Physical evolution of olivine-hosted melt inclusions during high-*T* homogenization treatments

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Silicate melt inclusions (MIs) form in thermodynamic equilibrium with their host mineral. After entrapment, during the ascent of the host magma and its cooling upon eruption, MIs may undergo physical and chemical changes, part of which are irreversible. Thus, to properly interpret petrological information recorded by MIs, a full understanding of their physico-chemical behaviour when submitted to variations of external temperature (T) and pressure is required. Homogenization temperature (T_h) of the inclusion content (gas + glass ± crystals) is thought to correspond to minimum entrapment temperature (T_e). However, T_h in olivine is observed to increase systematically with time during high-T treatments, thus revealing the occurrence of irreversible physico-chemical changes in the MI-host system.

To figure out what processes are responsible for T_h increase, we performed heating experiments on H_2O-rich (Vulcano Is., Italy) and H_2O-poor (Famous-Zone MORB, East Atlantic) olivine-hosted MIs. Equilibrium between melt and olivine compositions suggests $T_e \approx 1210°C$ for Vulcano MIs and ≈ 1220°C for Famous-Zone MIs. Each experiment consisted of several heating-cooling cycles performed in a rapid-quench optically-controlled Vernadsky heating stage.

In our experiments large variations of T_h with time were measured, along with high first T_h (1230-1300°C for Vulcano MIs; $T_h \geq 1315°C$, more often ≈ 1430°C for Famous-Zone MIs), which are inconsistent with calculated T_e. T_h increase from one cycle to the next is associated with an increase of low-T bubble size and a slower reduction of bubble volume at high T. Images taken during the experiments on Famous-Zone MIs allowed us to measure expansions of MI cavities up to ~30 vol% of the starting volume. Volume expansion occurred quite rapidly (after 10-80 min at $T > 1100$ °C) and increased with time. Its amount, and the associated first T_h as well, seem to be related with MI size, distance of MI walls from olivine faces, and ratio between bubble and MI volumes. T_h increase essentially results from the plastic deformation of host olivine (elastic deformation and dissolution/precipitation interfere but are reversible). Though diffusive water loss may interfere too during the first hours at high T, it cannot explain the observed cavity expansion nor the large and sustained increase in T_h.

Pace of soil formation based on soil structure indices

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Clay sized aggregates play a key role in soil formation as they accumulate and preserve organic matter (OM) by physical protection against microbial decomposition [1]. However, the development of microaggregates during soil formation is not well understood. For our study we collected soils of a chronosequence of approximately 10 to 10000 years in an alluvial plain of the River Danube [2]. A- and AC-horizons of Fluvisols and Chernozems under cropland, grassland and forest were sampled. Microaggregates (< 2μm), gained by ultrasonic dispersion and centrifugation, as well as bulk soil were physically and chemically analysed.

Microaggregates under semi-natural forest showed a steep increase of OM content and a depletion of amorphous Fe-(hydr)oxides in the first years of soil development. In the soils older than about 350 years, OM content in the clay sized aggregates remain more or less constant over time, indicating a possible saturation of the clay sized particles with OM. In contrast, the initally low OM content in the microaggregates under cropland was continuously increasing with soil age. A characterisation of OM in the microaggregtes (e.g. by STA) revealed that with time less degradable compounds are accumulating, especially in the AC-horizon. In the AC-horizon of a 2000 - 3000 year old soil the amount of labile and stable OM in the clay sized aggergates was about the same.

Soil structure build-up was strongly influenced by bioturbation (e.g. earthworms) and plant material inputs (roots, litter). A calculation of the annual soil formation rate, based on the depths of the A-horizons, indicates a very high soil formation rate up to ~4 mm/year at the beginning, decreasing to ~0.1 mm/year after 2000 years.

[1] Chenu and Plante (2006), *Europ. J. of Soil Science* **57** (4), 596-607. [2] Lair *et al.* (2009), Quat. Geochr. 4 (3), 260-266.

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