Fluid pressure and reaction zone formation at a lithological interface

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Chemical composition variations in reaction zones between two distinct lithologies are generally interpreted in terms of chemical potential gradients and diffusion process. Concentration profiles can then be used to quantify the species diffusion coefficients or the time scale of geological events. However, chemical potential gradients are also functions of temperature and pressure and local variations of these parameters can thus potentially modify the diffusion process. In northern Corsica, a centimeter scale reaction zone formed under blueschist conditions at a serpentinite – marble contact of sedimentary origin. Three sub-zones having chemical compositions evolving from one rock end-member to another divide the reaction zone along sharp interfaces. At the reaction zone – marble interface, marble decarbonation occurs to form wollastonite and carbonaceous matter. Thermodynamic calculations for this reaction and the respective increase in density of 25 % and 7 % in the bulk rock and in the garnet minerals are interpreted as records of a pressure gradient during reaction zone formation. Moreover, the formation of a volatile-free sub-zone in the reaction zone from reaction between the H_2O-bearing serpentinite and the CO_2-bearing marble released fluids at the contact. The impact of such a release on the fluid pressure was modelled by considering the effects of both the rock compaction and the transport of fluid by hydraulic diffusion. Modelling results indicates that > 0.5 GPa fluid overpressure can be generated at the contact if devolatilization rates are of the order of the one experimentally measured ($> 10^{-5}$ kg of fluid/m^3 of rock/s). The resulting pressure gradient is of the order of magnitude of the one necessary to counter-balance the effect on chemical potential of the chemical composition variations across the contact. Finally, after the reaction has run to completion, the model predicts that fluid rapidly diffuses away from the interface which thus stops reacting and is preserved during its exhumation.