saturating the region with groundwater. This might have enhanced the gas eruption. The earthquake tremors received recently might have opened up the fractures and in all probability gas emanations are due to release of trapped gases in amygdaloidal basalt as a result of a microearthquake. In both the cases of gas emanation, no fractures were observed on the surface. There is probably a change in fracture porosity of the weathered and fractured basalt flows present at deeper or shallow levels caused by the tremor shaking[6]. Gases were coming out from small pores. Termites were also reported to be coming out during emanation and both the sites were small mounds in nature. The rise in water table might have displaced the entrapped air that would find its way up through termite burrow holes which have acted as gas outlets. It is to be noted here that near the gas emanation sites, water clogging is observed. In the absence of radon and helium analysis, it is difficult to link these gas emanations to deep origin and it is preliminarily guessed that gas emanations at these sites are related to escape of trapped air in fractured basalt from a shallow level. The burning sensation experienced by the person might be explained by the release of injurious gas from the decay of biomass which is used in the field as fertilizers.

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R. D. KAPLAY
D. B. PANASKAR
A. M. RAKHE

School of Earth Sciences,
Swami Ramanand Teerth Marathwada University,
Nanded 431 603, India

Uranium mineralization in the Palnad sub-basin, Cuddapah Basin, Andhra Pradesh, India

Recent investigations by Atomic Minerals Division have brought into focus the presence of uranium mineralization hosted in fracture zones in granite close to the unconformity with the overlying Srisailam quartzite in Lambapur area[1,2], in the north-eastern part of the Cuddapah basin. Investigations further east of the Srisailam sub-basin have revealed the presence of significant concentration of uranium (up to 0.55% U_3O_8 with negligible ThO_2) in the quartzite grouped under Banganapalle Formation of Kurnool Group. This radioactive quartzite is exposed in the western parts of the Palnad sub-basin near Koppunuru, Alugurajupalle and Dwarakapuri villages (Survey of India Toposheet No. 56 P/7; 16°24′0″N; 79°20′20″E), Guntur district, Andhra Pradesh. Petrographically, the host rock is quartz arenite (orthoquartzite) with a high degree of mineralogical and textural maturity. Preliminary field data indicates that the mineralization has been influenced by major faults/fractures which facilitated the migration of (hydrothermal?) mineralizing fluids. The main uranium-bearing minerals in this rock are pitchblende, coffinite, phosphouranylite and metazeunerite associated with sulphides of copper, lead and iron. An attempt is made in this note to bring out the salient features of this new uranium find in the Palnad sub-basin, which has enhanced the uranium potentiality of the northern parts of the Cuddapah basin.

The Banganapalle quartzite is the oldest lithounit of the Palnad sub-basin (equivalent to Kurnool sub-basin) in the north-eastern corner of the crescent-shaped Cuddapah basin[3]. In this part of

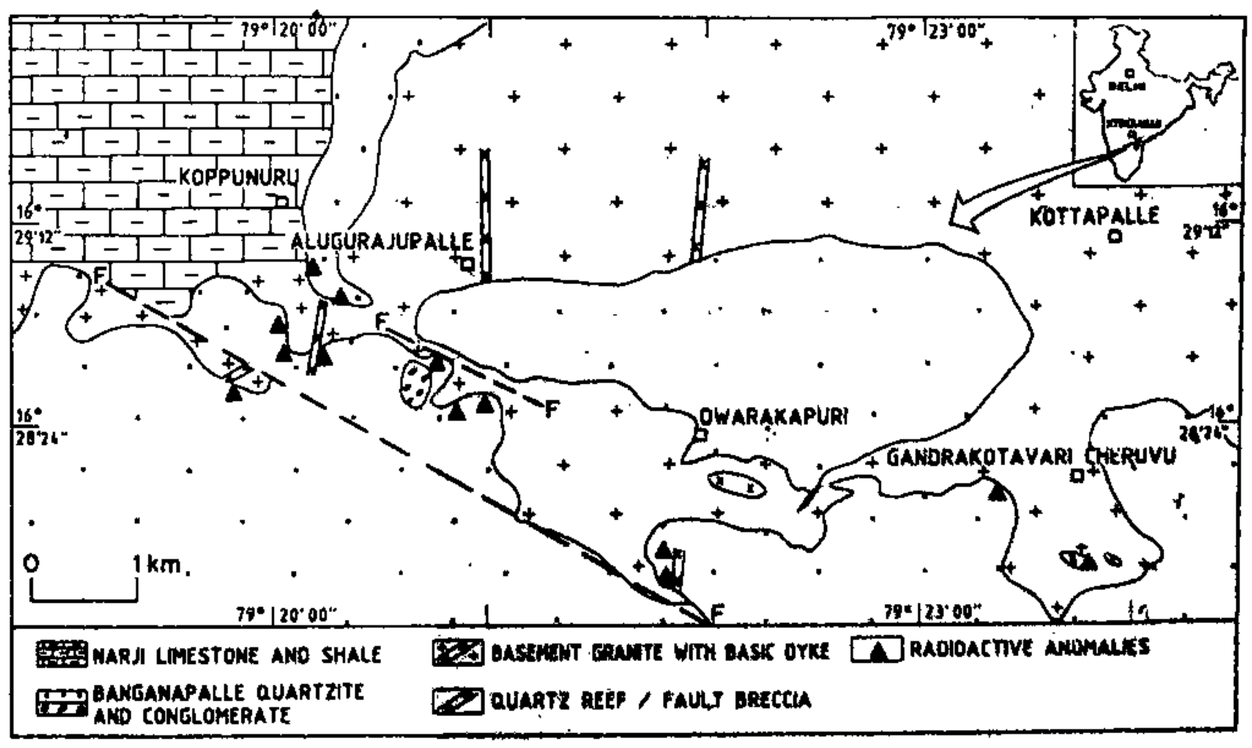

Figure 1. Geological map of Koppunuru–Dwarakapuri area.

the Cuddapah basin, the Banganapalle quartzite unconformably overlies the basement granite (Figure 1). The basal unit of this formation is a conglomerate/pebbly quartzite, followed by ferruginous and grey quartzite exhibiting primary sedimentary structures such as ripple marks and current bedding. These are invariably capped by pitted quartzite. At places, this quartzite has intercalations of black shale. Euhedral pyrite and specks of chalcopyrite occur throughout this sequence. The quartzite is subhorizontal with a low dip of 2° to 6° towards southeast. Major WNW-ESE trending faults, besides NNE-SSW trending minor faults, are the major structural features of this area and are marked by fault breccia, fault scarp and quartz reefs.

The preliminary petrographic studies on the samples suggest that the host rock is quartz arenite (orthoquartzite), which is well sorted, with subrounded to rounded, fine to medium-sized, grains of monocrystalline quartz, cemented by authigenic silica. In a few samples, lithic fragments of granite-mylonite, glauconite, chlorite, opaques and carbonaceous matter are present (8–20% modal). The rock fragments of crushed granite indicate granitic provenance. The presence of glauconite, with traces of carbonaceous matter, indicate marginal marine, mildly alkaline and reducing environment of deposition. The high degree of mineralogical and textural maturity and the chemical data of major oxides (analysed by rapid method of analysis using spectrophotometry, atomic absorption spectrometry, volumetry and flame emission photometry techniques) (Table 1) point to a stable erosional cycle of granitic provenance.

Uranium mineralization has been recorded in the grey and ferruginous quartzite of Banganapalle Formation and the quartz reef in basement granite. Mineralization occurs in several patches (Koppunuru – 20 m × 25 m to 150 m × 20 m, Alugurajupalle – 200 m × 1–5 (thickness), Dwarakapuri West – 300 m × 5 m (thickness) to 100 m × 2 m (thickness) and Dwarakapuri South – 400 m × 100 m) in a roughly E–W trending linear belt of 8 km, bounded on the southern side by a major fault (Figure 1). Uranium concentration, in the quartzite ranges from 0.013 to 0.55% U_3O_8 (Table 2) and the maximum concentration is observed at Dwarakapuri. Preliminary petrographic and X-ray diffraction studies indicate that the uranium mineralization is mainly attributed to the primary uranium minerals – pitchblende ($UO_2 \cdot UO_3$) and coffinite ($U(SiO_4)_{1-x}(OH)_{4x}$), the secondary uranium minerals – uranophane ($Ca(UO_2)_2(SiO_3OH)_2 \cdot 5H_2O$), phosphouranylite ($Ca(UO_2)_3(PO_4)_2(OH)_2 \cdot 6H_2O$) and metazeunerite ($Cu(UO_2)_2(AsO_4)_2 \cdot 8H_2O$) and the accessory uranium minerals – chevkinite (Ca, Ce)$_4$ (Fe Mg)$_2$ (Ti, Fe)$_3$ Si_4O_{22}) and zircon ($ZrSiO_4$). These are associated with chalcopyrite ($CuFeS_2$), pyrite (FeS_2) and galena (PbS). The uranium-bearing minerals occur along fractures, cavities and bedding planes. Some amount of uranium is also adsorbed on goethite, glauconite, clays, goethitized pyrite, carbonaceous matter and malachite. Interestingly the quartz reef, with associated chalcopyrite and pyrite analysed up to 0.036% U_3O_8.

The radiometric assay values indicate that most of the samples show disequilibrium in favour of parent (uranium). The disequilibrium ratio, on an average, is 1:1.35. This high disequilibrium in favour of uranium is apparently related to the high concentration of secondary uranium minerals in these quartzites.

In view of the favourable geological setting, similar to that of Lambapur[1,2] the presence of high concentration of

Table 1. Chemical analysis of Banganapalle quartzite Koppunuru–Dwarakapuri area, Guntur Dist., A.P.

Locality	S. No.	SiO_2	Al_2O_3	CaO	MgO	FeO	Fe_2O_3	MnO	Na_2O	K_2O	TiO_2	P_2O_5
Koppunuru East	1	99.00	0.25	<0.02	<0.02	0.28	0.06	0.0023	<0.10	<0.10	<0.05	0.02
	2	98.95	0.45	<0.02	<0.02	0.28	0.13	0.0036	<0.10	<0.10	0.09	0.04
Koppunuru South–east	3	98.00	0.36	0.031	<0.02	0.44	0.86	0.0015	<0.10	<0.10	0.05	0.06
	4	97.85	0.64	0.13	0.026	0.32	0.17	0.0088	<0.10	0.10	0.10	0.15
Alugurajupalle	5	88.60	1.15	0.036	0.026	0.46	9.50	0.0012	<0.10	<0.10	0.09	0.27
	6	80.60	2.87	0.062	0.040	0.36	13.04	0.0036	<0.10	<0.10	0.09	0.35
Dwarakapuri South	7	92.00	2.23	1.29	0.073	0.28	0.51	0.0033	<0.10	0.61	0.05	1.13
	8	98.00	0.55	<0.02	<0.02	0.22	0.21	0.0020	<0.10	0.22	<0.05	<0.02

Table 2. Radiometric assay data – Koppunuru–Dwarakapuri area, Guntur Dist., AP

Area	No. of samples (n)	Radiometric assay $\%U_3O_8$ Range	Average	$\%U_3O_8$ $\frac{(Beta)}{(Gamma)}$ Range	Average	$\%ThO_2$	Disequilibrium factor $\left(\frac{\%U_3O_8\ (Beta)}{\%U_3O_8\ (Gamma)}\right)$
Koppunuru	8	0.014–0.077	0.039	0.013–0.083	0.039	<0.005	1:1
Koppunuru east	11	0.010–0.092	0.047	0.020–0.16	0.071	<0.005	1:1.51
Koppunuru south east	6	0.016–0.28	0.095	0.019–0.42	0.143	<0.005	1:1.50
Alugurajupalle	5	0.011–0.039	0.024	0.016–0.045	0.030	<0.005	1:1.25
Dwarakapuri	7	0.054–0.34	0.153	0.059–0.55	0.231	<0.005	1:1.51

uranium in association with sulphides in the quartzite, the discovery of uraniferous anomalies in Koppunuru–Dwarakapuri area have opened-up the entire Palnad sub-basin as a very favourable target for uranium exploration.

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A. V. JEYAGOPAL
PRAKHAR KUMAR
R. M. SINHA

Atomic Minerals Division,
Department of Atomic Energy, Begumpet,
Hyderabad 500 016, India

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National Symposium on Natural Resources
Management System,
Department of Botany, St. Joseph's College
Tiruchirapalli 620 002
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Fax: 0431–27501

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