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Uranium Mineralisation in the Mesoproterozoic Quartzites of Cuddapah Basin in Gandhi area, Cuddapah District, Andhra Pradesh : A New Exploration Target for Uranium

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Abstract: Significant uranium occurrences are discovered recently for the first time in the Gulcheru Quartzite of Papaghni Group of Cuddapah Supergroup near Gandhi, east of Papaghni river, Cuddapah District, A.P. Mineralisation is associated with an E-W fault. Friable whitish to light pink quartzite is the main host rock of uranium. Mineralisation occurs in the form of lensoidal bodies having dimensions of 20 - 200 m x 2 - 10 m in an E-W fault scarp section, over 2 km in length. Dip section is also mineralised. Samples have revealed anomalous concentrations of uranium, up to 1.441% U_3O_8 with negligible thorium. Concentration of Ni (<25 to 1033 ppm), Mo (<25 to 643 ppm), Pb (33 to 1515 ppm) and Cu (<25 to 170 ppm) points to the economic potentiality of the area. Petrological studies have identified uranium minerals such as pitchblende, uraninite and coffinite as fracture fillings and disseminations in the chlorite-sericite matrix of quartzite. The associated ore minerals are chalcopyrite, arsenopyrite, pyrite and limonite. These findings have important implications in the selection of new exploration targets for uranium in the basal beds of Cuddapah Supergroup unconformably overlying the fertile granitoid basement in the Eastern Dharwar Craton occurring in the southwestern part of Cuddapah basin.

Keywords: Uranium mineralisation, Gulcheru quartzite, Cuddapah basin, Andhra Pradesh, Dharwar Craton.

INTRODUCTION

In southern Peninsular India, the Mesoproterozoic Cuddapah basin is one of the prime targets for uranium exploration. Concerted efforts over the past one and a half decades have resulted in establishing three distinct types of uranium mineralisation in and around the basin, viz., (i) carbonate-hosted stratabound type in the Vempalle Formation of Papaghni Group (Sundaram et al. 1989; Vasudeva Rao et al. 1989), (ii) unconformity-proximal type at the base of Srisailem/Banganapalle Formations in the northern part (Sinha et al. 1995; Jeyagopal et al. 1996) and (iii) fracture-controlled, basement granite/basic dyke, mylonite/phyllosite-hosted type along southwestern margin (Umamaheswar, 1997). In Papaghni sub-basin, the basal part of Gulcheru Formation, represented by impersistent polymictic conglomerate is known for placer type thorium mineralisation. However, recent modelling involving favourable geological environs, viz., the fertile granitoid basement (Gangadharan et al. 2000) with known uraniferous fracture/shear zones along the southwestern margin of the Cuddapah basin and post-sedimentary reactivation of

these fracture zones/ faults affecting the lower members of the Papaghni Group, present in Gandhi area close to the Papaghni river, has prompted detailed field investigations in the Gulcheru Formation.

Field investigations carried out during the field season 1998-99 in the Gulcheru Quartzite Formation of Papaghni sub-basin have revealed significant concentration of uranium (with values up to 1.441% U_3O_8 and negligible thorium) in quartzite exposed along stream section about 2 km east of the Lord Anjaneya temple at Gandhi (14°19'30"N; 78°30'30"E, Survey of India toposheet no.57 J/11) near the Vempalle town in Cuddapah District, Andhra Pradesh (Fig.1). These new finds of uranium are situated along a northeast-southwest and east-west lineament extending into the granitoid basement and suggests reactivation of the basement fault, which might have caused the uranium concentration along the fracture planes in the Gulcheru quartzites.

GEOLOGICAL SETTING

Gulcheru Quartzite Formation, the lower most

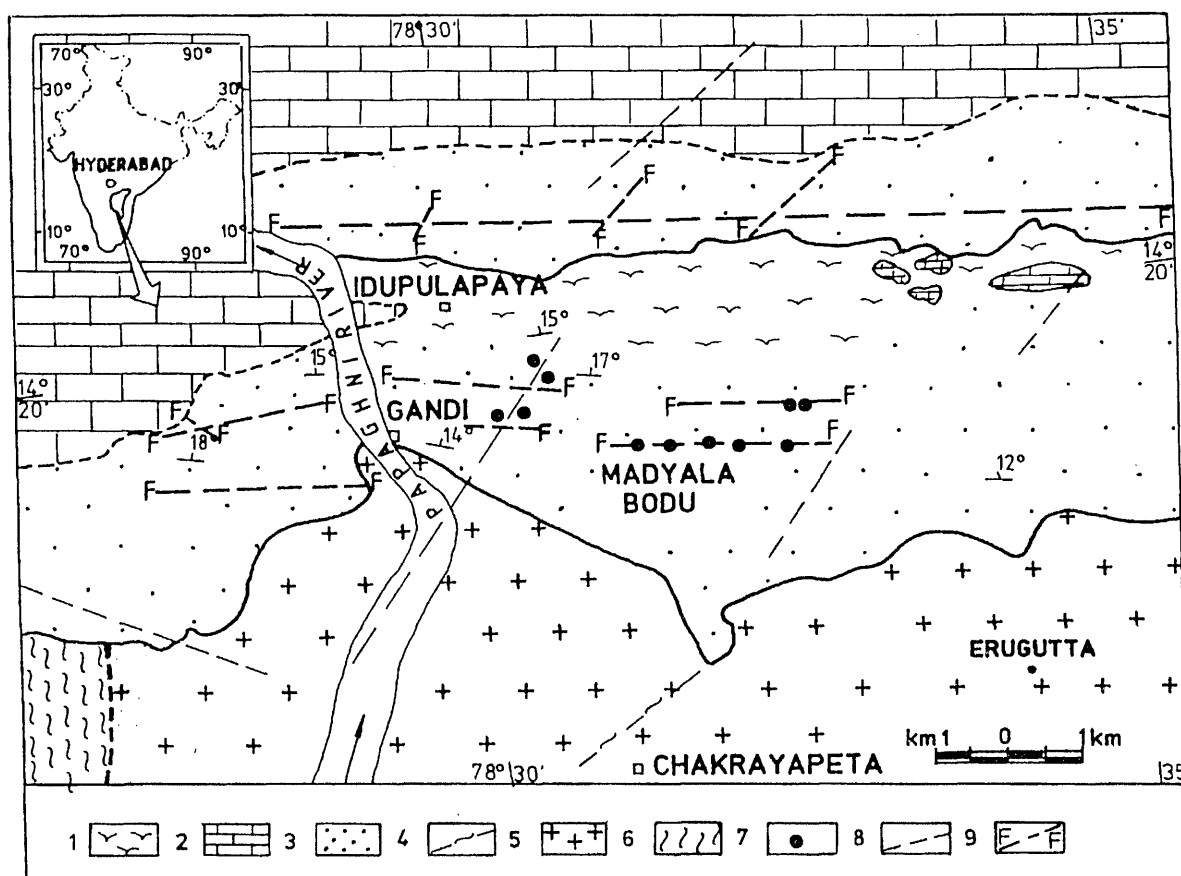


Fig.1. Geological map of the Gandhi area, Cuddapah District, Andhra Pradesh with location of uranium occurrences. Index: 1. Alluvium, 2. Vempalle Formation, 3. Gulcheru Quartzite, 4. Fracture zone (uraniferous), 5. Granite/gneiss with basic dykes and quartz reefs, 6. Dharwar Group (Veligallu schist belt), 7. Uranium occurrences, 8. Lincament, 9. Fault.

stratigraphic unit of Papaghni Group of Cuddapah Supergroup, fringes the western margin of Cuddapah basin and is represented by basal polymictic conglomerate/grit, arkose, intraformational conglomerate, quartzite with intercalations of shale, having a total thickness of 28 to 210m, and overlie the Archaean to Palaeoproterozoic basement consisting mainly of granite/gneiss and narrow, linear schist belts with a profound Eparchaeon unconformity (Nagaraja Rao et al. 1987). The arenaceous sequence of Gulcheru Quartzite is conformably overlain successively by dominantly calcareous rocks of Vempalle Formation, both belonging to the Papaghni Group. In the Gandhi area, the Gulcheru Quartzite is represented by light pink to grey ferruginous quartzite, grey/whitish quartzite, arkose, intraformational conglomerate and intercalations of purple shale. This is overlain by dolostone and cherty limestone with shale intercalations of the Vempalle Formation of Papaghni Group unconformably overlying the basement granitoid. The granitoid basement dated c.2300 - c.2500 Ma (Pandey et al. 1999) is fertile having intrinsic uranium content of 24 ppm (av.) with known uranium occurrences

hosted by granite/basic mylonite, cataclasite and breccia along ENE-WSW trending fracture zones (Umamaheswar, 1997).

Interpretation of the aerial photographs reveals that the Gulcheru Quartzite and Vempalle Formation are dissected by an east-west (Idupulapaya) strike fault with an upthrown northern block. Several NE-SW trending cross-faults developed across the major Idupulapaya fault have facilitated the upward movement of the northern block with gradual increment from west to east (Fig.1). Structural disturbance associated with the Idupulapaya fault as well as cross-faults have resulted in development of fractures/joints, brecciation, silicification and chloritisation in the quartzites. These cross faults might have controlled the course of the Papaghni river as it, while entering the Cuddapah basin, has changed its course from northeast to northwest.

About 2 km east of Gandhi and 6 km from Vempalle on the Gandhi-Palmyra Plantation road, the light pink, grey and whitish quartzites are exposed along dip slope with E-W strike and northerly dip of 12° - 17°. The quartzites are cut by deep nalas on the dip slope in two preferred

directions E-W and NE-SW representing lineaments which may be related to the reactivation of basement faults. Quartzites display primary structures like cross-bedding, ripple marks, parallel lamination and mud cracks suggesting deposition in shallow water.

MINERALISATION

Radiometric surveys have recorded significant radioactivity of the order of 0.02 to 1 mR/hr in quartzites at several places on either side of the NE-SW trending *nala* and along E-W trending *nala* section (morphological expression of a fault) at Madyala Bodu, spread over a length of 2 km (Fig. 1). The dimensions of individual radioactive occurrences range from 20 to 200m in length and 2 to 10m in width. Radiometric and chemical assays of samples have shown <0.010 to 0.703% eU_3O_8 , <0.010 to 1.156% U_3O_8 , <0.010 to 0.018% ThO_2 and 0.012 to 1.441% U_3O_8 (chemical) (Table 1). Radioactive quartzite is friable and at places arkosic. Uranium mineralisation is mainly confined to fracture/joint planes and is partly disseminated within quartzite suggesting its epigenetic nature. Radiometric assay

points to the disequilibrium of U with a factor of 0.55 to 2.04, both in favour of daughter products and the parent. High values in favour of the parent is due to abundant secondary uranium minerals present in the fractures of quartzite. The mineralised quartzite consists of sub-angular to rounded quartz clasts with subsidiary chert, chalcedony and silica over growths, set in chlorite, sericite matrix (Umamaheswar, 1999). Petrological study has shown that pitchblende is the major uranium phase occurring as disseminations in the matrix and as fracture filling. Uraninite occurs as irregular patches in lesser proportion, whereas coffinite marginally replaces both pitchblende and uraninite (Figs. 2a to 2d). Presence of uraninite is confirmed by λ RD studies. The associated ore minerals present are specular haematite, granular haematite, limonite, chalcopryrite, arsenopyrite, pyrite, bornite and galena. Accessory minerals include apatite and anatase. Anomalous concentrations of trace elements such as Ni (<25 to 1033 ppm); Mo (<25 to 643 ppm); Co (<25 to 77 ppm); Cu (<25 to 170 ppm); Pb (33 to 1515 ppm); and V (<25 to 107 ppm) in the mineralised zone are related to fault structures. Chemical analysis of mineralised quartzites indicates uranium having positive

Table 1. Chemical analysis of mineralised Gulcheru Quartzite of Gandhi area

Oxides (wt.%)	GL-4	GL-5	GL-6	GL-6/1	GL-6/2	GL-6/3	GL-6/6	GL-8/1	GL-8/2	GL-9	GL-5/N	GL-6/N
SiO ₂	96.99	94.38	76.84	95.62	96.60	97.19	96.70	75.44	90.58	95.60	97.21	96.14
Al ₂ O ₃	0.41	0.83	12.91	0.55	0.70	0.56	0.80	12.58	1.81	1.35	1.00	1.22
Fe ₂ O ₃	2.11	0.78	1.61	<0.05	0.18	<0.01	0.20	3.03	0.05	0.66	0.10	0.04
FeO	0.14	0.63	0.07	0.90	0.57	0.57	0.79	0.18	0.72	0.93	1.21	0.60
CaO	0.19	0.67	0.05	0.12	0.10	0.09	0.03	0.12	3.15	0.23	0.04	0.08
MgO	0.03	0.07	0.51	0.28	0.40	0.48	0.52	0.38	0.08	0.05	0.03	0.06
Na ₂ O	0.04	0.03	0.25	0.06	0.05	0.04	0.03	0.23	0.06	0.04	0.03	0.07
K ₂ O	0.01	0.03	3.84	0.05	0.02	0.02	0.03	3.81	0.54	0.10	0.03	0.23
P ₂ O ₅	0.06	0.49	0.11	0.06	0.04	0.04	0.03	0.18	2.03	0.31	0.06	0.05
TiO ₂	<0.05	0.08	0.12	<0.05	0.05	0.01	0.05	0.27	0.02	0.02	0.09	0.62
MnO	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	<0.01	0.01	0.02	0.01	0.01
LOI	<0.05	0.56	1.84	<0.05	0.40	0.44	0.64	1.44	0.86	0.56	0.37	0.78
U ₃ O ₈	0.035	0.065	0.086	1.441	0.428	0.371	0.089	0.045	0.031	0.076	0.003	0.003
Elements (ppm)												
Ni	33	59	<25	607	881	501	1033	<25	32	58	<25	<25
Mo	<25	<25	<25	<25	643	567	<25	<25	<25	<25	<25	<25
Cu	<25	63	<25	85	57	170	<25	<25	<25	<25	<25	<25
Pb	105	584	27	1515	1051	1051	167	54	33	245	<25	<25
Co	36	77	<25	<25	36	41	56	<25	<25	<25	<25	<25
V	<25	<25	28	<25	<25	45	107	72	<25	<25	<25	<25
Zr	<25	<25	74	<25	<25	<25	<25	119	27	<25	26	34
Y	35	90	<25	72	38	47	37	<25	<25	50	<25	<25

Analytical techniques : SiO₂, TiO₂, P₂O₅ by spectroscopy; FeO by titrimetry; K₂O, Na₂O by flame photometry; Al₂O₃, Fe₂O₃, CaO, MgO, MnO, Ni, Cu, Co, Pb by AAS; Mo, V by ICP (AES); U₃O₈ by fluorimetry; LOI by gravimetry methods

Analysts: Usha Nathan, Roopa Bose, Chemistry Laboratory, AMD, SR, Bangalore

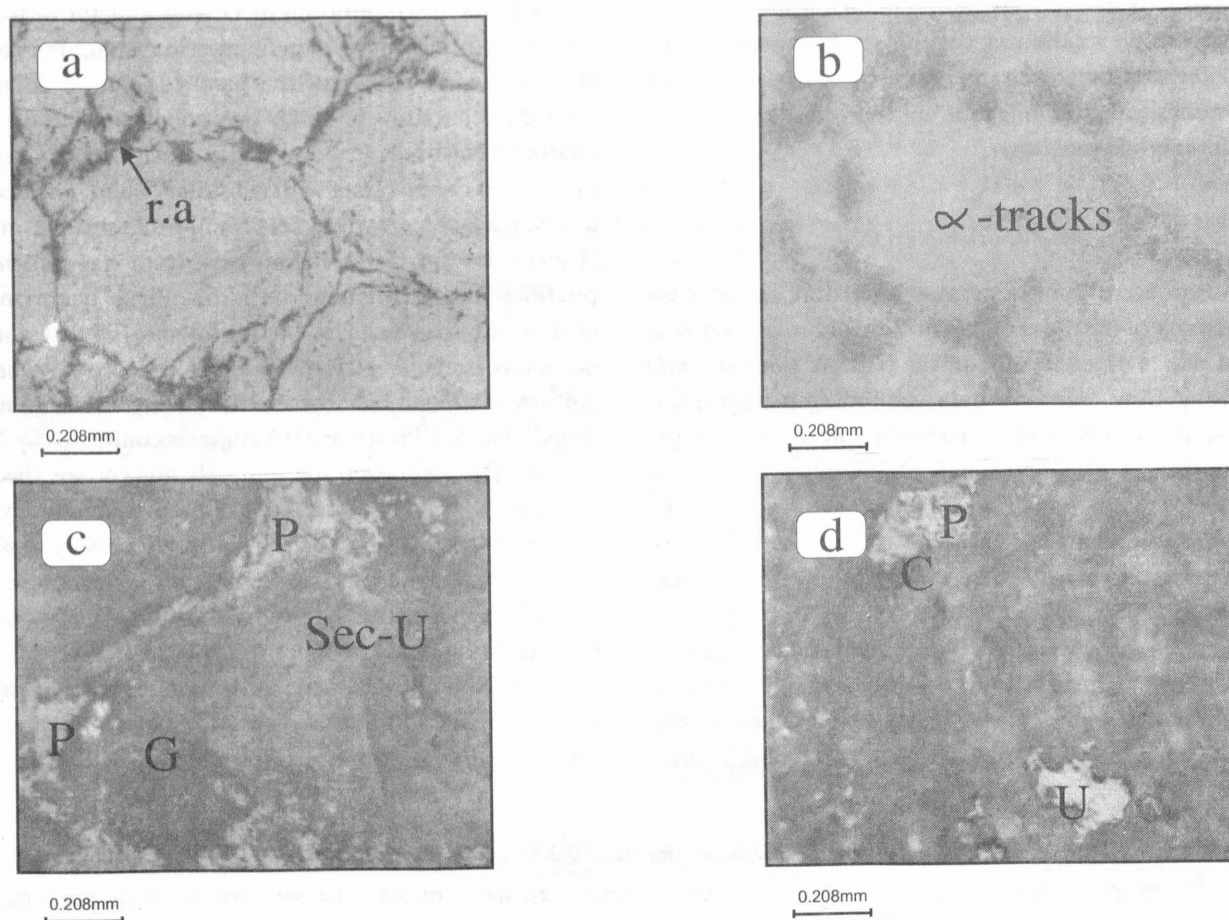


Fig.2. (a) Photomicrograph of orthoquartzite of Gandhi area showing black radioactive material (r.a) as interstitial and around the grain boundaries. (b) Alpha-tracks indicating the black material in Fig.2a as radioactive. (c) Photomicrograph showing pitchblende (P) along detrital quartz grain boundary and altering to secondary uranium mineral (Sec. U). Galena (G) is closely associated with pitchblende. (d) Photomicrograph showing anhedral grains of uraninite (U) and pitchblende (P). Coffinite (C) replaces pitchblende (P).

correlation with Ni, Cu, Mo and Pb. Petrological study of few drill-core samples of uraniferous quartzite (~0.27% U_3O_8), encountered below the Vempalle dolostone in the nearby Giddankipalli area (west of Papaghni river), has revealed pitchblende and coffinite as uranium minerals present in the form of fracture-fillings and veins, in association with pyrite, molybdenite and limonite. The ongoing reconnaissance drilling in Gulcheru Quartzite in Gandhi area has indicated U-mineralisation in fractured quartzites closely associated with E-W fault section, with core samples, assaying up to 10.21% U_3O_8 (chem.), whereas the boreholes planned for stratigraphic lithic controlled U-mineralisation have proved to be barren.

DISCUSSION

Mesoproterozoic Gulcheru Quartzite is exposed along the southwestern margin of Cuddapah basin and is dissected

by two sets of faults namely E-W and NE-SW, probably the result of reactivation of basement faults in several episodes. The granitoid basement is fertile with labile uranium manifested by abundant secondary uranium minerals developed along fracture/ joint planes. Uranium mineralisation occurs in the form of lensoidal bodies traced over 2 km length and 20 to 30 m wide zone along fault sections hosted by white/grey/pink quartz arenites. Apart from this, continuation of mineralisation in these quartzites in dip sections across the fault (nearly 30 m from fault) indicate the importance of lithology in conjunction with structure. Uranium minerals such as pitchblende, uraninite and coffinite are intimately associated with pyrite, chalcopryite, galena and arsenopyrite, indicating a reducing environment for precipitation of uranium. Systematic sampling across the E-W trending fault zone has recorded high concentration of trace elements such as Ni, Mo, Cu, Pb, Co, V along with U, associated with fractured quartzites,

while the samples of the same lithounit a few tens of metres away from the fault do not show any enrichment of these elements (Table 1). Anomalous concentrations of trace elements like Ni, Mo, Co, V, Cu and Pb and indications of silicification and chloritisation point to post-diagenetic emplacement of these elements into the sediments along with uranium, possibly through hydrothermal solutions during reactivation of basement faults and its spreading along favourable lithounits. Field evidences suggest that uranium mineralisation in the quartzites has structural as well as lithological control.

Favourable geological setting, together with association

of significant uranium concentrations in Gulcheru Quartzite in the Gandhi area, has opened up a new avenue for uranium exploration in contiguous areas covering the Gulcheru Quartzite on the eastern and western parts of the Papaghni river and to look for uranium in similar geological environs in other Mesoproterozoic sedimentary basins.

Acknowledgements: The authors thank their colleagues in Physics and Chemistry Laboratories at AMD, Bangalore for analytical support. Petrological work by P.V. Thirupathi, Petrology Laboratory, SR on the samples of the Gandhi area is duly acknowledged.

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(Received: 7 April 2000; Revised form accepted: 29 November 2000)