Kinetic experiments of some silicate mineral dissolutions in water from a subcritical to a supercritical state

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Measurements of steady-state dissolution rate of pyroxene, quartz, garnet, albite and actinolite in water were performed using flow through reactor (well mixed) from a subcritical to a supercritical state at temperatures from 25 to 435°C at 23-33 MPa. Minerals used in experiments are collected through microscope, cleaned and analyzed chemically. Usually, all reactive solutions were undersaturated with respect to the mineral. A few secondary product phases were found on the reacted surface. The kinetic experiments indicate that the measured dissolution rates of the minerals at T ≤300°C coincide with previous experiments of quartz, diopside and albite published in literatures. The dissolutions are stoichiometric, when the release ratio of molar concentrations of metal M_i versus molar concentration of Si in outlet solutions $\Delta Mi/\Delta Si$ is identical to the stoichiometric number N_i in solid. The stoichiometric dissolution of pyroxene in water is present at near 200°C, and it for albite in water is at 300°C. Dissolution rates (r_{Si}) for quartz, diopside, hedenbergite, albite, garnet in water were found to increase with increasing T from 25 to 300°C. Experiments indicate that the rates of pyroxene and albite decrease with increasing T from 300 to 400°C. The maximum release rates of Si for those minerals are reached at 300°C. The maximum rates for quartz are at about 374°C. The different metals of the minerals often behave the different release rates. Usually, the release rates of Na, Ca, Mg, Fe, Al of minerals are often higher than Si at T<300°C, and the metal M_i-H^+ exchange reactions are faster at low temperature. The hydrolysis of Si-O-Si bond and metal ion-H^+ exchange reactions at T< 300°C are different from reactions at T ⩾ 300°C. Because, the effects of water solvent properties (lowering density and dielectric constant within the region from a sub-critical to supercritical state, hydrogen networks of water molecules break) affect dissolution rates, e.g., dissolution rates of Si vary with 1/dielectric constant.

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Melting of juvenile lithospheric mantle: Geochemical evidence from Neoproterozoic mafic-ultramafic rocks in South China

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While many studies deal with the fate of ancient SCLM, less attention has been paid to the fate of juvenile lithospheric mantle. We present a geochemical study of a Neoproterozoic mafic-ultramafic complex in the eastern Jiangnan orogen, South China. Harzburgite is significantly depleted in Ca and Al, suggesting significant melt extraction; gabbro and spilite have low contents of TiO_2 and P_2O_5. While all the mafic rocks show the arc-like patterns of REE and trace element distribution, the harzburgite is complementary to the mafic rocks in the spidergrams. Zircon U-Pb dating on the gabbro gave three groups of ages at 891±13 Ma, 824±3 Ma and 764±19 Ma, respectively. The 891±13 Ma zircons are less common and unzoned or weakly zoned in CL images, which are interpreted as residues from magma source. The 824±3 Ma zircons are dominant and show clear magmatic zoning, representing crystallization age of the gabbro. The 764±19 Ma ages result from reworking of the collision orogen in response to supercontinent breakup. The harzburgite, troctolite and gabbro have positive $\varepsilon_{Nd}(t)$ values of 3.29 to 5.69 and lower initial $^{87}Sr/^{86}Sr$ ratios of 0.7033 to 0.7059, whereas the spilites show neutral $\varepsilon_{Nd}(t)$ values of -1.24 to 0.40 and higher initial $^{87}Sr/^{86}Sr$ ratios of 0.7039 to 0.7068. In particular, the gabbro rich in zircons has the highest $\varepsilon_{Nd}(t)$ values of 5.69 and the youngest Nd model age of 1.03 Ga. Lu-Hf isotope analyses on the zircons from the gabbro gave positive $\varepsilon_{Hf}(t)$ values of 10.2 to 12.1 at t = 824 Ma and Hf model ages of 0.90 to 0.98 Ga Ma. The positive $\varepsilon_{Hf}(t)$ and $\varepsilon_{Nd}(t)$ values as well as the small differences between the magma crystallization age and the Hf-Nd model age for the gabbro indicate its derivation from partial melting of an isotopically depleted mantle source. Along with available data in the Jiangnan orogen which suggests the postcollisional tectonic setting, it is concluded that the mafic-ultramafic rocks were derived from partial melting of the juvenile lithospheric mantle that probably formed by arc-continent collision at about 900 Ma, and underwent partial melting at about 820 Ma. Therefore, the gabbro and spilite represent the melts, whereas the harzburgite would be the restites after melt extraction. This provides geochemical evidence for anatexis of juvenile lithospheric mantle in the postcollisional regime.