

Plagioclase weathering across hydrological gradients

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Chemical compositions of drilled well waters from the Vila Pouca de Aguiar region (Northern Portugal) were related to weathering of granite and metasediment plagioclases using a mole balance model. These waters travelled across soils, then saprolites and finally fault zones, before being collected at depths $D = 18\text{--}96$ m. The model results indicate that plagioclase weathering along the more superficial paths produces gibbsite. This is justified by a rapid flow of water across the permeable soils and saprolites and by the local precipitation (> 1000 mm/yr). Along the less permeable fault zone path, made of gravity flow fractures in connection with networks of capillary flow micro fractures, the model results indicate that plagioclase weathering produces halloysite and smectite. A correlation was found between dissolved silica concentrations derived from the plagioclase \rightarrow halloysite reaction and D (Fig. 1), suggesting that halloysite precipitates along the walls of gravity flow fractures because this is a medium where solute transport is advective and therefore concentrations are expected to increase with increasing flow path lengths (D). The lack of a correlation for smectite (Fig. 1) suggests that precipitation of this clay mineral occurs at micro fractures adjacent to the gravity flow fractures, where solute transport is diffusive, mediated by local gradients of chemical potential and by the length of diffusion trajectories, and hence not necessarily dependent on D . Our results comply with observations made by Meunier *et al.* [1].

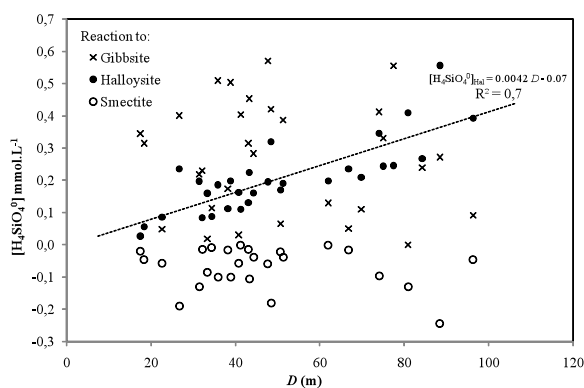


Figure 1: Plot of dissolved silica concentrations resulting from weathering reactions of plagioclase producing smectite, halloysite and gibbsite, as a function of D .

[1] Meunier, A., Sardini, P., Robinet, J.C., Prêt, D. (2007). *Clay Miner.* **42**: 415–435.

Textural record of metamorphic fluids expulsion during high-pressure deserpentinization

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Although the cyclic nature of metamorphic dehydration events in subduction zones is attested by intermediate-depth seismicity, the hydrodynamics of fluid expulsion during the high-pressure, breakdown of antigorite (atg) in these settings are still barely known. This is due to the complexity of the system and the paucity in the geological record of arrested dehydration fronts. The HP atg-dehydration front in the Cerro del Almirez ultramafic massif (Betic Cordillera, Spain) offers a unique opportunity to investigate the dynamics of expulsion of large amount of deserpentinization fluids (~ 9 wt %) [1, 2]. The prograde assemblage is a chl-harzburgite showing two contrasting textures: granofelsic (with coarse, round olivine) and spinifex-like (dendritic-like, cm-sized olivine and orthopyroxene). Both textures occur as interspersed, m-sized boudins behind the atg-dehydration front. We ascribe these textures to shifts of the growth rate due to temporal and spatial fluctuations of the affinity of the atg-breakdown reaction. These fluctuations are driven by cyclic variations of the excess fluid pressure which are ultimately controlled by the hydrodynamics of deserpentinization fluid expulsion. Crystallization at a low affinity of the reaction, corresponding to the granofelsic texture, may be attained if fluids are slowly drained out from the dehydration front. During the advancement of the dehydration front, overpressured domains are left behind preserving highly metastable atg-serpentine domains. Brittle failure results in a sudden drop of the fluid pressure, and a displacement of atg equilibrium towards the prograde products that crystallizes at a high affinity of the reaction (spinifex-like texture). This textural bimodality hence witnesses a unique example of the feedbacks between the cyclic dynamic of metamorphic fluid expulsion, the reaction rate and crystallisation of the atg-dehydrating system.

[1] Padrón-Navarta *et al.* (2008) *Contrib. Mineral. Petr.* **156**, 679–688 [2] Padrón-Navarta *et al.* (2010) *Contrib. Mineral. Petr.* **159**, 25–42.