CHAPTER III

SUMMARY AND CONCLUSIONS

GEOCHEMICAL AND GEOLOGICAL STUDIES OF MANGANESE OCCURRENCES IN NOVA SCOTIA

Ever since manganese was discovered in Nova Scotia previous workers assumed that the deposits were secondary in origin. As a result of several papers by the late D. F. Hewett of the United States Geological Service, interest was re-kindled in the manganese deposits of Nova Scotia. Hewett showed from his studies of United States and Mexican deposits that many veins of manganese oxides formerly considered supergene are hypogene in origin. Of 93 deposits studied in the American Southwest, the majority of the oxide minerals are hypogene. It was also pointed out that the presence of several trace elements within the oxides indicated a hydrothermal origin associated with base metal deposits.

Due to the numerous occurrences of manganese within Nova Scotia and their close proximity to known barite-base metal deposits, it was decided to proceed with a re-examination of some of the manganese deposits. Its purpose was twofold:

1. To re-map old workings and prospects to gather geological data relative to the deposits with a view to establishing geological and other criteria of value in judging the possible extension of ore occurrences.

2. To carry out a comprehensive trace element study of selected samples of manganese mineralization with the ultimate aim being the location of base metal deposits in association with the manganese.

It is well known that in the metal mining districts of Butte, Montana; Ely, Nevada; Bisbee and Tombstone, Arizona; rhodochrosite, rhodonite and alabandite are present in a zone surrounding a core of base metals. Also, in a number of western mining districts exploration in depth revealed that near surface manganese oxides are derived by alteration of manganese sulphide, silicate and carbonate. Hewett pictured the manganese source as thermal waters rising from depths and depositing rhodochrosite, rhodonite and alabandite with base metals. The remaining manganese in solution would rise in fissures and mingle with descending ground waters to form oxide minerals. Trace element studies of these manganese minerals revealed the presence of certain elements and abnormal amounts of others when compared with oxides of supergene origin. Subsequently, the genesis of manganese oxides can be determined from a study of trace elements. Some facts that may be used in identifying a hypogene mode of origin are:

1. Zinc, tungsten, lead, thallium, arsenic, molybdenum and antimony are more persistent and in greater amounts in hypogene oxides.

2. Beryllium, barium and strontium are present in higher amounts than in supergene oxides.

3. Presence of high tungsten (.1%) and/or arsenic indicates a hydrothermal source.

Other factors worthy of consideration are:

The persistent presence of barite and/or fluorite mineralization in association with the manganese; close proximity to explored deposits of barite or fluorite and a zonal arrangement of veins of manganese oxides and other mineral groups, e. g. Butte, Montana and Bisbee, Arizona.

ZONES OF HYDROTHERMAL MANGANESE

Hewett outlines three main zones in hydrothermal deposits that contain manganese. Different mineral assemblages characterize different depth zones in hypogene veins. The variation being due to the availability of oxygen, temperature and pressure.

1. Base metal zone containing sulphides of zinc, lead, and copper with silver and gangue minerals of quartz, barite, fluorite, manganoan siderite, rhodonite, rhodochrosite and alabandite. The manganese is in the bivalent state and represents the oxygen poor, high temperature in the deepest part of the epithermal zone (See Fig. 40).

2. Barite zone, may contain minor sulphides, hausmannite, and braunite, with manganese partly in the quadrivalent state and partly in the bivalent state (constituted of Mn^{++} and Mn^{++++}) is found in the middle zone.

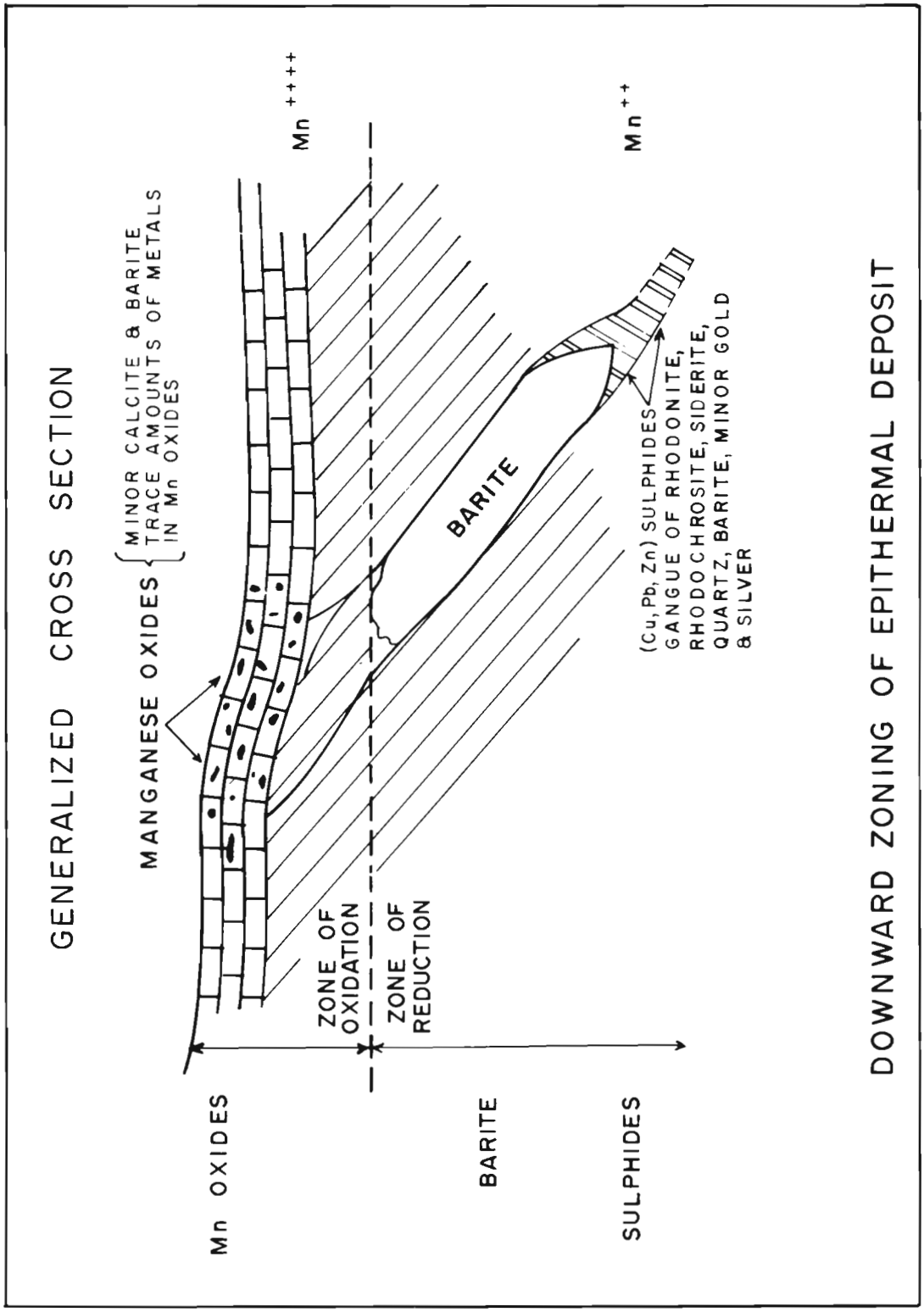
GENERALIZED CROSS SECTION
MANGANESE OXIDES
MINOR CALCITE & BARITE
TRACE AMOUNTS OF METALS
IN Mn OXIDES
Mn ++++
Mn ++
BARITE
(Cu, Pb, Zn) SULPHIDES
GANGUE OF RHODONITE,
RHODOCHROSITE, SIDERITE,
QUARTZ, BARITE, MINOR GOLD
& SILVER
ZONE OF OXIDATION
ZONE OF REDUCTION
Mn OXIDES
BARITE
SULPHIDES
DOWNWARD ZONING OF EPITHERMAL DEPOSIT

FIGURE 40.

3. Manganese oxides zone containing minor barite and manganoan or "black" calcite. As the ascending solution rises toward the surface, it mingles with the oxygen rich descending meteoric water and the higher oxides are formed consisting of pyrolusite, psilomelane, cryptomelane and coronadite.

The major manganese deposits of the world are classified into three braad genetic types (Park, 1956):

1. Hydrothermal - (a) hypogene vein deposits
   (b) thermal spring aprons

2. Sedimentary - all deposits formed as chemical sediments, irrespective af saurce. Thus deposits derived fram both volcanogenic and nonvolcanogenic saurces are included-includes deposits associated with iran formation and recent deep sea nodules.

3. Superficial - depasits formed by supergene and residual cancentration.

MANGANESE AREAS IN NOVA SCOTIA

The principal manganese bearing areas in Nova Scotia are as follows:

LOCATION	AGE
1. Walton-Minas Basin Deposits	Mississippian
2. New Ross	Devonian
3. Loch Lomond area	Mississippian
4. Nicholsville area	Silurian
5. Bridgeville area	Silurian-Mississippian

Walton-Minas Basin Deposits - Thirty-four occurrences of manganese are found along the Horton-Windsor contact from Truro, Colchester County west to Cheverie, Hants County, a distance of some sixty miles. Manganese oxides are concentrated in the basal Macumber and Pembroke limestones of the Windsor Group and in the underlying Cheverie sandstones and quartzites of the Horton Group. Manganite, pyrolusite and psilomelane are the common oxides with occurrences of hausmannite noted at Black Rock, Colchester County and at several localities in close proximity to the Walton barite and base metal deposit.

In the numerous deposits found in the Macumber and Pembroke limestones, the manganese oxides occur as nodules, stringers, veinlets, irregular masses, and relatively large spherical bodies in the voids between limestone fragments and along fractures and joint planes. The oxides are commonly associated with calcite in the form of dogtooth spar. The calcite fills fractures and open spaces forming comb structures and open vugs lined with crystals. In the majority of cases, the manganese is younger than the calcite. Barite crystals are intimately intergrown with pyrolusite and manganite which suggest contemporaneous deposition of barium and manganese.

Boyle (1972) makes note of the relatively high amounts of Cu, Pb, Zn, Sb, Ni, Co, Ag, Mo, V, Zr, B and Sr in the hypogene manganese oxides and concludes that the oxides are derived from the same solutions that gave rise to the barite and sulphide deposits. In the hypogene zone of reduction, the manganese is concentrated in the siderite but trace and minor amounts are found in barite, calcite, pyrite, and sphalerite. Boyle also goes on to state: "In the hypogene zone of oxidation deposition of manganese oxides, calcite, hematite, and minor barite took place probably contemporaneously with the deeper seated barite, siderite, sulphides and sulphosalts."

The Hants-Colchester County manganese deposits must be placed in their proper perspective. Within the Minas Basin area, there are deposits consisting of barite, manganese and sulphides at Tennycape, Brookfield, Middle Stewiacke, Smithfield, Londonderry and Bass River. With the exception of Bass River and Londonderry, all the deposits occur along the Horton-Windsor contact. The North Mountain basalt of Triassic age outcrops ten miles west of the area. Gabbro sills are found at Johnson Cove. The deposits are localized in the east-west steeply dipping fault zones at or near the Horton-Windsor contact. It is believed that the elements were deposited from hydrothermal solutions derived from igneous bodies or related to volcanic activity during the Triassic. Note the relatively high percentage of Ni, Ag, As, Zn, Ba, Pb, and Cu present in trace elements in the Hants-Colchester County manganese oxides (Pages 246, 247, 248, 249). It must also be noted here that float of hard manganese ore was found at Five Islands along the shore line. The manganese mineralization consists of psilomelane and plumose aggregates of fine manganite unlike any material observed in the mapped locations. It is believed the manganese mineralization is associated with the Triassic Basalts.

New Ross District

The once mined, frequently examined manganese deposits at New Ross occur as lenticular veins lying in crushed zones within Devonian granite. Manganese minerals present are pyrolusite, manganite, psilomelane, braunite, rhodochrosite, ramsdellite, knebelite and pinakiolite. The presence of a complex manganese borate mineral, manganese silicates and rhodochrosite indicate a possible hydrothermal origin for the manganese mineralization. The late D. F. Hewett confirmed that mineral specimens sent to him for study indicate a hypogene origin for the manganese


Cu
New Ross .032 %
Hants & Colchester .08 %
Bridgeville 062 %
Nicholsville .0625 %
McCuish Brook .041 %
Pb
New Ross .065 %
Hants & Colchester .032 %
Bridgeville .035 %
Nicholsville .0325 %
McCuish Brook .058 %
Zn
New Ross 018 %
Hants & Colchester .054 %
Bridgeville .039 %
Nicholsville .0087 %
McCuish Brook 053 %
Ba
New Ross 1.08 %
Hants & Colchester .958 %
Bridgeville 1.84 %
Nicholsville .55 %
McCuish Brook 51 %
As
New Ross .021 %
Hants & Colchester 0156 %
Bridgeville .015 %
Nicholsville .0122 %
McCuish Brook .0019 %
Ni
New Ross 015 %
Hants & Colchester 0317 %
Bridgeville NOT DETERMINED
Nicholsville NOT DETERMINED
McCuish Brook 0019 %
Ag
New Ross .627 ppm.
Hants & Colchester 1.335ppm.
Bridgeville .32 ppm.
Nicholsville .225 ppm
McCuish Brook .558 ppm
Mn CONTENT
New Ross 55.12 %, Hants & Colchester 48.75 %,
Bridgeville 45.85 %, Nicholsville 42.7 %
McCuish Brook 41.9 %
MANGANESE PROJECT
MINOR ELEMENT CONTENT OF SELECTED
Mn OXIDES FROM NOVA SCOTIA Mn DISTRICTS
ATOMIC ABSORPTION METHOD
1973
D.G. BISHOP

J.D.D.

mineralization (personal communication). The trace element content of the manganese oxides at New Ross indicate the following points: As, Ba, Pb, and Ag are relatively high. Beryllium content is highest in manganese oxides of hypogene origin. All twenty-three of the New Ross samples contained beryllium for an average of .005 percent. It is uncertain as to the significance of tin but since New Ross is a recognized tin district, it must be noted that the tin values average .14 percent and seem to bear out the premise that the manganese mineralization represents a zoning effect similar to the Cornwall tin district (Fig. 26).

Tungsten, strontium and nickel are persistently higher in the New Ross manganese deposits than elsewhere in Nova Scotia. The highest silver value (.01%) was olso found at New Ross.

Trace element cnalyses indicate a hypogene origin for the deposits. This dictates that deep drilling is essential at New Ross to test for the possibility of sulphide mineralization at depth.

Loch Lomond area

A number of interesting occurrences of pyrolusite, manganite, iron oxides, rhodochrosite and siderite occur in limestone and red shale, directly east of the Kaiser celestite deposit. Of additional interest is a possible connection between these manganese occurrences and an extensive low-grade lead deposit at Salmon River. McCuish Brook manganese oxides contain above average percentages of Pb, Zn, Ag, and Sn. Beryllium averages .003 percent. Barium and strontium are relatively high. Several samples of pyrolusite that averaged 58 percent manganese gave values of 28 percent lead; 37 percent zinc and .02 percent copper. This indicates that the manganese mineralization

at McCuish Brook is reflecting the lead-zinc mineralization of the Salmon River basin.

Nicholsville

This occurrence has been examined several times in past years. Pyrolusite and psilomelane are found in veins with crystalline barite, cutting red argillites at their contact with a gabbro dike 100 feet wide. This dike can be traced for several miles. Diamond drilling intersected numerous siderite veins, manganese mineralization with associated barite and calcite, and massive pyrite in four holes. Tin and arsenic values are high at Nicholsville, but silver is low and beryllium was not detected. Copper, Pb, and Ni values are persistently high, while the barium content is below the other elements.

Since the work on the area has been restricted to the immediate vicinity of the manganese occurrence it is recommended that a comprehensive mapping and sampling programme be carried out in the Nicholsville-Kentville belt of Silurian sediments.

Particular attention to the numerous mafic dikes and sills should lead to a further understanding of the manganese-barite mineralization.

Bridgeville

Limonite, manganese oxides, barite and siderite occur at the Windsor-Silurian contact. Although known primarily as an iron district, numerous samples of pure pyrolusite were obtained for study. Barium is extremely high followed by high values of Cu, Pb, Zn, As and Sr.

CONCLUSIONS

The majority of the Nova Scotian manganese deposits occur within Hants County, along the Horton-Windsor cantact and within the Macumber-Pembroke limestones. Other important occurrences are found at New Ross (Devonian granite) and at Nicholsville (Silurian sediments). It is believed that the manganese oxides were derived from ascending solutions that rose from great depth. As they mingle with descending meteoric water charged with oxygen, the higher oxides of manganese; psilomelane, pyrolusite and manganite are formed. The primary source of the manganese is manganoan siderite (FeMn) Co_3 and/or rhodochrosite. The presence of siderite with high manganese content is especially noteworthy, since it is a characteristic gangue mineral in many rich silver deposits such as Keno Hill, (Coeur d'Alene).

It is concluded that the majority of the Nova Scotian manganese deposits are hypogene and not supergene in origin. They were derived from manganoan siderite (Mississippian deposits) or rhodochrosite (New Ross) located at depth and deposited from ascending solutions. The zonal arrangement reflects decreasing temperature and increasing availability of oxygen.

Spectrographic analyses of selected specimens of manganese oxides confirm the widespread presence of measurable amounts of a group of elements that are rarely present in the supergene oxides. Arsenic, tungsten, beryllium and thallium seem much more persistent and the range of percentages are higher in the hypogene oxides than in supergene (Hewett). Frequency and amounts of Ba, Sr, Ni, B, Ge, Cr, Mo are higher in hypogene than supergene oxides. Abnormal amounts of tin were indicated in the manganese ore from New Ross, Bridgeville, McCuish Brook, Nicholsville, Walton

and Tennycape areas. In addition, persistent abnormal values of Cu, Zn, Pb and Ag would indicate association with base metal deposits. Such is true for the Hants County manganese occurrences but it is also true for New Ross and to a lesser extent for Nicholsville, McCuish Brook and Bridgeville. All of these areas should be examined and it is recommended that deep drilling be carried out.

The zonal alignment of the Walton-barite-sulphide deposit seems to substantiate Hewett's theory for the origin of many manganese deposits. Diamond drilling at Nicholsville has located manganese, siderite and sulphide mineralization. The New Ross mineral assemblage indicates a hydrothermal source and affiliation with the tin deposits. Trace element work indicates abnormal percentages of Pb, As, and Ag. It is therefore of the utmost importance that exploratory drilling be carried out along the manganese horizon at New Ross to prove or disprove the existence of manganese mineralization at a much greater depth than indicated in the previous drilling.