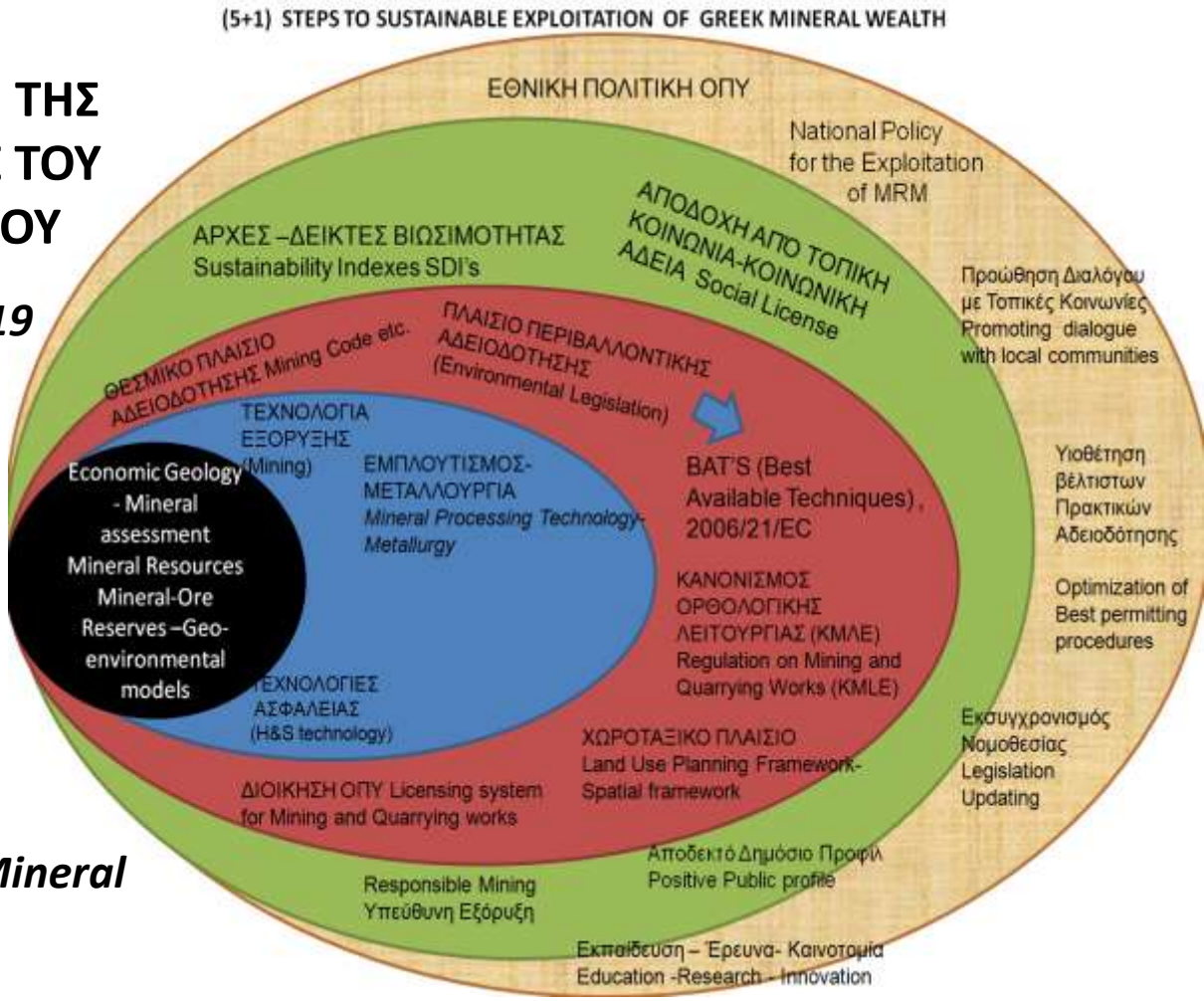
ΟΙ (5+1) ΕΠΑΛΛΗΛΟΙ ΚΥΚΛΟΙ ΤΗΣ ΟΡΘΟΛΟΓΙΚΗΣ ΑΞΙΟΠΟΙΗΣΗΣ ΤΟΥ ΕΛΛΗΝΙΚΟΥ ΟΡΥΚΤΟΥ ΠΛΟΥΤΟΥ

Δρ. Π. Τζεφέρης, 2019

(5+1) STEPS TO SUSTAINABLE EXPLOITATION OF GREEK MINERAL WEALTH

Dr. P. Tzeferis, 2019,



YPEN - General Directorate for Mineral Resources, February 2019

1. ΚΟΙΤΑΣΜΑΤΟΛΟΓΙΚΗ ΕΡΕΥΝΑ- ΟΙΚΟΝΟΜΙΚΗ ΓΕΩΛΟΓΙΑ

Economic Geology - Mineral assessment

Πανεπιστήμια-Ερευνητικά Κέντρα-Ερευνα Ιδιωτών
Universities-Research Centers

Olympias Ore:
Poymetallic mixed sulphide replacement deposit
4.6% lead (Pb), 6.0% zinc (Zn),
9 g/t gold (Au), 138 g/t silver (Ag)
11.5 million tonnes of ore
Mine life >25 years
+ Mineralogy
+ Geo-environmental model

Mineral Raw Materials (Resourses) – Mineral Reserves (Κοιτασματολογία-Οικονομική Γεωλογία)

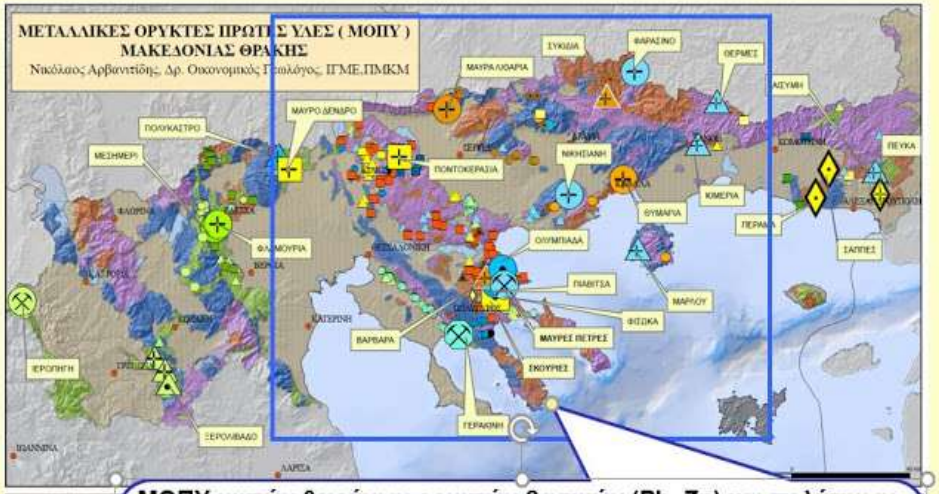
Skouries Ore:
Porphyry deposit
0.54% copper (Cu), 0.83 g/t gold (Au)
146.2 million tonnes of ore
Mine life >30 years

…and more

Locating New MRM. Economic Geology - Mineral assessment
Mineral Resources (Ορυκτές Πρώτες Υλες ΟΠΥ)
Mineral-Ore Reserves (Αποθέματα)
Geo-environmental models

include those potentially economically and technically feasible and those that are not (mineral occurrences)

must be economically and technically feasible to extract



ΜΟΠΥ μικτών θειούχων ορυκτών βασικών (Pb, Zn) και πολύτιμων μετάλλων (Au, Ag), συμπεριλαμβανομένων θειούχων ορυκτών του χαλκού, αλλά και αντίστοιχων προϊόντων οξείδωσης, που συνδέονται μεταλλογενετικά με πλουτώνιες γρανιτοειδείς διεισδύσεις στο μαρμαροφόρο κρισταλλοσχιστώδες υπόβαθρο της περιοχής (γεωτεκτονικό περιβάλλον ορογενετικού μαγματισμού)

ΜΟΠΥ επιθερμικών συστημάτων χρυσού που συνδέονται μεταλλογενετικά με ηφαιστειακά πετρώματα και σχετικούς ηφαιστειοιζηματογενείς σχηματισμούς (γεωτεκτονικό περιβάλλον νησιωτικού μαγματισμού)

ΜΟΠΥ νικελίου, χρωμίου και λευκολίθου που συνδέονται μεταλλογενετικά με υπερβασικά μαγματικά πετρώματα σε γεωτεκτονικό περιβάλλον ωκεάνιου φλοιού

Gross value of unexploited metal reserves in northern Greece (mine life-time > 25 years)

Metal commodities	Ni	Pb+Zn	Au	Cu	Ag	Total value (euro X 10^6)
Kastoria mine	2.819					2.819
Stratoni		853	320		361	1.534
Olympiada		2.818	3.834		1.398	8.050
Skouries			5.357	7.060		12.417
			852	27	12	891
			1.810		80	1890
)	2.819				1	**27.600**

sal studies
get about 4
etal mine will
ue as a net return

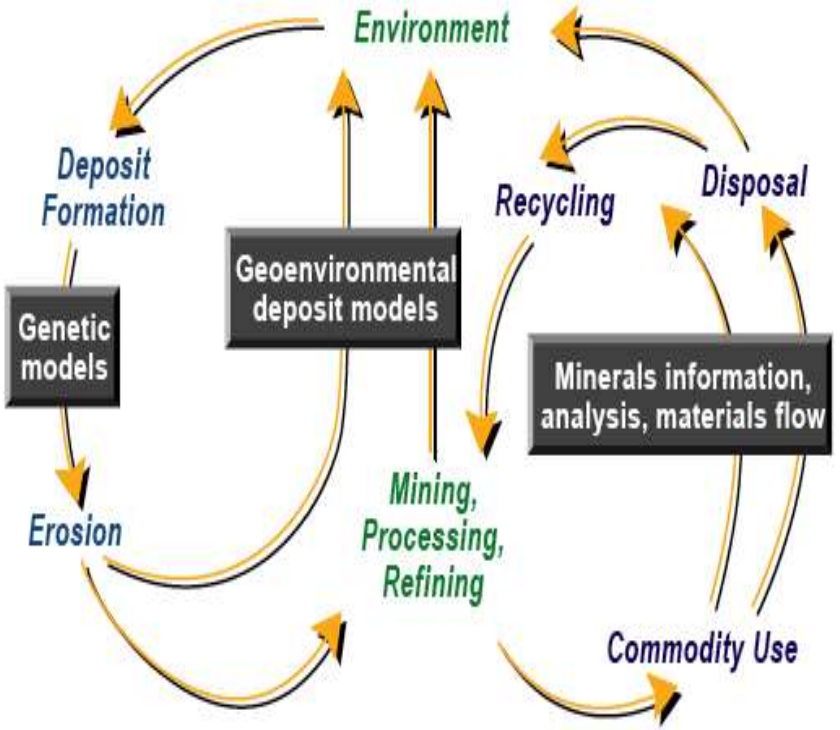
"Mineral wealth" is not a "treasure" to find and get money. In the end of the whole mineral processing a 5-10% net profit value of the total gross value would be a great success!

Key Issues for Economic Geology - Mineral assessment

•Urgent need **to locate new deposits** of Mineral Raw Materials to meet the growing global demand for high-tech metals.

• A prerequisite for identifying new deposits is to better **understand the geological processes** that these minerals bring to the geosphere. Also, **mineralogy** is a must for determining the best mineral processing methods.

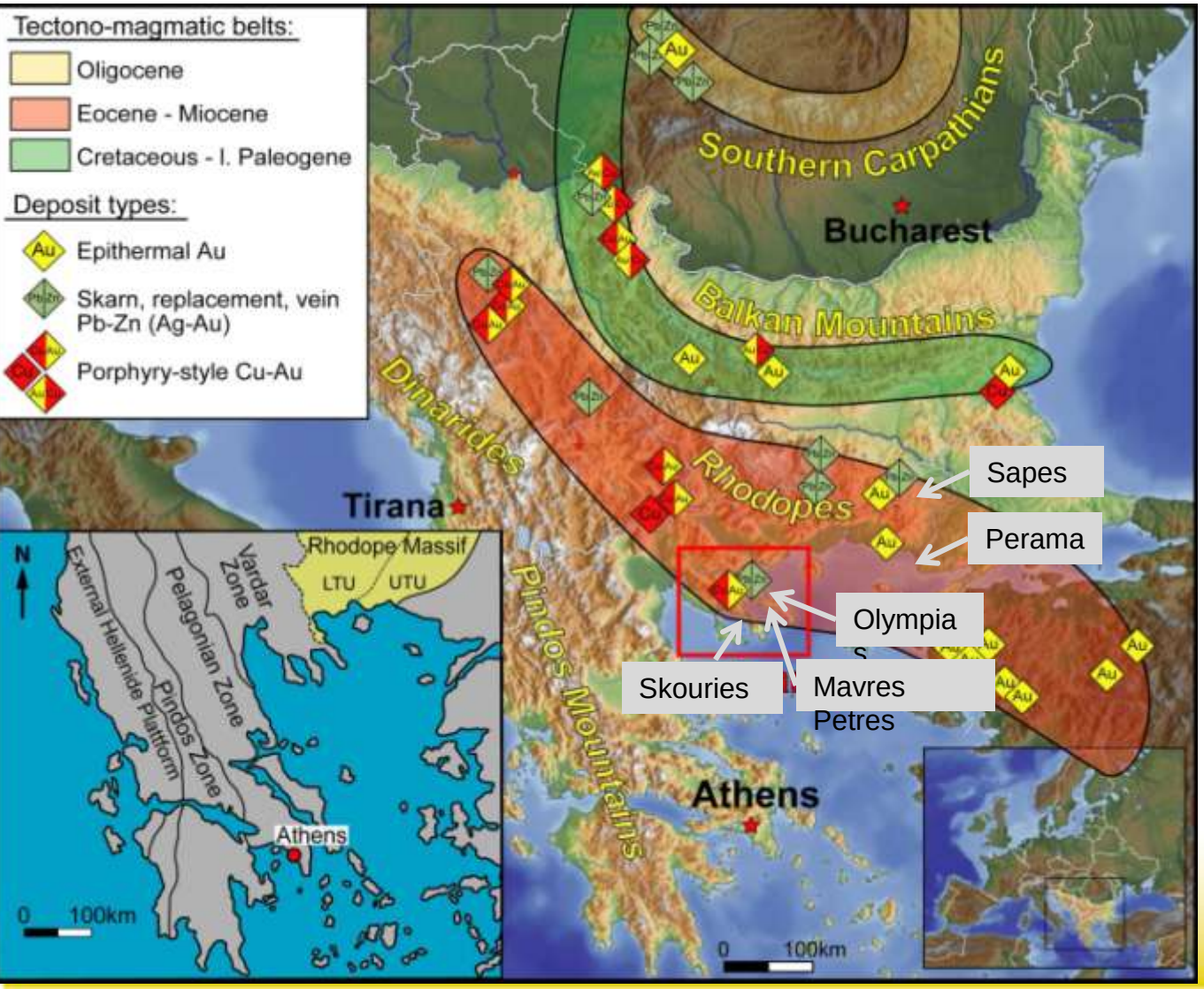
•**Geo-environmental models.** it is necessary to map the life cycle of metal deposits and metal commodities, from the deposit in the subsoil and through the metallurgical plant to the final industrial use and disposal (re-use, recycling, circular economy).



Lifecycle of deposit (mine)

Lifecycle of metal commodity

POLYMETALLIC SULPHIDE MINES IN NORTH GREECE

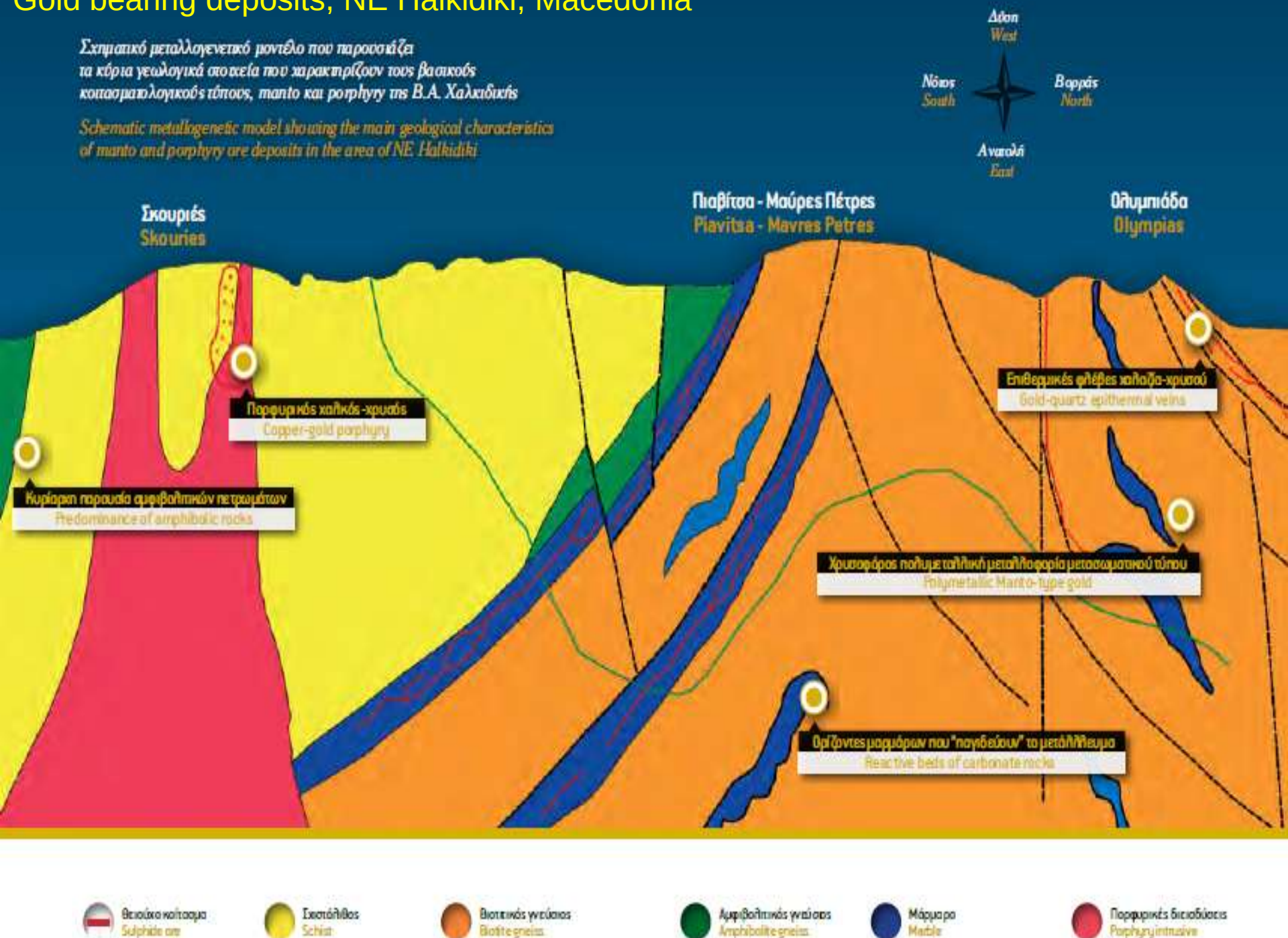


Rhodope Zone: Eocene – Miocene magmatic belt superimposed on pre-Mesozoic metamorphic basement

Magmatic-hydrothermal deposits within both Tertiary intrusive/stratified units (porphyry, epithermal systems) and in older sequences (carbonate replacement)

(From Hahn et al., 2010)

Gold bearing deposits, NE Halkidiki, Macedonia

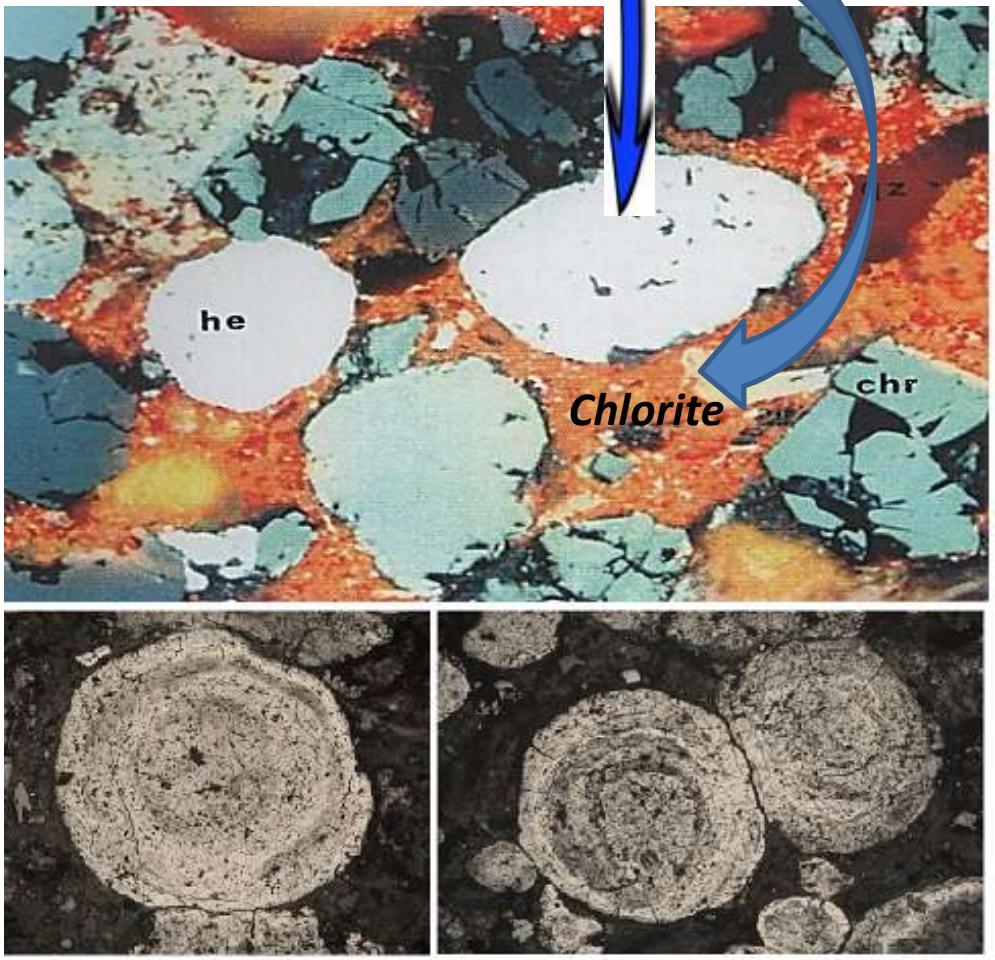


Mineralogy is a must

Mineralogy is a mixture of chemistry, materials science, physics and geology.

Greek nickeliferous low grade Laterites (Ni<1%)

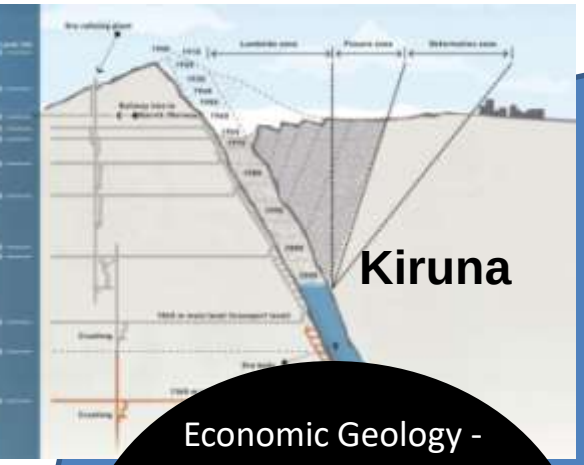
The mineralogical study shows that in the most common hematite type of laterite, Hydrometallurgy mainly solubilizes chlorite and illite, which make up 25-30% of the mineralogical composition of the ore, in the which **contains 80-85% of Ni,** justifying restrictions on extractivity. The remainder of the Ni found in hematite (or goethite) is not dissolved at least in low temperature and pressure conditions. To recover all of the Ni, more than 70% of the ore must be dissolved, making the method extremely expensive.



Pissolithic type of Fe-Ni-containing ore, he = hematite, chr = chromite, qz = quartz

2. ΕΠΙΛΟΓΗ ΟΡΘΗΣ ΤΕΧΝΟΛΟΓΙΑΣ ΕΞΟΡΥΞΗΣ ΚΑΙ ΜΕΤΑΛΛΟΥΡΓΙΚΗΣ ΕΠΕΞΕΡΓΑΣΙΑΣ ΜΕΧΡΙ ΤΟ ΤΕΛΟΣ ΖΩΗΣ ΤΟΥ ΠΡΟΙΟΝΤΟΣ

MINING-MINERAL PROCESSING AND EXTRACTIVE METALLURGY-RECYCLING--DISPOSAL TO THE END OF LIFE CYCLE



Economic Geology - Mineral assessment Mineral Resources Mineral-Ore Reserves –Geo-environmental models

1

ΤΕΧΝΟΛΟΓΙΑ ΕΞΟΡΥΞΗΣ (Mining, Open pit or Underground mine)

2

ΕΜΠΛΟΥΤΙΣΜΟΣ-ΜΕΤΑΛΛΟΥΡΓΙΑ
Mineral Processing Technology-Metallurgy

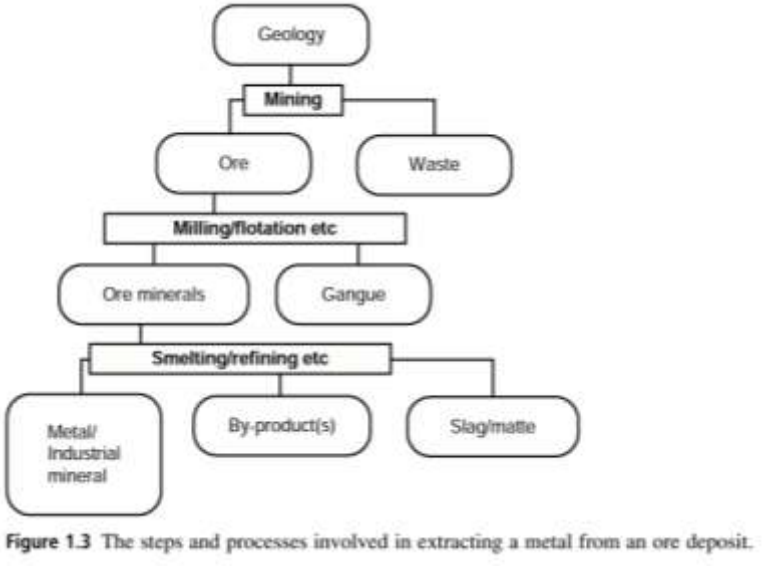


Figure 1.3 The steps and processes involved in extracting a metal from an ore deposit.

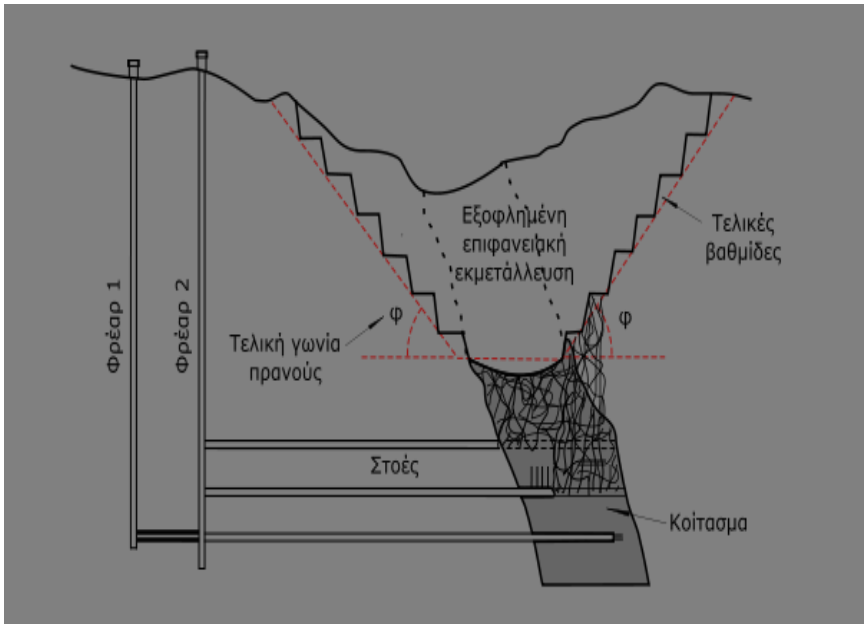
ΔΙΑΧΕΙΡΙΣΗ ΑΠΟΒΛΗΤΩΝ
Waste management

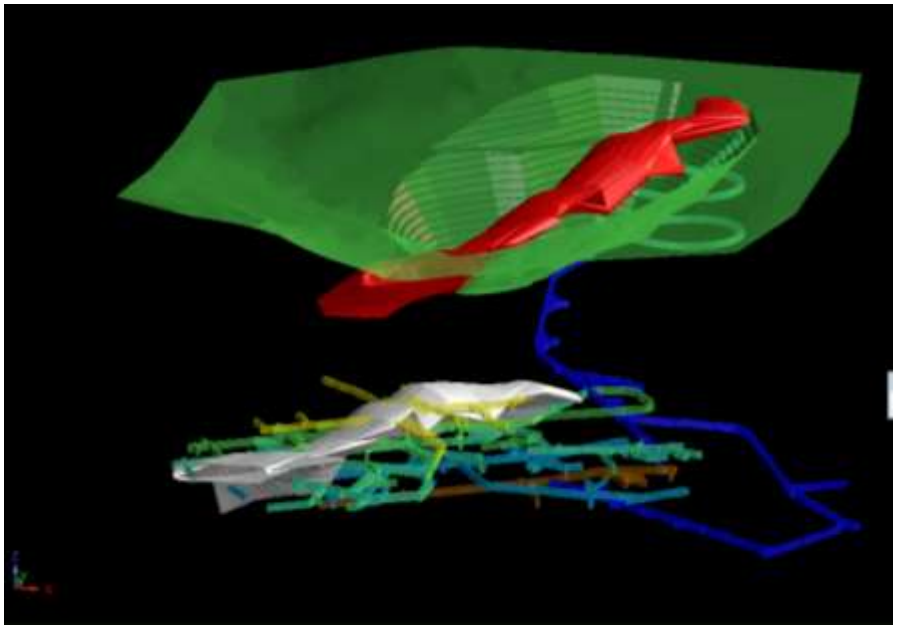
ΤΕΧΝΟΛΟΓΙΕΣ ΑΣΦΑΛΕΙΑΣ (H&S technologies, eg. Use of explosives, tailings dam safety)

MINING: Mining Engineers are responsible for the planning, design, operation management, sustainability and safety of the mineral exploitations.

Above ground or underground exploitation?

Cost is one of the main drivers for making the decision to move underground.





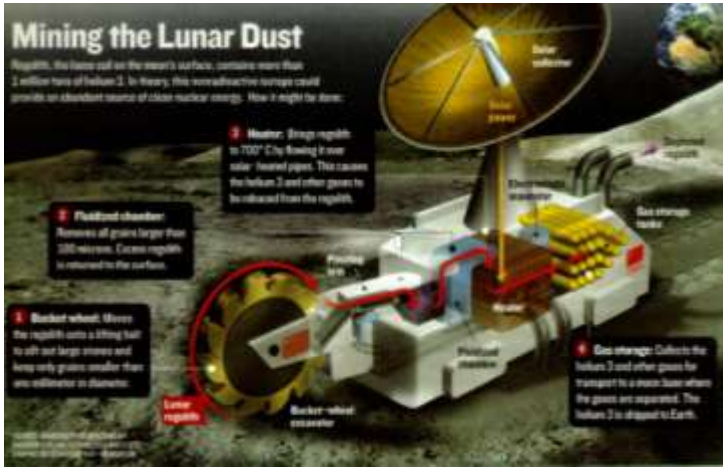
Cut-Off grade is the minimum grade required in order for a mineral or metal to be economically mined (or processed). For a mineral is the ratio between the ore and the overburden.

Key issues. Setting priorities:

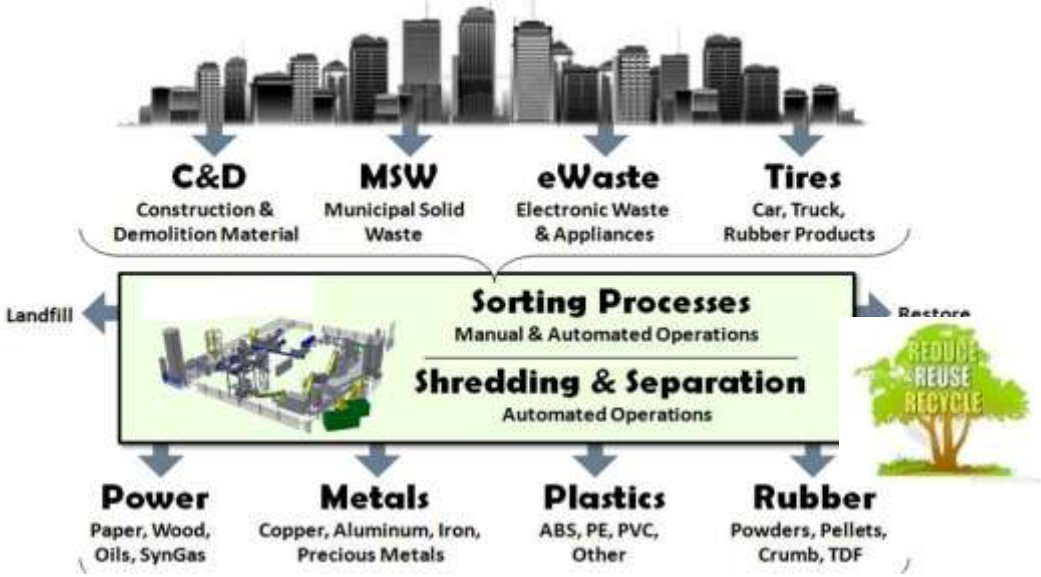
1. **Ensure the maximum safety level for the workers and the mine**
2. **Achieve the minimum exploitation cost**
3. **Attain the highest possible mineral recovery**

Mining: The far way forward…

Deep sea Mining: the possibility to exploit the seafloor's minerals



Extraterrestrial Mining: the possibility of exploiting raw materials from asteroids, the moon and other minor planets, including near-Earth objects



Mining the urban deposit: process of reclaiming raw materials from products, buildings and waste from towns, cities and metropolitan areas, with the goals of monetizing urban waste streams, enhancing recycling and releasing environmental strains.

Landfill mining and reclamation (LFMR)
Εξόρυξη …αποβλήτων!

LFMR is a process whereby solid wastes which have previously been landfilled are excavated and processed

Europe's more than half a million landfill sites could be mined for energy and minerals

Key issues

Mineral Processing and Metallurgy

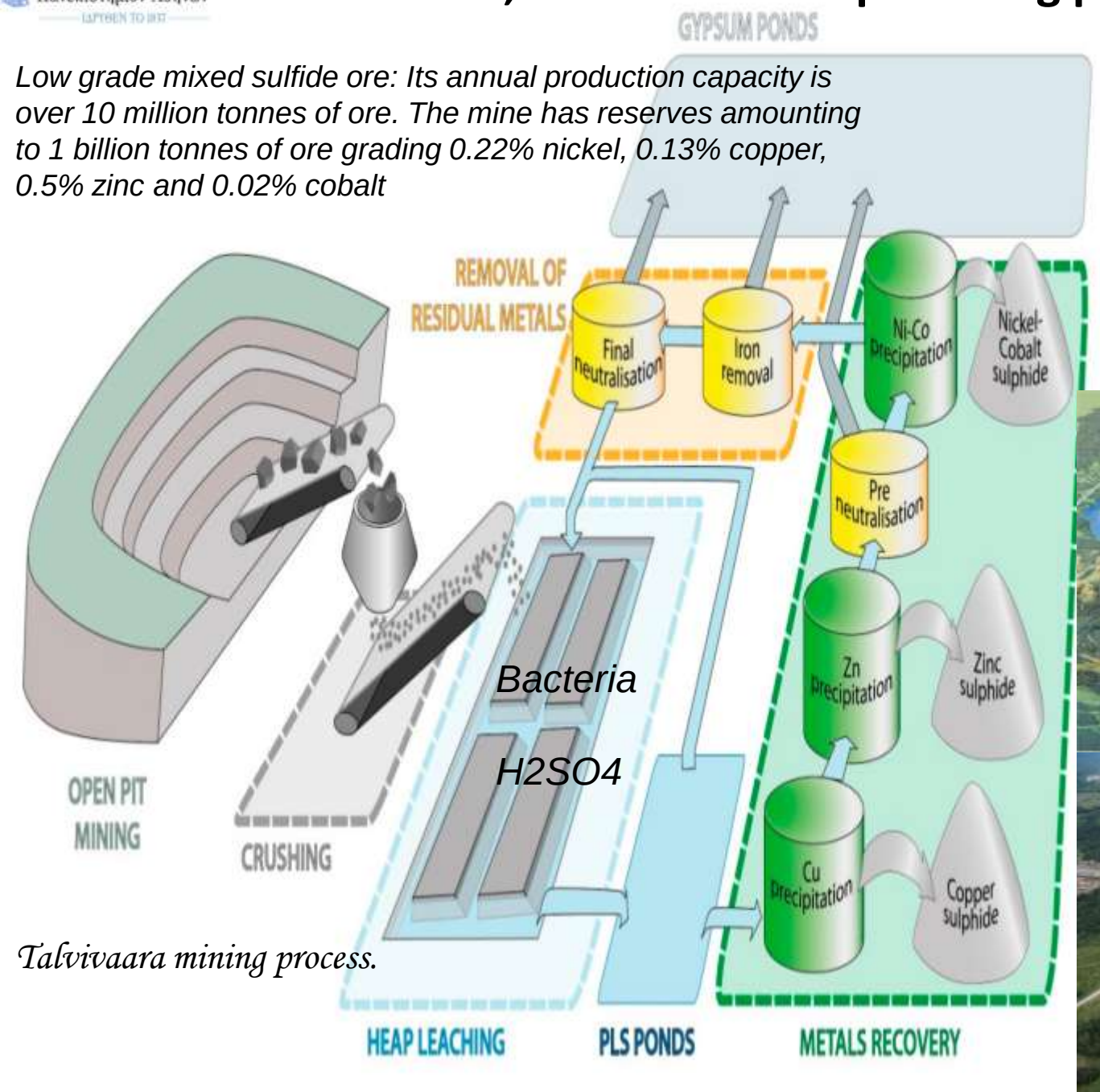
- **The immediate future** is in the poor (low concentration) polymetallic but abundant ore reserves. **Large Size, Low Grade minerals** (e.g Porphyries typically have 100 million to 5 billion tons of ore with a lower grade (0.2% to >1% copper).) It is the size of these deposits that allow for bulk mining and economies of scale)
- Finding the most appropriate **methods according to science, technology and economy.** Pyrometallurgy or Hydrometallurgy or (Bio) hydrometallurgy? Mineralogy of deposit types and economics are essential to select the most suitable method.

•Enhancing Mine Productivity, Safety and Environment

Safety (dam safety, etc.) **and Environment** (Waste disposal, waste management)

Talvivaara, Finland bioheapleaching process

Low grade mixed sulfide ore: Its annual production capacity is over 10 million tonnes of ore. The mine has reserves amounting to 1 billion tonnes of ore grading 0.22% nickel, 0.13% copper, 0.5% zinc and 0.02% cobalt



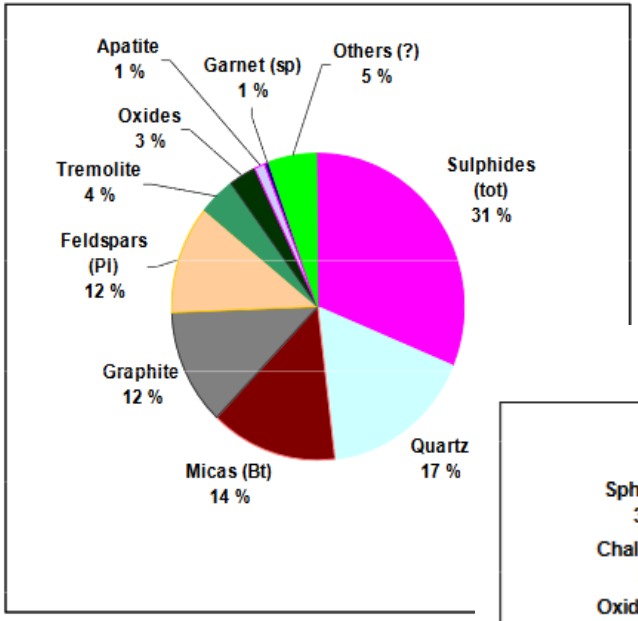
Talvivaara mining process.

Mineralogy and Ni distribution

Talvivaara, Finland

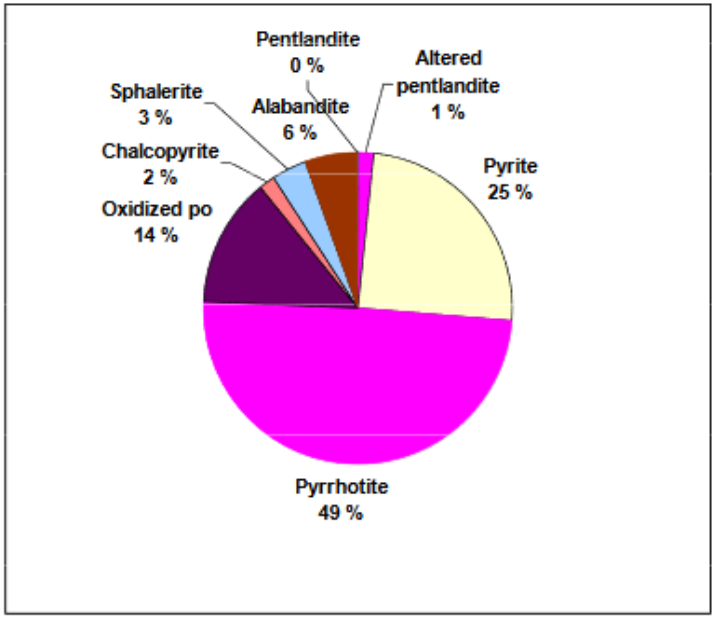
One of the largest known sulphide nickel deposits in Europe (total mineral resources >1000 Mt, 0.22% Ni)

Modal Mineral Composition (Wt%)

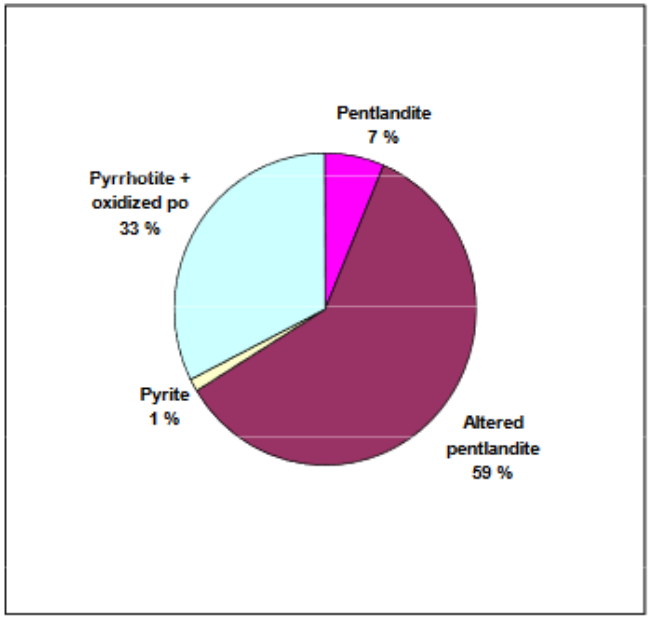


One of the largest known nickel sulphide deposits in Europe (in Sotkamo, over 1 billion in ore reserves) that will allow the production of 33 to 5,000 tons of nickel per year over the next 45 years. At the same time, zinc (90,000 tpa), copper (15,000 tpa) and cobalt (1,800 tpa) will be produced as valuable "by-products" of the process.

Sulphide Minerals

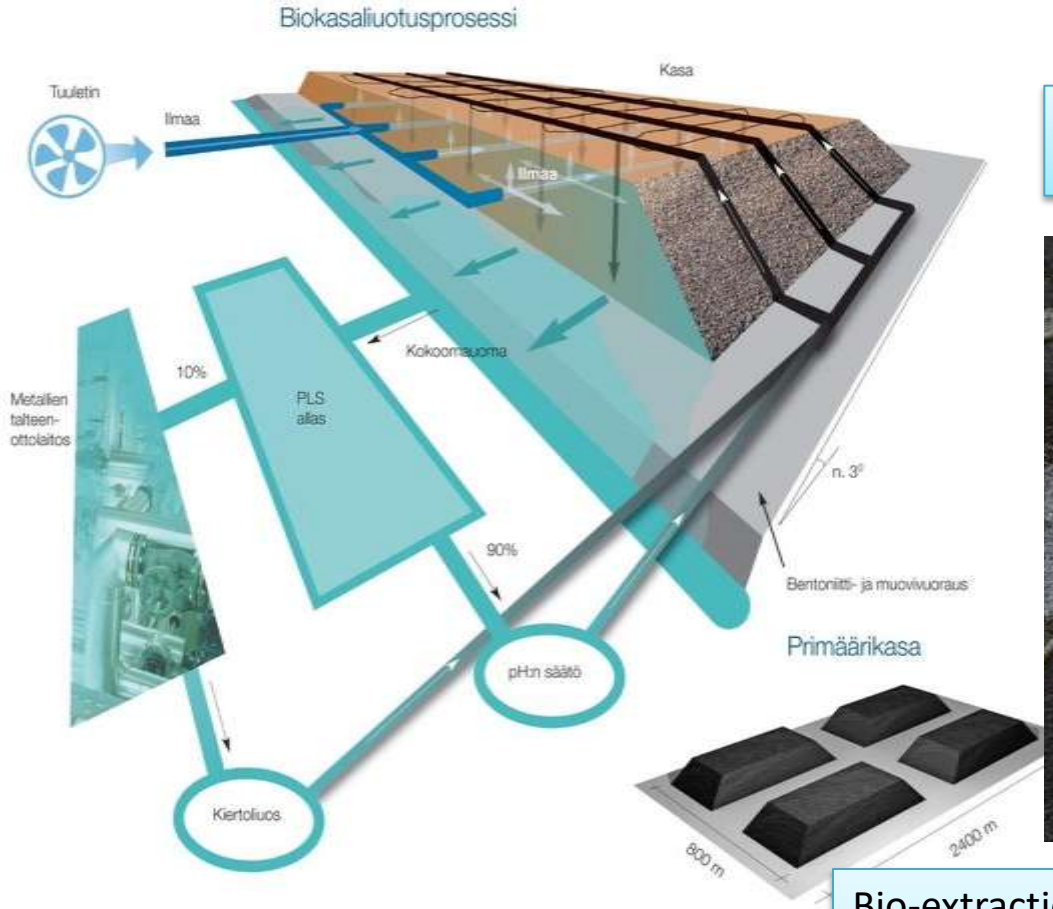


Distribution of Ni



0.23% Nickel distributed mainly in sulphides pentladite and pyrrhotite, the main nickel bearing minerals

Bio-hydrometallurgy in low grade sulfide ores in Talvivaara Finland



Key process parameters include particle size, aeration, irrigation and acid consumption

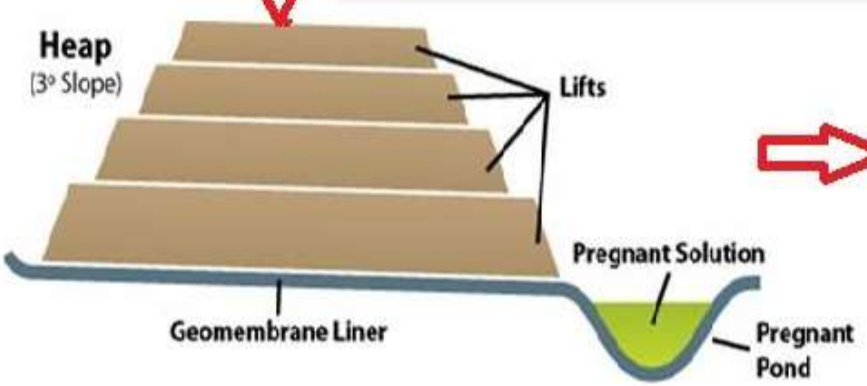
Bioheapleaching. Process run in two stages A) Primary leaching for 15-18 months; expected nickel recovery approx. 80% B) Secondary leaching for additional 3.5 years; total expected nickel recovery >90%

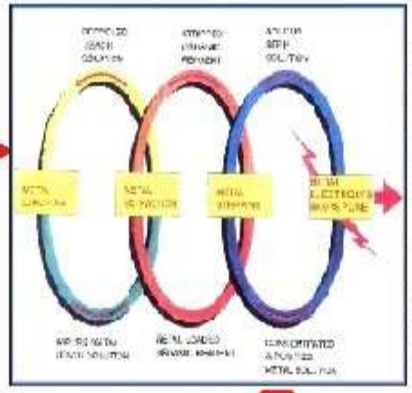
Bio-extraction process is already used to produce gold, copper and uranium from poor but large scale deposits. The first mine in the world with a microbial hydrometallurgical nickel extraction process from nickel ore Heaps is in Talvivaara, Central and Eastern Finland (by Talvivaara Mining Company Plc).

SKOURIOTISSA CYPRUS HBL/SX/EW HYDROMETALLURGY METHOD FOR CU EXTRACTION (Hellenic Copper Mines)

+ bacteria

$$Cu_2S + O_2 + H_2SO_4 \rightarrow CuSO_4 + CuS + H_2O$$





% Cu: 0.35%

Solvent Extraction

Bacterial **Heap Leaching- Solvent Extraction-Electrowining**

Χημική Αντίδραση Μεταφοράς Χαλκού από την Υδατική στην Οργανική Φάση (extraction)

$$2R-H+\left[Cu^{2+}+SO_4^{2-}\right]\rightarrow R2-Cu+\left[2H^{+}+SO_4^{2-}\right]pH=2$$

Χημική Αντίδραση Μεταφοράς Χαλκού από την Οργανική στην Υδατική φάση (stripping)

$$R_2-Cu+\left[2H^{+}+SO_4^{2-}\right]\rightarrow 2R-H+\left[Cu^{2+}SO_4^{2-}\right]180gplH_2SO_4$$

Mining and Metallurgy. Finding the best methods according to science, technology and economy.

The need for detailed experimental research

Εργαστηριακή κλίμακα

Πιλοτική κλίμακα

Μεταλλουργική έρευνα βιοεκχύλισης

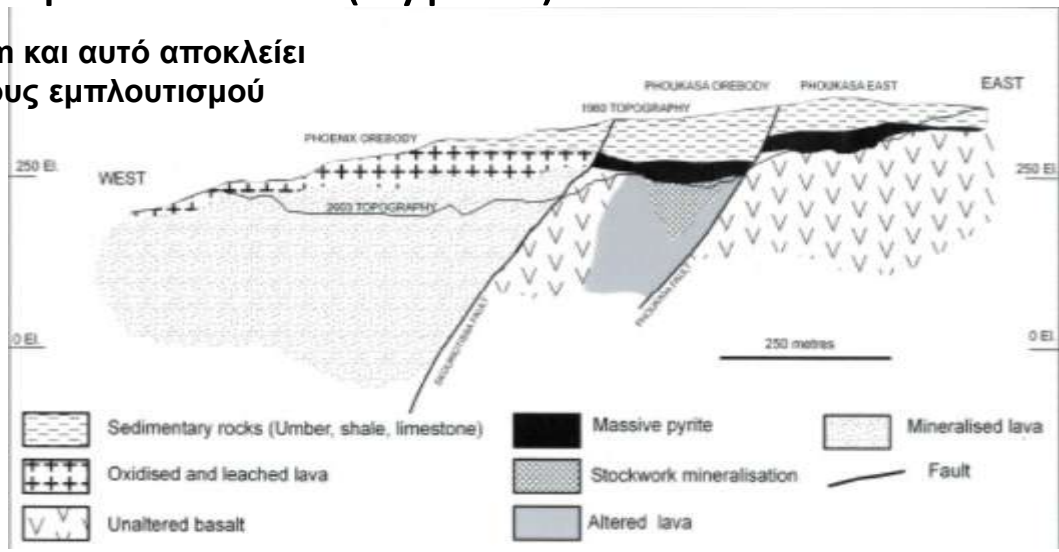
Πιλοτική κλίμακα

Ημιοβηχανική κλίμακα

Laboratory scale experiments, Pilot Plant, Column Leaching, Heap Leaching

Skouriotissa hydrometallurgical process for precious metal production (Cyprus)

Το μέγεθος των κόκκων χρυσού κυμαίνεται από 5-20 μm και αυτό αποκλείει τις βιομηχανικά εφαρμοζόμενες βαρυτομετρικές μεθόδους εμπλουτισμού του.



Κόκκοι χρυσού (άσπροι) μαζί με KFeS

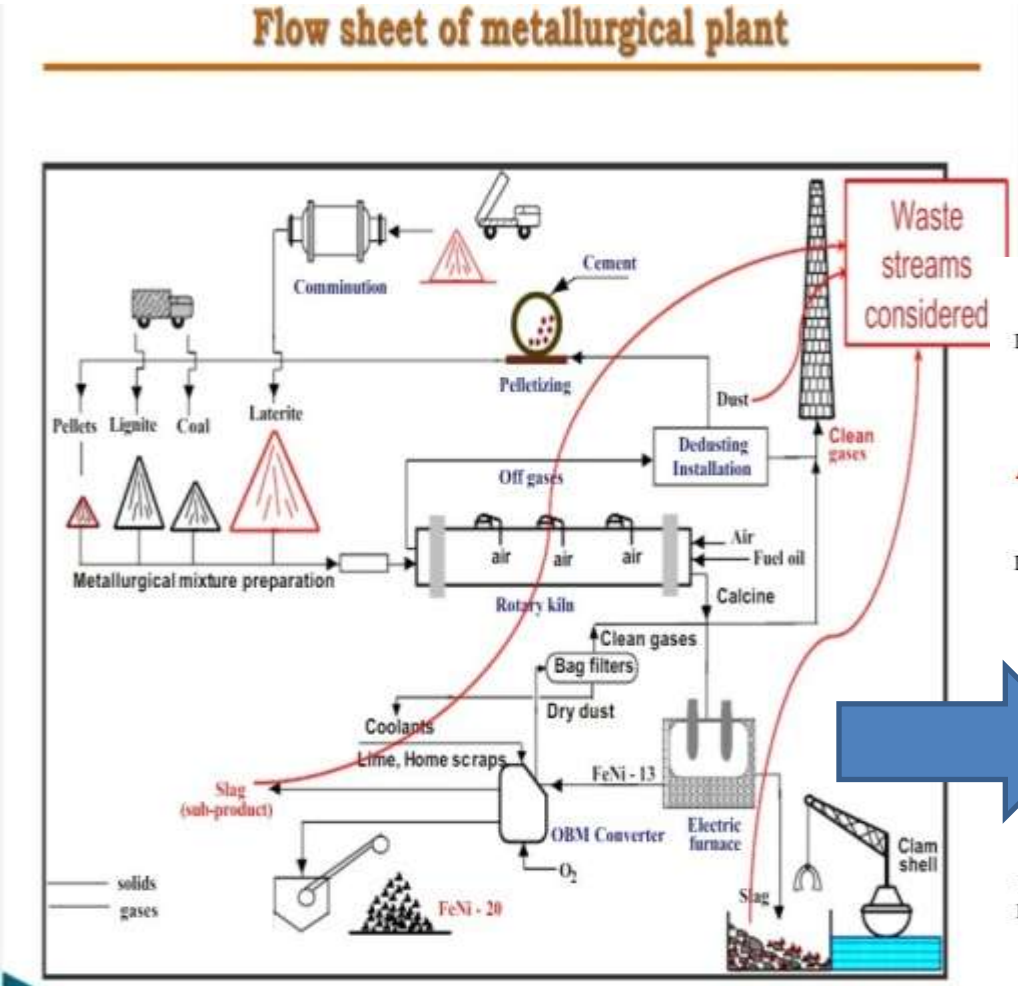
Dore Bar Analysis (XRF)		
Dore Number: 31		
Elements	Content %	Net Weight kg
Au	15,71	1,015
Ag	44,54	2,879
Cu	38,77	2,506
Fe	0,11	0,007
Zn	0,04	0,003
Ni	0,06	0,004
Se	0,64	0,041
Sr	0,01	0,001
Sb	0,08	0,005
Sc	0,01	0,001
Bi	0,03	0,002
Total	100	6,463

The case of LARCO GMMSA - General Mining & Metallurgical Company

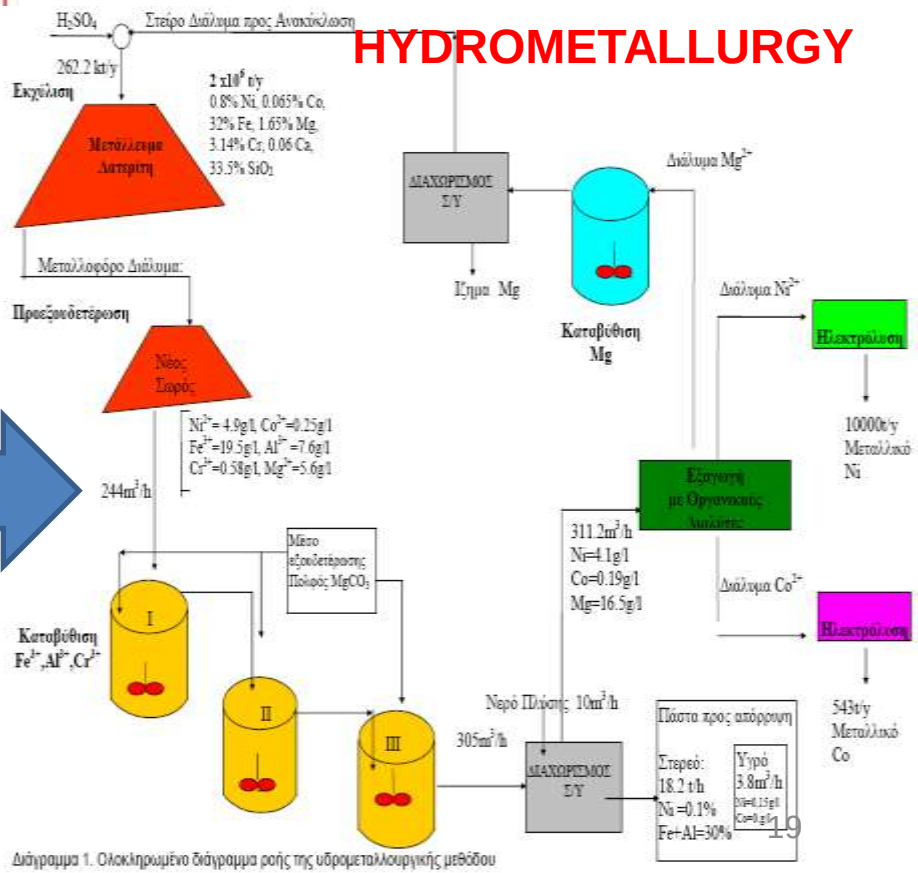
The future of Larco is Hydrometallurgy

of low grade Greek nickeliferous laterites (<1% Ni)

PYROMETALLURGY



HYDROMETALLURGY

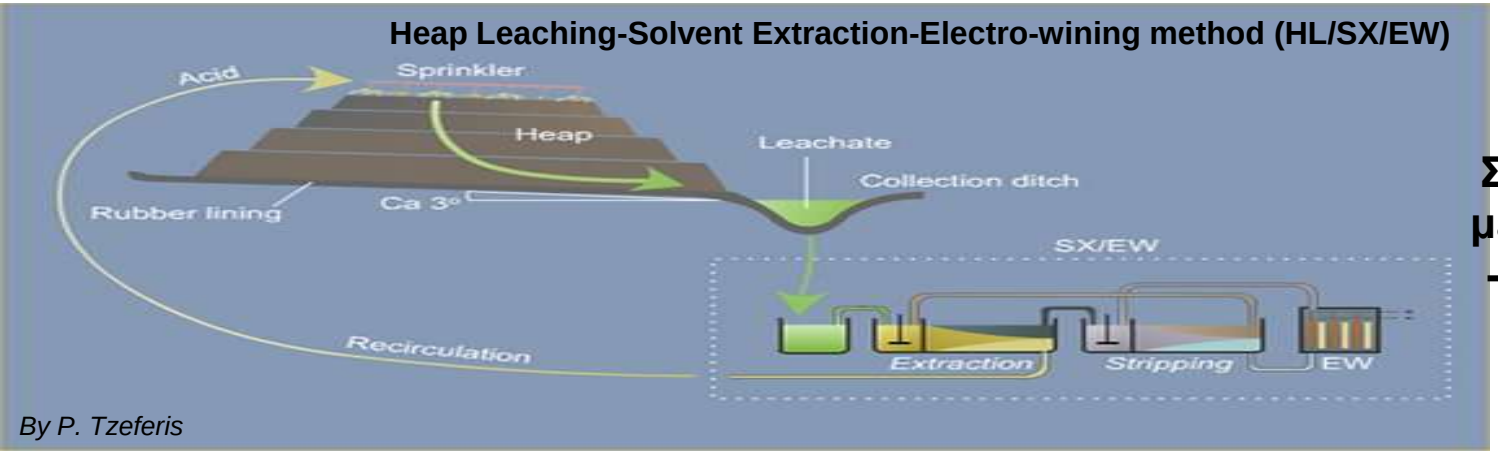


Διάγραμμα 1. Ολοκληρωμένο διάγραμμα ροής της υδρομεταλλουργικής μεθόδου

www.oryktosploutos.r

The future of low grade Greek (and nearby Balkan) laterites

Nickel Laterite Heap Leaching Pilot Plant Program



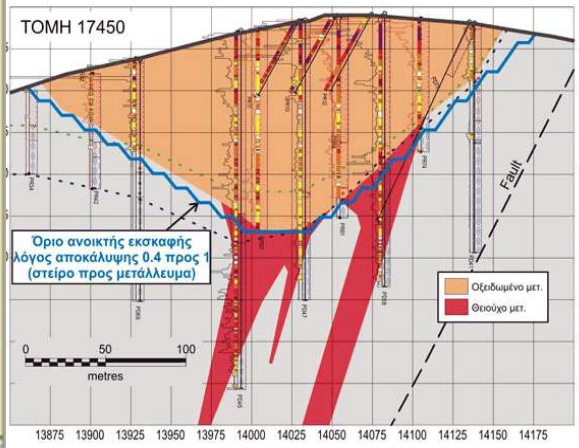
By P. Tzeferis

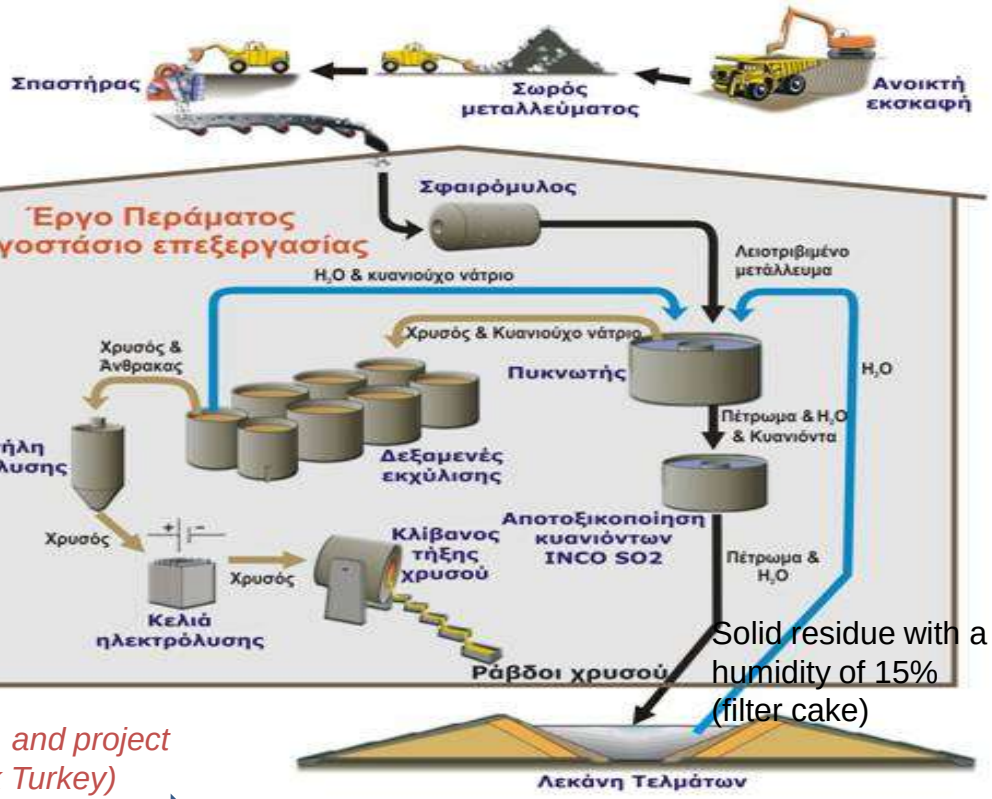
[*Πιλοτικό Υδρομεταλλουργικό πρόγραμμα Εκχύλισης Λατεριτών σε σωρούς*]

(Γ.Μ.Μ.Α.Ε. ΛΑΡΚΟ , ΙΓΜΕ, ΕΜΠ) στο Μεταλλείο του Αγίου Ιωάννου Βοιωτίας, σωρός εκχύλισης 1000t νικελιούχου μεταλλεύματος με περιεκτικότητα σε νικέλιο 0,7% για τη μελέτη της μεθόδου Εκχύλισης σε Σωρούς (heap leaching) .

Η μέθοδος Εκχύλισης σε Σωρούς - Εξαγωγής με Οργανικό Διαλύτη –Ηλεκτρανάκτησης (HL/SX/EW)

Perama Mining Project





Solid residue with a humidity of 15% (filter cake)

Deposit Type	Disseminated epithermal gold-silver
Mine Life	8 years
Mining Rate	1.25 Mtpa
Reserves	9.7 Mt @ Au: 3.13g/t (No As (arsenic), Pb (lead) or other heavy metals)
Gold Silver Production	110,000 oz./year 85,000 oz./year [gold and silver alloy (Doré)]
Processing	Conventional cyanide leaching
Recoveries	90% gold ; 60% silver

(Mineral deposit and project similar to Ovacik Turkey)

Highlights

- Approval of the PEIA issued in February 2012
- EIA submitted to the Ministry of Environment on March 2012

The final cyanide content <1ppm, 10 times less than what is required by the European legislation.

Sapes Mining Project - Overview

Deposit Type	Cu – Au epithermal
Mine Life	11 years
Mining method	Oxia mine Underground Drift & Fill Agios Dimitrios Open Pit
Mining Rate	0,2 Mtpa
Reserves	1.3 Mt @ Cu: 26,1g/t, Au: 15.1g/t
Processing	Flotation (Cu/Au conc.) & Gravity circuit (Au doré)

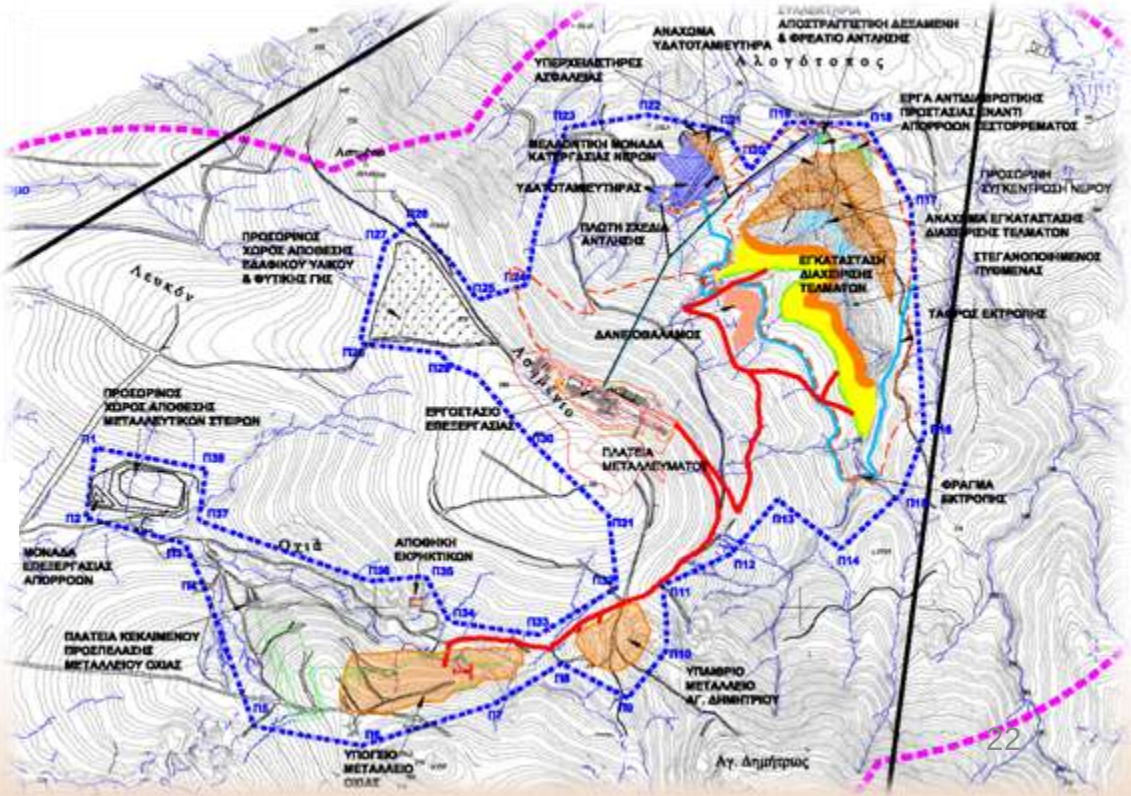
Gravity concentration works when gold is in a free elemental state in particles large enough to allow mechanical concentration to occur.

Highlights

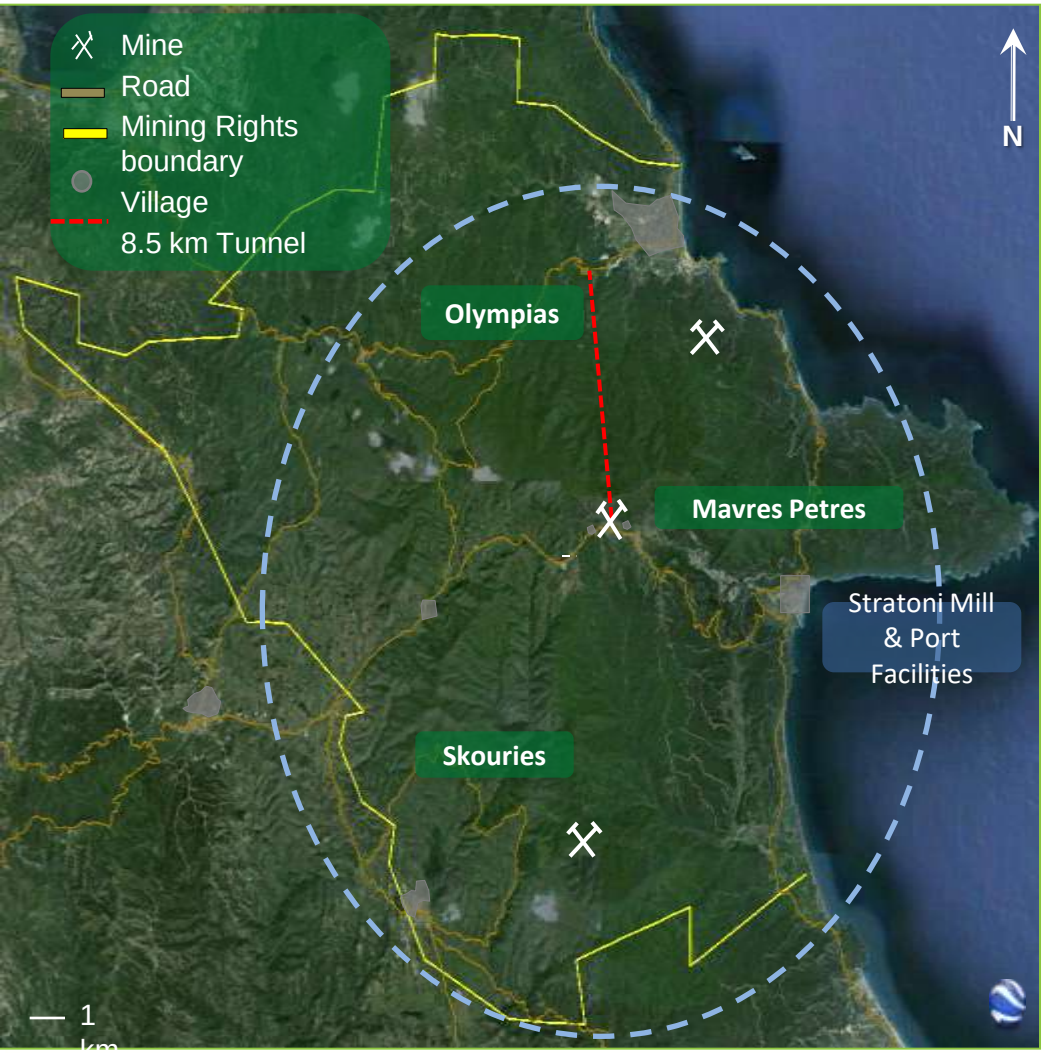
- Approval of the PEIA issued June 2012
- EIA for the project submitted to the Ministry of Environment December 2012
- EIE for Exploration Works Oxia Mine, Feb 2012

?

NOT APPROVED BY THE STATE 2018, SEE ALSO (SOCIAL LICENSE TO OPERATE)



Kassandra Mines (Olympias-Skouries-Mavres Petres-Stratoni projects)



KASSANDRA MINES

The investment in brief

Mavres Petres Mine

- Continue UG mine operation (Mavres Petres)
- X • Operation of existing flotation plant (Stratoni)

Olympias Mine

- Upgrading and development of existing UG mine
- X • Recommissioning & operation of upgraded flotation plant

Skouries Mine

Not yet • Combination of open pit and underground mine

Not yet • Flotation plant and recovery of free gold

• Disposal areas to be put into operation in stages and rehabilitated in phases

New Ore Treatment Facilities in Madem Lakkos

Not yet • New flotation plant for Mavres Petres and Olympias ore

Not yet • New metallurgy plant for Cu, Au & Ag production

Not yet • New Olympias – Madem Lakkos adit for transportation, exploration and ventilation

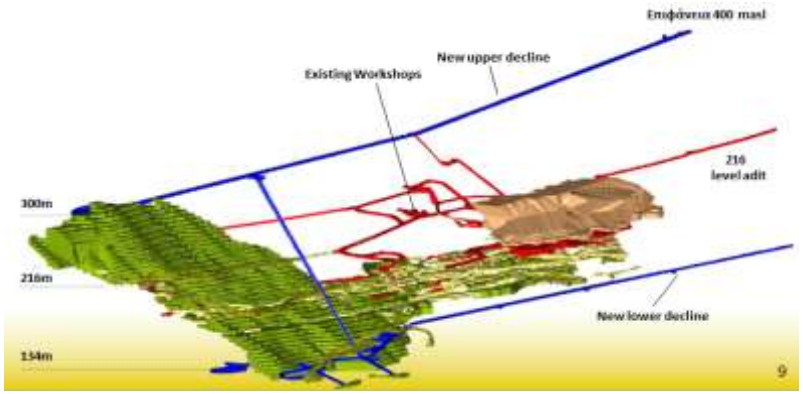
A phase of construction • New Kokkinolakkas TMF, high environmental protection standards **Tailings** Management Facility (**TMF**)

Parallel development of the 3 mines (Mavres Petres, Olympias & Skouries) & full vertical integration

Dr. P. Tzeferis, Gen. Director, Directorate General of Mineral Raw Materials, Ministry of Environment and Energy, 2019

Mavres Petres / Stratoni Mining Projects - Overview

Deposit style	Replacement mixed sulphides
Mining Method	U/G Drift & Fill
Mine Life	Potential mining operation for an additional 2 years of mine life Operation of existing flotation plant (Stratoni). Will be replaced by new flotation plant at Madem Lakkos
Reserves	0,9Mt @ Zn: 11.5%, Pb: 6.9% and Ag: 184g/t (+ Au υπομικροσκοπικών διαστάσεων (<1μm), δεν αξιοποιείται)
Production	±235kt ROM
Processing	Stratoni Flotation (Pb-Ag and Zn conc.)
Recoveries	92% Pb and Zn; 83% Ag to Pb concentrate



Highlights

- >100 yrs of historic production
- Cash flow positive

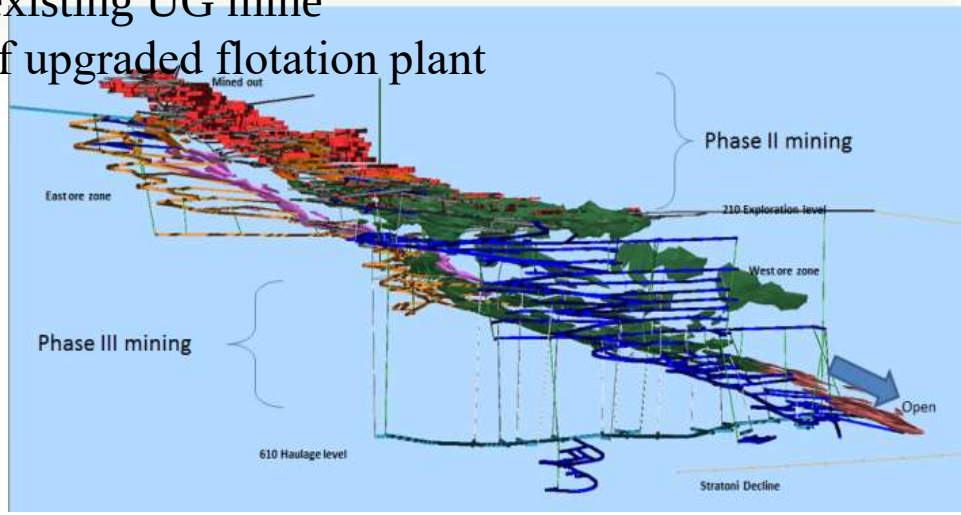
Upside

- Potential for an additional 2 years of mine life
- Huge exploration potential within area with drilled and drill ready targets

Olympias Mining Project- Overview

- Upgrading and development of existing UG mine
- Recommissioning & operation of upgraded flotation plant

Deposit Type	Replacement mixed sulphide
Mine Life	25 years
Reserves	2,4 Mt old tailings @ 3,4 g/t Au 11,5 Mt ROM @ Pb:4,6%, Zn:6,1%, Au: 9,0g/t, Ag: 137,5g/t
Mining Rate	Phase I –Tailings – 800 ktpa to 1M tpa* Phase II – Underground – 450 ktpa Phase III – Underground Expansion – 850 ktpa
Processing	Phase I - Flotation (AsPy) Phase II – Flotation (AsPy, Pb/Ag, Zn conc.) Phase III – Flotation + Gold plant(at Madem Lakkos)
Recoveries	Pb/Zn/Ag/Au in concs.: ±90%; Met plant: +/- 90%



Highlights
- Phase I processing underway
- Underground refurbishment & development underway
- Recruitment underway

Optimisation
- Continue with phased development plan
- Copper - gold metallurgy at Madem Lakkos
- Update current mine design based on new resource model

Upside
- Ore body open at depth
- Potential to add significant resource ounces

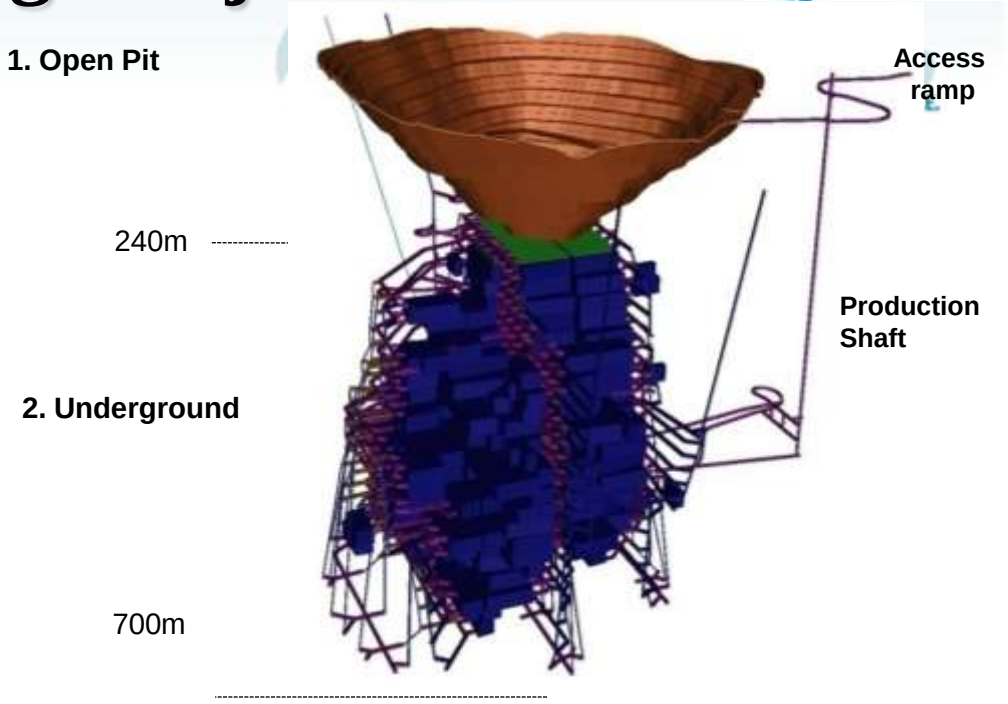
*tons per annum

Skouries Mining Project – Overview

Deposit Type	Cu - Au porphyry
Mining Rate	8Mtpa Open Pit ; 4.4Mtpa Underground SLOS
Mine Life	27 years , (7 y s open pit 20 y s underground)
Reserves	148 MT 0.76 g/t Au, 0.57 % Cu
Production	~140,000oz Au, ~30,000t Cu pa Open Pit ~100,000oz Au, ~22,000t Cu pa Underground
Processing	Flotation (Cu/Au conc.) & Gravity circuit (at Skouries Concentrator) Gold smelter (at Madem Lakkos) - (80% Au doré)
Recoveries	LOM average ~84% Au and ~91% Cu

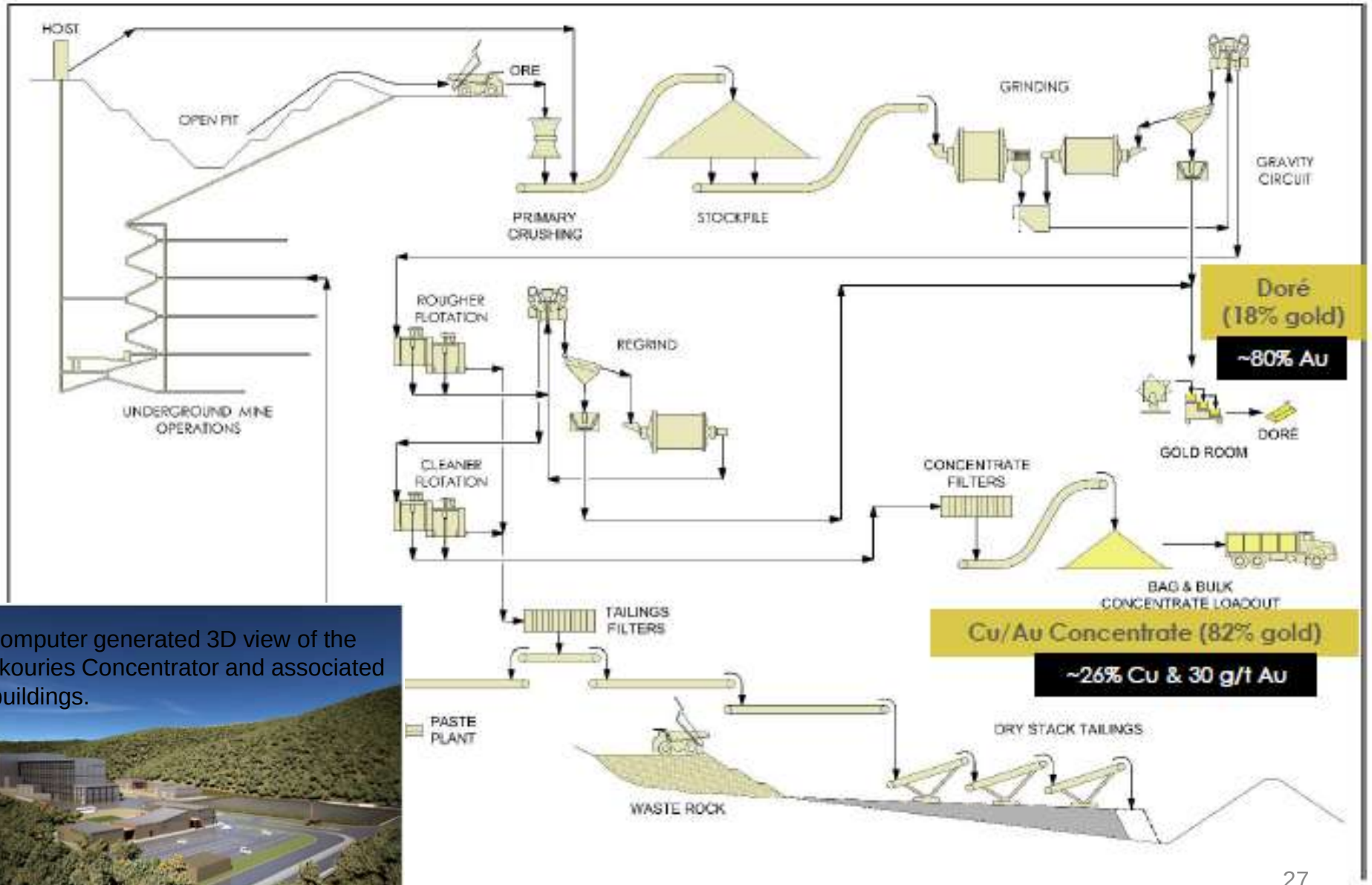
Highlights

- All permits issued (EIS, Technical Study, Forestry, Installation for electromechanical equipment)
- Metallurgy permit still pending



Skouries: Site Overview (March 2018)

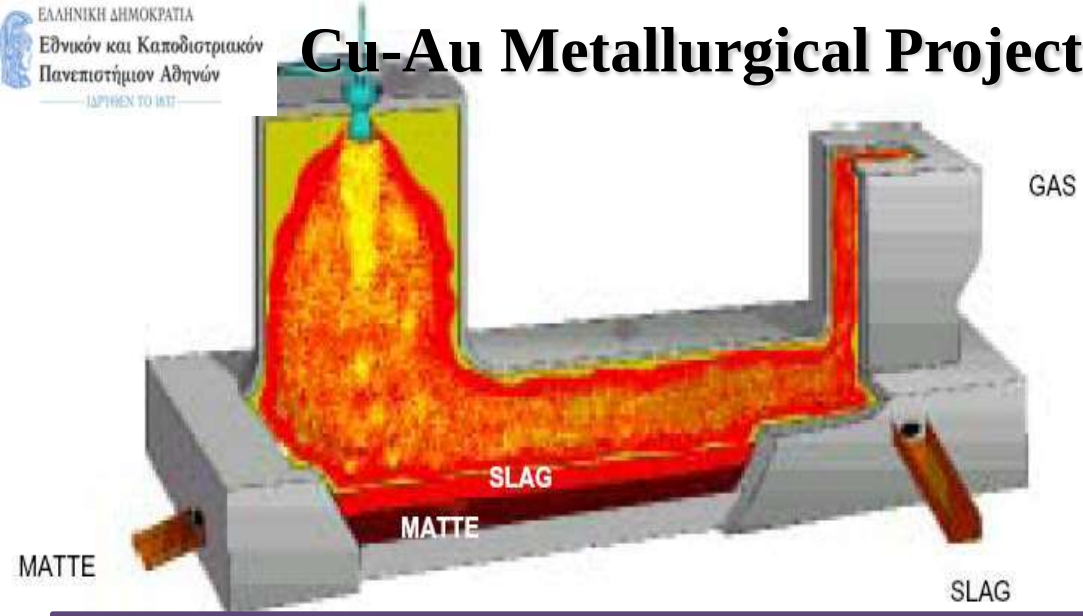
Schematic of the Skouries Concentrator Flow Sheet



Computer generated 3D view of the Skouries Concentrator and associated buildings.

Hellas Gold SA Technical report, March 2018

Cu-Au Metallurgical Project – Technical study



Η μεταλλουργική μονάδα θα κατασκευαστεί στην περιοχή του Μαντέμ Λάκκου, σε άμεση επαφή με το νέο εργοστάσιο εμπλουτισμού και τον νέο χώρο απόθεσης Κοκκινόλακκα. Στην μονάδα κατεργάζεται μίγμα συμπυκνώματος χρυσοφόρων πυριτών Ολυμπιάδας και συμπυκνώματος χαλκού – χρυσού Σκουριών για την παραγωγή χαλκού και χρυσού με τη τεχνολογία της ακαριαίας τήξης.

ΜΕΤΑΛΛΟΥΡΓΙΑ. Το μίγμα χρυσοφόρου αρσενοπυρίτη – σιδηροπυρίτη Ολυμπιάδας και χρυσοφόρου χαλκοπυρίτη Σκουριών των Μεταλλείων Κασσάνδρας τροφοδοτούνται σε κάμινο ακαριαίας τήξης από όπου παράγεται μάττα χαλκού-σιδήρου, η οποία δρα και ως συλλέκτης χρυσού και αργύρου, και σκωρία. Ακολούθως, η μάττα χαλκού-σιδήρου υφίσταται αρχικά εκχύλιση και στην συνέχεια εκαμίνευση σε κάμινο ακαριαίας μετατροπής για την απομάκρυνση του περιεχομένου σιδήρου και την παραγωγή αργού χαλκού (blister copper, ενδιάμεσο προϊόν χαλκού) ο οποίος συνεχίζει να δρα ως συλλέκτης χρυσού και αργύρου. Ο αργός χαλκός οδηγείται στην μονάδα ανάκτησης μετάλλων όπου καθαρίζεται με ηλεκτρόλυση και ανακτάται καθαρός χαλκός στις καθόδους της ηλεκτρόλυσης ενώ τα περιεχόμενα πολύτιμα μέταλλα συγκεντρώνονται στη [illegible] της ανοδικής **[illegible]ish smelting)**

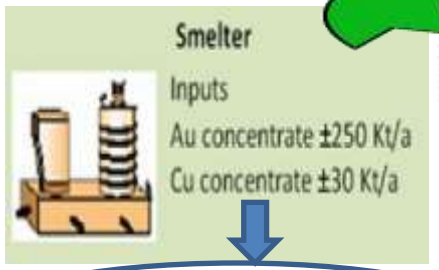
Sulphuric acid production. Το θείο που περιέχεται στα συμπυκνώματα που τροφοδοτούνται στην μεταλλουργία αδρανοποιείται με την μορφή ανάκτησής του ως θειϊκό οξύ. Στη μονάδα παραγωγής θειϊκού οξέος εφαρμόζεται η τεχνολογία της διπλής απορρόφησης προς μεγιστοποίηση της απόδοσης. Το παραγόμενο θειικό οξύ από τις εγκαταστάσεις της μεταλλουργίας στην περιοχή του Μαντέμ Λάκκου μεταφέρεται δια βαρύτητας μέσω αγωγού στις νέες λιμενικές εγκαταστάσεις του Στρατωνίου για θαλάσσια μεταφορά με πλοία.

As treatment Η μεταλλουργική διεργασία συνοδεύεται από μονάδα κατεργασίας για την σταθεροποίηση **του αρσενικού που περιέχεται στο συμπύκνωμα πυριτών Ολυμπιάδας και την μετατροπή του στη σταθερή** και περιβαλλοντικά ασφαλή μορφή του κρυσταλλικού σκοροδίτη.

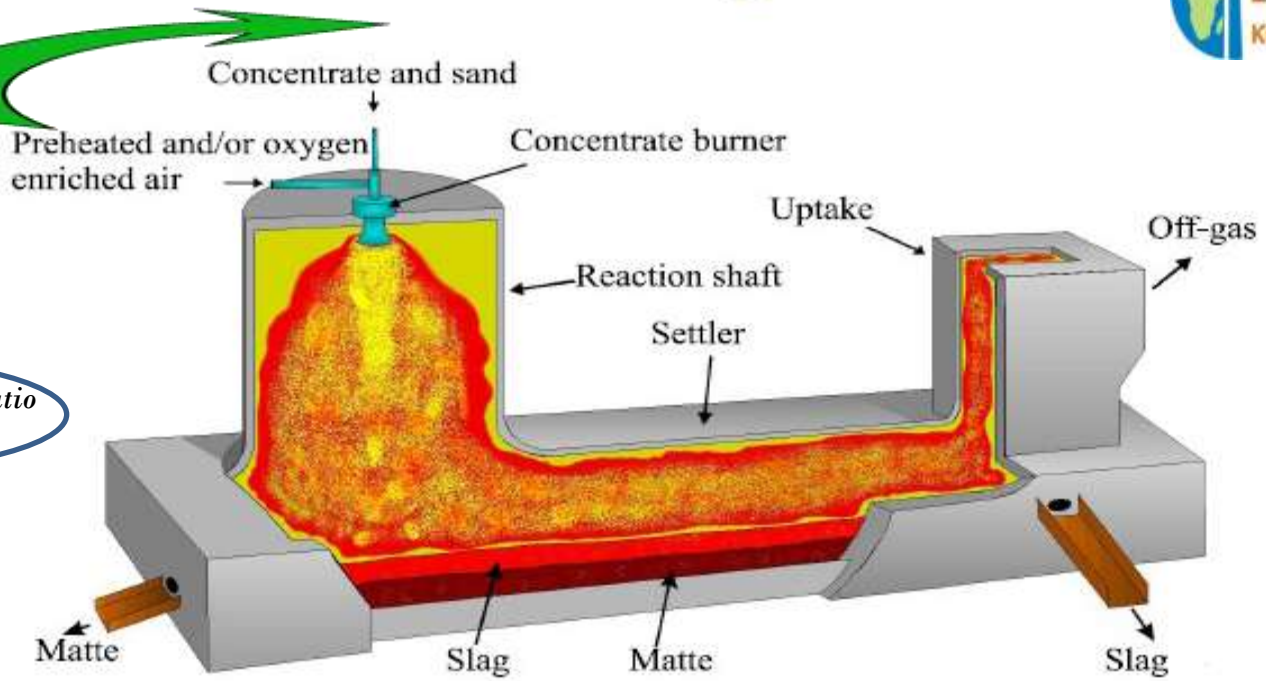
Waste Management. Η διαχείριση των κάθε μορφής στερεών αποβλήτων της μεταλλουργίας (σκωρία και σκοροδίτης) γίνεται υπό σχεδόν ξηρή μορφή για την ελαχιστοποίηση του όγκου τους και της ρυπογένειάς τους αλλά και την μέγιστη ανακύκλωση του βιομηχανικού νερού. Τέλος, το σύνολο των στερεών αποβλήτων, εφόσον δεν αξιοποιούνται ως δομικά ή εμπορεύσιμα προϊόντα, διατίθενται στον παρακείμενο νέο χώρο απόθεσης του Κοκκινόλακκα

Olympias-Skouries Metallurgical Project (simplified)

Flash smelting furnace



Olympias/Skouries concentrate Ratio as it is proposed in the AEPO



The construction of a metallurgical gold production unit is foreseen in Law 3220/04 which ratified the transfer of the Cassandra Mines from the Greek state to Hellas Gold SA

Η βασική χημική αντίδραση που λαμβάνει χώρα μέσα στο φρεάρ καθόδου της καμίνου, είναι:

$$4CuFeS_2 + 5O_2 + SiO_2 \rightarrow 2(Cu_2S \cdot FeS) + (2FeO \cdot SiO_2) + 4SO_2 + Q$$

concentrate blast flux matte slag off-gas

Προς διαδικασίες ανάκτησης Cu και πολύτιμων μετάλλων Au και Ag

Απαέρια. Πτητικές ουσίες, SO2, σκόνες, ενώσεις αζώτου, βαρέων μετάλλων ,αρσενικού κλπ.

Μονάδες επεξεργασίας απαερίων και σταθεροποίησης As

By P. Tzeferis

EXAMPLE PORPHYRY

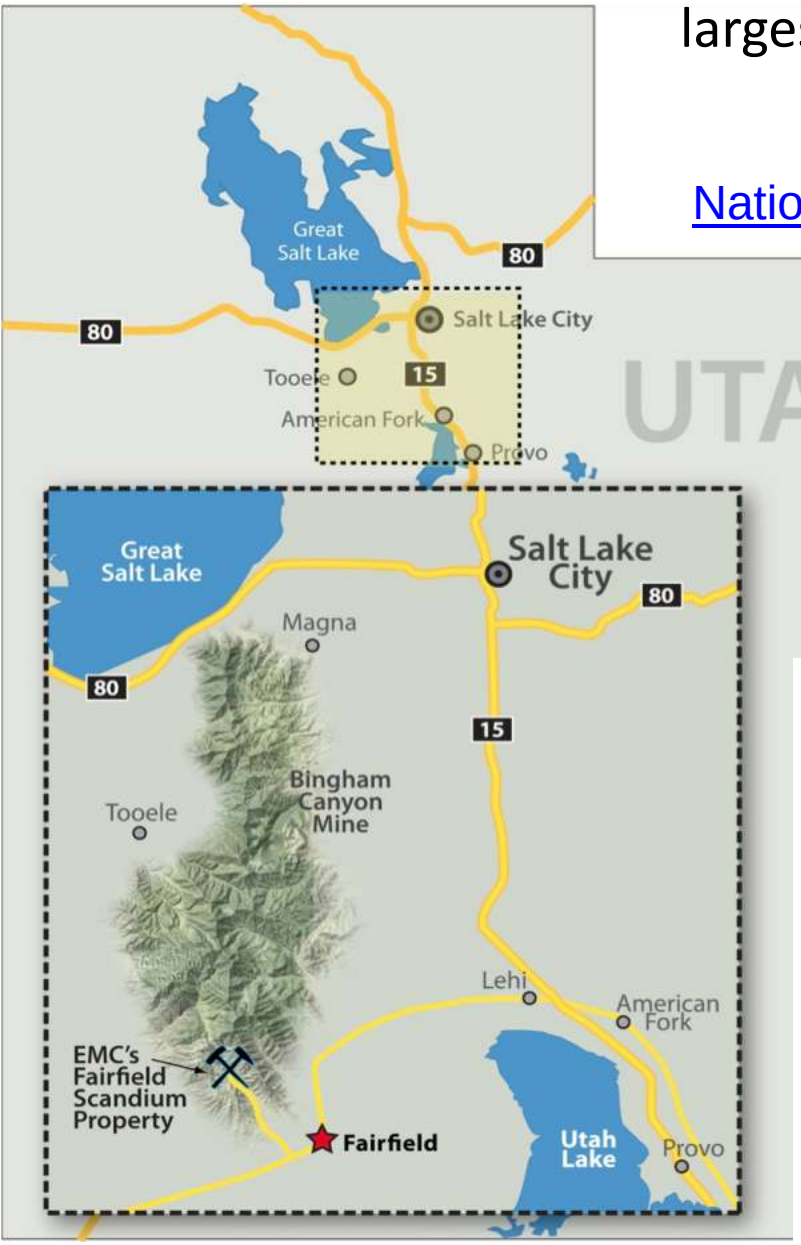
An open pit Cu-Au-Mo(-Ag-Pb) (principally copper) mine

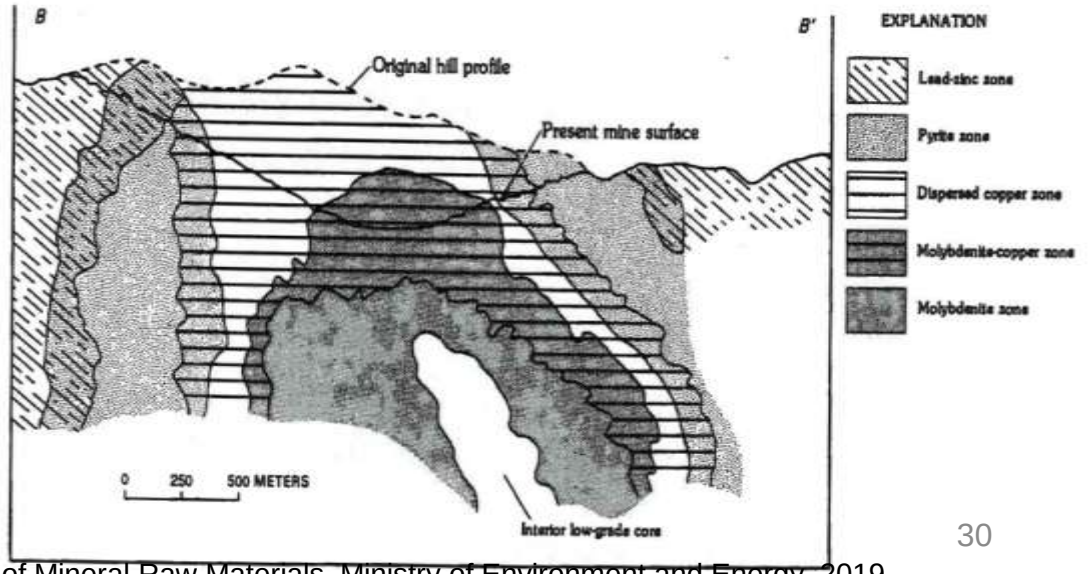
Bingham Canyon Mine: the largest artificially made excavation in the world (from 1903)

National Historic Landmark (from 1966)

Each year the Bingham Canyon Mine, located in Utah and owned by Rio Tinto and in production since 1906, produces approximately:

- 300,000 tons of copper
- 400,000 oz of gold
- 4,000,000 oz of silver
- 30,000,000 lbs of molybdenum





Kennecott Utah Copper

Bingham Canyon Mine

by P. Tzeferis

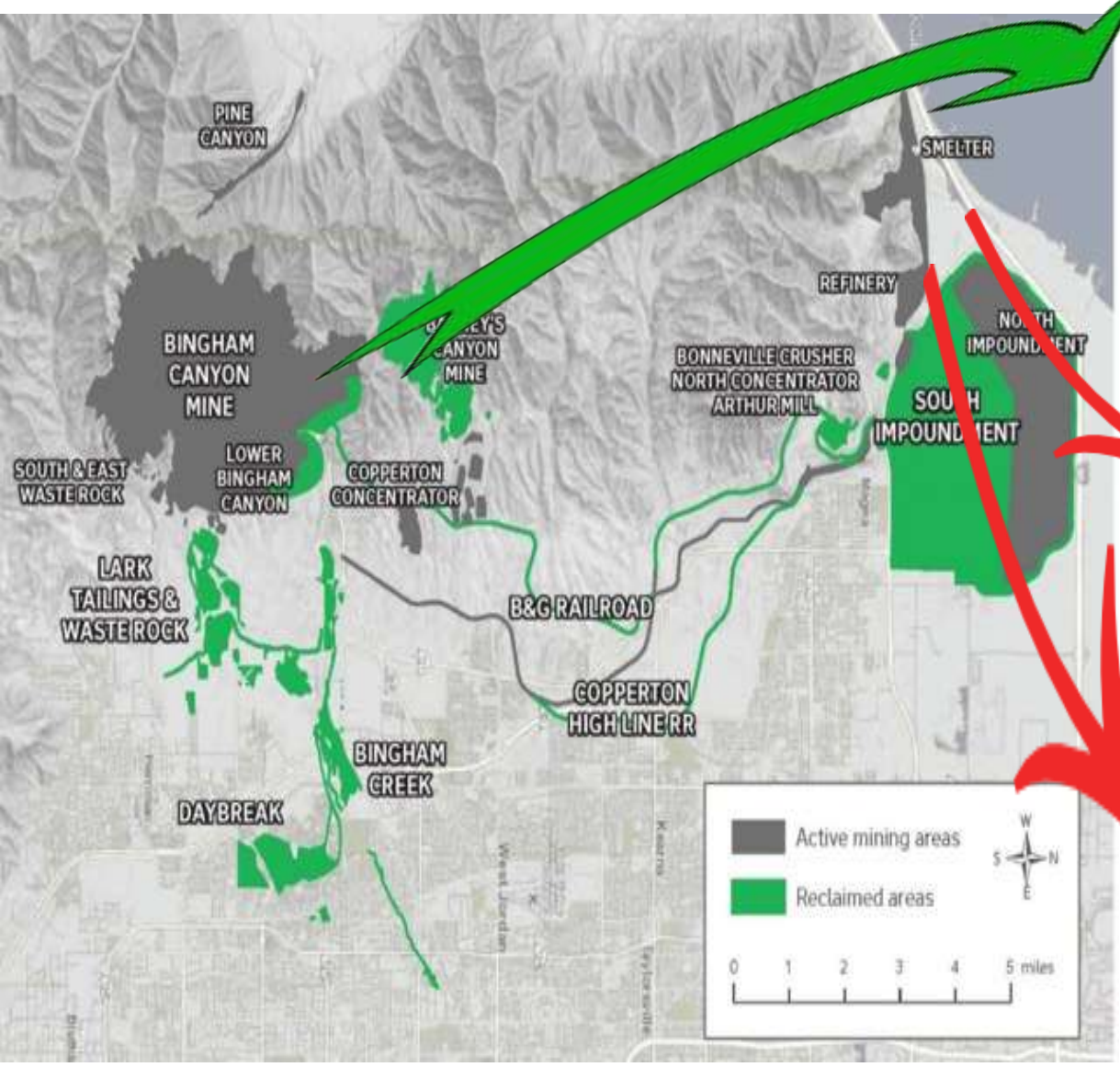
Located 28 miles southwest of Salt Lake City

Photo from the visitors center

http://elladitsamas.blogspot.com/2012/12/bingham-canyon.html

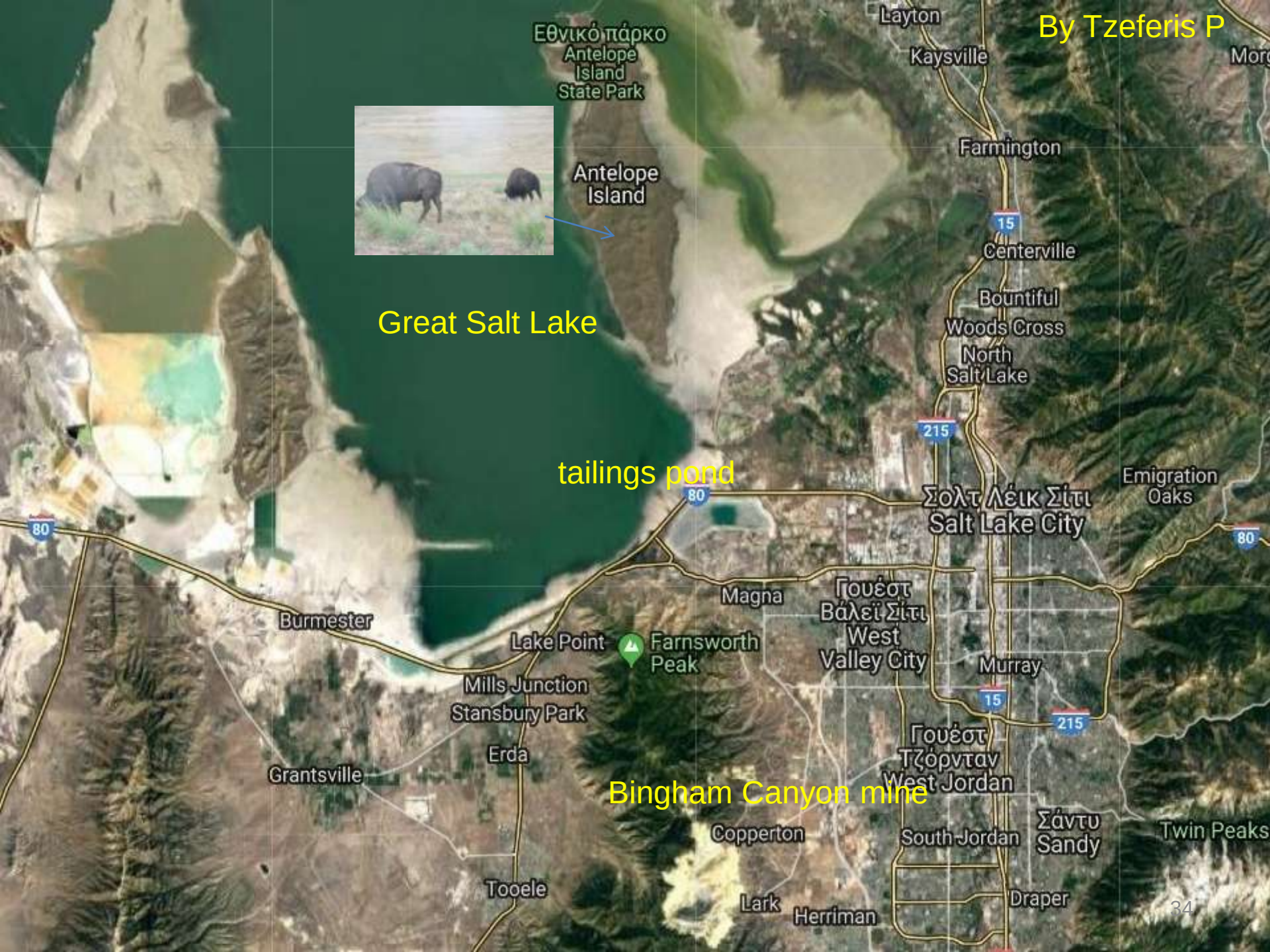
Bingham mine utah Large dump truck hauling copper ore in open pit mine.

Kennecott Utah Copper's (KUC) mineral processing



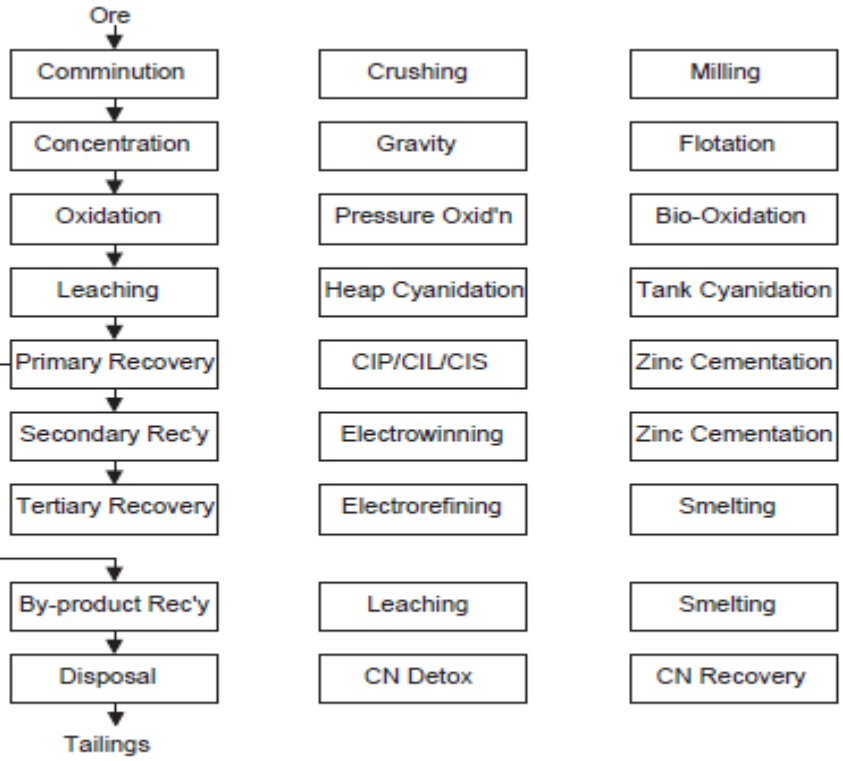
- After the ore has been mined and crushed, the first step it must go through is what is called **froth floating.**
- ***Flash Smelting,*** which involves the ore being first treated with extremely hot air (roasting). This is done to further purify the metal components that were previously purified by the froth flotation process. Then a flash smelting blister copper is produced. *The flash smelter used is entering its 29th year of operation since the Smelter Modernization Project in the early 1990's when flash smelting and Kennecott-Outotec Flash Converting was first implemented.*
- Last process is **Refining for pure Cu** 99.99% **production** (Au , Ag and Mo also produced)

https://www.youtube.com/watch?v=ye8xcEOJuzQ


By Tzeferis P
Εθνικό πάρκο Antelope Island State Park
Antelope Island
Great Salt Lake
tailings pond
Bingham Canyon mine
Layton
Kaysville
Farmington
Centerville
Bountiful
Woods Cross
North Salt Lake
Σολτ Λέικ Σίτι
Salt Lake City
Emigration Oaks
Magna
Γουέστ Βάλεϊ Σίτι
West Valley City
Murray
Burmester
Lake Point
Farnsworth Peak
Mills Junction
Stansbury Park
Erda
Grantsville
Γουέστ Τζόρνταν
West Jordan
Copperton
South Jordan
Σάντυ
Sandy
Twin Peaks
Tooele
Lark
Herriman
Draper
80
15
215

Generic Flowsheet for processing of refractory gold bearing ores

Selection of the most appropriate unit operations for a given project entails **a careful mineralogical and metallurgical investigation.**



Generic flowsheet for processing gold-containing ores.

Whether gold is the **primary value metal or part of a suite of metals such as platinum-group metals (PGMs),** selection of an appropriate combination of these units would likely result in a usable flowsheet.

Pressure oxidation (POX)

Bio-oxidation (BIOX)

?

Cyanidation ?

Smelting ?

Tailings Dam Safety

Tailings are the waste product of mining and consists of ground rock and process effluents that are generated in a Mine hydro-processing plant. Both the physical and chemical characteristics of tailings and their methods of handling and storage are of great and growing concern.


Tailings dam , Rio Tinto Alcan bauxite mining, Australia

Mining companies should adopt pro-active measures that include:

1**. Proper design of tailing dam**, using geo-technical knowledge and engineering experience

2. **Strong Tailing Dam Monitoring Systems** - lack of monitoring and maintenance of tailing dam is the primary cause of tailing dam failures. Proper maintenance and repair of water diversion channels and storm freeboard is essential to prevent such occurrences.

3. Recoding and monitoring movements in the dam wall using Slope Stability Radar and other monitoring systems with provisions for remote alarms.

4. Reducing the need for tailing dams and storage of slimes: Dry Tailing System for Concentrate Tailings and Centrifuge Systems for effluent sludge at the Effluent Treatment Plant for safe disposal without need for tailing dams.

5. **Hazard Identification and Risk Assessment** should be done in detail for the tailing dam construction and management at the conceptual stage itself considering the engineering, geotechnical as well as the process aspects. Regular Job Cycle Checks, and safety visits should be made; incidents/ observations/ near misses should be recorded and reviewed at highest possible level.

6**. Emergency Preparedness & Response Plan** need to be meticulously drawn with proper action plans and defined responsibilities. These plans should be regularly communicated to all concerned in form of periodic trainings and mock drills.

Dr. P. Tzeferis, Gen. Director, Directorate General of Mineral Raw Materials, Ministry of Environment and Energy, 2019

Mining Tragedies: Lessons to be learned

Baia Mare, Romania, 2000

Red *mud* flood of an alumina factory near Ajka, *Hungary, 2014*

Samarco's mines, Minas Brazil, 2015

Sludge and mining waste, Bento Rodrigues, Brazil, 2015

Mount Polley Mine, British Columbia Canada, 2014.

Tailings dam collapse, Minas Gerais, Brazil, 2019

Chronology of major tailings dam failures (from 1960)

By P. Tzeferis, 2019

Kokkinolakkas Tailings Management Facility (TMF)

Chalkidiki Greece

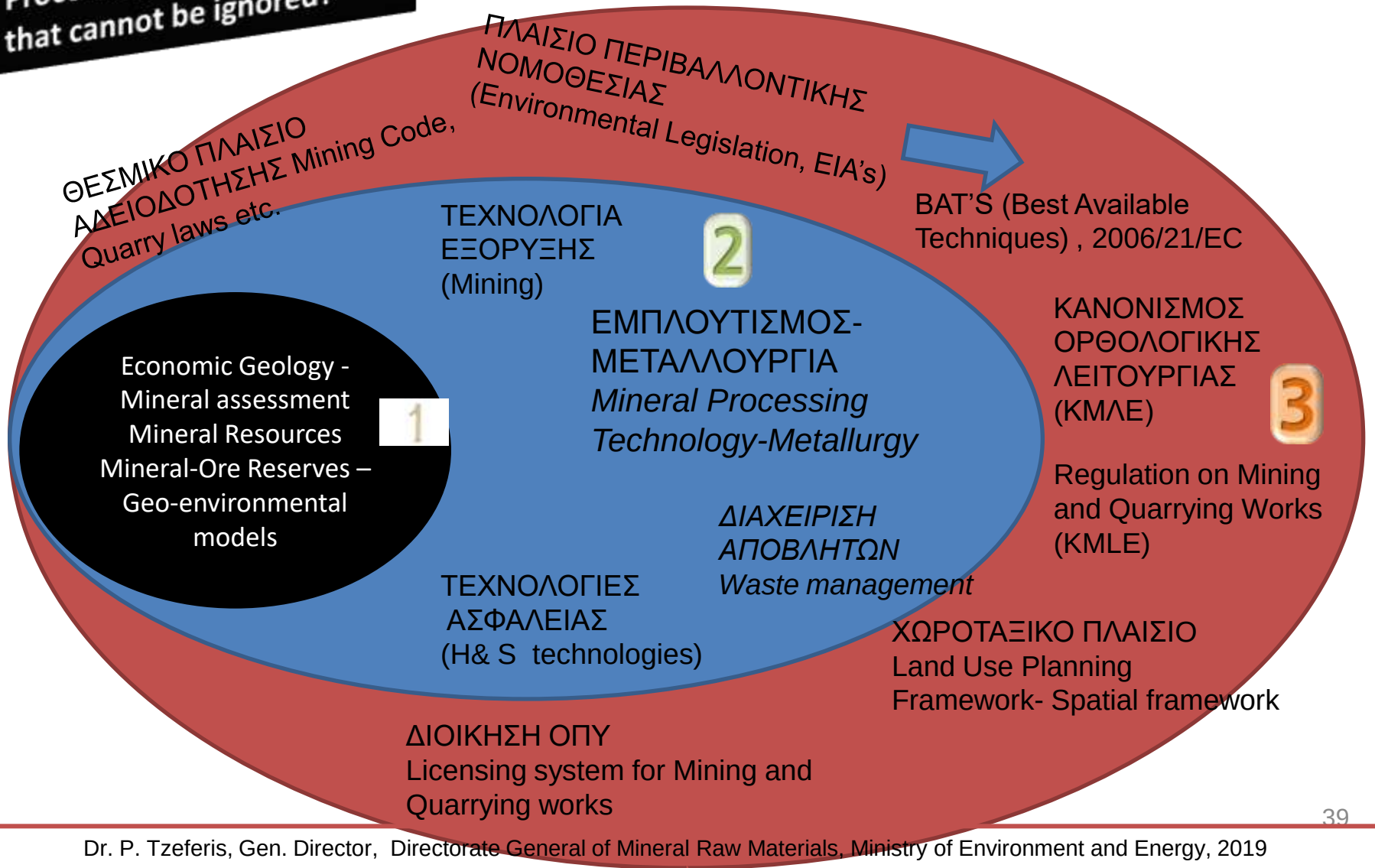
By P. Tzeferis, 2019

Construction phases of TMF

Are there other factors affecting our choices (with the zero solution including) for Mining and Mineral Processing applications and that cannot be ignored?

3. ΘΕΣΜΙΚΟ ΠΛΑΙΣΙΟ-ΤΕΧΝΙΚΟ-ΠΕΡΙΒΑΛΛΟΝΤΙΚΟ-ΧΩΡΟΤΑΞΙΚΟ-ΔΙΟΙΚΗΣΗ ΟΠΥ

Legal Framework-Technical-Environmental-Spatial-Licensing for Mining and Quarrying works



Legal Framework Impact

Legal framework is regulating everything from the definition of the minerals (metallic minerals-quarry minerals) to the exploration, exploitation, mineral processing, metallurgy, waste management, even the preservation and promotion of geo-mining heritage.

QUARRY MINERALS LICENSING SYSTEM

Key Risks

Do I need the licensing system?

A. Risk to Health and Safety
Local residents, workers, buildings & built-up areas, public utility projects, public works, tourist facilities etc. (Safety distances due to blasting, excavations, etc)

B. Risk to Cultural Heritage Archaeological sites & monuments, historic sites, etc.

C. Risk to Environment Landscape, Soil, Water Resources, Forest Areas etc.

D. Risk to the Sustainability of the deposit - Planning
Planning and feasibility of the exploitation. Ensure both the optimum exploitation of the deposit (non-renewable) and the local area, in order to fulfill the sustainable mining practices.

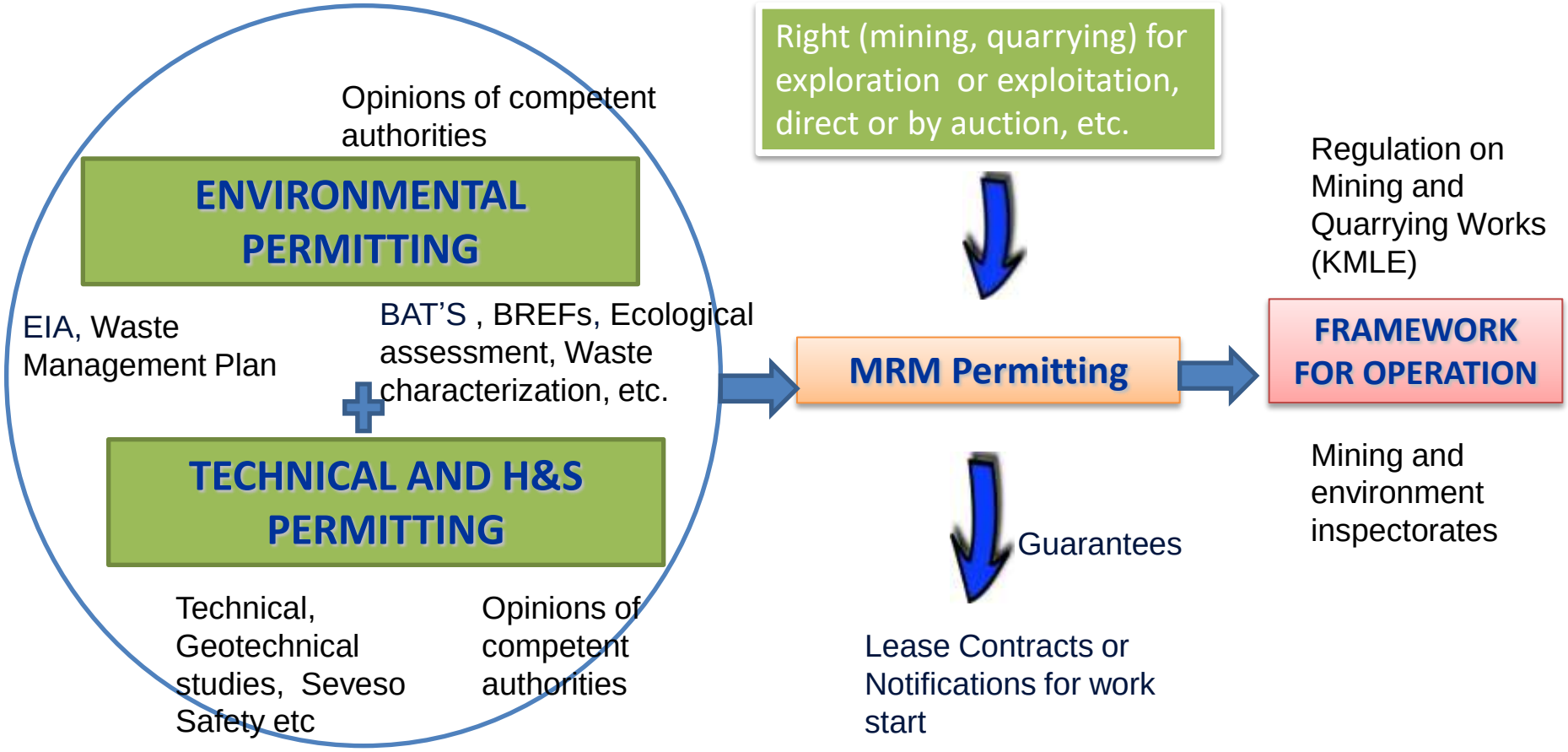
Opinions / Consents that no problems or disturbances will be caused to archaeological monuments and sites, local residents, buildings and built-up areas, public works & networks etc. ***(Risks A & B)***

Environmental Impact Assessment Approval (EIA). ***(Risk C)***

Technical-Planning Approval ***(Risk D)***

AFTER: Regular on-site inspections are carried out ex post by the Greek Mining Inspectorate on the basis of a risk assessment.

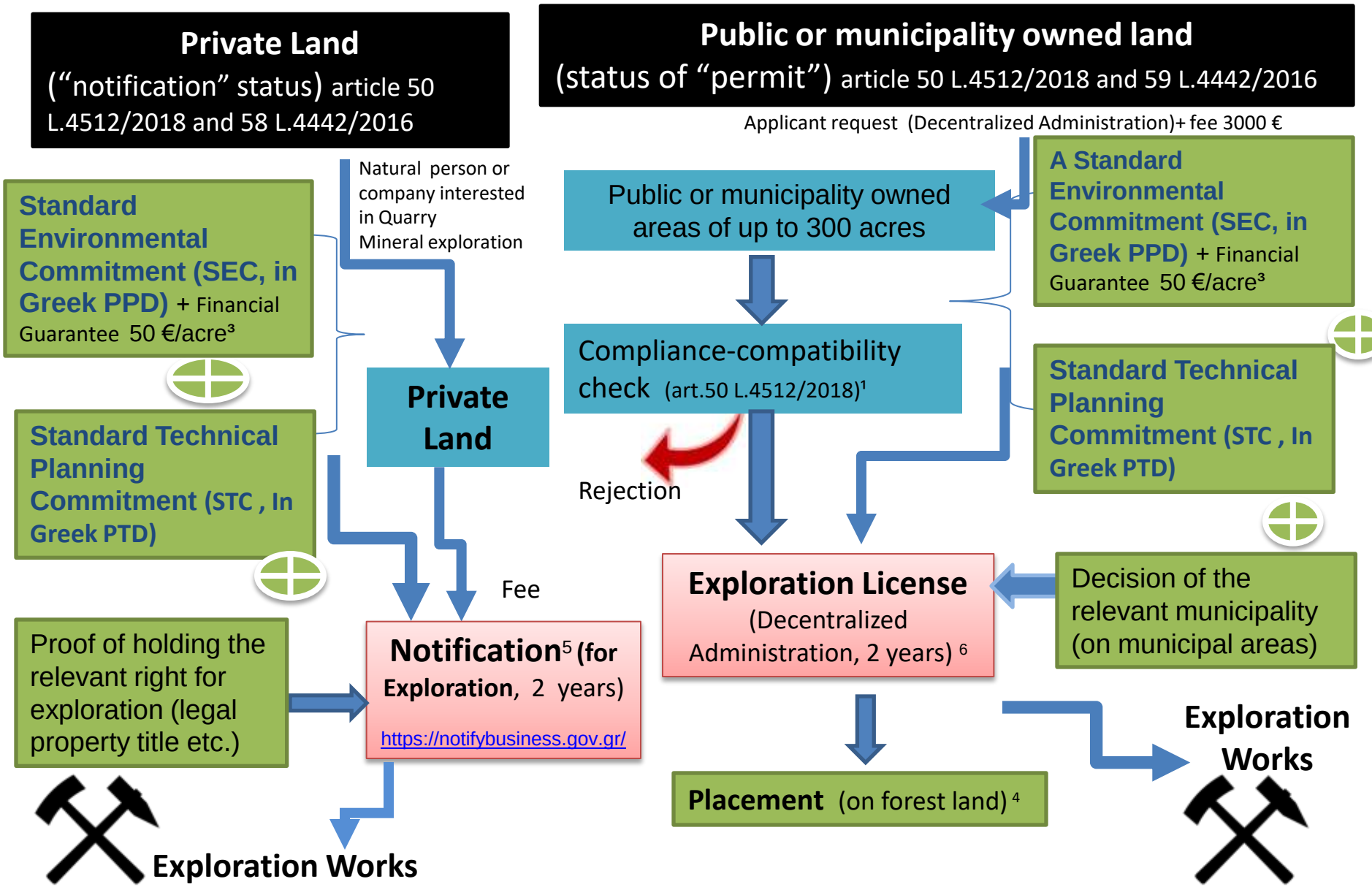
General Framework for Licensing of Mineral Raw Materials (MRM) activities



Legal Framework Impact

EXPLORATION LICENSING FOR QUARRY MINERALS

(MARBLE & INDUSTRIAL MINERALS, ORNAMENTS AND DECORATIVE STONES , AGGREGATES FOR SPECIAL USES ETC.)



Legal Framework Impact

EXLOITATION OF QUARRY MINERALS, on going licensing reforms 2018

(FOR AGGREGATES[1], MARBLE & INDUSTRIAL MINERALS) **on public or municipality owned land**, articles 51,52,53,54 L.4512/2018 and 61, 63 L. 4442/2016 (status of "permit"/lease contract)

Request to the relevant Decentralized (Regional) Administration or Municipality for direct tenancy no later than 6 months after the expiry of the exploration period (2 years)

Environmental Impact Assessment Approval (ETA , In Greek AEPO)

A Technical study approval for Planning and feasibility of the exploitation (including electromechanical installations within quarries for the processing of extracted minerals)

Financial guarantees for obligations arising from the relevant ETA (AEPO) and compliance with contract terms

fee

LEASE CONTRACT for exploitation of quarry minerals
(status of "permit",
article 7 L.4442/2016)

Decentralized (Regional) Administration or Municipality
For 20 years (+20+10+10+10=70 years max)

Ministry of Culture Approval(protection of cultural heritage, archaeological sites & monuments, etc). Art. 10 L.3028/2002

Mining Inspectorate Consent (Safety distances due to blasting etc) and Consents of article 49 (if required, not repeated unless three years have passed)

Decision of the relevant municipality (on municipal areas)

Notification for operation for the electromechanical equipment installations . In the case of additional building construction + Building permit

announcement

crushing

Start of Installations work

Start of Quarry works

Environmental Control

Legal Framework

Οδηγίες 97/11 και 2011/92,

Οδηγίες 92/43/ΕΟΚ και 2009/147/ΕΟΚ

Οδηγίες IPPC-IED , 2006/21/ΕΚ και BREF

Οδηγία seveso II

Legal Framework for Management of Extractive Waste

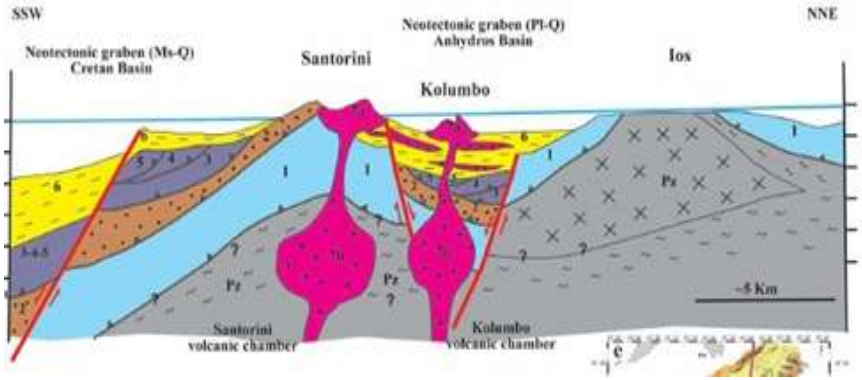
- Directive 2006/21/ΕΚ
- ΚΥΑ 39624/2209/Ε103/2009 (ΦΕΚ Β΄2076)

All relevant BAT reference documents **(the so-called BREFs)** that have been adopted by the specific bodies and departments of the European Commission for the Management of Extractive Waste (MWEI BREF) so as to prevent or reduce environmental and human health impacts from extractive waste management, are in use.

New BAT document (MTWR BREF) for the Management of Waste from the Extractive Industries (2006/21/EC)

Legal Framework for Seafloor mining

Should we mine Kolumbo?



Subsea Mineral deposits → *Polymetallic nodules*
Seafloor Massive Sulfides (SMS)
Cobalt-rich ferromanganese crusts

A WAY FORWARD? A HOLISTIC ASSESSMENT OF POTENTIAL TOXICITY USING THE ESTABLISHED EVIDENCE APPROACH TO QUANTIFY THE TOXIC RISK OF DEEP-SEAMINING TO BIOLOGICAL SPECIES AND COMMUNITIES

It is not possible to predict **a priori** the absolute toxicity of mining different seabed resources at bathyal and abyssal depths.

Should we mine Kolumbo, the shallow-submarine arc-volcano, near Santorini , Greece, with unique enrichments of polymetallic spires in Sb and Tl (+- Hg, As, Au, Ag, Zn)?

Answer:

a) No, because there is no such a national legal framework yet

*b) Moreover, there should be an updated mining code from the **International Seabed Authority.** If and when there is scientific evidence that active hydrothermal vent ecosystems are not areas at risk of serious harm from mining activities, such a moratorium should be enabled.*

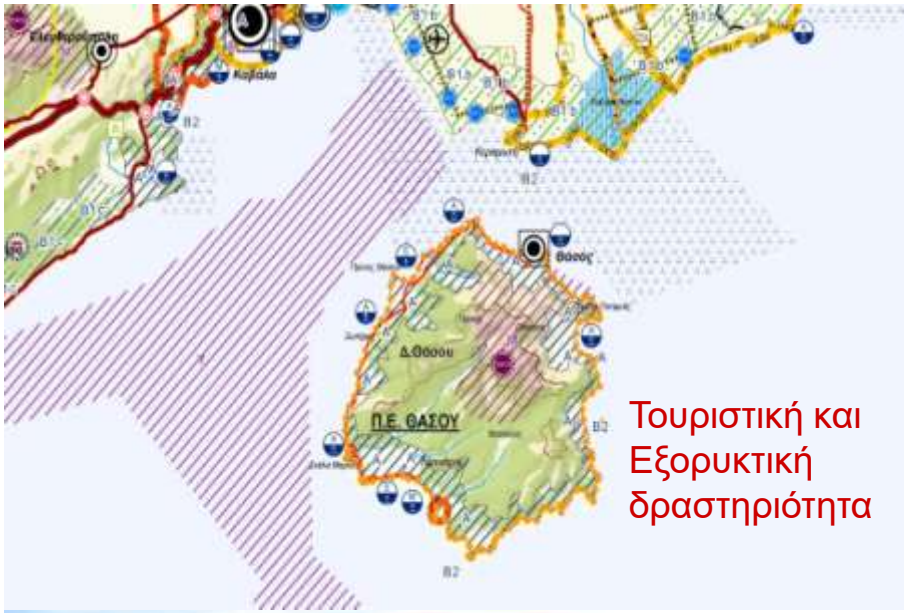
Important parameters in case of Greece affecting mining permits

A. Greece is a country with long **historical and archaeological heritage** that need to be3 protected (Ministry of Culture Prehistorically and Classic Antiquities, Byzantium monuments, etc).

B. There are a lot of special **protected areas of environmental interest** (Natura 2000, Special protected zones, Habitats Directive, Birds Directive, etc). The environmental authorities should evaluate and confirm that the proposed project will not compromise the integrity of the area concerned.

C. Greek Land Registry has not been completed yet. So there are many areas where the land ownership is not clear (included Public).

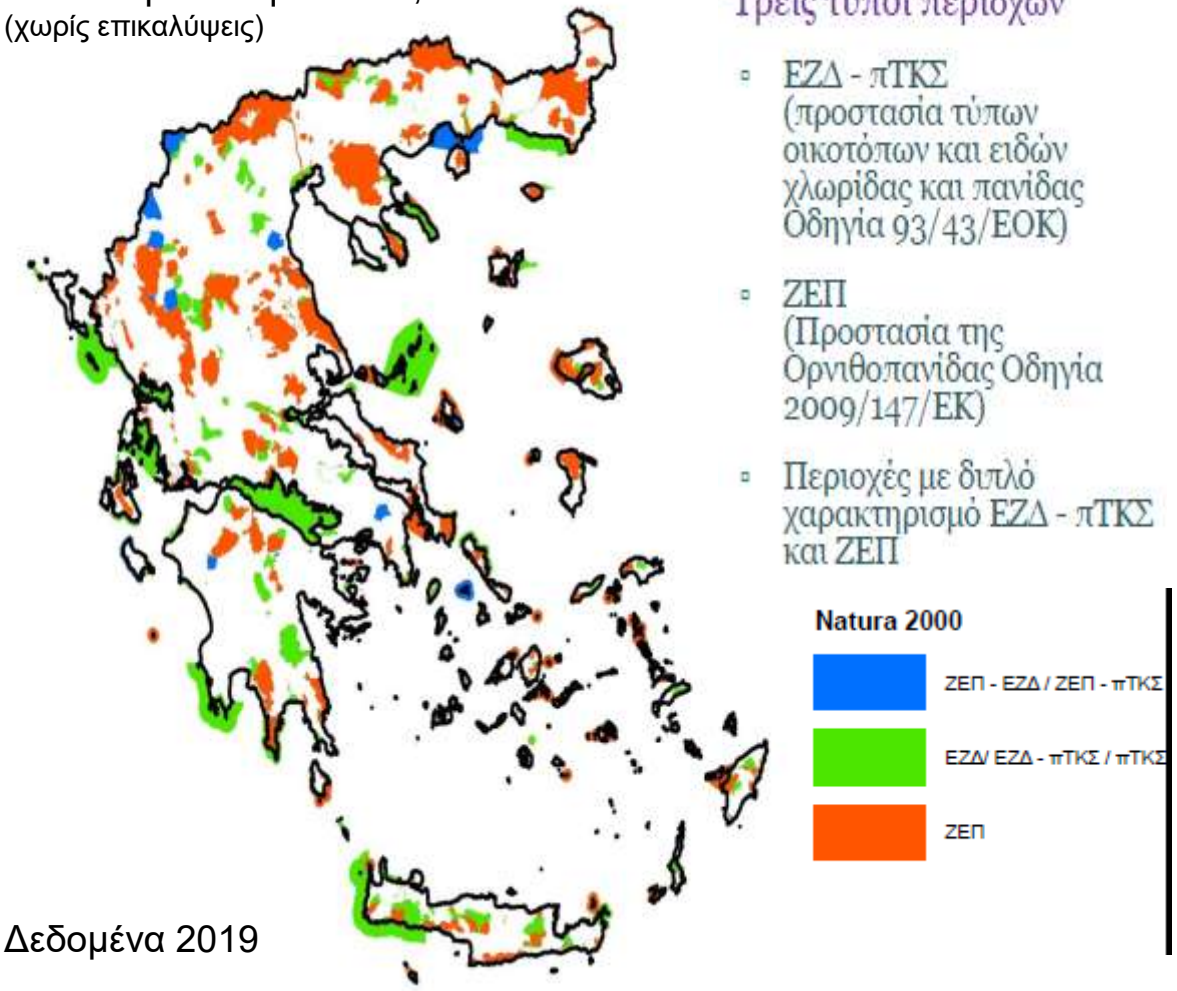
D. The need for coexistence with tourism, almost everywhere around the country



Τουριστική και Εξορυκτική δραστηριότητα

Extractive activity & Natura 2000 Ecological Network

446 περιοχές Natura
Συνολική έκταση: 58.773,2 Km2
(χωρίς επικαλύψεις)



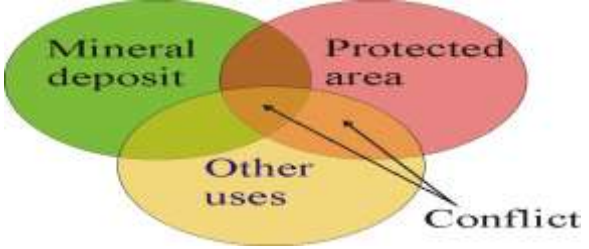
Δεδομένα 2019

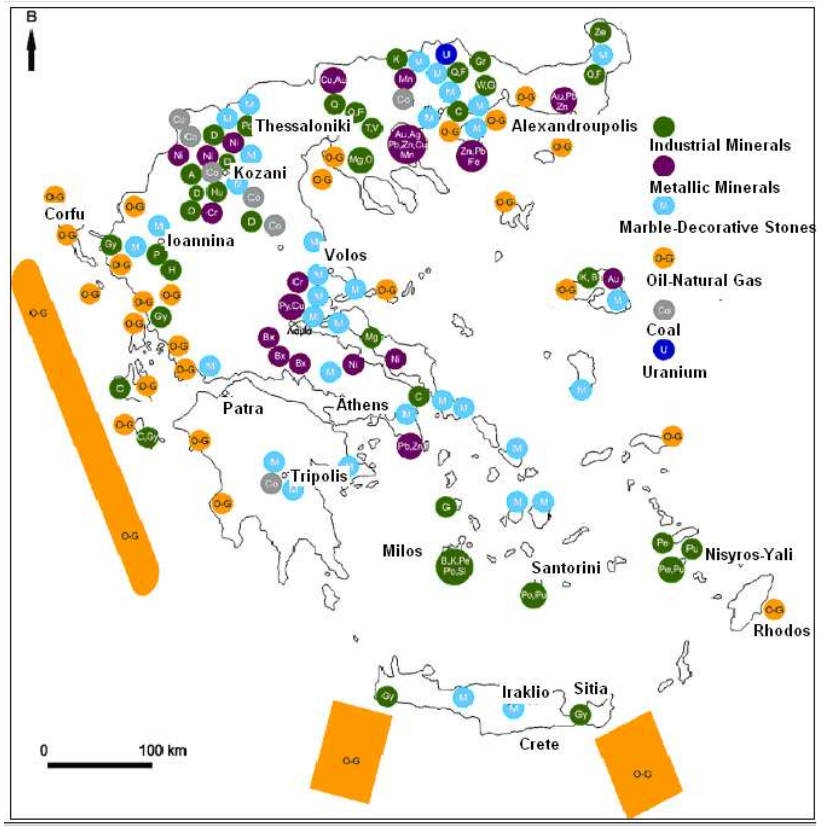
The extent of the Natura 2000 protected area of the country now exceeds **27.1% of the land territory** of our country

KYA 50743/11.12.2017 with which new areas mainly related to the marine environment have joined the network.

Greece is now 7th in the 28 EU Member States in terms of coverage, exceeding the EU average by 9 percentage units.

Extractive activity & Natura 2000 Ecological Network



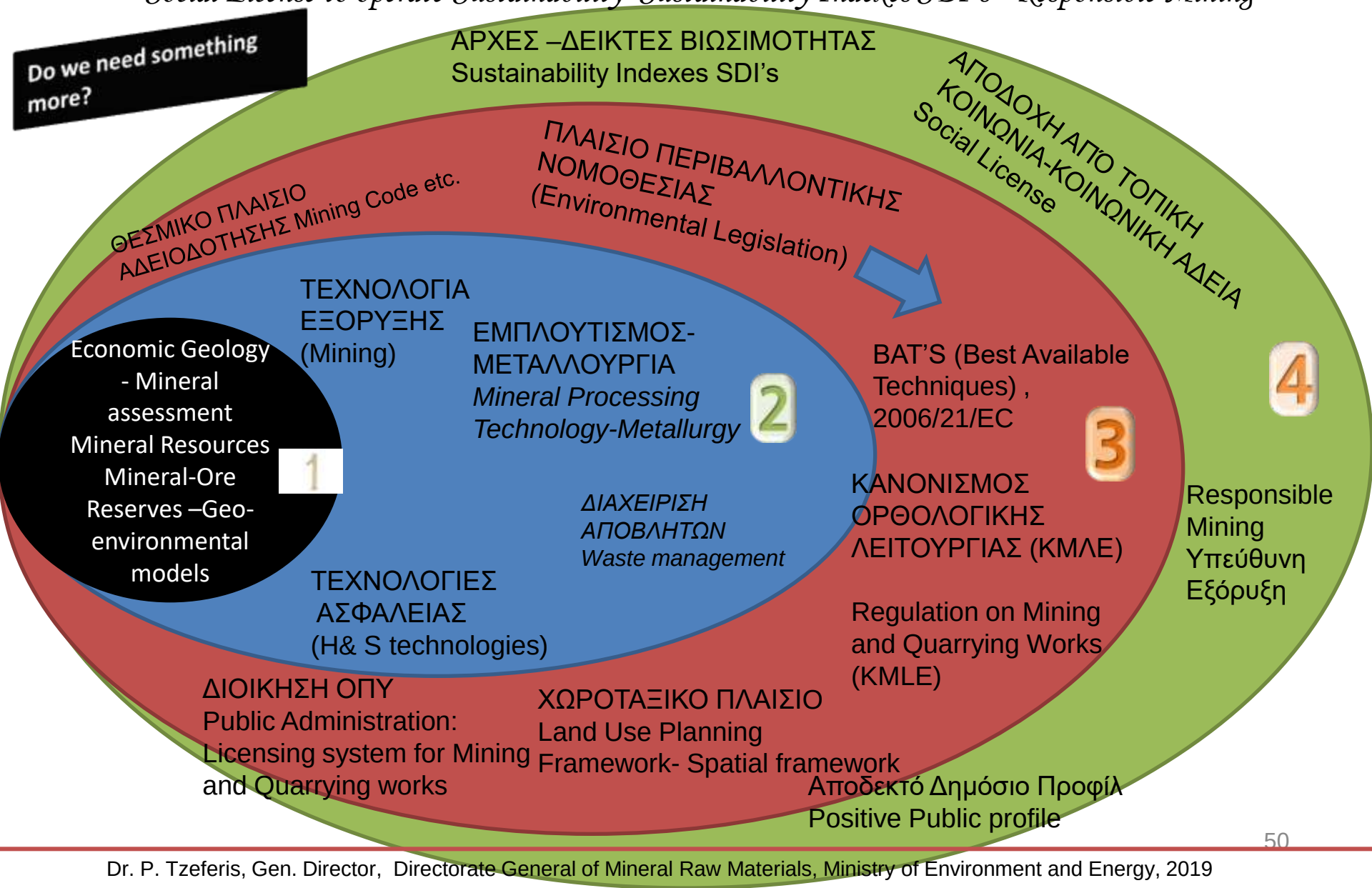


If we do not want to totally cancel mining in protected places, we must find a way of co-existence. The legal framework protection has to be clarified further with the help of the spatial planning and implemented by the administration.

The Greek mineral resources inside the Natura 2000 system area is estimated to exceed 30-35% of the total potential (excluding hydrocarbon deposits)

4. ΚΟΙΝΩΝΙΚΗ ΑΔΕΙΑ –ΒΙΩΣΙΜΗ ΑΝΑΠΤΥΞΗ- ΕΦΑΡΜΟΓΗ ΔΕΙΚΤΩΝ ΒΙΩΣΙΜΗΣ ΑΝΑΠΤΥΞΗΣ

Social License to operate-Sustainability- Sustainability Indexes SDI's –Responsible Mining



CONCEPT OF SUSTAINABILITY

Κλιματική Αλλαγή
Βιοποικιλότητα

Ποιότητα Νερού
Ποιότητα Αέρα

Περιβάλλον
Χρήση φυσικών πόρων
Περιβαλλοντική Διαχείριση
Πρόληψη ρύπανσης

Υποφερτό κοινωνικά
Περιβαλλοντικοί Κανόνες
Κανόνες Ασφαλείας και Υγείας H&S
Υγειονομική Προστασία
Πρόσβαση στο Νερό
Πρόσβαση στην εκπαίδευση
Διατήρηση Πολιτισμού
SOCIO-ENVIRONMENTAL

Ανεκτό (βιώσιμο) περιβαλλοντικά
Αποδοτικότητα Φυσικών Πόρων
Ενεργειακή Αποδοτικότητα
Οικολογικός Σχεδιασμός
Διαχείριση του Κύκλου Ζωής
Επαναχρησιμοποίηση
Ανακύκλωση
ECO-ECONOMY

Bearable
Viable
Equitable

Βιωσιμότητα

Κοινωνία
Επίπεδο διαβίωσης
Παιδεία
Δικαιοσύνη
Ίσες ευκαιρίες

Οικονομία
Κέρδος
Μείωση κόστους
Οικονομική μεγέθυνση
Έρευνα & ανάπτυξη

Ποιότητα Ζωής
Φυσικό Περιβάλλον
Υγεία
Εξάλειψη φτώχειας

Δίκαιο
Κώδικες δεοντολογίας
Τοπικός αντίκτυπος της οικονομίας
Θέσεις Εργασίας **SOCIO-ECONOMIC**

Sustainability performance indicators , SDI's

Sustainability performance indicators include employment matters, environmental management and land stewardship, waste management, energy and water management, H&S issues, local community development, etc.

Data from **twelve groups of Sustainable Development Indicators (SDIs)** provided by the Greek Mining Enterprises Association (GMEA) and Ministry of Environment and Energy, in the period 2007-2013.

Social License

Mining has to be sustainable and responsible aswell

License to operate

All permits issued by the Government → Social License must be granted → Mine operation

Social License to operate

Community perception of the mine legitimacy (Acceptance) → Credibility of the mine (Approval) → Development of full trust (Psychological) Co-Ownership → Social license to operate the mine

*The industry has to act positively to recover its reputation and gain a "social license to operate" in a process that, beginning at the level of individual mines and projects, would, over time, **create a new culture and public profile for the mining industry***

Jim Cooney
Director of international and public affairs of Placer Dome
Washington

From acceptance to full trust

Actions that should be taken:

- Financial
- Social
- Environmental

Social License

The maturing of communities on mining issues

"Business cannot succeed in a society that fails"

- **Κώδικας αρχών βιώσιμης ανάπτυξης**
- **Εξωστρέφεια, συναίνεση**
- **Διαφάνεια, επικοινωνία**
- **Επαναπροσδιορισμός της έννοιας του κέρδους ώστε να συμπεριλάβει διαστάσεις όπως η προστασία του περιβάλλοντος, η παιδεία, ο πολιτισμός.**

Μόνο όταν οι τοπικές κοινωνίες συμμετέχουν, δεν θα περιορίζονται να ασκούν μόνο στείρα αντι-δημοκρατία αλλά θα συμμετέχουν άφοβα και στην ανάληψη της όποιας ευθύνης.
Οι κοινωνίες «θέλουν» να ωριμάσουν. Αρκεί να τις βοηθήσουμε..

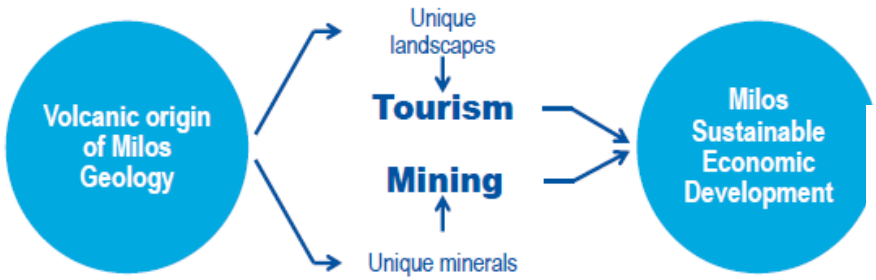
Community becoming the biggest hurdle for growth but also the key to success

ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
Εθνικόν και Καποδιστριακόν Πανεπιστήμιον Αθηνών
ΙΔΡΥΘΕΝ ΤΟ 1837

The Milos island (social license) case:

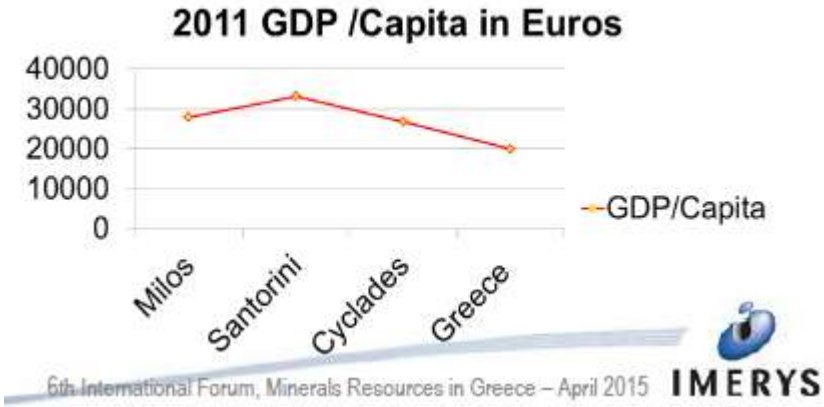
MILOTERRANEAN geo-experience

Milos island economy stands on two pillars



- 5,000 habitants
- GDP/capita est. at 28k euros (Greek avg. 20k euros), *2011 data*
- 4 hours from Athens by ferry, 30 min by plane
- 80-100.000 visitors/yr - tourism activity peaks in July-August
- Services (incl. tourism & public services) account for 55% of domestic product
- Milos enjoys nearly 0% unemployment – in fact it "imports" unemployed
- Over 1.5 million MTs of industrial minerals extracted annually
- More than 80% exported overseas

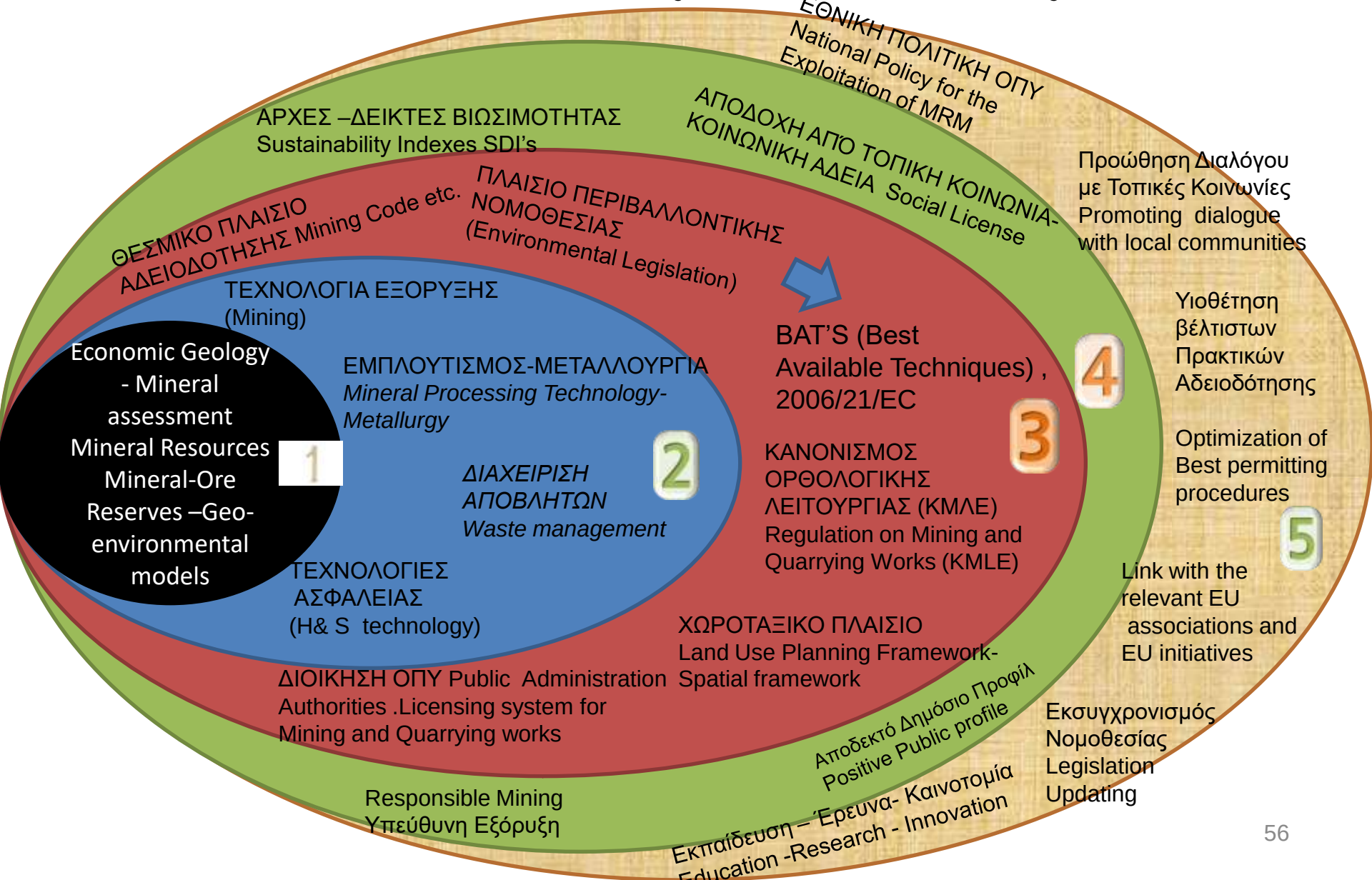
Tourism & Mining are driving the economic development of Milos hand-in-hand



Dr. P. Tzeferis, Gen. Director, Directorate General of Mineral Raw Materials, Ministry of Environment and Energy, 2019

All previous steps of actions have to be incorporated and combined in the NP

5. ΕΘΝΙΚΗ ΠΟΛΙΤΙΚΗ ΑΞΙΟΠΟΙΗΣΗΣ ΟΡΥΚΤΩΝ ΠΡΩΤΩΝ ΥΛΩΝ (ΟΠΥ)
NATIONAL POLICY FOR EXPLOITATION OF MRM

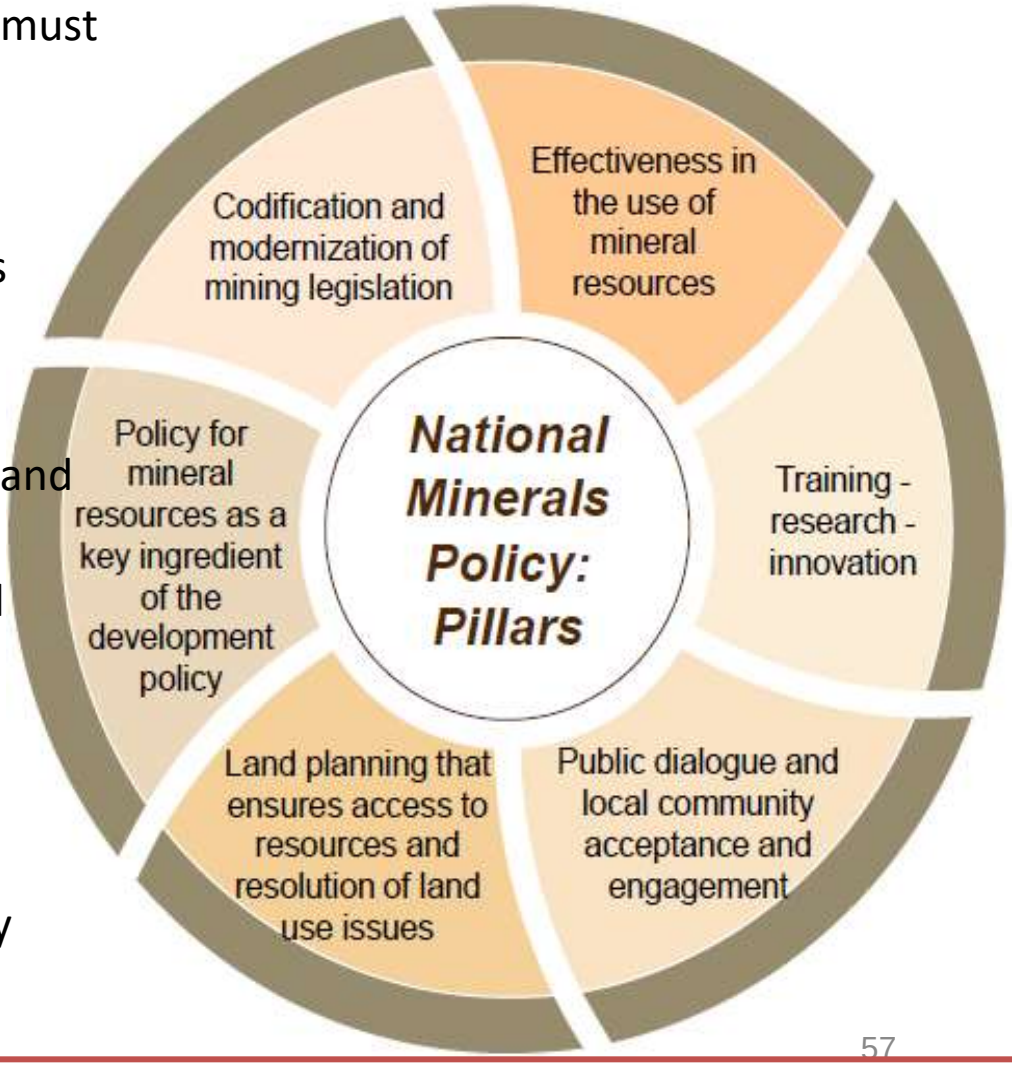


All previous cycles have to be incorporated and combined in the NP

A National Minerals Policy is key to unlocking mineral potential

The provisions of a national minerals policy must reflect the **national strategy for mineral resources built around the following objectives:**

- Ensure optimal exploitation of resources
- Actively promote innovation
- Safeguard sustainable development
- Impose rigorous healthy, safety, quality, and environment standards
- Consider reasonable offsets for the local society
- Foster enterprise
- Encourage R&D in new minerals and/or applications
- Render the industry competitive globally
- Promote the circular economy



National Policy (NP) for the Strategic Planning and Exploitation of Mineral Resources

The State in collaboration with all stakeholders has developed the main axes, directions, policies and the specific actions required for the sustainable exploitation of the mineral resources in order to respond to modern needs incorporating at the same time the context of European integration initiative on raw materials (RMI). This basic framework of the National Policy (NP) for the Strategic Planning and Exploitation of Mineral Resources was announced by the Greek Ministry of Environment and Energy, 2012.

The main goal of this NP:

It must ensure that the supply of mineral raw materials to the society will be done in a sustainable financial way, which is in harmony with the national development policies of other sectors, the protection of the environment and the principles of sustainable development.

It has not yet been legalized by the state as a legally binding text. However, in the 25.01.2018 meeting of the Government Economic Policy Council a proposal for the integrated and sustainable management of Mineral Raw Materials **was approved**. The aim of strategic planning is to **double the contribution of the mining industry to GDP** in the medium term in conditions of environmental protection and social cohesion and to maximize domestic value added through the dynamic of **vertical exploitation**.

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National Policy (NP) for the Strategic Planning and Exploitation of Mineral Resources

Specific goals, actions taken:

Establish the necessary regulatory framework and securing its implementation over time in a consistent and transparent way. **We have already taken the first step** by completing "Codification and modernization of the quarry/mining legislation (licensing system, exploration and exploitation, H&S control)". The result is a new "quarry law bill" that is already in place, L.4512/2018

A second step we are in the gateway is to incorporate all existing (or being under an exploration procedure) mineral/quarry deposits into **the land-use planning policy** of the country. As you can easily assume, the mining and quarrying industry is a very specific sector, it is important to acknowledge that minerals can be worked out where they are found. So we need adequate land-use planning that shall ensure the possibility of access to the mineral/quarry deposits and contribute to the resolution of issues related to competition of different land uses.
We have already did the first step in this too, aiming the development of **a specific land-use planning** for mineral raw materials. The specifications of the **spatial planning** for this previous project have already been determined by a competent committee.

Third, a National Mining Observatory is scheduled too by the Ministry, to be incorporated as a new service unit.

A National Minerals Policy is a key to unlocking the mineral resources potential of the country. Implementation of such a policy would spur innovation and Encourage R&D, improve productivity, and deliver substantial benefits to the Greek economy.

GREEK NATIONAL POLICY FOR THE EXPLOITATION OF MINERAL RESOURCES

Greek Ministry of Environment, Energy and Climate Change (YPEKA)

General Secretariat for Energy and Climate Change, Mineral & Aggregate Resources Division, Athens, Greece, www.latomet.gr

Introduction

Mineral products are essential to modern societies. The process of producing, using, and recycling minerals is a necessary activity for meeting market demand while at the same time contributing to employment and local economic development in both industrialised and less developed national economies.

The Greek extractive industry is an important sector of our country's economic activity providing the necessary raw materials to a number of fields that are essential for the national economy, such as power generation, cement and aluminium industry, constructions and construction materials industry etc. Also, it is a dynamic sector of the economy since its exports account for 65% of its total sales, both at the EU and the international market.

The sustainability of the minerals industry rests on three pillars: economy, environment, and society's needs. In addition, it is becoming clear that for enhancing sustainability, a fourth pillar is also required which will promote the balance and holistic integration of all three aspects: good governance. What is needed is a clear, structured national policy for the exploitation of the mineral resources that will ensure the accessibility to raw materials while at the same time satisfy the need for protection of the environment and other social and cultural values, thus making it possible to ensure the basic principles of sustainable development.

In this context, the State in collaboration with all stakeholders has developed the main axes, directions, policies and the specific actions required for the sustainable exploitation of the mineral resources in order to respond to modern needs incorporating at the same time the context of European integration initiative on raw materials (RMI).

This basic framework of the National Policy (NP) for the Strategic Planning and Exploitation of Mineral Resources was announced by the Greek Ministry of Environment and Climate Change (YPEKA) in 2012 and is presented below.

Background/Objectives

The National Policy (NP) acknowledges the importance of the Mineral Raw Materials (MRM) that contribute to progress and development, ensure a high living standard and create a competitive national and regional economy and new job positions. The NP must also ensure that the MRM are produced and distributed to the society in conformity with the constitutional principle of sustainable development.

The NP must be stable and transparent; it must also be able to adjust depending on the social and economic conditions or with a view of protecting the natural and anthropogenic environment.

Moreover, it must also be in harmony with the other National Policies, mitigating the conflicts that hinder the growth of the National Economy. Such a policy and all its different aspects of implementation can only be the outcome of a wide dialogue, information and public consultation both at national, regional and local level. Additionally, this policy requires -as a basic tool- a simplified, codified and updated regulatory framework.

The main goals of this NP are the following:

❑ The sufficient and constant supply of MRM to the society in a sustainable financial way that is harmonized with the national sectoral development policies of other activities.

❑ The enhancement and implementation of the best practices that prevent or reduce and, finally, rehabilitate, to the greatest extent possible, the impact of the extractive industry to the environment and human health.

❑ The MRM saving through best eco-efficient production practices.

❑ The upgrade and support of all University departments and faculties of geosciences through the adequate funding by all types of available programs of the Ministry of Education, the General Secretariat of R&D, the National Strategic Reference Framework (NSRF), etc.

❑ The ensuring of the use of MRM for the longest possible time through effective use practices, extension of their life-cycle and recycling.

❑ The maximization of the development benefit and minimization of the negative effects of the mining activity.

❑ The harmonization of the specificities and needs of the local societies with the development potential created by the mining activities at a local and regional level. The adoption of policies and measures that shall maximize the benefits from the actions at a local level in many ways (and not merely in terms of finance and employment).

Objectives

❑ The arrangement of the quarry and mining sites in such a way as they may be suitable for other planned uses after the completion of the extractive activities.

❑ The land use planning for the raw materials processing, when it is carried out outside the mines or quarries.

Also, the NP for the exploitation of the MRM must:

❑ Be based on the knowledge about the country's mineral reserves. This knowledge presupposes that all deposits of MRM are registered in a documented way and the relevant data are available in functional geospatial information system, which is compatible with the European MRM geological database.

❑ Take into account the specificities of the mining activity affecting decisively the location and the "sustainable" management of the activity requiring special interventions stemming from a) their localization in positions chosen by Nature itself b) the fact that the MRM are only 'renewable' at a geologic time scale and c) the fact that the exploitation of MRM leads to a visible footprint whose impact must be minimized.

❑ Take into account that the mining industry is vulnerable and inextricably linked to the national and international economic and political conditions and thus take into consideration the trends and variations of the international market of raw materials.

❑ Follow the European developments on issues related to the orientations and conditions of the MRM strategic development.

❑ Develop reliable and adequate conditions for attracting investments aimed to the best exploitation of the country's mineral resources.

Main Policy axes & Actions specification

NATIONAL POLICY FOR THE EXPLOITATION OF MINERAL RESOURCES

➢ It must ensure that the supply of mineral raw materials to the society will be done in a sustainable financial way, which is in harmony with the national development policies of other sectors, the protection of the environment and the principles of sustainable development.

➢ **ESSENTIAL PREREQUISITE:**
Establishing the necessary regulatory framework through a wide dialogue, information and consultation among all stakeholders and securing its implementation over time in a consistent, transparent and uniform way.

MAIN POLICY AXES	REQUIRED POLICIES & ACTIONS	ACTIONS SPECIFICATION
1. The national policy about the Mineral Resources as a basic component of the national and regional development policy of the Country.	❑ Integrating the guidelines of the national policy for the exploitation of mineral resources horizontally into all individual policies and plans in order to ensure the optimal exploitation of the deposits and the common interest. ❑ Establishment of a Forum for the Implementation of the National Policy for the Exploitation of Mineral Resources.	• Ensuring the exploitation of the MRM deposits potential through the proper interventions in the legal framework. • Providing MRM research oriented incentives to the enterprises. • Enhancing the existing state research institutes on MRM-related issues. • Re-evaluating the state owned mining areas through complementary exploration where needed, and then auctioning them to ensure their optimal exploitation for the benefit of the common interest.
2. Adequate land-use planning that shall ensure the possibility of access to the MRM deposits and contribute to the resolution of issues related to the competition of different land uses.	• Integrating the national policy of MRM into the land-use planning policy of the country in order to strike a balance between: ➢ A sustainable-supply of the necessary mineral raw materials ➢ Economic development ➢ Social environment ➢ Natural environment ➢ Competitive land uses. • The adequate land-use planning in order to ensure the possibility of exploiting the MRM deposits in the long term while providing accessibility to them. • The specificity of the mining industry, which, unlike other activities, is inextricably linked to the locations where nature has created the mining deposits and the fulfillment of the spatial requirements for carrying out the mining activities and the transportation of products (e.g. access to sea transportation), must be taken seriously into account at the land-use planning. • To provide for processes of land-use changes, when necessary, with a view to harnessing new deposits of mineral raw materials that had not been identified and, therefore, had not been taken into consideration during the previous phases of land-use planning.	• Mapping and registering the regions with exploitation of deposits of mineral raw materials in the land-use planning and adoption of measures (recognition of requirements to be met) to ensure the long-term continuation of their exploitation. • The land-use planning must also take into account any deposits that have identified but are not yet exploited in order to prevent, to the greatest extent possible, their potential "sterilization" due to the establishment of competitive land uses or the construction of infrastructure works. • Development of an updated GIS database of digital spatial data which, alongside its other uses, will include geological and mineralogical data, established zones for extractive activities, aggregate quarrying areas, possible Organized Development Areas for Productive Activities of mining and quarry activities, other existing areas with extractive activities. • Review of Regional Land-Use Planning Frameworks taking into account the priorities of the national policy on MRM. • Updating the management studies about the protected areas in the light of the new developments in the relevant legislation and the guidelines of the EU on the possibility of establishing mining activities in NATURA 2000 areas. In addition, a more clear delineation of these areas is required. • For the regions with deposits of raw materials that are classified as raw materials of particular importance for the national economy, it is necessary to make a special provision/reference to the spatial/urban plans in order to make sure that the land uses that will be considered during the planning process are compatible with the mining activity. • The land-use planning must provide for the utilization of the mining sites after the end of the mining activity.

Main Policy axes & Actions specification

MAIN POLICY AXES	REQUIRED POLICIES & ACTIONS	ACTIONS SPECIFICATION
3. Codification and modernization of the quarry/mining legislation (licensing system, exploration and exploitation, H&S control, environmental issues etc).	• The main features of the licensing regulatory framework shall be as follows: ❑ The simplicity, transparence, clarity, stability, understanding of the investment conditions, its uniform application and reasonable time frame for issuing the necessary approvals and licenses. ❑ The promotion – imposition of the implementation of Best Available Techniques exploiting the relevant European experience. ❑ Strengthening the role of inspection authorities. ❑ Strict implementation of the recent Regulation on Mining and Quarry Activities	• Reforming the regulatory framework when necessary. • Simplifying the licensing process taking into account the expressed mining policy and the spatial planning. • Updating the standards of the technical and environmental studies based on the modern requirements. • Avoiding overlapping procedures, parallel licensing evaluation in order to speed up the process. • Issuing guiding documents and manuals on the licensing requirements and processes for both interested parties and involved services and agents. • A more substantial and effective operation of the inspecting authorities (Mine Inspectorate, Environment inspectors, Greek Institute of Geology, Mineral Exploration and Survey etc.) so as to ensure H&S, rational exploitation, environmental protection and restoration. The above bodies must be properly staffed and equipped with the necessary material and technical infrastructure.
3a. Legal framework for the environmental permit.	• The granting of the environmental permit must be part of and go hand in hand with the mining policy. The following requirements must be met: ❑ The production of the exploitable and necessary MRM must be carried out in conformity with the principles of sustainable development (economic growth, social pillar, environmental requirements). ❑ The environmental permit process must be completed in defined and reasonable periods of time. ❑ An 'open door' policy must be adopted towards the local society and other stakeholders. ❑ The public administration must be involved in the environmental permit consultation process in a more substantial and active way.	Following the issue of Law 4014/11, the regulatory framework for the granting of environmental permits to mining activities should be further specified by means of: • Determining the content of the Environmental Impact Assessment (EIA) and setting modern standards for carrying out EIA, which will incorporate all relevant requirements (e.g. waste management plans, Best Available Techniques, ecological evaluation – appropriate assessment - for mining activities in the NATURA 2000 areas etc.). • Defining the content of the file for modifying and renewing the Environmental Approval for mining activities and setting relevant standards. • Clarifying the conditions under which it will be possible to conduct exploration and exploit mineral resources inside the protected areas. • Further specifying the processes with a view to integrating other necessary licenses and approvals into the Environmental Approval Decision. • Substantial control of the compliance with the terms of the environmental approval both during and after the mining activity. • A clear definition of the exploiter's obligations for the period after the end of the activity (after closure care) and an effective monitoring of their fulfillment. • Establishment of financial guarantees to secure the implementation of the environmental terms. Also: • Diversifying the requirements to be fulfilled for the granting of environmental permits for mining activities provided that a Strategic Environmental Assessment has been carried out previously in the area. • Providing for the potential development of alternative land uses after the end of the mining activity. • Restoring abandoned mining areas or changing their use for the benefit of the local society. • Specifying the provisions of the Presidential Decree on the Environmental Liability in the mining activity.
3b. Legal framework for the exploitation of aggregate quarries.	❑ To ensure the long-term supply of aggregates to the market and the construction works at an acceptable transport cost. ❑ Stipulation of a new quarry law.	• Rationalization of the production system (prevention of illegal exploitations). In this regard, the results of the EU SARMa project (Sustainable Aggregate Resources Management) which involves the Greek Institute of Geology, Mineral Exploration and Survey are helpful. • Setting the qualitative standards and certification processes for primary production or recycled aggregates. • Spatial planning regarding the quarrying areas and their operation. • Defining conditions for the operation outside quarrying areas, aggregates for special uses • Setting the requirements for the exploitation of aggregates inside Natura areas. • Lifting the legal restrictions – mostly provisions of Law 998/79 – to allow the establishment of relevant downstream processing units (ready-mixed concrete and asphalt units) in the aggregate quarries. • Modernizing the licensing system – overcoming problems, reducing bureaucracy • Offsets for local authorities.
4. Promotion of dialogue – Acceptance by the local society.	❑ Application in practice of the rules of sustainable development as the only factor that guarantees the on-going operation of the mining works. Implementation of relevant pilot projects. ❑ Obtaining the 'social approval' is an important factor for the sound development of the mining activity. ❑ A basic element of the implementation of the N.P. for the exploitation of mineral resources is the promotion of the dialogue and the establishment of a trust-based relation between the State, industry and the social partners (local society, NGOs, consumers, employees etc.). ❑ Organizing an information campaign aiming at raising awareness of the public and reversing the negative climate that has been created in the society for the extractive industry. Parallel undertaking of initiatives by the State and the extractive industry in order to perform pilot actions of exemplary restoration of mining sites which will be given back for use to the local society. ❑ The extroversion, the objective information about the value and utility of the sector and the transparent relations with local communities and agents, are the strongest and most effective tools of such an initiative.	• Promoting Best Available Techniques (BAT's). • Strengthening voluntary initiatives within the framework of the Corporate Social Responsibility. • Publication of all information about the application of best practices by the mining industry and the competent Departments of the Ministry of Environment, Energy and Climate Change. • Continuous registering of the impact to the local society and full information of the local stakeholders. • Improvement of the urban environment and infrastructure through the allocation of pre-determined financial resources stemming from the exploitation of mineral resources in their region.
5. Education-Research – Innovation	❑ Adapting the courses on geosciences to the modern needs of the extractive industry ❑ Satisfying the needs of extractive industry for middle and low level management executives. ❑ Promoting research and innovation on the whole scientific range of the sector (exploration – exploitation – processing – safety – environment restoration etc.).	• Developing modern courses to satisfy the real needs in terms of research and production in such areas as: ➢ Innovative processes, automation and optimization of mining and metallurgical processes. ➢Rational use of materials, energy, water. ➢Minimization of emissions. ➢Chemical and biological enrichment methods. ➢GIS and modeling. ➢Innovative research technologies for new deposits.

Main Policy axes & Actions specification

MAIN POLICY AXES	REQUIRED POLICIES & ACTIONS	ACTIONS SPECIFICATION
5. Education-Research – Innovation	❑ Continuous training of the active executives of the mining industry and the geo-scientific agents in general aiming at their progressive adaptation and more productive participation in new technological options and challenges. ❑ Reinforcing the teaching of courses on geosciences at the lower and middle level education to help citizens get the necessary information about the importance and the specificities of the MRM	➢Research and enrichment of minerals containing value-added metals used for high-tech, environmentally friendly applications. ➢Recycling and new alternative RM. • Establishment of professional schools for training middle and lower level management executives and specialized employees to satisfy the needs of the mining industry. • Associating the extractive industry with the Research Institutes and Universities.
6. Efficient use of MRM including substitution, reuse, recycling and use of by-products/waste of mining processes, tailings ponds waste and metallurgy waste. The aim is to ensure a rational management and minimization of all mining waste.	❑ Completing the legislative framework and incentives about recycling of raw materials and use of by-products and waste. ❑ Promoting research on the substitution of MRM, the more effective use, the study of their life cycle and their recycling.	• Applying the framework for the alternative management of waste from excavations, constructions and demolitions, which is based on the main EU SARMa project. • R&D on the substitution of some "critical" MRM. • Applying life-cycle analyses of mining products or by-products e.g. in the field of aggregates and construction materials.

The NP must be based on:

MAIN POLICY AXES	REQUIRED POLICIES & ACTIONS	ACTIONS SPECIFICATION
I. The knowledge about the country's mineralogy potential.	❑ Ensuring that all MRM deposits are registered in a documented way and that all relevant data are available on an functional geospatial information system that is compatible with the European database of geospatial MRM data. ❑ Participating in the development of a European spatial database with relevant data about MRM deposits. ❑ Creating a database of the MRM secondary sources.	❖ Promoting exploration in order to identify new MRM deposits and especially research to identify MRM declared to be "critical" for Europe or of particular importance for our country. ❖ Implementing research programs about the development and application of new deposit identification techniques (e.g. at big depths) ❖ Searching for and identifying deposits in a submarine metallogenic environment. ❖ Encouraging R&D programs by the private sector in cooperation with educational organizations or institutes ❖ Reinforcing the deposit research to identify ore bodies at big depths according to the EU ProMine project in which involves the Greek Institute of Geology, Mineral Exploration and Survey. ❖ Reinforcing research for environment-friendly new uses of MRM.
II. Ensuring and promoting the sustainability of the MRM of particular importance for the Country	❑ Examining the importance of the Greek MRM based on the following criteria: • Importance at a local, regional or national level • Importance for the Greek industry and constructions • Production • Distribution – Exports • Consumption • Needs and demand • Market trends. ❑ Creating a database of statistics (Mineral statistics) including all the above data that will constitute a tool for: • A better knowledge of the market • Research orientation • Attracting investments • Producing new high value-added products.	- Determining the MRM of particular importance for the mining industry of the country and the national economy: ❖ Lignite ❖ Laterite (Fe-Ni) ❖ Bauxite ❖ Mixed sulphide ores (Pb-Zn-Ag) ❖ Gold ❖ Magnesite ❖ Marble ❖ Bentonite ❖ Perlite - Conducting a plan for their sustainable development
III. On integrating the variations and perspectives of the European and global market of raw materials.	❑ Coordination of the General Secretariat of Trade of the Ministry of Regional Development & Competitiveness with the other stakeholders for laying out the national mining policy with regard to the framework of the imports/exports of raw materials. ❑ Continuous communication and coordination of the General Secretariat of Trade with the WTO (World Trading Organization) for actions dealing with the restrictive practices of third countries (non EU).	• Direct and continuous communication with executives of the EU Directorate General for Trade so that information on the developments in these issues must be complete and quick. • Ensuring the information of the Commercial Attachés at the Greek Embassies on issues related to the trade of mineral raw materials and also their contribution to the activities of the EU Directorate General for Trade. • Providing information to the Greek companies that are interested in investing in Third countries about the funding options offered by the Directorate General or other EU bodies. • Setting-up a mechanism for informing the Greek companies about investment fundings of European companies in third countries through the European Investment Bank. • Carrying out a detailed study about the origin and the industrial needs met by the importing MRM in Greece as well as the destination and industrial uses of MRM exported to third countries.
IV. Exploiting the country's mining potential with respect to the environment and in compliance with the sustainable development principles.		

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ΠΑΙΔΕΙΑ – ΠΟΛΙΤΙΣΜΟΣ
"Paideia"-Civilization-Mining Culture [5+1]

ΠΑΙΔΕΙΑ – ΠΟΛΙΤΙΣΜΟΣ
"Paideia"-Civilization-Mining Culture [5+1]

(5+1) STEPS TO SUSTAINABLE EXPLOITATION OF GREEK MINERAL WEALTH

ΕΘΝΙΚΗ ΠΟΛΙΤΙΚΗ ΟΠΥ National Policy for the Exploitation of MRM

Προώθηση Διαλόγου με Τοπικές Κοινωνίες
Promoting dialogue with local communities

ΑΠΟΔΟΧΗ ΑΠΌ ΤΟΠΙΚΗ ΚΟΙΝΩΝΙΑ-ΚΟΙΝΩΝΙΚΗ ΑΔΕΙΑ Social License

ΑΡΧΕΣ –ΔΕΙΚΤΕΣ ΒΙΩΣΙΜΟΤΗΤΑΣ
Sustainability Indexes SDI's

5 Υιοθέτηση βέλτιστων Πρακτικών Αδειοδότησης

ΘΕΣΜΙΚΟ ΠΛΑΙΣΙΟ ΑΔΕΙΟΔΟΤΗΣΗΣ Mining Code etc.

ΠΛΑΙΣΙΟ ΠΕΡΙΒΑΛΛΟΝΤΙΚΗΣ ΑΔΕΙΟΔΟΤΗΣΗΣ (Environmental Legislation)

4 Optimization of Best permitting procedures

ΤΕΧΝΟΛΟΓΙΑ ΕΞΟΡΥΞΗΣ (Mining)

ΕΜΠΛΟΥΤΙΣΜΟΣ-ΜΕΤΑΛΛΟΥΡΓΙΑ
Mineral Processing Technology-Metallurgy

BAT'S (Best Available Techniques) , 2006/21/EC

3 Εκσυγχρονισμός Νομοθεσίας Legislation Updating

Economic Geology - Mineral assessment Mineral Resources Mineral-Ore Reserves –Geo-environmental models

1

2

ΔΙΑΧΕΙΡΙΣΗ ΑΠΟΒΛΗΤΩΝ
Waste management

ΚΑΝΟΝΙΣΜΟΣ ΟΡΘΟΛΟΓΙΚΗΣ ΛΕΙΤΟΥΡΓΙΑΣ (ΚΜΛΕ)
Regulation on Mining and Quarrying Works (KMLE)

Link with the relevant EU associations and EU initiatives

ΤΕΧΝΟΛΟΓΙΕΣ ΑΣΦΑΛΕΙΑΣ
(H&S technology)

ΧΩΡΟΤΑΞΙΚΟ ΠΛΑΙΣΙΟ
Land Use Planning Framework-Spatial framework

ΔΙΟΙΚΗΣΗ ΟΠΥ Public Administration Authorities .Licensing system for Mining and Quarrying works

Αποδεκτό Δημόσιο Προφίλ
Positive Public profile

Responsible Mining
Υπεύθυνη Εξόρυξη

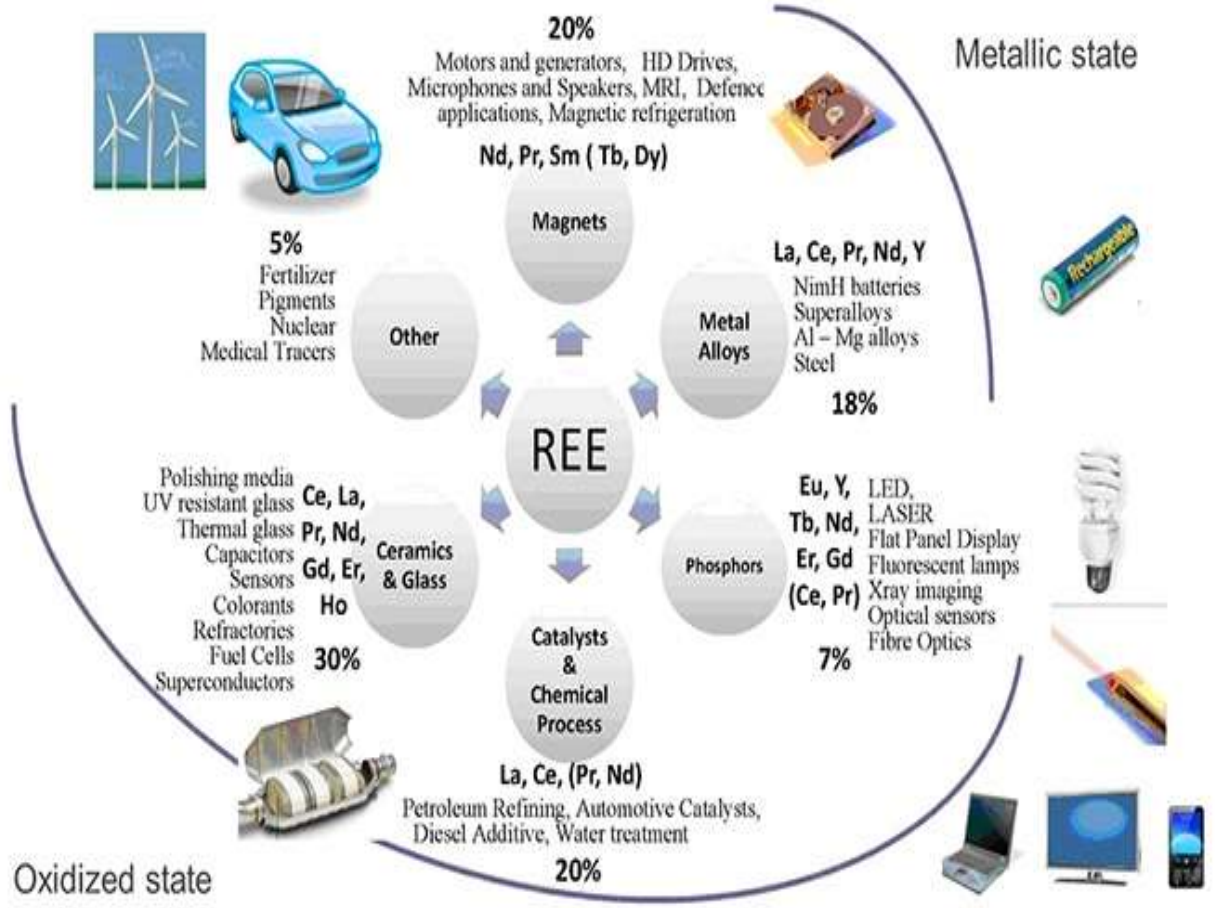
Εκπαίδευση – Έρευνα- Καινοτομία
Education -Research - Innovation

ΠΑΙΔΕΙΑ – ΠΟΛΙΤΙΣΜΟΣ
"Paideia"-Civilization-Mining Culture [5+1]

[5+1] ΠΑΙΔΕΙΑ –ΠΟΛΙΤΙΣΜΟΣ -ΜΕΤΑΛΛΕΥΤΙΚΗ ΚΟΥΛΤΟΥΡΑ

[5+1] PAIDEIA-CIVILIZATION- MINING CULTURE

If I need this,



I also need this..

No Growth Without Mining

EU: Before it's yours we mine it

«PAIDEIA» and mining culture help us to understand that we need «this» if we are to be proud of our marble history landmarks!

Ν. 3827/2010 : Κύρωση της Ευρωπαϊκής Σύμβασης για το Τοπίο

63

Do I need this?

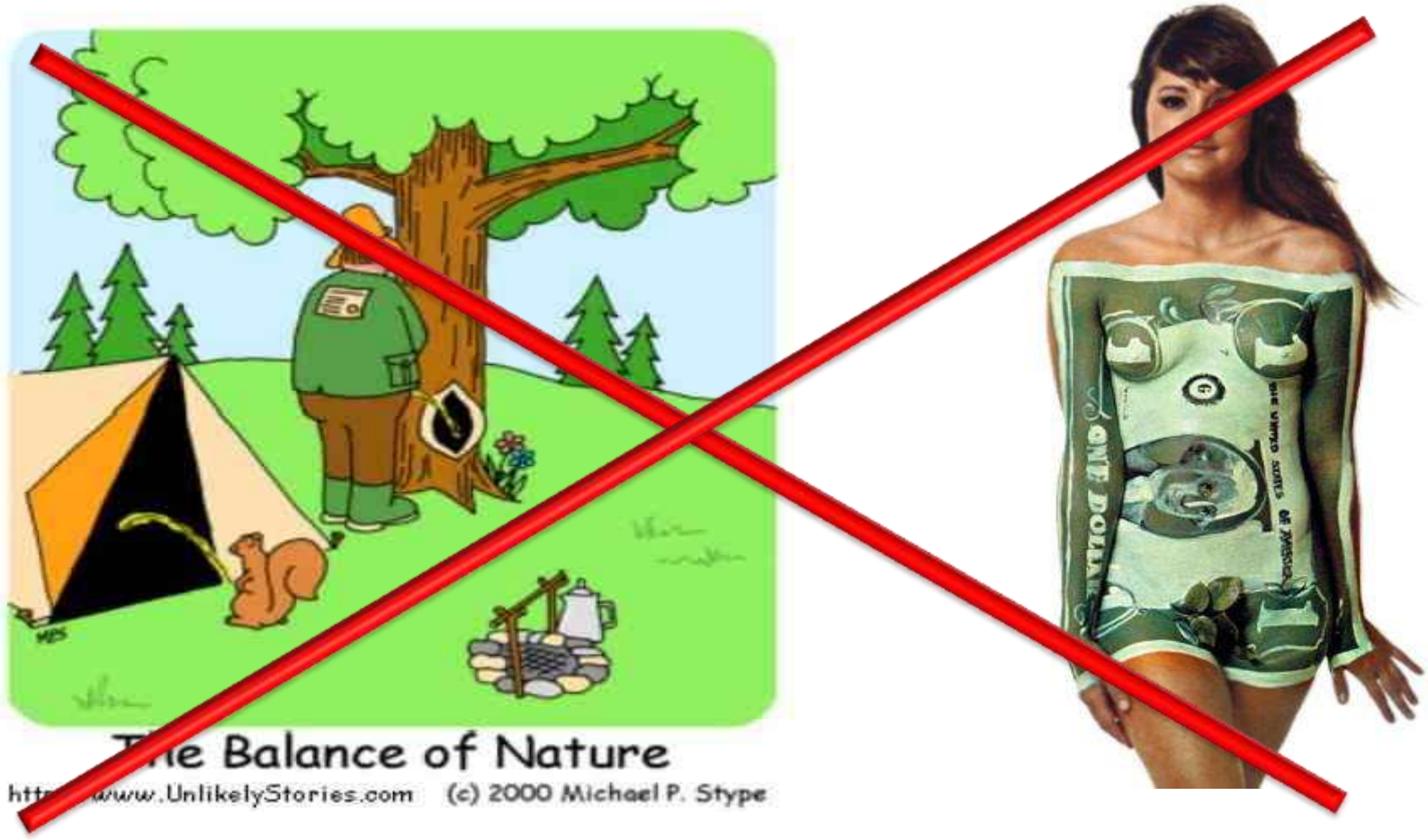
Το ορυκτό μπλε χρώμα των ψηφίδων της Αμφίπολης!

“PAIDEIA” and mining culture helps us to distinguish our real needs and what are the responsible mining and materials science goals

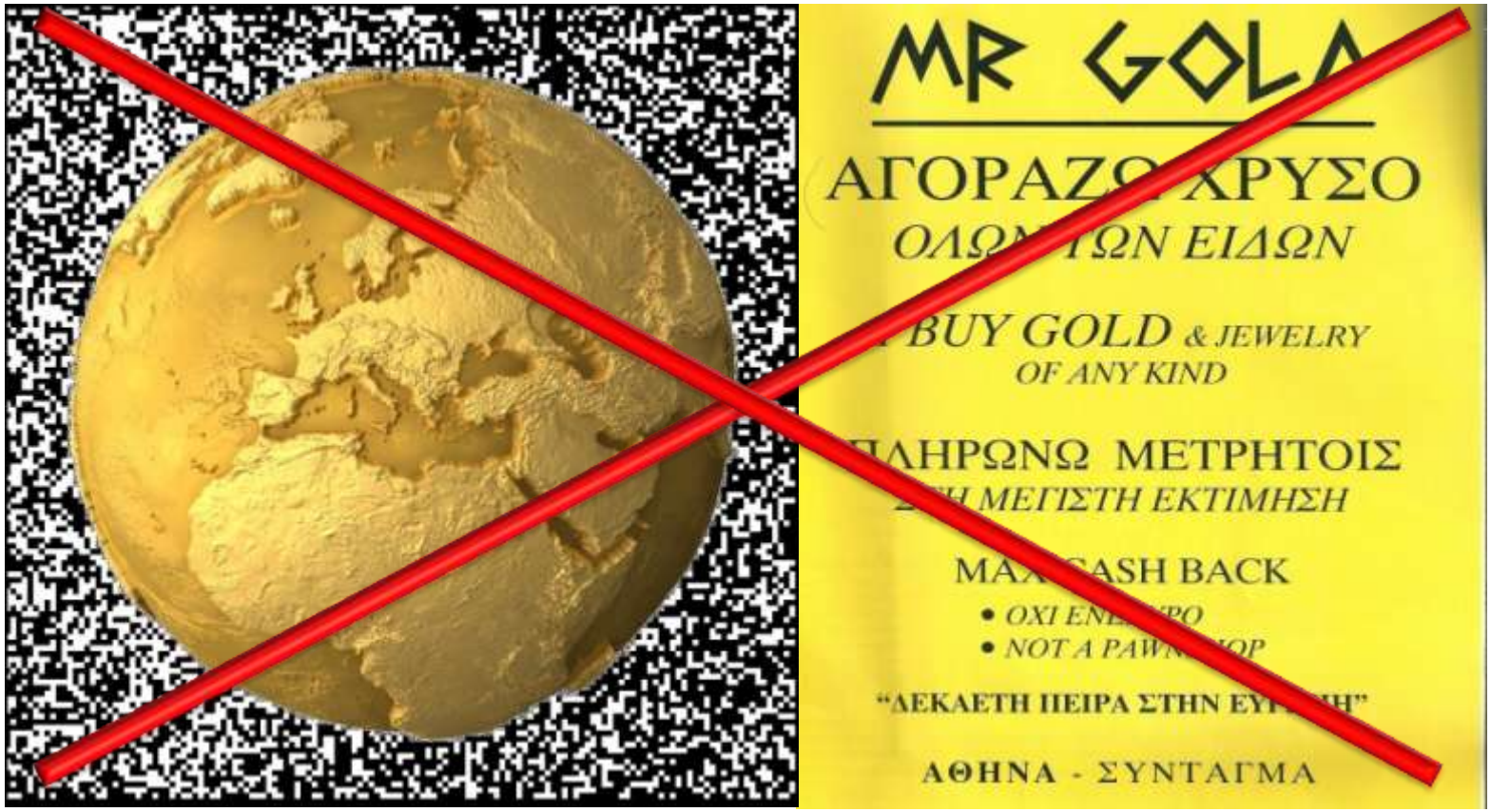
Responsible Mining

[Congo's Bloody Coltan: καλημέρα αληθινέ κόσμε ...]

“PAIDEIA” and mining culture helps us to distinguish our real needs and what are the limitations in exploiting natural resources?



“PAIDEIA” and mining culture help us to distinguish our real needs: *we don’t need a gold world but a sustainable world…*



"PAIDEIA" and mining culture help us to maintain sustainability in all materials value chain

Re-use and Recycling must also be carried out in terms of sustainability and responsibility

Η ανακύκλωση πρέπει να γίνεται κι αυτή με όρους βιωσιμότητας και θεμιτού ανταγωνισμού

PAIDEIA and MINING CULTURE

"Paideia" is not our educational degrees but our aesthetics in what we do, our culture and our human capital. It mobilizes and inspires all the material works we produce, it gives identity to our works. Human is the answer, no matter what the question.

Παιδεία δεν είναι τα εκπαιδευτικά πτυχία μας αλλά η αισθητική μας σε ότι κάνουμε, η κουλτούρα μας και το ανθρώπινο αξιακό μας κεφάλαιο. Αυτή κινητοποιεί και εμπνέει όλα τα υλικά έργα που παράγουμε, αυτή δίνει ταυτότητα στα έργα μας. Ο άνθρωπος ειναι η απάντηση, όποια κι αν είναι η ερώτηση.

Thank you!

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