Genesis of Quaternary high-K, 'A-type' rhyolites along part of the Yellowstone-Snake River Plain hot spot track

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Quaternary rhyolites of the eastern Snake River Plain (ESRP) segment of the Yellowstone hot spot track are distinguished by geochemical and mineralogical features in common with 'A-type granitic rocks', and may constitute an analog for magmatism leading to production of A-type magmas. Geochemical characteristics of the rhyolites include high SiO_2 (~75-76%), high K_2O (4.7 to 5.1%) and K_2O/Na_2O (1.1-1.3), moderate to high FeO* (1.7 to 2.4%), low MgO, CaO, Sr and Ba (0.1-0.02, 0.6-0.7%, and 0.6-9 and 213-281 ppm, respectively). Most contain anhydrous phenocryst assemblages including sanidine, quartz, fayalite, hedenburgite, oxides, and accessory zircon and apatite ± chevkinite. Some occur within comagmatic sequences of lavas spanning a continuous spectrum of volcanic rock compositions extending from basaltic trachyandesite to rhyolite. In these cases, $Sr_{(i)}$- and $Nd_{(i)}$-isotopes exhibit little or no change, and overlap with coeval basalts. Processes of magma genesis for ESRP Quaternary rhyolites are constrained by the extreme contrast in isotopic compositions between Archeon craton and plausible mantle reservoirs. AFC modeling constrains Archeon crustal inputs to less than a few percent. Fractional remelting of previously consolidated mafic to intermediate magma does not seem capable of producing the extreme fractionations of some elements observed in the rocks. Patterns of isotopic, compositional and mineralogical data are consistent with rhyolite genesis by extreme fractionation of a trachybasaltic parental magma.

The Reynolds Creek Rhyolite Flow: A large-volume evolved flow

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Introduction

Large-volume (> 4 km^3), evolved (SiO_2 > 60 wt.%) lava flows (LVEFs) are abundant and contribute a significant volume to the continental crust. As no observations exist of active rhyolite flows (small- or large-volume), detailed analysis of LVEFs is essential to gain a better understanding of their eruption dynamics and emplacement. The Reynolds Creek Rhyolite Flow (RCRF; Owyhee Plateau, SW Idaho) is an accessible, ~2.5 - 3.5 km^3, LVEF that may originally have been twice its current volume. The RCRF was produced by a fissure fed, valley-filling, eruption (~11.49 ma). An ignimbrite of similar SiO_2 content underlies the flow.

Data Analysis & Results

Models to estimate effusion rate and emplacement times were applied to the RCRF, and results were compared with other evolved flows. The RCRF was emplaced in ~0.2 – 5 years, comparable with the 15 km^3, Badlands Rhyolite flow (Owyhee Plateau) estimated at 6 - 9 years [Manley, 1996]. RCRF effusion rates were ~35 - 90 m^3/s and higher than for other large and small evolved flows [e.g.~ 0.2 - 0.9 m^3/s for Mt. St. Helens; Fink & Griffiths, 1998]. Chemical analysis of five samples from the RCRF and the underlying ignimbrite show that trace elements differ significantly for the RCRF and the underlying ignimbrite. The RCRF has much higher Ba and Zr implying greater contamination of its source.

Conclusion

The RCRF is a LVEF emplaced in ~ 0.2–5 years, shows petrographically to have been emplaced as a lava flow and, chemically, differs from the underlying ignimbrite. Trace element signatures of the RCRF imply greater storage time for its source which could account for greater degassing and, hence, effusive (not explosive) emplacement.

References

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