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The Pre- Carboniferous rocks of the western Cobequid Hills, Avalon zone, Nova Scotia

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Article abstract

Pre-Carboniferous rocks of the western Cobequid Hills outcrop north of the Cobequid Fault, are cut by several major east-west faults, and are onlapped unconformably to the north by the Late Carboniferous Cumberland Group. The oldest rocks comprise the Late Hadrynian Jeffers Formation. In the south, this unit consists of mafic and felsic volcanic rocks, interbedded with mudstones and carbonates, that are overlain by turbidites. To the north, the Jeffers Formation consists of a thick sequence of felsic volcanogenic turbidites. This stratigraphic succession of volcanic rocks passing up into turbidites differs from some other Late Hadrynian Avalonian sequences In the predominance of sediiDentary rocks, but does resemble the Georgevllle Group of the Antigonish Highlands.

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The Silurian Wilson Brook Formation outcrops only at the extreme northern edge of the Cobequid Hills: it consists of fossiliferous fine-grained sandstones and shales which overlie thin rhyolites, basalts and red clastic sediments. This sequence is very similar to the lower part of the Arisaig Group north of the Antigonish Highlands to the east. It is overlain unconformably by the Devono-Carboniferous Fountain Lake Group of volcanic rocks and by Carboniferous sedimentary rocks which are significantly deformed only near the Cobequid Fault.

Carboniferous granite plutons appear spatially related to the Kirkhill and Cobequid Faults. They are in places foliated and contain abundant mafic sills and dykes that appear to reflect continuing motion on the Cobequid Fault during emplacement and cooling of the granites.

THE PRE-CARBONIFEROUS ROCKS OF THE WESTERN COBEQUID HILLS, AVALON ZONE, NOVA SCOTIA

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Mafic dykes and sills, and associated porphyritic rhyolite intrusions, intruded the Jeffers Formation prior to the formation of a regional flat-lying cleavage. The Late Hadrynian Jeffers Brook Pluton, which post-dates this cleavage, consists of diorite with marginal granitic phases that also occur as dyke-like intrusions beyond the main pluton. Several smaller intrusions petrographically similar to the Jeffers Brook Pluton also occur. At least two series of later dykes, probably pre-Silurian in age, cut the Jeffers Formation and the Late Hadrynian intrusions.

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Carboniferous granite plutons appear spatially related to the Kirkhill and Cobequid Faults. They are in places foliated and contain abundant mafic sills and dykes that appear to reflect continuing motion on the Cobequid Fault during emplacement and cooling of the granites.

Dans l'Ouest des Monts Cobequid, les roches précarbonifères affleurent au nord de la Faille de Cobequid, sont recoupées par plusieurs failles majeures de direction est-ouest et sont recouvertes en discordance, au nord, par le Groupe de Cumberland d'âge tardicarbonifère. Les roches les plus vieilles englobent la Formation de Jeffers du Tardihadrynien. Au sud, cette dernière se compose de volcanites mafiques et felsiques interlitées avec des mudstones et des carbonates, le tout couronné de turbidites. Vers le nord, la Formation de Jeffers renferme une puissante assise de turbidites volcanogènes felsiques. Cette succession stratigraphique de volcanites passant vers le haut à des turbidites diffère certes de quelques autres séquences tardihadryniennes avaloniennes par la prédominance, en son sein, de roches sédimentaires mais rappelle aussi le Groupe de Georgeville dans les Monts Antigonish.

La mise en place de dykes et filons-couches mafiques, ainsi que des intrusifs de rhyolite qui leur sont associés, eût lieu avant la formation d'un clivage régional horizontal. Le Pluton tardihadrynien de Jeffers Brook, qui est postérieur à ce clivage, est formé de diorite avec des phases granitiques marginales qui se présentent aussi au-delà du pluton principal sous forme d'intrusions ressemblant à des dykes. On rencontre aussi plusieurs intrusifs plus petits mais de pétrographie similaire au Pluton de Jeffers Brook. Au moins deux ensembles de dykes plus tardifs, probablement d'âge présilurien, recoupent la Formation de Jeffers et les intrusifs tardihadryniens.

On n'observe la Formation silurienne de Wilson Brook qu'à la lisière la plus au nord des Monts Cobequid: elle englobe des grès fins fossilifères et des argilites qui recouvrent, tous deux, de minces rhyolites, basaltes et sédiments clastiques rouges. Cette séquence rappelle fortement la partie inférieure du Groupe d'Arisaig au nord des Monts Antigonish plus à l'est. Elle est recouverte en discordance par le Groupe de volcanites dévono-carbonifères de Fountain Lake et par des roches sédimentaires carbonifères qui ne sont déformées de façon importante qu'auprès de la Faille de Cobequid.

Les plutons granitiques carbonifères semblent rattachés dans l'espace aux failles de Kirkhill et Cobequid. Ils sont foliés par endroits et contiennent d'abondants filons-couches et dykes mafiques qui semblent traduire le jeu continu de la Faille de Cobequid durant la mise en place et le refroidissement des granites.

[Traduit par le journal]

INTRODUCTION

Geological Setting

Late Proterozoic and Palaeozoic rocks outcrop north of the Cobequid Fault in the western Cobequid Hills (Fig. 1). The Cobequid Fault marks the southern boundary of the Avalon zone in western Nova Scotia, forming part of the Minas Geofracture of Keppie (1982). The principal rock units of the

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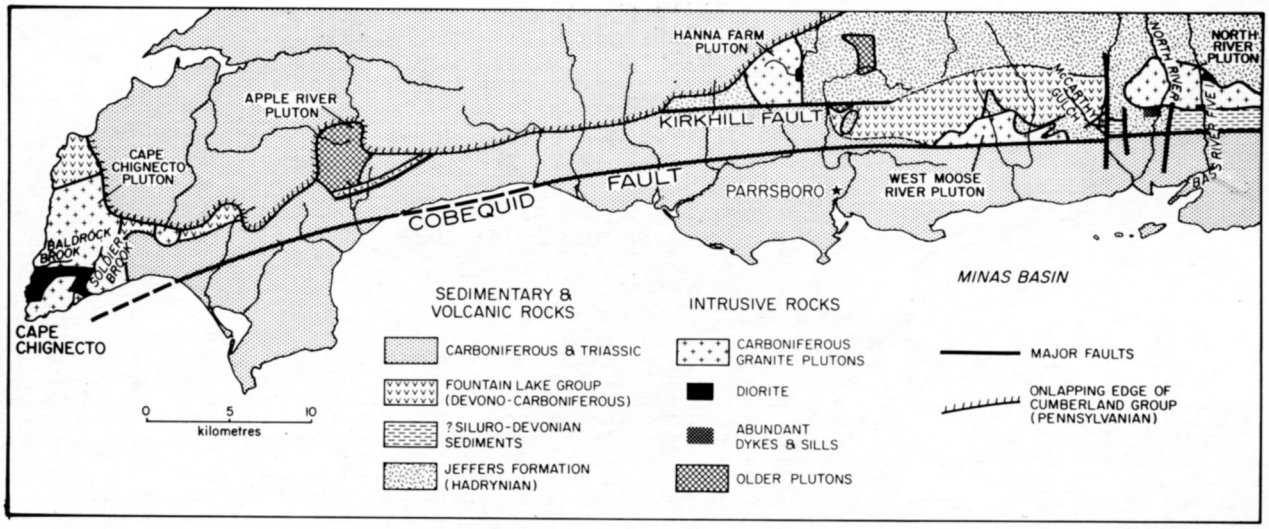

Fig. 1. General geological map of the western Cobequid Hills, based on Donohoe and Wallace (1982) and modified by our new mapping.

western part of the Cobequid Hills are the Hadrynian Jeffers Formation, Late Hadrynian intrusive rocks, sandstones and shales of the Silurian Wilson Brook Formation, basalts and rhyolites of the Devonian Fountain Lake Group, and a series of Carboniferous plutons (Fig. 1). Carboniferous sedimentary rocks onlap unconformably on the northern margin of the Cobequid Hills. South of the Cobequid Fault is a lowland region of Carboniferous and Triassic rocks.

The Cobequid Hills were mapped at a scale of 1:50,000 by Donohoe and Wallace (1982), who also established a general stratigraphic and structural history for the area. No pre-Jeffers Formation rocks outcrop in the western Cobequid Hills, although they are exposed further east in the Bass River and Mount Thom complexes (Cullen, 1984; Donohoe and Wallace, 1985). Donohoe and Wallace (1982, 1985) describe the Jeffers Formation as a series of quartz metawackes and volcanic metawackes, metasiltstone, mafic volcanic rocks and minor marbles. The Formation has a shallow to moderately dipping penetrative cleavage (S_1) which is parallel to the axial surfaces of inclined to recumbent isoclinal folds. Deformation was accompanied by regional metamorphism to the quartz-albite-muscovite-chlorite subfacies of the greenschist facies. The S_1 foliation is deformed by open to tight, upright to inclined folds (F_2). The Jeffers Brook pluton, dated as Late Hadrynian, cuts the S_1 foliation and appears to cut the F_2 folds (Donohoe and Wallace, 1980).

Purpose

The purpose of the work reported here was to remap the Jeffers Formation and associated rocks, in order to lithologically subdivide the Jeffers Formation and erect a stratigraphic sequence. The regional distribution of major faults has also been re-examined in order to understand the interrelation of different areas in which the Jeffers Formation outcrops. It was also necessary to define more clearly the age of both hypabyssal intrusions and plutons. This paper presents a preliminary report of our new geological data in the western Cobequid Hills, and a brief review of the implications of this data. A series of maps supporting the conclusions presented in this paper have been released (Pe-Piper and Piper, 1986). Our remapping of the area and detailed laboratory work is not yet completed and detailed petrologic and geochemical assessment of the igneous rocks is in preparation and will be reported elsewhere.

Structural Setting

Our mapping (Fig. 2) has shown a more prominent series of east-west fault zones than those recognised by Donohoe and Wallace (1982) in the western Cobequid Hills. The age and sense of movement on these faults has not yet been defined. From south to north, these faults are described below.

1. The Cobequid Fault, has a several hundred metre wide cataclastic zone, and associated penetrative foliation in some rocks up to 1 km from the fault. The fault cuts the Carboniferous Cape Chignecto and West Moose River plutons (Fig. 1).
2. The Kirkhill Fault is onlapped by Late Carboniferous Cumberland Group sedimentary rocks northwest of Parrsboro. Its westward continuation is uncertain, although it may mark the southern margin the Apple River pluton; it probably continues eastwards at least to the southern margin of the North River Pluton. It has a deformation zone similar in size to that of the Cobequid Fault. It appears to have experienced most of its strike slip motion prior to intrusion of the Carboniferous plutons.
3. A few kilometres north of the Kirkhill Fault, discontinuous east-west faults occur, notably north of Jeffers Brook and in the Harrington River area (Fig. 2). In the latter area the fault, together with the Kirkhill Fault and some north-south faults, appear to have had predominantly vertical motion in Devono-Carboniferous times, isolating individual outcrop areas of the Fountain Lake Group (H.V. Donohoe, pers. comm., 1986).
4. The contact between the Jeffers Formation and the Silurian Wilson Brook Formation in the area northeast of Parrsboro (Fig. 2) appears to be a

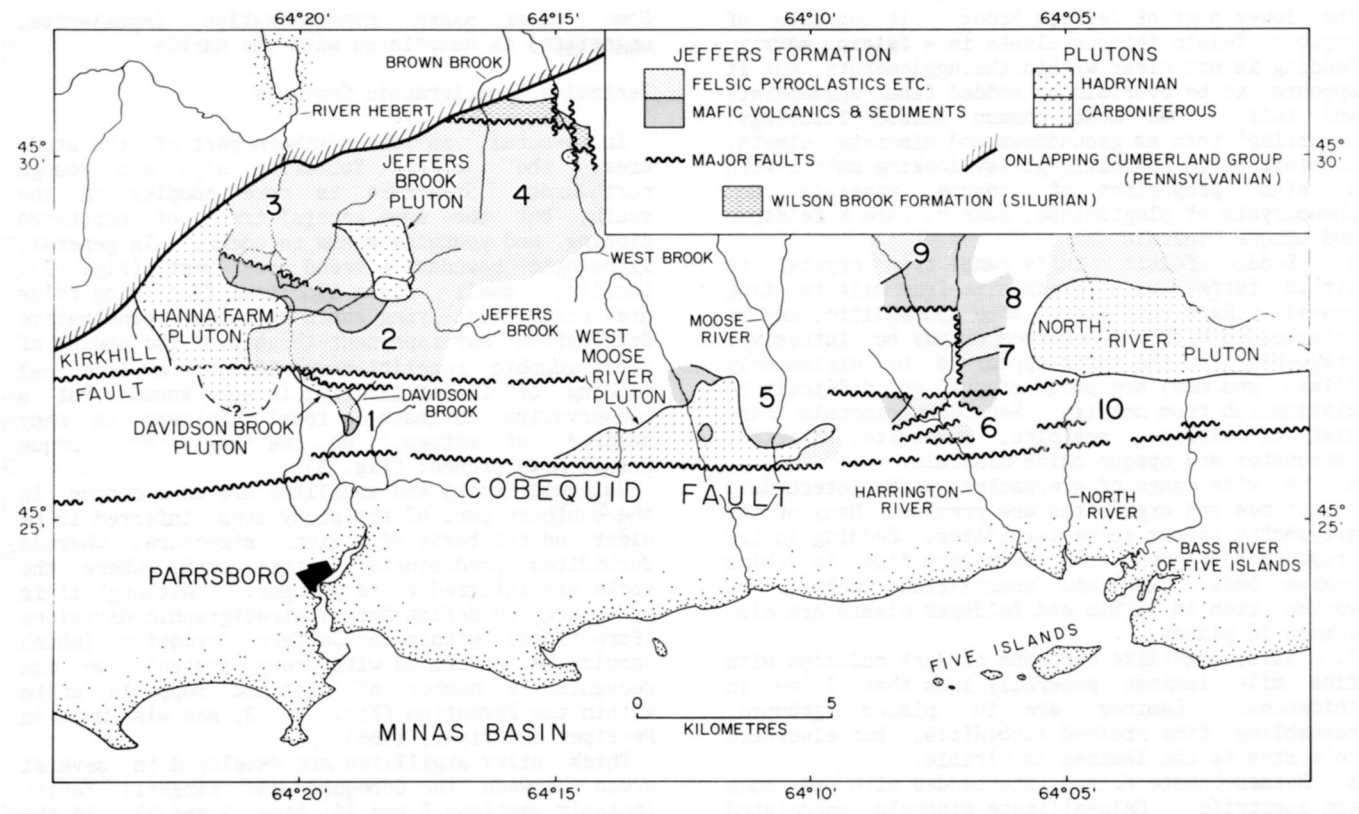

Fig. 2. Map of predominant lithologies in Jeffers Formation and plutons northwest of Parrsboro. Numbers indicate localities of sections in Fig. 3.

high angle east-west fault, here termed the Gilbert Mountain Fault.

These four major faults divide the area studied into a number of discrete blocks. If there has been major strike-slip motion along the Cobequid and Kirkhill Faults, these blocks may have had significantly different geological histories and must thus be considered separately.

JEFFERS FORMATION

Distribution

Between the Cobequid and Kirkhill Faults, most of the exposed rocks are of Devonian to Carboniferous age, and Jeffers Formation rocks are rare (Fig. 1, 2). Most of the area between the Cobequid and Gilbert Mountain faults consists of Jeffers Formation and younger intrusions, with minor inliers of Fountain Lake Group. Much of the northern part of this area was mapped as Silurian Wilson Brook Formation rhyolites and sedimentary rocks by Donohoe and Wallace (1982). These rocks are lithologically similar to rocks cut by the Jeffers Brook Pluton, have a flat-lying cleavage, and are lithologically quite distinct from the poorly lithified, fossiliferous Wilson Brook Formation: we have therefore interpreted these rocks as part of the Jeffers Formation.

Lithologies

The following principal lithologies have been mapped within the Jeffers Formation:

1. Massive mafic and intermediate flows consisting of fine to medium grained porphyritic rocks with or without vesicles. They show a variable degree of foliation. In thin section, the mafic rocks consist mostly of plagioclase, opaque minerals, and greenschist facies metamorphic mineral such as chlorite, sericite, epidote, actinolite, and quartz. Porphyritic and amygdaloidal textures are common and pilotaxitic texture occurs locally. Some rocks have sub-ophitic texture and include Ti-rich pinkish augite. The dacites are usually porphyritic with the hyalopilitic to pilotaxitic groundmass. Plagioclase is the most common phenocryst, but K-feldspar, quartz and opaque minerals also occur as phenocrysts. Secondary minerals in the groundmass include those noted in the mafic rocks, with the addition of rare biotite.
2. Bedded intermediate tuffs occur with a range of compositions from andesitic to rhyolitic, and variable grain sizes. They include both crystal and lithic tuffs. Clasts are commonly pseudomorphed and difficult to distinguish from matrix, which consists principally of chlorite, epidote and sericite.
3. Massive rhyolites occur both as isolated flows and as more extensive bodies that may represent rhyolite domes. In hand specimen they are grey to pinkish, and may appear glassy. They are usually fine to medium grained and most are porphyritic with quartz, plagioclase and K-feldspar phenocrysts. The groundmass consists of quartz, feldspare, sericite, and opaque minerals. Ignimbrites have been recognised locally.
4. Agglomerate occurs only in one large outcrop in

the lower part of Jeffers Brook. It consists of various felsic igneous clasts in a felsic matrix. Bedding is not clear within the agglomerate, but it appears to be overlain by bedded fine agglomerate and tuff. The most common felsic lithology, occurring both as groundmass and discrete clasts, consists of an aphanitic glassy-looking matrix with a high proportion of opaque minerals and phenocrysts of plagioclase, quartz, rare K feldspar and opaque minerals.

5. Bedded felsic tuffs range from crystal to lithic tuffs, with grain size from silt to fine gravel. Rare rhyolites, some spherulitic, may be interbedded with the sequence or may be intrusive. Fragments in the tuffs appear to be exclusively felsic and many are pseudomorphed and difficult to distinguish from matrix. Secondary minerals consist of chlorite, sericite, muscovite, biotite, carbonates and opaque oxide minerals.

6. A wide range of greywackes with interbedded siltstones and argillites are present. Many of the greywackes appear to be turbidites. Bedding in the greywackes ranges from thin very fine to thick coarse beds. Many are quartz-rich wackes, but wackes rich in lithic and feldspar clasts are also common in places.

7. Silty argillite consists of dark mudstone with fine silt laminae generally less than 1 mm in thickness. Laminae are in places grouped, resembling fine grained turbidites, but elsewhere no system to the laminae is visible.

8. Metacarbonate occurs interbedded with mudstones and quartzite. Calc-silicate minerals associated with thermal metamorphism are present, including garnet, clinopyroxene and epidote (Boner, 1985). Some minor skarn mineralisation (sphalerite, magnetite) is associated with the marble.

Tentative Stratigraphic Sequence

In general, in the northern part of the study area, the Jeffers Formation dips and youngs northwards. Structure is more complex in the south, but the same general trend of northward dipping and younging seems to occur. In general, lithologic boundaries trend east-west (Fig. 2). Locally, small scale isoclinal flat-lying folds are seen. Flat-lying zones of intense penetrative deformation may represent thrusts. The amount of stratigraphic repetition resulting from isoclinal folding or thrust faulting is not known, but a conservative estimate of total thickness is many hundred of metres, on the basis of unique lithologies present (Fig. 3).

Volcanic rocks and argillite are more common in the southern part of the study area, inferred to be older on the basis of regional structure, whereas turbidites predominate in the north, where the rocks are inferred to be younger. Although it is premature to define formal stratigraphic divisions (formations) within the Jeffers Formation (which should be redefined with Group status), we can recognise a number of distinct mappable units within the Formation (Fig. 2, 3; see also maps in Pe-Piper and Piper, 1986).

Thick silty argillites are developed in several areas between the Cobequid and Kirkhill Faults (notably sections 5 and 10, Figs. 2 and 3). In the Harrington River (section 8), silty argillite passes up into thick coarse greywackes, in turn

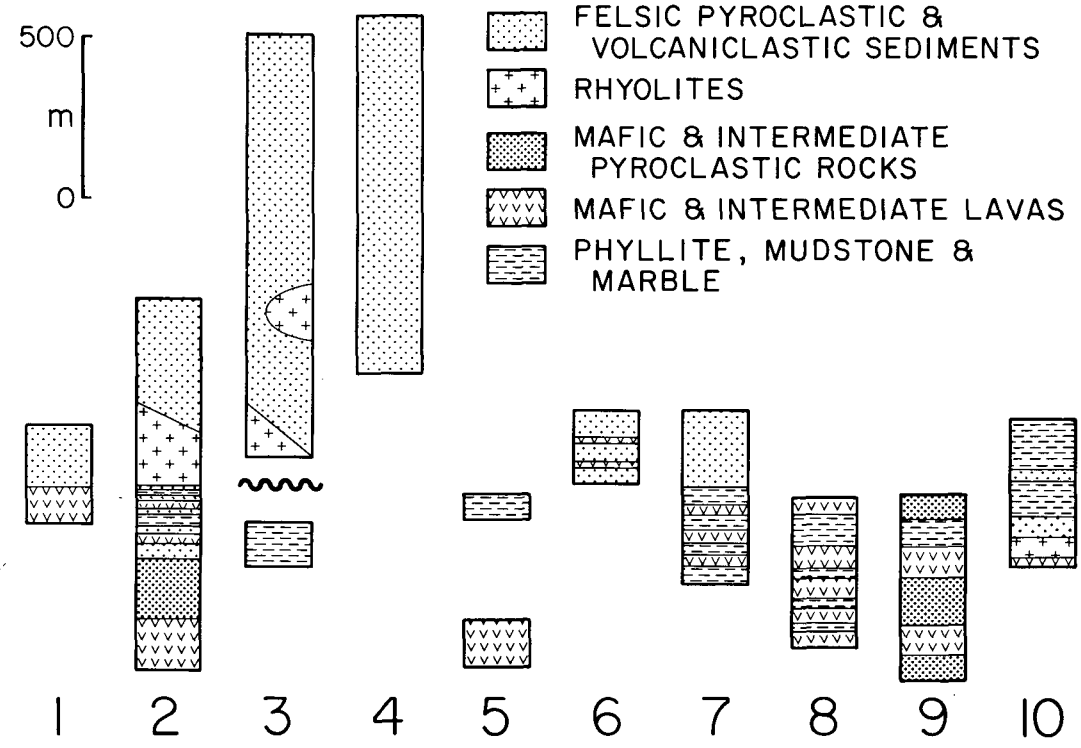

Fig. 3. Schematic stratigraphic sections for localities in Jeffers Formation shown in Fig. 2. Thicknesses are approximate, and assume only minor repetition of section by recumbent folding or thrust faulting.

overlain by intermediate tuffs and tuffaceous sandstones passing up into intermediate and mafic lavas. In the Lynn Road section (7), similar mafic lavas pass up into a thick turbidite sequence.

Thick greywacke sequences occur throughout the northern part of the Jeffers Formation; these include both fine grained thin bedded turbidite quartz wackes (e.g. section 4) and thickly bedded quartz wackes lacking distinctive turbidite features (e.g. section 3).

The Jeffers Brook type section (2 in Figs. 2 and 3) is cut by faults. Mafic lavas and intermediate and felsic tuffs are overlain by silty argillite, over which is thrust a sequence with thin tuffs at the base passing up into a thick sequence of mafic lavas, similar to that in Harrington River. The succession of agglomerate, felsic and intermediate tuffs and rhyolites in the lowest part of the brook is in fault contact with the main succession, and its stratigraphic position is not known.

The stratigraphic position of isolated successions south of the Kirkhill Fault, such as rhyolites in Davidson Brook (section 1); and rhyolite, mafic volcanic rocks and metacarbonate in southern North River (section 10) is also unknown. There are isolated occurrences of metacarbonate elsewhere in the area immediately north of the Cobequid Fault.

Pre-cleavage Hypabyssal Intrusions

Thick alkaline mafic sills and rare dykes, and feldspathic basaltic andesite sills, both cleaved, are common within the southern part of the Jeffers Formation outcrop area. Cleaved mafic dykes striking NE - SW, many of which pass into sills, and commonly associated with microgranite dykes, are also common in this southern area. Less abundant cleaved intrusions include a mafic porphyry with coarse plagioclase, and felsic dykes with prominent plagioclase phenocrysts.

Interpretation

The general style of the Jeffers Formation stratigraphy suggests intermittent volcanic activity in a marine basin. In most reasonably thick and continuous sections, volcanic rocks either overlie, interbed with or pass up into apparently marine sediments: turbidite sandstones, carbonates or silty argillites. The thickness and lack of pillows and hyaloclastites in some of the mafic volcanic rocks, and the presence of rare ignimbrites, indicates that at times this volcanicity was subaerial. No trace of basement to the volcanic sequence is seen, and in many sections the oldest rocks appear to be sedimentary rather than volcanic. Hypabyssal intrusions, which appear cleaved with the Jeffers Formation and are restricted to areas near volcanic lithologies within the Jeffers Formation, are interpreted as subvolcanic intrusions of Jeffers age.

LATE HADRYNIAN PLUTONS

The main Late Hadrynian pluton in the area is the Jeffers Brook Pluton, dated by K-Ar on hornblende at about 620 Ma (Table 1). This date is the basis for the inferred age of the Jeffers Formation and its flat-lying deformation. The pluton is an appinitic complex consisting of small gabbro and diorite bodies within the main quartz diorite pluton. It has an abrupt, steeply dipping, possibly faulted western margin. In contrast, the eastern margin has many marginal sills and dykes cutting country rock, including some hornblende pegmatites. On this eastern margin a 1 km wide thermal aureole is developed. In the finer lithologies of the country rock, biotite or spots now replaced by muscovite and quartz are develped. At the southeastern edge of the pluton a leucocratic granite appears to be a marginal phase of the pluton. It forms a dyke-like body beyond the main pluton. Similar dyke-like bodies also outcrop beyond the northeastern and northwes$rn margins of the pluton (Fig. 2).

The quartz diorite consists predominantly of plagioclase, with subordiante anhedral quartz and hornblende, and minor actinolite and biotite (generally partly altered to chlorite). The gabbro is sub-ophitic, with plagioclase and clinopyroxene, which is usually largely replaced by hornblende. Chlorite is also common. The dioritic phase consists predominantly of plagioclase and hornblende, with minor interstitial quartz and some actinolite and biotite.

Igneous bodies petrographically similar to the Jeffers Brook Pluton occur in a number of other areas. Hornblende diorite occurs within a cataclastic zone along the Kirkhill Fault northwest of Parrsboro. Abundant float may indicate a small granodiorite stock near West Brook (Fig. 2). The Davidson Brook Pluton, outcropping within and just south of the Kirkhill Fault zone southwest of the Jeffers Brook Pluton, is probably also of similar age, as it is petrographically distinct from the Carboniferous plutons. Parts of the Wyvern pluton, east of the area shown in Fig. 1, also petrographically resemble the Jeffers Brook Pluton.

LOWER PALEOZOIC SEDIMENTARY AND VOLCANIC UNITS

Probable Lower Paleozoic Hypabyssal Intrusions

In addition to the hypabyssal rocks that appear to be associated with the Jeffers Brook Pluton, a number of uncleaved hypabyssal intrusions cut the Jeffers Formation, but do not cut Silurian or younger rocks. They may thus be of Late Hadrynian or Lower Paleozoic age. There are at least two suites:

1. A series of wide, north-south striking mafic dykes, with ophitic texture and fresh clinopyroxenes. They are most common east of the Jeffers Brook Pluton and may cut the margin of the pluton.
2. A series of diabase dykes, many striking NW - SE, and some composite with microgranite margins. One such dyke cuts the Jeffers Brook Pluton.

Wilson Brook Formation (Silurian)

The Wilson Brook Formation outcrops in only a small area north of the Gilbert Mountain Fault (Fig. 2). It consists of fossiliferous shales and sandstones similar to the lower part of the Silurian Arisaig Group north of the Antigonish Highlands (Boucot *et al.*, 1974). Oolitic ironstone similar to that in the Doctor's Brook Formation at Arisaig has been found. In an area located

Table 1. Plutons of the Western Cobequid Hills

Pluton*	Lithology	Radiometric and other age data**
Jeffers Brook	Granodiorite, with lesser diorite, gabbro and granite	544+-22(b), 564+-22(b), 585+-23(b), 616+-28(h), 628+-28(h) (Donohoe and Wallace, 1982).
Davidson Brook	Biotite-bearing granodiorite, biotite-rich mafic diorite, minor gabbro (Blank, 1985)	Unknown (probably Hadrynian)
Cape Chignecto (Includes Soldier Brook diorite	Biotite-bearing granite (K-feldspar rich), with minor diorite	339+-22(Rw) (Donohoe and Wallace, 1982) 327+-11(b): new date)
Apple River	Leucocratic K-feldspar rich granite, with minor diorite, strongly foliated	Continuation of Cape Chignecto pluton (structural and petrographic similarity)
Hanna Farm	Biotite-bearing granite (K-feldspar rich) with minor diorite	Aureole 303+-11(b) (new data)
West Moose River	Biotite-bearing granite (K-feldspar rich), with minor diorite (Clerk, 1987)	Carboniferous by petrographic similarity
North River	Biotite-bearing granite (K-feldspar rich), with minor diorite (Boner, 1985)	Carboniferous by petrographic similarity

*Pluton names from Donohoe and Wallace (1982). Their Soldier Brook, New Yarmouth, and Fire Tower plutons are regarded as part of the Cape Chignecto pluton. Gilbert Mountain and Wyvern plutons have not been re-investigated in detail, but the former appears to be similar to Carboniferous plutons whereas the latter is probably Late Hadrynian. The "West Brook Pluton" of Donohoe and Wallace (1982) is a large dyke which may be a marginal phase of the Gilbert Mountain Pluton.

**Radiometric dates by potassium-argon on biotite(b) or hornblende(h), or whole-rock rubidium/strontium dating(Rw).

structurally near the base of the Wilson Brook Formation, basalt is interbedded with red siltstones, sandstones and conglomerate. Elsewhere, rhyolite is present near the base of the Formation overlain by a thin conglomerate. These volcanic rocks are correlated with the Dunn Point Formation of the Arisaig Group (Boucot *et al.*, 1974).

The Wilson Brook Formation is not cleaved, except near the Gilbert Mountain Fault at the base of the section at the contact with the Jeffers Formation. The rocks generally show a shallow dip to the north, except close to the faults marking the northern and southern limits of the Formation where dips steepen to almost vertical.

No work has been done on the Devono-Carboniferous Fountain Lake rhyolites and basalts, or the younger Carboniferous sedimentary rocks of the region as part of the present study (but see d'Orsay, 1986, and d'Orsay and van der Poll, 1985 for recent work).

CARBONIFEROUS PLUTONS

Description

A series of granitic plutons (Fig. 1) of probable Carboniferous age (Table 1) are associated with the Cobequid and Kirkhill Faults. They consist principally of biotite-hornblende granites with minor dioritic bodies. Their age assignment is based on radiometric data (Table 1) from the Cape Chignecto Pluton and the aureole of the Hanna Farm Pluton, and petrographic and geochemical similarity of the West Moose River and North River Plutons to the two dated plutons.

The plutons are all represented by a graphic granite phase and a minor dioritic phase. The granite is generally syenogranite in the IUGS classification. It is granophyric to varying degrees. The only mafic mineral is biotite. The diorites are medium grained with a sub-ophitic

texture typical of hypabyssal intrusions. The plagioclase is labradorite and the mafic phase is green hornblende. Brown magmatic biotite is also present in the Soldier Brook diorite. The rocks classify as diorite and gabbro in the IUGS classification. Lithologies mixed with the granites include monzonite and granodiorite.

Much of the Cape Chignecto Pluton is foliated and the southern part close to the Cobequid Fault is highly deformed. A series of thick diorite bodies (the "Soldier Brook Pluton" of Donohoe and Wallace, 1982) intrude the southern half of the pluton, although most observed contacts with the granite are tectonic. Similar diorites occur in the small Fire Tower and New Yarmouth and larger Apple River plutons, all of which are petrographically and structurally similar to the Cape Chignecto Pluton, and appear to be continuations of it. Later diabase and microgranite dykes cut both the granite and diorite, but are deformed along the Cobequid Fault.

The Hanna Farm Pluton has minor diorite bodies at its margin. It is cut by the Kirkhill Fault, but our mapping suggests there was little strike slip movement on the fault after emplacement of the pluton.

The West Moose River Pluton lies between the Cobequid and Kirkhill Faults. Diabase or gabbro sills are common in the southern part of the pluton; dykes are less common. Small diorite bodies occur at some margins of the pluton. Roof pendants of Jeffers Formation are common within the pluton. The southern margin of the pluton is deformed along the Cobequid Fault zone. Slithers of granite and diorite occur for up to 10 km east of the pluton along the Cobequid Fault.

The North River Pluton lies immediately north of the Kirkhill Fault, which is marked by a complex zone of porphyritic rhyolite and diabase dykes some 350 m wide. The North River Pluton has some marginal bodies of diorite, and is cut by many diabase dykes.

Interpretation

The Carboniferous plutons appear to be high-level on the basis of the presence of granophyric textures and the occurrence of roof pendants. Their intrusion appears spatially related to the Kirkhill and Cobequid Faults, and the abundance of mafic sills and dykes in the plutons (Fig. 1) may reflect continuing motion on the Cobequid Fault during emplacement and cooling of the plutons. The Variscan (mid-Carboniferous) tectonic event, which resulted in major thrusting in southern New Brunswick (Nance and Warner, 1986), deformed sedimentary rocks of Namurian age in the Cobequid Hills (Donohoe and Wallace, 1980) and is of approximately the same age as the radiometric dates for the Cape Chignecto Pluton. These dates may thus represent the development of the strong foliation, which by analogy with southern New Brunswick is interpreted as Variscan. The petrographic character of this pluton, however, is similar to that of the other Devono-Carboniferous plutons in the Cobequid Hills. The date for the Hanna Farm Pluton aureole is younger than this Variscan tectonic event; this young pluton, which appears little deformed by the Kirkhill Fault, may be correlative with the Pleasant Hills Pluton to the east (Donohoe and Wallace, 1982; Clarke *et al.*, 1980), which was intruded across the Rockland Brook Fault, and has been dated at 315 ± 25 Ma (Cormier, 1979).

CORRELATION WITH OTHER AVALON AREAS

The Jeffers Formation of the western Cobequid Hills differs from many Late Hadrynian Avalonian terranes in having only a thin sequence of volcanic rocks and a much greater thickness of sedimentary rocks of volcanic provenance. In this respect, it resembles the Georgeville Group of the Antigonish Highlands (Murphy and Keppie, this volume).

Rocks of the southern part of the western Cobequid Hills show similarities with the southern Antigonish Highlands, where the Keppock Formation includes both mafic and felsic volanic rocks overlain by silty argillite (Moose River Member). However, in the western Cobequid Hills there appears to be more of an alternation of volcanic with sedimentary rocks than has been observed in the southern Antigonish Highlands, although this might be a structural artefact. The metacarbonates in the western Cobequid Hills are similar to those of the Chisholm Brook Formation of the northern Antigonish Highlands (Murphy *et al.*, 1982; Murphy, 1984). The Jeffers Formation of the northern part of the western Cobequid Hills is a thick volcaniclastic turbidite sequence, which may be analagous to the upper part of the Georgeville Group. The Jeffers Brook Pluton and associated satellite intrusions form an appinitic suite similar to Late Hadrynian Greendale complex of the northern Antigonish Highlands.

CONCLUSIONS

The Late Hadrynian Jeffers Formation comprises a sequence of volcanic and interbedded sedimentary rocks overlain by a thick turbidite sequence. It was intruded by various hypabyssal intrusions prior to acquiring a regional flat-lying cleavage. This cleavage is cut by the Jeffers Brook dioritic pluton, which has been radiometrically dated as latest Hadrynian. The Jeffers Formation is similar in many respects to the Georgeville Group of the Antigonish Highlands, and the Jeffers Brook diorite resembles the Greendale complex.

The Silurian Wilson Brook resembles the Arisaig Group north of the Antigonish Highlands. It is less deformed than the Jeffers Formation, and has a very small areal extent.

Widespread Carboniferous plutons consist of biotite hornblende granites with minor diorite bodies. Petrographic and field evidence indicates that they are high-level intrusions perhaps associated with the Cobequid and Kirkhill Faults.

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