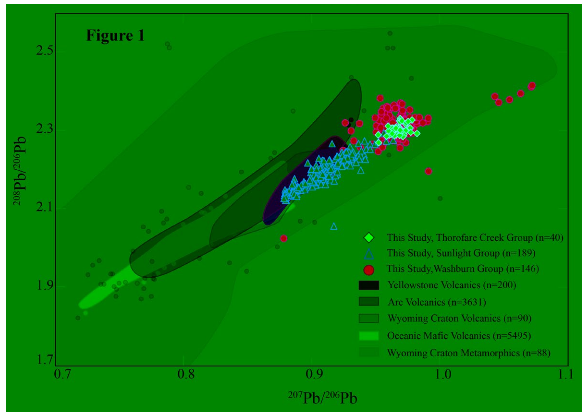
Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.32321

Employing detrital volcanic minerals to decipher original magma conditions

NATALI KRAGH, MADISON L. MYERS AND DEVON A. ORME

Montana State University

The ephemeral nature of primary volcanic rocks means that our ability to study ancient complexes is severely limited. Glassy to microcrystalline matrix tends to erode quickly, with the longest lasting components represented by the minerals that eventually re-deposit in sedimentary rock. This lack of preservation limits our ability to answer fundamental questions around mantle supply rates, determine mass balance between different reservoirs, or reconstruct tectonic processes. We present a novel method using single-crystal isotopes from volcaniclastic deposits to inform on both tectonic and depositional processes, and most importantly, observe shifts in magma source (mantle vs. metasomatic contribution) from material that is no longer connected to an edifice. This study focuses on volcanic and volcaniclastic rock across southwest Montana, U.S.A, formed in response to a shifting Farallon slab. Following multiple phases of volcanism from the Late Cretaceous to Eocene, thick sequences of volcaniclastic rock were deposited and now remain throughout the region. Single-crystal Pb isotopic signatures in plagioclase from primary volcanic rocks and detrital plagioclase from volcaniclastic rocks reveal an unexpected concentration in geochemical space in both proximal and distal volcaniclastic deposits. Importantly, each volcanic center from the field of study plots in distinct isotopic or physical space, allowing for each center to be uniquely identified. When these data are compared to various Pb isotope reservoirs, it is evident that two stages of the volcanic field's eruptive history reflect extreme Pb depletion, indicating that magmagenesis occurred in the lower crust (Figure 1). In contrast, the intermediate stage of volcanism shows a more enriched signature, where magmas assimilated more crustal material. This agrees with earlier studies that used whole rock isotopes of primary rock and could indicate that magma storage moved upward during development of this volcanic field. Our study strongly suggests that detrital plagioclase in volcaniclastic rock can be utilized to understand primary volcanic products worldwide so long as different isotopic reservoirs are available to influence volcanism.



Pb isotope reservoirs compared to primary and detrital plagioclase data from the three volcanic centers of this study. Two volcanic centers exhibit extreme Pb depletion, indicating a lower crustal source, while the other is slightly more enriched, indicating some degree of upper crustal assimilation.