Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.18194

Earth's Oldest Detrital Sediments Comprise Turbidites with Tonalitic Provenance

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The 3.7 to 3.8 Ga Isua Supracrustal Belt (ISB) mostly consists of basaltic volcanic rocks belonging to either enriched or low-Ti suites, which are intercalated with sedimentary rocks such as banded iron formations, cherts and, in rare outcrops, detrital sediments. It has previously been shown that the ISB detrital sediments contain graphitized remnants of early life-forms, which constitutes the earliest evidence of life [1][2].

We have drilled a ca. 80 m rock-core encompassing low-Ti meta-volcanic rocks, banded iron formations and turbidite-shale sequences. Turbidite-shale sequences preserve original structures and textures allowing for reliable characterization of sample protoliths. Gradual transition through the three depositional facies shows that the detrital sediments were deposited conformably onto the volcanic basement after cessation of local volcanic activity.

The turbiditic detrital meta-sediments comprise abundant plagioclase with Na-rich compositions, have enriched REE patterns and low Ti/Zr ratios, consistent with a provenance area containing differentiated magmatic rocks with tonalitic compositions. This shows that the volcanic basin formed proximal to a differentiated terrain that was not formed within the same magmatic system as the volcanic basement.

The protracted pelagic deposition of organic material, required for repeated deposition of carbon rich shales, may be related to a higher availability of nutrients caused by the weathering and erosion of the nearby differentiated terrain.

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