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ASSESSMENT OF BEDROCK FOR AGGREGATE USE, SOUTHWESTERN NEWFOUNDLAND

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ABSTRACT

The 1993 field season consisted of an evaluation of bedrock-aggregate potential of the southwest coast of Newfoundland.

A total 232 sites were visited and 283 samples collected. A petrographic number was assigned to each sample (based on a preliminary petrographic examination). Two hundred and twelve samples were considered to be of high quality, 33 samples are considered to be of fair quality and 38 samples were considered to be of low or poor quality.

Further detailed analyses, such as the Los Angles Abrasion, Magnesium Sulphate Soundness and Alkali-Aggregate Reactivity tests are planned for selected samples.

INTRODUCTION

During the 1993 field season, an evaluation of the bedrock-aggregate potential was carried out in the area between Corner Brook and Port aux Basques (Figure 1). This is a continuation of an aggregate-reconnaissance project started in 1985 to determine the bedrock-aggregate potential of different rock groups/formations in a particular region of the province. This assessment was conducted in order to determine the quantity and quality of bedrock for potential use as construction aggregates in road building, bridge repair or replacement and other applications and thus eliminate the use of poor-quality aggregate such as alkali-reactive rocks (Plate 1), which react with the cement paste to cause premature deterioration of concrete (Plate 2), weathered rock in asphalt (Plate 3) and friable rock for rip-rap (Plate 4) or armour stone.

FIELD WORK

Field work consisted of a detailed examination of all rock quarries, roadcuts and natural outcrops along highways and secondary roads. Each site investigation entailed rock identification, representative sampling, determining where possible land ownership and present or previous use, overburden thickness, the recording of any geological features present using the techniques developed by Bragg (1989).

Once the site investigation has been completed, an initial quality reference (petrographic number) is given to each sample collected based on the durability of the rock. The durability of a rock is based on a number of factors (fractures, joints, cleavages, grain size, bedding, flow structures, mineral alignment, hardness and degree of weathering), which may be deleterious to the rock. Deleterious substances are

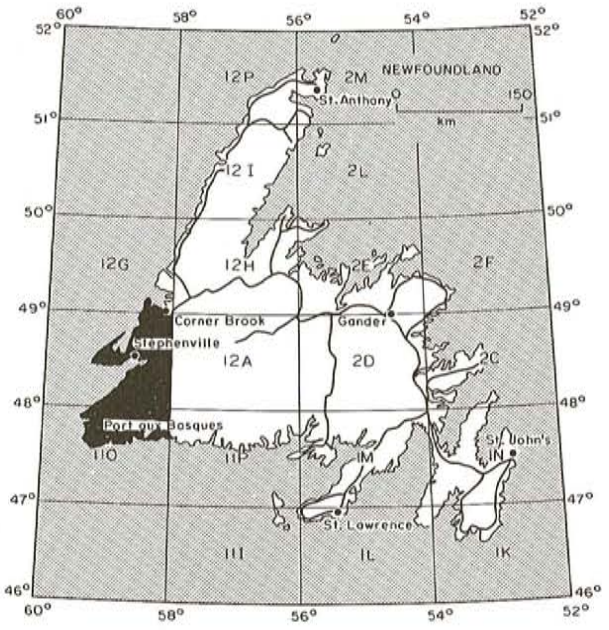

Figure 1. *Location map, 1993 study area.*

materials or structures that occur within, or on the rock surface, and are capable of producing adverse effects on the rock such as premature deterioration of the rock when used as a construction aggregate (road building, asphalt, concrete, rip-rap, and armour stone). Common deleterious substances include clay minerals, organic matter, mica, iron and manganese oxide staining and cherty or fine-grained siliceous material.

A petrographic number (P.N.) is calculated for each sample site. This is a preliminary screening test to measure

Plate 1. *Sandstone showing reactive rims around the pebbles.*

the quality of a material for aggregate use. The petrographic number may be calculated by multiplying the percentage of a particular rock type at a site or in a sample by its appropriate petrographic factor; then, the products are summed giving a petrographic number. The petrographic factor (P.F.) ranges from 1 (best) to 10 (worst) (Table 1; C.S.A., 1973). A revised version for Newfoundland rock types (Table 2; Bragg and Norman, 1988; and Bragg, 1989, 1990 and 1991) gives a more accurate petrographic factor range. The P.N. is the sum of the factors for the percentage of each rock type and can range from 100 to 1000.

The lower the P.N., the higher the rock quality (e.g., a clean, fresh, hard, fine-grained durable granite would normally have a P.F. of 1 and a P.N. of 100; whereas a friable, soft shale would normally have a P.F. of 10 and a P.N. of 1000).

Plate 2. *Premature deterioration of concrete, showing pattern cracking due to alkali-aggregate reactivity.*

Plate 3. *Premature deterioration of asphalt, caused by poor aggregate being used and poor design.*

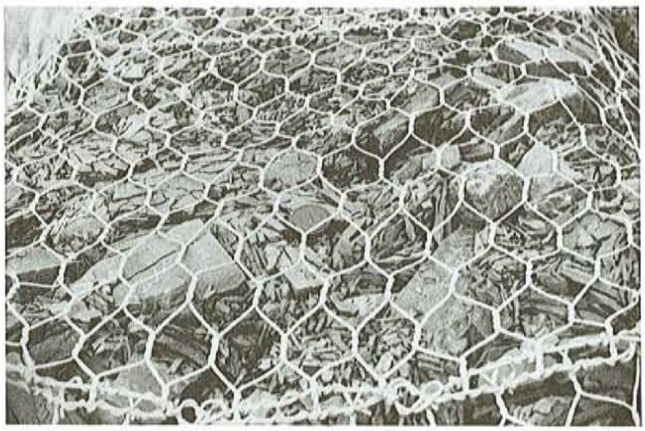

Plate 4. *Friable rock being used for rip-rap.*

GENERAL GEOLOGY

The geology of the field area consists of granitic rocks of the Rose Blanche Granite (white to pink equigranular garnetiferous, biotite–muscovite leucogranite, Chorlton, 1982) and the Port aux Basques Complex (Chorlton, 1982). The latter consists of two units: the Port aux Basques gneiss, a staurolite–kyanite–garnet–biotite gneiss having abundant amphibolite interbands and is migmatitic locally, and the Port aux Basques granite, a medium- to coarse-grained red, biotite, muscovite granite that is pegmatitic, locally. The Indian Head complex (Williams, 1981) consists mainly of anorthosites, minor norite, gabbro and granite, and the Burgeo granite (Dickson *et al.*, 1985) consists mainly of coarse-grained, feldspar porphyritic, biotite granite and granodiorite.

Carbonate sedimentary rocks (limestones and dolomites), which consist of fine- to medium-grained fossilized, oolitic, argilliferous, brecciated and fresh to moderately weathered rocks, and minor clastic sedimentary rocks (shales, siltstones and sandstones) of the St. George, Table Head and Humber Arm groups (Knight, 1977; Williams *et al.*, 1985; Knight and Saltman, 1980; James and Stevens, 1982) are found mainly

Table 1. Rock type and petrographic factors

Rock type	Classification	Factor
Carbonates (hard)	good	1
Carbonates (sandy, hard)	good	1
Sandstone (hard)	good	1
Gneiss (hard)	good	1
Quartzite (coarse grained)	good	1
Greywacke–arkose	good	1
Volcanic (slightly weathered)	good	1
Granite–diorite	good	1
Trap	good	1
Magnetite	good	1
Pyrite (disseminated in trap)	good	1
Iron-bearing quartzite	good	1
Sedimentary conglomerate (hard)	good	1
Carbonates (slightly weathered)	fair	3
Carbonates (sandy, medium hard)	fair	3
Sandstone (medium hard)	fair	3
Crystalline carbonates (hard)	fair	3
Crystalline carbonates (slightly weathered)	fair	3
Gneiss (soft)	fair	3
Chert and cherty carbonates	fair	3
Granite (friable)	fair	3
Volcanic (soft)	fair	3
Pyrite (pure)	fair	3
Flints and jaspers	fair	3
Carbonates (soft, slightly shaly)	poor	6
Carbonates (soft, sandy)	poor	6
Carbonates (deeply weathered)	poor	6
Carbonates (shaly clay)	poor	6
Carbonates (ochreous)	poor	6
Chert and cherty carbonates (weathered)	poor	6
Sandstone (soft, friable)	poor	6
Quartzite (fine grained)	poor	6
Crystalline carbonates (very soft, porous)	poor	6
Gneiss (friable)	poor	6
Granite (friable)	poor	6
Encrustations	poor	6
Cementations	poor	6
Schist (soft)	poor	6
Ochre	deleterious	10
Shale	deleterious	10
Clay	deleterious	10
Decomposed volcanics	deleterious	10
Slates	deleterious	10
Talc–gypsum	deleterious	10
Iron formations (very soft)	deleterious	10
Sibley formation	deleterious	10

on the Port au Port Peninsula and Corner Brook area. Sedimentary rocks (sandstones, siltstones, shales, conglomerates) with minor carbonates of the Codroy and Anguille groups (Knight, 1983), March Point Formation (James *et al.*, 1980) and part of the Spruce Brook formation (Colman-Sadd, 1985) are found mainly along the coastal areas.

Table 2: Petrographic factors for most common rock types in Newfoundland

Rock Type	Petrographic Factor Range	Usual Factor
1. Sandstone	1-6	1.15
2. Shale	6-10	7.5
3. Mudstone	1-6	2.5
4. Siltstone	1-6	1.2
5. Conglomerate	1-10	2.5
6. Arkose	1-3.5	1.15
7. Greywacke	1-3.5	1.15
8. Argillite	1-5	1.5
9. Chert	1-3.5	1.3
10. Limestone	1-3	1.2
11. Dolomite	1-3	1.15
12. Quartzite	1-2.5	1.1
13. Granite	1-3	1.1
14. Gabbro	1-2	1.0
15. Diorite	1-2	1.O
16. Granite-Diorite	1-3	1.15
17. Felsic volcanic rock	1-4	1.25
18. Mafic volcanic rock	1-3.5	1.2
19. Intermediate volcanic rock	1-3.5	1.2
20. Pyroclastic rock	1-6	1.5
21. Metavolcanic rock	1-4.5	1.5
22. Gneiss	1-6	1.25
23. Schist	2-10	2.5
24. Phyllite	2-10	3.1
25. Marble	1-4.5	1.2
26. Slate	2.5-10	3.8
27. Amphibolite	2-6	3.3
28. Ultramafic	1-10	2.1
29. Metasediment	1-5	1.35
30. Psammite	1-7	1.65
31. Pelite	2-8	3.1
32. Iron formation	4-10	5.5
33. Drift deposits	1-8.5	1.1-2.5

Metamorphic rocks (gneiss, schist, phyllite, psammitic and pelitic schist) of the Mount Musgrave group (Williams *et al.*, 1983) are found in the Corner Brook area and metamorphic rocks of Bay Du Nord Group (Chorlton, 1980) are found in the southwest section of the field area. Volcanic rocks (rhyolite, tuffs, basalt, agglomerate and breccia) and sediments of the Georges Brook Formation (Chorlton, 1978) are also found in the southwest.

RESULTS AND DISCUSSION

A total of 232 sites were visited and 283 samples collected. Table 3 shows the initial assessment of the quality of different rock groups/formations in southwestern Newfoundland based on field observations and petrographic numbers.

Eight samples were collected from the Rose Blanche Granite and 5 of these samples were from the fresh, hard, minor biotite–muscovite granite and had P.Ns. less than 150, which is the limit set by the Newfoundland Department of

Table 3: Petrographic numbers (P.N.) for different rock units in southwestern Newfoundland

Group/Formation	Number of Samples	P.N. Range	P.N. <150	P.N. >150	P.N. Average
Rose Blanche Granite	8	110-250	5	3	130
Port aux Basques gneiss	65	110-310	50	15	120
Port aux Basques granite	3	110-120	3	0	113
March Point Formation	5	120-155	4	1	125
St. George Group	31	110-130	31	0	115
Table Head Group	35	110-310	29	6	110
Humber Arm Group	15	115-500	5	10	280
Indian Head complex	12	110-220	10	2	120
Codroy Group	4	150-400	2	2	285
Anguille Group	2	250	0	2	250
Mount Musgrave group	30	110-350	10	20	250
Burgeo Granite	30	110-255	27	3	115
Georges Brook Formation	26	110-130	26	0	115
Bay Du Nord Group	10	110-350	8	2	125
Spruce Brook formation	7	145-600	2	5	350

Works, Services and Transportation for Class A aggregate; the remaining 3 samples were moderately weathered and thus had a P.N. greater than 150. The Port aux Basques Complex, which is divided into two units had 68 samples taken from it, 65 samples were from the gneissic unit, which is the main unit in the study area. Fifty of these samples were from the fresh, hard gneiss with P.Ns. less than 150, whereas the remaining 15 samples were from slightly to moderately weathered gneiss with high mica content and these had petrographic numbers greater than 150. Three samples from the Port aux Basques granite were all fresh and hard and have P.Ns. greater than 150. The March Point Formation had 5 samples collected from it; 4 samples were from the carbonate unit, which is a minor constituent of this formation with petrographic numbers less than 150; 1 sample was from the sandstone with P.N. greater than 150. Thirty-one samples were collected from the St. George Group and all had P.Ns. less than 150. Thirty-five samples were collected from the Table Head Group; of these, 29 samples, which were all limestones, had P.Ns. less than 150, 6 samples had P.Ns. greater than 150. Of the latter six, 2 samples were moderately weathered limestone and the remainder were weathered sandstones. Twelve samples were collected from the Indian Head complex; of these 10 samples had P.Ns. less than 150 and 2 samples, which were moderately weathered granites, had P.Ns. greater than 150. Thirty samples were collected from the Burgeo granite; of these, 27 samples, were from fresh, hard granites, while the remaining 3 samples were from moderately weathered granite. Twenty-six samples were collected from the Georges Brook Formation and all samples were assigned P.Ns. of less than 150. Ten samples were collected from the Bay du Nord Group; of these, 8 samples of fresh, hard metasediments were assigned P.Ns. of less than 150, while the remaining 2 samples, which were schist, had P.Ns. of greater than 150. The above units are considered to be of high-quality aggregate potential provided that the rock types from these units are fresh, hard and free of deleterious substances. Most of samples (225) collected come from these units, of which 193 samples are considered to be of high quality (P.Ns. 110 to 150) and the remaining 32 samples range from fair to poor quality (P.Ns. 155 to 350) aggregate potential.

Fifteen samples were collected from the Humber Arm Group; of these, 10 were considered to be of fair to poor quality (P.N. > 150), which consisted of slightly to moderately weathered sandstone, while the remaining 5 samples were considered to be high quality (P.N. < 150) and consisted of fresh and medium limestones. In the Anguille Group, only two samples were collected and both these consisted of moderately weathered sandstones with P.Ns. greater than 150. Four samples were collected from the Codroy Group; 2 samples consisted of weathered micaceous sandstone with P.Ns. greater than 150 and 2 samples consisting of slightly weathered limestone with P.Ns. less than 150. From the Mount Musgrave group, 30 samples were collected; of these, 20 samples consist of schist, weathered gneiss and phyllite have P.Ns. greater than 150, while the remaining 10 samples consisting of granitic gneiss had P.Ns. less than 150. The Spruce Brook formation, from which 7 samples were collected; 5 consist of weathered sandstones and siltstones. The P.Ns. were greater than 150, whereas the remaining 2 fresh, hard sandstones had P.Ns. less 150.

The Humber Arm, Anguille, Codroy and Mount Musgrave groups, and the Spruce Brook formation are considered to be of fair to poor-quality aggregate potential. A total of 58 samples were collected from these units, of which 39 samples are considered to be of marginal to poor-quality aggregate and of the remaining 19 samples, 12 samples are considered to be of fair quality and 7 samples are considered to be of high quality.

Although the initial assessment of the above units was made from representative sampling, further study and investigation should be carried out on materials from these

units before being considered for aggregate used; especially from the units with less than five collected samples.

SUMMARY

The granites, granitic-gneiss and other igneous rocks of the Rose Blanche and Burgeo granites, Port Aux Basques and Indian Head complexes, plus the carbonate and sedimentary rocks of the March Point, St. George, Table Head units, metasedimentary and volcanic rocks of the Bay Du Nord Group and Georges Brook Formation, respectively, show the highest potential for use as high-quality construction aggregates. Sedimentary rocks of the Codroy, Anguille and Spruce Brook units, carbonate rocks of the Humber Arm Group and metamorphic rocks of the Mount Musgrave group show the lowest potential for high-quality construction aggregates.

Further study and investigation such as Los Angeles Abrasion, Magnesium Sulphate Soundness, Alkali–Aggregate Reactivity and Stripping tests are recommended on rocks taken from these units depending on the final use of the material.

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