

GEOLOGY OF THE ORANGE COUNTY COPPER DISTRICT, VERMONT

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Introduction

The following is a brief abstract of a more detailed report available for inspection in the files of the Geological Survey, Washington, D. C., and of the State Geologist, Burlington, Vt. All illustrations in the report are included with this abstract.

The Orange County copper district in east-central Vermont includes an area about 20 miles long from north to south and about 5 miles wide (fig. 1). The district yielded important amounts of copper before 1882, mostly from the Ely mine, but since then has been only a small and intermittent producer. Total production is estimated to be between 50 and 60 million pounds of copper.

General geology

The district contains highly deformed stratified rocks of Ordovician or Devonian age (pl. 1). The western part is underlain by a series of calcareous schists known as the Waits River formation, and the eastern part contains dominantly quartz-mica schist. Needle amphibolite, probably of volcanic origin, and coarse garnet schist beds are locally important stratigraphic markers. All the rocks are highly metamorphosed.

The bedding is intensely folded on a large and small scale, and a well-developed cleavage lies essentially parallel to the axial planes of major and minor folds. The folds generally plunge less than 30° NNE.

The cleavage itself is deformed on a large and small scale. The copper district lies on the east flank of a broad cleavage arch whose axis lies parallel to and a few miles west of the district (fig. 2). Minor flexures or "rolls" in the cleavage are common in the central part of the district, and the Ely ore shoot lies within and plunges parallel to the axis of one such "roll" (fig. 3). The cleavage "rolls" plunge approximately parallel to the folds in the bedding. Faults that cut and deform cleavage as well as bedding also contain sulfide deposits.

Copper deposits

The ore bodies are lenticular and generally lie parallel to the cleavage of the wall rocks. The Elizabeth mine workings are confined to a single large body, but the other two large deposits are composed of several small lenses that overlap like shingles on a roof (pl. 4 and fig. 4). The two largest ore deposits, the Elizabeth and the Ely, are definitely elongate shoots, and their elongation is closely parallel to the plunge of minor folds in their vicinity. It is suggested that the Eureka-Union (Pike Hill) deposits may be connected to the upper end of a similar shoot at moderate depth.

The ore is a mixture of pyrrhotite with subordinate chalcocite and sphalerite. The average copper content of ore at the different mines ranges from 2 to more than 3 percent. Non-metallic minerals make up over 50 percent of the average ore; principal gangue minerals are quartz, feldspar, mica, hornblende, and carbonate. The gangue minerals represent, for the most part, unreplaced constituents of the country rock.

The sulfide minerals replaced the country rock, and were deposited at high temperatures, probably from hydrothermal solutions. These solutions are believed to have originated directly or indirectly from the intrusion of granitic rocks such as are now exposed north of the district. The ore deposits were probably formed during a late stage of the regional metamorphism. The structure of the wall rocks rather than their chemical composition appears to have been of greatest importance in localizing ore deposition.

Possibilities for future exploration

The most favorable areas for development of large extensions of known deposits lie in unexplored parts of the Elizabeth vein and north of and below the bottom of the Union mine.

Areas believed to be most favorable for discovery by geophysical methods (self-potential measurements) of new deposits are shown in plate 1. Possible extensions of the Elizabeth vein to the north and south of its known limits probably afford the best possibilities in the district. Areas underlain by cleavage "rolls" in which the cleavage strikes more westerly than elsewhere, are shown on the map; these areas, particularly in a zone 1 to 2 miles wide connecting the Ely and Elizabeth mines, are believed to be very favorable.

Most of the other recommended areas shown in plate 1 were chosen because sulfides are known to exist within them, or because of a favorable structural environment, suggested by erratic cleavage strikes or the presence of a fault.

Descriptions of deposits

All mines and prospects that were visited are shown on plate 1, with their names where any is in common use.

Elizabeth mine.--The Elizabeth mine has been described in a previous report available for inspection in the files of the Geological Survey. Maps accompanying this report may be obtained upon written request to The Director, Geological Survey, Washington 25, D. C.

Ely mine.--The Ely mine (pls. 2-6, fig. 3) produced between 30 and 40 million pounds of copper, mostly before 1882, but has been idle since 1902. The average grade of ore is 3.5 percent copper.

The country rock is quartz-mica schist with subordinate amphibolite or hornblende schist. The main ore shoot is parallel to the cleavage and follows the axis of a "roll" or flexure in the cleavage, brought out on plate 2 by the westerly strikes at the entrance to the main shaft. A reverse fault, locally mineralized, intersects this cleavage roll in the vicinity of the main ore shoot. Fold axes, cleavage-bedding intersections, axes of major and minor cleavage "rolls," and the intersection of the reverse fault with the cleavage "rolls" all plunge about parallel to the ore shoot.

The ore shoot is formed by successive sulfide lenses that overlap like shingles on a roof (pl. 4). The lenses, made up of one or more sulfide veins, average 10 feet in thickness, range from 50 to 250 feet in strike length, and are generally not more than 300 feet in pitch length. The pitch length of the main shoot, as mined to date, is 3,330 feet.

None of the many openings or drill holes away from the main shoot appear to intersect important bodies of sulfide ore. Known reserves are negligible, and prospects of increasing the reserves, except at the bottom of the shaft, are very poor.

Pike Hill mines.--The Pike Hill mines (pls. 7, 8, figs. 3, 4) include the Eureka, Union, and Smith mines; the latter is little more than a prospect. Total production from these mines is less than 9 million pounds of copper; the last mining was in 1919 at the Eureka mine and in 1881 at the Union mine. The ore from the Eureka mine contained an average of 2.5 percent copper.

The country rock is calcareous mica schist. The ore bodies are made up of overlapping lenses (fig. 4) that lie at or close to a single cleavage horizon defined by the structure contours on plate 8. The average thickness of individual lenses is 8 feet, average strike length 175 feet, and average dip length less than 100 feet.

An anticlinal "roll" in the cleavage that apparently lies just east of the workings may be an important locus of ore deposition, below and north of the bottom of the Union mine. Except for this possibility, the chances of finding substantial ore reserves adjacent to the mine workings are fairly well eliminated by old and recent drilling.

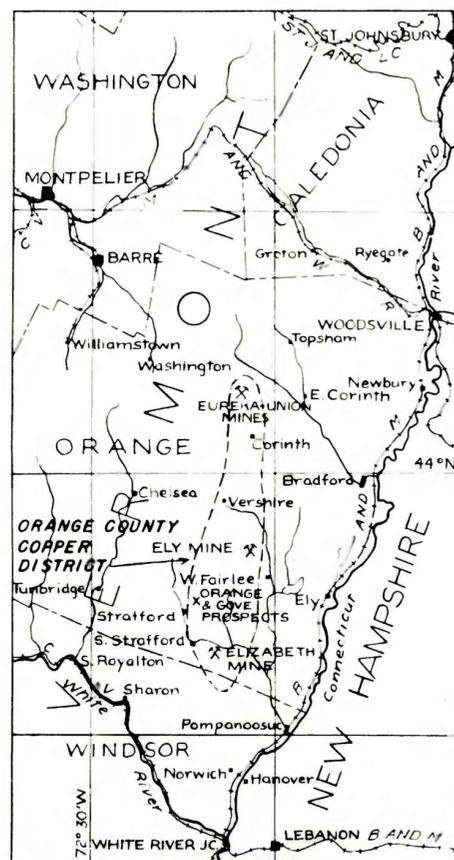
Orange and Gove mines.--The Orange and Gove mines (fig. 5), and a few scattered prospects between them, appear to lie in a single vein zone in amphibolite that more or less follows bedding and cleavage. Production has been negligible, and none of the present openings give promise of a large ore body. The stratigraphic horizon of the vein is easily followed (pl. 1).

Cookville mine.--The Cookville mine (fig. 6) appears to lie on a mineralized fault (see pl. 1) with a steep or vertical dip. Production has been negligible, and there are no reserves in sight. The fault is worth prospecting to the north and south.

Dimond property.--Extensive diamond drilling was done on the Dimond property (fig. 7) in 1943, on the basis of large and encouraging self-potential anomalies. The thickest sulfide stringer found was less than 1 inch thick.

Other prospects.--Other prospects visited are shown on plate 1. Most of them contained a few traces of sulfides, mostly pyrrhotite.

FIGURE 1



INDEX MAP OF EAST-CENTRAL VERMONT
SHOWING LOCATION OF COPPER MINES

0 10 20 Miles



Vermont (Orange Co. copper district). Geol. v. 8. 1944
sheet B,
cop. 1.