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Using Zirconium and Zinc Concentrations to Differentiate Basalt Flows in the Blackfoot Volcanic Field, Idaho, USA

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The quaternary aged Blackfoot Volcanic Field (BVF) located adjacent to the Snake River Plain in southeast Idaho, USA, is believed to be a result of the Yellowstone Hotspot track. Numerous basalt flows deposited in topographic lows during volcanic pulses form complex stratigraphic relationships that have not been thoroughly studied. These flows are occasionally separated by interbedded sediment intervals emplaced during lulls of volcanic activity, later crosscut by numerous thrust faults. Due to the lack of lateral continuity between these basalt flows, subsurface mapping is problematic. Using geologic and chemical data collected as part of an investigation into anthropogenic contamination at a Superfund site located in the BVF, lateral correlations of these basalt flows is possible.

Portable X-ray fluorescence was used to determine zirconium and zinc concentrations in uncontaminated drill core. The data presented here were compiled from 185 scans of three boreholes, with depths ranging from 0-75 meters below ground surface. Recognizing the changes in these concentrations coupled with conventional core logging techniques led to the identification an individual basalt flow marker bed relatively enriched in zirconium and zinc. This enriched marker basalt flow contains zirconium and zinc concentrations averaging 441.86 ± 7.56 ppm and 125.01 ± 10.30 ppm respectively. The adjacent basalt containing relatively depleted concentrations of zirconium and zinc average 236.96 ± 5.51 ppm and 100.35 ± 8.37 ppm respectively. This marker bed was then laterally correlated between boreholes, allowing the stratigraphy to be mapped with improved certainty. This methodology may be applied to other locations where conventional mapping methods alone are insufficient due to the often complex nature of volcanic deposits.

The reasoning for the chemical differences between these basalt flows is likely attributed to magmatic fractional crystallization and assimilation. Changes in zirconium concentrations with depth (and therefore time) from the same magmatic source may be an indication of alternating eruptive periods of primitive and evolved magmas, as indicated by the incompatible nature of zirconium.

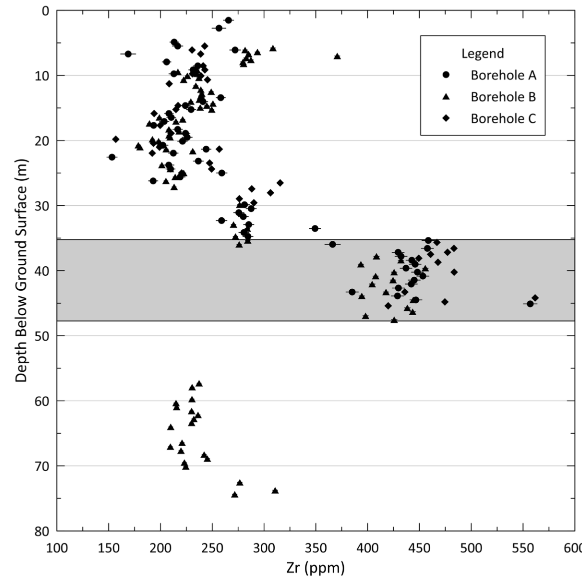

Figure 1: Zirconium vs. Depth. Shaded area represents approximate thickness of Zr enriched marker basalt. Boreholes A, B, and C chosen for their close proximity. Error bars represent one standard deviation.

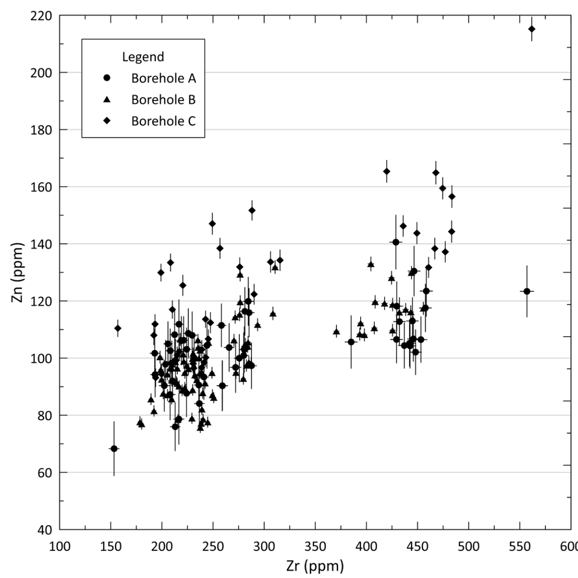

Figure 2: Zirconium vs. Zinc. Enriched marker basalt is shown to be chemically distinguishable from depleted basalts. Boreholes A, B, and C chosen for their close proximity. Error bars represent one standard deviation.