UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:

BOARD CAB-01	BOARD CAB-02	BOARD CAB-03
ASLBP No. 09-876-HLW	ASLBP No. 09-877-HLW	ASLBP No. 09-878-HLW
William J. Froehlich, Chairman	Michael M. Gibson, Chairman	Paul S. Ryerson, Chairman
Thomas S. Moore	Alan S. Rosenthal	Michael C. Farrar
Richard E. Wardwell	Nicholas G. Trikouros	Mark O. Barnett

In the Matter of U.S. DEPARTMENT OF ENERGY (High-Level Waste Repository)	Docket No. 63-001-HLW June 10, 2009

CLARK COUNTY, NEVADA'S NEW CONTENTION ARISING FROM THE DEPARTMENT OF ENERGY'S FEBRUARY 19, 2009 LICENSE APPLICATION UPDATE

Pursuant to 10 CFR § 2.309, the notice published by the Nuclear Regulatory Commission ("NRC" or "Commission") at 73 Fed. Reg. 63,029 (October 22, 2008), and the Atomic Safety Licensing Boards' ("ASLB") Order dated March 13, 2009, Clark County, Nevada ("Clark County") hereby submits this New Contention Arising from the Department of Energy's ("the DOE") February 19, 2009 License Application Update.

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I. INTRODUCTION

On February 19, 2009, the DOE provided updates and supplements to its initial application for construction authorization. Shortly thereafter, the ASLB issued an Order that any new or amended contentions arising from the DOE's February 19, 2009 updates and supplements "shall be deemed timely if filed within 30 days from the date of the CABs' [Three Construction Authorization Boards] initial order identifying the parties and admitted contentions."[1] The CABs issued the initial order identifying participants and admitted contentions on May 11, 2009.[2] Clark County timely submits this single new contention arising from the DOE's February 19, 2009 updates and supplements.

CLK-SAFETY-013 states that the DOE's reliance on its Probabilistic Volcanic Hazard Analysis Update ("PVHA-U") does not remedy the deficiencies of the Probabilistic Volcanic Hazard Analysis ("PVHA") as set forth in Clark County's contentions designated as CLK-SAFETY-003 through CLK-SAFETY-011.[3] Clark County, through its expert witness Dr. Eugene I. Smith, hereby submits this new contention asserting that the shortcomings identified in the previously admitted contentions relative to the PVHA remain uncured, and are likewise shortcomings of the PVHA-U.

II. CONTENTION

Clark County's new contention is as follows:

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[1] *U.S. Dep't of Energy*, Order (Clarifying CAB Case Management Order #1) (March 13, 2009) at 2.

[2] *U.S. Dep't of Energy*, Memorandum and Order (Identifying Participants and Admitted Contentions), LBP-09-06, 142, May 11, 2009 ("May 11 Order").

[3] CLK-SAFETY-003 through CLK-SAFETY-011 have been admitted for adjudication. *See* May 11 Order at Attachment A.

CLK-SAFETY-013
THE DOE'S PROBABILISIC VOLCANIC HAZARD ANALYSIS UPDATE (PVHA-U) IS INADEQUATE FOR CALCULATING PROBABILITY OF DISRUPTION OF A REPOSITORY AT YUCCA MOUNTAIN BY IGNEOUS EVENTS

1. A brief statement of the contention

The DOE's Yucca Mountain license application was recently amended (License Application Update # 1) and now relies on the Probabilistic Volcanic Hazard Analysis Update ("PVHA-U") as the basis for calculations of the probability of disruption of a repository at Yucca Mountain by an igneous event. The PVHA-U is inadequate for this purpose because it does not sufficiently integrate a comprehensive, self-consistent geologic model into probability calculations. Furthermore, SAR sections 2.3.11, 2.3.11.1, 2.3.11.2.2, 2.2.2.1.2, 2.2.2.3, 2.2.2.2.3.1 (and similar sections) and the PVHA-U do not adequately address alternative models, modern geophysical surveys, the entire 11 million year history of volcanism in the Yucca Mountain area or the Greenwater Range near Death Valley as part of the volcanic field about Yucca Mountain.

2. A summary of the basis for the contention

The PVHA-U essentially uses a two-dimensional spatial realization to characterize past volcanic events and predict the location of future events. This approach is inadequate because it is not based on the use of a coherent geological and geophysical model to obtain a fundamental scientific understanding of the intrinsically three-dimensional system and its likely evolution over time. Understanding and using a geological and geophysical model is critical for probability studies because it provides information about the source region for magmatism, areas of the lithosphere and asthenosphere where magma may reside, and flow patterns in the mantle. Although geophysical studies are mentioned in SAR subsection 2.2.2.1.2 as a way to identify and characterize the orientation of faults in the subsurface, the license application lacks geophysical data to substantiate models proposed by the DOE that use upper crustal structure and the local stress field to explain the location of volcanoes in the Yucca Mountain area. Geophysical studies are also critical for testing and comparing deep versus shallow melting models by revealing the location of low-viscosity zones (hot or wet zones) in the crust and mantle that might contain magma or rock close to the melting temperature. Furthermore, identifying patterns of mantle circulation and the nature of the topography at the base of the lithosphere is important for describing the geometry of volcanic source zones which ultimately control the location and shape of volcanic fields at the surface.

3. A demonstration that the contention is within the scope of the hearing

This contention raises the issue of whether the DOE has complied with the NRC requirements applicable to Yucca Mountain and falls within the scope of the hearing as specified in section II, paragraph 1 of the Notice of Hearing. Additionally, this contention applies the substance of CLK-SAFETY-003 through CLK-SAFETY-011 to the Amended License Application and its reliance on the PVHA-U. (These contentions were admitted by the CABs, but primarily addressed the PVHA because they predated the DOE's amended License Application and its reliance on the PVHA-U).

4. A demonstration that the contention is material to the findings the NRC must make to license Yucca Mountain

10 CFR § 63.31(a)(2) states that the NRC may authorize issuance of a construction authorization for Yucca Mountain if it determines that there is reasonable assurance or expectation that the materials described in the Application can be disposed of without

unreasonable risk to the health and safety of the public. In reaching this determination, 10 CFR § 63.31(a)(3) requires that the application satisfy the requirements in 10 CFR § 63.21, and that the site and design comply with Subpart E of 10 CFR Part 63. Further, 10 CFR § 63.21(c)(9) requires an assessment to determine the degree to which features, events and processes of the site that are expected to materially affect compliance with section 63.113 have been characterized, and subsection (c)(15) requires adequate support for the models used to provide the information required in subsection (c)(9). Section 63.114 (part of Subpart E) requires a performance assessment to be completed to evaluate the ability of the engineered barrier system along with natural barriers to meet the performance objectives of section 63.113. This performance assessment must include consideration of the probability and consequences of events and processes identified under 10 CFR § 63.21(c)(9).

The contention alleges non-compliance with these regulatory provisions. The contention challenges the DOE's reasonable assurance and expectation allegations and thus raises matters that are material to the findings that the Commission must make in order to be able to lawfully license Yucca Mountain.

5. A concise statement of facts or expert opinions supporting the contention, along with appropriate citations to supporting scientific or factual materials

Understanding the process of volcanism within the framework of a three-dimensional view of the volcanic system and its evolution in time is needed to make meaningful calculations of the probability of disruption of a repository at the Yucca Mountain site by volcanism. Although the PVHA-U uses different statistical techniques and includes some new data that was obtained after the 1996 release of the original PVHA, the PVHA-U still does not include a comprehensive and coherent model for volcanism to provide a three-dimensional view of the localization of volcanoes and volcanic fields.

Moreover, License Application Update #1 continues to rely heavily on the original PVHA, only briefly mentioning the PVHA-U in terms of amending probability estimates. As a result, Clark County's contentions CLK-SAFETY-003 to CLK-SAFETY-011 apply to the PVHA-U and License Application Update #1 since neither the PVHA-U nor License Application Update #1 have in any way cured the deficiencies identified in those original contentions. Accordingly, the PVHA-U is inadequate to support License Application Update #1 because it suffers from the same inadequacies that plague the PVHA. Several of those inadequacies are further explained below.

Lack of Consideration of Alternative Models:

In the PVHA-U, the DOE asserts that it properly considered alternative models for volcanism, but it did not in fact do so. The DOE's probability calculations focus on the observed spatial distribution of volcanoes in the Yucca Mountain area without properly integrating a geologic and geophysical model to describe how that distribution arose. This results in an inadequate basis for assessing the future spatial and temporal patterns of volcanic activity in the area. The DOE admits that it lacks the geophysical perspective to develop a three-dimensional view of the lithosphere and mantle required to characterize zones beneath the Yucca Mountain area that are close to the melting point:

> Developing a best estimate of spatial density is problematic because we have only one realization of the underlying statistical process—that is, the distribution of past volcanic events—and we cannot repeat geologic experiments in a natural system. Ideally, we would have a complete geophysical model for events. If we knew the distribution of melt in the asthenosphere and lithosphere, and knew the state of the lithosphere through which magma would rise, we could better predict where volcanoes likely will form next. We lack such a complete geophysical perspective, however. Some data, for example seismic tomographic models of "slowness" in the

> lithosphere and asthenosphere, give an idea of where partial melting of the mantle might occur (e.g., Zhao, 2001; Humphries, personal communication).[4]

The DOE further asserts that the PVHA-U gave adequate consideration of alternative models. For example:

> Dr. Coppersmith stated that Dr. Eugene Smith (University of Nevada, Las Vegas) had developed an alternative model for assessing future volcanism in the Yucca Mountain region. Although asked to present his model at the workshop, Dr. Smith declined because of policy considerations, so Dr. Coppersmith briefly summarized the key aspects of the model. In this model, volcanoes in Crater Flat are considered to be part of a larger zone of basaltic volcanism that stretches from Death Valley to the Lunar Crater field in the northeast. Volcanism within this zone is characterized by coeval and episodic periods of activity. An area of deep, hot mantle may underlie the entire zone. If this hypothesis is correct, then the higher recurrence rates for volcanism observed in Lunar Crater and the Reveille Range may apply to the Yucca Mountain area. Following Dr. Coppersmith's summary, the project team discussed the spatial distribution of volcanic centers and the evidence for shallow versus deep melting in the defined zone.[5]

This is one of the few times alternative models are mentioned in the PVHA-U. This example essentially admits and identifies the inadequacy of the DOE's approach, and most certainly does not cure that inadequacy. Thus, Clark County's contentions CLK-SAFETY-003, 005 and 009 apply to the PVHA-U just as they apply to the PVHA.

The DOE also claims that the PVHA-U panel did not rely on upper crustal models but considered a range of models, including deep melting. Clark County agrees that the PVHA-U experts were introduced to alternative models. In fact, the alternative models of Clark County's expert (Eugene Smith) were presented to the PVHA-U experts by Dr. Kevin Coppersmith. The PVHA-U experts, although introduced to various melting models, however, qualitatively adopted the DOE model of shallow melting while never quantitatively integrating it into their models. All of the PVHA-U experts accepted the DOE's interpretation that volcanic activity decreasing in volume and number of events over the last 5 million years was an indicator of a future marked

[4] "Probabilistic Volcanic Hazard Analysis Update ("PVHA-U") for Yucca Mountain, Nevada Rev 01" (09/02/2008), LSN# DEN001601965, at D-20.

[5] *Id.* at C-22.

by a low probability for future eruptions in the area relevant to the proposed repository. While mentioning the concept of asthenospheric melting in the PVHA-U report, none of the experts considered the consequences of deep melting in probability calculations. In fact, every expert based probability calculations on vent location, number of events, dike dimensions and orientation and their interpretation of a region of interest. None of the experts quantitatively considered the effects of a petrologic model in their probability estimates. This omission is a major problem with the PVHA-U report.

Lack of Consideration of the Entire Volcanic Record:

The PVHA-U relies heavily on volcanic events that have occurred in the last 5 million years. Although some of the PVHA-U experts did include events earlier than 5 million years in their probability models, none considered long term trends or patterns of volcanism. The philosophy of using data from post-5 million year old basalt is also evident in supporting publications (*e.g.,* Valentine and Perry, 2007).[6] The analysis in that paper uses geochemical indices that reflect the degree of partial melting of the mantle and shows that in the last 5 million years basaltic volcanism occurred within a trend of a steady decrease in the degree of partial melting. This evidence was used to suggest that basaltic volcanism in the Yucca Mountain area is dying and that future events will be rare.

Clark County does not disagree that the degree of partial melting is decreasing. But, if the full 11 million year record is considered, two such trends are evident (see CLK-SAFETY-004 and 008). This evidence indicates that volcanism is periodic, thus raising the possibility of another peak of activity in the future. If the DOE had looked at the entire record using the same techniques that they used for the post-5 million year period, they would have observed the same trends. Unfortunately, the DOE decided not to do so.

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[6] *See e.g.,* Valentine, G.A. and Perry, F.V. "Tectonically Controlled, Time-Predictable Basaltic Volcanism from a Lithospheric Source," at 201-16 (2007), LSN# DN2002382703.

A Larger Volcanic Field about Yucca Mountain:

The PVHA-U does not adequately consider the Greenwater Range near Death Valley in the probability analysis. Clark County's reasoning for including the Greenwater Range is provided in CLK-SAFETY-006 and is summarized below.

1. The DOE must consider all volcanic fields within a 50 km radius of Yucca Mountain in their volcanic hazard analysis. The Greenwater Range lies within 50 km of Yucca Mountain. As stated in NRC Yucca Mountain Review Plan (NUREG-1804, Revision 2), Review Method 2, probability Criteria, page 2.2-11:

   > Verify that probability estimates for future igneous events have considered past patterns of igneous events in the Yucca Mountain region. Evaluate the adequacy and sufficiency of the U.S. Department of Energy characterization and documentation of past igneous activity. This should include uncertainties about the distribution, timing, and characteristics of past igneous activity. *Confirm that, at a minimum, documentation of past igneous activity, since about 12 million years ago, encompasses the area within about 50 kilometers (30 miles) of the proposed repository site. Give particular attention to the documentation of the locations, ages, volumes, geochemistry, and geologic settings of less than 6- million-year-old basaltic igneous features, such as cinder cones, lava flows, igneous dikes, and sills.* Verify that the U.S. Department of Energy used geological and geophysical information relevant to past igneous activity contained in the literature. (emphasis added).

2. The basalts of the Greenwater Range are identical in chemistry, age and mineralogy to those near Yucca Mountain. This information, as set forth in Clark County's original contention, is summarized below:

   - Volcanic activity in the Greenwater Range is associated with at least 24 volcanic centers and occurred after about 5 million years ago, contemporaneous with activity near Yucca Mountain.[7]

   - Basalt from Death Valley is very similar in major and trace element chemistry to basalt from Crater Flat. Trace-elements usually better characterize volcanic rocks than do major elements and are considered as fingerprints that are commonly used to correlate volcanic rocks from area to area. For comparison purposes, volcanic rocks are usually normalized to a standard rock like average ocean island basalt. Plots of trace elements versus normalized concentration show characteristic patterns that can be used to fingerprint and compare rocks from different volcanic fields. Comparing Death Valley and Crater Flat basalt on such a plot shows that

[7] *See* "Geologic Map of California – Death Valley Sheet, with Index and Stratigraphic nomenclature" (01/01/1974), LSN# DN2001741565, solo page.

they share a similar pattern. Especially characteristic is low Nb and high Rb, Th and U.[8]

- Strontium (Sr) and neodymium (Nd) isotopes for Greenwater Range basalts[9] are identical to isotopic analyses from Crater Flat Basalts in both areas have low epsilon Nd values (between -9.95 and -12), and high $^{87}Sr/^{86}Sr$ (0.7069-0.7073).[10]

- Basalts in both the Crater Flat and Death Valley areas are similar in mineralogy and contain olivine as the major phenocrysts phase. Plagioclase is rare and usually occurs as microlites in the matrix.

In summary, the close geographic proximity to Crater Flat, similar age of eruption, similar mineralogy and major element chemistry, distinctive trace element patterns and distributions, and identical isotopic ratios demonstrate that Death Valley basalt in the Greenwater Range is closely associated with Yucca Mountain basalt. Hazard assessment for Yucca Mountain should consider the Greenwater volcanoes near Death Valley as part of a field of volcanoes about Yucca Mountain.

3. The probability of volcanic disruption of the Yucca Mountain repository block will increase by considering the Greenwater Range. The probability calculation is dependent on both the number of events (volcanoes) and the area selected to count the volcanoes. In its simplest form, the equation ("Equation 1") for the probability that an igneous event will intersect the repository is:

$$v_I = \frac{N(R,T)}{T} \cdot \frac{a_r^{\epsilon}}{A_R}$$

Equation 1 relates the probability of repository intersection V_I to the number of volcanoes (N) in area R during time T. A_r is the area of the region used to count volcanoes, a_r is the area of the repository block.[11] Equation 1 indicates that the probability of disruption of the repository will be larger if the number of cones in the area of interest (R) is larger. However, the probability will decrease as the region used to count cones becomes larger. Clark County estimates that by including the Greenwater Range, R will increase by a factor of about 0.33 but cone counts (N) will increase by at least 24 (a factor of 2 to 3 over cone counts used by PVHA experts). Although the larger area used to count will

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[8] *See* "Report of Research Activities in 2007 Prepared to Satisfy the Requirements of a Nevada Contract for Volcanic Hazard Assessment of the Proposed Nuclear Waste Repository at Yucca Mountain, Nevada" (07/08/2008), LSN# NEVADA000000071, at 10-13.

[9] *See* Asmerom, Y., Jacobsen, S.B., and Wernicke, B.P., "Variations in Magma Source Regions During Large Scale Continental Extension, Death Valley Region, Western United States," EARTH AND PLANETARY SCIENCE LETTERS, Vol. 125 (1994), at 235-54.

[10] *See* Report, *supra*, n.8.

[11] Equation from PVHA report page 3-2 of 115.

partially balance the increase in cone counts, the overall probability will increase (because the cone count term increases more than the area of the region).

The PVHA-U experts were provided with a map showing the locations of volcanic centers in the Yucca Mountain area including the Greenwater Range. It is Clark County's contention that, for the Greenwater Range, the volcano locations and number of volcanoes provided to the PVHA-U experts are incorrect.

The basis for this contention is that the reference on the map provided to the PVHA experts is Luedke and Smith (1981).[12] This map shows the distribution of volcanic rocks of various ages and the location of calderas and selected volcanoes. The distribution of volcanic rocks and volcano locations for the Greenwater Range were taken from two maps by McAllister[13] and a U.S. Geological Survey Professional Paper by Drewes.[14] These maps and report were produced to describe the borate deposits east of Death Valley, but also included a reconnaissance version of the geology of the Greenwater Range. The basalts of the Greenwater Range were mapped as Funeral Formation and separated into lava flows and areas of scoria. Vent locations were not specifically located but were interpreted to lie within areas of scoria. Drewes, however, did identify two areas of volcanic breccia as eroded volcanoes. Luedke and Smith[15] compiled the geology from the McAllister and Drewes maps and placed volcanic centers in the Greenwater Range based on the distribution of scoria and the location of Drewes' two volcanoes. The important point is that most of the volcano locations in the Greenwater Range on

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[12] R.G. Luedke and R.L. Smith, Map showing the distribution, composition, and age of Late Cenezoic volcanic centers in California and Nevada: U.S. Geological Survey Misc. Invest. Ser. Map 1-1091-C (1981).

[13] James F. McAllister, Geologic map and sections of the Furnace Creek borate area, Death Valley, Inyo County, California: California Division of Mines and Geology Map Sheet MS-14 (1970); James F. McAllister, Geologic map and sections of the Amargosa Valley borate area-southeast continuation of the Furnace Creek area-Inyo County, California: U.S. Geological Survey Miscellaneous Geologic Investigations Map 1-782, scale 1:24000, 1 sheet (1973).

[14] Harold Drewes, Geology of the Funeral Peak quadrangle, California, on the east flank of Death Valley: U.S. Geological Survey Professional Paper 413, 73 p.2 plates (1963).

[15] *See* Luedke and Smith, Map, *supra,* n.12.

the Luedke and Smith map are based on interpretation; they did not field check to verify their presence. For the purpose of the PVHA, a part of the Luedke and Smith map was redrafted to show only the location of volcanoes. On this map, the volcano locations were only approximately located and the PVHA-U was copied from that map. Both maps are inaccurate because they contain propagated errors induced in the process of copying information from earlier maps to new maps.

In conclusion, the maps provided to the PVHA and PVHA-U are not precise in terms of the number of volcanoes or their locations. The PHVA-U panel of experts was provided with a poor if not incorrect dataset.

Lack of Modern, High-Quality Geophysical Data:

Developing a three-dimensional model of volcano locations requires modern high quality geophysical data. The most valuable type of data relates to the velocity of seismic waves in the lithosphere and mantle beneath volcanic fields. Low-velocity zones reflect rock near the melting point due either to high temperature or elevated water content. Clark County agrees that some geophysical data was provided to both the PVHA and PVHA-U experts. The quality of these data can best be judged by several quotes from PVHA-U experts who are experienced in geophysical techniques. Dr. Charles Connor, a member of the PVHA-U panel and a professor of geology and geophysics at the University of South Florida stated in his PVHA-U elicitation report:

> As early as 1994, requests were made for detailed seismic tomographic studies in the YMR to assist with assessing volcanic hazards (Connor and Sanders, 1994). It is extremely unfortunate that no studies have been done. *The seismic tomographic data that are available are low in resolution and open to interpretation* (Biasi, oral communication at PVHA Workshop 1; Humphreys, personal communication). Although seismic tomographic anomalies appear to exist beneath Crater Flat and extend beneath Yucca Mountain, the DOE has not studied

> the YMR at the resolution available from, for instance, Northern Honshu, where such data are used in assessing potential sites for geologic high-level waste repositories (e.g., Martin et al., 2004). *I include no tomographic data in this analysis because of the low quality of available data. If high-resolution seismic tomographic data were available, the results of this hazard assessment could change considerably.*[16]

Dr. Connor also states:

> Volcanic hazards at YM will likely be reassessed in the future using improved information, and this information may change the hazard assessment. *Furthermore, there are techniques currently extant in the scientific community that have not been used at YM to assess volcanic hazards. For example, seismic tomography and magnetotellurics are two techniques that are used in Japan to assess long term volcanic hazards for potential HLW geologic repositories* (Martin et al., 2004; Umeda et al., 2006). Seismic tomography has revealed that along-arc variations in mantle P- and S-wave velocity correlates well with rates of volcanic activity. These data have been integrated into improved probabilistic volcanic hazard assessments. Magnetotellurics has been used to identify mid- to lower-crust magma bodies in the back-arc of Japan, in a region where no volcanism has occurred since the Mesozoic. Umeda et al. (2006) consider this to be evidence of potential future volcanic unrest, which should be factored into probabilistic assessments. *These state-of-the-art geophysical surveys have not been done at Yucca Mountain. Some seismic tomography analysis has been performed and presented to the PVHA panel (Biasi, PVHA presentation, Humphries, written communication), but not with a sufficiently dense network of sensors or in a dedicated experiment.*[17]

In addition, Dr. Bruce Crowe, a member of both the PVHA and PVHA-U panel and an expert in volcanology and geophysics stated: "I examined but did not use the teleseismic tomography data for assigning frequency zones because of low resolution, coarse grid size, and ambiguous interpretations."[18] Thus, two of the DOE's own experts found that the geophysical data provided was low-resolution and not suitable for use in their probability models.

Geophysical data was given low weight by the PVHA panel but several of the PVHA-U experts did use the teleseismic tomography data provided to them in their models. Modern seismic tomography data is available for the Yucca Mountain area through the EarthScope

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[16] PVHA-U, at D-33 (emphasis added).

[17] *Id.* at D-2 and D-3 (emphasis added).

[18] *Id.* at D-100.

project. For example, geophysicists at Brown University and the University of Colorado have generated tomographic profiles that cross near or through the Yucca Mountain area.[19] Data such as these should be used to test all available depths of melting models.

6. Sufficient information to show a genuine dispute with the DOE, along with specific references to the portions of the Application being controverted

This contention challenges the adequacy of the PVHA-U and SAR sections 2.3.11, 2.3.11.1, 2.3.11.2.2, 2.2.2.1.2, 2.2.2.3, 2.2.2.2.3.1 (and similar sections) for use in calculating the probability of disruption of a repository at Yucca Mountain by an igneous event. Supporting reasons are provided in section 5 above and are summarized as follows: Despite the use of new statistical techniques in the PVHA-U, it relies on a two-dimensional realization of volcano locations. In other words, disruption probability is calculated solely on the basis of the spatial distribution of volcanoes. This approach is inadequate because it is not based on the use of a coherent geological and geophysical model to obtain a fundamental scientific understanding of the intrinsically three-dimensional system and its likely evolution in time. Understanding and using a geological and geophysical model is critical for probability studies because it provides information about the source region for magmatism, areas of the lithosphere and asthenosphere where magma may reside, and flow patterns in the mantle. Modern seismic studies that show velocity profiles to depths of 150 kilometers and outline zones of the earth's mantle that are near the melting temperature are available but were not provided to the PHVA-U experts. Furthermore neither the PVHA-U nor License Application Update #1 adequately consider the entire 11 million year long history of volcanism near Yucca Mountain. The PVHA-U relies heavily on volcanic events that have occurred in the last 5 million years. Although some of the

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[19] *See e.g.,* Yang, Y. and M.H. Ritzwoller, "Teleseismic surface wave tomography in the western U.S. using the Transportable Array component of USArray," GEOPHYSICAL RESOURCE LETTERS, 5 L04308, doi:10.1029/2007GL032278 (2008); Yang, Y. and D.W. Forsyth, "Rayleigh wave phase velocities, small-scale convection and azimuthal anisotropy beneath southern California," JOURNAL OF GEOPHYSICAL RESEARCH, 111, B07306, doi:10.1029/2005JB004180 (2006).

PVHA-U experts did include events earlier than 5 million years in their probability models, none considered long term trends or patterns of volcanism. Finally, The PVHA-U does not adequately consider the Greenwater Range near Death Valley in the probability analysis.

III. CONCLUSION

For the foregoing reasons the LA should be denied. Clark County respectfully petitions the Presiding Officer to accept the additional contention raised herein.

Dated: June 10, 2009

Respectfully submitted,

/s/ filed electronically

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of: U.S. DEPARTMENT OF ENERGY (High Level Waste Repository)	Docket No. 63-001-HLW

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing "Clark County, Nevada's New Contention Arising From the Department of Energy's February 19, 2009 License Application Update," dated June 10, 2009, was served upon the following persons by Electronic Information Exchange.

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ATTACHMENT 1

Affidavit of Eugene I. Smith

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of: U.S. DEPARTMENT OF ENERGY (High Level Waste Repository)	Docket No. 63-001

DECLARATION OF EUGENE I. SMITH

1. My name is Eugene I. Smith. I am a professor of Geology at the University of Nevada, Las Vegas. My contact information is provided in my curriculum vitae, which is attached.
2. I specialize in Volcanology, Igneous Petrology, Geochemistry, Tectonics, and Planetary Geology. A copy of curriculum vitae is attached.
3. I have reviewed and am familiar with aspects of the Department of Energy's license application for this proceeding, including the DOE's Environmental Impact Statements and Update No. 1 of the LA.
4. I support Clark County's petition in this proceeding, and adopt as my own the opinions and statements expressed in contention CLK-SAFETY-013. Said contention was prepared by me or under my supervision, and the factual matters and expert opinions presented therein reflect my professional work and expert opinions.

STATE OF NEVADA)
) **ss.**
COUNTY OF CLARK)

[signature]
Eugene I Smith

SUBSCRIBED AND SWORN to before me this 9th day of June, 2009.

[signature]
Notary Public, in and for said County and State
Clark, NV

ANGEL NORBUT
Notary Public State of Nevada
No. 07-2494-1
My appt. exp. Mar. 19, 2011

3195126v2(60297.1)

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Educational Background:

University	Degree	Year
University of New Mexico	Ph.D.	1970
University of New Mexico	M.S.	1968
Wayne State University	B.S.	1965

Specialties:, Volcanology, Igneous Petrology, Geochemistry, Tectonics, Planetary Geology

Professional Experience:

8/88 to present: Professor of Geology, UNLV

7/83-7/86: Chair, Department of Geoscience, UNLV

9/80 to 8/88: Associate Professor of Geology, UNLV

9/76-8/80: Associate Professor of Earth Science, University of Wisconsin-Parkside

9/72-9/76: Assistant Professor of Earth Science, University of Wisconsin-Parkside

9/70-6/72: Post-doctoral Research Associate to Professor W.E. Elston, Department of Geology, University of New Mexico

9/68-8/70: Graduate Research Assistant to Professor W.E. Elston, Department of Geology, University of New Mexico

8/68-8/80: Geologist WAE, U.S. Geological Survey, Branch of Astrogeology, Flagstaff, AZ

6/66-7/68: Geological Field Assistant WAE, U.S. Geological Survey, Branch of Astrogeology, Flagstaff, AZ

6/64-9/64: Undergraduate Research Assistant to Professor A.J. Mozola, Department of Geology, Wayne State University, Detroit, MI

Professional Society Memberships:

American Association for the Advancement of Science
American Geophysical Union
Geological Society of America (Fellow)
Geological Society of Nevada
IAVCEI-International Association of Volcanology and Chemistry of the Earth's Interior
Mineralogical Society of America
Phi Kappa Phi
Sigma Gamma Epsilon
Sigma Xi

Grants:

- Bureau of Land Management contract to study the geology of the Sloan Canyon NCA (2006-2008).
- Bureau of Land Management contract to study the geology of the Sloan Canyon NCA (2005)
- Nevada Agency for Nuclear Projects grant to study basaltic volcanism in the Great Basin (2000-2001).
- U.S. Navy Geothermal Office Grant to study volcanic rocks in the Lava Mountains, (1998-1999.
- U.S. Navy Geothermal Office Grant *with Rodney Metcalf* to study volcanic rocks in the Lava Mountains, California and the Mt. Perkins Pluton, Arizona (1996-1998).
- Grants from Nevada Nuclear Waste Project Office (NWPO) to study late- Miocene and younger volcanic activity in southern Nevada (ten years of funding) (1985-1996).
- NSF Grant with J. Faulds and P. Gans to study the structural and geochemical development of the northern Colorado River extensional corridor (1991-1993).
- UNLV Research Council grant to support the study of Tertiary volcanic rocks in Clark County, Nevada (1983).
- NASA Grant NGR 50-009-001 for the study of volcanic fields in California, New Mexico and Wisconsin. The grant also funded the study of volcanic domes and craters on Mars, Mercury, Moon and Earth (6 years of funding)(1973-1979).
- Four University of Wisconsin research grants to support the study of Precambrian igneous rocks of south-central Wisconsin (1973-1977).

Awards:

- Recipient of the Harry Reid Nevada Star Award for Research (2006).
- Recipient of UNLV College of Sciences Distinguished Researcher Award, 1999.
- National Defense Education Act (NDEA) Title IV Fellowship, 9/65-6/68

Current Research:

1. Geology of Quaternary-Pliocene basalts in the southern and central Great Basin and Colorado Plateau.
2. Volcanic hazard studies related to placing a nuclear waste repository at Yucca Mountain, Nevada.
3. Geology of basalts in the Yellowstone Plateau volcanic field, implications for the future development of the Yellowstone volcanic system.
4. Geochemical, structural and field study of the volcanic and plutonic rocks of the Lake Mead Volcanic Field.
5. The formation of intermediate composition igneous rocks in an extensional environment.

Editorial Responsibilities

- Associate editor of the Geological Society of America Bulletin 1999-2008
- Associate editor of the Journal of Geophysical Research (Geochemistry and Volcanology)- 1996-1999

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- Bill Stupak
- Jill Hartnell
- Ray Spangers
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UNLV:
- **Crow, H. Clay, III**, 1984, *Geochemistry of shonkinites, syenites, and granites associated with the Sulfide Queen carbonatite body, Mountain Pass, California [MS thesis]*: Las Vegas, University of Nevada, 56 p.

- **Myers, Ingrid A.**, 1984, *Geology and mineralization at the Cyclopic mine, Mohave County, Arizona [MS thesis]*: Las Vegas, University of Nevada, 64 p.

- **Mills, James G., Jr.**, 1985, *The geology and geochemistry of volcanic and plutonic rocks in the Hoover Dam 7 1/2 minute quadrangle, Clark County, Nevada and Mohave County, Arizona [MS thesis]*: Las Vegas, University of Nevada, 119 p.

- **Timm, John J.**, 1985, *Age and significance of paleozoic sedimentary rocks in the southern River Mountains, Clark County, Nevada [MS thesis]*: Las Vegas, University of Nevada, 62 p.

- **Feuerbach, Daniel L.**, 1986, *Geology of the Wilson Ridge pluton : a mid-Miocene quartz monzonite intrusion in the northern Black Mountains, Mohave County, Arizona and Clark County, Nevada [MS thesis]*: Las Vegas, University of Nevada, 79 p.

- **Naumann, Terry R.**, 1987, *Geology of the central Boulder Canyon quadrangle, Clark County, Nevada [MS thesis]*: Las Vegas, University of Nevada, 68 p.

- **Schmidt, Casey S.**, 1987, *A mid-Miocene caldera in the central McCullough Mountains, Clark County, Nevada [MS thesis]*: Las Vegas, University of Nevada, 78 p.

- **Sewall, Angela J.**, 1988, *Structure and geochemistry of the upper plate of the Saddle Island detachment, Lake Mead, Nevada [MS thesis]*: Las Vegas, University of Nevada, 84 p.

- **Cole, Erin D.**, 1989, *Petrogenesis of late Cenozoic alkalic basalt near the eastern boundary of the Basin-And-Range: Upper Grand Wash trough, Arizona and Gold Butte, Nevada [MS thesis]*: Las Vegas, University of Nevada, 68 p.

- **Larsen, Lance L.**, 1989, *The origin of the Wilson Ridge pluton and its enclaves, northwestern Arizona: Implications for the generation of a calc-alkaline intermediate pluton in an extensional environment [MS thesis]*: Las Vegas, University of Nevada, 81 p.

- **Bridwell, Hayden L.**, 1991, *The Sloan Sag: A mid-Miocene volcanotectonic depression, north-central McCullough Mountains, southern Nevada [MS thesis]*: Las Vegas, University Of Nevada, 147 p.

- **Cascadden, Tracy E.**, 1991, *Style of volcanism and extensional tectonics in the eastern Basin and Range Province: northern Mojave Co., Arizona [MS thesis]*: Las Vegas, University Of Nevada, 156 p.

- **Morikawa, Shirley A.**, 1993, *The Geology of the Tuff of Bridge Spring: southern Nevada and northwestern Arizona [MS thesis]*: Las Vegas, University of Nevada, 165 pp.

- **Rash, Kelly B.**, 1995, *Geology and geochemistry of Tertiary volcanic rocks in the northern Reveille and southern Pancake Ranges, Nye County, Nevada [MS thesis]*: Las Vegas, University of Nevada, 171 p.

- **Sánchez, Alexander**, 1995, *Mafic volcanism in the Colorado Plateau / Basin-and-Range transition zone, Hurricane, Utah [MS thesis]*: Las Vegas, University of Nevada, 92 p.

- **Boland, Kelly A.**, 1996, *The petrogenesis of andsites produced during regional extension: Examples from the northern McCullough Range, Nevada and Xitle volcano, Mexico [MS thesis]*: Las Vegas, University of Nevada, 127 p.

- **Dickson, Loretta D.**, 1997, *Volcanology and geochemistry of Pliocene and Quaternary basalts on Citadel Mountain, Lunar Crater volcanic field, Pancake Range, Nevada [MS* *thesis]*: Las Vegas, University of Nevada, 146 p. (Received the UNLV Alumni Association award for the most outstanding thesis for the academic year 1997-98)

- **Downing Reina**, 2000, *Imaging the Mantle in Southwestern, Utah Using Geochemistry, and Geographic Information Systems* [MS thesis]: Las Vegas, University of Nevada, 129 p.
- **Keenan, Deborah L.**, 2000, *A study of the Lava Mountians, San Bernadino County, California* [MS thesis]: Las Vegas, University of Nevada, 81p.
- **Herrington, Juliana**, 2000, *Significance of the prevolcanic conglomerate of the Colorado River extensional corridor, Nevada and Arizona* [MS thesis]: Las Vegas, University of Nevada, 83p.
- **Sanford, Aaron L.**, 2000, *Geologic history of the McCullough Pass caldera* [MS thesis]: Las Vegas, University of Nevada, 111p.
- **Elizabeth Stickney**, 2004, *Quaternary basaltic volcanism in the northern part of the Lunar Crater volcanic field, Nevada*:, 103 p.
- **Matt Faust,** 2005, *Petrogenesis and geochemistry of Pleistocene and Pliocene basalt flows of the Pine Valley Volcanic Field, Utah and their relationship to the tectonics of the Utah Transition Zone* [MS thesis]: University of Nevada), 116 p.
- **Denise Honn,** 2005, *Nested Calderas of the northern Kawich Range, central Nevada* [MS thesis]: Lasa Vegas, University of Nevada, 92 p.
- **Denise Honn Ph.D**. *Linking a volcanic-plutonic system in the River Mountains and Wilson Ridge Pluton*. (work in progress).
- **Shara Leavitt**, 2006, *Volcanology and Petrogenesis of the Navajo Lake Volcanic Field, Utah* : [MS thesis]: Las Vegas, University of Nevada, 94 p.
- **Kristeen Bennett**, 2006, *Petrogenesis of Pleistocene basalts in the Norris-Mammoth Corridor, Yellowstone National Park* : [MS thesis]: Las Vegas, University of Nevada, 120 p.
- **Matt McKelvey,** *Geology of the southern Reveille Range, Nevada:* [MS thesis]: Las Vegas, University of Nevada, 103 p..
- **Audrey Rager (Ph.D.),** *Basalts, tectonics and Corona on Venus, How is important is plate tectonics* (work in progress).
- **Ashley Tibbetts (Ph.D.),** *Geology of the Death Valley volcanic field (work in progress).*
- **Christi Emery,** *Volcanology of the southern Quinn Canyon Range, central Nevada (work in progress).*
- **Racheal Johnsen,** *Volcanology of two volcanic fields in SW Utah, implications for tectonics and mantle source (work in progress).*

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- Mark Martin (now a research fellow at MIT)
- Jim Mills (now an associate professor at DePauw University, Indiana)
- Tim Bradshaw (now a science advisor to the House of Lords, London)
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1. Elston, W.E., Lambert, P.W. and Smith, E.I., 1968, Striated cones: wind abrasion features, not shatter cones: in Short, N.M., and French, B.M., eds., Shock Metamorphism of Natural Materials, Mono Book Corporation, Baltimore, p. 287- 290.

2. Mozola, A.J. and Smith, E.I., 1969, Glacial drift thickness map of Wayne County, Michigan: in Mozola, A.J., Geology for land and ground-water development in Wayne County, Michigan: Geological Survey of Michigan, Report of Investigation 3, 25 pp.

3. Elston, W.E., and Smith, E.I., 1970, Determination of flow direction of rhyolite ash-flow tuffs from fluidal textures: Geological Society of America Bulletin, v. 81, p. 3393- 3406.

4. Elston, W.E., Aldrich, M.J., Smith, E.I., and Rhodes, R.C., 1971, Non-random distribution of lunar craters: Journal of Geophysical Research, v. 76, no. 23, p. 5675-5682.

5. Smith, E.I., 1971, Determination of the origin of small lunar and terrestrial craters by depth-diameter ratio: Journal of Geophysical Research, v. 76, no. 23, p. 5683- 5689.

6. Rhodes, R.C., and Smith, E.I., 1972, Directional fabric of ash-flow sheets in the northwest part of the Mogollon Plateau, New Mexico: Geological Society of America Bulletin, v. 83, p. 1863-1868.

7. Smith, E.I., and Rhodes, R.C., 1972, Flow direction of lava flows: Geological Society of America Bulletin, v. 83, p. 1869-1874.

8. Rhodes, R.C., and Smith, E.I., 1973, Geology and tectonic setting of the Mule Creek Caldera, New Mexico, USA: Bulletin Volcanologique, v. 36, no. 3, p. 401-411.

9. Smith, E.I., 1973, Mono Craters, California: A new interpretation of the eruptive sequence: Geological Society of America Bulletin, v. 84, p. 2685-2690.

10. Smith, E.I., 1973, Identification, distribution and significance of lunar volcanic domes: The Moon, v. 6, nos. 1/2, p. 3-31.

11. Smith, E.I., and Sanchez, A.G., 1973, Fresh lunar craters: morphology as a function of diameter, a possible criterion for crater origin: Modern Geology, v. 4, p. 51-59.

12. Elston, W.E., Damon, P.E., Coney, P.J., Rhodes, R.C., Smith, E.I., and Bickerman, M., 1973, Tertiary volcanic rocks, Mogollon Plateau, New Mexico and surrounding regions: K-Ar dates and patterns of eruption: Geological Society of America Bulletin, v. 84, p. 2259-2274.

13. Elston, W.E., and Smith, E.I., 1973, Mars, evidence for dynamic processes from Mariners 6 and 7: Icarus, v. 19, p. 180-194.

14. Smith, E.I., and Rhodes, R.C., 1974, The Squirrel Springs volcanotectonic depression, a buried cauldron in southwestern New Mexico: Geological Society of America Bulletin, v. 85, p. 1865-1868.

15. Smith, E.I., 1974, Rumker Hills, a lunar volcanic dome complex: The Moon, v. 10, no. 2, p. 175-182.

16. Smith, E.I., and Sanchez, A.G., 1975, Fresh lunar craters: morphology as a function of diameter, a possible criterion for crater origin, Reply: Modern Geology, v. 5, p. 175-176.

17. Smith, E.I., 1976, Comparison of the crater morphology-size relationship for Mars, Moon and Mercury: Icarus, v. 28, p. 543-550.

18. Rhodes, R.C., and Smith, E.I., 1976, Stratigraphy and structure of the northwestern rim of the Mogollon Plateau volcanic province, Catron County, New Mexico: New Mexico Geological Society Special Publication No. 5, p. 57-62.

19. Smith, E.I., 1976, Structure and morphology of the John Kerr Peak dome complex, southwestern New Mexico: New Mexico Geological Society Special Publication No. 5, p. 71-78.

20. Smith, E.I., Aldrich, M.J., Deal, E.G., and Rhodes, R.C., 1976, Fission track ages of Tertiary volcanic rocks, Mogollon Plateau, southwestern New Mexico: New Mexico Geological Society Special Publication No. 5, p. 117-118.

21. Smith, E.I., 1978, Introduction to the Precambrian rocks of south-central Wisconsin: Geoscience Wisconsin, v. 2, p. 1-17.

22. Smith, E.I., Paull, R.A., and Mudrey, M.G., 1978, Precambrian inliers in south-central Wisconsin: Wisconsin Natural History and Geological Survey Field Trip Guide Book No. 2, 89 pp.

23. Smith, E.I., 1978, Precambrian rhyolites and granites in south-central Wisconsin: field relations and geochemistry: Geological Society of America Bulletin, v. 89, p. 975- 980.

24. Smith, E.I., and Stupak, W.A., 1978, A Fortran IV program for the classification of volcanic rocks using the Irvine and Baragar classification: Computers and Geoscience, v. 4, p. 89-99.

25. Smith, E.I., and Hartnell, J.A., 1978, Crater size-shape profiles for the Moon and Mercury: The Moon and Planets, v. 19, p. 479-511.

26. Smith, E.I., Slagle, M.J., and Luzader, S., 1980, Impact cratering experiment for a course in lunar and planetary geology: Journal of Geological Education, v. 28, p. 204-209.

27. Bell, J., and Smith, E.I., 1980, Geological map of the Henderson quadrangle, Clark County, Nevada: Nevada Bureau of Mines and Geology, Map 67.

28. Parolini, J.R., Smith, E.I., and Wilbanks, J.R., 1981, Fission track dating of gravity slide blocks in the Rainbow Gardens, Clark County, Nevada: Isochron/West, no. 30, p. 9-10.

29. Smith, E.I., 1982, Geology and geochemistry of the volcanic rocks in the River Mountains, Clark County, Nevada and comparisons with volcanic rocks in nearby areas: in Frost, E.G., and Martin, D.L. eds., Mesozoic-Cenozoic tectonic evolution of the Colorado River Region, California, Arizona and Nevada: San Diego, California, Cordilleran Publishers, p. 41-54.

30. Smith, E.I., 1984, Geochemistry and evolution of the early Proterozoic Post-Penokean rhyolites and granites, and related rocks of south-central Wisconsin: Geological Society of America Memoir 160, p. 113-128.

31. Smith, E.I., 1984, Geologic map of the Boulder City quadrangle, Nevada: Nevada Bureau of Mines and Geology, Map 81.

32. Choukroune, Pierre, and Smith, E.I., 1985, Detachment faulting and its relationship to older structural events on Saddle Island, River Mountains, Clark County, Nevada: Geology, v. 13, p. 421-424.

33. Myers, I.A., Smith, E.I., and Wyman, R.V., 1986, Control of gold mineralization at the Cyclopic Mine, Gold Basin District, Mohave County, Arizona: Economic Geology, v. 81, no. 6, p. 1553-1557.

34. Smith, E.I., 1986, Field Guide to the Geology of the eastern River Mountains and the Hoover Dam area, Clark County, Nevada: in Rowland, S.R., Field Guide to the Geology of Southern Nevada, prepared for the NAGT-FWS Meeting, Las Vegas, Oct. 3-5, 1986, p. 22-64.

35. Smith, E.I., Anderson, R.E., Bohannon, R.J. and Axen, Gary, 1987, Structure, volcanology, and sedimentology of mid-Tertiary rocks in the eastern Basin-and- Range Province, Southern Nevada: in Davis, G.H. and VandenDolder, Geologic Diversity of Arizona and its Margins: Excursions to Choice Areas: Arizona Bureau of Geology and Mineral Technology, Geological Survey Branch Special Paper 5, p. 383-397.

36. Weber, M.E., and Smith, E.I. 1987, Structural and geochemical constraints on the reassembly mid-Tertiary volcanoes in the Lake Mead area of southern Nevada: Geology, v. 15, p. 553-556.

37. Guth, Peter and Smith, E.I., 1987, Discussion of the paper by Ron and others, "Strike-slip faulting and block rotation in the Lake Mead Fault System", Geology, v. 15, p. 579-580.

38. Smith, E.I., Schmidt, C.S., and Mills, J.G., 1988, Mid-Tertiary volcanoes of the Lake Mead area of southern Nevada and Northwestern Arizona: in Weide, D.L., and Faber, M.L., This Extended Land, Geological Journeys in the southern Basin and Range, Geological Society of America, Cordilleran Section Field Trip Guidebook; UNLV Department of Geoscience, Special Publication No. 2, p. 107-122.

39. Faulds, J.E., Hillemeyer, F.L., and Smith, E.I., 1988, Geometry and kinematics of a Miocene "Accommodation Zone" in the central Black and southern Eldorado Mountains, Arizona and Nevada: in Weide, D.L., and Faber, M.L., This Extended Land, Geological Journeys in the southern Basin and Range, Geological Society of America, Cordilleran Section Field Trip Guidebook; UNLV Department of Geoscience, Special Publication No. 2, p. 293-310.

40. Smith, E.I., Feuerbach, D.L., Naumann, T.R. and Faulds, J.E., 1990, The area of most recent volcanism about Yucca Mountain, Nevada: Implications for volcanic risk assessment: in Proceedings of the International Nuclear Waste Symposium, v. 1, American Nuclear Society and American Society of Civil Engineers, p. 90-97.

41. Smith, E.I., Feuerbach, D.L, Naumann, T.R. and Mills, J.E., 1990, Geochemistry and evolution of mid-Tertiary igneous rocks in the Lake Mead area of Nevada and Arizona: in Anderson, J.L., Cordilleran Magmatism: Geological Society of America Memoir 176, p. 169-194.

42. Larsen, L.L. and Smith, E.I., 1990, Mafic enclaves in the Wilson Ridge Pluton, northwestern Arizona: Implications for the generation of a calc-alkaline intermediate pluton in an extensional environment: Journal of Geophysical Research, v. 95, p. 17693-17716.

43. Duebendorfer, E.M., Sewall, A.J., and Smith, E.I., 1991, The Saddle Island Detachment fault, an evolving shear zone in the Lake Mead area of southern Nevada: in Wernicke, B., Mid-Tertiary extension at the latitude of Las Vegas: Geological Society of America Memoir 176, p. 77-97.

44. Duebendorfer, E.M. and Smith, E.I., 1991, Tertiary structure, magmatism and sedimentation in the Lake Mead region, southern Nevada, in Seedorf, E., ed., Tertiary geology and volcanic-hosted gold deposits of the southern Great Basin: Geological Society of Nevada Special Publication 13, p. 66-95.

45. Naumann, T.R., Smith, E.I., Shafiqullah, M., and Damon, P.E., 1991, New K-Ar ages for mafic to intermediate volcanic rocks in the Reveille Range, Nevada: Isochron West, p. 12-16.

46. Feuerbach, D.L., Smith, E.I., Shafiquallah, M., and Damon, P.E., 1991, New K-Ar dates for mafic late-Miocene to Pliocene volcanic rocks in the Lake Mead area, Arizona and Nevada: Isochron West, p. 17-20.

47. Ho, Chih-Hsiang, Smith, E.I., Feuerbach, D.L. and Naumann, T.R., 1991, Eruptive probability calculation for the Yucca Mountain site, USA: statistical estimation of recurrence rates: Bulletin of Volcanology, v. 53.

48. Metcalf, R.V., Smith, E.I., and Mills, J.G., 1993, Magma mixing and commingling in the northern Colorado River extensional corridor: constraints on the production of intermediate magmas: *in* Lahren, M.M., Trexler, J.H., and Spinosa, C., eds., Crustal evolution of the Great Basin and Sierra Nevada: Cordilleran/Rocky Mountain Section, Geological Society of America Guidebook, Department of Geological Sciences, University of Nevada, Reno, p. 35-56.

49. Smith, E.I., , 1993, 1.76 b.y. old granites and rhyolites in the conterminous United States: *in* Reed, J.C., Bickford, M.E., Houston, R.S., Link, P.K., Rankin, D.W., Sims, P.K., and Van Schmus, W.R., Precambrian: Conterminous U.S., Geological Society of America, Decade of North America Geology (DNAG), v. C-2, p. 64-66.

50. Feuerbach, D.L., Smith, E.I., Walker, J.D. and Tangeman, J.A., 1993, The role of the mantle during crustal extension: constraints from geochemistry of volcanic rocks in the Lake Mead area, Nevada and Arizona: Geological Society of America Bulletin, v 105, p. 1561-1575.

51. Rowell, A.J., Rees, M.N., Duebendorfer, E.M., Wallin, E.T., Van Schmus, W.R., and Smith, E.I., 1993, An active Neoproterozoic margin: evidence from the Skelton Glacier area, Transantarctic Mountains: Journal of the Geological Society, London, v. 150, p. 677-682.

52. Duebendorfer, E.M., Smith, E.I., and Faulds, J.E., 1994, Geologic setting of the area between Lake Mead Nevada, and Needles, California in Sherrod, D. and Nielson, J., eds., Teriary stratigraphy of highly extended terranes: U.S. Geological Survey Bulletin 2053, p. 1-5.

53. Wallin, E.T., Duebendorfer, E.M. and Smith, E.I., 1994, Tertiary stratigraphy of the Lake Mead region in Sherrod, D. and Nielson, J., eds., Teriary stratigraphy of highly extended terranes: U.S. Geological Survey Bulletin 2053, p. 33-35.

54. Bradshaw, T.K., and Smith, E.I., 1994, Polygenetic Quaternary volcanism in Crater Flat, Nevada: Journal of Volcanology and Geothermal Research, v. 63, p. 165-182

55. Purkey, B.W., Duebendorfer, E.M., Smith, E.I., Price, J.G., and Castor, S.B., 1994, Geologic tours in the Las Vegas area: Nevada Bureau of Mines and Geology, Special Publication 16, 156 pp.

56. Metcalf, R.V. and Smith, E.I., 1995, Introduction to special section: Magmatism and Extension: Journal of Geophysical Research, v. 100, no. B7, p. 10,249-10,253.

57. Metcalf, R.V., Smith, E.I., Walker, J.D., Reed, R.C., and Gonzalas, D.A., 1995, Isotopic disequilibrium among commingled hybrid magmas: evidence for a two-stage magma mixing-commingling process in the Mt. Perkins Pluton, Arizona: Journal of Geology, v. 103, p. 509-527.

58. Yogodzinski, G.M., Naumann, T.R., Smith, E.I., Bradshaw, T.K. and Walker, J.D., 1996, Crustal assimilation by alkalic basalt, and the evolution of a mafic volcanic field in the central Great Basin, south-central Nevada: Journal of Geophysical Research, v. 101, p. 17,425-17,445.

59. Ho, C.-H. and Smith, E.I., 1997, Volcanic hazard assessment incorporating expert knowledge: application to the Yucca Mountain Region, Nevada, U.S.A.: Journal Mathematical Geology, v. 29, no. 5, p. 615-627.

60. Duebendorfer, E.M., Beard, Sue, and Smith, E.I., 1998, Restoration of Tertiary Extension in the Lake Mead region, southern Nevada: The role of strike-slip transfer zones: *in* Faulds, J.E. and Stewart, J.H., eds., Accomodation Zones and Transfer Zones: The

Regional Segmentation of the Basin and Range Province: Geological Society of America Special Paper 323, p. 127-148

61. Ho, C.-H. and Smith, E.I., 1998, A Spatial-Temporal/3-D model for volcanic hazard assessment: application to the Yucca Mountain region, Nevada: Mathematical Geology, v. 30, no. 5, p. 497-510.

62. Rees, M.N., Smith, E.I., Keenan, D.L., and Duebendorfer, E.M., 1999, Cambrian Magmatic Rocks of the Ellsworth Mountains, West Antarctica: Antarctic Journal of the United States, Review 1997, v. 32, no. 5, p. 3-5.

63. Faulds, J.E., Smith, E.I., and Gans, Phil, 1999, Spatial and temporal patterns of magmatism and extension in the Northern Colorado River Extensional Corridor, Nevada and Arizona: A preliminary report: in Faulds, J.E., Cenozoic geology of the Northern Colorado River Extensional Corridor, southern Nevada and northwestern Arizona: Economic implications of regional segmentation structures, Nevada Petroleum Society 1999 field trip guidebook, Reno, Nevada, p. 171-183.

64. Smith, E.I. and Sánchez, A., Walker, J.D. and Wang, K, 1999, Geochemistry of mafic magmas in the Hurricane volcanic field, Utah: implications for small and large scale chemical variability of the mantle: Journal of Geology, v. 7, no. 4, p. 433-448.

65. Spell, T.L., Smith, E.I., Sanford, Aaron, Zanetti, K.A., 2001, Systematics of xenocrystic contamination: preservation of discrete feldspar populations at McCullough Pass Caldera revealed by $^{40}Ar/^{39}Ar$ dating: Earth and Planetary Science Letters, v. 190, p. 153-165.

66. Downing, R.F., Smith, E.I., Orndorff, R.L., Spell, T.L. and Zanetti, K.L., 2001, Imaging the Colorado Plateau - Basin and Range Transition Zone using basalt geochemistry, geochronology and geographic information systems: *in* Erskine, M.C., Faulds, J.E., Bartley, J.M., and Rowley, P.D., The Geologic Transition, High Plateaus to Great Basin-A Symposium and Field Guide, The J.H. Mackin Volume, Utah Geological Association Publication 30 and Pacific Section American Association of Petroleum Geologists Publication GB 78, p. 127-154.

67. Faulds James E., Feuerbach Daniel L., Miller Calvin F., and Smith Eugene I., 2001, Cenozoic evolution of the Northern Colorado River Extensional Corridor, southern Nevada and northwestern Arizona: : *in* Erskine, M.C., Faulds, J.E., Bartley, J.M., and Rowley, P.D., The Geologic Transition, High Plateaus to Great Basin-A Symposium and Field Guide, The J.H. Mackin Volume, Utah Geological Association Publication 30 and Pacific Section American Association of Petroleum Geologists Publication GB 78, p. 239-271.

68. Tingley, J., Purkey, B.W., Duebendorfer, E.M., Smith, E.I., Price, J.G., and Castor, S.B., 2001, Geologic tours in the Las Vegas area-Expanded Edition: Nevada Bureau of Mines and Geology, Special Publication 16, 140 pp.

69. Wang. K., Plank, T., Walker, J.D., and Smith, E.I., 2002, A mantle melting profile across the Basin and Range, southwestern USA: Journal of Geophysical Research, v. 107, no. B1, 10.1029/2001JB000209.

70. Smith, E.I., Keenan, D.L., and Plank, T., 2002, Episodic Volcanism and Hot Mantle: Implications for Volcanic Hazard Studies at the Proposed Nuclear Waste Repository at Yucca Mountain, Nevada: GSA Today, v. 12, no. 4, p. 4-11.

71. Smith, E.I., Sánchez, A., Keenan, D.L., Monastero, F.C., 2002, Stratigraphy and Geochemistry of Volcanic Rocks in the Lava Mountains, California; Implications for the Miocene Development of the Garlock Fault: *in* Allen Glazner, J.D. Walker and John Bartley, Geologic Evolution of the Central Mojave Desert and Southern Basin and Range; Geological Society of Memoir 195, p. 151-160.

72. Keenan, D.L. and Smith, E.I., 2002, Geological Map of the Western Lava Mountains Volcano: *in* Allen Glazner, J.D. Walker and John Bartley, Geologic Evolution of the Central Mojave Desert and Southern Basin and Range: Geological Society of America Memoir 195, CD in front pocket.

73. Smith, E.I. and Keenan, D.L., 2005, Yucca Mountain could face greater volcanic threat: EOS, Transactions of the American Geophysical Union, v. 86, no. 35, p. 317.

74. Smith, E.I. and Bennett, K., 2006, The Panther Creek Volcano, Yellowstone National Park: Yellowstone Science, v. 14, no. 1, p. 5-12.

75. Ho, C.-H., Smith, E.I. and Keenan, D.L., 2006, Hazard area and probability of volcanic disruption of the proposed high-level radioactive waste repository at Yucca Mountain: Bulletin of Volcanology, v. 69, no. 2, p. 117-123

76. (IN PRESS) Smith, E.I., Honn, D.K, Johnsen, 2008, Volcanoes of the McCullough Range, southern Nevada: Geological Society of America Special Paper.

77. Smith, E.I., Conrad, C.P., Plank, T., Tibbetts, A., Keenan, D., 2008, Testing models for basaltic volcanism: implications for Yucca Mountain, Nevada: American Nuclear Society, Proceedings of the 12th International High-Level Radioactive Waste Management Conference, p. 157-164.

78. Honn, D.K. and Smith, E.I., 2008, The mid-Miocene Wilson Ridge pluton and River Mountains volcanic section, Lake Mead area of Nevada and Arizona: Linking a volcanic and plutonic section: *in* Duebenforfer, E.M., and Smith , E.I., Geological Society of America Field Guide II: Field Guide to Plutons, Volcanoes, Faults, Reefs, Dinosaurs,and Possible Glaciation in selected Areas of Arizona, California, and Nevada, Geological Society of America Field Guide 11, p. 1-20.

Edited Volumes:

- Smith, E.I. and Metcalf, R.V., 1995, Magmatism and Extension: Journal of Geophysical Research, v. 100, no. B7, p. 10,249-10,557 *(includes 17 papers that discuss magmatism and extension worldwide).*
- Duebenforfer, E.M., and Smith, E.I., 2008, Field Guide to Plutons, Volcanoes, Faults, Reefs, Dinosaurs, and Possible Glaciation in selected Areas of Arizona, California, and Nevada: Geological Society of America Field Guide 11, 262 pp. *(includes 11 papers and field guides for the 2008 GSA Cordilleran/Rocky Mountain section meeting in Las Vegas).*

B. Abstracts:

1. Smith, E.I., and Elston, W.E., 1968, Determination of flow directions of rhyolitic ash-flow tuffs and andesitic lavas from fluidal textures: Geological Society of America Special Paper 115, p. 207.

2. Smith, E.I., 1969, Rumker Hills, a volcanic plateau in the Oceanus Procellarum, Moon: Transactions of the American Geophysical Union, v. 50, no. 4, p. 229.

3. Smith, E.I., 1970, A pumiceous rhyolite dome, Mono Craters, California: an analog to small lunar cratered domes and relationship to a proposed Mono Craters eruptive sequence: Geological Society of America, Abstracts with Programs, v. 2, no. 2, p. 145.

4. Smith, E.I., 1971, The determination of origin of small lunar and terrestrial craters by depth-diameter ratio: Transactions of the American Geophysical Union, v. 51, no. 4, p. 342.

5. Rhodes, R.C., Smith, E.I., and Krohn, D.H., 1971, The Squirrel Springs volcano-tectonic depression, southwestern New Mexico: evidence for a buried cauldron and possible analog to some lunar ghost craters: Transactions of the American Geophysical Union, v. 51, no. 12, p. 832-833.

6. Smith, E.I., and Rhodes, R.C., 1971, The Mule Creek Caldera, a recently discovered felsic volcanic center in southwestern New Mexico: Geological Society of America, Abstracts with Programs, v. 3, no. 2, p. 196.

7. Smith, E.I., and Elston, W.E., 1971, Martian stratigraphy and terrain classification: a basis for the geological mapping of Mars: Transactions of the American Geophysical Union, v. 52, no. 4, p. 263.

8. Elston, W.E., and Smith, E.I., 1971, Stratigraphy and classification of martian terrains photographed by Mariners 6 and 7: XV General Assembly of the I.U.G.S., Moscow.

9. Rhodes, R.C., Smith, E.I., and Elston, W.E., 1972, The mid-Tertiary Mogollon-Datil volcanic province, southwestern New Mexico, Part I, Volcano-tectonic timing: Geological Society of America, Abstracts with Programs, v. 4, no. 3, p. 224.

10. Elston, W.E., Smith, E.I., and Rhodes, R.C., 1972, The mid-Tertiary Mogollon-Datil volcanic province, southwestern New Mexico, Part 2, Petrology and Petrogenesis: Geological Society of America, Abstracts with Programs, v. 4, no. 3, p. 155.

11. Smith, E.I., 1972, Volcanic geology of the John Kerr Peak dome complex, southwestern New Mexico: Geological Society of America, Abstracts with Programs, v. 4, p. 411-412.

12. Smith, E.I., 1973, Lunar domes: identification, distribution and significance: Transactions of the American Geophysical Union, v. 54, no. 4, p. 360.

13. Smith, E.I., and Hartlaub, D.E., 1974, Precambrian Marquette Rhyolite, Green Lake County, Wisconsin: volcanic stratigraphy, petrography and flow direction determination: Geological Society of America, Abstracts with Programs, v. 6, no. 6, p. 546.

14. Smith, E.I., 1975, Chemical characteristics of the Marquette Rhyolite, Green Lake County, Wisconsin: Geological Society of America, Abstracts with Programs, v. 7, no. 6, p. 860.

15. Smith, E.I., 1975, Mineralogy and chemistry of the Precambrian Marquette rhyolite, Green Lake County, Wisconsin: Proceedings of the 21st Institute of Lake Superior Geology, p. 9.

16. Smith, E.I., 1976, Geology and geochemistry of the Precambrian Marcellon rhyolite, Columbia County, Wisconsin: Proceedings of the 22st Institute of Lake Superior Geology, p. 58.

17. Smith, E.I., 1977, Precambrian basement rocks of south-central Wisconsin: Programs and abstracts for the 3rd annual American Geophysical Union Midwest meeting, p. 11.

18. Smith, E.I., and Hartnell, J.A., 1977, The effects of nongravitational factors on the shape of martian, lunar and mercurian craters: target effects: NASA Technical Memoir (NASA TM X3511), p. 91

19. Smith, E.I., 1978, A new Precambrian surface contour map for south-central Wisconsin: Proceedings of the 24st Institute of Lake Superior Geology, p. 36.

20. Smith, E.I., and Hartnell, J.A., 1979, Revised crater shape-size data for the Moon and Mercury: NASA Technical Memoir (NASA TM 79729), p. 147-149.

21. Smith, E.I., 1979, Tertiary volcanoes of the River Mountains, Clark County, Nevada: Transactions of the American Geophysical Union, v. 61, p. 69.

22. Smith, E.I., 1980, Rare-earth element distribution in the Precambrian rhyolites and granites of south-central Wisconsin: Proceedings of the 26st Institute of Lake Superior Geology, p. 19.

23. Brandon, C.N., Smith, E.I., and Luther, F.W., 1980, The Precambrian Waterloo Quartzite, southeastern Wisconsin: evolution and significance: Proceedings of the 26st Institute of Lake Superior Geology, p. 17-18.

24. Smith, E.I., 1981, Contemporaneous volcanism, strike-slip faulting and exotic block emplacement in the River Mountains, Clark County, Nevada: Geological Society of America, Abstracts with Programs, v. 13, no. 2, p. 107.

25. Parolini, J.R., and Smith, E.I., 1982, Landslide masses in the Rainbow Gardens, Clark County, Nevada: lithology, emplacement and significance: Geological Society of America, Abstracts with Programs, v. 14, no. 4, p. 223.

26. Smith, E.I., and Howard, W.R., 1983, Chemical and mineralogical zonation in the late-Miocene Tuff of Bridge Spring, Eldorado Mountains, Nevada and comparisons with ash-flow tuffs in nearby areas: Geological Society of America, Abstracts with Programs, v. 15, no. 5, p. 391.

27. Myers, I.A., and Smith, E.I., 1984, Relationship of detachment faulting to mineralization at the Cyclopic Mine, Arizona: Geological Society of America, Abstracts with Programs, v. 16, no. 5, p. 324.

28. Myers, I.A., and Smith, E.I., 1984, Structural control of ore deposition at the Cyclopic Mine, Mohave County, Arizona: Geological Society of America, Abstracts with Programs, v. 16, no. 6 p. 606.

29. Crow, Clay, and Smith, E.I., 1984, Rare-earth element geochemistry and petrogenesis of shonkinites, syenites and granites associated with the Sulphide Queen Carbonatite, Mountain Pass, California: Transactions of the American Geophysical Union, v. 65, no. 45, p. 1130.

30. Mills, J.G. and Smith, E.I., 1985, Mid-Miocene volcanic rocks of the Hoover Dam area, Clark County, Nevada: Geological Society of America, Abstracts with Programs, v. 17, no. 6, p. 370.

31. Smith, E.I., and Mills, J.G., 1985, Geochemistry of Post-15 m.y. old volcanic and plutonic rocks in the River Mountains-Hoover Dam area of southern Nevada and northern Arizona: Geological Society of America, Abstracts with Programs, v. 17, no. 6, p. 409.

32. Weber, M.E. and Smith, E.I., 1985, Structural geology of the southern McCullough range, Clark County, Nevada: Abstracts-Symposium on southwestern geology and paleontology, Museum of Northern Arizona Publication, p. 11.

33. Schmidt, C.S., and Smith, E.I., 1985, The Tertiary volcanic stratigraphy of the southern McCullough Range, Clark County, Nevada: Abstracts-Symposium on southwestern geology and paleontology, Museum of Northern Arizona Publication, p. 8.

34. Weber, M.E., and Smith, E.I., 1985, Tertiary lamprophyre dikes in the River Mountains, Clark County, Nevada: Journal of the Arizona-Nevada Academy of Sciences, v. 20, p. 42.

35. Naumann, Terry and Smith, E.I., 1986, Late-Miocene extension in the northern Black Range, Clark County, southern Nevada: Abstracts-Symposium on southwestern geology and paleontology, Museum of Northern Arizona Publication, p. 11.

36. Feuerbach, D.L., and Smith, E.I., 1986, The Wilson Ridge Pluton, a decapitated mid-Miocene intrusive complex in northwest Arizona: Abstracts-Symposium on southwestern geology and paleontology, Museum of Northern Arizona Publication, p. 5.

37. Feuerbach, D.L., and Smith, E.I., 1986, The mid-Miocene Wilson Ridge Pluton: a subvolcanic intrusion in the Lake Mead region, Arizona and Nevada: Transactions of the American Geophysical Union, v. 67, no. 44, p. 1262.

38. Smith, E.I., and Mills, J.G., 1986, The mid-Miocene Lake Mead volcanic field, southern Nevada: geochemical constraints on magmatic evolution: Transactions of the American Geophysical Union, v. 67, no. 44, p. 1262.

39. Sewall, Angela, and Smith, E.I., 1986, The Saddle Island detachment fault, Lake Mead, Nevada: upper plate geology and regional significance: Geological Society of America Abstracts with Programs, v. 18, p. 182-183.

40. Smith, E.I., Schmidt, C.S., and Weber, M.E., 1986, Mid-Tertiary volcanic rocks of the McCullough Range, Clark County, Nevada: Geological Society of America Abstracts with Programs, v. 18, p. 187.

41. Feuerbach, D.L., and Smith, E.I., 1987, Late-Miocene Fortification Hill basalt, Lake Mead area, Nevada and Arizona: source areas and conduit geometry: Geological Society of America Abstracts with Programs, v. 19, no. 6, p. 376-377.

42. Naumann, T.R., and Smith, E.I., 1987, Evidence for magma mixing in Mid-Tertiary volcanic rocks: Lake Mead region, southern Nevada: Geological Society of America Abstracts with Programs, v. 19, no. 6, p. 435-436.

43. Schmidt, C.S., and Smith, E.I., 1987, The McCullough Pass caldera: a mid-Miocene caldera in the central McCullough Mountains, Clark County, Nevada: Geological Society of America Abstracts with Programs, v. 19, no. 6, p. 447.

44. Smith, E.I., Eschner, E., Feuerbach, D.L., Naumann, T.R., and Sewall, A., 1987, Mid-Tertiary extension in the eastern Basin and Range Province, Nevada and Arizona: The Las Vegas Valley-Detrital Wash transect: Geological Society of America, Abstracts with Programs, v. 19, no. 7, p. 848-849.

45. Feuerbach, D.L., and Smith, E.I., 1988, Changes in volcanism during declining stages of regional extension in the Lake Mead area, Nevada and Arizona: Geological Society of America, Abstracts with Programs, v. 20, no. 7, p. 114.

46. Naumann, T.R., and Smith, E.I., 1988, Compositional trends within late-Cenozoic alkalic basalts of the central Great Basin, Nevada: Geological Society of America, Abstracts with Programs, v. 20, no. 7, p. 114.

47. Larson, L.L., and Smith, E.I., 1988, Mafic blobs: evidence for felsic and mafic magma commingling, Wilson Ridge Pluton, northwestern Arizona: Transactions of the American Geophysical Union (EOS), v. 69, no. 44, p. 1491.

48. Cole, E.D. and Smith, E.I.,, 1989, Late-Cenozoic alkalic basalts near the eastern boundary of the Basin-and-Range province, northwestern Arizona and Nevada: Geological Society of America Abstracts with Programs, v. 21, no. 5, p. 67.

49. Naumann, T.R., Smith, E.I., and Shafiqullah, M., 1990, Post 6-Ma intermediate volcanism in the Reveille Range, Central Great Basin, Nevada: Geological Society of America, Abstracts with Programs, v. 22, no. 3, p. 72.

50. Feuerbach, D.L., Smith, E.I. and Shafiqullah, M., 1990, Structural control of Pleistocene volcanism in Crater Flat, Nevada: Geological Society of America, Abstracts with Programs, v. 22, no. 3, p. 23.

51. Duebendorfer, E.M., Sewall, A.J., Eschner, E., Feuerbach, D.L., Naumann, T.R., and Smith, E.I., 1990, The Saddle Island detachment, Lake Mead, Nevada: Regional extent and significance: Geological Society of America, Abstracts with Programs, v. 22, no. 3, p. 20.

52. Duebendorfer, E.M., Feuerbach, D.L., and Smith, E.I., 1990, Syntectonic sedimentation, volcanism, and kinematics along the inferred eastern extension of the Las Vegas Valley shear zone, Nevada: Geological Society of America, Abstracts with Programs, v. 22, no. 3, p. 20.

53. Feuerbach, D.L., and Smith, E.I., 1990, Structural control of Pleistocene volcanism in Crater Flat, Nevada: Geological Society of America, Abstracts with Programs, v. 22, no. 3, p. 23.

54. Smith, E.I., Feuerbach, D.L., and Duebendorfer, 1991, Magmatism, extensional tectonics and sedimentation in the Lake Mead area, Nevada and Arizona: A new model: Geological Society of America, Abstracts with Programs, v. 23, no. 2, p.99.

55. Cascadden, T.E., and Smith, E.I.,1991, The eastern boundary of the extensional allochthon in the eastern Basin and Range: volcanic and structural geology of the northern White Hills, Arizona: Geological Society of America, Abstracts with Programs, v. 23, no. 2, p. 12.

56. Feuerbach, D.L., Smith, E.I., Walker, J.D., and Tangeman, J.A., 1991, The transition from subalkalic to alkalic volcanism in the Lake Mead area of Nevada and Arizona: Geochemical and isotopic constraints: Geological Society of America, Abstracts with Programs, v. 23, no. 2, p. 24.

57. Naumann, T.R., Feuerbach, D.L., and Smith, E.I., 1991, Structural control of Pliocene volcanism in the vicinity of the Nevada Test Site: An example from Buckboard Mesa: Geological Society of America, Abstracts with Programs, v. 23, no. 2, p. 82.

58. Faulds, J.E., Feuerbach, D.L., and Smith, E.I., 1991, New insights on structural controls and emplacement mechanisms of Pliocene/Quaternary basaltic dikes, southern Nevada and northwestern Arizona: Geological Society of America, Abstracts with Programs, v. 23, no. 5, p. A118.

59. Cascadden, T.E., and Smith, E.I., 1991, Intermediate and mafic volcanic rocks of the northern White Hills, Arizona: Implications for the production of intermediate composition volcanic rocks during regional extension: Geological Society of America, Abstracts with Programs, v. 23, no. 5, p. A390.

60. Smith, E.I., Feuerbach, D.L., Naumann, T.R. and Ho, C.-H., 1991, Volcanic risk assessment studies for the proposed high-level radioactive waste repository at Yucca Mountain, Nevada, U.S.A.: International Conference on Active Volcanoes and Risk Mitigation, Naples, Italy, Abstract Volume.

61. Metcalf, R.V., Smith, E.I., Nall, K.E., and Reed, R.C., 1992, The Mt. Perkins pluton: shallow level magma mixing and mingling during Miocene extension: Geological Society of America, Abstracts with Programs, v. 24, no. 7, p. A87.

62. Bradshaw, T.K., and Smith, E.I., 1993, Quaternary basalts in S. Nevada, U.S.A.: Melting of metasomatised lithospheric mantle: IAVCEI General Assembly, Canberra, Australia, Abstracts, p. 12.

63. Smith, E.I., Feuerbach, D.L., Naumann, T.R., Walker, J.D., and Tangeman, J.A., 1993, Role of the mantle during crustal extension: IAVCEI General Assembly, Canberra, Australia, Abstracts, p. 102.

64. Smith, E.I., Morikawa, S.A., Martin, M.W., Gonzales, D.A. and Walker, J.D., 1993, Tuff of Bridge Spring: a mid-Miocene ash-flow tuff, northern Colorado River extensional corridor, Nevada and Arizona: Geological Society of America, Abstracts with Programs, v. 25, no. 5, p. A148.

65. Smith, E.I., Bridwell, H., Schmidt, C., Switzer, T., and the UNLV 1993 Winter Field Course, 1993, Late-Miocene intermediate to felsic volcanism in the McCullough range, southern Nevada: (abs.) Journal of the Arizona-Nevada Academy of Science, v. 28, p.45.

66. Johnson, W.M., Reed, R.C., Metcalf, R.V., and Smith, E.I., 1993, Potential extrusive equivalents of the Miocene Mt. Perkins pluton, Mohave County, Arizona: (abs.) Journal of the Arizona-Nevada Academy of Science, v. 28, p.44.

67. Smith, E.I., and Faulds, J.E., 1994, Patterns of Miocene magmatism in the northern Colorado River extensional corridor (NCREC), Nevada, Arizona and California: Geological Society of America, Abstracts with Programs, v. 26, no. 5, p. 93.

68. Faulds, J.E., Gans, P.B., and Smith, E.I., 1994, Spatial and temporal patterns of extension in the northern Colorado River extensional corridor, northwestern Arizona and southern Nevada: Geological Society of America, Abstracts with Programs, v. 26, no. 5, p. 51.

69. Yogodzinski, G.M., Naumann, T.R, and Smith, E.I., 1994, Temporal and geochemical features of volcanism in the Reveille Range of south-central Nevada, USA, Colima Volcano, Fourth International Meeting, Abstracts, p. 187.

70. Smith, E.I., Bradshaw, T.K., and Walker, J.D., 1994, Polygenetic Quaternary volcanism in the western USA: an example from Crater Flat, Nevada: Colima Volcano, Fourth International Meeting, Abstracts, p. 187.

71. Metcalf, R.V., Smith, E.I., Walker, J.D. and Gonzales, D.A., 1994, Implications of large isotopic variations among commingled magmas: Geological Society of America Abstracts with Programs, v. 26, no. 7, p. A-477.

72. Duebendorfer, E.M., and Smith, E.I., 1994, Restoration of Miocene extension in the Lake Mead area, Nevada: Geological Society of America Abstracts with Programs, v. 26, no. 7, p. A-250.

73. Yogodzinski, G.M., Naumann, T.R., Smith, E.I., and Bradshaw, T.R., 1994, Mantle and crust in continental basalt and evolution of a mafic volcanic field in the central Great Basin, south-central Nevada: Geological Society of America Abstracts with Programs, v. 26, no. 7, p. A-354.

74. Yogodzinski, G.M., and Smith, E.I., 1995, Isotopic domains and the area of interest for volcanic hazard assessment in the Yucca Mountain area: Transactions of the American Geophysical Union (EOS), v. 76, no. 46, p. 669.

75. Boland, Kelly A., and Smith, E.I., 1996, The petrogenesis of andesites produced during crustal extension: Geological Society of America Abstracts with Programs, v. 28, no. 5, p. 51

76. Rash, Kelly, B., Smith, E.I., Lux, D.R., 1996, Evidence for the location of two caldera margins in the nothern Reveille and southern Pancake Ranges, Nye County, Nevada: Geological Society of America Abstracts with Programs, v. 28, no. 5, p. 104.

77. Sanchez, Alex, Smith, E.I., Walker, J.D, and Snee, L.W., 1996, Mafic volcanism in the Colorado Plateau/Basin and Range transition zone, Hurricane, Utah: Geological Society of America Abstracts with Programs, v. 28, no. 5, p. 107-108.

78. Blaylock, Joe and Smith, E.I., 1996, Geochemical investigations at Sunset Crater, Arizona: Complex petrogenetic history of a low-volume magmatic system: Geological Society of America Abstracts with Programs, v. 28, no. 7, p. 1162.

79. Smith, E.I., Blaylock, Joe, Boland, Kelly, Morikawa, Shirley, and Sanchez, Alex, 1996, Complex behavior of low-volume mafic magma systems: polycyclic, polygenetic, and complex monogenetic Quaternary cinder cones in the western US and Mexico: Geological Society of America Abstracts with Programs, v. 28, no. 7, p. 502.

80. Metcalf, R.V., and Smith E.I., 1996, Difficulties in recognizing a mantle component in intermediate hybrid magmas formed by crust-mantle interaction: A comparative study of two mid-Miocene plutons, northwest Arizona: 30th International Geological Congress, Abstracts Volume 2, p. 415, Beijing. China

81. Ho, C-.H. and Smith, E.I., 1996, Volcanic hazard assessment incorporating expert knowledge: application to the Yucca Mountain Region, Nevada, U.S.A: 30th International Geological Congress, Abstracts Volume 2, p. ??, Beijing. China.

82. Hammond, K.J.; Feig, A.D.; Smith, E.I.; Danielson, L.R., 1996, The variability of mineral suites in pluvial lacustrine sediments as a paleohydrologic and paleoecologic indicator; a preliminary example from the southern Great Basin: Transactions, American Geophysical Union, v. 77, p. 304.

83. Dickson, L.R. and Smith, E.I., 1997, Volcanology and geochemistry of Quaternary basalts on Citadel Mountain, Lunar Crater Volcanic Field, Pancake Range, Nevada: Geological Society of America Abstracts with Programs, v. 29, no. 5, p. 11.

84. Metcalf, R.V., McDaniels, S.M. and Smith, E.I., 1997, A unique lithospheric mantle source for Miocene tholeiitic basalt in the northern Colorado River Extensional Corridor

(NCREC), AZ-NV: Geological Society of America Abstracts with Programs, v. 29, no. 5, p. 53.

85. Sanchez, Alex and Smith, E.I., 1997, Evidence for magma mixing/commingling in the Lava Mountains Volcanic Field, southeastern California: Geological Society of America Abstracts with Programs, v. 29, no. 5, p. 62.

86. Smith, E.I., Rees, M.N., and Duebendorfer, E.M., 1997, Cambrian magmatic rocks of the Ellsworth Moutains West Antarctica: Implications for Gondwana Reconstructions: Geological Society of America Abstracts with Programs, v. 29, no. 7, p. 89.

87. Kuntz, M.A., Anderson, R.E., Beard, L.S., Bohannon, R.G., Burke, W.J., Dixon, G.L., Howard, K.A., Mankinen, E.A., and Smith, E.I., 1997, Status of geologic mapping and related studies in the Las Vegas Urban Corridor II: Lake Mead 1:100,000 scale quadrangle: Geological Society of America Abstracts with Programs, v. 29, no. 7, p. 288.

88. Rees, M.N., Smith, E.I., Duebendorfer, E.M. and Keenan, D.L., 1998, Cambrian marginal basin rifting and subduction recorded in the Ellsworth-Whitmore Mountains Terrane, West Antarctica: *in* Special Abstracts Issue, Gondwana 10: Event Stratigraphy of Gondwana, Journal of African Earth Sciences, v. 27, no. 1A, p. 151-153.

89. Wang, Kefa, J.D. Walker, T. Plank and E.I. Smith, 1998, Mantle melting during Basin and Range extension in southern Nevada and adjacent areas: EOS (Transactions of the American Geophysical Union), v. 79, no. 45, p. 1019.

90. Downing, R.F., Smith, E.I. and Orndorff, R., 1999, Imaging the boundary between the Basin and Range and Colorado Plateau using basalt geochemistry and GIS: Geological Society of America Abstracts with Programs, v. 31, no. 6, p. A-51.

91. Sanford, A.L., Smith, E.I., and Spell, T.L., 1999, The McCullough Pass Caldera, southern Nevada: Geometry of a relatively undeformed volcanic center in the highly extended Northern Colorado River Extensional Corridor: Geological Society of America Abstracts with Programs, v. 31, no. 7, p. 262.

92. Smith, E.I., Sánchez, A., Keenan, D.L., and Monastero, F.C., 1999, Stratigraphy and geochemistry of volcanic rocks in the Lava Mountains, California: implications for the Miocene development of the Garlock Fault: Geological Society of America Abstracts with Programs, v. 31, no. 7, p. 262.

93. Metcalf, R.V., Smith, E.I., and Miller, C.F., 2000, Coeval Tertiary volcanic and plutonic rocks, Colorado River extensional corridor (CREC), USA: Implications for crust-mantle interaction and magma mixing as a petrologic process: 15th Australian Geological Convention, abstract volume, p. 346.

94. Plank, T., Wang, Kefa, Walker, J.D. and Smith, E.I., 2001, A mantle melting profile across the Basins and Range, SW USA: Geological Society of America Abstracts with Programs, v. 33, p. A211.

95. Smith, E.I., Keenan, D.L., Plank, T., and Ho, C.-H., 2002, Deep melting of hot mantle: Implications for Volcanic Hazard Studies at the Proposed Nuclear Waste Repository at Yucca Mountain, Nevada: Geological Society of America Abstracts with Programs, v. 34, no. 6, p. 106.

96. Stowell, Shara and Smith, E.I., 2003, Volcanology of the Navajo Lake Volcanic Field, Southwestern Utah: Geological Society of America Abstracts with Programs, v. 35, no. 5, p. 12.

97. Smith, E.I., Keenan, D.L., Ho, C.-H., and Freeman, Elizabeth, 2003, Buried volcanic centers near Yucca Mountain, Nevada: Significance for volcanic hazard studies and the Neotectonics of southern Nevada: Geological Society of America Abstracts with Programs, v. 35, no. 7, p. 475.

98. Smith, E.I., and Bennett, Kristeen, 2004, A Geochemical and Geochronological database for the Yellowstone Plateau volcanic field: implications for the origin of post-caldera basalt and the future of the Yellowstone magmatic system: Geological Society of America Abstracts with Programs, Vol. 36, No. 4, p. 10.

99. Bennett, Kristeen and Smith, E.I., 2004, The Panther Creek Volcano: a newly discovered basaltic vent in Yellowstone National Park: Geological Society of America Abstracts with Programs, Vol. 36, No. 4, p. 8.

100. McKelvey, Matt and Smith, E.I., 2004, Mid-Miocene calderas in the Reveille Range, Nevada: Geological Society of America Abstracts with Programs, Vol. 36, No. 5, p. 431.

101. Druschke, Peter; Honn, Denise; McKelvey, Matt; Nastanski, Nicole; Rager, Audrey; Smith, E.I., and Belliveau, Robert, 2004, Volcanology of the northern Eldorado Mountains, Nevada: new evidence for the source of the tuff of Bridge Spring: Geological Society of America Abstracts with Programs, Vol. 36, No. 5, p. 431.

102. Spell, T.E., Smith, E.I., Nastanski, N., Bennett, K., 2004, Establishment and Evolution of a new Silicic Magma System North of Yellowstone Caldera: Geochronology, Geochemistry and Petrographic Relationships of Extracaldera Basalts and Rhyolites in the Norris-Mammoth Corridor: Eos Transactions of the American Geophysical Union, v. 85, no. 47, Abstract V52B-08.

103. Faust, M.E. and Smith, E.I., 2005, Volcanology of the Santa Clara and Diamond Valley Lava flows, Snow Canyon State Park, Utah: Geological Society of America Abstracts with Programs, Vol. 37, No. 4, p. 67.

104. Honn, Denise and Smith, E.I., 2005, Coalescing calderas and volcanic debris avalanche deposits in the northern Kawich Range, central Nevada: Geological Society of America Abstracts with Programs, Vol. 37, No. 4, p. 65.

105. Honn, Denise and Smith, E.I., 2005, Volcanoes of the McCullough Range, southern Nevada: A window into the pre-extensional history of the Colorado River extensional corridor: Geological Society of America Abstracts with Programs, Vol. 376, No. 7, p. 229-230.

106. Smith, E.I. and Keenan, D.L., 2005, Defining the Boundaries of the Volcanic Field about Yucca Mountain, Nevada: Implications for Volcanic Hazard Studies: Eos Transactions of the American Geophyical Union, v. 86, no. 52, Fall Meeting Supplement, Abstract V31E-03.

107. Hirsch, A.C., Snelson, C.M., and Smith, E.I., 2006, TI: An Integrated Geophysical Study of Hidden Valley, Central McCullough Range, NV: Characterization of a Volcanotectonic Terrain: Eos Transactions of the American Geophysical Union, v. 87, no. 52, Fall Meeting Supplement, Abstract NS41A-1114.

108. Honn, D.K. and Smith, E.I., 2006, Nested Calderas in the Northern Kawich Range, Central Nevada: Termination of the Ignimbrite Flare-up in the Great Basin: Eos Transactions of the American Geophysical Union, v. 87, no. 36, Joint Meeting Supplement, Abstract V41A-10.

109. Honn, D.K., Simon, A.C., Smith, E.I., and Spell, T.L., 2007, The River Mountains volcanic section - Wilson Ridge pluton, a long lived multiphase mid-Tertiary igneous system in southern Nevada, and northwestern Arizona, USA: Eos Trans. AGU, 88(52), Fall Meet. Suppl., Abstract V43G-05.

110. Honn, D.K., Johnsen, R., and Smith, E.I., 2007, Volcanic centers of the northern McCullough Range, southern Nevada USA: a view of pre-extensional volcanism in the Colorado River extensional corridor: Eos Trans. AGU, 88(23), Joint Assembly Suppl., Abstract V23A-04.

111. Honn, D.K, and Smith, E.I., 2007, Redefining an igneous system: volcanic-plutonic links between the Wilson Ridge pluton and the River Mountains volcanic section, Nevada USA: Eos Trans. AGU, 88(23), Joint Assembly Suppl., Abstract V53B-08.

112. Johnsen, R., and Smith, E.I., 2007, Evidence for dome collapse and coeval mafic-felsic volcanism in the central McCullough Range, Nevada: Geological Society of America Abstracts with Programs, v. 39, no. 5, p. 35.

113. Smith, Eugene, Johnsen, Racheal, Honn, Denise, Brainard, Ray, and Coon, Richard, 2008, A new 3-dimensional view of the mid-Miocene volcanic and plutonic rocks of the River Mountains, southern Nevada: Geological Society of America, Abstracts with Programs, v. 40, no. 1, p. 34.

114. Honn, Denise, Johnsen, Racheal, and Smith, E.I., 2008, Developing geological educational materials for BLM's Sloan Canyon National Conservation Area: Presenting the Miocene volcanic history of the Northern McCullough Mountains, southern Nevada to the public: Geological Society of America, Abstracts with Programs, v. 40, no. 1, p. 90.

115. Johnsen, Racheal and Smith, E.I., 2008, Dome eruption, collapse, and pyroclastic flows of a mid-Miocene volcanic section in the central McCullough Range, southern Nevada: Geological Society of America, Abstracts with Programs, v. 40, no. 1, p. 94.

116. Spell, Terry, Wooton, Katie, Nastanski, Nicole, Smith, E.I., and Bennett, Kristeen, 2008, The role of basalt in eruption of Quaternary rhyolites north of the Yellowstone Caldera: Geological Society of America, Abstracts with Programs, v. 40, no. 1, p. 62.

C. Open File and Technical Reports

1. Anderson, J.L., Young, E.D., Clarke, H.S., Orrell, S.E., Winn, M., Schmidt, C.S., Weber, M.E., and Smith, E.I., 1985, The geology of the McCullough Range Wilderness area, Clark County, Nevada: U.S. Geological Survey, Final Technical Report, 26p.

2. Eggleton, R.E., and Smith, E.I., 1967, Geologic map of the Rumker Quadrangle of the Moon: U.S. Geological Survey Open File Report.

Plus over 300 reports to the Nevada Nuclear Project Office, U.S. Navy's Geothermal Project Office and the Bureau of Land Managment.