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Origin of Unique Scapolite (Silvialite)-bearing Mafic Granulite Xenoliths as Deep Arc Cumulates

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Mafic granulite xenoliths from the Great Falls Tectonic zone, Montana likely formed as cumulates from arc magmas; they are enriched in Sr, Ba and Eu and depleted in Nb, Ta and Ti (Ringwood et al., 2024, CMP). These cumulates re-equilibrated at the high-pressure granulite facies and contain the sulfur-bearing end-member of scapolite (silvialite), clinopyroxene, plagioclase, garnet, and kyanite intergrown with quartz. In one sample, silvialite crystallizes in a radial pattern surrounding a currently unknown heterogeneous center phase that contains small sulfides, forming multiple rosettes seen throughout the thin section (Fig 1). Silvialite and kyanite stability fields overlap with the intersection of several thermobarometers applied to these samples, indicating equilibration at 1.8-2.3 GPa and 890-1000°C. These conditions correspond to modern mantle depths, however it is unknown whether these rocks truly crystallized in the mantle, or at the base of a tectonically thickened lower crust. This project aims to use the isotope geochemistry of the rocks (both stable and radiogenic) to determine whether they initially crystallized in the lower crust or mantle lithosphere and the degree to which they incorporated pre-existing continental crust. Such information will inform models of continental crust formation and evolution.