

The Marinoan ^{17}O depletion (MOSD) event in northern Baltica

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The formation of sedimentary barite crystal fans directly after the Marinoan glaciation at ~635 Ma was a global phenomenon, with documented occurrences in South China, West Africa, Laurentia, and Central Australia. Their uniqueness lies in both their morphology, which likely occurred only once in the Earth's history, and their non-mass-dependent ^{17}O -depleted oxygen isotope compositions. This indicates an ultra-high pCO_2 post-Marinoan atmosphere, consistent with a hard Snowball Earth. The extant model for barite fan growth is that they formed in shallow water on or inside cavities in horizontally deposited cap dolostones, where an influx of sulfate from oxidative surface weathering combined with Ba^{2+} from upwelling of deeper waters. Here we present an example from northern Baltica (in today's East Finnmark, N. Norway) that essentially supports this model, but with a set of distinctive palaeogeographic, sedimentary, geochemical, and stable isotope features.

In East Finnmark, barite occurs only in the Ruossoaivi-Lappaluokoivi area, west of Varangerfjord. Barite fans grew either directly on a smoothed but very uneven end-Cryogenian, post-Marinoan glaciated Archean crystalline basement surface or on/within the basal few centimeters of the immediately post-glacial carbonate/clastic sediments (Nyborg Formation), although no direct relationships between the barite fans and the cap dolostone have been found.

Barite also occurs as random blades within the sediments, cutting coarse dolomite, and as euhedral prismatic crystals within calcite veins. Fans are generally less than 2 cm thick and are sometimes overlain by sandstones; evidence for multiple growth phases, not all fanned, and breakage/redeposition of barite has been found. One sample shows macroscopic features suggestive of a short phase of sinter deposition during or before barite growth. SEM investigations show that the original matrix has been completely or nearly completely replaced by calcite and quartz in all samples; barite blades have also been partially replaced by calcite and quartz.

REY analysis of calcite from 10 fractions from four samples indicates non- or only very slightly saline fluid conditions; as REY are typically stable during diagenesis/alteration, these analyses most likely reflect the initial depositional conditions. Sedimentation occurred in a flooded glacial palaeo-valley that formed a restricted tidal or very shallow-marine environment with a high input of fresh water.

Analysis of 10 samples gave $\Delta^{17}\text{O}$ values ranging from -0.36‰ to -1.08‰. The northern Baltica barite fans probably grew the closest to a palaeo-continent amongst all the known occurrences, which is consistent with their ^{17}O anomalies being the largest (down to -1.08‰) recorded. The variable $\Delta^{17}\text{O}$, $\delta^{18}\text{O}$, and $\delta^{34}\text{S}$ values of these newly discovered barite fans fit the global distribution and represents the first Marinoan ^{17}O depletion (MOSD) record from Baltica.