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Experimental petrology constrains on melting conditions of high-potassium melts under the Central Sierra Nevada, California, USA

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High potassium abundances in magmas from the Sierra Nevada have been used to argue for several melting mechanisms, including gravitationally-driven loss of the lower lithosphere (e.g. Farmer et al., 2002; Elkins-Tanton and Grove, 2003) and crustal filtering of existing upper mantle melts erupted because of stresses from deep faulting along the Walker Lane transitional plate boundary (e.g. Putirka and Busby, 2007; Koerner et al., 2009).

The purpose of this study is to constrain the pressure and temperature conditions of mantle melting and the chemical and mineralogy composition of the mantle-melting source. Phase equilibrium experiments have been conducted on a primitive Miocene high-potassium basalt from the central Sierra Nevada, California. The near-liquidus phase relations were determined from 1.0 to 1.7 GPa and at temperatures from 1250 °C to 1330 °C in a piston-cylinder apparatus. The dry composition is multiply saturated with orthopyroxene, clinopyroxene, and plagioclase at approximately 1 GPa and 1290 °C; wetter compositions may have originated at similar depths of $\sim$33 km or as deep as $\sim$65 km.

The investigated melt composition from the Sierra Nevada indicate melting of unusual metasomatized mantle source regions (pyroxenites), and their melting conditions can be used to place constraints on presently discussed tectonic models. In concert with geophysical studies, these independent laboratory experiments helped to discriminate between hypotheses for the provenance of these magmas. The experimenmtal results are consistent with the hypothesis that the lower lithosphere under the Sierra Nevada was removed, and fluid metasomatized mantle melted to produce the high-potassium lavas.