Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.30884

Microstructural and Chemical Insights into Ryugu's Dolomite: Implications for Aqueous Alteration and Shock History

ROBERTO CONCONI[1], CORENTIN LE GUILLOU[1], SYLVAIN LAFORET[1], MAYA MARINOVA[2], DAMIEN JACOB[1] AND HUGUES LEROUX[1]

[1]Université de Lille, CNRS, INRAE, Centrale Lille, UMR 8207-UMET-Unité Matériaux et Transformations, F-59000 Lille, France
[2]Université de Lille, CNRS, INRAE, Centrale Lille, Université Artois, FR 2638-IMEC-Institut Michel-Eugène Chevreul, F-59000 Lille, France

Carbonates in meteorite and asteroid samples provide key insights into aqueous alteration and impact processes in the early Solar System. Carbonate microstructures and compositions in carbonaceous chondrites provide information about crystal growth, fluid-rock interactions, and the physicochemical conditions of aqueous alteration in the parent body. Additionally, carbonates preserve shock deformation features, making them key indicators of impact histories. In the Ryugu samples dolomite is the primary carbonate phase. These carbonates are particularly interesting since traditional shock indicators, like olivine and pyroxene, are either absent or poorly preserved.

Despite the significance of Ryugu's carbonates, no systematic electron microscopy study has been conducted to examine their microstructures and nanoscale chemical variability. Thus, we conducted detailed electron microscopy analysis on grain A0159, which contains an exceptional abundance of dolomite crystals, including a vein that crosscuts most of the grain. Focused ion beam lamellae extracted from both isolated crystals in the matrix and from the vein revealed polycrystalline clusters composed of aggregated dolomite grains. Individual grains exhibit a variety of microstructures, including dislocations, subgrain boundaries, nanoscale planar modulations, and ribbon defects. These last two categories of defects are likely linked to chemical segregation along dolomite's basal plane. These features may reflect variations in growth kinetics and environmental conditions during crystallization, rather than shock metamorphism. However, since planar modulations and subgrain boundaries have been observed in experimentally deformed dolomite, we cannot rule out that these dolomites recorded impact events [1]. Additionally, nano-inclusions, possibly containing fluid and solid phases as well as phyllosilicates, are preserved along grain boundaries and within grains, suggesting formation in fine-pored, water-rich regions of the matrix [2]. In contrast, the millimeter-scale vein provides evidence of fluid redistribution at a scale larger than usually observed in chondrites. Finally, a chemical zonation over a few micrometres, involving Mn and Mg, was identified. The gradual decrease in Mn at the crystal rim might reflect its progressive depletion in the fluid over time.

[1] Barber, Heard & Wenk (1981), Physics and Chemistry of Minerals 7, 271–286.

[2] Lee, Lindgren & Sofe (2014), Geochimica et Cosmochimica Acta 144, 126-156.