Estimation of Thickness of Limestone Formation in Part of Kurnool Sub Basin from Aeromagnetic Anomalies

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Summary

Analysis of Aeromagnetic anomalies, from the regions of exposed basement rocks and hard rock terrains, greatly help in understanding the subsurface magnetic lithology and fracture/fault lineament pattern. The semi-arid tracks of limestone/shale sequence belonging to Kurnool sediments are underlain by comparatively porous quartzites of the Chitravati group of rocks of Cuddapah formation. Moderately intense, short wavelength aeromagnetic anomalies have been observed over a stretch of shale limestone sequence belonging to the Nandyal-Nargi sequence of Kurnools. Occurrence of these short wavelength magnetic anomalies over the non magnetic shale-limestone sequence is attributed to the presence of the Gandikota quartzites of the Chitravati group of rocks.

Modeling of 20 aero magnetic anomalies has resulted in delineating 600meters thick Kurnool sediments in the Southeastern part of the study area. The ferruginous quartzite formations appear to dip towards southeast with a depth range of 50-600 meters. A north-south structural/magnetic lineament has also been inferred. The Kundra Vagu, a tributary to Kunderu River, with dendritic drainage pattern has been following this inferred north-south magnetic lineament.

Introduction

Airborne magnetic data collected over any region becomes a potential source of valuable information containing signals related to hidden/covered magnetic lithology and subsurface structure/tectonic environment. The aeromagnetic maps/images help one in understanding the geological evolution of the areas under study and are helpful in isolating zones of mineral potential and/or ground water horizons in addition to regional geological mapping. Aero magnetics have been successfully used in delineating, indirectly, fault/fracture controlled aquifer zones in crystalline and metamorphic/hard rock terrains in most parts of the world. (Astier and paterson1987, Astier 1969, Chandra and Reddy, 1987, Paterson and Bosschart, 1987 and Rama Rao et al 2000). Astier and Paterson (1987) have shown, in crystalline basement complex in some parts of West Africa a direct correlation between the yield of bore wells and their proximity to faults and dykes determined from aeromagnetic data. Rama Rao et.al (2000) delineated a set of subsurface fracture system in a hard rock terrain west of Cuddapah Basin and a potential ground water aquifer system.

In this paper we present results of analysis of aeromagnetic data from a region of shale/lime stone formations associated with the Cuddapah-Kurnool system of rocks in the Proterozoic Cuddapah Basin (CB).This analysis has brought out a deep aquifer zone in the quartzite horizon associated with Cuddapah formations. The quantitative analysis of magnetic anomalies were also made to estimate the thickness of the overlying Kurnool sequence of rocks. Further, attempt has been made to delineate structural lineaments in the study area.

Geological setting of the study area

The 400 km long crescent shaped intracratonic Cuddapah Basin (CB) located in the eastern part of the Eastern Dharwar Craton (EDC) of the Indian Peninsular Shield is a repository of valuable base metals and has attracted the intellectual curiosity of many a geologist and geophysicist.
Extensive geological and geophysical studies related to structure, stratigraphy and evolution of CB have been carried out by King (1872), Narayana Swamy (1966), Sen & Narasimha Rao (1967), Raju et al. (1979), Murthy (1979), Murthy et al. (1985), Dutt (1986), Naqvi et al. (1986), Naga Raja Rao (1987), Bala Krishna et al. (1967), Bala Krishna and Paul (1979) Kaila et al. (1979), Bhattacharji & Singh (1982), Krishna Brahmam et al. (1986) and many others.

The CB is a composite of sub-basins consisting of the Papagni basin (the oldest) in the western part, followed gradually towards east, by the Kurnool basin and Nallamalai basin containing Cuddapah-Kurnool system of sediments with a maximum thickness of more than 6000 mts (Babu Rao, 1991). Srisailam and Palnad sub-basins occupy the north and north east part of CB. Six episodes of intense igneous activity has a direct bearing in the evolution and development of this Intra Cratonic Basin. (Naga Raja Rao et al. 1987). Presence of igneous flows and sills spread over as intra trappeans during different times of sedimentation act as good indicators in understanding the basin evolution. The ferruginous quartzites, mafic sills and flows gave rise to perceptible short wave length magnetic anomalies in a non magnetic sedimentary environment which has indirectly helped us to delineate zones of possible ground water accumulation and estimation of thickness of sediment and in isolating a north south trending fault/contact zone in the limestone/shale formations of Kurnool in a part of Kurnool Sub-Basin. The study area is located on the Cuddapah-Kurnool formations (57 I/8).

**Hydrological setting of the study area**

The study area forms a part of shale and limestone belonging to the Kurnool system of rocks in the middle and northern part where as the south western part and the north western part contain the Gandikota Quartzites as hillocks with a peak of 300mts above msl. The north-south traversing Kunderu River is a major river channel fed by east-west trending drainage channels in the south and by north east trending channels in the south west corner. The Kundra Vagu located towards east of Kunderu river is a straight, parallel, north south trending major drainage channel perhaps controlled by a structural lineament meets Kunderu in the south. Another drainage channel Pal Eru traversing from north western direction meets Kunderu and feeds the main river. These drainage channels seem to be dendritic and structurally controlled. These channels form sources of replenishment to the ground water system in this region.

**Aeromagnetic field**

The National Geophysical Research Institute (NGRI) collected vast quantum of aeromagnetic data in parts of the metamorphic crystalline basement located towards west and north of CB and in Papagni, Kurnool, Srisailam and Palnad sub basins during 1980-82 field seasons. The survey was carried out along North-South flight lines, at a line spacing of 1000 mts and at a flight elevation of 150 mts a.g.l., with a tail boom mounted rubidium vapor magnetometer.

Short wave length magnetic anomalies (about 100nT) are superposed on a smoothly varying long wavelength magnetic field characterizes the CB. As the sediments are generally non magnetic, any anomalies found within the sedimentary region can be attributed to the presence of magnetic sources associated with Fe rich formations like Quartzites, sills, flows and dykes. Figure 2 is the aeromagnetic anomaly field (corrected for IGRF) observed on the Kurnool and Cuddapah group of rocks in the study area. As the flight lines are aligned in a north-south direction, any source along north-south orientation cannot be traced unless otherwise the sources are remanently magnetized.

**Qualitative inferences from the anomaly field**

The short wave length magnetic anomalies (in blue color, Fig. 2) located in the south western corner and towards east in the bottom are associated with the Gandikota Quartzites and Tadipatri formations of Chitravati group of sediments of Cuddapah rocks.
The long wavelength anomalies with lesser amplitudes in the NE and middle part of the map are associated with the Kurnool sediments comprising the shale/limestone sequence. As no igneous activity was reported during the Kurnool sedimentation the magnetic anomalies located within the Kurnool formations must be related either to Gandikota quartzites and/or to the sills and flows erupted during the times of Cuddapah sedimentation. As field observations indicated weak magnetizations for some of the sills and flows the anomalies observed at a flight height of 150 mts in the present study area must be related to Fe rich quartzites of Gandikota times.

Any estimation of depth for these sources of magnetic anomalies, give the thickness of Kurnool formations overlying the Cuddapah formation in the northern part of the sub basin. As the quartzite horizon seemed to be associated with potential ground water zones in typical areas in some parts of CB, we infer the depths computed from the magnetic anomalies to be the horizons of high yielding quartzite aquifer zones under Kurnools.

Quantitative analysis of aeromagnetic anomalies

Twenty three aeromagnetic anomalies distributed all over the area have been selected for modeling using the MAGMOD software of Paterson, Grant and Watson Ltd., Canada. This program requires the user to provide the observed field data and a suitable geological model like tabular1, or 2½D model, or step/ribbon or a 3D prism model for computing the size and shape parameters. The program initially requires starting values for size and shape parameters for computation of a theoretical anomaly over the assumed model which then is compared by a least square method of Marquardt (1963) with the observed profile. The Marquardt algorithm is then used to adjust the body parameters so that the subsequent iterations converge rapidly to produce a best fit to the observed field data. Vertically disposed 2½D model has been assumed for the sources and depths have been computed for all the anomalies and noted at the locations as indicated in the Figure 3.

The calculated depths range from 0-625 mts. The sources appear to be located mainly at three different levels. The first level with depth range 0-90 mts is shallower and coincides with the exposed Gandikota Quartzites in the south west corner. The second level of the sources appear to be in the depth range 150-200 confined to the middle and north west portion and the third level with depth range of 200-600 mts appear to be confined to east and south east part of the study area in the vicinity of Kundra Vagu between Uyyalawada and Suddapalle.
The dashed line is the inferred North – South trending lineament along which the Kundra Vagu flows.

Conclusions

a. A study of the depth ranges indicates that the sources are associated with Gandikota Quartzites/Tadipatri sills and flows of the Chitravati group of rocks in this area.

b. The shallow depths obtained are confined towards the south west corner of the area and coincide with the surface exposures of the Quartzite hillocks. The WNW trending zone having a depth range of 200 mts between Kanala- Akkampalle towards west of north-south trending Kundra Vagu indicates a 200 mts thick Narji limestones overlying the Gandikota Quartzites and can be inferred to contain ground water resources at deeper levels.

c. A gradual thickening (up to 600mns) of the limestone / shale of Kurnools are observed in the south east corner, near and around Suddepalle.

d. Figure 4 shows depth contour map/image compiled from the results of modeling of the aeromagnetic anomalies. This picture clearly brings out the fact that the Gandikota Quartzite horizon deepens towards south east and is overlain by the Kurnools whose thickness is around 600mns in Suddepalle area and thus coincides with the geological estimates (after GSI 1981 and Raju et al. 1979).

e. The north south trending linear band of contours in blue color located towards east of Uyyalawada- Akkampalle with a depth range of 300mts perhaps indicate a lineament along which the Kundra Vagu flows.

f. Raju and Murty 1987 have indicated and identified deep ground water horizons in most of the areas below 150mns depth in and around CB. Their studies lend support to the inference that potential ground water aquifers may present in the deeper levels in this study area.

References


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