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Kinetic and fluid control of mineral growth during very low and low grade metamorphism

AP Willner and H.-J. Massonne

Universität Stuttgart, Institut für Mineralogie und Kristallchemie, Mineralogie, Stuttgart, Germany (arne.willner@rub.de, +4968581222)

Successful geothermobarometry on metamorphic rocks that had experienced temperatures below 320°C (sub-greenschist facies) strongly depends on the understanding of the kinetic processes and hydrous fluid access at these conditions. A number of studies on such rocks of various lithologies using particularly potassic white mica led us to conclude that below $\sim$ 320°C small grains of solid-solution phases are formed continuously that are not systematically zoned as it is typical for minerals in greenschist, blueschist and amphibolite facies rocks. However, the assembly of such grains is characterized by a compositional heterogeneity acquired by changing PT conditions. By contrast, above $\sim$ 320°C grain growth results either from recrystallization or from specific mineral reactions. These larger grains are characterized by zoning. This important difference is interpreted by nucleation rate exceeding growth rate below $\sim$ 320°C presumably caused by local supersaturation of dissolved cations due to sluggishness of fluid transport, whereas growth rate dominates at higher temperature. By modelling with PT pseudosections it can be shown that between 220°C and 320°C (depending on pressure) most hydrous fluids are released in common rock types such as metapelite and metabasite. This has not only consequences for deformation, but particularly for attainment of local equilibria at very low grade and systematic grain growth at low grade conditions during variable local water access. With examples from Nova Scotia and Newfoundland it will be shown that PT pseudosections have advantages to treat these equilibria quantitatively compared to calculations of multivariant equilibria. Also clockwise PT paths can be reconstructed for low temperature conditions using this method. Any further method that depends on integration over large compositional differences within minerals must lead to insufficient results.