae**. This method has given very consistent results from the two stratigraphic horizons we have sampled extensively (the base of the organic/detrital section in the 'western' Eleana and the top of the 'eastern' Eleana). We would now like to determine how these ages compare to conodont and radiolarian ages from the same rocks.

We have not dated any additional samples using **palynology**, because we have found widespread skepticism about the accuracy of this technique among colleagues in academia. We were using this method to date the mudstones of the 'eastern' Eleana section, and we have yet to find an effective alternate dating method for these rocks. Claude Spinosa (of Boise State University) sampled 'eastern' Eleana core and processed it for conodonts in his lab, but, so far, the samples have been barren.

Ideally, we would like to have a single biostratigraphic dating tool that could be applied throughout both 'eastern' and 'western' Eleana sections; this would be the most reliable way to compare the ages of the two. The best candidate for such a tool is

conodonts, which can be found in both carbonates and mudstones. In previous years, we have gotten conodont ages from both 'eastern' and 'western' Eleana rocks, although these have only been from the carbonates in each section. We are now in the process of setting up a conodont extraction lab. This will allow us to run more (potentially barren) samples in our attempt to find datable rocks. Dora Gallegos and Claude Spinosa of Boise State University are willing to do preliminary identifications for us, but have recommended that we contact an expert on Mississippian conodonts (Anita Harris or Bruce Wardlaw of the USGS) to do the final identifications.

IMPLICATIONS FOR HYDROCARBON POTENTIAL

The 'eastern' Eleana is the only potential hydrocarbon **source rock** within the Eleana Formation, and its surface exposure is limited to the area around Yucca Flat. It can probably be traced to correlative units (Chainman Shale and Scotty Wash quartzite) to the northeast. To the southwest, it is exposed in the Calico Hills (Fig. 1(a)), where it extends to a depth of at least 2552' in drillhole UE25a-3 (Jim Cole, written comm., 1991). We have no data about the extent of the 'eastern' Eleana west of the Calico Hills. In the southern Eleana Range, 'eastern' Eleana is structurally juxtaposed against the 'western' Eleana along a cryptic fault. We must understand the geometry and kinematics of this fault in order to predict the sub-surface distribution of the 'eastern Eleana'. This distribution will be a critical factor in assessment of hydrocarbon potential near Yucca Mountain.

The other potential source rock in the area is the Tippipah limestone. This unit has received almost no attention to date, and will be a target of our investigations in the next year.

The coarse clastic 'western' Eleana is a potential hydrocarbon **reservoir**, although surface exposures suggest very low porosity and permeability. These strata do have correlatives to the west and probably project to Bare Mountain, where a section of mostly fine-grained siliciclastic sediments has been mapped as Eleana Formation. The paleotopographic control on the 'western' Eleana strongly indicates that coarse facies cannot be projected northwest or southeast, but that very likely they will extend to the southwest toward Yucca Mountain

Thermal maturation data indicate that the 'eastern' Eleana and Tippipah Limestone may have had a favorable thermal history for hydrocarbon generation, while the 'western' Eleana is overmature.

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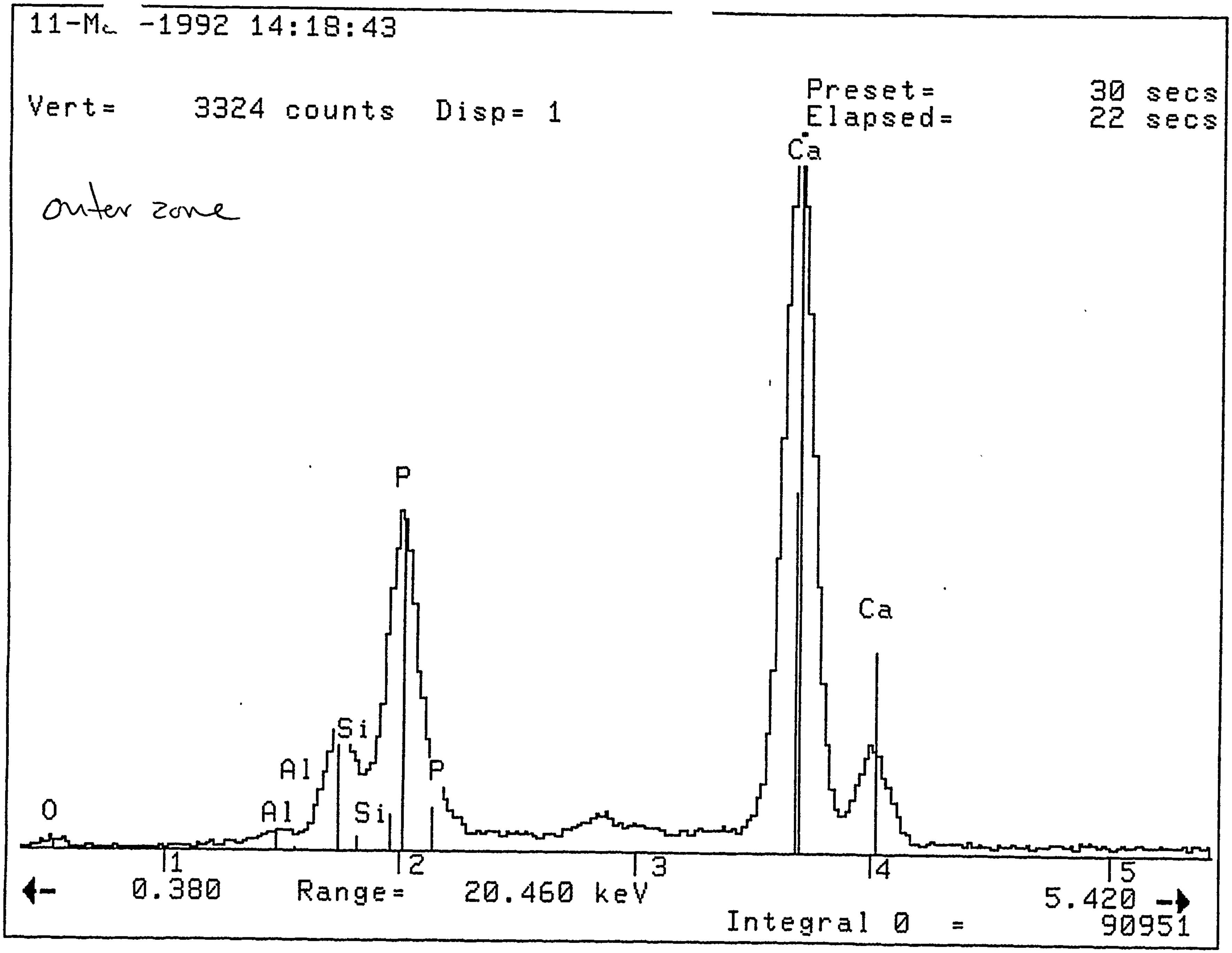
APPENDICES

Appendix 1: Three analyses -- core to rim -- of a white-weathering phosphatic clast from the 'western Eleana' (sampled near the base of the Castle Valley measured section). Phosphate, silica and calcium contents vary concentrically across the clast. Analyses were done using the energy dispersive spectrometer on the SEM.

Appendix 2: Table of samples processed by Task 8.

Appendix 3: Table of sample processing in progress.

APPENDIX I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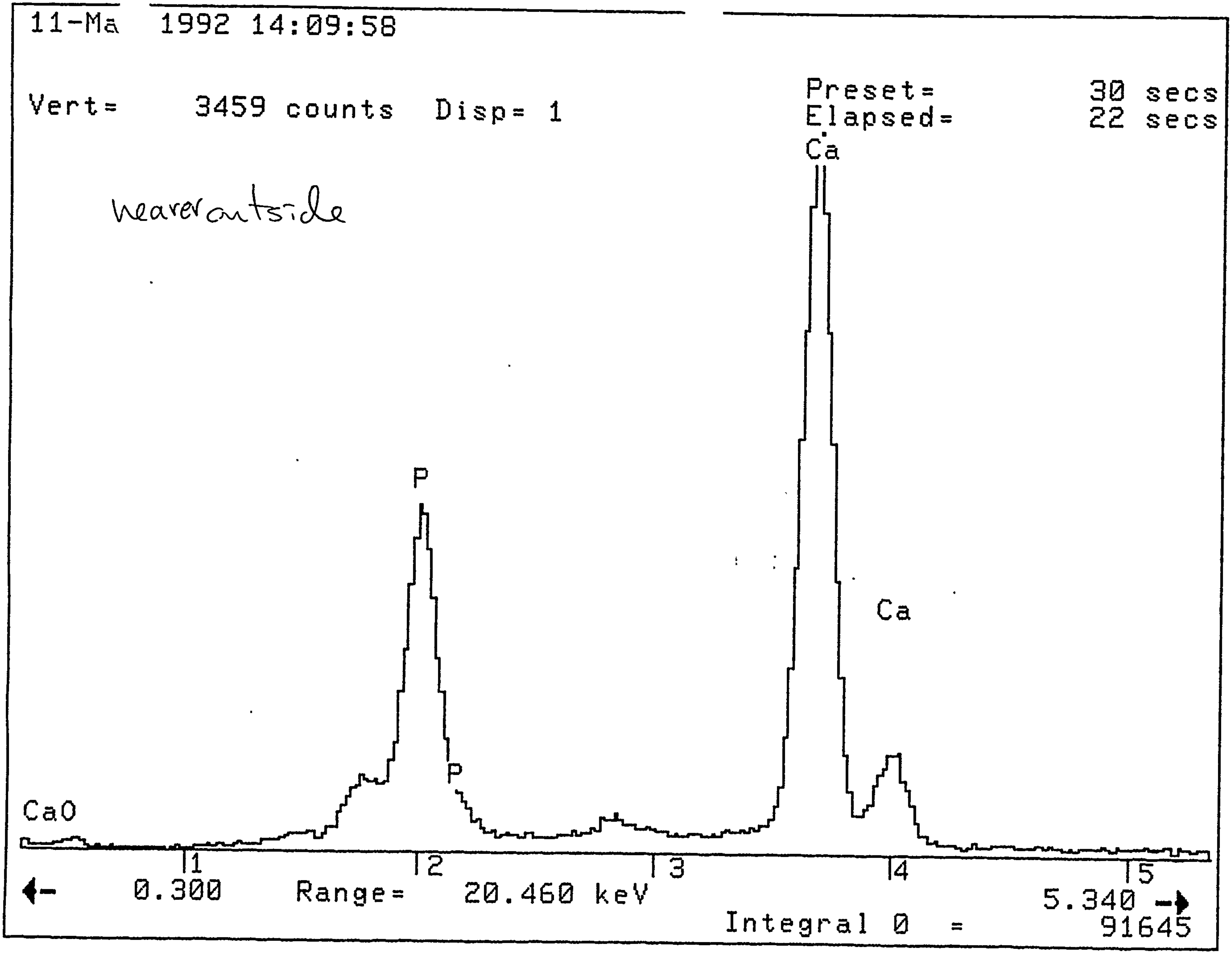
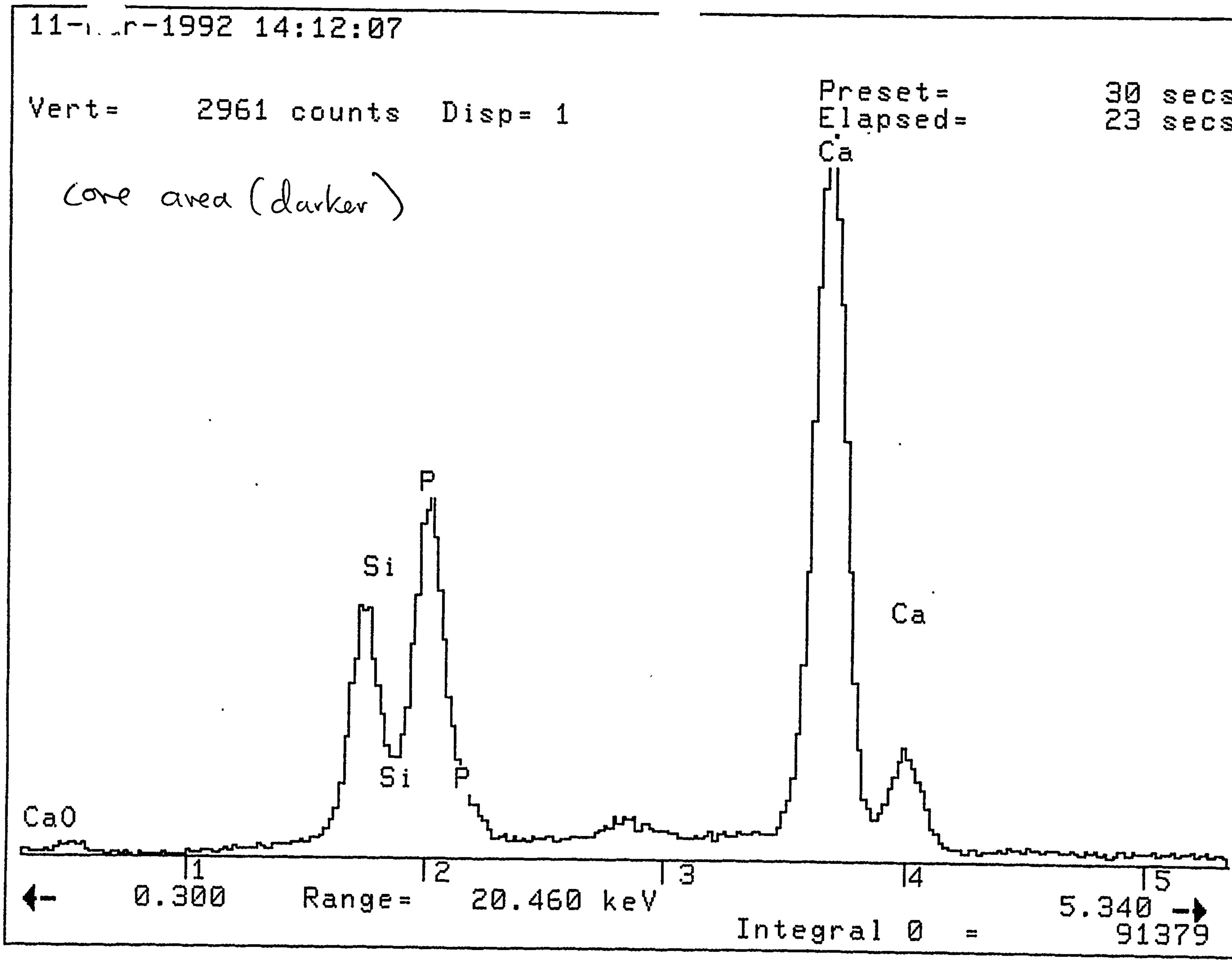
Vert= 3324 counts Disp= 1
Preset= 30 secs
Elapsed= 22 secs
outer zone
Ca
P
Ca
Si
Al
P
Al
Si
O
1
2
3
4
5
0.380
Range= 20.460 keV
5.420
Integral 0 = 90951


11-Ma 1992 14:09:58
Vert= 3459 counts Disp= 1
Preset= 30 secs
Elapsed= 22 secs
nearer outside
Ca
P
P
Ca
CaO
1
2
3
4
5
0.300 Range= 20.460 keV
5.340
Integral 0 = 91645



11-…r-1992 14:12:07
Vert= 2961 counts Disp= 1
Preset= 30 secs
Elapsed= 23 secs
core area (darker)
Ca
Si
P
Si
P
Ca
CaO
1
2
3
4
5
0.300
Range= 20.460 keV
5.340
Integral 0 = 91379

APPENDIX II

DATED NTS SAMPLES

SAMPLE#	DATE	ROCK TYPE	STRATIGRAPHIC UNIT	PURPOSE FOR COLLECTION
89-JT-331	UNKNOWN	LS	Mdp	PALEO
89-JT-341	6/8/89	LS	TRIPON PASS FM (?)	PALEO
89-JT-402	7/9/89	LS	Mdp	PALEO
89-JT-442	7/10/89	LS	Mdp	PALEO
89-JT-446	7/10/89	LS	Mdp	PALEO
89-JT-451	7/11/89	LS	Mdp	PALEO
89-JT-454	7/11/89	LS	ELY (?)	PALEO
89-JT-455	7/11/89	LS	ELY	PALEO
89-JT-457	7/11/89	LS	ELY	PALEO
89-JT-461	7/11/89	LS	ELY	PALEO
2-89-SN-402	3/18/89	LS	MDe	PALEO
2-89-SN-402	3/18/89	LS	MDe	PALEO
2-89-SN-404	3/18/89	MICRITE	MDe	PALEO
2-89-SN-421	3/18/89	MICRITE	MDe	PALEO
2-89-SN-423	3/18/89	BLACK SH	MDe	PALEO
2-89-SN-461A	3/20/89	BCLSTC PACKSTONE	MDe	PETROG
2-89-SN-461B	3/20/89	BCLSTC PACKSTONE	MDe	PALEO
2-89-SN-601	5/20/89	DOL	DEVONIAN CARB	CAI
2-89-SN-612	5/20/89	BXTED, SLIGHTLY SLCFD BCLSTC LS	DEVONIAN CARBONATE	CAI
2-89-SN-613	5/20/89	BCLSTC LS	M ELEANA	CAI
2-89-SN-633	5/21/89	BCLSTC LS	M ELEANA	CAI
2-89-SN-642	5/21/89	MED GREY FINE-GRAINED LS	DEVONIAN	CAI
2-89-SN-643	5/22/89	DARK FETID LS	DEVONIAN	TOC
2-89-SN-651	5/22/89	FUSILINID-RICH SILTY LS	PERMIAN: BIRD SPG LS, *	CAI
2-89-SN-653	5/22/89	SANDY BCLSTC LS	M ELEANA FM	CAI
2-89-SN-662B	5/22/89	BCLSTC SILTY LS	M ELEANA	CAI
2-89-SN-671	5/22/89	BCLSTC LS	ORDOVICIAN ANTELOPE VALLEY	CAI & PALEO
2-89-SN-681	5/23/89	COARSE-GRAINED BCLSTC LS	M ELEANA	CAI/PETROG
2-89-SN-684A	5/23/89	MICRITE	PENN - PERM BIRD SPG	PALEO/CAI
2-89-SN-721	5/24/89	DOL	DEVONIAN	CAI
2-89-SN-722	5/24/89	BCLSTC LS	M ELEANA	CAI/PALEO
3-89-SN-826	6/30/89	BCLSTC LS	M ELEANA	CAI
4-89-SN-923	9/1/89	BCLSTC MICRITE	M ELEANA	PALEO & CAI

LOCATION	MAP LOCALITY
LMR 355A	DIAMOND SPG, NV 15' SEC 6, NW 1/4, T 22 N, R 55 E
LMR 355A	DIAMOND SPG, NV 15' SEC 1, SW 1/4, T 22 N, R 54 E
LMR 355A	DIAMOND MTS, NV 15' SEC 6, T 22 N, R 55 E
LMR 355A	BUCK MT, NV 15' SEC 1-2, T 20 N, R 56 E
LMR 355A	BUCK MT, NV 15' SEC 1-2, T 20 N, R 56 E
LMR 355A	DIAMOND SPG, NV 15' SEC 6, T 22 N, R 55 E
LMR 355A	DIAMOND SPG, NV 15' SEC 6, T 22 N, R 55 E
LMR 355A	DIAMOND SPG, NV 15' SEC 31, T 23 N, R 55 E
LMR 355A	DIAMOND SPG, NV 15 ' SEC 31, T 23 N, R 55 E
LMR 355A	DIAMOND SPG, NV 15' SEC 32, T 23 N, R 55 E
LMR 355A	BEATTY MT, NV 7.5' SEC 24, T 12 S, R 47 E
LMR 355A	BEATTY MT, NV 7.5' SEC 24, T 12 S, R 47 E
LMR 355A	BEATTY MT, NV 7.5' SEC 24, T 12 S, R 47 E
LMR 355A	BEATTY MT, NV 7.5' SEC 24, T 12 S, R 47 E
LMR 355A	BEATTY MT, NV 7.5' SEC 24, T 12 S, R 47 E
LMR 355A	JACKASS FLAT, NV 7.5' SEC 30, NE 1/4, T 12 S, R 51 E
LMR 355A	JACKASS FLAT, NV 7.5' SEC 30, NE 1/4, T 12 S, R 51 E
LMR 355A	CARRARA CYN, NV SEC 29, SW 1/4, T 12 S, R 48 E
LMR 355A	BEATTY MT, NV SEC 20, NW 1/4, T 12 S, R 48 E
LMR 355A	BEATTY MT, NV SEC 20, NW 1/4, T 12 S, R 48 E
LMR 355A	BEATTY MT, NV 40.81.2 X 5.29.4
LMR 355A	RAINIER MESA, NV 41.14.6 X 5.72.5
LMR 355A	RAINIER MESA, NV 41.15.6 X 5.73.2
LMR 355A	TIPPIPAH SPG, NV 41.02.5 X 5.75.3
LMR 355A	MINE MT, NV 40.94.4 X 5.75.5
LMR 355A	MINE MT, NV 40.93.5 X 5.77.4
LMR 355A	YUCCA LAKE, NV 40.93.9 X 5.79.2
LMR 355A	YUCCA LAKE, NV 40.86.1 X 5.81.9
LMR 355A	YUCCA LAKE, NV 7.5' 40.86.1 X 5.81.9
LMR 355A	JACKASS FLAT, NV 40.80.1 X 5.60.5
LMR 355A	JACKASS FLAT (CALICO HILLS), NV 40.80.1 X 5.60.8
LMR 355A	TIPPIPAH SPG, NV 41.05 X 5.71.9
LMR 355A	TIPPIPAH SPG, NV 40.99.7 X 5.71.7

DESCRIPTIVE LOCALITY
WALTERS CYN SECTION, RIDGE BETWEEN WALTERS & HOMESTEAD CYNS; LS AT BASE OF SEGMENT III
WALTERS CYN SECTION & RIDGE BETWEEN WALTERS & HOMESTEAD CYNS; AT BASE OF SECTION
1800 m LEVEL; WALTERS CYN SECTION
152 m LEVEL; BUCK MT SECTION & S END OF BUCK MT
315 m LEVEL; BUCK MT SECTION, S END OF BUCK MT
2160 m LEVEL; WALTERS CYN SECTION
2295 m LEVEL; WALTERS CYN SECTION
2420 m LEVEL; WALTERS CYN SECTION
2570 m LEVEL; WALTERS CYN SECTION
2640 m LEVEL, TOP OF SECTION; WALTERS CYN SECTION
SECRET PASS SECTION, BARE MT; 63 m
SECRET PASS SECTION, BARE MT @ 63 m
SECRET PASS SECTION, BARE MT @ 160 m
SECRET PASS SECTION, BARE MT @ 320 m
~ 10 m N OF SPECIE SPG PASS RD, SECRET PASS @ 500 m
CALICO HILLS, S FACING ARROYO, DOWNSLOPE FROM KLIPPEN OF DEVONIAN CARBONATE
CALICO HILLS, S FACING ARROYO, DOWNSLOPE FROM KLIPPEN OF DEVONIAN CARBONATE
S END OF TARANTULA CYN RD, Eern SIDE OF BARE MT
UP PLATE OF MEIKLEJOHN THRUST ~1km N OF TOP OF TARANTULA CYN MSRD SECT
E SIDE OF BARE MT, TARANTULA CYN SECTION @ 870 m
ALONG SPECIE SPG RD ~ 0.2 km E OF SECRET PASS & SECRET PASS SECT, BARE MT & UPR PLATE PANAMA, LWR PLATE MEIKLEJOHN @ 410 m
W SIDE OF TONGUE WASH, AREA 12 NTS & UPPER PLATE OF BELTED RANGE THRUST, BETWEEN G & N RDS
W SIDE OF TONGUE WASH AREA 12 NTS ALONG NEXT RD S OF N TUNNEL RD & UPPER PLATE BELTED RANGE THRUST
N END OF SYNCLINE RIDGE, S OF PAHUTE MESA RD
W SIDE OF MINE MT, LOW SLOPES ~ 1km NW OF MINE MT SUMMIT
E SIDE OF MINE MT IN FOOTWALL OF MINE MT THRUST (C.P. THRUST)
E OF MINE MT, S SIDE OF MINE MT RD ~ 1 km W OF INTERSECTION W/ MERCURY HWY
LEDGES OF BIOCLASTIC LS @ C.P. HILLS SECTION; 54 m
C.P. HILLS MEASURED SECTION, C.P. HILLS, NTS @ 85 m
CALICO HILLS, NTS, SE OF PEAK 5015
NEAR RX SMPL #721, W/IN HINGE OF W VERGENT SYNCLINE, IMMEDIATELY BELOW UPPER PLATE OF DEVONIAN CARBONATE
S ELEANA RANGE SECTION @ 400 m
TIPPIPAH SPG SECTION, SYNCLINE RIDGE @ 30 m

OUTCROP DESCRIPTION
UNRESISTENT LS FORMS SADDLE
THIN & POORLY EXPOSED LS
RECESSIVE LS
SILTY, LEDGY LS
LEDGY LS
BIOCLASTIC WACKESTONE
MICRITE
MICRITE & WACKESTONE
PACKSTONE & WACKESTONE
CHERTY LS, WACKESTONE & MICRITE
LOW LS LEDGE IN MEASURED SECTION
LOW LS LEDGE IN MEASURED SECTION
ALONG SECRET PSS MICROWAVE TOWER RD
LOW SWITCH BACK, SECRET PASS RD
HINGE ZONE OF OVEERTURNED FOLD BELOW MEIKLEJOHN THRUST
~ 2 m THICK LEDGE OF OVERTURNED LS & MICRITE
~ 2 m THICK LEDGE OF OVERTUNED LS & MICRITE
RESISTENT CARBONATE BLUFFS ALONG S SIDE OF TARANTULA CYN RD, ~ 1 km W OF TARANTULA MEASURED
LOW OC OF BXTED & SILICIFIED BIOCLASTIC LS FROM TOP OF RIDGE
LAST (HIGHEST) RESISTENT LS LEDGE W/IN TARANTULA CYN FACIES
OLIVE GREY BIOCLASTIC LS ALONG SW SIDE OF SPECIE SPG RD
STEEP KNOB OF CARBONATE ~ 500 m W OF RAINIER MESA RD
EXPOSURES IN RDCUT ADJACENT TO THRUST CONTACT W/ MISSISSIPPIAN
LOW LEDGY BENCHES OF ORANGE WEATHERING SILTY FUSILINID LS FROM LOW ON N-FACING TIP OF SYNCLINE RIDGE
LOW OC OF LS IN A SADDLE AREA
LOW OC OF LS BELOW DEVONIAN CARBONATE OF HANGING WALL
LOW HILLS TO S OF MINE MT RD, LOW EXPOSURES OF LIGHT GREY LS
LOW LEDGES OF LS
FIRST (LOW) OCCURRENCE OF GREY FINE-GRAINED MICRITE
RESISTENT RIDGE IN UPPER PLATE OF C.P. THRUST
SMALL GULLEY EXPOSURES IN SE -FACING CYN WALL
NONE
ORANGE WEATHERING LATERALLY PERSISTENT BED OF BIOCLASTIC MICRITE

PROCESSING & RESULTS

2/3 SAMPLE TO MICROSTRAT 7/20/89& PROB ZONE 7 OR SLIGHT YNGR (MID TOURNAISIAN, UP KINDER OR SLIGHT YNGR
1/2 SAMPLE TO MICROSTRAT 7/20/89& ZONE PRE-7, KINDERHOOKIAN, E. MINIMA MICROFACIES
1/2 SAMPLE TO MICROSTRAT 7/20/89& APPROX ZONE 16, BASAL CHESTERIAN
ENTIRE SAMPLE TO MICROSTRAT 7/20/89& APPROX ZONE 16, BASAL CHESTERIAN
ENTIRE SAMPLE TO MICROSTRAT 7/20/89& ZONE 16 OR 17, MID CHESTERIAN
ENTIRE SAMPLE TO MICROSTRAT 7/20/89& BOUNDARY BETWEEN ZONES 18 & 19, LATEST CHESTERIAN
1/2 SAMPLE TO MICROSTRAT 7/20/89& BOUNDARY BETWEEN ZONES 19 & 20, LATEST CHESTERIAN/EARLIEST PENN
ENTIRE SAMPLE TO MICROSTRAT 7/20/89& EARLIEST PENN
1/2 SAMPLE TO MICROSTRAT 7/20/89& ZONE 20, EARLY PENN, MORROWAN, PART OF THE ELY
1/2 SAMPLE TO MICROSTRAT 7/20/89& ZONE 21, PENN, BASAL ATOKAN
SENT TO MICROSTRAT 5/18/89& INDETERMINATE, REWORKED MUDFLOW
SENT TO MICROSTRAT 5/18/89& INDETERMINANT, REWORKED MUDFLOW,
TO MICROSTRAT 5/18/89& INDETERMINATE-BASINAL
TO MICROSTRAT 5/18/89: INDETERMINATE, BASINAL, VERY CALM
TO MICROSTRAT 5/18/89& INDETERMINATE- BASINAL, VERY CALM
NONE (?)& ZONE 16, CHESTERIAN OT YOUNGER
TO MICROSTRAT 5/18/89& CHESTERIAN (ZONE 16), POSSIBLE MUDFLOW
TO MICROSTRAT 5/31/89& UPPER MIDDLE DEVONIAN, ENSENSIS ZONE, CAI 5
TO MICROSTRAT 5/31/89& POSSIBLE DEVONIAN, CAI 6
TO MICROSTRAT 5/31/89& CAI 5, POST-EARLY KINDERHOOKIAN
TO MICROSTRAT 5/31/89& CAI-4.5, INDETERMINATE
TO MICROSTRAT 5/31/89& CA1-6, DEVONIAN
TO MICROSTRAT 5/31/89& TOC-0.16%
TO MICROSTRAT 5/31/89& CAI 1.5-2, * UPPER DEVONIAN : FRASNIAN, FAMENNIAN
TO MICROSTRAT 8/28/89, RTRND 10/19/89 (OR 12/3/89?)& CAI-3, EARLY MISS, PROB KINDERHOOKIAN
TO MICROSTRAT 8/28/89, RTRND 10/19/89 & 12/3/89: CHESTERIAN, CAI-4
TO MICROSTRAT 5/31/89& CAI-5.5, EARLIEST MID ORD
TO MICROSTRAT 5/31/89 & TO NBMG (TS) 7/9/89& CAI-4 & INDETERMINATE (NOT INCONSISTENT W/ MISS)
TO MICROSTRAT 8/28/89, RTRND 10/19/89 & 12/3/89& CAI-4, LOW PENN (MORROWAN)
TO MICROSTRAT 5/31/89& INDETERMINANT & BARREN OF CONODONTS
TO MICROSTRAT 5/31/89& CAI-4, MID MISS (OSAGEAN)
TO MICROSTRAT 8/28/89& RTRND 10/19/89, CAI 4.5 +, INDETERMINATE
TO MICROSTRAT 3/13/90& REPORT MSI 90-15 (5/90), PENN, CAI- 4

DATED NTS SAMPLES #2

SAMPLE#	DATE	ROCK TYPE	STRATOGRAPHIC UNIT
3-89-SN-1033	9/6/89	BCLSTC LS	M ELEANA
3-89-SN-1053	9/7/89	MICRITE	PENN BIRD SPG
4-89-SN-1113	9/9/89	BLACK SH	M ELEANA*
4-89-SN-1153	9/21/89	SILICEOUS SLTST	M ELEANA
4-89-SN-1264	9/25/89	SILICEOUS MDST	M ELEANA MID SEQUENCE (LOWER MEMBER)
5-89-SN-1452	11/4/89	CLAYSTONE	M SCOTTY WASH
90-JTA-12	6/25/90	MDST	ELEANA FM
90-JTA-21	6/25/90	CALCARNT (MAMET: MED-GRND FSL BCLST PKSTN)	ELEANA FM
90-JTA-22	6/25/90	MDRX	ELEANA FM
90-JTA-31	6/25/90	MDST	ELEANA FM
90-JTA-32	6/25/90	MDST	ELEANA FM
90-JTA-33	6/25/90	MDST	ELEANA FM
90-JTA-34	6/25/90	MDST	ELEANA FM
90-JTA-41	6/25/90	CALCARNT (MAMET: MED-GRND FSL PCKSTN)	ELEANA FM
90-JTA-42	6/26/90	MDRX	ELEANA FM
90-JTA-43	5/26/90	CALCARENITE (MAMET: FOSSIL PACKSTONE)	ELEANA FM
90-JTA-51	6/26/90	CALCARNT (MAMET: CRS-GRND FSL LUMP GRAINSTN)	ELEANA FM
91-PC-172	3/21/91	BCLSTC LS; CHERT FLOAT	ELEANA, W FACIES
91-PC-271	5/10/91	BCLSTC LS	ELEANA, UPPER PART OF W FACIES
91-PC-282	5/10/91	BCLSTC LS	ELEANA, W FACIES- UP PART
UE16d-944	3/21/91	LS	NONE
UE16d-1461	3/21/91	DARK FOSSILIFEROUS LS	NONE
88-JT-201	7/12/88	GRUNGE: TAILINGS F/ PANCAKE COAL MINE	PENN ELY LS (?)
88-JT-311	7/14/88	BCLSTC LS	Mdp
88-JT-382	8/7/88	BCLSTC LS	PENN ELY
88-JT-383	8/8/88	MUDROCK	Mc (WHITE PINE SHALE)
88-JT-402B	8/8/88	CRINOIDAL LS	Mdp
88-JT-481	8/10/88	LS	Mdp
88-JT-511	8/12/88	CALCARENITE	Mdp "LOWER SEQUENCE
88-JT-513	8/12/88	SILTY LS	Mdp
88-JT-541	8/13/88	BLACK SLTST	Mc (?) BASE OF Mdp
88-JT-542	8/13/88	CRINOIDAL LS	Mdp
88-JT-581B	9/29/88	CALCAREOUS ARENITE	Mdp; "NEWARK VALLEY SEQUENCE?"
88-SN-41	10/13/88	COARSE LS PACKSTONE	Me, ELEANA FM- UPPER SEQUENCE

PURPOSE FOR COLLECTION	LOCATION	MAP LOCALITY
CAI	LMR 355A	TIPPIPAH SPG, NV 41.02 X 5.70.8
PALEO	LMR 355A	TIPPIPAH SPG, NV 41.01 X 5.73.8
TOC/PALEO	LMR 355A	TIPPIPAH SPG, NV 41.05.5 X 5.73.5
TOC	LMR 355A	MINE MT, NV 40.94.8 X 5.76.4
TOC/PALY	LMR 355A	RAINIER MESA, NV 41.09.5 X 5.74.8
TOC/PALY	LMR 355A	HANCOCK SUMMIT, NV 41.50 X 6.47.6
TOC/ ROCK EVAL	LMR 355A	TIPPIPAH SPGS, NV 7.5' 41.04.7 X 5.72.4
PALEO	LMR 355A	TIPPIPAH SPG, NV 7.5' 41.04.8 X 5.72.3
TOC/ ROCK EVAL	LMR 355A	TIPPIPAH SPG, NV 7.5' 41.04.9 X 5.71.95
TOC/ ROCK EVAL	LMR 355A	TIPPIPAH SPG, NV 7.5' 41.06.5 X 5.72
TOC/ ROCK EVAL	LMR 355A	TIPPIPAH SPGS, NV 7.5' 41.06.1 X 5.72.9
TOC/ ROCK EVAL	LMR 355A	TIPPIPAH SPG, NV 7.5' 41.05.9 X 5.73.1
TOC/ ROCK EVAL	LMR 355A	TIPPIPAH SPG, NV 7.5' 41.05.6 X 5.73.4
PALEO	LMR 355A	TIPPIPAH SPG, NV 7.5' 41.06.5 X 5.71.8
TOC/ ROCK EVAL	LMR 355A	TIPPIPAH SPG, NV 7.5' 41.06.5 X 5.71.8
PALEO	LMR 355A	TIPPIPAH SPG, NV 7.5' 41.06.5 X 5.71.6
PALEO	LMR 355A	TIPPIPAH SPRINGS, NV 7.5' 41.06.6 X 5.71.2
PALEO (ENDOTHYRIDS IN LS, RADS IN CHERT)	LMR 355A	TIPPIPAH SPRING, NV 7.5' 41.03.9 X 5.70.7
PALEO	LMR 355A	TIPPIPAH SPRING, 7.5' 41.03.4 X 5.69.4
PALEO	LMR 355A	TIPPIPAH SPRING, NV 7.5' 41.01.3 X 5.70.4
PALEO	LMR 355A	TIPPIPAH SPRING, NV 7.5' 41.03.5 X 5.74.6
PALEO	LMR 355A	TIPPAH SPRING, NV 7.5' 41.03.5 X 5.74.6
PALEO (PALY)	LMR 355A	PANCAKE SUMMIT, NV 15' SEC 28, NE 1/4, T 18 N, R 56 E
PALEO	LMR 355A	UNKNOWN
PALEO	LMR 355A	GREEN SPRINGS, NV 15' SEC 4, NW 1/4, T 14 N, R 57 E
PALEO- BRACH FAUNA	LMR 355A	GREEN SPRINGS, NV 15' SEC 4, NW 1/4, T 15 N, R 57 E
PALEO	LMR 355A	GREEN SPRINGS, NV 15' SEC 32, NW 1/4, T 16 N, R 56 E
PALEO	LMR 355A	UNKNOWN
PALEO	LMR 355A	PANCAKE SUMMIT, NV SEC 2, NW 1/4, T 19 N, R 57 E
PALEO (CRINOID SPINES & BRACHS)	LMR 355A	PANCAKE SUMMIT, NV SEC 2, NW 1/4, T 19 N, R 57 E
PALEO	LMR 355A	BUCK MT, NV SEC 12, NW 1/4, T 20 N, R 56 E
PALEO	LMR 355A	BUCK MT, NV 15' SEC 11, NE 1/4, T 20 N, R 56 E
PALEO	LMR 355A	MOODY PK, NV 15' SEC 15, NE 1/4, T 15 N, R 54 E
PALEO	LMR 355A	YUCCA LAKE, NV 7.5' SE 1/4, 5.81 X 40.86

DESCRIPTIVE LOCALITY

E GAP WASH, S ELEANA RANGE @ 150 m
SYNCLINE RIDGE @ 290 m
BOTTOM OF RED CYN WASH, WELL OUT ON THE PEDIMENT, ELEANA RANGE
MINE MT SECTION @ 15 m, INCISED PEDIMENT ~ 0.5 km N OF MINE MT RD
IN INCISED ARROYO OUT ON PEDIMENT N OF GROUSE CYN
NE END OF E PAHRANAGAT RANGE ~500 m S OF HWY 375
S ELEANA RANGE SECTION, MDST SECTION
S ELEANA RANGE SECTION, LS AT TOP OF SILIC SEQUENCE
S ELEANA RANGE SECTION, UPPER SILICICLASTIC UNIT
RED CYN SECTION, MDST SEQUENCE NEAR BASE (=SPN 1551)
RED CYN SECTION, MID OF MDST INTERVAL
RED CYN SECTION, MID OF MDST INTERVAL (=SPN 1581)
RED CYN SECTION, HIGHEST EXPOSED MDST (~SPN 1113)
RED CYN SECTION, MIDDLE OF CALC TURBIDITE SECTION (= 90-JTA-42)
RED CYN SECTION, MID OF CALC TURBIDITE SECTION (= 90-JTA-41)
RED CYN SECTION , MID OF CALC TURBIDITE SEQUNENCE
RED CANYON, LOW-MID CARBONATE TURBIDITE SECTION
STRUCTURALLY BELOW THRUST SLICE OF TIPPIPAH LS & ABOVE E FACIES ELEANA
W RIDGE OF S ELEANA RANGE, IMMEDIATELY S OF PAHUTE MESA RD
SADDLE AT JUNCTION OF W & E RIDGES OF S ELEANA RANGE JUST N OF BUCKBOARD MESA RD
W EDGE OF SYNCLINE RIDGE, IMMEDIATELY N OF PAHUTE MESA RD
W EDGE OF SYNCLINE RIDGE, IMMEDIATELY N OF PAHUTE MESA RD
COLLECTED F/ TAILING PILE NEAR ADIT, Sern MOST OF 3 COAL MINE SHAFTS IN PANCAKE COAL MINE
OLD HWY 80, CARLIN TUNNEL
TOP OF GREEN SPRINGS MESURED SECTION
BASE OF GREEN SPRINGS MEASURED SECTION; LOW HILLS E OF BASE OF SECTION, WHITE PINE RANGE
BASE OF MEASURED SECTION "PANCAKE SOUTH"
HOBSON PASS AREA, TOGININI SPRINGS MTS/MAVERICK SPRINGS RANGE
BASE OF "DRY MOUNTAIN" MEASURED SECTION
145 m, DRY MT SECTION W/IN "LOWER SEQUENCE"
IN A GULLY BOTTOM, EXPOSED BLACK FOSSILIFEROUS SLTST
PROMINENT GREY-GREY VERTICAL BLUFF BENEATH WHITE-COLORED SS
LOW BED IN THE "UPPER SEQUENCE" ABOVE ANGULAR UNCONFORMITY, "E POGUE'S STATION"
Sern FLANK C.P. HILLS

OUTCROP DESRIPTION
NONE
NONE
CUT BANK EXPOSURE OF SH & SLTST
PIT EXCAVATION
BLACK MDST EXPOSED IN INCISED ARROYO
CUT BANK ALONG DIRT RD/ARROYO
RUBBLY MDST, POOR EXPOSURE
(=SPN 826)
THIN-BEDDED MDST, SLTST & SS W/ MINOR GRIT
RUBBLY POOR EXPOSURES OF MDST & FINE SS
RUBBLE OC OF MDST
RUBBLE OC OF MDST
RUBBLE OC OF MDST
WELL-EXPOSED SILICIC MUDRX & CALC TURBIDITES
WELL-EXPOSED SILIC MUDRX & CALC TURBIDITES
CARBONATE TURBIDITE & SILIC MUDRX
WELL-BEDDED CARBONATE TURBIDITES
NONE
MED-GREY BIOCLASTIC LS INTBDD W/ BLACK SILICEOUC ARGILLITE & SLTST
ORANGE-WTHRNG DOLOMITE (?), MED GREY BIOCLASTIC LS (FETID!) & BLACK SILICEOUS ARGILLITE
CORE; 944.5-944.7' BELOW SURFACE
CORE; 1461.4-1461.7' BELOW SURFACE
LEDGY, CHERT LS; COAL DOES NOT CROP OUT AT SURFACE
OC OF LS BETWEEN CGL PACKETS
LOW RESISTANT LEDGE OF BIOCLASTIC LS OF ELY
RECESSIVE SLOPE W/ OCCASIONAL GOOG (!) EXPOSURES OF CHAINMAN MUDROCK
LOW OC AT BASE OF MEASURED SECTION
LS @ 145 m; HOBSON PASS MEASURED SECTION; TOP OF FIRST CGL PACKAGE
LOWER CGL BODY, SAMPLE F/ TOP OF CGL @ 5 m
PLATY WX BUFF LS @ TOP OF LOWER SEQUENCE
GULLY BOTTOM
STRATIFIED CRINOIDAL PACKSTONE BEDS- CRINOID GRAVEYARD
LOW BEDS IN UPPER SEQUENCE; LATERALLY PERSISTENT
LOW CO ~ 10 m UPHILL F/ LOW QZ ARENITE IN UPPER UNIT

PROCESSING & RESULTS

TO MS 3/13/90; MSI 90-14 (5/90), LT DEV, POST-FRAS, PROB CREPIDA-RHOMB ZONES & CAI-4
TO MS 3/13/90; MSI 90-15 (5/90), CHEST, YNGR ZONE 16, ENDOS & CALC ALGAE, 8 SPEC, EXT DOLOMIT & RECRYST, OPEN MARINE, RWRKD CARI
TO MS 3/13/90; MSI 90-15 (5/90): CAI=1.5, CDONT PRB PENN (MRWN), ONE SPECIES "PROB" ID
*TO MS 3/13/90; MSI 90-15 (5/90): PALY - PROB UPP DEV - UP FAM.ENVIR-MARINE. TOC = 0.68.TAI = 3+.SAMPLE CNSDRD PILOT SH FM
MS 3/13/90; MSI 90-15 (5/90): PALY- LWR M- TOURN, RSTRCT TO KINDER (PROB LWR). 4 SPEC; LWR M-TOUR JOANA FM. TOC - 0.53%. TAI
TO MS 3/13/90; REPORT MSI 90-15 (5/90): PALY- UP DEV TO MISS. MARINE. TOC- 0.79% TAI- 3-3+
TO MS 3/13/90; MSI 90-15 (5/90) PALY: UP MISS-VISEAN (RSTRCTD TO BASAL TC SPORE ZONE). TOC- 0.69%. TAI= 3-3-. LOWER CHAINMAN SH
SPLIT TO MS F/ TOC 7/20/90, PALY & TAI REQ 8/15/90; MSI 90-21 (10/90)TOC=1.09, TAI=3+ AGE= LWR MISS-UP DEV TRANS AREA. ONE SPOF
MS 7/20/90; MSI 90-21 (10/90): E CHEST~ ZONE 16. . AGE (CNDNTS): UP OSOG (ANCHORALIS-LATUS ZONE). CNDNTS MAY BE REWORKED (ENDO,
SPLIT TO MS F/ TOC (7/20/90), PALY & TAI REQ (8/15/90); MSI 90-21 (10/90): TOC=0.29, TAI=3+ , LWR M-UP D TRANS AREA, PROB RSTRCT
SPLIT TO MS 7/20/90, PALY & TAI REQ 8/15/90; TOC=0.38, TAI=3+ (AMOR KRGN, UP D-FAM (PROB RSTRCTD TO TOP D UP FAM). RARE HVY RBD
SPLIT TO MS F/ TOC 7/20/90, PALY & TAI REQ 8/15/90; MSI 90-21 (10/90)TOC=1.25, TAI=3+, UP D (PROB RSTRCD TO TOP D OF FAM. RARE WI
SPLIT TO MS F/ TOC 7/20/90, PALY & TAI REQ 8/15/90; MSI 90-21 (10/90): TOC=1.29, TAI=3+ UP D (PROB RSTRCT TO TOP D OF TOURN-FAM
SPLIT TO MS F/ TOC 7/20/90, PALY & TAI REQ 8/15/90; MSI 90-21 (10/90): TOC=0.91, TAI=3+, LWR M (PROB KNDRHK, POSS BASAL KNDRHK;
SPLIT TO MS 7/20/90; MSI 90-21 (10/90): E CHEST ~ ZONE 16. PALEOENVIRON- OPEN MARINE. PRESS SOLN.
SPLIT TO MS F/ TOC 7/20/90, PALY & TAI REQ 8/15/90; MSI 90-21 (10/90): TOC=0.28, TAI=3+, UP D-FAM (RSTRCTD TO VU-GM SPORE ZNS OF
MS 7/20/90; MSI 90-21 (10/90): E CHEST ~ ZONE 16 (F/ ENDO/CALC ALGAE). CONODONT AGE- OSAGEAN (MAY BE REWORKED). CAI=5.
M-S F/ AGE 7/20/90; MSI 90-21 (10/90): CHEST. POOR ZONATION. REWORKED. POSS TURBIDITE.
CHERT TO NORM SILBERLING & LS TO M-S (4/17/91); MSI 91-06 (5/91) RCV'D 7/26/91: AGE= (ENDO) MISS (?)
MS 5/15/91; MSI 91-06 (7/91):AGE= MISS (ENDO), LT MERAM TO E CHEST [ZONE 16?]. SIM TO 91-PC-282; BOTH F/ THE "GONIATE MARKER BE
M-S 5/15/91; MSI 91-06 (7/91): AGE= MISS, LT MERAM TO E CHEST [ZONE 16 ?].
TO MS 4/17/91; [ENDOS]MSI 91-06 (5/91-RCYD 7/91): MISS
TO MS 4/17/91; [ENDOS]MSI 91-06 (5/91-RCYD 7/91): MISS (?)
TO MS 11/4/88; UP MISS/BASAL PENN, PROB UP CHEST
TO MICROSTRAT 2/22/89; CHESTERIAN
TO MICROSTRAT 2/22/88; VERY LOW IN CHESTERIAN, APPROX ZONE 16i
TO MS 11/4/88; UP MISS/BASAL PENN, UP CHEST/MORROWAN
TO MS 11/4/88: MISS-LT CHESTERIAN-ZONE 18
TO MS 11/4/8; PROBABLY BASAL CHESTERIAN, ZONE 16 INF.
TO MICROSTRAT 2/22/89: UPPERMOST MERAMECIAN, PROBABLY ZONE 15
TO MICROSTRAT 11/4/88; MISS/PENN ?, NO ORGANIC MATTER ! (?)
TO MICROSTRAT 11/4/88; PROBABLY BASAL CHESTERIAN, ZONE 16 INF
TO MICROSTRAT 2/22/89; LOWERMOST CHESTERIAN, ZONE 16i
TO MICROSTRAT 11/4/88; PROBABLY BASAL CHESTERIAN, ZONE 16 INF

APPENDIX III

SAMPLE#	DATE	ROCK TYPE	PURPOSE FOR COLLECTION	LOCATION
UE17e-2995.0-2995.5	12/11/91		PALEO-CONODONT/PETROG	LMR 355A
UE17e-1943.5-1944	12/11/91		PALEO-CONODONT/PETROG	LMR 355A
UE17e- 2859.5-2860	12/11/91		PALEO-CONODONT/PETROG	LMR 355A
UE17e-71.0-71.6	12/11/91		PALEO-CONODONT/PETROG	LMR 355A
UE 17e-355.0-355.5	12/11/91		PALEO-CONODONT/PETROG	LMR 355A
UE16d-1463.0-1463.5	12/11/91		PALEO-CONODONT/PETROG	LMR 355A
UE16d-2317-2319.5	12/11/91		PALEO-CONODONT/PETROG	LMR 355A
91-PC-461	12/11/91	FINE-GRAINED CARBONATE TURBIDITE	PALEO-CONODONT/PETROG	LMR 355A
PC-91-332	11/18/91	LS "M1" AT SHOSHONE MT	PALEO	LMR 355A
91-PC-342	11/18/91	SLTST "M1" @ SHOSHONE MT	PALEO	LMR 355A
92-PC-282	3/10/92	LS INTBDD BLACK CHERT	PALEO (CONODONT/PETROG;	LMR 355A
92-PC-513	1/15/92	CGL	CLAST COMPOSITION	LMR 355A
92-PC-522	1/16/92	MICRITE	PALEO	LMR 355A
92-PC-551	1/17/92	CHERT	PALEO; RADS	LMR 355A
92-PC-522B	1/17/92	CHERT	PALEO (RADS)	LMR 355A
92-PC-554	1/17/92	MICRITE/DOL	PALEO (CONODONPETROG)	LMR 355A
92-JTA-193	4/16/92	CHERT; SPICULITES (?)	PALEO	LMR 355A
92-JTA-223	4/18/92	SPICULITE MUDSTONE	RADIALARIAN PALEO	LMR 355A
92-JTA-232	4/18/92	MDST	PALEO-RADS	LMR 355A
92-JTA-263	4/19/92	CHERT (?)	PALEO-RADS/SPICULES	LMR 355A
92-JTA-271	4/19/92	CHERT	PALEO- RADS/SPICULES	LMR 355A
92-JTA-274	4/19/92	SPICULITE	PALEO	LMR 355A

MAP LOCALITY	DESCRIPTIVE LOCALITY
TIPPIPAH SPRING, NV 7.5' 5.70.8 X 41.02.1	E RIDGE , S OF PAHUTE MESW RD
MINE MT, NV 7.5' 5.71 X 4.86	STATION 332, SHOSHONE MT
MINE MT, NV 7.5' 5.70.6 X 40.86.4	M1 @ SHOSHONE MT ~ 3/4 OF THE WAY UP IN THE SLTST SECT
TIPPIPAH SPRINGS, NV 7.5' 5.71.2 X 41.04.4	N END OF E RIDGE AT INTERSECTION OF S ELEANA RANGE
TIPPIPAH SPRINGS, NV 7.5' 5.71 X 4.03.6	E RIDGE, N OF PAHUTE MESA RD, OC AT N END OF SUMMIT
TIPPIPAH SPRING, NV 7.5' 5.71.1 X 41.03.6	E RIDGE, N OF PAHUTE MESA RD
TIPPIPAH SPRING, NV 7.5' 5.71.2 X 41.03.2	E RIDGE, N OF PAHUTE MESA RD
TIPPIPAH SPRING, NV 7.5' 5.70.9 X 41.03.1	SLOPE BETWEEN 92-PC-553 & 92-PC-533
	S ELEANA RANGE
	SE OF SYNCLINE RIDGE NEAR E-W ELEANA CONTACT
	START OF N BRANCH OF S ELEANA RANGE
	RED CANYON @145 m
	RED CANYON @172 m
	CASTLE VALLY, N END

STRATIGRAPHIC UNIT	PROCESSING & RESULTS
	TO BSU 12/91
	TO BSU 12/91
	TO BSU 12/91
	TO BSU 12/12/91 F/ BIOSTRATIGRAPHY
	TO BSU 12/12/91
	TO BSU 12/91
	TO BSU 12/91
M ELEANA, W FACIES	TO BSU 12/12/91; CLAUDE SPINOSA 1/15/92
DEPOSITIONALLY OVERLYING "Dd" BASE OF E FACIES ?	TO BSU 2/8/92 F/ BIOSTRATIGRAPHY
M1	
	CRUSHED 5/20/92
M ELEANA, W-FACIES	
M ELEANA, W-FACIES	TO BSU 2/8/92 F/ BIOSTRATIGRAPHY
M ELEANA; W-FACIES	HF ETCHING
M ELEANA, W-FACIES	HF ETCHING
M ELEANA	
CASTLE VALLEY SECTION; 178 m	CRUSHED 5/20/92
SYNCLINE RIDGE SECTION	CRUSHED 5/20/92
	CRUSHED 5/20/92
	CRUSHED 5/20/92
	CRUSHED 5/20/92
	CRUSHED 5/20/92

OUTCROP DESCRIPTION

FINE-GRAINED TURBIDITE
348/24W PARTING, PROBABLY S0. IN LIGHT GREY LS--GOOD
CONT SUBCROP ALL THE WAY TO THE Tv; NO SS LAYERS IN OC OR FLT OBSERVED

CGL FLOAT; CLASTS RESEMBLE FELSIC VOLCANICS
ORANGE-WTHRNG, FRACTURED, VEINED
BLACK CHERT
ORANGE-WTHRNG FINE-GRAINED LS W/ BIOTURBATION ON WTHRD SURFACES.
FLOAT; ORANGE WTHRNG MICRITE/DOLOMITE. BIOTURBATION REMNANTS

POSS CTS W/ MEASURED SECTION ON HILL TO N
SECTION HERE PROJECTED F/ TOP OF MAIN SECTION

EASTERN: BEDDED TAN WX SLTST W/ ABNT BUROWS; WERN: TOP TO E

reprints, preprints, and abstracts removed.
ds