Marine electromagnetic forward modeling in a resistivity model constrained by seismic and well log data from a field at Campos basin SE-Brazil

Artur Benevides¹, Naser Meqbel¹, Williams Lima¹, Sergio Fontes¹, Gary Egbert², Paulo Werdt¹, and Emanuele La Terra¹
¹Geophysical Coordination, Observatório Nacional, Rio de Janeiro, Brazil
²College of Earth, Ocean, and Atmospheric Sciences, Oregon State University, Corvallis, USA

This work presents electromagnetic (EM) responses using both marine magnetotelluric (MMT) and controlled source electromagnetic (MCSEM) methods applied to a resistivity model typical of the Campos basin. The Campos basin is located in the Brazilian east margin, with origin in the Neocomian stage of the Cretaceous period 145–130 million years ago during the breakup of the supercontinent Gondwana (South America and Africa split). The clastic reservoirs in this basin have been the largest oil producer in Brazil for the past three decades and the present challenge moves to deeper waters, well known for great challenges in exploration enforced by the complex geology posed by the tectonics associated with giant saline bodies. The seismic reflection is the highest resolution geophysical method and the most used tool in hydrocarbon (HC) exploration; however, it finds difficulties in generating good images in complex geological environments (i.e., associated with the presence of salt and volcanic rocks) and is not a direct hydrocarbon indicator. EM methods, in contrast, are sensitive to resistive variations, and can therefore aid in indicating a reservoir HC-filled and/or in the obtaining subsurface images that can be integrated in joint approaches with seismic for producing less ambiguous interpretations. A set of geophysical data available in the study area includes: CSEM stations, 2D seismic lines, and 3D seismic cube, in addition to 33 well logs. The studies are still in an early stage and the main objective now is to evaluate the responses of the MMT and MCSEM methods in different scenarios involving hydrocarbon accumulations in a thin post-salt Maastrichtian reservoir. The EM forward modeling responses was performed using the modified version of Modular System for EM inversion (ModEM code) within a research project at Observatório Nacional – Brazil. The resistivity model used in this study incorporates vertical transverse isotropy (VTI) in resistivity and is derived from the interpretation of the seismic data and well logs present in the study area. The obtained EM responses demonstrate the effectiveness of the method for detecting thin reservoirs HC-filled, when compared to an environment without accumulation, and the exercise is valuable to compare and understand the real data collected in the study area.