WEST COAST SHALE PROJECTS

by

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Two shale surveys were carried out in western Newfoundland during the 1984 field season. In the Corner Brook area, a search was carried out in conjunction with North Star Cement Company to locate new shale reserves which would be geochemically compatable with limestones used in the production of cement. In the Codroy-Anguille area, a lithogeochemical survey was carried out to continue the investigation of base metal potential in the Mississippian Anguille Group.

Corner Brook Shale Survey

The North Star Cement Company quarries shale adjacent to its cement plant in Corner Brook. Shale comprises 20% of the raw mix used in the making of cement and the existing shale quarry presents problems because of its variable geochemistry. A reconnaissance survey of Paleozoic shales was carried out to locate new potential shale reserves close to the plant.

A number of geochemical parameters restrict the type of shale used in the production of cement. They are (1) an SiO_2:Al_2O_3 ratio greater than 4:1, to assure long term strength of the cement, and (2) low levels of MgO, SO_3, K_2O and Na_2O. To avoid the buildup of undesirable residue in the kiln, a sulphur content below 1% is necessary to prevent the formation of sulphates by reaction with alkalai elements.

North Star's present and preferred shale geochemistry is shown in Figure 1 with the ranges of some of the elements in brackets:

	North Star Shale	Ideal Shale
SiO_2	57% (53-65%)	60-65%
Al_2O_3	15% (11-21%)	10%
Fe_2O_3	5.5% (4-7%)	Not critical
MgO	3.8%	As low as possible
K_2O	2.8%	As low as possible
SO_3	1.3%	As low as possible
Na_2O	1%	As low as possible
S	1%	1% maximum

Figure 1

North Star counters the effect of the variable geochemistry of their shale pit by using a preblended stockpile. To attain the desired high silica content, unconsolidated siliceous sand is added to their mix, although grinding problems place a limit on the amount of sand which can be added. Location of a more consistent silica-rich, alumina-poor shale facies would not only facilitate day to day operations, but would allow greater flexibility in the production of various speciality cements.

Fine grained clastic sediments were sampled from 5 formations ranging in age from latest Precambrian to Carboniferous and representing several contrasting depositional environments. The geochemical composition of these units (Figure 3) are equally contrasting providing a varied selection of shale geochemistry and data which may modify some of the present geological contacts in the Corner Brook area. North Star analyzed the samples with their XRF unit as the project was being carried out, thus allowing for immediate follow-up of the most promising results.

The first group of "shales" studied belong to the Humber Arm Supergroup. Samples were collected from roadcuts on the Corner Brook "ring road" and on the north and south side of the Humber Arm (Figure 2). Lithologies sampled include red and green slates and gray to black fissile shales and interlaminated siltstones from the Summerside and overlying Irishtown Formations. These rocks are believed to have accumulated as a wedge of continental slope/rise sediments to the east of Lower Paleozoic shelf carbonates over which they were later thrusted during the Taconic Orogeny (Williams et al., 1982). Analyses of shales from these two units show that they are chemically very similar, but distinctively different than the shale from North Star's present quarry (see Figures 1 and 3). The SiO_2:Al_2O_3 ratios of less than 3:1 make the shales from these formations unsuitable for use in the production of cement.

The uppermost group in the carbonate shelf sequence is the Table Head Group. Near the top of this group there is a unit of black, pyritiferous shale/mudstone, the Black Cove Formation, whose type section is exposed on the coast just north of the Port au Port Peninsula. The shales were deposited in a restricted basin after the collapse of the Lower Paleozoic carbonate platform during the Middle Ordovician (Klappa et al., 1980). Sediments of this formation closely resemble those seen in the North Star's quarry but analyses are not available for geochemical comparison at this time.

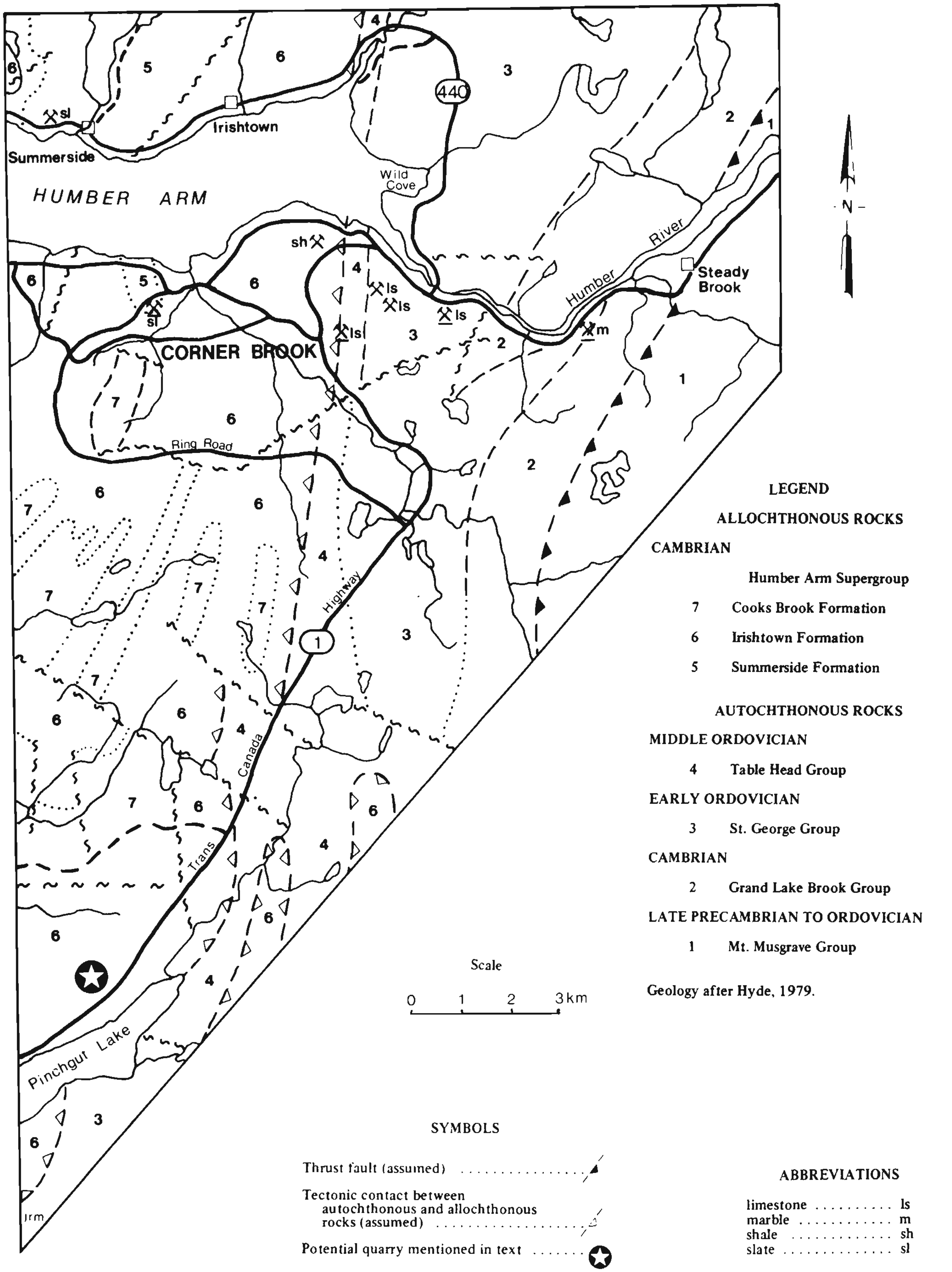


Figure 2: *Geology of the Corner Brook area.*

FORMATION	SiO_2	Al_2O_3	Fe_2O_3	CaO	SO_3	MgO	K_2O	TiO_2	Number of samples averaged	$SiO_2:Al_2O_3$
Summerside	52.3	18.7	7.0	0.7	0.1	3.5	3.3	0.8	4	2.80:1
Irishtown	49.8	20.3	6.9	1.5	0.3	3.4	2.8	0.8	22	2.45:1
North Star shale (Black Cove ?)	57.0	15.0	5.5	-	1.3	3.8	2.8	-	average from North Star	3.80:1
Green shale and sandstone	52.7	13.9	6.3	4.3	0.1	5.1	2.3	0.6	26	3.79:1
Rocky Brook	38.9	10.3	4.5	9.7	0.3	10.4	0.5	2.1	7	3.77:1

Figure 3

A third shale unit was sampled south of Corner Brook in the vicinity of Pinchgut Lake. Here, greenish to blackish gray, slightly chloritic shales interbedded with greenish gray schistose siltstones and sandstones outcrop on the west side of the Trans-Canada Highway and in an abandoned quarry to the southwest. While these sediments are distinctly different in appearance from those seen in North Star's quarry, their $SiO_2:Al_2O_3$ ratio is comparable, although the SO_3 and K_2O content is lower. On the basis of these results North Star began a small drill program in the abandoned quarry during the fall of 1984. Preliminary trace element analyses show that the average nickel content from this unit is 94 g/t, as compared to 38 g/t and 37 g/t from the Summerside and Irishtown Formation respectively, suggesting the chloritic shales are probably not correlative with the allochthonous formations. The high Ni content may, however, suggest the chloritic shales are autochthonous easterly derived flysch deposits of Middle Ordovician age perhaps equivalent to the Mainland sandstone of Schillereff and Williams' (1979). This formation has not been previously recognized in the Corner Brook area.

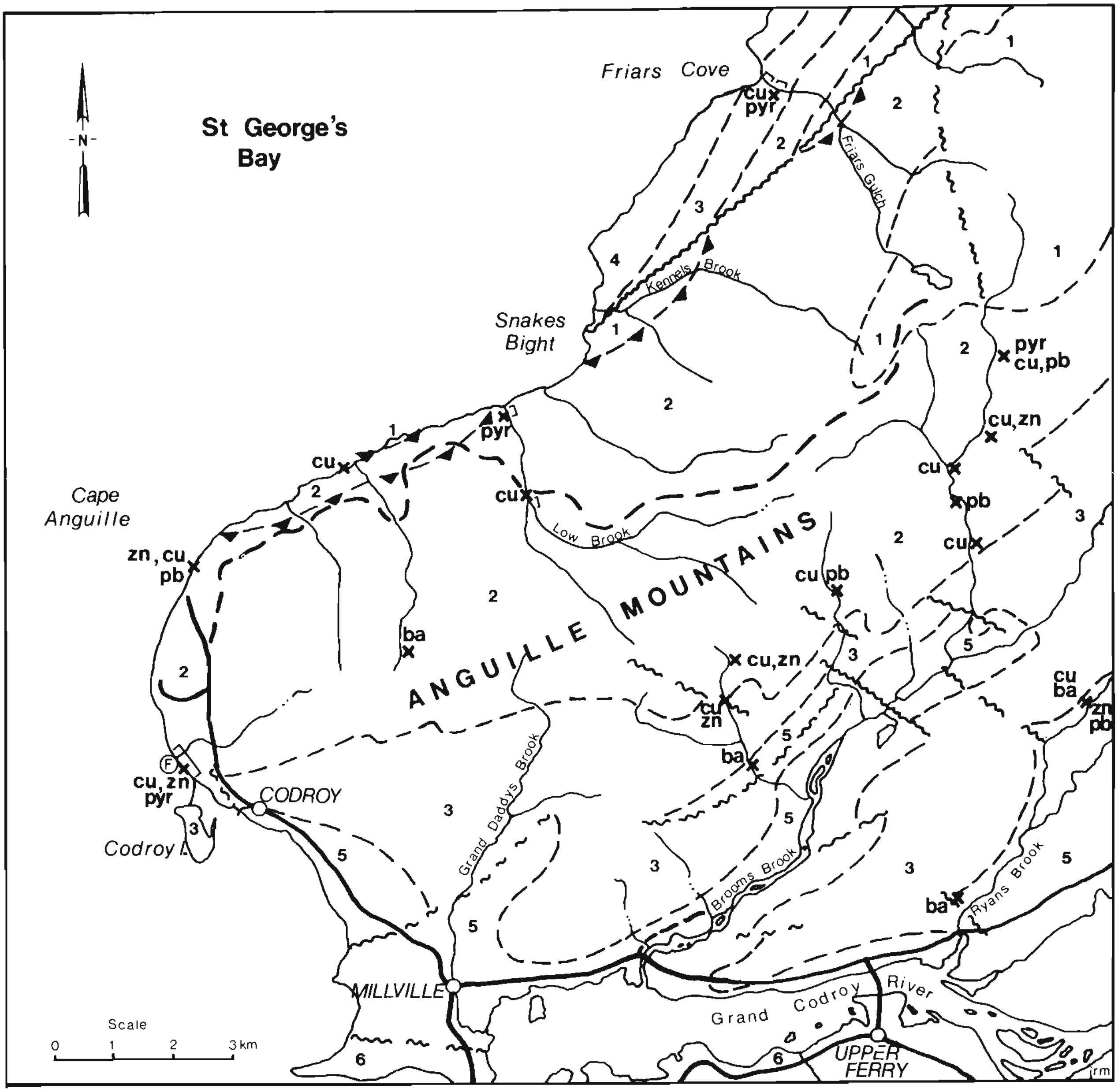
The youngest sediments investigated in this survey belong to the early Carboniferous Rocky Brook Formation which is exposed to the north of Deer Lake. Gray to black bituminous mudstones and greenish gray calcareous and/or pyritic shales deposited in a perennial lacustrine setting (Hyde, 1981) were sampled from roadcuts, stream exposures, and drill core. These sediments are comparatively lower in SiO_2 and Al_2O_3 than the other shale units sampled but have an average $SiO_2:Al_2O_3$ ratio of 3.77:1. The MgO content greater than 10% however, makes these shales unsuitable for the manufacture of cement.

From the geochemical data collected in this survey, the most favourable exploration targets for shale to be used in the production of cement in the Corner Brook area, would be: 1) recessively weathered shales of the Black Cove Formation, (near the upper contact of the Table Head Group in Figure 3), and 2) green chloritic shales and interbedded sandstones that outcrop south of Corner Brook.

Codroy Project

An investigation of the mineral potential of shale units of the Anguille Group in the Codroy-Anguille area was carried out in June, 1984. Shales and associated fine grained clastic sediments were sampled from the type sections and well exposed mineralized sections of the Mississippian Anguille Group. Base metal showings have been well documented in this area by Knight (1983) and Howse (1983). The mineralization is commonly associated with calcite and/or quartz veins which transect black shale of the Snakes Bight Formation. Knight (1983) suggested that mineralization found in small faults, tension joints and fractures was precipitated from fluids derived from the compaction and dewatering of this shale.

The Anguille Group consists of nonmarine sediments of late Devonian to early Carboniferous age. The sediments were deposited within a successor basin that evolved into a narrow fault bounded graben (approximately 30 km wide) that paralleled the Long Range Fault and shallowed to the northeast. Over 3 km of red and gray fluviatile sandstone, conglomerate and slate (Kennels Brook Formation) were initially laid down in the late Devonian. Wrench fault movement, initiated in the early Carboniferous along the Long Range Fault, controlled the formation of a pullapart basin and uplifted highlands around the basin. Deep to shallow water lacustrine sediments of the 1 km thick Snakes Bight Formation were deposited at this time in the wrench graben. The lake shallowed with time and became restricted to the southwest of the basin as gray fluvial deltaic and red fluvial sands and muds of the Friars Cove and Spout Falls Formation filled the basin. The main locus of subsidence within the basin at this time shifted to the northeast coupled with the displacement of highlands to the north of the basin (Knight, 1983).



LEGEND

6 BARACHOIS GROUP (Namurian to Westphalian)
5 CODROY GROUP (Middle to Upper Visean)
ANGUILLE GROUP (Tournaisian, may include Fammenian)

(Units 1-4)

4 SPOUT FALLS FORMATION
3 FRIARS COVE FORMATION
2 SNAKES BIGHT FORMATION
1 KENNELS BROOK FORMATION

SYMBOLS

Geological Boundary (approximate)
Fault (definite, approximate, assumed)
Thrust Fault (approximate)
Mineral Occurrence × zn
Fossil Fish Ⓕ
Section

ABBREVIATIONS

Barite...... ba
Copper...... cu
Lead........ pb
Pyrite...... pyr
Zinc........ zn

Geology from Knight and Brown, 1975.

Figure 4: *Geology of the Codroy-Anguille area.*

Sediments at the base of the Snakes Bight Formation consist of lacustrine black shale and mudstone which are often finely laminated, pyritiferous and carbonaceous, indicating euxinic basin conditions. The lake was subsequently infilled with density current deposits that produced a variety of sandstone, siltstone, and shale lithofacies. Thick mixtite units punctuate deposition and suggest that the basin had steep unstable flanks and was tectonically active. Growth faults, notably the Snakes Bight Fault (Figure 4) were active at this time. Characteristics found in the Snakes Bight Formation compare favourably to the geological setting of known sediment-hosted massive sulfide deposits described in a review by D. Large (1983). This survey will attempt to document whether any rocks of the Snakes Bight and Friars Cove Formations have an anomalously high background in base metals and possess the potential for economic concentrations of such metals.

Three sections were mapped and sampled from the Snakes Bight Formation. Two of these are on Low Brook, which drains into St. George's Bay at Snakes Bight. The first is at the mouth of Low Brook and the second is upstream of the road to the site of the abandoned Brinex Union Oil oil well site (Figure 4). The third is a coastal section northwest of the breakwater at the town of Codroy. Each section contains two or more of the following styles of mineralization: (1) stratiform pyrite laminations up to 4 mm thick; (2) finger-sized "clots" of disseminated pyrite/chalcopyrite; (3) veinlets of pyrite and/or chalcopyrite, and (4) sphalerite crystals (1-4 mm in size) in calcite veins and/or galena crystals (1-3 mm in size) on calcite-coated fracture planes. Further work in this formation included prospecting and sampling short and long sedimentary sections on the northernmost tributary of Brooms Brook, where Howse (1983) previously found showings of chalcopyrite and galena. In the Codroy breakwater section a complete, well preserved fish fossil was found, the first non-marine vertebrate fossil found in the Anguille Group (see Boyce et al., this volume).

Two shale sections within the Friars Cove Formation were sampled at the type section on Friars Gulch (Figure 2). Both contain 1-3 mm pyrite laminations in shale, finely disseminated chalcopyrite in both interlaminated siltstone and in 5-10 mm rounded "clots" in sandstone interbeds. As in the Snakes Bight Formation much of the shale sampled is black, finely laminated, carbonaceous and sulphide-rich, although gray shales also occur in the sections.

In total 77 chip samples were collected from 1 to 3-metre stratigraphic intervals and are presently being analyzed for Cu, Pb, Zn, Ag, Ba, Fe, Mn, Ni, Co, V, U, F, and major elements.

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