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Petrologic and geochemical links in the Jackass Lakes volcanic-plutonic complex, Sierra Nevada batholith

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The 99-97 Ma Jackass Lakes pluton (JLP) within the central Sierra Nevada batholith spans an area of 175 km² and consists of granodiorites with minor quartz monzonite, granite, and diorite, which intruded into dacitic and rhyolitic volcanic ejecta. Additionally, various fine-grained leucogranite bodies are distributed throughout the JLP. U-Pb zircon geochronology indicates coeval ages between 99 – 97 Ma for all units. This timing relationship is essential to determine the petrologic connection of the volcanic–plutonic units.

Our hypothesis is that the granodiorites of the JLP are compositionally complementary to the leucogranites and meta-rhyolites/dacites, the latter of which formed through melt-extraction from a JLP magma reservoir, leaving behind granodioritic crystal cumulates. The leucogranites and meta-rhyolites/dacites are compositionally equivalent, and the leucogranites may represent remnant, un-erupted melt-rich magma pools.

Zircon hafnium isotopes for plutonic, leucogranite, and volcanic rocks show εHf values ranging between +5 and -5 across all units, indicating a similar source. Ti-in zircon temperatures are <850°C in all units. Petrographic observations, XRF bulk-rock element analyses, and zircon trace elements support a complementary relationship between some granodiorites and leucogranites, further corroborated by crystal accumulation of plagioclase crystals in granodiorite thin sections. Crystal-melt separation is inferred from granodiorite and leucogranite bulk-rock Ba and Zr versus SiO_2 plots. At 68 wt.% SiO_2 the two "unmixed" from the linear trend, likely reflecting a magma crystallinity conducive to crystal-melt separation at this composition. This magma mush was subsequently intruded by younger granodiorites that did not “unmix”. Volcanic samples exhibit a spread between the granodiorites and leucogranites, suggesting a weak complementary/equivalent relationship with the two.

Our results support a common magma source and reservoir for all JLP rocks and a complementary relationship of early granodiorites to leucogranites and some metavolcanics that underwent crystal-melt separation in a ca. 2-myr long active magma mush at <850°C. Other metavolcanics are direct eruptables of granodiorites. However, the leucogranites and metavolcanics largely do not appear to be direct equivalents to one another. We suggest that the metavolcanics are related to an earlier melt extraction event, while the leucogranites pooled late. Younger granodiorites representing melt-compositions intruded feldspar-enriched granodiorite cumulates as activity ceased.