A Quaternary xenolith record of lower-crustal pyroxenite formation and foundering in the Andean arc

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Mass balance of crust formation in convergent margins requires that an ultramafic component be removed from typical primary arc magmas, which are dominantly basaltic, in order to produce the andesitic bulk composition that characterizes the continental crust. Gravitational foundering of dense ultramafic cumulates formed during high-pressure fractional crystallization of hydrous arc magmas is thought to be a primary mechanism for this removal, but clear petrologic evidence for this process has been elusive. Here, we present new petrologic, thermobarometric, geochronologic and thermochronologic results from a suite of lower-crustal mafic and ultramafic xenoliths from the Northern Volcanic Zone of the Andean arc, which record Plio-Pleistocene (and likely active) formation and foundering of mafic/ultramafic lower crust underneath this thick Cordilleran orogen. P-T constraints from garnet pyroxenites indicate that most of these equilibrated below the seismically-determined Moho in the region (53 ± 3.5 km), and also provide evidence of foundering of crustal material to conditions of at least ca. 2.9 GPa (ca. 107 km). Internal Lu-Hf isochrons and zircon CA-TIMS U-Pb dates indicate ages for metamorphic re-equilibration/crystallization of mafic and ultramafic products between ~5 and 2.9 Ma, and titanite U-Pb results date high-T cooling to ca. 1.5 Ma. Because these titanite U-Pb dates overlap with zircon (U-Th)/He cooling ages from a gabbroic cumulate (also ca. 1.5 Ma), we argue that these constrain the volcanic exhumation of the Mercaderes xenolith suite and date the eruption of the host Granatifera tuff to the Quaternary. These geochronometric results demonstrate that these are the youngest lower-crustal xenoliths yet identified from the Andean arc, and provide a unique opportunity to study the petrologic record of foundering.