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A note on the qualitative appraisal of aeromagnetic image of Chhattisgarh basin

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ABSTRACT
Qualitative appraisal of aeromagnetic image of Chhattisgarh region has been carried out to study the geology of the region. The study area comprises of Chhattisgarh basin, one of the seven-purana basins of Peninsular India. The aeromagnetic anomaly map of the area has been used as input for interpretation to extract the geologic information from the mapped and imaged anomalies in a systematic way that makes a positive contribution to the geology of the area. On the basis of aeromagnetic anomalies, Chhattisgarh basin can be divided into the northern low anomaly zone and the southern high anomaly zone. The northern portion of the main Chhattisgarh basin has been further divided into two sub-basins namely Hirri sub-basin (HRSB) in the west and Baradwar sub-basin (BRSB) in the east by NW-SE trending Sonakhan greenstone belt with maximum negative amplitude. The positive magnetic anomaly zone east of 81.5^0 E and bounded by 19.5^0 and 21.0^0 N latitude is due to Dongargarh granites and their equivalents. The greenstone belt, Dongargarh granite, granulites/gneisses occurrences in the region and intrusive bodies are clearly demarcated in the inferred geological map.

INTRODUCTION

The study area comprises of Chhattisgarh basin one of the seven purana basins of Peninsular India, the other purana basins being Cuddapah, Kaladgi, Bhima, Indravati, Pakhal and Vindhyan basins. Among these basins, the Cuddapah, Vindhyan and Bhima have been studied extensively while the others have attracted little attention from the geophysical point of view. The Chhattisgarh basin has still remained uninvestigated as a single unit even on a regional scale. Therefore, with a view to study the magnetic picture of Chhattisgarh basin as a single unit, aeromagnetic study of the basin area is taken. The aeromagnetic anomaly map of the area is used as input for the interpretation to delineate the geological information. Aeromagnetic data were collected over the area bounded by 17^0 to 24^0 N, 78^0 to 88^0 E in the period 1983-1992 at a terrain clearance of 1.52/ 2.13 km, with north-south oriented flight lines with 4 km flight line spacing [Geological Survey of India (GSI), 1995]. Data were also collected in the period 1978-79 over parts of the Narmada Sone region at a flight altitude of 1.06 km and with line spacing of 2 km. Mita Rajaram & Anand (2003) have analyzed the aeromagnetic map to demarcate the various tectonic blocks of the region and have published an image/map of the aeromagnetic anomalies. In the present work, the aeromagnetic anomaly map at the terrain clearance of 1.50 km of the area lying in the region between latitudes 19^0-22^0 N and longitudes 80^0-84^0 E has been re-digitized using SURFER package and is analyzed using GEOSOFT package (Geosoft 1999) for further interpretation. In interpretation an attempt is made to analyze the aeromagnetic data over Chhattisgarh basin area with the aim of delineating the geological features of the area.

GEOLOGY AND TECTONICS

The study area (Fig.1) is bordered by 20^0 and 22^0 N latitudes and 81^0 and 83^0E longitudes and occupies an area of approximately 33,000 square km (Murti 1987). The intracratonic Chhattisgarh basin is a crescent shaped basin within the Central Indian Craton (CIC) formed due to thermal subsidence during Precambrian times, and comprises of a variety of rock types (King 1885; Krishna 1968). The sedimentary infill of the basin is predominantly dominated by limestone, sandstone and shale formations of Middle to Upper Proterozoic (1600 – 900 Ma). The main basin is divided presumably by NNW-SSE trending Sonakhan greenstone belt into two sub-basins, the Hirri sub-basin (HRSB) in the west and Baradwar sub-basin (BRSB) in the east (Das et al., 1992). The most litho units of Chhattisgarh supergroup are best developed in the Hirri sub-basin. The oldest litho unit i.e. Singhora group is best developed in small proto basin

lying just south of Baradwar sub-basin. The Chhattisgarh basin in the Central Indian Craton is filled with stable sediments equivalent in age with Vindhyans (Ball 1877; King 1885). The Chhattisgarh basin is bordered by the Mahanadi Graben in the northeast, Godavari Graben in the southwest, Satpura Belt in the northeast and the Eastern Ghat Mobile Belt (EGMB) in the east and southeast. The basement in the Chhattisgarh basin is composed of the Archaean granites and gneisses with associated metavolcanic- metasedimentary belts (King 1885; Krishna 1968). The basin is affected in east, north and western margins by tectonic disturbances, whereas the southern and southeastern margins of basin do not show any signs of disturbance (Murti 1987). The oldest recorded age for the Chandarpur sediments is 1250-1300 m. y. that falls in the Meso-Proterozoic era (Middle Proterozoic). The Sakoli belt lies towards west of the Chhattisgarh basin.

GEOLOGICAL MAPPING FROM AEROMAGNETIC ANOMALY MAP

The aeromagnetic map bounded by 19^0 - 22^0 N in latitudes and 80^0- 84^0 in longitudes is characterized by moderate amplitude magnetic anomalies (Fig.2). The aeromagnetic anomalies range from -157 to +128 nT with clear disposition of different zones with distinct anomaly ranges. In the northern part of the Chhattisgarh basin moderate negative amplitude anomalies ranging from -50 to -157 nT are observed which is sub-divided by a northwest-southeast (NW-SE) trending negative anomaly zone. The southern part of the basin is characterized by positive anomaly zone

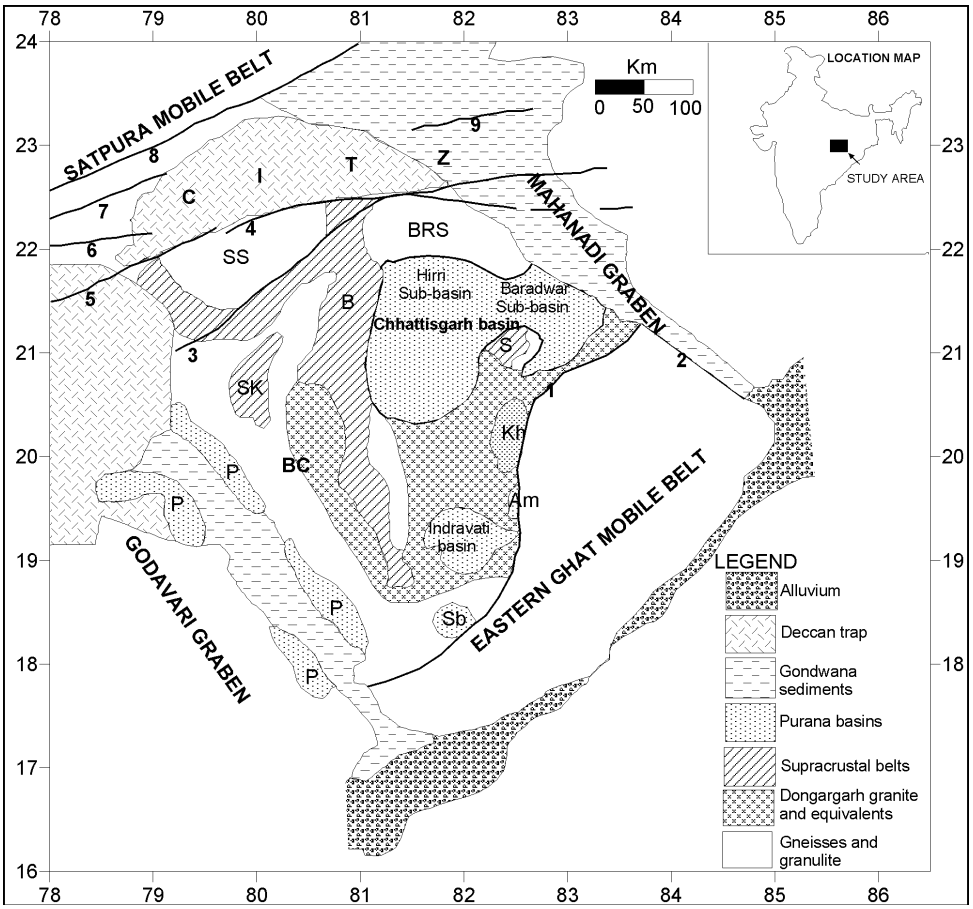

Figure 1. Chhattisgarh basin area and surrounding tectonic features (after Das et al., 1992). B–Bailadila- Rowghat-Dalli-Rajhara- Dongargarh- Khairagarh-Abujmarh belt, BC- Bastar Craton, BRS – Bilaspur- Raigarh – Surguja belt, S-Sonakhan belt, CITZ- Central Indian Tectonic Zone, SS – Sausar belts, P- Pakhal basin, SK- Sakoli belt, Sb- Sabari basin, Am – Ampani basin, Kh- Khariar basin, S- Sonakhan belt; 1-Sileru shear, 2- Sukinda thrust, 3- Central Indian shear, 4 - Tan shear, 5 – Gavilgarh fault, 6 – Tapti fault, 7- South Narmada fault, 8- North Narmada fault, 9- Bamni-Chilpa fault.

ranging from +10 to +128 nT with isolated negative anomalies. A prominent positive anomaly zone ranging from +100 to +128 nT lies in the south of the Chhattisgarh basin. A weak to moderate magnetic anomaly zone ranging from -30 to +60 nT in the south-eastern part of the magnetic anomaly map is due to less magnetic granulites-gneisses associated with EGMB.

From the aeromagnetic anomaly map, a geological sketch map over the study area is complied, which provides a new insight on the basement geology (Fig.3). The geological map inferred from the aeromagnetic image is presented in Fig.3. The basin is covered with the Chhattisgarh sediments with intrusions of granite and greenstone. The striking feature with NW-SE trending maximum negative magnetic anomaly zone in the northern part of basin is associated with Sonakhan greenstone belt buried under the sediments. The northern part of the Chhattisgarh basin is divided into two parts by Sonakhan greenstone belt into two sub-basins: Hirri sub-basin in the west and Baradwar sub-basin in the east. In the inferred geological map, the buried Sonakhan greenstone terrain under the sediments has been magnetically demarcated (Ram 2004). The southern part of the Chhattisgarh basin, south of 21.5^0 N latitude features granite-gneisses forming basement, which lies beneath the sedimentary fills and is represented by positive magnetic anomaly zone with isolated negative anomalies. The predominantly positive magnetic anomaly zone east of 81.5^0 E and bounded by 19.5^0 and 21.0^0 N latitude is interpreted as revealing the extent of Dongargarh granites and their equivalents. The disposition and edge shaped boundaries indicate intrusive nature into the granite-greenstone terrains. The continuous patches between 81.0^0 to 81.5^0 E traversing in almost N-S direction with intermittent breaks and discontinuities is greenstone associated with Sakoli belt forming the western boundary of Chhattisgarh basin. The moderate to weak magnetic anomaly zone (+20 to -70 nT) in the northeast of the basin area and lying between 83^0 to 84^0 E and north of 21.5^0 N is due to the magnetically weak sediments associated with the Mahanadi graben. The weak and moderate anomaly zone (-30 to +60 nT) at the distant south-east of the area and east of sileru shear zone represents the less magnetic granulites-gneisses (Subrahmanyam & Verma 1981) terrain associated with Eastern Ghat Mobile Belt.

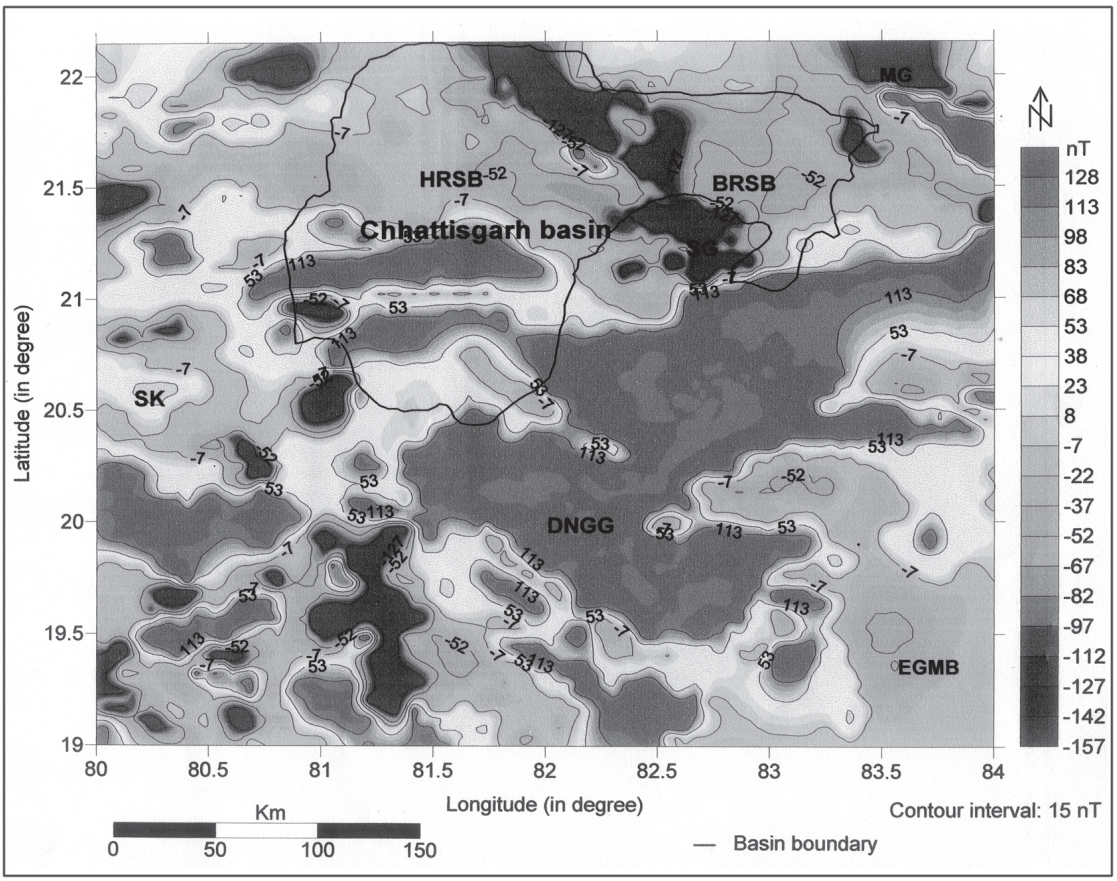

Figure 2. Aeromagnetic anomaly map of the area.

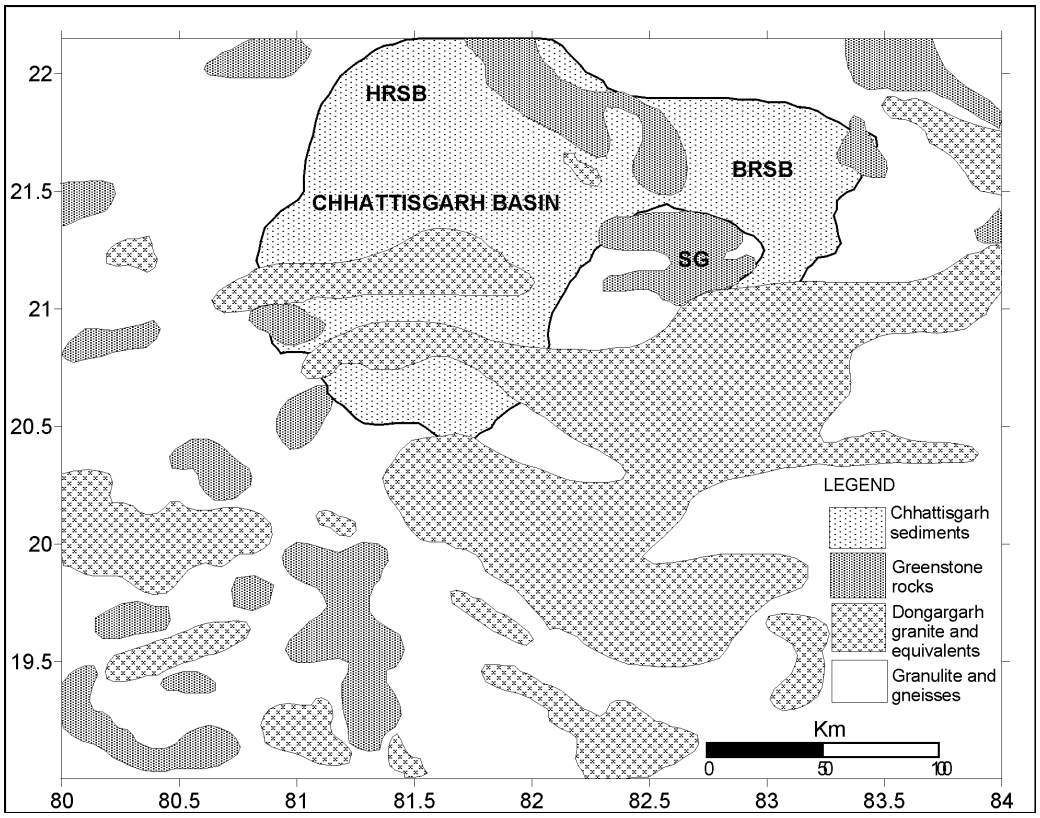

Figure 3. Inferred geological map prepared from the aeromagnetic anomaly map of the area.

CONCLUSIONS

The aeromagnetic map provides valuable information on geological mapping of the region. By magnetic zoning based on anomaly pattern and their distribution, the inferred geological map of the study area has been presented.

On the basis of the aeromagnetic anomalies, the Chhattisgarh basin has been divided into northern low magnetic anomaly zone and southern high magnetic anomaly zone. The northern portion of the main Chhattisgarh basin has been further divided into two sub-basins namely Hirri sub-basin in west and Baradwar sub-basin in east by NW-SE trending Sonakhan greenstone belt with maximum negative amplitude. The positive magnetic anomaly zone in the south of the area reveals the extent of Dongargarh granites and their equivalents. The greenstone belt, Dongargarh granite, granulites and gneisses occurrences in the region and intrusive bodies are clearly marked in the inferred geological map. The study depicts utility of aeromagnetic anomaly map for delineating geological information of the area.

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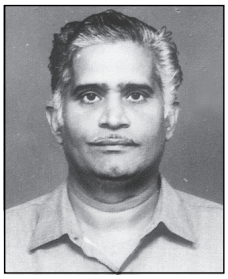

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