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LATE CRETACEOUS OPHIOLITE EMPLACEMENT AND CENOZOIC COLLISIONAL TECTONICS IN THE NORTHERN UAE: INSIGHTS FROM BROADBAND MAGNETOTELLURIC DATA

by

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Abstract

The Late Cretaceous obduction of the Semail Ophiolite onto the rifted passive Arabian margin and the Cenozoic collisional tectonics with the final closure of the Neotethys Ocean are major contributors to the present-day crustal architecture of the northern United Arab Emirates. The emplacement of the Semail Ophiolite and the progressive accretion of the underlying thrust sheets onto the previous Arabian rifted margin in the Cenomanian resulted in lithospheric flexure of the Arabian Platform and led to the formation of a Foreland basin adjacent to the mountain belt in the United Arab Emirates and Oman. Tectonic stacking of the foreland sediments and thrusting of the platform and the basement resumed as a result of the collisional tectonics in the Cenozoic with the final closure of the Neotethys Ocean. The geological structures associated with the emplacement of the Semail Ophiolite during the Late Cretaceous and the subsequent collisional tectonics in the Cenozoic hold considerable scientific and economic significance. The ophiolite blocks in the United Arab Emirates and Oman are globally recognized as the most extensive and exceptionally well-preserved ophiolite formations. Geoscientists have widely utilized ophiolites as a significant resource for exploring various features, including the magmatism occurring at mid-ocean ridges, the chemistry of the Earth's mantle, and the subduction processes inside orogenic belts. The acknowledgment of ophiolites as structural counterparts to oceanic lithosphere played a vital role in the progression of the plate tectonic theory during the 1960s. Ophiolites have proven to be of significant economic importance to human societies and civilizations due to their abundant reserves of minerals and ore deposits, as viewed through an economic lens. The ultramafic-mafic rocks of the ophiolitic complex have been recognized as a geological setting that contains a wide variety of economically valuable metals, including gold, silver, platinum-group elements, chromium, manganese, titanium, cobalt, copper, and nickel. Foreland basins and Fold and Thrust Belts provide important information regarding crustal shortening and mountain-building processes in convergent orogens. The foreland basin and the Fold and Thrust Belts of the United Arab Emirates are known for their oil/gas resources. In this study, broadband magnetotelluric data were acquired for the first time in the northern United Arab Emirates to examine subsurface structures related to these two major tectonic events. The broadband magnetotelluric data were acquired from 73 stations with about 5 km intervals. The main objective of this study is to image the base of the ophiolite blocks in the northern United Arab Emirates and to map subsurface deformation related to the post-obduction Cenozoic collisional tectonics in the northern United Arab Emirates. This study presents the first three-dimensional resistivity model of the crustal structure of the northern section of the United Arab Emirates.

The recovered resistivity model from the three-dimensional inversion of the broadband magnetotelluric data reveals the subsurface geometry of the highly resistive ophiolite blocks, the underlying conductive thrust sheet (Haybi-Hawasina nappe), a second "wedge-shaped" conductive foreland basin flanking the Hajar mountain ranges, and at depth underneath the conductive foreland sediments, a high resistivity structure associated with a fold-thrust belt adjacent to the allochthonous units. The ophiolite in Fujairah and Khor Fakkan is thicker than 20 km and dips eastward. Along the Wadi Ham fault, the resistive ophiolite displays a gap indicative of the out-of-sequence Bani Hamid metamorphic rocks that cut across the mantle sequence. The thin-skinned thrust sheets of the proximal-distal Tethyan sedimentary units (Haybi-Hawasina complexes) exhibit low resistivity in the Dibba zone. In contrast to its gently east-dipping geometry in the Dibba Zone, the conductive Haybi-Hawasina structure in the southern portion of the study area appears nearly vertical beneath the dense (> 20 km) Khor Fakkan and Fujairah Ophiolites. This could suggest extensive deformation of the thrust sheets beneath the southerly dense ophiolite blocks.

Keywords: Magnetotelluric method, Semail Ophiolite, foreland basin, fold and thrust belt, Haybi-Hawasina complexes, UAE