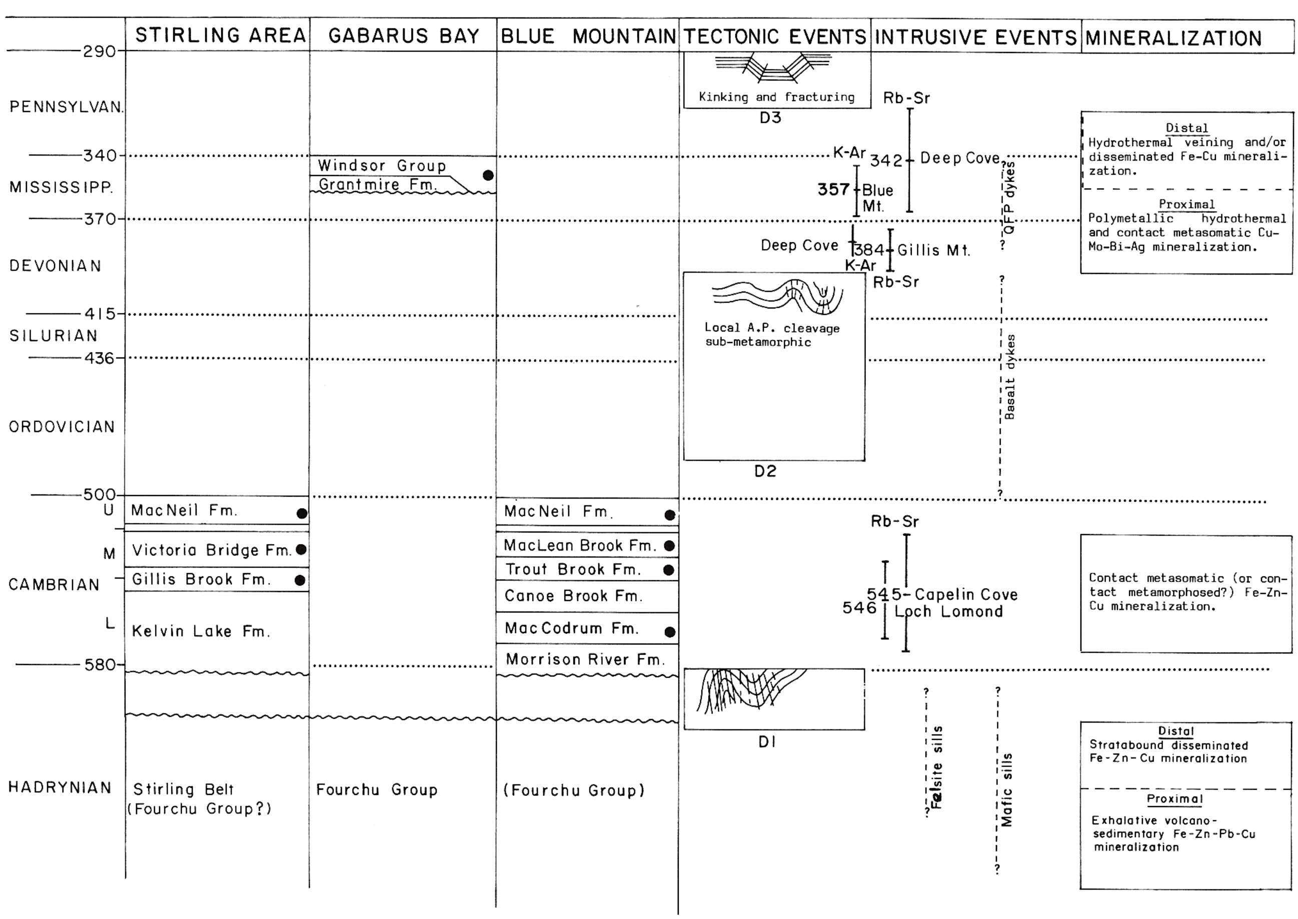
PART 4: SUMMARY AND CONCLUSIONS

Stratigraphic, structural and plutonic relationships within and between the areas studied are presented in Table 4-1. These suggest that much of southeastern Cape Breton Island has been affected by: (1) at least three periods of deformation involving folding, (2) at least two periods of granitoid intrusion and (3) at least four episodes of localized metallic sulphide mineralization.

The earliest and most intense tectonic deformation (D_1), which is associated with lower greenschist facies metamorphism, is found only in the Hadrynian(?) mainly volcanic and volcaniclastic rocks of the Fourchu and Stirling belts (believed to be approximate time-equivalent sequences). Direct evidence of the younger, less intense deformations having affected these rocks is generally sporadic and weak. The first period of granitoid intrusion into these rocks appears to have been syn-orogenic to late-orogenic, as represented by the foliated Capelin Cove intrusion and by the unfoliated Loch Lomond composite pluton respectively. Radiometric ages of both the Capelin Cove and Loch Lomond Plutons are, within error limits, principally Cambrian. Yet Lower Cambrian(?) conglomerates in the Stirling area contain distinctive

Table 4-1. Summary and comparison of geological relationships among the three areas studied.



cobbles almost certainly derived from the Loch Lomond Pluton. Therefore, either the intrusions are actually Precambrian in age or the unmetamorphosed clastic cover rocks in the Stirling area are indeed post-Cambrian in age as was originally proposed by Weeks (1954).

Two types of mineralization are associated with the Precambrian-Cambrian(?) crystalline rocks of the area and are apparently restricted to the rocks of the Stirling belt:

(1) exhalative volcano-sedimentary Fe-Zn-Pb-Cu mineralization within or at favourable stratigraphic sequences and interfaces and

(2) contact metasomatic or metamorphosed(?) Fe-Zn-Cu mineralization adjacent to the Loch Lomond Pluton.

Even without considering the Mindamar Zn-Pb-Cu deposit, the relatively common occurrence of stratabound pyritic (Fe-Zn-Cu) mineralization, carbonate precipitates and alteration, and epiclastic rocks within the Stirling belt suggests that the belt has a greater potential for exhalative syngenetic mineralization than the apparently time-equivalent Fourchu belt. In this regard, it is interesting to note that mean Cu and S values (Table 4-2) are consistently higher in volcanic and related intrusive rocks of the Stirling belt than in those of the Fourchu belt. Pyritic occurrences within the Stirling belt are also quite different in character from those within the Fourchu belt which are considered to be much younger epigenetic features.

The second type of pyritic (Fe-Zn-Cu) mineralization occurs locally within rocks of the Stirling belt adjacent to the Loch Lomond Pluton. The mineralization may be genetically related to the pluton, as it occurs within medium to high grade hornfelsed volcanic and volcaniclastic rocks forming a septum between granitic and dioritic phases of the pluton. However, it is also possible that it represents contact metamorphosed volcanogenic mineralization of the first type. Copper mineralization within the pluton itself has been reported from near Enon on the northwest side of the pluton (O'Reilly, 1976). Thus there may be some potential for hydrothermal, contact metasomatic mineralization where such plutons, of apparent Cambrian age, intrude favourable host rocks such as those of the Stirling belt.

The second period of folding (D_2) clearly affected the Cambrian sedimentary succession in the Blue Mountain area, and the sedimentary cover sequence in the Stirling area which has been tentatively assigned to the Lower Cambrian(?) Kelvin Lake Formation (Smith, 1978). Although a weak slaty cleavage is developed in folded pelitic units, this deformation apparently occurred at sub-metamorphic temperatures. While the age of the deformation is not precisely known, it definitely pre-dates intrusion of the Gillis Mountain Pluton (384 $\pm$ 10 Ma; Cormier, 1979) and contact metamorphism in the Blue Mountain area. It is therefore assumed to be of Acadian age, but could conceivably be Taconian.

The third episode of mineralization was intimately associated with intrusion of the small, high-level stocks and plutons of Devono-Carboniferous age, such as Deep Cove, Gillis Mountain and the presumably related body which must underlie the contact aureole at Blue Mountain. This mineralization is of a complex polymetallic type which occurs in two presumably related modes:

(1) in the granitoid rocks at Deep Cove and Gillis Mountain, as disseminated and

Table 4-2. Volcanic rock geochemistry: background values of Cu, Pb, Zn and S.

A. Volcanic Rocks

	MAFIC FLOWS			FELSIC FLOWS		
	Stirling 49-54% SiO_2 n=6	Fourchu 49-56% SiO_2 n=6	Calc-Alkaline Ranges*	Stirling 70-77% SiO_2 n=5	Fourchu 61-70% SiO_2 n=5	Calc-Alkaline Ranges*
	$\bar{x}$ s					
Cu	58 ± 43	26 ± 20	≈100 - 50	18 ± 24	4 ± 3	≈50 - 10
Pb	17 ± 21	9 ± 3	5 - 10	6 ± 4	20 ± 31	10 - 20
Zn	108 ± 52	108 ± 37	100 - 85	48 ± 16	103 ± 25	75 - 40
S	473 ± 701	240 ± 226	≈250	216 ± 211	72 ± 18	260 - 275

* Calc-alkaline ranges from Gribble (1969).

B. Mafic Sheets

	Stirling n=3	Fourchu n=1
	$\bar{x}$	
Cu	86	41
Pb	41	7
Zn	113	150
S	1640	80

vein material closely associated with moderate to intense alteration and

(2) in the country rocks within the contact aureoles at Deep Cove and Blue Mountain, as replacement, disseminated and vein material associated with hybrid metamorphic-metasomatic alteration.

Favourable host rocks for the more distal of these two modes of mineralization appear to be volcanic and volcaniclastic rocks of the Fourchu belt, and calcareous or pyritic horizons within black shales of the Lower to Middle Cambrian sequence. Potential obviously exists for other occurrences of similar mineralization within or adjacent to any other Devono-Carboniferous intrusions which may be identified. Donohoe (1980) has distinquished a number of small granitoid bodies within the Fourchu belt, some of which could be of Devono-Carboniferous age, and Smith (1978) has suggested the existence of several Devono -Carboniferous(?) stocks southwest of the Mira River, where they apparently intruded rocks of the Lower Cambrian(?) Kelvin Lake Formation.

The sporadic minor occurrences of Fe-Cu mineralization, forming vein- and shear-related fillings and disseminations within rocks of the Fourchu belt (e.g. Irish Brook and Gull Cove), although not obviously spatially associated with either Devono-Carboniferous intrusions or their aureoles, could represent dispersed distal mineralization of the same vintage. Certainly, crosscutting quartz-feldspar porphyry dykes, which petrographically resemble the Deep Cove intrusion, are not uncommon occurrences in the general area of Gabarus Bay. Of course, not all occurrences of pyrite within the Fourchu belt need be of this type, for example common pyrite porphyroblasts within chlorite metatuffs are demonstrably of regional metamorphic origin.

The third period of folding (D_3) is inferred from kink banding and related minor folding which sporadically affect all thinly laminated rocks of the Cambrian cover sequence and its Precambrian metamorphic infrastructure. While the actual age of this deformation has not been established, it is thought to have either accompanied or followed emplacement of the Devono-Carboniferous stocks and plutons. Equally uncertain is the age of the fourth episode of mineralization, except that it was synchronous with or post-dated deposition of Carboniferous strata. It is typically stratabound in nature and although the only known example within the study area is the MacIntyre Lake Cu occurrence in basal Windsor Group rocks, numerous stratabound occurrences of Cu, Pb and Zn in Carboniferous rocks are known from basins farther to the northwest (Kirkham, 1978; Lydon, 1978). While these occurrences have been generally regarded as low temperature syngenetic or diagenetic, some initial studies of geothermometry of stratabound deposits in Carboniferous rocks (Stewart, 1978; Scott, 1980) suggest that more elevated temperatures (up to 300° C?) may be involved, perhaps due to a late thermal event. Such an event could be indirectly related to the younger Devono-Carboniferous plutonism, the youngest radiometric age yet obtained in Cape Breton Island being 330 $\pm$ 23 Ma (Cormier, 1980). However, the potential for this type of mineralization within the study area appears limited due to the restricted distribution of Grantmire Formation and Windsor Group rocks.

COMPARISON OF THE FOURCHU AND STIRLING VOLCANIC BELTS

While there are a number of obvious similarities between the Fourchu and Stirling volcanic belts, some significant differences emerge when the rocks are compared petrologically and geochemically (Table 3-2).

The volcanic rocks of the Fourchu belt are apparently transitional between tholeiitic and calc-alkaline and have a wide compositional range. However, pyroclastic rocks predominate and much of the package appears to have been deposited under subaerial conditions, although minor amounts of epiclastic rocks within the sequence indicate that shallow-water depositional conditions also existed locally. Two suites of intrusive rocks, mafic and felsic, which are ubiquitously associated with the volcanic and pyroclastic rocks appear to be essentially comagmatic in origin and synchronous with the volcanism in their emplacement. The group as a whole, including the intrusive suites, is strongly and pervasively deformed and metamorphosed to lower greenschist facies.

The volcanic rocks of the Stirling belt, in contrast, are apparently uniformly calc-alkaline in character and distinctly bimodal in their compositions. Pyroclastic and volcanic rocks are present in approximately equal proportions. Extensive, locally thick accumulations of epiclastic wackes, siltstones and cherts and common local bodies of carbonate rock within the sequence indicate that depositional conditions were in large part subaqueous, although no pillowed lavas were positively identified. Only one suite of intrusive rocks appears to be intimately associated with the volcanic and other rocks. This is mafic in composition, but distinctly tholeiitic and hence dissimilar to the mafic flows so that contemporaneity cannot be assumed. The group as a whole, including the mafic intrusive suite, exhibits relatively inhomogeneous deformation, is metamorphosed only up to lowest greenschist facies (prehnite-pumpellyite subfacies of burial metamorphism may be present locally) and is extensively carbonatized. Some of the mafic flows resemble spilites.

Table 4-3. Comparison of the Stirling and Fourchu belts.

ROCK TYPE	%	Stirling Belt	%	Fourchu Belt
VOLCANIC ROCKS	30	Rhyodacite Andesite Basalt CALC-ALKALIC	20	Dacite Andesite Basalt THOLEIITIC TO CALC-ALKALIC
PYROCLASTIC ROCKS	50	Felsic lapilli tuff 25% Intermediate lapilli tuff 75% and ash Predominantly water-lain tuff?	70	Felsic tuff 25% Felsic-intermediste tuff 35% Intermediate-mafic tuff 40% Mainly debris flows and air-fall(?) tuff, minor ash-flows and crystal tuff
EPICLASTIC ROCKS	15	Chert, siltstone and thick volcanic wacke (graded bedding, scour and slump structures common).	5	Volcanic mudstone, siltstone, rare wacke (graded bedding, scour and slump structures)
ASSOCIATED INTRUSIVE ROCKS (FOLIATED)	5	Basalt sheets Dacite sills/sheets(?)	10	Andesite porphyry plugs(?) Dacite sills/sheets Basalt sills/sheets
STRUCTURE		i. S_1 schistosity of variable intensity ii. Sparse kink bands and related folds, and several weak fracture cleavages		i. Penetrative S_1 schistosity ii. Sporadic wesk S_2 crenulation cleavsge iii. Several sets of kink bands and folds, snd related(?) fracture cleavsges
METAMORPHIC GRADE		Lowermost greenschist facies (transitional from prehnite-pumpellyite facies?) Extensive carbonatization		Lower greenschist facies (transitional between subfacies quartz-slbite-muscovite-chlorite and quartz-albite-epidote-biotite)
YOUNGER INTRUSIVE ROCKS (UNFOLIATED)		Quartz-feldspar and feldspar porphyry Granitoid dykes Basalt dykes(?)		Quartz-feldspar and feldspar porphyry dykes Basalt dykes Gabbro
SYNGENETIC MINERALIZATION		Volcanic exhalative Fe-Zn-Cu mineralization		None identified