

## **The formation of pyrite framboids: a view from TEM and APT**

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Pyrite framboids have been of interest to (paleo)-oceanographers and economic geologists for several decades as they are a rich archive of environmental information. These spherical, polycrystalline masses are important as sinks for S that forms both within the water column and sediments. In recent years their trace element (TE) chemistry has been argued to track the chemistry of the waters from which they formed. However, despite over 40 years of study, there is still controversy regarding framboid formation; the reaction pathways that lead to FeS<sub>2</sub> from HS<sup>-</sup> and Fe<sup>2+</sup>; and the reason for the localized nucleation of the microcrystals that make up the pyrite framboids.

In this contribution, we use the advanced chemical imaging techniques Transmission Electron Microscopy and Atom Probe Tomography to investigate the atomic-to-nanoscale composition and structure of framboids from 3 different periods of Earth history: Devonian (Leicester pyrite member), Cretaceous (Demerara Rise) and modern sediments (Cariaco Basin). Each sample set shows two pyrite phases: 1) pyrite with well-defined crystal structure containing few void spaces or other mineral phases; 2) inclusion-rich pyrite that contains nanoscale voids and high TE (Ni, Cu). This suggests that the formation of pyrite framboids are more complicated than currently understood which suggests we may need to rethink current interpretations of TE incorporation and associated interpretations.