Mining Engineering
The way forward

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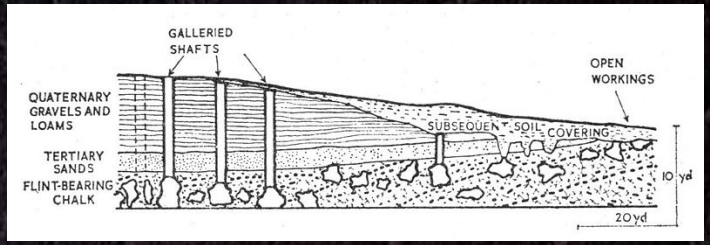
Mining: An essential task

Neolithic Flint Mines at Spiennes (4300-2200 BC)



"The Neolithic flint mines at Spiennes (Belgium) provide exceptional testimony to early human inventiveness and application.

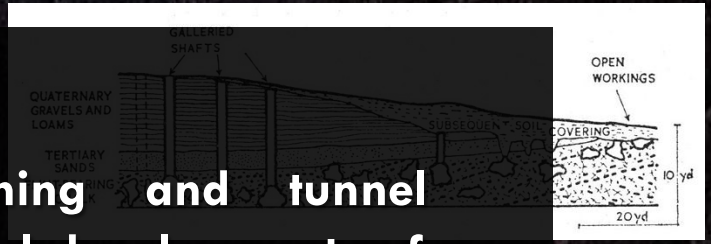
The arrival of the Neolithic cultures marked a major milestone in human cultural and technological development, which is vividly illustrated by the vast complex of ancient flint mines at Spiennes."

UNESCO

Mining: An elaborate essential task

…evidence of underground mining and tunnel construction works reflects the cultural developments of civilizations and particularly the growth of technical and economic strength.

(Sandstrom, 1963)



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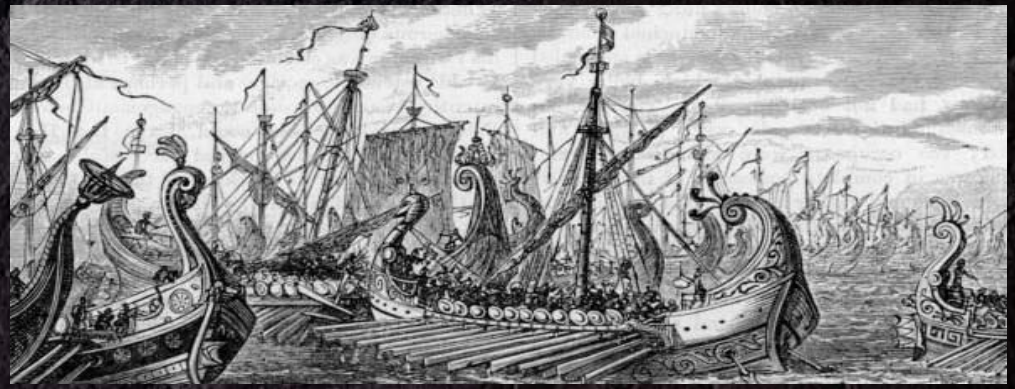
Neolithic Flint Mines at Spiennes (4300-2200 BC)

Importance of raw materials

Athenian tetradrachm (c. 5th BC)



The wealth of the Lavrion silver mines was used for the construction of the Athenian fleet. Thus in 9 years time (489 BC to 480 BC) the number of the Athenian triremes from 40 grew to almost 200. This naval power funded by mining was the decisive factor for the Persian defeat in the battle of Salamis.

Importance of raw materials

Ancient marble extraction (Korres, 1994)

The cultural wealth of Athens (and Greece) still remains vivid through the several marble temples and statues found in the country. The Pentelicon marble is still today one of the most recognizable and desirable marbles in the world.

Importance of raw materials

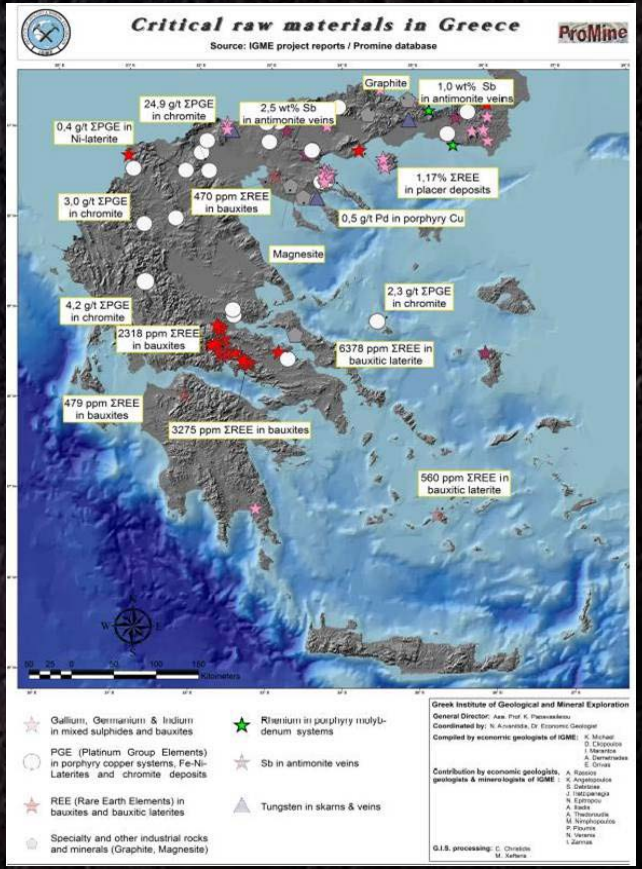
Greece now:

- In the 1st place in the world perlite producers
- In the top 3 of the world bentonite producers
- In the top 10 of the world marble producers
- In the 1st place in nickel production in the EU
- In the 1st place in bauxite production in the EU
- In the 3rd place in lignite/coal production in the EU

…

with at least 3 world class gold deposits

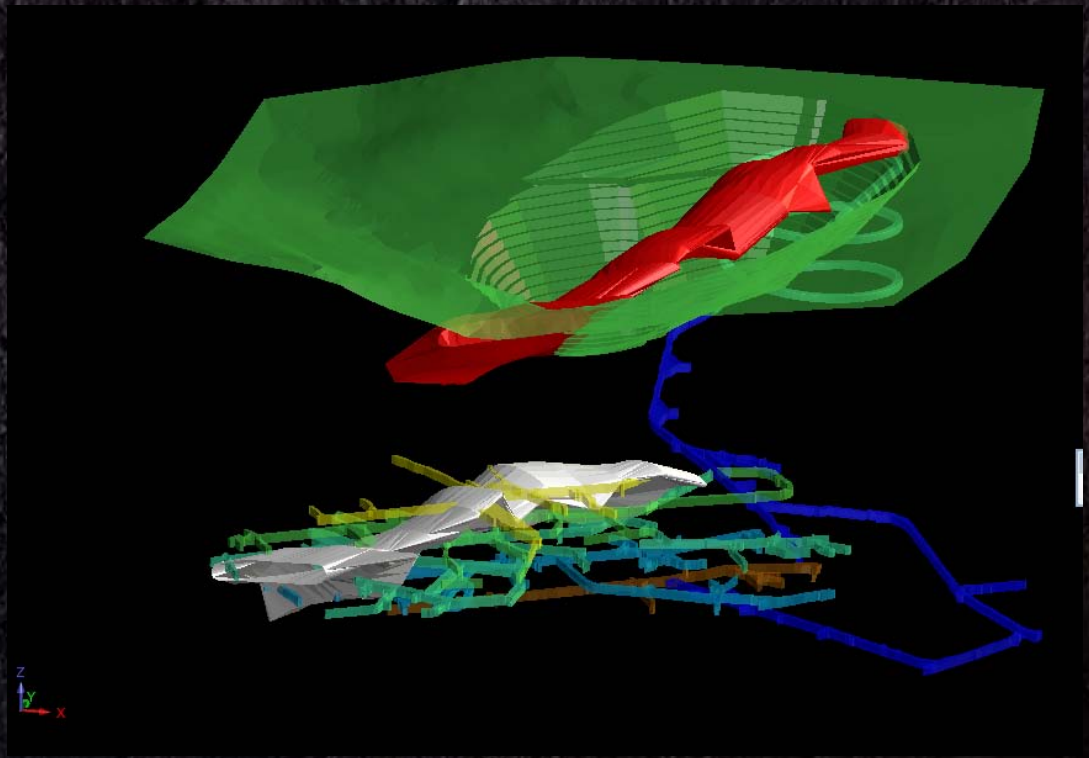
with encouraging data for hydrocarbon deposits



Critical Raw materials in Greece (ProMine)

Mining Engineering 101

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



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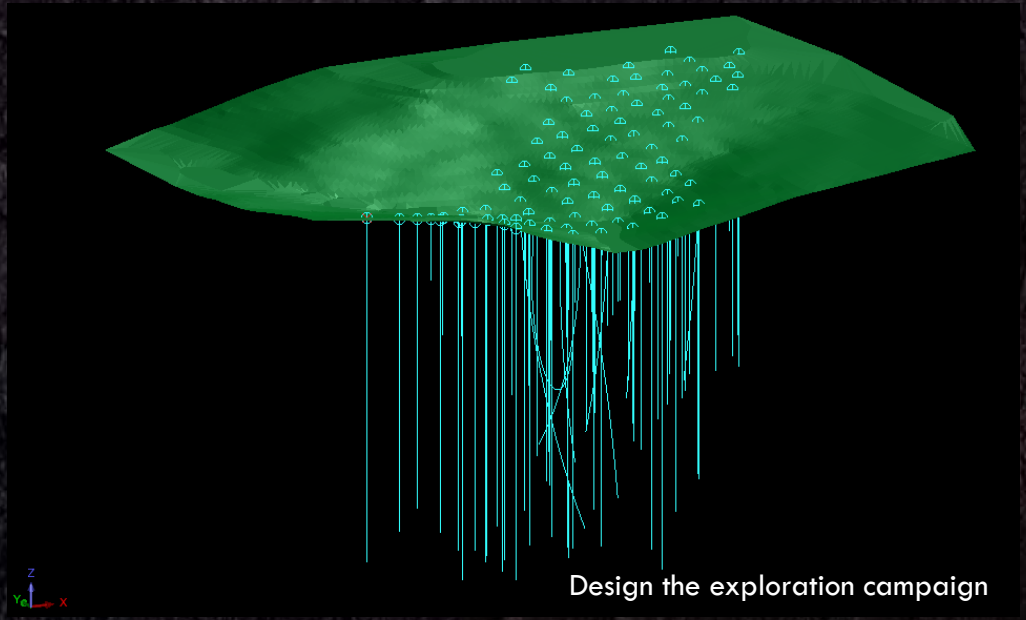

Design the exploration campaign

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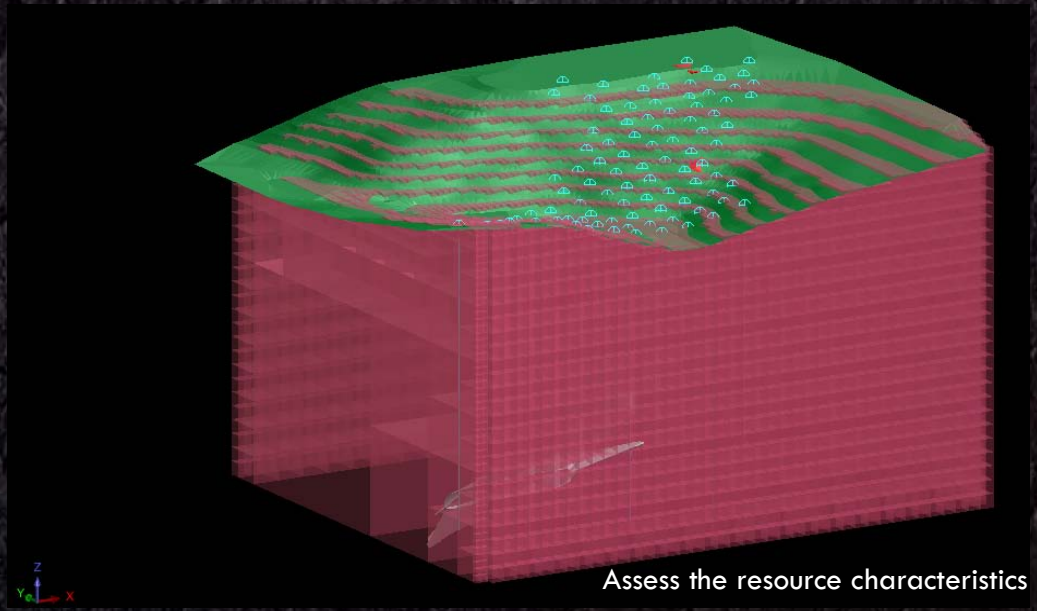

Assess the resource characteristics

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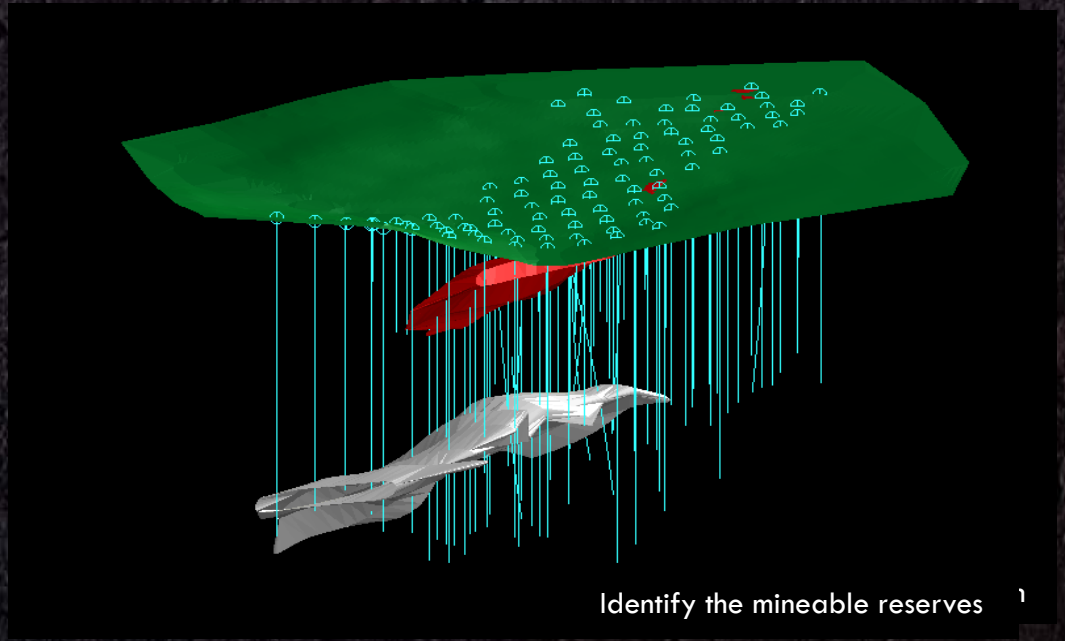

Identify the mineable reserves

Mining Engineering 101

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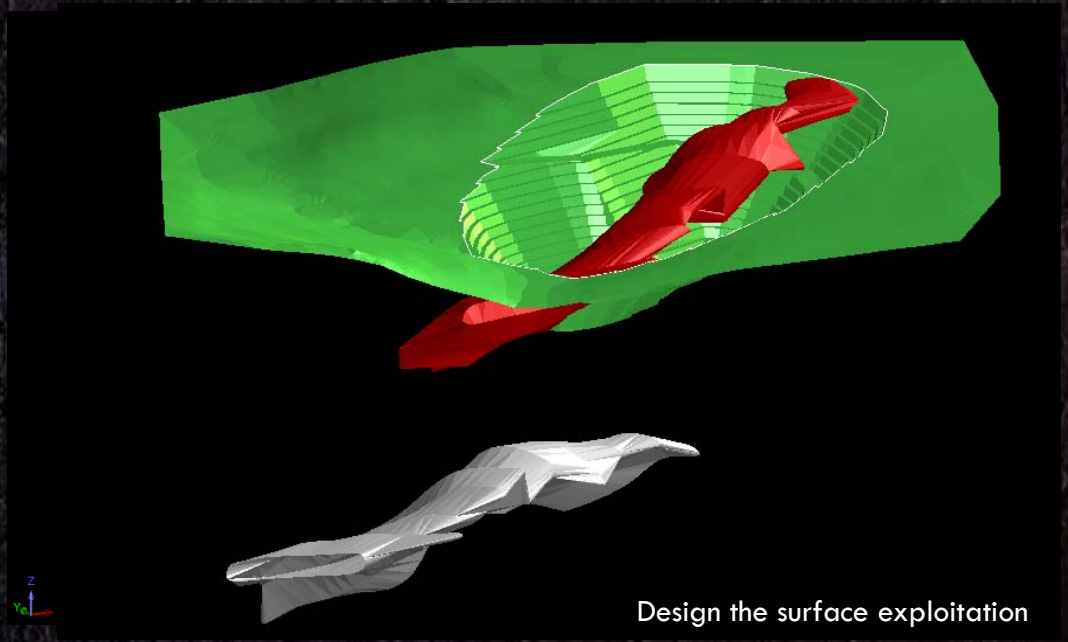

Design the surface exploitation

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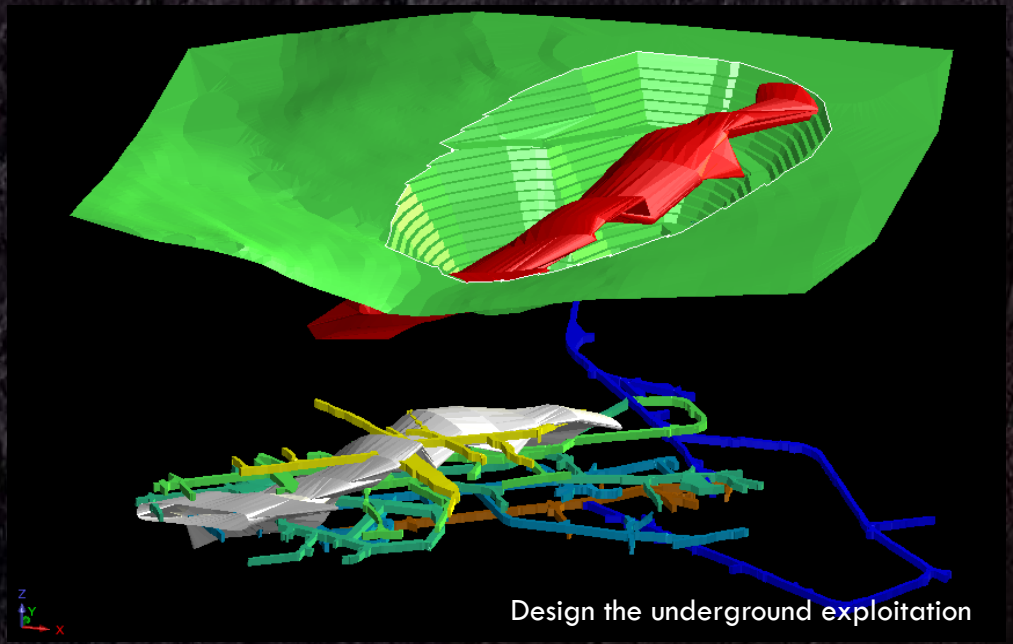
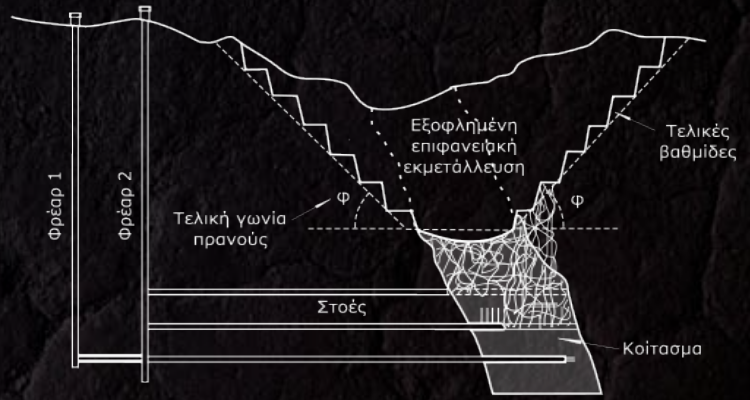


Design the underground exploitation

Mining Engineering 101

Above ground or underground exploitation?



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

Mining Engineering 101

Mining Engineers should beat the cost.
But, not at all cost…

Setting priorities:

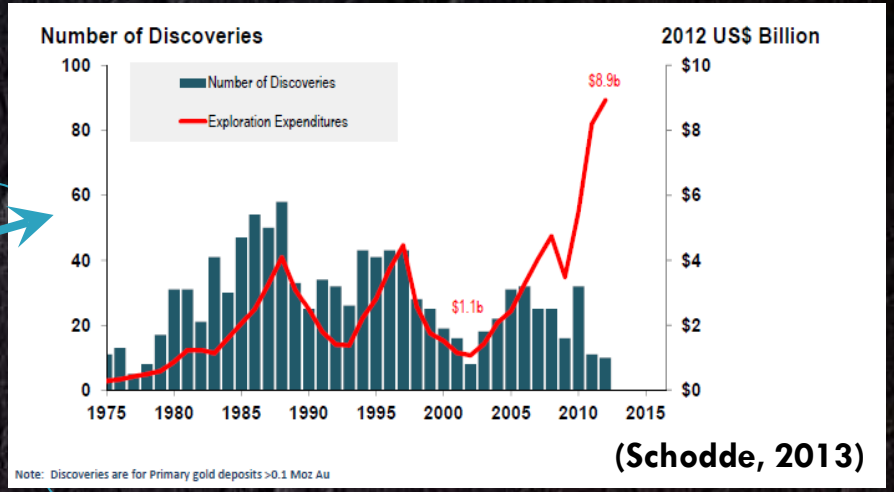
1. Ensure the maximum safety level for the workers and the mine
2. Achieve the minimum exploitation cost
3. Attain the highest possible mineral recovery

Ensure a high degree of environmental protection, minimizing the possible environmental impacts.

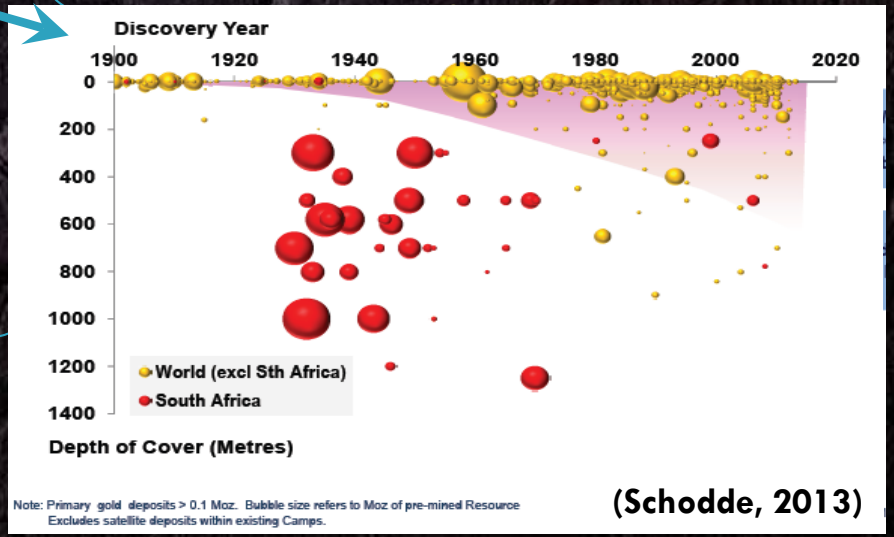
Mine engineers must carry out successfully the safe, economic and environmentally sound extraction of minerals and resources.

Issues to consider

- Limitation in the discovery of rich surface deposits
- Exploitation of more complex, deeper and lower grade deposits
- New stricter environmental standards
- A global scale game with many stakeholders (companies, governments, traders, etc.)



(Schodde, 2013)



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Issues to consider

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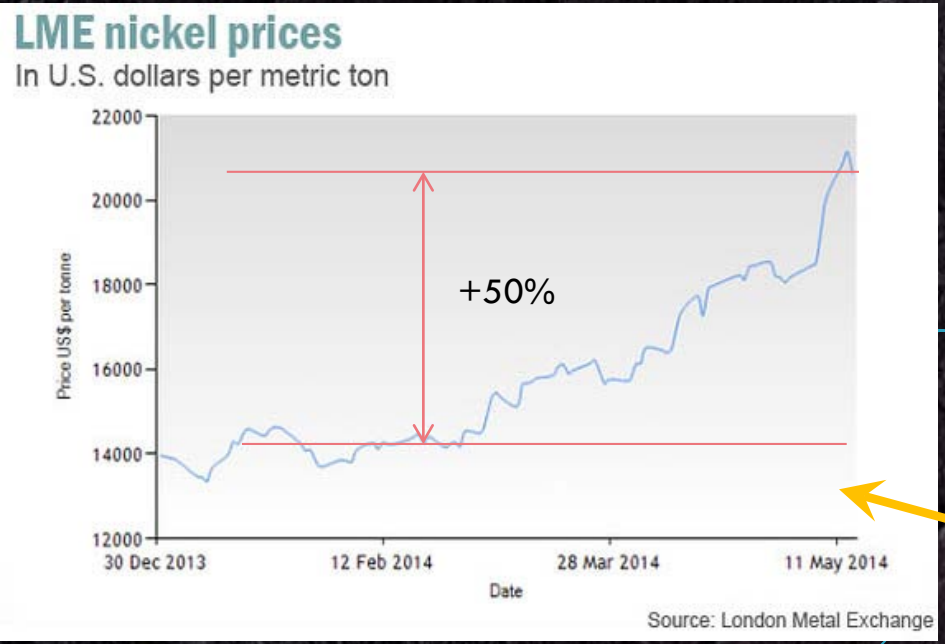
- Gradual shift towards underground exploitation schemes
- Increase in the operational cost of mining (workforce, energy, equipment)
- Rise of resource nationalism issues (especially in critical materials)

Issues to consider



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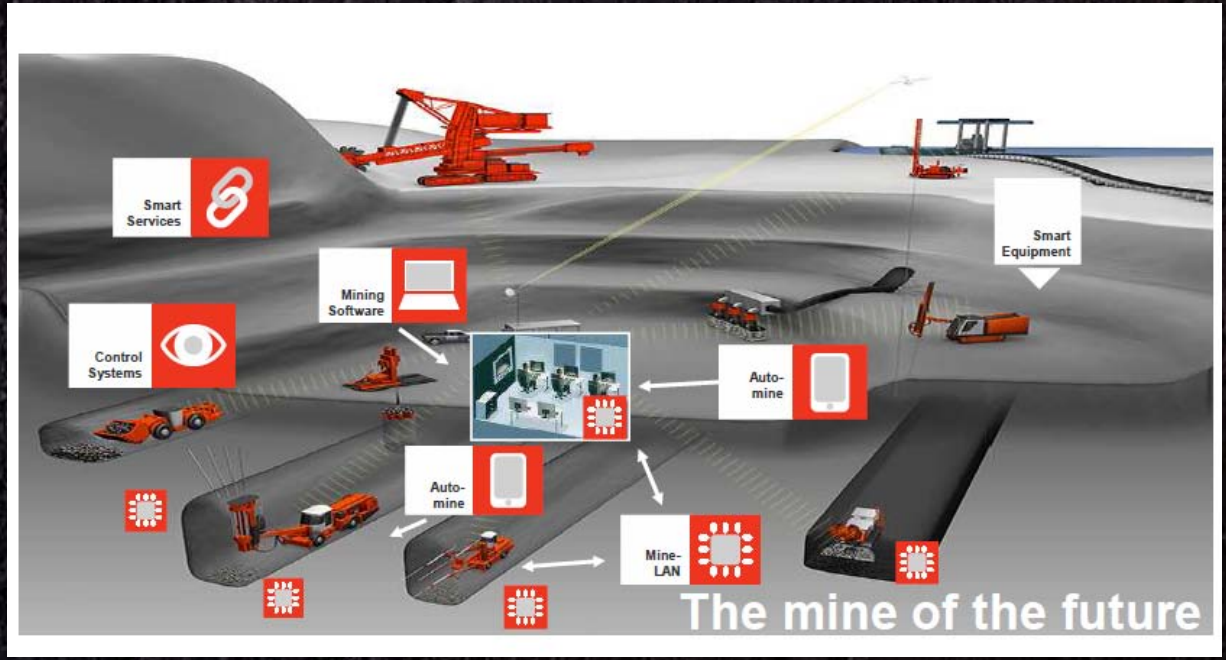
The way forward…

The answer to the new challenging environment : ***An autonomous or remotely operated, efficient, mining scheme, driven by skilled workforce***

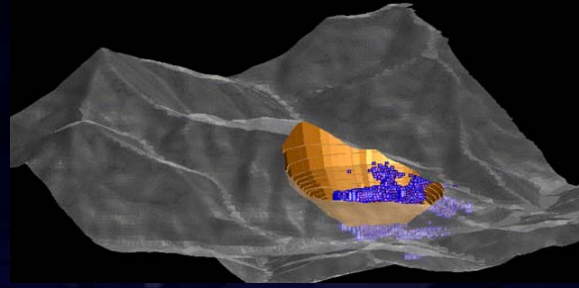


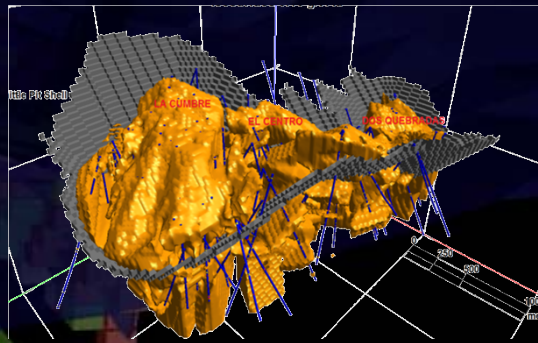
(Sandvik, 2013)

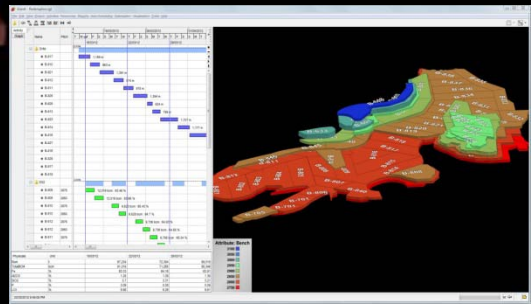
The way forward…

- **Resource Identification and Mine Design**

  Efficient discovery techniques focusing on great depth resources
  Accurate assessment of resource characteristics
  Uncertainty management in grade control
  Enhanced design and visualization capabilities
  Specialized design focus (e.g. geotechnical, environmental)
  Scheduling and production modelling



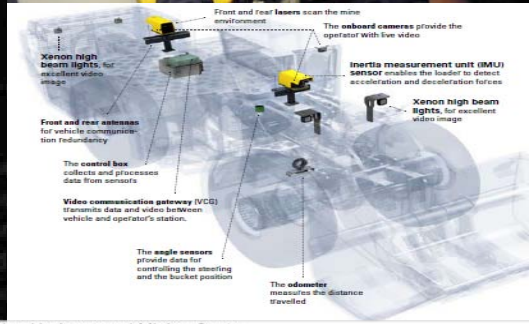


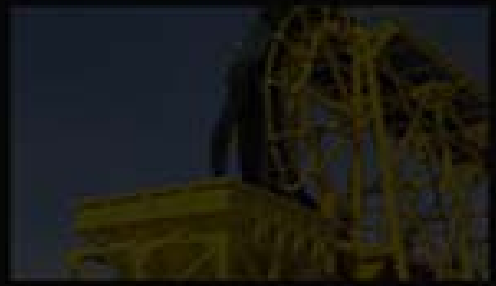


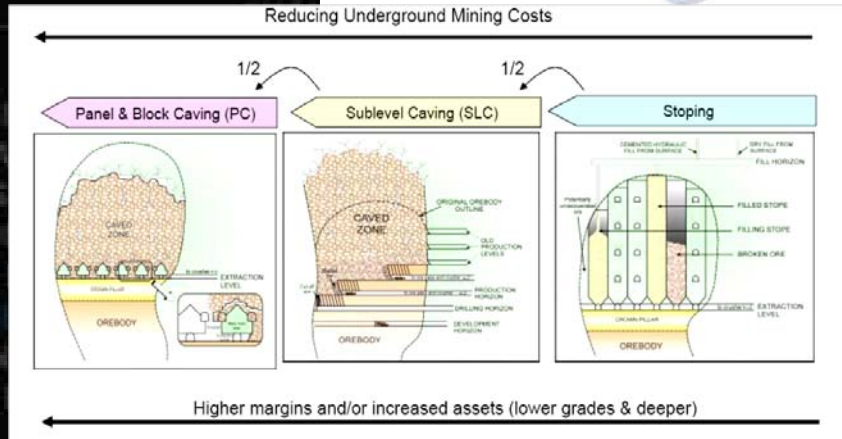
The way forward…

- **Enhancing Mine Productivity and Safety**

  New fleet of autonomous or remote controlled equipment
  Large scale and highly specialized machinery
  Real time monitoring and control throughout the mining cycle
  Energy and materials efficient mining
  Selective mining
  Skilled workforce to carry out the mining plan







The way forward…

- **Respecting the Environment**

  Respecting the Environment
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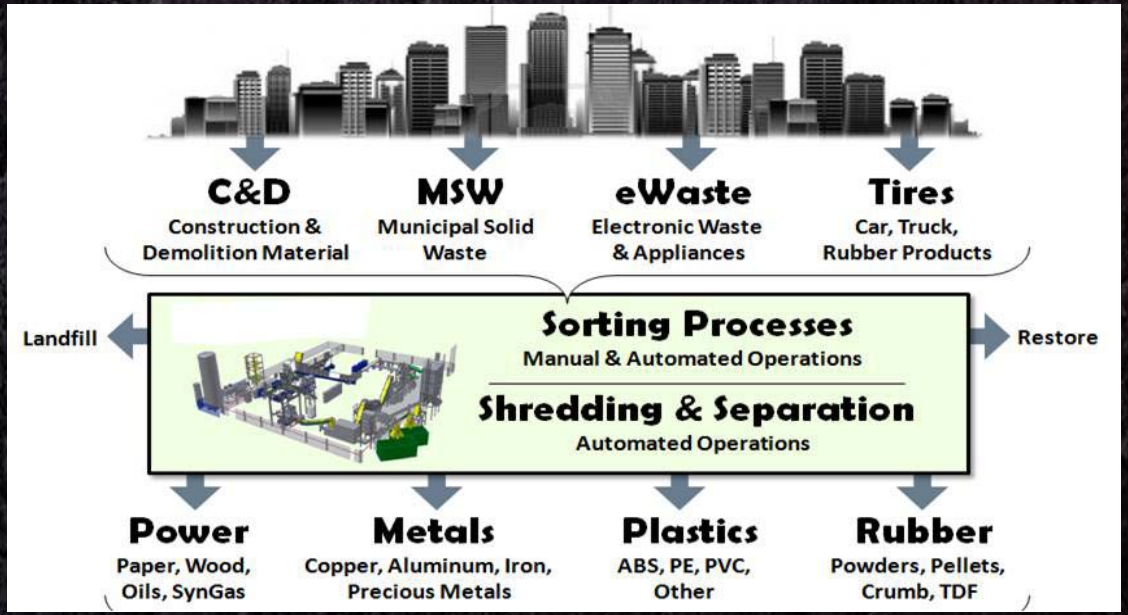
  …

Future Developments…

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.



(eCyclingUSA, 2013)

Future Developments…

Landfill Mining: the process of excavating previously disposed of materials from a landfill to recover metal, glass, plastic and other combustibles, soil, and the landfill volume itself

- Addressing contamination problems
- Creating new capacity for future landfills.
- Reducing closure cost.
- Recovering recyclable materials and energy

Nantucket Landfill Mining Project

Future Developments…

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

Is this really an option?

THE SPACE ECONOMY: A MODERN DAY GOLD RUSH

Asteroid Mining Will Create A Trillion-Dollar Industry

As our **population grows** we need to find a **sustainable supply of natural resources** to fuel exploration in space and prosperity on Earth.

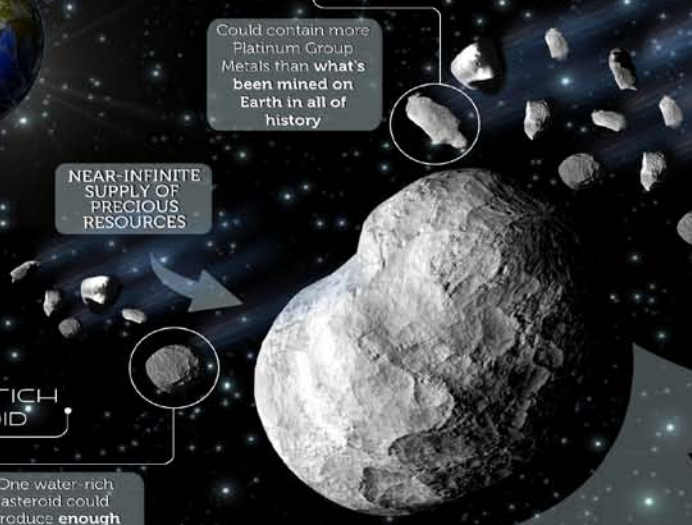
MORE ASTEROIDS DISCOVERED NEAR EARTH EVERYDAY

1,500	EASIER TO REACH THAN MOON
8,800	DISCOVERED TO DATE
1000+	NEARLY 1K+ FOUND EVERY YEAR

PLATINUM-RICH ASTEROID

Could contain more Platinum Group Metals than **what's been mined on Earth in all of history**

NEAR-INFINITE SUPPLY OF PRECIOUS RESOURCES



WATER-RICH ASTEROID

One water-rich asteroid could produce **enough fuel for every rocket launched in history.**

USES OF PLATINUM GROUP METALS ON EARTH

REDUCE COST OF ELECTRONICS

ELECTRIFY TRANSPORTATION

DRIVE INNOVATION, AND CREATE A GREENER EARTH

ONE SINGLE 500M platinum-rich asteroid

At current market prices one ounce of platinum is valued over $1,500

Worth $2.9 Trillion

174 times more than the yearly world output of platinum

20+

More than the known world-reserves of PGMs

USES OF WATER IN SPACE

- ROCKET **FUEL**
- BREATHABLE **AIR**
- DRINKABLE **WATER**

ONE SINGLE 500M water-rich asteroid

$ 5 trillion

would produce over $5 trillion worth of water for use in space.

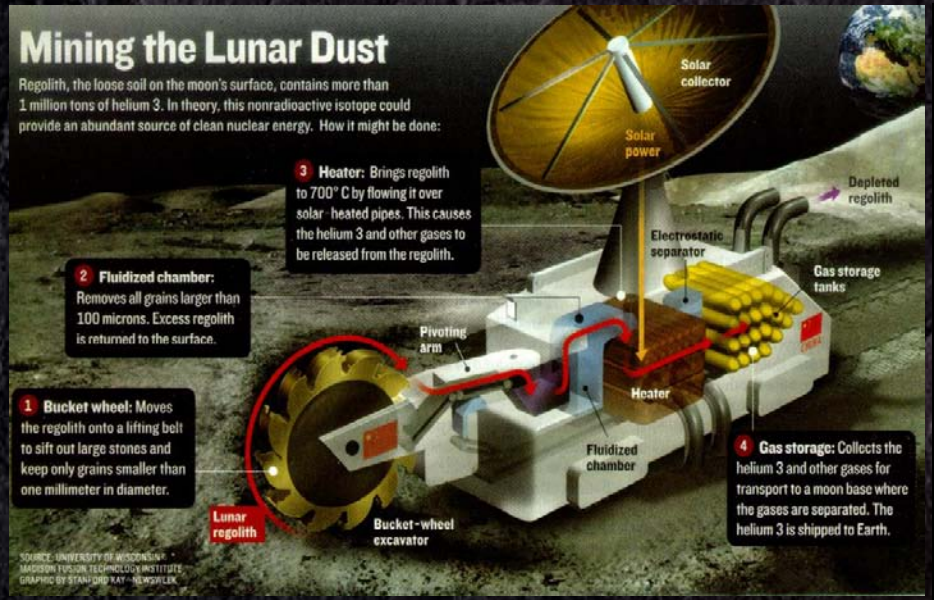
It currently costs $20,000 to send a liter of water from Earth to Deep Space

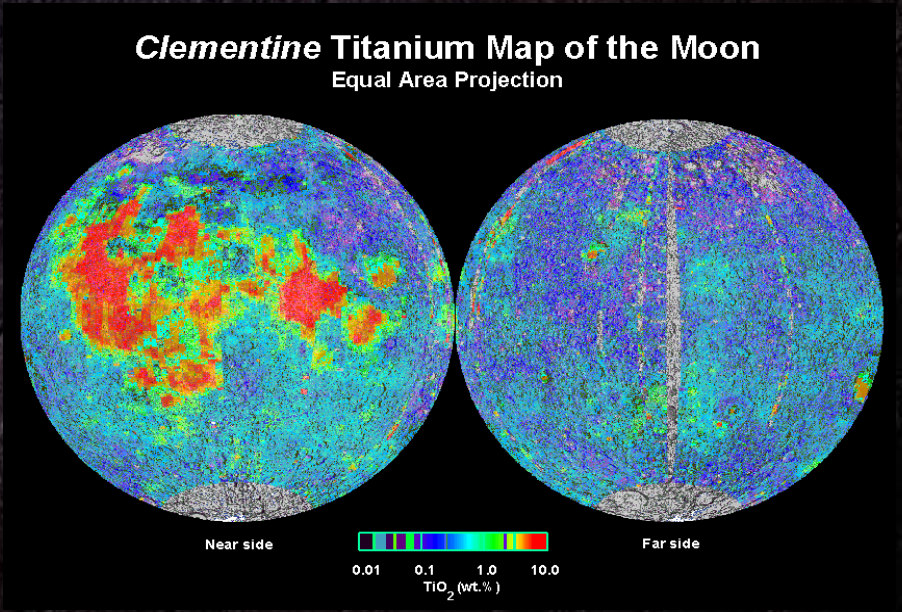
Asteroid mining will open a trillion-dollar industry and provide a **near-infinite supply** of Platinum Group Metals and water to **support our growth** both on this planet and off.

PLANETARY RESOURCES

Future Developments…

The mining is not only focused on minerals but also to other scarce elements in space (water, O_2, etc.).
Resources could be either moved to earth or be directly used in the space environment.



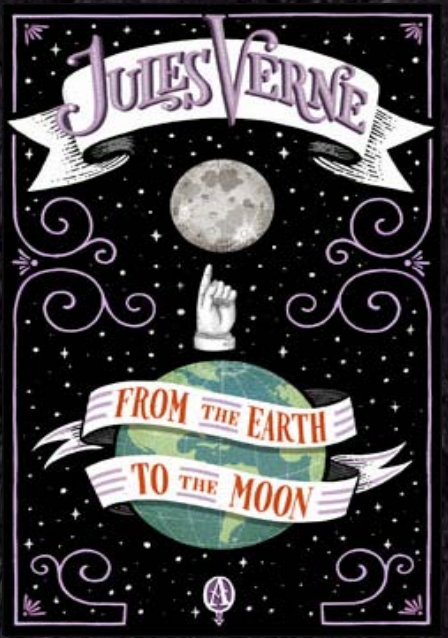


Future Developments…

You…

All leaps start with a dream. Make your own a reality.

Thank you for you attention…



De la Terre à la Lune
From the Earth to the Moon
Από τη Γη στη Σελήνη
Jules Verne, 1865