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Impurity-controlled recrystallization in natural fluorite

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Microfabrics in natural fluorite from stratiform fluorite occurrences in Zechstein carbonate rocks (Ca2) near Eschwege (Germany) exhibit complex recrystallization features with different stages of accretive crystallization. Thin sections were studied using standard petrographic microscopy and hot-cathodoluminescence microscopy (CL); to identify fluid inclusion composition microthermometric analysis was applied.

Though fluorite occurs in various forms at the locality, the focus of this study lies on early-diagenetic fluorite that replaced aragonitic ooids in the Zechstein carbonate. It can be subdivided into three groups: (I) brown or violet, impurity-rich replacement fluorite, (II) aggregates of parallel, bar-shaped or fibrous crystals with brown to violet grain boundaries, and (III) white fluorite grains with rectangular to mostly polygonal grain boundaries. Type (III) is the product of merged type (II) crystal aggregates.

Artificial decoration of fluorite grain surfaces due to CL-induced electron irradiation (acceleration voltage: 14 kV) helped to visualize otherwise invisible crystallographic features. This technique revealed a strong crystallographic control on bar-shaped fluorite (type II) at an early stage of recrystallization. Parallel bundles of type (II) crystals show a crystallographic preferred orientation after {100}, that is no longer apparent after consumption by type (III) fluorite and formation of polygonal grains.

Impurities such as fluid and solid inclusions in type (I) fluorite were segregated during progressive recrystallization; subsequently, solid and fluid inclusions accumulated along newly formed grain boundaries. Increase in grain size due to recrystallization is locally hindered by the concentration of impurities along grain boundaries. Therefore, we assume that impurity-controlled recrystallization not only influenced the formation of bar-shaped crystals prior to the development of a polygonal fabric, but locally also strongly affected the resulting grain size (pinning).

Primary intergranular monophase aqueous fluid inclusions within type (II) fluorite suggest low trapping temperatures and confirm diagenetic recrystallization during shallow burial. This observation is in agreement with the regional geologic history (burial depth: < 1000 m). As recrystallization started at relatively low temperatures, we suppose a fluid-enhanced recrystallization mechanism.