Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.30119

Exploring Archean geodynamics: Decoding the P-T-t history of sapphirine-bearing granulites in the 2.9 Ga Fiskenæsset Anorthosite Complex, SW Greenland

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The Fiskenæsset Anorthosite Complex (FAC) in southwest Greenland is one of the best-preserved Archean igneous complexes globally, hosting a diverse suite of lithologies, now present as high-grade metamorphic rocks, including anorthosites, peridotites, garnetiferous amphibolites, garnetiferous pyroxenites, and chromitites. Several studies suggest that the FAC formed in a subduction zone setting, with hydrous recycling of lithosphere and arc magmatism therefore operating as early as the Mesoarchean [1], but this interpretation remains debated. Our study aims to constrain the metamorphic history of the FAC post its 2.9 Ga igneous emplacement, which started as early as the Neoarchean based on metamorphic U-Pb zircon ages [2,3]. This temporally constrained knowledge of the Neoarchean P-T history can be used as fingerprints of the prevalent geodynamic setting in the region.

We report results for a group of highly aluminous, sapphirine-bearing amphibolites dominated by orthopyroxene, corundum, phlogopite and anorthitic plagioclase, along with associated garnetiferous amphibolites and granulites from the FAC. These metamorphosed mafic rocks occur as discrete bodies and enclaves within the anorthosites. By integrating geochemistry, petrography, elemental mapping, geothermobarometry and phase equilibria modeling, we reconstructed the metamorphic P-T-t history of the terrane. We show that the rocks in Fiskenæsset have been subjected to multistage metamorphism with the mafic rocks initially metamorphosed to amphibolite facies (M1) at ~5-7 kbar and ~700°C and subsequently to granulite facies conditions (M2) at *ca*. ~11-12 kbar and ~900°C, forming corundum and eventually sapphirine during retrogression and cooling (M3). A K-rich fluid is further affecting these assemblages during retrogression leading to phlogopitic biotite formation. Thermodynamic modeling allows us to reconstruct the fluid compositions in equilibrium with the phase assemblages of these metamorphic events, and thereby enhance our understanding of the role of element-redistributing fluids in the evolution of these rocks, and cratons in general.

References:

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