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Mega crystals of uraninite and euxenite in the mica pegmatite mine-dumps near Talupuru, Nellore district, Andhra Pradesh

Fine-sized uraninite has been reported earlier from the Sankara mine within the Nellore Schist Belt (NSB), Andhra Pradesh (AP), India[1]. Here, we report the occurrence of euhedral mega uraninite (UO_2) crystals and euxenite (niobate and titanate of yttrium, heavy rare earths and uranium) from the mica mine-dumps of mica pegmatites located near Talupuru (Survey of India toposheet No. 57 N/11; lat. 14°18′24″N: long. 79°40′55″E) (Figure 1) in NSB. The Archaean NSB, with an overall N–S trend and a westerly arcuate disposition, extends over 200 km in Nellore and Prakasam districts of AP. It comprises mainly two distinct litho-stratigraphic units, viz. (i) the lower, high-grade metamorphic schists (hornblende schist and amphibolite with ± garnet and biotite) and associated migmatites in the eastern, central and southern parts, and (ii) the upper metavolcanics (Kandra volcanics) and metasediments, mainly in the western, northwestern and southwestern parts. Within the NSB, a cluster of economically important Proterozoic pegmatites occur in an area of 100 × 20 km, starting from Ojili in the south to Udaigiri in the north, which is popularly known as the Nellore Mica Belt (NMB; due to it being an economically important source of muscovite mica)[2]. Rajeswari, Yashoda Krishna, Bhavani Shankar, Radha Krishna, Parlapalle and Kattubadipalle mica mines are located around Talupuru occur in the west-central part of the NMB; the first two are working mines. The size (m) of the studied mine-dumps is as follows: Rajeswari mine: 15 (length) × 5 (width) × 1 (height); Yashoda Krishna: 50 × 5 × 0.5; Bhavani Shankar: 25 × 3 × 1; Radha Krishna: 50 × 3 × 1; Parlapalle: 15 × 3 × 0.5, and Kattubadipalle: 20 × 3 × 0.5. The dumps of these mines were examined for radioactivity using a scintillometer and the radioactive material was separated. From this

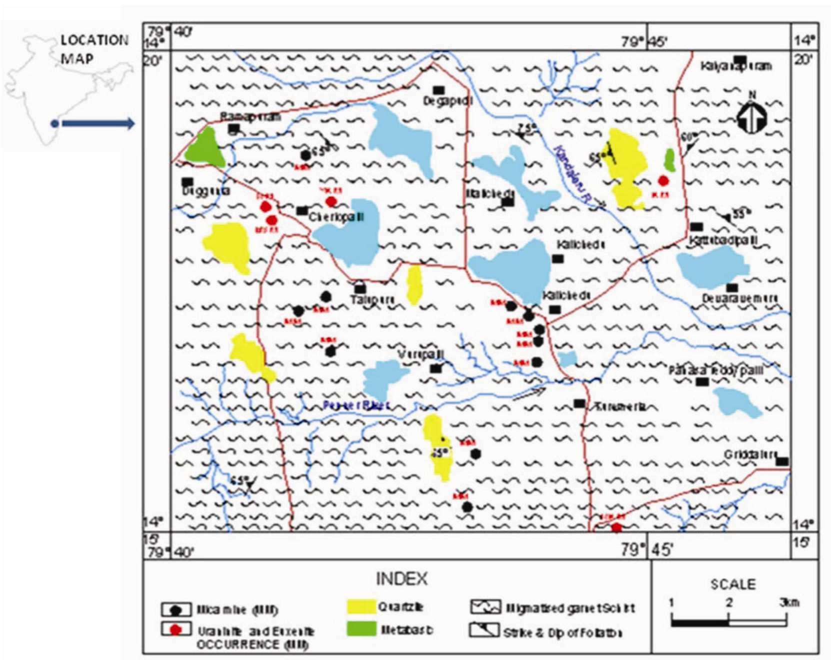

Figure 1. Geological map of part of Nellore mica belt showing uraninite–euxenite occurrence, Nellore district, Andra Pradesh, India (toposheet no. 57N/11, 12 and 15).

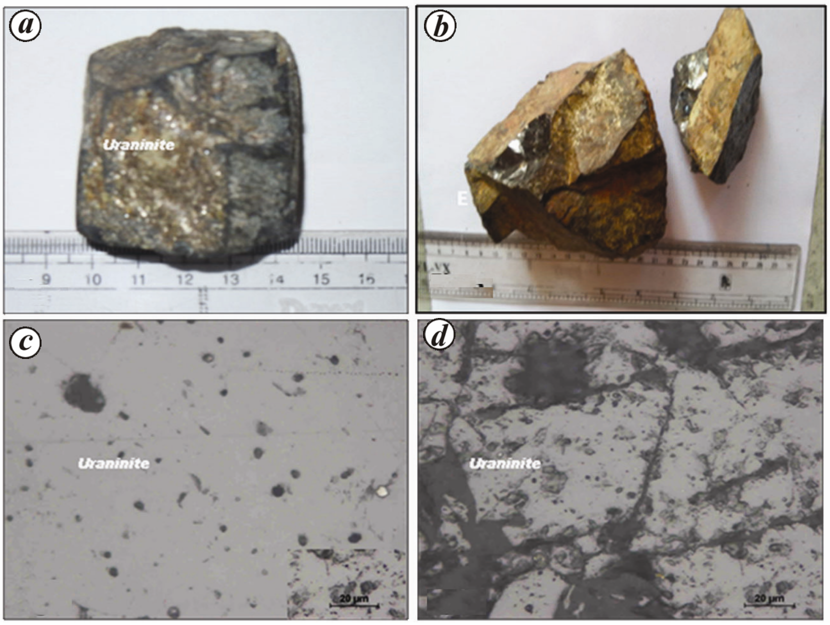

Figure 2. ***a***, Mega crystal of uraninite from the dump of Yashoda Krishna mica mine, Talupuru. ***b***, Metamict euxenite (E), in association with rare metal and rare earth minerals from R.K. mica mine, Griddaluru. ***c***, Uraninite (RL, 1N) grains, grey in colour, low reflectivity, fresh and no pitting from Yashoda Krishna mica mine, Talupuru. ***d***, Uraninite (RL, 1N) grains showing microfractures, healed with fine-grained quartz and calcite from Rajeswari mine.

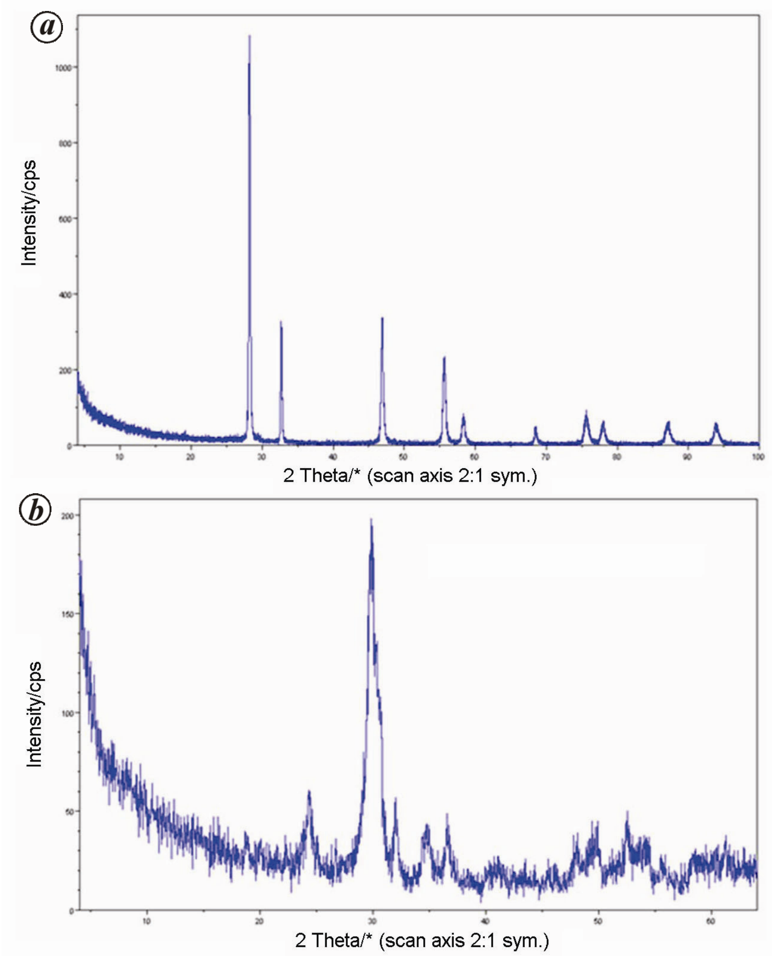

Figure 3. X-ray powder diffraction pattern of (***a***) uraninite and (***b***) heat-treated euxenite.

radioactive concentrate, non-magnetic heavy minerals were hand-picked. Megascopic examination and laboratory studies led to the identification of mega crystals of uraninite (Figure 2 *a*, *c* and *d*) from the first three mines and euxenite (Figure 2 *b*) from the last three mines.

Cubic crystal of uraninite (4.5 × 4.5 cm; Figure 2 *a*) is black in colour with a dull lusture and specific gravity of 9.20. Chemical analysis of mega uraninite crystals ($n = 2$) revealed (wt%): U_3O_8: 53.95 and 71.67; ThO_2: 6.90 and 8.35; ∑REE: 3.21 and 2.45 (LREE: 1.16 and 0.98; HREE: 2.05 and 1.47). X-ray diffraction (XRD) study of mega uraninite crystal (Figure 3 *a*) revealed unit cell dimension (a_0) of 5.4747 Å and unit cell volume (V) of 164.090 Å^3. The values of a_0 of uraninite are anomalously high compared to those of uraninite standard (5.445 Å) given in the International Centre for Diffraction Data (ICDD) Card No. 75-420. Anomalously high values of a_0 are due to the presence of notable Th and REE contents in uraninite. The high values of Th and REE are due to the substitution of U by Th^{4+} and REE^{3+} in the crystal lattice of the investigated uraninite. The high values of Th and ∑REE, especially HREE, and high values of a_0 and V of uraninite indicate that it is a high-temperature variety, typical of pegmatitic source[3], which corroborates its derivation from a pegmatitic melt that gave rise to mica pegmatites in the study area. XRD study of euxenite indicated that it is metamict in nature. After heat-treatment it yielded XRD pattern of euxenite (Figure 3 *b*). Its crystallographic parameters are $a_0 = 4.8650$ Å, $b_0 = 5.6180$ and $c_0 = 5.1840$ Å with unit cell volume (V) = 141.68 Å^3. Its partial chemical analysis (in wt%) is as follows: Nb_2O_5: 33.19; Ta_2O_5: 11.40; U_3O_8: 5.59; ThO_2: 0.68, and ∑REE: 4.55 (LREE: 1.89; HREE: 2.66). Similar to uraninite, euxenite is also radioactive due to the presence of U and shows a preponderance of HREE over LREE. It may be noted that scientists at the Atomic Minerals Directorate for Exploration and Research (AMD), Hyderabad have earlier identified the following rare metal and rare earth (RMRE) minerals in the NMB: beryl, columbite-tantalite, fergusonite, samarskite, microlite, metamict chevkinite and sipylite from different mica pegmatites of the NPB[4–6].

The occurrence of uraninite and a few RMRE minerals in various working and abandoned small to large mine-dumps of the NMB, as documented by the present and earlier studies of AMD, indicates that there is a potential to recover these minerals as by-products by physical beneficiation techniques from the waste dumps. It may therefore be worthwhile to take up further studies to quantify resources of these minerals for their recovery.

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Mafic and ultramafic dykes of Singhbhum craton from Chaibasa district, Jharkhand, Eastern India: geochemical constraints for their magma sources

The Singhbhum Granitoid Complex (SGC) of 3.2–2.8 Ga forms a major part of the Singhbhum craton (Figure 1 *a*)[1]. It is intruded by ultramafic, mafic and felsic dykes (having NE–SW and NW–SE as major trend directions) which are jointly called newer dolerite dykes (NDD)[2–10]. Available K/Ar age data[3] indicate that mafic members of NDD swarm had intruded the SGC intermittently during 2200 to 950 Ma. On the basis of K–Ar ages, Mallik and Sarkar[4] suggested three pulses of mafic intrusive activity, viz. 2100 ± 100, 1500 ± 100 and 1100 ± 200 Ma. Recently, mafic dykes of Singhbhum craton are reported as having 1765 Ma age by using Pb–Pb baddeleyite thermal extraction–thermal ionization mass spectrometer method[10]. The, ultramafic members of NDD swarms are dated 2613 ± 177 Ma on the basis of Rb–Sr isochron method[5]. Some workers have suggested that the ultramafic, mafic and felsic members of NDD swarms are genetically related representing cumulates, direct crystallization and partial melting products respectively[3]. However, Bose[6] opined that more studies are required to know possible genetic link between the mafic and ultramafic members of NDD swarms. Thus, it is not yet clear whether the mafic and ultramafic members of NDD swarms are genetically related or

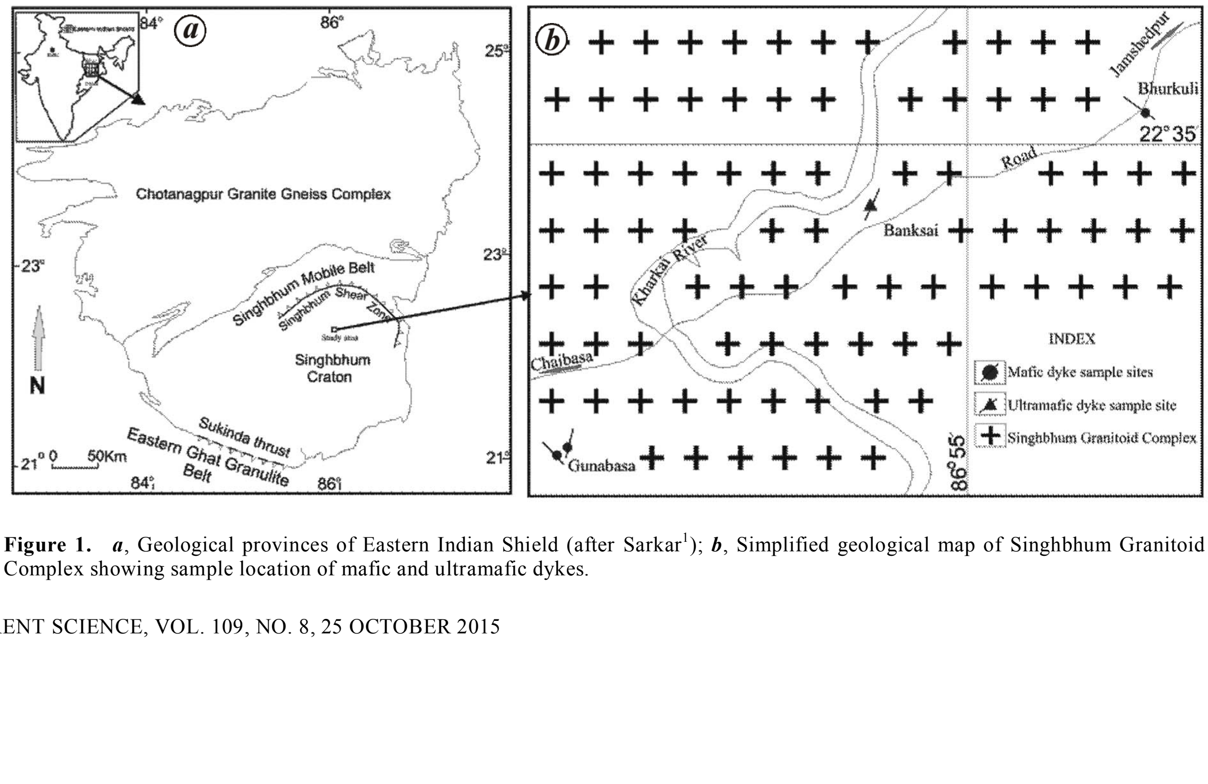

Figure 1. *a*, Geological provinces of Eastern Indian Shield (after Sarkar[1]); *b*, Simplified geological map of Singhbhum Granitoid Complex showing sample location of mafic and ultramafic dykes.