Geochemical investigation of Proterozoic continental arc evolution: The lower crustal perspective from central Arizona, USA

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It is widely known that producing intermediate to felsic continental crust in arc settings via peridotite melting is problematic because mantle melting generates basalts. One mechanism to explain continental crust compositions in arcs requires significant mafic to ultramafic cumulate formation to compositionally balance voluminous granitoid production. Here we investigate the geochemical composition of a suite of mafic lower crustal xenoliths sampled from beneath the Paleoproterozoic Yavapai-Matzatal accreted terranes in southwestern USA. These terranes are thought to be accreted island and continental arcs. The xenoliths are comprised primarily of garnet pyroxenites with some amphibolites and gabbros, all with SiO_2 < 51 wt. %. The suite can be divided into two groups: 1) a high MgO group dominated by clinopyroxene with lesser amounts of garnet and amphibole, higher SiO_2 (48–51 wt. %), and less than 1 wt. % TiO_2, and 2) a low MgO group dominated by garnet and/or amphibole (> 40 vol. %), low SiO_2 (38–47 wt %), and up to 4 wt. % TiO_2. Interestingly, the low MgO pyroxenites are coarse-grained with cumulate texture while the high MgO pyroxenites are fine-grained with partially to wholly recrystallized textures. Whole rock REE patterns are generally enriched in HREE relative to primitive mantle, suggesting garnet and/or amphibole are primary phases. Preliminary thermobarometry on a sample from the high MgO group suggest final equilibration temperatures and pressures range from 580 to 840 °C and 12 to 25 kb (35–75 km), in agreement with previous estimates from Smith et al. (1994). These pyroxenites have remarkably similar major and trace element compositions to Phanerozoic continental arc cumulates. If indeed they formed in the Proterozoic, they provide the oldest window into deep arc lithosphere. However, this raises the question of how such a thick, cold, and dense pyroxenite layer could survive in the lithosphere without delaminating. Alternatively, the pyroxenites may represent cumulates associated with Cretaceous–Tertiary magmatism, implying replacement of the original Proterozoic lithosphere.