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Mesoarchaean premetamorphic hydrothermal alteration of tholeiitic basalt resulting in aluminous lithologies, Storø supracrustal belt, Nuuk region, southern West Greenland

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The island of Storø in Godhåbsfjord, about 40 km NE of Nuuk, lies within the North Atlantic craton. Supracrustal rocks on Storø are in tectonic contact with Mesoarchaean orthogneisses to the west and Eoarchaean orthogneisses to the east, which form an east-dipping frontal thrust ramp.

Metavolcanic and metasedimentary rocks make up a composite supracrustal belt with ages of ca. 3050 and 2800 Ma separated by a thin thrust zone. Zircon LA-ICP-MS age determinations of gabbro and biotite gneiss provide evidence for these two separate supracrustal sequences, which record different metamorphic events at ∼2720 and ∼2635 Ma, respectively, and thus belong to different terranes. The older sequence comprises anorthosite, gabbro and amphibolite, whereas the younger sequence comprises amphibolite, magnetite-garnetite, biotite-gneiss, garnet-sillimanite gneiss and quartzite.

Here we focus on the younger supracrustal sequence which contains a volcanic suite of dark homogenous amphibolite (5-9 wt.% MgO and 47-52 wt.% SiO2) with primitive mantle-normalised NbN/LaN between 1.0-0.5 and variable LaN/SmN from 0.8-1.4. These rocks plot in the IAT and MORB fields in various tectonic discrimination diagrams and are generally similar to tholeiitic rocks from other Archaean supracrustal belts in SW Greenland and elsewhere. The quartzite and biotite gneiss units have a distinct calc-alkaline affinity and are interpreted as being derived from mature components in an arc setting.

The quartzite, biotite gneiss and garnet-sillimanite gneiss adjacent to the main amphibolite unit have previously been regarded as metasedimentary rocks. However, it is possible to show that the garnet-sillimanite gneiss that is in direct contact with the amphibolite has very different immobile trace element ratios (e.g. Zr/TiO2 ∼50-75, Hf/Lu ∼4-7) compared to the metasedimentary quartzite and biotite gneiss units (Zr/TiO2 ∼120-200, Hf/Lu ∼10-16). Enclaves of amphibolite within the garnet-sillimanite gneiss together with immobile trace element ratios similar to those of the amphibolite suggest that the garnet-sillimanite gneiss was derived from the amphibolite protolith. This can indeed be modeled with the isocon method to give large, but plausible mass changes of the more mobile elements and suggests that the garnet-sillimanite gneiss represents the hydrothermal alteration product of the tholeiitic basaltic rocks that was later metamorphosed to give the present aluminous mineral assemblages.

The garnet-sillimanite gneiss shows a net mass loss of up to 20 wt.% with depletion of mainly SiO2, MgO, FeO and CaO. It plots towards sericite and pyrophyllite endmembers on variation diagrams confirming its origin from hydrothermal clay minerals.