

Marine chemical sedimentary protoliths determined for ca. 3.71 Ga calc-silicate schists and quartzites from the Isua Supracrustal Belt, West Greenland

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Foliated calc-silicate schists and quartzites from a ca. 3.71 Ga domain within the northeastern part of the Isua Supracrustal Belt (southern West Greenland) may be interpreted as either deformed layered “metasedimentary” rocks, or the metasomatic fluid alteration products of a deformed mafic igneous precursor (i.e. basaltic protolith). One important reason for protolith assignment in this case stems from the debated claim that these are originally clastic sedimentary rocks which host the oldest interpretable bio-mediated sedimentary structures (cf. “stromatolites”). To determine the protolith, we used correlated mineralogical, outcrop- and regional-scale structural, and in situ major-, minor- and trace-element geochemical analyses coupled with high spatial resolution Si, O, and S isotope measurements. We conclude the protoliths were sedimentary chemical precipitates with a minor detrital clay fraction. This interpretation is bolstered by the low levels of generally immobile elements (Zr, Cr, Y, Ti, and P) which rule out either a purely igneous or clastic sedimentary origin. Further evidence for a sedimentary origin includes heterogeneous Si and O isotopes and mass-independent S isotope values ($\Delta^{33}\text{S} > 0$, S-MIF), along with rare earth element (REE + Y) signatures that show light REE-depletion in PAAS normalized REE patterns and seawater-like Y/Ho. Pervasive deformation has masked or obliterated most if not all primary sedimentary structures, such that no chemical or physical features can be reliably used as indicators for (shallow) water depth at time of deposition. Although we conclude these rocks are of sedimentary origin we reiterate (viz. our previous work) that the nabla-shaped (inverted chevron) features found within them are not biogenic stromatolites. Instead, evidence points towards their formation as products of local and regional strain and recrystallization, long after deposition.