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ORE MICROSCOPIC, X-RAY AND TRACE ELEMENTAL DATA ON MANGANESE ORES FROM SANDUR, KARNATAKA, INDIA

J. S. R. KRISHNA RAO, B. VENKATA NAIDU and K. VISWESWARA RAO

INTRODUCTION

One of the best manganese deposits occurs in Sandur belt belong to the Dharwar super group. Originally these ores were considered by FERMOR [1909] as 'lateritic' later NAGANNA [1971] made a detailed study of these deposits and suggested them, as 'syngenetic sedimentary'; however, recently DIXIT [1976] suggested these are probably due to 'alterite' affiliations. According to him alterite is defined as a rock by intensive tropical chemical weathering of varied rock types as metalavas, greywackes, tuffaceous and metasedimentary schists, amphibolites, intrusive sheets and dykes of basic rocks and at times even the acidic rocks like quartz and felsite porphyrites, granites and gneisses. In view these interesting observations, the present authors examined some typical manganese ores from this belt. The ores were subjected to X-ray examination and a minor elemental study was carried out. The results are presented herewith suggesting no genetic relation with alterite, but the typical textures and minerals are sedimentary metamorphic and have undergone supergene enrichment.

MINERALOGY

The following minerals were identified in polished sections — cryptomelane, ramsdellite, pyrolusite and bixbyite. The iron minerals like magnetite, goethite, associated with manganese minerals were also observed. Manganosite, jacobsite, woodruffite, hydrohausmannite, braunite, lithiophorite, coronadite were identified by X-rays in addition to those observed in polished sections.

Cryptomelane

This is the most abundant mineral in the ores. Cryptomelane is microcrystalline to amorphous, presenting gel structures and it is isotropic. Another important feature is the round oolitic structure with regular layering. The matrix is clay.

The cell dimensions calculated (a=9.85 Å; c=2.87 Å) were tallying with the A.S.T.M. Card data.

The mineral shows close similarity in structure and granularity with that of Nicopol-Chiatura type.

Pyrolusite

It is the next abundant mineral to cryptomelane. It is tabular, crystalline with characteristic pleochroism and strongly anisotropic. The cell dimensions calculated (a=4.41 Å; c=2.86 Å) were tallying with the A.S.T.M. Card data. The pyrolusite is developing from cryptomelane and shows a radiating structure or coarse grain size. The hand specimens are massive and show layering (a few mm thick).

Ramsdellite

Ramsdellite is fibrous closely associated with pyrolusite. It is greyish white, pleochroic and anisotropic. The cell dimensions calculated (a=4.54 Å; b=9.28 Å; c=2.86 Å) and compared with the A.S.T.M.Card data.

Bixbyite

Bixbyite shows wide variation and it is usually found in polished sections, but often detected in X-ray patterns. It has a unit cell a=9.3847 Å and this is compared with that of A.S.T.M.Card data. Bixbyite is crystalline, idioblastic found in a matrix of pyrolusite. The color is yellowish with moderate reflectivity. It is isotropic.

Magnetite—Goethite—Jacobsite

These are observed in X-ray patterns but magnetite is observed rarely in polished sections.

Manganosite

It is also a common mineral but only observed in X-ray patterns.

Some of the specimens metabasalt or andesite from the area were polished and studied for manganese minerals. Oxidation of magnetite into goethite were observed and no manganese mineral was detected.

X-RAY STUDIES

The following minerals were detected in X-rays to confirm the minerals already discussed above. The *d*-spacings and peak intensities are given in Table 1.

TABLE 1

Mineral	*d* (Å)	*I*
Pyrolusite	1.6178	8
	1.3571	5
	1.5502	7
Cryptomelane	3.1060	10
	2.1440	5
	1.5275	6
Woodruffite	2.52	7
	1.48	8
	1.97	5
Manganosite	1.3371	8
Goethite	2.238	4
	2.433	7
Hydrohausmannite	2.47	8
	1.53	5
Ramsdellite	2.53	8
	1.88	5
	1.6413	6

Coronadite	2.4042	4
	2.2061	4
	1.5417	8
Jacobsite	1.6431	8
	1.5071	10
Braunite	2.3613	5
	1.6634	10
	1.4207	8
Bixbyite	1.8371	2
	1.6563	10

The above *d*-spacings and *I* values of the minerals were compared and tallying with A.S.T.M. Card data.

TEXTURES AND STRUCTURES

Colloform, gel layers, oolitic texture and concretions were observed in pyrolusite and cryptomelane minerals. Scaly forms due to replacing other materials, cavities of different sizes, radiating structures of pyrolusite have been observed in polished sections. Based on the above textures and structures the ores of Sandur under examination can be grouped into primary and secondary ores given below.

Primary ores

Colloform *(Fig. 1)*, gel layers *(Fig. 2)* and oolitic *(Fig. 3)* are present. The minerals chiefly cryptomelane, ramsdellite, manganosite, braunite and hydrohausmannite.

Secondary ores

Scaly forms due to replacing other materials *(Fig. 4)*, presence of cavities in different sizes, radiating structures *(Fig. 5)* developing from the cryptomelane are present. The minerals are chiefly pyrolusite, bixbyite etc.

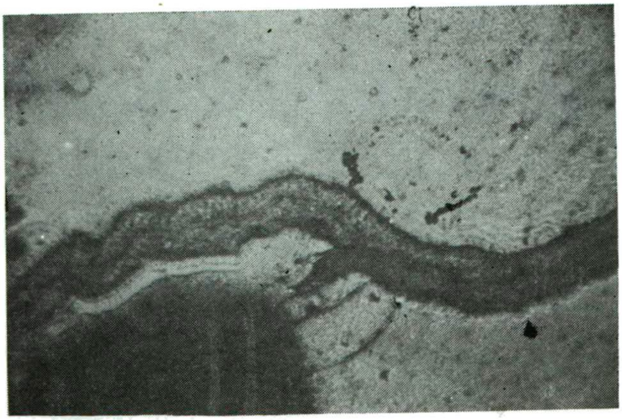


Fig. 1. Colloform banding in cryptomelane. Black color showing the cavity. Sandur, Karnataka. Polished section, ×70

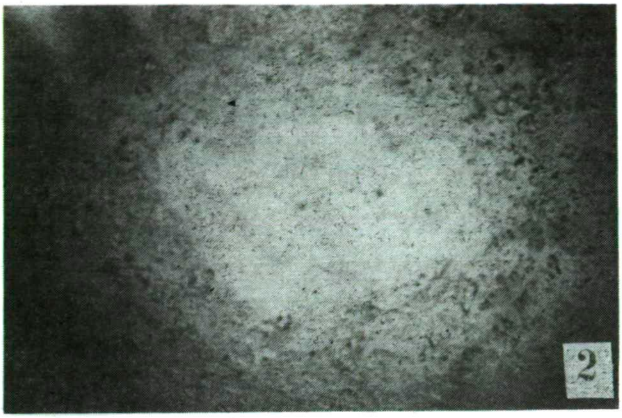


Fig. 2. Gel structure in cryptomelane, Sandur, Karnataka, polished section, ×70

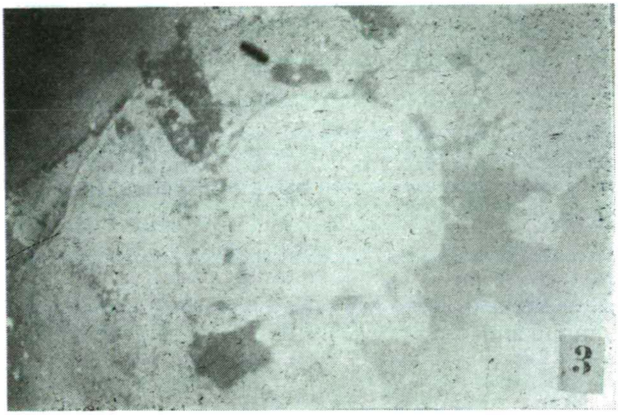


Fig. 3. Oolitic texture in cryptomelane. The gangue is clay material. Sandur, Karnataka. Polished section, ×70

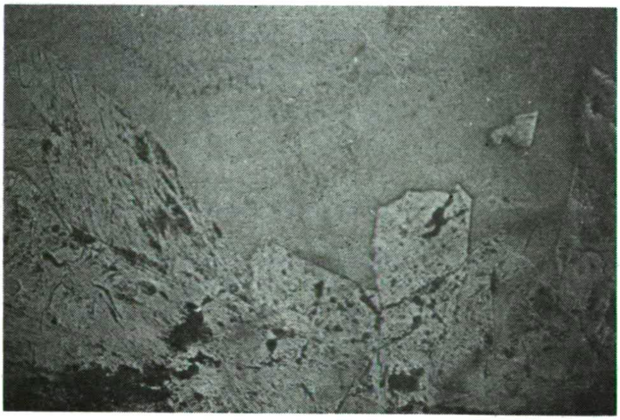


Fig. 4. Scaly forms of pyrolusite replacing cryptomelane. Sandur, Karnataka. Polished section, ×70

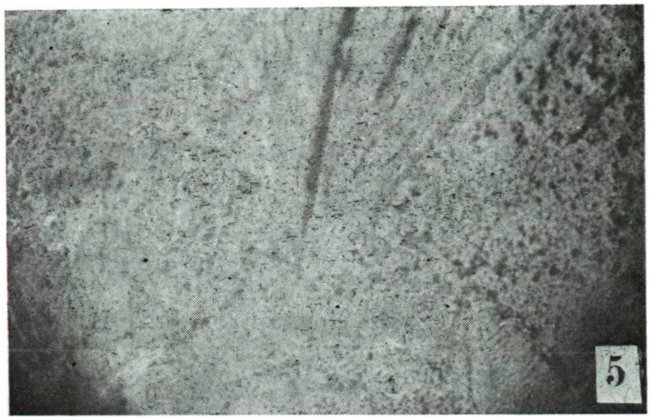


Fig. 5. Radiating structure of pyrolusite developing from the cryptomelane banding. Sandur, Karnataka. Polished section, ×70

TRACE ELEMENTS AND THEIR DISTRIBUTION

Four samples have been analysed for trace elements and the concentrations of the elements is given in ppm in the Table 2.

TABLE 2

Sample No.	847	829	997	954
Co	9	106	ND*	ND*
Ni	8	43	ND*	ND*
V	36	140	ND*	2
Cr	82	190	>1000	>1000
Y	4	8	17	3
Cu	800	>1000	23	300
Ga	31	3	ND*	6
Pb	32	147	ND*	ND*
Sn	26	64	78	63

ND* = Not detected.

Co and Ni

According to Dana [1959] the two elements Co and Ni are present together in most of the primary deposits, yet supergene processes result in their separation. The total absence of these two elements in the secondary deposits (sample Nos. 997 and 954) is the result of intensive supergene processes. Ni and Co were generally absent in the minerals of cryptomelane [SUPRIYA ROY, 1966].

Cu, Pb and V

Considerable amounts of these elements have been detected in coronadite [DANA, 1959]. This is true with the sample Nos. 847 and 829 in which coronadite is found by X-rays. However, the presence of a little Cr may be due to the replacement of Mn by Cr in coronadite.

Cu and Cr

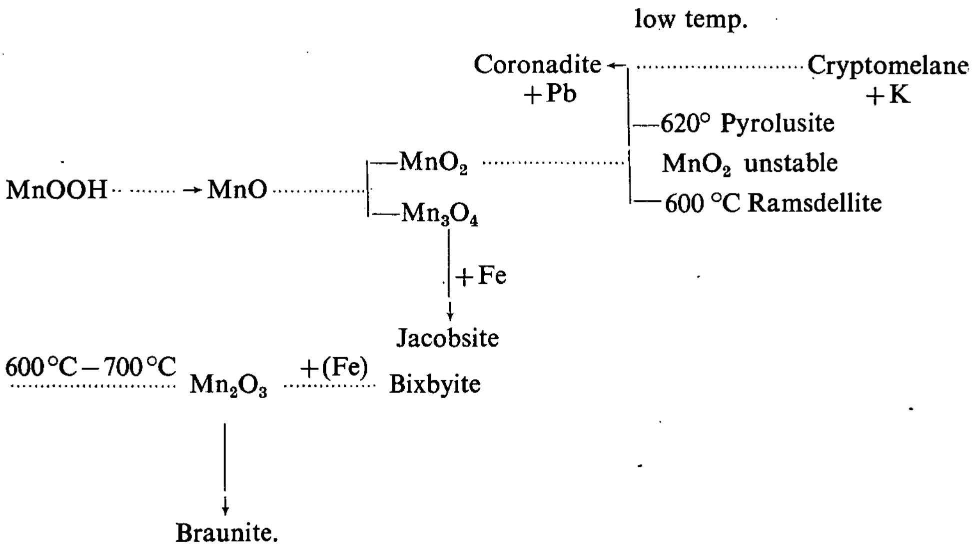
Sreenivas and Roy [1961] made observations on the cation exchange in some manganese minerals by electrodialysis and as a result they found replacement of K^+ by Cu^+ and replacement of a part of the Mn^{4+} by Cr^{3+} giving internal compensation for the loss of K^+. Applying these experimental results to the natural formation of minerals it is possible of higher concentration of Cr and Cu in the sample Nos. 997 and 954. Moreover there is a close resemblance in the ionic sizes of Mn^{4+} and Cr^{3+} ($Mn^{4+}=0.60$; $Cr^{3+}=0.63$).

Yttrium

Yttrium is present in small amounts (mostly $<0.01\,\%$) in jacobsite, manganosite, in collodial pyrolusite and cryptomelane.

PARAGENESIS

Manganese was originally deposited as MnOOH and then transformed to various oxides as it is metamorphosed. The scheme of transformation is given below.



As shown in the above the MnOOH after dehydroxylization gives manganosite, this mineral oxidized with active oxygen and forms $MnO_2 + Mn_3O_4$.

The MnO_2 forms different minerals at different temperatures leaving behind, the unstable MnO_2. However, either alteration of the minerals like pyrolusite cryptomelane and ramsdellite etc., or de-oxidation of unstable MnO_2 forms Mn_2O_3 braunite, bixbyite with Fe and other minerals.

The various manganese minerals were worked by supergene processes and the most important mineral in the deposit is the cryptomelane. It may be stated the manganese mineralization is sedimentary metamorphic and have undergone supergene enrichment.

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J. S. R. KRISHNA RAO,
B. VENKATA NAIDU
and
K. WISWESWARA RAO
Dept. of Geology, Andhra University
Waltair-530 003, India