Structural Control of Basaltic Volcanism in the Northern Reveille Range, Nye County, Nevada

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by

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(Slides #1/2- Title slide, and blank slide)

Introduction:

A consensus has not been reached concerning the role played by older structure as an influence for the eruption of recent basaltic volcanism in the area around the proposed Yucca Mountain repository site.

In an effort to address the question "Does older shallow crustal basement structure control eruption of recent basalt volcanism?", we have selected a slightly older geologic analog in the northern Reveille Range.

(Slides #3/4- Regional geologic map, and field photo looking north over the northern Reveille Range)

Point out the location of the Reveille Range with relationship to the Nevada Test Site.

The northern Reveille Range was selected as a study site for two reasons:

1) Pliocene basalts (3-6 Ma) were emplaced/erupted through both Paleozoic marine sedimentary rocks and Tertiary volcanic rocks. These older rocks are well exposed beneath the basalt flows in this area.

2) Previous mapping (1:48,000) in the northern Reveille Range by Ekren et al. (1973) [USGS-MAP I-806] suggested that, prior to basaltic eruption, basement rocks were highly faulted.

Therefore, if basaltic volcanism does utilize older structures as conduits for eruption in the shallow crust then the northern Reveille Range appears to be a suitable study location.

(Slides #5/6- Conclusions, and blank slide)

As outline for talk (where it will go and what you will hear!)

1) Detailed mapping (1:24,000) in the northern Reveille Range indicates that previous interpretations represented by the mapping (1:48,000) of Ekren et al. (1973) are not unique.

2) The eruption of Pliocene basalt in the Reveille Range occurred along both range crest and range margins.

3) Pliocene basalts in the northern Reveille Range appear to utilize older shallow crustal structures as conduits for eruption (such as pre-existing tectonic joint sets and caldera margins).

(Slides #7/8- Text-previous mapping by Ekren et al. (1973), and generalized geologic map of the northern Reveille Range)

In order to understand how pre-existing basement structures influence basaltic volcanism, we must understand what these structures are.

The geologic interpretation from published mapping by Ekren et al. (1973) at 1:48,000 of the northern Reveille Range is not unique. Although their placement of lithologic contacts and lithologic calls within the Tertiary volcanic section is not questioned their interpretation of the nature of these lithologic contacts is.

The interpretation presented by Ekren et al. (1973) is that most lithologic contacts in this area are strike-slip faults or reverse faults. However, mapping at 1:24,000 indicates that most of the contacts between the Tertiary volcanic rocks are depositional and that their environment of deposition is within or proximal to a nested caldera complex.

This is important because the absence of faults in the central portion of the Reveille Range means that basaltic volcanism probably was not influenced significantly by pre-existing faults in this area.

(Slides #9/10- Photo of Caldera margin (looking north), and generalized cross-section)

For example...Ekren et al. (1973) interpreted this high-angle contact as a left-lateral strike-slip fault which is also associated with several thrust faults (presumably kinematically linked to the strike-slip fault).

However, more detailed mapping indicates that there is no compelling evidence along this contact for faulting (brecciation, lateral offset of geologic units, etc...).

A more consistent interpretation of the field data supports the conclusion that this contact represents the structural wall of a caldera that erupted two of the tuffs found in the northern Reveille Range (Tuff of Northern Reveille Range [intracaldera deposit] and Tuff of Streuben Knob [outflow deposit]). This interpretation is shown schematically in the cross-section.

The field data that support this interpretation are highlighted in the following slides.

(Slides #11/12- Text-field criteria for calderas, and field photo of buttress unconformity on structural wall of caldera (looking south))

The following list is not a complete list of criteria for distinguishing calderas in the field; there are numerous criteria. However, the following criteria are found in caldera settings and these relationships are observed in the northern Reveille Range. Together, these relationships suggest that two remnant calderas (late Oligocene and Miocene) are exposed in the northern Reveille Range.

1) Buttress unconformity.
2) Thickness and coarseness of individual Tuffs (>700m (intracaldera deposit).
3) silicification of the tuffs along caldera margins.
4) surge deposits within the Tuff of northern Reveille Range ponding against the caldera wall and which contain lenses of mega-breccia eroded from the caldera margin.

(Slides #13/14- Examples of such field criteria; field photos showing large volcanic clast in tuff and surge deposit both interpreted to be intra-caldera deposits)

(Slides #15/16- generalized geologic map of northern Reveille Range, and map showing distribution of known and inferred Oligocene and Miocene calderas in this region (from Best et al., 1989))

This interpretation is further corroborated by previous studies in central Nevada which show that this region contains numerous Oligocene and Miocene calderas.

Therefore, based on detailed mapping in the northern Reveille Range, my interpretation of the contacts between the different Tertiary units is that very few of them are faults as represented by Ekren et al. (1973). But, rather, most are depositional and that the geometry of these contacts is a function of topography associated with calderas at the time of deposition.

(Slides #17/18- Text- where are basalt centers found, and map of Reveille Range showing the distribution of basalt centers)

Crowe et al. (1991) have stated that "Basalt centers tend to occur in alluvial basins and along range margins and rarely within range interiors".

However, approximately 10% of basaltic vents in the Reveille Range are found along the topographic range crest.

(Slides #19/20- Examples- field photos of basalt vents along the range crest in the northern Reveille Range (both slides looking north)

(Slides #21/22- Text-structural control on emplacement of basalts in the northern Reveille Range, and field photo (looking west) of basalt dikes in basement rocks feeding overlying basalt vent and flows)

More detailed mapping in the northern Reveille Range (preceding discussion) indicates that there are fewer pre-Pliocene faults than previously inferred by Ekren et al. (1973). The faults that do exist, appear to be minor structures and these faults do not appear to influence the emplacement or eruption of basalts within the range interior.

However...pre-existing structures such as tectonic joint sets in older tuffs and shallow crustal fragmentation along caldera margins do appear to guide the eruption of basalts.

(Slides #23/24- Close-up field photos of basalt dikes in previous slide emplaced along pre-existing tectonic joint set of 24.5 Ma Tuff of Goblin Knobs)

It is important to note that in this example we our afforded the opportunity to see relatively deep into the basement rocks (some 200-300 meters in this example) through which these basalt systems are being emplaced. To actually observe the plumbing architecture of these systems at this level of the shallow crust, in this region, is rare. This is a unique example!!!

(Slides #25/26- Field photos of basalt vents (cones) along caldera margin and at range crest)

Elsewhere in the northern Reveille Range basalt vents are also found along contacts that are interpreted to be pre-existing caldera structural walls (previously discussed). This is shown in the following generalized cross-section...

(Slides #27/28- Generalized geologic map and cross-section from the northern Reveille Range)

Schematic cross-section of caldera margin and basalts coming up along this margin.

It is important to understand that an equal number of basalt dikes and vents are also located at high-angles to pre-existing structures (tectonic joint sets), or are (apparently) not associated with older structures.

(Slides #29/30- Text- Conclusions and Warnings)

1) Detailed mapping (1:24,000) in the northern Reveille Range indicates that previous interpretations represented by the mapping (1:48,000) of Ekren et al.(1973) are not unique.

2) Pliocene basalt eruption in the Reveille Range occurred along both range crest and range margins.

3) Pliocene basalts in the northern Reveille Range do appear to utilize older shallow crustal structures as conduits for eruption (such as pre-existing tectonic joint sets and caldera margins).

Warnings:

1) Field interpretations are seldom unique at any scale, and pre-existing mapping can always be improved upon. However, more detailed studies and better understanding of the regional geology will lead to fewer equivocal interpretations (e.g., we must understand what the pre-existing basement structures are before we can understand how they influence basaltic volcanism).

2) Basaltic volcanism should not be expected to occur only along range margins or in alluvial basins; within range and range crest eruptions should also be expected.

3) Existing faults are not the only structures that basalts can utilize as conduits for eruption; pre-existing shallow crustal fragmentation (as a result of caldera formation) and existing tectonic joint sets are equally suitable as conduits.

References cited:

Best, M.G., Christiansen, E.H., Deino, A.L., Gromme, C.S., McKee, E.H., and Noble, D.C., 1989, Eocene through Miocene volcanism in the Great Basin of the western United States: New Mexico Bureau of Mines and Mineral Resources Memoir 47, p.91-133.

Crowe, B.M, Valentine, G., Morley, R., and Perry, F.V., 1991, Recent progress in volcanism studies: site characterization project: Report *in* U.S. Department of Energy (DOE) responses to State of Nevada comments on study plan 8.3.1.8.1.1, "Probability of magmatic disruption of a repository", 16 p.

Ekren, E.B., Rogers, C.L., and Dixon, G.L., 1973, Geologic and Bouguer gravity map of the Reveille Range quadrangle, Nye County, Nevada: U.S. Geological Survey Misc. Geologic Investigations Map I-806, 1:48,000.

Oct. 13, 1992

To whom it may concern,

Enclosed are duplicate slides for the talk given by Dr. Mark W. Martin at Sept. ~~19th~~ NWTRB panel meeting on Volcanic activity in the proposed Yucca Mountain site. This meeting was conducted in Las Vegas, NV.

Thank you for your attention.

Sincerely,

Mark W. Martin

(P.S.)

Slides are # in order of presentation (2 projectors)