Hornblende gabbros formed by crustal melting at Joshua Tree National Park, California

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Hornblende-dominant mafic to intermediate rocks intrude at all crustal levels within a tilted crustal section exposed in Joshua Tree National Park (JTNP) in the southern Mojave Desert of California. At JTNP, these bodies range in composition from hornblende gabbro to tonalite-granodiorite, and some sheets and pods observed have a cumulate texture and predominance of hornblende suggestive of fractional crystallization. The style of intrusion is controlled by the depth of emplacement, forming roughly equant, equigranular bodies in the upper crust, porphyritic sheets in the middle crust, and a variety of shapes in the migmatitic lower crust.

We establish a multi-stage emplacement history through field observations, petrography, U-Pb in zircon radiometric dating, and bulk rock and single mineral geochemistry suggesting Late Cretaceous (~80-74 Ma) magma bodies incorporating components of Jurassic (~148 Ma) intermediate intrusions and Proterozoic (~1400, ~1700 Ma) metamafic amphibolites through anatexis and incorporation of xenocrysts. As primary mafic melts mix with magmas from different anatectic sources to form intermediate compositions, we see evidence of increasing complexity in plagioclase and hornblende zonation with increasing silica.

While it is well-established that crustal melting contributes to plutonic formation and growth (e.g. peraluminous granitoids), an important observation at JTNP is the genesis of silica-poor, hornblende gabbros through crustal melting. An abundance of gabbros, tonalites, and peraluminous granites with crustal Sr-Nd-Pb isotopic signatures (>0.707 Sr_i) supports formation by the partial melting of a heterogeneous metaigneous and metasedimentary source. Similar gabbros and migmatized cratonic blocks have been observed across the Transverse Ranges and Mojave, suggesting a zone of intense partial melting and an elevated and persistent heat source at the base of the crust in the latest Cretaceous. This scenario is not compatible with the currently understood tectonic regime of flat subduction of the Farallon plate, and we interpret this to be a result of asthenospheric upwelling and decompression melting at this time resulting from a previously unrecognized slab tear.