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URANIUM MINERALIZATION IN THE KHETRI SUB-BASIN, NORTH DELHI FOLD BELT, INDIA

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INTRODUCTION

Palaeo-Mesoproterozoic North Delhi Fold Belt (NDFB) [1&2] of the Aravalli craton trending NE-SW extends from Delhi in the north to Ajmer in the south in parts of Rajasthan and Haryana states. The NDFB is characterised by presence of synkinematically emplaced granites yielding 1.73 - 1.70 Ga age (combined zircon U-Pb ages and Lu-Hf isotope data) [3-5]. This belt comprises three sub-parallel volcano-sedimentary sub-basins namely Khetri, Alwar and Lalsot-Bayana from west to east. Among these Khetri Sub-basin is identified as an important host for copper [6], uranium [7-12] molybdenum, iron and fluorite mineralisation. This paper deals with uranium mineralisation of Khetri Sub-basin in light of its geological attributes and potentiality.

GEOLOGICAL SET-UP

The folded sequences of Palaeo-Mesoproterozoic Delhi Supergroup (DS) of rocks form a narrow belt extending from Haryana in the north to Gujarat in the south. This belt is further sub divided into older North Delhi Fold Belt (NDFB) and younger South Delhi Fold Belt (SDFB) [2]. This subdivision is based largely on the Rb-Sr whole-rock isochron data from synkinematically emplaced granites that yielded 1.65 - 1.45 Ga and ˜ 0.85 Ga ages, respectively in NDFB and SDFB [4-5]. These belts are separated by a migmatitic gneiss tract around Ajmer [13]. The NDFB is constituted of three sub-basins designated as Khetri, Alwar and Lalsot-Bayana sub-basin from west to east respectively.

The Mangalwar Complex of Banded Gneissic Complex (BGC) forms the basement and comprises high grade metamorphic and migmatised rocks in the southern parts of Alwar sub-basin. The grade of regional metamorphism recorded in the rocks of the Delhi Supergroup is upto amphibolites facies.
The Khetri Sub-basin (KSB) exposes rocks of DS over basement comprising gneisses, paragneiss and mica schists of Mangalwar Complex. DS in this sub-basin is further subdivided into Alwar Group, followed by Ajabgarh Group with gradational contact. Alwar Group comprises mainly arenaceous units and Ajabgarh Group is predominantly argillaceous and calcareous. Occurrence of felsic tuff was recorded in the quartzite of upper part of Ajabgarh Group which has been dated 1830 Ma [3]. The lithounits of KSB have experienced three phases of deformations related to Delhi Orogenic cycle [14 & 15]. The first and second phases of folds are coaxial and trending NE-SW direction. F1 folds are isoclinal and F2 folds are normal upright to inclined with moderate plunge due northerly. F3 folds have their axial plane trending along WNW-ESE direction. The lithounits of DS of KSB have experienced two major events of regional metamorphism. The first phase of metamorphism is prograde upto amphibolite facies while second phase of metamorphism is retrograde to greenschist facies. Several phases of acidic and basic igneous activities including emplacement of granites and pegmatites have been recorded in this sub basin.

This sub-basin is characterised by presence of broad zones of albitisation [16-18] including 20km linear zone in the Khandela-Kerpura-Guhala sector of southern Khetri copper belt [12] and two other zones in Maonda-Sior sector of northern Khetri copper belt and Sakun Ladera sector of NDFB, which define a narrow zone of approximately 170 km length along NNE –SSW direction. S. K. Ray [16] defined this zone as 'Albitite Line' indicated by linearly arranged albitite, albitised and alkali metasomatised rocks along deep seated fracture zones. Majority of the litho-units in the vicinity of albitite zones have been subjected to albitisation. These albitite zones follow NNE-SSW trend which is also trend of Kaliguman and Khetri lineaments. A few other

albitite occurrences have been subsequently reported by other researchers which form a linear zone about 130 km in length and 5–12 km in width from Neorana in the north to Nayagaon in the south. This zone has regional NE-SW trend and forms another albitite line about 20-40 km east of the known albitite line (18). Polymetallic occurrence of Narda is reported along this albitite zone. Thus different episodes of albitisation have been observed in this sub-basin.

URANIUM MINERALISATION

Uranium exploration including heliborne geophysical survey, ground radiometric survey, hydro-, litho- and pedo-geochemical surveys carried out in this sub-basin by Atomic Minerals Directorate for Exploration and Research (AMD) helped in delineating several potential zones for uranium mineralisation [19-23]. Multi-parametric, high resolution heliborne geophysical surveys including aeromagnetic, frequency domain electromagnetic (FDEM) and time domain electromagnetic (TDEM) surveys and gamma ray spectrometry identified potential zones for U mineralisation within Ajabgarh Group in soil covered areas. Ground geophysical surveys in selected blocks helped in delineating low magnetic, high chargeability trends and low resistivity zones for further exploration. Radiometric survey during last six decades brought to light more than 400 radioactive anomalies. These anomalies are predominantly confined to litho-units of Ajabgarh Group and associated with structurally weaker and altered zones.

The KSB can be sub-divided into three blocks namely Southern, Central and Northern. The Central Block extending from Rohil to south of Kantli lineament, is characterised by intensive albitisation and other alterations with more number of uranium occurrences and polymetallic mineralisation. Rohil and Jahaz uranium deposits are located in this block. Southern block extending from Rohil to Khatundra along NE-SW direction is characterised by comparatively less albitisation and less number of uranium occurrences as compared to Central Block. Northern Block, extending from north-east of Kantli lineament to Narnaul, is characterised by presence of extensive copper mineralisation and lesser number of uranium occurrences and lesser albitisation. Uranium occurrences in KSB are broadly associated with two NE-SW trending (eastern and western) albitite zones. Rohil, Guman Singh Ki Dhani, Narsinghpuri, Maota, Jahaz, Bagholi uranium occurrences are associated with western albitite zone, while Buchara, Ladi Ka Bas, Geratiyon Ki Dhani, Kalatopri, Rela-Ghasipura are associated with eastern albitite zone.

DISCUSSION AND CONCLUSION

Uranium exploration in Khetri sub-basin brought to light the presence of a low grade and medium tonnage 'metasomatite type'uranium deposit at Rohil and significant uranium occurrences in the contiguous area viz. Jahaz-Maota-Bagholi, Narsinghpuri, Guman Singh Ki Dhani, Hurra Ki Dhani, Ladi Ka Bas - Geratiyon Ki Dhani, Rajasthan and Rambas-Gorir, Haryana, which are under prospecting and evaluation. Uranium mineralisation in KSB is mainly associated with deep seated fractures/shears and axial region of F2 folds with intense hydrothermal activities and is preferably hosted by sheared / fractured, albitised and altered metasediments viz. quartz-biotite-chlorite schist, quartzite, carbonaceous/graphitic phyllite, quartz amphibole schist and calc-silicate of Ajabgarh Group. Alterations recorded in this area are mainly albitisation, chloritisation, silicification, sericitisation, calcitisation and sulphidisation [23]. Uraninite is the dominant uranium mineral in addition to minor brannerite and coffinite. It occurs in clusters, as disseminations of subhedral grains and in vein/veinlets. The geochemistry of the mineralised rock indicates polymetallic (U-Cu-Mo) nature of mineralisation associated with sulphides like chalcopyrite, molybdenite, pyrite and pyrrhotite. The uranium mineralisation of KSB exhibits its similarity to 'metasomatite type'[24] especially with Na-metasomatite subtype of uranium deposits of Australia, Ukraine, Brazil, Canada and Guyana as indicated by its close association with albitite zone, high Na2O content and high Na2O/K2O ratio. Presence of coarse sized dispersed uraninite in albitite veins also supports close relation of albitisation and uranium mineralisation. The age of uranium mineralisation in Rohil and Jahaz are 830±5Ma and 841±26Ma respectively [25].

Presently, heliborne geophysical data is being utilised in conjunction with detailed surface and sub-surface geological, geochemical and geophysical investigations for prioritising potential target areas for uranium mineralisation in other parts of Khetri sub-basin for follow-up exploration. High chargeability zones with low magnetic anomalies have emerged as a geophysical guide for exploration for concealed uranium mineralisation in Khetri sub-basin, North Delhi Fold Belt in parts of Rajasthan.

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Country or International Organization

INDIA

Primary author: Mr MISHRA, BRUNDABAN (GOVERNMENT OF INDIA DEPARTEMNT OF ATOMIC ENERGY ATOMIC MINERALS DIRECTORATE FOR EXPLORATION AND RESEARCH)

Co-authors: Mr KAMLESH, KUMAR (GOVERNMENT OF INDIA DEPARTEMNT OF ATOMIC ENERGY ATOMIC MINERALS DIRECTORATE FOR EXPLORATION AND RESEARCH); Mr NANDA, LALIT KUMAR (GOVERNMENT OF INDIA DEPARTEMNT OF ATOMIC ENERGY ATOMIC MINERALS DIRECTORATE FOR EXPLORATION AND RESEARCH); Mr KHANDELWAL, MAHESH KUMAR (GOVERNMENT OF INDIA DEPARTEMNT OF ATOMIC ENERGY ATOMIC MINERALS DIRECTORATE FOR EXPLORATION AND RESEARCH)

Presenter: Mr MISHRA, BRUNDABAN (GOVERNMENT OF INDIA DEPARTEMNT OF ATOMIC ENERGY ATOMIC MINERALS DIRECTORATE FOR EXPLORATION AND RESEARCH)

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