International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 7, July - 2014

Geochemistry and Ore Distribution Pattern of the Manganese Ores of Sandur Area, Karnataka

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***Abstract*— Sandur Manganese (mn) deposits belong to the Sandur schist belt, of Dharwar Supergroup. The Sandur schist belt is one of the important greenstone belts of the Karnataka craton and is named after the town Sandur where it is typically exposed. The rich manganese ore deposits associated with schist belt have evoked the interest from very early times of economic geologists, mining engineers and metallurgist. The Deogiri formation comprises of orthoquartzites, dolomitic limestone, mangenophyllite, metabasalt and meta grey wacke with intercalated banded ferruginous chert. The Mn deposits of Deogiri are known for its high grade Mn ores in our country. The dominant ores are pyrolusite, psilomelane, braunite, nsutite, cryptomelane and manganite. The Mn ore samples were collected from different working blocks of mine from Deogiri and SB halli, and were chemically analyzed for their major constituents like MnO_2, Fe_2O_3, MnO, SiO_2, Al_2O_3, P_2O_5, CaO and MgO. The bi-metallic ratio between Mn and Fe was determined to determine the grade pattern of Mn ores in the working blocks of Deogiri and SB halli. The Deogiri block bi-metallic ratio varies from 45.60 % to 59.50 % from the data it is observed higher the bi-metallic ratio the concentration of Mn is higher and lower the bi-metallic ratio lower the concentration of Mn. In SB halli block the bi-metallic ratio ranges from 44.60 % to 57.30 %. The same yardstick holds good for the SB halli block also. The higher concentration of Mn is also controlled structurally.**

Keywords*— Sandur, Manganese, Geochemistry, Bimetallic ratio.

I. INTRODUCTION

The Karnataka Manganese ore deposits are believed to have been derived mainly by the process of supergene enrichment of manganiferrous phyllites belonging to Dharwar system. A number of manganese ore deposits of varying dimensions occur all along the western margin of the Sandur schist belt over a lenCBGh of 40 km with widths ranging from 0.2 to 1.5 km. The belt extends from Deogiri in the southeast to Raman Mala and further northwest. Low to medium grade iron manganese ores (38% to 48% Mn) are mainly confined to the manganiferous greywacke of Deogiri Formation, which is sandwiched between the Lower Yeshwanthnagar and Upper Donimalai Formations. Sandur Manganese deposits belong to the Sandur schist belt, of Dharwar Supergroup. The Sandur schist belt is one of the important greenstone belts of the Karnataka craton and is named after the town Sandur where it is typically exposed. The rich manganese ore deposits associated with schist belt have evoked the interest from very early times of economic geologists, mining engineers and metallurgist. The Deogiri formation comprises of orthoquartzites, dolomitic limestone, mangenophyllite, metabasalt and meta grey wacke with intercalated banded ferruginous chert. The Mn deposits of Deogiri are known for its high grade Mn ores in our country. The dominant ores are pyrolusite, psilomelane, braunite, nsutite, cryptomelane and manganite.

The bi-metallic ratio between Mn and Fe was determined to determine the grade pattern of Mn ores in the working blocks of Deogiri and SB halli. The Deogiri block bi-metallic ratio varies from 45.60 % to 59.50 % from the data it is observed higher the bi-metallic ratio the concentration of Mn is higher and lower the bi-metallic ratio lower the concentration of Mn. In SB halli block the bi-metallic ratio ranges from 44.60 % to 57.30 %. The same yardstick holds good for the SB halli block also.

The details of the investigation are described in the full paper.

II. GEOCHEMISTRY

A. Deogiri block

Mn ore samples were collected from CBG block, RMK, SK top, and JLK which belong to Deogiri block. The major elements MnO_2, Fe_2O_3, MnO, SiO_2, Al_2O_3, P_2O_5, CaO and MgO were chemically analyzed to know the behavior of elements and also metallic ratio was calculated, for the individual blocks of Deogiri, as tabulated in table 1.

CBG block: The content of MnO2 ranges between 49.98 to 60.06 % and the bi-metallic ratio is 49.04 %. The silica content depicts heterogeneous character and so also Al2O3. The content of P2O5, CaO and Mgo shows little homogeneity in their concentration.

RMK Block: The content of MnO2 ranges between 58.57 to 68.69 % The content of Fe shows homogeneous character and so also SiO2 and Al2O3. The bi-metallic ratio ranges between 51.60 to 54.20%.

TABLE I. Analytical values for major elements and bi-metallic ratio in Deogiri Block

Sample No	MnO_2	Fe_2O_3	SiO_2	Al_2O_3	P_2O_5	CaO	MgO	Mn %	Fe %	Bimetal Ratio
CBG1	60.06	12.29	4.56	14.25	0.048	0.83	0.06	40.80	8.60	49.40
CBG 2	52.63	26.15	0.47	5.77	0.062	0.84	0.10	34.30	18.30	52.60
CBG 3	52.06	13.71	5.90	13.65	0.080	0.67	0.03	36.00	9.60	45.60
CBG 4	49.98	14.72	1.20	11.82	0.050	0.60	0.20	34.60	10.30	44.90
CBG 5	55.96	15.86	1.08	11.82	0.039	0.20	0.06	38.10	11.10	49.20
RMK 1	58.57	17.29	1.73	9.72	0.064	0.45	0.10	39.50	12.10	51.60
RMK 2	61.69	16.72	1.41	9.25	0.062	0.20	0.09	42.50	11.70	54.20
S.K.	53.88	27.00	1.16	3.47	0.062	0.25	0.02	38.40	18.90	57.30
JLK 1	77.38	13.00	1.05	3.30	0.112	0.67	0.08	49.50	9.10	58.60
JLK 2	54.28	28.15	3.14	7.00	0.071	0.26	0.06	37.50	19.70	57.20
JLK 3	62.74	24.58	0.58	5.70	0.043	0.30	0.09	42.30	17.20	59.50

S K: The content of MnO2 is 53.88% and that of Fe is 27%. The SiO2 content is 1.16% and that of Al2O3 is 3.47%. The bi-metallic ratio is 15.30%.

JLK: The content of MnO_2 ranges between 58.00 to 77.38 % The concentration of Fe_2O_3 ranges between 13.0 to 28.15%. The SiO_2 content ranges between 0.58 to 3.14% and that of Al_2O_3 ranges between 3.30 to 7%. The bi-metallic ratio shows homogeneous nature that is around 58.43 %.

B. SB halli block

Mn ore samples were collected from KMK, N Kolla and KPTS which belong to SB halli block. The major elements MnO_2, Fe_2O_3, MnO, SiO_2, Al_2O_3,P_2O_5, CaO and MgO were chemically analyzed to know the behavior of elements and also metallic ratio was calculated, for the individual blocks of SB halli block, as tabulated in table no. II.

KMK: The content of MnO_2 ranges between 49.72 to 73.08 % and the bi-metallic ratio ranges between 53.10 to 57.30 %. The silica content depicts heterogeneous character but the Al_2O_3 content ranges from 5.85 to 11.80%. The content of P_2O_5, CaO and MgO shows little homogeneity in their concentration.

N Kolla**:** The content of MnO_2 ranges between 60.91 to 66.90 % The concentration of Fe_2O_3 ranges between 11.14 to 16.00%. The SiO_2 content ranges between 5.40 to 11.80 % and that of Al_2O_3 ranges between 5.40 to 8.0%. The bi-metallic ratio ranges between 52.40 to 56.50 %.

KPTS: The content of MnO_2 is 54.14 to 69.5%. The SiO_2 content ranges from 2.17 to 11.95%. The concentration of Fe_2O_3 ranges between 10.86 to 13.00%. The bi-metallic ratio ranges between 44.60 to 54.80%.

TABLE II. Analytical values for major elements and bi- metallic ratio in SB Halli Block

Sample No	MnO_2	Fe_2O_3	SiO_2	Al_2O_3	P_2O_5	CaO	MgO	Mn %	Fe %	Bimetal Ratio
KMK 1	73.08	11.57	0.37	7.43	0.121	0.37	0.09	48.50	8.10	56.60
KMK 2	72.37	11.14	0.41	6.73	0.012	0.53	0.17	47.00	7.80	54.80
KMK 3	71.85	13.71	1.12	7.98	0.126	0.38	0.09	47.00	9.60	56.60
KMK 4	64.17	20.72	0.08	5.85	0.080	0.67	0.13	42.80	14.50	57.30
KMK 5	49.72	28.00	0.48	11.80	0.120	0.62	0.11	33.50	19.60	53.10
N. Kolla 1	60.91	16.00	5.45	6.65	0.076	0.20	0.10	40.50	16.00	56.50
N. Kolla 2	58.31	15.57	3.62	5.40	0.190	0.73	0.16	39.00	10.90	49.90
N. Kolla 3	63.39	13.29	4.91	7.15	0.150	0.60	0.12	43.40	9.30	52.70
N. Kolla 4	66.9	11.14	4.45	8.00	0.093	0.32	0.07	44.60	7.80	52.40
KPTS 1	58.83	12.29	8.12	5.30	0.062	0.17	0.07	39.50	8.60	48.10
KPTS 2	60.84	10.86	5.09	5.85	0.062	0.63	0.12	40.80	7.60	48.40
KPTS 3	69.5	13.00	2.17	3.55	0.277	0.47	0.08	45.70	9.10	54.80
KPTS 4	55.06	12.72	10.77	9.95	0.066	0.23	0.08	36.93	8.90	45.83
KPTS 5	54.14	12.00	11.95	6.13	0.052	0.72	0.18	36.20	8.40	44.60

III. BIMETALLIC RATIO

Bi-metallic ratio was determined for CBG workings, SK top, RMK and JLK for Deogiri block and so also for SB halli block KMK, N Kolla and KPTS. The bi-metallic ratio was determined between % of Mn and % Fe as tabulated in table 3.

CBG workings: Bi-metallic ratio was determined by analysis of 5 samples. From the data it is observed the bi-metallic ratio ranges from 44.90% to 49.40% higher the concentration of bi-metallic ratio lower the concentration of Mn content.

RMK: Bi-metallic ratio of RMK was determined by analysis of 2 samples; from the data it is observed the bi-metallic ratio ranges from 51.60 to 54.20%. Here higher the bi-metallic ratio higher the Mn % also higher the bi-metallic ratio homogeneity of Fe% is noticed in RMK block.

SK Top: Bi-metallic ratio of RMK was determined by analysis of 1 sample, from the data it is observed the bi-metallic ratio is 57.3% and the % of Mn is 38.4 and that of Fe is 18.9.

JLK: JLK block indicate heterogeneity in the concentration of Mn because of the higher concentration of the Fe in JLK sample no 2 and 3. In JLK sample no 1 the content of Fe is less, even though the bi-metallic ratio is 49.50%, this may be attributed to the free leaching of Fe in the deposit.

KMK: KMK deposits bi-metallic ratio was determined from 5 samples. The bi-metallic ratio shows homogeneous character for 4 samples i.e. sample no 1 to 4. The fifth sample depicts bi-metallic ratio 54.50 and the content of Mn is 33.50. The concentration of Fe is more than compared to all other samples of KMK.

N Kolla: The bi-metallic ratio of N kola was determined from 4 samples and it ranges from 52.40% to 49.90% The Mn content ranges between 43.40 to 44.60% and that of Fe% varies between 7.80 to 10.90%. Here higher the bi-metallic ratio higher the concentration of Mn.

KPTS: The bi-metallic ratio was determined from 5 samples and it ranges from 44.60% to 48.10%. The content of Mn varies from 36.20 to 39.50% and that of Fe% is 7.60 to 9.10%. Here also higher the bi-metallic ratio higher the content of Mn% and so also lower the bi-metallic ratio lower the concentration of Mn as noticed in the sample no 4 and 5. The content of Fe shows homogeneity in samples 1, 4 and 5.

TABLE III. Bimetallic ratio

Sr. no	Sample no	Mn %	Fe %	Bimetalic ratio
1	CBG 1	40.80	8.60	49.40
2	CBG 2	34.30	18.30	52.60
3	CBG 3	36.00	9.60	45.60
4	CBG 4	34.60	10.30	44.90
5	CBG 5	38.10	11.10	49.20
6	RMK 1	39.50	12.10	51.60
7	RMK 2	42.50	11.70	54.20
8	S.K.Top	38.40	18.90	57.30
9	JLK 1	49.50	9.10	58.60
10	JLK 2	37.50	19.70	57.20
11	JLK 3	42.30	17.20	59.50
12	KMK 1	48.50	8.10	56.60
13	KMK 2	47.00	7.80	54.80
14	KMK 3	47.00	9.60	56.60
15	KMK 4	42.80	14.50	57.30
16	KMK 5	33.50	19.60	53.10
17	N. Kolla 1	40.50	16.00	56.50
18	N. Kolla 2	39.00	10.90	49.90
19	N. Kolla 3	43.40	9.30	52.70
20	N. Kolla 4	44.60	7.80	52.40
21	KPTS 1	39.50	8.60	48.10
22	KPTS 2	40.80	7.60	48.40
23	KPTS 3	45.70	9.10	54.80
24	KPTS 4	36.93	8.90	45.83
25	KPTS 5	36.20	8.40	44.60

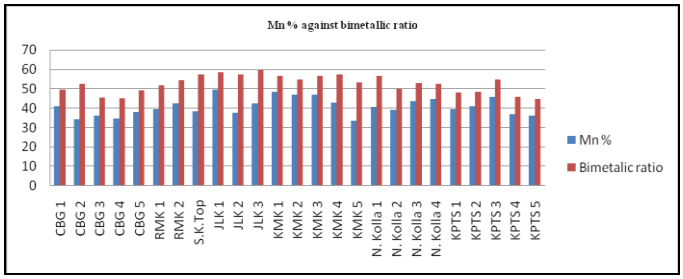

Fig. 1. Graphical represntation of Mn % against bimetallic ratio.

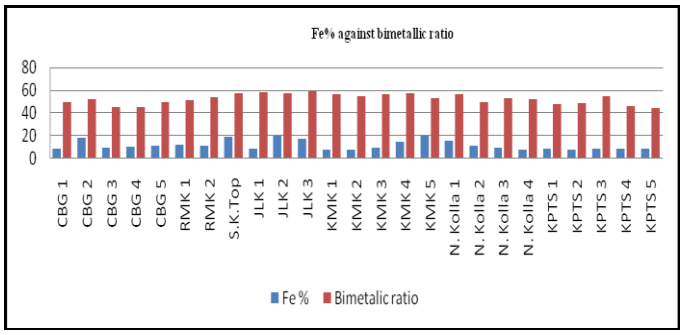

Fig. 2. Graphical represntation of Fe % against bimetallic ratio.

IV. RESULTS AND COCLUSIONS

Ore distribution pattern of Mn ores of Deogiri deposits Sandur schist belt Karnataka, was studied based on the constituents like MnO_2, Fe_2O_3, MnO, SiO_2, Al_2O_3,P_2O_5, CaO and MgO. The bimetal ratio was determined between Mn and Fe from different working blocks. The higher concentration of Mn is also controlled structurally. From the above investigations the following conclusions were drawn.

The concentration of Mn ore is more at higher level of lateritic surface (R. L. 3300') which is a structural control for the formation of Mn deposits. The lateritization extends to a depth of 150 m in contrast with low level lateritic surface (R.L. 2500' – 2700') which indicates the mineralization is poor.

The bi-metallic ratios were determined for CBG, RMK, SK top, JLK, KMK, N Kolla and KPTS. The bi-metallic ratio was calculated between Mn and Fe. Based on % of Mn and Fe as tabulated in table no. 3

The bi-metallic ratio for CBG block ranges between 44.90 to 49.40% which indictes higher the bi-metallic ratio lower the concentration of Mn.

The bi-metallic ratio for RMK block ranges from 51.60 to 54.20%. This depicts higher the bi-metallic ratio higher the concentration of Mn.

The bi-metallic ratio of SK block analyzed 57.3% and Mn % is 38.4% in this case the concentration of Mn is less even though the bi-metallic ratio is high it may be due to the higher concentration of Fe i.e. 18.9%.

The bi-metallic ratio for JLK block shows heterogeneity in the concentration of Mn because of the higher concentration of Fe, but in the sample no. 1 the content of Fe is less even though the bi-metallic ratio is 49.50 %. This is due to the leaching of iron in the process of formation.

The bi-metallic ratio of KMK block indicates homogeneous character for 4 samples. The sample no. 5 indicates high ratio of 54.50 % and the Mn content is 33.50 %. The content of Fe is maximum in comparison to other samples of KMK.

The bi-metallic ratio for N. Kolla ranges from 49.90 to 56.50 % the Mn content ranges between 4.50 to 44.60 % the higher content of Mn is due to the less concentration of Fe in all the samples.

The bi-metallic ratio of KPTS block ranges between 44.60 to 54.80 % and the Mn content varies from 36.20 to 45.70 %. The concentration of Fe is less compared to other blocks. The content of Fe shows homogeneity in sample 1, 4 and 5.

The variation in bi-metallic ratio in different blocks may be attributed to the pockety nature of the ore occurring in the schist belt, as it is evident from the mining sections and so also by the geochemistry of Manganese ore distribution.

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