Electromagnetic Imaging of Fluids in Subduction Zones and the Effect of Anomalous Seafloor on Electrical Anomalies

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Magnetotelluric (MT) data have been increasingly used to image subduction zones. The data used have been collected in a variety of ways, including traditional campaign style profile acquisition, large grids of sites such as the US Earthscope Transportable Array, and innovative network MT techniques on land. Important to fully constraining the subduction settings are data that span the entire system from incoming plate to the arc and back-arc. Such profiles are, however, quite rare.

Models of electrical resistivity at subduction zones commonly show features related to the release of fluids at several depths through the systems imaged, consistent with thermal and petrological models of dehydration of the downgoing slab. Imaging the release of aqueous fluids from sediments and pore-space in the crust requires controlled source EM (CSEM) techniques which have, to date, only been used in one setting off Nicaragua. The deeper release of fluids related to the transition of basalt to eclogite is commonly imaged with magnetotelluric (MT) data. Fluid release signals at higher depth, from the breakdown of minerals like serpentine, are highly variable.

Based on observations of the best electrical datasets available and of the structure of the seafloor in these locations, we hypothesize that regions where very strong conductive anomalies are observed in the mantle wedge at depths ~80-100km are related to the subduction of anomalous seafloor, either related to excessive fracturing of the crust (e.g., fracture zones), subduction of seamounts or other ridges and areas of high relief. These features deform the seafloor prior to entering the trench, permitting the subduction of a higher volume of fluids and therefore a more widespread serpentinization of the mantle than would otherwise occur.

Moving forward, we need observations that span the tectonic scope of the system, mapping along-strike variability of fluid inputs and release. An advantage of MT over seismic methods is that data sets can be built up over time, but new approaches to acquiring large data sets at low cost will need to be considered.

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