

We present results from three-dimensional inversion of an amphibious magnetotelluric (MT) array from Cascadia consisting of nearly 400 long-period sites. The dataset includes 102 new onshore sites covering the forearc in Oregon and SW Washington, 71 new offshore sites (43–47N) as well as long-period sites from several legacy 2D land profiles, and the Earthscope TA. The prior model for the inversion includes ocean bathymetry, conductive marine sediments, and a resistive (1000 ohm-m) subducting plate, with geometry derived from the model of McCrory. Conductance of the 10 km thick layer above the resistive slab (Fig. 1) peaks along three distinct slab-depth contours: 17.5, 30, and 65 km, consistent with bands of fluid release into the overlying crust associated with (1) clay dehydration/pore collapse; (2) metabasalt dehydration associated with transformation to eclogite; (3) deeper dehydration reactions associated with arc magmatism. These peaks are clearest in latitudinal averages, but are also commonly (but not uniformly) found along individual margin-crossing profiles. However, there are substantial variations (up to two orders of magnitude) in conductance along margin, even at fixed slab depth. Even given uncertainties in fluid conductivity and connectivity, this translates into along-margin variations in fluid volume sequestered in the overlying crust of at least an order of magnitude. Estimates of fluid volume from the conductance maps, combined with slab fluid inputs derived from recent off-shore seismic experiments imply residence times in the overriding crust of 0.1–1 Ma. There is a strong correlation between areas with high conductance/fluid volume and crustal lithology—metasediments of the deep accretionary complex (Olympic peninsula; thrust beneath the outboard edge of Siletzia in SW Washington and in Oregon; Klamath terrane) store fluids, and the mafic Siletz block does not. Thus the 30 km depth contour conductance peak is mostly absent beneath Siletzia, but present and strong to the north and south. Furthermore, there is high conductivity material above the slab all along (but thrust under) the outboard edge of Siletzia, wherever this boundary occurs at slab depths less than 30 km. High conductivities occur also in a narrow band that parallels the southern edge of Siletzia. The high conductivities (at variable slab depth) along the edge, and the near absence of high conductivity beneath, Siletzia suggests that this mafic block may be relatively impermeable. We suggest that fluids released from metabasalt dehydration reactions near the forearc mantle corner escape vertically into the overlying crust where metasediments predominate, but flow upward along the megathrust (possibly episodically, during seismic events) beneath Siletzia to escape into metasediments trapped along the outer edge. Further support for this picture is provided by the negative correlation between the quantity of fluids trapped in the crust above the 30 km slab contour, and along the edge of the Siletz block. Previously noted correlations between continental crustal lithology and ETS intensity would have a different interpretation in this model: fracturing of the interface associated with ETS would be associated with vertical fluid transport into metasediments, while higher pressures would be supported under the more quiescent zones below the Siletz block. Enhanced fluid flow updip, and egress at shallower depths in Oregon may help explain apparent reductions in plate locking at these latitudes.

