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SPHALERITE GEOBAROMETRY OF SOME METAMORPHOSED OREBODIES IN THE FLIN FLON AND SNOW LAKE DISTRICTS, MANITOBA

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Abstract

The Flin Flon (South Main), Schist Lake, Chisel Lake, Stall Lake and Osborne Lake orebodies of the Hudson Bay Mining and Smelting Company are associated with Precambrian metavolcanic and metasedimentary rocks of the Amisk Group or their equivalents. Amisk Group rocks crop out from west of Amisk Lake, Saskatchewan, to east of Wekusko Lake, Manitoba. Metamorphic grade of Amisk Group rocks increases from south to north. The Flin Flon and Schist Lake orebodies are associated with rocks of the greenschist facies. The Chisel Lake and Stall Lake orebodies occur with rocks containing staurolite and the Osborne Lake orebody occurs within the sillimanite zone.

Massive portions of these orebodies are characterized by the mineral assemblages: pyrite—sphalerite—chalcopyrite, pyrite—pyrrhotite—sphalerite—chalcopyrite, pyrrhotite—chalcopyrite—sphalerite or pyrite—sphalerite.

Compositions of sphalerites were determined by electron microprobe. Their equilibration temperatures have been estimated from the metamorphic grades of the rocks associated with the orebodies. Sphalerite equilibration pressures estimated from data given by Scott & Barnes (1971) are: Flin Flon (South Main) 5½-6+ kb, Chisel Lake 4-5½ kb, Stall Lake 4½-6+ kb and Osborne Lake 5½-6+kb. Sphalerite equilibration pressures estimated from data given by Scott (1973) are: Flin Flon (South Main) 6½ - 9½ kb, Chisel Lake 4 - 8½ kb, Stall Lake 4+ - 9 kb, Osborne Lake 8 - 10+ kb.

Introduction

The Flin Flon and Snow Lake mining districts are located within an easterly-trending belt of metamorphosed volcanic and sedimentary rocks of Precambrian age, named the Amisk Group (Byers *et al.* 1965; Bailes 1971; Coates *et al.* 1970). Amisk Group rocks crop out from west of Amisk Lake, Saskatchewan, to just east of Wekusko Lake, Manitoba, a distance of approximately 135 miles. The Amisk Group consists of volcanic rocks which vary from basic to acid in composition and include both flow and pyroclastic varieties. Clastic sedimentary rocks, principally greywackes and argillites, also occur within the Amisk Group (Byers *et al.* 1965; Coates *et al.* 1970; Mukherjee *et al.* 1973). Metamorphism in Amisk Group rocks ranges from greenschist to amphibolite facies (Byers & Dahlstrom 1954) increasing from south to north (Bailes 1971; Froese 1973).

Numerous stratabound sulphide orebodies have been discovered within volcanic rocks of the Amisk Group. The locations of the orebodies which were sampled for this study are shown in Fig. 1. Typical assemblages of principal sulphide minerals are: (1) pyrite—sphalerite—chalcopyrite, (2) pyrite—pyrrhotite—sphalerite—chalcopyrite, (3) pyrrhotite—chalcopyrite

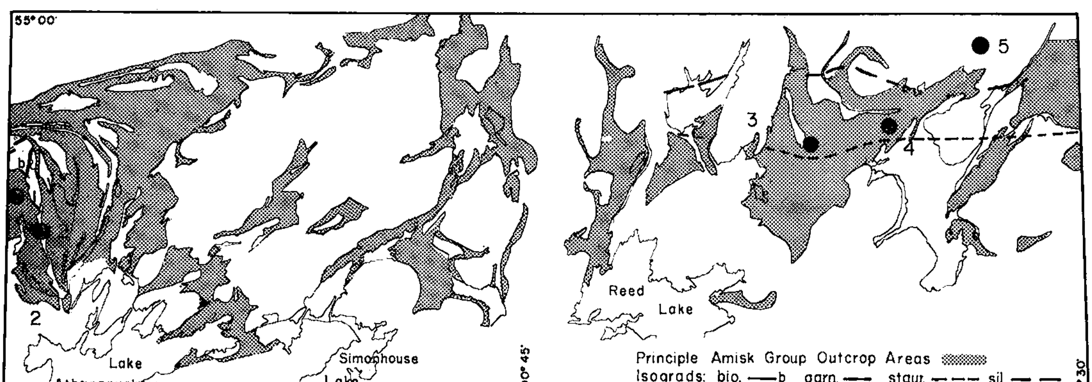

FIG. 1. Flin Flon - Snow Lake area, Manitoba. Locations of orebodies, metamorphic isograds and principal areas of Amisk Group outcrop. 1. Flin Flon (South Main) mine. 2. Schist Lake mine. 3. Chisel Lake mine. 4. Stall Lake mine. 5. Osborne Lake mine.

—sphalerite, (4) pyrite—sphalerite. The variety of mineral assemblages in these orebodies makes them suited to studies relating to the experimental data for the Fe—Zn—S system (Scott & Barnes 1971; Scott 1973).

Sample Distribution

Massive portions of the aforementioned orebodies were sampled at hanging wall, center and footwall locations. Several levels in each mine were sampled in an attempt to determine variations, if any, of FeS contents of sphalerites with lateral distribution and depth. Sample locatitons for each of the mines are provided in Table 1.

Analytical Procedure

Analyses of sphalerites were obtained using an A.R.L.-E.M.X. microprobe. An operating potential of 15 kv, a beam current of 0.1 μa and a focused beam spot of 1 μm or less were used for all analyses. Ten 20-second counts were used for each analysis. Specimens were shifted slightly after each 20-second count; maximum specimen shift was 6 μm.

Where possible, 3 sphalerite grains in each section were analyzed for Fe, Zn, S, Se, Cd, Mn, Cu and As. In a few sections, composed almost entirely of pyrrhotite and chalcopyrite, only 1 or 2 grains of sphalerite were found.

TABLE 1. SAMPLE DISTRIBUTION DATA AND FeS CONTENTS OF SPHALERITES

Mine & Level	Sample Number*	Location	Mole % FeS	With Sp.**
Flin Flon (South Main) 1330'	7.1	56 footwall raises	10.95	Py+Po
	7.2		11.16	
	7.3		10.92	
	8.1	56 footwall raises	10.66	Py+Po
	8.2		11.42	
	8.3		11.55	
	9.1	56 footwall raises	11.53	Py+Po
	9.2		11.11	
	9.3		10.96	
	10.1	56 footwall raises	10.12	Py
	10.2		10.22	
	10.3		10.91	
3000'	11.1	2 vertical pillar No.5	10.05	Py
	11.2	Scram and undercuts	9.70	
	11.3	3 panel South hanging wall -Shrinkage stope cones	9.85	
	12.1	2 vertical pillar No. 5	11.81	Py+Po
	12.2	Scram and undercuts	9.99	
	12.3	3 panel South hanging wall -Shrinkage stope cones	10.28	
	1.1	hanging wall	9.96	Py
	1.2		9.96	
	1.3		9.81	
	2.1	center	12.12	Py+Po
	2.2		11.59	
	2.3		12.42	
	3.1	footwall	9.44	Py
	3.2		9.53	
	3.3		9.31	
3250'	4.1	hanging wall	10.02	Py
	4.2		10.16	
	4.3		9.97	
	5.1	hanging wall	9.99	Py
	5.2		10.08	
	5.3		9.92	
	6.1	footwall	12.05	Py+Po
	6.2		12.28	
Schist Lake 1600'	1.1	No.6 orebody - hanging wall	9.55	Py
	1.2		9.83	
	1.3		9.35	
	2.1	No. 6 orebody - center	7.39	Py
	2.2		7.61	
	2.3		7.32	
	3.1	No. 6 orebody - footwall	7.01	Py
	3.2		6.61	
	3.3		6.61	
	4.1	No. 6 orebody - footwall	7.50	Py
	4.2		7.85	
	4.3		7.37	
1850'	5.1	No. 7 orebody - hanging wall	7.35	Py
	5.2		7.62	
	5.3		7.46	
	6.1	No. 7 orebody - center	5.68	Py
	6.2		6.09	
	6.3		5.96	
	7.1	No. 7 orebody - footwall	7.34	Py
	7.2		7.42	
	7.3		7.45	

Mine & Level	Sample Number*	Location	Mole % FeS	With Sp.**
Schist L. 3350'	8.1	No. 4 orebody- hanging wall	4.91	Py
	8.2		5.14	
	8.3		4.72	
	9.1	No. 4 orebody- footwall panel- 0'	2.84	Py
	9.2		2.82	
	9.3		3.04	
	10.1	No. 4 orebody- footwall panel- 2'	4.80	Py
	10.2		5.10	
	10.3		4.67	
	11.1	No. 4 orebody- footwall panel- 4'	3.67	Py
	11.2		3.86	
	11.3		4.20	
	12.1	No. 4 orebody- footwall panel- 6'	4.53	Py
	12.2		4.60	
	12.3		4.62	
Chisel Lake 250'	7.1	411-412 V.P. crosscut- hanging wall	13.69	Py
	7.2		13.96	
	7.3		14.31	
	8.1	411-412 V.P. crosscut- center	12.79	Py+Po
	8.2		13.27	
	8.3		13.61	
	9.1	411-412 V.P. crosscut- footwall	13.66	Py+Po
	9.2		14.23	
	9.3		14.06	
650'	4.1	811 V.P. cross-cut - hanging wall	15.03	Py
	4.2		15.28	
	4.3		14.73	
	5.1	811 V.P. cross-cut - center	14.82	Py
	5.2		14.45	
	5.3		14.06	
	6.1	811 V.P. cross-cut - footwall	14.37	Py+Po
	6.3		14.03	
1100' (sub level)	1.1	1241 V.P. crosscut - hanging wall	12.49	Py+Po
	1.2		12.60	
	1.3		12.66	
	1.4		11.49	
	2.1	1241 V.P. cross crosscut - center	14.87	Po
	2.2		14.81	
	2.3		14.18	
	3.1	1241 V.P. crosscut - footwall	12.74	Py+Po
	3.2		12.59	
	3.3		13.60	
Stall Lake 900'	13.1	No. 1 orebody 1011 footwall stope	13.31	Py+Po
	14.1	No. 1 orebody 1011 footwall stope	13.07	Py+Po
	14.2		13.76	
	14.3		11.76	
	15.1	No. 1 orebody 1011 footwall stope	15.07	Py+Po
	15.2		12.83	
	15.3		13.80	
1900'	7.1	No. 1 orebody 1911 stope, west	13.58	Po
	7.2		11.47	
	7.3		11.38	
	8.1	No. 1 orebody 1911 stope, west	12.85	Po
	8.2		13.58	
	8.3		12.42	

Mine & Level	Sample Number*	Location	Mole % FeS	With Sp.**
Stall L.	9.1	No. 1 orebody 1911 stope, west	12.60	Po
	9.2		14.04	
1800'	10.1	No. 4 orebody 1841 stope, west	11.60	Py+Po
	10.2		11.13	
	10.3		11.02	
	11.1	No. 4 orebody 1841 stope, west	12.65	Po
	12.1	No. 4 orebody 1841 stope, west	11.19	Po
	12.2		11.22	
	12.3		12.14	
2100'	4.1	No. 4 orebody 2141 stope, west	11.86	Po
	5.3	No. 4 orebody 2141 stope, west	11.67	Po
	6.2	No. 4 orebody 2141 stope, west	10.97	Po
Osborne Lake 1150'	7.1	No 6 panel, hanging wall drift	11.62	Py+Po
	7.2		11.69	
	7.3		11.63	
	8.1	No. 6 panel, hanging wall drift	8.26	Py+Po
	8.2		8.61	
	8.3		8.52	
	9.1	No. 6 panel, hanging wall drift	10.69	Py+Po
	9.2		10.57	
	9.3		10.73	
1500' (sub level)	4.1	No. 8 panel, C.L. crosscut	10.15	Py+Po
	4.2		11.20	
	4.3		11.32	
	5.1	No. 8 panel, C.L. crosscut	10.07	Py+Po
	5.2		10.27	
	5.3		10.27	
	6.1	No. 8 panel, C.L. crosscut	9.92	Po
	6.2		9.97	
	6.3		9.80	
1800' (sub level)	1.1	No. 10 panel, No. 2 crosscut	10.73	Po
	1.2		10.30	
	1.3		10.54	
	2.1	No. 10 panel, No. 2 crosscut	11.10	Po
	2.2		11.45	
	2.3		11.17	
	3.1	No. 10 panel, No. 2 crosscut	10.54	Po
	3.3		10.39	

* 1.2 = sample 1 grain 2 ** iron sulphide minerals occurring with sphalerite

A synthetic FeS standard was used for Fe and S analyses. Arsenic analyses employed a synthetic FeAsS standard. Zinc analyses employed a natural sphalerite from Picos de Europa, Spain. Analyses for Mn, Se, Cd and Cu employed reagent-grade metal standards.

All analyses were corrected for matrix effects using the EMPADR VII computer program (Rucklidge & Gasparrini 1969).

Results

Flin Flon (South Main) mine

The Flin Flon orebody is associated with metamorphosed basic to acid volcanic flow and pyroclastic rocks of the Amisk Group. Immediate host rock of the pyrite—pyrrhotite—sphalerite—chalcopyrite-bearing ore is quartz porphyry. Within the ore zone and footwall the rocks are altered to chlorite schists (Koffman *et al.* 1948; Brownell & Kinkel 1935). Metamorphism in Flon Flon area is low grade, up to greenschist facies (Coates *et al.* 1972; Stauffer & Mukherjee 1971). Sangster (1972) describes the chlorite alteration of the footwall rocks as a feature common to some volcanogenic deposits, whereas Koo (1973) attributes a wide range of mineralogy, textures, and chemical characteristics of the host rocks and orebody to Amisk volcanism, regional and dynamic metamorphism, and dike intrusion.

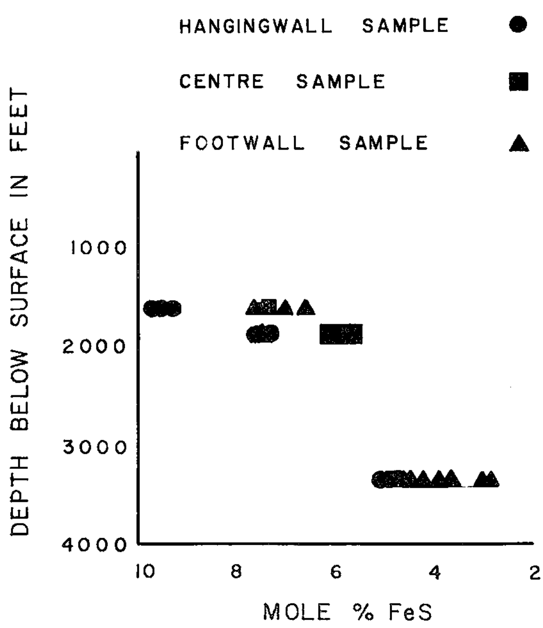

FIG. 2. Variation of FeS contents of sphalerites from the Schist Lake orebody.

FeS contents of sphalerites from Flin Flon (South Main) orebody average 10.60 mole %, range from 9.31 to 12.42 mole %, and show no regular pattern with depth. Sphalerites in apparently pyrrhotite-free samples have FeS contents in the lower portion of this range (average 9.90 mole %), whereas sphalerites coexisting with pyrite and pyrrhotite average 11.30 mole % FeS. This suggests that higher ZnS contents in sphalerites occur in the hanging wall and footwall portions of the massive ore. Coates *et al.* (1972) and Brownell & Kinkel (1935) have noted previously that the Flin Flon orebody as a whole is zoned, with more pyritic material occurring on the footwall and beneath the orebody.

Mn contents range up to 0.03 wt. %, with no apparent preference of Mn for sphalerites of either pyrite or pyrite—pyrrhotite-bearing assemblages. Cu contents of sphalerites range from zero to 0.08 wt. %. Sphalerites in apparently pyrrhotite-free assemblages have Cu contents in the lower portions of the range. Only Cu and Mn contents in the upper portions of these ranges have statistical significance. Homogeneity indices for Cu range from 3 to 9, suggesting that Cu contents for some sphalerites may be due to very small Cu blebs within the sphalerites. Statistically significant As and Se were not detected.

Schist Lake mine

The Schist Lake orebodies are associated with greenschist facies lava flows and pyroclastics of the Amisk Group. Wall rocks adjacent to the orebodies are sericite-carbonate schists.

Although three ore mineral assemblages have been recognized previously (Cairns *et al* 1957), samples examined in the present study have only the ore assemblage: pyrite—sphalerite—chalcopyrite with minor galena.

FeS contents of sphalerites average 6.20 mole % and range from 2.84 mole % in samples from the 3350 foot mine level to 9.82 mole % in samples from the 1600 foot mine level, as shown in Figure 2. (Fe+Zn)/S ratios range from 0.96 to 1.03. Arsenic in sphalerites from the 1600 and 1850 mine levels varies up to 0.03 wt. %. Sphalerites from the 3350 foot mine level contain 0.09 to 0.21 wt. % As. A few sphalerite analyses show up to 0.04 wt. % Se.

Chisel Lake and Stall Lake mines

The Chisel Lake and Stall Lake orebodies occur in Amisk Group metavolcanic rocks comprised of basic to intermediate flows, associated intermediate pyroclastics and acid pyroclastic rocks. According to Froese (1973), metamorphic grade in the Snow Lake area increases from south to north, with the Chisel Lake and Stall Lake orebodies associated with staurolite-bearing rocks.

Most Chisel Lake specimens examined are characterized by the assemblage pyrite—pyrrhotite—sphalerite. Two specimens are pyrrhotite-free and one specimen is pyrite-free. Chalcopyrite and/or galena are present in many specimens, as are arsenopyrite and magnetite. Six analyses of sphalerites in the two pyrrhotite-free samples range from 13.69 to 15.28 and average 14.50 mole % FeS. FeS contents of the three analyzed sphalerites in the pyrite-free specimen are 14.18, 14.81 and 14.87 mole %. Sphalerites in pyrite- and pyrrhotite-bearing specimens range from 11.49 to 14.82 and average 13.41 mole % FeS. For reasons of clarity, only FeS contents of sphalerites coexistent with pyrite and with pyrite and pyrrhotite are shown in Figure 3c. Sphalerites from Chisel Lake contain Mn up to 0.45 wt. %. Se contents of up to 0.21 wt. % are characteristic. Calculations have shown Mn and Se values to be statistically significant.

The Stall Lake orebody occurs in metamorphosed acidic pyroclastic rocks, near the contact with overlying metamorphosed basic tuffs and flows (Coates *et al.* 1970). Samples contain two principal sulphide assemblages: pyrrhotite—chalcopyrite—sphalerite and pyrrhotite—pyrite—chalcopyrite—sphalerite. Sphalerites in samples containing pyrrhotite as the sole iron sulphide range from 10.97 to 14.04 mole % FeS and average 12.30 mole % FeS. Sphalerites coexisting with pyrite and pyrrhotite range from 11.02 to 13.80 mole % FeS, with a single analysis showing 15.07 mole %. Sphalerites coexisting with pyrite and pyrrhotite average 12.74 mole % FeS. (Fe+Zn+Cu)/S ratios range from 0.97 to 1.01, with the majority equaling 1.00. Cu contents of sphalerites range from 0.04 to 0.74 wt. % and are statistically significant. The As contents of Stall Lake sphalerites are higher than those of sphalerites from the other mines, ranging from 0.04 to 0.53, with most analyses showing 0.20 to 0.35 wt. %. Traces of Se appear in some analyses.

Osborne Lake mine

Osborne Lake is the most northern of the mines in the Snow Lake district, and occurs within the sillimanite metamorphic zone (Froese 1973).

Two mineral assemblages were observed: pyrrhotite—chalcopyrite—sphalerite, and pyrrhotite—pyrite—chalcopyrite—sphalerite. FeS contents of sphalerites in samples containing pyrrhotite as the sole iron sulphide range from 9.80 to 11.17 and average 10.53 mole %. Sphalerites coexistent with pyrrhotite and pyrite contain 9.26 to 11.69 and average 10.31 mole % FeS. Included in this range are three analyses from a single specimen, which show unusually

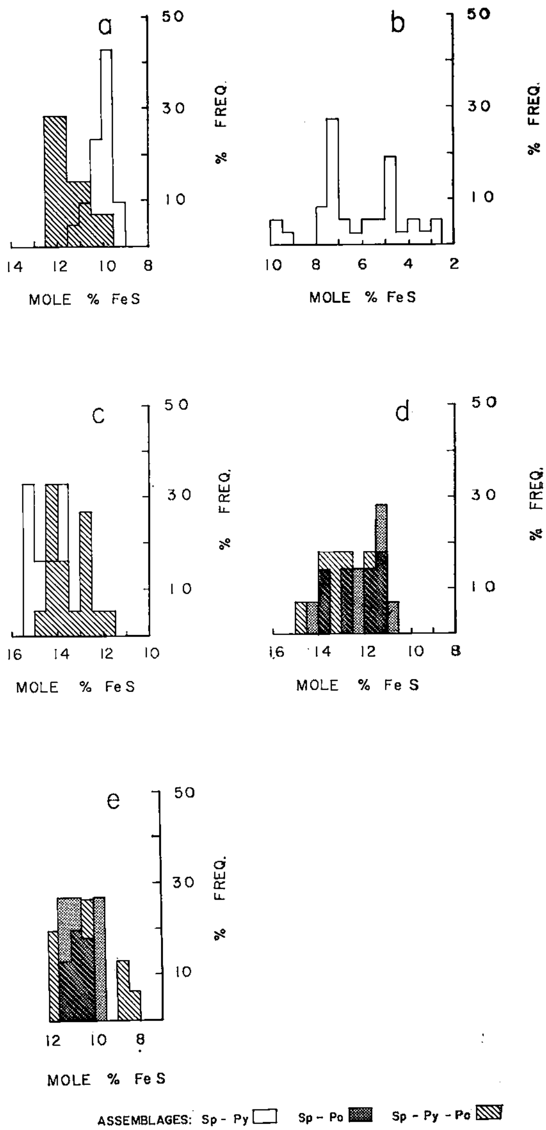

FIG. 3. Histograms of FeS contents of sphalerites from a. Flin Flon (South Main) orebody (35 analyses), b. Schist Lake orebody (36 analyses) c. Chisel Lake orebody (27 analyses), d. Stall Lake orebody (25 analyses), e. Osborne Lake orebody (26 analyses).

low FeS contents of 8.26, 8.61 and 9.52 mole %. MnS contents of sphalerites are high in comparison to those from the other orebodies studied, ranging from 0.87 to 2.33 mole %. Se contents vary from 0.05 to 0.12 wt. %. Trace amounts of Cu were present in some grains.

Discussion of Results

FeS contents of sphalerites are related to the presence or absence of coexistent pyrite and/or pyrrhotite and the structure of the pyrrhotite. Iron sulphide minerals in samples used in this study were identified optically and by *x*-ray powder diffraction analyses of small amounts taken from polished mounts. In addition, pyrrhotite was magnetically separated from specimens from which the polished mounts originated. Pyrrhotite structures were identified employing data from Desborough & Carpenter (1965).

Samples containing pyrrhotite as the sole iron sulphide are limited to the Chisel Lake, Stall Lake and Osborne Lake orebodies. Pyrrhotite was not observed in samples from Schist Lake and is a minor constitutent of a few South Main samples, where it coexists with pyrite and sphalerite. Only one South Main sample contained sufficient pyrrhotite for an *x*-ray powder diffractogram.

Both hexagonal and monoclinic pyrrhotites are present in samples from Chisel, Stall and Osborne Lakes. Where pyrrhotite is the only iron sulphide in the sample, hexagonal pyrrhotite is the sole or dominant polymorph. Where pyrrhotite and pyrite coexist with sphalerite, monoclinic pyrrhotite is the dominant and, commonly, the only pyrrhotite polymorph present. Samples containing hexagonal pyrrhotite and no pyrite prevail in upper levels of the Stall Lake and Osborne Lake mines. Monoclinic pyrrhotite coexisting with pyrite is prevalent in samples from lower levels.

Histograms of FeS contents of sphalerites from the 5 mines are shown in Figures 3a-e. With the exception of the Schist Lake samples, limited ranges of FeS contents are evident.

The two orebodies occurring in greenschist facies rocks are principally pyritic deposits. The wide range of FeS contents in sphalerites from Schist Lake might be expected as the a_{FeS} is not fixed in the absence of the pyrrhotite—pyrite buffer reaction. FeS contents of sphalerites from South Main samples show a limited range with some overlap between those of pyrite—sphalerite and pyrite—pyrrhotite—sphalerite assemblages. A clear distinction between modes of histograms for sphalerites of these assemblages is evident, occurring at 9.5 — 10.0 mole % FeS for sphalerites coexistent with pyrite and 11.5—12.5 mole % FeS for those coexistent with pyrite and pyrrhotite.

The Chisel Lake and Stall Lake orebodies occur in staurolite-bearing metamorphic rocks. Ranges of FeS contents of sphalerites from these orebodies are more restricted, and higher, than those of sphalerites from Schist Lake. FeS data for Chisel Lake (Fig. 3c) show that modes for sphalerites coexistent with pyrite and coexistent with pyrite and pyrrhotite are bimodal. The occurrences of dominantly monoclinic pyrrhotite with pyrite and dominantly hexagonal pyrrhotite as the sole iron sulphide were not noted in data for Chisel Lake samples.

In Stall Lake samples, monoclinic pyrrhotite is associated with pyrite and sphalerite. Where pyrrhotite is the sole iron sulphide coexistent with sphalerite, the pyrrhotite is dominantly

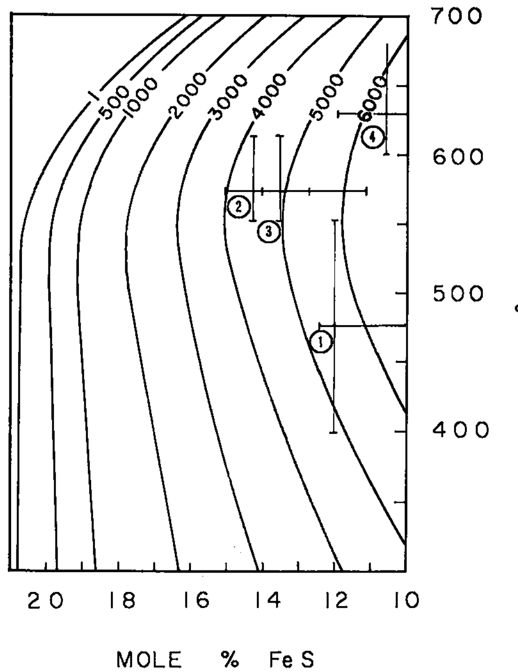

Fig. 4. T-X diagram after Scott & Barnes (1971) with superimposed temperature and composition data for sphalerites from the 1. Flin Flon (South Main) orebody, 2. Chisel Lake orebody, 3. Stall Lake orebody, 4. Osborne Lake orebody. Pressure data represented by curves are given in bars. Horizontal bars represent ranges of FeS contents of sphalerites. Vertical bars represent temperature ranges indicated by metamorphic grade of rocks associated with orebodies. Lateral positions of vertical bars coincide with modes of FeS contents of sphalerites.

hexagonal with only minor monoclinic pyrrhotite present. Distribution of FeS contents of sphalerites of both assemblages is bimodal with extensive overlap in range.

Samples from the Osborne Lake orebody contain pyrite—pyrrhotite—sphalerite—chalcopyrite, or pyrrhite — sphalerite — chalcopyrite. Where pyrrhotite is the only iron sulphide it is dominantly hexagonal. Pyrrhotites coexisting with pyrite and monoclinic. Sphalerites coexisting with pyrrhotite have a bimodal distribution of FeS contents, grouped between 9.5 and 11.5 mole %; those coexisting with pyrite and pyrrhotite have a bimodal distribution with maxima at 8.0 — 9.6 and 9.6 — 12.0 mole %.

Figure 4 shows the compositions of sphalerites coexisting with pyrite and pyrrhotite in samples from the Flin Flon (South Main), Chisel Lake, Stall Lake and Osborne Lake mines superimposed on experimental and calculated data from Scott & Barnes (1971). Horizontal bars represent the range in FeS contents of

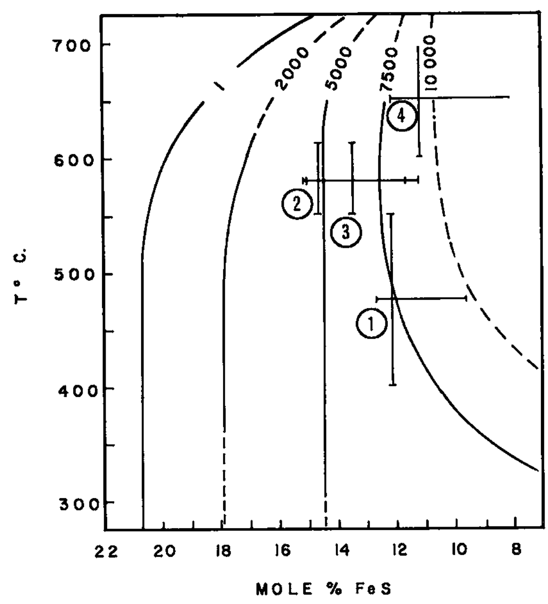

FIG. 5. T-X diagram after Scott (1973) with superimposed temperature and composition data for sphalerites from the 1. Flin Flon (South Main) orebody, 2. Chisel Lake orebody, 3. Stall Lake orebody, 4. Osborne Lake orebody. Horizontal bars represent ranges of FeS contents of sphalerites. Vertical bars represent temperature ranges indicated by metamorphic grade of rocks associated with orebodies. Lateral positions of vertical bars coincide with modes of FeS contents of sphalerites.

sphalerites from each of the orebodies. Vertical bars express the temperature range for the metamorphic grade of the rocks associated with each orebody. Lateral positions of the vertical bars represent principal modes of FeS contents.

Presence of minor hexagonal pyrrhotite in samples containing monoclinic pyrrhotite, pyrite, and sphalerite, suggests that equilibration may have taken place above the pyrrhotite inversion temperature. Campbell & Williams (1968) suggest that the last bulk chemical equilibration in such systems takes place above this temperature and pyrrhotite inverts with continued decrease in temperature and no subsequent compositional change of pyrite or sphalerite.

Pressure and temperature conditions indicated by metamorphic grade are: greenschist grade 390 — 550°C and 5 — 6 kb, staurolite grade 545°C ± 15°C and 4 — 7 kb, and sillimanite grade 600+°C and 6+ kb (Winkler 1967). With the temperature of sphalerite equilibration indicated by the metamorphic grade of the rocks associated with each orebody and FeS contents of sphalerites known, data from Scott & Barnes (1971) allow estimates of pressures existing at the time of sphalerite equilibration. These pressure estimates should be commensurate with those indicated by the metamorphic grade.

The plots in Figure 4 indicate that sphalerite in the Flin Flon (South Main) orebody equilibrated between 5½ and 6+ kb and that in the Chisel Lake orebody equilibrated between 4 and 5½ kb. Sphalerite from Stall Lake equilibrated between 4½ and 6+ kb and that at Osborne Lake at 5½ to 6+ kb.

Figure 5 shows compositions of sphalerites from the Flin Flon (South Main), Chisel Lake, Stall Lake and Osborne Lake orebodies superimposed on experimental data from Scott (1973). Data presentation is similar to that in Figure 4. The plots in Figure 5 indicate that sphalerite from the Flin Flon (South Main) orebody equilibrated at 6½ — 9½ kb and that in the Chisel Lake orebody equilibrated at 4 — 8½ kb. Sphalerite from Stall Lake equilibrated between 4+ and 9 kb and that from Osborne Lake equilibrated between 8 and 10+ kb.

CONCLUSIONS

Four assemblages of principal sulphide minerals were identified in the samples of massive ore examined. These assemblages are: pyrite—sphalerite—chalcopyrite, pyrite —pyrrhotite — sphalerite—chalcopyrite, pyrrhotite—chalcopyrite—sphalerite, and pyrite—sphalerite. Pyrrhotite is the prevalent iron sulphide in samples from orebodies associated with rocks of higher grades of metamorphism. Pyrite is the dominant iron sulphide in samples from orebodies associated with rocks of greenschist grade.

Samples from the Schist Lake orebody do not contain pyrrhotite. FeS contents of sphalerites in these samples exhibit a wide range which is lower than those of FeS contents of sphalerites in assemblages containing both pyrite and pyrrhotite as the only iron sulphide. The wide range of FeS contents in Schist Lake sphalerites is interpreted as due to the absence of the pyrrhotite—pyrite reaction controlling sulphur fugacity.

Samples from 4 of the 5 mines contain pyrite, pyrrhotite, sphalerite and chalcopyrite. The presence of hexagonal pyrrhotite in many of these samples suggest equilibration above the pyrrhotite inversion temperature. It can be assumed that sphalerite coexisting in these samples equilibrated above the pyrrhotite inversion temperature, data from Scott & Barnes (1971) or Scott (1973) may be used to estimate the pressure of sphalerite equilibration, providing that the FeS contents of the sphalerites are known. Coexisting pyrite and pyrrhotite were not observed in samples from the Schist Lake orebody. Therefore, an estimate of the equilibration pressure for sphalerite in this orebody cannot be made at present. Equilibration pressures for sphalerites from the other 4 orebodies based on Scott & Barnes (1971) are Flin Flon (South Main) 5½ — 6+ kb, Chisel Lake 4 — 5½ kb, Stall Lake 4½ — 6+ kb and Osborne Lake 5½ — 6+ kb. These pressures are compatible with those indicated by the metamorphic mineral assemblages of the rocks associated with these orebodies. Equilibration pressures for sphalerites from the above orebodies, based on Scott (1973) are: Flin Flon (South Main) 6½—9½ kb, Chisel Lake 4—8½ kb, Stall Lake 4+—9 kb and Osborne Lake 8 — 10+ kb. These pressures appear somewhat high when compared to those indicated by the metamorphic assemblages of the rocks associated with the orebodies.

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