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Review

Metallogeny of South Greenland: A review of geological evolution, mineral occurrences and geochemical exploration data

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ABSTRACT

South Greenland has been the site of historic mining of cryolite, copper, graphite and gold, hosts mineral deposits with gold, uranium, zinc, niobium, tantalum, zirconium, hafnium, REE, iron, titanium, vanadium, fluorite and graphite, and has additional potential for lithium, beryllium, phosphorus, gallium and thorium. Data from stream sediment geochemical surveys document that South Greenland is enriched in a range of these elements relative to the rest of Greenland and to estimates of the upper crust composition. Distribution patterns for individual elements within south Greenland exhibit enriched regions that are spatially related to lithological units, crustal structure and known mineralisation.

The Northern Domain of South Greenland includes the southernmost part of the orthogneiss-dominated North Atlantic craton. Orogenic gold mineralisation is hosted by quartz veins and hydrothermally altered rocks associated with shear zones intersecting the Mesoarchaean Tartoq Group of mafic metavolcanic rocks. Geochemical exploration indicates that additional potential for gold mineralisation exists within Palaeoproterozoic supracrustal rocks overlying the Archaean basement.

Rocks formed during the Palaeoproterozoic Ketilidian orogeny occupy a major part of South Greenland and has been divided into two domains. The Central Domain is underlain by the Julianehåb igneous complex forming a 100 km wide ENE–WSW zone centrally across South Greenland. Intrusive and extrusive, mostly felsic magmatic rocks were emplaced in two main stages (1850–1830 and 1800–1780 Ma) in a continental arc setting. Positive anomalies in aeromagnetic data indicate that mafic plutons are common in the late igneous complex. Intra-arc mafic metavolcanic rocks contain syngenetic stratabound copper sulphide and epigenetic shear zone-hosted copper–silver–gold mineralisation at Kobberminebugt and Kangerluluk, whereas metasedimentary and metapyroclastic rocks contain stratabound uraninite mineralisation. Orthomagmatic iron–titanium–vanadium mineralisation is hosted by a gabbro. A potential for porphyry-type mineralisation related to the late intrusive stages of the Julianehåb igneous complex is suggested by showings with copper, molybdenum and gold together with stream sediment anomalies for these elements. Vein-type uranium mineralisation occurs in fault zones in the Julianehåb igneous complex related to Mesoproterozoic rifting.

The Southern Domain contains an assemblage of Palaeoproterozoic metasedimentary and metavolcanic rocks that underwent moderate to strong deformation, peak HT–LP metamorphism and partial melting with subsequent retrograde exhumation at 1790–1765 Ma. The supracrustal rocks contain syngenetic Au, As, Sb, U, and Zn mineralisation in volcanic or graphite- and sulphide-rich sedimentary environments; graphite was mined historically at two sites. Many stream sediment gold anomalies are located in a NE-trending belt along the boundary between the early Julianehåb complex and the supracrustal rocks to the south. They reflect a number of auriferous quartz vein occurrences, including the Nalunaq gold deposit, hosted in a system of shear zones and probably generated as orogenic gold during Ketilidian accretion. The 1755–1730 Ma, A-type Ilua plutonic suite is the latest magmatic event in the Ketilidian orogen.

The 1300–1140 Ma Gardar period involved continental rifting, sedimentation and alkaline magmatism. Numerous dykes and 10 ring-shaped intrusion complexes were formed across South Greenland. An orthomagmatic iron–titanium–vanadium deposit is hosted by troctolitic gabbro. Residual magmas and fluids resulting from extreme magmatic differentiation, possibly combined with assimilation of older crust, created mineral deposits including cryolite that was mined at Ivigtut, large low-grade deposits of uranium–rare earth elements–zinc at Kvanefjeld and tantalum–niobium–rare earth element–zirconium at Kringlerne, in the Ilímaussaq complex, as well as tantalum–niobium–rare earth elements at Motzfeldt Sø in the Igaliko complex.

The South Greenland crustal evolution records effects of mantle processes, such as lithospheric extension, subduction and underplating, which resulted in recurrent magma emplacement in tectonically active environments.

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As such, the geology of South Greenland reflects events and circumstances that are favourable to the generation and preservation of hydrothermal ore-forming fluid systems during the Ketilidian orogeny as well as to the development of extreme rock compositions within the Gardar alkaline igneous province.

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