Minor elements in some rocks and minerals of the Rakha mines area, Singhbhum, India

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Summary. The minor elements present in some rocks and minerals of the Rakha mines area, Singhbhum district, Bihar, India, have been determined by X-ray fluorescence spectroscopy. Geological and geochemical studies in different parts of this shear zone already favour a hydrothermal origin. Some of the minor elements concentrated in the sulphide ores are found in lower concentration in the epidiorite and the chlorite–mica schist; these are, however, present in abundance in the soda-granites that are closely associated in space to the east and west of the Rakha mines area. A genetic link between sulphide ores and soda-granite may be predicted although the sulphides in the Rakha mines area are not directly associated with the soda-granite.

THE Singhbhum Shear Zone, a 160 km long arcuate belt of metal mineralization in Singhbhum district, Bihar, is of outstanding importance in the geological map of India. This belt contains potential reserves of copper deposits (Dunn, 1937). In evaluating the genetic aspects of copper mineralization in the Rakha mines area (fig. 1), preliminary studies on the distribution of minor elements in the ore minerals and associated rocks across the shear zone have been carried out by X-ray fluorescence spectroscopy.

In the Rakha mines area, the shear zone is mainly represented by chlorite schist, chlorite–biotite schist, mica schist, garnet–mica schist, kyanite quartzite, sheared conglomerate, and tourmaline–quartz schist. The chlorite and biotite–chlorite schists show differential response to hydrothermal alteration and are the host rocks of major sulphide mineralization (Ghosh, 1964). Mica schist and garnet–mica schist with some concordant metadolerite bands cover the tract to the north of the shear zone, whereas 'Dhanjori' epidiorite and associated quartzites occur to the south.

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Analytical procedure. This study is based on a semi-quantitative X-ray fluorescence spectroscopic analysis of sixteen samples, selected from areas to cover the maximum number of lithologic units (neglecting the quartzites and their variants). Of the rock samples analysed, four came from the north of the shear zone, three from the south, and five

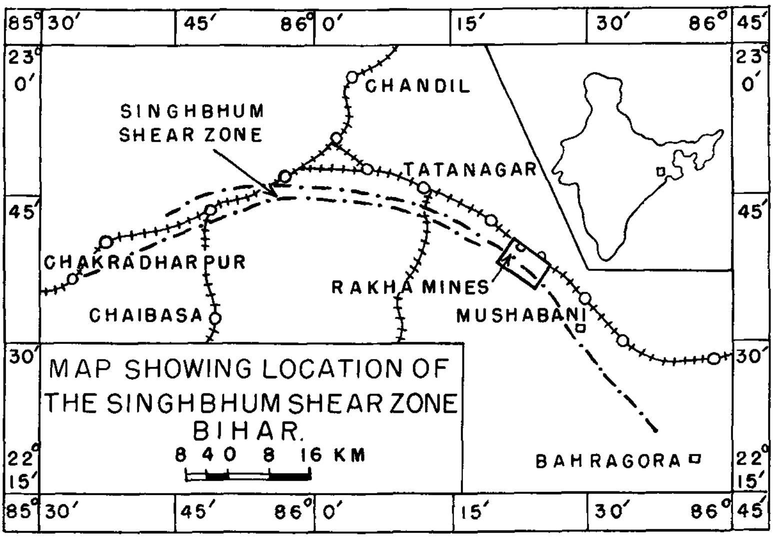

FIG. 1. Location map of the area of study. Inset map of India shows the location of the Rakha mines.

from within the shear zone. Two samples of chalcopyrite, one of pyrite, and one of an assemblage of sulphide minerals containing 90 % chalcopyrite, all collected from the mineralized zones of Roam, were also analysed.

A basic Philips X-ray unit with an electronic control and X-ray spectroscopic attachment were used; the fluorescence X-rays from the powdered sample (200–300 mesh) were diffracted by the cleavage planes of a rotating calcite crystal (d = 3·029 Å), detected by a Geiger-Müller counter, passed into a scaling circuit, and finally registered by the recorder. It should, however, be noted that in this preliminary investigation, no special search was made for any particular trace elements, and therefore, further detailed analysis may add to the list given here.

Results. The distribution of minor elements and their relative abundances are given in table I. A comparative study on the basis of the presence or absence of one or more elements and their concentration in a particular sample leads to the following major features:

As far as the distribution of minor elements in the rocks within the shear zone and also to its north and south are concerned, a number of elements such as Zn, Pb, and U are found in all or most of the rocks.

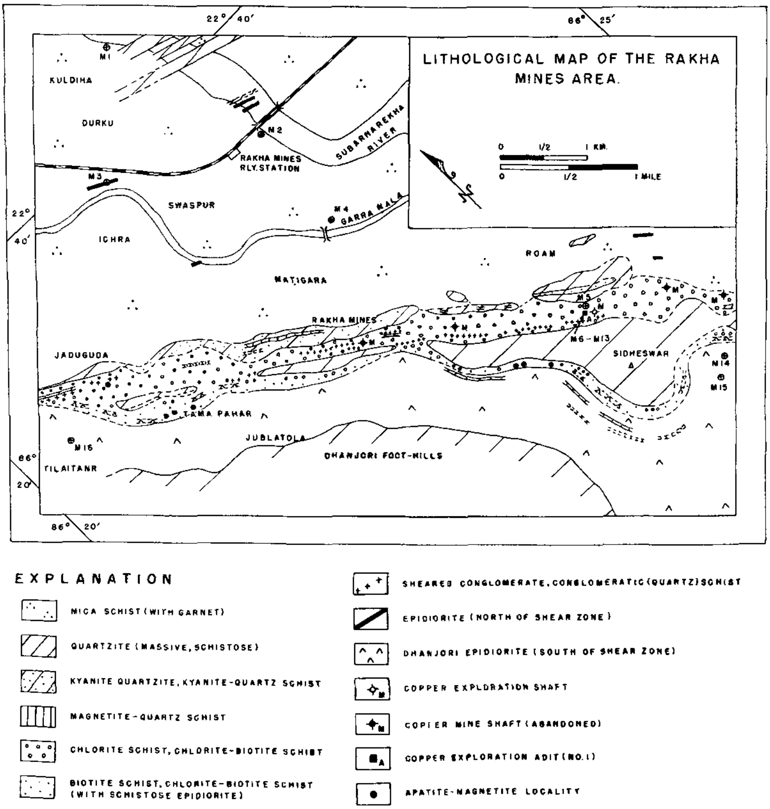

FIG. 2. Lithological map of the Rakha mines area showing the distribution of samples (⊕).

Cs is present in some of the rocks within the shear zone as well as to its north but absent from the rocks to the south of the shear zone. Amounts of Cu and Ni are moderate in all the shear zone rocks, and low to moderate in the schists within the shear zone and of areas lying to the north, but always low in the Dhanjori epidiorite to the south of the shear zone. The sulphide minerals are characterized by the concentration of a number

TABLE I. Distribution of minor elements in rocks and sulphide minerals of Singhbum.

(The numbers indicate the relative concentration of the elements from 0, not detected, to 5, high)

	Locality [see fig, 2]	*Description*	Ni	Cu	Zn	Ge	Ag	Cd	Sn	Te	Cs	Ce	Au	Tl	Pb	Th	U
Group A. North of shear zone																	
M 6	6	Garnet-mica schist	2	2	2	0	0	0	0	0	0	0	1	0	1	1	1
M 2	1	,, ,,	2	1	2	0	0	0	0	0	1	0	2	1	1	1	1
M 3	5	Amphibolite	2	1	2	1	1	0	0	0	1	2	2	0	0	0	1
M 4	7	Mica schist, phyllitic	2	3	2	0	1	1	0	0	0	0	0	0	2	0	1
Group B. Within shear zone																	
M 5	70	Mica schist (Stage 3, biotite zone)	2	2	2	0	1	0	0	0	0	0	0	0	0	1	1
M 6	A/4 Adit 1	Biotite-chlorite schist	1	2	2	0	0	0	0	0	1	1	0	0	1	1	1
M 7	A/12 Adit 1	Chlorite schist (Stage 2, chlorite zone)	3	2	0	2	2	0	1	1	1	0	1	0	1	1	1
M 8	A/23 II Adit 1	Chlorite-biotite schist (Stage 2, chlorite zone with sulphide dissemination)	2	4	2	1	0	0	0	0	0	1	0	0	1	0	1
M 9	A/39 II Adit 1	Sericite schist (Stage 1, sericitised zone)	3	4	2	2	1	0	0	0	0	0	0	0	1	0	1
Group D. Ore zone sulphides (within shear zone)																	
M 10	Adit 1 Adit level	Sulphide assemblage (Chalcopyrite 90 %)*	2	2	1	0	0	0	0	0	0	0	0	0	1	0	1
M 11	AS/29 Adit 1, sub-level	Pyrite†	4	4	1	1	0	0	0	0	0	0	0	1	0	1	0
M 12	AS/30. Adit 1, sub-level	Chalcopyrite‡	2	2	1	0	0	2	1	0	2	0	0	0	0	0	0
M 13	AS/E. Adit 1, sub-level	Chalcopyrite§	2	3	1	0	0	0	0	0	0	0	0	1	0	0	1
Group C. South of shear zone																	
M 14	56	Dhanjori epidiorite, massive	2	1	2	0	1	0	0	0	0	0	0	0	1	1	1
M 15	57	,, ,, ,,	1	1	2	1	0	0	0	0	0	0	0	0	1	0	1
M 16	22	,, ,, ,,	1	1	2	1	0	0	0	0	0	0	0	0	1	1	1

* Also V 1, Gd 2, Ta 1. † Also Nb 1, Ba 1, Ta 1. ‡ Also Cr 1, Co 2, Y 1, Sb 2. § Also Ti 2, Co 1, In 2, Ir 1.

of elements such as Ta, V, Gd, Nb, Ba, Y, Co, Cr, Sb, Ir, In, which are almost absent from the rocks from the Rakhamines area. Moreover, the abundance of Gd in the sulphide assemblage and Sb, Ir, In, Co, and Ti in chalcopyrite is noteworthy. Thus the minor element contents of sulphide minerals have certain differences when compared with the rocks of the shear zone or outside it and this may have some bearing on the genesis of these sulphides. According to Fleischer (1955) the concentration of minor elements in sulphide minerals depends solely on the amounts of these elements present in the ore-forming solution. It is, therefore, quite probable that the sulphides were derived from an extraneous source and the very high nickel and copper concentration in the pyrite support Fleischer's idea of a hydrothermal origin.

Discussion. The present study shows a higher concentration of some minor elements such as Ba, Co, Cr, V, Y, in the sulphide ores than in the associated rocks of this area. These elements were also detected in the soda-granites of the shear zone (Saha, Sankaran, and Bhattacherjee, 1965; Mukherjee, 1968). The soda-granite being closely associated in space with the sulphides both to the east and west of the Rakha mines area, a genetic link between sulphide mineralization and the soda-granite may be predicted although it is not directly associated with the sulphide ores in this area. Geological and geochemical studies carried out in different parts of the Singhbhum shear zone, including the present tract, have a strong support in favour of a hydrothermal origin of the copper ores (Sarkar, 1966; Ghosh, 1966).

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