Nuclear Tracks, Vol. 12, Nos 1-6, pp. 793-796, 1986.
Int. J. Radiat. Appl. Instrum., Part D
Printed in Great Britain.

0191-278X/86 $3.00+.00
Pergamon Journals Ltd.

URANIUM ESTIMATION IN SIWALIK VERTEBRATE FOSSIL BONES USING SSTD

N.P. Singh, Manwinder Singh, Surinder Singh and H.S. Virk

Department of Physics, Guru Nanak Dev University, Amritsar - 143005, India.

ABSTRACT

Results of fission track analysis for uranium content in Siwalik vertebrate fossil bones are reported. Background threshold for U content in fossil bones of this area is found to be 56.23 ppm. Uranium anomalies of 159.77, 165.10 and 418.08 ppm, respectively are found in samples from Saharanpur (U.P.), Naraingarh (Haryana) and Nalagarh (H.P.) areas of Siwalik Himalayas. The alpha-autoradiographic studies yield a linear relationship between alpha track rate and uranium content in the samples. The calibration curve obtained can be used to estimate the unknown U content in the Siwalik fossil bones. Uranium distribution studies on molar teeth of stagdon show U enrichment in ferruginous matrix in comparison to siliceous matrix.

KEY WORDS

Uranium, vertebrate fossil bones, alpha-autoradiograph, lexan print.

INTRODUCTION

Dar (1972), has reported the presence of uranium in Siwalik fossil remains of Elephas, Mastodon, Stagdon and Bos with U_3O_8 percentage varying from 0.003 to 0.005 %. Later, Udas and Mahadevan (1974) reported that the vertebrate fossils from upper Siwaliks contain uranium as high as 0.34% with no thorium. Various authors (Sahni et al, 1983; Sharma et al, 1983) have suggested the possible mechanism for uranium enrichment and it has been suggested that studies on spatial distribution and concentration of uranium in fossil bones from different stratigraphic levels of Siwalik rocks might help in the discovery of new uranium occurrences.

In the present work Siwalik bone samples of different localities have been collected and analysed for uranium using fission track techniques. Alpha autoradiographs and lexan prints of thin and small sections have also been studied to observe spatial distribution of uranium in these samples.

EXPERIMENTAL TECHNIQUES

Uranium estimation in fossil bone samples was carried out using homogenized fission track technique (Fisher, 1970). Spatial distribution studies were carried out with alpha autoradiographic technique (Basham, 1930, 1981). Brief description of the techniques is as follows:

Fission track technique

The bone samples were dried and powdered to a mesh size of 100 μm. 50 mgm of the bone powder was thoroughly mixed with 100 mgm of methyl cellulose powder which acts as a binder and the mixture was pressed into a pellet. The pellets (thin polished sections) then sandwitched between lexan detectors, were packed in aluminium capsule and were irradiated with a thermal neutron dose of $\approx 10^{14}$ (nvt) from CIRUS Reactor of BARC, Trombay. After irradiation the

lexan detectors were etched in 6.25N NaOH for 25 minutes and were scanned for track density measurements under Olympus microscope. Uranium content was determined using the formula (Fleischer et al, 1975):

$$C_x = C_s \frac{\rho_x}{\rho_s} \frac{I_s}{I_x} \frac{R_s}{R_x} \quad \ldots \quad (1)$$

where the subscripts x and s stand for unknown and standard respectively, U, the uranium content T, the fission track density, I, the isotopic abundance ratio of U^{235} to U^{238} and R, the range of fission fragments in microns. The correction factor (R_s/R_x) has been taken to be unity. Similarly, (I_s/I_x) has been taken to be unity on the assumption that isotopic abundance ratio is the same in the unkown and the standard.

Alpha autoradiographic technique:

A sheet of LR-115 plastic (acting as alpha track recorder) was pressed against the polished section of the bone samples. This assembly was then stored undisturbed for a period (depending on the alpha activity of the sample) to allow the alpha tracks to accumulate. After the accumulation period the LR-115 plastic was removed and etched for 3 hrs in 2.5N NaOH at 50°C. The plastic samples were then scanned to study the distribution of alpha tracks and the track densities were recorded.

RESULTS AND DISCUSSIONS

Our present work is based on the study of 25 vertebrate fossil bone samples collected from six different locations. Results of fission track analysis for U content and alpha track rate (N) for alpha autoradiography are reported in Tables 1 and 2.

Table 1. Fossil Bone Samples with normal U content

S.No.	Specimen	Locality	U content (ppm)	N*
F1	Limb bone	Kangra Area	15.55 ± 0.39**	-
F2	Elephant tusk	"	12.07 ± 0.34	187
F3	Bone fregment (Teeth dentate)	"	49.75 ± 0.83	-
F4	Hexaprotodone sivalerensis	"	39.46 ± 0.75	286
F5	Rib of Eliphas	Tirlokpur	41.34 ± 0.34	267
F6	Rib of Eliphas	"	37.56 ± 0.32	-
F7	Tortoise	"	25.76 ± 0.27	352
F8	Molar teeth of Stagdon	"	50.29 ± 0.37	-
F9	Unidentified	"	51.65 ± 0.37	301
F10	Teeth roots of Elephant	Nada Sahib	12.34 ± 0.18	203
F11	Teeth of Eliphas	"	23.82 ± 0.26	-
F12	Unidentified	"	20.28 ± 0.24	225
F13	-do-	"	26.78 ± 0.27	292
F14	Tortoise	"	18.52 ± 0.23	-

* Tracks/cm²/day.
** Statistical error (1σ)

Based on the present data for U content, threshold value is found to be 56.23 ppm for these samples. Uranium anomalies of 159.77, 165.10 and 412.08 ppm are found in the samples from Saharanpur (U.P.), Naraingarh (Haryana) and Nalagarh (H.P.) areas respectively of Siwalik Himalayas (Table 2). Sahni et al. (1983) have indicated that U concentration in fossil calcified tissues, irrespective of age is controlled by availability of uranium in contemporary environments in which the vertebrate lived and the nature of mineralising solutions acting as the carrier of uranium. The vertebrate fossil bones with anomalous U content can thus be used as an indicator for the uranium mineralization in the area. Thus U content anomalies identified in fossil bone samples from Saharanpur, Naraingarh and Nalagarh areas may be

helpful in uranium exploration programme.

Alpha - autoradiographic and lexan prints obtained from the polished section of samples have shown in general the uniform distribution of alpha and fission tracks except in one sample of molar teeth of Stagdon collected from Saharanpur (U.P.). In this sample uranium enrichment

Table 2. Fossil Bone Samples with anomalous U content

S.No.	Specimen	Locality	U content(ppm)	N*
FS1	Elephant Tusk	Saharanpur	118.60 ± 1.09	527
FS2	-do-	"	93.83 ± 0.96	255
FS3	Molar teeth	"	102.92 ± 1.01	430
FS4	Unidentified	"	159.77 ± 1.26	572
FN1	Tortoise Skull	Naraingarh	120.91 ± 1.30	-
FN2	Bone Fragmentry of Tortoise	"	98.50 ± 1.18	-
FN3	-do-	"	165.10 ± 1.52	691
FN4	Unidentified	"	119.78 ± 1.30	501
FV1	Horn piece	Nalagarh	418.08 ± 3.38	1379
FV2	Elephant tusk	"	292.86 ± 2.84	966
FV3	Unidentified	"	131.76 ± 1.03	551

* Alpha Tracks/cm^2/day
Threshold value of U content = 56.23 ppm.

(high fission track density in ferruginous matrix in comparison to Siliceous matrix (low track density) is shown in Figs. 1 & 2. Our result of uranium enrichment in ferruginous matrix corroborate the findings of Sahni et al (1983). When alpha track densities recorded directly through alpha-autoradiographic analysis are plotted against U content a linear dependence is obtained (Fig. 3) with the relation:

$$U = 0.34N - 54.61$$

where N is the alpha track rate/day. The absence of thorium in fossil bones of this area, which can contribute alpha tracks alongwith uranium, is already reported by Udas and Mahadevan (1974). Fig. 3 can thus be used as a calibration curve for estimating unknown U content in bone samples of this area using LR-115 type 2 as alpha track recorder.

ACKNOWLEDGEMENTS

The authors acknowledge the financial assistance of council of scientific and Industrial Research, New Delhi under Project No. 3(520)/83/EMR-II. Thanks are due to Dr. R.H.Iyer, BARC, Trombay and Dr. P.C.Ghosh, AMD, Hyderabad for the supply of plastic sheets. Thanks are also due to Dr. V.S.Soni, Lecturer, Mahindra College, Patiala and Dr. A.C. Nanda, Wadia Institute of Himalyan Geology, Dehra Dun for providing samples of fossil bones.

Fig.1. Microphotograph of molar teeth of stagdon

Fig.2. Microphotograph of lexan prints

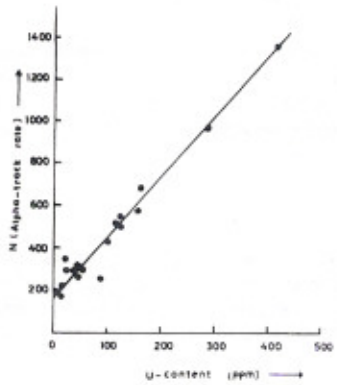

Fig.3. Variation of alpha track rate with U content

REFERENCES

Basham, I.R. (1980) Nucl. Tracks, 4, 33.
Basham, I.R. (1981) Economic Geology, 76, 974.
Dar, K.K. (1972) Proc. 24th Int. Geol. Cong. Section. Canada. 4, 387.
Fisher, D.E. (1970) Anal. Chem. 42, 414.
Fleischer R.L., P.B. Price, R.M.Walker (1975) Nuclear Tracks in Solids. Principals and Applications, University of California Press, Berkley.
Sahni, A., K.K.Nagpal, N.Lal, P.S.Suri, P.K.Sharma, and N.D.Bal (1983). Proc. 3rd National SSNTD Conf., Amritsar. p89.
Sharma, K.K., O.P.Sharma, V.M. Choubey and K.K. Nagpal (1983). Trans. Am. Nucl. Soc. 33, 148.
Udas, G.R. and T.M. Mahadevan (1974). Proc. Symposium. Athens. IAEA Vienna. pp.425.