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Elemental uptake by individual calcite crystals

RINAT GABITOV[1], ALEKSEY SADEKOV[2], ALBERTO PEREZ-HUERTA[3], CHIARA BORRELLI[4] AND MUSTAFA REZAEI[1]

[1]Mississippi State University
[2]University of Western Australia
[3]The University of Alabama
[4]University of Rochester

Presenting Author: rinat.gabitov@gmail.com

Heterogeneous distribution of trace and minor elements (impurities) within individual crystals or aggregates of calcite grown at near-constant environmental conditions is a phenomenon commonly observed in natural and laboratory systems. A number of studies demonstrated that bulk precipitation rate and growth step geometry have strong effects on elemental (E) incorporation into calcite, which is expressed as partition coefficient of E between calcite and fluid (K^E= $(E/Ca)_{calcite}/((E/Ca)_{fluid})$) e.g., [1-4].

The combination of aforementioned parameters reveals observed heterogeneities in elemental distribution, and hence, causes complication in evaluating of environmental conditions using carbonate proxies, but it also creates exciting research direction regarding the role of calcite in environmental remediation techniques. Although a decoupling of sectoral zoning and growth rate effects on calcite crystal faces (10-14) and (01-12) was conducted in [5], more investigations of K^E on the other crystallographic orientations are required. Application of Lattice Strain and Growth Entrapment models can explain the sectoral zoning phenomenon in calcite as well as growth rate control on elemental partitioning. However, calcite, slowly grown on the Iceland spar template immersed in seawater solution, revealed unexpectedly high K^E for Li, B, Sr, and Ba [6], corroborating the importance of further investigations.

Our recent study continues to evaluate the K^E on different crystal faces grown at monitored rate using an in situ experimental technique, which helps to identify and eliminate potential micro-inclusions of impurity-rich mineral as well as a presence of polymorph carbonate phase. Specifically, we evaluated K^E in: i) thick (>20 microns) overgrowth or individual crystals using spatial analyses (i.e., EBSD, SIMS, LA-ICP-MS); and ii) thin (a few microns) calcite overgrowth using vertical depth profiling technique.

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