



SIKA AT WORK

Kassandra mines, Halkidiki, Greece

- Shotcrete production
- Tank waterproofing
- Anchoring & grouting
- Joint sealing
- Industrial flooring

KASSANDRA MINES – FULL PRODUCT RANGE SOLUTIONS FROM SIKA



PROJECT DESCRIPTION

Hellas Gold S.A. is a gold, silver, lead and zinc mining company headquartered in Athens, Greece. Since 2004, Hellas Gold operates the "Kassandra Mines" assets at N.E. Halkidiki, under the strictest EU safety and environmental standards and regulations. The Kassandra Mines consist of: Stratoni and Olympias operating mines, and the Skouries project.

Evolving a mining history of 25 centuries, Hellas Gold invests in the development of sustainable mining in the region, contributing to the local economic growth and prosperity with investments of more than \$1 billion, the employment of about 2,000 people, the active support to the local suppliers, and important investments to local community initiatives and projects.

Since 2012, Hellas Gold operates as a subsidiary of the Canadian-based Eldorado Gold Corporation, which has over 25 years of experience in exploration, construction and operation of mines around the world.

PROJECT DEMANDS

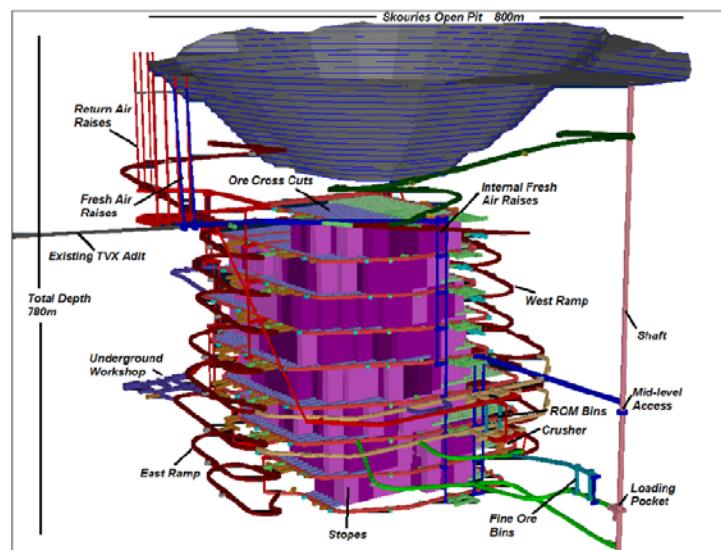
Olympias Mine: Olympias is a pre-existing gold-silver-lead-zinc underground mine. The mine is being redeveloped and modernized in phases. Phase I involves an environmental clean up of previously mined tailings (mining waste) and the refurbishment of the original processing plant and underground mine. It started in 2013 and continued during 2017. Phase II began in the first quarter of 2017, with the commencement of underground production alongside operation of the Olympias flotation plant. The renovated flotation plant and the modernized underground mine were officially declared in commercial production at the end of 2017.

Stratoni mining facilities: Stratoni is an underground, silver-lead-zinc mine. The Stratoni mining area is composed of the Mavres Petres underground orebody, the Stratoni plant and the Stratoni port facilities. Ore from the Mavres Petres mine is transported to the Stratoni plant where, through a multistage flotation process, a lead-silver concentrate

and a zinc concentrate is extracted and then shipped from the Stratoni and Thessaloniki ports to overseas refineries. Its facilities include:

- The crushing unit of the ore
 - Flotation unit
 - The condensation-filtration system of condensate products
 - The fiduciary unit and the port loading facilities of the products
- For the period 2006-2013, a total of € 50 million were invested in upgrading and modernization projects.

Skouries Project: Skouries is a high-grade gold-copper porphyry deposit. Upon completion, the Skouries Project will operate initially as an open-pit and underground mine, later followed by only underground production. Hellas Gold's objective for the Skouries Project is to use the smallest possible surface area for construction of the mine.



SIKA SOLUTION

Sika has been actively involved in the provision of specialized products since the beginning of the project. A multitude of materials and systems were required for each construction phase that Sika had commissioned. Below we list the most demanding cases for addressing key issues for project progress:

Shotcrete production: Mining development projects require the opening of several kilometers of underground tunnels. The tunnel linings are supported using shotcrete, which has to meet increased efficiency requirements (high early & final strengths, improved pumpability), cost requirements (optimized composition, reduced rebound), but also ecological requirements (use of non-toxic admixtures). To meet these requirements, Sika has provided special plasticizers and accelerators with the best combination of performance vs cost. One of the main issues that had to be addressed in designing and handling of the mix was the increased thixotropy of the shotcrete, a feature that was particularly improved with the incorporation in the mix of the special superplasticizer designed for shotcrete **Sika® ViscoCrete® SC-360**. The tests on site under real construction conditions confirmed the improvement of the pumpability of the mix, facilitating the concreting process and making it faster and with reduced equipment wear (shotcrete pumps). In addition, the use of **Sika® ViscoCrete® SC-360** superplasticizer made it possible to reduce the water content of the mixture (active water / cement ratio) and reduce the amount of cement without loss of the early and final strengths and at the same time with reduced rebound, significantly improving the cost of shotcrete.

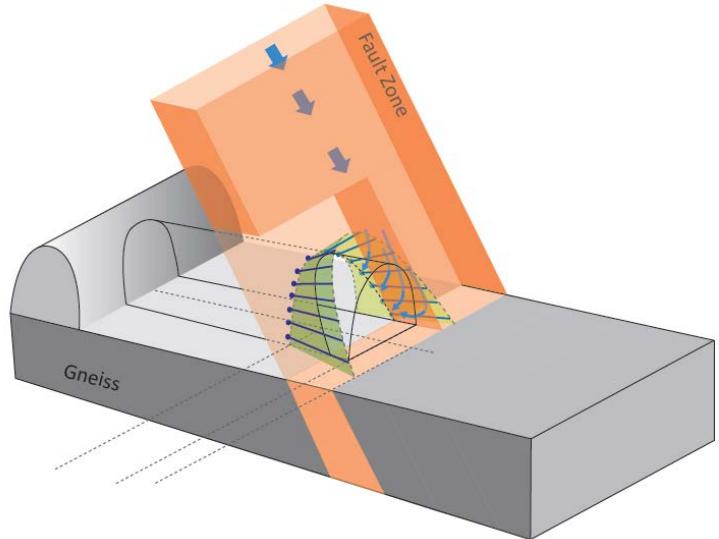
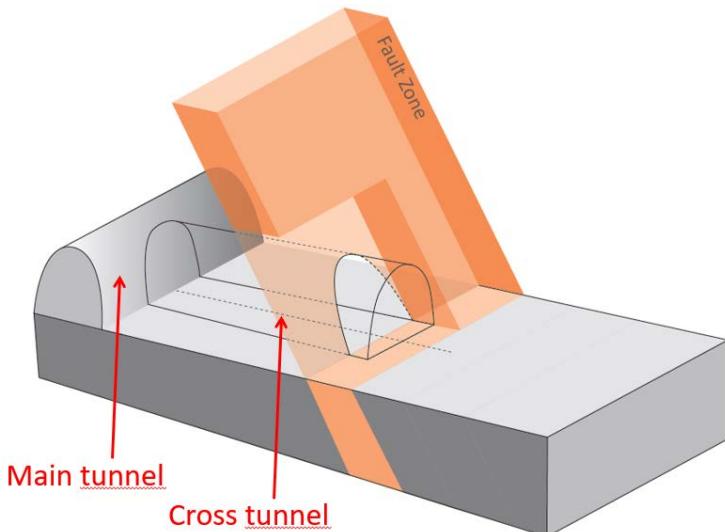
The high environmental management, hygiene and safety requirements of the project required the use of an alkali-free shotcrete accelerator. Thanks to the optimization of the mixture with **Sika® ViscoCrete®** technology superplasticizers, it was possible to use **Sigunit® AF** alkali-free accelerator at very low dosages. On-site tests have confirmed that the finally produced mix with Sika admixtures fully meets the high requirements of EN 14487-1.



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Suspension of water penetration/Waterproofing: During the auxiliary tunneling phase in the Stratoni area, there was a severe problem of water inflow from the rock branches. The auxiliary tunnel, which was to be constructed vertically to the main tunnel, aiming to be used as a reversing area for trucks, entered a troubled crushed rock area with a large flow of water of 200 m³/h. Due to the inclination of the main tunnel (10°) all the incoming water came to the front, creating a serious problem in the opening procedure.

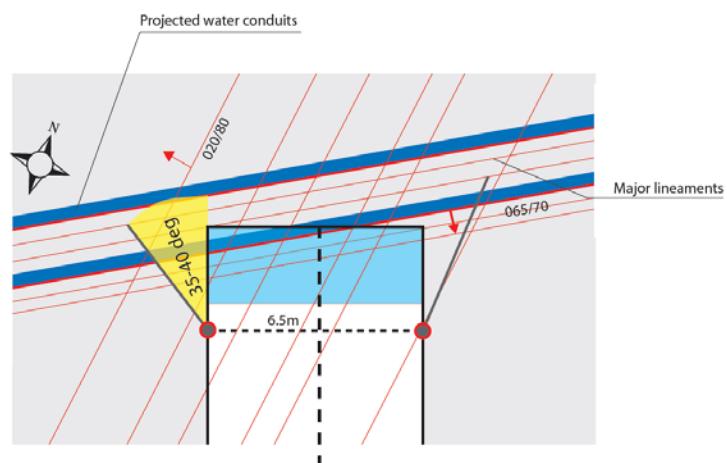


Following an assessment of the current situation, Sika's waterproofing plan was to form a sealing casing (green section on the graph) around the transverse tunnel inside the crushed zone. With the "punch-insert-punch" method, the incoming waterfront was progressively moved to the top of the front, where the final injections were performed.



○ Previous injection holes

In addition to all the above parameters, during the project implementation phase, Sika also had additional challenges to face. Many previous injection procedures stabilized the substrate but blocked the existing injection routes and caused additional inconsistent cracks due to pressure. In addition, the rock mass was covered with shotcrete, which made it difficult to identify the crack and path connections and caused the penetration of water and grout at the interface between the shotcrete and the rock mass. Briefly, Sika had to stabilize a partially stabilized but unseen substrate. The location of most of the holes indicates that they were drilled behind the main "water duct" responsible for the large water inflow to the left of the middle of the tunnel.



The 2-component polyurethane injection **SikaFix®-210** was used in the low-medium water penetration areas, while in the areas with increased water penetration, **SikaFix®-210** was combined with the **SikaFix® AC-21** accelerator allowing less than 45-second reaction time. The **SikaFix®** injections expansion rate, their high mechanical strength (approx. 80MPa) for pressure resistance and their high penetrating ability have been the decisive factors for the success of the application.



Waterproofing of the Kokkinolakas reservoir: For the processing of the ores, it was necessary to seal the 1,680 m² surface reservoir of the Kokkinolaka mine, in which the water from the Kokkinolaka dam in the area of Stratoni is being driven finally. The waterproofing process should take place with a coating resistant to mechanical stress - due to the use of mechanical equipment for its scheduled maintenance - as well as against chemicals. For the waterproofing **Sikalastic®-843 GP** spray system was applied, a pure polyurea based liquid waterproofing membrane. Its short curing time and its almost instantaneous space utilization combined with its large service temperature range (-30°C to + 100°C) and its excellent crack bridging ability have been just a few of the benefits that have been taken into account for selecting this system.

The floor substrate was smoothed with a single disc machine equipped with polycrystalline diamonds, suitable for concrete substrates. The internal walls were smoothed with angular wheels with diamond discs.

The main waterproofing of the reservoir was performed using the 2-component, liquid, hot-spray, pure polyuria based membrane **Sikalastic®-843 GP**, up to the height of the handrails:



The 2-component acrylic-polyurethane final paint with weather-resistant **SikaCor® EG-5** was applied to the entire surface of the water-free reservoir and exposed to UV radiation (from the height of its upper level water and the handrail, about 1 m below the rim of the tank) in Ral 7035 colour shade.



Then water jetting followed for dust removal and application of the 3-component micromortar based on cement and epoxy resins **Sikagard®-720 EpoCem®** for surface smoothing of the floor of the reservoir:



On the perimeter walls, the 2-component **Sikafloor®-161** epoxy primer was applied first, followed by **Sikafloor®-161** scratch coat:



SIKA PRODUCT QUANTITIES:

- **Sika® ViscoCrete®** superplasticizers: 374 tn
- **Sika® ViscoFlow®** superplasticizers: 39 tn
- **Sika® ViscoCrete® SC** special superplasticizer for shotcrete: 187 tn
- **SikaTard®-930** cement hydration stabilizer: 4.3 tn
- **SikaFiber® PP 940-50** polypropylene fibers: 5 tn
- **Sigunit®** alkali accelerator: 2,438 tn
- **Sigunit® AF** alkali free shotcrete accelerator: 373 tn
- **SikaFix®-210** polyurethane injection: 22.5 tn
- **SikaFix® AC-21** accelerator for polyurethane injection: 2.2 tn
- **Sikafloor® QuartzTop** mineral surface hardener: 19 tn
- **Sikafloor® Proseal-W** curing compound and sealer: 1 tn
- **Sikaflex®** polyurethane sealants: 1700 sausages 600ml
- **Sikafloor®-161** 2-component epoxy primer: 1.1 tn
- **Sikagard®-720 EpoCem®** 3-component micromortar: 2.8 tn
- **Sikalastic®-843 GP** liquid hot-spray membrane: 4.5 tn
- Εποξειδική βαφή ανθεκτική σε UV ακτινοβολία **SikaCor® EG-5**: 2.2tn
- **Sikaplan® WT-6200** synthetic membrane for sealing chemical containing tanks: 800 m²
- **SikaGrout®** cementitious grouts: 48.5 tn
- **Sikadur®-42 SP** epoxy grout: 6.7 tn
- **Sika AnchorFix®** chemical anchors: 1,755 cartridges
- Waterproofing & repair mortars: 7.5 tn
- **Sika® Waterbars** waterstops: 1 km



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PROJECT PARTICIPANTS:

Owner: **HELLAS GOLD S.A.**

Main contractor: **AKTOR S.A.**

Sub-contractor for the Kokkinolaka reservoir waterproofing:

Emmanouil Kypraios

Our most recent General Sales Terms shall apply.

Please consult the most recent Product Data Sheets prior to any use and processing.

