Role of the subducting plate on the ETS-type phenomena around the mantle wedge corner

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Episodic tremor and slip (ETS) and related phenomena around the mantle wedge corner usually occur in young-slab subduction zones and are most abundant in Nankai, Cascadia, and Mexico. They are rare or absent in old-slab subduction zones such as Japan Trench. The relationship of these ETS-type phenomena with the subducting plate is a question of fundamental importance. In this work, we address this question through thermal modelling using heat flow data as model constraints. Our model employs the hypethesis that extremely high fluid pressure exists around the mantle wedge corner, consistent with relevant seismic and other observations.In young-slab subduction zones Nankai, Cascadia, and Mexico, the subduction fault has two frictional segments, with the first one being shallower than the mantle wedge corner because the viscous strength of the subduction faults is relatively small. Around the mantle wedge corner, the second frictional segment appears, but with abnormally low frictional strength due to the high fluid pressure and possibly the presence of hydrous minerals. We propose this is where the ETS occurs. Between these two frictional segments, the fault exhibits semi-frictional and/or viscous behaviour, which may facilitate long-term slow slip events and/or aseismic creep. For most old-slab subduction zones such as Japan Trench, there is only one frictional segement which extends to deeper than the mantle wedge corner because of the greater viscous strength of its megathrust than in young-slab subduction zones. We think the lack of a second frictional segment retards the development of ETS. However, two frictional segments are present in the old-slab Northern Hikurangi subduction zone because the greater frictional strength of its megathrust causes the termination of the frictional segement to occur shallower than the mantle wedge corner, explaining why ETS-type phenomena are observed here. The greater frictional strength is attributed to the roughness of the subducting seafloor. Our results indicate that both the age and roughness of the subducting plate play a key role on fault rheology which may control the occurence of the ETS-type phenomena.

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