Geophysical Research Abstracts
Vol. 13, EGU2011-10661, 2011
EGU General Assembly 2011

Tholeiitic 'komatiite'−basalt and calc-alkaline andesite–dacite succession in the Archaean Kvanefjord Area (South-West Greenland): A composite oceanic and volcanic arc suite?

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The Archaean Craton in South-West Greenland is made up of a series of predominantly amphibolite facies crustal terranes, which in the Kvanefjord area (∼62°S) are dominated by foliated TTG gneisses and a number of inter-folded amphibolite belts. These ca. 4 km wide and synfomally folded belts appear as dismembered parts of a presumed continuous supracrustal sequence. One supracrustal belt on the Nigerlikasik peninsula was visited during the 2010 GEUS-led (co-sponsored by Greenland Bureau of Mining and Petroleum) field expedition in the area, with the intent of establishing a detailed stratigraphical log and a dense sampling profile for geochemical and geochronological characterisation. The sequence at Nigerlikasik is relatively well-preserved and undeformed, and describes a compositional evolution from ultramafic serpentinites near the base (∼30 m), to mafic amphibolites through mid-section (∼230 m), to felsic schists in the top-section (∼300 m). All rocks are of likely igneous origins based on examples of relict volcanic structures, such as possible fiamme-textured ignimbrites, pyroclastic breccia-flows and rare pillow-basalts. The sequence was intruded by some syn-volcanic gabbroic intrusions in the mafic lower part of the section. The latest magmatic activity is represented by vaguely oblique, cross-cutting aplite sheets (<2 m wide) that dominate at the base (closer to the contact to the surrounding TTG's), but are found up through the entire sequence.

A total of 100 rock samples were collected from the ∼560 m thick metavolcanic section, including 6 samples from the TTG 'basement' and aplite sheets of similar compositions. Four of these aplite sheets were dated by LA-ICPMS zircon U/Pb dating at GEUS, yielding fairly consistent igneous ages of (1) 2.929±5, (2) 2.931±4 (3) 2.913±5 and (4) 2.922±5 Ga, and providing a minimum age of the metavolcanic succession at ∼ 2.93 Ga. Major element similarities between the aplites and the adjacent TTG-type intrusions support a petrogenetic relationship between the two. Major elements classify the metavolcanic units as part of a subalkaline succession, ranging from low-Al_2O_3 komatiitic basalts ($sensu\ lato$, without any preserved spinifex textures and 10-24 wt% MgO), through basalts, basaltic andesites, andesites to dacites. With increasing stratigraphic height there is an overall systematic increase in SiO_2 and corresponding decreases in CaO, MgO, Fe_2O_3 and MnO contents, with several off-set sub-trends typical of some rhythmic crystal fractionation. Whereas the lower mafic section defines a tholetiitic trend in an AFM-diagram, however, the upper felsic section is distinctly calc-alkaline and cannot be petrogenetically related to the basaltic tholeiites on the basis of many other geochemical characteristics. For example, the high-FeOT and low-Al_2O_3/TiO_2 basaltic tholeiites have flat REE-patterns whereas the relatively low-FeOT and high-Al_2O_3/TiO_2 calc-alkaline andesite-dacites have steep, HREE-depleted patterns that are more consistent with a deeper, garnet-bearing mantle source.

It is uncertain whether the lower mafic part of the Nigerlikasik metavolcanic section is made up of tholeiitic island arc basalts, derived from a hydrated juvenile mantle wedge, OIBs, or "hot" Archaean MORBs. The overlying andesites-dacites represent a more diagnostic calc-alkaline volcanic island arc suite, which (together with the <2.93 Ga intrusive TTG?) could have been derived from decreased proportions of partial melts from a subducted oceanic slab, rather than representing progressively more fractionated melts.