Geochemistry and geochronology of a Miocene volcanic suite from Mt. Tsaratanana, northern Madagascar

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Mt. Tsaratanana, the highest peak in north-central Madagascar (~2876 m), is one of several volcanic centers of Cenozoic age in the western Indian Ocean that extend from the Seychelles south to the Comores Islands. New $^{40}Ar/^{39}Ar$ ages and geochemical data provide a refined petrogenetic framework for the Mt. Tsaratanana volcanic sequence, northern Madagascar. Lavas of the Mt Tsaratanana include the volumetrically dominant trachytes and phonolites and lesser amounts of basanites. $^{40}Ar/^{39}Ar$ ages were determined from four plagioclase concentrates and show that the sequence erupted regularly from approximately 17.5 - 16 Ma.

Rocks of the suite, ranges from 44 to 66 wt% SiO_2 with a significant gap between 47-56 wt %, consistent with the geochemistry of volcanic rocks on oceanic islands worldwide. Primitive mantle normalized trace element concentrations are typical of ocean island basalts, showing characteristic high relative concentrations of Nb and Ta and pronounced negative depletions of Ba, Sr, and Ti. These patterns are similar to those of the other Indian Ocean basalts including the Comores and Reunion. The samples range from 0.70312 to 0.70403 in $^{87}Sr/^{86}Sr$, in εNd from 3.41 to 5.13, and delta ^{18}O values are between 5.2 and 6.9 ‰. The basanite samples have average Pb isotope ratios of $^{206}Pb/^{204}Pb = 19.53$, $^{207}Pb/^{204}Pb = 15.66$ and $^{208}Pb/^{204}Pb = 39.14$, indicating a significant HIMU mantle component, consistent with the trace element data. The observed variations suggest that the Mt. Tsaratanana magmas originated from a sub-lithospheric HIMU reservoir similar to Comores Island basaltic magmas. The Sr- and O-isotope variations observed in trachytes and phonolites point to contamination of the magmas by only small amounts of continental crust (<5%).

Polymodal compositions in large volume rhyolite magmas of the Miocene Yellowstone hotspot, USA

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The Cougar Point Tuff (12.7–10.5 Ma) (CPT) and associated lavas (~ 11–8 Ma) of the Bruneau-Jarbidge (B-J) eruptive center of the Yellowstone hotspot represent a sequence of large volume eruptions (10^2–10^3 km^3 ea) of high-temperature (800–1000°C) rhyolitic magma. The ten ash flow tuffs that constitute the CPT have an average interval between eruptions of 250 ka, and are characterized by multiple discrete compositional modes of minerals and glass, as determined by electron microprobe analyses. Anhydrous phenocryst assemblages in individual eruptions include polymodal ferroan pigeonite and augite. Pyroxene thermometry indicates the presence of multiple equilibrium pairs in individual eruptive units. Multiple equilibrium pairs are present in both basal and upper vitrophyres in individual ash flow sheets but their relative proportions to one another are such that upper vitrophyres are dominated by higher temperature, more magnesian material than their companion basal vitrophyres. Airfall glass compositions in several units are also polymodal, and support the mineralogical evidence for the syn-eruption of multiple, discrete magma volumes. The multiple modes of glass and pyroxene and their vertical distribution patterns in individual ash-flow sheets are interpreted to reflect step-wise normal zonation in pre-eruptive magma. This interpretation is consistent with patterns of trace element concentrations measured by INAA in whole rock compositions. During the 2.2 Ma of explosive volcanism at the B-J eruptive center, seven of ten eruptions contain polymodal material. Moreover, both sequential and non-sequential eruptions duplicate in detail the glass compositions and equilibrium assemblages of pyroxene found in previous units. The recurrence of multiple identical mineral pairs and glass modes in different eruptions, the persistent near-liquidus temperatures, and the patterns of mineral abundances in basal vs. upper stratigraphic horizons provide circumstantial evidence for long-term (e.g. 250–900 ka) storage at high temperatures of a large magma volume that was zoned in a step-wise fashion and tapped by multiple eruptions. Neodymium isotopic ratios in glass (ε_{Nd}=-8.5 to -6.6) indicate open system conditions for magma evolution and/or storage.