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Radiometric Study in the Putlur and Yellanur Mandals of Ananthapur District, Andhra Pradesh

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Abstract: ***Structural analysis using ground radiometric investigations over parts of western part of Cuddapah basin in Putlur and Yellanur mandals of Ananthapur District, A.P., was carried out to highlight the structures and influence the effects of such features, the tectonics events in the study area. Analytical techniques like low pass filter and Vertical Derivative and tilt derivative techniques brought out radiometric highs and lows and lineaments. The radiometric lineaments aligned in 3 major directions mainly, NW-SE, NE-SW and N-S, and E-W trends are very few. Derived lineaments from these maps generated structural wealth of the map. This area is structurally disturbed and where there is shales area present the radiometric response low and where sill bodies expected area the radiometric response high comparatively with shales.***

Keywords: Qualitative analysis, radiometric response, buried sill bodies, Tadipatri shales, lineaments, Analytical techniques

1. Introduction

The Cuddapah basin hosts a wide spectrum of mineral resources like the world famous Mangampeta Barytes deposits, the Asbestos, the Cuddapah slates, Uranium, diamondiferous Kimberlites etc. Further, Cuddapah basin has considerable sediments thickness abundant stromatolitic assemblages favorable for hydrocarbon generation and accumulation. The rocks are least metamorphosed in the western part of the basin the conditions favorable for hydrocarbon generation.

In 2007 the study area Putlur and Yellanur mandals of Ananthapur District A.P, are in news that the gas was gushing out along with the ground water from irrigation wells. ONGC report showed that 89% of methane (CH_4) is present in the gases emanating from these wells. It is inferred from the report by [1] the natural leakage of gas in the Tadipatri area is dominantly fracture / fault controlled. The sills are presumably acting as cap rocks for the gas rising from deeper levels.

Radiometric investigations are being successfully employed in recent years, in addition to the usual prospecting for radioactive minerals, to solve some of the geological problems, such as tracing of tectonic zones, mapping of different geological formations and locating mineralized zones.

The present paper deals with the Radiometric investigations across south western margin of Cuddapah basin and qualitative analysis of the radiometric data which form a part of integrated studies in Tadipatri region of Cuddapah basin, and to locate geological structures such as faults, sill bodies and boundaries of lithological formation and tectonic boundaries.

2. Geological Setting

The Cuddapah basin is situated in the south-central part of Andhra Pradesh constituting 12Km thick sediments with minor volcanic and is formed by the deposition of several discrete sub-basins [2]. Two litho-stratigraphic groups, each with distinctive rock assemblages and ages constitute the basin. The lower and older Cuddapah Super group occupying the entire basin is overlain by the younger Kurnool group in the western part. The geological map of the study is shown in Figure 1 is composed mainly of arenaceous and argillaceous sediments with minor carbonates and the latter consists of carbonate sediments minor clastics Cuddapah super group is further divided in to Nallamalai, Chitravathi and Papaghni groups. Several subareal basaltic lavas and sills occur forming an arcuate pattern mostly in the Papaghni sub-basin in the western part of the basin.

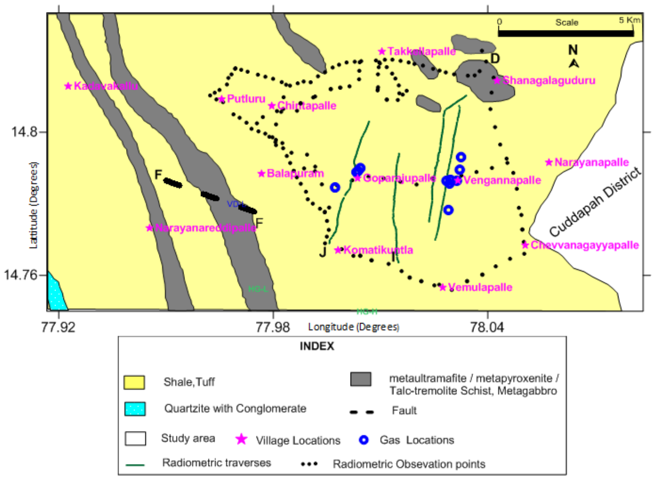

Figure 1: Geological and Magnetic layout map of the study area, Ananthapur District, AP.

Western part of the Cuddapah basin is known to be tectonically less disturbed while the eastern part is more disturbed and structurally more complex. The main structural element identified is the north plunging asymmetric synclinorium made up of gently dipping, practically as the eastern limb is intensely folded, overturned and thrusted [3]. The Cuddapahs are composed of much indurated and compacted shales, slates, quartzite's and lime stones. During the period of formation of the lower half of the system contemporaneous volcanic activity prevailed on a large scale as may be seen from a series of bedded traps of tuff beds in the south western part of the basin [4].

Several structural elements of the Cuddapah basin such as faults has innumerable dykes and dyke swarms which are presumed to be related to the igneous activity with in the basin in the form of basic sills and flows. [5,6]. Understanding of the structural configuration of the lower Cuddapah basin (Papaghni and Chitravati groups of sediments) in the western part holds the key to unravel the sequence of events that led to the formation of the basin and its subsequent development.

3. Acquisition of Radiometric Data and Analysis

The study area covered about 10sqkm. and lies between latitude 14°45' -14°50' and longitude 77°55'-78°05'E and covering the villages Komatikuntla, Chintapalle, Shanagalaguduru, Balapuram, Vengannapalle, Goparajupalle and Yellanur and in Putlur with mandals of Ananthapur district of Andhra Pradesh. 704 Radiometric observations were taken using the Instrument "Scintillometer", along all available approach roads and tracks in the region with a station interval of 200 m and along four traverses for detailed study, each traverse length is 4km, station interval is 25mtrs. The layout map of radiometric observations is shown in Figure 1. This area falls under Survey of India (SOI) Toposheet No. D44G1 and D43L13 (scale of 1:50,000).

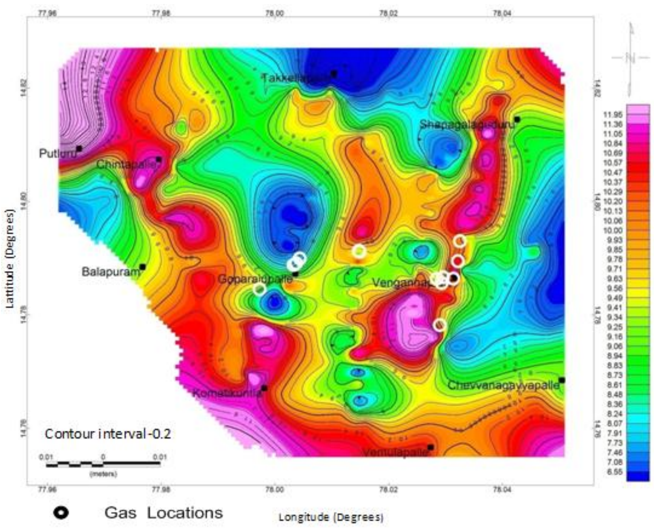

Figure 2: Radiometric contour map of the study area

The radiometric intensity image / contour map (Figure 2) of the study area with an interval of 2µR/hr. The total radiometric response varies in the study area is 5 to 13 µR/hr and the highest response observed at eastern and western part of the study area with amplitude of 9-13 µR/hr, hidden sill bodies. Low radioactivity recorded over Tadipatri shales ranging from 5-8.4 µR/hr. Intermediate anomalies in the range of 8.4-10µR/hr are observed over outcrops of the sill bodies occupied by metagabbro, metaultramafite, metapyroxenite, Talc, and tremolite schist. In Figure 2 the distinct pattern of highs and lows and the steep gradients belts then at places that describe prominent radiometric linear are attributable to the complex assemblage of features of varied dimensions and direction resulting from different phases of radiometric activity, some of the features are associated with basic intrusive dykes that indicated zones of radiometric activity.

A low pass filter anomaly map, Vertical derivative, Tilt derivative maps and contours are generated using a using Geosoft software [7]. With a view to eliminating the high - frequency noise, a low - pass was applied to data. Figure 3 shows the color shaded contour map of the low pass flittered output of the radiometric map in the study area.

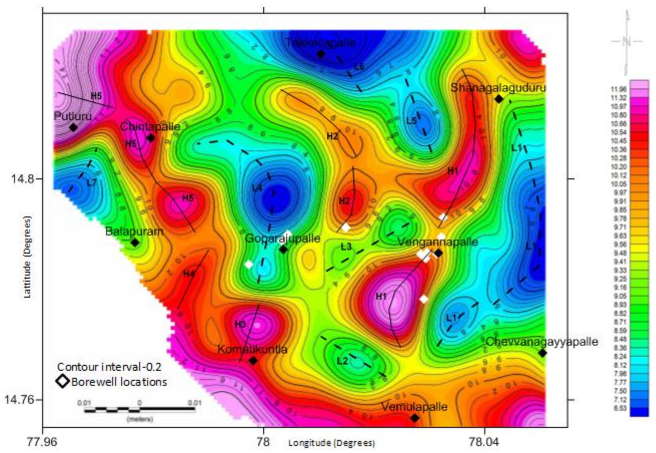

Figure 3: Low pass filter Radiometric Anomaly map of the study area

In the low pass contour map presented in the figure 3 reflecting five radiometric (H1 to H5) highs and seven (L1 to L7) lows are delineated. While comparison of the radiometric signatures with geology of the study area not many inferences are made because the study region lies in the western part of the Cuddapah basin show subtle radiometric response. The radiometric highs (red color) and lows (blue colour) are indicative of different trends. Radiometric high trend of H1- trending NE-SW, North and South of the Vengannapalle, H2 - trending NW-SE, in the central part of the study area, H3 - N-S, North part of the Komatikuntla, H4 - NE-SW, Northwestern side to Komatikuntla and H5 - NW-SE, Western extending part of study area extending upto Chintapalle. All radiometric lineaments are observed over Sill bodies.

Seven radiometric lows (L1 to L7), L1- lies in the eastern side of the study region trending NE-SW, direction and suddenly shifting towards N-S, extended up to east side of the Shanagalaguduru. L2 - runs NW-SE direction, East side of the Komatikuntla, L3 - NE-SW, extending in the direction, situated in the west side of the Vengannapalle, L4 trend is running in the direction of NE-SW, western part of the Goparajupalle and furthermore, L5 - NW-SE, lineament is situated at west side of the Shanagalaguduru, L6 - trending in the NW-SE direction up to Takkellapalle and L7 passing in the NE-SW direction lies at South part of the Putlur. These prominent radiometric lows are characterized less amount of radioactivity. The broad low of 5 to 8.4 µR/hr corresponds to the Tadipatri shales. Western and eastern margins are reflected by sharp peaks. High radioactivities values are characterized over a Hidden sill bodies. The radioactivity of low pass filter anomaly trends of lows and highs reflect occurrence of sills are later tectonic activity and so are important in the study area. In the present investigations lowpass lineaments are delineated are representing only shallow features and step gradients reflecting the faults / contact zones.

A vertical derivative map [8] enhances the response from shallow sources, suppressing deeper ones by enhancing high wave number components of the spectrum. Thus, closely spaced sources can be better differentiated on derivative thus helping in the identification of more geological features.

Vertical derivatives, on the other hand, are based on the concept that the rate of change of radiometric field is much more sensitive. Therefore, such maps constitute a useful technique for demarcation of geological boundaries, details of which are obscured in the original map. Figure 4 is a plot of the vertical derivative of the Radiometric of the study region. This map is dominated by essentially NW-SE and NE-SW striking lineaments are similar to low pass filter lineaments derived.

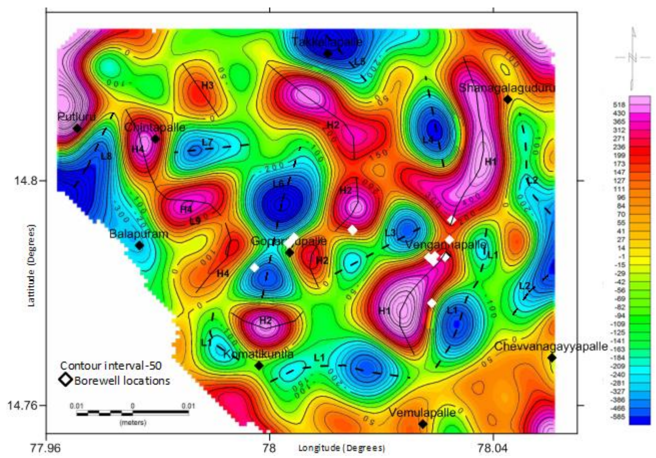

Figure 4: Vertical derivative of the Radiometric Anomaly map of the study area

In general, the tilt derivative enhances the high frequencies relative to low frequencies and eliminates the long wavelength regional component and effectively resolves the adjacent anomalies. [9] introduced the tilt angle method for one-dimensional magnetic data and [10] extended it to two - dimensional gridded data. [11] proved that tilt angle technique is applicable to map the linear geological features from magnetic gradient data. Subtle anomalies attenuated in dynamic range due to the presence of high amplitude radiometric anomalies. Continuity of individual bodies features lateral changes in radioactivity and / or depth of burial and edges of structures by adequately accounting for the nature of the rock radioactivity.

The tilt angle [12] is the ratio of the vertical derivative to the absolute amplitude of the total horizontal derivative. Also, it produces positive and zero values over as well as the edge or fault of the source region respectively whereas negative values outside the source region.

Tilt derivative (Figure 5) maps are study area enhanced the structural trends, lineaments and many faults which can be attributed to major lineaments, faults and structural fabric of the study region. The significant feature is the similar to the first vertical derivative map, high and low zones correspond to the sill bodies and shales respectively.

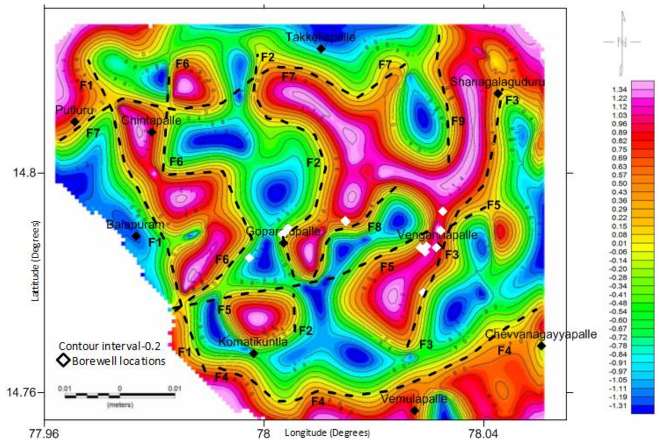

Figure 5: Tilt derivative of the Radiometric Anomaly map of the study area.

A total nine (F1-F9) faults are mapped in Figure 5. The fault / lineament F1- NW-SE, is observed in the western part of the study area which is the contact zone between shales and Sill bodies, F2 - fault lies in the central part of the study region trending N-S direction (south of Goparajupalle to Takkallapalle). This faults appear to be controlling gas leakage were traced at Goparajupalle village. F3 - NE-SW, extends from south of Vengannapalle to Shanagagudur, F4 - running in the E-W direction lies in the southern extreme of the study area. F5, runs from north of Komatikuntla to Vengannapalle and further more is separated by faults F1, F2 and f3 and place a major role where cross over points intersection of the faults indicative of gas leakage. F6, is small extend and bounded by the western part trending in the NE-SW to NW-SE, F7 fault trending W-E direction nearer Putlur and pass through south of Takallepalle to shanagalagudur, F8 - lies east of Goparajupalle in the direction of NE-SW and F9 - lies west of Shanagalaguduru in the N-S direction.

For comparative analysis, structural features inferred from the radiometric anomaly analytical techniques (lowpass filter, vertical, and tilt derivative) shown in Figure 6. Some of these lineaments correlate or coincident with the mapped structures such as faults shear zones and dykes.

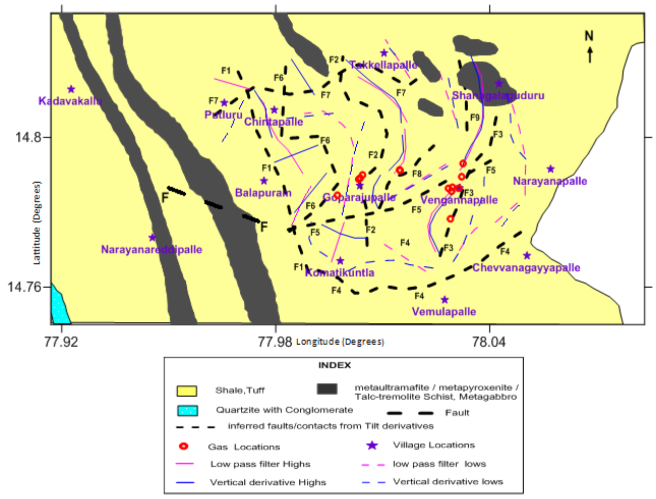

Figure 6: Structural map of the study region, as inferred from Radiometric data analysis

4. Summary and Conclusions

Analysis of radiometric data, lowpass filter, vertical gradient and tilt derivatives of the study region brought structural fabric of the region. The radiometric response in the study area could be correlated with the geological situations, 1) presence of contacts between various rock formations, 2) occurrence of fault 3) presence of a gas leakage zone. Two different rock formations Tadipatri shales and basic sill bodies exhibit different characteristic features in gamma intensity, which may enable geological mapping of these formations. The sediments consisting mostly of Tadipatri shales which are comparatively less radioactive are characterized by an intensity of 5-8.4 µR/hr. The exposed sill bodies show an intensity of about 7-10 µR/hr and hidden sill bodies which are derived from the tilt derivative radiometric image intensity of about 9.8-13 µR/hr. The sill bodies where they are exposed in the northern part of the area, radiometric response is low because of rock exposures, due to sparse dissemination of radioactive mineral concentrations.

The observed structural lineaments corresponds to major fracture zones cutting across the sills and also show that occurrence of the gas shows is closely dependent on location of bore wells with respect to the major fracture zones. The bore wells located in such zones and reaching the depth levels corresponding to fracture zone that also pass through the sills, may be considered to be facilitating the outflow of the gas along with the water, thus showing consistency with the proposed model which envisages an important role of the sills in preserving the gas. The observation that locations of the gas shows fall on the intersection of faults in the study region**.**

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