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Geochemistry and microfabrics of syndiagenetic strata-bound fluorite from Eschwege, Germany – Implications for fluorite formation and remobilization in Zechstein carbonates from the Lower Saxony Basin

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Core samples of Stassfurt carbonate rocks (Zechstein, Ca2) from various locations in the Lower Saxony Basin (LSB) often contain fluorite which occurs as pore filling cement, replacement fluorite, or as fault-related fracture mineralizations. Recent studies on fluorite geochemistry and fluid migration in the LSB suggest a sedimentary rather than a hydrothermal fluorite source for some of these deep-seated (> 2500 mbs) accumulations. Outcrop samples from lens-shaped and stratiform fluorite occurrences within oolithic limestone (Ca2) near Eschwege, Germany, give insight into syndiagenetic fluorite formation in Zechstein carbonates. They serve as a shallow-burial analogue for remobilized fluorite within deeply buried carbonate rocks of the LSB. Samples were studied using petrographic microscopy, hot-cathodoluminescence microscopy, and laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS).

Five different fluorite types were identified: a first generation (I) is represented by a dark brownish to violet fluorite that replaced ooids during early diagenesis. As pressure increased during burial the replacement fluorite recrystallized forming white aggregates of parallel bar-shaped fluorite crystals (type II), type (III) consists of white fluorite grains with rectangular and mostly polygonal grain boundaries; type (IV) is a colorless to blueish pore-filling fluorite, and type (V) is a colorless fracture-hosted fluorite.

In-situ LA-ICP-MS analyses of respective fluorite types revealed relatively low REE concentrations in general with Tb/Ca vs. Tb/La signatures that are typical for sediment-hosted fluorite. The REE distribution patterns reflect the processes of recrystallization and remobilization. Though stylolitization affected both host rock and replacement fluorite, only little fluorite remobilization did occur due to pressure solution.

Geochemical analyses prove that fluorite formation was controlled by precipitation from a sedimentary parental fluid during early burial, as no external fluid input could be detected. Fractionation in fluorite was probably favored by both, a continuous mineralization process and subsequent recrystallization.

This study allowed us to: (a) confirm geochemical and microstructural similarities between different fluorite types within Stassfurt carbonate rocks (shallow/deep burial) in the LSB and adjacent areas, (b) identify a possible source material for deep-seated fluorite concentrations in the LSB, and thereby (c) complement existing genetic models for fluorite formation in the LSB from deposition of the host rock to fluorite remobilization during basin extension.