The present geophysical study aims at subsurface structural investigation and/or exploration of chromite and uranium deposits over three different areas from the Eastern Indian Shield with the help of integration of suitable geophysical methods that are comparatively economical, easier and fast. The integrated geophysical investigation with gravity, magnetic, very low frequency (VLF) electromagnetic and DC-Resistivity soundings depicted a chromite deposit extending to a depth of ~35 m and/or ~100–200 m at places, over the northern part of Tangarparha. Three-dimensional (3D) compact inversion model depicted the volume of the chromite mineralization. For the first time in India an integrated geophysical study has been performed for chromite exploration in a laterite cover area on the southern part of Tangarparha. This study shows that the delineation of chormite deposits in laterite covered area needs focused application of geophysical methods as well as more sophisticated and unbiased modeling approach. The geophysical study over uranium mineralization at Beldih mine area of South Purulia Shear Zone (SPSZ) reveals correlation between low resistive, low gravity and moderate to high magnetic anomalies. These geophysical signatures are utilized for uranium exploration around SPSZ. The semi-regional gravity-magnetic study around SPSZ depicted the subsurface fractures/faults, the width of the shear zone and hydrothermally altered possible zone of uranium mineralization. Two-dimensional (2D) compact inverse model of residual gravity anomaly nullifies the possibility of deeply rooted shear zone. The gravity study across Talchir basin over Angul-Talchir-Rengali demonstrates that the low density crust must underlie the high density surface granulites. The basin forms in a half graben structure and is underlain by the Eastern Ghats Mobile Belt crust. The subsurface investigation also confirms the repeated reactivation of this region. This study indicates that the North Orissa Boundary Fault continues to be susceptible to seismic activity even at the present-day. Thus, the study also gives significant input to seismic hazard analysis of this region. The MATLAB codes have been developed for gravity-magnetic data processing, and 2D-3D compact inversion of gravity data. In this thesis joint-inversion scheme for gravity and VLF data has been developed using the compact inversion approach for density and current density modeling from gravity and real anomaly data, respectively. This inversion scheme provides a better resolution for the conducting subsurface bodies compared to other existing VLF digital linear filtering methods. Thesis also provides a priori guideline about the geophysical signatures for chromite and uranium mineralization to the mineral prospectors.

(**Keywords:** Eastern Indian Shield, Gravity, Magnetic, VLF, DC-resistivity, 2D-3D Compact Inversion, Joint Inversion)