Mineral reactions and melt generation in Metapelites: Insights from torsion experiments and thermodynamical modelling

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This study describes a series of laboratory experiments to investigate the role of deformation on metamorphic reactions in a quartz-muscovite rock. The thermodynamic calculations for the KFASH system in the equilibrium conditions were also taken into account to compare theoretical and experimental data and to show the effect of deformation and rock composition on mineral reactions and melt generation (Perple_X 2007, Connolly). Two types of experiments (static and dynamic) were conducted in an internally heated gas medium deformation apparatus at 750°C and 300 MPa for different time periods. The dynamic experiments were made in torsion with a constant strain rate of 3x10-4/s. The samples showed disequilibrium breakdown reaction of muscovite. After 1 hour some melt appeared, then sillimanite and then some Fe-rich minerals (probably spinel and biotite) were crystallized from the melt. The last product phase was K-feldspar. The rate and amount of melting and crystallization is independent of the imposed conditions (static/dynamic) for the first 1.5 hours of experiments. The application of differential stress gradually become effective in terms of the increasing the rate and the amount of partial melting compared to the static experiments.

Carbonate-silicate equilibria in upper-mantle peridotites saturated with C-O-H fluids

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The mass transfer from the subducting lithosphere to the overlying mantle wedge is mediated by complex solutions deriving from dehydration and decarbonation processes. Relations among high pressure fluids, carbonates, hydrous silicates, graphite/diamond and nominally volatile-free phases in C-O-H-bearing ultramafic systems are substantially unexplored in the subsolidus, with the exception of a couple of pioneristic works [1, 2].

We experimentally investigated at P=1.8-3.5 GPa and T=900-1050°C the phase relations in fluid-saturated ultramafic compositions, involving hydrates and carbonates at controlled oxygen fugacity. A K-bearing lherzolite has been modelled in the system KNCFMAS+ COH. Seeded gels were loaded in a piston-cylinder using double capsule technique, and NNO as $f\text{H}_2$ buffer. GCOH fluids are generated by addition of 10 wt.% oxalic acid dihydrate and pure graphite.

Phlogopite is the ubiquitous hydrate and coexists with olivine, orthopyroxene, clinopyroxene, garnet, ternary carbonates, and, up to 3 GPa at 900°C, amphibole. As expected Na/Na+Ca content in amphibole is increasing with pressure, and it is coupled by jadeitic content in clinopyroxene. X_{Mg} ranges from 0.90 to 0.92, not that different compared to clinopyroxene (0.89-0.93), which displays a jadeite content from 13 to 25%. At 980°C, Al in orthopyroxene decreases with pressure from 0.15 to 0.09 a.p.f.u. (at 1.8 and 3.2 GPa, respectively). Garnet displays X_{Mg} from 0.81 to 0.88. The X_{Ca} (Ca/Ca+Mg) increases with pressure from 0.09 (1.8 GPa, 980°C) to 0.18 (3.2 GPa, 980°C). Phlogopite shows an increase of Si content with pressure, which is anti-correlated with Al. Carbonates are represented by dolomite and magnesite. At 1.8 GPa and T=900-1000°C, dolomite is the stable carbonate. It displays an X_{Mg} ~0.93 and X_{Ca} of ~0.49. At 2.35 GPa, both carbonates dolomite and magnesite are stable. In dolomite, X_{Ca} decreases with temperature (0.40 at 1000°C, 0.46 at 900°C). In magnesite, X_{Ca} is 0.04 and X_{Mg} 0.94. At P>3GPa, magnesite is the stable carbonate, and it shows a X_{Mg} of 0.92 and X_{Ca} 0.04.

The position of the amphibole-out, the dolomite vs. magnesite stability fields, and the element partitioning between garnet and carbonates are discussed.

[1] Olaffson & Eggler (1983) *EPSL* **64**, 305-315. [2] Wallace & Green (1988) *Nature* **335**, 343-346.