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3D-Mapping of Dolomitized Structures in Lower Cambrian Phosphorites

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Dolomitization is a widespread phenomenon in ancient sedimentary rocks, particularly close to the Precambrian-Cambrian boundary. Dolomite can form in synsedimentary or hydrothermal environments, preferentially via the replacement of solid carbonate precursor phases. Synsedimentary dolomite formation is often associated with microbial activity, such as bacterial sulfate reduction or methanogenesis.
In this study, we investigate dolomitic phosphorites from the Lowermost Cambrian Tal Group, Mussoori Syncline, Lesser Himalaya, India, using micro-CT 3D-mapping, in order to unravel the complex diagenetic history of the rocks. The selected sample shows alternating layering of phosphatic mudstones and sparitic dolostone, in which brecciated layers of phosphorite or phosphatic mudstones are immersed in a dolomite-rich matrix. Lamination occurs on a sub-millimetre scale, with lamination sometimes wavy to crinkly. This fabric is interpreted as former microbial mats, providing the environment for early diagenetic phosphatization. Preliminary electron backscatter imaging with scanning microscopy revealed that dolomite crystals often occur in spherical to ellipsoidal structures, typically with a high porosity. This dolomite is associated with botryoidal apatite, organic matter and small amounts of calcite.
Micro-CT 3D-mappings reveal that dolomite structures are cigar-shaped, elongated and up to 600 μm long. They are further arranged in a Mikado-like oriented framework spanning a layer thickness of a few millimetres. Analyses of ambient pore space, with similar elongated outlines and filled with organic matter, suggest a potential coherence of ambient pore space and shape of the dolomite structures. Allowing for other associated mineral phases, such as pyrite and silicates, and their spatial distribution, the present approach can be used to unravel distinct diagenetic reaction pathways, and might thus constrain the proxy potential of these Lower Cambrian dolomitic phosphorites to reconstruct ambient environmental at the time of deposition.