Hydration State of the Upper Mantle in Subduction Arc-Backarc Regions from Magnetotellurics Using the Western U.S. as an Example

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The distribution of water in the upper mantle is believed to have strong influence upon global dynamics by influencing mantle rheology, modal mineralogy, melting systematics and chemical differentiation. The principal input of water is the process of subduction which is estimated to have introduced several ocean volumes to the mantle over Earth history. In principal, a large proportion of this water may be dissolved in the nominally anhydrous silicate minerals (NAMs), but quantifying this has been challenging. Electrical conductivity is strongly sensitive to mineral hydration and could provide estimates of mineral water content with suitable constraints. A 1300 km E-W transect of ~400 magnetotelluric (MT) soundings from the northern California coast over the Gorda plate, across the Great Basin of Nevada and western Utah, and spanning the Colorado Plateau of eastern Utah reveals an upper mantle whose resistivity below the broad Great Basin falls progressively with depth from values of ~100 ohm-m near 50 km to <10 ohm-m by 400 km depth. We test the hypothesis that the vertical resistivity profile is consistent with the maximal hydration degree allowed by ambient T-P short of triggering H_2O-undersaturated melting (cf. Ardia, 2012, EPSL). Assuming standard and enhanced adiabats, deep resistivity profiles predicted using lab data suggest only resistivities in the near 'hanging wall' of the Gorda subduction zone under northwestern Nevada are low enough to represent full NAMs hydration. Under the central (eastern Nevada) and eastern (western Utah) Great Basin, large-scale resistivities are at least 2-3x too high, nominally.
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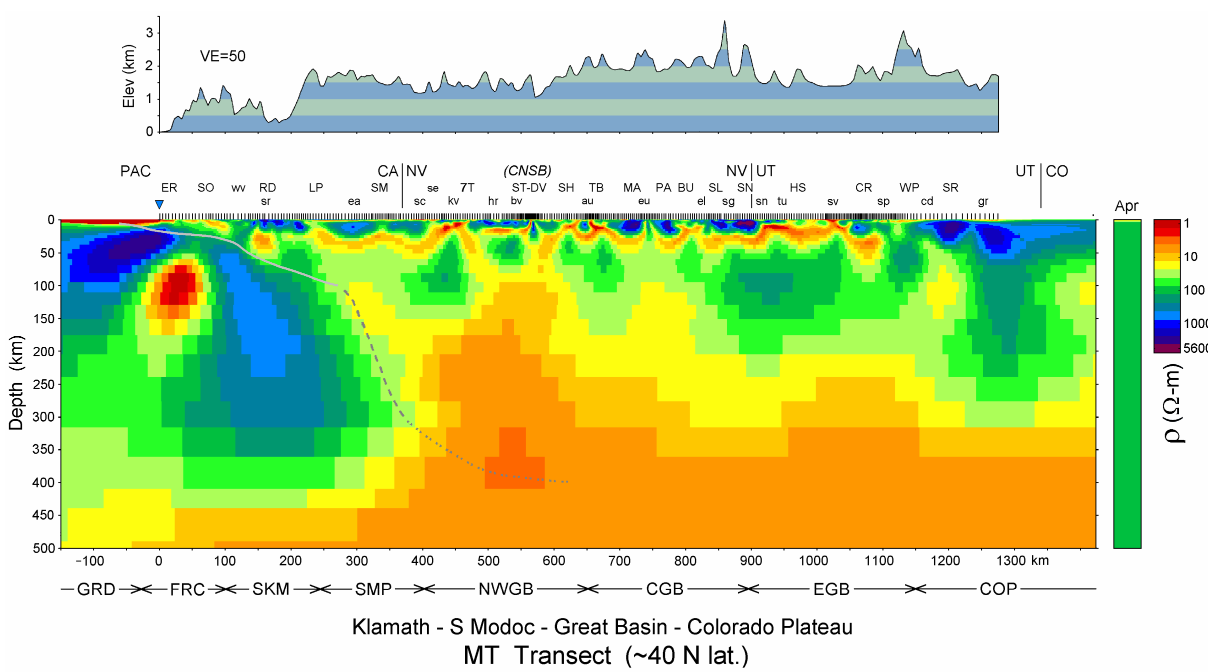

MT resistivity cross section from Gorda Plate, through Great Basin and Colorado Plateau.