

Revegetation/reforestation practices in the “Amiantos” asbestos mine in Troodos, Cyprus

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January, 2014



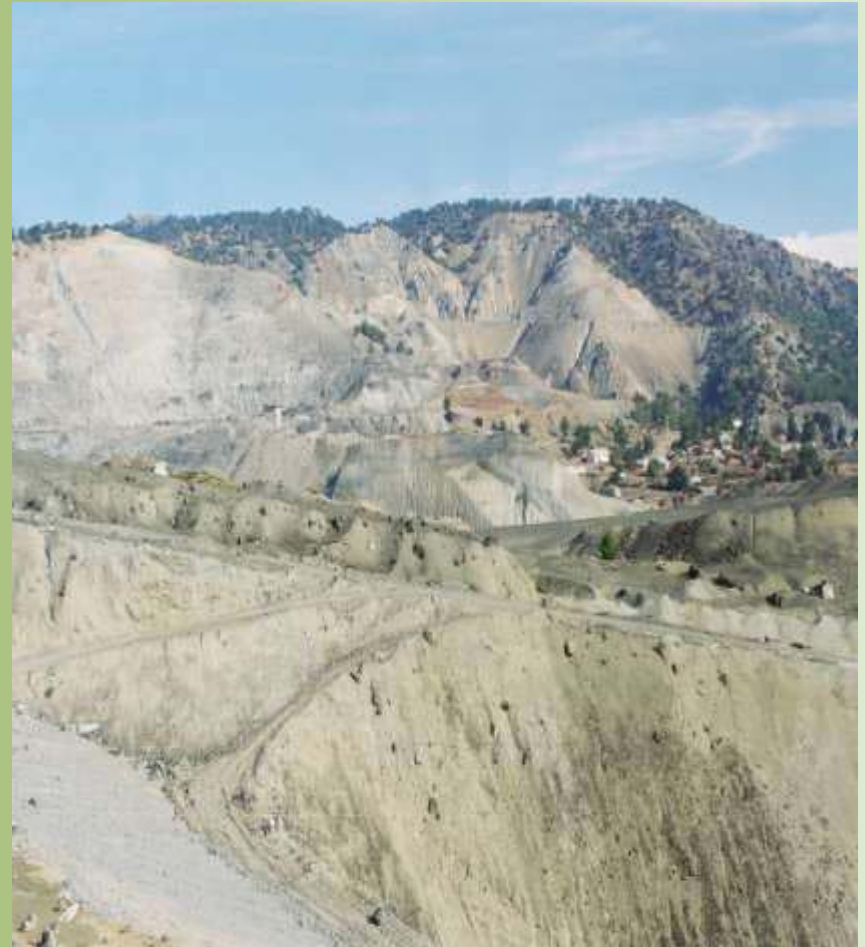
Area for rehabilitation



Need for rehabilitation

- **Restoration at the end of its useful lifetime as is the case of any mine.**
- **Its surface is occupied by asbestos wastes and rock fronts- potential sources of air born asbestos fibers.**
- **The mine is part of the Troodos National Forest Park.**
- **It is part of a NATURA 2000 site.**
- **Part of a very important water catchment area with water flow to the largest water dam in Cyprus.**

Note: All data presented provided by the Dept of Forests



General info

- **Area** to be rehabilitated: 330 hectares (3,3 km²)
- It is state forest land as well as **National Park** and **NATURA 2000** site. Owner is the department of Forests.
- **Elevation**: 1100-1600 m
- **Topography**: inclined (>75% of area), scattered flat and gullies.
- **Climate**: Sub-humid Mediterranean with long, dry hot summers, and comparatively cold and moist winters
- **Geology**: Ophiolitic complex of Troodos, serpentized harzburgite with narrow veins of chrysotile asbestos. Topsoil and subsoil over the entire mine area have been removed.
- **Vegetation** has been cleared. Mine area surrounded by natural forest (*Pinus brutia*, *Quercus alnifolia*).
- **Fauna**: Endemic birds, bat species.



Political willingness for rehabilitation

In 1992 the Ministerial council decided:

- Not to renew the mining license**
- Area should be rehabilitated and the cost taken by the state.**
- Interdepartmental technical committee to prepare a master plan for the area.**

No deadlines were set.

Earthworks

Responsibility of Water Development and Geological Survey Depts. to:

- Stabilize waste tips.
- Provide areas with suitable space and inclination for reforestation/revegetation.
- Design a monitoring program for future waste movements.

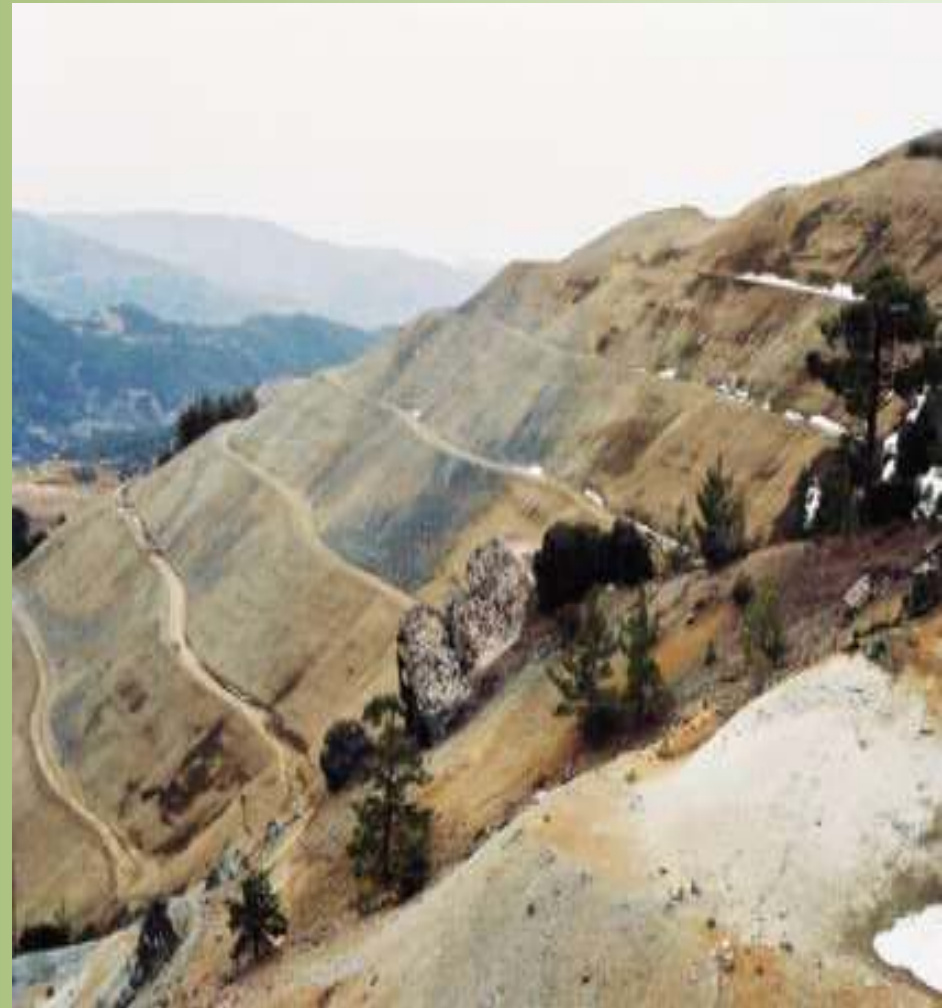
ANGLE OF SLOPE ADOPTED: 27°



INCLINATION: 51%

MINIMUM WIDTH OF TERRACES: 8m

Earthworks: before and after

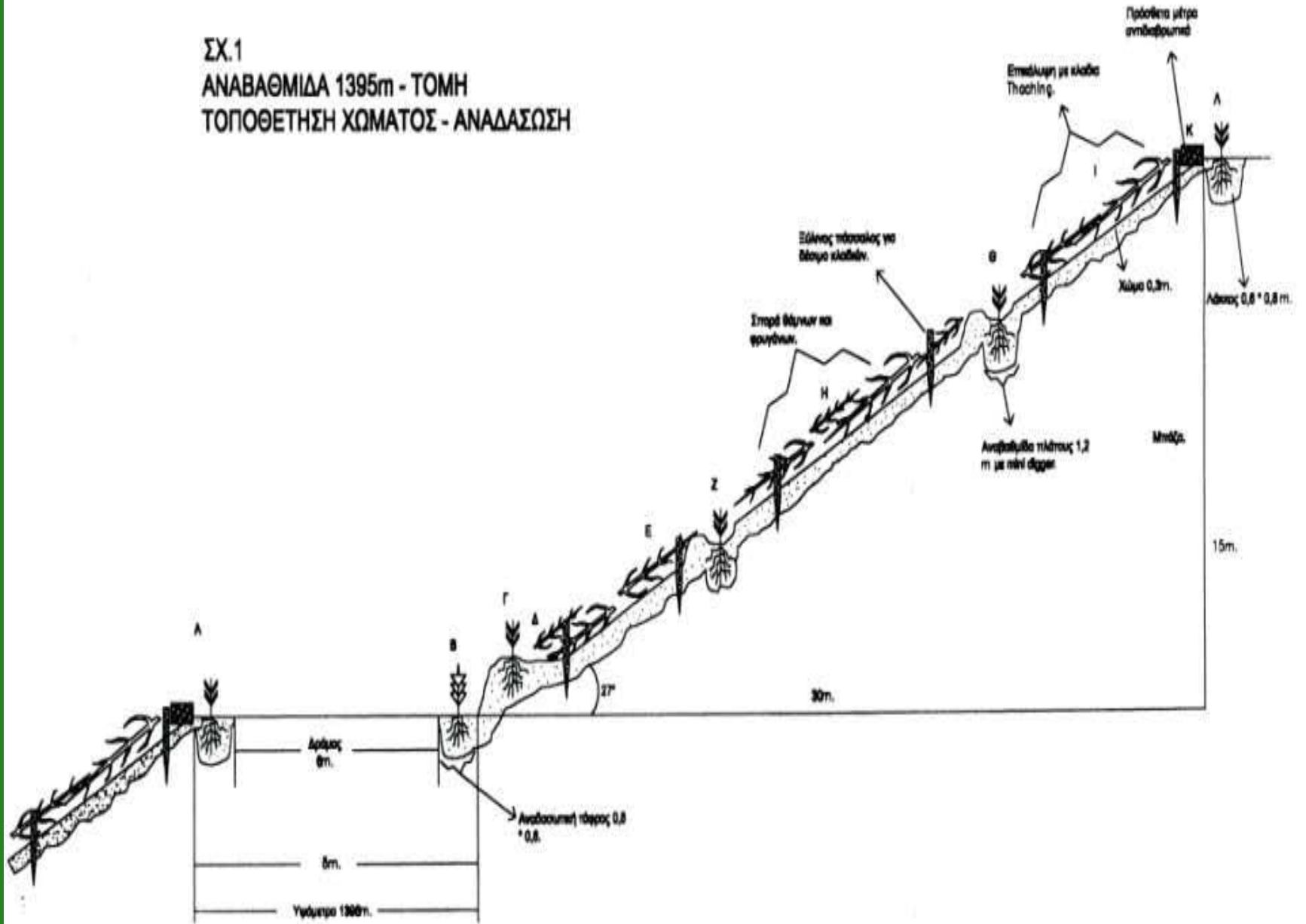


Reforestation

Establishment of a stable, self maintained forest ecosystem similar to the surrounding one through:

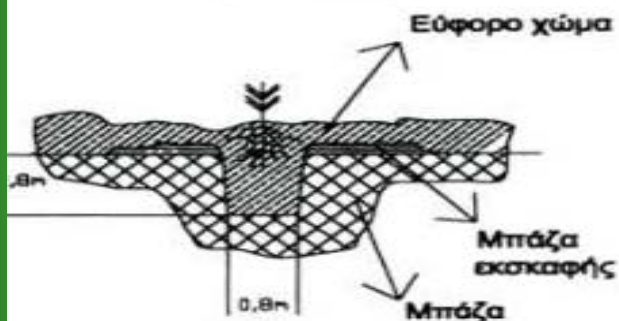
- **Covering of exposed serpentine surfaces (potential sources of asbestos).**
- **Maintain the water catchment.**
- **Restore the potential uses of the area.**
- **All the works designed and implemented by the Department of Forests.**

ΣΧ.1
 ΑΝΑΒΑΘΜΙΔΑ 1395m - ΤΟΜΗ
 ΤΟΠΟΘΕΤΗΣΗ ΧΩΜΑΤΟΣ - ΑΝΑΔΑΣΩΣΗ

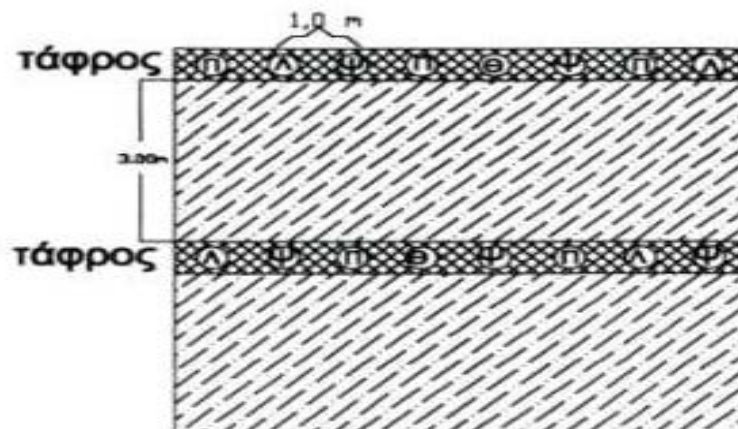


ΣΧ. 3Α και Β. Αναβάθιση σε πλατείες με μπάζα.

ΣΧ. 3Α: (Τομή)

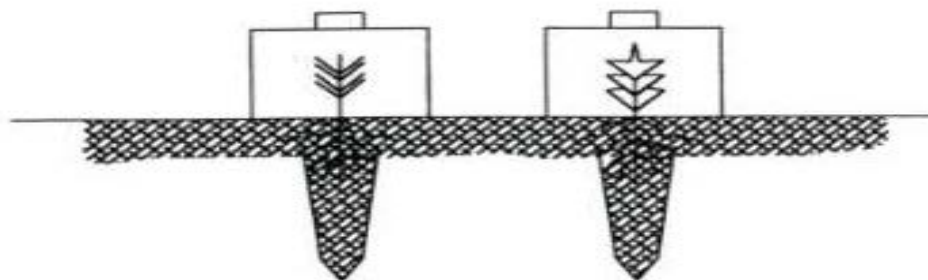


ΣΧ. 3Β: (Κάτοψη)



- Ψ Ψευδοσακακία
- Π Τραχεία Πευκή
- Θ Θάμνος, Αντρουκλιά, Τρεμιθιά, Ρούδι.
- Λ Λατζιά (Βαλανίδι)

ΣΧ. 3Ε: Προστασία φυτών με ξύλινες κατασκευές.



ΑΝΑΒΑΘΜΙΔΑ

Reforestation

Problems encountered:

- Complete lack of soil.
- High inclinations
- High pH values
- Undesirable properties of wastes: high Mg:Ca ratio and toxic concentrations of heavy metals.
- Lack of experience

Reforestation

Strategy adopted:

- Use as many plant species as possible
- Propagation material from sites adjacent to the mine.
- Suitable top soil was transported to the area.
- Cover the inclined areas with branches (thatching).

Reforestation: Pre-planting and preparation

Flat areas: 15% of total area, trenches 70cm deep-50cm wide, 6 m from each other, top soil spread 25-30 cm depth. 5000m³ of soil per hectare of land, chicken manure as an enriching agent, organic waste material from forests.

Inclined areas: Inclination 51%, length of slope 35m, trench opened 50cm*100 cm, topsoil 25-30 cm, terraces 10 m apart 100cm*120 cm wide, ridge at the top of the bank at the outer edge 100 cm high to be planted and to hold water.

Reforestation: Pre-planting and preparation



Spread topsoil



Topsoil and manure

Reforestation: Planting and seeding

Trenches on both flat and inclined sites, secondary terraces, ridges trees and shrubs the species of which are found to adjacent forests.

All other surfaces are seeded of perennial or biennia lherbs, sub-shrubs and trees. No grasses used due the hot summer conditions.

Significant number of herbs transported with the topsoil from neighbouring villages.

After sowing the area is covered with branches.

Need for irrigation of plants after planting.

Reforestation: Planting and seeding



Seeding by hand



Thatching in 2006

Reforestation: Hydroseeding



Ejection mechanism up to 50m

Tank with seeds water and glue

Reforestation: Planting and seeding

After planting and seeding:

- Plant layers fixed to ground
- Plant guards are fixed around the stems of plants.
- Terraces ripped before winter to increase water



Species planted

Pinus nigra



Arbutus andrachne



Species planted

Quercus alnifolia



Cistus spp



Reforestation: Maintenance

- **Irrigation through irrigation systems (June –September).**
- **Weeding**
- **Use of fertilizers.**
- **Failures replanted.**
- **Pruning**
- **Spraying**
- **Fire protection**

Natural reproduction of cypress from seeds from thatching



Results



Results



Conclusions

- **115 ha reforested**
- **Successful species selection**
- **Planting successful-plant guards effective.**
- **Supply of top soil at reasonable cost.**
- **Thatching has proved helpful**
- **Problems still exist: plant germinability and growth not sufficient in some cases, great amounts of topsoil needed.**
- **Need to evaluate in more detail the techniques used.**

Conclusions

The management plan for the area is well under preparation.

CHALLENGE AHEAD:

Restore the area, attract visitors and create a self sustained “park”.

THANK YOU!

