Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.19032

Fractional crystallization and open system processes of H_2O-poor primitive basalt at the Jurassic Emigrant Gap intrusive complex, Sierra Nevada batholith, California

JULIET RYAN-DAVIS[1], CLAIRE E BUCHOLZ[1] AND DR. TOM W. SISSON, PHD[2]

[1]California Institute of Technology
[2]U.S. Geological Survey, California Volcano Observatory
Presenting Author: jrd@caltech.edu

The Jurassic, Alaskan-type Emigrant Gap complex (northern Sierra Nevada, California, USA) exposes mid to upper crustal mafic to intermediate intrusions and ultramafic cumulates that likely fed a Mesozoic arc volcanic center. Age, geologic setting, and major- and trace-element compositions are consistent with its formation as part of the Jurassic Sierra Nevada arc. The ~45 km^2 complex comprises four roughly central masses of dunite, wehrlite, and olivine clinopyroxenite surrounded in succession by subtly banded gabbronorite and non-layered diorite. Biotite-amphibole granodiorite is exposed to the north as a ~115 km^2 pluton. Field relationships, petrology, and geochemistry of the complex support a petrogenetic model in which parental arc basalts crystallized and differentiated at the level of emplacement, leaving a series of gabbronorites and gabbros distinctive for their near-absence of igneous amphibole. Gabbronorite is the largest member of the mafic complex by area and represents the crystallization products of apparently low-H_2O parental arc basalts that underwent limited differentiation at the level of emplacement(a,b). Associated fine-grained mafic dikes, approximating melt compositions, and gabbronorites have similar FeO* concentrations that suggest a tholeiitic index [1] of ~0.9 for MgO spanning ~9 to 5 wt%. Cumulate gabbronorites preserve peritectic reaction of olivine to orthopyroxene (in some biotite-bearing samples to pigeonite, now inverted/exsolved), and represent near-equilibrium crystallization with some internal differentiation, whereas ultramafic cumulates (dunite to olivine clinopyroxenite) formed by fractional crystallization of near-primitive arc basalts. Field relations and geochemical trends indicate that a higher SiO_2 magma, similar to or represented by the granodiorite, intruded and mixed with basaltic andesitic melts of the complex at the level of emplacement to form the full compositional range. In addition, field and petrographic observations of concentrically zoned dunite-wehrlite-clinopyroxenite indicate that open-system percolation of basalts through pre-existing cumulate mushes contributed to producing dunite patches in some of the ultramafic masses(c,d). Our study gives insight into the geometry and geochemical interactions within the frozen upper crustal intrusive complex of a primitive, low-H_2O arc tholeiitic differentiation sequence where multiple basaltic to dacitic magmas formed and then interacted in an open-system at shallow arc depths.

[1] Zimmer *et al.* (2010) Journal of Petrology **51**(12), 2411–2444.