

Cordierite nucleation and growth rates in the Torres del Paine contact aureole

¹ ROBERT BODNER, ² LUKAS BAUMGARTNER
AND C. THOMAS FOSTER

1 University of Lausanne, Switzerland, Institute of Earth Sciences [robert.bodner@unil.ch]

2 University of Lausanne, Switzerland, Institute of Earth Sciences [lukas.baumgartner@unil.ch]

3 University of Iowa, USA, Department of Geoscience [tom-foster@uiowa.edu]

The Torres del Paine (~ 12.59 Ma) intrusion consists of three granite and four mafic batches, which formed within 160 ± 11 ka (Michel *et al.* 2008, Leuthold *et al.* 2012). It intruded into fine grained pelites, sandstones, and conglomerates of the Cerro Toro and Punta Barrosa formations at a depth of 2-3 km. Its contact aureole is characterized by the occurrence of porphyroblastic cordierites (crd). The crd forming reactions are the chlorite break-down reaction (ca. 480°C) and the phengite break-down reaction (530-550°C), which is accompanied by a modal decrease in biotite and the appearance of k-feldspar

We present differences of crystal size distributions (CSDs) in a 400m long sample profile from the igneous contact to the outer part of the aureole. Samples close to the contact have the smallest crystals (radius < 0.06mm), while samples at 400m from the intrusion contain the largest crystals (radius < 0.09 mm). The maximum population density decreases from 11.5mm^{-4} close to the intrusion to 9.5mm^{-4} at distances between 200 and 400m from the intrusion. T-t paths close to the intrusion are characterized by rapid heating (e.g. to 610 °C at 40 m), while the temperature increases much slower to the cordierite-in reaction temperature in the outer aureole. The observation on crd textures were fit with with a numerical nucleation-crystallization model. We assumed diffusion controlled mineral growth and we tested different nucleation laws (e.g. Ridley and Thompson 1986, Carlson *et al.* 1995). The large differences in the temperature-time paths for samples of similar chemistry allowed us to fit nucleation and growth parameters by matching calculated and observed textures.

The resulting parameters indicate rapid completion of reaction before the thermal peak in the inner parts of the contact aureole, and continued reaction after the thermal peak in the outermost contact aureole. In the innermost part of the aureole the overstepping is several tens of degrees (50-150 °C), depending on the nucleation model and the choice of parameters. Calculations with these parameters further show a narrow transition zone (~ 5m width) of full reaction to no reaction between the prograde contact aureole and the unreacted host rock, indicating a relatively sharp isograd for sampling purposes.

Interpretation of Calcium Isotope Variations in Marine Fossil Records

BÖHM, F. AND EISENHAUER, A.

Geomar, Helmholtz Centre for Ocean Research Kiel, Kiel, Germany; fboehm@geomar.de; aeisenhauer@geomar.de

Many studies indicate the existence of calcium isotope excursions and trends in sequences of fossil marine carbonates (e.g. [1, 2]). However, interpretation of these calcium isotope variations is still controversial [3]. Several studies explain calcium isotope excursions as indicators of an imbalance between the major calcium fluxes in the oceans, riverine input and output by carbonate sediments (e.g. [2, 4]). These studies tend to neglect the direct coupling between calcium and carbonate ion fluxes in both weathering and carbonate precipitation. As a consequence the neglect may lead to very unlikely scenarios for the corresponding ocean carbon cycle. Here we present a simple numerical model to calculate mass balances for both marine calcium and carbonate ion concentrations in response to changes in the weathering and carbonate sediment fluxes. The model results clearly show that neither weathering nor carbonate sedimentation may explain observed calcium isotope variations unless extreme scenarios for the inorganic carbon cycle are assumed. Hence alternative explanations other than weathering and carbonate sedimentation are necessary to explain the calcium isotope excursions observed in the Phanerozoic record.

Yet for interpretation of the marine Ca isotope record it has not been taken into account that precipitation rate has a significant influence on calcium isotopes in calcium carbonate minerals [5, 6, 7]. Nielsen *et al.* [8] recently suggested that the influence of the $\text{Ca}^{2+}:\text{CO}_3^{2-}$ ratio on precipitation rate has a significant impact on calcium isotope fractionation. Variations of the marine $\text{Ca}^{2+}:\text{CO}_3^{2-}$ ratio by up to one order of magnitude may have occurred in the Phanerozoic oceans and may explain at least some of the observed calcium isotope trends.

[1] Farkas *et al.* (2007) *Geochim. Cosmochim. Acta*, **71**, 5117-5134; [2] Blättler *et al.* (2011) *Earth Planet. Sci. Lett.*, **309**, 77-88; [3] Fantle (2010) *Amer. J. Sci.*, **310**, 194-230; [4] De La Rocha and DePaolo (2000) *Science*, **289**, 1176-1178; [5] Lemarchand *et al.* (2004) *Geochim. Cosmochim. Acta*, **68**, 4665-4678; [6] Gussone *et al.* (2005) *Geochim. Cosmochim. Acta*, **69**, 4485-4494; [7] Tang *et al.* (2008) *Geochim. Cosmochim. Acta*, **72**, 3733-3745; [8] Nielsen *et al.*, (2012) *Geochim. Cosmochim. Acta*, **86**, 166-181;