SHORT COMMUNICATION

PROTEROZOIC UNCONFORMITY RELATED URANIUM MINERALISATION AROUND CHITAKHOL, KORBA DISTRICT, CHHATTISGARH, INDIA

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The paper reports for the first time uranium mineralisation along the northern fringes of the late Proterozoic Chhattisgarh basin that enhances the potential of the region to host "unconformity related uranium deposits".

Introduction

Several uranium deposits have been discovered in the last few decades, which by their large size and higher grades have been brought under a new class, called "Proterozoic unconformity related uranium deposits" which are lithostratigraphically confined to the unconformity, along or near, between the Lower Proterozoic basement and the Middle Proterozoic cover sediments. Some of the outstanding examples of such class are the deposits of Pine Creek geosyncline, Australia (Needham and Roarty, 1980; Needham et al. 1988) and Athabasca basin, Canada (Fogwill, 1981; Sibbald, 1987 and 1988; Matthews et al. 1997) that account for more than 30% of the total uranium reserves of the world. These deposits are of two types: (a) fracture bound and (b) clay bound, and are defined by their setting with respect to the unconformity, host rock paragenesis and ore grades (Dahlkamp, 1993). In India the discovery of unconformity related uranium mineralisation at Lambapur, Nalgonda district, Andhra Pradesh in the northern margins of Cuddapah basin has given a new direction to uranium exploration efforts in other analogous Proterozoic basins (Sinha et al. 1995). Chhattisgarh basin and its surroundings have been under intensive exploration for uranium by AMD for the past three decades, which has resulted in locating numerous uraniferous anomalies in its southeastern margin. This includes the polymetallic mineralisation associated with uranium at Juba confined to the basal member of Rehatikhol Formation of Singhora Group of Chhattisgarh Supergroup (Jain et al. 1998) and the anomalies associated with the fracture zones in the basement Sambalpur granites close to the unconformity with the Chandarpur sediments around Dulapali-Dongripali-Damdama (Mukundhan et al. 2000). Thus, geological favourability and potentiality of Chhattisgarh basin for hosting uranium mineralisation was recognised and exploration activities were intensified in the northeastern margin of the basin. This resulted for the first time, presence of significant uranium occurrences along the unconformity between the basement granites and overlying sediments of Chandarpur Group of Chhattisgarh Supergroup around village Chitakhol, Korba district, Chhattisgarh.

Geology of the Area

The nearly crescent shaped Chhattisgarh basin of Central India forms a part of Bastar Craton and occupies an area of about 33,000 sq. km. It has a maximum length of 300 km along ENE-WSW and a maximum width of 150 km in the south-central part. It is bound by Sonakhan greenstone belt in the south, Bilaspur-Raigarh–Surguja crystallines/ metamorphics in the north, the Sambalpur granitoids in the East and the N-S trending Kotri Supergroup and Chilpi Group are juxtaposed with the Chhattisgarh sediments in the west. The Chhattisgarh Supergroup comprises three Groups viz., the lower Singhora Group, the middle Chandarpur Group and the upper Raipur Group. The Singhora Group is exposed only along two embryonic basins namely the Singhora and Narwapahar protobasins situated along the southeastern and eastern portion of the Chhattisgarh basin respectively. The main basin, which has an E-W axis, can be divided into two sub-basins viz., Hirri sub-basin in the west and the Baradwar sub-basin in the east. Majority of the litho units of Chhattisgarh Supergroup are best developed in Hirri sub-basin (Das et al. 1992).

The E-W trending Central India Shear (CIS) zone traverses the basement close to the northeastern margin of the Chhattisgarh basin resulting in intense structural disturbance in the study area as evidenced by the presence of faults, folds, joints etc. The faults have formed escarpment faces exposing the basement granites and overlying sediments.

Chitakhol area (Fig. 1) lies in the northeastern margin of the Chhattisgarh basin where Early Proterozoic granitoids

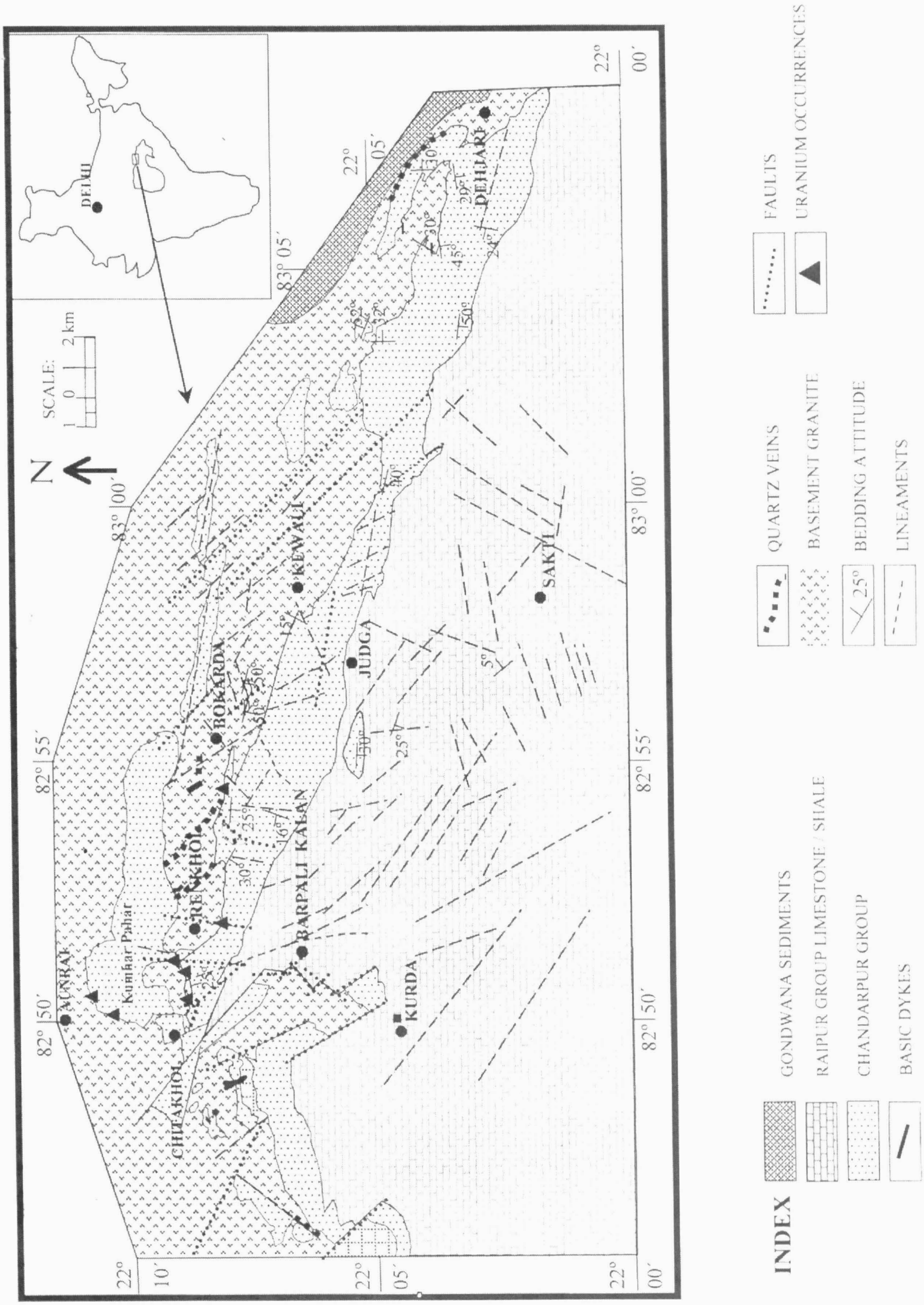

Fig.1. Lithostructural map of Chitakhol and adjacent areas, Korba, Jangir-Champa and Raigarh Districts, Chhattisgarh. (T.S. No. 64J/16 and 64N/4).

of Bilaspur-Raigarh-Surguja crystallines are overlain by the middle to upper Proterozoic sediments of Chhattisgarh Supergroup (Sarkar et al. 1990). Topographically the study area is characterized by WNW-ESE trending hill range and falls within Sakti Reserve Forest area. The northern and western sides of the hills show faulted escarpments. The southern side exposes southward dipping Chandarpur sediments. The basement granitoids comprise a number of varieties of granites of which the medium grained, hypidiomorphic grey granite dominates and covers vast areas. The granites are highly altered (chloritisation, ferruginisation) particularly near the unconformity contact. Highly ferruginised, pre-sedimentary basic dykes traverse the basement granites along NW-SE. The Chhattisgarh Supergroup of rocks comprises two groups — namely the older Chandarpur Group and the younger Raipur Group. The Chandarpur Group unconformably overlies the basement granites and comprises mainly conglomerate (basal as well as intraformational), siltstone, shale, arkosic sandstones and quartz arenites. The Chandarpur sediments have dips of 5-30^{O} due south and thicknesses varying from 20 to 200 m. There may be local variations of dip and strike due to structural disturbances. The Raipur Group mainly comprises impure limestones and calcareous shales. The Raipur Group of sediments are exposed in the lowlands to the south of the hill range and show dips of 5-30^{O} in both north and south directions. Lineament map of the area, prepared using LISS III satellite imagery shows WNW-ESE, NW-SE and NNE-SSW to be the major trends. Rose diagram plots of joint/fracture attribute data have revealed the presence of four dominant trends viz., WNW-ESE, NW-SE, N-S and E-W, of which the WNW-ESE trend is the most prevalent and the N-S direction being the youngest of them.

Uranium Mineralisation

Systematic radiometric checking in the area has picked up significant uranium mineralisation along the unconformity of basement granite and Chandarpur Group of sediments in Korba district of Chhattisgarh state. Detailed radiometric checking reveals six major anomalous zones, near Chitakhol, Renkhol, Bokarda, Kumharpahar and Aunrai (22°08'37"N - 22°09'26"N & 82°50'28"E- 82°54'20"E, Survey of India Toposheet No. 64J/16) spread over an area of 20 sq.km. Two of these zones in Chitakhol are 1500 m and 700 m long and 0.50-1.0 m thick. The other anomalies extends from 100 to 300 m and are 0.10 to 0.50 m thick. Surface samples assay from 0.016 - 0.39% U_3O_8 (n =58) with <0.005 % ThO_2. In all the occurrences, the uranium mineralisation extends over a zone, which includes the basement granites and the overlying Chandarpur sediments. A major part of the mineralisation is confined to sediments just above the unconformity irrespective of rock type viz., conglomerate, shale, siltstone and quartz arenites.

The granites are highly fertile in general and show better mineralisation along fractures (values upto 0.073 % U_3O_8). Highly ferruginised pre-sedimentary basic dykes within the granites are also mineralized with surface samples assaying upto 0.21%U_3O_8. Intense fracturing and associated ferruginisation is observed both in the granites and in the sediments along WNW-ESE, E-W, N-S and NW-SE directions indicating reactivation of these fractures after the sedimentation. As mineralisation is found in almost all the rock types in the area, the unconformity contact as well as the fractures/joints seem to be important factors in the localization of the mineralisation.

The mineralized sedimentary rock samples are identified as ferruginous sub-litharenites and chloritised sub-arkoses. The clasts are fine to coarse sand-sized with rare granule to pebble-sized grains, sub-angular to sub-rounded, poorly sorted and immature in nature. Major minerals are quartz, microcline and microperthite. The lithic fragments include schists, granite, quartzites and altered basic rock. Minor/accessory minerals are identified to be goethite, pyrite, biotite, zircon, sphene, chalcopyrite and rare leucoxene. The cementing material is ferruginous or sericitic/chloritic or clayey. Pyrite occurs as fine specks and is marginally to fully altered and released out iron oxide in the form of goethite. The host rocks are criss-crossed by microfractures that are filled with goethite forming fine veinlets. Radioactivity is mainly due to uranium adsorbed on to goethite, which is also present as cementing material. It is noted that intensity of radioactivity increases with concentration of goethite. Chlorite present in fractures is formed as a result of alteration of biotite and shows feeble radioactivity. Uranophane/kasolite a secondary uranium mineral is seen on the surface and along the fractures. It is dull brown to dull white and gives a brilliant green fluorescence under ultraviolet light. Refractory minerals such as monazite and zircon are present in sediments. Metamict and broken zircons are present in a disseminated way throughout the rocks. In addition, the basal conglomerate contains profuse meta-autunite in the microfractures traversing the samples.

The basic dyke material is identified to be altered glass bearing basalt. The rock is very fine grained, showing intergranular and intersertal, ophitic to sub-ophitic texture with lot of interstitial glass. Major minerals are plagioclase, pyroxene and glass. Minor/accessory minerals are ilmenite, leucoxene, pyrite, sphene and rare grains of chalcopyrite.

Plagioclase i.e. labradorite occurs as fine laths forming triangular network structure. Ilmenite forms skeletals, needles and fine granules, which are disseminated in the rock. Most of the ilmenite grains are altered into leucoxene and also forms aggregates of sphene. Pyrite forms cube and aggregate of grains and occurs, mostly, in altered portion of the rock. Significant radioactivity is associated with the altered portion (goethitic) of the pyrite grains, especially near the grain boundaries, where concentration of hydrous iron oxide is more. Feeble radioactivity is also found due to secondary brannerite (uraniferous leucoxene) disseminated throughout the rock. Radioactivity is mainly confined to the altered portion of the rock samples containing good concentration of sulphide.

The mineralized granitic basement samples are identified to be monzo-granites. The rock is medium to coarse grained, subhedral, equigranular showing hypidiomorphic texture. Major minerals are identified as quartz, microcline, perthite, plagioclase (oligoclase) and myrmekite. Minor minerals are biotite, chlorite, magnetite, sphene, rutile, muscovite and secondary calcite. Fe and Ti that are released out of the biotite grains have been deposited along the grain boundaries. Magnetite, sphene and rutile are disseminated throughout the rock. Magnetite is titanium rich and contains exsolution lamellae of ilmenite. Traces of uraninite and extremely fine pitchblende have been identified by XRD apart from refractory phases such as metamict zircon and rare allanite.

Concluding Remarks

The discovery of significant uranium occurrences associated with the unconformity contact, between the basement granites and Chhattisgarh sediments is reported. Six anomalous zones of uranium mineralisation have been delineated in the area. Uranium minerals like extremely fine pitchblende, beta-uranophane, autunite and brannerite are identified by XRD studies and uranium seems to occur in an adsorbed state onto ferruginous matter forming U-Fe-Ti complex. Petromineralogical studies of all the rock types indicate a probable dynamothermal reactivation of the study area. This has probably resulted in the introduction of uranium through hydrothermal solutions and later adsorption/absorption on to available iron oxide material within the microfractures in the rocks especially in the vicinity of the unconformity interface. The geological setting i.e., the unconformity between the Chandarpur sediments and basement crystallines is a notable feature and calls for targeting such zones for uranium exploration. Present preliminary work carried out in field as well as in laboratory led to initiation of sub-surface exploratory drilling, which has commenced at Chitakhol area to probe the nature, control and extent of the mineralisation. In view of favourable criteria, this discovery has opened up a new vista in the field of uranium exploration in the northeastern margin of Chhattisgarh basin.

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JGSI-Radhakrishna Prize for the best paper published in the Journal of the Geological Society of India during the year 2004.

N.N. Chatterjee Award for contributions in the field of Energy Resources

S. Narayanaswami Award for contributions in the field of Economic Geology.

GSI Sesquicentennial Commemorative Award for outstanding contributions in the field of Engineering Geology and Coastal Geotechnics in India.

Hari Narain Award for outstanding work in the field of Indian Geophysics.

K.K. Menon Award for outstanding work in the field of Sedimentology.

While making the nominations, Fellows are requested to furnish the following information:

1. Name of the Award
2. Full name, age and address of the nominee
3. Academic qualifications and positions held by the nominee
4. List of significant publications and
5. A brief statement by the proposer (not more than 300 words) giving a gist of major scientific achievements of the nominee in justification of the award.

Self nominations may be avoided.

R.H. SAWKAR
Secretary