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The role of lithostatic and non-lithostatic stress on dissolution-precipitation reactions: Examples from open experimental systems and observations in stressed metamorphic rocks.

ANDREW PUTNIS[1] AND JOSEPHINE MOORE[2]

[1]Institut für Mineralogie, University of Münster

[2]University of Lausanne

Presenting Author: putnis@uni-muenster.de

Reactions between aqueous solutions and minerals in open experimental systems almost invariably result in pseudomorphic replacement that couples dissolution and precipitation at a sharp interface. The equilibration reactions may be isochemical or involve a chemical change depending on the composition of the fluid phase. Porosity generation is an integral outcome of the mechanism and provides transport pathways for chemical exchange as well as accounting for density changes between parent and product phases. In rocks the number of possible scenarios is wider, from open systems as in surface weathering (that nevertheless involves pseudomorphic replacement in the saprolite zone), to hydration reactions in the deep earth where far-field stresses may interact with local stresses generated by density changes. Non-lithostatic stress uncouples the dissolution and precipitation steps in a hydration reaction and the mass transfer results in dissolution-precipitation creep as the principal deformation mechanism. The transition from lithostatic stress to non-lithostatic stress associated with localized shear zones also marks a transition between dissolution and precipitation as the rate controlling steps. In the latter case epitaxy and minimisation of surface energy exerts a strong control on the sites of precipitation and results in metamorphic differentiation and gneissic textures. The principles involved may apply to any situation where fluid-induced recrystallisation takes place under an applied differential stress (Putnis, 2021).

Examples to illustrate these processes will be given from both natural occurrences (Moore et al., (2020) and experiments where fluid-rock reaction and deformation are simultaneously induced (Stunitz et al., 2020).

Moore, J., Beinlich, A., Piazolo, S., Austrheim, H. & Putnis, A. (2020). Metamorphic differentiation via enhanced dissolution along high permeability zones. Journal of Petrology, 61, egaa096.

Putnis A. Fluid-mineral interactions: Controlling coupled mechanisms of reaction, mass transfer and deformation. Journal of Petrology 62, 1-27 (2021)

Stünitz, H., Neufeld, K., Heilbronner, R., Finstad, A. K., Konopásek, J. & MacKenzie, J. R. (2020). Transformation weakening: diffusion creep in eclogites as a result of interaction of mineral reactions and deformation. Journal of Structural Geology, 139, 104129.