Abstract

The coastline of the Indian peninsula is rich in heavy mineral placer sands. The areas along southern coastal Odisha (Rushikulya, Podampata, Chhatrapur, Gopalpur) are known to be enriched in heavy minerals. DC resistivity and time-domain induced polarization (IP) techniques have been used to delineate the vertical and spatial extent of the heavy-mineral enriched placer deposits in these areas. The heavy mineral zones appeared to reach depths of 10–15 m below the shallow horizon. The major types of mineralization seen are either dispersed to shallower occurrences associated with the surface-visible discontinuous black patchy mineralization or localized at medium to deep horizons, suggesting the existence of buried or concealed mineralization. These beach sands include ilmenite and magnetite, which enables the application of DC resistivity and IP possible. The study area's heavy minerals exhibit chargeability values of more than 30 to 35 mV/V and resistivities ranging from 0.1 to 1.1 Ωm. The alternating heavy mineral layers within the host of the sandy/clayey soil can contribute to macro-anisotropy. The interpretation of data using the direct current (DC) resistivity method can be improved by considering subsurface anisotropy in the modeling algorithm. Therefore, 2D anisotropic inversion of DC resistivity data is performed using a newly developed code (named Anisotropic DC resistivity Forward and Inverse, *ADCFI*). The estimated depth of the hidden pockets of heavy mineralization is corrected by the use of anisotropic inversion. To justify the performance of the 2D DC anisotropic inversion code, additional DC resistivity data have also been collected from the areas having significant anisotropy. To compare the anisotropy coefficients estimated by the 2D anisotropic DC resistivity inversion, a 1D joint inversion (a galvanic and an inductive method) code is also developed. The two methods utilized in the joint inversion algorithm are DC resistivity and the far-field mode of controlled source radiomagnetotellurics (CSRMT). Also, the selection of an optimum regularization parameter plays an important role in determining the convergence of an inversion algorithm. In this regard, some already available regularization parameter estimation techniques are considered and their results are compared with a newly developed empirical approach for regularization parameter estimation. After appraising the performance of all the regularization parameter estimation techniques on synthetic data, it is applied to field data. For this purpose, the CSRMT field data have been collected from the fractured granite-gneissic terrains of Eastern Ghats, India. A borehole from the area verified the results of the joint inversion and 2D DC anisotropic inversion. A juxtaposition of the results of the 2D anisotropic DC resistivity inversion and 1D joint DC-CSRMT inversion assisted in the comparison. The anisotropy in the subsurface is detected at the onset of the fractured zone.

Keywords: electrical resistivity tomography, time domain IP, heavy minerals, Odisha, anisotropy, far-field CSRMT, joint inversion.