Dissolution, nucleation and growth of mineral phases in aqueous solutions

C. NOGUERA[1], B. FRITZ[2] AND A. CLEMENT[2]

[1]INSP, CNRS-UPMC, Paris, France
(claudine.noguera@insp.jussieu.fr)
[2]CGS, CNRS-ULP, Strasbourg, France
(bfritz@illite.u-strasbg.fr)

In order to take into account the initial stages of formation of mineral nanoparticles in water-rock interaction models, we have developed a theoretical approach of nucleation, growth and ageing processes, relevant for precipitation in solution. It is based on the classical nucleation theory, on a size-dependent (algebraic) growth law allowing growth, resorption and ripening of particles simultaneously, and on conservation laws akin to a thermodynamically closed system.

We will apply it to the formation of silicate phases, and particularly kaolinite-type minerals, from aqueous solutions resulting from rock alteration processes, through the geochemical code NANOKIN that we have elaborated. The nanoparticle formation is simulated versus time in terms of populations of particles appearing successively, surviving and growing or disappearing depending on the evolution of the resulting saturation state of the solution with respect to the corresponding mineral phase.

We will show that two very different scenario may take place, depending upon whether an initial supersaturation is provoked in the solution (i.e. in an experimental approach), or whether it progressively appears as a consequence of rock dissolution. The time dependence of the supersaturation, the size evolution of the particles and the crystal size distribution functions present very specific features in these two cases.

The simultaneous precipitation of competitive secondary phases has also been tested taking into account their specific solubilities, surface energies, geometric shapes and growth rates. This allows to predict the surviving phase in long-term processes

Work is currently under progress to include chemical variability of the produced particles in the model.

Support of the French ANR-PNANO 2006 (project “SIMINOX” 0039) is acknowledged in the last phase of this work.

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Stabilisation of continental crust by dehydration melting: An example from the Västervik area, SE-Sweden

NICOLE NOLTE, WIEBKE BAERO, BENT T. HANSEN AND ILKA C. KLEINHANNS

GZG-Isotope Geology, Georg-August University of Göttingen, Goldschmidtstr. 3, 37077 Göttingen, (nicole.nolte@geo.uni-goettingen.de)

The Paleoproterozoic Västervik area (Baltic shield, SE-Sweden) is located at one major terrane boundary on the Baltic Shield. To the south lies the Transscandinavian igneous belt and to the north follows the Svecofennian domain. In addition, the Västervik area is known for lp-hT amphibolite metamorphism in combination with intensive metasomatism.

From field relationships at least three different granitoid generations can be identified that discriminate in their geochemical and isotope signatures as well. Primitive granitoides (QMD) of quartzmonzodioritic and granodioritic composition, metagranitoides (MG) of quartzmonzonitic (MG_{nf} = non fluid) and alkaligranitic composition (MG_f = fluid) as well as anatectic monzogranites (AG). QMD and MG_{nf} seem to represent “normal” crust-building granitoides with geochemical signatures of rather typical continental crust. The above mentioned metasomatic fluids seem to have affected the MG_f and AG as for example initial Sr isotope ratios are as high as 1.5, respectively. Such increased ratios are observed in the surrounding metasedimentary Västervik-Formation as well indicating a genetic relation with the anatectically created AG. Further, geochemical signatures and fluid classifications show that both MG-groups probably share the same petrogenetic evolution with the sole difference of a fluidchemical imprint in the MG_f granitoides.

Based on the results, a geotectonic model for the evolution of the different granitoides was developed. We postulate an active subduction zone beneath the svecofennian continental margin. This subduction zone was blocked leading to the evolution of a new subduction zone further southwest building up an island arc of which rocks of the Oskarshamn-Jönköping belt belong to. Our geotectonic model relates the evolution of the QMD and MG_{nf} to this maturing island arc. The accretion of this mature island arc on the continental margin of the Svecofennian terrane caused compression and folding leading to crustal thickening. Subsequently, intruding melts show higher SiO_2 contents and are higher differentiated (MG_f). Pressure increase due to crustal thickening and heat input by the ascending melts finally resulted in mica breakdown. Resulting dehydration melting is thus the trigger for the crustal anatexis event that produced the AG and led to fluids that percolated through some of the MG.