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Barian muscovite from the Jhabua manganese belt, Madhya Pradesh, India[1]

A GROUP of interesting silicate minerals associated with manganese ores occurring in the Jhabua manganese belt were described by Fermor (1909), but no further work has been done on the mineralogy of this belt except by Nayak (1963). During the course of detailed geological mapping of this belt Das Gupta (1959, also Venkatesh *et al.*, 1958) collected a number of mineral samples in which pink barian muscovite has been recorded for the first time. The mode of occurrence, mineralogy, and composition of this rare type of mica are little known apart from the data of Bauer and Berman (1933), Heinrich and Levinson (1955), and Hirowatari (1957). Therefore an attempt is made in this note to present the geological setting and mineralogy of the barian muscovite occurring in the Kajlidongri mines of the Jhabua manganese belt of Madhya Pradesh.

Geologically the terrain belongs to the southern continuation of the Precambrian Aravalli system (Gupta and Mukherjee, 1938) of Rajasthan. The area around Kajlidongri (22° 57′ N; 74° 31′ E.) consists predominantly of various types of phyllites interbanded with either massive quartzites rich in conglomerates and pebble beds or calcareous phyllites and dolomitic marbles. Regionally the rocks trend N.–S. to NNW.–SSE. with dips ranging between 35° and 75° mainly to the west. The dominant structural patterns in the rocks, which have been strongly deformed, are folds the axes of which run parallel to the regional trend. Granites of different periods are noted and one that has been paratectonically intruded into the piles of metasediments in the western parts of the Kajlidongri mines is accompanied by widespread feldspathization. A number of thin manganiferous quartzites and cherts, which carry manganese

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deposits, occur within the green chlorite-rich or white and grey sericite-rich phyllites. Payable manganese ore bands are in general restricted to the troughs of flowage and similar folds and, to a lesser extent, their limbs or anticlinal arches (Roy Chowdhury, 1955, and Roy Chowdhury *et al.*, 1966). The manganese ores comprise braunite, psilomelane, orthorhombic psilomelane (with 11 % BaO, Mukherjee, 1959), cryptomelane, etc.

Barian muscovite occurs in quartz veins that traverse the manganese-rich quartzites along transverse joints formed at right angles to the trend of the quartzites; the veins are sheared, fractured, and marginally granulated around the coarse grains, which show deformation lamellae. Barian muscovite is also associated with manganese-rich quartzites along grain boundaries of quartz where streaky quartz veins are segregated; minute clusters of micaceous foliae line the cracks and fracture planes or are irregularly developed in the crevices of manganese ores. Less commonly it occurs in pink siliceous or sericite phyllite near the contact with the manganese-rich quartzites. The clusters in phyllite consist of pink mica alone and locally with hematite (specularite); it shows decussate pattern. The phyllites contain dodecahedral spessartine as discrete crystals set in a groundmass of quartz and pink mica. The mica phyllites are well foliated with coarse pink micas (< 1 cm) defining the foliation planes; pink mica that swerves around the minute folds or puckers is locally bent or torn apart. At places pink mica has crystallized along the shear zones but the refractive indices of the micas remain constant irrespective of their occurrence in groundmass or shear fractures.

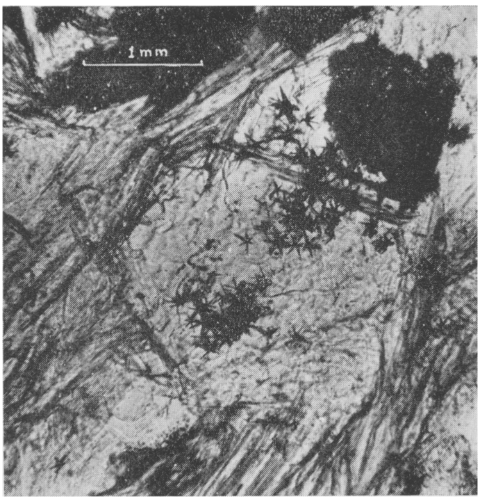

FIG. 1. Starlets of hematite in barian muscovite.

Some of the flakes of mica are charged with tiny dots of psilomelane, braunite, and hematite. Others contain inclusions of manganophyllite, minute grains of quartz and droplets of manganapatite. In some basal flakes inclusions of hematite (fig. 1) occur as perfect six-rayed starlets oriented parallel to the direction of pressure figures in mica, i.e. one of the rays is parallel to [010]. In the individual flakes the orientation of the rays forming the starlets is nearly constant; locally imperfect starlets are also developed.

The mineralogical properties of the analysed specimen separated from a phyllite 0·5 km south of Kajlidongri are given in table I. The mineral can be easily handpicked because of its coarse size. The flakes were further crushed to pass through 80–100-mesh screen sizes, and repeatedly passed through the Frantz isodynamic separator. The non-magnetic portion was further cleaned by Clerici solution. The analysed mica forms the major part of the assemblage comprising barian muscovite (80 %), quartz (5 %), hematite, manganese ores, and manganapatite.

It has nearly the ideal composition with low manganese and iron content. Its BaO content is lower than that of oellacherite but comparable with the manganoan barian muscovite (4·14 % BaO) of Hirowatari (1957). Total OH and F is lower than normal.

Mode of formation. The occurrence of pink barian muscovite within phyllites indicates that it has been formed by metamorphic recrystallization of manganese- and barium-rich shaly sediments. The regional grade of metamorphism at Kajlidongri and its

TABLE I. *Barian muscovite from India*

		Number of ions on the basis of 24 (O, OH, and F)		*Physical properties*
SiO_2	41·60	Si	5·85	α 1·553±0·003, colourless
Al_2O_3	32·65	Al	2·15	β 1·585±0·003, rose
		Al	3·26	γ 1·593±0·003, pink
TiO_2	0·15	Ti	0·02	$\alpha < \beta < \gamma$
Fe_2O_3	3·85	Fe^{3+}	0·41	$2V\alpha$ 30°; Sp. gr. = 2·90
Mn_2O_3	1·06	Mn^{3+}	0·11	Cleavage {001} perfect;
MgO	2·00	Mg	0·42	Twinning composition plane {001} with twin axis [310];
BaO	3·51	Ba	0·21	Cell size: *a* 5·24±0·02 Å
CaO	2·60	Ca	0·39	*b* 9·04±0·02 Å
Na_2O	0·70	Na	0·19	*c* 20·01±0·02 Å
K_2O	8·00	K	1·44	β 95° 13′±0° 30′; Z = 2; $2M_1$ polymorph.
H_2O+	3·20	OH	3·00	
H_2O-	0·50			
F	0·12	F	0·05	
Total	99·94			
F ≡ O	0·05			
	99·89			

Analysts: R. N. Sen Sarma and V. N. Marathe.

immediate west has never crossed the limit of the greenschist facies and the rocks over the greater part of the area reflect features of the muscovite-chlorite subfacies. The local presence of spessartine in the phyllitic rocks possibly suggests that metamorphism has reached the upper limit of the greenschist facies. Pink barian muscovite, which shows para- to post-crystalline deformation, has been formed under this facies condition; star-shaped inclusions are a primary growth phenomenon and developed as a result of the force of crystallization of growing hematite at right angles to the (001) flakes of muscovite. Simultaneously with the crystallization of the muscovite-bearing assemblage of phyllite, the manganiferous zone came under the influence of hydrothermal activity, resulting in segregation of pink barian muscovite with or without quartz veins and opaque minerals.

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Montmorillonite and zeolites in Mesozoic and Tertiary beds of southern England

IN a recent article in this magazine Brown *et al.* (1969) described zeolites of the clinoptilolite–heulandite type occurring in association with montmorillonite and other minerals in certain late Mesozoic and early Tertiary deposits of south-east England. We are interested in their conclusion that these minerals formed diagenetically in conditions chemically and physically equivalent to those provided by water-deposited volcanic ash but nevertheless are unrelated to volcanoes. This is based on the lack of