

SATELLITE IMAGE - ASBESTOS MINE

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ENVIRONMENTAL REHABILITATION: ASBESTOS MINE CYPRUS



Year 1911: entire families work and reside at the mine site.



Until the 1970s the mine was operating without taking serious measures for the protection of the environment.



The processing plant.



Mechanisation of extraction and production.

A Historical Account of the Asbestos Mine

Cyprus is regarded as one of the most ancient sources of asbestos. The asbestos outcrops attracted the interest of people, due to its characteristic fibrous texture. The usage of asbestos was found quickly, utilising its natural properties. In the ancient times, particularly during the Classical and Roman periods, asbestos was used for the manufacturing of shrouds for the cremation of the dead, shoes, and wicks for lamps. Actinolite from the area of the Lemesos and Akapnou Forests was exclusively used, due to its lengthy fibres that allowed better processing. The modern exploitation history of asbestos begins very early in the 20th century, when the chrysotile type of asbestos began to be used extensively by the construction industry. The interest for exploitation of the asbestos was shifted in the area of east Troodos, where rich veins of chrysotile asbestos suitable for economic exploitation have been discovered. In 1904 some villages were given the permit for exploitation of this type of asbestos from the slopes of Troodos.

The right for exploitation was transferred many times to various foreign companies and it was finally granted to the "Cyprus Asbestos Mines Ltd", to which a mining lease was granted in 1934 for a period of 99 years.

The Cyprus Asbestos Mines Ltd was operating profitably until 1982, when the international campaign against the usage of asbestos caused the decrease in both its demand and price. Consequently, the company began to experience financial difficulties. At the same time, serious environmental problems as well as problems relating to the stability of the vast waste dumps, created during the long period of exploitation, began to accumulate.

The production of asbestos in an organised scale began at the present site in 1904. Since then and until the mine's closure in 1988, it is estimated that 130 million tonnes of rock have been excavated, producing one million tonnes of asbestos fibres. Until 1950, the excavation of the ore was carried out manually and consequently it was absolutely dependant on the employment of a large number of workers (several thousands), while its processing (separation of the fibres from the host rock) was done in a series of mills, without taking strict measures for the protection of the environment. Most of the employees were staying in nearby temporary buildings which gradually evolved into permanent houses, developing thus a community with schools, hospital and shops. Noteworthy is the fact that during the first years of the mine's operation, the processed ore was transported to Lemesos with a 30-km long airlift line. Later, with the improvement of the road network, the transport was done with trucks.

After 1950, the mechanisation of the mine began with the use of heavy extraction machinery, while from 1963 onwards a 9-storey processing plant began to operate. That led to a decrease of the number of employees and the gradual abandonment of the community that had developed around the mine.

GEOLOGICAL DATA

The Asbestos Mine is situated at the central part of the Troodos Range, which is regarded as a model ophiolite complex. The Troodos Ophiolite is a fragment of an ancient oceanic crust that was formed approximately 90 million years ago and is composed of plutonic rocks (harzburgite, serpentinite, dunite, wehrlite, pyroxenite, gabbro and plagiogranite), intrusive rocks (sheeted dyke complex - diabase) and volcanic rocks (basaltic and andesitic pillow lavas).

The Ophiolite contains asbestos ore in the form of chrysotile veins arbitrarily distributed within the serpentinite (serpentinised harzburgite), which constitutes the central part of the complex and is situated at an elevation of 1500 m above mean sea level. As a result of the serpentinisation, the constituent minerals, and in particular olivine, have been altered to minerals of the serpentine group, such as chrysotile (asbestos) but also lizardite and antigorite.

Chrysotile is found in the form of vein-filling fibres. The length of the fibres varies from some mm to 2 cm, depending on the width of the veins. The average grade of the ore is between 0.8% and 1.0%. During the ore processing and enrichment, very high recovery rate was achieved.

MINE AND NATURE

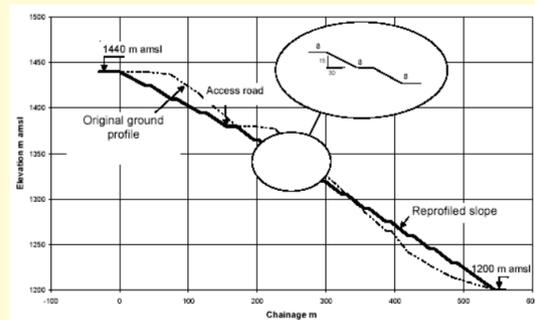
The mining activity is closely associated with nature. The ore is extracted from the earth; this extraction brings about changes in the landscape and the vegetation of a place.

The lengthy operation period of the mine by the open cast method has unavoidably affected the natural environment of the area and had direct and indirect impact on the broader environment. The main environmental problems that resulted from the mine operation are the vast mine pit, the extensive waste dumps with steep, in places unstable, slopes, the complete destruction of the pine forest of the area as well as the pollution (from the presence of the fibres) of the atmosphere (air) and the surface water that drains in dams further downstream. All these changes have possible consequences to the safety and health of the people who reside at nearby villages.

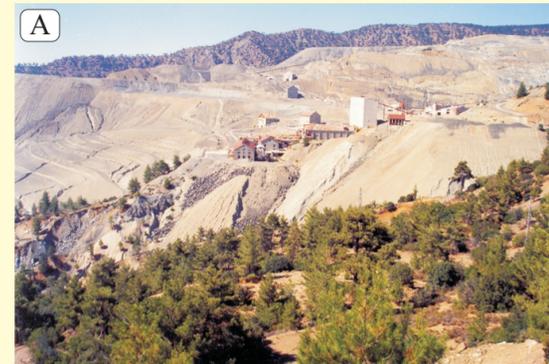
Following the termination of the mining activities and the mining lease in 1992, the Government undertook the rehabilitation works.

REPROFILING AND STABILITY OF THE WASTE DUMPS

The rehabilitation works began in the autumn of 1995 under the guidance of a multidisciplinary team consisting of a geologist, a geotechnical engineer, a forester, a mining engineer, a town planner, a health inspector, and an environmental scientist. The work, aiming mainly at the stability of the waste dumps and the reforestation and revegetation of the restored areas, is conducted following a Restoration Plan. The stability of the waste dumps involves an extensive reprofiling programme, aiming at the increase of the overall stability. The stability, rehabilitation and reforestation of the waste dumps constitute part of the aim for proper rehabilitation of the broader mine area.



Berm design for the stability of the waste dumps.



The various restoration stages of the waste dumps and the construction of berms.

REFORESTATION AND REVEGETATION OF THE BERMS

The reforestation aims at the restoration of the natural landscape and the rehabilitation of the environment at the mine site. The various works, such as soil covering, planting of trees and bushes and seeding, contribute to the stability of the waste dumps, but also to the drastic decrease of the asbestos fibres, exposed to erosion and transportation downstream.

Soil covering: The waste dumps are barren and do not offer any nutrients for vegetation. The improvement of the vegetation conditions is achieved by covering the area with fertile soil. The thickness of the soil reaches 1 m on the horizontal surfaces and 20-30 cm on the reprofiled slopes. The soil covering is done with material derived from earth works in the nearby villages. Approximately 5,000 m³ of soil per hectare are needed and so far 650.000 m³ have been used with an average cost of €4,00 per m³.

Seeding: At this stage of rehabilitation, the restored part of the mine begins to green. Approximately 12,5 tonnes of seeds of 20 different endemic and native species have been used until the end of 2014, aiming at the reproduction of the local flora. Thatching is used for the protection of the seeds from the wind and the rain.

Hydro-seeding: During the last few years a new method of seeding was introduced, that is very widely used internationally in replanting of slopes and downgraded regions. The method of hydro-seeding, as it is called, involves spraying of pressurized mixture of seeds, adhesives (glue), organic fertilizer and mulching material on the planting surface on a height of up to 40 metres. This is done by using a hydro-seeder that is constituted of a reservoir, stirrer, pump and launch pipe. Afterwards this material is covered with straw that is launched with the help of second machinery, the

straw-distributor (mulcher). The method is very effective, faster and cheaper than the thatching. However, the latter offers better protection and conditions for growth of new plants and thus a combination of the two methods is preferred.

Planting of trees and bushes: The selection of the plants is closely related to the elevation, the geological and the climatic conditions of the area. Approximately 150,000 trees and bushes of 15 native species have been planted. The planting is done in holes of 1 m in diameter and 1.2 m apart.



Construction of berms and soil-covering.



Reforestation of the reprofiled berms.

The cost of the reforestation works is quite high due to the harsh conditions. The cost percentage of the various works is: 40 % for soil transport, 30% for thatching, 10% for machines for shaping and opening ditches and pits, 10% for seeding and 10% for planting.

BOTANICAL GARDEN

On the edge of the Amiantos mine, a Botanical Garden was created by the Forestry Department, named, Troodos Botanical Garden "A. G. Leventis". The Garden was opened to the public in May 2010. It includes plant exhibitions with various sections, a children's activity area and a Visitor's Center with various exhibits. The objectives of the Garden are education and information on wild plants especially the indigenous, enrichment of the recreational and tourist opportunities, research and conservation of threatened plants.



View of the Botanical Garden.

VISITORS CENTER OF TROODOS GEOPARK

The old school building of the mine was renovated under the Geotopia INTERREG Programme of the cross border cooperation between Greece - Cyprus 2007 - 2013, for the creation of the Geopark Troodos. Since June 2015 the renovated building of the old school is used as the visitor centre of the Geopark.



The school building .

TIME SCHEDULE

According to the Restoration Plan, the waste dump stability works and the restoration of the area (3.3 km²) will be completed by 2020, while the reforestation and revegetation works by 2030. The above works are adapted according to the proposed actions in the Master Plan for the Development of the area of the mine which it was completed in April 2014. The cost of the implementation of the Rehabilitation works has been almost entirely undertaken by the Government.