Are high pressure metamorphic rocks hotter than model?

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P-T conditions of high-pressure metamorphic rocks are valuable data for understanding the thermal structure of subduction zones. However, numerical subduction models predict temperatures that are on average colder than those recorded by the metamorphic rocks (Penniston-Dorland et al., 2015). Differences are significant for P < 2 GPa, where model averages are 100–300ºC colder than average conditions recorded by rocks. In addition, P-T conditions for metamorphic rocks compiled by Penniston-Dorland et al. (2015) show following features. P-T conditions for rocks associated with a slow subduction tend to show a higher P/T ratio than that with a fast subduction. There are two types of prograde P-T path: one has a slope (dP/dT) similar to P/T ratio and the other has a slope higher than P/T ratio.
To understand these features and the origin of differences between models and rocks, we calculated thermal structure of subduction zones using a numerical model that take account of variable mechanical properties of rocks composing plate boundary. For a wide range of subducting plate age and subduction velocity, our model shows nearly constant coupling depth (70-80 km) between slab and mantle wedge. This is a result of feedback mechanism that works between thermal and flow structures due to several processes including dehydration of oceanic crust, serpentinization of mantle wedge and hydrolytic weakening of peridotite. This coupling depth is concordant with the maximum pressure (ca 2.5 GPa) recorded by high-pressure metamorphic rocks. Temperature along a plate boundary varies with mechanical properties of the boundary rocks. In general, dP/dT ratio along a shallow (P < 1 GPa) plate boundary is lower than a deeper part. We will compare these results with P-T conditions of high-pressure metamorphic rocks including the Western Alps, Sanbagawa and Dominican Republic.

Keywords: high pressure metmorphic rocks, subduction zones, numerical model, pressure-temperature condition