Field observations uncover complex feedbacks between eclogitization kinetics and state of stress in reacting rocks

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Résumé

Layered continental granulites from the island of Holsnøy (Norway) are partially eclogitized along either shear zones or so-called " static " finger-shaped structures. While eclogite shear zones suggest that reaction progress is mainly controlled by strain, a mechanism is still required to explain the propagation of the still puzzling finger-shaped reaction fronts in adjacent low-strain domains. Combining petrological observations with a detailed structural analysis of the partially eclogitized Holsnøy massif, we discuss how the state of stress can modify the mechanical and fluid transport properties of these rocks and in turn how transient weakening induced by the reaction can affect the local stress field. We show that fingers and shear zones are not randomly distributed. Finger-shaped reaction fronts indeed preferentially propagate in specific directions depending on the relative orientation between the granulitic foliation and the local maximal principal stress inferred from measured shear directions of the adjacent eclogite shear zones. Dependance of reaction kinetics on the state of stress can be described using the Damköhler number (ratio of reaction rate over diffusion coefficient). Dependance of the local stress field on the reaction is suggested by evidence of weakening processes linked to the eclogite paragenesis: mechanical twinning, subgrain individualization and partial melting. We therefore propose that conjunction of anisotropic kinetics and anisotropic state of stress state actually controls reaction patterns in metamorphic rocks, as for instance the development of finger-shaped eclogitization reaction fronts studied here.

Mots-Clés: mechanical anisotropy, stress field, eclogitization, weakening, plagioclase mechanical twinning, grain size reduction, reaction propagation

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