Hydrothermal alteration of Archeaen oceanic crust in the Ivisaartoq greenstone belt, southern West Greenland

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Some of the best-exposed Archaean rocks on Earth are to be found in the Nuuk region in southern West Greenland. Whereas supracrustal sequences of the Early Archaen Isua greenstone belt attracted considerable attention in the past, only recently Meso- to Late Archaean greenstone belts became the focus of detailed geological research. To some extent this interest was triggered by the discovery of economically interesting gold mineralisation in some of these belts (e.g. Storø, Appel et al. 2000). Some of these belts, like the Ivisaartoq greenstone belt, have also high potential for tungsten. Strata-bound scheelite deposits there, interpreted as syngenetic mineralisation of exhalative hydrothermal in origin (Appel 1994), are currently re-investigated in a collaborative project by the authors. This contribution reports on the different types of hydrothermal alteration observed in this belt. The relation of hydrothermal processes to seafloor and regional metamorphism as well as tungsten mineralisation will be discussed.

The c. 3.075 Ga Ivisaartoq greenstone belt includes metamorphosed basalts, ultramafic rocks, gabbros, diorites and minor sulphide-bearing siliceous, siliciclastic, calc-silicate and tourmaline rocks. Primary magmatic textures are partly preserved in low-strain zones, most spectacular being pillow structures in the basalts. The mafic volcanics are komatiitic, picritic to tholeiitic in composition and formed in a supra-subduction type setting in the Mesoarchaean (Polat et al., in press).

Two major stages of deformation can be distinguished: D1 includes the formation of the main fabric (early to main S1 foliation, F1 isoclinal to tight folds; late D1 boudinage of calc-silicate layers; extension veins). D2 resulted in small to large scale open folding as well as formation of syn- and antiforms on the km scale. Widespread pegmatites were emplaced between these two deformation events. Peak metamorphic mineral assemblages are consistent with low-P type regional metamorphism. Garnet + biotite + sillimanite (+ muscovite + quartz) is a stable peak metamorphic assemblage (M1) in the rare metapelites. Several types of alterations have been recognised: (a) silicification; (b) Stage 1 calc-silicate formation (epidote + quartz, ± diopside, ± scapolite); (c) carbonatisation; (e) Stage 2 calc-silicate formation (garnet + diopside + epidote ± calcite ± quartz ± amphibole ± vesuvianite ± scheelite); (f) Post-pegmatite Stage 3 calc-silicate formation (epidote + quartz ±

amphibole). Silicification is to be observed in the pillow basalts and in sulphide-bearing siliceous layers. Early stage calc-silicate alteration (Stage 1) resulted in formation of epidosites. It commonly developed in the permeable cores of zoned pillows, in the interstitial pillow material and in veinlets. Carbonate alteration (calcite ± minor calc-silicates) is restricted to strongly deformed ultramafic flows. No scheelite has been observed in alterations a-c. From mineral assemblages and field relations it is concluded that Stage 1 calc-silicate alteration postdates silicification of pillows though both these alterations are regarded as the effects of seafloor hydrothermal alteration and ocean floor metamorphism. They predate D1 deformation and re-crystallised and re-equilibrated during the subsequent regional M1/D1 event.

Main scheelite mineralisation is hosted by calc-silicate rocks of Stage 2. These rocks are preferentially found within S1 high strain zones. The best scheelite showings were found within and near to a magnetite-rich ultramafic schist horizon ("magnetic marker"). Scheelite is also present in strongly deformed calc-silicate rocks at the contacts to more rigid peridotite layers higher up in the stratigraphic sequence. Formation of the commonly banded and coarse-grained Stage2 calc-silicate rocks post-dates formation of *early* S1 fabrics. S1 foliation planes in siliceous rocks and metabasites are truncated by the reaction fronts of Stage 2 calc-silicate bodies. Formation of these rocks overlaps the main S1/M1 stage and was outlasted by late D1 deformation; the latter resulted in boudinage of calc-silicate layers and formation of extension veins locally containing molybdenite. D2 clearly refolded Stage 2 alteration. Quantitatively negligible Stage 3 calc-silicate rocks are related to post-pegmatite hydrothermal alteration. The hypothesis that Stage 2 calc-silicate rocks formed by syn-metamorphic fluid-rock interaction (i.e., reaction skarns) will be further investigated.

Appel PWU (1994) Stratabound scheelite in altered Archaean komatiites, West Greenland. Mineral. Deposita 29: 341-352

Appel PWU, Bliss IC, Coller D, Grahl-Madsen L, Petersen JS (2000) Recent gold discoveries in Archaean rocks of central West Greenland. Trans. Institution Mining Metallurgy. Sect. B: Appl. Earth Sci. 109:34-41

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