Growth-rate induced disequilibrium of boron and divalent cations in calcite: An *in situ* approach

RINAT I. GABITOV, ALEKSEY SADEKOV[2]
CLAIRE ROLLION-BARD[3] AND BRUCE WATSON[4]

[1]Mississippi State University, Mississippi State, MS, 39762, USA
[2]The University of Cambridge, Cambridge, CB2 3EQ, UK
[3]CRPG, Univ. de Lorraine, F-54500 Vandoeuvre-lès-Nancy, France
[4]Rensselayer Polytechnic Institute, Troy, NY 12180, USA

Concentrations of trace and minor elements in marine and terrestrial calcite have the potential to yield information on environmental conditions during crystallization. However, thermodynamic and kinetic effects on element partitioning in calcite are not well understood. The phenomenon of sectoral zoning (geometrically distinct distribution B, Mg, Sr, and Ba in non-equivalent vicinal faces of calcite crystals) has been reported in several studies [1-3, etc.]. The potential factors controlling element partitioning between different calcite faces and fluid include: structural difference of atomic layers at the calcite near-surface region and elements diffusion rates in those layers, difference in growth rate of crystal faces, and chemical speciation at the calcite - fluid interface [2,4,5, etc.].

We used the growth entrapment model (GEM) together with experimental data explore B heterogeneity within single calcite crystals. The GEM describes disequilibrium fractionation of elements and isotopes between a crystal and its growth medium as a consequence of the "capture" of a chemically and isotopically anomalous near-surface region of the lattice during crystal growth [5]. We show that crystal zoning could be explained by different diffusion rates of B in the near-surface layer of the non-equivalent faces of calcite - which is not inconsistent with the extreme anisotropy of the calcite crystal structure. In addition to our B results, we will present GEM simulations for divalent cations in calcite in the context of sectoral zoning.

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Revealing a high altitude paleoclimate record from a Southern Europe ice core

P. GABRIELLI[1], C. BARBANTE[23], L. CARTURAN[4], M. DAVIS[1], G. DALLA FONTANA[4], G. DREOSSI[2], R. DINALE[5], G. DRAGÀ[6], J. GABRIELI[2], N. KEHRWALD[2], V. MAIR[7], V. MIKHALENKO[8], K. OEGGL[9], U. SCHOTTERER[10], R. SEPPI[11], A. SPOLAOR[2], B. STENNI[12], L.G. THOMPSON[1] AND D. TONIDANDEL[7]

[1]The Ohio State University, USA, gabrielli.1@osu.edu
[2]IDPR-CNR - University Ca'Foscari of Venice, Italy
[3]Accademia Nazionale dei Lincei, Italy
[4]University of Padua, Italy
[5]Ufficio Idrografico – Provincia Autonoma di Bolzano, Italy
[6]Waterstones geomonitoring, Varna, Italy
[7]Ufficio Geologia, Provincia Autonoma di Bolzano, Italy
[8]Russian Academy of Sciences, Russia
[9]University of Innsbruck, Austria
[10]University of Bern, Switzerland
[11]University of Pavia, Italy
[12]University of Trieste, Italy

Low latitude ice cores offer unique and detailed paleoclimate information from high elevations. However, as most of the accessible low latitude drilling sites have already been explored and as glaciers are melting worldwide, it is difficult to identify ice fields that contain novel and intact ice core records. The "Ortles Project" is an international scientific effort gathering a dozen institutes from six nations with the primary goal of obtaining a high altitude climate record from Southern Europe. Atmospheric temperatures in the entire alpine region are currently increasing at twice the rate of global temperatures and this change may be amplified at the highest elevations. Unfortunately there is a scarcity of paleo-climate information from high altitudes in the Alps to place the current rapid climate change in a paleo-perspective. To fill this gap we drilled in 2011 four ice cores on Alto dell'Ortles (3859 m, South Tyrol, Italy) the highest glacier in the eastern Alps. We have found an annually preserved climatic signal (in terms of stable isotopes, dust and major ions) embedded in the deep cold ice of this glacier. Alto dell'Ortles is the first low-accumulation alpine drilling site where both winter and summer layers can be clearly identified. From the seasonal layers in the ice core record we estimate an average accumulation rate of ~ 850 mm of water equivalent per year during the last 50 years. Preliminary annual layer counting and two absolute time markers suggest that the time period covered by the Ortles ice cores may span from several centuries to a few millennia.

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