Investigation of structural features from gravity data using derivative techniques

Manoj Prabhakar Bhimavarapu\textsuperscript{a,}, Abhay Kant\textsuperscript{b}, and Durgam Hanmanthu\textsuperscript{c}

\textsuperscript{a}Geological Survey of India, Central Region, Nagpur-440006, India.
\textsuperscript{b}Geological Survey of India, Southern Region, Hyderabad-500068, India.

*Corresponding Author: bmp121758@gmail.com

ABSTRACT

This study aims to investigate the source boundaries of the geological structures and their depths in Pomburna-Thenewasna-Ghanpur area, located in the western part of Bastar Craton (WBC), using Bouguer gravity data where copper mineralization has earlier been reported. So far, no geophysical investigations have been conducted in this area. For the first time, gravity survey with an interval of 200 to 6000 meters was conducted. The Tilt depth and Euler deconvolution techniques obtained from the first-order vertical derivative of residual gravity anomaly were applied to field data. The vertical derivative map shows presence of a NS trending fault in the western part of the study area, while the central portion shows the NNW-SSE trend, which reflects linear features. The TDR map also shows the same trend. However, it enhances the sharpness of the features. The Tilt depth method and the Euler deconvolution technique was used to calculated the source depths. The resultant Tilt depth solutions were compared with the solutions from the Euler Deconvolution technique. In the study area, four promising zones were detected. The first two zones were found in Thanewasna shear zone, and the remaining two zones on existing faults in the southwestern region. These findings provide constraints on the source boundaries, which will be helpful in developing research programme in the study area for mineral exploration.

Keywords: Residual gravity data, Vertical derivative, Tilt depth solutions, Euler solutions, Source boundaries, Bastar craton.

INTRODUCTION

The primary source of mineralization may be one of the linear structures that are geologically discontinuous. The gravity data are related to a change in the density of geological structures among the causative sources with different shapes and depths. The geometric shape of linear anomalies on the gravity map connected to buried faults and contacts, is important for studying geologic structures. Therefore, gravity data are used to determine the locations and the depths of causative sources using edge detection and depth estimation techniques (Oruc, 2010). The short wavelength anomalies are originated from shallow contact bodies and are extracted by the vertical derivative technique from the gravity map (Aku, 2014).

Several approaches are available to enhance and identify these types of contact source bodies (Hansen et al., 1987; Rajagopalan and Milligan, 1995; Hsu et al., 1996; Alvandi and Asil, 1996; Thurston and Smith, 1997; Pawlowski, 1997; Bournas and Baker, 2001; Ardestani and Motavalli, 2007; Al-Garni, 2010; Ferreira et al., 2013; Ghosh and Dasgupta, 2013; Saada, 2016; Ghosh, 2016, 2019; Alhassan et al., 2021). The vertical derivative has been employed for many years to locate the boundaries in potential field data (Evjen, 1936). The second-order vertical derivative technique is applied to gravity data and the elongated zero contours are formed by this technique, which corresponds to the edges of lithological boundaries (Aku, 2014). The most popular technique like tilt angle (TDR) (Miller and Singh, 1994; Verduzco et al., 2004) has been used in a variety of situations for edge enhancement and detection in the potential field data. The total horizontal derivative of the tilt angle (THDR) (Verduzco et al., 2004), the horizontal tilt angle derivative (TDX) (Cooper and Cowan, 2006), and the Theta map (Wijns et al., 2005), are the widely used tilt angle methods. A new edge detection technique was introduced by Oruc (2010) based on the first vertical gradient of gravity anomaly using a synthetic model of semi-infinite vertical contact. Salem et al. (2007) developed the Tilt-depth method using the tilt angle derivative of the potential field data, which provides the contact source depths. The Euler deconvolution (ED) technique has come into wide use to interpret potential data before the tilt angle derivative has been developed. In this paper, an attempt is made for enhancement, edge detection, and to find depth of potential source bodies using the Tilt angle derivative (TDR) and Euler deconvolution (ED) techniques over the gravity data collected in Pomburna-Thenewasna-Ghanpur area of Maharashtra (India).

GEOLOGY OF THE AREA

Pomburna-Thenewasna-Ghanpur study region (Figure 1) is located in the eastern province of Maharashtra, India. The IOCG (Iron oxide–copper–gold) deposit of the Thanewasna shear zone is situated in the center of the study area, and it is a new genetic type of ore deposit (Dora et al., 2017). The