GRAVITY SURVEY AND QUALITATIVE APPRAISAL IN A PART OF LOWER GODAVARI VALLEY, A.P.

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ABSTRACT

A Bouguer gravity map was prepared occupying about 700 gravity stations in a limited area of about 9,000 sq. km in a part of the Lower Godavari Valley of Andhra Pradesh. The established auxiliary base gravity values and the measured density values of various formations in the surveyed area are given.

The Bouguer anomaly trends obtained are highly regular when correlated with the surface geological formations. A qualitative appraisal of these anomalies brought out some interesting features supporting the possible extension of the Gondwanas below the alluvial cover and showing the presence of some basement ridges.

INTRODUCTION

THE present work forms a part of the regional gravity investigations carried out by the Andhra University, under a research scheme sponsored by the CSIR, New Delhi, in a part of the Lower Godavari Valley lying in the West Godavari and Krishna Districts of Andhra Pradesh. No systematic geophysical survey was carried out in the area, till the regional magnetic work undertaken by Krishnabrahmam (1962) and Sitapatirao (1963) in a part of the present surveyed area. Compiling all the available gravity data, namely, those of Survey of India and ONG Commission with the NGRI occupied stations, Quereshy *et. al.* (1968) presented a regional Bouguer gravity map for the entire Gondwana basin right from Sironcha in the north-west up to the coast in the south. The present gravity surveys were conducted in a limited part of the Lower Godavari valley establishing about 700 gravity stations in an area of about 900 sq. km. In fact, the observed Bouguer gravity anomalies when correlated with the surface geology revealed some interesting and useful information.

GEOLOGY

In the Godavari Valley, the Gondwana rocks are extensively developed from the Chandrapur District (Maharashtra State) in the north, down to the West Godavari District in Andhra Pradesh (the present area of investigation). Detailed geological mapping was carried out by Blandford (1871) and King (1872-82). Later, working with Geological Survey of India, Krishnan (1960) has contributed valuable information regarding these coal fields. Detailed geological surveys on Gondwanas were carried out by a number of workers, *viz.*, Venkayya (1947), Apparao (1952), Ramachandra Raju (1952), Sarma (1957) and Sathiraju (1959) among others of Andhra University. A generalised regional geological map of the area under investigation compiled from the results of the above is shown in Fig. 1.

Formation	*Equivalent*	*Age*
Godavari Alluvium	Alluvium	Recent
Rajahmundry Sandstones	Cuddalore Sandstones	Miocene
Godavari traps and intertrappeans	Linga and Chindwara flows and intertrappeans.	Cretaceous-Eocene
Infra-trappeans	Lametas of Jabalpur	Upper Cretaceous
Tirupati Sandstones	Chikiala	Upper Jurassic
Raghavapuram Shales	Kota	Upper Jurassic
Gollapalle Sandstones	Kamthis	Lower Triassic
Barakar Sandstones	Barakar	Lower Permian
Kondalite Series	Charnockites Khondalites Gneisses	Archeans
Unclassified Crystallines	Peninsular Gneisses	

PLAN AND PROCEDURE OF THE SURVEY

The present investigations cover an area of about 9,000 sq. km. bounded by north latitudes 16° 30′ to 17° 15′ and the east longitudes 80° 45′ to 81° 45′ and was covered by 12 (one inch to a mile) Survey of India toposheets. A total of 700 gravity stations with a density of 1 station per 13 sq. km. were set up in the area (Fig. 2). All the gravity values are connected to the Survey of India station at Vijayawada (16° 30′ 19″, 80° 37′ 46″) with a value of 978·4515 (Gulatte, 1956) which is the primary base

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FIG. 1-GEOLOGICAL MAP OF A PART OF GODAVARI VALLEY A.P.

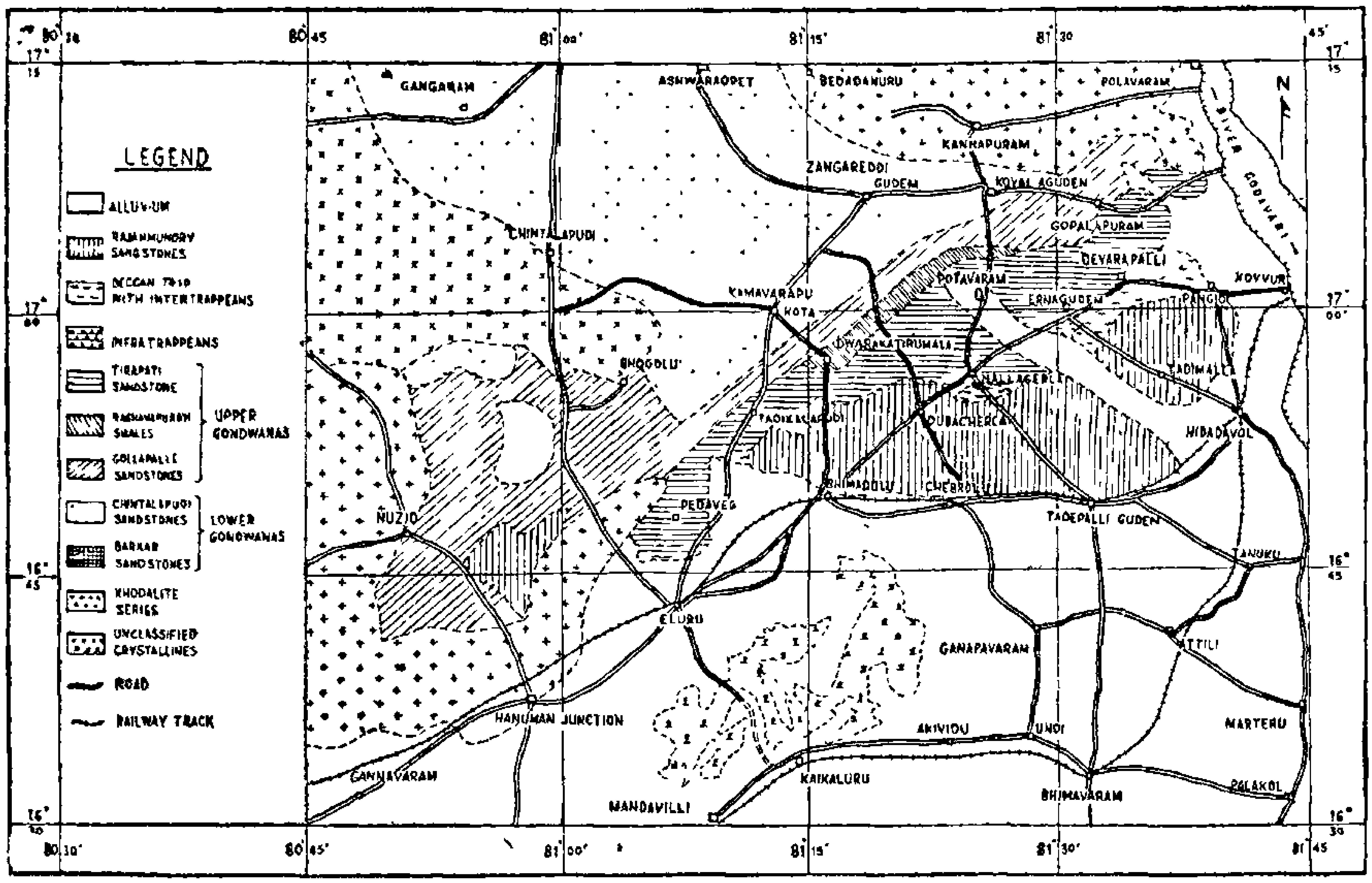
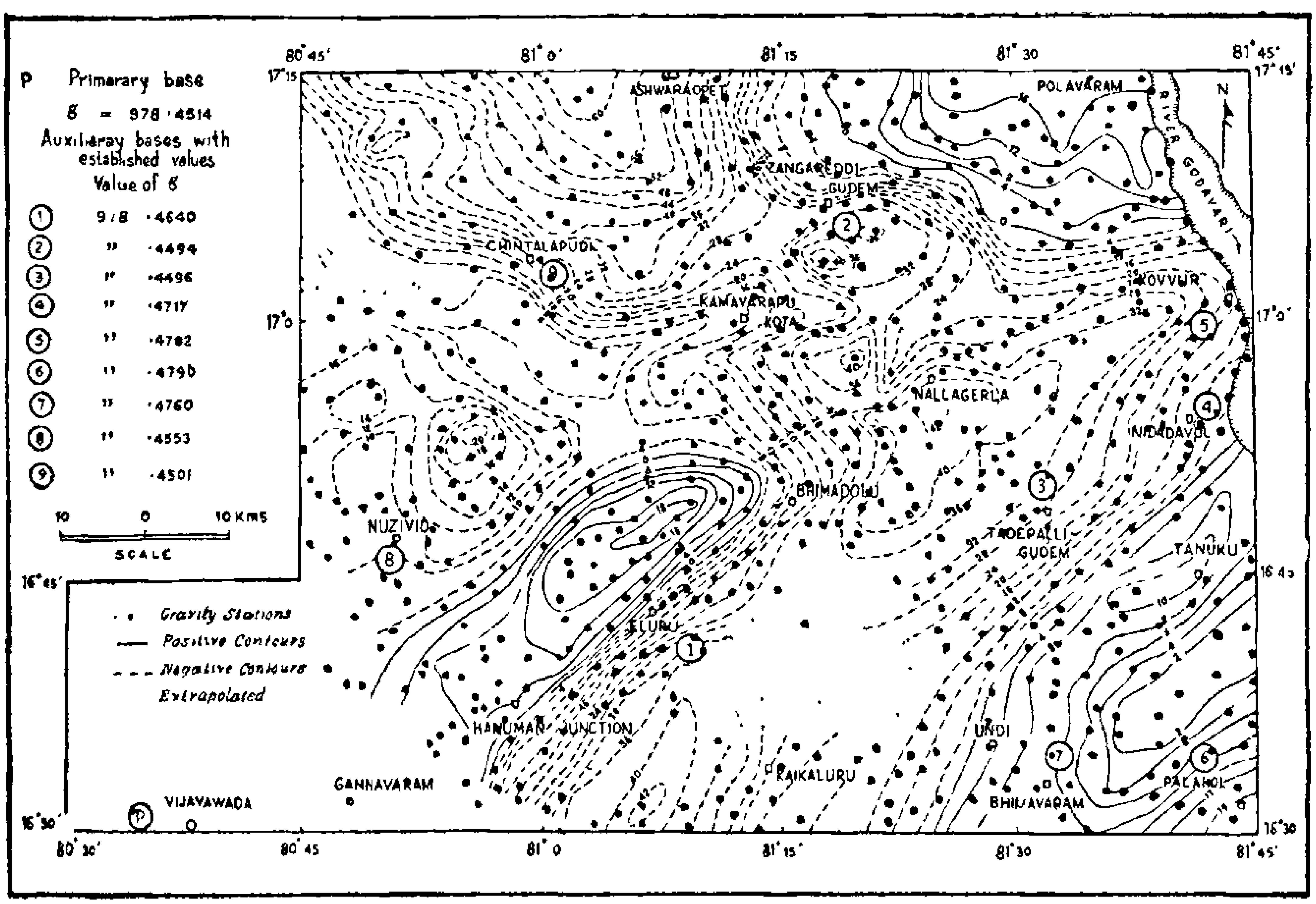


FIG. 2.- BOUGUER GRAVITY MAP IN A PART OF LOWER GODAVARI VALLEY A.P.



for the entire survey. Applying the usual corrections assuming a density of 2·67 gm/cc, the reduced Bouguer gravity to the mean sea level is shown in Fig. 2, along with the established auxiliary bases and the station locations. Over forty rock samples were collected from the different geological formations at various places. Care has been taken to obtain fresh, unweathered samples and in many places samples were collected from quarries and other wells. In measuring density for porous rocks, namely, the sedimentary rocks, the method given by Garland (1965) is adopted. The average of measured values of density for each formation are shown in Table I.

TABLE I

Sl. No.	Formation	No. of Samples	Average density value gm/cc
1.	Rajahmundry Sandstone	5	2·18
2.	Deccan Traps	6	2·82
3.	Upper Gondwanas:		
	Tirupati Sandstones	4	2·02
	Raghavapuram Shales	3	2·97
	Gollapalli Sandstones	4	2·08
4.	Lower Gondwanas:		
	Chintalapudi Sandstones	5	2·10
	Barakar Sandstones	3	2·11
5.	Khondalite Series:		
	Charnockites	4	2·72
	Khondalites	3	2·57
6.	Unclassified Crystallines	5	2·60

DISCUSSION OF THE BOUGUER ANOMALY MAP

The Bouguer anomaly reflects the composite effect of many factors namely intra-crustal structures, intrusions which may or may not reach the surface and surface geological inhomogeneities. The Bouguer anomalies obtained, when correlated with the surface geology, reveal the following factors. The trend and pattern of anomalies associated with the Lower Gondwana sediments are highly regular. The Lower Gondwanas, namely, the Chintalapudi sandstones show a maximum negative anomaly of 62 mgal west of Ashwaraopet. The magnitude of this anomaly gradually decreases to the south with a − 28 mgal anomaly contour practically coinciding with the boundary of this formation. The trend of the negative anomalies, lying between 8 and 28 mgals, which is east to west in this region, takes a turn between Kamavarapukata and Zangareddigudem and follows the strike of the Upper Gondwana formations. The closure near Zangareddigudem of about 40 mgals negative anomaly probably indicates thickening of the sediments in this area. The magnitude of the anomalies, in general, indicates less thickness for the Upper Gondwana formations than the Lower Gondwanas.

The remarkable feature in the Bouguer anomaly map is a band of parallel contours trending northwest-southeast direction, from Ashwaraopet to Kovvur with an anomaly variation of 30 mgals. This anomaly pattern, which closely follows the sedimentary boundary, might represent the sloping of the crystallines towards the sedimentaries. Similar pattern of contours was observed from Kovvur, Tadepallegudem down to Kaikaluru in the far south, on the area covered by tertiaries and recent alluvium formations. A similar approach can be made for understanding this anomaly pattern from Kovvur Tadepallegudem to Kaikaluru. Thus, it may be envisaged that the above pattern of contours running through Ashwaraopet-Kovvur-Tade pallegudem and Kaikaluru limits the eastern margin of the sedimentary basin. In the western side, the anomaly contours from Tadikalapudi, Kamavarapukota and Chintalapudi roughly follow the sedimentary crystalline boundary.

The closure at Nallagerla and just west of Nallagerla are probably due to the thick sedimentary columns, as in the case of the closure at Zangareddigudem. The Deccan trap formations near Pangidi and Nallagerla do not show up in the Bouguer anomaly map probably due to their very limited areal extension and thickness. A closure of about − 20 mgals is observed north of Nuzvid. This may be due to the limited exposed patch of lower Gondwanas just outside the basin.

Regarding the anomalies outside the area of the basin, the noteworthy one is the strikingly elongated positive closure of the order of 18 mgals extending in a southwest-northeast direction from Tadikalapudi. This anomaly starts from Gannavaram and extends upto Tadikalapudi in the above strike direction. From the surface geology, metamorphics were outcropping near Gannavaram and extending in the same strike direction of southwest-northeast, upto Pedavegi, with Upper Gondwanas on the northern side and recent alluvium on the southern side. These elongated positive anomalies may thus be correlated with the metamorphic structure, even in its subsurface portions.

The positive anomalies in the eastern part of the area Polavaram and the positive anomalies in the region of Bhimavaram-Tanuku with a 10 mgal closure near Tanuku need some elucidation. The positive anomalies in the vicinity of Polavaram may be due to variations of density in the

Khondalite formations produced possibly by intrusions of Charnockites, particularly near Prakkilanka (17° 8' 0"; 81° 40' 30") as discussed by Sitapatirao (1963) and as evidenced from outcrops north of Polavaram. However, the gravity effect of these intrusions may be quantitatively inadequate to account for the observed Bouguer anomalies. It may also be pointed out that the southern limit of this positive anomalies roughly coincides with the Archaean basement boundary. Also these positive anomalies are known (Quereshy *et al.*, 1968) in the eastern ghats strike direction, *i.e.*, NE–SW. This may point to the possibility of a structure faulting on the eastern edges of the basin and parallel to the general strike direction of the eastern ghats. It is, however, not possible to establish this aspect unless more detailed investigations are undertaken.

The elongated positive anomaly closure near Tanuku and Bhimavaram is quite interesting particularly as it is situated over an area covered by tertiaries and alluvium. Taking a maximum thickness of about 1,000 feet for tertiaries (Balasundaram, 1969) and of about 500 feet for alluvium, there is hardly room for a structure large enough to produce this 12 mgal anomaly. Thus the observed anomaly has to be visualised as arising due to the effect of something within the basement. With this background, it is very difficult to distinguish an anomaly which might be a result of moderate folding or faulting in the sediments, or of moderate relief of the basement surface. Bhaskara Rao and Satyanarayana Murty (1969) from their magnetic studies in parts of the alluvial areas of the East Godavari District, just adjacent to the present area (on the other side of Godavari river) pointed the possible presence of a ridge-like basement structure running ENE and plunging in the WSW direction. During their extensive geophysical surveys for oil structures, the ONG Commission reported the same order of anomaly at Tanuku and attributed the same, primarily in the variation in basement topography (Ramana, 1961–62; Das *et al.*, 1970). Also these two basement ridges discussed above have been demarcated by the ONG Commission in their Tectonic Map of India (1968) based on the geophysical results. The observed gravity anomalies are in alignment with the strike of the reported ridge. Thus, this anomaly may be due to ridge-like feature of sufficient relief in the basement. It is, however, interesting that, a high negative parallel band of contours from Nallagerla to Kaikaluru with positive anomalies on either side, all with the same general strike direction, are observed in the southern parts of the area surveyed. This negative band of contours can only be explained accounting the presence of Gondwanas below the alluvial cover. In fact, the basement structure derived from the gravity results, assuming a reasonable thickness of alluvial cover in these parts is very informative and is being presented separately with tectonic history of the Lower Godavari Valley (Bhaskara Rao and Venkateswarlu, under preparation).

Conclusions

A systematic gravity survey was conducted in a part of the Lower Godavari Valley of Andhra Pradesh. A network of 9 auxiliary bases were established during the course of the survey. Densities of the surface rocks were determined in the laboratory taking representative samples from all the geological formations in the area.

The trend of the Bouguer anomalies is highly regular demarcating the various geological formation boundaries. The Lower Gondwanas are characterised by a "Low" negative anomaly of 62 mgals west of Ashwaraopet. It is suggested that the band of contours with an anomaly variation of about 30 mgals running through Ashwaraopet Kovvur-Tadepallegudem and Kaikaluru limits the eastern margin of the sedimentary formations. The present gravity survey supports the earlier views about the existence of the subsurface ridges at Tanuku and north of Eluru and delineated their extensions. Also, the run of negative contours from Kovvur-Tadepallegudem-Kaikaluru, flanked by positive elongated contour closures, suggests the presence of Gondwana sediments below the alluvial cover in these parts of the area.

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1. Appa Rao, T. V. N. N., *M Sc. Thesis*, Andhra University, Waltair, 1952, (Unpublished).
2. Balasundaram, M. S, *Jour. Geol. Soc. of India*, 1969, 10.
3. Bhaskara Rao, V. and Satyanarayana Murty, B. V., *Indian Geophy. Union*, 1969, 6, 112.
4. Blandford, W. T., *Rec. Geol. Surv. of India*, 1871, p. 49.
5. Das *et al.*, *Proc. Sec. Symp. Upper Mantle Project*, NGRI, December, 1970.
6. Garland, G. D., *The Earth's Shape and Gravity*, Pergamon Press, 1965.
7. Gulatee, B. L., *Survey of India*, Technical Paper No. 10, 1956.

8. King, W., *Rec. Geol. Surv. of India*, 1872, 5, 112.
9. —, *Ibid.*, 1873, 6, 125.
10. —, *Ibid.*, 1874, 7, 158.
11. —, *Rec. Geol. Surv. of India, Min Geol.*, 1875, 16, 195.
12. —, *Rec. Geol. Surv. of India*, 1882, 15, 202.
13. Krishnabrahmam, N., *Ph.D. Thesis*, Andhra University, Waltair, (Unpublished), 1962.
14. Krishnan, M. S., *Geology of India and Burma*, Rev. Edn., Higginbothams Ltd., Madras, 1960.
15. Quereshy, M. N. *et al.*, *Geol. Soc. of America. Bull.*, 1968, 19, 1221.
16. Ramachandra Raju, A. T., *M.Sc. Thesis*, Andhra University, Waitair, 1952, (Unpublished).
17. Ramana, E. V., *Gravity and Magnetic Surveys at Nidadavole Pakhal Amalapuram Area*, ONGC, Unpublished Report, 1961–62.
18. Sarma, B. B. G., *D.Sc. Thesis*, Andhra University Waltair, 1952, (Unpublished).
19. Sathiraju, T., *M.Sc. Thesis*, Andhra University Waltair, 1959, (Unpublished).
20. Sitapatirao, P., *D.Sc. Thesis*, Andhra University, Waltair, 1963, (Unpublished).
21. Venkayya, E., *M.Sc. Thesis*, Andhra University, Waltair, 1947, (Unpublished).

EFFECT OF 2, 4-DINITROPHENOL AND ATP ON UPTAKE, TRANSLOCATION AND DISTRIBUTION OF ^{32}P IN COTTON PLANTS UNDER DIFFERENT LIGHT CONDITIONS

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ABSTRACT

Cotton seedlings were subjected, in light and darkness, to DNP, ATP or both for 3 hours, then allowed to remain in contact with ^{32}P for further 6 hours. Darkness decreased phosphorus uptake and its translocation. In the light, DNP decreased the uptake of ^{32}P, but enhanced its translocation to the shoot. ATP did not affect ^{32}P uptake but enhanced its translocation. ATP could not overcome the negative effect of DNP on ^{32}P uptake. In the dark, neither DNP nor ATP exerted significant effect on ^{32}P uptake, yet accelerated its translocation. Under both light conditions, DNP accumulated most of the translocated ^{32}P in the stem, while ATP moved it further to the leaves. The enhancement of ^{32}P translocation was accompanied by the presence of higher percentage of ^{32}P in an organic form. It was concluded that high energy compound formed during photosynthesis may play a role in the metabolic active uptake of phosphorus.

INTRODUCTION

THE uptake of phosphorus and its translocation in plants were suggested to be metabolic active processes (Brower, 1965 and El-Fouly and Ashour, 1969). The energy required for such a process is supplied from the adenosine-triphosphate (ATP) deposited in the cells (Weigh, 1963). The high energy compound (ATP) is produced during the process of oxidative phosphorylation (Jackson *et al.*, 1962). Thus, 2, 4-dinitrophenol (DNP), an inhibitor of oxidative phosphorylation was found to decrease the uptake of phosphorus by plant roots (Stenlid, 1959).

The uptake of phosphorus by roots and its translocation to the shoot are higher in the light than in the dark (Linser, 1965), and increase with increasing light intensity (Ashour *et al.*, 1968). Raven (1969) suggested that the ATP required for regulation of ion pump can be produced in the light by cyclic photosynthetic phosphorylation.

The aim of this work was to investigate the effect of DNP and ATP on ^{32}P uptake, translocation and distribution in the cotton seedlings in light and in darkness.

MATERIALS AND METHODS

One month old, uniform cotton seedlings (*G. baradense*) cv. Ashmouni grown in water culture were selected. The plants were rinsed in large test tubes (2·5 cm dia and 20 cm long) filled with distilled water and left over-night. On the second day, the distilled water in each test tube was replaced by 50 ml of 1/4 strength complete Hoagland's nutrient solution containing 10^{-4} M 2, 4-dinitrophenol (DNP), 10^{-3} M ATP (the dipotassium salt of ATP) or both and left for 3 hours. Then 8μ Ci of ^{32}P as KH_2PO_4 supplied from the Egyptian Atomic Energy Establishment was injected in the nutrient solution in each tube, and the plants were allowed to remain in contact with the ^{32}P for 6 hours at 21° C. This experiment was conducted under conditions of both light (20·000 Lux) of fluorescent lamps, and darkness. Each treatment under both conditions had seven replicated tubes, thus each treatment included seven plants. At the end of the incubation period, the plants of four replicates were harvested, and the roots were washed carefully with running water for 2 min. then the plants were divided into roots,