GEOCHEMICAL INVESTIGATIONS
IN
ESSEX AND CALEDONIA COUNTIES, VERMONT

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INTRODUCTION

During the summer of 1968 a preliminary geochemical survey was carried out in Essex and Caledonia counties, Vermont, for the Vermont Geological Survey. About 1000 stream sediment samples were collected in these two counties and analyzed for copper, lead, and zinc.

The only previously published geochemical data from the state of Vermont are given by Canney (1965). His investigations were on soil samples collected from the area of the Elizabeth Mine at South Strafford in Orange County, Vermont. Because there were no previous regional geochemical surveys in Vermont, it was decided to begin investigations in the northeastern part of the state and work systematically south and west. Important reasons for starting the project in northeastern Vermont are: 1) this area is along the regional geologic trend of the proven copper deposits in Orange County; and 2) much of this area is remote, densely forested and sparsely populated, so that possible ore deposits may have been overlooked.

ACKNOWLEDGMENTS

The writer acknowledges the able assistance of Messrs. Evan Englund and Ronald Marcotte, both in the field and in the laboratory. Professor Carl Lucarini made the lead analyses.

SAMPLING PROCEDURE

All of the samples were collected from active stream channels throughout the two counties. Care was taken to avoid human contamination. Whenever possible, samples were collected upstream from metal culverts and garbage dumps. Also, no samples were collected downstream from the larger towns.

The samples were wet sieved in the stream with a Spex Industries 100-mesh nylon sieve in a plastic holder. The less than 100-mesh fraction was collected in glass vials for the analyses.

SAMPLE ANALYSES

The sample analyses were made in the Department of Geology at the University of Vermont. The samples were dried and analysed for copper, lead, and zinc, using the pyrosulfate fusion technique outlined by Ward, et al (1963). Copper was determined by the 2,2'-biquinoline method and each sample was placed in one of the following groups according to its copper content: 0 to 10 ppm, 10 to 20 ppm, 20 to 40 ppm, 40 to 75 ppm, 75 to 150 ppm, 150 to 300 ppm, and greater than 300 ppm. Zinc was determinted by the dithizone method and each sample was placed into one of the following groups on the basis of its zinc content: 0 to 50 ppm, 50 to 100 ppm, 100 to 150 ppm, 150 to 200 ppm, and greater than 200 ppm. Lead was also determined by a dithizone method and each sample placed into one of the following groups: 0 to 25 ppm, 25 to 50 ppm, 50 to 100 ppm, 100 to 150 ppm, and greater than 150 ppm.

GENERAL CONCLUSIONS

The purpose of a geochemical survey is to locate ore deposits of economic value. The reconnaissance nature of this survey did not lead to the direct pin-

pointing of specific ore bodies, but only points out areas in which more work should be done. An explanation for each of the anomalous samples must be found, whether it is contamination, non-economic mineralization, or mineralization which can be mined at a profit. Also, because an area did not show anomalous results doesn't mean that no ore bodies exist there. Deposits of metals other than copper, lead, or zinc may be present, and it is even possible that some copper, lead, and zinc occurrences were not found by this survey.

ESSEX COUNTY

General Geology

The Geology of Essex County has been described in detail in the following bulletins of the Vermont Geological Survey: No. 11, Geology of the Concord-Waterford Area, Vermont, Eric and Dennis, 1958; No. 20, Geology of the Island Pond Area, Vermont, Goodwin, 1963; No. 22, Geology of the Lunenburg-Brunswick-Guildhall Area, Vermont, Johansson, 1963; No. 27, Geology of the Vermont Portion of the Averill Quadrangle, Vermont, Meyers, 1964; and No. 28, The Geology of the Burke Quadrangle, Vermont, Woodland, 1965.

Essex County is underlain by three major rock divisions, namely, the Gile Mountain Formation; the Albee Formation; and a variety of igneous rocks.

The Gile Mountain Formation is a metasedimentary unit composed of gray, quartz-muscovite phyllite or schist with local units of crystalline limestone and quartzite. In the northern part of the county, Meyers (1964) subdivided the Gile Mountain into six mappable lithologic units: "(1) phyllitic quartz-mica schist, (2) graywacke and subgraywacke, (3) hornblende schist (4) dark slate containing lenses of (5) coarse feldspathic grits, and (6) interbedded phyllite, dark gray schist, quartzite, limestone, and lime silicate rocks."

The Albee Formation is also a metasedimentary unit which consists of massive gray quartzite and feldspathic quartzite interbedded with slates, phyllites, and schists.

The metasediments of both formations have been metamorphosed to varying degrees. Metamorphic zones from chlorite through sillimanite are present in Essex County with the staurolite, andalusite, and sillimanite surrounding the intrusive rocks.

Igneous rocks make up about a third of the bedrock in Essex County. The most important igneous bodies are: the Averill pluton - white to pink biotite granite; the Nulhegan pluton - quartz monzonite; the Monadnock pluton - quartz syenite; the Maidstone pluton - muscovite-biotite granite; the Victory pluton - quartz monzonite similar to the Nulhegan pluton; and the Lancaster pluton - granodiorite and quartz monzonite.

The following metallic mineral occurrences are described from Essex County (the numbers refer to the locality numbers used on Plate I):

1. small copper mine on Bolles Hill, 3.5 miles S65°W of Guildhall Center, Johansson, 1963; this locality was searched for, but could not be located during this study.

2. small prospect holes about a mile southwest of 1., Johansson, 1963; this was also not locatable.

3. vein of chalcopyrite, pyrrhotite, and galena 0.7 miles northwest of Stevens Pond, Johansson, 1963; this vein was not seen, but the geochemical survey shows its approximate location.

4. copper minerals in quartz stringers in the bed of Granby Stream, Johansson, 1963.

5. traces of galena and pyrite just west of the summit of Flynn Hill, Guildhall, Johansson, 1963.

6. traces of galena and pyrite on the west side of Bear Mountain, Maidstone, Johansson, 1963.

7. "gold mine" on the east side of Monadnock Mountain, reported by many local residents.

8. Essex Copper Mine in Concord described by Eric and Dennis (1958) and visited during this project.

Results of Geochemical Investigations (see Plate I for data)

COPPER

The average copper content of the stream sediments in Essex County was in the range 10 to 20 ppm. Samples with 20-40 ppm copper have been plotted on the map although they are not considered anomalous. A few samples collected in Essex County give anomalous results. These are:

(1) two samples from an area northwest of Stevens Pond; these are from an area with a vein of chalcopyrite, pyrrhotite, and galena described by Johansson (1963) (Locality number 3 on Plate I.)

(2) two samples south of Shadow Lake, which are the closest samples to the Essex Copper Mine (Locality number 8 on Plate I.)

(3) four samples from the area around French

Mountain west of Bloomfield which are not associated with any known sulfide occurrences.

(4) two isolated samples, one northeast of Lewis Pond and one north of Island Pond.

LEAD

The lead results for Essex County were very low with the exception of a few samples showing 25-50 ppm lead and one sample from East Concord with 100-150 ppm (this was taken near the town and is possibly contaminated).

ZINC

No anomalous zinc samples were collected in Essex County.

Suggestions for Future Work

There are two areas in Essex County in which a more detailed sampling program should be carried out. One is the area with a number of anomalous samples around French Mountain west of Bloomfield. The second is the area near the Essex Copper Mine in Concord. This mine seems to be at the eastern end of an area of high copper values (see Caledonia County).

CALEDONIA COUNTY

General Geology

The following bulletins of the Vermont Geological Survey describe the geology of Caledonia County: No. 8, The Geology of the Lyndonville Area, Vermont, Dennis, 1956; No. 10, Bed Rock Geology of the East Barre Area, Vermont, Murthy, 1957; No. 11, Geology of the Concord-Waterford Area, Vermont, Eric and Dennis, 1958; No. 13, The Geology of the St. Johnsbury Quadrangle, Vermont, Hall, 1959; No. 16, Geology of the Plainfield Quadrangle, Vermont, Konig, 1961; No. 20, Geology of the Island Pond Area, Vermont, Goodwin, 1963; No. 24, The Geology of the Hardwick Area, Vermont, Konig and Dennis, 1964, and No. 28, The Geology of the Burke Quadrangle, Vermont, Woodland, 1965.

The major rock types found in Caledonia County are: the Waits River Formation, the Gile Mountain Formation, the Albee Formation, Meetinghouse Slates, and igneous intrusives.

The Waits River Formation is largely quartzose and micaceous crystalline limestones with some calcareous and quartz schists. The Standing Pond member, an amphibolite, is also present in parts of Caledonia County.

The Gile Mountain Formation and the Albee Formation are similar to the descriptions given for these formations in Essex County. Metamorphic grades vary from chlorite to sillimanite.

Igneous rocks make up a much smaller portion of Caledonia County than of Essex County. There are several small bodies of biotite granite near Newark and a large body of Knox Mountain granite in the southern part of the county.

There are no reported occurrences of metallic mineralization in Caledonia County.

Results of Geochemical Investigations (see Plate 2. for data)

COPPER

There are a large number of anomalous copper samples in Caledonia County in the town of Waterford. These are geographically related to the high copper samples in Essex County near the Essex Copper Mine. There are no other areas of high copper values in Caledonia County with the exception of some isolated samples.

LEAD

There are three areas with anomalous lead values. One is in Barnet, east of the Passumpsic River; one is in St. Johnsbury, east of the Passumpsic River; and one is near the town of Sheffield.

ZINC

High zinc values were found along Trout Brook in Sheffield; also at a number of localities in Walden; and at several isolated localities.

Suggestions for Future Work

A careful sampling program should be set up for the town of Waterford, because of the high copper values in this area. Also, the three areas of anomalous lead samples, and two areas of anomalous zinc samples should be checked further.

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GEOLOGICAL SURVEY

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REPRESENTED BY THE STATE GEOLOGIST

VERMONT
ISLAND POND QUADRANGLE

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15-MINUTE SERIES (TOPOGRAPHIC)

EXPLANATION

△ Location of samples of active stream sediment analysed in this investigation. When no numbers are shown at the sample location, the sample contained less than 20 ppm (parts per million) copper, 25 ppm lead, and 50 ppm zinc. The amounts of copper, lead, and zinc present above these amounts are shown as follows:

- $\triangle_1$ 20 to 40 ppm copper
- $\triangle_2$ 40 to 75 ppm copper
- $\triangle_3$ 75 to 150 ppm copper
- $\triangle_4$ 150 to 300 ppm copper
- $\triangle_1$ 25 to 50 ppm lead
- $\triangle_2$ 50 to 100 ppm lead
- $\triangle_3$ 100 to 150 ppm lead
- $\triangle_1$ 50 to 100 ppm zinc
- $\triangle_2$ 100 to 150 ppm zinc
- $\triangle_3$ 150 to 200 ppm zinc

Location of reported sulfide occurrences (outcrops, prospect pits, mines) see the text for specific descriptions.

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

PLATE 1. RESULTS OF GEOCHEMICAL INVESTIGATIONS IN ESSEX COUNTY, VERMONT

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UNITED STATES
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VERMONT
HARDWICK QUADRANGLE
560000 FEET

VERMONT
LYNDONVILLE QUADRANGLE
620000 FEET

EXPLANATION

△ Location of samples of active stream sediment analysed in this investigation. When no numbers are shown at the sample location, the sample contained less than 20 ppm (parts per million) copper, 25 ppm lead, and 50 ppm zinc. The amounts of copper, lead, and zinc present above these amounts are shown as follows:

- $\overset{1}{\triangle}$ 20 to 40 ppm copper
- $\overset{2}{\triangle}$ 40 to 75 ppm copper
- $\overset{3}{\triangle}$ 75 to 150 ppm copper
- $\overset{4}{\triangle}$ 150 to 300 ppm copper
- $\triangle_1$ 25 to 50 ppm lead
- $\triangle_2$ 50 to 100 ppm lead
- $\triangle_3$ 100 to 150 ppm lead
- $_1\triangle$ 50 to 100 ppm zinc
- $_2\triangle$ 100 to 150 ppm zinc
- $_3\triangle$ 150 to 200 ppm zinc

● Location of reported sulfide occurrences (outcrops, prospect pits, mines) see the text for specific descriptions.

ROAD CLASSIFICATION
Heavy-duty — Light-duty
Medium-duty — Unimproved dirt
U.S. Route — State Route

APPROXIMATE MEAN DECLINATION, 1955

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

PLATE 2. RESULTS OF GEOCHEMICAL INVESTIGATIONS IN CALEDONIA COUNTY, VERMONT

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