



Coordinating and integrating state-of-the-art
Earth Observation Activities in the regions of
North Africa, Middle East and Balkans
and Developing Links with GEO related initiatives
toward GEOSS

Proposal of pilot studies for T 4.3 „Access to Raw Materials” Part II

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Aim of the pilot sites

- Selection of the regional mining study areas based on the local characteristic and mining exploitation history and activity (e.g. 3 locations).
- The aim of this selection is establishing a roadmap for long-term monitoring, mapping, and management of mineral deposits in a severely under-explored ROI.

Monitoring of Illegal Quarrying

In spite of an existing legislative framework for Quarrying, some SEE countries are facing problems with illegal quarrying activities. This issue is related to severe economic, social and environmental impacts affecting not only the restricted area where such activities take place, but also wider areas. [Source: Synthesis report of baseline study reports; Activity 3.2 (Illegal quarrying). <http://www.sarmaproject.eu/>]



Stakeholder Consultation in Greece

The Institute of Geology and Mineral Exploration (IGME) organized a stakeholder consultation event titled: “Sustainable Planning of Aggregates in Greece” within the framework of the SNAP-SEE project in collaboration with the Technical University of Crete. The main purpose of the consultation event was the open collaboration between the stakeholders which are involved in the planning of aggregates in Greece.



Greece

Pilot 1

Consultation through GEO-CRADLE

Public Authorities are interested strongly to control and diminish Illegal Quarrying (IQ). The Ministry of Environment and Energy thinks that this needs to be further regulated and clearly stated. Weaknesses of the existing framework in combination with potential weakness for control “facilitates” illegal activities.

Efficient and consistent monitoring processes and tools will allow better management of quarrying and will mitigate illegal quarrying activities.



Monitoring of Illegal Quarrying

Illegal Quarrying is related almost exclusively with:

1. Quarrying of raw materials for the production of primary crushed rock aggregates;
2. Quarrying of river sands for the production of other primary aggregates;
3. Quarrying of clays for the production of construction items (tiles, bricks);
4. “Illegal activities” related to extractive waste from other activities – abandoned quarries (i.e. marble extraction) for the production of aggregates.

Marble extractive waste – N. Greece



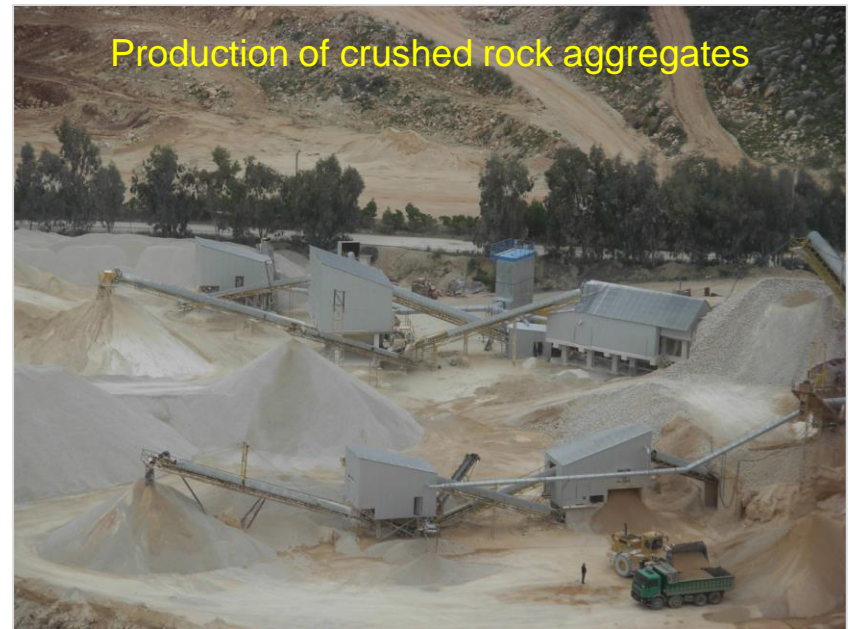
Marble extractive waste - N. Greece



Monitoring of Illegal Quarrying

Illegal activities, that should be considered as different levels of approach, concern:

1. Illegal activities of a legal quarry (e.g. disposing off extractive waste in forbidden areas). This may concern all types of quarries and mines. In Greece, it's a major issue for marble quarries, due to low recovery percentages (sometimes, as low as 5%);
2. Illegal operation of a quarry, which owns a license that has expired. Consequently, the scale is noticeable;
3. Completely illegal activity out of quarries, where the quantities may be minor and the scale is usually small, difficult to monitor.





Greece

Pilot 1

Existing EO and geological/mining data

IGME is using Earth Observation data since the 80s for supporting geological mapping / mineral exploration activities

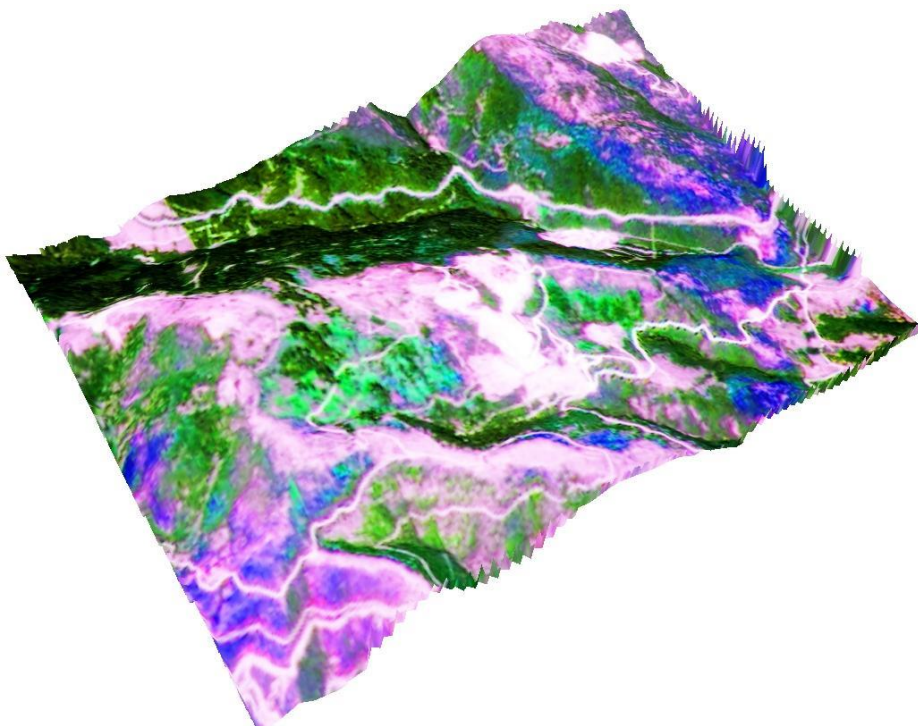
However no Earth Observation data have been used for supporting “Mining activities” in the suggested pilot project areas.

A GIS OPEN Database of the legal quarries

http://www.latomet.gr/lp_adranon/
is operated by the Ministry of Environment and Energy.



Objectives



Sentinel 2: Velvendos Quarrying Areas Date: 23/7/2016
Area: 12.7 km²

Future use of Earth Observation data & techniques for mapping and monitoring “Quarries”:

- ☐ *Selection of suitable sites for quarrying;*
- ☐ *Monitoring reforestation;*
- ☐ *Support land Use planning;*
- ☐ *Monitoring Land cover;*
- ☐ *Monitoring illegal quarrying;*
- ☐ *assess “waste”;*
- ☐ *assess possible instabilities;*
- ☐ *support restoration actions.*



Greece

Pilot 2

Environmental Monitoring of Ayios Filippos Abandoned Public Mine of Mixed Sulphide Ores – Kirki Village (North Greece)

Site Information: Ayios Filippos sulphide Pb-Zn deposit

- ❑ For a 100 of years (1890 – 1981) a rotation of private and public ownerships took place;
- ❑ 1981: The private company which had the rights for exploitation at that time, was suspended and the rights were transferred to a partly state owned company (GEMEE).
- ❑ 1983-1987, IGME with GEMEE carried out an exploration drilling program (47 drill holes);
- ❑ 1988: IGME carried out a feasibility study based on the results of this program





Greece

Pilot 2

Environmental Monitoring of Ayios Filippos Abandoned Public Mine of Mixed Sulphide Ores – Kirki Village (North Greece)

Site Information: Ayios Filippos sulphide Pb-Zn deposit

- ☐ 1989-1992: The mining operations restarted by a private company, followed by a number of problems, including environmental ones.
- ☐ Overburden and waste rock generated by the mining operations were disposed off along the bed of Kirkalon stream and close to the open pit.



2nd Networking Event, 17/10/16, Rabat



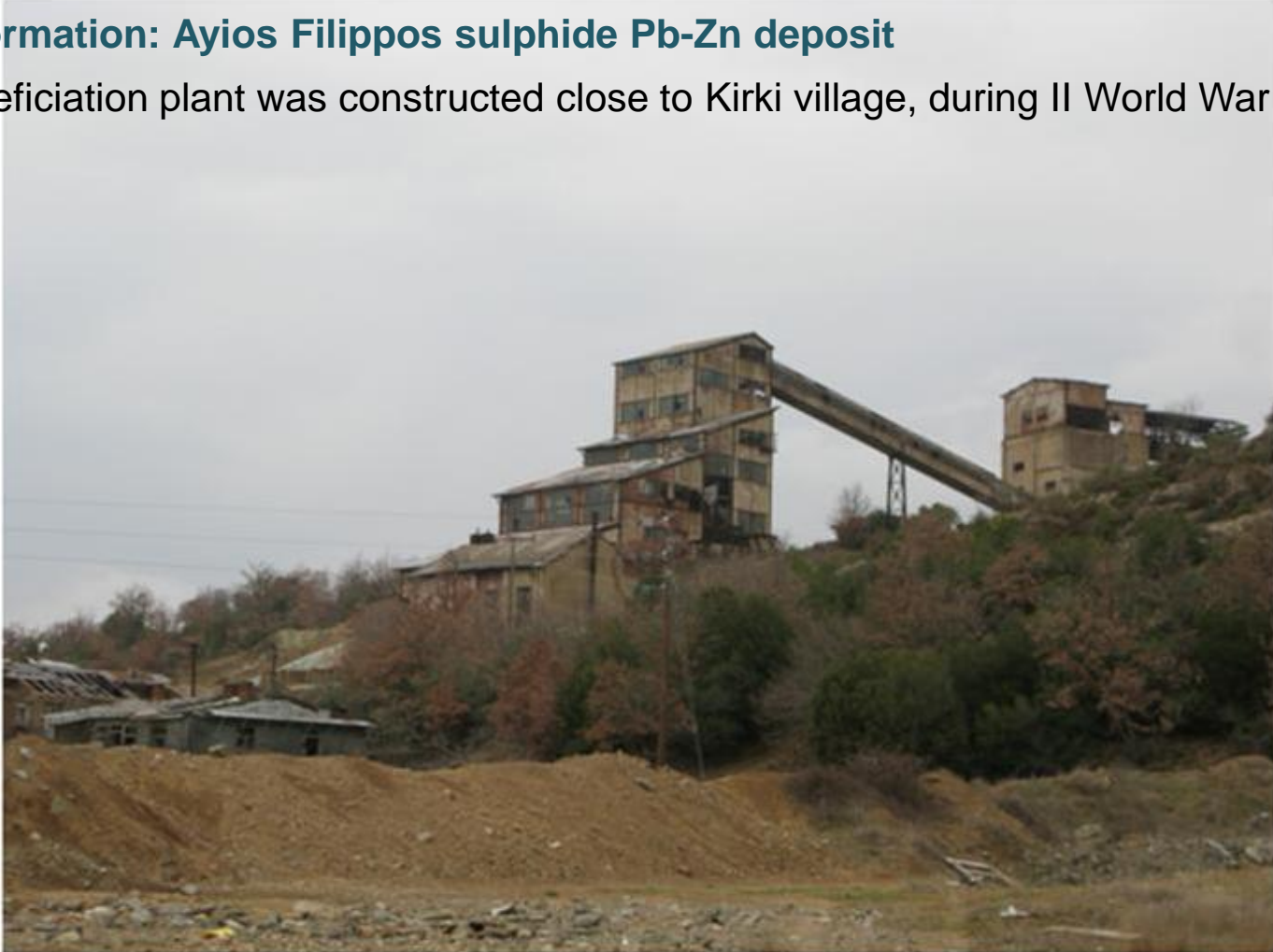
Greece

Pilot 2

Environmental Monitoring of Ayios Filippos Abandoned Mine – Kirki Village

Site Information: Ayios Filippos sulphide Pb-Zn deposit

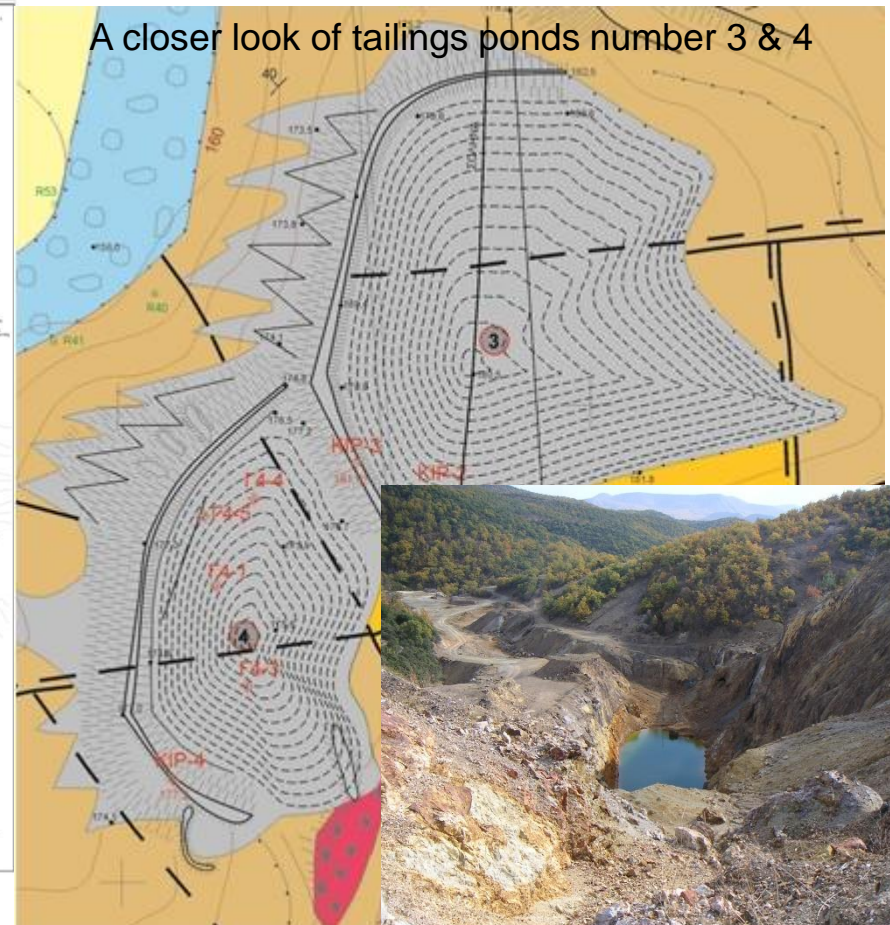
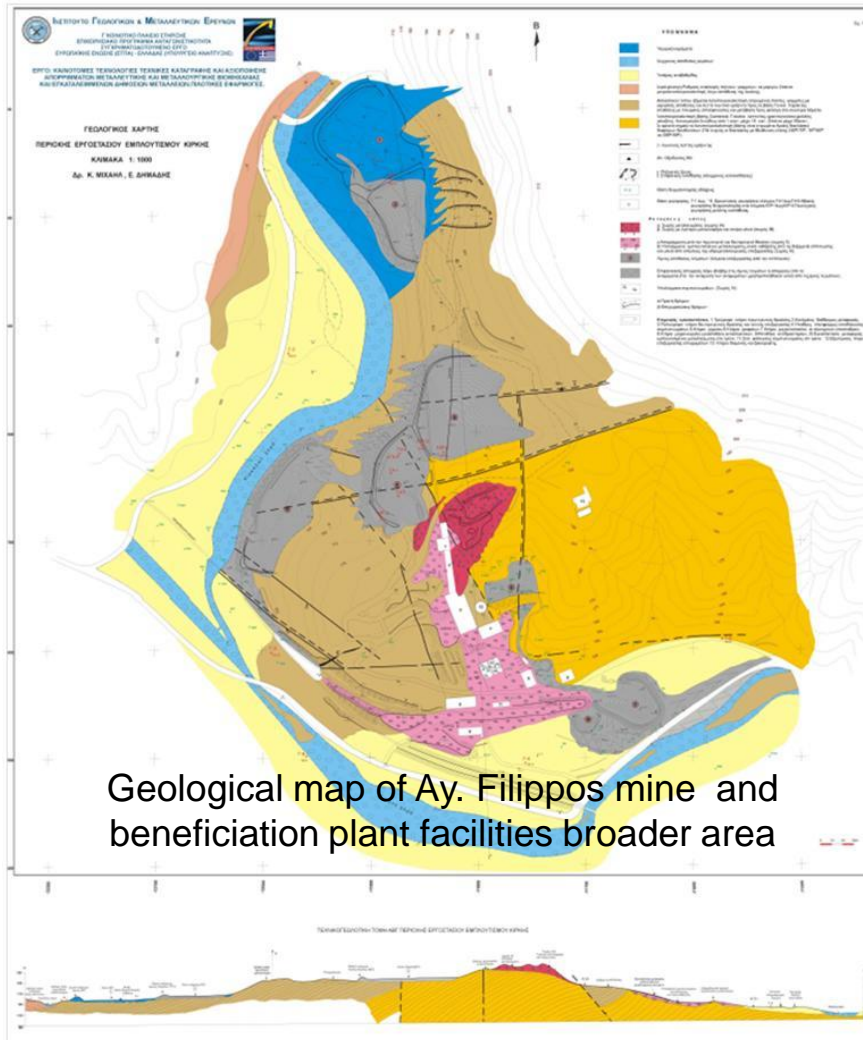
The beneficiation plant was constructed close to Kirki village, during II World War



2nd Networking Event, 17/10/16, Rabat

Environmental Monitoring of Ayios Filippos Abandoned Mine – Kirki Village

Site Information: Ayios Filippos sulphide Pb-Zn deposit





Greece

Pilot 2

Environmental Monitoring of Ayios Filippos Abandoned Mine – Kirki Village

Site Information: Ayios Filippos sulphide Pb-Zn deposit

Tailings were produced from the operation of the plant and were disposed off, in ponds around the mineral processing facilities.



2nd Networking Event, 17/10/16, Rabat

Environmental Monitoring of Ayios Filippos Abandoned Mine – Kirki Village Existing EO and geological/mining data

Ayios Filippos mining area and Kirki' s beneficiation plant are the two principal sites, where most of the potentially polluting hotspots, e.g. excavation works, waste rock piles and flotation tailings ponds, are located.

Several studies have been carried out for the environmental characterization of these abandoned mining sites, for the evaluation of their impact on the quality of the natural receivers as well as for the geotechnical study of the abandoned tailings ponds.





Greece

Pilot 2

Objectives

Creation of a database to include satellite data and other thematic, physical, environmental, geomorphic, geologic, socio-economic information pertaining to factors that affect post-mining restoration activities.

- ☐ monitoring and visualizing the mine site within its setting,
- ☐ compiling detailed database of the land-use in the area of the proposed mine, including the surrounding areas and
- ☐ developing quantitative measures of land productivity such as vegetation indices in order to be compared with similar data after restoration.
- ☐ monitoring ground stability – slope failure on dump sites.

This methodology is to be used to assess the environmental impact at local and regional scale and to serve as a baseline for assessment of post mining restoration. Deliverables are to be used by the End Users for the improvement in the environmental rehabilitation works.



ROMANIA

Geographic and geological characteristics of the pilot site

The field campaign has covered six sites which were visited for sample collection and ground observations.

- (1) Rovinari, represents a lignite quarry, still in operation. It is located in the Subcarpathian Hills, in the Dacic Basin, Getic Zone. In an alternation of sands, sandy clays, clays and carbonaceous clays belonging to the clay horizon of Dacian-Romanian age, the lignite occur as beds.

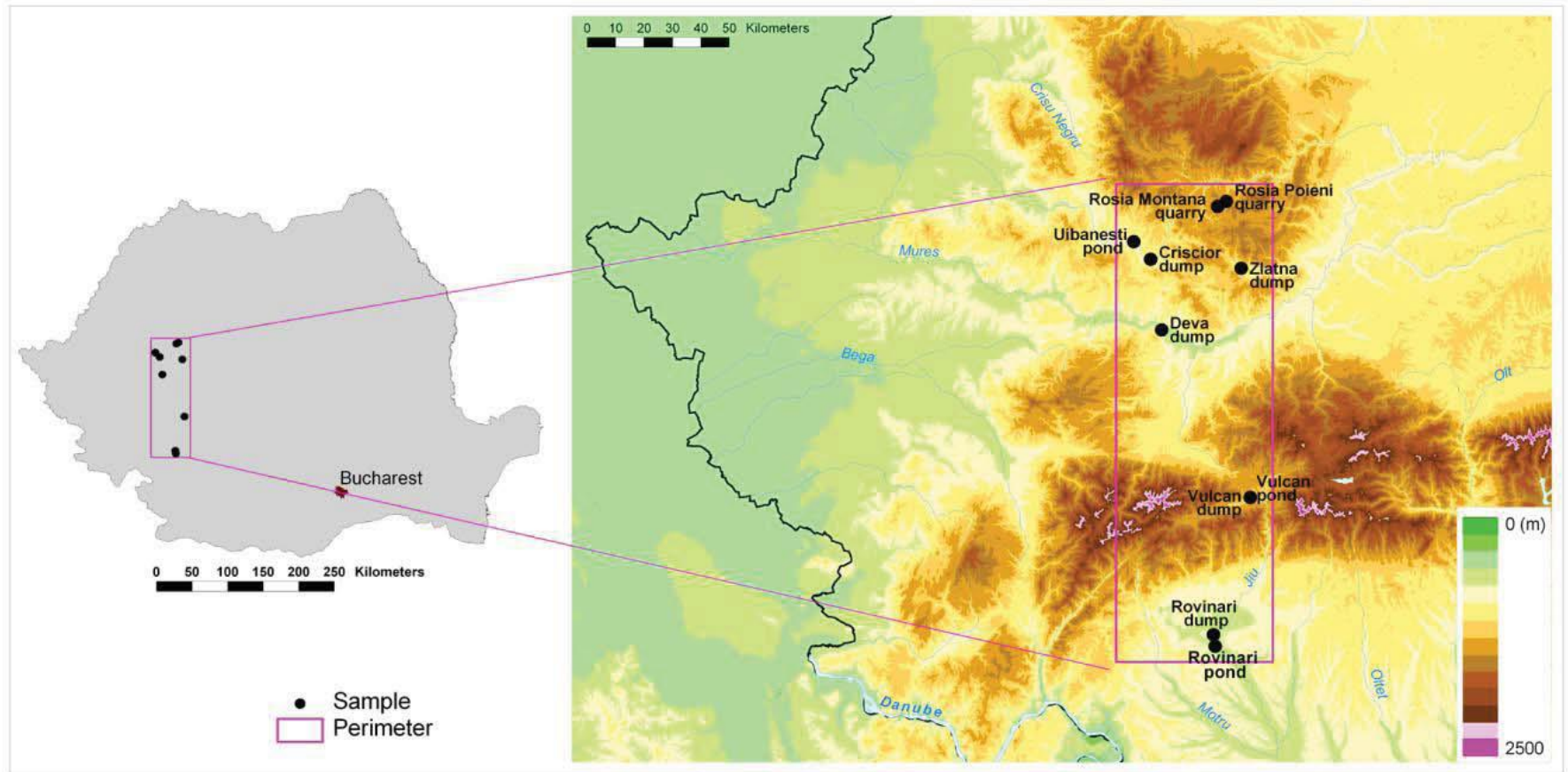
- (2) Vulcan, located in the post-tectonic cover, in the Petrosani Depression of the South Carpathians Basin of Jiu Valley, the exploitation is done underground. The mine is in operation. The samples are made up of rock fragments representing mine wastes in different stages of alteration, as well as black bituminous coal fragments.



ROMANIA

- (3) Deva, represents the dump site of the porphyry copper mine, presently closed. It belongs also to the South Carpathians (Poiana Rusca Mts.), the volcanic zone of Mures Valley. Samples were collected from the dump site located north of Deva.
- (4 - 5) Two sites represent dumps of deposited material originating from the mines located nearby Brad, in the Brad-Sacaramb Neogene volcanic zone of Western Carpathians. The dumps originated from the closed mines extracting gold and silver, accompanied in most of the cases by lead, zinc and copper. The genesis of the ores is hydrothermal.
- (6) The sixth site represents the quarry for gold at Rosia Montana, where the exploitation is temporarily stopped, waiting for a decision of the government.

Location of the mining / post mining area





Objectives

Samples collected from six mineral extracting and processing sites, representing commodities of different origin and in different environments (lignite, bituminous coal, porphyry copper and gold extraction mines, copper flotation, metallurgic waste dump), were analyzed in the laboratory for: **mineralogy on thin sections, X ray diffraction (XRD), gamma spectrometry, density and spectral reflectance measurements.**

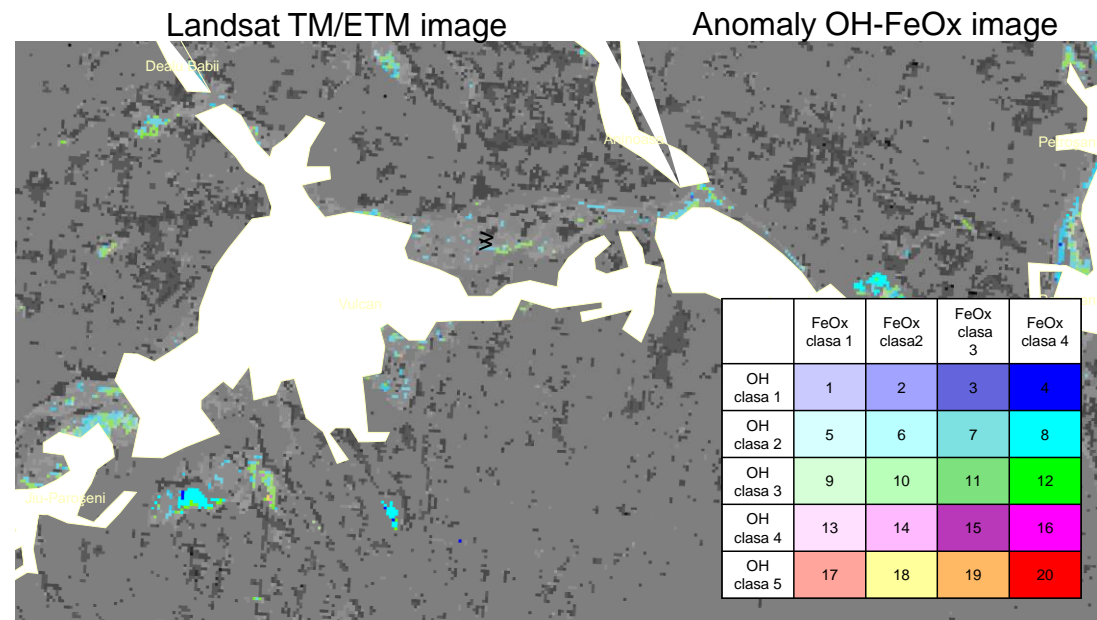
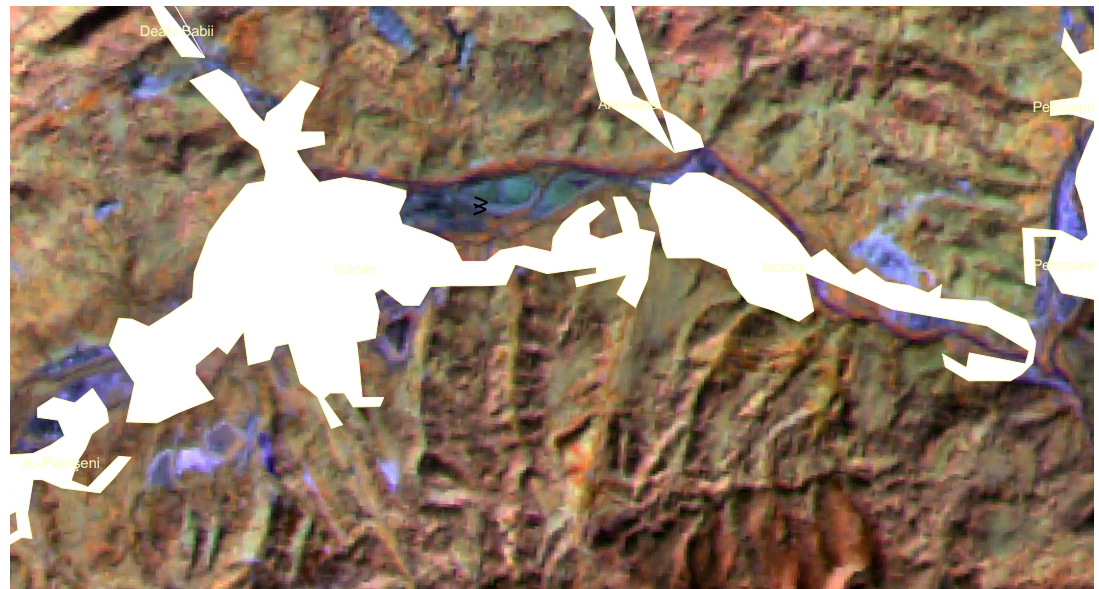
In sample locations, estimated ground reflectance spectra were extracted from **Landsat-TM images, in order to verify the OH-FeOx anomalies, obtained by processing the satellite images with a methodology previously developed for mapping mining wastes at regional scale.** The processed satellite images highlighted, by means of the extent and type of OH-FeOx anomalies, the area coverage of the deposited mined material and pointed out the modifications in time.

A differentiation of the sites was performed by **statistically analyzing the remote sensing anomalies and comparing with the results of the microscopic analyses and XRD.**

Rovinari site, an example



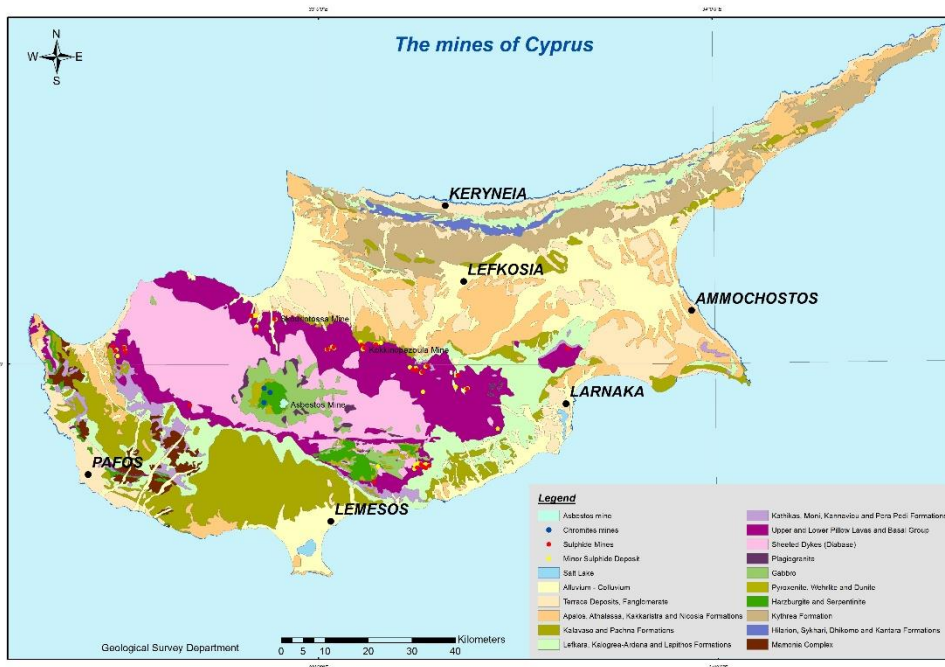
Google Earth image (20.07.2003)





Cyprus

Guidelines for the presentation:



- Cyprus has 33 mines and 32 of them are abandoned.
- For the purpose of this study and the proposition of possible sites for pilot projects we recommend **three mines** with different characteristics which can be used either as a group or individual sites and can fulfill the targets of the project.
- The three mines are located on the **Troodos Ophiolite** and they are:
- Abestos mine (abandoned – under restoration)
- Skourriotissa (operating - massive sulfides)
- Kokkinopezoula (abandoned - massive sulfides)

Objectives

- Mapping of waste materials and low grade ores left over in abandoned mines that could potentially re-open by exploiting both primary and secondary mineral resources with parallel environmental restoration.
- Long term monitoring of ground deformation /stability during or after mining activities in order to handle environmental pollution and possible subsidence / landslides.
- The evaluation of the environmental impact, together with feasibility assessment for the potential of the extractive or mining waste to become exploitable as secondary resources.
- Take mitigation measures to handle environmental pollution in abandoned mines in order to fulfil certain obligations derived from the EU Water Framework Directive 2000/60/EC.

Objectives

- Use Space born data to **assess possible instabilities in waste dumps** in order to take the proper remedial measures.
- Use Space born data to **map the waste dumps of abandoned mines** in order to select locations for borehole drilling for the assessment of the waste dumps for secondary mineral resources.
- Use Space born data to assess the **stability of reprofiled waste dumps** in under restoration mines and take the necessary measures if needed.
- Use Space born data to **record the behavior of the leaching heaps** of the operating mine in Skourriotissa and look for instabilities and possible environmental pollution.

Geographic and geological characteristics of the site (Asbestos Mine)



- It is located in the central part of Troodos Ophiolite and it is an outcrop of serpentine.
- The Asbestos Mine operated between 1904 and 1988
- It is estimated that 130 million tones of rock have been excavated
- One (1) million tones of asbestos fibers (chrysotile) were produced

Consequences

- adverse effects on the environment
- the enormous open pit
- the extensive waste tips
- pollution of the soil/water
- stability of the waste tips
- the barren nature of the tips



Geographic and geological characteristics of the site (Skourriotissa Mine)



- It is located in the northern part of Troodos Ophiolite on an outcrop upper and lower pillow lavas.
- It is a historic mine with 4000 years history and it is still operating today.
- In the modern times, the Foukasa deposit (Skourriotissa) was explored in 1914, with estimated reserves of six million tones of massive sulphides and an average grade of 2,5% Cu.
- Its exploitation commenced in 1920 by the Cyprus Mines Corporation and since 1996 by Hellenic Copper Mines.
- The mine since 1996 is producing metallic copper with the application of bioleaching and hydrometallurgy.

Geographic and geological characteristics of the Kokkinopezoula site



- It is located in the northern part of Troodos Ophiolite on an outcrop upper and lower pillow lavas.
- It is an abandoned mine that operated during the 20th century.
- It is a massive sulphide mine and it was an Au bearing deposit.
- It has the potential to be mapped for possible exploitation for both primary and secondary mineral resources with parallel environmental restoration.
- There are not any Earth Observation data for the Kokkinopezoula mine.



Cyprus

Expected results, road map of future operations and impact:

The opportunity to obtain and use Space born data will help us develop the necessary skills in order to plan and execute more comprehensive and effective solutions / measures for:

- a) long term monitoring of ground deformation /stability waste dumps,**
- b) map waste dumps and abandoned mines as potential exploitation for both primary and secondary mineral resources with parallel environmental restoration,**
- c) develop better practices for the rehabilitation of abandoned mines.**