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A Stratabound Zinc-Lead Deposit in Meguma Group Metasediments at Eastville, Nova Scotia

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The Eastville zinc-lead deposit, discovered by soil sampling in 1976, occurs near the contact of the Goldenville and Halifax Formations, the two divisions of the Cambro-Ordovician Meguma Group. The stratigraphic succession in the contact zone comprises an assemblage of quartz metawacke, calcareous quartz metawacke and slate. Quartz metawacke is predominant in the Goldenville Formation and slate is the dominant lithology in the overlying Halifax Formation. These rocks are interpreted as the middle to outer fan and basin plain deposits of a submarine fan complex. Pyrrhotite and pyrite, the predominant sulphide minerals in all lithologies in the contact zone, were deposited by reduction of iron in the sediments, independent of the mineralizing process.

Sphalerite and galena occur in rocks over a 10 km strike length in elongate blebs, 2 to 5 mm long, distributed parallel to bedding and in cross-cutting fractures. The deposit is stratabound and generally occurs in black slate beds near the Goldenville-Halifax contact. Geochemical analyses of the rocks have indicated a concentration of Mn in the calcareous quartzite member, the upper unit of the Goldenville Formation. A relationship between the Mn enrichment and the abundance of sphalerite and galena in the section has not been established. The sulphide mineralogy, laterally continuous stratigraphy and lack of metal zonation and underlying feeder structures indicate the sphalerite and galena were syngenetically deposited from metal-rich brines at a site distant from where the brines entered the basin of deposition.

Le dépot de plomb et de zinc de Eastville, qui a été découvert par des prises d'échantillons de terre en 1976, est situé prê du contact des formations Goldenville et Halifax (les deux unites du groupe Meguma). La succession stratigraphique dans la zone de contact est constitué d'un assemblage de métagrauwacke de quartz, de métagrauwacke calcaire de quartz, et d'ardoise. Le métagrauwacke de quartz est prédominant dans la formation Goldenville et l'ardoise est la lithologie dominate de la formation de Halifax, qui est superposé sur la premiére. Ces roches sont expliquées comme étant le cône central ou exterieur et des dépots de la plaine d'un basin d'un complexe de cône. La pyrrhotite et la pyrite, les mineraux sulfides principaux dans toutes les lithologies de la zone de contact, ont été déposés par une réduction de fer dans les sédiments, indépendement des processus de minéralisation.

La sphalérite et la galêne se trouvent dans les roches sur une longueur de 10 kilométres le long de la couche en temps que soufflures de 2 à 5 mm de longueur, réparties paraléllement à la couche et dans les fractures à trafers banc. Le dépot est limité aux strates et se trouve en général dans de l'ardoise noire prés du contact Goldenville-Halifax. Des analyses géochimiques des roches ont indiqué une concentration de Mn dans les quartzites calcaires, l'unité la plus élevé de la formation Goldenville. Un rapport entre l'enrichissement en Mn et l'abondance de la sphalérite et de la galène dans la section, n'a pas été établie. La minéralogie des sulfides, la stratigraphie latérale continue, et le manque de zonation de métaux et de structures de conduite d'alimentation, indique que la sphalérite et la galéne ont été déposées sygénétiquement à partir de saumures riches en métaux dans un site éloigné de l'endroit où les saumures pénètrent le basin de dépot.

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INTRODUCTION

The Eastville deposit, discovered by St. Joseph Explorations Limited in 1976, represents the first reported occurrence of extensive zinc and lead sulphides in the Meguma Group metasedimentary rocks of Nova Scotia. The Cambro-Ordovician Meguma Group underlies a large area of Nova Scotia south of the Glooscap Fault. It comprises a thick (up to 14 km) assemblage of quartz metawacke turbidites interstratified with black slate. The basal half (Goldenville Formation) is mainly thick sandy turbidites; the upper half (Halifax Formation) is mainly black slate (Schenk, 1978). At Eastville, sphalerite and galena occur in stratabound disseminations and in small cross-cutting veinlets within 100 m of the contact of the Goldenville and Halifax Formations. The deposit is located between latitude 45 15'30" and longitude 62 52'30" on the west to latitude 45 17'45" and longitude 62 44'30" on the east within map area NTS 11E7. The deposit is accessible by a good quality gravel road from Eastville in the Stewiacke River valley.

This paper describes the lithology and stratigraphy of the Meguma Group in the Eastville area and the occurrence and distribution of sulphides and selected elements. An account of the exploration history of the deposit is presented and exploration guidelines for similar deposits are suggested.

The Eastville area was originally mapped by H. Fletcher and E.R. Faribault (1902) at a scale of 1:63,360. The lack of access, low relief and few outcrops in the eastern part of the area hampered accurate mapping. Benson (1967) remapped the area, placing most of the rocks southeast of Eastville in the Goldenville Formation of the Meguma Group. More recent mapping by Binney at a scale of 1:10,000 used a network of logging roads for access and the results of diamond drilling and geophysical surveys in areas of poor ourcrop to determine the extent of the Goldenville and Halifax Formations (Figure 1). This work has confirmed much of Fletcher and Faribault's early mapping.

The only previous exploration activity in the Meguma Group rocks of the area prior to 1976 was assessment of the potential for gold mineralization in the quartz veins exposed on Fulton and Cox Brooks.

EXPLORATION HISTORY

The zinc-lead deposit, located immediately south and east of Eastville, Colchester County, was discovered in 1976 during exploration for gold in regional structures cutting the Meguma Group. A significant AFMAG (electromagnetic) anomaly has been noted on Geological Survey of Canada map 762G (1960) and this anomaly was thought to represent a regional fault. No previous exploration work was recorded for the area when St. Joseph Explorations Limited undertook a reconnaissance soil sampling program. Initially, in addition to gold, analyses for copper, lead and zinc were carried out for samples taken every 30 m on lines spaced one kilometre apart along strike. The initial two sample lines included lead values in excess of 1,000 ppm delineating the rough shape of a west-trending anomaly coincident with the contact of the Goldenville and Halifax Formations. Anomalous gold values were not detected. The area was staked by St. Joseph Explorations Limited and has been held since 1981 by a successor company, Sulpetro Minerals Limited.

The unrecorded presence of significant zinc and lead occurrences in the metasedimentary rocks of the Meguma Group resulted in a cautious program of exploration with B-horizon soil sampling and an electromagnetic survey (Crone CEM) on widely-spaced, uncut lines. A strong electromagnetic anomaly was located over the length of the claim group and strong geochemical

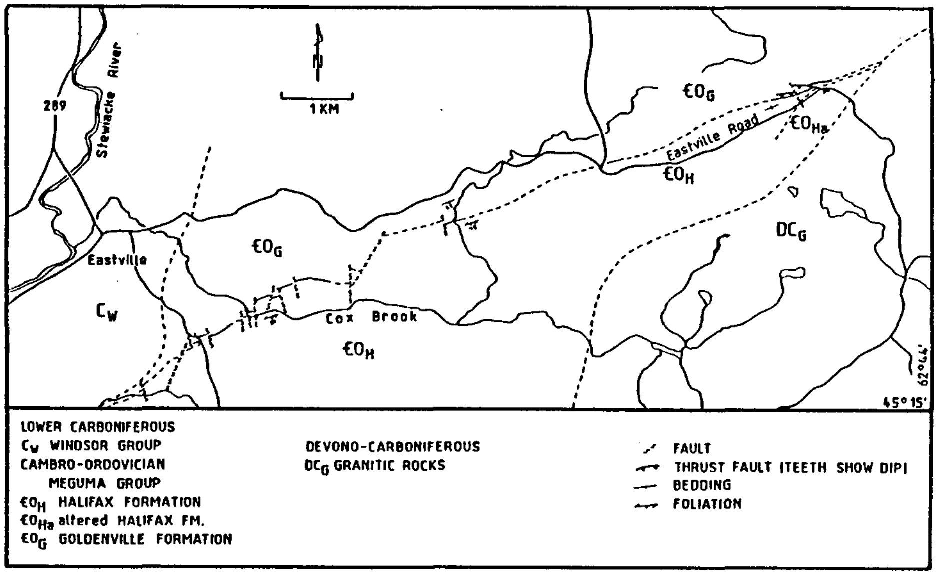

Figure 1 - Geological map of the Eastville area of Nova Scotia.

anomalies for lead and zinc were delineated in two areas coincident with the electromagnetic anomaly. As a result of these data three shallow holes were diamond drilled in 1977. Black graphitic slate was encountered at the base of the Halifax Formation, which explained the electromagnetic anomaly. Detailed examination of the drill core from the contact zone of the Goldenville and Halifax Formations revealed fine grained sphalerite and galena. Recovery of drill core was poor in hole 1 but chips recovered from a 7.0 m section assayed 3.26 per cent combined zinc-lead. Drill hole 2 included a 14.9 m section with a combined zinc-lead grade of 1.32 per cent. Hole 3 was drilled on a geochemical anomaly with no coincident electromagnetic anomaly and was completely within barren quartz metawacke of the Goldenville Formation.

Once the presence of mineralization was established a more ambitious exploration program was initiated. Grids were cut over the major geochemical anomalies with lines spaced 100 m apart. A total-field magnetic survey, horizontal-loop electromagnetic survey (Max-Min II) and detailed soil sampling were carried out along all cut lines. The geophysical surveys provided information on the location of the graphitic slate at the base of the Halifax Formation, essential for stratigraphic control of diamond drilling. Soil geochemistry outlined areas of potential zinc and lead sulphides along the Goldenville-Halifax contact. Concurrent with the geophysics and soil sampling, an orientation survey of organic-bank stream sampling was undertaken to assess the practicality of this method in regional data collection. Anomalous lead and zinc results were obtained in highly organic samples up to 1 km downstream from the mineralized area.

Between 1977 and 1982, twenty-eight diamond drill holes between 30 m and 260 m long were used to explore the Eastville deposit. Early drill holes were concentrated in areas where geochemical anomalies were coincident with the Goldenville-Halifax contact as located by geophysical surveys. Later drilling included: 1) deeper holes to test the rocks below better mineralized sections, and 2) systematic drilling of holes to examine the zinc-lead content of rocks along the length of the Goldenville-Halifax contact. Not all drill holes containing sphalerite and galena coincide with geochemical anomalies. Drilling was monitored continuously with sludge samples analysed for zinc and lead. The analytical results were used to confirm the assay sections chosen on the basis of visual examination of the drill core.

In 1980, a program of overburden drilling and drill core analysis was completed in an effort to outline geochemical trends which might indicate untested areas of potential mineralization. Some of the analytical results are presented in this paper. The till drilling data reflect the element abundances in the underlying rocks but no new areas of mineralization were detected.

The exploration work to date has failed to outline an economic deposit of zinc and lead. Most drill holes include 2 m to 10 m sections of 1 to 3 per cent combined zinc-lead at various stratigraphic positions. Drill holes with the better grades include hole 7 with 3.34 per cent combined zinc-lead over 6.1 m of black slate and hole 28 with 4.09 per cent combined zinc-lead over 9.33 m in fault gouge at the contact between the Goldenville and Halifax Formations. The property remains of interest for base metal exploration and represents a new type of occurrence in Meguma Group metasediments.

GENERAL GEOLOGY

Low relief and bogland in the Eastville area result in poor exposures of the rock units and their contact relationships. Only in the deeply incised valleys of Fulton Brook and Cox Brook with its tributary Little Brook, are there extensive outcrops of the Meguma Group rocks (Fig. 1). The distribution of rock units shown in Figure 1, and in detail in Figures 2 and 3, is based primarily on drill results and geophysical survey.

The oldest rocks exposed in the Eastville area are massive quartz metawacke and minor interbedded slate (Fig. 4) of the Cambro-Ordovician Goldenville Formation, the basal member of the Meguma Group (Fig. 1, 2, 3). This formation is in fault contact with younger Carboniferous clastic sedimentary rocks to the north. The base of the formation is not exposed at Eastville or at other locations in Nova Scotia. Benson (1967) measured a 700 m stratigraphic section of Goldenville Formation rocks on Cox Brook. He noted that regionally a stratigraphic thickness of up to 5,400 m of the formation is recognized.

The Goldenville Formation is overlain to the south by the Halifax Formation, the upper unit of the Meguma Group. Slate, argillite and interbedded quartz metawacke and metasiltstone form the Halifax Formation in the Eastville area where it exceeds 2,000 m thickness (Fig. 1 and 5). The slate is locally graphitic, and pyrrhotite and pyrite are common throughout. At Eastville, sphalerite and galena occur near the contact of the Goldenville and Halifax Formations.

The rocks of the Meguma Group are truncated by a Devono-Carboniferous intrusion to the east (Fig. 1 and 3). Granodiorite and granite are recognized as two phases of this pluton. North of the intrusion the slates of the Halifax Formation show effects of contact metamorphism with the development of secondary biotite, almandine garnet and andalusite crystals as much as 1.5 cm across. Light grey to white, chlorite-blotched, muscovite schist occurs in the immediate contact area of the intrusion. In some drill sections mineral segregation and gneissic textures have been developed.

South and west of Eastville (Fig. 1 and 2) the Goldenville Formation and the contact zone with the Halifax Formation are unconformably overlain by the lower Carboniferous Windsor Group. Within the mapped area the group comprises a basal limonite-cemented, quartz metawacke clast conglomerate overlain by limestone, red siltstone and thick gypsum beds.

The Eastville area is on the north

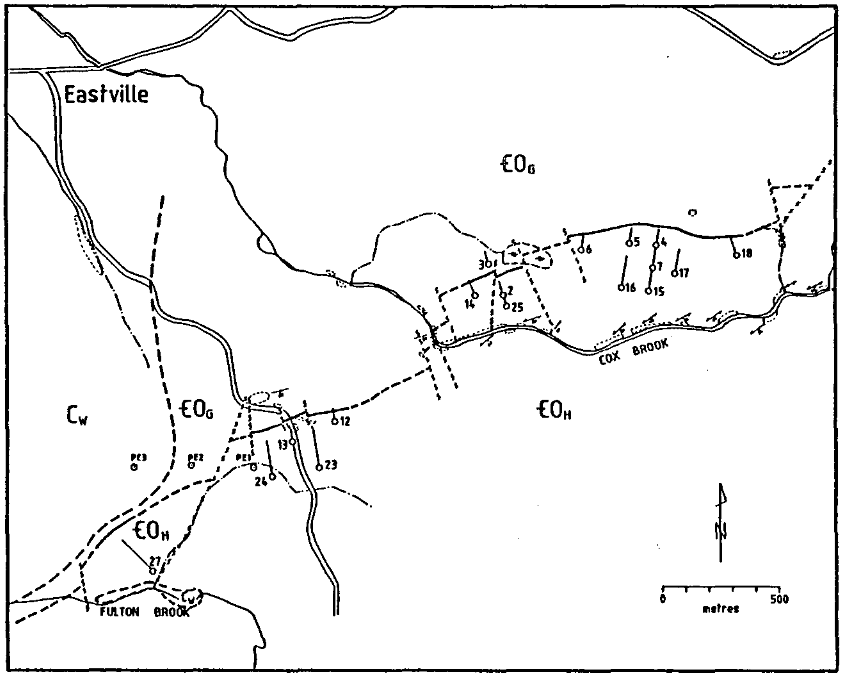

Figure 2 - Map of the weatern part of the Eastville zinc-lead deposit showing geology and diamond drill locations. Drill holes prefixed PE are vertical holes for exploration of the Carboniferous basal Windsor Limestone. Holes with no prefix were drilled by St. Joseph Explorations Ltd./Sulpetro Minerals Ltd. for exploration of the Eastville zinc-lead deposit. For an explanation of rock divisions and symbols refer to Figure 1.

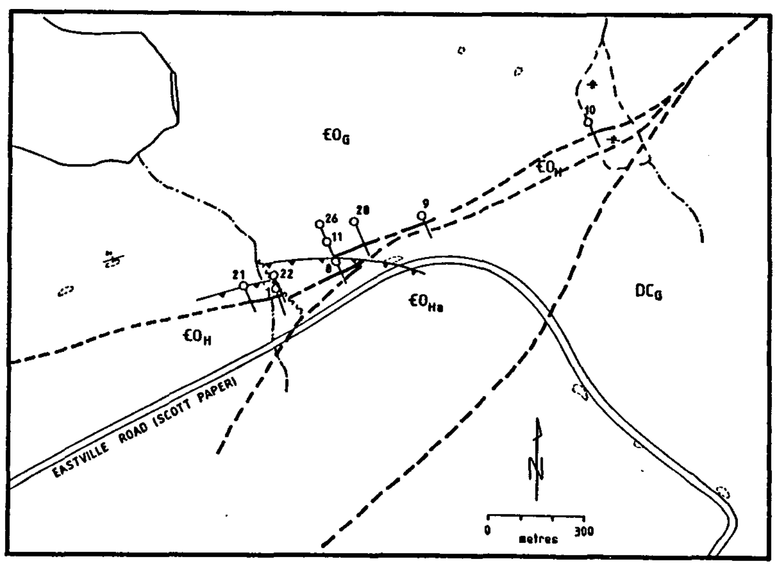

Figure 3 - Map of the eastern part of the Eastville zinc-lead deposit showing geology and diamond drill hole locations. All holes were drilled by St. Joseph Explorations Ltd./Sulpetro Minerals Ltd. For an explanation of rock divisions and symbols refer to Figure 1.

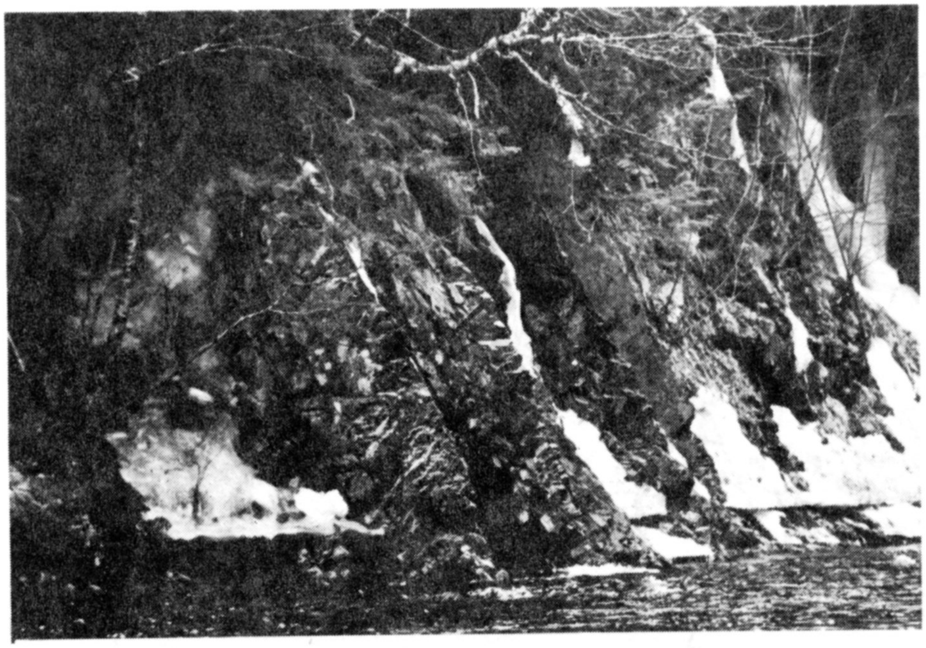

Figure 4 - Massive quartz metawacke beds of the Goldenville Formation exposed on Cox Brook. Bedding is outlined by partings and weathered argillaceous interbeds.

limb of a large east-northeasterly-trending syncline in the Meguma Group. The contact of the Goldenville and Halifax formations dips 45 to 80 degrees south in the western exposures (Fig.2). To the east the angle of dip increases to 90 degrees and locally the rocks are overturned and dip north (Fig. 3).

Two sets of steeply-dipping faults cut the contact. The first set comprises faults trending about 160 degrees which offset the Goldenville-Halifax contact from 10 to 150 m. Offsets on most faults are left lateral. Larger offsets of 200 m to greater than 500 m occur along the second set of faults trending 010 to 030 degrees (Fig. 1 and 2). In the eastern area of closer spaced drill holes (Fig. 3), a low angle thrust fault forms the boundary of a normal stratigraphic succession to the west and a sheared contact between the Goldenville and Halifax Formations to the east. In the sheared contact area at least 20 m of the section is absent as a result of a fault sub-parallel to the Goldenville-Halifax contact. The juxtaposition of the two types of contact and the continuation of the metamorphic aureole from one side of the thrust fault to the other suggests that the fault pre-dated the emplacement of the granite. Compression from the southwest could have initiated faulting along the Goldenville-Halifax contact in the east and later have thrust undisturbed rocks from the west over the brecciated contact. The thrust fault is offset by a later fault trending 150 degrees.

In outcrop, a penetrative cleavage sub-parallel to the bedding plane of slates of the Halifax Formation has obscured primary bedding features (Fig. 5). In drill core bedding is visible and the main evidence for this cleavage is the redistribution of sulphide minerals into elongate millimetric blebs. A less developed secondary cleavage perpendicular to bedding is observed both in drill core and outcrops along Cox Brook.

STRATIGRAPHY AND LITHOLOGY OF THE MEGUMA GROUP AT EASTVILLE

The detailed stratigraphy of the Meguma Group at Eastville is based on twenty-eight drill holes of St. Joseph

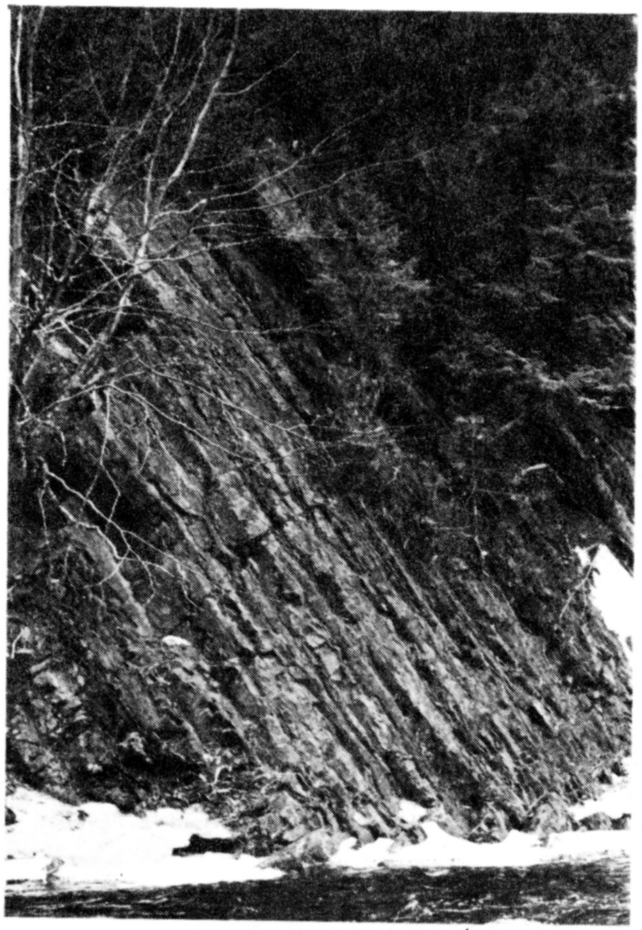

Figure 5 - Outcrop of the Halifax Formation on Cox Brook with black slate and thin interbeds of quartz metawacke. Bedding is obscured by the cleavage.

Explorations Ltd. and Sulpetro Minerals Ltd. The maximum thickness of the stratigraphic sequence represented by diamond drill cores is the upper 100 m of the Goldenville Formation and the basal 200 m of the overlying Halifax Formation. More extensive exposures exist along Cox and Fulton Brooks but faults and a pervasive cleavage subparallel to bedding have obscured the detailed stratigraphic relationship. The units defined in drill core have not been recognized in outcrops; only the gross division between the Goldenville and Halifax Formations can be mapped. A stratigraphic column is presented in Figure 6. Two drill sections (Fig. 7 and 12) illustrate the variability of the contact relationships between the Goldenville and Halifax Formations.

Three members of the Goldenville Formation have been recognized in drill cores through the Eastville deposit (Fig. 6). The basal member is a massive, grey to greenish-grey quartz metawacke. Up to 100 m of the member has been drilled (hole 3) with no slate interbeds and no base metal mineralization observed. The rock constituents include recrystallized quartz, muscovite, plagioclase, garnet, biotite, chlorite and minor iron sulphides. The idiomorphic garnets coexisting with biotite and chlorite in the rock indicate a regional metamorphic grade of middle greenschist facies (Jenner, 1982).

Overlying the basal massive quartz metawacke is the transition zone (Fig. 6), a 30 to 35 m-thick section of interbedded massive, structureless, grey quartz metawacke and finely laminated, graphitic, black slate. The base of the transition zone member is defined as the first black slate interbed (Fig. 7). Slate interbeds range from 1 cm to several metres in

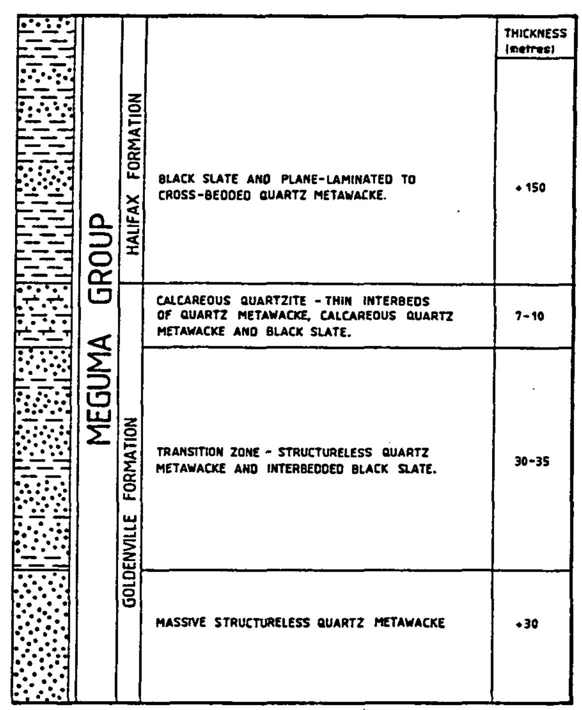

Figure 6 - Stratigraphic column of the Meguma Group rocks at Eastville based on diamond drill cores.

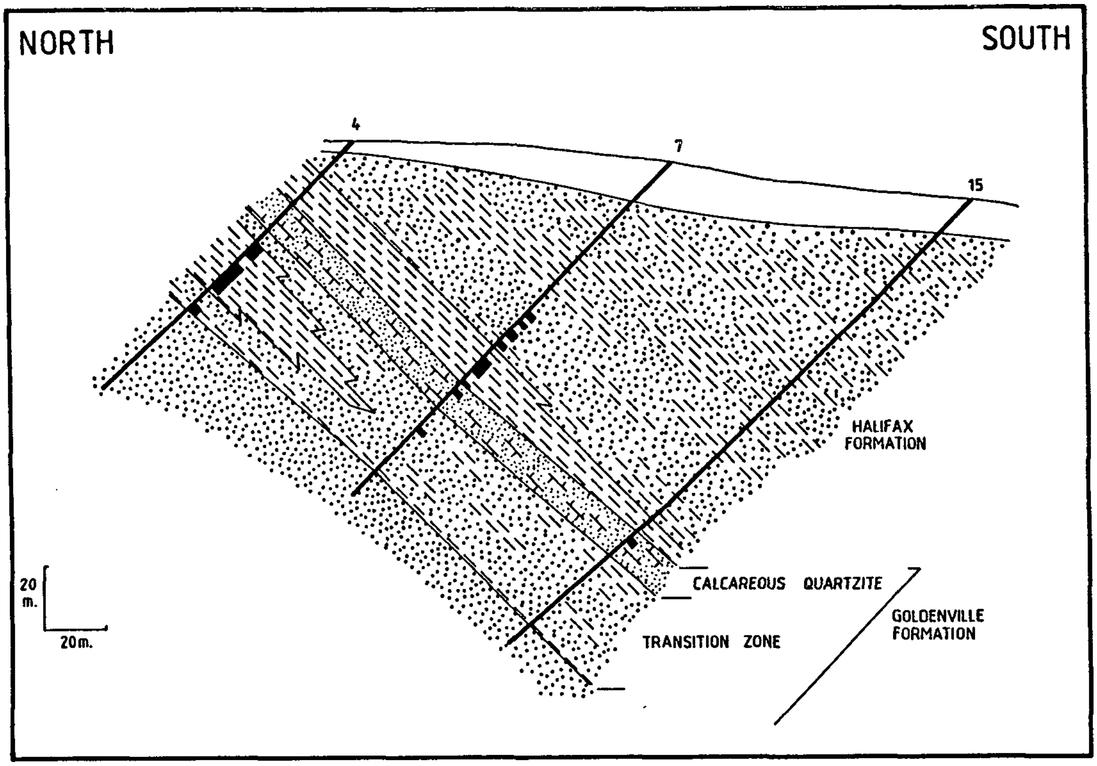

Figure 7 - Section through drill holes 4, 7 and 15 (for location see Figure 2). Major stratigraphic divisions are noted. Heavy bars beside drill holes represent sections with combined zinc-lead grades in excess of 1 per cent.

thickness and comprises from 10 to 50 per cent of the member. The total free carbon content is not accounted for solely by graphite in the black slate; accumulations of bituminous matter occur in some quartz metawacke interbeds (Zentilli and MacInnis, 1983). The restricted distribution of individual thick slate beds in the transition zone member is illustrated by the rapid lateral facies change between drill holes 5, 6 and 2 (Fig. 2). Pyrrhotite and pyrite, the principal sulphide minerals, are concentrated in the slate interbeds with few sulphides in massive quartz metawacke. Figure 7 illustrates that sphalerite and galena are also concentrated in the slate interbeds of the transition zone. In individual drill holes combined zinc-lead grades in excess of 1 per cent occur over thicknesses as great as 14 m. Drill holes with fewer slate interbeds have thinner and lower grade mineralized transition zone section. Mineralogically, the transition zone member is similar to the underlying quartz metawacke member. Quartz, muscovite, biotite, plagioclase and chlorite form an equigranular matrix enclosing disseminated blebs of pyrrhotite. Graphite occurs in the slate interbeds. Garnets are rarely observed in this lithological division.

The transition zone member is overlain by the well bedded calcareous quartzite member (Fig. 6). This marker unit, which forms the top of the Goldenville Formation in the Eastville area, comprises 7 to 10 m of interbedded quartz metawacke, calcareous quartz metawacke and black slate. Distinctive features of the member include the calcareous nature, the thin 1 to 15 mm interbeds of the different lithologies and the highly contorted bedding (Fig. 8). The base of the member is chosen as the lower limit of visible deformed bedding and both upper and lower contacts are gradational over 0.5 to 1.5 m into the adjacent units. The proportion of each lithology varies vertically within the calcareous quartzite member with slate

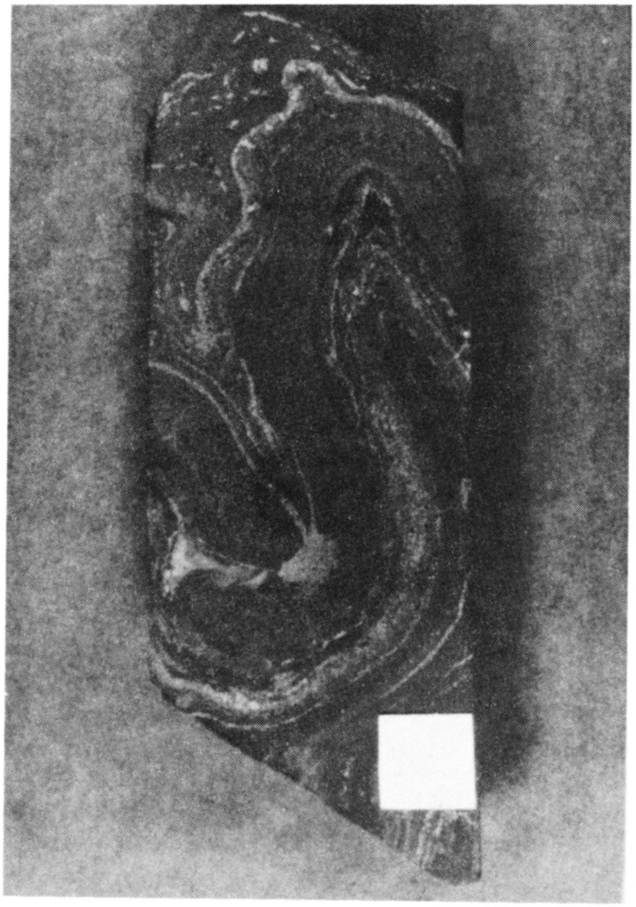

Figure 8 - Core sample of the calcareous quartzite member showing the contorted fine laminae of black slate (dark grey), quartz metawacke and calcareous quartz metawacke (medium grey) and pyrrhotite (light grey). White block is 1 cm square.

interbeds prominent at the top, and quartz metawacke interbeds prominent at the base. Pyrrhotite is a major component of the member, forming more than 10 per cent by volume of the rock in the slate-rich upper section. Iron sulphides (pyrrhotite and pyrite) form distinct beds or occur dispersed in other lithologies (Fig. 8). The distribution of sphalerite and galena is fracture-controlled in most drilled sections of the calcareous quartzite member. The member includes: quartz metawacke with recrystallized quartz, biotite and spessartine garnet; calcareous quartz metawacke with 0.5 mm calcite crystals intermixed with recrystallized quartz; and black slate with alternating bands of carbon-rich and quartz-rich detritus. Spessartine garnet porphyroblasts are present in all lithologies. Fine scale bedding in some sections results from different concentrations of garnets in adjacent beds and is thought to reflect original element distributions in the sediments.

The Halifax Formation overlies the Goldenville Formation in all drill holes (Fig. 6 and 7). A bed of black, pyrrhotitic, graphitic slate 5 to 15 m thick forms the base of the Halifax Formation in the Eastville area. The rock contains 5 to 10 per cent pyrrhotite, both disseminated and in distinct beds. Jenner (1982) recognized pressure shadows of aligned muscovite and quartz grains surrounding pyrrhotite blebs and suggested the sulphides had crystallized before the development of the slaty cleavage. Sphalerite and galena concentrations occur in the basal black slate beds. Although the unit is laterally extensive and has been traced by drilling for 10 km of strike length, the sphalerite and galena are not laterally continuous and occur principally in the western drill holes. The black slate includes chlorite and spessartine garnet (Fig. 9) in a groundmass of quartz, muscovite and graphite.

The remainder of the Halifax Formation intersected in drill holes consists of black graphitic slate with quartz metawacke interbeds. The latter comprise 20 to 50 per cent of the stratigraphic section. Bouma sequences (Walker, 1979) and load casts on basal contacts indicate that the quartz metawacke beds were deposited from turbidity currents (Fig. 10). Individual metawacke interbeds may contain calcite, either in structureless beds of calcareous quartz metawacke or on foreset laminae of ripples in quartz metawacke. These calcareous sections are not common in the Halifax Formation. The internal laminations in the quartz metawacke interbeds serve to distinguish this formation from the massive structureless quartz metawacke beds of

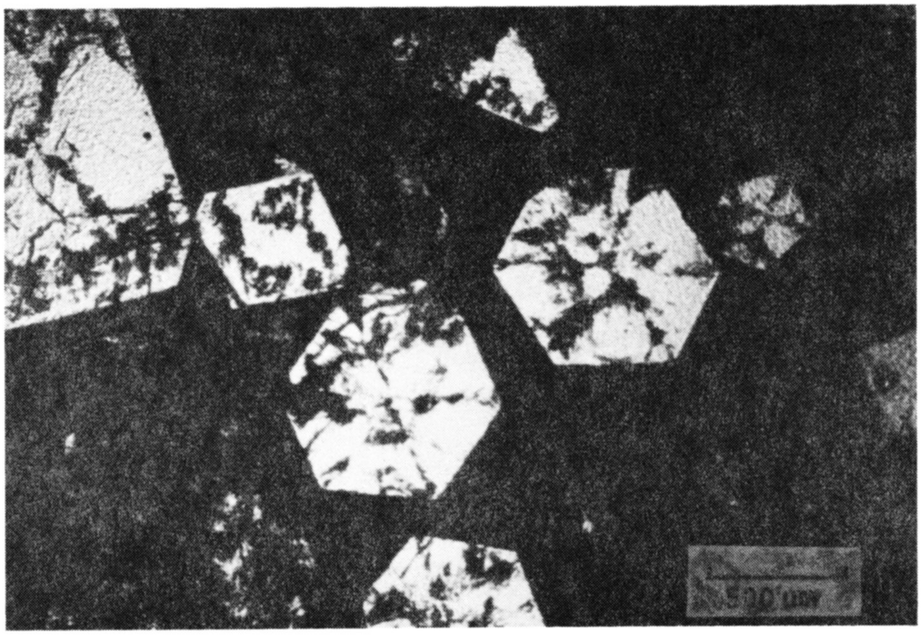

Figure 9 - Photomicrograph of spessartine garnet within the basal black graphitic slate bed of the Halifax Formation (plane light). Dark inclusions within the garnet are carbonaceous matter.

with black slate partings. The quartz-rich interbeds are conformable with other bedding on the scale of a drill hole but lateral continuity of individual beds between drill holes has not been established. Pyrrhotite and pyrite are common and locally abundant in both slate and quartz metawacke of the Halifax Formation. Both bedding-controlled and fracture-controlled sphalerite and galena occur in the section. Slate and quartz metawacke contain quartz, muscovite, chlorite, garnet and sulphides. Black slate contains laminae of carbonaceous material (now graphite), probably of detrital origin, finely interbedded with more quartzose laminae.

This typical stratigraphic assemblage from quartz metawacke beds in the Goldenville Formation through to the Halifax Formation has been traced for 10 km of strike length from hole 27 the transition zone in the Goldenville Formation. Quartz-rich interbeds approximately 10 to 15 cm thick (Fig. 11) occur locally in the drilled section of the Halifax Formation. These siliceous interbeds comprise thin quartz-rich layers finely interbedded near Fulton Brook in the west (Fig. 2) to hole 8 adjacent to the thrust fault in the east (Fig. 3). The drill section in Figure 7 illustrates the lateral continuity of beds and the uniform thickness of beds between drill holes. In individual drill holes, faults have caused local repetition or truncation of beds.

Conformable contact relationships between the Goldenville and Halifax Formations are not observed east and north of the low angle thrust fault (Fig. 3). A drill section that includes holes on both sides of this fault is illustrated in Figure 12. The Goldenville Formation includes quartz metawacke with slate interbeds (correlative with the transition zone) and brecciated quartz metawacke with minor fluorite. In deeper drill holes close to the granitic intrusion, mineral segregation occurs with discrete layers of quartz and ferro-magnesian silicates. The calcareous quartzite member is absent in all these drill holes and the transition zone varies in thickness due to faulting in the section (Fig. 12).

The contact between the Goldenville

Figure 10 - Quartz metawacke interbed in black slate. Plane lamination and load casts on the basal contact of the beds are features of many interbeds in the Halifax Formation. Pyrrhotite in small pods and in cubic habit (after pyrite) disrupts the bedding.

and Halifax Formations is defined in this section by a fault zone. The basal part of the Halifax Formation comprises quartz metawacke and slate blocks in a matrix of black, graphitic fault gouge. Sphalerite and galena occur within the competent blocks and in the gouge, and iron sulphides are ubiquitous as in other sections of the Halifax Formation. Contact metamorphism by the granitic intrusion has produced biotite, almandine garnet and andalusite crystals up to 1.5 cm in cross section in the Halifax Formation. At the base of the drill holes (Fig. 12) a schist with pink garnetiferous layers in a medium-grey siliceous matrix occurs in contact with the slate. This schist could be a highly metamorphosed equivalent of the Halifax Formation and the contact between the two units a fault. The schist does not contain sulphides.

METALLIC MINERALS: HABIT AND INTERGROWTHS

Both sulphide and oxide minerals have been recognized in the Meguma Group metasedimentary rocks at Eastville. Sulphide minerals are quantitatively and economically more significant and include, in decreasing order of abundance, pyrrhotite, pyrite, sphalerite, galena, chalcopyrite and arsenopyrite. Jenner (1982) recognized both pyrite partly replaced by pyrrhotite in elongate 1 to 10 mm sulphide blebs and pyrite that is

Figure 11 - Quartz-rich layers within the Halifax Formation. Thin interbeds of quartz-rich laminae and black slate partings occur in the slate sequence.

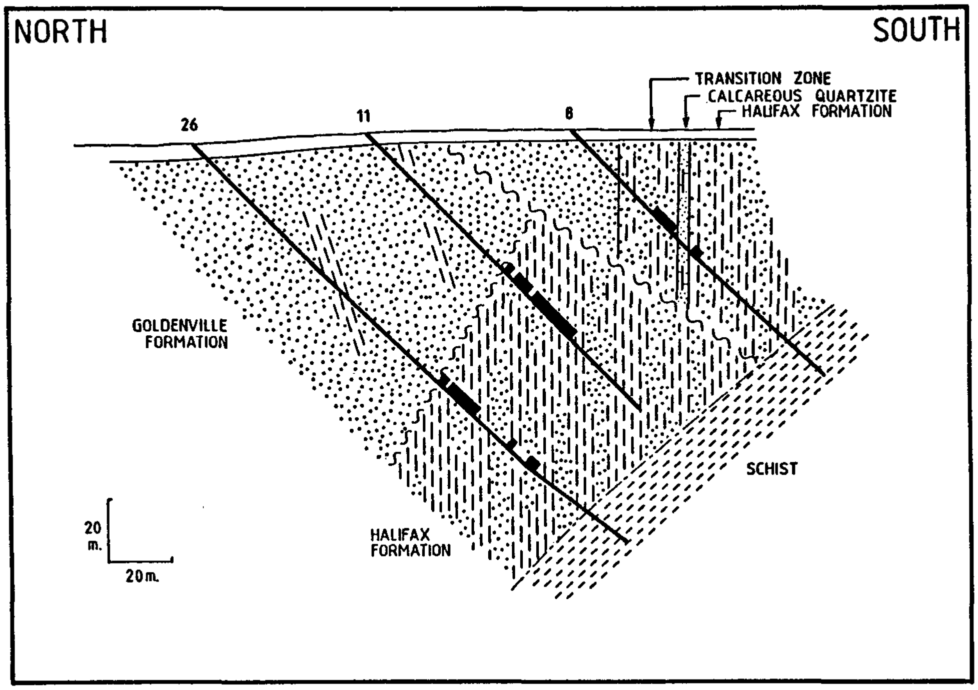

Figure 12 - Section through drill holes 26, 11 and 8 (for location see Figure 3). Hole 8 is above the thrust fault and contains a typical stratigraphic succession. In holes 26 and 11 the Goldenville and Halifax Formations are in fault contact. Bedding orientations are indicated by the attitude of the lithological patterns. Heavy bars beside the drill holes represent sections with combined zinc-lead grades in excess of 1 per cent. Drill hole 26 includes 15.7 m of 2.61 per cent Zn+Pb, and drill hole 11 includes 19.8 m of 2.19 per cent Zn+Pb. The sulphide distribution is governed by the position of the fault on the formational contact.

secondary after pyrrhotite in cross-cutting veins. The replacement textures record regional metamorphic conditions rather than primary sulphide deposition. The replacement texture, however, does suggest that much of the pyrrhotite was originally deposited as pyrite. Sphalerite and galena occur as discrete mineral grains or intergrowths with each other, and as replacement grains engulfing pyrrhotite. Chalcopyrite forms anhedral masses enclosed in pyrrhotite or sphalerite, and arsenopyrite has been observed only in a few locations in veins in the calcareous quartzite member.

Oxides include ilmenite and rutile which occur as discrete crystals in the metasediments. Ilmenite crystals (Fig. 13) in the slate of the Halifax Formation contain significant MnO. Rutile occurs as small needle-like crystals in the calcareous quartzite member and appears to outline pressure shadows around garnet porphyroblasts (Fig. 14). Both ilmenite and rutile formed during metamorphism of the sedimentary rocks and have not been observed intergrown with the sulphides.

Two principal styles of sulphide occurrence have been noted. Conformable sulphides are the most common. Pyrrhotite and lesser amounts of pyrite, galena and sphalerite occur in small blebs 1 to 2 mm thick and 2 to 5 mm long, elongate parallel to bedding (Fig. 15). Pyrrhotite also forms 1 mm to 1 cm thick beds in the slate and quartz metawacke and irregular pods on foreset laminae and plane laminae in the quartz metawacke. Nodules of pyrrhotite, up to 1 to 3 cm in size occur in all lithologies. The nodules have sharp boundaries with the enclosing sediment and in some cases are surrounded by a halo of disseminated pyrrhotite.

Redistribution of sulphides has

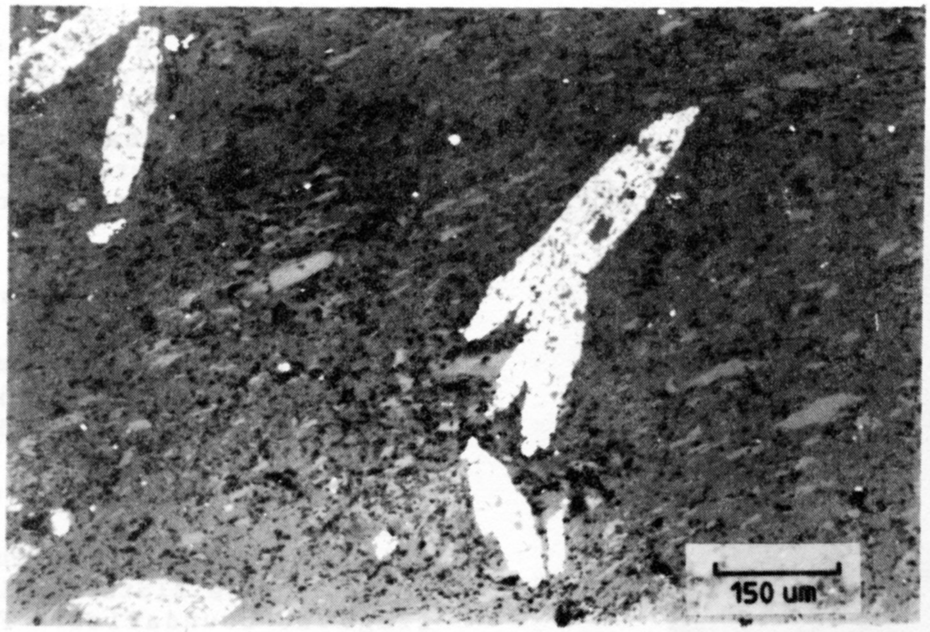

Figure 13 - Ilmenite crystal porphyroblasts dispersed in slate of the Halifax Formation (reflected light).

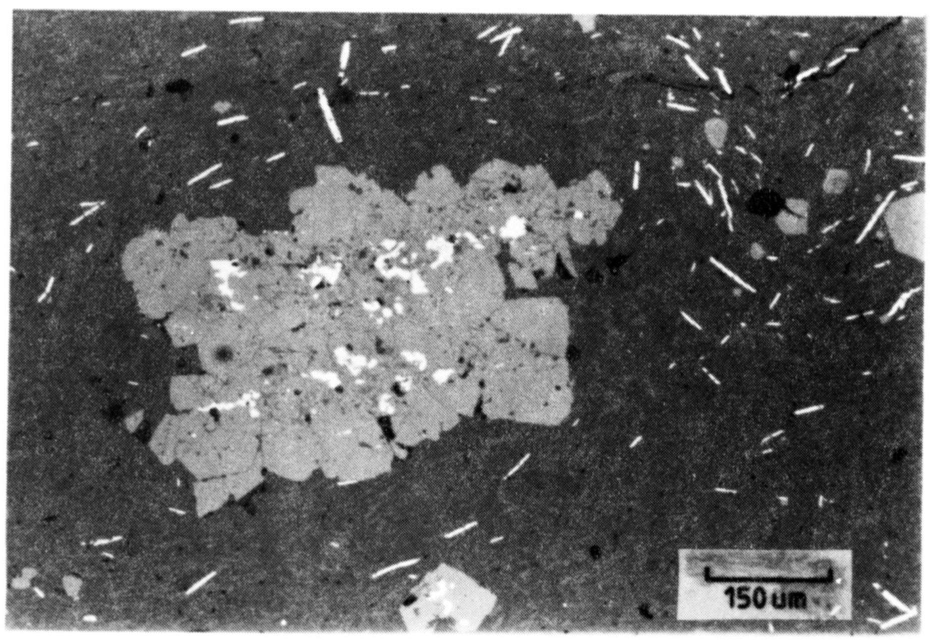

Figure 14 - Calcareous quartzite member containing small rutile needles with a preferred orientation around a porphyroblast of garnet (grey) enclosing minor sphalerite (white) (reflected light).

occurred. Pyrrhotite replaces pyrite in quartz metawacke interbeds in the Halifax Formation. Cleavage redistribution of sulphides has formed a series of elongate, disconnected millimetric blebs on one lithological horizon but with each bleb at a slight angle to the bedding. Pronounced redistribution of iron sulphides in beds that are cross-cut by the cleavage is common (Fig. 16). Sphalerite coats cleavage planes in the black slate beds.

Conformable sphalerite and galena are

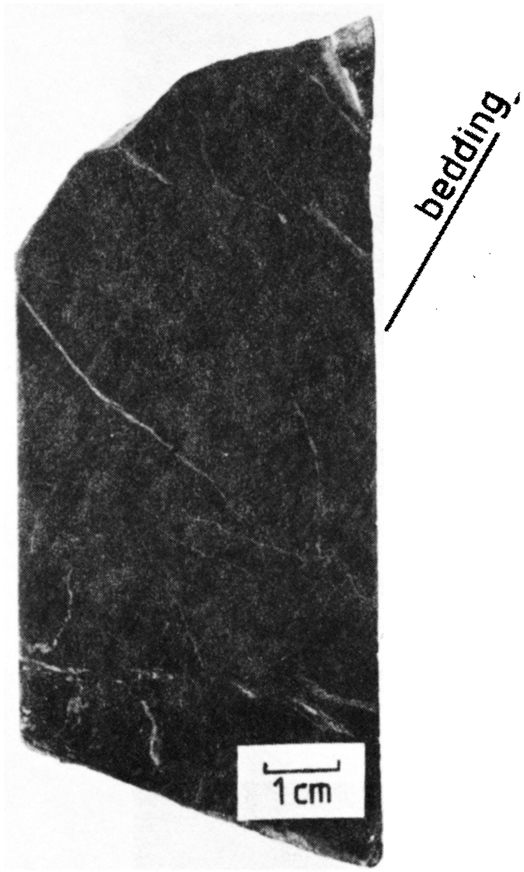

Figure 15 - Core sample of conformable galena and sphalerite (grey) in black slate. Small cross-cutting veinlets contain sphalerite. The section that includes this sample assayed 2.24 % Pb and 5.36 % Zn.

concentrated in the argillaceous and carbonaceous slate beds of the transition zone of the Goldenville Formation and in the Halifax Formation. Individual mineral grains occur in the calcareous quartzite member but the concentration is very low. Conformable iron sulphides (pyrrhotite and pyrite) are ubiquitous in the transition zone member and calcareous quartzite member of the Goldenville Formation and throughout the Halifax Formation.

Fracture-controlled sulphides account for the remainder of the ore minerals, and include pyrite and sphalerite with lesser amounts of pyrrhotite, galena and arsenopyrite. The sulphides occur in networks of 0.1 to 1 mm thick veinlets cross-cutting bedding or with quartz in 5 mm to 2 cm wide veins. In the larger veins the principal sulphides are pyrite and pyrrhotite. Sphalerite and galena in fractures (Fig. 17) occur in black slate near conformable galena and in quartz metawacke and calcareous quartz metawacke beds where fractures are the only depositional site for sphalerite and galena.

In that part of the deposit north and east of the thrust fault (Fig. 3), the style of sulphide mineralization is the same, even though the rocks have been highly brecciated. Individual blocks within the fault gouge at the base of the Halifax Formation contain both conformable galena and fracture-controlled sphalerite. The fracture-controlled veinlets terminate at the fragment boundaries. Fault gouge between the blocks contains sphalerite

Figure 16 - Transposition of a pyrrhotite bed along the cleavage in the Halifax Formation. The sulphide bed is at a high angle to the cleavage and parallel to the drill core at this location.

and galena, but these sulphides have probably been mechanically redistributed during brecciation of slate, rather than having been introduced during or after faulting.

ROCK GEOCHEMICAL STUDIES

As part of the 1980 exploration program of the Eastville property all available drill core was split and analysed by Bondar-Clegg and Company Ltd., Ottawa, by atomic absorption of acid extractable Pb, Zn, Fe, Mn, As, Sb, Ba and Sr. Usually, 3 m intervals of core of the Halifax Formation and transition zone and 2 m intervals of core of the calcareous quartzite member were split for analysis. The basal massive quartz metawacke was not analysed in a systematic manner.

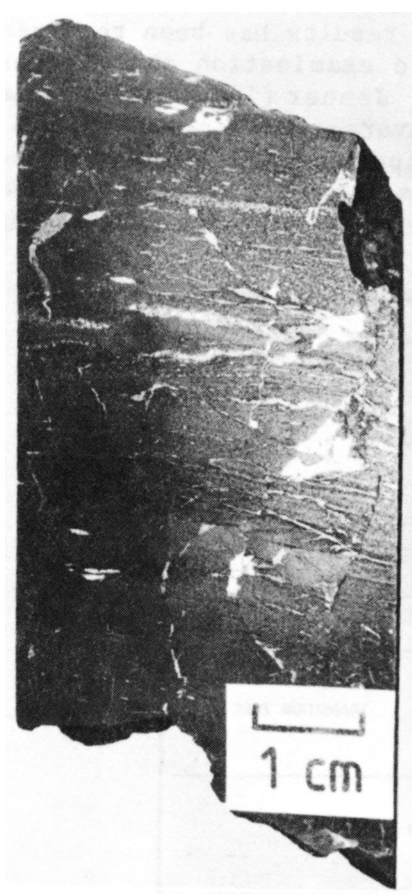

Figure 17 - Discontinuous sphalerite and galena veinlets and adjacent disseminations in black slate.

In 1983, 50 selected samples from holes 24 and 25 were analysed by X-Ray Assay Laboratories Limited, Don Mills, for 48 major and trace elements using X-ray fluorescence techniques. A program of small scale analyis of individual beds was initiated by Zentilli in 1983 and is continuing.

The 1980 exploration data represents the most complete data set applicable to all drill holes; analytical results from selected drill holes are presented in this paper. Preliminary results of the 1983, more detailed, geochemical analyses are outlined.

Two distinct groups of drill holes are noted. Holes 1, 2, 4-8, 12-25 and 27, forming the first group, each intersected a complete stratigraphic section with slate, calcareous quartzite and transition zone rocks. Some of the units may be in fault contact but extensive brecciation has not taken place. While individual beds contain distinctive amounts of particular elements, the most obvious partitioning is shown by Mn and Sr. Drill hole 13 (Fig. 2 and 18) is representative of the element distributions within this group of drill holes.

The second group of drill holes, all at the east end of the property, include holes 9-11, 26 and 28. In these holes, the contact of the Goldenville and Halifax Formations is a zone of intense faulting. The calcareous quartzite member is absent from the core and only parts of the transition zone occur in the section north and east of the fault (Fig. 12). Drill hole 9 is an example of these holes, in which the distribution of elements is not governed by rock lithology but is fault controlled.

For drill hole 13, representing the first group of drill holes with normal stratigraphic sequences, the Sr, Ba, Mn and Pb+Zn profiles are shown in Figure 18. At the base of the exposed stratigraphic section, the quartz metawacke unit of the Goldenville

Formation was not analysed in drill hole 13, but in drill hole 3 (Fig. 2) the quartz metawacke contains from 100 to 170 ppm Sr. In the overlying transition zone rocks in hole 13, Sr contents range from 40 to 80 ppm. The Sr levels in the rocks decrease to 20 to 50 ppm in the calcareous quartzite member and then increase rapidly across the contact of the Goldenville and Halifax Formations. Within the Halifax Formation, Sr content ranges from 200 to 400 ppm with a gradual decrease in levels from the base to the top of the section.

Mn trends are opposite to those of Sr. In the massive quartz metawacke in drill hole 3, Mn values range from 400 to 750 ppm. In the overlying transition zone the distribution of Mn is erratic, ranging from 1,000 to 4,000 ppm Mn. The calcareous quartzite member is markedly enriched in Mn with contents of 5,000 to 17,000 ppm or 0.5 to 1.7 per cent Mn. From these high contents the Mn values drop to 1,000 to 2,000 ppm in the overlying Halifax Formation. The Mn content of the rocks is slightly lower at the base of the formation, immediately above the calcareous quartzite member.

The 1983 analyses of rock powders show a major discrepancy in Mn levels between whole rock (XRF) date and acid extractable metal data. In drill hole 24, which was chosen for detailed analysis since it contains more than 150 m of the Meguma Group section, the Mn analyses by acid extraction are within 75 to 95 per cent of the whole rock (XRF) values for rocks in the transition zone and Halifax Formation. In the calcareous quartzite member, acid extraction accounts for only 10 to 35 per cent of the whole rock values; the 1983 analyses indicate Mn levels between 6.9 and 8.6 per cent. Analysis of individual beds in the calcareous quartzite has given values up to 13 per cent Mn. The level of Mn in the calcareous quartzite member of the Goldenville Formation has, therefore, been greatly underestimated in the exploration data.

The discrepancy between the analytical results has been resolved by microscopic examination and microprobe analysis. Jenner (1982) demonstrated that the average Mn content is 22.6 per cent in spessartine garnets in the calcareous quartzite member. Calcite grains in this member contain 1.0 to

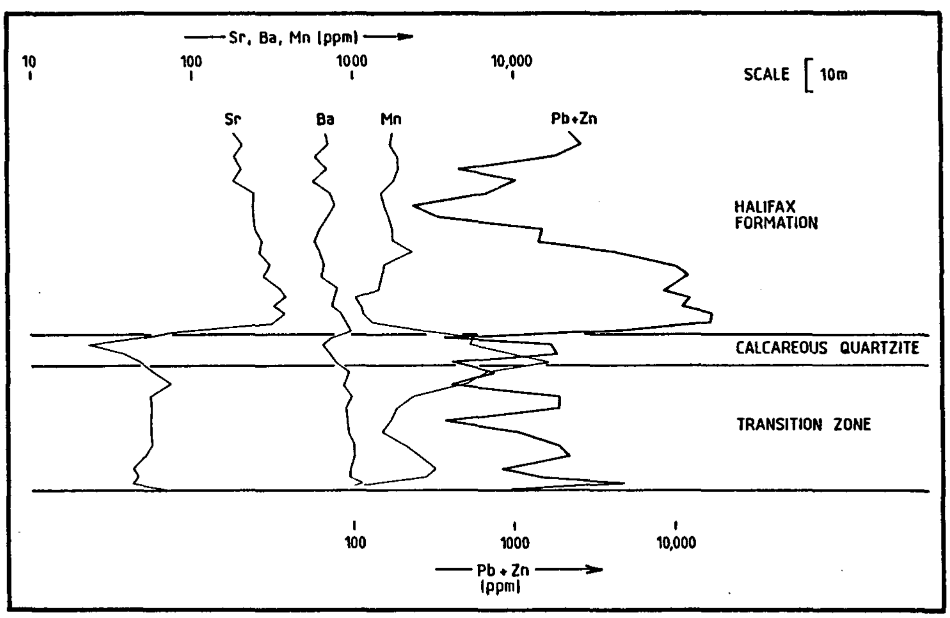

Figure 18 - Distribution of Sr, Ba, Mn and Pb+Zn in a typical stratigraphic succession of Meguma Group rocks (drill hole 13) (Fig. 2). Note that the scale for Pb+Zn data is offset by a factor of 10 for clarity. The drill hole is approximately perpendicular to the strata.

2.4 per cent Mn. In the overlying black slate of the Halifax Formation only 0.3 per cent Mn was detected in the graphitic slate but pyrrhotite-rich samples of slate contained up to 1.1 per cent Mn. Spessartine garnets in the slate beds immediately overlying the calcareous quartzite member contain an average of 17 per cent Mn.

The results indicate that most of the Mn in the calcareous quartzite member is contained in spessartine garnets which would be weakly attacked by an acid leach. The values in the transition zone (Goldenville Formation) and slate beds of the Halifax Formation are in close agreement for the two analytical methods and indicate that most Mn in these units occurs with pyrrhotite, other sulphides and perhaps calcite. Although garnets are abundant in all units, except in the calcareous quartzite and immediately overlying black slate, they are not necessarily spessartine garnets. The Mn distribution probably reflects the original composition of the sediments with the primary Mn concentration preserved in spessartine garnets, as it also is in association with other metamorphosed stratabound base metal deposits (Stumpfl, 1979).

Ba contents show only minor variation between lithologies of the Meguma Group. The content of Ba in the massive quartz metawacke of the Goldenville Formation ranges from 600 to 800 ppm (drill hole 3). In drill hole 13 the transition zone contains 900 to 1,000 ppm Ba. The levels are slightly depressed in the calcareous quartzite member, with 600 to 800 ppm Ba, but rise again at the base of the Halifax Formation. The Ba content of the Halifax Formation ranges from 600 to 1,000 ppm with the higher values toward the base of the section (Fig. 18). If Ba distribution is primary, and has not been affected by regional metamorphism, then the Ba content of the rocks appears related to lithology and independent of the base metal distribution.

In contrast to Sr, Mn and Ba, the total amount of Pb+Zn is highly variable both within and between units. In drill hole 13 (Fig. 18) the combined Pb+Zn content ranges from 240 ppm up to 18,000 ppm or 1.8 per cent. Higher values occur in a thin slate bed at the base of the transition zone and in black slate beds at the base of the Halifax Formation. The distribution of Pb+Zn is completely independent of that of Sr, Mn and Ba. Figure 7 indicates some of the local variation in the stratigraphic position of higher grade sections between adjacent drill holes.

The variation in the ratio of Pb/Zn with respect to the content of Mn and Fe for drill hole 13 is shown in triangular diagrams (Fig. 19 and 20). If Mn or Fe are related to the mineralizing process, then a variation in the Pb/Zn ratio might be expected with changing contents of Mn or Fe. In many exhalative Pb-Zn deposits the ratio of Pb/Zn increases closer to the exhalative vent of the ore solutions (Large, 1983; Franklin et al., 1981). On the Mn-Pb-Zn plot (Fig. 19) the ratio of Pb/Zn varies slightly due to possible post-depositional remobilization of Zn into fractures, enhancing the Zn content in some areas while depleting it in others. Despite this remobilization, the data clusters about a Pb/Zn ratio of 1:2.2 for all values of Mn and Fe (Fig. 19 and 20). This pattern of constant Pb/Zn ratios occurs in all drill holes of the first group with typical stratigraphic assemblages.

The detailed analytical work on drill holes 24 and 25 indicates some elements that do correlate with Pb and Zn (Fig. 21). In the transition zone Cd, Ag, Nb and Sb contents do correlate with those of Zn and Pb. In the Halifax Formation the Cd and Ag contents correlate strongly with Pb. In neither lithological unit are the major element distributions related to the Zn and Pb contents.

The element distributions for all drill holes with typical stratigraphic successions are similar to those described for drill hole 13. The levels of individual elements may differ by up to a factor of 10 but the pattern of element distribution between units remains constant.

In the second group of drill holes (9-11, 26, 28) (Fig. 3) the calcareous quartzite member, parts of the transition zone and an undetermined amount of the Halifax Formation are absent. The contact of the Goldenville and Halifax Formations is a zone of intense faulting. Additional areas of fault gouge occur within the Halifax Formation disrupting the stratigraphic succession. The element distribution patterns for drill hole 9 are illustrated in Figure 22. The distribution of Sr, Ba Mn and Pb+Zn is in marked contrast to the variations of elements by lithology observed in drill hole 13 (Fig. 18). Sr levels range from 100 to 150 ppm throughout the hole, except in the contact zone where only 50 ppm Sr is present. Mn content is more variable with 200 to 500 ppm in rocks of both formations and a peak of 1,300 ppm at the faulted contact of the Goldenville and Halifax Formations. Average Mn values are slightly higher in the quartz metawacke than in the slate-rich section. The absolute levels of Mn are about one-tenth those in the sections with typical, unfaulted stratigraphic sequences. This may reflect an analytical problem with most of the Mn in spessartine garnets which were not attacked by the acid extraction techniques used on these samples. Whole rock analyses have not been done on these faulted sections. Ba levels are between 650 and 900 ppm with a small peak of 1,450 ppm at the fault contact. Ba and Sr levels, unlike that of Mn, are of the same order to magnitude as in the drill holes of the first group.

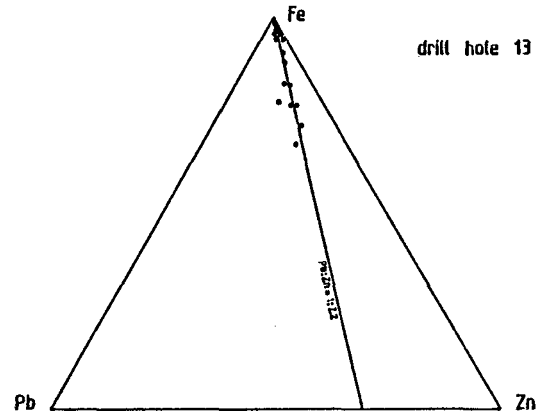

Figure 20 - Triangular plot of Fe-Pb-Zn for rocks of a typical stratigraphic succession (drill hole 13).

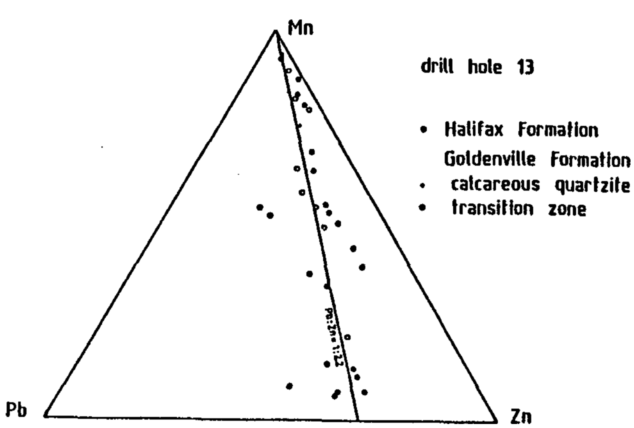

Figure 19 - Triangular plot of Mn-Pb-Zn for rocks of a typical stratigraphic succession (drill hole 13).

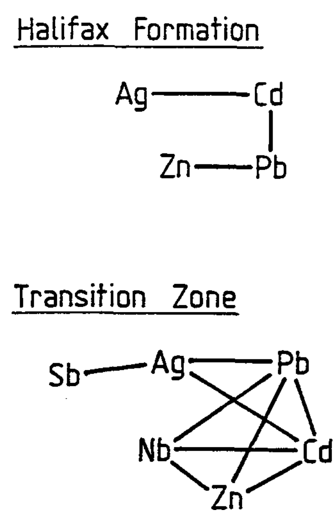

Figure 21 - Diagram showing those elements whose distributions correlate with those of Pb and Zn in rocks of the transition zone and Halifax Formation (drill holes 24 and 25) (Fig. 2).

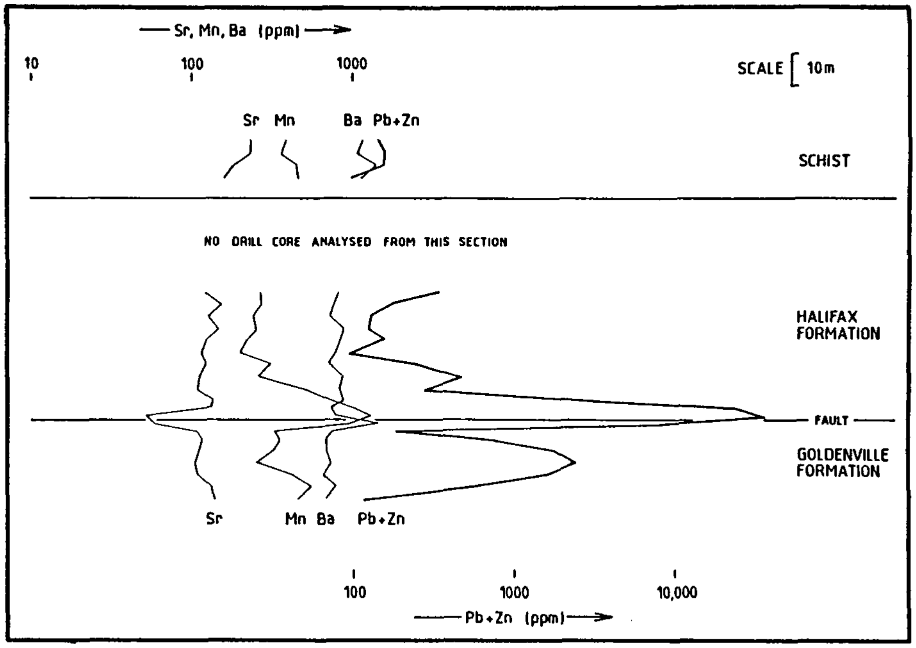

Figure 22 - Distribution of Sr, Ba, Mn and Pb+Zn in a section through the Meguma Group east of the thrust fault (Fig. 3) where the stratigraphic assemblage has been truncated by a fault at the contact of the Goldenville and Halifax Formations. Note that the scale for Pb+Zn data is offset by a factor of 10 for clarity. Drill hole 9 is plotted in reverse of the sequence drilled so that information is in the appropriate stratigraphic order. The drill hole cut the rocks at approximately a 45^{o} angle so that true stratigraphic thickness is not represented.

The distribution of Pb+Zn in drill hole 9 is also independent of other elements. In this drill hole Pb+Zn is in excess of 3 per cent at the faulted contact between the Goldenville and Halifax Formations. Although the highest grade section of Pb+Zn is in the Halifax Formation above the fault contact, a significant amount of Pb+Zn (0.2%) occurs in quartz metawacke with slaty interbeds below the fault. This weakly mineralized section is interpreted as correlative with part of the transition zone.

In the schistose rocks at the base of the drill hole, Sr, Ba and Mn contents are slightly elevated above the adjacent, less altered rock.

Triangular plots of Mn-Pb-Zn for two drill holes cutting the faulted Goldenville-Halifax contact are presented in Figures 23 and 24. In these drill holes Mn levels are relatively constant while variation in the Pb and Zn contents of the rocks defines the graphical relationship. Two patterns have been observed depending on the location of the drill holes. The western drill holes (11, 26; 28 not analysed) (Fig. 3) represented by drill hole 26 (Fig. 23) have two groupings of data. Samples from the Goldenville Formation, which is generally poorly mineralized, group about the Mn apex of the diagram. Mineralized areas of the Halifax Formation, although they contain the same amounts of Mn, plot in the Pb-Zn part of the diagram. All data are dispersed about a Pb/Zn ratio of 1:2.2, identical to the ratio for the drill holes in the typical undisturbed stratigraphic successions to the west of the thrust fault.

The two eastern drill holes (9, 10) (Fig. 3) are lower in Pb except in the mineralized sections. As in the other areas, the absolute Mn levels are constant and the variations of Mn-Pb-Zn contents are determined by variation in the relative amounts of Zn and Pb (Fig.

24). Data for both the Goldenville and Halifax Formations plot on the Mn-Zn side of the triangular diagram. Only two samples from the extreme base of the Halifax Formation plot on the Pb-Zn side of the diagram. These two samples are from a relatively well mineralized section where the combined zinc-lead grade is 3.10 per cent over 4 m.

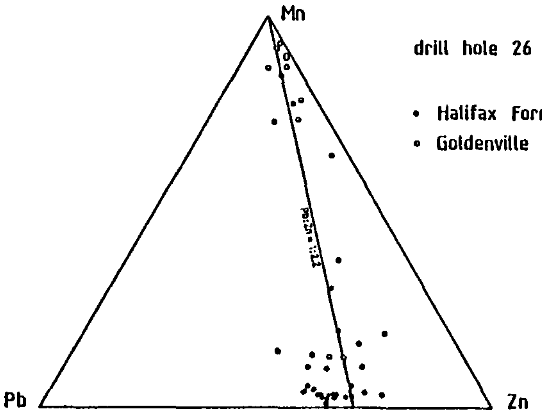

Figure 23 - Triangular plot of Mn-Pb-Zn for rocks of the faulted stratigraphic succession east of the thrust fault in drill hole 26.

In summary, element distribution patterns for two groups of drill holes have been described. In the first group, represented by hole 13, typical stratigraphic sections contain contents of Sr, Mn and to a lesser extent Ba, that are controlled by rock types. The calcareous quartzite member, a distinctive marker horizon at the top of the Goldenville Formation, is depleted in Sr but enriched in Mn with values up to 13 per cent Mn in individual beds. Zn and Pb are present in black slate beds immediately above the calcareous quartzite member and in slate beds within the transition zone. In the second group of drill holes, represented by hole 9, Sr, Mn and Ba values are relatively constant in all lithologies in faulted sections east of the thrust fault (Fig. 3). At the fault contact of the Goldenville and Halifax Formations Mn and Ba contents are higher and Sr is lower. Zn and Pb contents in excess of 1 per cent occur

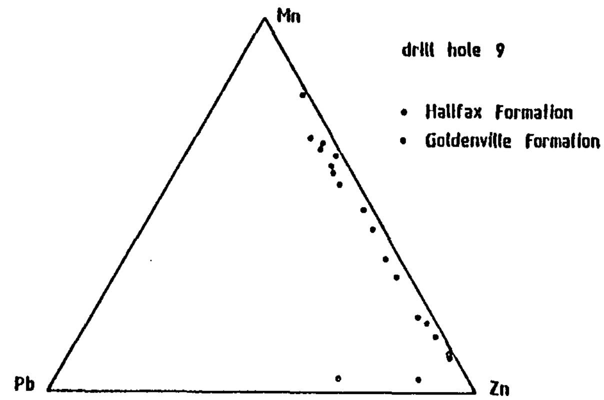

Figure 24 - Triangular plot of Mn-Pb-Zn for rocks of the faulted stratigraphic succession east of the thrust fault in drill hole 9. Note the depletion of Pb in most rocks in the section.

in the basal Halifax Formation, adjacent to the fault.

Triangular plots of Mn-Pb-Zn indicate a ratio of Pb/Zn of 1:2.2 in all drill holes with the exception of two holes (9, 10) in the extreme east end of the exposed contact area close to the granite intrusion. These latter holes are lower in Pb and do not have a regular ratio of Pb/Zn.

The rocks along the faulted contact of the Goldenville and Halifax Formations in the eastern area tend to be higher grade than those in the undisturbed sections to the west, although Mn levels are lower and no zoning of elements by lithology has been recognized. The lack of zoning suggests a pervasive alteration of the rocks east and north of the thrust fault with destruction of pre-existing element patterns. This alteration is not related to the granite intrusion since drill holes above the thrust fault, which contain schistose sections metamorphosed by the granite, retain typical element distributions.

DISCUSSION AND CONCLUSIONS

The metasedimentary rocks of the Meguma Group have been interpreted by Harris and Schenk (1975) and Schenk

(1978) as a eugeoclinal complex with abyssal plain, coalescing submarine fan and overlying continental rise deposits on a passive Atlantic-type continental margin.

The Goldenville Formation regionally includes the following rock types or their metamorphosed equivalents: massive sandstone, pebbly sandstone, conglomerate and minor interbedded black shale. The association of these rocks and the identification of sedimentary features such as flute casts, prod marks and dewatering structures indicates mid-fan deposition of turbidites in a submarine fan complex (Harris and Schenk, 1975; Walker, 1979). At Eastville, drill core has not proved adequate for a detailed sedimentological study of the Goldenville Formation. The general facies association of massive structureless quartz metawacke overlain by quartz metawacke and intercalated slate (transition zone) agrees with deposition in a mid-fan position with suprafan lobes of well-sorted sand and intervening shale between the lobes.

The Halifax Formation at Eastville, with its predominance of black slate containing plane-laminated to cross-bedded sandy turbidite interbeds, is interpreted as part of the outer fan and basin plain deposits. The black slate bed at the base of the Halifax Formation may represent a termination of supply of coarse sediment to a particular lobe of the submarine fan complex, a hiatus in supply of coarse detritus to the whole basin, or the development of a local sub-basin within the larger Meguma eugeocline.

The calcareous quartzite member of the Goldenville Formation contains calcite and a high content of manganese and does not readily fit the model of submarine fan deposition. The regional extent of the calcareous quartzite outside the Eastville area is unknown as the unit is thin relative to the entire stratigraphic succession and difficult to identify in outcrop. Except in the gold mining areas of Nova Scotia, subsurface exploration of the Meguma Group has been limited. The calcareous quartzite may represent a chemical precipitate in a local sub-basin within the more extensive Meguma basin. Further drilling of a regional nature is needed to establish the lateral extent of both the calcareous quartzite and the overlying black slate section of the Halifax Formation.

Many features, both sedimentological and metallogenic, bear on the genesis of the Eastville deposit. The deposit is laterally extensive with zinc+lead in excess of 1 per cent in drill holes over 10 km of strike length. The zinc and lead sulphides are stratigraphically restricted to rocks of the transition zone and calcareous quartzite members of the Goldenville Formation and the basal part of the Halifax Formation, about 100 m of section. No volcanic rocks have been recognized in the sequence which, as outlined, comprises mid-to outer-fan and basin plain turbidity current deposits and intercalated black slate.

Pyrrhotite and pyrite are the dominant sulphides in all lithologies. Rock lithology has determined their distribution, abundance and habit, and their distribution is independent of that of galena and sphalerite. Most iron sulphides probably formed by reduction of iron in the carbonaceous sediment as an early diagenetic process and were later deformed and metamorphosed.

Sphalerite, galena and minor chalcopyrite and arsenopyrite occur in conformable accumulations and in fractures due to possible post-depositional redistribution of sulphides. No barite has been observed in drill core and the continuity of the stratigraphic section indicates that no major accumulations of barite existed prior to regional metamorphism. The ratio of lead to zinc is constant both laterally and vertically throughout the deposit.

These features of the Eastville zinc-lead deposit all serve to class it as a sediment-hosted stratabound lead-zinc deposit as described by Morganti (1981) and Large (1983). The independent distribution of iron and zinc and lead, the grossly stratiform nature of the deposit and the affinity of base metal sulphides for graphitic black slate (shale) are similar to features of other stratiform lead-zinc deposits. Insufficient information about the stratigraphy in the environs of the deposit inhibits speculation on any underlying or marginal graben feeder structures to account for the input of metal-bearing brines into the basin. The lack of metal zonation throughout the deposit suggests a distal exhalative vent area for ore fluids.

In sediment-hosted lead-zinc deposits at Meggen, McArthur River and Tynagh, manganese is concentrated in carbonate rocks at the same stratigraphic level as the stratiform sulphides (Large, 1983). Zentilli et al. (1984) suggested that the manganese-enriched beds at the Goldenville-Halifax contact are associated with sphalerite and galena at Eastville. The calcareous quartzite member of the Goldenville Formation contains 6 to 9 per cent Mn versus background levels of 800 ppm (0.08 per cent) for slate and quartz metawacke in the Meguma Group (Liew, 1979). Although the calcareous quartzite member is enriched in manganese, most zinc and lead occurs either stratigraphically lower in the transition zone or in the overlying Halifax Formation. The manganese content of the calcareous quartzite member bears no relation to the lead and zinc grades or to the ratio of these metals.

Deposition of the sediments and zinc and lead sulphides was followed by metamorphic and structural events. The regional greenschist metamorphic assemblage consists of recrystallized quartz, biotite, chlorite and garnet. The high manganese content of the calcareous quartzite is reflected in spessartine garnets, ilmenite and calcite. During regional metamorphism pyrrhotite formed from pyrite in the carbonaceous sediments.

The Eastville area is on the north limb of a regional syncline. The Goldenville-Halifax contact at the east end of the deposit was faulted, and undeformed rocks from the southwest were thrust over underlying units. During this deformation and metamorphism some sulphides were redistributed into veins and fractures and elongate blebs parallel to cleavage.

After the main disturbance, the Meguma Group rocks at the east end of the map area were intruded by granite. Contact metamorphism of the Halifax Formation slate developed andalusite, garnet and biotite. Mineral segregation and schistosity developed in rocks in close proximity to the intrusion.

Late north-trending faults cut the rocks of the Meguma Group and offset earlier structures. Filling of post-orogenic Carboniferous basins with clastic sediments, marine carbonate and evaporites produced the Windsor Group which unconformably overlies the Meguma Group to the west of Eastville.

Exploration guidelines for zinc-lead deposits in the Meguma Group must be preliminary in nature as many features of the Eastville deposit are still poorly understood and undergoing further research. Stream and soil geochemical sampling can outline potential areas for zinc and lead sulphides. Acid groundwater caused by the abundance of iron sulphide in the Halifax Formation ,and the mobility of zinc in solution, result in removal of zinc from the immediate area and result in geochemical anomalies with lead more abundant than zinc close to the bedrock source. Zinc is twice as abundant as lead in the rock. Till sampling provides a direct indication of base metals in the underlying rock.

Exploration at Eastville has shown the importance of detailed correlation between drill holes. Individual quartz metawacke beds in the slate should correlate as turbidity current deposits are not laterally confined on the scale of drilling; the gross similarities between beds make such correlations difficult by visual means. The correlation could best be accomplished by geophysical logging of holes to determine the stratigraphic succession. Vertical gradiometric magnetic surveys can provide more detailed stratigraphic information (Waldron and Jenson, 1983) than the total field magnetic surveys and ground electromagnetic surveys used for stratigraphic information at Eastville. Detailed stratigraphic information permits a better assessment of any surficial geochemical anomalies as potential indicators of base metals. As an example, a high proportion of slate in the section may reflect a suitable depositional environment for zinc and lead. With detailed stratigraphic information the question of whether or not the deposit is truly conformable could also be addressed.

Regionally, the black graphitic slate can be a potential host for sphalerite and galena (Sangster, 1981). The presence of black slate does not indicate mineralization will be present, but, as demonstrated at Eastville, without the black slate significant accumulations of base metal sulphides will not be found. The manganese-enriched calcareous rocks may also be an important indicator of base metals (Zentilli et al., 1984). At Eastville no direct correlation exists between manganese and lead and zinc, but the area is enriched in these elements relative to other parts of the Meguma Group. The implications of this feature are being assessed by Zentilli with further work on the carbonate-manganese units both at Eastville and in other parts of the Meguma Group (Zentilli and MacInnis, 1983).

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