

Table 4

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GEOLOGICAL SURVEY OF CANADA  
OTTAWA, ONTARIO

Phases reported to occur in natural and synthetic ferro-manganese material by Buser and Graf (1955), Buser and Grütter (1956), McMurdie (1944), Burns and Fuerstenau (1966) and others.

PHASE	COMPOSITION	DISPERSED STATE MORPHOLOGY	CRYSTAL SYSTEM	CELL PARAMETERS				CHARACTERISTIC X-RAY LINES	REMARKS
				a	b	c	β		
1 (See Remarks)	α - MnO <sub>2</sub>	Fibrous	Tetragonal or Monoclinic	3.1	6.9	2.4	90°		51% Mn <sup>4+</sup> + 8% Mn <sup>2+</sup> May be CRYPTOMELANE if it contains K.
2 PYROLUSITE	β - MnO <sub>2</sub>	Fibrous	Tetragonal	4.4		2.8		3.14(10), 2.41(5), 1.63(5)	57% Mn <sup>4+</sup> + 5% Mn <sup>2+</sup>
3 NSUTITE	γ - MnO <sub>2</sub>	Acicular	Orthorhombic	4.4	9.4	2.8		3.96(10), 2.42(10), 2.32(8)	May also be RAMSDELLITE, with peaks at 4.1, 2.5, 2.3 and 1.7 Å
4 BIRNESSITE	δ - MnO <sub>2</sub>	Platy	Hexagonal	2.4				2.44(10), 1.41(10)	One of the more common minerals of Fe-Mn deposits. Occasional broad lines at 7.4 Å and 3.7 Å
5 HAUSMANNITE	MnMn <sub>2</sub> O <sub>4</sub>	Granular	Tetragonal	5.7		9.4		2.49(10), 2.77(9), 1.54(8)	
6 (manganese oxide)	Mn <sub>3</sub> O <sub>4</sub>		Cubic	8.4				2.54(s), 1.49(m), 4.86(m)	
7 PARTRIDGEITE	Mn <sub>2</sub> O <sub>3</sub>		Cubic	9.4				2.72(10), 1.66(3), 3.84(2.5)	
8 GROUTITE	MnO (OH)		Orthorhombic	4.6	10.7	2.8		4.20(10), 2.81(7), 2.67(7)	
9 PYROCHROITE	Mn (OH) <sub>2</sub>		Hexagonal	3.4		4.7		4.73(10), 2.45(4), 1.83(3)	
10	MnO.H <sub>2</sub> O		Tetragonal	5.8		9.5			
11	Mn <sub>2</sub> O <sub>3</sub> .H <sub>2</sub> O	Platy	Monoclinic	8.9	5.2	5.7	90°	3.40(s), 2.64(m), 2.28(m)	The same parameters as MANGANITE, MnO (OH).
12 Manganous	4MnO <sub>2</sub> .Mn(OH) <sub>2</sub> .2H <sub>2</sub> O	Fibrous	Hexagonal	5.8		14.6			Two layer mineral.
13 Manganites	Mn <sub>3</sub> O <sub>4</sub> .H <sub>2</sub> O		Tetragonal	5.8		1.6 or 9.5		4.65(10), 2.50(6), 2.78(5)	Also called HYDROHAUSMANNITE, possibly (Mn <sub>4</sub> Mn) Mn <sub>8</sub> O <sub>16</sub> (OH)
14 10 Å Ferrous	Layered alternations of MnO <sub>2</sub> , Mn(OH) <sub>2</sub> , H <sub>2</sub> O and	Platy	Hexagonal	8.4		9.8		9.8(s), 4.8(m), 2.44(m)	Mn:Fe: 2:1 or 3:1
15 7 Å Manganites	Fe (OH) <sub>3</sub>	Platy	Hexagonal	5.8		14.6		6.9(s), 4.8(m), 2.44(m)	Mn:Fe: 2:1 or 3:1
16 TODOROKITE	(Mn <sup>2+</sup> , Mg, Ca, Ba, Na, K) Mn <sub>5</sub> <sup>4+</sup> O <sub>12</sub> .3H <sub>2</sub> O	Platy	Monoclinic	9.7	2.8	9.6	90°	4.86(10), 2.83(3), 9.34(2)	
17 GOETHITE	α - FeOOH	Platy	Orthorhombic	4.6	10.0	3.0		4.18(10), 2.69(3), 2.45(3)	Forms when Fe occurs in excess of the amount needed to form the ferrous manganites (10 Å and 7 Å manganite).
18 LEPIDOCROCITE	γ - FeOOH	Platy	Orthorhombic	3.9	12.5	3.0		6.26(10), 3.29(9), 2.47(8)	
19 (See Remarks)	FeOOH.nH <sub>2</sub> O	Colloidal	Amorphous						Related to LIMONITE.