

alkali analyses are being done outside, but all the others will be carried out on the new X-ray fluorescence equipment in the Council laboratories.

The final phase of the work will involve differential thermal analysis of some of the samples.

The above mineralogical, chemical and physical data will be combined and correlated to give a basis for assessing the utilization potential of the clays and shales. The results, which are hoped will be reasonably precise, will be published in the latter half of 1966.

It is hoped to develop a ceramic section within the Mineralogical Group, generally intended to be of service to the industry and also promote interest in this field. With this in mind, a program of ceramic researches is being established. The first, following on the present investigation, will be on the blending of local materials either with each other, or with imported clay, so as to obtain a particular ceramic effect. Another long term project will take into account the synthesis of clay minerals.

#### Manganese-Iron Concretions in Nova Scotia Lakes\*

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#### Introduction

Research on manganese-iron concretions by the author, under the direction of DR. W.R. TROST of the Department of Chemistry, is being undertaken at DALHOUSIE UNIVERSITY. The concentrically-formed mineral oxides, composed predominantly of manganese and iron, have been found in several eastern Nova Scotian lakes. The concretions lie flat on the lake bottom covered with a thin veneer of silt or may be slightly embedded in the sediment.

Six lakes and one harbour between Halifax and Ship Harbour, Nova Scotia, were investigated for these concretions during the summer of 1965. Firsthand observation of these in their natural environment was made by SCUBA-equipped divers. Lakes Charlotte, Porter and Chezzetcook all contain definite concretions while Pace's Lake and Second Lake show intensive manganese iron precipitation in the areas investigated. Bayer's Lake shows very little black oxide precipitate on lake rocks and no precipitation at all was observed at the mouth of Ship Harbour.

The concretions are dark brownish-grey to black, and are friable when dry. Their size ranges from a few to 25 cm across. Shape is variable, but generally flat or curved; many are biconcave discoidal with a thickened rim (Figure 1).

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Figure 1. Manganese-iron concretions from the floor of Lake Charlotte, Halifax County, Nova Scotia. Typical outlines of concretions are shown: left, from Area No 1; centre, from Area No 2; right, from Area No 3.

Two theories to account for the possible origin of these concretions have been proposed. The first, proposed by E.M. KINDLE (1935), favors a biological origin. This theory was based largely on the work of CARL ZAPFFE (1931) concerning the precipitation of manganese and iron by several species of bacteria; although bacteria were postulated as a possible origin, the formation of the concretions by bacteria has never been demonstrated satisfactorily.

A more recent contribution to this subject has come from F.T. MANHEIM (1965) whose study of several Scandinavian lakes and near-shore environments caused him to support a purely chemical origin for the concretions. He maintained that diffusion of the chemical constituents through interstitial water of bottom sediments into an oxidizing aquatic environment, causes the precipitation of manganese and iron oxides around pebbles or other solid objects lying in the sediment.

#### Lake Charlotte Study

Three areas of concretion occurrence in this lake were chosen for study. The concretions in these three areas showed small differences in shape (Figure 1), so the chemical and physical properties of each area were studied and compared.

Area No 1: This area was located on a 7° lacustrine slope. The concretions were abundant laterally along this slope for a distance of 1½ miles. There was a distinct increase in size of the concretions lakeward. They ranged from 8 cm in diameter at the top of the slope (depth 11 feet) to 14 cm in diameter at the bottom of the slope (depth 25 feet). The bottom material at the top of the slope consisted of a muddy sand which gave way to a smooth clay near the bottom and a flat-lying mud at the end of the slope. The smaller concretions at the top of the slope were partially buried in the muddy sand while the larger

concretions near the bottom were welded together and relatively free of sediment. The concretion area showed a sharp boundary at the slope-plain junction.

Area No 2: This was located one mile south of Area No 1 in shallow water (3 to 5 feet). The bottom profile here was very flat and covered with a thin growth of short grass. The root system of the grass had woven the bottom sediments into a smooth carpet on which the concretions grow. The concretions here were biconcave in appearance and covered abundantly with green organisms due to the shallow depth.

Area No 3: This was situated  $\frac{1}{2}$  mile east of Area No 2 in a small protected cove, at a depth of 15 feet. The bottom material was composed of a thick, flat-lying organic mud. This area, although surrounded entirely by a mud substrate, was floored by a fine muddy sand which projected through the mud. The concretions here were quite different in shape, being nodular or bun shaped. The concentric nature and nuclei were not outwardly evident.

Each area was sampled in a systematic way. Water samples from Area No 1 indicated no significant change in pH or Eh with distance across the area or depth. The pH values ranged from 6.26-6.35. The redox potential was similar, ranging from 0mV to +5mV. The carbon dioxide and oxygen concentrations in the water were also depth independent; the former ranged from 3.0 ppm to 4.9 ppm, while the latter ranged from 8.00 cc/litre to 8.34 cc/litre. The greatest concentration of concretions was 86 per sq m near the bottom of the slope.

The results for the water of Area No 2 were generally similar to those of Area No 1. The pH ranged from 6.05 to 6.19, and Eh from +5 mv to -4mV. The carbon dioxide concentration was generally higher than for Area No 1, ranging from 4.2 ppm to 5.2 ppm. However, the dissolved oxygen concentration was noticeably lower ranging from 5.83 cc/litre to 6.18 cc/litre. The greatest concretion concentration was 30 per sq m at the centre of the area.

The pH values for the water at Area No 3 ranged from 6.30 to 6.40 and were slightly higher for values of the other two beds. The Eh values were significantly higher, ranging from +10mV to +15mV; the carbon dioxide concentration was the lowest, ranging from 3.0 ppm to 4.0 ppm, and similarly for oxygen ranging from 5.82 cc/litre to 5.94 cc/litre. The greatest concretion concentration for this bed was 91 per sq m.

It is the purpose of the research to continue the study and exploration of this phenomenon from the lakes and estuaries on to the continental shelf and eventually into the deep sea. In this respect, the discovery of manganese coatings on pebbles in sediments of the Scotian Shelf just south-east of Ship Harbour is of particular interest; these were reported by research workers of the INSTITUTE OF OCEANOGRAPHY of Dalhousie University. Attempts will be made to grow concretions of similar character to those found, under laboratory conditions.