Pressure solution deformation of Shimanto accretionary complex: Its mass transfer and temperature dependent feature

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Pressure solution (PS) is an important mechanism for mass transfer and for release of accumulated strain energy, which was formed through successive processes of dissolution, material transport and deposition. Pressure solution seams (PSS) has been observed in accretionary complexes of subduction zone, which would causes mass transfer. We evaluated mass transfer by PS as calculating volume change, and investigated relationship between intensity of PS and temperature, using microscopic observations, chemical analyses and paleotemperature. Studied samples are natural deformed shales associated with two distinct types of deformation, that is shear-dominated type (type S) and compaction-dominated type (type C). The PSS density is used as a quantitative index of PS intensity.

We obtained three results as following. (1) Ti concentrated within PSS for both type, implying that Ti is less soluble than other elements during PS deformation. (2) Positive correlation existed between PSS density and TiO_2 for both types and whose inclination of correlations are parallel to each other, indicating that TiO_2 concentration associated with development of PSS are always stable despite the different deformation types. (3) Positive relationship was figured out between PSS density and paleotemperature, implying that development of PSS depend on temperature.

From the former two results, volume change (ΔV) was calculated on the basis of compositional change of Ti using isocon method (Grant, 1986). Results of volume losses show large amount of decrease (~54%) in both types. Volume change in accretionary complexes can be described by a simple equation using PSS density (γ) as,

$$\Delta V = -(2.4 \cdot \gamma)/(2.4 \cdot \gamma + 1)$$

From the last result (3), we estimated activation energies for each type by assuming duration of PS. Activation energies (type S: 18 kJ/mol, type C: 45 kJ/mol) are estimated to be lower than previous results (e.g. Schutjens, 1991) and dissimilar between two types. Possible reasons for the low values and the variation would be related to grain comminutions.

References

Grant, J. A., (1986). *Econ. Geol.* **81(8),** 1976-1982.

Schutjens, P. M. T. M., (1991). *Jour. Geol. Soc.London.* **148**, 527-539.

Anomalously low D/H ratio of H_2 gas from high temperature hydrothermal fluids in the Mariana Trough

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Previously reported δD values of H_2 gas (δD_{H2}) in high temperature hydrothermal fluid (>300°C) ranged from -400‰ to -300‰ [1]. It has been thought that those δD values result from hydrogen isotope equilibrium between H_2 and H_2O, which makes δD_{H2} value -400‰ to -300‰ around 300°C to 400°C [1, 2].

In contrast, we discovered uniquely deuterium-depleted H_2 molecules (δD_{H2} = -800‰ to -700‰) in high temperature hydrothermal fluid at Southern Mariana Trough (SMT) arc and backarc systems in the western Pacific. The δD_{H2} in the SMT hydrothermal systems are so light that the fractionation during the hydrogen isotope equilibrium cannot explain these values at measured fluid temperature [2]. Assuming that the hydrogen isotope equilibrium is negligible in the SMT hydrothermal systems, we should consider kinetic isotope fractionations during some potential H_2 production processes in order to investigate an origin of such light H_2 in the SMT.

Degassing of H_2 from mantle would induce heavy δD values due to extremely high temperature, at which kinetic isotope fractionations are generally too weak to make such light δD value. Serpentinization of ultramafic rocks has been thought as a major H_2 source in hydrothermal systems, while serpentine rock has not been collected in the SMT. Volcanic rock in the SMT is rather acidic than general MORs so that H_2 production by serpentinization may be little in the SMT hydrothermal systems.

On the other hand, it has been reported that chemical reaction between H_2O and crushed rock, caused by fault activity, enables to make large amounts of light H_2 (-770‰ to -470‰) [3, 4, 5]. Similar chemical reactions are expected to occur at low temperature by fracturings in plate subduction zones, close to the SMT hydrothermal systems, which is a possible origin to explain the uniquely deuterium-depleted H_2 discovered in this study.

References

[1] Proskurowski *et al.* (2006), *Chemical Geology*, **229**, 331-,

[2] Horibe and Craig (1995), *Geochimica et Cosmochimica Acta*, **59**, 5209-,

[3] Wakita *et al.* (1980), *Science*, **210**, 188-,

[4] Kita *et al.* (1980), *Geochemical Journal*, **14**, 317-,

[5] Kita *et al.* (1982), Journal of Geophysical Research. **87**, 10789-.