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Neoarchean mineral systems in the lower continental crust of the North Atlantic Craton, Greenland

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The North Atlantic Craton (NAC) on the western and eastern coasts of Greenland is characterized by upper amphibolite to granulite facies Archean rocks. Some of these rocks underwent a complex evolution since the Eoarchean, but most are shaped by Neoarchean orogeny. Explorers generally avoid such complex and high-grade metamorphic terranes, because they are considered much less prospective than their low-grade metamorphic counterparts. We present examples of processes that form mineralization in the deeper crust or recycle mineral occurrences in deeper parts of orogens.

Targeted fieldwork in the past decade identified new mineral occurrences such as orogenic Au, orthomagmatic Ni-PGE, and Cu-bearing massive sulfides. Hypozonal orogenic Au deposits in the Godthåbsfjord and Tasiusarsuaq gold provinces of western Greenland are hosted by shear zones and quartz veins. They formed at 530-660°C and up to 6 kbar in the collision stage of the 2650-2580 Ma Kapisilik Orogeny in recycled older rocks of the hinterland. Outward collision or accretion led to hydrothermal Au mineralization during retrograde exhumation. Gold deposits formed in dilational zones along reactivated shear zones, where fluid flow was effectively focused. Younger shear zones contain widespread Au anomalies where Au has not been concentrated due to dispersed hydrothermal activity during one single structural stage.

In contrast to hypozonal orogenic Au deposits, orthomagmatic Ni-PGE and Cu-bearing massive sulfide occurrences often did not form in the deeper crust. Examples of Cu-bearing massive sulfide occurrences with metamorphosed alteration zones and orthoamphibole-cordierite-garnet assemblages are found in the Godthåbsfjord area of southern West Greenland. They form tens-of-metre-scale lenses, and their 3D geometry has not been studied. Massive sulfide occurrences are preserved at terrane boundaries or at the base of nappe structures. Some of these occurrences are proximally associated with rocks that have undergone high-pressure amphibolite facies metamorphism and, thus, likely represent remnants of a progressively recycled active margin in the Neoarchean Tasiusarsuaq Orogen south of Nuuk, the capital of Greenland.

Orthomagmatic Ni-PGE mineralization in the Archean Thrym Complex of South-East Greenland is hosted by small massive to semi-massive sulfide lenses in ultramafic rocks. Pyrrhotite, pentlandite and

chalcopyrite form net-textured mineralization. The ultramafic melts intruded syn-tectonically at granulite facies conditions into Mesoarchean mafic granulite during the Neoarchean Skjoldungen Orogeny. These mineral occurrences are scattered and relatively low-grade, but they nonetheless indicate that orthomagmatic mineralization has formed in lower crustal settings of an orogen.

The lower crustal rocks of the NAC host recycled massive sulfide and orthomagmatic Ni-PGE mineralization close to deformed and metamorphosed paleo-margins. In contrast to these mineral occurrences, hypozonal orogenic Au and possibly orthomagmatic Ni-PGE mineralization directly form through orogenic processes in the lower crust during Neoarchean orogeny.