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Uranium Estimation in Mussoorie Phosphorites using Solid State Nuclear Track Detector

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A fission track analysis has been used to estimate the uranium concentration in phosphorite deposits of Mussoorie syncline in the lesser Himalayan region of Uttar Pradesh. The uranium content in these deposits has been found to vary from 0.01 to 0.06%.

It is an established fact that sedimentary type of uranium deposits are generally more enriched in uranium than precambrian metamorphic complexes[1-3]. The concentration of uranium in phosphorite deposits of Mussoorie syncline has been measured using homogenized fission track technique developed by Fisher[4].

The phosphorite deposits in Mussoorie outcrop along the periphery of a double plunging syncline for some 120 km. The syncline axis extends in a NW-SE direction for about 20 km. The phosphorite horizon occurs at the transition zone between the underlying Krol limestone and the overlying Tal shales and sandstones and has intercalations of chert and black shales.

Experimental technique—The experimental technique for uranium estimation is the same as reported elsewhere[5-7]. Sample powder (50 mg) was mixed with 100 mg of methyl cellulose powder used as a binding material. The mixture was pressed into a pellet of 1.3 cm diameter and 1 mm thickness. One such pellet was made of standard glass having a uranium concentration of 12 ppm. The pellets covered with Lexan discs on both sides were enclosed in an aluminium capsules and were irradiated from CIRUS Reactor of Bhabha Atomic Research Centre, Trombay, with a total integral thermal neutron dose of 5×10^{15} (nvt), where nv represents the thermal neutron flux available for irradiation in the reactor (5×10^{12} n/cm^2/sec for IC-1 position of CIRUS Reactor) and t is the irradiation time. The Lexan discs were etched in 6N NaOH at a temperature of 70°C for 30 min. The induced fission track density on Lexan discs was recorded using Olympus binocular research microscope with a magnification of ×600. Density of fission tracks was measured on surfaces showing uniform distribution of uranium. In order to avoid errors due to the external contamination, only the inner portions of the discs were scanned.

Uranium concentration in the rock sample was measured by comparison between track densities registered on Lexan detectors around the sample pellet and that of the standard glass pellet[5-7], from the relation:

$$C_{ppm}(\text{sample}) = \frac{\rho_{(\text{sample})}}{\rho_{(\text{standard})}} \times C_{ppm}(\text{standard}) \qquad \ldots(1)$$

where ρ is the induced fission track density and C_{ppm} denotes the U content.

In order to establish the correlation between uranium, phosphorus and magnesium in phosphorites, the magnesium content was determined complexometrically using EDTA titrations and phosphorus content was measured gravimetrically by precipitating phosphate as phosphomolybdate. U, Mg and P_2O_5 contents estimated are summarized in Table 1.

Results and discussion—The present investigations are based on the uranium estimation in phosphorite samples collected from Durmala, Maldeota and Parritibba deposits of Mussoorie syncline. The uranium content varies from 0.01 to 0.06%. Phosphorite sample from Parritibba mine has yielded maximum uranium content of 0.06% which is significant from the prospecting and exploration angle.

Udas and Mahadevan[3] have reported an average uranium content of 0.03% in the phosphorite horizon of Mussoorie syncline on the basis of geochemical investigation by Sarswat *et al.*[8] Thus results obtained here corroborate the earlier findings[8]. From the data (Table 1) it is evident that there is no direct correlation between uranium, magnesium and phosphorous contents of these phosphorites. The absence of correlation seems to be due to the fact that chemogenic precipitation of phosphates is possible under a much wider range of Eh-pH conditions than uranium[3].

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Table 1—U, Mg and P_2O_5 Contents (in ppm) in Mussoorie Phosphorites (Number of samples studied in each case is three)

Sample location	U (Mean)	Mg	P_2O_5
Maldeota	124.55 ± 0.99*	1.90	31.20
Durmala	143.82 ± 1.69	2.70	24.70
Parritibba	612.11 ± 1.16	2.30	33.40

*Standard error of the mean $S_M = \left[\frac{1}{N(N-1)} \sum_{i=1}^{N} (X_i - \bar{X})^2\right]^{1/2}$

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