necessary to remove molybdenum completely.

The effect of acid concentration on the formation and extraction of the ion-association complex into an organic phase was investigated with hydrochloric, sulphuric, phosphoric and nitric acids. The ε values of the complex in 0.3 to 3 M hydrochloric, 1.3 M sulphuric and 1.3 M phosphoric acid solutions are: 2.12×10^4; 1.88×10^4 and 4.17×10^3 $dm^3\ mol^{-1}\ cm^{-1}$, respectively. The complex is not quantitatively extracted in nitric acid medium. Hence hydrochloric acid was selected for further work. Addition of large excess of ascorbic acid, LH and thiocyanate had no adverse effect on the absorption and maximum wavelength of the coloured complex. The chloroform extract of the complex obeys Beer's law in the range 0.2–3 ppm of molybdenum.

The following amounts (ppm) of foreign ions are found to give +2% error in the determination of 2 ppm of Mo: Na (I), 1000; K (I), 1000; Mg (II), 100; Ca (II), 300; Ba (II), 250; Pb (II), 50; Zn (II), 100; Cd (II), 3000; Mn (II), 1000; Ti (IV), 750; V (V), 250; Cr (VI), 750; Cr (III), 2000; W (VI), 250; Al (III), 2000; Bi (III), 15; Fe (III), 1000; Ni (II), 100; Ru (III), 100; Rh (III), 200; Pd (II), 50; Ag (I), 20; Os (VIII), 100; Pt (IV), 50; Au (III), 750; Co (II), 200; U (VI), 1000; Zr (IV), 100; La (III), 250; As (III), 50; fluoride, 1000; bromide, 1000; iodide, 2000; phosphate, 10000; nitrate, 1000; sulphate, 3000; acetate, 5000; citrate, 5000; tartrate, 2000; and carbonate, 15,000. However, thiosulphate interferes.

Composition of Mo-SCN-LH Complex: The ratio of molybdenum to the thiocyanate and LH was determined by Job's method of continuous variations. The results indicate that the molar ratio of Mo (V) to SCN^- is 1:4 and of Mo (V) to LH is 1:1. The mole ratio method confirms the ratio of Mo (V) to LH as 1:1. Hence the composition of the extracted thiocyanate-molybdenum (V) complex with LH is: (LH) [$MoO(SCN)_4$]. Analysis of steel sample by the proposed method gave a result of 0.94% Mo (certified value is 0.95%).

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1. Elwell, W. T. and Wood, D. F., *Analytical chemistry of molybdenum and tungsten*, Pergamon Press, Oxford, 1971, p. 78.
2. Boltz, D. F. and Mellon, M. G., *Analyt. Chem.* 1976, **48,** 221R; 1974, **46,** 234R; 1972, **44,** 300R.
3. Howell, J. A. and Hargis, G. H., *Analyt. Chem.*, 1978, **50,** 243R; 1980, **52,** 306R; 1982, **54,** 171R; 1984, **56,** 228R.
4. Vogel, A. I., *Quantitative inorganic analysis*, ELBS & Longmans, London, 1968, p. 506.

ALLANITE-BEARING MIGMATITES OF THE ARCHAEAN SCHIST BELT OF KHAMMAM, ANDHRA PRADESH

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THE Archaean schist belt of Khammam, Andhra Pradesh occurs in the area included in the toposheets of 65 C/3, 4, 7 and 8. The schist belt has been equated with the 'Sargur belt' of Karnataka on the basis of lithology, amphibolite to granulite facies metamorphism and geologic setting[1–4]. The migmatites of pelitic derivation of Khammam schist belt are represented principally by feldspathised schists and to a lesser extent by quartz-biotite-oligoclase (with or without K-feldspar) gneiss. In the feldspathised schist, the neosome defined by feldspar and recrystallised biotite is parallel to palaeosome of mica schist which on a regional scale is parallel to the foliation. The quartz-biotite-oligoclase gneiss shows neocrystallisation with the melanosome and leucosome separated by 1–2 cm. In the migmatites of Khammam, both metamict and non-metamict allanites occur. The metamict allanite is coloured light greenish yellow or reddish yellow and is non-pleochroic and is isotropic. The non-metamict allanite is pleochroic with α = light greenish brown, β = light brown and γ = reddish brown. The $2V(-)$ = 36°, $n_\gamma - n_\alpha = 0.023$. It gives an extinction angle ($Z \wedge c$) of 10° to 12°. Allanite is described as an epidote group mineral containing Ce, La, Y and Th which occur replacing calcium in the structure[5]. It is generally held that the alpha particles which generate in the process of disintegration of the radioactive components bombard the structure of allanite causing metamictization[6].

Allanite grains show different growth pattern in the migmatites of Khammam which are described below from photomicrographs. It occurs in rectangular plate or semi-oval shape with a grain size varying from 0.4 mm to 1.5 mm. It lies in the plane of foliation

defined by the laths of biotite. Allanite occurs in the palaeosome and neosome of the feldspathised schists and also in the melanosome of the quartz-biotite-oligoclase gneiss. The proportion of allanite in a given thin section is between 0.05 % and 0.1 % of the mode by volume. The grains are conspicuous in thin section by their shape, high relief and association with apatite.

Photomicrograph 1: (× 54). Uncrossed polarised light. Metamict allanite in the interior within the thick border shows anastomosing system of cracks. These are thought to be due to expansion of the lattice consequent to disintegration of radioactive components[6]. The light brown ring outside the thick border surrounding the metamict allanite is non-metamict allanite. Small granules of sphene can be noticed within this zone. The outer zone is defined by apatite grains, white in colour. Biotite laths, brown in colour, can be noticed outside the zoned allanite.

Photomicrograph 2: (× 54). Crossed polarized light. A semi oval-shaped allanite with an inner zone of metamict allanite surrounded by a zone of non-metamict allanite (white colour) and again an outer zone of metamict allanite. The outer most white coloured zone is again non-metamict allanite, thus giving two zones of metamictization. The black-coloured grain bordering allanite is apatite. Biotite laths and blastic plagioclase grains with twinning can be noticed in the outer area.

The occurrence of allanite in the migmatites of the schist belt of Khammam is significant in more than one way. Allanite occurs mainly in the biotite-rich folia of the rock. It has grown in situ during recrystallisation of the schists. Migmatisation only aided the diffusion of the chemical components to the centres of growth of allanite from within the schists. It was not introduced from external source of any granitic or pegmatitic intrusion. Though allanite is known to occur as a detrital heavy mineral in sands[7], the present shape of allanite in the pelitic migmatites is clearly due to recrystallisation. The occurrence of allanite in the Khammam schist belt is also relevant in assessing the nature of the early crust, which supplied the sediment detritus of the schists of Khammam belt. Allanite is a characteristic constituent of acidic igneous rocks. The Khammam schists which are considered as early supracrustals[3] have therefore derived their sediments from early acidic crust.

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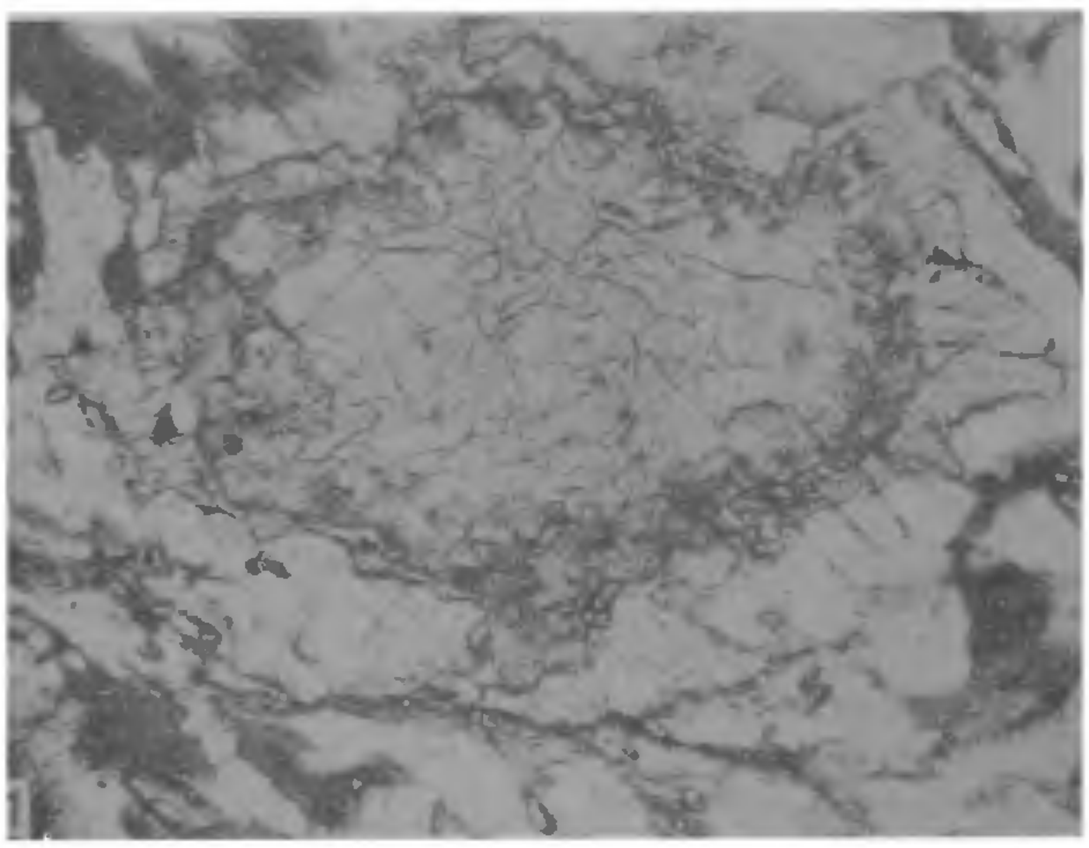

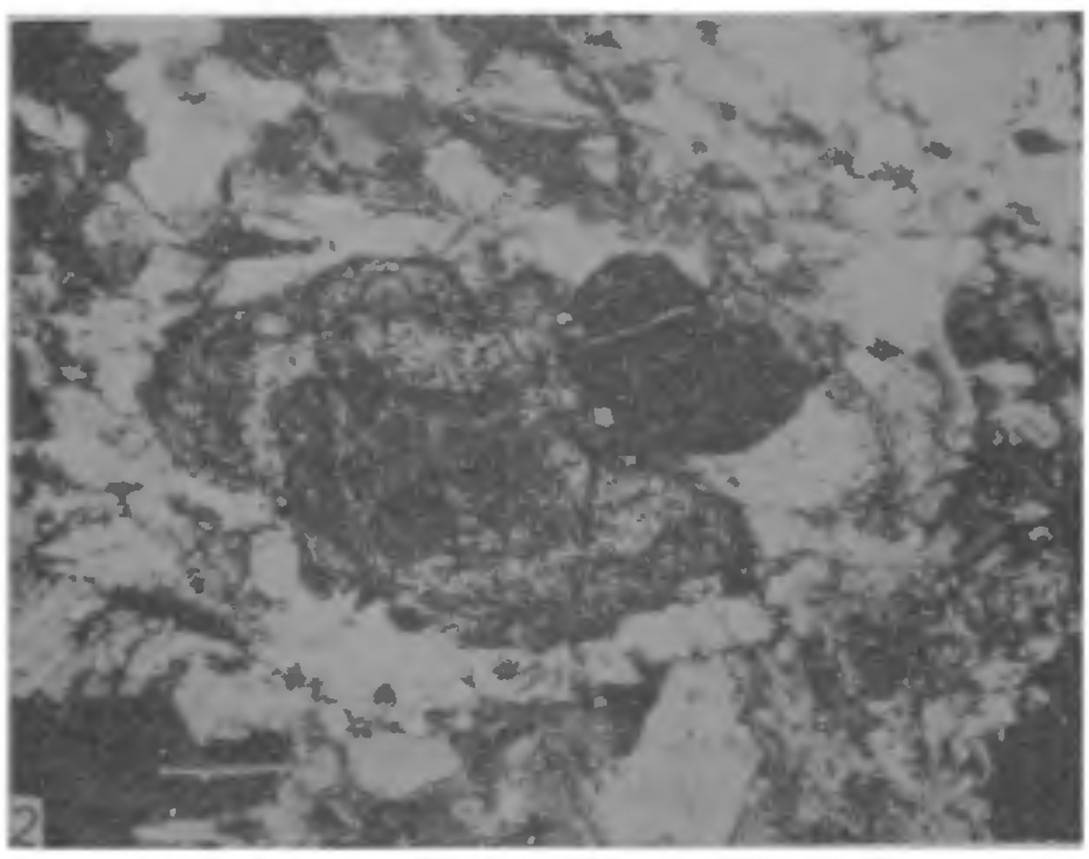

Figures 1.2. 1. Anastomosing system of cracks in metamict allanite, **2.** Two zones of metamictisation in allanite.

1. Narayanaswami, S., *Indian Min.*, 1975, **16,** 16.
2. Subbaraju, M., *Indian Min.*, 1975, **16,** 35.
3. Prasada Rao, V. S. V., Ph.D. thesis, A. U., Waltair, 1982.
4. Ramamohana Rao, T., Prasada Rao, V. S. V., Sairam Prasad, D. and Ranga Rao, N., *Curr. Sci.*, 1983, **52,** 1139.
5. Deer, W. A., Howie, R. A. and Zussman, J., *Rock-forming minerals*, 1963, Vol. 1.
6. Pabst, A., *Am. Min.*, 1952, **37,** 137.
7. Hutton, C. O., *Bull. Geol. Soc. Am.*, 1950, **61,** 635.