

## Contrasting mechanisms for two pulses of garnet growth at Stillup Tal, Tauern Window, Austria

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Growth of *ca.* 110 cm<sup>3</sup> sub-spherical garnet crystals in a shear zone in the Austrian Tauern Window required *ca.* 7.5 Myrs, with the vast majority of this growth occurring in two distinct pulses [1]. These pulses are characterised by growth rates at least 5 times higher than the 'ambient' rate experienced during the *ca.* 2 Myr inter-pulse hiatus, and during the final stages of crystal growth. Here we explore possible mechanisms for such short crystal growth bursts, testing their viability in terms of an Alpine history, and using the available constraints to calibrate an exhumation velocity.

The first growth pulse occurred early in the preserved garnet history (inner 2 cm diameter of the crystal core) and is well resolved to no more than a few hundred thousand years duration (likely much less). A thermodynamically constrained garnet growth model [2] and a complex suite of mineral inclusions suggest that this records growth over a relatively limited range of *P* and *T*, at > 35 km depth and temperatures several 10s of degrees above the garnet-in reaction. A sharp Mn decrease within this growth phase likely reflects Rayleigh fractionation, but otherwise both garnet composition and its mineral inclusion assemblage are effectively constant. This supports the hypothesis that a kinetic trigger initiated and accelerated garnet growth at this time, with a distinct network of radiating fluid inclusions (absent outside the crystal core) attesting to fluid abundance [1].

A second phase of accelerated growth is more poorly resolved to no more than 1.5 million years (again, probably much less). Characteristic changes in all measured divalent cations imply that both this rapid crystal overgrowth and the slowly-grown crystal segment that preceded it grew during *ca.* 5 kbars decompression and 50-100 °C heating. Results are consistent with equilibrium growth along a *P-T* trajectory that traversed fields of relatively constant mineral assemblage and then intersected a set of mineral reactions that accelerated garnet growth. Both slow garnet growth *after* the first pulse and rapid growth in the second pulse are thus possible without recourse to additional kinetic mechanisms or substantial increases in heating or decompression rate.

[1] Pollington & Baxter (2010) *EPSL*. **293**. 63-71. [2] Caddick *et al.* (2010) *J. Pet.* **51**. 2327-2347.

## The characteristics of organic matter adsorbed on clay minerals and its significance in carbon cycling

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The protection of organic matter (OM) via adsorption on clay minerals is well recognized in recent years, however, the quantity and occurrence of OM adsorbed on different kinds of clay minerals may be not the same. As a result, smectite and illite were selected to synthesize with OM which are positive (HDTMA), negative (SDS) and neutral (Op-10) OM in various CEC. The amount, stability and occurrence of OM combined with different kinds of clay minerals were studied and their evolution distinction in the carbon cycling was discussed as well.

The result shows that the total organic carbon (TOC) absorbed on both the smectite and illite is 5-20%, and increasing with the CEC. Moreover, the TOC of positive OM absorbed on the smectite or illite is higher than the other kinds of OM. After 6 months at room temperature, the TOC absorbed on smectite decreases slightly (5-20%), whereas the TOC absorbed on illite decreases sharply to less than 2%. In a programming heating experiment, the TOC of smectite-complexes was 7% at the temperature of 300°C, and decreased to 2% as the temperature up to 500°C; however, the TOC of illite-complexes decreased to below 2% at 100°C. These results suggest that the stability of the complexes combined with smectite and illite is distinctively different. The diagnostic peaks of the smectite-complexes, including the d001 reflection peak on XRD, the methyl vibration peak and water vibration peak on IR, were changed in a programming heating, which indicate that the OM was not simply adsorbed on the surface of smectite but also into the interlayer space. However, the diagnostic peaks of the illite-complexes on XRD and IR were changed slightly, which indicate that the OM was simply adsorbed on the surface of illite. The different occurrences of OM associated with smectite and illite must determine the fate of OM in the evolution, which is significant in carbon cycling study.

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