The Fors Prospect, a Proterozoic Sedimentary Exhalative Base Metal Deposit in Middle Aldridge Formation, Southeastern British Columbia (82G/5W).

James M. Britton,
B.C. Geological Survey Branch,
1810 Blanshard Street, Victoria, B.C. V8V 1X4

David L. Pighin,
Consolidated Ramrod Gold Corporation,
104-135 10th Avenue South, Cranbrook, B.C. V1C 2N1.

INTRODUCTION

The 1992 discovery of high-grade base and precious metal mineralization at the Fors property, 17 km SW of Cranbrook, rekindled interest in the Middle Proterozoic Aldridge Formation (Pritchard equivalent) and provides a new exploration target. Ag-Pb-Zn mineralization occurs at the top of a discordant zone of pebble wacke or "fragmental" in middle Aldridge sandstone and mudstone. Pyrrhotite, sphalerite, galena, arsenopyrite, pyrite, chalcopyrite, and bismuthinite occur in stratiform, semi-massive to massive lenses, as well as disseminations and veins. Scheelite is a local accessory. Gold values range up to 0.7 grams per metric ton; silver to 734 grams per metric ton. Best drill intersections were up to 25% combined Pb and Zn over 1 m. No tonnage estimates are available. The deposit is unusual in having extensive and varied alteration assemblages dominated by plagioclase, biotite, tourmaline, white mica, carbonate, tremolite-actinolite, talc and silica.

EXPLORATION HISTORY

Early in 1966 Helg Fors of Kimberley discovered lead-zinc mineralized float on logging roads near Moyie Lake. Subsequent prospecting by Cominco Ltd. discovered the Main showing, a small lens of bedded lead-zinc sulfides. Follow-up work from 1966 to 1983 included at least 5 shallow and 2 deeper diamond drill holes totalling 944 m (Webber, 1978a,b). No mineralization of economic interest was encountered and eventually the claims were allowed to lapse. The area was restaked and optioned to Placer Dome who explored the property in 1989 (Maheux, 1990).

In 1992 Kokanee Explorations (later Consolidated Ramrod Gold Corporation) commenced a diamond drill program on behalf of Chapleau and Barkhor Resources. Their first drill hole (F92-1), collared at the Main showing, intersected thin zones of disseminated to massive sulfide mineralization over a stratigraphic interval 42 m thick (Klewchuk, 1993). The highest grade intercept was 1 metre of massive sulfides with 9.35% lead, 16.4% zinc, 0.09% cadmium and 98 grams per metric ton silver (The Northern Miner, December 7, 1992). To date 12 holes (2440 m) have tested the extent of the 1992 discovery.

GEOLOGY OF THE FORS AREA

The Fors area is underlain by gently to moderately north to northeast dipping strata of the lower and middle divisions of the Aldridge Formation that have been intruded by three mafic sills (Figure 1). The deepest intrudes near the lower-middle Aldridge contact and is at least 250 metres thick. At its closest it is 350 metres below the top of the Fors deposit (Figure 2). The two other sills are above it.

The northeast striking Moyie fault (a reverse fault of regional significance) defines the southern limit of prospective ground. Minor northwest and west striking high-angle faults break the stratigraphic sequence into a mosaic of structurally homogeneous blocks. Deformation is mostly limited to gentle open folds. Near faults bedding can be deflected into the plane of the fault. Shearing and tight folding occur only along the Moyie fault zone (Hoy and Diakow, 1982).

Metamorphic grade is at most upper greenschist facies (Hoy, 1993), and is attributed to simple burial. Despite metamorphic effects primary sedimentary structures are very well preserved. Only where there has been intense hydrothermal alteration or deformation are they obliterated.

STRATIGRAPHY

The oldest rocks on the property are siltstones, quartzites and silty argillites of the lower Aldridge Formation. At Fors they crop out in a thin wedge along the Moyie fault (Figure 1) against which they have been folded. They are distinguished by rusty weathering, thin, planar bedding and coarse reddish biotite porphyroblasts that parallel bedding and grow at random angles to it. Near the top of this unit (at the stratigraphic equivalent of the Sullivan horizon), thickening to the NE away from the Fors deposit, is a concordant layer of pebble-wacke or "fragmental" up to 50 m thick (Figure 2).

Middle Aldridge consists of thick, monotonous sequences of mostly AE turbidites: fine-grained quartzofeldspathic sandstones (mostly wackes, some arenites), siltstones and argillites with variable amounts of biotite, white mica, pyrrhotite and pyrite. Coarse and fine units are commonly interbedded.

A pipe-shaped body of coarsely clastic material, referred to herein as a "discordant fragmental", occurs at depth (Figure 2). It consists of sand to pebble sized clasts of sandstone and siltstone in a silty to sandy matrix. Most clasts are subrounded to subangular and matrix supported. The unit is up to 100 metres in diameter and 300 meters high.

A sequence of nearly massive fine grained sediments 30 to 60 m thick was recognized by early workers near the Main showing. It consists of "intermixed quartzitic and argillaceous material with a zone of abundant pyrrhotite" in which "bedding is either lacking or obscure" (Gifford, 1966).

We interpret both the discordant fragmental and the massive unit as products of dewatering phenomena that channeled fluids upwards in response to increasing hydrostatic and lithostatic loads. Fluid pathways may have been localized by growth faults which could have provided the initial permeability. The clastic or massive fabrics result from either hydraulic milling of poorly consolidated sediments by upwelling fluids or venting a slurry of mud and sand onto the sea floor, forming a volcano-like edifice.

ALTERATION AND MINERALIZATION

The deposit and its associated alteration envelope are crudely mushroom shaped (Figure 2). Its stem consists of an alteration zone within and adjacent to the fragmental pipe; its cap comprises plagioclase-biotite, calc-silicate and mica alteration assemblages with disseminated to bedded sulfides. Both stem and cap are cut by a thick, late-stage, sulphide-rich vein.

Alteration can be grouped into the following main associations: 1) tourmaline; 2) plagioclase-biotite-garnet; 3) biotite; 4) calc-silicate; 5) sericite; and 6) silica. (N.B. Alteration types are described in terms of their present metamorphic mineralogy. "Actinolite altered" is not meant to imply that hydrothermal alteration produced actinolite. Rather this is the product of metamorphism of precursor minerals that formed during alteration.)

TOURMALINE alteration consists of partial to complete replacement of original sedimentary material by microscopic grains of tourmaline. Two types of tourmaline alteration occur at the Fors. The first and probably oldest is bedded black tourmaline (Fe-rich; schorl) that prefentially affects argillaceous layers. A model for this form of tourmaline alteration is that ascending boron rich hydrothermal solutions pass through coarser sediments to become trapped by less permeable clay rich strata, reacting with them to form bedded tourmalinite (Slack, 1993). Bedded tourmalinite is locally associated with white Mn-rich garnets (< 0.5 mm). The second type is light to dark brown (Mg-rich; dravite). It is mainly confined to the discordant fragmental in which both clasts and matrix are altered. Both types are locally associated with a little pyrrohtite, more rarely with arsenopyrite, sphalerite and galena.

PLAGIOCLASE-BIOTITE ± GARNET alteration ("Albitization") affects large volumes of rock, including part of the fragmental pipe and bedded sediments surrounding it. It appears to be assymetrically distributed around the pipe, skewed to the NE. It is pervasive and texture destructive, and results in an aphanitic to very finely granular mottled grey, white and pink rock. It occurs as veins, patches, hairline fractures and broad diffuse areas. Its contacts are sharp to gradational. Garnets in this zone are pale pink and up to 2 mm in diameter. Pyrrhotite is common in these areas, preferentially replacing biotite.

BIOTITE AND CALC-SILICATE alteration is mainly confined to the "cap" of the deposit. It consists of complexly interlayed, coarse-grained assemblages of micas (brown biotite and muscovite), amphiboles (actinolite and tremolite) and carbonate minerals (clacite and dolomite). Because these minerals form 100% of the rock it is thought that this zone may represent a hydrothermal vent area. The cap or vent horizon is crudely stratified with a nearly massive zone of actinolite at its base, a biotite rich zone in the middle and a thin magnesium-rich zone (talc-tremolite-dolomite) at the top.

Actinolite also occurs away from the calc-silicate cap. It always appears to replace biotite.

Sericite alteration occurs as a distal aureole around the other alteration assemblages at depth and above the bedded sulfide zone up to and including the Main showing. Locally it is texture destructive and pervasive but more commonly it is confined to bedding planes in porous, feldspathic units.

Silica alteration is mainly confined to strata immediately overlying the bedded sulfide horizon that overlies the calc-silicate alteration cap. Core is blue grey, hard, with a diffusely granular appearance. This alteration also occurs as thin envelopes around late stage quartz veins.

MINERALIZATION

Zones of nearly massive sulfides are rare. They occur in two forms: stratiform and vein. Thickest and highest grade drill intersections were encountered in F92-1.

Conformable massive sulfides consist of fine to coarse-grained pyrrhotite, sphalerite, and galena mineralization within a plagioclase-biotite-sericite envelope. The sulfides locally contain coarse (to 8 mm) clasts of transparent quartz and have a cataclastic fabric. Upper and lower contacts approximate bedding in the enclosing sediments. A maximum thickness of 2 m was intersected. The unit lies a few meters above the top of the calc-silicate alteration cap.

A semi-massive sulphide vein almost 2 m thick, with a calcite-quartz gangue, cuts an actinolite-rich alteration zone. The vein consists mainly of granular pyrrhotite rimmed by arsenopyrite with variable amounts of sphalerite and galena and accessory scheelite, chalcopyrite and bismuthinite. One assay returned 734 grams per metric ton Ag, 16.7% Pb, and 5.40% Zn over 0.3 m.

Low grade zones of sulfides are quite widespread. They consist of disseminations, stringers, veins, small semi-massive to massive stratiform lenses and irregular patches of mainly pyrrhotite, with subordinate amounts of sphalerite, galena, pyrite, and rare arsenopyrite and chalcopyrite and bismuthinite.

DEPOSIT MODEL

A simplified genetic model for the Fors deposit is as follows:

1) pelagic, turbidite sedimentation with entrained organics and iron in a fault controlled graben or half graben results in a thick sequence of poorly consolidated sediments.

2) development of a fragmental pipe which acts as a long-lived conduit for upward migration of fluids at least until the time of formation of the bedded sulfides above the calc-silicate zone and probably until after the formation of the

Main showing at surface. The upper limit of coarse fragmentals appears to lie just below the calc-silicate cap which may represent an exhalative vent deposit. The pipe may have formed in the hangingwall of a growth fault. Parallel and conjugate fractures related to this fault may have provided subsequent pathways for fluid migration.

3) tourmalinizing fluids ascend, preferentially travel along beds, but also change chemistry with time: most bedded tourmalinites are schorlitic (Fe rich); however much of the fragmental pipe is brown to pale brown, dravitic (Mg rich).

4) "albitizing" fluids ascend reacting with bedded tourmaline alteration locally but mainly spread laterally away from the pipe to the northeast.

5) potassium, iron and magnesium rich fluids deposit biotite (pale brown to bronze brown) in the main part of the vent horizon.

6) late carbonate rich fluids ("flooding") along parasitic or antithetic structures overprint biotite to produce actinolite assemblages and deposits of sulfides. Two pulses are possible: the first produced semi-massive to massive, locally stratiform Zn-Pb-Ag rich mineralization with a high base metal to iron ratio. The second pulse produced veins enriched in As, W, Ag and Bi, as well as Zn, Pb and Fe.

7) upwelling carbonate rich fluids mix with downward circulating seawater to produce Mg enriched assemblages including talc, tremolite, dolomite at the top of the alteration cap, and possibly the Mg rich tourmalinites found in the upper part of the fragmental pipe.

8) later fluids yield sericite (-silica) alteration with minor sulfides that enrich the overlying sedimentary package and formed the Main showing.

9) heat and fluids for hydrothermal alteration and mineralization may have been provided by the intrusion of a thick mafic sill into wet sediments.

10) regional metamorphism creates present silicate mineralogy and redistributes some sulfides.

CONCLUSION

The Fors prospect is a well preserved example of a small, high-grade Pb-Zn-Ag sedimentary exhalative and vein deposit hosted in Middle Proterozoic Aldridge Formation. It is associated with an unusually strong alteration assemblage variously dominated by plagioclase, biotite, tourmaline, white mica, carbonate, tremolite-actinolite, talc and silica. It is a blind discovery that resulted from drill-testing a geological model of low-grade mineralization found at surface.

It provides a new exploration target in the Sullivan camp, having some similarities with the Sullivan deposit and some important differences. Similarities include the presence of such "Sullivan indicators" as bedded sulfides, fragmental units that locally carry sulfide-bearing and tourmalinized clasts, garnet porphyroblasts, and tourmaline and albite alteration. Differences are that it is located outside the Sullivan corridor, is stratigraphically higher, has unusual alteration assemblages, and has elevated silver, gold, tungsten and arsenic.

The deposit deserves further study and would make an excellent project for a graduate student interested in water-rock interactions. Very good core storage, logging and rock cutting facilities exist at the field office of Consolidated Ramrod Gold Corporation to support such work.

REFERENCES

Gifford, R.G. (1966): Report of Geological, Geochemical and Geophysical Surveys on the Helg Groups of Claims; B.C. Ministry of Energy, Mines and Petroleum Resources, Assessment Report 834, 6 pages.

Hoy, T. (1993): Geology of the Purcell Supergroup in the Fernie West-half Map Area, Southeastern British Columbia; B.C. Ministry of Energy, Mines and Petroleum Resources, Bulletin 84, 157 pages.

Hoy, T. and Diakow L. (1982): Geology of the Moyie Lake Area; B.C. Ministry of Energy, Mines and Petroleum Resources, Preliminary Map No. 49, scale 1:50,000.

Klewchuk, P. (1993): Assessment Report on Two Diamond Drill Holes (F92-2 & 3), Fors Property; B.C. Ministry of Energy, Mines and Petroleum Resources, Assessment Report 22817, 11 pages.

Slack, J.F. (1993): Models for Tourmalinite Formation in the Middle Proterozoic Belt and Purcell Supergroups (Rocky Mountains) and their Exploration Significance; in Current Research, Part E, Geological Survey of Canada, Paper 93-1E, pages 33-40.

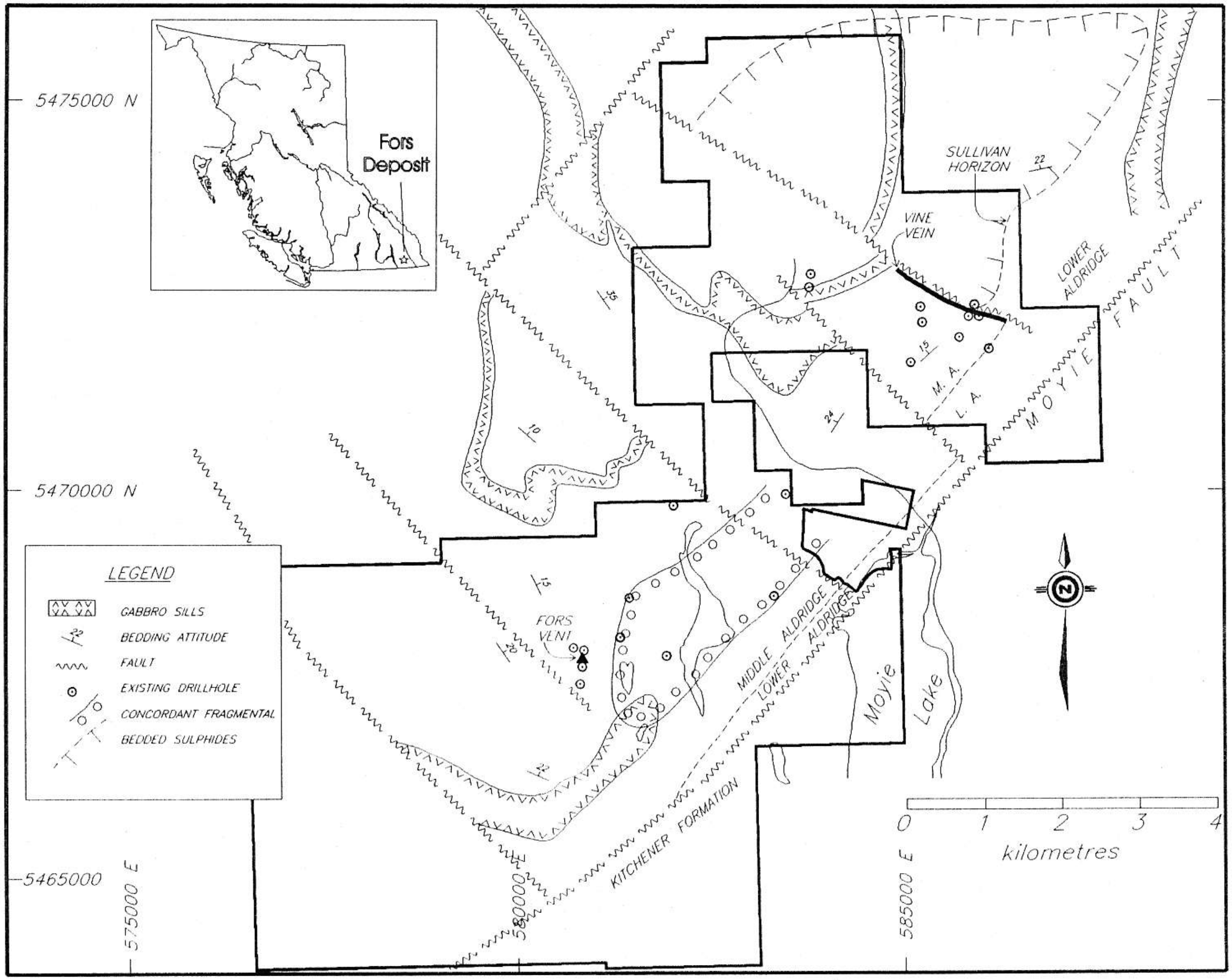
Webber, G.L. (1978a): Diamond Drilling Report, Vine No. 29 Claim, N.T.S. 82G/5, Fort Steele Mining Division; B.C. Ministry of Energy, Mines and Petroleum Resources, Assessment Report 6936, 5 pages.

Webber, G.L. (1978b): Geological Report, Vine Property 1978, N.T.S. 82G/5, Fort Steele Mining Division; B.C. Ministry of Energy, Mines and Petroleum Resources, Assessment Report 7087, 9 pages.

FIGURE CAPTIONS

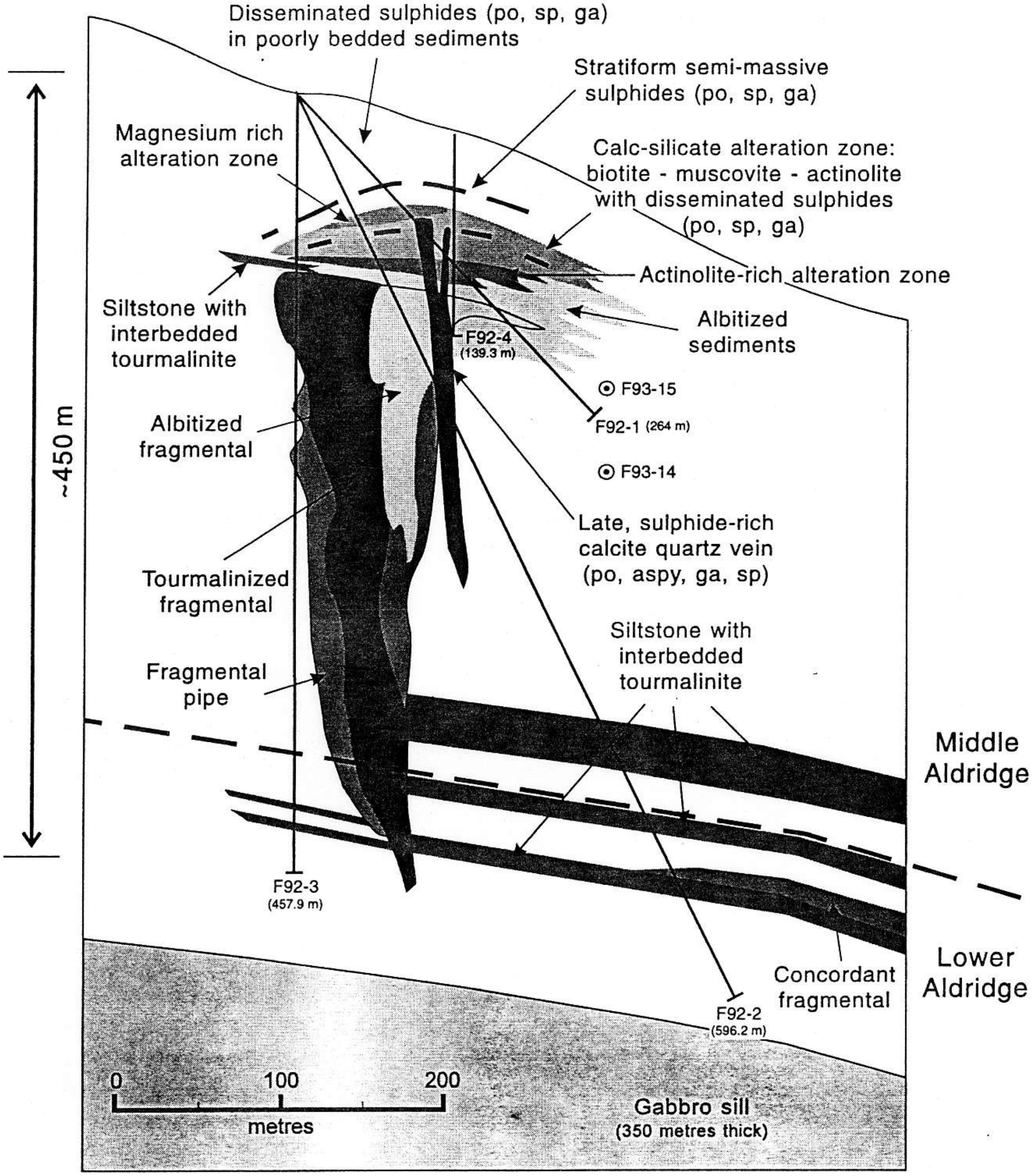
Figure 1. Geology of the Fors -Vine area] by Pat Stinson

Figure 2. Schematic NE-SW cross section of the Fors deposit] by Mike F.



Fors Deposit
5475000 N
5470000 N
5465000
575000 E
580000
585000 E
SULLIVAN HORIZON
VINE VEIN
LOWER ALDRIDGE
MOYIE FAULT
M. A.
L. A.
FORS VENT
MIDDLE ALDRIDGE
LOWER ALDRIDGE
KITCHENER FORMATION
Moyie Lake
0 1 2 3 4
kilometres
LEGEND
GABBRO SILLS
BEDDING ATTITUDE
FAULT
EXISTING DRILLHOLE
CONCORDANT FRAGMENTAL
BEDDED SULPHIDES

Fors Deposit Cross-Section



Modified from Consolidated Ramrod Gold Corporation.