Thrust or land slide: The origin of Black Butte Nevada and implication for offset estimates along the Stateline Fault, California and Nevada

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Abstract

The Stateline Fault in California and Nevada is the eastern-most active fault in the eastern California shear zone, and forms the boundary between stable North America and its mobile western margin. Guest et al. (2007) proposed an offset for this fault of 30 km based on offset relationships between Black Butte, Nevada and Devil's Peak, Nevada. This offset value requires a minimum long-term geologic slip rate of ~2.5 mm/year, significantly more than previous estimates. Testing the geologic relationships used to obtain this slip rate is critical for our understanding of seismic hazards in the Las Vegas region.

Black Butte is largely composed of Paleozoic carbonate megabreccia sheets that overlie and are interbedded with Miocene volcanic rocks and Tertiary siltstones. The volcanic and rock avalanche deposits of Devil's Peak and Black Butte are similar in texture and composition, and were tested as offset markers by relative comparison on U/Pb ages on zircons from silicic ash, and stony rhyolite obtained from both localities. The U/Pb geochronological analysis indicated that the samples were of the same age, ~13.1 Ma. Guest et al. (2007) suggested that the Black Butte stratigraphy records catastrophic landsliding into the Miocene Spring Mountain supra-detachment basin. The megbreccia material is derived from Paleozoic rocks that were uplifted, folded, and destabilized around the Devil's Peak rhyolite plug.

A recent geophysical study (Scheirer et al. unpublished) suggests that the Stateline Strike-Slip system was created from a two-stage history; early extension followed by strike-slip faulting. This paper suggests that the correlation between Black Butte's stratigraphy and Devil's Peak's stratigraphy are dubious and that the rocks exposed at Black Butte result from uplift along a high-angle reverse fault; not associated with large magnitude strike-slip offset. A key element of

their argument is the interpretation that the fault exposed along the southwest flank of Black Butte is a thrust fault, rather than a basal slide surface as proposed by Guest et al. (2007).

This study is focused on evaluating the nature of the fault contact between the hanging wall megabreccia sheets of Black Butte and the volcaniclastic rocks in the footwall. Here we present new geological data based on field mapping that shows the possible structural architectures for Black Butte and we evaluate the thrust versus landsliding models.

Preliminary analysis of the data reveals some interesting relationships. A sharp contact was observed between a Paleozoic megabreccia and lacustrine siltstone along a cliffwall that extends for several hundred metres. The lacustrine siltstones are sub-parallel to the over-riding megabreccia and exhibit way-up indicators that show that the tertiary silts are not overturned. This flat-on-flat relationship is consistent with either thrust-faulting or landsliding where the run-out breccia was deposited over a lacustrine environment. In the thrust fault interpretation, the flat-on-flat relationship requires a triangle-zone-type geometry where the megabreccia sheets in the hanging wall are thrust up a ramp and onto a flat, within a lacustrine succession with hanging wall lacustrine rocks being back-thrusts along a roof thrust over the entire megabreccia succession. This geometry requires that the lacustrine sediments be younger than the overthrust megabreccia succession and that the roof thrust and overlying lacustrine succession is exposed structurally above the breccia sheets. During the course of our field mapping, we were not able to identify a roof thrust or an overlying lacustrine succession. Furthermore, the lacustrine succession below the fault includes volcanic rocks as well as breccia sheets that are similar to the breccia sheets and volcanic rocks observed above the fault. All of this suggests that the landsliding hypothesis is a more viable interpretation of the geology. This is important because it strengthens the argument for a mid-Miocene to recent 30 km offset along the Stateline Fault.