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PRELIMINARY REPORT ON EXAMINATION OF SULPHIDE-RICH ZONES WITHIN THE PROTEROZOIC SNYDER GROUP, LABRADOR, AND THE SEDEX POTENTIAL OF THESE UNITS[1]

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ABSTRACT

The Lower Proterozoic Snyder Group is an 11- by 3-km sequence of metasedimentary rocks within the contact aureole of the Kiglapait Intrusion, northern Labrador. The group comprises five formations viz.; *Lower Quartzite, Iron Silicate, Quartzite–Marble, Graphite–Sulphide Siltstone and Upper Quartzite. The Graphite–Sulphide Siltstone contains massive sulphide lenses and interlayers, which are composed predominantly of pyrrhotite and have lesser pyrite and minor chalcopyrite. The presence of sphalerite has been reported by others. The Graphite–Sulphide Siltstone formation was sampled to assess base-metal contents. The XRF analyses indicate maximum Cu, Pb and Zn contents of 1352, 237 and 3589 ppm, respectively. Pyrrhotite and pyrite are also common in a granodiorite that intruded the Snyder Group. The potential for significant concentrations of base metals within the Snyder Group appears to be low.*

INTRODUCTION

This project was initiated to examine sulphide-rich sedimentary zones within the Snyder Group, Labrador. The two objectives of this part of the project are (1) to define the economic potential of such zones, and (2) compare them with known sedimentary exhalative (SEDEX) deposits such as the Sullivan Pb–Zn deposit of British Columbia (Hamilton *et al.*, 1983). The study is part of a larger project to examine the SEDEX potential of Proterozoic sedimentary sequences developed on the Archean Nain Province of northern Labrador. The other units of interest include the Mugford and Ramah groups, which will be examined during the 1992 and 1993 field seasons, respectively.

The Snyder Group constitutes a Proterozoic, predominantly sedimentary, supracrustal sequence that unconformably overlies Archean basement gneiss to the northwest of the Middle Proterozoic (ca. 1.32 Ga) Kiglapait Intrusion (Figure 1), and is essentially within the contact-metamorphic aureole of the intrusion (Speer, 1978). The Snyder Group is exposed south from Cold Comfort Bay in a very limited outcrop pattern that is only about 11 km long and 2 to 3 km wide. Small, isolated remnants of the unit extend along the southern coast of Snyder Bay for another 15 km east from Cold Comfort Bay (Speer, 1978).

PREVIOUS WORK

The sedimentary components of this unit were first described by Wheeler (1942), who concluded they were younger than the surrounding gneisses. Morse (1969) formally defined the rocks as the Snyder Group. Speer (1972), mapping predominantly in the Cold Comfort Bay area, designated a stratigraphy for the unit consisting of five members *viz.;* (1) Lower Quartzite member, which unconformably overlies the Archean gneiss with a basal conglomerate, (2) Quartz-Gneiss member, up to 10 m thick, which consists of alternating quartz, quartz–amphibolite–garnet, quartz–cordierite and quartz–hypersthene layers, (3) Quartz–Marble member, (4) Sulphide Hornfels member, and (5) Upper Quartzite member. Speer (1972) defined the area between the Snyder Group and the Kiglapait Intrusion as the Outer Border Zone of the Kiglapait Intrusion, and also mapped the Wendy granodiorite (so named by Morse, 1969) as intruding along the margin between the Snyder Group and the Outer Border Zone south of Cold Comfort Cove.

Berg (1975) remapped the Snyder Group in the Cold Comfort and Middle bays area and completed more detailed mapping of the unit south to the Avakutakh River. He renamed the middle members of the Snyder Group, the Silicate–Iron Formation, the Quartzite–Marble and the Graphite–Sulphide Hornfels, and he suggested a redefinition of the Snyder Group, in which the Snyder Group as mapped by Speer (1972) was designated as the Lower Snyder Group and the Outer Border Zone became the Upper Snyder Group. The reason for this subdivision into upper and lower groups was that Berg *(op. cit.)* could recognize distinct, mappable units, in particular a banded-ironstone unit and a calcsilicate unit, stratigraphically above Speer's Upper Quartzite member. The

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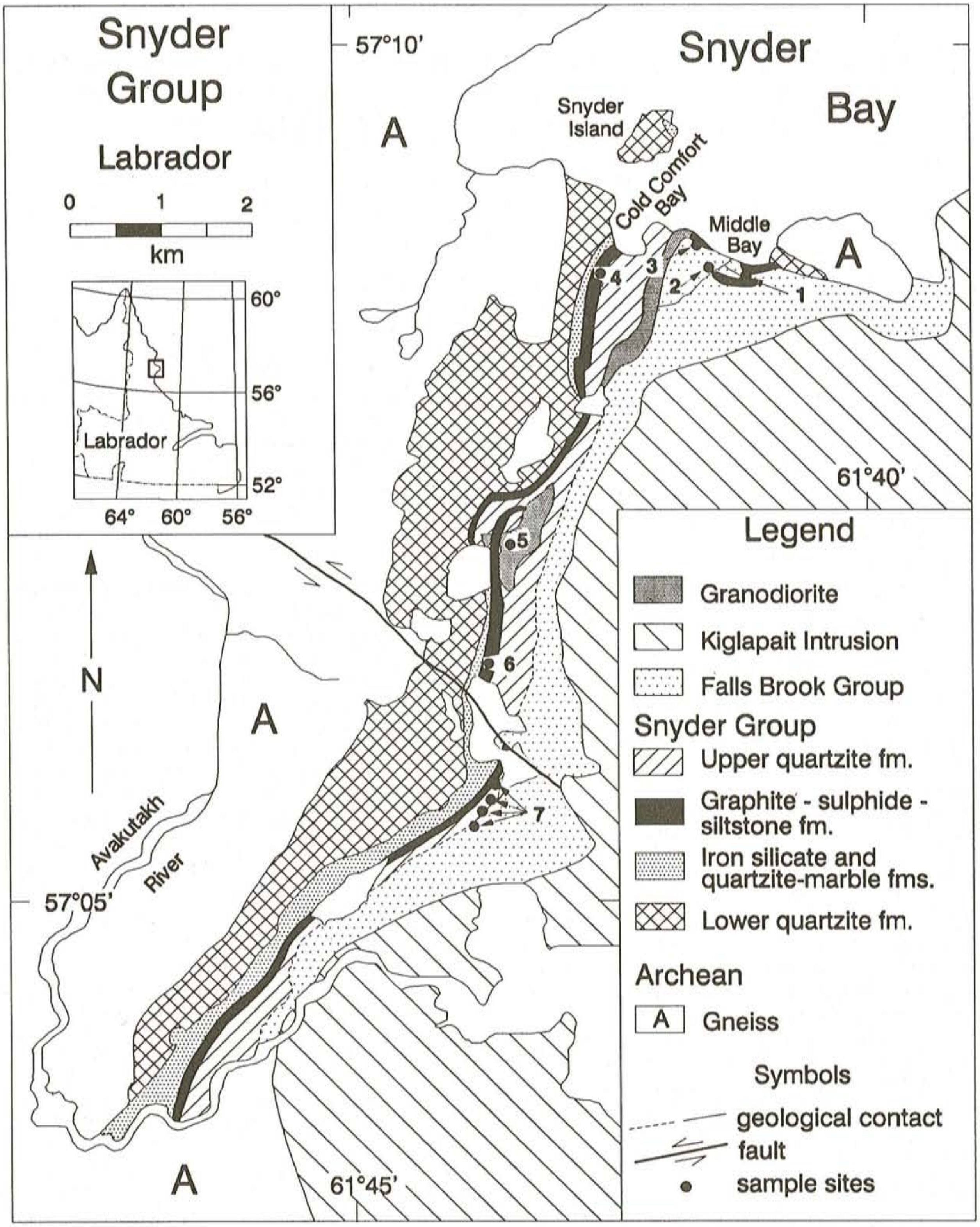

Figure 1. *Geology of the Snyder and Falls Brook groups, Labrador; compiled from Berg (1975) and Speer (1978). Sample-site localities are denoted as solid circles.*

type area for the Upper Snyder Group is along Falls Brook, which flows into Middle Bay. He was unable to define the contact between Upper and Lower Snyder groups (although he suggested that it might be unconformable) because of the presence of extensive mafic granulites within the Upper Snyder Group, which obscured the contact zone and expanded the stratigraphic width of the upper unit. He was also unable to readily distinguish if the granulites represented metavolcanic rocks or were sills. Berg's *(op. cit.)* mapping also revealed that the Graphite–Sulphide Hornfels and Upper Quartzite members extended south to the Avakutakh River.

Speer (1978) modified his stratigraphy of the Snyder Group and suggested that the stratigraphic thickness of the unit was on the order of 240 m. He described the constituent formations as A formation: lower quartzite (120 m thick), B formation: iron formation (15 m), C formation: quartzite–marble (10 m), D formation: graphite–sulphide siltstone (14 m), and E formation: upper quartzite (80 m). Speer's nomenclature is used in this report except for the alphabetical annotation for the formations (e.g., the lowest unit is referred to here as 'Lower Quartzite' rather than 'A formation'; the second formation is called the 'Iron Silicate formation' rather than 'Iron formation').

Speer (1978) continued to refer to the rocks between the Snyder Group and the Kiglapait Intrusion as the Outer Border Zone, but in discussing Berg's findings, he suggested that the sedimentary units within the zone must be unconformable upon the Snyder Group. He also renamed the Wendy granodiorite between the Snyder Group and the Outer Border Zone as the Border breccias, and postulated, as had Morse (1969), that they represent anatectic melts of country rock caused by the Kiglapait Intrusion. Speer *(op. cit.)* found that the granodiorite resembles the upper quartzite formation and the two units are commonly difficult to distinguish between in the field.

Smyth and Knight (1978) compared the stratigraphic columns of the Snyder, Mugford and Ramah groups. They suggested that the Snyder Group was correlative with the other two groups up to and including the Graphite–Sulphide Siltstone formation, but that the Upper Quartzite formation was unique. They generally agreed with Speer's (1978) five-fold subdivision of the Snyder Group, but suggested that describing the B formation as an iron formation is a misnomer as the unit actually contains less than 15 percent Fe, and hence is not iron formation *sensu stricto.*

Docka (1980), mapping the mafic granulites in Speer's (1978) Outer Border Zone or Berg's (1975) Upper Snyder Group, called the host unit the unnamed sequence. Docka *(op. cit.)* was unable to define an exact protolith for the granulites but suggested that they predated the Kiglapait Intrusion. He agreed with Berg's (1975) revision of the Snyder Group south of Cold Comfort Bay in that Graphite–Sulphide Siltstone and Upper Quartzite formations crop out as far as the Avakutakh River. Also, he further suggested that the granodiorite along the eastern side of Cold Comfort Bay (Morse's [1969] Wendy granodiorite) is an igneous breccia, which may have been intruded along the fault that juxtaposed the Upper Quartzite formation with southeast-trending units of his unnamed sequence.

Schuh (1980a), in examining the geology of the Cold Comfort–Middle bays area, proposed that Speer's (1978) map was fundamentally correct in the Cold Comfort Bay portion and that Berg's (1975) map was the more accurate around Middle Bay. Schuh (1980b) completed a detailed stratigraphic examination of the unnamed formation, especially the iron formation and calcsilicate members.

Berg (1981) formally named the formation unconformably overlying the Upper Quartzite formation as the Falls Brook Group and defined the lowest member as a banded iron formation. He also suggested that correlations between the Mugford and Snyder groups are unjustified.

SULPHIDE MINERALIZATION

Speer (1972) described the Sulphide Hornfels (sic) as a massive sulphide-bearing unit interbedded with graphite hornfels and quartzite layers, in which the sulphide hornfels is thickest just south of Cold Comfort Bay, but the complete expression of the unit is obscured by large dykes.

In the type area on the shore of Cold Comfort Bay, Speer (1978) later suggested that the D formation, the Graphite–Sulphide Siltstone, is composed of finely laminated siltstone containing abundant pyrrhotite, pyrite and sphalerite (with exsolved chalcopyrite–presumably chalcopyrite 'disease'; cf. Barton and Bethke, 1987) in both disseminated and vein form. Two- to three-centimetre-thick sandy layers are interlayered with the siltstone. Speer *(op. cit.)* also found lenses of the Graphite–Sulphide Siltstone in the underlying Quartzite–Marble formation, and disseminated pyrrhotite, sphalerite and chalcopyrite in the Upper Quartzite formation.

Speer (1972) described the areal extent of the Upper Quartzite formation as being restricted to a hill south of Cold Comfort Bay. He observed that the unit was extensively mineralized by pyrite, pyrrhotite and minor chalcopyrite, and suggested that the sulphides were associated with a later intrusive body. He also stated that sulphide mineralization affecting the upper units of the Snyder Group were 'spatially associated' with the 'marginal intrusive rocks' (Wendy granodiorite).

Berg's (1975) revised map of the Snyder Group indicated that the Upper Quartzite formation and Graphite–Sulphide Siltstone formation extended much farther south to the Avakutakh River. Speer (1978) suggested that Berg actually mapped the Upper Quartzite formation as the Graphite–Sulphide Siltstone formation in the region between the second and third ponds south of Cold Comfort Bay, implying that the true Graphite–Sulphide Siltstone formation was restricted to the Cold Comfort Bay area, and that the Upper Quartzite formation contains sufficient sulphide mineralization to resemble the Graphite–Sulphide Siltstone formation. Berg (1975) also mapped two more outcrops of sulphide in Falls Brook, the presence of which were substantiated by Docka (1980).

Table 1. Geochemical data for Snyder Bay samples

Sample	SB91-004	SB91-006	SB91-007A	SB91-007B	SB91-007C	SB91-007D	SB91-009	SB91-010	SB91-016	SB91-017	SB91-018	SP91-020A
SiO_2	51.99	81.90	22.48	30.48	4.34	41.96	7.53	12.63	45.90	44.91	37.11	39.51
TiO_2	0.51	0.18	0.03	0.01	0.07	1.53	0.25	0.55	0.58	2.22	1.80	1.62
Al_20_3	7.21	9.10	0.32	0.12	0.61	11.01	1.30	3.18	9.89	12.80	13.64	10.67
Fe_20_3	1.54	0.27	5.63	4.31	5.44	1.83	5.31	4.63	1.89	1.47	1.61	1.42
FeO	12.47	2.20	45.56	34.90	44.02	14.82	42.97	37.51	15.29	11.92	13.05	11.46
MnO	0.04	0.01	0.26	0.14	0.01	0.09	0.03	0.06	0.05	0.14	0.23	0.19
MgO	2.36	1.00	3.71	1.09	0.00	6.15	0.00	1.01	1.75	10.20	5.05	5.49
CaO	2.37	2.25	5.34	3.84	0.39	5.10	1.42	3.75	5.77	5.87	11.28	9.13
Na_20	1.33	2.19	0.00	0.00	0.06	1.96	0.12	0.29	2.85	3.08	1.15	2.89
K_20	0.61	0.45	0.00	0.01	0.09	0.31	0.13	0.22	0.54	0.17	0.24	0.30
P_20_5	0.10	0.07	0.61	0.87	0.04	0.19	0.09	0.07	0.22	0.28	0.22	0.16
Cr	126.01	60	33	31	218	138	74	71	124	296	76	94
Ni	698.51	18	8	28	956	0	667	496	230	148	62	55
Sc	14.52	0	9	0	0	46	0	16	8	35	41	38
V	1675.95	104	63	20	791	432	481	646	388	461	466	642
Cu	418.87	18	33	183	1198	59	401	317	198	180	33	107
Pb	16.67	237	11	0	32	82	25	18	18	7	0	27
Zn	3588.87	84	233	31	2571	820	225	980	95	144	98	2173
S	74968.33	9730	18290	137841	265516	9008	314201	241176	87017	7791	1167	37408
As	0.00	0.00	0.00	0.00	33.00	0.00	346.19	186.71	16.46	0.00	0.00	44.87
K	5097.00	3760	17	100	722	2598	1046	1785	4508	1453	1976	2490
Rb	8.36	4	0	1	2	4	4	4	4	0	2	2
Ba	289.15	114.73	0.00	0.00	66.99	622.54	82.89	113.56	498.86	0.00	153.01	217.26
Sr	52.78	50.37	17.34	11.81	18.02	209.97	59.95	114.32	185.37	95.96	431.09	237.61
Ga	0.00	0.00	0.00	0.00	0.00	18.79	0.00	0.00	0.00	21.73	18.12	16.43
Nb	11.19	2.80	2.77	1.66	3.90	14.52	5.34	6.85	8.36	8.21	12.78	11.48
Zr	84.16	156.56	13.31	6.16	20.35	112.27	43.10	39.85	137.53	143.39	85.05	115.27
Ti	3033.00	1055	162	54	432	9190	1517	3285	3501	13315	10785	9718
Y	33.86	9.9	22.0	21.5	18.2	21.0	23.4	20.8	23.0	29.8	23.2	29.6
Th	4.97	0.0	0.0	0.0	0.0	0.0	4.7	0.0	0.0	0.0	0.0	0.0
U	31.31	4.1	0.0	0.0	22.6	0.0	17.7	7.9	3.4	0.0	4.0	4.2
Ce	39.91	0.0	0.0	61.1	0.0	82.2	44.3	50.7	42.2	65.0	43.6	99.6
Cl	35.10	49.02	70.18	94.89	0.00	41.39	24.90	20.37	38.24	27.38	76.15	49.29

* NR = not recorded; trace element values in ppm; major oxides in wt%

THE PRESENT STUDY

REGIONAL GEOLOGY

As the preceding compilation indicates, there is substantial variation in intrepretation as to where the sulphide-bearing formation occurs within the Snyder Group, including the areal extent of the formation and its relationships to intrusive rocks. In this study, the stratigraphy has not been examined in detail; instead, work has concentrated essentially on sampling and studying the sulphide-bearing formation within the Snyder Group as mapped by Berg (1975). The Falls Brook Group has not been examined because sulphide zones have not been reported within the unit. The present authors agree with Smyth and Knight's (1978) contention that the so-called iron formation within the Snyder Group is more properly termed an iron silicate formation; outcrops of true iron formation consisting of appreciable iron oxide were not found.

The authors agree with Berg's (1975) extension of the Graphite–Sulphide Siltstone and Upper Quartzite formations south through to the Avakutakh River. The consistency in stratigraphic position and relatively uniform thickness (up to 1 to 3 m) of the sulphide layer suggest that it clearly represents a mappable unit, rather than simply interbeds within the Upper Quartzite formation (as suggested by Speer, 1978). As a result of most of the previous studies being concentrated on stratigraphic examinations of the Snyder–Falls Brook groups, the definition and delineation of the minor intrusive rocks that cut the sequences have been inconsistent and conflicting. The most critical example is the granodioritic intrusion that occurs within the Upper Quartzite and Graphite–Sulphide Siltstone formations. In more recent reports, this intrusive unit has been referred to as the Border breccia (Speer, 1978) and the igneous breccia (Docka, 1980). Such appellations only add to the confusion because on the western side of Cold Comfort Bay, in the contact region between the Lower Quartzite and the Archean rocks, there is a very distinctive and totally unrelated unit called the Snyder breccia (Barton and Barton, 1975; Speer, 1978).

The Snyder breccia is a medium- to dark-grey intrusive rock that contains rounded to angular xenoliths of Snyder Group quartzite and Archean basement rocks. According to Speer (1978), the breccia is composed of up to 15 percent rounded to subrounded gneiss, angular amphibolite and biotite schist, and uncommon, angular Snyder Group quartzite xenoliths. Barton and Barton (1975) derived an Rb–Sr isotopic age of 1842 + 17 Ma for the matrix of the breccia and K–Ar ages of 1257 ± 9 and 1281 ± 9 Ma for biotite and hornblende

Table 1. (continued)

SB91-020B	SB91-020C	SB91-020D	SB91-025	SB91-026	SB91-030A	SB91-030B	SB91-030C	SB91-030D	MAYNARD-CM	MAYNARD-CR
39.14	10.07	5.64	57.27	61.83	48.05	50.23	52.21	50.77	0.00	0.00
0.19	0.58	0.28	0.41	0.50	0.67	0.88	0.77	0.86	0.00	0.00
1.89	2.07	1.11	7.33	19.51	13.65	19.08	19.65	19.40	0.00	0.00
3.66	4.64	5.41	1.62	0.04	0.86	0.62	0.71	0.75	0.00	0.00
29.66	37.57	43.79	13.10	0.30	6.94	5.01	5.76	6.06	0.00	0.00
0.03	0.04	0.05	0.03	0.00	0.04	0.03	0.05	0.03	0.04	0.04
0.03	0.25	0.00	1.86	1.55	2.25	2.35	3.35	2.67	0.00	0.00
1.79	0.78	1.06	1.57	0.31	2.26	1.17	2.40	1.17	0.00	0.00
0.60	0.27	0.13	1.14	4.13	1.37	3.85	3.17	3.83	0.94	0.36
0.18	1.29	0.16	2.74	6.40	1.92	3.50	1.07	3.47	3.13	3.37
0.03	0.03	0.03	0.10	0.03	0.02	0.02	0.01	0.02	0.00	0.00
101	190	160	160	123	289	188	221	169	170	61
0	642	941	985	0	8	105	386	186	154	40
10	18	11	13	16	23	14	16	16	0	0
1095	1378	986	1916	390	1810	307	594	360	610	280
114	477	1352	268	6	82	63	62	134	144	28
28	75	47	54	25	13	5	5	7	37	24
240	1990	3044	1495	0	110	121	101	106	101	129
22118	251766	328656	76496	1693	5142	15682	16724	24607	0	0
246.42	136.88	166.07	0.00	0.00	23.93	0.00	0.00	0.00	0.00	0.00
1494	10692	1287	22779	53145	15922	29046	8849	28789	0	0
2	20	4	61	137	41	30	11	31	0	0
79.91	451.90	94.87	632.21	1450.96	1381.21	930.79	326.00	1356.90	1290.00	6550.00
40.40	56.18	46.48	145.27	222.59	134.29	78.92	236.30	104.26	113.00	380.00
0.00	0.00	0.00	0.00	26.55	21.77	40.20	27.74	32.12	73.00	NR
2.96	3.77	3.63	11.23	13.05	5.44	7.79	8.51	8.95	0.00	0.00
45.17	45.28	26.42	78.30	144.04	126.28	156.64	141.41	133.31	230.00	110.00
1151	3483	1655	2458	2992	4005	5294	4592	5168	0	0
2.7	17.9	14.4	51.0	14.0	9.4	3.9	5.8	2.9	41.0	NR
0.0	0.0	0.0	4.6	12.8	4.6	0.0	0.0	0.0	0.0	0.0
6.0	32.0	17.7	46.3	5.2	0.0	0.0	0.0	0.0	0.0	0.0
0.0	41.3	36.2	64.4	66.5	37.2	65.6	110.2	88.6	0.0	0.0
51.60	59.27	22.87	92.38	28.27	41.44	27.81	28.15	10.67	0.00	0.00

separates from the breccia. They suggested that the 1842 Ma age was probably that of the breccia and the 1257-1281 Ma ages represent cooling ages for the Kiglapait Intrusion. Speer (1978) defined this breccia as a premetamorphic intrusion into the Snyder Group, with the metamorphic peak being contact metamorphism caused by the Kiglapait Intrusion. The authors could find no reaction or hornfels rims around any of the xenoliths, which, when coupled with the subrounded to round nature of some of the basement xenoliths, suggests that the breccia was an explosive, fluidized intrusion.

Speer (1978) describes the igneous breccia between the Snyder Group and the Outer Border Zone (Falls Brook Group of Berg, 1975) as a synmetamorphic intrusion related to the Kiglapait Intrusion as an anatectic melt. On the eastern shore of Cold Comfort Bay and in outcrop on the eastern shore of the third pond from the bay, this granodioritic intrusive contains angular xenoliths of Snyder Group sedimentary rocks and mafic granulite. In places near the third pond, the xenoliths have thin (3 to 5 mm thick) reaction rims composed of almandine. Unlike the xenoliths within the Snyder breccia, which exhibit fluidized intrusion-related shape modification and have no hornfelsic rims, the xenoliths in the granodiorite look like fragments stoped from a cooler country rock. This granodioritic rock is readily distinguishable from the Snyder breccia and thus it is suggested here that the name Wendy granodiorite be retained for this intrusive unit.

PRELIMINARY RESULTS

As indicated on Figure 1, sulphide zones were sampled at seven localities. Samples collected (Table 1) were grab samples, and where zones were sufficiently thick, a series of samples were collected across the outcrop width.

Site 1 comprises the two sulphide layers (samples 16 and 17) in Falls Brook. The thicker layer is 1.5 m wide and consists of massive, layered pyrrhotite and pyrite in silicious siltstone containing quartzite interlayers. The second layer to the south consists mainly of disseminated pyrrhotite and pyrite in a granular siltstone.

Site 2 is a sulphide zone (sample 18) between Falls Brook and Site 3. It is composed of massive pyrrhotite−pyrite sulphide lenses within graphitic siltstone−quartzite. The host rock also contains very fine-grained disseminated pyrite.

Site 3 is a sulphide zone (sample 20) on strike from that at Site 2. The mineralization occurs as lensoid, massive pyrrhotite containing pyrite hosted by siltstone. The sulphide zone bifurcates from a massive 6-m-thick layer to thinner lenses, 0.15 to 0.3 m thick, which enclose host-rock fragments. This bifurcation and engulfing of country rock is suggestive of ductile remobilization of sulphide during deformation. The outcrop of Site 3 is very heavily weathered to gossan, and the massive sulphides are friable.

Site 4 is the type locality (samples 25 and 26) for the Graphite–Sulphide Siltstone formation (after Speer, 1978). On the shore, the outcrop is a 1- to 2-m-wide interlayered siltstone, quartzite and sulphide sequence. The outcrop to the south of the beach consists of a 10-m-high gossan zone containing massive pyrrhotite and siltstone interlayers.

There is a ridge between Sites 3 and 4 extending from the point between Middle and Cold Comfort bays to the first pond. The ridge is underlain by Upper Quartzite formation outcrops that were extensively intruded by the Wendy granodiorite. Outcrop exposures of the quartzite and granodiorite are commonly rusty weathering due to the high contents of disseminated pyrite within both rock types.

Site 5 (sample 30) by the third pond, is a 3- to 4-m-thick siltstone and quartzite unit containing massive pyrrhotite–pyrite. It is complicated by the intrusion of numerous dykes of the Wendy granodiorite; the granodiorite itself is rusty weathering due to disseminated pyrite. The rusty granodiorite is very conspicuous and can be traced both downstream in the river from the third pond and on the ridge to the east of the pond.

Site 6 is a small, 4-m-across outcrop (sample 4) of very rusty, gritty siltstone. Pyrrhotite, including minor chalcopyrite, is present as thin (<1 cm) layers within the siltstone.

Site 7 (samples 6, 7, 9 and 10) was sampled over a lateral distance of more than 500 m. The rock types are interlayered siltstone and quartzite containing either massive pyrrhotite lenses up to 1 to 2 m thick, or disseminated pyrrhotite in host rocks. Pyrrhotite is also present as sheared, recrystallized pods containing xenoliths of host rock. Pyrite, and much less abundant chalcopyrite, occur in the host rocks as disseminations and microstringers. The massive pyrrhotite areas are very heavily stained and gossanous.

GEOCHEMICAL DATA

Major- and trace-element data for the sulphide zones are listed in Table 1. The analyses were completed on pressed-powder whole-rock pellets using a fully automated XRF at the Department of Earth Sciences, Memorial University of Newfoundland. Data reduction and plotting were executed using Clarke's (1991) NEWPET program. As indicated by data in Table 1, the base-metal contents of these sulphide zones are generally low and unremarkable. Copper contents range from 6 to 1352 ppm, Pb from 0 to 237 ppm, and Zn from 0 to 3589 ppm. Barium ranges from 0 to 1451 ppm and As contents are generally very low but may reach up to 346 ppm. The most enriched lense sampled was at Site 3, followed by Site 7–two areas where sulphide zones were not mapped by Speer (1978).

When compared to the average metal contents of D-Band ore, the lowest grade ore at the Sullivan deposit (Hamilton *et al.*, 1983), as listed in Table 2, the sulphide samples from the Snyder Group are of very low grades.

Table 2. Average major oxide (wt%) and base-metal concentrations (ppm) in D-Band ore, Sullivan Mine (from Hamilton *et al.*, 1983)

Fe_2O_3	33.61 %
MnO	0.315 %
Cu	330*
As	830*
Pb	13900
Zn	66800

* note Cu and As are average values for Sullivan ore

Based on Cu–Pb–Zn ratios within the samples (Figure 2), the Snyder Group sulphide zones would be classified as volcanogenic massive sulphide type rather than sedimentary exhalative (SEDEX) type (after Lydon, 1983) because of very low Pb contents. Only the sample having the highest Pb content (SB91-6 @ 237 ppm) would be classified as SEDEX type.

Maynard (1991) suggested that shale-hosted Pb–Zn–Ba deposits can be subdivided into two main types: (1) continent margin(CM)-type and (2) cratonic rift(CR)-type. The CM-type deposits are developed on the slope to basin floor of continental margins proximal to closing oceanic basins, and hence exhibit the geochemical influence of oceanic crust. They are generally base metal poor and Ba rich. The CR-type systems are developed within rifts in continental crust and are Pb–Zn rich. The CR-type deposits, therefore, are more economically important in that they may contain ore-grade concentrations of Pb and Zn.

Maynard (1991) compiled geochemical data from the literature and defined typical end-member compositions for host rocks to the CM- and CR-types of mineralization. The biggest differences between the two types lie in the Na–K ratios (higher in CM), Co–Ni–Cu contents (higher in CM) and Sr and Ba contents (both higher in CR). Maynard *(op. cit.)* deduced that these geochemical differences can be ascribed to different proportions of continental- and oceanic-crust involvement in the generation of the two types.

Figure 3 shows extended trace-element variation diagrams for the sulphide zones in the Snyder Group. In Figure 3a, the samples are ratioed to Maynard's (1991) CM end-member values and on Figure 3b to Maynard's CR end-member values. Also illustrated on each diagram are values for the other type (i.e., on Figure 3a, the values from CR are ratioed to CM, and vice versa on Figure 3b). These diagrams reveal striking element-distribution patterns for the Snyder Group samples in that the field for all samples

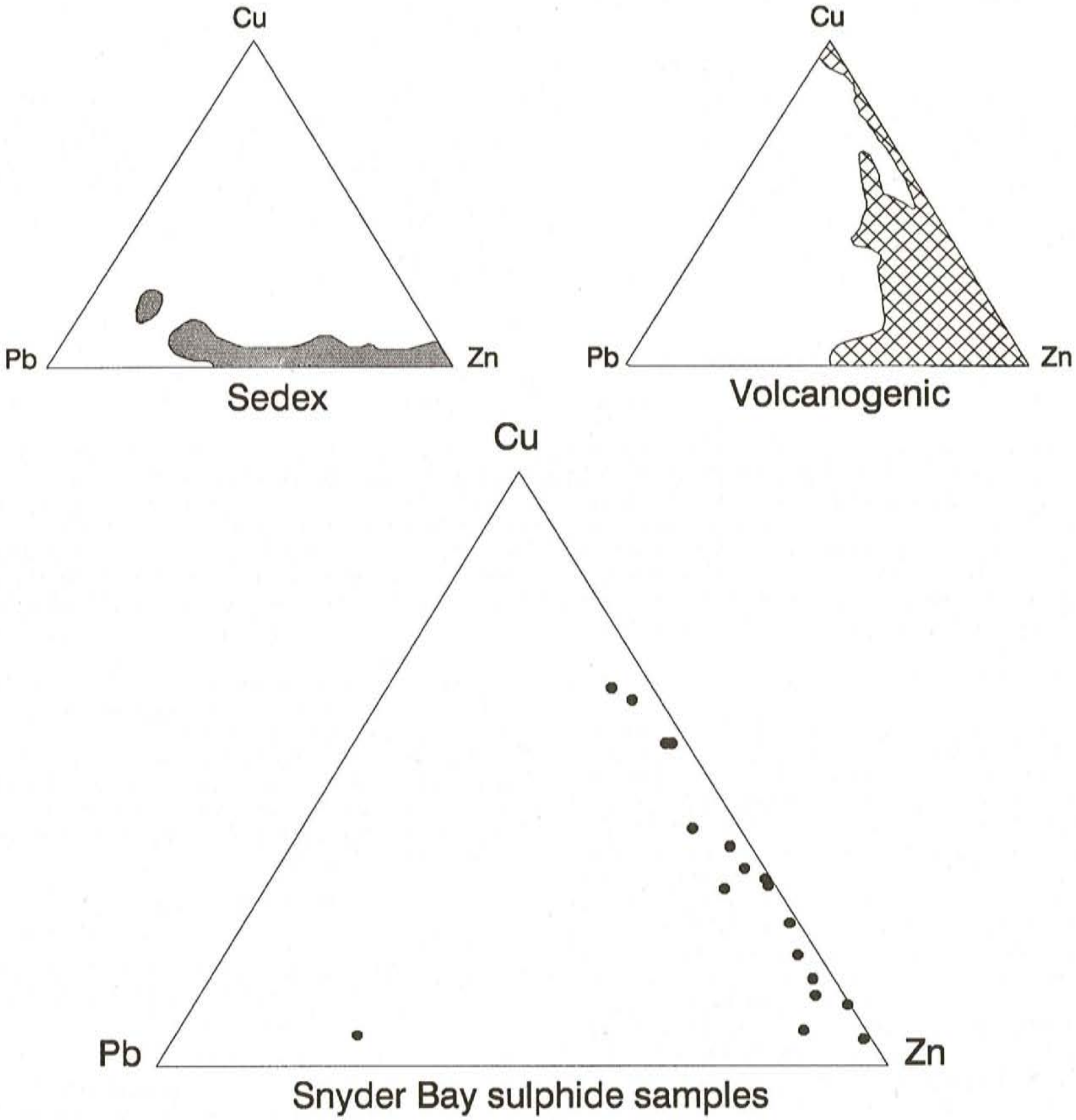

Figure 2. *Base-metal (Pb–Cu–Zn) variation diagram for samples from the sulphide zones in the Snyder Group. The inset diagrams show Lydon's (1983) fields for volcanogenic massive sulphide (VMS) deposits and sedimentary exhalative massive sulphide (SEDEX) deposits.*

parallels the element variations of the CM end member but is out of synchronicity with the variations in the CR end member. In particular, the average CM-type end member exhibits a similar Na_2O depletion relative to K_2O and MnO as the Snyder Group samples,and the concentrations and distributions of other elements, including Ni, Cu, Ba, Zn, V and Cr, are similar in the Snyder Group to those in the CM end member.

This close correlation of geochemical parameters suggests that the Graphite–Sulphide Siltstone formation of the Snyder Group was deposited in the Early Proterozoic on a continental margin with oceanic crust outboard. Such a supposition is at odds with Speer's (1978) suggestion that the Snyder Group was deposited as an epicontinental shelf sequence within the Archean craton. Definition of the sulphide zones in the Snyder Group as being similar to continental-margin mineralization, coupled with the low contents of base metals as determined in this study, unfortunately suggests that the possibility of locating economic concentrations of base metals within the Snyder Group is highly unlikely.

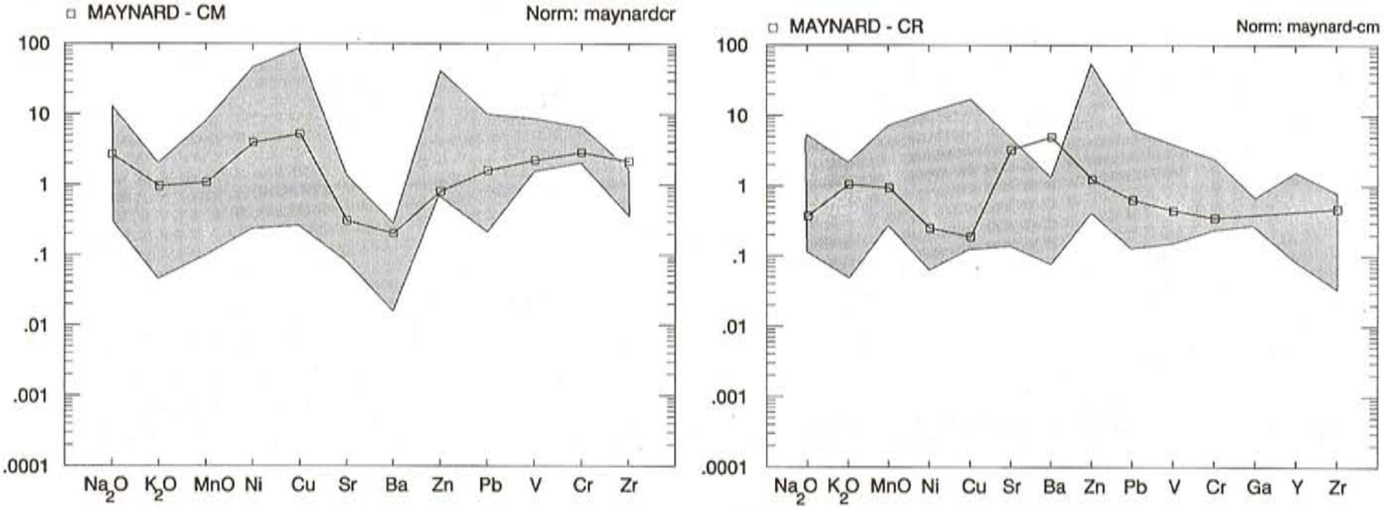

Figure 3. *(a) Normalized extended trace-element variation diagram for samples from the Snyder Group. The range in values for the Snyder Group samples is illustrated by the shaded field on the diagram, and the values for Maynard's (1991) average host rocks to Cratonic Rift-type Pb–Zn–Ba mineralization are denoted by the open symbols. The normalization factors are Maynard's (1991) average host-rock values for Continental Margin-type Pb–Zn–Ba mineralization. (b) Normalized extended trace-element variation diagram for samples from the Snyder Group. The range in values for the Snyder Group samples is illustrated by the shaded field on the diagram, and the values for Maynard (1991) average host rock to Continental Margin-type Pb–Zn–Ba mineralization are denoted by the open symbols. The normalization factors are Maynard's (1991) average host-rock values for Cratonic Rift-type Pb–Zn–Ba mineralization.*

CONCLUSIONS

The Snyder Group consists of five sedimentary formations that have been contact metamorphosed by the Kiglapait Intrusion. One of these formations, the Graphite–Sulphide Siltstone formation, contains massive sulphide lenses and sulphide disseminations. The sulphides are predominantly pyrrhotite and lesser pyrite, and minor chalcopyrite. Sphalerite has been reported by previous workers and although not positively identified in hand specimens from this study, the geochemical data indicate elevated Zn contents in some samples. The base-metal contents of the sulphide zones are rather low, certainly well below grade necessary for economic exploitation. The relative apportionments and absolute contents of trace and major elements suggest that the sulphide zones in the Snyder Group are analogous to those that form on continental margins, and hence they exhibit the geochemical influence of oceanic crust.

Granodioritic intrusions within the unit contain abundant disseminated pyrite and consequently have rusty-weathering outcrops. These rusty granodiorites can be readily mistaken for the similarly rusty-weathering and spatially close sedimentary sulphide zones.

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