Diffusion induced by pressure gradients in natural garnets

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Recently, we proposed that diffusion relaxation of major elements in garnet induces pressure gradients within the crystal [1]. This is based on the fact that the molar volumes of the garnet end-members vary roughly by 10%. Consequently, the re-equilibration of a zoned garnet by diffusion will produce pressure gradients due to the elastic (nearly isochoric) response of the crystal. Diffusion experiments [2], which show apparent uphill diffusion, were used to argue that such pressure gradients do exist and that ductile accommodation of volume changes only occured in the experiments at the highest temperature (1250 °C). We examined HP garnets with coesite inclusions in order to investigate the significance of this process for natural environments.

Whiteschists from the Dora Maira Massive in the Western Alps underwent eclogite facies metamorphism (3.3-4.3 GPa, 720-780 °C) during the Alpine event at 35Ma [3]. Coesite included in garnet ($py_{0.96}gr_{0.02}alm_{0.02}$) during the HP stage was partially transformed to quartz during the subsequent, rapid exhumation (from 3.5 to 1 GPa within 2 Ma [4]). Coesite is preserved by maintaining a high pressure on the inclusion wall due to the large volume change of the phase transition. The surface of the host garnet experiences a lower pressure controlled by the exhumation *P-T* path. This pressure difference should induce a diffusion of major elements in the garnet surrounding the inclusion. Element distribution maps show well-defined Fe-rich, Ca-poor halos surrounding the coesite-inclusions. The observed diffusion profiles are in agreement with predictions, assuming a positive ΔP around the inclusions. The measured diffusion lengths (40-150 μm) agree with simple diffusion models using published diffusion coefficients.

Thus, understanding the effect of pressure gradients on diffusion and, alternatively, the generation of pressure due to relaxation of chemical gradients by diffusion, is crucial for interpreting *P-T-t* paths of zoned minerals correctly.

[1] Baumgartner *et al*. (2010), *GSA meeting Denver*. [2] Vielzeuf & Saúl (2010), *CMP* 1-20. [3] Compagnoni & Rolfo (2003), *UHP Metamorphism - EMU notes 5*. [4] Rubatto & Hermann (2001), *Geology* **29**, 3-6.

Interaction of particulate pollution and precipitation

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In the litterature, numerous studies regarding a possible reduction of precipitation as a result of anthropogenic pollution have been published. A scientific review of the aerosol pollution impact on precipitation can be found in [1].

Often, these results were obtained by modelling exercises in an individual cloud using a simple dynamical framework. We have studied extensively the validity of the simple "air parcel" type assumption, in focussing on the particular role of supersaturation in a bin resolved microphysics model and a 3-D dynamics of an entire cloud. We could confirm a strong dependancy of the results on the dynamic framework used.

The results of parcel model studies seemed to indicate that increasing particulate pollution and decreasing solubility suppresses rain formation. In individual and short time cloud simulations this behaviour was confirmed in our 3D model studies. However, we could identify an important amount of particle processing by repeated super- and subsaturation cycles.

Thus, taking into account entire cloud fields over longer periods of time yields the strong spatial and temporal variability of the results with isolated regions of inverse correlation of the effects. Even though in general the expected behaviour was found, after several hours of simulation, the integrated precipitation of the more polluted cases caught up. This suggests that a changing pollution will affect the spatial and temporal pattern of precipitation, but will probably not reduce the overall long term precipitation amount which might be entirely governed by the moisture state of the atmosphere [2].

[1] Levin, Z., and W.R. Cotton (Eds.) (2009), Springer, 386pp.
[2] Flossmann, A. I. and W. Wobrock (2010) *Atmos. Res.* **97** , 4, 478-497