Keon

GEOLOGICAL ASSOCIATION OF CANADA - NEWFOUNDLAND SECTION

1982 FALL FIELD TRIP

BURGEO ROAD - PORT AU PORT PENINSULA

Leaders:

B.F. Kean
R.K. Herd
R.K. Stevens

BURGEO ROAD FIELD TRIP (ROUTE 480) - DAY 1

Assemble at Hotel Stephenville for 8:00 a.m. departure. Take new Stephenville access road (route 490) out of town to TCH (route 1), follow route 1 north to Burgeo Road (route 480), turn right onto route 480.

INTRODUCTION

The Burgeo Road field trip area lies in southwestern Newfoundland at the southern extremity of the Central Paleozoic Mobile Belt (Figure 1). It is a one-day traverse through rocks of the Humber and the Dunnage Zones in southwestern Newfoundland.

REGIONAL GEOLOGY

The field trip takes us across two of the tectonostratigraphic zones of the Newfoundland Appalachians, namely the Humber and Dunnage Zones (Williams, 1978, 1979). The Humber Zone underlies western Newfoundland and is interpreted as the ancient continental margin of eastern North America (Williams, 1978). It is defined as a complex zone of allochthonous ophiolitic and sedimentary rocks and authochthonous carbonate and clastic sequences underlain by a crystalline Grenvillian basement. In northern Newfoundland the eastern margin is drawn at the Baie Verte Line.

The Dunnage Zone underlies central Newfoundland and constitutes the axial region of the Central Mobile Belt. The Dunnage Zone is continuous from Notre Dame bay to the south coast of Newfoundland, although it is

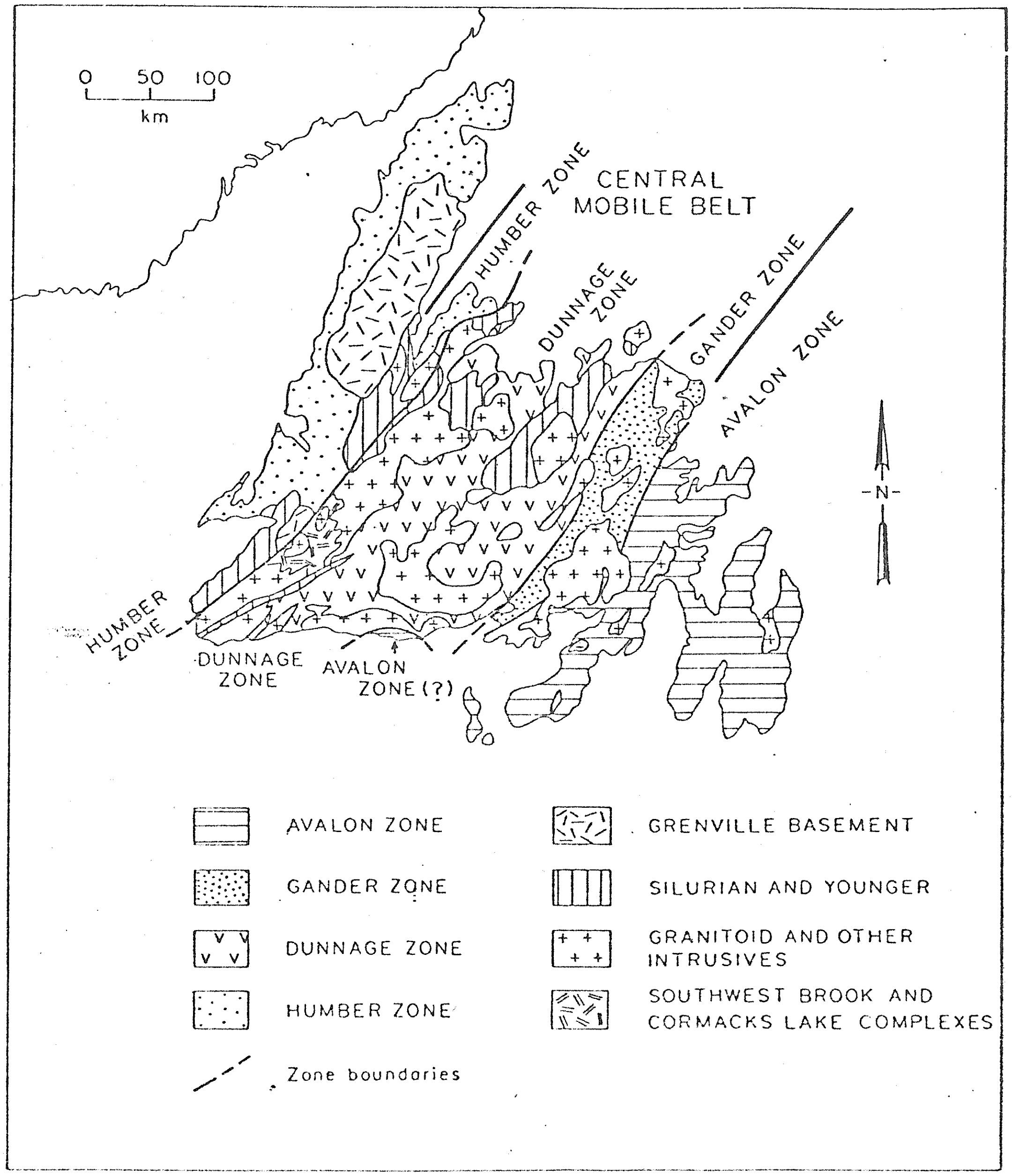

Figure 1: Tectonostratigraphic zones of the Newfoundland Appalachians

structurally and metamorphically more complex in southwestern Newfoundland. It is characterized by calc-alkaline island arc volcanic and associated marine sedimentary and epiclastic rocks resting upon parauthochthonous ophiolitic rocks.

The boundary between the Humber Zone and Dunnage Zone in southwestern Newfoundland is not well defined and may not be a sharp tectonic break as in northern Newfoundland. There appears to be a zone of mixing or gradation between what is demonstrably Humber Zone and what is Dunnage Zone. That is the area occupied by the Southwest Brook Complex (Figures 1, 2 and 3). However, for the purpose of this guide the Cabot Fault is considered the boundary between the two zones. This fault separates the Grenvillian age Steel Mountain Anorthosite of the Humber Zone from the Mid-Ordovician Southwest Brook Complex. The Southwest Brook Complex is a granodioritic to tonalitic complex with inclusions of mafic-intermediate plutonic rocks, ophiolite, paragneiss and rocks of the Cormacks Lake Complex. The Cormacks Lake Complex consists of paragneiss, amphibolite and deformed granite. It is characterized by a prominent northwesterly structural trend and is separated from the regionally northeasterly trending rocks by faults (e.g. Lloyd's River Fault) or younger intrusives (e.g. Lloyd's River Intrusive Suite). It is tentatively interpreted to be Grenvillian age.

The Dunnage Zone in this area is interpreted to be at least partially floored by ophiolites. The ophiolites occur as dismembered blocks within the Ordovician volcanics and as large inclusions floating in tonalite and granodiorite of the Southwest Brook Complex and its equivalents. U/Pb age determinations on trondhjemite intruding gabbro of the Annieopsquotch Ophiolite Complex yield ages of 475 ± 3 Ma and 483 ± 3 Ma (G. Dunning, personal communications, 1981).

The ophiolites are interpreted to be conformably overlain by the Middle Ordovician and older volcanic and sedimentary rocks of the Victoria Lake and Bay du Nord Groups. The original contact relationships are either fault modified or obscured by younger intrusive activity. Metasediments, metavolcanics and migmatites underlying a large part of southwestern Newfoundland are interpreted to be the metamorphic equivalents of the Bay du Nord Group and are included in that Group.

Deformed conglomerate of possible Silurian age (Rogerson Lake Conglomerate) locally unconformably overlies the Victoria Lake Group. The conglomerate forms a narrow, linear unit which extends for approximately 160 km to the northeast. It was probably deposited in shallow water along an old fault scarp.

Silurian(?) to Upper Lower Devonian red and gray sedimentary rocks and mafic and felsic volcanic rocks herein referred to the Windsor Point Group unconformably overlie the ophiolites, the Victoria Lake and Bay du Nord Groups, the Lloyd's River Intrusive Suite and the Boogie Lake Gabbro. The Group was deposited in fault-bounded troughs along a major splay of the Cape Ray Fault.

Intrusive rocks range in age from Grenvillian to Devonian and possibly Carboniferous and range in composition from anorthosite to granite.

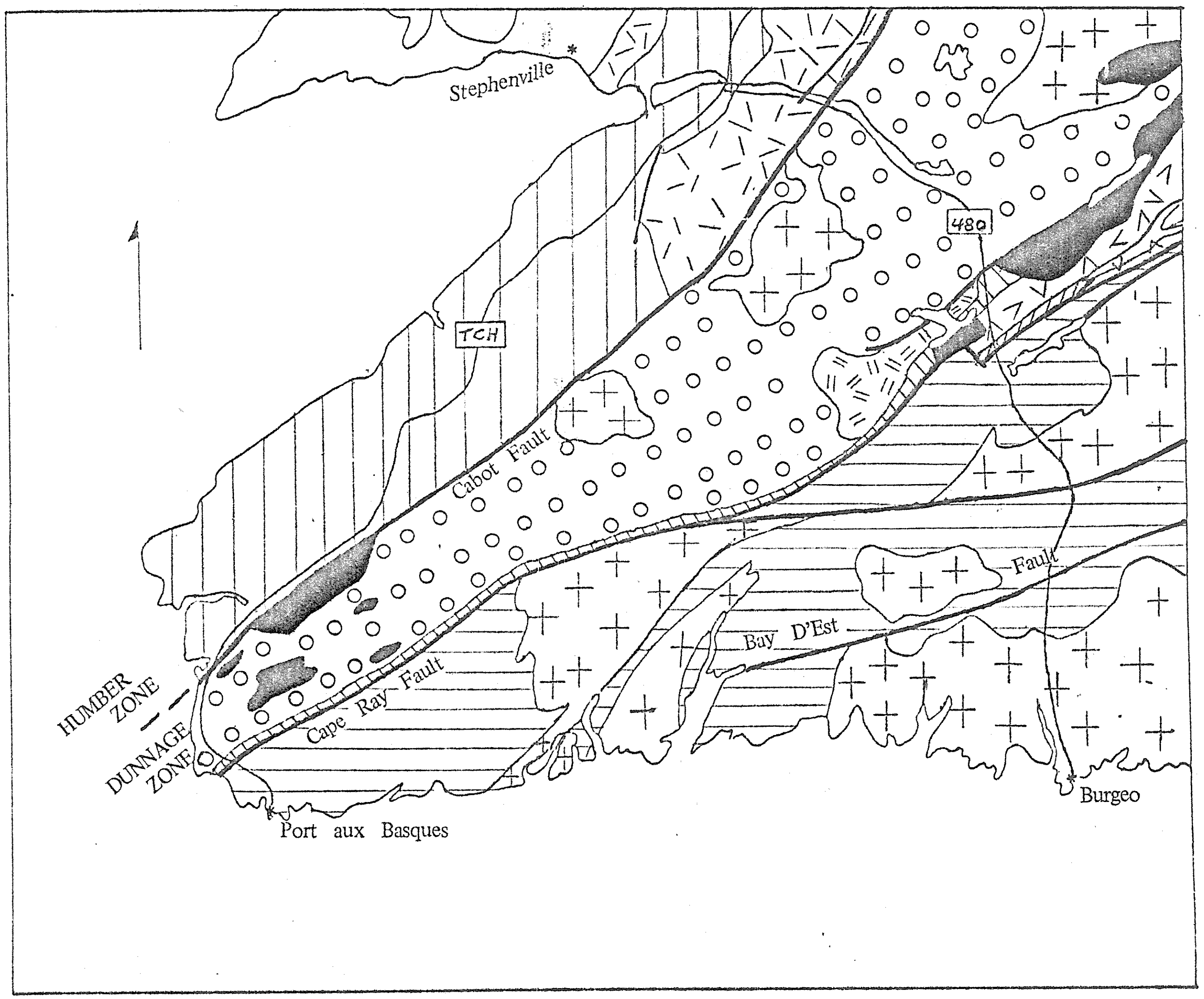

Figure 2: Generalized Geology of Southwestern Newfoundland

CARBONIFEROUS

ST. GEORGES CARBONIFEROUS BASIN

DEVONIAN

WINDSOR POINT GROUP

SILURIAN (?) - DEVONIAN

GRANITES

LLOYDS RIVER INTRUSIVE SUITE

ROGERSON LAKE CONGLOMERATE

ORDOVICIAN

BAY du NORD GROUP

VICTORIA LAKE GROUP

SOUTHWEST BROOK COMPLEX includes CORMACKS LAKE COMPLEX and unseparated granite, ophiolite and gneiss

OPHIOLITE includes ANNIEOPSQUOTCH and KING GEORGE IV LAKE OPHIOLITE COMPLEX

PRECAMBRIAN

INDIAN HEAD RANGE COMPLEX - STEEL MOUNTAIN ANORTHOSITE

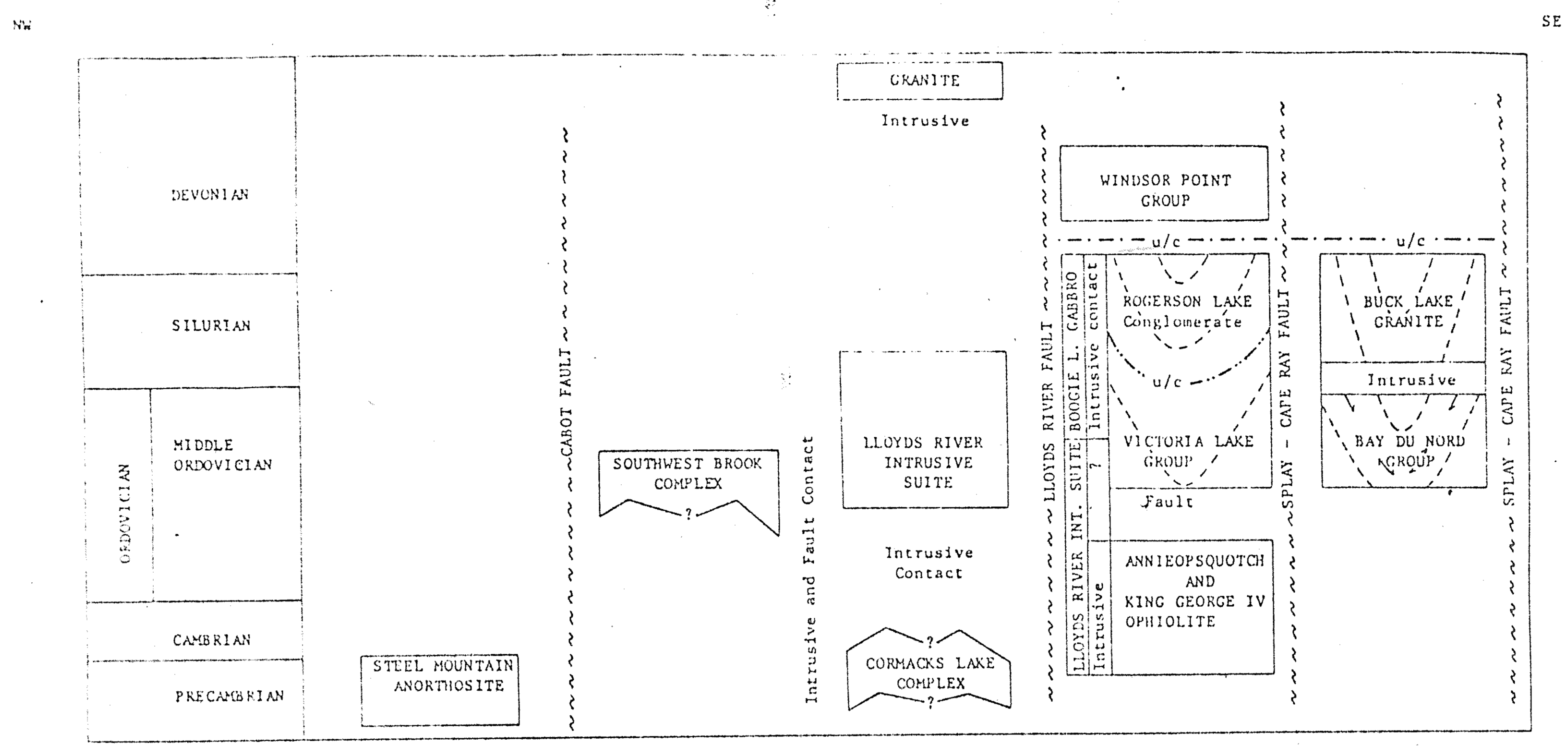

Figure 3: Schematic table of formations for the field trip area

A number of northeast trending faults transect the area, the most significant being the Cabot Fault, and the Cape Ray Fault and its splays, including the Lloyd's River Fault. The Cabot Fault juxtaposes rocks of the Grenvillian Steel Mountain Anorthosite and the Mid-Ordovician Southwest Brook Complex. The Cape Ray Fault system juxtaposes rocks of different lithology, structural complexity, metamorphic grade and, in places, age. The Lloyd's River Fault in the King George IV Lake area cuts the Lloyd's River Intrusive Suite and separates the northeasterly trending rocks to the south from the northwesterly trending Cormacks Lake Complex.

Part I: From the Trans-Canada Highway to the red bed quarry south of the Lloyds River (NTS 12B/9, 8; 12A/5, 4

by R.K. Herd

Introduction

During construction of the Burgeo road, beginning in 1977 and continuing to present, the Geological Survey of Canada conducted mapping of the bedrock geology of NTS 12A/5, the Puddle Pond map area through which Route 480 passes; also mapped were parts of adjacent map areas for continuity. This 1:50 000 scale mapping was to provide a basis for revision of the 1:250 000 scale map of 12A W/2 (Riley, 1957). The results of the GSC regional work to present are summarized in the following references: Herd, 1978; Herd & Dunning, 1979; Dunning & Herd, 1980; Dunning, 1981; Dunning, Carter & Best, 1982.

Prior to and during GSC mapping, information on immediately adjacent areas was available from mapping by B.F. Kean and others from the Mines Branch, Newfoundland (Kean, 1977, 1978, 1979). The geology of the King George IV Lake map area was investigated by Kean & Jayasinghe (1981) and that study constitutes the basis for the second part of this day's guide.

As a result of the regional work, several detailed studies were commenced on areas of particularly complex geology. Carew (1979) investigated a suite of mafic to intermediate hypabyssal igneous rocks on the boundary of the Main Gut (12G/8) and Puddle Pond map areas. Since 1979, G.R. Dunning (cf. op. cit.) has been investigating the geology of the Annieopsquotch ophiolite and related ophiolitic rocks as the basis for

Ph.D. study at MUN. Chandler (1982) and Best (1982) conducted field and laobratory studies on red beds and grey beds which postdate the ophiolites south of the Lloyds River. Detailed work on the southern lobe of the Topsails batholith, and its relationship to granites throughout the region, was commenced in 1981 (Whelan & Currie, 1982), and a series of M.Sc. and Ph.D. studies at MUN have been conducted on rocks in the Corner Brook and Glover Island areas (cf. Knapp, Kennedy & Martineau, 1979).

Many of these studies would not have achieved the results now seen, without the access provided by Route 480. Fresh rock cuts were available from 1977 onwards, and the road was widened after the original cuts were examined, providing a second slice through the geology. A network of forest access roads serving logging crews allows easier access to upland areas along the valley of Southwest Brook, as do numerous streams entering the valley.

The geology along Route 480 is complex; indeed it is difficult to understand the relationships exposed in the rock cuts without keeping the regional geology constantly in mind. The rocks are variably metamorphosed to high grade but preserve evidence of igneous parentage.

Only a few major units are exposed along the road, and one in particular, the agmatitic Southwest Brook complex, is the major feature from the Long Range (Cabot) Fault to the Lloyds valley - but being an agmatite it exposes a number of other units as inclusions in a grey granodiorite-tonalite matrix. All the stops described here are on Route 480, but several additional side trips ('A' and 'B' stops) are indicated where interested (and physically fit!) users of this guide may clamber out of the valley of Southwest Brook and onto upland areas which expose different map units. All units within the map area can be reached by this method of following stream valleys or bush roads up from Route 480, but seeing all units entails several such traverses, up and down, and the relief from the river valley to the plateau areas is at least 200 metres. There are no particularly difficult climbs, but mature forest on lower slopes is characterized by deadfall, and gives way to a dense fringe of tuckamore before the more open, boggy uplands are attained. Hikers onto the uplands are rewarded by views of the Annieopsquotch to the southeast, Blow-Me-Down and the Lewis Hills to the northwest, Glover Island to the north, and by alpine shrubs and flowers in abundance. Most users of Route 480 do not appreciate that the hilltops are bare along Southwest Brook valley.

Regional Geology

As work progressed, it has become evident that the geology of this region is key to understanding and relating much of the geology of western and central Newfoundland. Non-metamorphosed equivalents of the rocks can be sought elsewhere and protoliths identified.

Two major fault zones serve to separate major geological terranes in this region of southwest Newfoundland (Fig. 4):

1) The Long Range fault which runs from the southwest point of the island to Grand Lake and beyond, separates Precambrian anorthosite of the Steel Mountain massif to the west, from the terrane of the Southwest Brook complex and other grey gneiss/granite terranes to the southeast.

North of Port aux Basques, the granite-gneiss terrane is faulted against Carboniferous rocks of the Codroy basin, but any Carboniferous cover on the Steel Mountain anorthosite has apparently been removed.

2) The Cape Ray fault which runs northeasterly from Port aux Basques and probably splays into a series of faults in central Newfoundland, is expressed in a major fault along the Lloyds River valley. Northwest of this fault is the Southwest Brook complex, and southeast lies the Annieopsquotch ophiolite, volcanics of the central volcanic belt, and deformed granites and migmatites which belong to the Hermitage Flexure region. The Lloyds River fault contains mylonitized mafic to granitic rocks.

Both these faults will be crossed on this trip.

Figure 5, the Puddle Pond map area, shows further subdivisions of the regional geology. The least accessible area of the map is occupied by the Cormacks Lake complex, a distinctive high grade metamorphic assemblage of migmatized pelitic, amphibolitic and granitic rocks, in the southwest. This complex is probably of Grenvillian age, perhaps with both older and younger components. It possesses a coherence of straigraphhy and structure which are not seen in the Southwest Brook complex to the northeast; the two gneiss complexes are probably faulted against each other along Little Barachois Brook as indicated. A core region of the Cormacks Lake complex near the western border of the map area preserves granulite facies mineralogy in all rock types, with cordierite, garnet, hypersthene etc. depending on compositional variations. These assemblages are variably downgraded to the southeast. The occurrence of granulite grade rocks is rare in the Appalachians, and especially noteworthy here because granulite facies rocks are locally preserved within the agmatitic Southwest Brook complex, and may be traces of pre-existent old basement. Granulites also occur near Stephenville in the Precambrian Indian Head range.

The Southwest Brook complex is characterized by variably foliated granitoid rocks of granodiorite to tonalite composition, as matrix to an incredible variety of agmatized inclusions which are present from fist-sized and seen in outcrop, to rafts of mappable scale, identifiable regionally. Most of the inclusions are mafic-intermediate plutonic or hypabyssal igneous in origin, but north and south of Southwest Brook there occur terranes of migmatite with sillimanite-cordierite schists and gneisses. Among the inclusions of igneous rocks there are many reminiscent of ophiolitic gabbros, and southwest of Silver Pond a mass of harzburgite is found, associated with metagabbro and cut by both foliated tonalitic and massive pink granitoid rocks. Even engulfed in tonalite, the larger ophiolitic fragments preserve facing direction, and the distribution of fragments in the tonalites is also stratigraphically coherent.

The Annieopsquotch igneous complex (Fig. 5, 6, 7) is a prime example of a well-preserved ophiolite, and constitutes the major and most varied member of a belt of ophiolitic fragments found along the King George IV Lake - Red Indian Lake valley (Dunning, 1981; Dunning, Carter & Best, 1982). The Annieopsquotch ophiolite faces southeast and is complete from layered olivine-plagioclase cumulates, thought to represent MOHO lithologies, to mafic pillow lava and bedded chert which pass into overlying Victoria Lake group metavolcanic rocks. The sheeted dyke zone of the ophiolite is particularly extensive and well preserved, and is transitional downward into massive gabbro, and upward into pillow lava, some dykes actually budding and becoming pillowed. Coarser grained dykes are cut by finer grained mafic dykes, and both gabbro and mafic dykes are cut by plagiogranite; the latter bears sufficient zircon to allow age dating of the complex (see below). Along its margins, and in certain internal zones, the Annieopsquotch ophiolite is faulted and recrystallized to amphibolite, especially where there has been intrusion of later granite. Other low grade alterations are recognized. In general, the complex appears to have acted as a resistant block, the fault zone along its stratigraphic base in the Lloyds River valley coinciding with the regional splay from the Cape Ray fault.

Once lithologies and their deformed and metamorphosed equivalents are recognized in the immediate vicinity of the Annieopsquotch ophiolite, they can be recognized in various regions removed from the ophiolite, e.g. surrounded by tonalite/granodiorite within the Southwest Brook complex. Such recognition leads to the surprising conclusion, now supported by age dating, that the granites and gneisses of the Southwest Brook complex contain fragments of, and are younger than, the ophiolites, and are not just younger than the Cormacks Lake complex. The ophiolites being Cambro-Ordovician in age, the major grey gneiss complex of the Southwest Brook region and its equivalents, turn out to be Taconic, although previously dismissed as a mess of Precambrian rocks because of their complexity.

The Annieopsquotch ophiolite, the Southwest Brook complex, and the Cormacks Lake complex are all cut by later pink granite-granodiorite which may be only slightly foliated, although where it cuts the Cormacks, a quartz-rich variety seems to have endured three fold episodes. Along the northwest margin of the Annieopsquotch ophiolite, intrusion of granodiorite was accompanied by movement and foliated amphibolitic rocks developed. Chunks of amphibolite in mylonite in the Lloyds River valley are interpreted as fragments stoped from the margins of the ophiolite; the granodiorite can be seen cutting ophiolite in blocks near Route 480 (see Road Log). Within the Southwest Brook complex, several phases of late granodiorite and pegmatite intrusion are recognized, and regionally some of these pink dykes are accompanied by porphyry-type copper and molybdenum mineralization, which is present whether the tonalites are foliated or not. A few late diabase dykes have been recognized in the road cuts as well. To the northeast, it is worth noting that the margin of the Southwest Brook complex with the Star Lake ophiolite is an intrusive one, with massive to foliated granodiorite then intruding the Southwest Brook complex along its northern margin with the Topsails terrane (Dunning et al., 1982; J.B. Whalen, pers. comm., 1982).

Red beds of lithological similarity to those of the Springdale or Botwood Formations of north-central Newfoundland, are exposed in the valley of the Lloyds River and King George IV Lake. When first mapped they were postulated to be Devonian in age (Riley, 1957), then Carboniferous (DeGrace, 1974) and now it is recognized that there is both a red and grey sequence of sediments at least (Chandler, 1982; Best, 1982) of somewhat different provenance, with the grey beds overlying the red beds unconformably. Volcanic and ophiolitic as well as granitic debris are found in the red sequence, volcanic and granitic debris in the grey sequence. Best (1982) summarizes data for different provenance of the two sequences. Where the red bed sequence laps onto the Annieopsquotch ophiolite at its southwest end, sedimentological data indicate transport from southwest to northeast, and a red sandstone close to the unconformity contains 20% unaltered clinopyroxene and 30% basic platioclase, indicating the local mafic igneous rocks as source. Plant spores and megafossils from the grey sequence indicate Early Middle Devonian (Emsian) age and a zircon age from rhyolite within the red sequence will be available shortly. It is probable that the red sequence represents alluvial deposits under dry continental climate in the absence of land plants during the Silurian period. The grey sequence resembles meandering river deposits. Both sequences rest unconformably on the post-ophiolite granodiorites.

Physiographic features in Newfoundland were probably similar to those of today from the Silurian onwards; not only are Silurian-Devonian sediments preserved in long valleys, but also Carboniferous deposits, some being reported from the Lloyds River valley and other known near Buchans.

Lovers of the Pleistocene will note a number of exposures of glaciofluvial deposits along the Burgeo road, including an excellent example of folding during compaction (see Road Log). Also of interest is the identification of the site of the core of an ice mass, just south of the Annieopsquotch Mountains (D.R. Grant, pers. comm., 1982).

Geochronology and Regional Relationships

A programme of age dating has been undertaken in connection with the detailed studies in the region. G.R. Dunning of MUN has obtained zircon separates from ophiolitic rocks (plagiogranite phases) and from diorites and younger rhyolites. A zircon age of 483 ± 3 Ma has been obtained on plagiogranite from the Annieopsquotch ophiolite (Dunning et al., 1982). Search for palynomorphs and conodonts within the sedimentary sequence has generally been unsuccessful, except as noted above. A series of K-Ar ages on biotites and hornblendes from tonalites and dioritic rocks along Route 480 indicate cooling and uplift about 430-450 Ma. A preliminary look at zircon data from the same rocks confirms this general age range (G.R. Dunning, pers. comm., 1982) but there is also evidence of an older zircon component, as might be expected from the regional geology. O. van Breemen, GSC, has sampled the high grade rocks from within the Cormacks Lake complex and the Southwest Brook complex, and granites from the Topsails terrane, for zircon studies.

What are the equivalents of these complex rocks elsewhere in Newfoundland? With the exception of the red and grey sediments, the question may be difficult to answer, but clues have been gathered over the years of work.

First there are pelitic relics within the metasedimentary migmatites that occur north and south of Southwest Brook, reminiscent of Fleur de Lys material. The Cormacks Lake complex is similar in grade and lithologies to rocks in the Indian Head range, and the abundance of sulphides in some rusty horizons along with the metamorphic grade and gedrite-cordierite mineralogy are reminiscent of the Gull Pond area of central Newfoundland. Perhaps the rocks at Gullbridge are Precambrian? Correlations have already been drawn between ophiolitic fragments in the Southwest Brook complex, and the ophiolite masses, and it is very obvious now that the Southwest Brook complex, dominated by tonalitic and mafic-dioritic rocks, is equivalent to the Hungry mountain complex (Kean, 1979) and the Long Range gneiss (Brown, 1976; Chorlton, 1980, 1982), and to other amphibolitic-tonalitic slivers along the western margin of the central volcanic belt of Newfoundland. These gneisses cannot be basement to the ophiolites because they contain ophiolitic fragments and have a complex structural history post-ophiolite generation. Screens of these rocks occur within the margin of the Topsails terrane, which itself must have a history stretching back into the Ordovician. Thus we are looking at events in western Newfoundland that occurred during the Taconic orogeny, with little or no evidence for a strong Acadian event in the zone northwest of the Lloyds River valley/Cape Ray fault zone. If the sediments in the region of King George IV Lake are equivalent to the Windsor Point group to the southwest, then they have suffered less from later fault movements, although locally they dip steeply in blocks.

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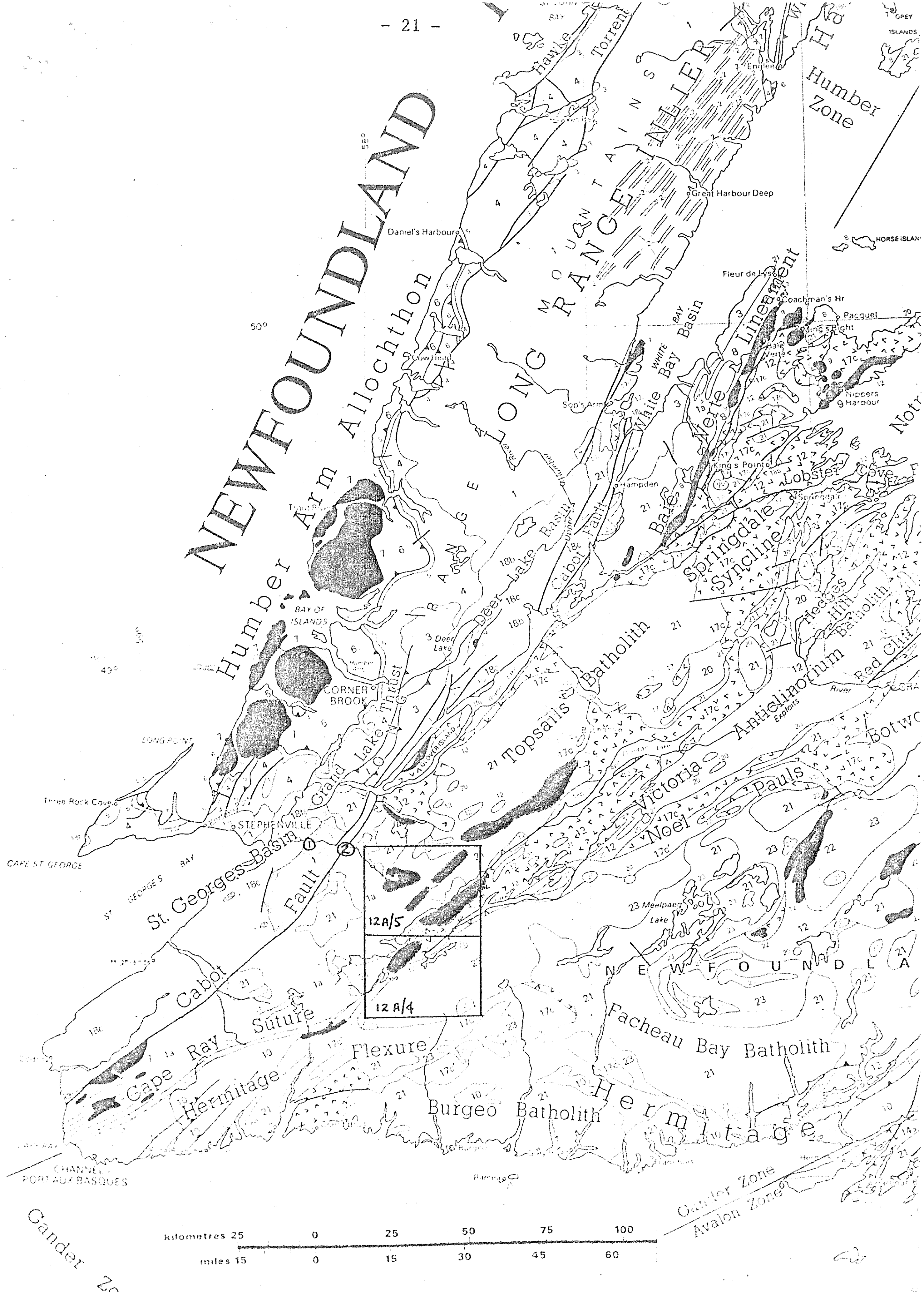

Figure 4: After Williams (1978). Light shading, anorthosite; dark shading, ophiolites.

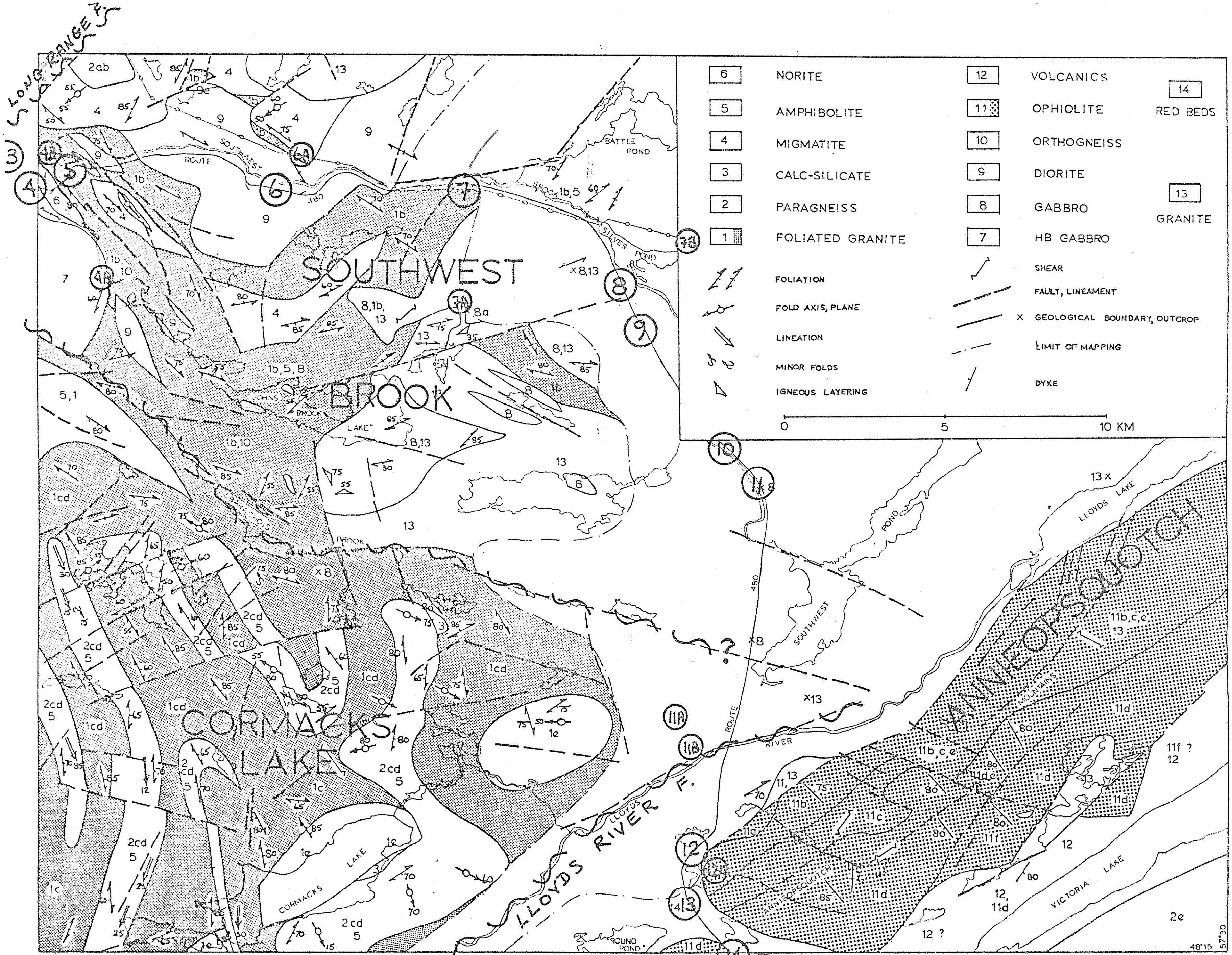

Figure 5 *Geological sketch-map of the Puddle Pond area; informal names are in quotation marks.*
Complex names, bold; Day 1 stop nos., circled

Detailed legend of units, Puddle Pond area

? SILURIAN

14 Redbeds; sandstone, shale, limestone, conglomerate

? ORDOVICIAN

13 Granite, pink, massive; 13a, massive granite; 13b, foliated pink granite; 13c, aplite, granite, pegmatite dykes

ORDOVICIAN

12 Volcanic and associated rocks; 12a, pillow lava; 12b, agglomerate; 12c, massive basalt

11 Annieopsquotch igneous complex; ophiolite and associated rocks; 11a, pyroxenite; 11b, gabbro; 11c, gabbro and diabase dykes; 11d,sheeted diabase dyke zone; 11e, leucogabbro/plagiogranite dykes; 11f, diabase dykes in mafic pillow lava; 11g, amphibolite, epidote-amphibolite zones

ORDOVICIAN AND/OR OLDER

10 Orthogneiss; 10a, quartz diorite – granodiorite orthogneiss; 10b, mylonitic orthogneiss, pink, with epidote

9 Hornblende diorite and related rocks; 9a, diorite; 9b, quartz diorite; 9c, granodiorite; 9d, granite; 9e, hornblende-biotite ultramafic; 9f, diabase dykes in diorite

8 Gabbro, massive; 8a, pyroxenite; 8b, gabbro-metagabbro, coarse grained; 8c, anorthosite; 8d, hornblendite; 8e, serpentinite; 8f, diabase dykes in gabbro

7 Hornblende gabbro; 7a, noritic; 7b, ophitic; 7c, porphyritic (hornblende, plagioclase); 7d, leucocratic; 7e, troctolitic; 7f, diabase dykes in hornblende gabbro

6 Hornblende norite; 6a, medium grained, massive and coarsely jointed; 6b, layered; 6c, pegmatitic; 6d, porphyritic (hornblende); 6e, agmatite of norite in orthogneiss; 6f, diabase dykes in norite

5 Amphibolite; 5a, amphibolite in orthogneiss; 5b, amphibolite in migmatite; 5c, Cormacks Lake complex, metagabbro(?); 5d, Cormacks Lake complex, calc-silicate(?)

4 Migmatite composed of: paragneiss of unit 2, locally pelitic (4a) or calc-silicate – rich (4b), and granodioritic gneiss, with inclusions of amphibolite, gabbro, calc-silicate rock, sillimanite schist, rarely serpentinite, etc.

3 Marble, and calc-silicate rock with garnet, diopside, quartz, sphene, actinolite, tremolite, talc etc.

2 Paragneiss, biotite-rich; 2a, aluminous, pelitic; 2b, containing calc-silicates; 2c, Cormacks Lake complex, pelitic and magnesian paragneisses; 2d, Cormacks Lake complex, calc-silicate gneiss; 2e, paragneiss southeast of Victoria Lake

1 Foliated granite/orthogneiss; 1a, granulite facies; 1b, hornblende-biotite orthogneiss; 1c, Cormacks Lake complex, biotite orthogneiss; 1d, Cormacks Lake complex, hybrid biotite – magnesian amphibole orthogneiss; foliated quartz-eye granite: Not 1e but 13.

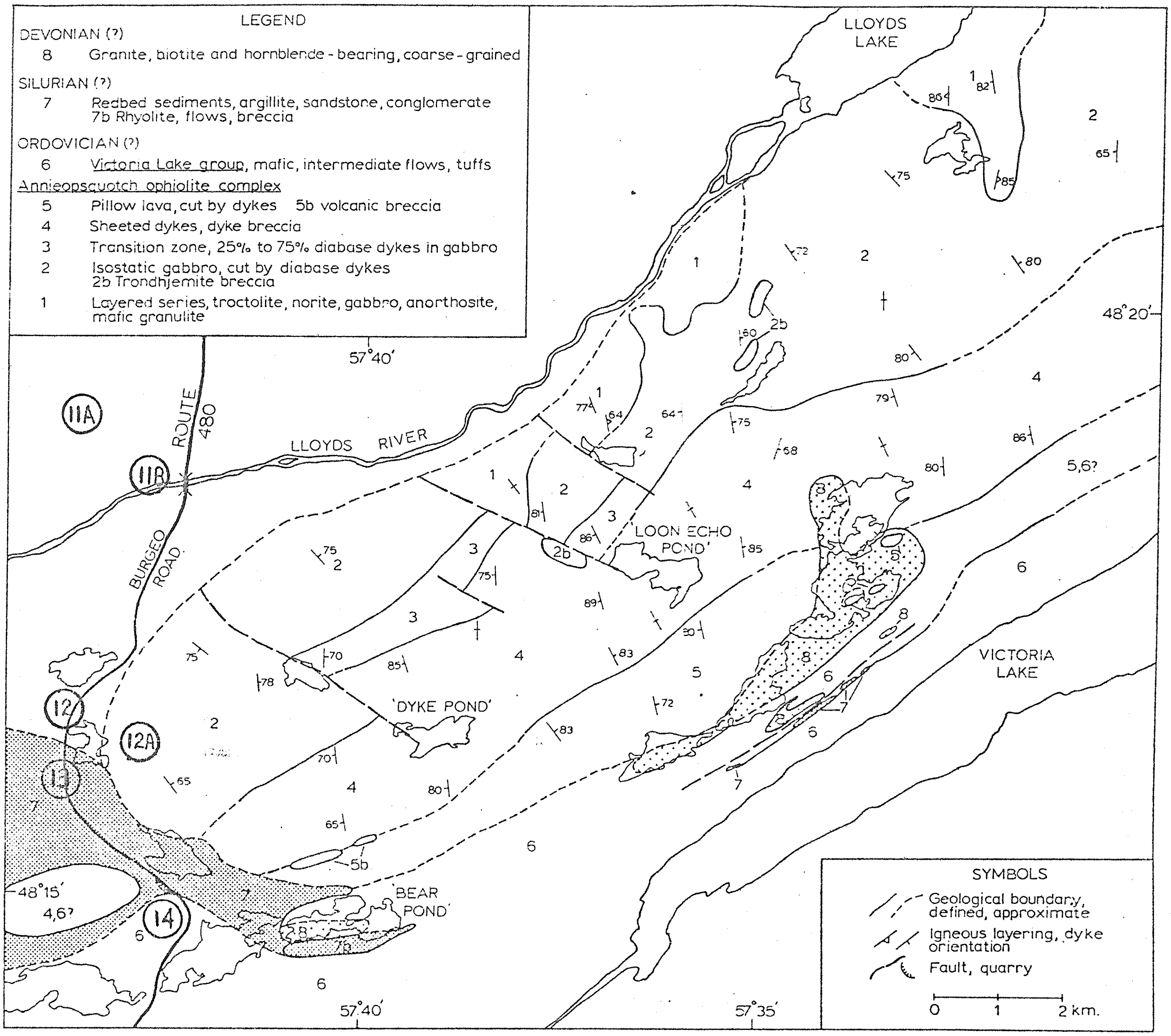

Figure 6 Geological sketch-map of the Annieopsquotch ophiolite (informal names are in quotation marks).

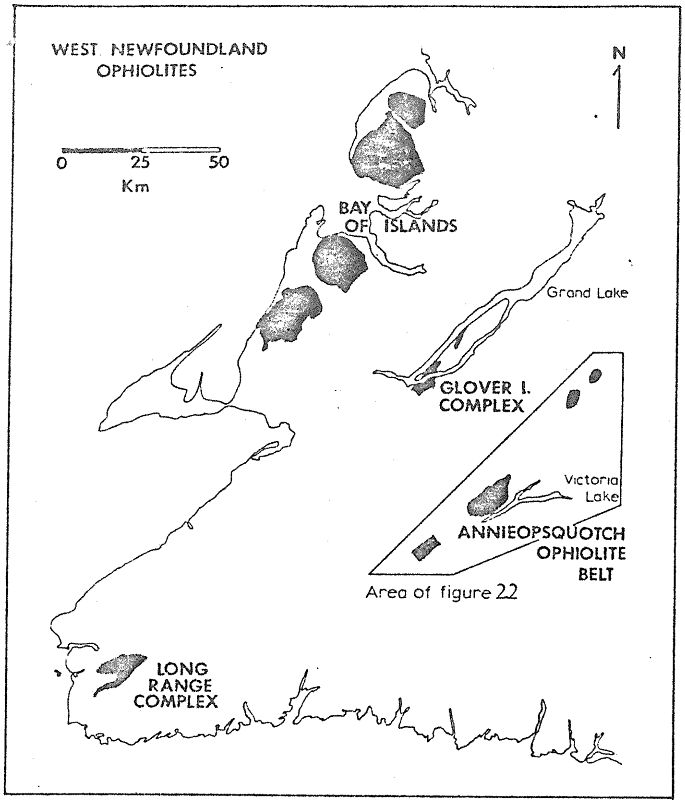

Figure 7A *The Annieopsquotch ophiolite belt and other ophiolite complexes of western Newfoundland.*

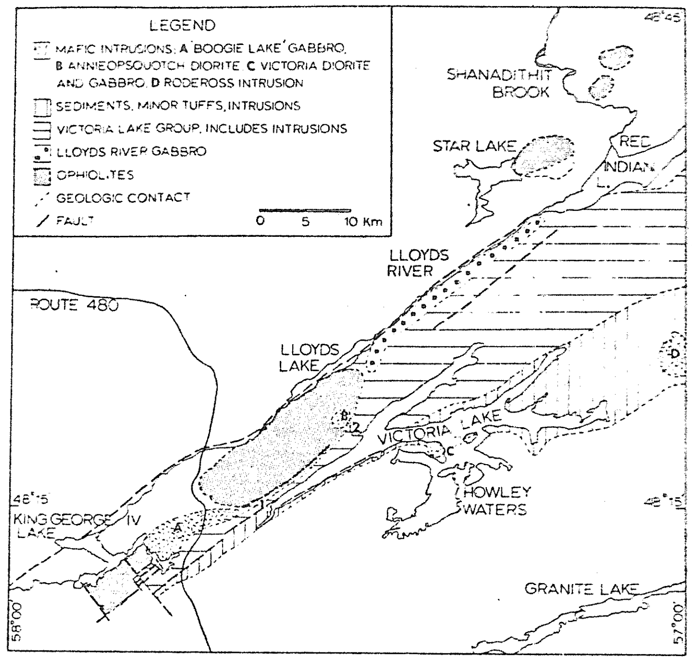

Figure 7B *The Annieopsquotch ophiolite belt, southwestern Newfoundland. General geology after Kean (1977), Dunning and Herd (1980) and Kean and Jayasinghe (1981).*

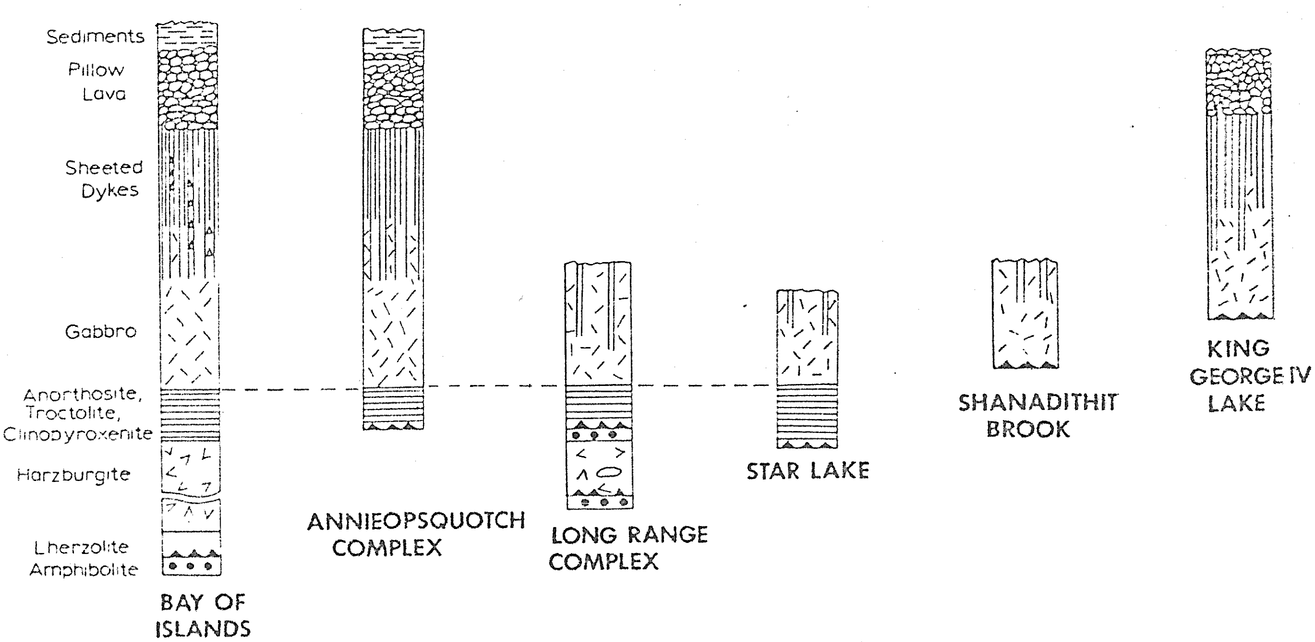

Figure 7C *Schematic cross sections of west Newfoundland ophiolites. Thicknesses uncertain as some lithological units are separated by faults. Bay of Islands complex modified from Malpas and Strong (1975); Annieopsquotch complex after Dunning and Herd (1980); Long Range complex after Brown (1976); King George IV Lake ophiolite after Kean and Jayasinghe (1981).*

Fig. 7: See Dunning(1981) for additional references

Road Log: Optional stops are asterisked*; 'A' and 'B' stops are side trips.

Km (accumulating in brackets)

0.0 The trip begins at the junction of the Trans-Canada Highway and Route 480. Proceed east along Route 480.

2.4 *(Stop 1.1A). To the right is a turn-off into the northern margin of Little Barachois Pond Provincial Park. The road runs for 18.1 km and passes through the Steel Mountain anorthosite, across the Long Range fault zone, and into the terrane of the Southwest Brook complex within hornblende gabbro rocks (Unit 7, Fig. 5). Large boulders with large feldspar, and hypersthene crystals, enclosed within a deformed matrix of feldspar, pyroxene and magnetite, occur on the north side of this road at about the halfway point. The road provides access for logging, and could be used to assist in mapping the Steel Mountain anorthosite and other units in 12B/8.

0.5 (2.9) *(Stop 1.1). Steel Mountain anorthosite is exposed in a long outcrop. Small relict purplish plagioclase porphyroclasts are set in a whitish matrix of recrystallised and altered feldspar. The overall appearance of specimens is typical of Grenville-type anorthosites. Similar anorthosite occurs at Indian Head near Stephenville, and aeromagnetic patterns indicate that anorthosite exposed south of Flat Bay is extensive below Carboniferous sediments.

7.8 (10.7) Layered Pleistocene sediments preserving slump structures are exposed on the south side of the road.

1.5 (12.2) (Stop 1.2). Strongly layered rocks striking northeasterly and dipping steeply to the northwest are exposed in high rock cuts along the south side of the road. Major components are deformed anorthosite and more mafic rocks, and amphibolite dykes which cut the layering but have been rotated almost into conformity by deformation. The zone is structurally and lithologically complex, and may coincide with the margin of the Steel Mountain anorthosite and also be part of the Long Range fault zone. Southeast of this zone lies the Southwest Brook complex with its mafic inclusions, and it is possible that the mafic components from the southeastern side of the fault have been deformed together with anorthosite. If this is the Long Range fault zone, it shows a long and complicated history, encompassing high temperature deformation and re-crystallization, in marked contrast to its appearance further south where it juxtaposed Carboniferous rocks with gneisses and forms a prominent scarp north of Port aux Basques.

5.1 (17.3) *(Stop 1.3). A long outcrop just past the logging camp exposes fresh hornblende norite; the rock contains orthopyroxene with minor clinopyroxene lamellae, olive-brown hornblende as reaction rims on pyroxene, plagioclase laths (An 55), iron oxides and pyrrhotite, and minor amounts of apatite and red-brown biotite. The hornblende and biotite are probably late magmatic. The norite is a coarse grained representative of the noritic inclusions (Unit 6, Fig. 5) within the foliated tonalitic terrane of the Southwest Brook complex. Right here it is unmetamorphosed and remote from the marginal contact, where the noritic rocks become agmatized by tonalite (Stop 1.4). A variety of noritic rocks occur within this mass, which forms a prominent cut-over razorback hill along the north side of the road. These particular noritic rocks may be comagmatic with the diabasic hornblende gabbros and diorites (Unit 7 and Stop 1.3B) as structures within the two areas are conformable although the masses are separated by a narrow zone of granitoid rocks. On the crest of the razorback hill there are magnetite layers in the norite, and coarse grained igneous breccia with blocks of gabbro and leucogabbro in a noritic matrix, cut by noritic pegmatites. These rocks were studied by Carew (1979) who concluded they might form part of an appinite suite. It seems unlikely that appinite is a suitable epithet; they bear most similarity to post-ophiolite gabbro-diorites found in the Anneiopsquotch mountains and along the Lloyds River valley (Dunning, 1981). Biotite from this rock yields a K-Ar age of 447 ± 8 Ma.

*(Stop 1.3A). An outcrop of pegmatoid noritic rocks and magnetite-plagioclase cumulates occurs on an older road route just before the logging camp. Stop opposite the logging camp, before Stop 1.3, and follow the old road back over the bridge over John's Brook to the outcrops visible in the hillside on the south side of the old road. The magnetite-plagioclase rocks occur in rusty subcrop to the west, and very coarse grained noritic pegmatite is exposed in blocks and in a steep face below overburden. Coarse plagioclase, hornblende and hypersthene are recognizable in the pegmatite.

*(Stop 1.3B). From just before Stop 1.3, follow a forest access road over John's Brook and up the hill to the southwest. A stream occupies the roadbed so the journey is easier on foot. This road leads into a series of roads along which are exposed various kinds of hypabyssal hornblende gabbro, the primary representative of Unit 7 (Fig. 5) studied by Carew (1979). Local examples of igneous graded layering can be found as well as complex pegmatites and diabase dyke rocks that may be comagmatic. To the west, north of White Hill pond, a cumulate olivine-orthopyroxene layer has been identified in the sequence, and all indications are that these rocks differentiated from hydrous mafic magma at a high level in the crust. They are rich in magnetite, and amphibole, with local

biotite concentrations. Like the norite at Stop 1.3, they are recrystallized along their margins but preserving their igneous heritage in the interior. Hornblende from one of these rocks yielded a K-Ar age of 455 $\pm$ 65 Ma, and a zircon of similar age has been extracted from hornblende gabbro/diorite. J.B. Whalen (pers. comm., 1982) reports very similar mafic rocks as the earliest screens in the Topsails terrane, and postulates their generation in an island arc.

1.0 (18.3) (Stop 1.4). Agmatized hornblende norite is exposed in the outcrops on the north side of the road, and granodiorite of the Southwest Brook complex on the south side. When these outcrops were first mapped, only the jointed diabasic norite now visible above the present outcrops on the north, was exposed, along with apparently underlying granodioritic gneiss. It had to be reasoned that the norite lay stratigraphically above the granodiorite, e.g. in thrust contact, or was an inclusion. In 1978 the original road course was widened, and the present roadcuts made, exposing the norite invaded by a network of veins from the granitoid rocks. Examination in hand specimen and thin section shows that this invasion probably took place under quite high temperature conditions. The norite becomes sugary and recrystallized close to the margins, and tonalitic rocks with noritic schlieren occur all along the norite mass margin. Hornblende and garnet have been found as metamorphic products along the margin, indicating probable upper amphibolite high pressure conditions.

*(Stop 1.4A). At the end of the razorback hill, another forest access road leads almost due south along the margin of the norite mass. Low outcrops along the road expose hybrid norite/granitoid gneiss. Close to the end of the road, low outcrops on the west side expose recrystallized diopside-bearing hornblende gabbro of Unit 7. Note that the trend of the valley in which the norite razorback hill lies is almost due northwest, and parallel to foliations in the tonalite-granodiorite, the latest structural features in this region, at right angles to regional Appalachian trends.

*(Stop 1.4B). North of the road at the end of the norite hill, access is possible down a boggy stream valley to the valley of Southwest Brook. The trek reveals some important features of the Southwest Brook complex, for exposed in low outcrops on the sides of the Brook, are two-pyroxene-bearing tonalite orthogneiss with northeasterly foliation, cut by biotite tonalite orthogneiss with northwesterly foliation (Units 1a, 10, Fig. 5). Also present in the Brook are large boulders of cordierite and hypersthene-bearing gneiss, with inclusions of spinel-rich rock and eyes of hypersthene and diopside with biotite skins, suggesting relict granulite grade metasediments and their restites within the tonalite terrane.

1.9 (20.2) *(Stop 1.5). At a very sharp turn in the Route (WATCH FOR LOGGING TRUCKS!) high outcrops on the south side of the road expose a varied suite of tonalitic rocks with a regional northwesterly trend. There are many inclusions of amphibolitic nature, and the latest tonalitic rocks appear to be quite leucocratic, perhaps in the form of sills or dykes, bearing only biotite, and cutting hornblende-biotite tonalite. Late pink aplitic veins may also be noted. Biotite from these tonalites gave a K-Ar age of 449 ± 8 Ma.

The route continues through many roadcuts of tonalitic and dioritic rocks, some with many inclusions, local diabase dykes, pink joint surfaces, slickensides and numerous granitic sills and dykes. Eventually the main rock type becomes an essentially massive hornblende diorite, cut by granitic dykes.

5.2 (25.4) (Stop 1.6). The south side of the road is occupied here by low, well-jointed outcrops of hornblende diorite with bluish quartz eyes (Unit 9, Fig. 5), cut by pink or white dykes and rusty zones. The stop is at a narrow rusty zone. Depending on local weather conditions, there may be a number of rivulets draining over these outcrops. The diorite weathers rapidly and the granitic sills and dykes are resistant; a spectacular series of waterfalls can be viewed by following the next major stream valley a short distance inland to the south. The diorite is coarser grained and more homogenous than the gabbros and norites seen previously as inclusions in the tonalite. In its interior, it is essentially massive with an igneous texture. As its margins are approached, large K-feldspar phenocrysts develop and locally there are masses of a hornblende-biotite ultramafic which appears to be cogenetic with this diorite. Chunks of this ultramafic, and of the diorite, occur within the more varied terrane both east and west of the core area. At this stop, the vertical rusty zone in the diorite should be closely examined. Chalcopyrite has been found, along with some malachite stain, in the rusty veins which appear zoned from K-feldspar-rich centres to margins with porphyry-type alterations.

0.9 (26.3) *(Stop 1.6A). Just beyond the long outcrops of diorite and past the stream valley, another forest access road leads north across Southwest Brook. At the T-junction across the bridge, one road leads west and allows access to the high hills south of North Lake which expose sillimanite-cordierite gneisses in migmatite and massive pink granite. These can be reached by traversing from the access road due north across the power line and up a steep slope, the climb taking about 20 minutes to reach open outcrop areas. The other arm of the T-junction may also be used as access bo boggy uplands areas underlain by diorite, tonalite, migmatite and granite; the slopes have recently been cut over.

5.0 (31.3) (Stop 1.7). The route follows the course of Southwest Brook and parallels a power line for several km. Long outcrops on the south side expose, once more, the variably tonalitic and inclusion-choked terrane of the Southwest Brook complex. Just after passing a bog on the south side of the road where the power line is visible, there is a large quarry with high sides, and lower outcrops on the north side of the road. The geology here is quite varied, but dominated by the layered rocks exposed in the quarry, which appear to be highly deformed and foliated equivalents of the hornblende diorite and tonalite-granodiorite suites seen earlier. The flat-lying aspect is due to interference of two sets of folds which plunge shallowly in the directions 240 and 190-165. The foliation is cut by intermediate to basic dykes, and one diabase in the rock face just east of the quarry on the south side, has molybdenite along its contact. On the north side of the road, there are rusty quartz veins bearing chalcopyrite and pyrrhotite.

It is probable that the quarry exposes a folded fault zone in the tonalite terrane of the Southwest Brook complex. Significantly, beyond this point on the route, and in the Southwest Brook complex to the south and east, ophiolitic inclusions occur in the tonalites. Could the rocks in the quarry mark the old suture zone between oceanic crust and continental crust, the zone itself and the continental and oceanic protoliths now migmatized and folded cryptically into the Southwest Brook complex?

*(Stop 1.7A). An interesting hike can be made south from Route 480, following any of a number of small streams that drain the highland areas. At a point about 5 km south, metagabbro with anorthositic and troctolitic layers, and harzburgite, occur, surrounded by younger pink granodiorite but also invaded further south by layered tonalite. These gabbroic etc. rocks belong to Unit 8, Fig. 5, and there is little doubt that they belong to a disrupted ophiolite suite occurring south and east of John's Brook Lake. The granodiorites are marked as Unit 13 on Fig. 5.

*(Stop 1.7B). Requires a boat in all probability to cross Southwest Brook as it empties from Silver Pond. The power line and Route 480 diverge from this point, although a planned connection from Buchans to Route 480 may allow access to the power line from the east in future. Just east of the easternmost tip of Silver Pond, on the power line, orthopyroxene-bearing tonalitic rocks are again exposed as are inclusions of noritic rocks in the tonalite terrane. If a boat is used to reach the (shallow!) eastern bay of Silver Pond, it is only a short plough to the power line to look at these peculiar rocks.

5.1 (36.4) *(Stop 1.8). At the south end of Silver Pond, these rocks are again part of the Southwest Brook complex. How many kinds of tonalitic rocks can be found in the outcrops? At least one variety has a distinctly metamorphic fabric and has undergone at least two phases of deformation. Does it represent the old, basement tonalite in the Southwest Brook complex? The rocks have been sampled for zircon age dating. Amphibolitic mafic rocks are the oldest portion of the outcrops, and are very abundant in outcrops from here on to the south. The structurally youngest rocks are pink pegmatites and aplitic veins; on some joint surfaces, rosettes of prehnite are found.

0.7 (37.1) *(Stop 1.9). High outcrops on the west side of the road expose a large boudin of gabbroic rock invaded by leucocratic veins. An appreciation of the problem of identifying protoliths in this terrane can be gained by trying to determine the origin of the hornblende and whether the textures are metamorphic or mimetic after igneous features. Relict layering, probably igneous but mimicked by metamorphic hornblende, can be seen in boulders in the ditch below the outcrop.

The aspect of the mafic rock invaded by leucocratic veins is very reminiscent of the exposures of the Littleport complex at Trout River. Whether the mafic inclusions are easily identifiable as ophiolitic or not, it seems clear that we are in a terrane with a component of oceanic crustal material, now invaded by granodiorite-tonalite.

5.3 (42.4) *(Stop 1.10). At a sharp bend in the road, where a right of way for the link from Buchans can be seen, another outcrop of the Southwest Brook complex occurs. In the exposure to the west, virtually undeformed tonalite occurs at the southern end of the roadcut, while at the northern end, foliation in the tonalites has increased as the proportion of inclusions has increased. This observation illustrates that while regional trends in the Southwest Brook complex may be significant, local perturbations in foliation occur near inclusions, and indeed the granitoid rocks may not register a foliation unless they contain inclusions.

The roadcut face on the east exposes narrow late mineralized veins; chalcopyrite has been noted.

0.8 (43.2) (Stop 1.11). Roadcuts here expose more gabbroic and tonalitic rock of the Southwest Brook complex. The most important observation, is that some of the gabbroic rock has a very even texture with purplish plagioclase laths visible. This rock is very reminiscent of the massive gabbros of the Annieopsquotch ophiolite. A small sample from this stop might be useful to compare with the Annieopsquotch gabbros.

Significantly, Route 480 here crosses a line of hills which run northeasterly and expose gabbroic rocks on their tops and steep northwest-facing sides; in the Padille Pond and Puddle Pond areas to the northeast, troctolite and metamorphosed harzburgite with orthopyroxene oikocrysts, occur. It is probable that a line of ophiolitic rocks is preserved in this zone, variably invaded by tonalite etc. The zone is in fact almost directly on strike from the Star Lake ophiolite.

6.5 (49.7) *(Stop 1.11A). From approximately this point, just north of the bridge over the Lloyds River, a hill can be seen to the west, with low tuckamore and rhododendron scrub flourishing on sandy soil. Low outcrops on the south side of the hill mark the most easterly extent of the Cormacks Lake complex; brown paragneiss and brecciated quartzite are exposed.

0.8 (50.5) *(Stop 1.11B). Proceed west along the north bank of the Lloyds River for approximately 1 km. At several places highly mylonitized rocks of indeterminate protolith, some folded, can be observed. At a series of rapids, flaggy granitoid rocks with amphibolitic boudins are found, cut by granodiorite which is itself elsewhere strongly deformed. This is the Lloyds River fault zone, and the protoliths of the mylonitic rock were mafic material from the Annieopsquotch ophiolite, invaded by granodiorite as seen elsewhere. One low outcrop of mylonite, quite close to

Route 480, actually contains quartz fragments which may be deformed pebbles, so sedimentary material may have been present in the fault zone.

VIEW: from the bridge over the river, of the Annieopsquotch (Micmac for 'rocky place') mountains.

3.9 (54.4) (Stop 1.12). Crossing the Lloyds River we enter the region of the Annieopsquotch ophiolite complex. From this point on the road a view can be had of the black massif of the mountains rising just to the southeast. Stratigraphically, these outcrops are of the massive gabbro zone of the ophiolite. Within the base of this zone are found layered troctolitic and pyroxene-rich rocks thought to represent mantle lithologies. Above the gabbro zone, up stratigraphy to the southeast, there is a transitional zone, and then a thick sheeted dyke zone. The dykes strike north to northwest; the dyke zone eventually gives way upward into pillow lavas with some interpillow red cherts, and the whole massif is in fault contact with tuffaceous rocks of the Victoria Lake group. The major zones of the ophiolite strike northeast and dip steeply southeat, and the total exposed thickness is some 7 km. Except along its southeast margin, there has been little internal effect from faulting; the upper and lower contacts are both fault-bounded, and granodiorite has invaded the ophiolite along the base especially. Post-ophiolite dioritic rocks and granodiorite occur as plugs invading its upper levels. Zircon from plagiogranite cutting dykes in the sheeted dyke zone gives an almost completely concordant age of 483 ± 3 Ma. More details of the ophiolite are to be found in references cited above.

Pause to sing the following sone if you are in the mood (to the tune of 'On Top of Old Smokey'). Paul Dean, Memorial University and Mines & Energy, Newfoundland, discovered that the Annieopsquotch mountains exposed an ophiolite in 1977, while he was working for a mining company doing regional reconnaissance. The ophiolite was redisdovered in 1978 during GSC mapping by Greg Dunning, Richard Herd, Wayne Carew and Greg Noah.

ODE TO ST. ANNIE

(St. Annie Opsquotch, the patron saint of ophiolites:
Dean, pers. comm., 1979)

1. On top of St. Annie,
As everyone knows,
It's cold as a witch's,
Though once hot, you know.

2. For she's a great ophiolite,
Dykes, gabbros all topped
With well exposed pillows,
Red cherts developed.

3. If you drive to Burgeo,
And the weather is fine,
The view from the Lloyds
Will shiver your spine.

4. Take the time to ascend her,
Have a look at the ground,
She's a well preserved lady,
But she's been around.

5. Born in the Cambro-
Ordovician seas,
Then covered by Springdale,
Exposures that tease!

6. So here's to St. Annie,
And all of her joys,
Discovered by MUN - Dean,
And the GSC boys.

RKH 14/9/82.

Boulders at this stop expose material from the layered portion of the ophiolite, i.e. the lowermost zone, and a brief wander off the road will show green-weathering boulders of the massive gabbro, some cut by granodiorite.

The northwestern edge of the Annieopsquotch ophiolite is marked by a very strong magnetic anomaly, apparently coincident with a layered sill described by Dunning (1981). If the sill is not the cause of the anomaly, then there exists the possibility that lower zones, i.e. harzburgite and dunite, of the ophiolite are present in the subsurface. Boulders of ultramafic rock, not common, have been noted in the Lloyds River valley.

*(Stop 1.12A). The trip into the outcropping ophiolitic rocks takes about 30 minutes of sweating through nasty tuckamore and over boulders and talus. There is no easy route at present, and the trip is only recommended for those who are fit and familiar with travel in the Newfoundland wilds. Once the mountain ridges are reached, there is plenty of outcrop (slippery when wet!) and with the aid of published maps of the ophiolite, the different zones can be visited. To do the rocks justice, either a helicopter is required, or a day should be consigned to visit the ophiolite.

Proceed south along Route 480. Outcrop of varied granodiorite occurs along the west side of the road; this is the material which intrudes the ophiolite, and with the ophiolite is overlain by the red and grey sedimentary sequences. In Fig. 5, there are three areas of granitoid rocks marked 'le' which intrude the southern margin of the Cormacks Lake complex, and probably were deformed with it. It now seems probable that whatever the history of these rocks in the Cormacks Lake area, they are the same granodiorite that invades the ophiolite, and equivalent in age to granites of Unit 13, Fig. 5. A K-Ar age on hornblende from an amphibolite inclusion in Unit 'le' gave 360 $\pm$ 25 Ma. This Acadian age may be indicative of the age of some events in the Lloyds River valley.

0.5 (54.9) *(<u>Stop 1.13</u>). The first exposures of red beds occur on both sides of the road. On the west, the rocks are fine grained pebble conglomerate composed of fragments of quartz, pink feldspar and rare altered basaltic and felsic volcanic clasts. Pebble to cobble conglomerate with crude size layering occurs, with imbrication indicating northeasterly transport, i.e. the red beds lap onto the ophiolite. Some fine grained beds are cross-bedded. Calcite cement that may indicate a dry climate during deposition is patchily developed. The beds, if undisturbed, dip gently southwest.

2.2 (57.1) (Stop 1.14). Exposed is a sequence of red beds in a large quarry on the west of the road. The beds strike northeasterly and dip steeply. Characteristics of the red beds can be seen in loose blocks, in the quarry face, in low roadcuts on the east side of the road, and on the weathered upper surface exposed above the quarry.

Crossbeds in sandstone and silty mudstone make it clear that the sequence is here overturned to the southeast. The lowest stratigraphic units in the quarry occur along its southern edge, where reddish mudstone is overlain by purplish felsic-intermediate volcanics, containing patches of the reddish mudstone and showing a network of calcite veins and vugs. The pink mineral on joint surfaces is manganoan epidote, and dendrites of other manganese minerals also occur. Above the massive volcanics, there are several metres of breccia with angular blocks of welded tuff, fine-grained massive volcanics, and gabbroic rocks, in a red-weathering matrix. Fiamme can be seen on weathered surfaces of the tuff blocks, above the quarry. The unit is probably a lahar. It is in fault contact to the north with overlying crossbedded red sandstones and mudstones described by Chandler (1982) as follows:

'...laminated current-lineated, fine grained sandstone is the main rock type. Waning-current cycles on a scale of 20 cm include flat bedded current-lineated fine grained sandstone with mud chips, overlying a basal scour and succeeded by rippled silt. A second type of cycle, on a 5-8 cm scale, contains climbing ripples overlain by about 0.5 cm of red mud. Within the rarer coarse grained sandstone, cycles include coarse grained, crossbedded or massive sand with mud chips, resting on a scoured base either present as nested sets or passing up through laminated fine grained sand and rippled sand to a mud capping. Rare 5-8 cm thick grit layers in the sandstone sequence show a mixed parentage of felsic volcanics, basalt and granite (s.l.). Other sedimentary features include mudcracks, mud flake layers and mud curls. A noteworthy lack of separation of a clearly defined muddy facies points to ephemeral streams and floods. These characters may be evidence of a dry climate...'

Radioactivity due to heavy mineral lags (monazite) is noted in crossbeds in the sandstone just above the fault contact with the breccia.

END OF PART I.

Part II: From the quarry south ot the southern boundary of the King George IV Lake map sheet (12A/4)

GENERAL GEOLOGY OF THE KING GEORGE IV LAKE AREA

By B.F. Kean

Stratigraphy

The geology of the King George IV Lake area is readily divided into six main elements: namely, (1) gneiss and amphibolite of the Cormacks Lake Complex, (2) gabbro, dikes and pillow lava of the King George IV Lake Ophiolite complex, (3) volcanic and sedimentary rocks of the Victoria Lake Group, (4) metasedimentary and mignatitic rocks of the Bay du Nord Group, (5) Devonian volcanic and sedimentary rocks of the Windsor Point Group, and (6) intrusive rocks (Figure 8).

The Cormacks Lake Complex (Unit 1) (Herd and Dunning, 1979), a poly-deformed assemblage of paragneiss, amphibolite and foliated granite with a prominent northwest structural trend occurs in the northwest corner of the map area. It is thus interpreted as the oldest unit in the area and possibly of Grenvillian age. It is separated from the other rocks by intrusives and the Lloyds River Fault.

The King George IV Lake Ophiolite (Unit 2) consist of fault bounded blocks of gabbro, diabase dikes and mafic pillow lava. It is considered to be a correlative of the Ordovician Annieopequotch ophiolite complex (Dunning and Herd, 1980) to the northeast. The King George IV Lake Ophiolite is in fault contact with the Victoria Lake and Bay du Nord Groups. These ophiolite complexes are interpreted as forming the oceanic basement to island arc type volcanic rocks of the Victoria Lake Group (Unit 3) and sedimentary and migmatitic rocks of the Bay du Nord Group (Unit 4).

The Victoria Lake Group in this area consists of interbedded felsic and mafic tuffs, epiclastic rocks and minor pillow lava. It is continuous along strike to the northwest with the fossiliferous Middle Ordovician and older Victoria Lake Group (Kean, 1977). The Bay du Nord Group ia a sedimentary and metasedimentary rock sequence that becomes progressively metamorphosed and migmatized to the south. It is considered to be a possible lateral equivalent to the Victoria Lake Group on the basis of relationships in the areas to the northeast (Kean and Jayasinghe, 1980).

Gray and red, polymictic conglomerate of Unit 5 contains clasts of the Victoria Lake Group and is considered to locally unconformably overlie the Victoria Lake Group (Kean and Jayasinghe, 1980). It is correlated with the Rogerson Lake Conglomerate of central Newfoundland, and forms a narrow band extending for 160 km and was probably deposited along an old fault scarp.

The fossiliferous Upper Lower Devonian grey bed sequence of the Windsor Point Group (Unit 10) comprises the youngest layered rocks in the map-area. This Group consists of a sequence of fluviatile red bed conglomerate, sandstone and siltstone with intercalated subaerial mafic and felsic volcanic and an overlying gray bed sequence of litharenite and interbedded fossiliferous black siltstones. Sedimentological data indicate transport from southwest to northeast. The red-beds are lithologically similar to the Botwood and Springdale Groups and may be of Silurian age. These rocks outcrop in a narrow, northeast-southwest trending belt underlying the northwest ern part of the map area and unconformably overlies the King George IV Lake ophiolite, the Bay du Nord Group, the Lloyd's River Intrusive Suite and the Boogie Lake Gabbro. The contacts are usually modified by later faulting.

Intrusive rocks range in age from pre-Devonian through to possibly Carboniferous and range in composition from gabbro to granite. Mylonitized granite and granodiorite dated at 389 ± 20 Ma (U/Pb) constitute

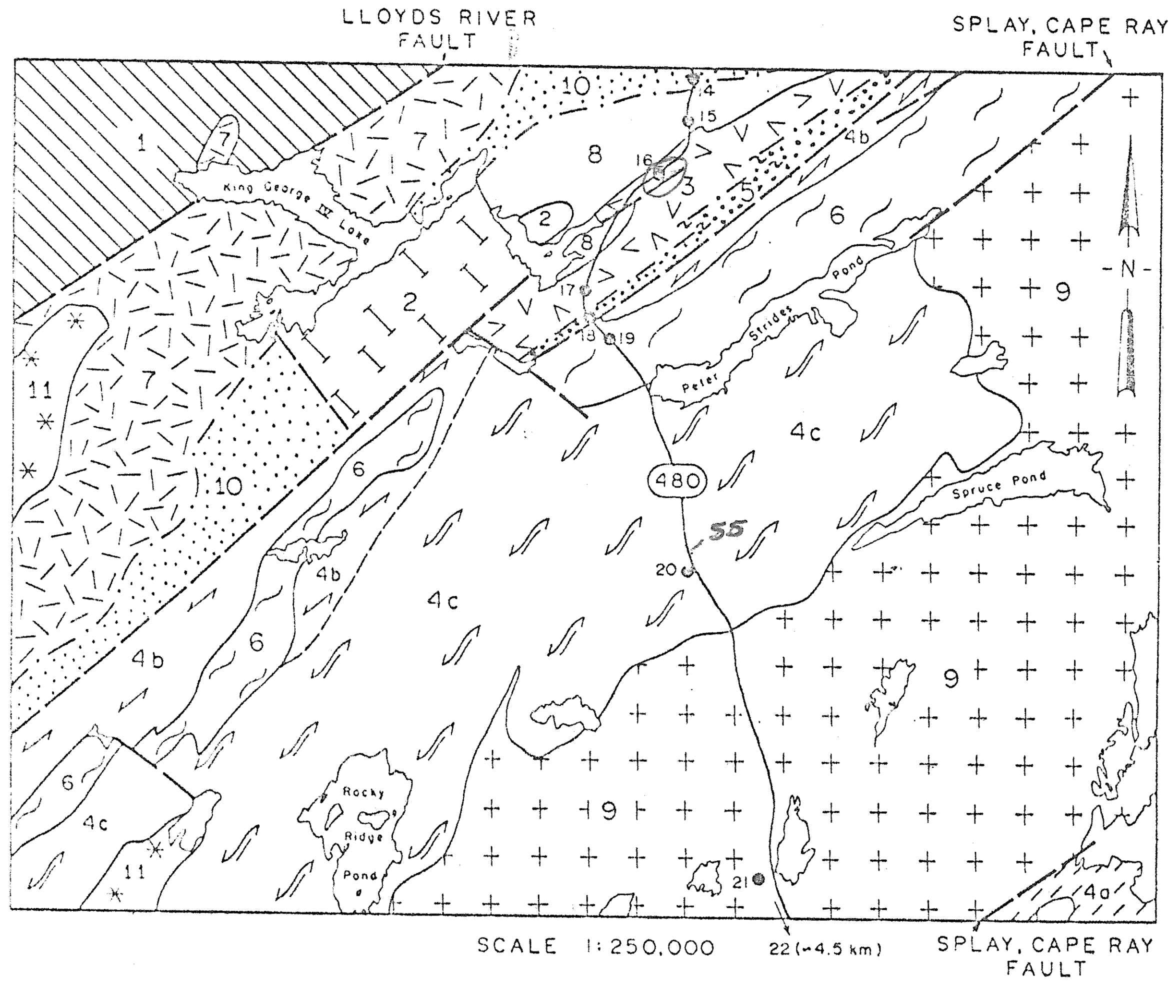

Figure 8: Generalized geological map of the King George IV Lake map-area

LEGEND

(King George IV Lake Area)

11	GRANITE: red and pink granite
10	WINDSOR POINT GROUP: red sandstone, siltstone and conglomerate; grey greywacke, black siltstone; mafic and felsic subaerial volcanics
9	BUCK LAKE GRANITE: K-feldspar megacrystic granite, minor equigranular granite and granodiorite
8	BOOGIE LAKE GABBRO: gabbro, diorite, granodiorite and granite
7	LLOYDS RIVER INTRUSIVE SUITE: gabbro, quartz diorite, granodiorite, tonalite and granite
6	GRANITE: mylonitized red granite and grey granodiorite
5	ROGERSON LAKE CONGLOMERATE: deformed polymictic conglomerate and minor sandstone
4	BAY du NORD GROUP: 4a, siltstone, argillite and minor sandstone; 4b, mica-schist, psammitic paragneiss and amphibolite; 4c, granodioritic and tonalitic migmatite
3	VICTORIA LAKE GROUP: interbedded felsic and mafic tuffs, epiclastic rocks, minor pillow lava and agglomerate
2	KING GEORGE IV LAKE OPHIOLITE: gabbro, sheeted dikes and basaltic pillow lava
1	CORMACKS LAKE COMPLEX: paragneiss, amphibolite and deformed granite

Unit 6. A complex of seemingly related gabbro, diorite, granodiorite and granite are referred to the Lloyd's River Instusive Suite (Unit 7). Clasts of both these units occur in the Upper Lower Devonian Windsor Point Group. Unit 6 intrudes the Bay du Nord Group post-migmatization and is folded with the regional folding of the Victoria Lake and Bay du Nord Groups.

The Boogie Lake Gabbro (Unit 8) and granodiorite and megacrystic granite of the Buck Lake Granite (Unit 9), although undated, are tentatively considered pre Windsor Point Group in age. Undeformed to weakly foliated pink to red granite (Unit 11) and biotite gabbro-norite are probably Devonian or younger in age.

Structure

Type 1 and 3 interference fold patterns (Ramsey, 1967) are common in the Cormacks Lake Complex and Herd and Dunning (1979) recognized at least three phases of folding in the Puddle Pond map area to the north. There, "early isoclines in paragneiss, are folded about relatively open folds with plunge variably southwest and northeast and consistently have a northeasterly axial trend. Left-lateral offset faults parallel this trend." They considered the northeast trends to represent an earlier phase of deformation than the northwest trends but younger than the isoclines. A similar complex structural history is evident from the King George IV Lake area where a predominant northwest trend defined by a gneissic banding is folded around northeast trending structures. Early isoclines are preserved within the gneissic banding. Late north to northwest trending folds are locally present.

These rocks are tentatively interpreted to have been originally deformed by the Grenvillian Orogeny based mainly on the regionally northwest structural trend. They have been subsequently remobilized, overprinted by Paleozoic structures, and intruded by younger rocks. In the King George IV Lake map area they are intruded by the rocks of the Lloyd's River Intrusive Suite and, in fact, may constitute a large roof pendant or xenoliths.

In all other rocks northeasterly structural trends predominate. Polyphase deformation is best developed in the Bay du Nord Group but is also seen in the Victoria Lake Group. In the Bay du Nord Group the earliest discernible deformational event or events resulted in the production of the composite metamorphic layering or mineral segregation and a co-planar micaceous foliation. This layering probably is an amplification of pre-existing primary structures. In areas to the south of the King George IV Lake map area, tight, possibly recumbent, folding and the initiation of major slide zones accompanied this deformation (Chorlton, 1980b). Metamorphism was probably in the greenschist facies(?) and may have increased to lower amphibolite facies during the late stages of or following deformation (Chorlton, 1980b). Extensive mylonitization of Unit 6 granite occurred after the migmatization of the Bay du Nord Group but prior to major granite emplacement and thus predates the main regional foliation.

These early structures were overprinted by a regionally mappable foliation associated with tight to isoclinal northeast, and locally southwest, plunging folds. The micaceous schistosity in the psammitic to pelitic rocks of the Bay du Nord Group and the inhomogeneously developed cleavage and schistosity in the volcanic rocks of the Victoria Lake Group is attributable to this event. The foliation in the Victoria Lake Group is defined by sericite and chlorite in areas of low grade metamorphism and by biotite, muscovite and hornblende in the higher grade rocks. The linear fabrics imparted by stretched fragments in the conglomerate of Unit 5 are also attributed to this deformation; however, the intensity of the fabric has been enhanced by faulting. Granite sheets cutting the layered rocks are folded with the host by this deformation. Protomylonites developed in the Buck Lake Granite formed during this deformational event or subsequently.

The next major tectonic event occurred after the deposition of the Windsor Point Group. It resulted in open to moderately tight folding and tilting and local overturning of the Windsor Point Group around northeast trending axes; however, there is no associated axial planar penetrative fabric. Internal faulting and shearing along the contacts may also be related to this deformation. The effects of this deformation outside of the fault zone along which the Windsor Point Group was deposited are hard to recognize. It may be restricted to movements on pre-existing faults and shear zones.

A set of north to northwest trending open folds, kink bands, minor shear zones and late ptygmatic folding are the latest deformational events.

Faulting was significant in the tectonic development of the area. Two major faults are present in the map area and they merge to the south in the La Poile River map area (110/16) to form the Cape Ray Fault (Chorlton, 1980b). The northern splay trends approximately forty-five degrees (45°) northeast and affects mostly rocks of the Bay du Nord Group, the granites of Unit 6, and the Rogerson Lake Conglomerate. The Windsor Point Group was deposited along the northern margins of this fault zone. The fault is considered to have both dip-slip and strike-slip movement and to have been initiated during the earliest stages of deformation (Chorlton, 1980b) as it predates, in part, the emplacement of the Buck Lake granite. However, unlike the Cape Ray Fault to the south, post-Windsor Group movements are minor and are localized along contacts. The southern splay trends sixty degrees (60°) across the extreme southeast corner of the map area and resulted in the development of mylonites in the Buck Lake Granite. Minor shear zones, faults and cataclasites are developed throughout the map area.

Metamorphism

Rocks of the Cormacks Lake Complex in the Puddle Pond map area to the north are characterized by metamorphic assemblages of cordierite, garnet, and sillimanite (Herd and Dunning, 1979). This suggests metamorphism was probably in the middle to upper amphibolite facies. The complex in the present map area has been retrogressed and is generally characterized by hornblende, biotite, epidote, calcite and by a granoblastic hornfels texture as a result of contact metamorphism.

Herd and Dunning (1979) reported the presence of 'gedrite garben-schiefer' confined to ($?S_0/S_1$) layering in the paragneiss of the Cormacks Lake Complex and suggested that indicated metamorphism began early in the fold history.

The Bay du Nord and Victoria Lake Groups and the King George IV Lake Ophiolite Complex are interpreted to be deformed and metamorphosed synchronously; thus they are considered to represent parts of the same metamorphic facies series reflecting different tectonic levels which are now juxtaposed by faulting. Elsewhere in central Newfoundland progressive increase in metamorphic grade without a major structural break is demonstrable (Kean and Jayasinghe, 1980). The general regional lack of andalusite, cordierite and staurolite, except in contact aureoles, and only the local occurrence of sillimanite suggest that the metamorphism is of the medium pressure type (Myashiro, 1973) but modified by granite emplacement.

Metamorphism began during and peaked after the first deformation. The development of migmatite (mobilizate) in the Bay du Nord Group occurred during the metamorphic peak. Migmitization may be the result of either partial melting or in situ metamorphic segregation and/or emplacement of granite derived from partial melts formed at deeper levels. Porphyroblasts overgrew the compositional (metamorphic) banding and early foliation and formed augen in subsequent deformations. The porphyroblastic growth is spatially related to granite emplacement.

The Bay du Nord Group generally contains the assemblage quartz, plagioclase, biotite, muscovite and rare sillimanite in the psammitic to pelitic compositions; and green hornblende, feldspar and quartz in the amphibolites. Anthophyllite is common in the calc-silicate bands. Staurolite, garnet, andalusite and cordierite overgrow the main fabric and generally occur in spatial relationship to granite intrusions.

Most rocks of the Victoria Lake Group and King George IV Lake Ophiolite complex were metamorphosed in the greenschist facies. Mafic to intermediate compositions are characterized by chlorite, biotite, epidote, clinozoisite, calcite, albite and quartz. Sericite, muscovite, quartz and albite characterize the felsic and psammitic compositions. Green hornblende and late euhedral garnets, related to intrusions, are locally present indicating the metamorphic grade was locally in the amphibolite or upper greenschist facies.

The Windsor Point Group was deposited after the peak metamorphism in the other rocks and was metamorphosed to sub to low greenschist facies during the third deformational event.

Economic Geology

The most significant mineralization discovered in the King George IV Lake map area is associated with the Victoria Lake Group and the granitic rocks of the Lloyd's River Intrusive Suite and the Buck Lake Granite, although the ophiolite rocks have potential for Cyprus-type massive sulphides.

In the Victoria Lake Group, idsseminated pyrite and minor chalcopyrite and sphalerite occur associated with the felsic volcanic rocks. Outside of the map area to the northeast lead, zinc and copper mineralization form a number of subeconomic deposits, e.g. Tulks and Victoria Mines (Kean, 1979; Kean and Jayasinghe, 1980). These are strata-form volcanogenic massive sulphides associated with felsic pyroclastics. A similar potential may exist in the present map area, although the felsic pyroclastics are not as extensively developed.

A boulder of highly altered, green, granite, similar to the marginal phase of Unit 7 (Lloyd's River Instrusive Suite), with galena, sphalerite, pyrite and gold bearing quartz veins was found in the stream to the west of Princess Lake.* Galena bearing stringers were also reported in stream bed outcrops by G. Harvey (1930) while prospecting for the Anglo-Newfoundland Development Company Ltd. This mineralization occurs along the contact between the Windsor Point Group and Unit 7 in a fault zone related to the Cape Ray Fault. This belt of rocks can be extended to the southwest where significant fold mineralization is associated with a subsidiary shear zone off the Cape Ray Fault within the Windsor Point Group and in quartz veins in the consanguineous Windowglass Hill Granite (Bucknell et al., 1980).

Float of Unit 11 granite containing disseminated molybdenite was found west of Rocky Ridge Pond. Minor molybdenite disseminations were noted in the late, garnetiferous granite dykes and veins in the Buck Lake Quarry. Beryl was also seen in garnet-tourmaline pegmatites in Buck Lake Quarry and was also noted in granite pegmatite float north of Burnt Pond Brook.

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* Assays: 5% Zn, 1.5% Pb, 42 ppm Cu, 25 ppm Au, 8 ppm Ag.

Veinlets of pyrite and chalcopyrite were seen in the granite-granodiorite immediately north of Burnt Pond Brook. Disseminated chalcopyrite and pyrite was locally found in the deformed conglomerate of Unit 5 along the Burgeo Road.

ROAD STOPS KING GEORGE IV LAKE AREA

Km (accumulating in brackets)

1.4 *STOP 15 (58.5): Boogie Lake or Annieopsquotch Gabbro(?)

Coarse grained, hornblende gabbro intruded by fine to medium grained diabase-diorite dykes. Trondhjemite dykes and pink and red aplite dykes are common. Intrusion breccias awr well developed and epidote veining is widespread. The Boogie Lake Gabbro is a medium to coarse grained hornblende gabbro and diorite with minor felsic differentiates. It intrudes the Victoria Lake Group and King George IV Lake Ophiolite and contains numerous xenoliths of ophiolitic gabbro and diabase dykes. This outcrop is not typical Boogie Lake and may be an ophiolite gabbro xenolith in the Boogie Lake.

1.6 STOP 16 (60.1): Victoria Lake Group

Interbedded felsic tuffs and minor mafic feldspar-crystal tuffs of the Victoria Lake Group. Quartz eyes are locally common in the felsic tuffs. South plunging isoclinal folds are well developed and are typical of the deformation in this area; the folds variably plunge northeast or southwest. In most places they refold an earlier fabric. Diabase and granite dykes are present here. Disseminated pyrite and minor chalcopyrite occur in this unit.

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* Optional stops that are included for completion and for later personal tours.

1.5 *STOP 17 (61.6): Victoria Lake and Windsor Point Groups

Sheared and altered, green basaltic pillow lava of the Victoria Lake Group are exposed on the east side of the road. Zones of strong hematization are developed within the pillow lava. The pillow lavas of the Victoria Lake Group are generally less than 0.5 metres in diameter, are not highly vesicular and contain minor interpillow material.

They are in fault contact with a thin sliver of red sandstone, conglomerate, breccia and mafic flows of the Windsor Point Group. The sandstone and conglomerate are exposed on the west side of the road. The breccia and flows are exposed approximately 50 metres north on the east side of the road.

3.5 STOP 18 (65.1): Rogerson Lake Conglomerate

Deformed and sheared, gray and purple, polymictic conglomerate. The conglomerate contains clasts of volcanic and sedimentary rocks, chert, quartz, porphyry and granite; some of the clasts were derived from the underlying Victoria Lake Group. This unit can be traced for about 160 km to the northeast and about 3 km to the southwest. A fault contact with the Victoria Lake Group is exposed a few metres up the hill. A major splay of the Cape Ray Fault passes through the valley approximately 0.75 km to the south. Disseminated pyrite and chalcopyrite are common.

1.5 STOP 19 (66.6): <u>Deformed Granite on a splay of the Cape Ray Fault</u>

Mylonitized, pink to red granite. This zone can be traced for approximately 50 km. This granite was emplaced into the Victoria Lake Group and the Bay du Nord Group after the peak metamorphism and migmatization. However, the cataclastic fabric is folded about the northeast trending regional structures.

6.5 STOP 20 (73.1): <u>Bay du Nord Group Migmatites</u>

Migmatites consisting of a biotite rich melanosome and a granodioritic to tonalitic leucosome. The migmatites of this area are mainly nebulitic but locally are crudely to moderately layered. This banding or gneissosity has an early co-planar foliation preserved in the melanocratic bands. Numerous 'granite' sheets intrude the migmatites and are folded with the migmatite with the development of a northeast trending axial planar cleavage. Sweats or veinlets of quartz + plagioclase + microcline are common. Garnet-tourmaline pegmatites are also common.

Rafts and xenoliths of paragneiss and amphibolite are common in the migmatite terrain and increase in prominence to the northwest towards the paragneiss and schist units of the Bay du Nord Group.

11.8 STOP 21 (84.9): Buck Lake Quarry Turnoff

Psammitic metasediments of the Bay du Nord Group intruded by the K-feldspar porphyritic Buck Lake Granite. Both are intruded by fine grained, biotite granodiorite; they are then folded with the development of an axial planar cleavage. Quartz and quartz - plagioclase veinlets are developed in the metasediments. Rapakavi textures are commonly developed in the Buck Lake Granite.

Medium grained, biotite-muscovite granite sheets; garnetiferous (muscovite + biotite) leucogranite and garnetiferous, tourmaline (-beryl) pegmatites are common.

4.5 *STOP 22 (89.4): Mylonitized Buck Lake Granite

Mylonitized Buck Lake Granite along a splay of the Cape Ray Fault. Mortar and augen structures, fractured porphyroclasts, fluxion structure and pseudotachylytes are developed.