

Edgardo Leiva Preconditioning and Development Unit Supervisor, Division El Teniente



“What is valuable of being part of this organization is the willingness to innovate and to expand knowledge”

Nowadays, Mr. Leiva is working on a great project for the national company Codelco. It is the preconditioning with hydraulic fracture which is about preparing the rock mass to carry out the extraction of the mineral, in more favorable and safer conditions.

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Edgardo Leiva, who was born in Copiapó, recognizes that mining is his passion. He studied mining engineering and then civil engineering in the University of Atacama. He started his career in the National Company of Oil (ENAP) in the area of drilling of Punta Arenas, in the Strait of Magellan, for a short time.

27 years ago, he completed his thesis in Codelco and since then he has worked in El Teniente Mine. There he has developed as a professional and has shared his experience and knowledge with younger professionals teaching techniques such as Blasting and now Preconditioning with Rock hydro-fracture. Such technology is only used by Codelco in our country with cutting edge technology, that comes

from Germany and other European countries and is assembled in Canada.

Edgardo has been married to María Ximena for 23 years. She is a cosmetician, and they are parents of Ximena and Felipe, both university students. What he likes most is to spend time with his family, and he also dreams of registering the knowledge of workers and professionals in El Teniente in books and databases so that new generations can learn from the experience which is being gained.

In general terms, what is preconditioning?

It means preparing the rock mass for future exploitation, so that the mineral extraction is carried out in more favorable conditions for its treatment.

Essentially, it is to prepare it in order to generate micro fractures and reduce the potential of rock explosion.

How many ways of preconditioning are there, and which are carried out in El Teniente?

Dynamic detonation of explosives and hydro-fracture are known. In El Teniente, hydro-fracturing has been applied extensively. In a period of 6 years, we have done approximately 15,000 fractures. The preparation of the rock mass is done at the beginning of the mining preparation and corresponds to the first link in the chain of preparation.

How is it carried out?

A section of a hole has to be sealed hermetically. Then, water is injected at a very high pressure in the section that exceeds the rock resistance and produces a fracture that spreads within the mass.

What is the origin of this process?

Preconditioning with hydraulic fracturing originated in the oil industry, to connect reservoirs. It has been adapted to metallic copper mining, both in pressures and volumes of injected water in every fracture. It means drilling a 10 cm diameter borehole and, say 100 meters long. This borehole can be upward or downward in a gallery, with a certain preferential vertical inclination. Afterwards, the fracture instrument is introduced and seals a section of it, which is the place where water is injected under pressure until the rock breaks and spreads the fracture in a plane perpendicular to the axis of perforation. In this way, the fracture cycle is repeated until drilling is completed. Then, the process is carried out in several boreholes until the required volume of rock is completed.

What types of equipment are used in this process?

Two main pumps are used. One of them is the sealing pump with low flow of water, but it produces a pressure of up to 9,000 lbs/in² (300 times the inflation pressure of a car tyre). The second pump is used to fracture the rock and injects a flow of 250liters/min of water and pressure slightly lower than the former – up to 7,000 lbs/in². The pressures and flows are controlled with the fracture instrument, which is approximately 4 mts. long. It is a steel body with rubber ends which are inflated to

isolate the perforated section where the fracture will be done. The other component is a standard mining drilling machine that permits it to support the column of steel rods and the fracture instrument. Hoses and accessories that resist these high hydraulic pressures are also used. The entire process of controlling pumps pressures and flow is carried out remotely at a safe distance, through electronic signals with a computer.



Which are the ranges of pressure and application times of hydraulic fracture? Which others variants are important to consider?

Normally, the rock is fractured at 5000 pounds/inch² and every fracture is done for 30 minutes, reaching 20 meters of radius. Then, the fracture instrument is displaced within the borehole for 1,5 meters and the cycle is repeated. In every drilling period, 50 fractures are accomplished. The important variables are that the rock must be hard enough to withstand resistance to the flow and to increase water pressure and that a relevant tensional state exists in the mass.

In relation to Human Resources, how many operators are needed and what are the qualifications required?

In terms of operators, they must have specialization in structural geological interpretation and know about hydraulics, mechanics and electricity with computing knowledge at a user level. Engineers must have experience in mining design, rock mechanics design and mining

exploitation. A system of fracturing is operated by 4 people and also a supervisor, an expert operator in charge of the process, a probe operator and two assistant operators.

What are the general results of the technique from a point of view of fragmentation or any other parameter?

The great achievement of this technique of preconditioning is the favorable control of the seismic magnitude of the mining exploitation, making the operation of mineral extraction safer and more reliable.

What is the cost per ton and how does this technique promote production?

The increase of the cost per tone is approximately 3% of the cost without preconditioning. This technique makes the operative continuity possible in mining preparation and exploitation, permitting a safer and more productive mining.

Are the advantages of this technique applicable in continuous mining?

Not only in continuous mining. The technology itself contributes to the current methods of exploitation, permitting operative continuity. Given the depth of exploitations in underground mining, the primary rock becomes harder and competent; therefore, the preconditioning is the main pillar for this type of exploitation.

Could this technique be related to in situ mining in the future?

It is possible, although we must remember that hydraulic fracturing produces cracks, which close

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once water injection is stopped. In situ mining requires a mass that is permeable to acid solutions.

What repercussions will this technology have in the future?

It is expected that its use will be expanded, since several open pit mines will start to be exploited underground and in more competent rock.

There are some problems of water shortage in the region. What is done with discarded water?

Water is not wasted, since it is retrieved and conducted through the mine and subsequently it feeds an electro-winning plant, where copper of high purity is obtained, 99,99% composition.

Who are the key suppliers?

Those who supply sealing pumps, one of them, who is very important for us is IPI from Australia. We have worked since the beginning and we have learnt together.

