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BEDROCK-AGGREGATE POTENTIAL OF THE GREAT MOSQUITO COVE AREA, BULL ARM

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ABSTRACT

The bedrock geology of the Great Mosquito Cove area was mapped to determine the quantity and quality of bedrock for potential use in the construction of the Gravity-Based Structure for the Hibernia project. The study consisted of geological mapping and detailed testing of the selected rock units found in the area. Geotechnical bedrock properties, including geological structures and deleterious substances were examined; abrasion and soundness testing were analyzed, petrographic analyses and petrographic number computations were carried out. Results show that there are sufficient quantities of high-quality bedrock in the area for use as aggregate.

INTRODUCTION

The Great Mosquito Cove area is situated on the western side of Bull Arm, an inlet that extends northwestward from Trinity Bay on the Isthmus of Avalon. The closest community is Sunnyside, which lies at the northwestern extremity of Bull Arm. A recently constructed road connects the area to the Trans-Canada Highway, 6 km to the west.

The production system for the Hibernia oilfield includes a Gravity-Based Structure (GBS) and a Topsides module. Construction of the GBS, Topsides module, and mating of the Topsides with the GBS will take place at Great Mosquito Cove. The site is presently being prepared for construction.

High-quality aggregate is required in the construction of the GBS. Previous sampling in the area by Bragg (1991) resulted in locating suitable bedrock for high-quality aggregate potential close to Great Mosquito Cove. The present study was undertaken to geologically map the area in order to define the extent and thicknesses of suitable bedrock units and to test representative samples from selected rock types within these units to verify their quality.

In order for a particular rock type to be considered as a high-quality aggregate for concrete use it must pass rigorous physical and chemical testing procedures. Physical testing such as the Los Angeles Abrasion (ASTM C131-89), Magnesium Sulphate Soundness (ASTM C88-83) and specific gravity (ASTM C127-88), and chemical testing such as alkali-aggregate reactivity (Oberhoster and Davis, 1986) were performed on selected samples. Petrographic analyses were done on all samples from the field area.

FIELD WORK

Field work consisted of detailed mapping of the geological units found in the area. Each site investigation included, rock identification, representative sampling, determination of overburden type and thickness, the description of geological features, and determination of petrographic number, following the methods outlined by Bragg (1989).

GEOLOGY

The map area is underlain by a succession of late Precambrian volcanic and sedimentary rocks that are part of the Musgravetown Group (Hayes, 1948), which consists of a lowest formation of mainly volcanic rocks called the Bull Arm Formation (McCartney, 1967) conformably overlain by a sequence of sedimentary rocks.

Within the map area (Figure 1), the Bull Arm Formation (Units 1 to 3) consists of interbedded mafic and felsic volcanic rocks. The mafic rocks (Unit 1) consist of dark-grey, green and purple basaltic flows, tuffs and agglomerates. In places, the rocks are vesicular and amygdaloidal. Amygdules are generally filled with calcite, epidote, chlorite or quartz. Epidote also occurs as veins and in the matrix of the basaltic tuff. The dacitic rocks (Unit 2) consist of light-green crystal-lithic tuffs and ash flows. The felsic rocks (Unit 3) consist of buff, purple and red rhyolitic crystal-lithic tuff, breccia and ash flows. Flow banding, autaxitic structures and zones of lithophyses are common. Crystals in the acidic tuffs are generally K-feldspar, albite and quartz. The volcanic rocks form belts of varying composition that strike in a northwesterly direction and dip moderately (20 to 35°) to the

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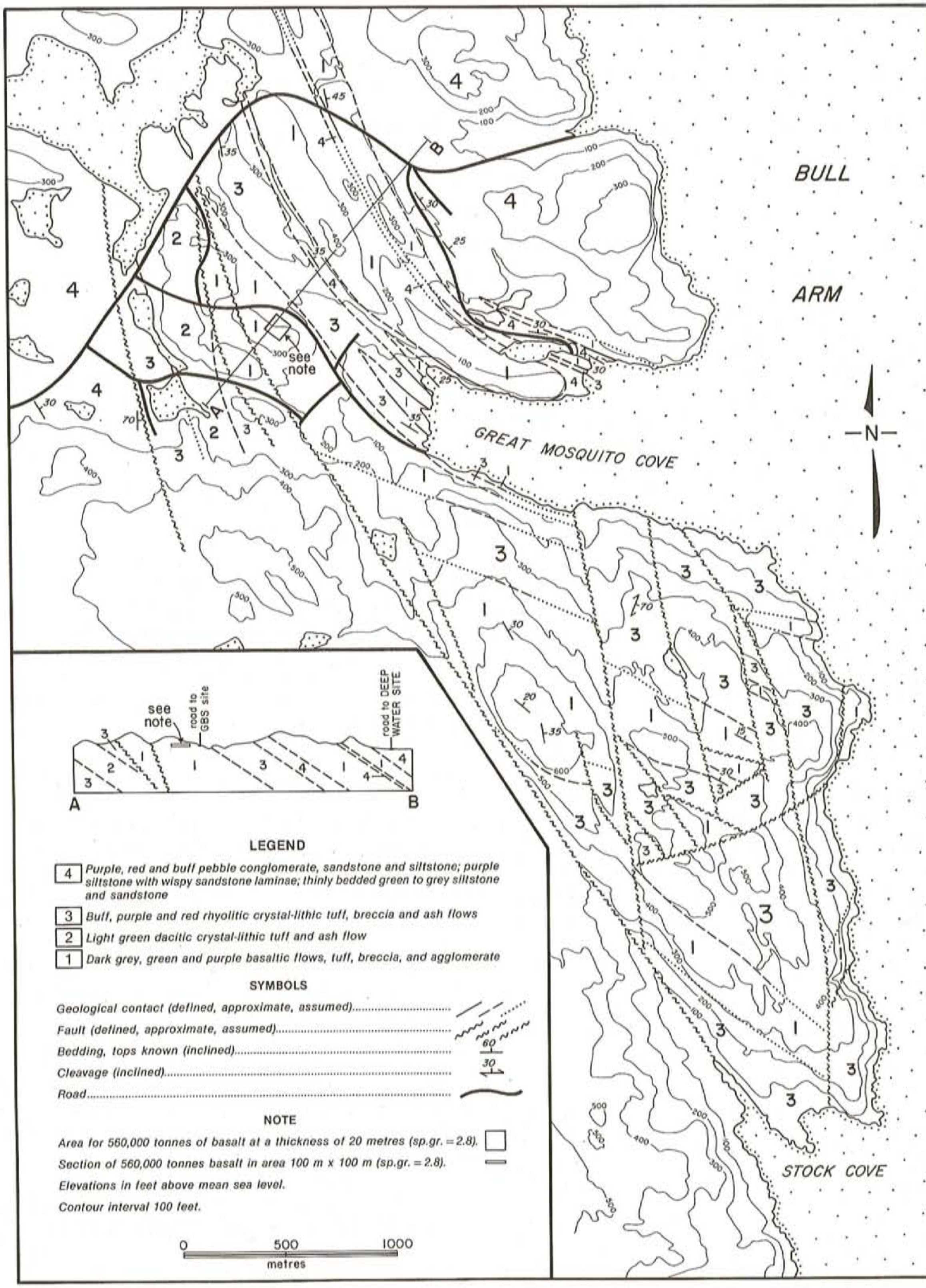

Figure 1. *Geology of the Great Mosquito Cove area.*

Table 1. Petrographic number ranges of different rock units found in the Bull Arm—Mosquito Cove area

Group/ Formation	Number of samples	Petro. number range	Petro. number < 150	Petro. number > 150	Average petro. number
Musgravetown Gp.					
(Unit 4)	16	110-325	10	6	185
Bull Arm Fr.					
(Unit 1)	25	110-140	25	0	130
(Unit 2)	3	110	3	0	110
(Unit 3)	14	110-185	12	2	140

Table 2. Results of Magnesium Sulphate Soundness testing on representative samples from the Mosquito Cove area

Unit #	3	1	1	4	3	1
Sample #	90-001	90-006	90-010	90-013	90-025	91-001
Rock Type	tuff	basalt	basalt	sandstone	rhyolite	basalt
% Loss Fine	2.453	1.63	1.764	3.213	2.63	1.654
% Loss Coarse	1.321	.793	.835	1.841	1.231	.813

northeast. The thicknesses of individual units vary from a few metres to 300 m. North- to northwest-trending faults crosscut the area and offset some of the units.

Sedimentary rocks (Unit 4) of the Musgravetown Group gradationally overlie the volcanic rocks in the northeast part of the map area and are in fault contact to the west. They consist of red to purple, pebble to cobble conglomerates up to 70 m thick are interbedded with and overlie the upper sections of the volcanic rocks. The conglomerates grade upward through red and buff, well-bedded sandstone and siltstone, to very finely bedded grey and green siltstone and sandstone.

LABORATORY INVESTIGATION

Petrographic examination (ASTM C295-85) was carried out on all hand specimens and thin sections. Petrographic examination involves identification of the different rock types and the determining the quality of the rock sample by identification of microstructures (fractures in the crystals) and degree of alteration from weathering and/or metamorphism. Also, a more reliable petrographic number (P.N.) (Bragg, 1989) assessment can be obtained from a petrographic analysis. Table 1 shows petrographic number ranges of different rock units found in the Great Mosquito Cove area as obtained from petrographic examination.

Magnesium Sulphate Soundness Test (ASTM C88-83), which is used to indicate the durability of an aggregate in relation to weathering agents, was performed on selected samples from the area (Table 2).

Los Angles Abrasion Test (ASTM C131-89) for small-size, coarse aggregate was also conducted on the selected samples from the area Table 3. This test is used to measure the durability of an aggregate in relation to wear, impact and abrasion from other agents.

Alkali-Aggregate Reactivity (Oberholser and Davies 1986), which is a 14-day accelerated mortar-bar test was performed on representative samples of the major rock units (acidic crystal-lithic tuff, basalt, basaltic tuff, sandstone and flow-banded rhyolite) and of selected samples from the field area Table 4. This test was chosen because it obtains results quickly (14 days) and it is the most severe test known; if a sample passes this test, no further testing may be necessary. Samples failing the test will require the longer (1 year) Mortar Bar (ASTM C-227) or Concrete Prism (CSA A23.2-14A) tests.

Density and absorption (ASTM C127-88) was performed on selected samples from the basalt unit in the Bull Arm Formation Table 5.

RESULTS AND DISCUSSION

A total of 65 sites were visited and 58 samples collected. A petrographic examination was performed on all hand specimens and thin-sections and an average petrographic number for total samples from each unit is shown in Table

Table 3. Results of Los Angles Abrasion testing on representative samples from the Great Mosquito Cove area

Unit #	3	1	1	4	3	1
Sample #	90-001	90-006	90-010	90-013	90-025	91-001
Rock Type	tuff	basalt	basalt	sandstone	rhyolite	basalt
% Loss L.A. Abrasion	13.4	10.12	11.2	17.8	11.4	11.1

Table 4. Alkali–Aggregate Reactivity of difference rock types in the Bull Arm–Mosquito Cove area

Site #	Rock Type	% Expansion	Comments
Representative Samples			
90-001	Crystal lithic tuff	0.365	Reactive
90-008	Basalt	0.020	Non-reactive
90-010	Basalt	0.029	Non-reactive
90-013	Sandstone	0.404	Reactive
90-025	Flow-banded rhyolite	0.078	Non-reactive
Selected Samples			
91-001	Basalt	0.053	Non-reactive
91-002	Basalt	0.037	Non-reactive
91-003	Crystal lithic tuff	0.254	Reactive
91-004	Basalt	0.015	Non-reactive
91-005	Lithic tuff	0.286	Reactive
91-006	Basalt	0.018	Non-reactive

1. A petrographic number is an initial quality assessment of aggregate or rock sample. Each rock type is assigned a petrographic factor of either 1(best), 3(fair), 6(poor) and 10(deleterious) (CSA A23.2.30, 1973). A petrographic number limit of 135 and 150 is recommended for concrete and asphalt mix, respectively, in Newfoundland. Of the 58 samples collected, 50 samples are considered to be of high quality (P.N. <150); these are mainly from the mafic (Unit 1, 25 samples) and acidic (Unit 3, 12 samples) and intermediate (Unit 2, 3 samples) volcanic rocks from the Bull Arm Formation and the remaining 10 samples are from the Musgravetown Group (Unit 4); 5 samples are considered to be of marginal quality (P.N. range from 150 to 300); 3 samples from Unit 4 (Musgravetown Group) and 2 samples from Unit 3 (Bull Arm Formation). The remaining 3 samples considered to be of poor quality (P.N. >300), and are from Unit 4 of the Musgravetown Group.

Magnesium Sulphate Soundness testing was performed on 6 representative samples from the area (Table 2). A limit of 10 to 15 percent loss is considered maximum for a high-quality aggregate. Table 2 shows that all representative samples from the area passed well below this limit.

Los Angles Abrasion testing was also performed on the 6 representative samples from the Great Mosquito Cove area (Table 3). A limit of 35 percent loss is considered maximum for high-quality aggregate for the above test. Table 3 shows that all representative samples from the area passed well below the limit.

Alkali-Aggregate Reactivity was performed on 5 representative samples and 6 selected samples from the Great Mosquito Cove area (Table 4). An expansion > 0.15 percent at 14 days is considered deleterious and thus reactive for this test. Table 4 shows that the basalt (Unit 1) from the Bull Arm Formation is non-reactive and the flow-banded rhyolite (Unit 3) is non-reactive. The acidic tuffs (Unit 3) from the Bull Arm formation are all potentially reactive, as is the sandstone (Unit 4) from the Musgravetown Group.

Density and Absorption testing was preformed on selected samples from Unit 1 of the Bull Arm Formation in the Mosquito Cove area (Table 5). Aggregates may be classified as low density (< 2.5), normal density (2.5 to 2.9) and high density (>3.0) (Dolar-Mantuani, 1983). The selected samples from the area range from 2.7 to 2.9 having an average of 2.8, and are thus considered normal-density aggregate. The absorption limit varies from 1 to 5 percent depending on use of the aggregate. The selected samples gave results below 1 percent and are thus considered low-absorption aggregates and suitable for all aggregate uses.

CONCLUSIONS

Results from the physical and chemical testing indicate that the basaltic rock types in the area are of high quality and are excellent for use in concrete. This sequence of basaltic rocks is shown as Unit 1 in Figure 1 and can be found in a number of easily accessible areas in sufficient quantities for immediate use. The quality and volume of material in the area suggests that the site may offer potential for aggregate export (Bragg, 1990). The remaining rock types in the area passed the physical testing and are considered excellent sources for road-construction aggregates.

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Table 5. Results of Density and Absorption testing of selected samples from the Mosquito Cove area

Unit #	1	1	1	1	1	1
Sample Number	1	2	3	4	5	6
Rock Type	Basalt	Basalt	Basalt	Basalt	Basalt	Basalt
Bulk Relative Density	2.814	2.914	2.790	2.790	2.834	2.825
Absorption	0.190	0.303	0.337	0.195	0.188	0.129
Average Bulk Relative Density	= 2.827					
Avergate Absortion = 0.223						

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