Electrical resistivity structure under the western Cosmonauts Sea at the continental margin of East Antarctica, inferred through a marine magnetotelluric experiment

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The breakup of the Gondwana supercontinent is one of key targets to advance our understanding of the plate tectonics and related mantle dynamics. The crust and the upper mantle structure under the western Cosmonauts Sea at the continental margin of East Antarctica, where a rifting of Gondwana and a subsequent seafloor spreading occurred, are anticipated to reflect the breakup process of Gondwana. We carried out a marine electromagnetic experiment to reveal an electrical resistivity structure at depth of the crust and the upper mantle under the western Cosmonauts Sea. Time variations of the electromagnetic field were acquired at two seafloor observational sites in the experiment. The time variations data were processed on the basis of the magnetotelluric (MT) method. The MT response function was obtained after considering influence of non-plane magnetic field sources at high geomagnetic colatitude. The obtained MT response functions and polar diagrams imply that the MT responses involve topographic distortion and/or reflect non 1-D resistivity structure under the observational sites. Three dimensional forward modeling was conducted to examine influence on the observed MT responses from the topographic variation around the observational sites and a conductive layer just under the sites. The results of the forward modeling clearly show that the topographic variation and the surface conductive layer that is mostly regarded as sediment have severe influence on the observed MT responses. A series of 3-D forward modeling including the topographic variation and the surface conductive layer was implemented to examine a resistivity structure at depth of the crust and the upper mantle. The results indicate that the resistivity structure is explained by a two-layer resistivity structure, in which the upper layer is resistive and the lower layer is conductive. The upper resistive and the lower conductive layers likely represent dry and water/melt rich oceanic upper mantle, respectively. The thickness of the upper resistive layer is thinner than that expected for a typical oceanic upper mantle of the plate age of the study area. The thin upper resistive layer may represent a resistivity structure generated during and/or after the initial breakup of Gondwana at the continental margin of East Antarctica through mantle convection.