STRATIGRAPHIC SUBDIVISION AND MAPPING OF THE LOWER MISSISSIPPIAN ANGUILLE GROUP, DEER LAKE – WHITE BAY AREA, NEWFOUNDLAND

by Richard Hyde

INTRODUCTION AND STRATIGRAPHIC FRAMEWORK

This report presents results from the first year of field work of a five year project to map and assess the mineral potential of Carboniferous strata in the Deer Lake-White Bay area of western Newfoundland. The Carboniferous rocks underlie an area of approximately 2800 km^2 in a roughly elliptical pattern. Field work in 1977 concentrated on the White Bay and Grand Lake areas, but brooks and roads were also traversed. Outliers of Carboniferous rock also occur in the Conche-Cape Rouge region of the Great Northern Peninsula (Baird, 1966), the western end of Red Indian Lake (Belt, 1969,p.741), and possibly at King George IV Lake (DeGrace,1974). Carboniferous rocks in the St. George's Bay region have recently been mapped by Knight and Fong (see McArthur and Knight, 1974).

The Carboniferous of the Deer Lake area consists of two groups of rocks: **a)** the Anguille Group of Lower Mississippian age and **b)** the Deer Lake Group of Upper Mississippian to Lower Pennsylvanian age.

The highly folded and faulted Anguille Group underlies a narrow, fault bounded strip in White Bay, and continues southwesterly into the Grand Lake area. The group derives its name from Lower Mississippian strata in the Anguille Mountains of southwestern Newfoundland (Hayes and Johnson, 1938), and its use in the Deer Lake area was introduced by later workers (Belt, 1969; Popper, 1970). Anguille sediments in the White Bay area were called the Spear Point Formation by Heyl (1937), but because much of the Lower Mississippian lithologies in the Deer Lake area are not present at Spear Point, Heyl's terminology has not received general acceptance. Popper (1970) informally subdivided the group near Grand Lake.

The Anguille Group probably has a maximum thickness of 3000 m, but folding and faulting make an accurate determination difficult. The base of the Anguille Group is not exposed in the map area, and the top is exposed at only one locality near Grand Lake. A Lower Mississippian age is assigned to the group based on plant spores and plant remains (Baird, 1959; Belt, 1969). No marine fossils are known from the group in the Deer Lake region.

Overlying the Anguille group with angular unconformity is the Upper Mississippian-Lower Pennsylvanian Deer Lake Group. The Deer Lake Group is not as deformed as the Anguille, except locally near faults, and is subdivided into three formations (Belt, 1969). These are, in ascending order: 1) North Brook Formation, 2) Rocky Brook Formation, and 3) Humber Falls Formation.

Another group of beds termed the Howley Formation (Howley "Beds" of Belt, 1969) is not formally included in the Deer Lake Group, but evidence from spores indicates stratigraphic equivalence to the Humber Falls Formation.

Work in 1977 resulted in subdivision of the Anguille Group over the entire Deer Lake region. Five stratigraphic units are tentatively proposed (figure 1). Because many different areas were visited during the summer, it was not possible to completely map a single NTS sheet. Hence, figure 1 represents a compilation of my own work on the Anguille Group, an maps by Betz (1948), Werner (1956), Riley (1957), Baird (1959), Popper (1970), and Belt (unpublished map).

DESCRIPTION AND INTERPRETATION OF UNITS WITHIN THE ANGUILLE GROUP

Unit 1 (unit 6 on map)

This is probably the oldest of the Anguille units; it occurs on the west shore of White Bay, on Millers Island near the south end of White Bay, and in the south end of White Bay. Its northern extent is at present unknown, but it may terminate against the fault at Saltwater Cove. Because this unit is fault bounded, its original thickness cannot be determined, but it is at least 500 m.

Unit 1 is dominated by medium to very coarse-grained, massive gray sandstone that forms beds about 50 cm thick. A commonly occurring feature in the gray sandstones is a well- developed, evenly-spaced parting which is parallel to bedding; the distance between partings is normally 2-3 cm. This parting is interpreted as a fracture cleavage. Siltstone and mudstone intraclasts and graded bedding also occasionally occur in these sandstones. Cross-stratification (sets 10-20 cm thick) occurs less commonly. In places, these sandstones pass vertically into graded quartz and/or feldspar granule conglomerate. Dark gray and red sandstones occur to a lesser extent. Dark gray sandstones contain planar and trough cross-stratification with sets about 15 cm thick. Red sandstones contain carbonate concretions.

Also present in unit 1 is gray, pebble-cobble, clast-supported conglomerate in which well rounded clasts average about 5 cm in apparent long dimension. Quartz and felsic volcanic debris are the dominant clast types. A conglomerate at Gold Cove seems to thicken along strike to the southwest, and underlies most of Millers Island in the southern part of White Bay. Red conglomerate occurs to a lesser extent, and in contrast to the gray conglomerate, most clast types in the red conglomerate are metamorphic and sedimentary rock.

Two varieties of dolomite, based on color of the weathered surface, occur in unit 1; greenish-gray, and orange. The dolomite is recrystallized and highly fractured so that stratification is difficult to observe. Dolomite forms stratigraphic units measurable in tens of metres.

Siltstone and shale is dominantly dark gray, but red and green siltstones and shales and black shales also occur. These fine grained beds can be up to 2 m thick, but most are less than 1 m in thickness, and are interbedded with sandstone. Red siltstone and shale usually contain carbonate nodules, and these nodules are also locally found in gray siltstone. The red beds tend to have gradational color boundaries with the green and gray beds. In general, siltstone and mudstone are subordinate to sandstone, dolmite, and conglomerate.

Measurements on the orientation of planar cross-stratification in sandstones tended to yield paleocurrents directed towards the northwest, but southerly directed currents were also recorded. Measurements of the orientation of parting lineation also generally resulted in current motion directions aligned northwest-southeast. This northwestward transport of sediment is supported by the abundance of felsic volcanic clasts in the gray conglomerates, because volcanic rocks are much more abundant in a southerly and easterly direction than to the north or west.

A fundamental problem in interpreting the depositional environment of unit 1 and much of the Anguille group is the apparent absence of marine fossils. Even trace fossils are generally absent. This led Popper (1970) to suggest that much of the Anguille was lacustrine. Although there is little positive evidence to substantiate this interpretation, it seems to be the most plausible available.

Unit 1 sediments accumulated in a wide variety of environments including fluvial, nearshore, and offshore areas. Numerous graded beds may indicate some turbidity current activity, but no Bouma sequences were observed. This, coupled with the observation that most sand layers are not graded, suggests that the occasional graded material was deposited in an environment not normally receiving turbidity currents. Graded beds may be analogous to Carboniferous graded shelf deposits described by Kelling and Mullin (1975). Carbonate nodules in red beds are interpreted as pedogenic deposits in what was apparently a semiarid to arid climate.

Unit 2 (unit 7 on map)

This unit occurs at Spear Point, and westward to Little Spear Cove, where it is in fault contact with Silurian strata. It probably extends as far south as Saltwater Cove, and, if so, is in fault contact with unit 1. The age of unit 2 relative to unit 1 cannot be stated with confidence because of the faulting. However, since facing directions along the entire length of White Bay are mainly westwards, it is probable that unit 2 (which lies west of unit 1) is younger than unit 1. The thickness of unit 2 is difficult to determine, but is probably a reasonable minimum.

Unit 2 is characterized by laterally persistent beds (1-40 cm in thickness, average about 5 cm)of orange-tan, impure, silty to fine sandy dolomites alternating with either dark gray siltstones, reddish-brown siltstones, or black mudstones. One dolomitic sandstone bed was observed.

The dolomite beds are characterized by basal cross-lamination, parallel lamination (usually above the cross-lamination), and sharp-based graded bedding. Climbing ripples, starved ripples, convolute lamination, and basal groove and load marks were also observed.

Siltstones, mudstones, and shales a few centimetres to 100 cm thick are usually massive (but not bioturbated), although some laminated siltstones occur. Micritic dolomite nodules occur parallel to bedding in some of the siltstones. Absence of any lamination or cross-lamination and the finer grain size within the nodules indicate that these nodules are not a loading or boudinage phenomenon of the detrital dolomite beds.

From the types of sedimentary structures and their vertical sequence, these dolomites and fine grained beds are interpreted as turbidites. Cross-lamination near the bottoms of dolomite beds represent the Bouma C division, and overlying parallel laminated and massive siltstones and mudstones, the Bouma D and E divisions, respectively. Dolomite nodules are viewed as chemical precipitates in what must have been a carbonate saturated body of water. Orientation measurements on groove marks, parting lineation, and cross-lamination indicate that the turbidity currents originated from a northwesterly direction.

Based on descriptions by Baird (1966) and Belt (personal communication, 1977), unit 2 appears to resemble the Lower Mississippian Cape Rouge Formation in the Conche-Groais Island area of the Great Northern Peninsula. Unit 2 is also reminiscent of the type A cementstone facies of Belt *et al.* (1967). Unit 2 may also be similar to portions of Popper's (1970) dolmite-silstone suite from the Grand Lake area.

Unit 3 (unit 8 on map)

This unit is the most extensive in the Anguille Group; it occurs (1) on the western shore of White Bay south of Gold Cove, (2) on Birch Ridge, (3) on part of the western shore of Grand Lake, and (4) inland from the western shore of Grand Lake. In southern White Bay, unit 3 seems to be younger than unit 1, although the contact is faulted. Elsewhere, unit 3 may be equivalent in age to, or even older than, unit 1. Again, an accurate thickness cannot be determined; however, 2700 m of strata occurs on the west limb of a syncline on the west side of Glide Mountain between Deer Lake and Grand Lake.

Unit 3 contains two contrasting facies which, although described separately, are tentatively combined into a single stratigraphic unit. This combination is based on the fact that sandstones and siltstones in both facies contain high abundances of white mica.

Facies 1 This facies is well exposed on the western shore of Grand Lake and in quarries along the Trans-Canada Highway. It underlies much of Birchy Ridge and Glide Mountain. Important lithologies are very fine-grained- to medium-grained, dark gray micaceous sandstone, very dark gray, micaceous siltstone, and black carbonaceous shales.The sandstones and siltstones form beds 5-15 cm thick, and contain straight-crested, symmetric and asymmetric ripple marks, wavy and lenticular bedding, cross-lamination, and parallel lamination. Synsedimentary deformation also occurs in places, with examples of loading, convoluted bedding, and rotated slump blocks. Sandstones and siltstones are sometimes laminated on a millimetre scale, and may include carbonate laminae. Fractured surfaces of siltstones often have a black, hard, carbonaceous aspect. Rarely, very thin beds (1-2 cm) of shale may contain enough carbon to be classified as impure coal. Plant debris is abundant in this facies. In siltstones, plant debris occurs as broken stems and twigs; in sandstones, branches and logs up to 10 cm in diameter are common.

These relatively fine grained beds are interbedded with medium to very coarse grained sandstones, conglomerates, and rarely occurring limestones. These coarse sandstones are light gray and buff colored and contain less mica and plant material than the finer grained and darker colored sandstones. Coarse sandstone tends to form single thick beds that invariably have sharp contacts which, in places, cut down into underlying finer grained sediments. Top contacts are also usually sharp, but some gradational boundaries are present. Internally, these sandstones are usually massive, and siltstone-shale intraclasts are common. Cross-stratification was also observed in some beds.

Conglomerates occur uncommonly in this facies. Clasts in conglomerate average about 5 cm in long diameter, and consist of the following: quartz, jasper, cream colored chert, black chert, white feldspar, orange feldspar, siltstone, felsic volcanic rock, fine grained granite, gneiss, schist, and phyllite. Clast composition varies from locality to locality, but quartz is ubiquitous, and is probably the most abundant. Impure limestone was seen only along Grand lake, and was fine grained and thinly bedded. It grades into calcareous siltstone.

In the Grand Lake-Glide Mountain area, available paleoccurrent information suggests currents mainly flowing towards the northwest (thus agreeing with Popper, 1970). However, current directions towards the southwest and southeast were also recorded.

Environmentally, these strata most likely represent nearshore and coastal accumulations of sediment. Thick, coarse grained, massive sandstones are tentatively interpreted as distributary channel deposits associated with a series of deltas. Finer grained deposits represent accompanying deltaic facies.

Facies 2. This facies appears restricted to the southern part of White Bay; it apparently interfingers or grades laterally into the first facies. It is dominated by thin to thick bedded (1 cm to 1 m, average about 20 cm), dark gray micaceous sandstone, dark gray siltstone, and black mudstone. The gray sandstones, which sometimes weather to brown, are very fine to medium grained. Most sandstone beds are massive, and many are graded, but cross-lamination and parallel lamination may occur. Load casts, grooves, flute casts, longitudinal ridges, and parting lineation also occur. Bedding is persistent, with sharp, even, basal contacts. Mudstone intraclasts near the tops of some sandstone beds are an unusual feature.

Siltstones are usually massive or laminated, but wavy bedding and lenticular bedding are present in some beds. Siltstones and mudstones contain much comminuted plant material.

In the lower part of this facies paleocurrents trend northeast-southwest, but as only parting lineation and groove casts were measured, no true direction of transport was determined. However, in the upper part, groove marks, longitudinal ridges, and flute marks suggest paleocurrents were directed almost due south.

The presence of abundant, sharp-based graded bedding suggests that these beds are turbidites, although no well defined Bouma sequences were observed. This facies may be a basinal equivalent of the deltaic sandstones of the first facies. If so, the paleocurrents in the lower part of the second facies were probably directed towards the northeast.

Unit 4 (unit 9 on map)

This is a poorly exposed unit on the west flank of Glide Mountain, where it underlies unit 3. It is also in fault contact with younger Carboniferous red beds of the North Brook Formation. Unit 4 is approximately 500 m thick, but because the upper contact is gradational with unit 3 sandstones, a more accurate thickness cannot be determined.

Unit 4 consists of two contrasting lithologies: a) conglomerate in which clast types are restricted to quartz and tan or orange weathering recrystallized dolomites (gray or buff on fresh surfaces);and interbedded limestones and dark gray siltstones, with some dolomites and gray micaceous sandstones. In unit 4a, clasts are set in a matrix of calcareous and sericitic quartz arenite. Clast size is less than 20 cm in long dimension. Individual beds are usually greater than 1m thick. Dolomite clasts were probably derived from Cambrian and Ordovician carbonates from the north and west. As suggested by Popper (1970) these conglomerates probably represent alluvial fan deposition. In unit 4b, individual beds are usually about 1-5 cm thick; dolomite and siltstone are laminated on a millimetre scale. Symmetrical ripple cross-lamination and parallel lamination were the only sedimentary structures observed. This group of lithologies probably represent nearshore accumulations of fine sediment, but a more detailed picture of the depositional environment cannot be constructed on the basis of the limited outcrop.

Unit 5 (unit 10 on map)

This unit, which is poorly exposed on the Trans-Canada Highway where the highway crosses Birchy Ridge, is at least 400 m thick, and appears to interfinger or grade laterally to the northeast into the deltaic facies of unit 3.

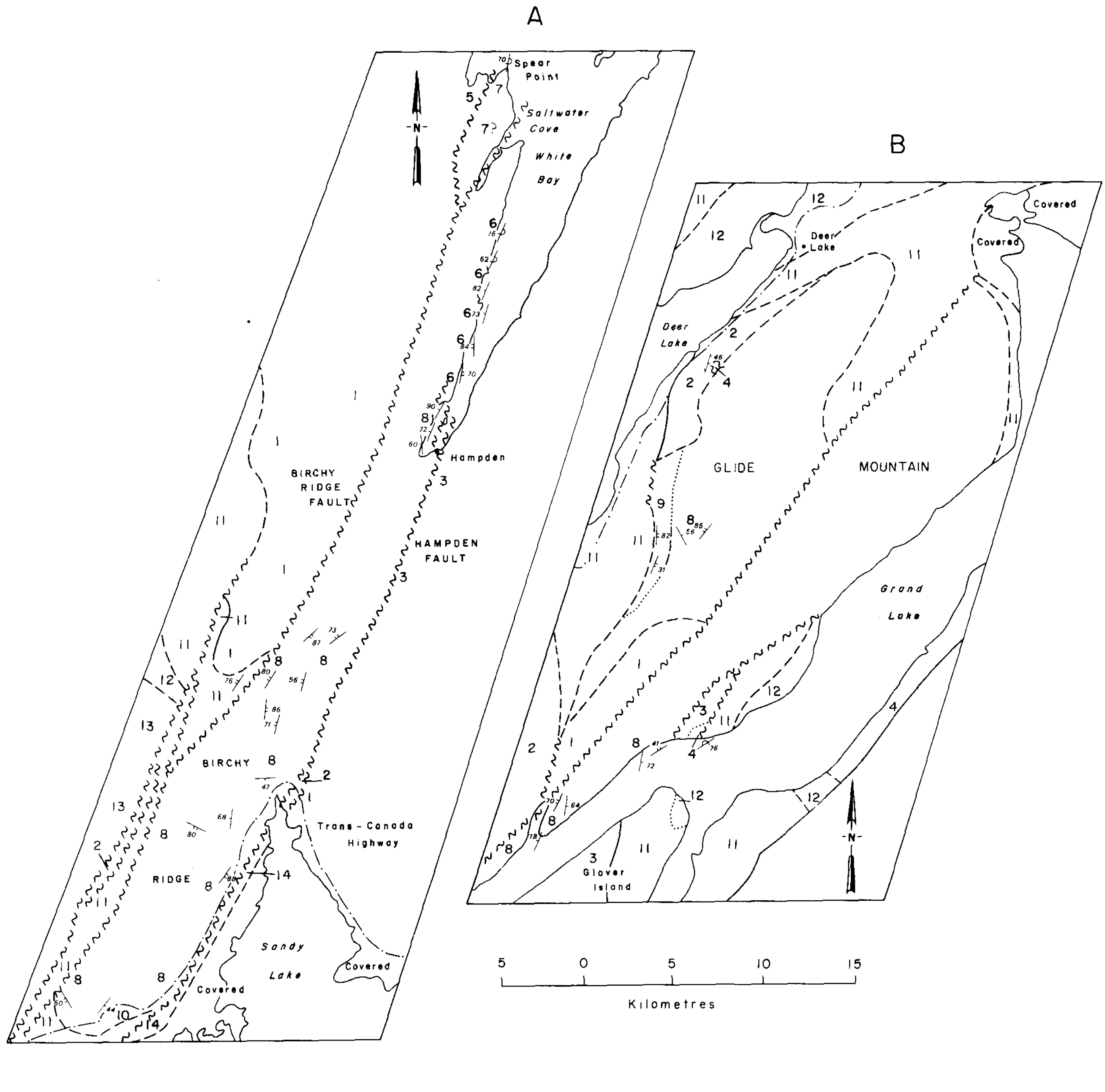
Lithologies are dominated by medium to coarse grained, micaceous, greenish-gray sandstones, very fine to medium grained, micaceous, red sandstones, and red siltstones. These rock types are organized into fining upwards sequences 2-3 m thick, with the gray sandstones at and near the base. The gray sandstones grade upwards into finer grained red sediments, which form the top of each sequence. Gray sandstones often contain red siltstone intraclasts quartz and orange feldspar pebbles were noted at the base of one gray sandstone bed. Other structures in the gray sandstones are linguoid ripple marks, cross-lamination, and very small organically produced tracks. The red sediments contain abundant plant debris as well as raindrop imprints and wrinkle marks.

The greenish-gray to red fining upwards sequences, the red siltstone intraclasts, and the presence of structures indicating intermittent subaerial exposure near the top of each sequence strongly suggests that these sequences represent meandering stream deposits. The presence of abundant plant fossils within unit 5 red beds is in strong contrast to unit 1 red beds, which contain dolomite nodules but no plant debris. This may reflect a change in climate from semiarid to arid (represented by unit 1) to a more humid climate in which plant growth was more luxuriant (represented by unit 5).

Unit 5 appears to lie between two separate deltaic portions of unit 3 (one delta system at Birchy Ridge, the other near Grand Lake). This suggests the presence of two separate lacustrine basins, one located to the northeast and the other to the southwest of unit 5.

IGNEOUS ROCKS

Previously unrecognized diabasic dikes and sills appear to intrude mainly carbonate rocks, but also siltstones, on the west shore of White Bay where unit 1 occurs. The diabases are dark gray in color and very fine grained. Betz (1948,page 12) also reports a small lamprophyre dike cutting Anguille strata on the west shore of White Bay. The diabases and the strata which they cut might represent upfaulted basement rock. However, because diabase intrudes what appears to be Carboniferous siltstone, it is more likely that the diabase is Carboniferous or younger.



A
B
-N-
Spear Point
Saltwater Cove
White Bay
Hampden
BIRCHY RIDGE FAULT
HAMPDEN FAULT
BIRCHY
RIDGE
Trans-Canada Highway
Sandy Lake
Covered
Deer Lake
GLIDE
MOUNTAIN
Grand Lake
Glover Island
5 0 5 10 15
Kilometres

LEGEND

PENNSYLVANIAN

14 — **HOWLEY BEDS:** *Yellow, orange, and red sandstones, pebbly sandstones, and conglomerates; gray and red shales, thin impure coals.*

MISSISSIPPIAN

DEER LAKE GROUP (11-13)

13 — **HUMBER FALLS FORMATION:** *Orange and red sandstones, pebbly sandstones and conglomerates; red shales.*

12 — **ROCKY BROOK FORMATION:** *Red and gray siltstones and shales; buff calcilutite, dololutite, and oil shales.*

11 — **NORTH BROOK FORMATION:** *Red, brown, and gray sandstones, pebbly sandstones, and conglomerates; some shale.*

ANGUILLE GROUP (6-10) Relative ages unknown

10 — *Gray and greenish-gray sandstones and siltstones; red and reddish brown siltstones with abundant plant fossils; rare pebble conglomerate.*

9 — *Pebble-cobble conglomerate with orange and gray dolomite clasts; interbedded gray, micaceous siltstone, limestone, and dolomite; some gray micaceous sandstone.*

8 — *Gray to white, coarse grained sandstone; gray, medium to fine grained, micaceous sandstone; dark gray, micaceous siltstone; black carbonaceous shale; pebble conglomerate; rare carbonate beds.*

7 — *Interbedded orange dolarenite and gray to reddish brown siltstone; carbonate nodules in some siltstone beds; rare gray sandstone.*

6 — *Gray and white, fine to very coarse grained sandstone; gray pebbly sandstone and conglomerate; dark gray siltstone and shale; red conglomerate, sandstone, and siltstone, and red beds containing carbonate nodules; green siltstone and shale; greenish-gray, brown, and orange dolomite.*

PRE-CARBONIFEROUS (1-5) Ages not distinguished

5 — *Little metamorphosed carbonate, sandstone, and shale.*

4 — *Ultramafic rock.*

3 — *Volcanic and hypabyssal rocks.*

2 — *Schist, phyllite, quartzite and metaconglomerate.*

1 — *Granitoid rock.*

SYMBOLS

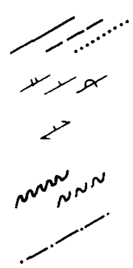
Geological boundary (defined, approximate, assumed) ....

Bedding (tops unknown, tops known, overturned) ....

Schistosity ....

Faults (defined, approximate) ....

Trans Canada Highway ....



STRUCTURAL GEOLOGY

Large and small scale, flexural-slip folds trend northeastwards, and large regional folds have axial planes dipping steeply (>50°) to the southeast. Plunge directions and plunge angles vary considerably, but consistent northeasterly plunge directions were recorded from the Spear Point region. Most plunge angles are less than 60°, and subvertical to vertical plunges are restricted to minor drag folds. Several small kink folds were observed in laminated rock in southern White Bay. The hinge line of one of the kinks trends at 098°, which is a strong deviation from the regional structural trend.

Large fault zones parallel to the regional strike occur within Carboniferous strata of western Newfoundland, and are responsible for the existence of Grand Lake and White Bay. Both high angle normal and reverse faults were recognized in small faults. There is also little consistency in fault plane dip directions for northeasterly trending faults in White Bay and Grand Lake. All observed fault plane dips were greater than 40°. Faults are responsible for large changes in bedding plane orientations.

A bedding plane cleavage is developed in sandstones, siltstones, and especially carbonate rocks near the White Bay fault zone. Cleavage oblique to bedding rarely occurs, but two occurrences were noted in unit 3 at White Bay and in a quarry off the Trans-Canada Highway.

MINERALIZATION

Basement rocks: In basement rocks, several gossans occur in metasandstone exposed in roadcuts along the Trans-Canada Highway just east of Routh 420. One gossan contains disseminated pyrite and chalcopyrite. Carbonate rocks probably belonging to the Ordovician St. George Group contain calcite veins that have brecciated the country rock. These veins contain knots of pyrite and, more rarely, grains of chalcopyrite and sphalerite (?). These showings were observed in quarries near the intersection of Routes 430 and 422. Mafic and ultramafic (?) rocks exposed on the west shore of Grand Lake contain a large gossan with disseminated pyrite, chalcopyrite, and possibly some arsenopyrite. Asbestos occurs in serpentinized peridotite on the west side of Glide Mountain.

Anguille Group: In unit 1 , folded quartz veins, potential hosts for saddle reef type gold deposits, are numerous in sandstones. Small gossans occur in siltstones and sandstones in unit 3 along the west shore of White Bay and in quarries off the Trans-Canada Highway. These gossans are usually barren, but some contain disseminated pyrite and chalcopyrite. Some shales in unit 3 may contain enough carbon to be classified as impure coal, but if so the seams are very thin(2 cm). Hematite forms coatings on bedding planes in some red siltstones in unit 5.

Deer Lake Group: Oil shale, natural gas, and coal are known in the Deer Lake Group (Baird, 1950; Fleming, 1970; Hayes, 1949). In addition to these well-known occurrences of fossil fuels in the Deer Lake Group, one 0.5 m thick bed of calcareous mudstone in the Rocky Brook Formation yielded radiation counts up to ten times the background value of the enclosing strata. This anomaly was recorded north of Deer Lake along North Brook. Also in the Rocky Brook Formation below the Big Falls of the Humber River, veins within carbonate concretions contain small amounts of barite.

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