Regional silica enrichment in subduction-type metasediments: Evidence from deformed mineral vein sets in the Del Puerto Canyon region, Franciscan Belt, USA

*Shogo Soejima[1], Simon Richard Wallis[1]

1. Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo

It is well known that the presence of water fluids in subduction zones plays an important role in the occurrence of slow earthquakes. Silica, which dissolves well in water fluids in subduction environments and is most abundant in subducting rocks, has also received much attention in recent years as a potentially important factor controlling the time scale of slow earthquakes. For example, Audet & Burgmann (2014) proposed the silica accretion process as a factor that determines the ETS recurrence period, based on the observation that the Vp/Vs ratio on the upper plate of the subduction zone is positively correlated with the ETS recurrence period. Specifically, the theory is that the periodicity of slow earthquakes is determined by the repetition of gouge rupture during fault slip and healing due to quartz precipitation. This theory requires that 5–15vol.% of silica be accreted in the lower regions of the continental crust. The movement of such a large amount of silica should be reflected in a volume decrease at the source region and a volume increase in the region where precipitation occurs. Due to the widespread presence and high solubility of silica, volume changes in these regions should correlated with the amounts of silica transferred. Therefore, estimates of synmetamorphic volume change of metasedimentary rock that has been subducted to ETS depths or deeper can be used to test the idea of significance silica transport in these regions.

Previously applied methods for estimating rock volume change are based on estimates of absolute stretch, or changes in whole-rock chemical compositions. Estimates based on these approaches give large discrepancies even when applied to the same region. In this study, we develop a largely unexplored method for estimating volume change using the direction and deformation type of deformed mineral veins (Passchier, 1990; Wallis, 1992). The assumptions in this method are few and appropriate uncertainties can be estimated.

Application of the new method to the metagreywacke in the Del Puerto Canyon of the Franciscan belt constrains the syn-metamorphic volume change to be greater than 7%, contrasting with previous proposals for large volume-loss in the same region (Ring, 2008). The results of previous studies can be modified taking into account rigid body rotation of individual grains accommodated by grain boundary sliding and solution transfer. The final result of our approach yields a positive volume change of 7–21vol.% and implies the accretion of silica to the rock. This result is in good accord with the estimate of Audet & Burgmann (2014).

Reference

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