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of Beryllium Minerals

on the Seward Peninsula, Alaska

U.S. Geological Survey:

By C. L. Sainsbury

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MENLO PARK, CALIFORNIA

Paper presented at the AIME meeting in

Anchorage, Alaska, April 26-28.

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BERYLLIUM MINERALIZATION ZONE FOUND ON SEWARD PENINSULA, ALASKA

Discovery of a new mineral zone containing beryllium on public lands in western Alaska was announced today by the Department of the Interior. The prospect was found by the Department's Geological Survey on the public domain in 1961, during geologic mapping of the Lost River area on the western Seward Peninsula, Alaska.

The beryllium occurs as the mineral chrysoberyl intergrown with fluorite and tourmaline in veinlets in limestone, and along the walls of dikes that intrude the limestone in Rapid River, a tributary of Lost River. Randomly selected specimens of beryllium ore range from .01 to 3.3 percent BeO and average 1.2 percent.

The prospect is discussed in more detail in a paper prepared by C. L. Sainsbury and presented today (April 27) at the meeting of the American Institute of Mining, Metallurgical and Petroleum Engineers in Anchorage, Alaska.

Copies of the paper are on file for inspection at the following depositories: Geological Survey offices in the Brooks Memorial Building, College, Alaska; 111 Federal Building, Juneau, Alaska; 503 Cordova Building, Anchorage, Alaska; State Division of Mines and Minerals, 404 State Capitol Building, Juneau, Alaska; 232 Appraisers Building, San Francisco, California; 1031 Bartlett Building, Los Angeles, California; South 157 Howard Street, Spokane, Washington; 468 New Custom House, Denver, Colorado; 602 Thomas Building, Dallas, Texas; Alaskan Geology Branch, 345 Middlefield Road, Menlo Park, California; and at Geological Survey Libraries in Room 1033 General Services Building, 18th and F Streets, N. W., Washington, D. C.; Building 25, Denver Federal Center, Denver, Colorado; and 345 Middlefield Road, Menlo Park, California.

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P.N. 6857-62

A new occurrence of beryllium minerals on the Seward Peninsula, Alaska

Abstract

Beryllium in the form of chrysoberyl was found at a new locality on the public domain on the Seward Peninsula. The beryllium is associated with altered dikes and marmorized limestone veined with fluorite-tourmaline-chrysoberyl veinlets. Although the chrysoberyl is fine grained and intergrown intricately with the fluorite and tourmaline, it has been separated and identified by X-ray diffraction. Specimens of ore selected randomly from areas of fluoritized limestone contain beryllium in the range .01 to 3.3 percent BeO. The area warrants detailed mapping and sampling, which will be done by the U.S. Geological Survey in 1962.

INTRODUCTION

History of beryllium on the Seward Peninsula

The first reference to beryllium minerals on the Seward Peninsula, Alaska, appeared in U.S. Geological Survey Bulletin 533, published in 1913, in which Fred H. Moffit mentioned beryl in a dike at North Star Creek, north of Nome. Since that time brief mention has been made of beryllium minerals associated with the tin deposits at Lost River, Cape Mountain, and Ear Mountain, mostly in published and unpublished reports of the U.S. Bureau of Mines and the U.S. Geological Survey that deal with the Lost River mine. During exploration of the Lost River deposits in 1940-44, a cooperative project of the U.S. Bureau of Mines and the U.S. Geological Survey, beryl was collected by P. L. Killeen from a quartz vein at the Lost River mine, and the beryllium mineral phenacite was identified by the U.S. Bureau of Mines in drill cores from the Lost River mine (Heide, 1946). The beryllium content of ore samples collected in 1940 by J. B. Mertie, Jr., from Lost River was determined by semiquantitative spectrographic analyses, and was anomalously high. R. R. Coats (oral communication) of the U.S. Geological Survey found in 1943 that garnet and idocrase from the Lost River mine contain abnormally high concentrations of beryllium. During the last period of operation of the Lost River mine from 1950-55, however, no attention was paid to beryllium, and the writer, in a publication based on detailed mapping of the Lost River mine prior to its closure in 1955, merely mentioned that phenacite and beryl had been found there previously.

Interest in the commercial potential of the beryllium in the tin districts of the Seward Peninsula was revived and intensified in late 1959 and early 1960 by both the U.S. Geological Survey and the U.S. Bureau of Mines. This interest can be attributed to the increasing use of beryllium in spacecraft, high-speed aircraft, and in the nuclear program, and also to the fact that a direct ore-finding instrument had become available which greatly facilitates the recognition of beryllium in any form. A second factor was the discovery of other non-pegmatitic beryllium deposits in the Thomas Range, Utah, in altered volcanic rocks, and at Mt. Wheeler, Nevada, in veins in limestone.

Present investigations

The present investigation by the U.S. Geological Survey began in the fall of 1959 when G. Donald Eberlein and Wallace R. Griffitts, who, as a Survey geologist had been investigating the beryllium at Spor Mountain in the Thomas Range, Utah, discussed the Seward Peninsula in terms of the new interest in beryllium and the known widespread occurrence of beryllium on the western Seward Peninsula. Information assembled by P. L. Killeen and the writer was studied, and a program laid out which consists of four steps, as follows:

(1) A geochemical reconnaissance by use of stream sediments of the three principal tin districts at Lost River, Cape Mountain, and Ear Mountain, to outline the areas of greatest concentration of beryllium.

(2) Detailed geologic mapping of the Lost River area to determine the geologic setting of the known tin-tungsten-beryllium deposits, and to establish the stratigraphy of the Port Clarence limestone.

(3) Geologic mapping by plane table of unmapped mineralized areas at scales commensurate with detail required.

(4) Laboratory studies of the mineralogy of the beryllium-bearing minerals, and to a lesser extent of the tin and tungsten minerals.

The tin and tungsten mineralization had been described by Collier (1903), Knopf (1906), and Steidtmann and Cathcart (1922), and the relations between the tin-tungsten mineralization and the clay alteration by the writer (Sainsbury, 1960). Hence, our information about the tin and tungsten was relatively adequate, but our information about the beryllium was totally inadequate.

In 1960 a geochemical reconnaissance of the three principal tin-bearing districts of the Seward Peninsula-Lost River, Cape Mountain, and Ear Mountain was made by the writer (Sainsbury, 1961). This work demonstrated that the Lost River district is the most promising of the three and contains beryllium concentrations at the Lost River mine, particularly in the drainage of Camp Creek, at the Tin Creek granite, at the Bessie and Mabel prospect some 2 miles southwest of the Lost River mine, and around the Brooks Mountain granite. As a result, the Survey began detailed geologic mapping of this area in 1961. During this time R. V. Berryhill and A. L. Kimball of the U.S. Bureau of Mines continued their beryllium investigations at Lost River mine, and these two engineers furnished us with information which proved useful in our present work. We are particularly indebted to Berryhill for pointing out that chrysoberyl is the main beryllium mineral of the beryllium-tourmaline-fluorite veinlets at Lost River. Our geologic mapping extended eastward and westward beyond the area covered by the geochemical reconnaissance, and during the mapping west of Lost River Valley, we discovered the beryllium which is the principal reason for, and subject of, this paper.

Beryllium on Rapid River

The new prospect is on the public domain on the east side of Rapid River (fig. 1), a tributary of Lost River, about 5¼ miles above the confluence of the two streams. The prospect area can be found easily by ascending Rapid River to the point where it turns north and is joined by a tributary which enters from the east in a sharp gully. Light aircraft can land on a crudely marked airstrip some 800 feet long at the southern end of the prospect area. This strip was used by the writer during the field work in 1961.

Geology

At the prospect, argillaceous limestone of the Port Clarence Formation is cut by a number of discontinuous dikes averaging perhaps 3 feet thick that are intruded along or near a fault that strikes about N. 80° E. and dips steeply south. The generalized geology of the prospect area is shown on figure 2. The dikes are dark gray on fractured surface and brownish gray on weathered surface. Some segments of the dikes are intruded along well-defined joints striking N. 80° W. and dipping 54° N. The dikes are altered and contain carbonate and sulfide minerals; they were probably quartz diabase originally. In thin section they display a marked trachytic or diabasic texture with fine-grained plagioclase feldspar and biotite surrounding phenocrysts of plagioclase and quartz. The carbonate probably represents altered pyroxene.

The limestone over an area some 2,000 feet along the fault and up to several hundred feet wide south of the fault locally is converted to white marble and cut by innumerable small veinlets containing fluorite, tourmaline, topaz, calc-silicate minerals, and chrysoberyl, and by siliceous veinlets. Banded fluorite-tourmaline-chrysoberyl rock forms discontinuous selvages up to 8 inches thick along dike walls, and on the walls of the veinlets is limestone. Parts of the mineralized limestone are covered by a thin mantle of overburden, but mineralized float can be found over much of the area. At present, however, no statement can be made as to the proportion of the fluoritized to barren limestone.

Beryllium occurs as the mineral chrysoberyl in and near the fluoritized limestone along the veinlets and dike walls. The chrysoberyl forms fine-grained intergrowths with fluorite and tourmaline (fig. 3). Much of the chrysoberyl is almost microcrystalline, and forms veinlets and clots which are semi-opaque in thin section and curdy-white in oblique light (fig. 4). Chrysoberyl was identified by X-ray diffraction after separation from the fluorite and tourmaline with which it is intergrown. Separation of pure chrysoberyl required sizing of a ground sample to 150-200 mesh, leaching in a hot $AlCl_3$ solution to remove fluorite, separation of much of the tourmaline from the chrysoberyl by the Frantz isodynamic separator, and centrifuging the non-magnetic fraction in heavy liquid at a specific gravity of 3.285, which depressed a part of the chrysoberyl. The depressed chrysoberyl consists of both small, clear crystals and of milky clots. The X-ray pattern of this material contains no peaks other than those of chrysoberyl. The density of the curdy clots of chrysoberyl is substantially lower than that quoted in textbooks for crystalline chrysoberyl--3.285+ as opposed to 3.5-3.84 (Dana and Ford, 1951). Anyone attempting separation of chrysoberyl from these ores should be aware of this disparity in density.

The beryllium content of seven hand specimens selected randomly from float of fluoritized limestone, and of one specimen of banded fluorite-tourmaline rock from the dike walls, as determined by the neutron detector for beryllium, ranges from .01 percent to 3.3 percent BeO. The specimens of float averaged 1.2 percent BeO (1.34 percent BeO if the lowest value is excluded). The single specimen of fluoritized limestone from the dike walls contained 0.45 percent BeO. Semi-quantitative spectrographic analyses of one specimen was made by Harry Bastron of the U.S. Geological Survey in Menlo Park, California, and confirmed the high beryllium content. As five specimens of silicified limestone contain only trace amounts of BeO it appears that the fluoritized limestone is more likely to contain beryllium ore. It has proved impossible to date to determine how much of the beryllium is accounted for by chrysoberyl, and how much might be contained in the tourmaline, owing to the fine-grained intergrowth of the two. Undoubtedly some of the beryllium, but probably a minor part, is contained in the tourmaline and hence unrecoverable without chemical digestion. X-ray diffraction patterns made of pieces of the selected specimens that were leached in $AlCl_3$ disclosed peaks characteristic of chrysoberyl, however. It is interesting to note that banded fluorite-tourmaline-tactite rock from the Lost River mine is very similar to that at Rapid River, and also consistently carries beryllium (Sainsbury, 1961).

The data collected to date do not provide enough evidence to estimate the amount of ore of economic grade that might be found in the Rapid River area. It is clear, however, that beryllium is an abundant constituent of some of the rocks, and this, together with the favorable geologic structure and the widespread and varied mineralization, indicate that further work is warranted.

The identification of chrysoberyl in the new prospect indicates that chrysoberyl may be an important mineral in the tin districts of the Seward Peninsula. R. V. Berryhill, of the U.S. Bureau of Mines, states that most of the beryllium found by him at Lost River occurs as chrysoberyl (oral communication, 1961), although both P. L. Killeen, of the Survey, and Donald Grybeck, my assistant in 1961, have obtained beryl crystals from small quartz veins on the surface at the Lost River mine. The writer has separated chrysoberyl from the banded fluorite-tourmaline rock from the walls of the Cassiterite dike at the Lost River mine which is similar to that at the prospect on Rapid River. Hence, chrysoberyl may be assumed to be common. The chrysoberyl that occurs as milky clots without crystal form is difficult to identify without tedious methods of purification, which explains why it escaped detection so long. The neutron detector for beryllium detects these fine-grained beryllium minerals as well as coarser ones, and in work with samples that are known to contain considerable beryllium, one's task becomes relatively easy. The discovery at Rapid River, however, was made by visual recognition of the banded fluorite-tourmaline rock, and hence prospecting for additional occurrences does not necessarily require a neutron detector, although such an instrument facilitates the work.

Beryllium is a highly strategic metal used in making fatigue-resisting alloys with copper, which are used as springs, electrical contacts, and electronics components. It is of importance in nuclear reactors, where it is used as a reflector and moderator of neutrons to control the speed of fission. The metal is light in weight, it has a high strength-to-weight ratio, an unusual stiffness, a high thermal conductivity and heat capacity, and a high melting point, all of which favor its use in the aircraft and missile industry. The use of beryllium has expanded greatly in recent years, and if adequate sources of supply are established, it should continue to expand. Most of the supply of beryllium used in the United States comes from imported ores, and the discovery of commercial-grade deposits in the United States is of prime importance from both a technologic and strategic viewpoint.

In summary, we may state that beryllium has been found at many places in the tin districts of the western Seward Peninsula. At two places, Lost River mine and Rapid River, material of ore grade has been found. The aggregate amount of beryllium already found is substantial in terms of the total domestic supply, and will probably increase with continued exploration. Whether minable tonnages of commercial grade ore will be found can be answered only after detailed geologic mapping and careful physical exploration. Because the beryllium ores at Rapid River and Lost River are associated closely with tin, tungsten, and fluorite, all of which are valuable and which are recoverable, these deposits merit careful scrutiny by both private industry and government.

The Geological Survey plans to continue detailed geologic mapping and sampling of the Rapid River prospect in 1962.

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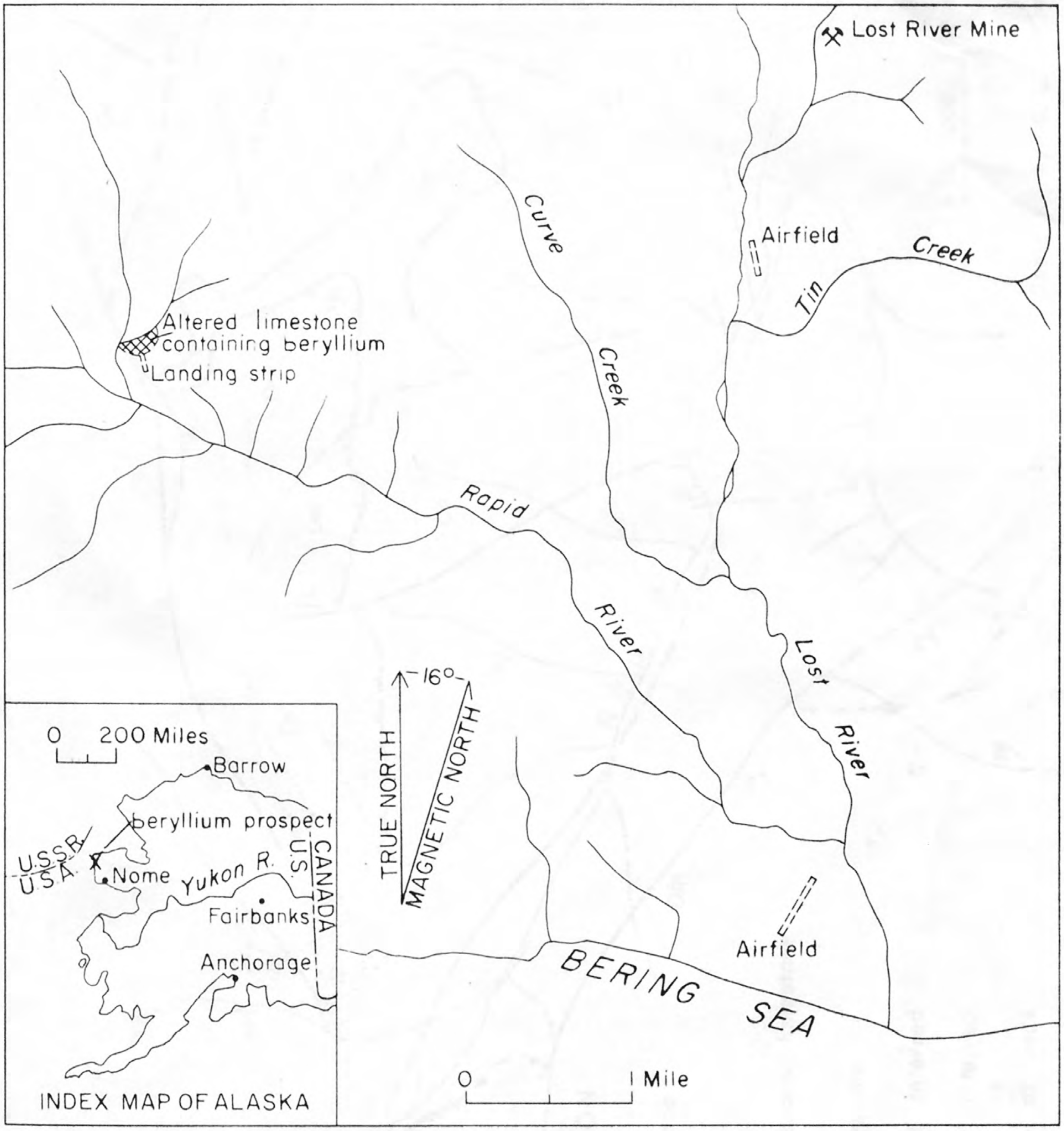

MAP SHOWING LOCATION OF BERYLLIUM PROSPECT, LOST RIVER AREA, ALASKA

FIGURE 1

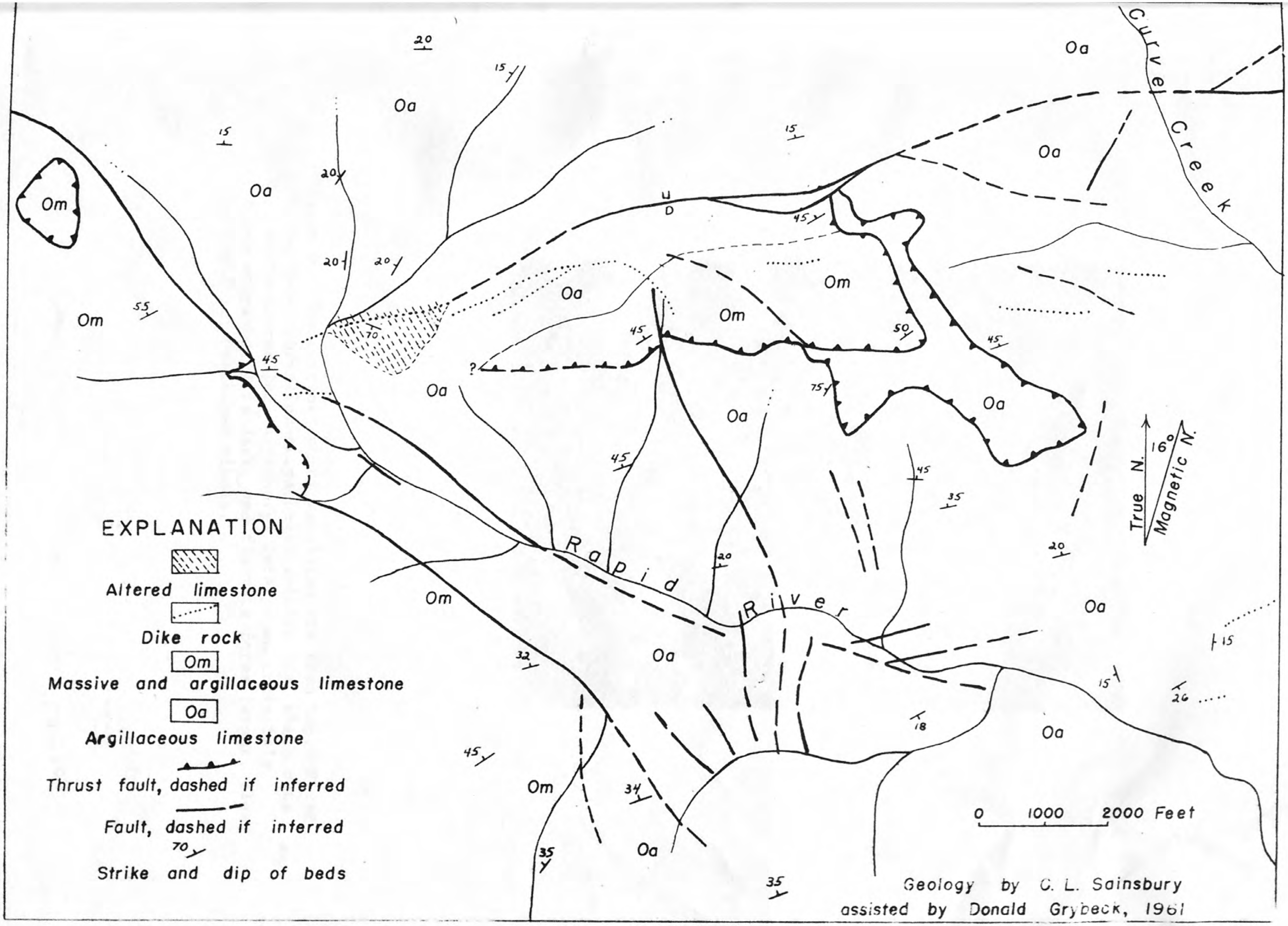

FIGURE 2 GEOLOGIC MAP OF PROSPECT AREA ON RAPID RIVER

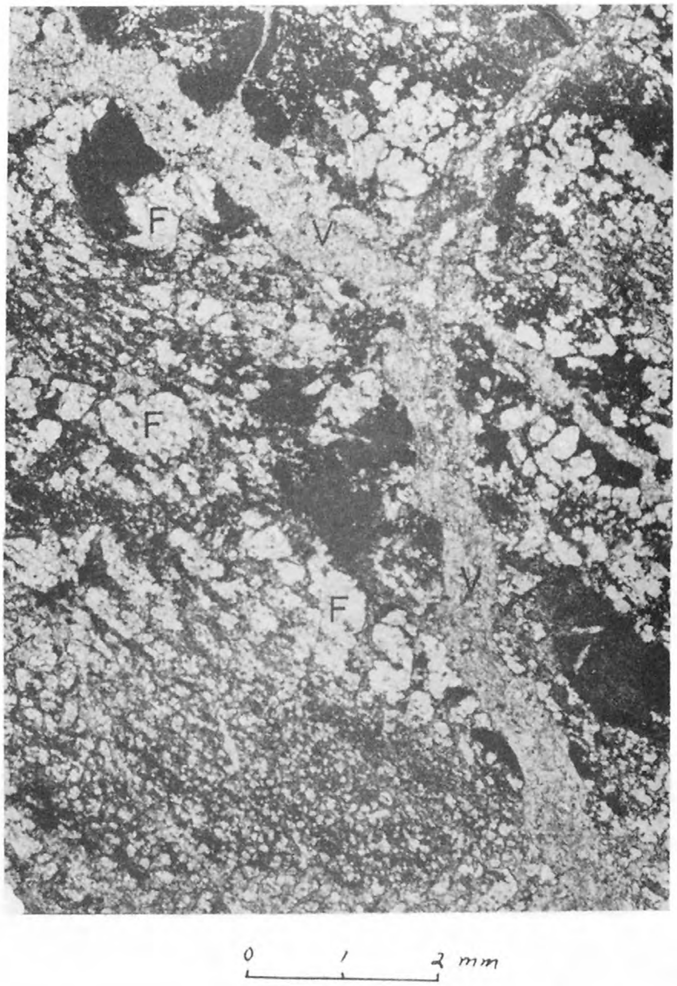

Figure 3. Photomicrograph of beryllium ore from Rapid River. Shows late tourmaline-chrysoberyl veinlet (V), which cuts fluorite-tourmaline-chrysoberyl intergrown intimately. Curdy chrysoberyl is dark, and fluorite forms larger, clear grains (F). Uncrossed nicols.

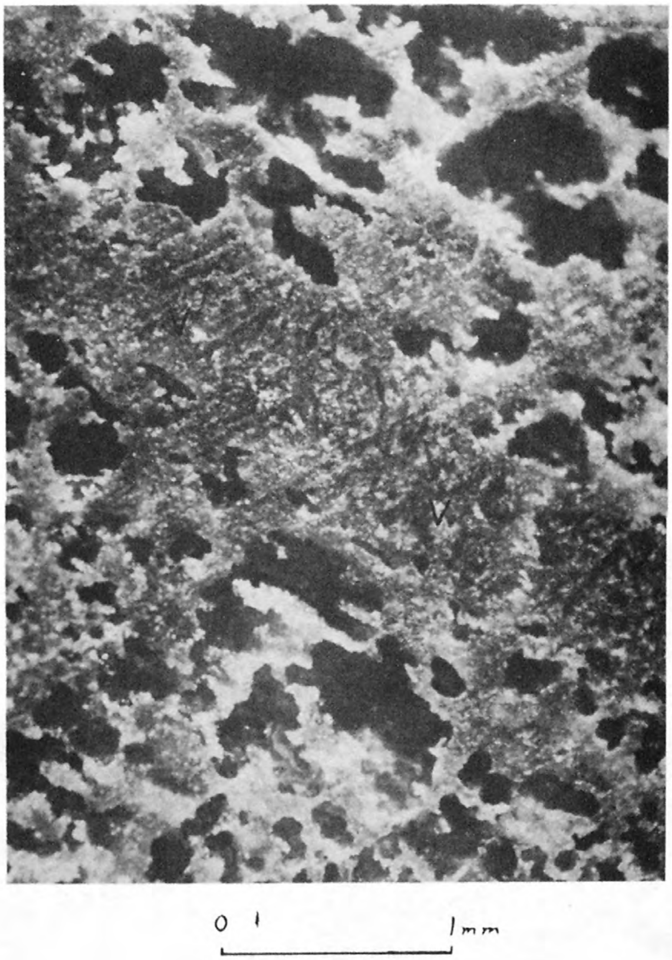

Figure 4. Slab of chrysoberyl-tourmaline-fluorite rock from Rapid River after leaching in aluminum chloride to remove the fluorite. Mineral remaining is tourmaline in veinlet (V), and chrysoberyl intergrown with tourmaline in other areas. Photomicrograph taken in oblique light.