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Regional magnetic surveys in Macherla-Agnigundala region

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ABSTRACT. Regional magnetic surveys conducted in an area of about 4000 sq. km between Macherla and Agnigundala, forming a part of the geophysical investigations in the North Cuddapah basin are reported. The magnetic anomaly near Macherla extending to comparatively great dimensions both in area as well as in magnitude has been interpreted as due to a huge deep seated spherical body. A possible relationship between this body and the rich mineralisation at Agnigundala is suggested.

1. Introduction

The Department of Geophysics of Andhra University has embarked on a long range project to carryout geophysical surveys in Godavari valley, Cuddapah basin and Gondwana basin of Andhra Pradesh. The project envisages a close network of gravity and magnetic stations at 3 to 5 km separation over these areas in the first instance. This is, naturally, to extend over a number of years. Its first phase, however, has been completed with magnetic and gravity surveys over the North Cuddapah basin, and parts of Godavari valley and Gondwana basin. The magnetic investigations carried out in a part of North Cuddapah basin form the subject matter of this paper.

The geological importance of the Cuddapah basin, as a remarkable tectonic and orogenic belt of of unfossiliferous Pre-Cambrian rocks of Peninsular India has been recognised for a long time. King (1872) was the pioneer, who made a detailed study of the geology, structure and tetonics of the basin in his classic Memoir *The Kadapah and Karnul formations in the Madras Presidency*. After this, there have been a few publications on the detailed geology of the basin especially on its structure and tectonics, among which Narayanaswami's (1966) deserves a special mention.

Cuddapah basin is very well known for its rich economic mineral potentialities. In addition to the known deposits of limestones, slates, barytes, asbestos, steatite, iron-ore etc. the base metal deposits of copper and lead near Agnigundala are now proving to be much more extensive than hitherto realised. The depth extension of many of these mineral deposits are controlled by the structure of the enclosing formations, which need to be studied in great detail.

2. Geology of the area

The area under study is roughly 400 sq. km in extent. The surface geology of the area is shown in Fig. 1. The formations exposed in the basin are Kundair limestones, Paniam quartzites and Jammalamadugu limestones of the younger Kurnool System, and Srisailum quartzites and Cumbum shales of the older Cuddapah system. The rest of the area is covered by crystallines of the Archaean age. Schists and gneisses of Dharwar age are found west of the basin, while unclassified quartzites in two patches occur within the basin. The Kurnools overlie unconformably the Cuddapahs, which in turn are deposited on the denuded and upturned edges on the gneisses or the Dharwars. The Purana era, during which the Cuddapahs and Kurnools were deposited, corresponds roughly with the Algonkian and part of the Cambrian, and followed the Archaean era.

In the area surrounding the basin, there are good number of evidences of igneous activity. Being both volcanic and hypabyssal, the instrusives are mostly in the form of sills and dykes. The network, formed by the mullitudinous dyke system in the surrounding Archaean country rocks, is one of the most remarkable displays of trappean injection known in any country (Foote 1872). Abrupt termination of these dykes at the sedimentary junction suggest that they are pre-Cuddapah and they may extend underneath the sediments.

3. Magnetic surveys

Though every attempt has been made to see that the magnetic stations are evenly distributed in the area, it was not completely possible as some parts are covered by dense thorny jungle and impenetrable hilly terrain. Survey of India one-inch-to-one-mile topographic maps were used for the location of the observations. A jeep vehicle was used mostly for transport while some of the stations had to be reached on foot only. The anomalies reported here are computed with respect to the primary base station at Vijaya-

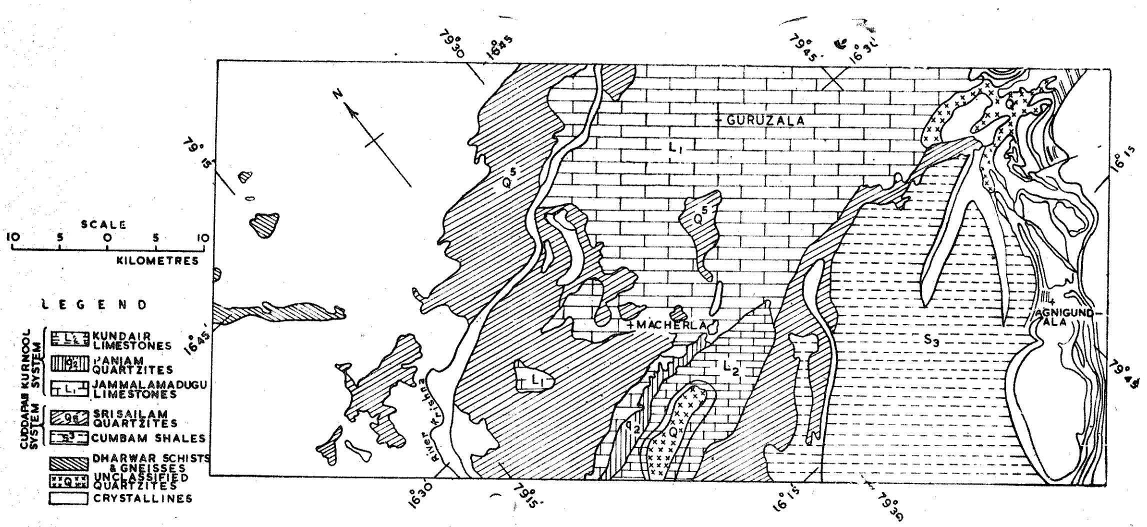

Fig. 1. Geology of the area

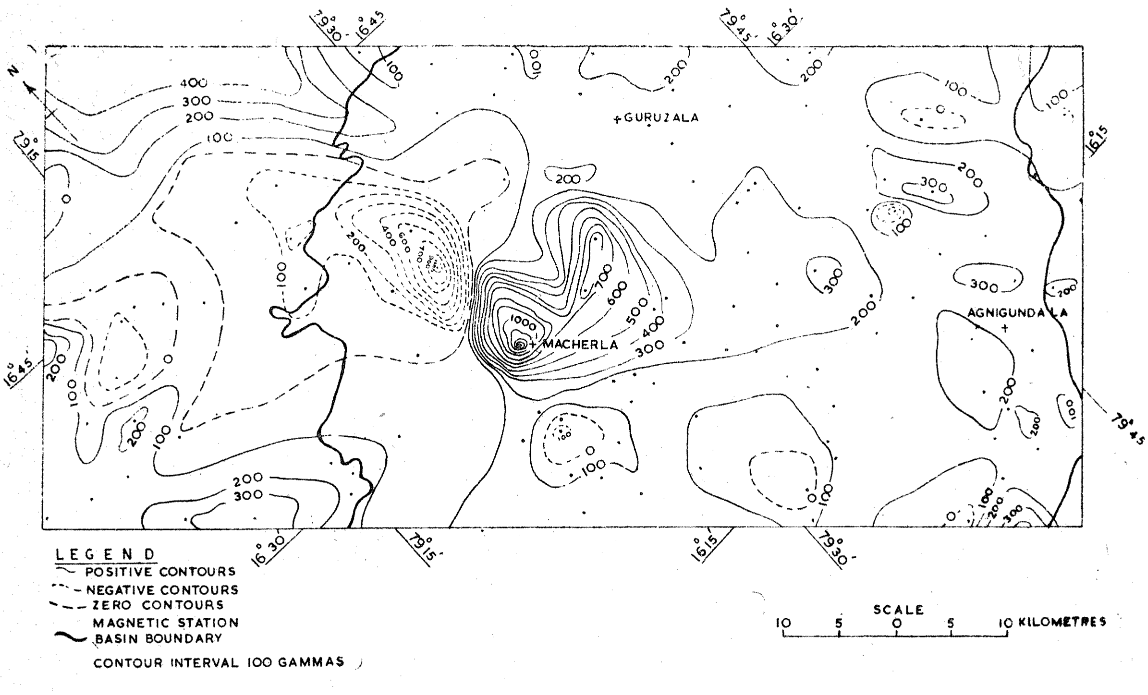

Fig. 2. Vertical magnetic anomalies in the area

wada ($H = 0.38$ œ, $I = 20°$) set up in the foreyard of the Public Works Department Inspection Bungalow. For practical workability and convenience, and for the computation of the correction for the diurnal magnetic variation, number of auxiliary bases were set up during the course of the survey, which were later duly tied with the primary base by the standard method (Nettleton 1940).

A torsion magnetometer of type CfZ of Askania Werke has been used for the observation. Diurnal correction was applied by the standard method, while for the normal correction, geomagnetic charts and tables published by Carnegie Institute of Washington (Vestine *et al.* 1959) have been used.

4. Magnetic anomalies

Fig. 2 shows the magnetic anomaly map of the area along with station locations. Broadly speaking, 200 gamma anomaly represents regional value in the basin with some regions having anomalies of lower and higher values. The one exception to the otherwise magnetically flat nature of the basin not only in the present area under discussion but also in the rest of the basin area (Narasimhaswamy 1970), is the high mag-

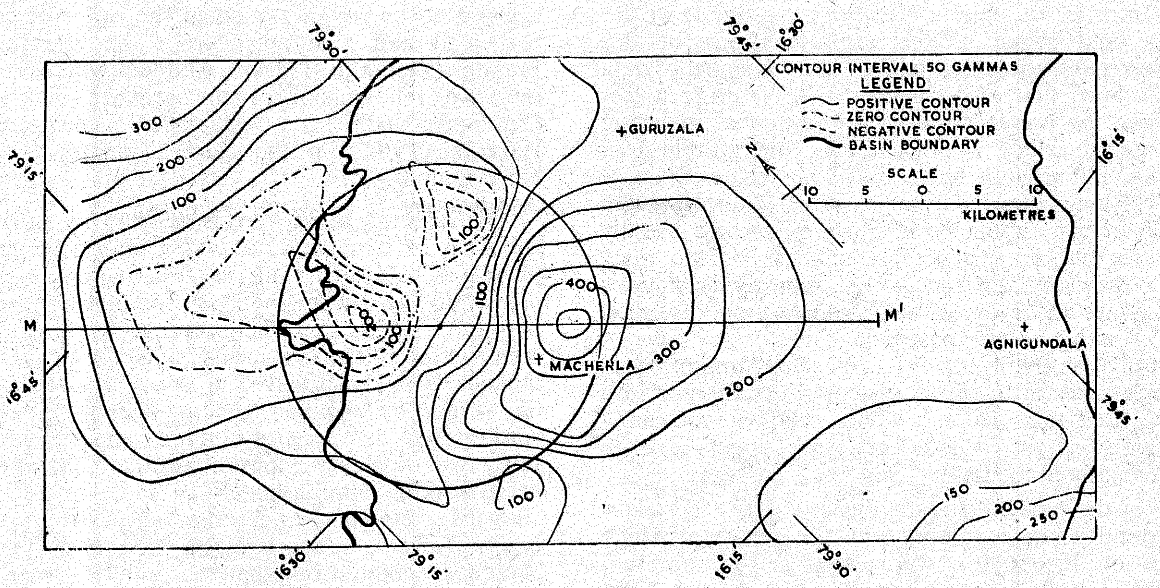

Fig. 3. Average anomalies in the area

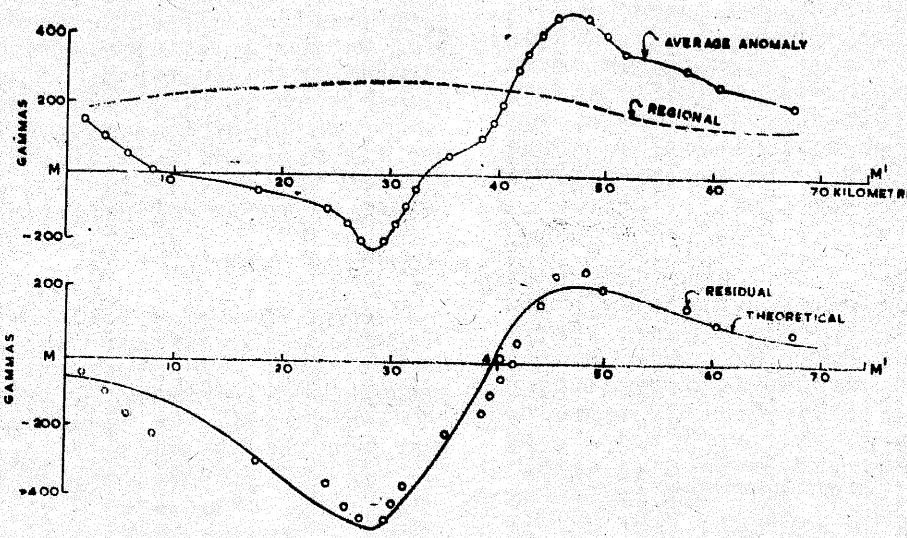

Fig. 4. Profile MM′

netic disturbance observed near Macherla. The intense positive and negative anomalies of the order + 1400 and —1200 gammas, around Macherla could not be considered to be due to any local cause owing to the consistency in their range and their distribution over a large area around Macherla. The distribution of the observations in the area is also fairly satisfactory, to rule out any possibility of a local cause. The Dharwar schist band of about 1 km width extending NNW-SSE in the gneissic and granite terrain NNW of Nagarjunasagar dam could also possibly extend SSE-SE underneath the Srisailam quartzites and Jammalamadugu limestones towards Macherla. The magnetic anomalies observed in the area of outcropping Dharwars do not suggest that the high magnetic disturbance at Macherla could be due to the underlying Dharwars. Also, the areal extent of the anomaly points out the deep seated cause possibly being related to the structure near or underlying the basement. This is of particular interest in view of the possible correlation of this magnetic anomaly with the process and place of origin of mineral deposits around Agnigundala southeast of Macherla. Narayanaswami (1966) has suggested possibility of a relationship of the Agnigundala mineralised belt with either the adjacent granite domes along the eastern margin of the basin or some deep seated igneous bodies beneath the domal upwarps and culminations of the strata. Apart from their high magnitude, these anomalies show a NW-SE trend, and the 200 gamma contour enclosing positive high, stretches towards Agnigundala, the place of outcrop of the ore deposits.

In order to make a quantitative estimate of the size and shape of the causative body of this high magnetic disturbance, the magnetic data has been first of all subjected to filtering to remove the noise. Local concentration of magnetic material, which would cause no measurable anomaly if buried a few tens of metres, may cause local magnetic disturbance, which interferes with the interpretation work. Such effects are usually noticeable as a general roughness of the map, for they give differences, between nearly stations that are too large or to irregular to be ascribed reasonably to the basement surface. As suggested by Nettleton (1940), the best treatment in such cases is to use a system of averaging, with the idea that average values will be reasonably typical of the desired magnetic effects due to deep seated bodies.

In the present investigations, average of values around a circle of unit grid, the centre of which lies on the station was taken as the representative anomaly of that particular station. The contour map of the average anomalies thus obtained was then used for further quantitative interpretation. Fig. 3 shows the part of the average anomaly map pertaining to the area under report now. Major and broad features remaining, all the minor closures observed in the basin area have been filtered out in the average anomaly map. Though the magnitude of the anomaly is reduced, the Macherla anomaly shows up more prominently in its areal extent.

5. Discussion

The disposition of the contours both in the observed anomaly map as well as in the average anomaly map clearly indicates a huge structure and as mentioned earlier, the extent of the anomalies shows its deepseated and three dimensional character. So, for simplicity, a sphere of radius 14.5 km with its centre buried at depth of 20 km was postulated and theoretical anomaly computed over it was fitted with the average anomalies along the profile MM′ (Fig. 4). For obtaining a suitable matching of the anomalies, it was found necessary, to assume rather a high value of intensity of magnetisation, of .0026 cgs, units, the intensity being a resultant of the induced and remnant intensities.

6. Agnigundala mineralisation

The mineralisation here, is chiefly of copper, lead and subordinate zinc. The formation of ore shoots has been much influenced by structural, lithologic and stratigraphic controls.

The close association of the mineralised belt along the margins of the plutons has led to the view that the mineralisation is related to the occurrence of granite close to the belt. The presence of subsurface granite has come to light when trial pits for the Nagarjunasagar canal were dug at Mugachintalapalem (not shown in the map). Besides, the mineralisation itself following the margin of the granite plutons, there appears to be rough zoning in the order of copper, lead and zinc away from the margin of granite (Ziauddin 1964). And elsewhere, the intrusive relationship of the granites with the Cumbums had been established (Setty and Rajurkar 1964) in the eastern margin of the Cuddapah basin.

The mineralisation here is marked by profuse injection of a network of veins filling the fractures and also such wall rock alternations at silicification and shear fractures, sericitisation, carbonitisation and tourmalinisation. It is to be seen whether the suggested huge deep seated igneous body proposed near Macherla could be the origin of all this igneous activity possibly resulting in the mineralisation. The numerous intrusives outside the basin, north of Macherla area, striking approximately in radial directions showing their centre near the suggested igneous body, also give support to this idea. However, it should be pointed out that the granite domes on the eastern margin of the Cuddapah basin do not find any expression in the magnetic anomaly map. Thus the structure causing this high magnetic disturbance should be viewed as under lying the granites and might indirectly be responsible for the mineralisation observed at the eastern margin of the Cuddapah basin. More detailed work with close network of stations in the area between Macherla and Agnigundala is necessary in order to establish such relationship between the igneous body and the mineralisation.

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