ABSTRACT

To determine uses for Nova Scotia clays and shales 266 samples were collected from numerous surface exposures in several areas of the Province. Tests were performed on 224 of the more promising clays and shales, results of which are found under Individual Sample Data.

The following variables were determined and presented for each sample in this report: (1) unfired characteristics such as workability, plasticity, water of plasticity, and drying shrinkage, and (2) fired characteristics such as pyrometric cone equivalent (P.C.E.), absorption, shrinkage, colour and hardness. From these results an evaluation was made indicating that 151 samples have the potential for one or more of the following uses: face brick, common brick, floor tile, roofing tile, chimney tile, hollow tile, decorative brick, artware, earthenware, structural products, terra cotta, refractories, conduit and sewer pipe, and lightweight aggregate.

INTRODUCTION

The Nova Scotia Department of Mines and Energy has in its files numerous reported occurrences of clay and shale throughout the Province. The purpose of this report is to compile all data on samples taken from every reported clay and shale occurrence in Nova Scotia covering 13 counties and 10 geological units.

The samples and data are presented by counties which are listed alphabetically (Fig. 1). Samples collected in the Musquodoboit Valley area of Halifax County were excluded from this report because they are unique in the fact that the clays are of Cretaceous age and results from extensive work done on these occurrences have already outlined two deposits of clay and interbedded silica sand (Fowler, 1972; Wright, 1969a).

Included in this report are samples from a Nova Scotia Department of Mines study on Cumberland County clay and shale (Wright, 1969b) and a report on Kings, Annapolis and Digby Counties clay and shale (Fowler, 1967) and the results of an extensive clay and shale program by R. Wambolt and G. Dickie in 1973.

GENERAL GEOLOGY

A general geology map, which classifies the rocks of Nova Scotia according to age, is shown in Figure 2. The legend lists the major rock types occurring within each of the age groups. Each clay and shale sample in this report is identified with an age and a specific geological unit. For a more detailed look at the geology of the Province the reader is referred to the Geological Map of Nova Scotia (Keppie, 1979).

Nova Scotia is underlain by rocks ranging in age from Precambrian, the oldest, to Cretaceous, the youngest. The Province lies within the Appalachian Mountain System that extends from Alabama to Newfoundland. The region underwent extensive deformation during the Taconian Orogeny of

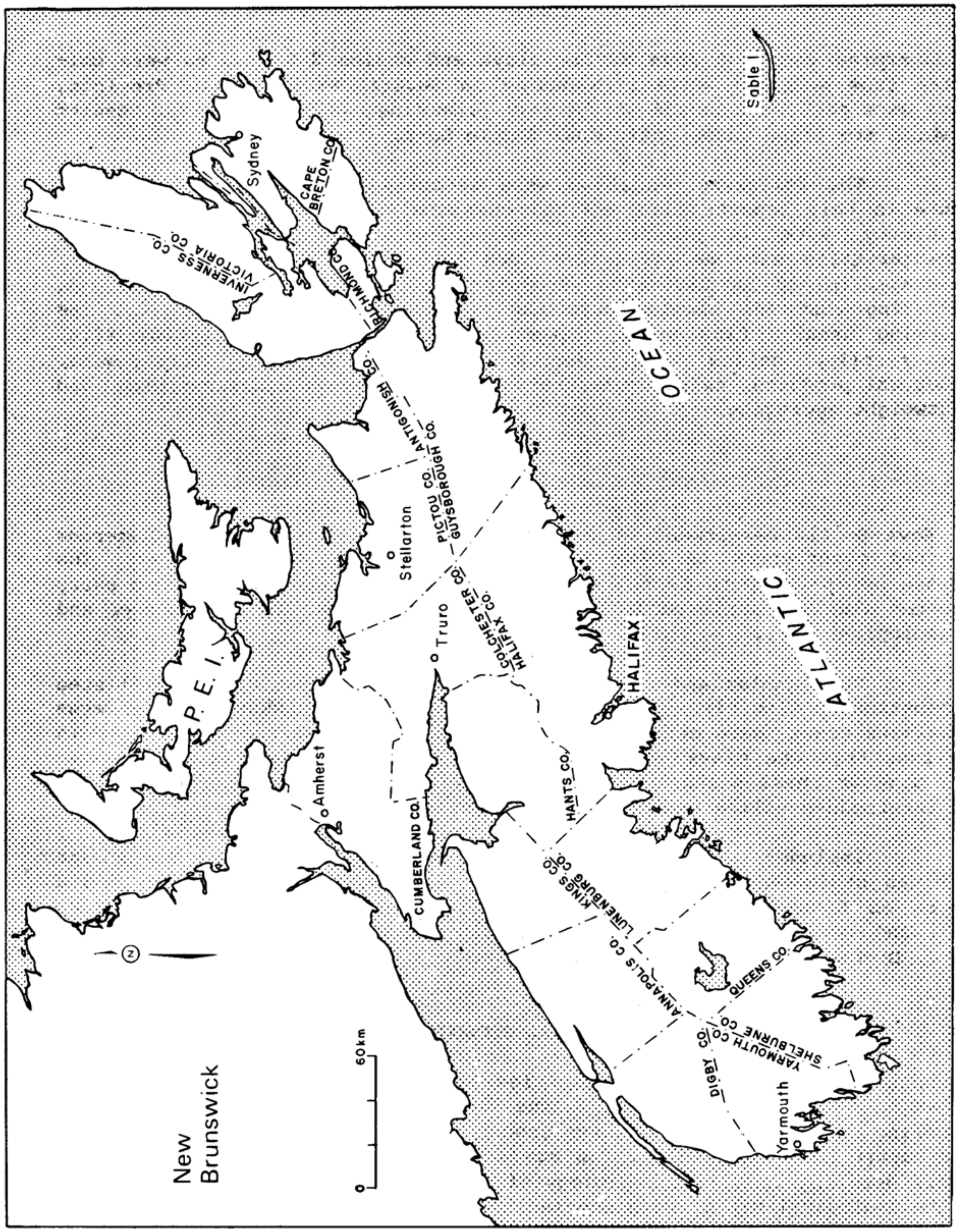

Figure 1. County map of Nova Scotia

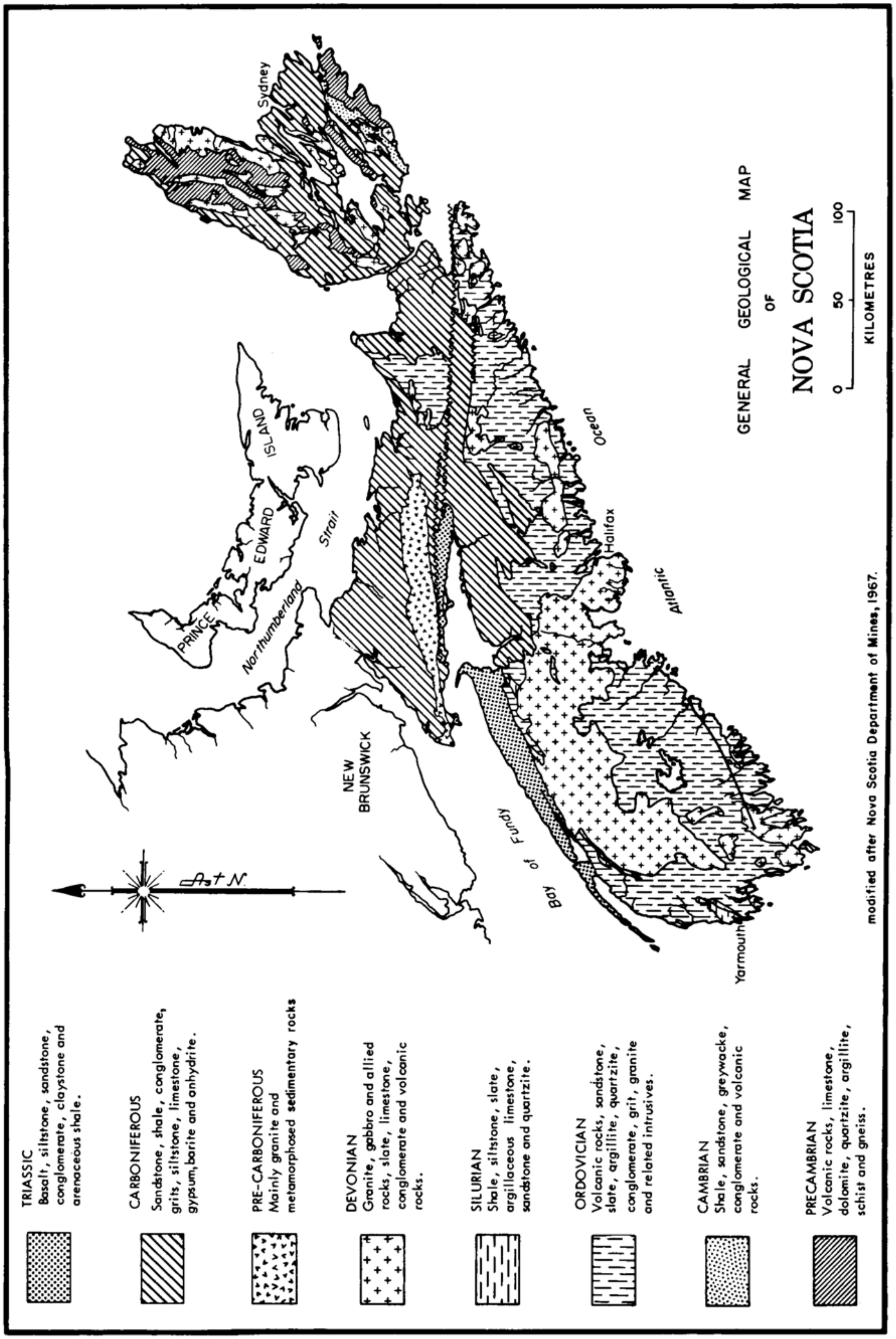

Figure 2. General geological map of Nova Scotia

Late Ordovician age, and in the Devonian during the Acadian Orogeny. At the close of the Paleozoic the Appalachian Orogeny had only local affects on the rocks of Nova Scotia.

Precambrian rocks in the Province are mostly concealed under Paleozoic and younger strata except in the Cape Breton Highlands and eastern half of Cape Breton Island. The rocks are folded and faulted metasediments and complex igneous intrusions.

Numerous areas of the Province are underlain by Carboniferous rocks. On Cape Breton Island and the northern mainland the Pennsylvanian strata have long been of considerable economic significance for their coal deposits.

On the northern mainland the Pictou-Antigonish Upland is underlain by metamorphosed sedimentary, volcanic and intrusive rocks of Ordovician age. Tilted and folded Silurian sedimentary rocks are exposed in Antigonish County and are underlying younger rocks, only on the mainland. Triassic and Jurassic age rocks are restricted to the shores of Minas Basin and Cobequid Bay in the north, and to the Annapolis Valley in the south. In the Valley they occupy a narrow band of sedimentary rocks overlain by amygdaloidal basalt which forms the North Mountain Upland.

Extending from Yarmouth County to Guysborough County (Fig. 1) on the southern mainland is a thick package of closely folded quartzitic greywacke and slate of Ordovician age. A broad irregular belt of Devonian intrusives, chiefly granitic, intruded these sedimentary rocks here and throughout Cape Breton Island.

Cretaceous deposits of clay, quartz-sand and lignite occur in the Musquodoboit/Shubenacadie area of Halifax County (Fig. 1) and in southern Cape Breton Island. They are overlain by Pleistocene boulder clay which covers most of the bedrock in Nova Scotia.

TYPES AND DISTRIBUTION OF CLAYS AND SHALES

On the key map to the location of figures (Fig. 3) the areas that were sampled are plotted showing the distribution of the Province's clays and shales. They occur within the Carboniferous and Triassic age rocks as seen on the geology map (Fig. 2). Pleistocene clays are included on Figure 3, but are not found on the geology map.

Residual clay is formed by the decomposition of rocks, a product of the soil forming process. In glaciated regions, such as Nova Scotia, they are extremely rare. There was a report of white residual clay on Coxheath Mountain in Cape Breton Island (Ries and Keele, 1911), however this occurrence could not be located during this study.

Pleistocene clays have a widespread occurrence in the Province. They were formed indirectly by glacial runoff, composed of material derived from the ice, but deposited by water, therefore stratified.

Cretaceous clay and silica sand, although not included in this report, are an important type of occurrence. Classified as estuarine, the interbedded clay and silica sand were laid down in a shallow area of the sea during the latter part of the Mesozoic.

CLAY PRODUCTION IN NOVA SCOTIA

The clay and shale industry of Nova Scotia has been active for over 100 years. In most cases the early operations were small and supplied local demand. Production has ranged from 566 t (combined clay and shale) per year in 1925 to a high of 70 515 t per year in 1960 (Fig. 4).

At present (1988) two clay pits are operating in the Province. A red plastic clay is taken from a pit in Lantz, and a grey clay from Shubenacadie, both in Hants County. Combined, they produced a total of 26 500 t of clay in 1987. Shale is quarried at Milford, Hants County and New Glasgow, Pictou County. Figures for 1987 show a total of 17 700 t of shale produced from the two quarries. All four sites are owned and operated by L. E. Shaw Limited. Raw materials from the four operations are brought to the company plant at Lantz where they are used in the manufacturing of brick and tile.

SAMPLING AND TESTING PROCEDURES

Sampling

The sampling program consisted of collecting 4.5 kg samples from each occurrence and plotting locations on 1:50000 topographical maps. Whenever feasible channel samples were collected, if not, a grab sample was obtained. Notes concerning the raw properties, such as general description, colour, and prominent features were taken at each sample location. Dimensions of the exposure and attitude of bedding were recorded whenever possible. All of these notes accompany the Individual Sample Data section of this report.

Physical Tests

Samples were delivered to the Technical University of Nova Scotia in Halifax for analysis. The procedures used are those employed by the Ceramic Section of the Laboratory for the Investigation of Minerals (C.L.I.M.) for the evaluation of clays and shales. These procedures are standard in the ceramic laboratories of the Department of Mines and Technical Surveys, Ottawa, and also meet the standards set by the American Society for Testing Minerals (A.S.T.M.).

General Testing Procedures

The samples received are dried for 24 hours at ll0°C in a convection dryer. The presence of stones, colour, and the nature of the material is

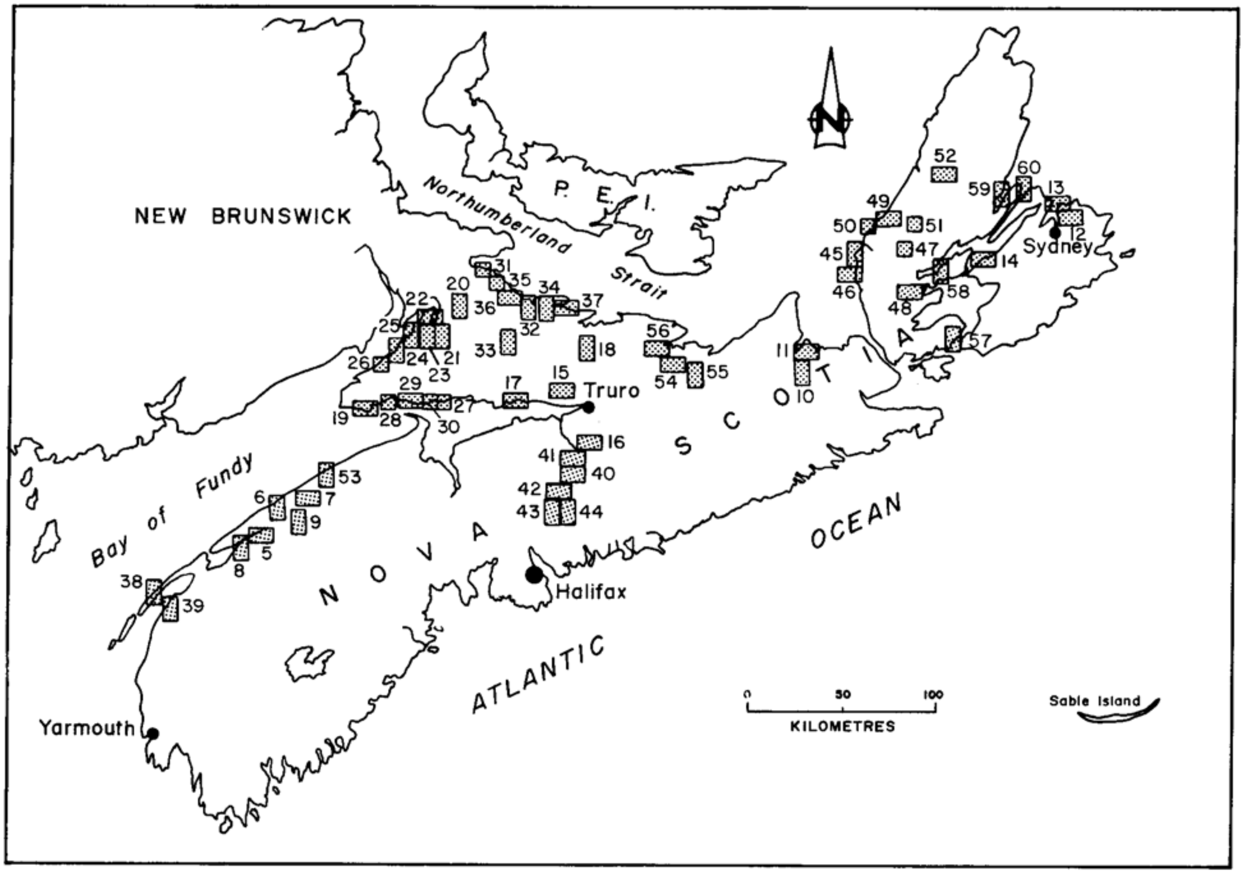

Figure 3. Key map to location of Figures 5-60

Figure 4. Annual production of clay and shale 1930-1987

determined. Carbonates in the sample are detected by using dilute (20%) hydrochloric acid. The sample is then ground to pass a 16 mesh Tyler screen.

After grinding, a differential thermal analysis (D.T.A.) curve is obtained. The curve gives a good indication of mineralogical content, and outlines the temperature range and extent of exothermic and endothermic reactions which occur during firing. The clay mineral present in an argillaceous material has a definite bearing on its physical properties, for example low fusion clays are often illitic, chloritic or mixed layers of various clay minerals. Additional materials such as pyrite, calcite, dolomite, quartz, and carbonaceous material often have a marked effect on the raw and fired properties or on the firing schedule necessary to fire the clay properly. After the D.T.A. curve is established the dried and ground clay is tempered with water to determine per cent water of plasticity, workability and plasticity.

The next step in the procedure is making briquettes for air drying and shrinkage calculations. The briquette, which measures 10 cm by 3.8 cm by 2.5 cm, is air dried for 24 hours. Abnormal properties such as warping or scumming are noted. Air shrinkage is determined by measuring marks put on the briquette before and after it is dried. Another briquette is placed in a dryer at 85°C to determine if any cracking will occur with rapid drying.

The pyrometric cone equivalent (P.C.E.) is now determined, before firing can take place. The P.C.E. of a clay or shale is commonly referred to as the fusion point, softening point, deformation point, or melting point. It is determined by preparing a pyramidal test cone and heating it along with the standard pyrometric cones. The P.C.E. is the number of the standard cone whose tip touches the supporting plaque at the same time as that of the material being tested.

When the P.C.E. has been determined the briquette is ready to be fired. Temperatures are now selected for the firing of the sample. The most frequently used temperatures are cones 08, 06, 04, 02, and 2, since most requirements for ceramic ware are within 982°-1204.4°C. Standard pyrometric cones are usually used in order to know when firing is complete. By using one cone standard higher and one lower than the known cone of the sample, it is possible to tell if the sample has been overfired or underfired.

The briquettes and standard cones are placed in a furnace programmed to rise at a rate of 60°C or lso°C per hour. The firing is complete when the cone to which the samples are fired is down. The furnace is turned off and allowed to cool for 24 hours. When the briquettes are cooled to room temperature the colour and hardness are recorded and fired shrinkage is measured.

To determine per cent absorption the briquettes are now placed in water and allowed to soak for 24 hours. They are then wiped and weighed (wet weight). After drying for 24 hours at ll0°C the briquettes are weighed (dry weight). They are then dried and weighed again until a constant weight is attained giving the per cent absorption.