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Fluid pressure and shear zone development over the locked to slow slip region in Cascadia

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At subduction zones, the deep seismogenic transition from a frictionally locked to steady sliding interface is thought to primarily reflect changes in rheology and fluid pressure, and is generally located offshore. The development of fluid pressures within a seismic low-velocity layer (LVL) remains poorly constrained due to the scarcity of dense, continuous onshore-offshore broadband seismic arrays. We image the subducting Juan de Fuca oceanic plate in northern Cascadia using onshore-offshore teleseismic data and find that the signature of the LVL does not extend into the locked zone. Thickening of the LVL down dip where viscous creep dominates suggests that it represents the development of an increasingly thick and fluid-rich shear zone, enabled by fluid production in subducting oceanic crust. Further down dip, episodic tremor and slip events occur in a region inferred to have locally increased fluid pressures, in agreement with electrical resistivity structure and numerical models of fault slip.