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Preface

The Track of the Yellowstone Hotspot: Multi-disciplinary Perspectives on the Origin of the Yellowstone-Snake River Plain Volcanic Province

Linear tracks of volcanoes have long been noted on the ocean floor and, to a lesser degree, on continental land surfaces. In the early 1960's, J. Tuzo Wilson interpreted these linear chains of volcanoes to be the result of the earth's lithospheric plates passing over "hotspots" rooted in the mantle. Jason Morgan (1972) took this concept further and suggested one example of a hotspot interacting with a continental plate might be the Yellowstone-Snake River Plain (YSRP) volcanic province. Since then, the concept that a hotspot is responsible for this young (<17 Ma to present) bimodal volcanic province has been sustained in debate and research. A seminal paper by Mansfield and Ross (1935) documented the presence of numerous, laterally extensive rhyolitic welded ignimbrite sheets along the margins of the Snake River Plain. Later, Armstrong et al. (1975) provided evidence for a general progression of volcanism younging to the northeast for both the rhyolitic and basaltic sequences. In 1979, a 1500-meter-thick section of rhyolite was described from the north-central margin of the eastern Snake River Plain and interpreted as caldera fill; later this was one piece of evidence used to support the idea that large calderas were buried beneath the eastern Snake River Plain. These discoveries were followed by more research that focused on all parts of the eastern, central, and southwestern Snake River Plain and related areas and provided further evidence for the eruption of large volumes (>500 km^3) of rhyolite, mostly as ignimbrites. These ignimbrites are interpreted as products of "super-eruptions" from multiple caldera-forming systems. Flood basalt volcanism in Washington, Oregon, and northern California is associated with the initial stages in the formation of the province and provides further support for an origin coupled with a thermal mantle plume.

Mantle plumes are thought to play a crucial role in the Earth's thermal and tectonic evolution. The YSRP volcanic province is a key area where a mantle plume is thought to interact with the continental lithosphere to produce a sustained process of large-scale volcanism, faulting, and uplift that has progressively migrated to the northeast over the past 17 m.y. Recent advances in seismic tomography have identified a thermal anomaly thought to be a mantle plume directly below the present location of the 640,000-year-old Yellowstone caldera. The anomaly dips ~70°NW to a depth of at least 500 km (Yuan and Dueker, 2005; Waite et al., 2006; Allen et al., 2008). A mantle plume origin for the track of the Yellowstone hotspot, however, remains a somewhat controversial topic and continues to generate much interest in a broad variety of geoscience disciplines, ranging from neotectonics to structural and sedimentary geology to volcanology and petrogenesis to geophysics.

As this special volume demonstrates, researchers from disparate disciplines have contributed new results in the study of the YSRP volcanic province that pertain to the mantle plume hypothesis for this significant North American province. Some of the critical questions that motivate these studies include: (1) What has been the response of the lithosphere to the passage of the North American plate over a "fixed" thermal anomaly, and are there unique indicators associated with this process? (2) How do uplift and subsidence relate to passage of the hotspot? (3) How does late Cenozoic faulting relate to passage of the hotspot? (4) What has been the environmental impact of continuous large-volume volcanism over such a long period of time? (5) What physical and chemical conditions are associated with the evolution of individual volcanic centers, and with the progression of the magmatic system(s)? (6) Did preexisting structures control the location and type of volcanism and faulting? (7) Can specific indicators be identified to distinguish volcanism associated with a mantle plume and how are they best characterized? (8) What new methods can be utilized in the characterization of deposits related to the passage of the North American plate (both crust and lithosphere) over a fixed thermal anomaly to assess future geologic hazards in this region?

The spatial and temporal scale of volcanism along the track of the Yellowstone hotspot, characterized by a 17-m.y. history of rhyolitic super-eruptions, make it one of the youngest and largest igneous provinces on Earth (Mason et al., 2004). Integration of the different approaches presented in this special volume may provide the best course towards understanding the subsurface processes that have resulted in the origin of the YSRP volcanic province. The 21 papers comprising this volume encompass results from seismic tomography and geodynamic modeling, isotope geochemistry and petrology, hydrothermal alteration and epithermal mineralization, neotectonics, and sedimentology. A special symposium, entitled "The Track of the Yellowstone Hotspot: What do Neotectonics, Climate Indicators, Volcanism, and Petrogenesis Reveal about Subsurface Processes?", at the Geological Society of America Annual Meeting in October 2007 in Denver, Colorado, USA, served as the springboard for this special volume.

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References

Allen, R.M., Xue, M., Hung, S., 2008. Complex geological interactions in the mantle beneath western USA. Eos Transactions, American Geophysical Union 89 (53) Fall Meeting Supplement, Abstract S31D-02.

Armstrong, R.L., Leeman, W.P., Malde, H.E., 1975. K-Ar dating, Quaternary and Neogene rocks of the Snake River Palin, Idaho. American Journal of Science 275, 225–251.

Mansfield, G.R., Ross, C.S., 1935. Welded rhyolitic tuffs in southeastern Idaho. EOS Transactions of the American Geophysical Union 308–321.

Mason, B.G., Pyle, D.M., Oppenheimer, C., 2004. The size and frequency of the largest explosive eruptions on Earth. Bulletin Volcanology 66, 735–748.

Morgan, W.J., 1972. Plate motions and deep mantle convection. Geological Society of America Memoir 132, pp. 7-22.

Waite, G.P., Smith, R.L., Allen, R.L., 2006. *VP* and *VS* structure of the Yellowstone Hotspot from teleseismic tomography: Evidence for an upper mantle plume. Journal of Geophysical Research 111, B04303, 21. doi:10.1029/2005JB003867.

Yuan, H., Dueker, K., 2005. Teleseismic P-wave tomogram of the Yellowstone plume. Geophysical Research Letters 32, L07304. doi:10.1029/2004GL022056.

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