Carbonation of serpentinite and spinel-peridotite under fore arc conditions – an experimental study

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Decarbonation of subducting slabs under the fore arc may lead to carbonation of ultramafic rocks in the overlying mantle wedge. We present an experimental study of carbonation of serpentinite and spinel peridotite beneath the fore arc region of the mantle wedge, to assess the effectiveness, rate and magnitude of this process. Using cylindrical natural serpentinite and spinel-peridotite cores as starting materials in piston-cylinder experiments we have simulated the natural fluid-rock interactions.

With decreasing $CO_{2,aq}$ antigorite is replaced by quartz + magnesite, talc + magnesite and antigorite + magnesite (at 2 GPa, 600 °C) in distinct, metasomatic fronts along veins parallel to the serpentinite foliation. The reactions occur quickly and formation of magnesite may represent an unrecognized carbon reservoir in the serpentinized mantle wedge. The volume of solid phases decreases during antigorite carbonation, increasing porosity and promoting further reaction with subsequent fluids. Carbonation of peridotite occurs along grain boundaries forming reaction rims with decreasing X_{CO2} in the fluid: quartz + magnesite and talc + magnesite replace primary enstatite and quartz + dolomite and dolomite + diopside replace diopside.. Hydration of olivine to antigorite + brucite is favoured over carbonation to talc + magnesite (all at 2 GPa, 600 °C). The volume of olivine increases during hydration and carbonation, which might have a shielding affect but may also lead to reaction driven cracking.