Structural changing control of potassium saturated smectite at high pressures and high temperatures: Application for subduction zones

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The lithospheric mantle is characterized by pressure ranges from ~ 2.0 and ~ 7.7 GPa and a specific mineralogy and composition. This region can be re-hydrated and re-enriched in incompatible elements (eg. potassium) through subduction processes that bring pelagic material, composed of clay minerals and other phyllosilicates, into these regions. These minerals act as carriers of water and incompatible elements, re-enriching the lithospheric mantle as they are destabilized. Then, simulating conditions of high pressure and temperature in potassium enriched smectite would help to check the stability field of this mineral and its transformations during the process of subduction. This research focuses on the construction of a phase diagram of smectite, previously saturated with potassium at different temperatures and pressures. We performed experiments in smectite under pressures between 2.5 and 4.0 GPa and at different temperatures (400°C to 700°C). From our results, we conclude that at 2.5 GPa pressure, which is about 75 km depth in the mantle, the clay mineral transform into a new phase at 500° C that correspond to the illite. At higher pressures, we conclude that at 4.0 GPa pressure, equivalent to 120 km depth, the same transformation occurs at 400°C. Such results aid new information to understand the dehydration of pelagic sediments in a process of subduction, and the mobility of some incompatible elements in such tectonic setting.

Elasticity and anelasticity of relaxor ferroelectrics

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The elastic behaviour of ferroelectric and relaxor ferroelectric materials makes an interesting contrast with that observed in association with ferroelastic phase transitions in minerals, though the same basic principles apply. Softening of the bulk and shear moduli of polycrystalline samples occurs in the high temperature structure as a consequence of dynamical effects, there are marked elastic anomalies associated with the phase transition, and anelastic losses arise due to mobile transformation microstructures. Distinctive features of relaxor ferroelectric perovskites are frequency-dependent softening and acoustic losses associated with freezing of polar nanoregions (PNR's), together with a large degree of softening of shear elastic constants due to condensation of static PNR's in the stability field of the paraelectric phase. The latter occurs ahead of the transition to a long range ordered ferroelectric structure. These distinctive features have been investigated by Resonant Ultrasound Spectroscopy (RUS) measurements of polycrystalline $Pb(Mg_{1/3}Nb_{2/3})O_3$ (PMN) and single crystals of $0.955Pb(Zn_{1/3}Nb_{2/3})O_3$-$0.045PbTiO_3$ (PZN-PT). In PMN the pattern of the elastic compliance as a function of temperature mirrors the real part of the dielectric constant and the inverse mechanical quality factor mirrors tanδ, showing that a key aspect of PNR formation is the development of local strain fields. In PZN-PT, there is a large difference in the shear elastic constants between poled and unpoled crystals in the stability fields of the rhombohedral and tetragonal phases and well into the stability field of the cubic phase. This signifies that the PNR's themselves develop a stable microstructure which can be polarised and which gives rise to acoustic losses in much the same way as a conventional ferroelectric microstructure. Central to all this behaviour, as with other types of phase transitions, including order/disorder, displacive, magnetic transitions and changes in spin state, is the coupling of strain with some primary order parameter or with microstructure.