SHORT COMMUNICATION

New Occurrence of Manganocolumbite from Late Proterozoic Pegmatites of Bhurpidungri, Jharsuguda District, Orissa

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Abstract: Manganocolumbite in the pegmatites of Bhurpidungri (Lat: 21°51'30": Long: 84°15'52", T.S.No.73C/5) in the Jharsuguda district of Orissa is reported for the first time from the pegmatites of India. It contains upto 18.46% MnO, with an average (n=8) of 14.52% MnO, 7.26% $FeO^{(T)}$, 60.18% Nb_2O_5 and 14.33% Ta_2O_5. A swarm of pegmatites is exposed, intruding at the contact of granite gneiss and amphibolite/charnockite near the Bhurpidungri village. These pegmatites are well-zoned with prominent quartz core, intermediate zone and wall zone. About 4 tonnes of manganocolumbite has been estimated in the gravels of these pegmatites for exploitation. Apart from this, beryl is also found in sufficient quantity.

Keywords: Manganocolumbite, Pegmatites, Jharsuguda district, Orissa.

Introduction

In the course of detailed investigations, including mapping, in and around Pandikimal in Orissa, the authors came across the occurrence of manganocolumbite in the pegmatites of Bhurpidungri (Lat: 21°51'30": Long: 84°15'52", T.S.No.73C/5), 2 km northwest of Pandikimal columbite-tantalite bearing pegmatite (Fig.1) (Sinha et al. 1996; Ramesh Babu, 1999). Important and well-known pegmatites hosting rare metals are known from Bihar mica belt, Nellore mica belt, Andhra Pradesh and Rajasthan pegmatite belt. New pegmatite belts containing rare metals viz., Nb-Ta, Li, Be etc., are reported by AMD in Chattisgarh, Orissa, Karnataka and Tamil Nadu (Banerjee, 1999). Manganocolumbite-bearing pegmatites of the Bhurpidungri area, Jharsuguda district, Orissa are reported here for the first time in India. Geology of these pegmatites and mineral chemistry of some of the pegmatitic minerals are dealt with in this communication.

Geological Setting

The study area is situated in southeastern part of the Jharsuguda district, Orissa. The country rocks exposed locally in the area are granite gneiss, amphibolite, pyroxene granulite, garnetiferous schist (spessartite-bearing), metadiorite and aplite. These are intruded by pegmatites and quartz veins. Some of the pegmatites contain rare minerals like manganocolumbite and beryl. The basement is generally covered by granite gneiss overlain by quartzite, quartz-mica schist and amphibolite of Iron Ore Group (IOG), intruded by pegmatites, quartz veins and basic dykes (Fig.1). Geochronological data on the basement granite

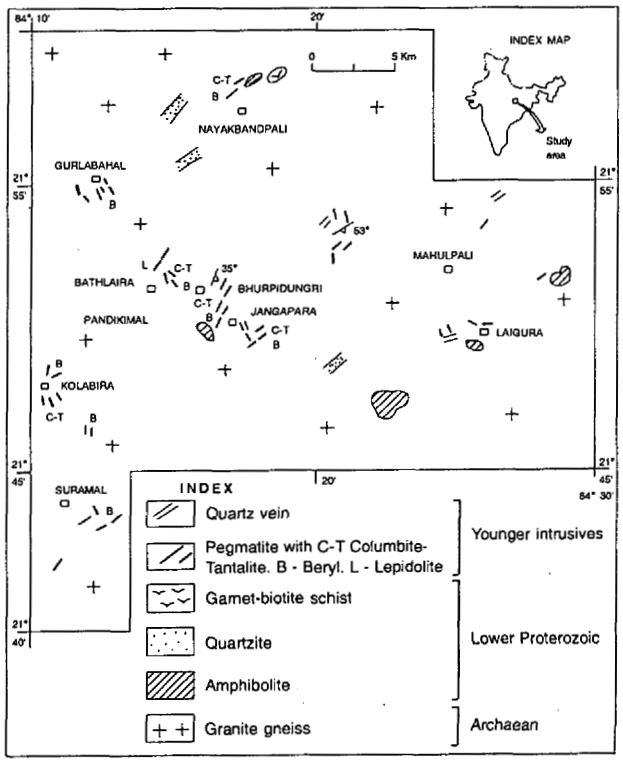

Fig.1. Geological map of the Kolabira-Pandikimal area, Jharsuguda district, Orissa (*modified after* Ramesh Babu, 1999).

gneiss have indicated Rb-Sr whole rock isochron age of 2762±200Ma with initial $^{87}Sr/^{86}Sr$ ratio of 0.7096 ± 0.0027 (Sinha, 2002). The granitic rocks are foliated and are mostly biotite granite. The granite is metaluminous to peraluminous and similar to A-type granite with higher contents of SiO_2 and Na_2O+K_2O and low CaO (Kumar et al. 2001). It contains quartz and plagioclase as major minerals, with microcline, hornblende, augite and opaques as minor minerals, and chlorite, sphene, apatite, leucoxene and allanite as accessories. Numerous injections of pegmatites occur within the granite and at the contact of the granite and amphibolite. The general trend of the pegmatites varies from NE-SW through NNE-SSW to NW-SE.

Mode of Occurrence of Pegmatites

A swarm of pegmatites forms a mound near the village Bhurpidungri, 2 km NW of the Pandikimal pegmatites (Jagadeesan, 2002). They comprise two prominent pegmatite bodies each of 220 m and 260 m in length and 10-30 m in width, and were emplaced along the contact of granite gneiss and amphibolite/charnockite. The pegmatites trend in N-S to NNE-SSW direction (Jagadeesan, 2002). They are well-zoned with detached quartz-core surrounded by quartz+muscovite and blocky perthite intermediate zones followed by a wall-zone of fine-grained quartz+ feldspar+ muscovite+tourmaline. Detached pods of quartz-core with a maximum length of 80 m and a width of 10 m are seen at the center of the pegmatites. Microcline, with perthitic intergrowth of sodic plagioclase, constitutes the intermediate zone surrounding the quartz-core. Blocky perthite is well developed in the northern portion of one of the pegmatites. Greisenisation is observed, at places (Fig.2).

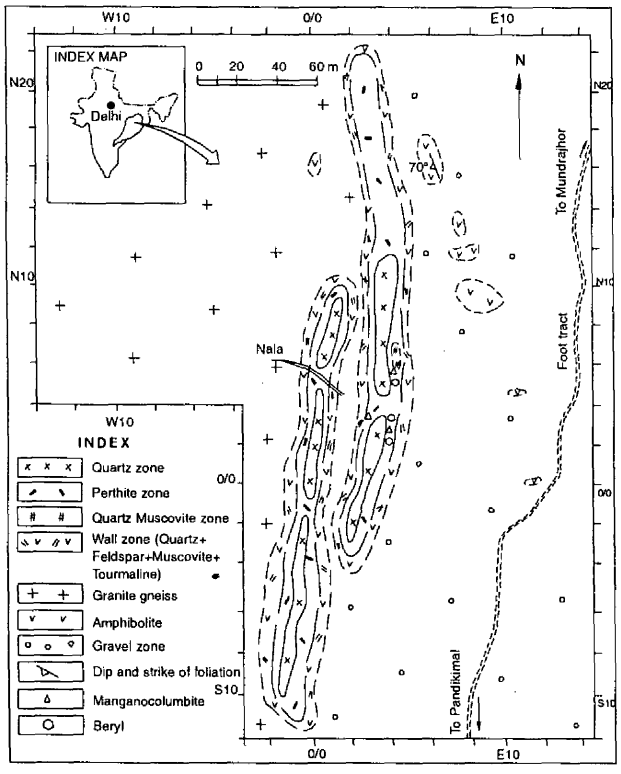

Fig.2. Geological map of Bhurpidungri showing zonation in pegmatites, Jharsuguda district, Orissa.

Mineralogy and Geochemistry

The major minerals of the pegmatites are quartz, perthitic feldspar, muscovite and tourmaline with magnetite as a minor mineral. In these pegmatites, large pockets of columbite-tantalite and beryl are found at the contact of intermediate zone and quartz-core. Quartz is milky white in colour. The perthitic feldspar has high concentration of Rb (1685-1845 ppm) and Nb (2207-2566 ppm) (Table 1). White to greenish muscovite occurs mostly within the wall zone and, at places, in the intermediate zone. Muscovite has also analysed high contents of Rb (1184 ppm) and Nb (179 ppm). These high contents of Rb and Nb in both perthitic feldspar and muscovite (Table 1) point to the fractionated nature of the pegmatites. Beryl is light green to pale yellow in colour and is found in all the zones of the pegmatite.

Table 1. Trace element analyses in ppm of the feldspar and muscovite from the Bhurpidungri pegmatite, Jharsuguda district, Orissa

Trace Elements	BP/Feldspar-1	BP/Feldspar-2	BP/Muscovite
V	8	7	133
Cr	17	16	125
Co	<5	<5	52
Ni	33	40	59
Cu	<5	<5	24
Ga	<5	<5	122
As	<10	<10	<10
Rb	1845	1685	1184
Sr	7	<5	<5
Y	5	27	23
Zr	40	41	59
Nb	2207	2566	179
Ba	<50	304	200
Ce	<50	<50	<50
Pb	31	47	13

Analyses by WDXRF Method at AMD, Nagpur.
Analysts: K. Shivkumar, P.K. Jain, K.Vijay Raj and M.G. Shinde.

Manganocolumbite is the manganiferous end-member of the columbite-tantalite series. It is generally found in fractionated Li-bearing pegmatites. It is dark steel grey in

Table 2. Analysis of Columbite-tantalite from Bhurpidungri area, compared with Pandikimal area, Jharsuguda district, Orissa

Oxides (%)	BP/1	BP/2	BP/3	BP/4	BP/5	BP/6	BP/7	BP/8	BP x (n=8)	PM x (n = 8)
Nb_2O_5	63.14	57.94	49.29	61.29	55.62	61.75	62.61	69.81	**60.18**	**57.11**
Ta_2O_5	13.58	16.18	24.45	12.01	13.81	13.84	14.63	6.12	**14.33**	**15.13**
SnO_2	0.20	0.23	0.29	0.17	0.13	0.24	0.15	0.09	0.18	0.16
WO_3	<0.10	<0.10	0.09	<0.10	<0.10	<0.10	0.53	1.51	0.33	0.34
$FeO^{(T)}$	5.55	6.52	6.14	7.90	10.37	6.88	6.52	8.25	**7.26**	**10.73**
MnO	15.28	18.06	18.46	15.04	8.97	16.72	13.10	10.50	**14.52**	**5.32**
TiO_2	0.57	0.19	<0.10	0.82	3.02	0.43	1.59	1.91	1.08	4.00
U_3O_8	0.45	0.30	0.29	0.29	0.33	0.30	0.40	0.36	0.34	0.33
ThO_2	<0.10	<0.10	<0.10	<0.10	0.23	<0.10	<0.10	<0.10	0.04	0.14

BP- Bhurpidungri; PM- Pandikimal. Analyses by WDXRF Method at AMD, Nagpur.
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colour, with specific gravity of 6.5 and hardness of 6. Its lustre is submetallic and streak is reddish black. Under the microscope, manganocolumbite is greyish white to slightly brown in colour and shows distinct anisotropism and straight extinction. Eight samples of manganocolumbite from the Bhurpidungri pegmatites show 55.62 to 69.81% Nb_2O_5, 6.12 to 24.45% Ta_2O_5, 8.97 to 18.46% MnO, 5.55 to 10.37% $FeO^{(T)}$, 0.09 to 0.29% SnO_2 and <0.10 to 1.51% WO_3 (Table 2). Subsequently two samples were investigated by the X-ray diffraction method that confirmed it as manganocolumbite (PDF data Card No.33-899 of JCPDS). From the X-ray diffraction patterns, unit cell dimensions were calculated and are as follows:

	Sample-I	Sample-II
a (Å)	5.7133± 0.0009	5.7209± 0.001997
b (Å)	14.2396± 0.0034	14.1977± 0.008341
c (Å)	5.1248± 0.0008	5.1057± 0.002118
Cell Vol. ($Å^3$)	416.9324± 0.098	414.7011± 0.2619

From the XRF analyses, the empirical formula of the studied manganocolumbite on the basis of 6(O) is $[(Mn_{0.76} Fe_{0.37}) (Nb_{1.65} Ta_{0.24} Ti_{0.05} O_6)]$. Compositional trends of the columbite-group minerals mimic those typically displayed in pegmatites of the lepidolite subtype viz. from the ferroan manganocolumbite with Mn/Mn+Fe ratio of 0.35 to near end- member manganocolumbite with Mn/Mn+Fe ratio of 0.95 (Breaks et al. 1998). The manganocolumbite from the Bhurpidungri area has a compositional range with Mn/Mn+Fe varying from 0.46 to 0.75. Manganocolumbite is one of the end-members in the columbite-tantalite series with a chemical formula $[(Mn, Fe^{++}) (Nb, Ta)_2 O_6]$. In the triangular variation diagram of Nb_2O_5 - TiO_2 + MnO + $FeO^{(T)}$ - Ta_2O_5, the manganocolumbite plots parallel to the Nb_2O_5 - Ta_2O_5 plane, with clustering towards Nb-end and is well within the manganocolumbite field of the San Diego Mine, Mesa Grande, California and Pakeagama pegmatite, Ontario, Canada (Fig.3). However, columbite-tantalite from the adjoining Pandikimal area is typically ferrocolumbite with average contents of 5.32% MnO and 10.73% $FeO^{(T)}$ (Table 2).

Discussion and Conclusions

Zoned pegmatites are believed to result from differentiation and crystallization of pegmatite-forming fluids in a restricted system, and it is possible that the late filling represents the rare metal element enriched end-stage residuum trapped in the fractures or openings developed in and around the pegmatite (Cerny, 1992a). The

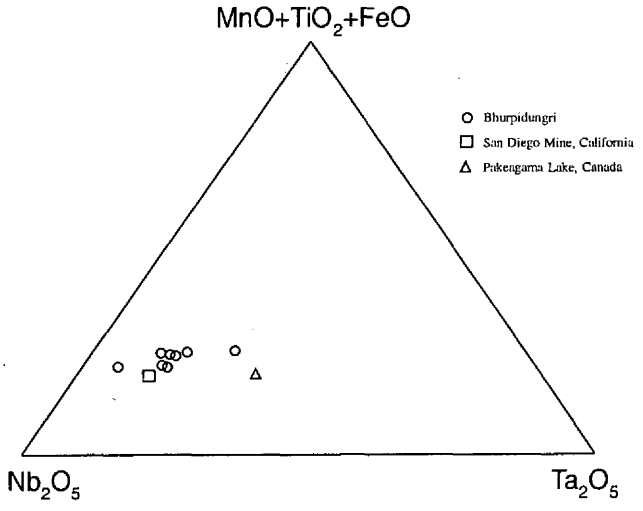

Fig.3. Nb_2O_5 - Ta_2O_5 - $[MnO+TiO_2+FeO^{(T)}]$ ternary diagram with plots of the Nb-Ta minerals from the Bhurpidungri area, Jharsuguda district, Orissa, compared with that from San diego Mine, California and Pakegama lake, Ontario (Breaks et al. 1998).

Table 3. Average analysis of manganocolumbite from Bhurpidungri area, Orissa and its comparison with San Diego mine, California and Pakeagama Lake, Ontario, Canada

Oxides %	Bhurpidungri, Jharsuguda Dist., Orissa (n=8)	San Diego Mine, Mesa Grande, California*	Pakeagama Lake, Ontario, Canada*
Nb_2O_5	60.18	68.22	48.82
Ta_2O_5	14.33	12.56	30.99
SnO_2	0.18	n.d.	0.13
WO_3	0.33	n.d.	0.24
$FeO^{(T)}$	7.26	0.35	5.79
MnO	14.52	19.27	12.59
TiO_2	1.08	0.17	0.27

* Data from Breaks et al. (1998); n.d.= not detected

manganocolumbite-bearing pegmatites of Bhurpidungri are reported, for the first time, from this area, which is well known for columbite-tantalite deposits, e.g., pegmatites of Pandikimal and Jangapara area (Ramesh Babu, 1999). The manganocolumbite under study contains upto 18.46% MnO, and is comparable with that from the San Diego Mine, Mesa Grande, California (MnO-19.27%) and Pakeagama pegmatite, Ontario, Canada (MnO - 12.59%) (Breaks et al. 1998) (Table 3). Manganocolumbite and magnocolumbite owe their origin to specific geochemical situations (Foord, 1982). Fractionation of Mn and Fe, with enrichment in the late stages of pegmatite evolution, is particularly conspicuous in F-rich pegmatites. However, in some cases the enrichment in Mn appears to be a primary feature of pegmatite populations, being inherited from a Mn-rich parent magma or acquired by digestion of Mn-rich substrate (Cerny, 1992a). The country rock in the vicinity of Bhurpidungri pegmatites is garnetiferous (spessartite-rich garnet) schist, which could be the major source for the occurrence of manganocolumbite in these pegmatites. The pegmatites in the nearby area like those of Pandikimal and Jangapara contain less MnO as they host ferrocolumbite with >10% $FeO^{(T)}$ and <6% MnO. These pegmatites have intruded at the contact of granite and amphibolite and the later could be the contributor of Fe in ferrocolumbite; this needs to be confirmed by further study. The high abundance of Nb and Rb in perthitic feldspar and muscovite of the pegmatite from Bhurpidungri points to its highly fractionated nature. The secondary concentration of manganocolumbite in the deluvial/colluvial gravels spread up to a distance of 130 m on either side of the ridge portions, demonstrates the potentiality of the pegmatites for this rare mineral. About 4 tonnes of manganocolumbite has been estimated in the gravels of these pegmatites for exploitation. As manganocolumbite-bearing pegmatites typically occur in swarms of numerous pegmatites, the study area appears to be potential for locating additional rare metal-bearing pegmatites.

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