Evidence for localized high fluid pressure along the paleo subduction boundary exposed in the Sanbagawa belt, SW Japan

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Petrological and thermal modelling has shown that the Sanbagawa metamorphic belt formed in a warm subduction zone setting. The metamorphic rocks mainly consist of pelitic, quartz and mafic schists derived from the subducted slab. However, ultramafic units locally reaching kilometers in scale are also found widely distributed throughout the belt. The distribution of these mantle derived units is restricted to the higher metamorphic grade zones. This observation shows that the mantle units of the Sanbagawa belt were derived from the wedge mantle and the boundary with the surrounding schists is a paleo subduction boundary. In present day convergent margins the subduction boundary between shallow mantle wedge and subducting slab is commonly the site of episodic tremor and slow slip. This relationship is particularly clear in warm subduction zones such as SW Japan. Slow slip is associated with very low stress drops and can be induced by small changes in the regional stress field of the order of 10s kPa. These observations require the subduction boundary to be very weak in the domain of ETS. Localized high fluid pressure is likely to play a role in forming weak boundaries and this is supported by seismic studies that reveal high Vp/Vs and Poisson ratios. However, the wedge mantle in this region is likely to be highly serpentinized and consist in part of minerals such as brucite and talc, which have low coefficients of friction. These minerals may also play a role in weakening the boundary. Structural-petrological studies of serpentinized mantle wedge adjacent to a paleo subduction boundary in the Sanbagawa belt reveal the presence of a strongly deformed zone of antigorite rock up to 100 m thick. This shear zone is overlain by a domain of metamorphosed serpentinite that originally contained 10-20 % brucite. The presence of significant amounts of brucite should cause the rock to be much weaker than the antigorite-dominant zone. However, the brucite-domain is largely undeformed. The only reasonable explanation of this observation is to invoke a high fluid pressure localized to the antigorite shear zone. The localization of the fluid can be explained by anisotropic fluid flow caused by the presence of the strong foliation.

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