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Double décollement zone bordering the subduction channel in an ancient erosive subduction complex: implications for seismogenesis

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Subduction channels are relatively thick shear zones marking plate boundaries where material is dragged downward between the plates, or, at depth, allowing return flow. Our study concentrates on the shallow, max 5 km depth, portion of a fossil subduction channel exposed in the Northern Apennines of Italy. The fossil Apennine subduction channel has two main characteristics: (1) the deeper outcropping portion records T of about 150°C (clay mineral assemblages, apatite fission tracks and vitrinite Ro) corresponding to a sediment load of about 5 km in agreement with the conditions for the up-dip limit of seimogenesis observed at modern convergent margins; (2) the material incorporated in the subduction channel was part of the upper plate and it was delivered to the subduction channel by subduction erosion. In particular, besides basal subduction erosion is globally more common, and in the Northern Apennines is present as the the process tectonically removing blocks from the no longer active accretionary prism, we recognized frontal erosion. Frontal erosion is shown by the complete cut and incorporation in the subduction channel of the entire section of frontal prism with overlying slope deposits and slide blocks from the no longer active accretionary prism forming the upper plate. Field analysis revealed that frontal erosion developed through two coexisting décollements, roof and basal. One of the main questions here is whether the two décollement were active at the same time and what was their implication for the aseismic-seismic behavior. Detailed structural analysis of the deformation features associated to the sediments within the subduction channel and of their cross-cutting relationship reveals a well defined downdip strain evolution: the shallow portion is characterized by diffuse extension with strain accommodated by contemporaneous failure and compaction; the intermediate portion is characterized by localised extension with

basal décollement locking and development of a fluid pressure cycle with two competing mechanisms: (1) fast events with a stress drop; (2) slow pressure-solution; the deep portion characterized by compression and with fluid flow still present, but reduced in comparison to shallow portion. In this regime the basal and roof décollements seem to have been active contemporaneously, but they had different behaviors. The roof décollement is able to transmit only the lithostatic load of the upper plate to the channel, revealing that it is weak and under continuous creep until at least intermediate depths. The basal décollement, instead, is already partially locked at intermediate depths in the subduction channel and becomes fully locked at deep portions of the channel. This study shed some light on the possible link between strain evolution and seismic behavior of the channel, usually invoked to be exclusive pertinence of temperature and fluid flow reactions. It is long known that in extensional regime it is easy for Pf to decrease because hydrofracturing occurs at low λ (=Pf/σ). Extension is the strain regime observable in the shallow, water rich/low friction plate boundary shear zone where the leading stress was lithostatic. It is also known that at 150°C, though, most of the interstitial and bound water is already gone from sediments. In this case we envision that as long as fluids were available, they were easily released through hydrofracturing. When fluid supply decreased, hydrofracturing drove sediment hardening. Friction increased and strain accumulated triggering discontinuous opening/shearing processes and seismic behaviour.