Water content variation in low temperature eclogite inferred from the Sesia Zone, Western Alps

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H_2O derived from dehydration in a subducting slab has important roles in causing various geological/geophysical processes in the subduction zone, such as the island arc magmatism, the enhancement of serpentinization of mantle wedge and the induction of intraslab earthquake. However, the systematics of fluid activity in the subduction zone has not been unraveled yet, such as how much fluid subducts into the mantle, how much fluid is released from the subducting slab, and what kinds of reactions control the dehydration. Due to uncertainties in these fluid activities, there are various perspectives on the nature of subduction system.

We examined the water content variation and the systematics of dehydration reaction in the glaucophanite and eclogite from the Orco Valley area in the Eclogitic Micaschist Complex of the Sesia Zone, using the modal analysis and the pseudosection modeling. The application to the conventional geothermobarometry for eclogite yields *ca* 500ºC and 15kb in the southern Orco Valley and 560ºC and 17kb in the northern Orco Valley, suggesting that a regional metamorphic gradient (*ca* 9ºC/km) exists in the Orco Valley area.

The result of the modal analysis shows that the eclogites in the southern and northern Orco Valley contain *ca* 0.9 and 0.8 wt%H_2O, respectively, and the Lws-free glaucophanites in the Orco Valley contain an identical water contents of *ca* 1.8 wt%. The water content of Lws-bearing glaucophanite is estimated as *ca* 3.0 wt%. These data suggest that prograde Lws decomposition can supply a significant amount of H_2O (*ca* 1wt%) from subducting slab by overstepping the Lws decomposition reaction [Lws+Jd/Ab=Czo+Pg+H_2O] at 450ºC and 12-13kb. The pseudosection modeling predicts that the water content in the eclogite gradually decreases by a ratio of *ca* 0.4 wt%/100ºC with increasing metamorphic temperature from *ca* 500 (1.5 wt%H_2O) to 700ºC (0.7 wt%H_2O). Therefore, we conclude that a prograde Lws dehydration is a substaintial fluid supplier at *ca* 35-45km depth (12-13kb) in subducting slab.

The metamorphic field gradient of the Orco Valley area is well concordant with the inferred thermal structure along the subducting Philippine Sea slab beneath SW Japan. Recently, the deep low-frequency (DLF) earthquakes and tremors observed at *ca* 25-45 km depth around the plate boundary below the non-volcanic area of SW Japan. The DLF earthquakes and tremors are considered to be a result in the fluid activity caused by the dehydration in subducting slab. As most of DLF earthquakes and tremors take place at *ca* 25-45 km depth in SW Japan, where are coincidence with the expected depth of Lws decomposition in SW Japan, we emphasize that the lawsonite decomposition is one of the candidates for causing DLF earthquakes and tremors.

Gravitational trapping of carbon dioxide in deep sea sediments: A geomechanical analysis

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Carbon dioxide is denser than the surrounding pore water at great depth and relatively cold temperature found in geological formations below the deep ocean floor and thus would be trapped by gravitational forces (House *et al*. 2006). Gravitational forces will drive the CO_2 from above and below toward the level of neutral buoyancy (L_{NB}), below which warm CO_2 is less dense than the surrounding pore water and thus will rise and above which the CO_2 is denser than water and thus will sink. CO_2 storage near the neutral buoyancy level is therefore stable. Storage capacity varies with seafloor depth, geothermal gradient, pore water salinity, permeability, and porosity of deep-ocean sediments. Using field data from pelagic sediments from the Atlantic, Pacific, and Indian Oceans, we show how in-situ conditions would affect storage capacity by shifting the level of neutral buoyancy and therefore the sediment depth available for CO_2 accumulation. We also measured permeability and porosity in core samples from relevant sites.

The majority of tectonically stable ocean sediments at the minimum required water depth of 2700m is composed of calcareous sediments or clays. Pelagic clays have very low permeabilities unsuitable for injection. Our data illustrate that pelagic carbonates have low to moderate permeabilities (µD to mD), suggesting that reservoir stimulation techniques such as hydraulic fracturing would be necessary to increase the injectivity. We evaluate the potential for CO_2 injection in calcareous sediments based upon a geomechanical analysis. Young basalts located under pelagic sediments and turbidites may offer attractive alternatives with higher permeabilities for injection.

Reference

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