# Process

## Processes from extraction to shipping

Before shipping its finished products to its customers, Niobec must complete three processes: exploration, mining and transformation. The exploration process is comprised of several activities, namely diamond drilling (to determine the lenses' potential) and fill-in drilling (to determine the niobium grade). Once the deposit has been located and defined, development occurs through shaft sinking (scaling, clearing and installing of support systems).

The production process follows the exploration process. Drilling and blasting take place, and the ore is subsequently broken to be extracted. The underground mine is in operation 24 hours a day and 7 days a week. It extracts over 2.3 million tons of ore which, once transformed, produces some 5000 tons of niobium annually.

The primary crushing is performed underground. Then, the ore is brought to the surface, where secondary crushing takes place. At that point, the ore can be sent via a conveyor to the concentrator to separate the economical content of the ore and finally to the converter to obtain the FeNb, the final product at Niobec.

### Mining method

Since the beginning, Niobec has been using the open stope mining method. Mine planning and design are performed based on the geological information obtained during the diamond-drilling process.

To break the ore, vertical holes, with a diameter of 17 centimetres (6.5 inches) are drilled off filled with explosives and detonated. The broken-up ore is

collected at the base of the open room in a draw point with a loader and transported by truck to the ore pass. After, the ore is crushed underground, and hoisted to the surface to be crushed again prior to being transferred to the concentrator.

Since September 1999, the extraction was performed at depths varying between 100 and 440 metres (300 to 1,450 feet). Today, an 800 metres shaft (2,800 feet) and a ramp provide direct access to the various mine levels, which now cover 730 metres (2,400 feet).

### Concentrator

Niobec's concentration plant uses the one of the most complex ore recovery processes in the world. In order to produce a pyrochlore concentrate (58% niobium pentoxide, $Nb_2O_5$), the following steps must occur during the transformation process, which takes place at the plant: milling, sieving, desliming, magnetic separation, three types of flotation, leaching, two-step filtration and concentrate drying. Each ton of ore (1,000 kg) produces in average 2.4 kg of niobium oxide. About 15 different chemicals are used during the concentration process. However, the concentration plant's waste is pH neutral. In other words, it does not generate acid and is essentially carbonate-bearing.

### Convertor

The conversion of the niobium concentrate into ferroniobium (FeNb) is performed on site by way of thermite reaction. This process is divided into 5 components: niobium oxide concentrate ($Nb_2O_5$), aluminum powder and pellets, metallic iron, sodium nitrate, fluxing agents and fine recycled matter. This combination produces a powerful exothermic reaction that generates enough heat to bring the temperature up to 2,250ºC, thus melting the entire load in less than 10 minutes. A typical load of 6,400 kg generates 2,400 kg of ferroniobium. Following a cooling period, the ferroniobium is crushed to sizes specified by various steel plants, packaged in 10 to 1,500 kg containers, and shipped worldwide.

## Quality control

Niobec is ISO 9001: 2015 certified. Quality control and assurance are performed at all production levels, and the materials' quality is verified on a constant basis. The concentration process is monitored throughout the processing stage. An audit is performed at various strategic check points with the help of a content analyzer. Several samples are also regularly taken at various check points in the flotation circuit, which are then sent to the control laboratory.

At the convertor, the products resulting from the reaction are systematically sampled, and so is the ferroniobium during the crushing and packaging processes so as to determine its various attributes, such as its chemical composition and grain size.

The control laboratory uses certified standards and highly sophisticated apparatus to perform chemical samplings, namely an X-ray fluorescence spectrometer, a plasma atomic emission analyzer and other specific equipment for carbon, sulfur, and other elements. To cover all these sectors, no less than 100,000 analyses are performed each year by the laboratory's personnel.


## About Us

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The Niobec mine is located in the municipality of St-Honoré in the Saguenay-Lac-Saint-Jean region, 200 kilometres north of Québec city, it is the only underground niobium mine in the world and one the 3 [...]

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