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Infrared Spectra of Manganese ores from Deogiri of Sandur Schist Belt Area Karnataka India

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ABSTRACT: The aim of the present work is to study the infrared spectra of collection of manganese ores from Deogiri of Sandur schist belt, Karnataka India, with aview of finding out whether the characteristics of the ores are reflected in the spectra and also to report the data which would be helpful for the other investigators. The infrared spectra are described in terms of frequency shifts, intensity and half band width (broadness). No efforts are made to determine quantitatively the important constituents such as silica, alumina, etc. but qualitative inferences based on comparison of the intensities have been drawn. The manganese ores of Deogeri dominantly consists of Pyrolusite, Psilomelane, Braunite and Manganite. The dominant iron minerals are Hematite, Magnetite, Goethite and Limonite. The authors are reporting for the first time the presence of Ramsdellite and Hausmanite in the absorption spectra of manganese ores of Deogiri.

Index Terms- Manganese; Infrared spectra, Deogiri, Sandur schist belt

INTRODUCTION

Manganese ore is an important and indispensable input raw material for steel making and steel production and consumption are among the key indicators of industrial development in any country. Manganese ore in the form of ferro and silicomanganese alloys are the most important ingredients in the production of steel, both crude and stainless.

Manganese enjoys a high strategic importance for an industrialized nation since no quality steel can be produced without the addition of small quantity of Manganese. Because of its sulfur fixing, deoxidizing, and alloying properties, the principal use of manganese is in iron and steel manufacture. Relatively small amounts of manganese and different manganese compounds are utilized in the manufacture of other metal alloys, animal feed, soil conditioners, dyes and paints, pharmaceuticals, dry-cell batteries, and as a coloring material in pottery, tile, and brick.

The aim of the present work is to study the infrared spectra of collection of manganese ores from Deogiri area of Sandur schist belt area, Karnataka India, with view of finding out whether the characteristics of the ores are reflected in the spectra and also report the data which would be helpful for the other investigators. The infrared spectra are described in terms of frequency shifts, intensity and half band width (broadness). No efforts are made to determine quantitatively the important constituents such as silica, alumina, etc. but qualitative inferences based on comparison of the intensities have been drawn. The infrared spectra of the manganese ores of Deogiri area has not been carried out earlier. The present work has been undertaken to study the absorption spectra of Manganese minerals.

EXPERIMENTAL

Sixteen samples of manganese ores were collected from different mining benches of Deogiri Manganese mining pits of M/s SM&IO Ltd. The chemical analysis was carried out by classical methods. The analytical data of the individual samples is presented in the tabulated form in table number 1. Manganese % ranges between 57.48 to 19.14 %. Fe % of individual samples ranges 0.5 to 39.64%. The wide difference in Mn and Fe content of samples shows the heterogeneous nature of the Mn ores of Deogiri.

INFRARED ABSORPTION SPECTRA

The infrared spectra of manganese ores were measured using a Carl zeiss UR-10 and X 99 I.R Spectrophotometer in mull media. The samples were ground to very fine powder to pass +150 meshes and are then agated and a small quantity of the same is mixed with pure paraffin oil, thus forming a suspension of minute crystallites in a viscous medium. The resultant paste was then smeared over an alkali halide plate (of either NaCl or KBr) and a second halide plate was kept on the first one and squeezed to get a thin film of the compound in the oil. This was kept in the spectrometer and the radiations were passed. The resultant absorption spectrum was measured and the minerals were identified by comparing the values with those given

in standard spectras from Atlas of Infrared spectroscopy of clay minerals and their admixtures(H.W vanderMarel and H. Beutelspacher.Elsevier Sci. pub. 1976)

Sr. No.	Sample No.	Frequency cm^{-1}	Mn %	Fe %
1	Mn 23	475.74 sh, 538.04 m, 587.61 d, 908.50 sh, 1027.62 s, 1114.57 w, 1646.71 sh, 3450.51 svb, 3619.87 sh, 3652.25 w	38.94	17.98
2	Mn 21	409.58 vs, 570.32 s, 797.10 vs, 914.35 vs, 1009.30 sh, 1041.70 md, 1114.22 ssh, 1632.88 s, 1619.93 s,1661.49 vs, 3692.29 s, 3735.08 sh	39.57	17.91
3	Mn 19	431.09 vs, 470.34 vs, 539.39 vs, 697.17 vs, 753.99 s, 796.15 vs, 912.93 vs, 944.56 ssh, 1008.32 vs, 1032.16 vs, 1113.62 ssh, 1637.57 bs, 2854.95 w, 2925.59 ms, 3434.00 bs, 3619.68 vs, 3651.98 vs, 3695.42 vs	35.20	23.05
4	Mn 17	431.58 w, 470.92 vs, 543.23 bs, 690.64 vs, 752.47 ssh, 796.05 vs, 913.82 vs, 1011.53 vs, 1034.38 vs, 1096.43 s, 1634.07 bs, 3620.57 vs, 3661.09 wsh, 3695.48 v, 3620.57 vs, 3661.09 wsh, 3695.48 vssh	36.93	20.09
5	Mn 16	471.43 vs, 539.01 s, 797.38 ssh, 912.69 vs, 1008.85 vs, 1031.67 vs, 1106.16 vs, 1521.50 wsh, 1558.03 wsh, 1598.08 vwsh, 1635.18 ms, 1671.63 wsh, 1751.10 w, 2854.95 wm, 2919.71 wsh, 3442.60	40.17	17.54

Table 1. Infrared spectras and nature of peak for Manganese samples of Deogiri
Abbreviations: s= strong, m= medium, w= weak, sh= shoulder, b= broad, v= very, d= doublet

Results And Discussion

The infrared absorption spectra study of the Manganese ores of Deogeri was carried out in the region 400-4000 cm^{-1}. There are no bands after 3652 cm^{-1}.The spectras of manganese minerals occur below 450 cm^{-1} to 3652 cm^{-1}. The mineralogy of manganese ores of Deogiri is very complex because of the occurrence iron minerals along with manganese ores because of its nearest atomic number and total atomic mass.

From the mineragraphic studies of manganese ores it is found that Pyrolusite is dominant followed by Psilomelane, braunite, manganite etc. In the present investigation an attempt has been made to scan the manganese ores for their individual minerals by studying absorption spectra.

5 samples were subjected to scan the minerals in the range of 400-4000 cm^{-1}. The spectral region 3450 cm^{-1}- 3452 cm^{-1} is assigned for the OH group and from 475 cm^{-1} to 1646 cm^{-1} is assigned for the individual manganese minerals. Each spectras are described in terms of band width and absorption pattern. The details of the spectral bands are tabulated in table no. 2 along with its chemical composition i.e. Mn and Fe %.

The minerals identified from infrared absorption spectra predominantly show the presence of Pyrolusite followed by Psilomelane, Braunite,

Manganite, Ramsdellite, Groutite and Hausmanite as tabulated in table number 2.

Pyrolusite

The Pyrolusite bands occur in region between 1106.16 cm^{-1}, 1096.43, 1034.38, 1009.30, 1008.32, 912.69, 469.85 and 458.87 cm^{-1}. So these are the dominant bands for Pyrolusite, which accounts for maximum concentration in the samples which equals to MnO_2.

Psilomelane

Psilomelane is the second important mineral of manganese associated with Deogiri manganese ores. The absorption spectral bands occur around 912.39 cm^{-1}, 796.15, 581.72, 478.68 and 476.53 cm^{-1}. There is shift in band position by 1 cm^{-1} to 2 cm^{-1}.

Braunite

The absorption spectra of braunite depict around 908.50 cm^{-1}, 550.01, 478.68, 473.59, 471.43 and 470.92 cm^{-1}. These are assigned for the presence of braunite. There is a shift of band position by 3-5 cm^{-1}.

Manganite

The absorption of manganite depicts only 3 bands around 1114.57 cm^{-1}, 944.58 and 597.22 cm^{-1}. The wide difference in the bandwidth may be due to heterogeneous chemical composition of the ore.

Ramsdellite

The absorption spectra bands for Ramsdellite are observed at 799.10 cm^{-1}, 796.15, 753.99, 697.17, and 693.59 cm^{-1}.

Groutite

The infrared absorption spectrum for Groutite was observed at 1114.22 cm^{-1}, 1111.60 and 1111.63 cm^{-1}.

Hausmanite

Absorption spectra bands for Hausmanite are observed at 944.56 cm^{-1} and 550.01 cm^{-1}.

Sr. no.	Sample no.	Wave number in cm^{-1}	Nature of peak	Deviation from standerd cm^{-1}	Mineral identified
1	Mn 23	908.5	Medium	1.5	Pyrolusite
		587.61	Doublet	1.61	MnO2
		908.5	Shoulder	1.5	Braunite
		1114.57	Weak	0.57	Manganite
		475.74	Shoulder	0.26	Goethite
2	Mn 21	914.35	Very strong	0.65	MnO2
		1009.3	Very strong	0.3	Pyrolusite
		1114.57	Weak	0.57	Manganite
		797.1	Very strong	0.1	Goethite
		1632.88	Strong	2.88	Hematite
		1632.88	Strong	2.88	Magnetite
3	Mn 19	470	Strong	0	MnO2
		697.17	Very strong	2.17	Ramsdellite
		753.99	Strong	0.01	Ramsdellite
		796.15	Very strong	0.15	Ramsdellite
		1008.32	Very strong	0.32	Pyrolusite
		1032.16	Very strong	0.16	MnO2
		796.15	Very strong	1.15	Psilomelane
		944.56	Shoulder	1.34	Manganite
		944.56	Shoulder	1.34	Hausmanite
		431.09	Very strong	0.91	Magnetite
		431.09	Very strong	1.09	Limonite
		912.93	Very strong	2.93	Hematite
4	Mn 17	470	Strong	0	MnO2
		752.47	Strong shoulder	1.53	Ramsdellite
		796.05	Very strong	0.05	Ramsdellite
		1034.38	Very strong	0.62	Pyrolusite
		1096.43	Strong	1.43	Pyrolusite
		470.92	Medium	1.08	Braunite
		431.58	Very strong	0.42	Magnetite
5	Mn 16	471.43	Very strong	0.57	Pyrolusite
		539.01	Strong	0.99	MnO2
		912.69	Very strong	0.69	Pyrolusite
		1008.85	Very strong	0.85	Pyrolusite
		1031.67	Very strong	0.33	MnO2
		1106.16	Very strong	0.16	Pyrolusite
		471.43	Weak	0.57	Braunite
		797.38	Strong shoulder	0.38	Goethite

Table 2. Infrared spectral bands with deviation from standard spectra$cm^{-1}$and Mn/Fe minerals identified.

The manganese ore of Deogeri dominantly consists of Pyrolusite, Psilomelane, Braunite and Manganite. The occurrence of Iron minerals may be due to the close association of atomic number and total atomic mass of Mn and Fe. The influx of iron into manganese ore is due to the above factor.

The dominant iron minerals are Hematite, Magnetite, Goethite and Limonite. The infrared spectra of Fe_2O_3 has been reported in the literature around band set 571 cm^{-1}, 476, 444, 385, 323 and 235 $cm^{-1}$are assignable to Hematite. But in case of Manganese ores the bands stretch away from the literature values

like 1632.88 cm^{-1}, 1031.98, 1031.14, 1030.86, 1029.20, 1009.40, 912.93, 911.44 cm^{-1}which are assignable for Hematite as the content of Fe % ranges between 12.85% to 39.64%.

Magnetite bands are observed around 1632.88 cm^{-1}, 1011.53, 1009.84, 581.72, 431.09 cm^{-1}.The Goethite bands are observed at 1111.63 cm^{-1},797.10, 796.15, 494.19, 476.53 and 475.74 cm^{-1}. The Limonite bands are noticed at 1639.25 cm^{-1} and 431.09 cm^{-1}.

The authors are reporting for the first time the presence of Ramsdellite and Hausmanite in the absorption spectra of manganese ores of Deogiri. The absorption spectra of Mn ores depicts the presence of Ramsdellite in the spectral region 797.10 cm^{-1}, 796.15, 753.99, 697.17, and 693.59 cm^{-1} and these are the spectras compared with the international spectras of manganese ores from lake valley Mexico USA.

The spectra also scans the presence of Hausmanite in the region 944.56 cm^{-1} and 550.01 cm^{-1} these are also compared to the standards from Germany.

Conclusions

1. Infrared spectra of Manganese ores from Deogiri shows prominent bands as compared to those given in the literature of different countries. Strong, broad, very strong nature of bands leads to the higher concentration of Mn as compared to the other countries.
2. The minerals identified from infrared absorption spectra predominantly show the presence of Pyrolusite followed by Psilomelane (912.39 cm^{-1}, 796.15, 581.72, 478.68 and 476.53 cm^{-1}. There is shift in band position by 1 cm^{-1} to 2 cm^{-1}), Braunite (908.50 cm^{-1}, 550.01, 478.68, 473.59, 471.43 and 470.92 cm^{-1} with shift in band position by 3-5 cm^{-1}), Manganite (1114.57 cm^{-1}, 944.58 and 597.22 cm^{-1}), Groutite(1114.22 cm^{-1}, 1111.60 and 1111.63 cm^{-1}.), Ramsdellite and Hausmanite.
3. The authors are reporting for the first time the presence of Ramsdellite and Hausmanite in the absorption spectra of manganese ores of Deogiri.
4. The absorption spectra of Mn ores depicts the presence of Ramsdellite in the spectral region 797.10 cm^{-1}, 796.15, 753.99, 697.17, and 693.59 cm^{-1} and these are the spectras compared with the international spectras of manganese ores from lake valley Mexico USA.
5. The spectra also scan the presence of Hausmanite in the region 944.56 cm^{-1} and 550.01 cm^{-1} these are also compared to the standards from Germany.
6. The dominant iron minerals identified from infrared absorption spectra are Hematite (), Magnetite (1632.88 cm^{-1}, 1011.53, 1009.84, 581.72, 431.09 cm^{-1}), Goethite (1111.63 cm^{-1},797.10, 796.15, 494.19, 476.53 and 475.74 cm^{-1}) and Limonite (1639.25 cm^{-1} and 431.09 cm^{-1}).

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