JOURNAL GEOLOGICAL SOCIETY OF INDIA
Vol. 31, May 1988, pp. 488 to 490

A NOTE ON THE SIGNIFICANCE OF URANIUM AND THORIUM DISTRIBUTION IN GRANITOIDS FROM JOSHIMATH-BADRINATH OF CENTRAL CRYSTALLINE AXIS—KUMAUN HIMALAYA

PRAVEEN RAJ SAXENA* AND V. DIVAKARA RAO
National Geophysical Research Institute, Hyderabad 500007

Abstract

Thorium and uranium concentrations in the pelitic-schists and granitic gneisses in Joshimath-Badrinath area of Central Crystalline Axis, show gradual decrease with increase in metamorphism upto anatectic stage. The leucogranites of anatectic origin show unusual increase in uranium. The distribution suggests that with increase in metamorphism these elements were expelled. At a late stage there was uranium enrichment as indicated by scattered distribution in the leucogranite, ranging from 5 ppm to 32 ppm.

Introduction

The Central Crystalline Zone of the Himalaya consists of metamorphic/metasomatic and magmatic granites of pre-, syn- and post-tectonic stages occurring together with undoubted vestiges of Precambrian shield crystallines.

In the Badrinath-Joshimath area, the metamorphics show a gradual granitisation from pelitic schist to granitic/augen gneiss, resulting finally in anatectic leucogranite intrusives (Saxena, 1986). This gradual change in lithology along with certain variations in mobile element chemistry is observed throughout, especially in respect of thorium and uranium.

Analytical Technique

A gamma-ray spectrometer was used for uranium and thorium analysis. The detector forms an integral part of assembly, consisting of a 4″ (dia) × 2″ thin NaI (Tl) crystal coupled to a 3″ RCA-8054 photo-multiplier tube operated at 1200 V, with amplifier gain about 70.

Count rates obtained under distinct segments of the amplitude spectrum, with the rock sample as well as with standard samples containing known amounts of uranium and thorium under identical sample detector conditions and fixed sample detector geometry, gave the uranium and thorium content in the rock samples. Inherent in this analysis is the assumption, of secular equilibrium of U^{238} and U^{232} with their respective daughter isotopes down the series, as the samples have been thoroughly treated to remove leachable uranium before analysis.

Uranium, Thorium Concentrations

From the different metamorphic zones of Kumaun Himalaya, uranium (U) and thorium (Th) were determined in a few selected samples from biotite chlorite sericite schists, banded augen gneisses, granitic gneisses and post-tectonic tourmaline granites (see Table I).

* Present Address: Scientist/Lecturer in Applied Geochemistry, Department of Geology, Osmania University, Hyderabad, 500007.

0016-7622/88/31-5-488/$ 1.00

TABLE I.
U, Th and Th/U ratios in granitoids from Joshimath-Badrinath.

Sample description	S. No.	U (ppm)	Th (ppm)	Th/U
I Biotite-chlorite-sericite schist	1	9	25	2.77
II Augen gneisses	1	4	18	4.50
	2	3	16	5.30
	3	4	16	4.00
	4	4	23	5.70
	5	3	14	4.60
	6	3	13	4.30
III Granitic gneisses	1	3	11	3.60
	2	3	15	5.00
	3	3	15	5.00
	4	3	14	4.60
	5	3	15	5.00
	6	4	20	5.00
IV Leucogranite	1	32	13	0.42
	2	5	1	0.20

Discussion

Apart from K, Rb, Ca and Sr, Th, U and Th/U ratios can also be used to demarcate the magmatic/metasomatic origin of granitoids. This is mainly due to the fact that till late granitic and/or pegmatitic stage, these elements behave sympathetically giving a proportional variation in Th/U ratio with degree of fractionation, while this ratio is influenced by the processes at the hydrothermal stage, where uranium gets separated as uranyl (U^{+6}) causing an increase in the Th/U ratio.

The Th, U and Th/U in Badrinath-Joshimath crystallines indicate that the Th/U ratio in the augen gneisses and granitic gneisses is high, compared to crustal average (c. 3.5) due to increase in Th and U. Overall ratio is within the limit suggested for amphibolite facies metamorphic rocks (Lambert and Heier, 1968). The scatter that is observed in few samples is attributed to the heterogeneous compositional layering, the complex nature and differentiation history the rock had undergone (Heier and Rogers, 1963).

The scatter in uranium content in leucogranites of Badrinath is comparable to S-type granites. Albitisation processes appear to have played a dominant role in increasing uranium, as Th and U are usually enriched and K is depleted during albitisation (Dostal, 1984). There is also evidence that S-type granites generated in collision orogeny are associated with uranium mineralisation, like those in Massif Central of France (Cunney, 1978), the Boherian Massif in Czecholovakia (Ruzicka, 1971) and the Rossing in Namibia (Berning *et al*, 1976). The scattered uranium values in the leucogranites can also be attributed to burial of metasedimentary rocks (at lower crustal levels) rich in water and radioactive elements which have unevenly enriched the rocks in uranium. The anatectic nature of leucogranites of the Himalaya is evidenced by their Pb isotope data (Gariepy *et al.* 1985; Le Fort, 1981). Close proximity of these intrusions to the major thrust zone like the Main Central Thrust also supports large-scale crustal involvement in their formation and suggest that the anatectic magma had a long history of uranium and thorium enrichment (Gariepy *et al*, 1985).

The thrust and tectonic movements appear to have resulted in a free movement of fluids and were responsible for changing the chemistry from the preexisting pelitic schists and their metamorphic equivalents, the augen gneiss/granitic gneiss.

Acknowledgements: The authors are grateful to the Director, NGRI, Hyderabad for his kind encouragement.

References

BERNING, J., COOKE, R., HEIMSTRA, S. A. and HOFFMAN, U., (1976) The Rossing uranium deposit southwest Africa. Econ. Geol., v. 71, pp. 351-368.

CUNEY, M., (1978) Geological environment mineralogy and fluid inclusions of the Bois Noirs Limouzat uranium vein, Forez, France. Econ. Geol., v. 73, pp. 1567-1610.

DOSTAL, J., DUPUY, C., CHIKHAUOI, M. and ZENTILI, M., (1984) Uranium and thorium in late Proterozoic volcanic rocks from northwestern Africa. Chem. Geol., v. 42, pp. 297-306.

GARIEPY, C., ALLEGRE, C. J. and RONG HUA XU (1985) The Pb-isotope geochemistry of granitoids from the Himalayan-Tibet collision zone: Implications for crustal evolution. Earth and Planet. Sci. Lett., v. 74, pp. 220-234.

HEIER, K. S. and ROGERS, J. J. W., (1963) Radiometric determination of thorium, uranium and potasium in basalts and in two magmatic differentiation series. Geochim. Cosmochim. Acta, v. 27, pp. 137-154.

LAMBERT, I. B. and HEIER, K. S., (1968) Geochemical investigations of deep-seated rocks in the Australian Shield. Lithos, v. 1, pp. 30-53.

LE FORT, P., (1981) Manaslu leucogranite: a collision signature of the Himalaya: A model for its genesis and emplacement. Jour. Geophys. Res., v. 86, pp. 10545-68.

RUZICKA, V., (1971) Geological comparison between east European and Canadian uranium deposits. Geol. Surv. Can. Pap., v. 70-48, pp. 1-196.

SAXENA, P. R., (1986) Geology, Geochemistry and Tectonic significance of Granites/Gneisses from Joshimath and Badrinath of Kumaun Himalaya. Ph.D Thesis (Unpublished), Osmania University, Hyderabad, p. 171.

(Received: May 5, 1987; Revised form accepted: July 3, 1987)