Geophysical Research Abstracts,
Vol. 11, EGU2009-3741, 2009
EGU General Assembly 2009

Dehydration and stability of clay in the seismogenic zone

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The variation of smectite volume during dehydration with increasing temperature or decreasing aH2O is a step function. Discontinuous variations of volume at discrete temperature or aH2O resulting from the loss of water layers alternate with a continuous dehydration at almost constant volume and number of water layers. The discontinuous character of smectite dehydration has important geological implications, because it is accompanied by large changes of volume that can be as high as 30% and a release of free water (about 150 kgH2O/m3 smectite). We propose a macroscopic thermodynamic model that reproduces i) the experimentally observed 3 -> 2 -> 1 -> 0 water-layer transitions and associated volume changes as a function of the nature of interlayer cation and aH2O, and ii) the stability and compatibility relations of smectite with other minerals at high temperature and pressure condition. The model is used to predict by energy minimizing the variations of the solid volume of sediments and the amount of water expelled in subduction zones, from the conditions of early diagenesis to high-pressure, low-temperature metamorphism. Large and abrupt changes are predicted to occur within the seismogenic zone up to 350°C. This result suggests a possible role of clay dehydration in the onset of < 30 km seismicity. This contrasts with the classical interpretation of the updip limit of the seismogenic coupling zone as the result of smectite breakdown into illite.