Enhanced and asymmetric melting beneath the southern Mariana back-arc spreading ridge, influenced by the subduction of the Pacific plate

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The southern Mariana Trough has distinct features from the remain of the Trough, such as slow seafloor spreading but axial high topography, gravitationally low anomaly and thick crust, slow crustal seismic velocity under the ridge influenced by slab-derived water, lack of currently active subaerial arc volcanoes but signatures of slab-derived or arc components in rocks sampled on and off the ridge axis. These features suggest enhanced melting beneath the ridge and the influence on the back-arc spreading process from water dehydrated from the subducted Pacific slab, which lies beneath the ridge. To reveal the distribution of melt and water in the upper mantle and the upper mantle dynamics in the southern Mariana Trough from electrical resistivity, we conducted a marine magnetotelluric experiment along a ~120 km transect across the ridge at ~13°N. Electromagnetic field data obtained at 9 sites were analyzed to image a 2-D electrical resistivity structure by inversion, after processing the data and striping seafloor topographic distortion from magnetotelluric responses. The obtained 2-D model shows 1) low resistivity at ~10-20 km depth beneath the ridge center but slightly offset to the trench side, 2) moderately low resistivity expanding asymmetrically to the remnant arc side and deeply under the conductor of 1), 3) high resistivity having a constant thickness of ~150 km under seafloor on the trench side, and 4) high resistivity under seafloor thickening from the ridge center up to ~50 km on the remnant arc side. These model features suggest 1) the presence of melt beneath the ridge center, possibly including slab-derived water 2) melt/water-retained mantle produced by asymmetric passive decompression melting of hydrous back-arc mantle, 3) cold and depleted mantle wedge and Pacific slab, and 4) cold and residual lithospheric mantle off the ridge axis. The electrical resistivity structure of the southern Mariana Trough, which clearly contrasts with the structure of the central Mariana Trough at 18°N that is absence of conductor beneath the ridge center, provides insights on the mantle dynamics and its relation to a characteristic tectonics and many observations in the southern Mariana Trough.

