



Pic. left: Shaft sinkers while grouting work inside the foreshaft

Pic. above: Draining of grouting material

## SKS-1 Norilsk shaft tubbing successfully sealed with emulsion grouting – NOH20 (SCEM 66)

**The SKS-1 project: shaft sinking and sealing cast-iron tubbings in the foreshaft zone to a depth of 150 m**

In 2011, THYSSEN SCHACHTBAU GMBH was contracted by OOO Norilsk Nickel to sink the SKS-1 shaft at Skalisti mine. After completing the surface buildings and installations, and the construction of the shaft cellar, fan drift and shaft neck, work started on the sinking of the 150 m-deep foreshaft in early 2012.

The sinking operation used conventional drilling and firing, with cast-iron tubbings installed as the shaft lining. Between the 105 and 140 m levels the sinking encountered water-bearing strata that resulted in an inflow of water into the shaft amounting 3 to 5 m<sup>3</sup>/h. Small inflows affected the entire tubbing column, especially in the area around the fan drift.

In order to minimize the flow of water from the foreshaft and prevent it from affecting the main shaft sinking phase, a grout injection of the tubbing column between the 16.5 and 140 m levels, was employed.

Two decks of the seven-deck sinking stage were used as a working platform for the injection operation. This installation was operated by two platform winches that could traverse the entire depth of the foreshaft. The compressed air-powered emergency winch provided for the foreshaft sinking was used for manwinding duties. An additional power winch, which was available as an emergency unit, was employed for transporting the grout injection equipment and materials.

### ■ Phase 1: Injecting the tubbing column with cement emulsion

The injection operation was carried out in two phases. In phase one, the entire length of the tubbing column was injected from top to bottom with a cement suspension. This succeeded in reducing the water inflow into the shaft by about 50%. In phase two, the column was then re-injected from bottom to top with NOH20. Two specialists from the SOVEREIGN-THYSSEN Joint Venture were in attendance throughout this phase of the operation.



Pic. above left: Injection mounting for the sealing material "NOH20"

Pic. above right: Arrangement of the injection pumps on the working platform

Pic. left: Shaft sinker while monitoring of the grouting process

## Phase 2: Injection of the tubbing column with NOH20 (SCEM66)

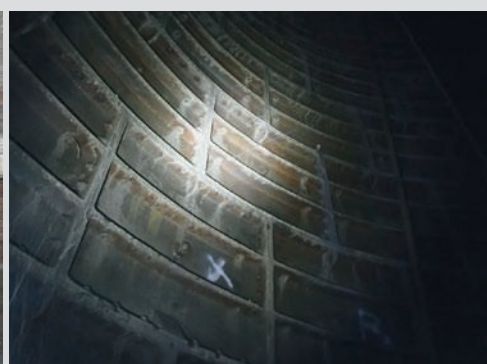
The scope of the work was to seal tubbings in the shaft column section from 16.5 m to 140 m below the surface (tubbing rings number 6 to number 88) to prevent water inflow by grouting with NOH20 (SCEM 66). Work was scheduled for the summer with a plan to complete the labor before temperatures reached freezing condition, in order to achieve optimal penetration conditions in the upper permafrost section. The preliminary work of the dye injection was utilized to determine a suitable drilling and grouting pattern. The lower section of the tubbings from ring number 88 to ring number 50 was the target area we focused on, as this was the transition zone between the water bearing formation and permafrost formation. Although all the tubbings were leaking from top to bottom, the section below the permafrost produced the majority of the water inflow and was the level where water was intersected during excavation.

A staggered drilling pattern was adopted within the 9 m shaft and on average, every 3rd tubbing was horizontally drilled and every 45 degree grout port was also drilled, where possible. Although injection pressures were kept to a minimum the grout migrated both horizontally and vertically, reporting in some cases, 11 rings higher than point of injection. The grouting phase was accomplished in one continuous operation from ring 88 to ring 6 in just over two weeks. The total shaft water intake was 3.6 cubic meters per hour prior to injection. On completion, the tubbings were absolutely dry with no water flowing down the shaft walls. The project was completed safely, successfully and on schedule. The final shaft lining was classified as "dust dry".

Grouting material is leaking out of the tubbing joints- a sign of effective grouting



Leakage of grouting material between tubbings



The grouting material take effect, the tubbing surfaces are drying







Chemical grouting material ready for the removal



View inside the foreshaft SKS-1



The grouting material is leaking out from an expansion hole

## SOVEREIGN-THYSSEN Joint Venture: providing shaft sealing services throughout Europe



**SOVEREIGN-THYSSEN**  
*Joint Venture*

Thyssen Mining Construction of Canada has 30 years of experience working in the high grade uranium mines of Northern Saskatchewan, including the McArthur River and Cigar Lake uranium mines, which use large-scale and long-term ground freezing to stabilize the ground and form a water barrier.

SOVEREIGN has been the world leader in providing grouting solutions at problem sites where all previous grouting initiatives have failed. SOVEREIGN provides not only the site specific formulated proprietary grouting materials, but also designs the drilling program for optimum grouting results. SOVEREIGN then acts as the project manager for this grouting process. This approach has generated many well documented success stories over the past 42 years.

The SOVEREIGN-THYSSEN Joint Venture was created when after working on several projects together as separate entities; both parties realized that there was a mechanical synergy between their areas of expertise: shaft sinking, especially with applying shaft freezing method and emulsion grouting. Each company enhanced its own capabilities by the use and availability of the other's technology.

In addition to the technical synergies between the two very different approaches to controlling ground water inflows, the Joint Venture has also brought together two world leaders in their fields, each of whom has a long and credible track record in their areas of expertise.

It is our belief that the combination of our products, services and experience makes us the world leader in the area of water sealing technologies, which is also attributed to the global unsolicited demand for our services.

The SOVEREIGN-THYSSEN Joint Venture will be providing and carrying out sealing work for the deep mining industry (shafts, roadways and other cavities) and tunnel construction sector as part of its strategic services segment in the future. The polymer-based injection material 'NOH20' (SCEM 66) has proved so convincing that clients can be guaranteed a successful sealing operation. This product can even cope with water inflow rates of more than 50 m<sup>3</sup>/hour and hydraulic pressures of as much as 60 to 80 bar.

This service segment will provide THYSSEN SCHACHTBAU GMBH with an opportunity to fulfill its duty as a specialist mining contractor while underlining the company's expertise in injection and sealing technology.

*Dietmar Schilling · schilling.dietmar@ts-gruppe.com*

*John Minturn · jminturn@thyssenmining.com*

*Andreas Neff · neff.andreas@ts-gruppe.com*