Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.29017

Excess pyroxene, a hallmark of melt-solid interaction in the intra-plate mantle

EMMA J. CONWAY, BALZ S. KAMBER, DAVID T MURPHY AND DAVID GUST

Queensland University of Technology

Due to the lid effect of the lithosphere, melts generated in intraplate settings experience variably pronounced interaction with mafic granulite and refractory peridotite, at and below the Moho, respectively. This apparently results in a preponderance of erupted sodic trachybasalt (hawaiite), far removed from plausible parental melt compositions. Many deep xenoliths erupted in intraplate volcanic fields have a high modal abundance of clinopyroxene and feature microstructures indicative of melt-solid interaction. They include: clinopyroxene-garnet-plagioclase granulites; Mg-poor clinopyroxene-garnet 'arclogites'; and very pyroxene-rich websterites (see figure). Despite the consistent association of hawaiite and clinopyroxene-rich xenoliths in Hawaii, Eastern Australia and the San Francisco Volcanic Field, there has been no systematic attempt at testing petrologic consanguinity. Here we present results from curated and new xenolith mineral modes and chemistries and bulk rock geochemistry of volcanics from these areas and combine them with thermodynamic models of magma migration and interaction in the lithosphere. Specifically, the impacts of polybaric melt-solid interaction are explored for both the solids (i.e., the xenoliths) and the escaping resulting liquid (i.e., the erupted volcanic rock).

The modelling requires a very high temperature origin of websterite (>1200ºC) via reaction of ascending Mg-rich basalt and antecedent lithospheric mantle. Upon cooling, original highly aluminous clinopyroxene unmixes to pigeonite and garnet to yield 'garnet' websterite. At higher melt/solid ratios, both clinopyroxene and garnet (or orthopyroxene) precipitate near Moho depths. The crystallisation of excess pyroxene in these reactions results in simultaneous depletion of silica and enrichment of alkalis in the escaping melt, giving rise to sodic trachybasalts. Modelling further shows that excess orthopyroxene precipitates when lithospheric mantle interacts with picrite or komatiite. The ubiquitous occurrence of deep xenoliths with excess pyroxene suggests an important role for melt-solid interaction in intraplate magmatism globally.

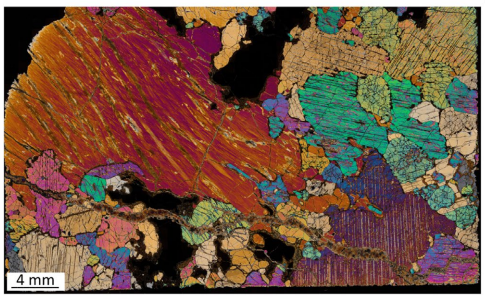

Figure 1. XPL image of a coarse-grained 'garnet websterite'