British Columbia Department of Mines
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INFORMATION CIRCULAR B.C. 7

NOTES ON COLUMBIUM (NIOBIUM) AND TANTALUM

Properties and Uses

Columbium is properly called niobium, but the change is recent and both names are in use. The older word columbium is listed in market quotations and consequently is used here. Columbium is a brilliant, steel-grey metal, as hard as wrought iron and only slightly heavier but vastly more workable. It melts at about 3,500° F. and resists corrosion even at elevated temperatures. The principal use in the past has been in the form of ferrocolumbium and ferro-tantalum-columbium as stabilizing additives to austenitic stainless steels. Columbium is now coming into use in atomic reactors, jet engines, rockets, and guided missiles.

Tantalum is a greyish-white metal which melts at about 5,200° F. It is as hard as soft steel but more than twice as heavy, rather less workable than columbium but equally resistant to corrosion. The metal is used in electronic and corrosion-resistant equipment and in surgery. The ferroalloy is used to stabilize stainless steels. Tantalum carbide is used in high-speed cutting tools, where it is slightly superior to tungsten carbide.

Mineralogy

Some two dozen minerals contain essential columbium or tantalum or both. The commonest are pyrochlore, columbite, and tantalite. Pyrochlore, samarskite, and several others contain also uranium and rare-earth metals. Many contain titanium. These minerals normally cannot be distinguished outside a laboratory, but as a group they are characterized by brown to black colour and fairly high density and hardness. The black minerals commonly have submetallic lustre but are non-magnetic and therefore are readily distinguished from magnetite. Those minerals carrying appreciable uranium will affect a Geiger or scintillation counter.

Field Test for Columbium

Assemble:

Gasoline blow-torch

Steel plate, about 4 inches in diameter

Flux, consisting of 1 part sodium fluoride, 20 parts hydrous sodium carbonate, and 20 parts hydrous potassium carbonate

Powdered sample

Mineralight

Heat the steel plate thoroughly with the blow-torch, sprinkle flux on the plate, and melt the flux thoroughly. Let cool and check with the mineralight; if the sodium fluoride is not completely fused it may fluoresce. Sprinkle some of the powdered sample on the fused flux and heat it again thoroughly. Let cool and test with the mineralight. If any columbium-bearing grains are present they will be surrounded by a ring of blue-white fluorescence, similar to that of scheelite. Uranium will cause a fluorescence cream to canary-yellow in colour. If both metals are present the glass will fluoresce some intermediate colour.

Deposits

Granite pegmatites, and placer deposits derived therefrom, have yielded the bulk of columbium-tantalum minerals produced to date. Pyrochlore and other columbium-bearing minerals may occur sparsely disseminated through alkalic intrusive rocks and carbonatites.

Pegmatites are dykes or similar bodies of igneous rock characterized by coarseness and irregularity of crystal size. They may vary in composition but granite pegmatites predominate, constituting 90 per cent of all pegmatites. Columbium and tantalum-

bearing minerals have been found in most types but are best known from granite pegmatites. Where found, granite pegmatites are usually associated with masses of granite or granodiorite, and may occur inside or outside the intrusive mass but are usually in the general contact zone. The larger dykes tend to weather out as ridges.

Granite pegmatites are classified as zoned and unzoned. The unzoned are essentially uniform in texture and mineralogy from wall to wall, and are built of grains less than 2 inches across. They consist almost entirely of plagioclase, quartz, microcline, and micas, and therefore are rarely mined. They are the commoner type. Zoned pegmatites show a more or less systematic zonal change in mineralogy and average grain size from walls to centre, and also show replacement of one mineral by another. The crystals range from a few inches to several feet across. The core is commonly largely quartz. In addition to the principal minerals, feldspars, quartz, micas, and tourmaline, zoned pegmatites may contain any or all of the following ore minerals: columbium-tantalum minerals, beryl, lithium minerals, cassiterite. Most of the commercial pegmatite deposits of columbium-tantalum minerals comprise pockets of crystals in or next to the quartz core.

The principal producing pegmatites are in Western Australia, the Rocky Mountain and Appalachian regions of the United States, northeast Brazil, and central Africa. In Canada columbium-tantalum-bearing pegmatites are very largely restricted to the Canadian Shield, the majority occurring in Ontario. In British Columbia uranium-bearing samarskite occurs in small quartz pockets in syenite pegmatite 2 miles northwest of Crescent Valley, fergusonite has been reported from pegmatite 15 miles east of Kelowna, and tantalite has been reported a few miles from Kamloops.

Hillside rubble and stream gravels near the source pegmatites have yielded much of the columbium and tantalum from Australia and Nigeria. The source of alluvial tantalum and columbium in Burma is not exposed. In Canada, pyrochlore in gravels along Bugaboo Creek, East Kootenay, is derived not from pegmatite but from granite.

Pryochlore and other columbium-bearing minerals are sparingly disseminated through some bodies of alkalic granite and syenite in various parts of the world, but are more common in nepheline syenites and related intrusive rocks, in carbonatites, and in associated gneisses. The alkalic granites and syenites commonly contain the blue-grey amphibole riebeckite instead of hornblende or the bright green pyroxene acmite instead of augite. Carbonatites are carbonate-silicate igneous rocks which usually occur in or near stocks of nepheline syenite and related rocks. Gneisses which have been altered by intruding nepheline syenite are called fenites. Apatite and magnetite are usually associated with the pyrochlore in these rocks. In British Columbia columbium occurs sparingly in carbonatite and nepheline-bearing rocks of the Ice River complex in Kootenay Park; the mineral containing it has not been identified. It occurs also in interbanded marble and amphibole gneiss on Granite Creek, near Manson Creek, and at Lempriere on the north Thompson River. On Granite Creek very fine-grained ilmenorutile is dusted through the marble and traces of uranian pyrochlore, columbite, and ilmenite occur in the gneiss. At Lempriere pyrochlore is associated with apatite in the marble.

Grade and Treatment of Ores

Columbium-tantalum minerals in pegmatites and derived placers are usually recovered as by-products of mining for other minerals. Where they, with or without uranium and rare earth metals, are the only valuable constituents the minimum ore grade has to be determined by bulk testing. Where the crystals in pegmatites are large enough some of the columbium-tantalum ore is won by hand-cobbing, but more commonly a concentrate is produced by a process of milling. The columbium-tantalum minerals may be separated from ground rock or from placer by a variety of processes employing gravity, pneumatic tabling, magnetic separation, and electrostatic separation. Columbium and tantalum can be extracted from the simpler minerals, such as columbite-tantalite, by fusion with alkali and treatment with hydrochloric and hydrofluoric acids. More complex minerals require longer and more costly extraction procedures.

On Bugaboo Creek Quebec Metallurgical Industries Ltd. produced 24,931 pounds of pyrochlore concentrate from 7,220 yards of gravel. The minus one-eighth inch fraction of screened gravel was fed to spiral classifiers and the dense fraction further concentrated on Wilfley-type tables. A wet magnetic separator was used to remove as much as possible of the magnetite. The pyrochlore concentrate was shipped to the company's laboratories in Ontario for research on extraction methods.

In Norway the Sove pyrochlore ore contains about 0.30 per cent columbium pentoxide (Cb_2O_5). The ore is crushed, ground, classified, and tabled to produce a pyrochlore-apatite concentrate. The apatite is removed by leaching with nitric acid.

General Information

Chemical assays for columbium and tantalum are exceedingly difficult and time-consuming, therefore assays are usually done with a spectrograph. The Department of Mines and Technical Surveys in Ottawa and the three exploration and mining companies listed below have spectrographic facilities. Spectrographs are also maintained by several commercial assayers in Vancouver and other large Canadian cities. It is expected that the new spectrograph of the British Columbia Department of Mines will be in full operation early in 1959.

Prices paid for ores and concentrates vary not only with the content of columbium oxide and/or tantalum oxide but also, inversely, with the complexity of the minerals. The price is commonly determined on the basis of bulk samples of several hundred pounds. In 1958 high-grade columbite concentrate averaged about $1 per pound of contained columbium pentoxide (Cb_2O_5).

The following companies have been interested in exploring for deposits of columbium or tantalum in British Columbia:

Quebec Metallurgical Industries Ltd.,
Room 602, 88 Metcalf Street,
Ottawa, Ontario.

Northwestern Explorations Ltd.,
25 King Street West,
Toronto, Ontario.

The Consolidated Mining and Smelting Company
of Canada, Limited,
Trail, B. C.

Assistance in developing metallurgical processes may be obtained from:

The Battelle Memorial Institute,
505 King Avenue,
Columbus 1, Ohio.

Mines Branch,
Department of Mines and Technical Surveys,
Ottawa, Ontario.

Reference

Columbium (Niobium) and Tantalum - Memorandum Series No. 135, Mines Branch, Ottawa, 1957. 50 cents.