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Review Paper

Identification of disturbed zones from the magnetic data analysis Tadipatri Region, Cuddapah Basin, India

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Abstract

In 2007, there was gushing of methane gas from a few existing irrigational borewells located in Tadipatri region, Southwestern part of Cuddapah Basin, India. To procure the causes for gas leakage magnetic measurements were carried out along four Traverses (T1, T2, T3 and T4) in the study area covered about 16 sq.km. These traverses are about 4 km long with station interval of 25m and are oriented in NNE-SSW direction. All these borewells are located in and around the prominent villages Vengannapalle, Goparajupalle and Komatikuntla of the Tadipatri region. Coefficient of Variation is an important parameter to identify tectonically disturbed zones (faults/fractures), applied to the magnetic data (T1-T4). Using these computed values the contour map is prepared which inferred few anomalous zones marked as "A,B,C,D,E and F" and all the borewells emanating gas fall on these disturbed zones. Magnetic anomalies (profiles) are compared with computed coefficient of variation along four Traverses T1-T4 to delineate tectonically disturbed zones. These zones are the faults and fractures associated with gas occurrences. In general, the magnetic anomaly and its coefficient of variation is well corroborated. It may be noted that the traverses T1 and T4 are highly disturbed zones and maximum bore wells over or near these traverses emanated gas.

Keywords: Tadipatri shales, coefficient of variation, disturbed zones, Faults, Fractures, irrigational borewells.

Introduction

In April/May 2007, the print and electronic media reported and screened the gushing of natural gas from few agricultural bore wells situated in the Tadipatri region, Cuddapah Basin. All the bore wells (agricultural and domestic) in the area were investigated by Oil and Natural Gas Corporation (ONGC) of India and reported that 89% of methane (CH_4) is present in these borewells[1,2]. Before 2007, these bore wells were used for agricultural and domestic purpose for about 15-20 years and the gas leakage started abruptly in the bore wells. Vengannapalle, Goparajupalle and Komatikuntla are the prominent villages in the study area (Tadipatri region), Anantapur District, Andhra Pradesh where the irrigation borewells were emanating gas. Present work consists of the analysis of the results from the detailed Magnetic surveys carried out in a study area, in the vicinity of gas gushing bore wells. The aim is to study and identify the disturbed zones and to determine the causes for the leakage of gas from the borewells.

Geology of the Study Area

The Proterozoic Cuddapah basin occupies an significant place in geology of India and tectonics. With the origin of the basin dating back to ~2.0 Ga, the crescent shaped basin covers about 44,000 sq.km an area and it length and width about 450 km and 140 km[4-6].

The igneous activity in Cuddapah basin is confined to the area near the western margin where the Cuddapahs are exposed. Several mafic volcanic rocks like sills and dykes are intruded into Tadipatri shales and. These sills are parallel to each other and individual thickness varies from a few feet to a few hundred feet[7].

The present study area is covered with Tadipatri shales of Chitravathi group. The Chitravati group, in turn, consists of Pulivendla quartzites (1-75m) at the base, Tadipatri shales (4600 m) in the middle and Gandikota quartzites (300m) at top. The Tadipatri formation primarily consists of shale, ignimbrite tuff, cherty and jasper. These shales are dominantly arenaceous and argillaceous with subordinate limestones[8].

The study area (Tadipatri region) lies between latitudes 14°45' - 14°50'N and longitudes 77°55' - 78°05'E as shown in Figure-1. The NW trending elongated sills on the left side are present as elevated hills and as small outcrops on the north. These are metaultramafite / metapyroxenite / talc-tremolite schist and metagabbro[9].

The stream patterns show two prominent directions - a set flowing SW-NE and the other W-E. The flow of the streams is shown by arrows. It may be assumed that this area has two sets of lineaments running parallel to the streams. Most of the bore

wells yielding water and gas are along the streams flowing in the NE direction.

Magnetic data acquisition

The magnetic measurements were carried out using a Proton Precession Magnetometer along four traverses T1, T2, T3 and T4 with a close station interval of 25m. These traverses are about 4 km long and are spaced about 1 km apart. The study area span across agricultural fields and is mostly inaccessible so these are not uniform. These traverses are planned to cover all the irrigation borewells (borewells producing only water and emanating gas with water) in this area. A total of 629 measurements were taken and these traverses are oriented in NNE-SSW direction subjected all corrections. It may be noted that the bore wells over or near these traverses, especially T1 and T4, emanated gas. The layout map of these traverses is shown in Figure-1.

Magnetic Data Analysis

Coefficient of Variation Contour Map: Coefficient of variation, a statistical measure of departure from the background anomaly values, shows zones of interest from geological and tectonic disturbance point of view[11,12]. It is computed for the IGRF corrected magnetic values using 3- point window for each traverse.

Coefficient of variation C.V. = $\left(\frac{\sigma}{\overline{X}}\right)$ X (100%)

Where: σ - Standard deviation and $\overline{X}$ - Mean value of the magnetic field.

This parameter has been computed over the traverses with closer station intervals and resulting contour image using these computed values the contour map is prepared and is shown in Figure-2. In this colour image the lows (A, C and F) and the highs (B, D, E and F) are identified and they represent tectonically disturbed zones. The borewells with 'gas shows' mapped are seen to be located in these disturbed zones.

Comparison of Magnetic Anomaly and its Coefficient of Variation: In this section Magnetic anomalies are compared with computed coefficient of variation along four Traverses T1-T4 shown in Figure-3 to 6 in order to delineate tectonically disturbed zones. These zones are the faults and fractures associated with gas occurrences.

Traverse-T1: Vemulapalle to Shanagalaguduru through Vengannapalle: The 4080m long Traverse-T1(3(b)) shows a combination of high and low magnetic anomalies in the central part. There is a high anomaly with an amplitude of 485nT at 1680m and a low with -187nT amplitude at 2070m. Apart from this pair of high and low, minor fluctuations are also present in this profile. This profile is further magnified (Figure-3(c)) to make the minor anomaly look more clearly. The presence of near surface lithological units with higher magnetic susceptibility/geological structures like fault or fractures might have given rise to these small anomalies. It may be noted that a large number of borewells with gas shows are present on this profile and may be located close to the anomalous feature as shown in the Figure-3(c).

Coefficient of variation profile in Figure-3(a) shows tectonically disturbed zones "a, b, c, d, e, f and g" which correlate well with the magnetic anomaly in Figure-3(c).

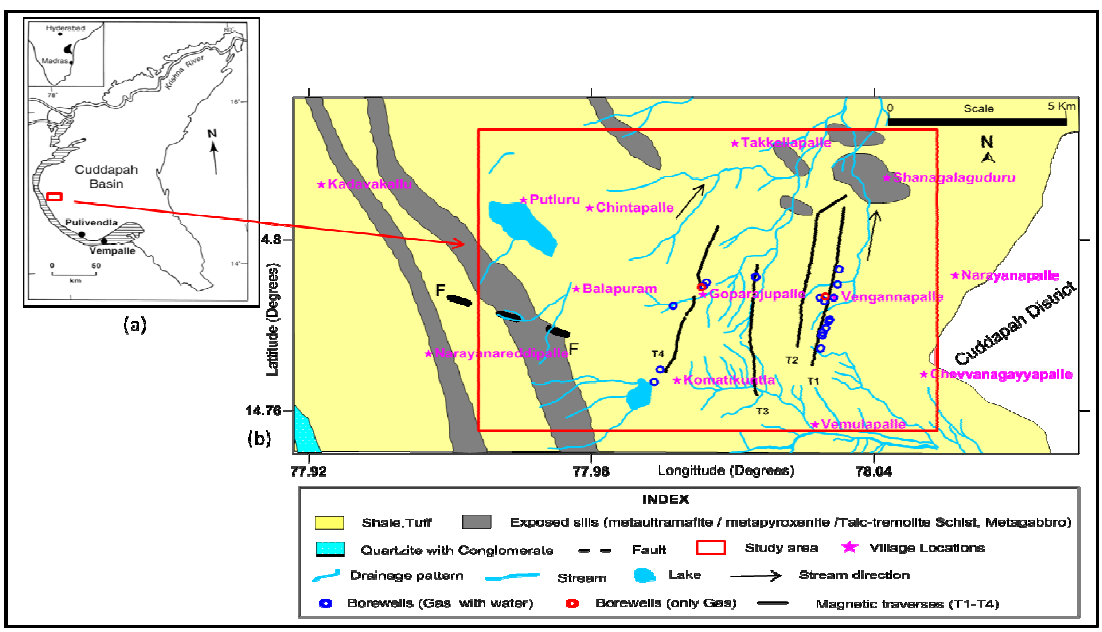

Figure-1: (a) Cuddapah Basin map[9] and (b) Geology and drainage pattern of the study area[10] along with Magnetic Traverses (T1-T4) and along with Borewell locations.

Traverse-T2: West of Traverse-T1: A 4000m long magnetic Traverse-T2 is shown in Figure-4(b). A broad low (-605nT) is observed in the middle of the traverse from 1300m to 2500m. It may be due to the presence of a fracture/ fault. From the station 2500m to the end of the traverse a series of small variations are also observed which may be due to different geological contacts and tectonically disturbed zones. In fact disturbed zones "a, b, c, d", shown in Coefficient of variation profile (Figure-4(a)) correlate with magnetic anomalies. There are no borewells with emanating gas on this traverse.

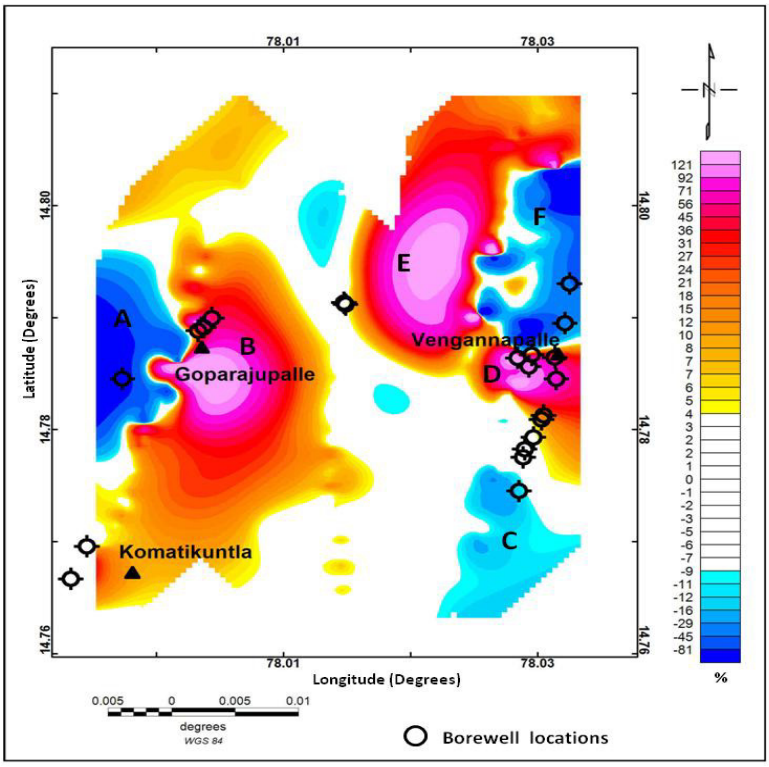

Figure-2: Coefficient of Variation contour map of the study area with tectonically disturbed zones (A, B, C, D, E and F) along with borewell locations.

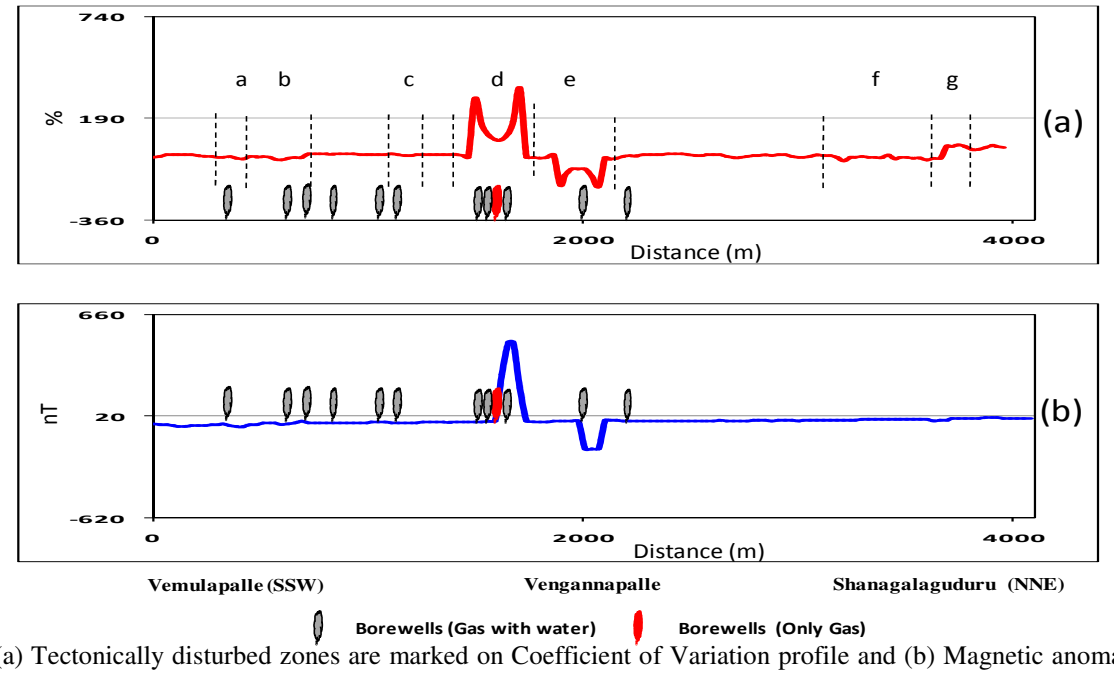

Figure-3: (a) Tectonically disturbed zones are marked on Coefficient of Variation profile and (b) Magnetic anomaly profile along the Traverse-T1.

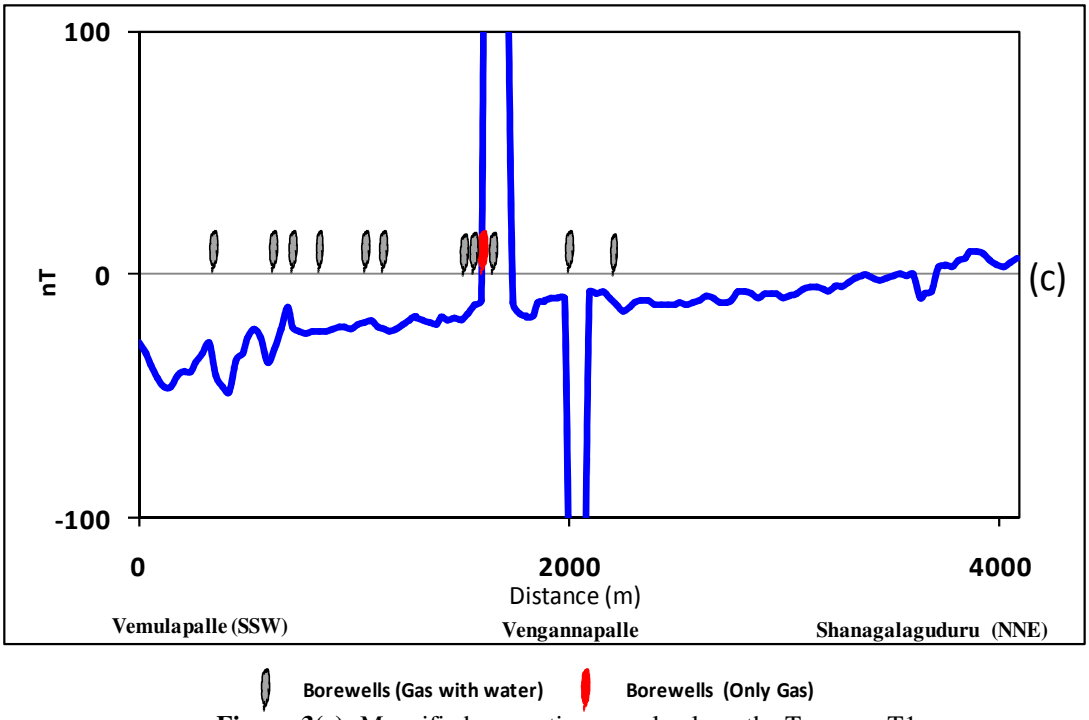

Figure-3(c): Magnified magnetic anomaly along the Traverse-T1.

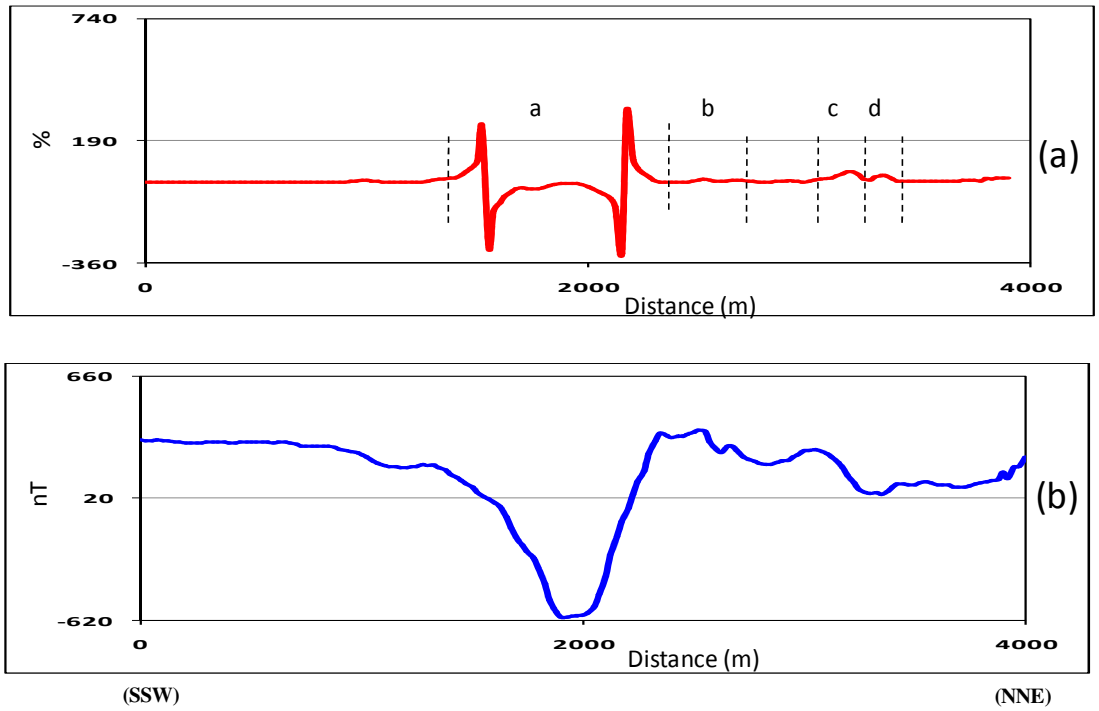

Figure-4(a): Tectonically disturbed zones are marked on Coefficient of Variation profile and (b) Magnetic anomaly profile along the Traverse-T2.

Traverse-T3: West of Traverse-T3: A 3200m long magnetic Traverse-T3 (Figure-5(b)), has a series of small highs and lows with a broad low (116nT) in the middle between stations 1200m and 1600m. Magnetic traverse shown in Figure-5(c) on a magnified scale so as to see the anomalies more clearly. The coefficient of variation profile (Figure-5(a)), shows the disturbed zones "a, b, c, d, e and f" which correspond to the magnetic anomalies Figure-5(c). Two borewells with gas shows are located on this traverse.

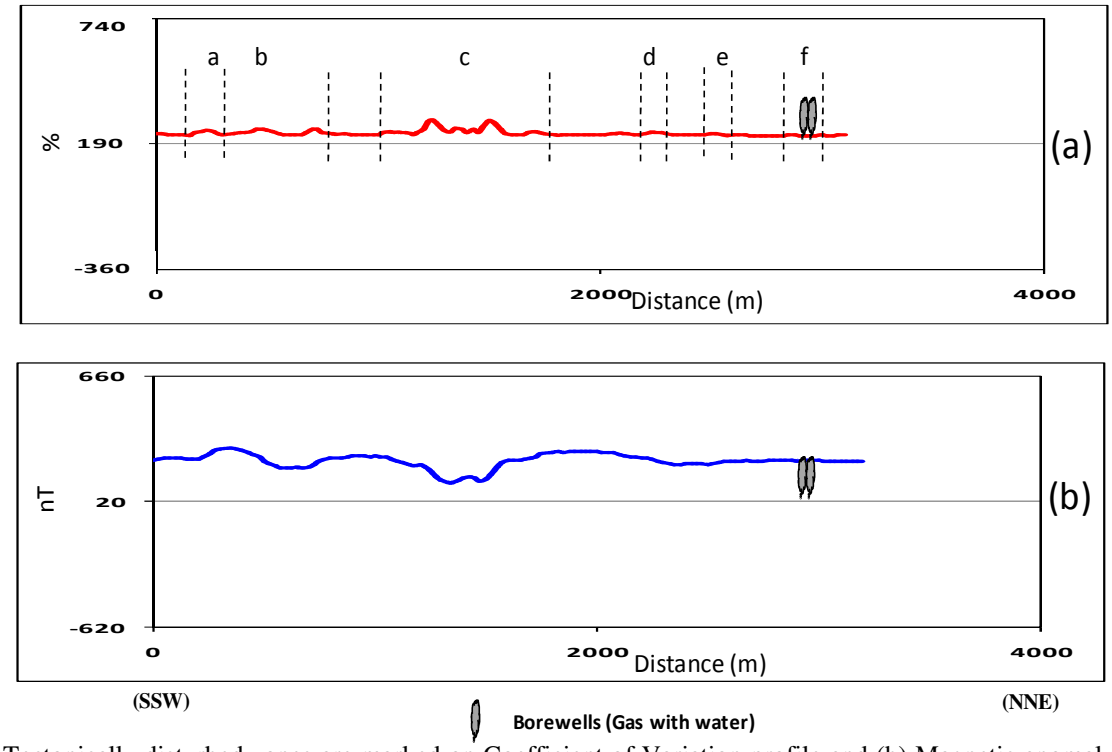

Figure-5: (a) Tectonically disturbed zones are marked on Coefficient of Variation profile and (b) Magnetic anomaly profile along the Traverse-T3.

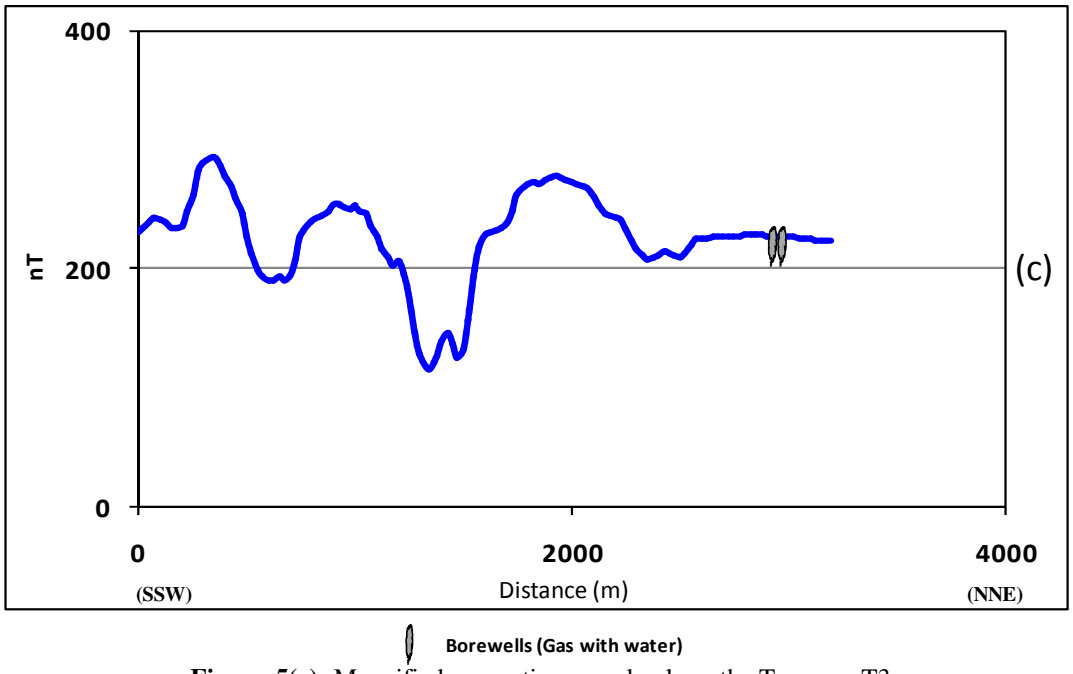

Figure-5(c): Magnified magnetic anomaly along the Traverse-T3.

Traverse-T4: Komatikuntla through Goparajupalle and further: Figure-6(b) shows the 3800m long magnetic Traverse – T4. A broad low (-294nT) is observed in the middle of the traverse between 1125m to 1950m and a sharp high (650nT) at the distance of 3000m on the NE. Apart from these, a few more small high and low anomalies are also clearly seen.

Coefficient of variation profile in Figure-6(a) shows disturbed zones "a,b,c,d,e and f" correlating with magnetic anomalies shown in Figure-6(b). This zone appears to be tectonically highly disturbed. There are indeed four borewells with 'gas shows' located on this traverse.

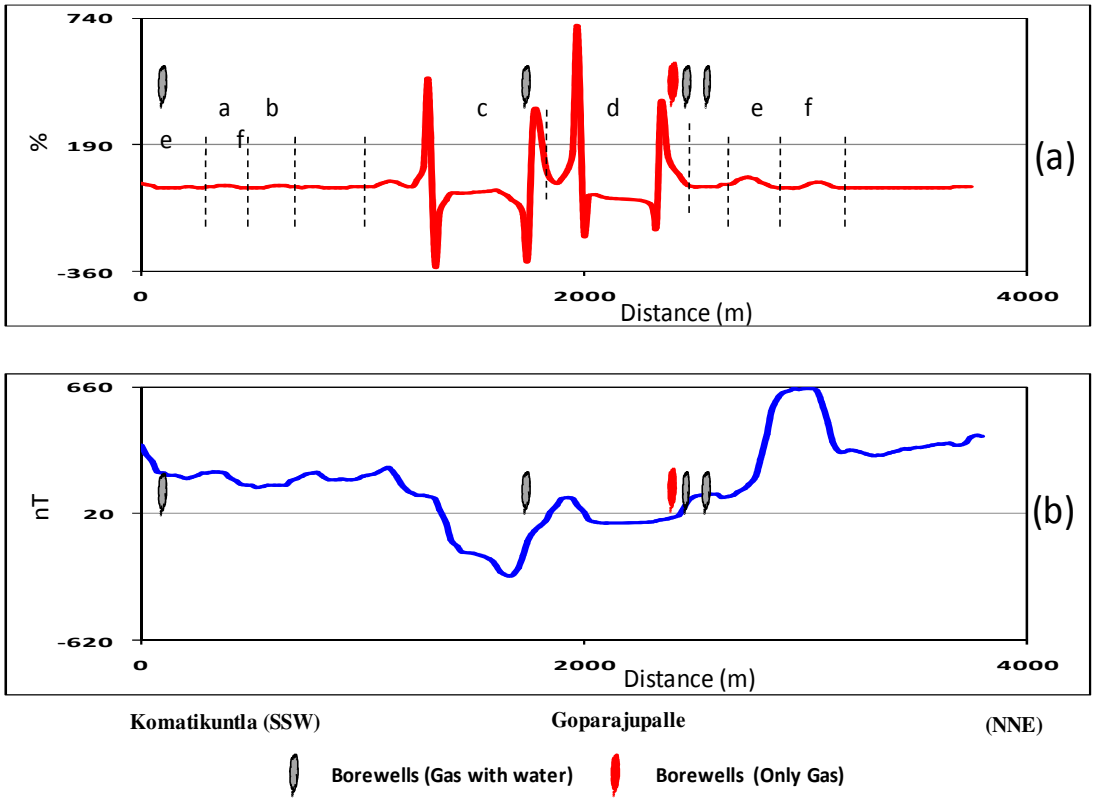

Figure-6: (a) Tectonically disturbed zones are marked on Coefficient of Variation profile and (b) Magnetic anomaly profile along the Traverse-T4.

Results and discussion

i. In the coefficient of variation colour image (Figure-2) the low (A, C and F) and the high (B, D, E and F) anomalous zones are identified and they represent tectonically disturbed zones, possibly represented by geological contacts and faults and fractures. All the irrigational borewells with 'gas shows' located in these disturbed zones. ii. In comparison of magnetic anomaly with its coefficient of variation plots to identify the disturbed zones and point out to high degree of consistency between the two. From these Figures-3 to 6, it is observed that traverses T1 and T4 are highly disturbed and its coefficient of variation profiles also show the disturbed zones clearly and all the borewells located on these zones. It is clearly seen Traverses T2 and T3 are tectonically less disturbed and only two borewells are there on the traverse-T3.

Conclusion

According to geology the study area comprises Tadipatri shales and several sills and dykes are intruded in the shales. From the above results the observed disturbed zones are correspond 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 these 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, which envisages an important role of the sills in preserving the gas.

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References

1. Sreedhar Murthy Y. (2007). Report "A Geophysical Investigation on gushing of Gas in parts of Cuddapah Basin: An Aid to Future Hydrocarbon Exploration Programmes.
2. Sreedhar Murthy Y., Sarma S.V.S., Murali S. and Preeti M. (2012). Geophysical Study of the Gas Show Area in the South Western Region of the Proterozoic Cuddapah Basin. *Jour. of Geophysics,* 33(3), 41-48.
3. King W. (1872). The Kuddapah and Karnul formations in the Madras Presidency: Mem. *Geol. Surv. India*, 8, 124-258.

4. Vijayam B.E. (1968). Tectonic framework of sedimentation in the northwestern part of Cuddapah Basin. *Jour.of the O.U. (science),* Golden Jubilee Hyderabad, 63-73.

5. Leelanandam C. (1980). Some observations on the Alkaline province in Andhra Pradesh. *Curr. Sci.,* V., 60, 799-802.

6. Radhakrishna B.P. (1987). Purana Basins of Peninsular India (Middle to late Proterozoic). *Geological Society of India*, Memoir 6.

7. Rajagopal V.D. (2007). Report on Drinking water Borewell from which Gas is gushing out in S. Venganapalli Village, Putlur Mandal, Anantapur District. Director of Mines and Geology, Hyderabad.

8. Nagaraja Rao B.K, Rajurkar S.T., Ramalingaswamy G. and Ravindara Babu B. (1987). Stratigraphy, structure and evolution of the Cuddapah basin. In B.P. Radhakrishna, (Ed.) Purana basins of Peninsular India, Memoir 6, *Geol. Soc. India*, Bangalore, 33-86.

9. Riding R. and Sharma M. (1998). Late Palaeoproterozoic (~ 1800–1600 Ma) stromatolites, Cuddapah Basin, southern India: cyanobacterial or other bacterial microfabrics?. *Precambrian Research*, 92(1), 21-35.

10. GSI (2001). Geological Survey of India District Mineral resource map of Anathapur district. A.P.

11. Bhimasankaram V.L.S. (1980). The philosophy of Integrated geophysical exploration technology and interpretation. *Journal of Association of Exploration Geophysics*, 1(2), 1-14.

12. Himabindu D. and Ramadass G. (2003). A note on qualitative appraisal of radiometric investigations along the Goa-Kushtagi profile. *Jour. Indian Geophy. Union*, 7(1), 37-41.