Mesoarchaean andesites in SW Greenland – Evidence for Archaean subduction zones?

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Many of the Mesoarchaean supracrustal belts of SW Greenland host leucocratic amphibolites of intermediate composition with volcaniclastic features. These rocks are commonly associated with basaltic amphibolites with pillow lava structures supporting eruption in an oceanic environment. The geochemical composition of these Mesoarchaean andesites share many characteristics with andesites found in modern subduction zone settings.

Here we present new bulk-rock Lu-Hf isotope data for basalts and andesites from the Qussuk supracrustal belt and discuss these in the context of previously published Lu-Hf isotope data from andesites of the Fiskenæsset region. Trace element modelling reveals that simple assimilation in combination with fractional crystallisation is not capable of producing the geochemical compositions of these andesitic rocks. Instead, their petrogenesis requires large degrees of magma mixing involving mafic tholeiitic and felsic TTG-type endmembers.

We argue that because modern andesites also show evidence for large degrees of mixing between mafic and felsic melts (as seen from their melt-inclusions and phenocryst assemblages), and because there is also independent structural evidence for horizontal tectonics in the Archaean crust of SW Greenland, it appears very likely that some form of plate tectonics was in operation by at least the Mesoarchaean.

However, one remaining enigmatic feature of the Mesoarchaean andesites of SW Greenland is that many have near-chrondritic initial Hf-isotope compositions. This may either represent a conincidence controlled by the mixing components or could alternatively indicate the presence of Eoarchaean or even Hadean crust with near-chondritic Hf-isotope composition that contributed as a source to the Mesoarchaean andesites. We note that near-chondritic isotope values have also been reported for TTG-type orthogneisses from this region and thus they may share a common origin.