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NEVADA NUCLEAR WASTE PROJECT OFFICE
PRESENTATION TO THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUBJECT: VOLCANIC RISK STUDIES

DATE: JUNE 26, 1989

PRESENTER: DR. EUGENE I. SMITH
PROFESSOR OF GEOLOGY

ORGANIZATION CENTER FOR VOLCANIC AND TECTONIC STUDIES
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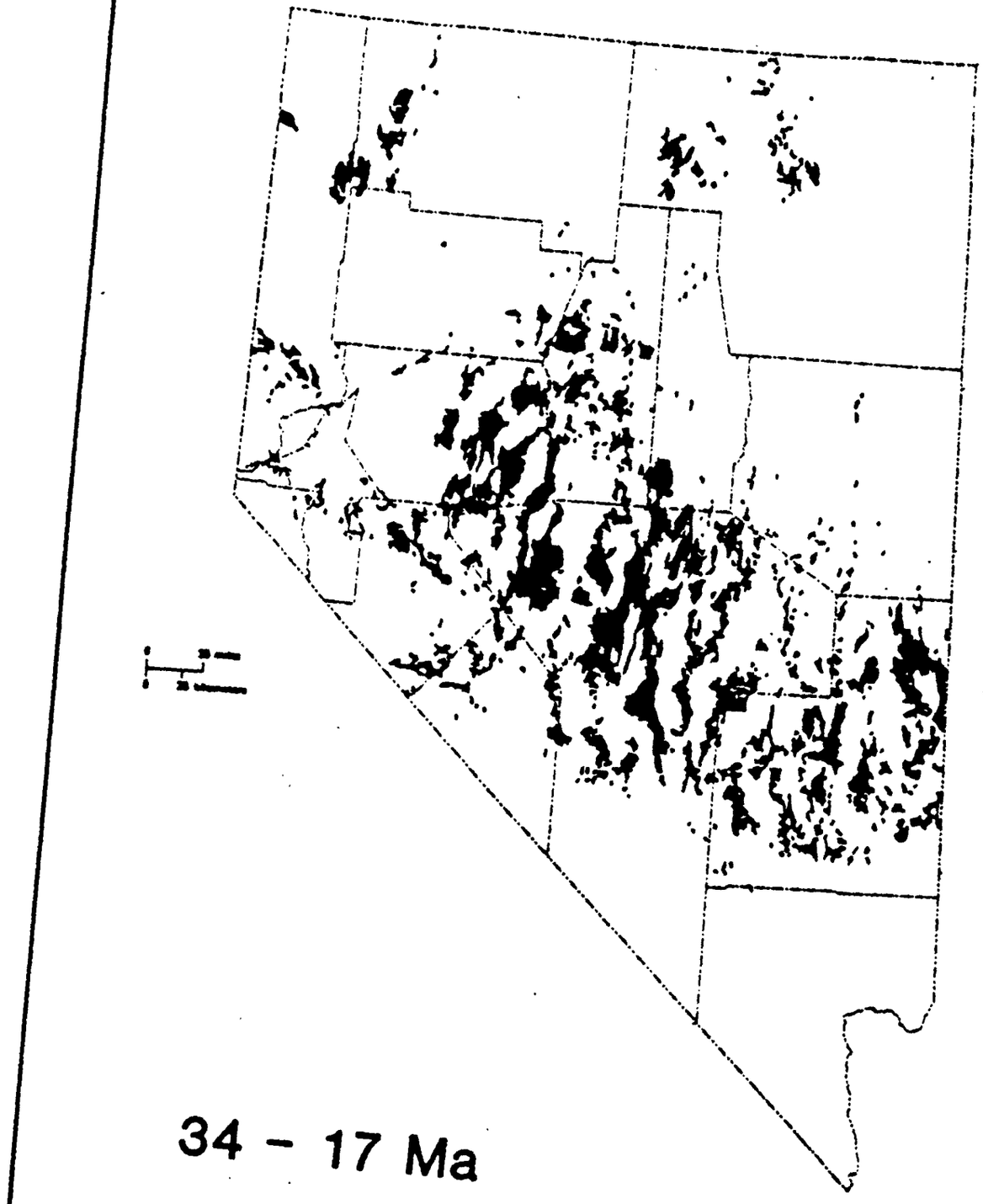

34 – 17 Ma

After Stewart, 1980

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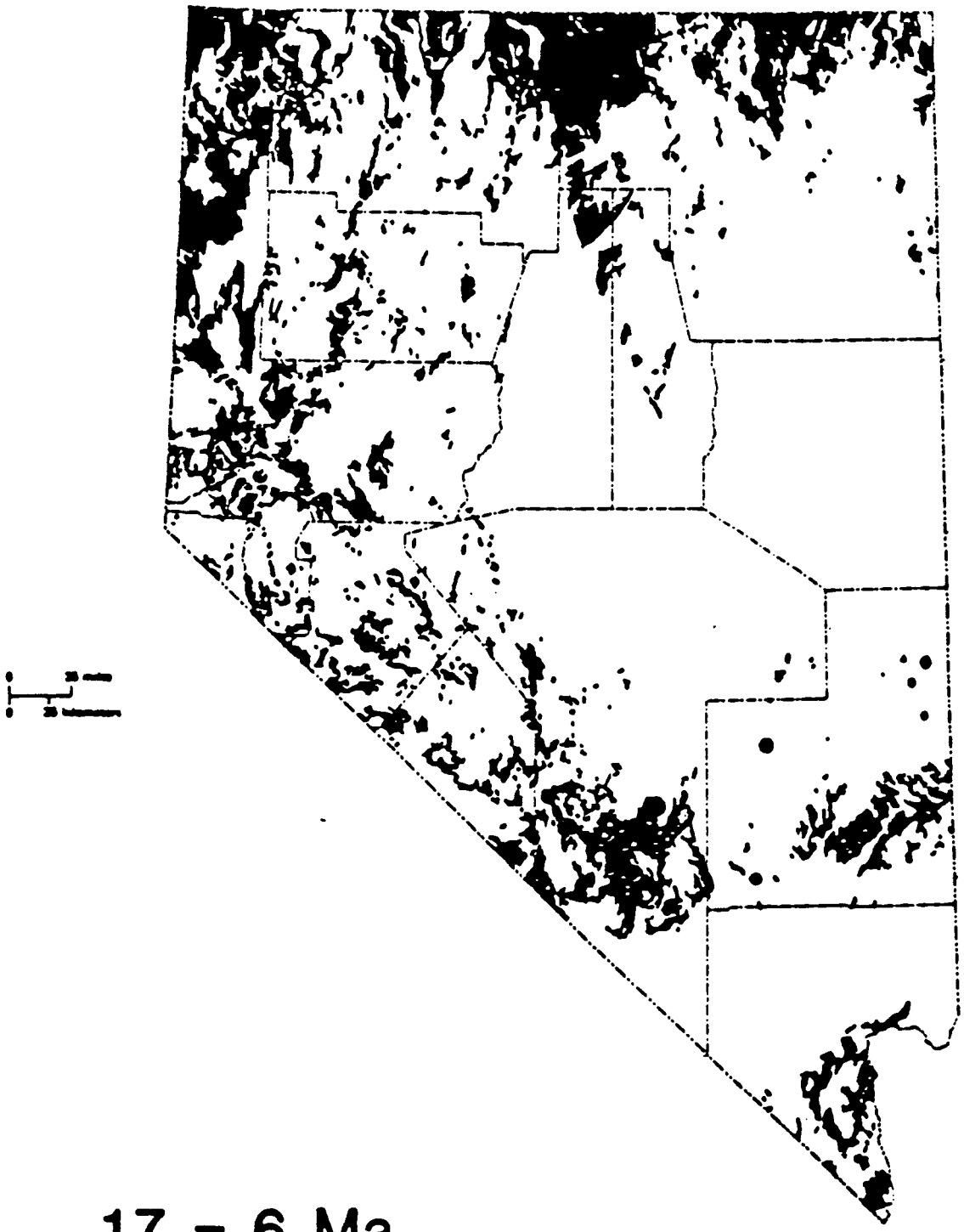

17 – 6 Ma

After Stewart, 1980

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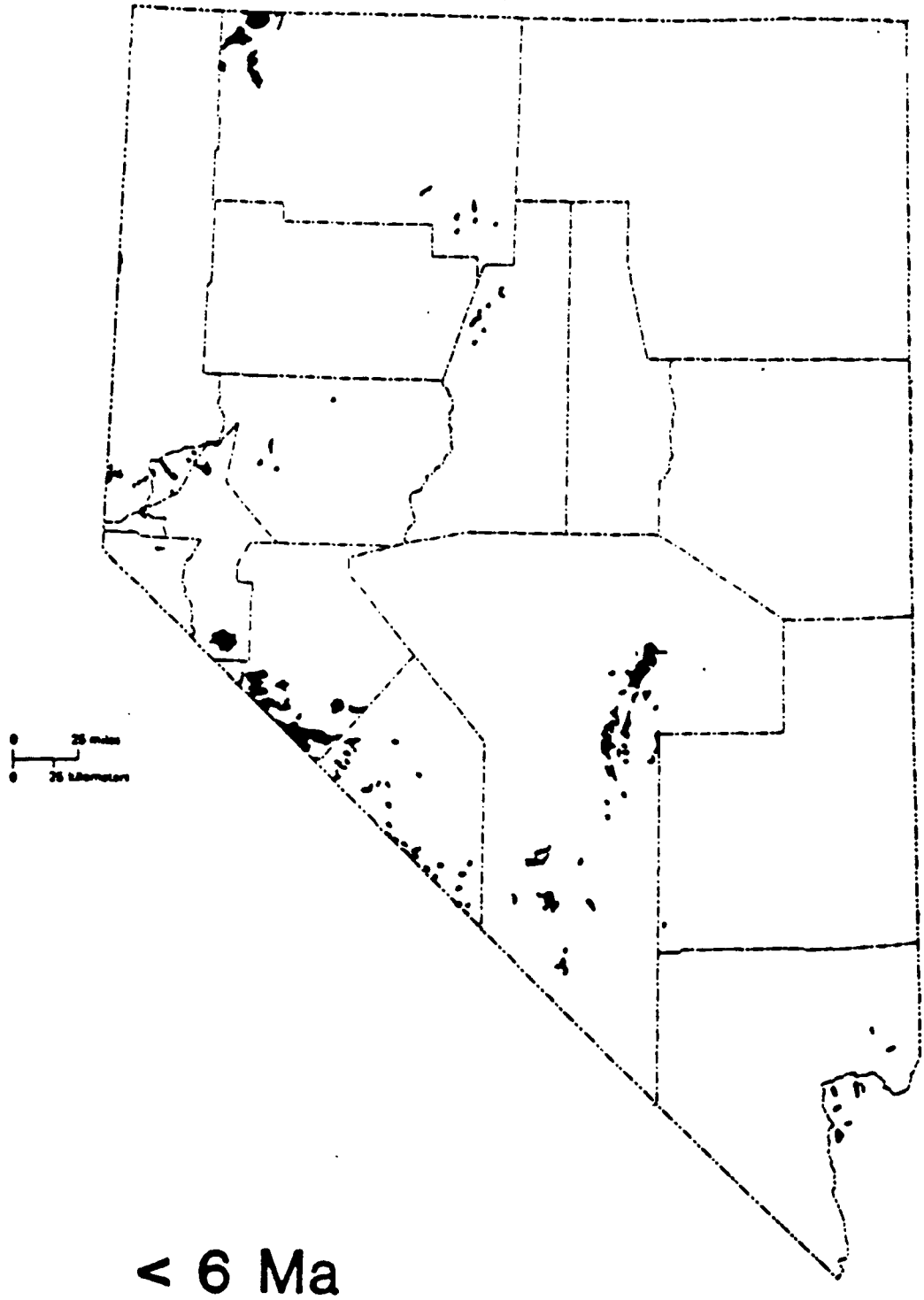

< 6 Ma

After Stewart, 1980

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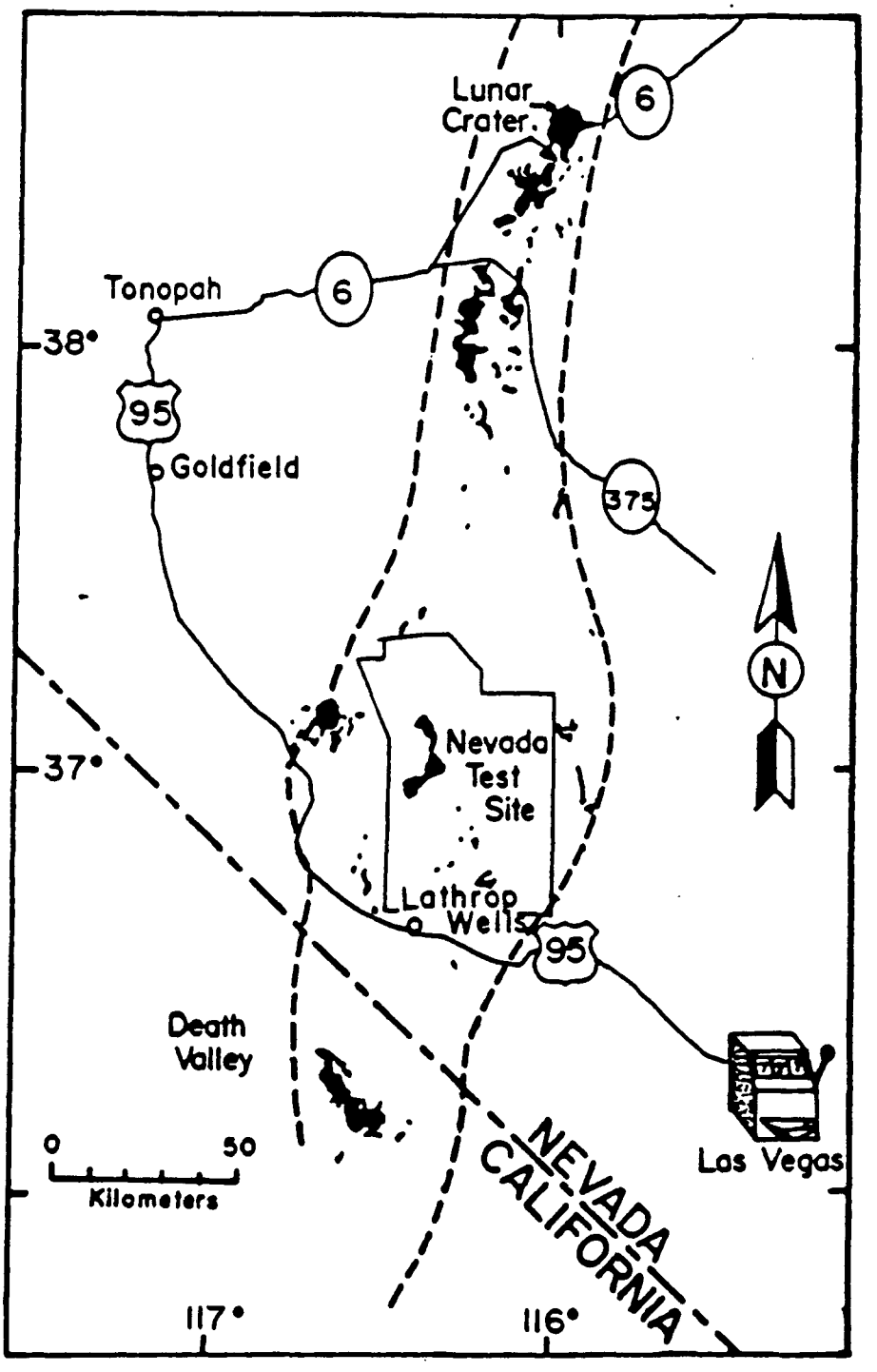
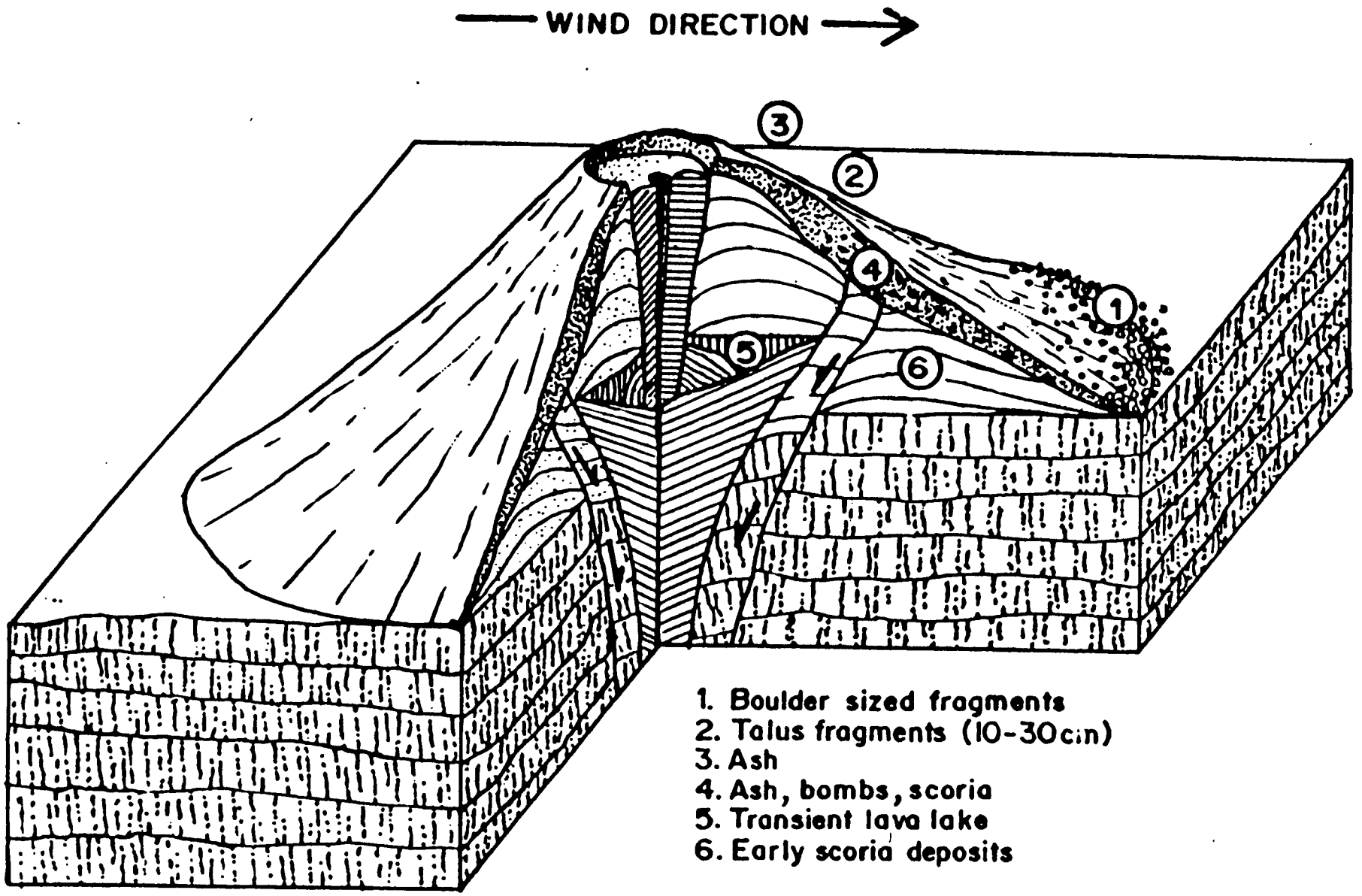

Lunar Crater
6
Tonopah
6
38°
95
Goldfield
375
N
Nevada Test Site
37°
Lathrop Wells
95
Death Valley
0
50
Kilometers
NEVADA
CALIFORNIA
Las Vegas
117°
116°

CVTS

(after McGetchin et al, 1974)



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VOLCANIC RISK STUDIES

IMPORTANT ISSUES AND QUESTIONS

1. STRUCTURAL CONTROL

   WHERE WILL VOLCANISM OCCUR?

   WILL VOLCANISM BE CONTROLLED BY EXISTING GEOLOGIC STRUCTURES?

   WILL FUTURE ERUPTIONS OCCUR AT SITES OF PAST ERUPTIONS?

2. LENGTH AND NATURE OF AN ERUPTION

   HOW LONG WILL AN ERUPTION LAST?

   WILL THE ERUPTION BE SIMPLE OR COMPLEX?

3. CRITERIA FOR IDENTIFYING AN EXTINCT VOLCANIC FIELD

   ARE THERE RELIABLE CHEMICAL CRITERIA THAT INDICATE THAT A VOLCANO IS EXTINCT?

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STRUCTURAL CONTROL

CINDER CONES MAY NOT BE CONTROLLED BY FAULTS-----DIKES AND CONDUITS MAY AVOID FAULT ZONES

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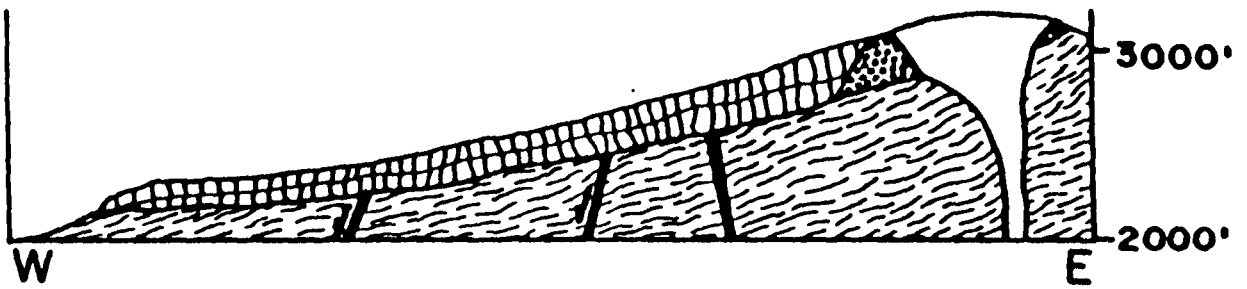
LAVA CASCADE, NW ARIZONA



BASALT

PLUG

SCORIA

PRECAMBRIAN BASEMENT

0 0.5 mi.

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STRUCTURAL CONTROL

FUTURE ERUPTIONS MAY OCCUR AT OR NEAR
SITES OF PAST ERUPTIONS

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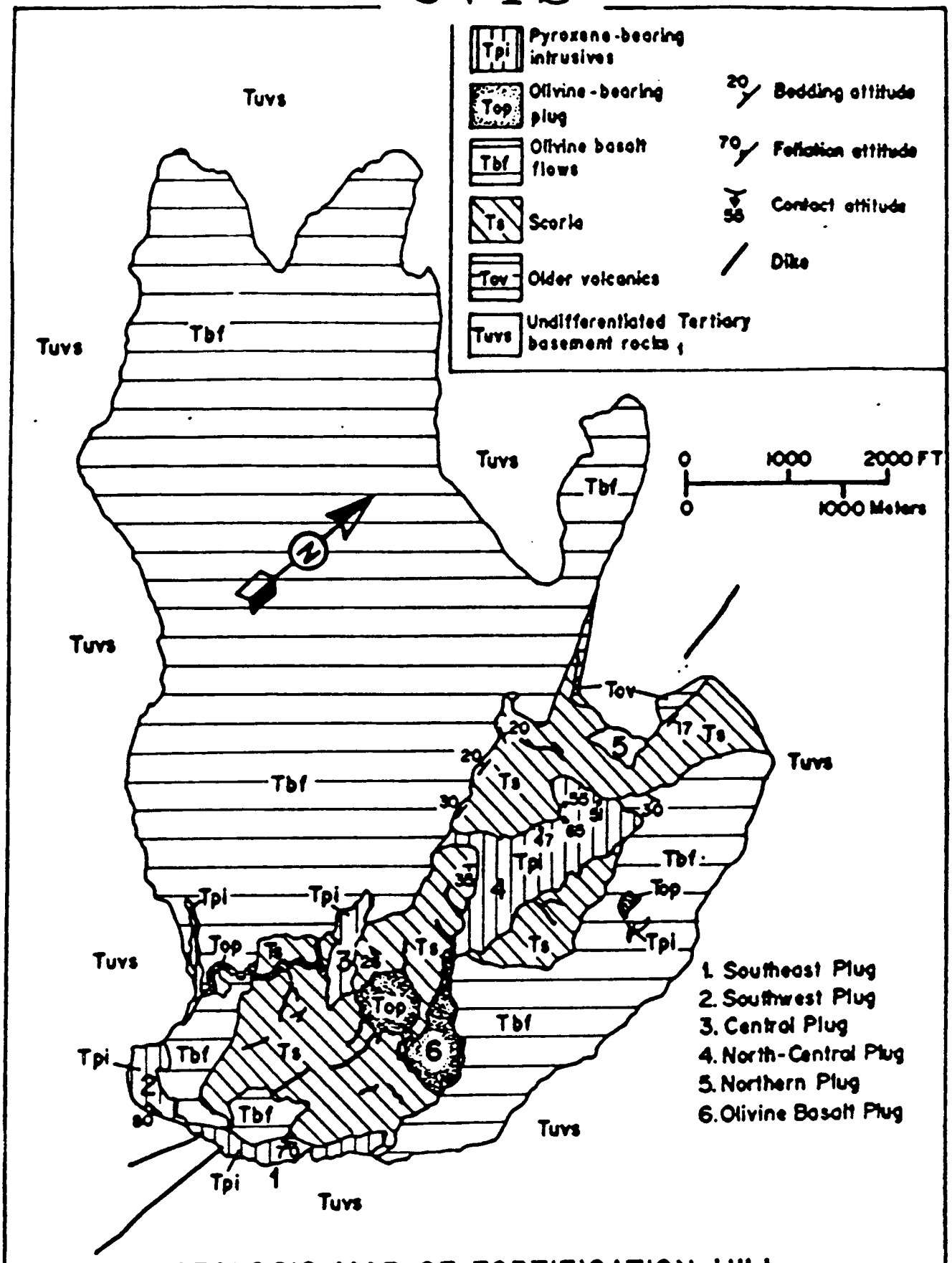

GEOLOGIC MAP OF FORTIFICATION HILL

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LENGTH AND NATURE OF AN ERUPTION

FORTIFICATION HILL 470,000 +/− 160,000 YEARS

LAVA CASCADE 420, 000 +/−130, 000 YEARS

CINDER CONES IN THE CENTRAL GREAT BASIN
"SEVERAL HUNDRED THOUSAND YEARS"
CROWE ET AL. (1988)

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LENGTH AND NATURE OF AN ERUPTION

ERUPTIONS AT A CINDER CONE COMPLEX MAY LAST AS LONG AS 10^5 YEARS

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LENGTH AND NATURE OF AN ERUPTION

ERUPTIONS MAY BE COMPLEX AND INVOLVE ERUPTIVE PULSES RANGING FROM RELATIVELY QUIET LAVA FOUNTAINING TO MODERATELY EXPLOSIVE STROMBOLIAN OR HYDROMAGMATIC

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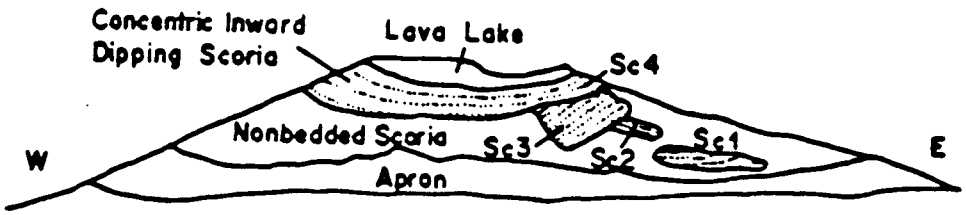
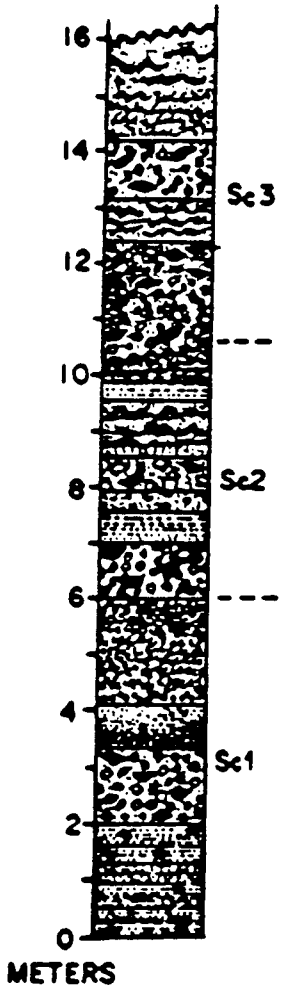
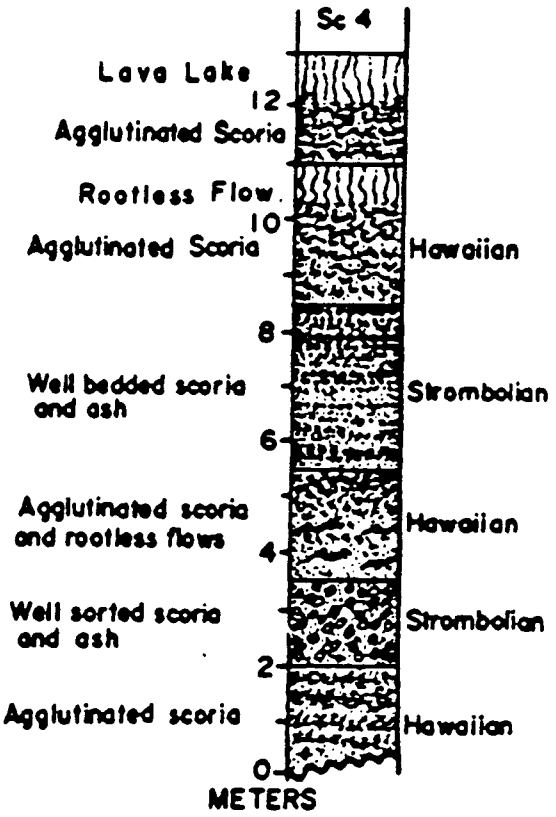
BLACK CONE (CRATER FLAT, NEVADA)



52 eruptive pulses observed





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LENGTH AND NATURE OF AN ERUPTION

MORE FELSIC AND POSSIBLY MORE EXPLOSIVE ACTIVITY MAY OCCUR DURING OR BETWEEN ERUPTIONS OF BASALT

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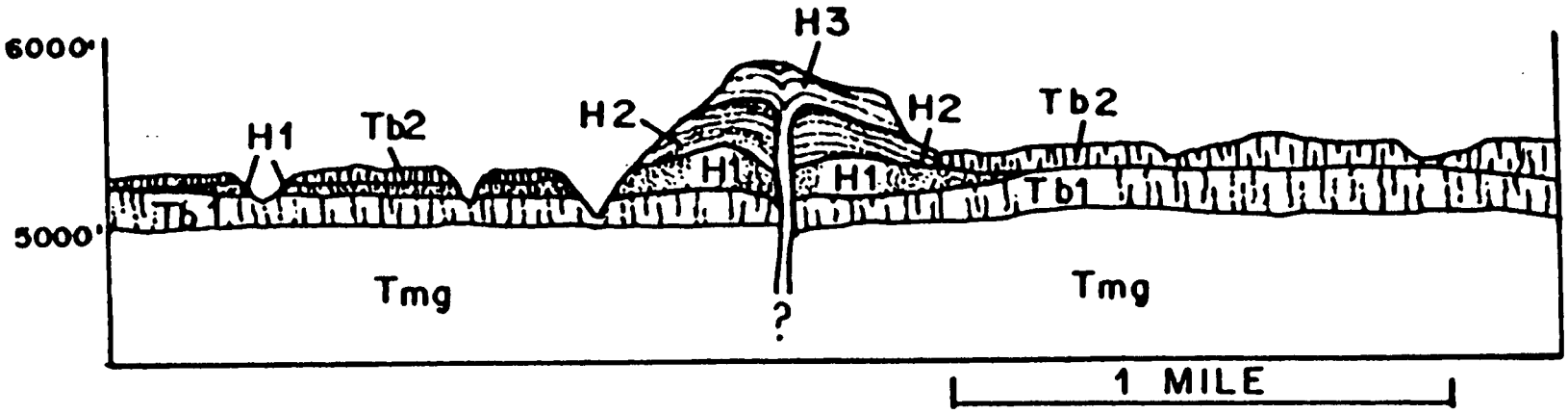

Tb2	EPISODE 2 BASALT (4Ma)
H3	TRISTANITE LAVA (59% SiO_2) (4Ma)
H2	TRACHYTE LAVA (60% SiO_2)
H1	PYROCLASTIC SURGE AND FALL
Tb1	EPISODE 1 BASALT (5Ma)
Tmg	MONOTONY TUFF (25Ma)

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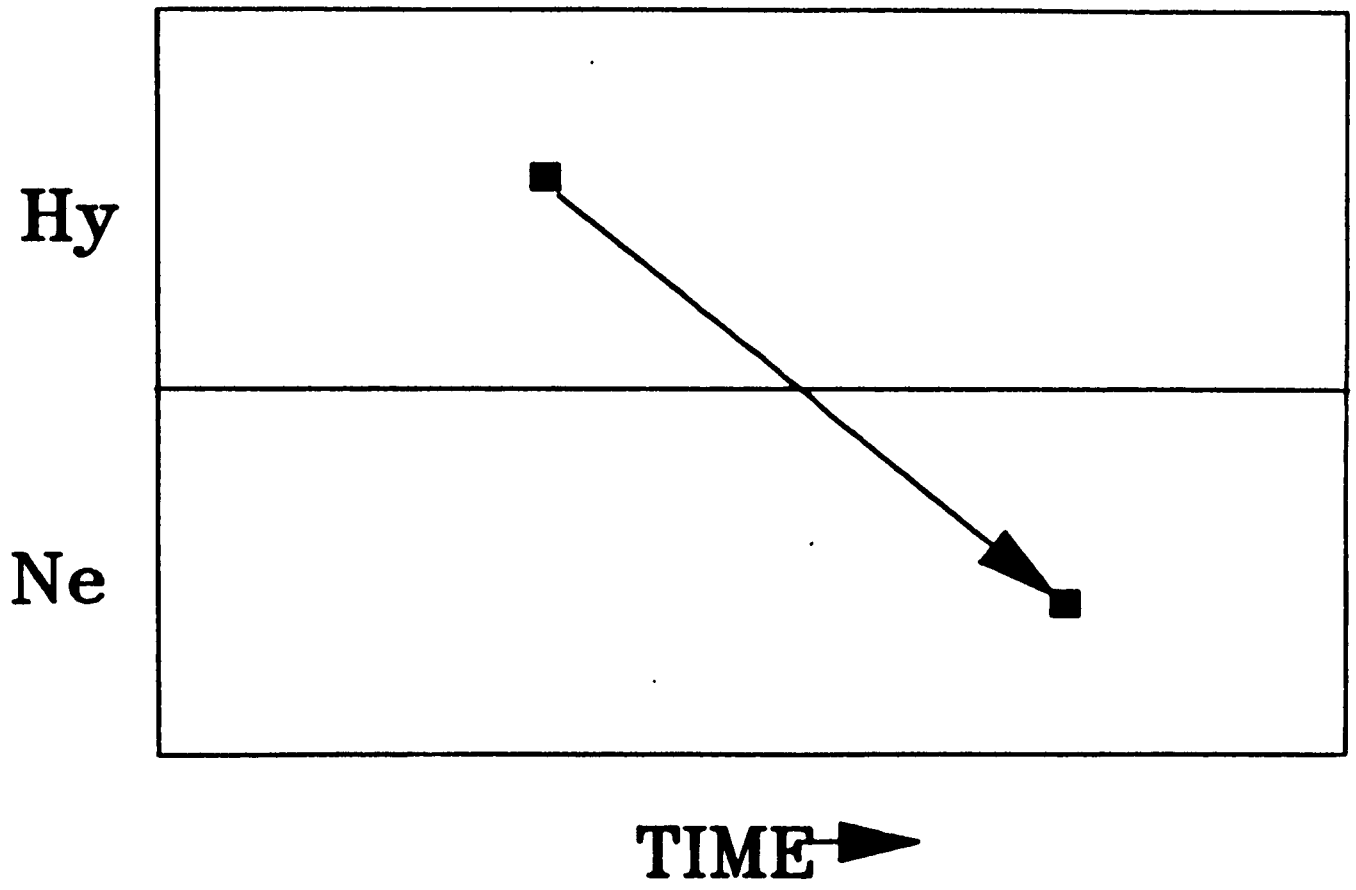
CRITERIA FOR IDENTIFYING AN EXTINCT VOLCANIC FIELD

THE ERUPTION OF ALKALIC BASALTS (NEPHELINE BEARING)

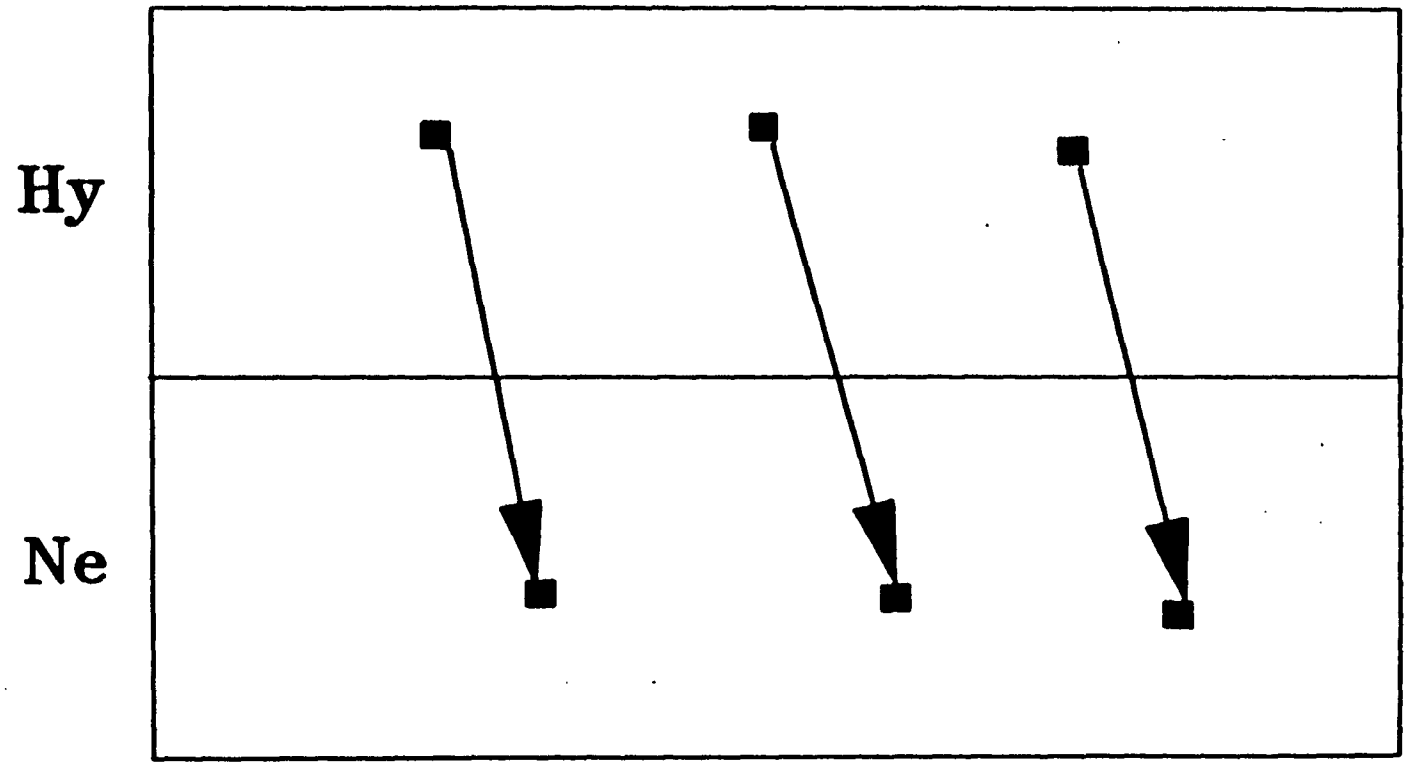
MAY NOT REFLECT THE TERMINATION OF

VOLCANISM IN A PARTICULAR VOLCANIC FIELD

APPARENT TWO SAMPLE VARIATION



VARIATION BASED ON DETAILED SAMPLING



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VOLCANIC RISK STUDIES

IMPORTANT ISSUES AND ANSWERS

1. STRUCTURAL CONTROL

CINDER CONES MAY NOT BE CONTROLLED BY FAULTS-----DIKES AND CONDUITS MAY AVOID FAULT ZONES

FUTURE ERUPTIONS MAY OCCUR AT OR NEAR SITE OF PAST ERUPTIONS

NO CONSISTENT MIGRATION PATTERNS FOR PLIOCENE VOLCANISM

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VOLCANIC RISK STUDIES

IMPORTANT ISSUES AND ANSWERS

2. LENGTH AND NATURE OF AN ERUPTION

ERUPTIONS AT A CINDER CONE COMPLEX MAY LAST AS LONG AS 10^5 YEARS

ERUPTIONS MAY BE COMPLEX AND INVOLVE ERUPTIVE PULSES RANGING FROM RELATIVELY QUIET LAVA FOUNTAINING TO MODERATELY EXPLOSIVE STROMBOLIAN OR HYDROMAGMATIC

MORE FELSIC AND POSSIBLY MORE EXPLOSIVE ACTIVITY MAY OCCUR DURING OR BETWEEN ERUPTIONS OF BASALT

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VOLCANIC RISK STUDIES

IMPORTANT ISSUES AND ANSWERS

3. CRITERIA FOR IDENTIFYING AN EXTINCT VOLCANIC FIELD

AT THE PRESENT THERE ARE NO RELIABLE CHEMICAL CRITERIA THAT INDICATE THAT A VOLCANO IS EXTINCT

TRENDS TOWARD ALKALIC VOLCANISM MAY NOT SIGNIFY THE DEATH OF A VOLCANIC FIELD

CURRICULUM VITAE
EUGENE I. SMITH

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Marital Status: Married, no children

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

Professional Experience:

8/88 to present: Professor of Geology, University of Nevada.

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

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

9/78-8/79: Visiting Associate Professor of Geology, University of Nevada

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, Flagstaff, AZ

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

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

Teaching Experience:

Courses: Petrology, Optical Mineralogy, Petrography, Geochemistry, Crystallography and X-ray crystallography, Mineralogy, Structural Geology, Lunar and Planetary Geology, Volcanology, Economic Geology, Introductory Geology, Instrumental Techniques, Advanced Geochemistry, Igneous Petrology

Professional Society Memberships:

Sigma Xi
Sigma Gamma Epsilon
Phi Kappa Phi
Geological Society of America
American Geophysical Union
AAAS

Honors:

National Defense Education Act (NDEA) Title IV Fellowship, 9/65-6/68

Grants:

NASA Grant NGR 50-009-001 for the study of volcanic features and craters on Mars, Mercury, Moon and Earth (6 years of funding).

Four University of Wisconsin research grants to support the study of Precambrian igneous rocks of south-central Wisconsin.

UNLV Research Council grant to support the study of Tertiary volcanic rocks in Clark County, Nevada.

Grant from Nevada Nuclear Waste Project Office (NWPO) and DOE to study late-Miocene and younger volcanic activity in southern Nevada (3 years of funding).

Current Research:

1. Geochemical, petrological and structural studies of the Tertiary volcanic and plutonic rocks of the Lake Mead area, Nevada and Arizona.

2. Study of volcanic rocks in the McCullough Range, Nevada

3. Study of the late-Miocene Fortification Hill Basalt.

PUBLICATIONS:

A. Journal Articles in refereed journals, symposium volumes:

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.

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.

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.

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.

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.

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

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.

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

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

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.

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.

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

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.

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

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.

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

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.

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.

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.

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.

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.

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.

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.

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.

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.

Articles in Press:

Smith, E.I., 1987, 1.76 b.y. old granites and rhyolites in the conterminous United States: Geological Society of America Decade of North America Geology (DNAG) Volume: Precambrian Conterminous United States (in press).

Smith, E.I., Feuerbach, D.L, Naumann, T.R. and Mills, J.E., 1989, Geochemistry and evolution of mid-Tertiary igneous rocks in the Lake Mead area of Nevada and Arizona: Geological Society of America Special Paper, "Cordilleran Magmatism", Anderson, L.A. ed.

Duebendorfer, E.M., Sewall, A.J., and Smith, E.I., 1989, The Saddle Island Detachment fault, an evolving shear zone in the Lake Mead area of southern Nevada: Geological Society of America Special Paper, "Mid-Tertiary extension at the latitude of Las Vegas", Wernicke, Brian editor.

Articles Submitted:

Feuerbach, D.L., and Smith, E.I., Miocene and Pliocene basalts in the Lake Mead area, Nevada and Arizona: volcanism during the waning stages of extension and implications for volcanic hazard assessment: Geological Society of America Bulletin (to be submitted March 1, 1989).

B. Articles in Guidebooks, maps

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.

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.

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.

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.

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

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.

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

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.

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 area: 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.

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

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.

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.

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.

Faulds, J.E., Hillemeyer, F.L., and Smith, E.I., 1988, Geometry and kinematics off a Miocene "Accomodation 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.

C. Abstracts:

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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

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.

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.

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.

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.

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.

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

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.

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.

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

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.

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.

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.

Parolini, J.R., andSmith, E.I., 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.

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. 361.

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.

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.

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.

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.

Smith, E.I., and Mills, J.G., 1985, Geochemistry of Post-15 m.y. old volcanicand 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.

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.

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.

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.

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

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

C. Open File and Technical Reports

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.

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