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Critical Raw Material: Moving from Words to Facts

1. CRM Assessment

Critical raw materials (CRM) are those that have a **high importance for all Industries and whose supply is associated with a high risk of disruption** according to the two parameters of Economic Importance (EI) and Supply Risk (SR).

The EC has published on several occasions the list of CRMs based on the assessment of EI and SR but matter of fact this **list has grown in terms of the number of CRMs in** every update that has been done from 2008 on, meaning that the situation is becoming more critical year by year. A significant number of CRMs included in the list are also specifically critical for the technologies linked to the so-called green energy transition but most of them are critical for most of our basic industries.

Among the most important CRM related to the decarbonization technologies (energy production, energy efficiency, energy storage...) we can find not only the more exotic elements like Neodymium, Niobium, Tantalum, Gallium and Germanium but also the **well-known old elements that have been used by humans since the industrial revolution** like Al, Cu, Nickel, Manganese, and Zinc.

With the crisis of Russia and Ukraine, we have also seen how critical **other common products like fertilizers** are (basic chemicals containing Phosphorus and potassium, also linked to mineral extraction)..

The de-carbonisation technologies rely also on several more exotic elements like 1) **rare earth elements (REEs**) for **e-vehicle traction motors** as well as wind power generators, 2) **cobalt, lithium and graphite** for energy storage, and 3) **boron, indium, gallium, germanium for solar energy production** applications. With the evolution of technologies, the **alloys needed to create new structures require more performing elements: for example, niobium** is key in a multitude of roles for adding strength while decreasing the weight of special steel constructions such as wind generator structures, e-vehicles etc.

Arsenic is well known to be a dangerous poison, but we also find this element in the list of CRM: **Gallium arsenide is an important semiconductor used in integrated circuits and photovoltaic panels**. Circuits made from gallium arsenide are much faster, but much more expensive, than those made from silicon.

Therefore, we may say that **sooner or later** we will see how **other elements, contained in the periodic table** of Mendeleyev, are critical.

It is worth noting, that the rapidly increasing demand for these elements, through the large-scale and rapid implementation of green energy technologies, **will be in full competition with other old applications causing an unbalance of supply while changing the prices for the new values**.

For example, in the energy sector, the demand for cobalt, lithium and REEs will increase so much (by 10-20 times) compared to today's requests, that the **current mines, plus the mines under development and the planned recycling plants, will not be able to cover the minimum forecasted demand**.

We have to say that up to now with today's design of energy/electric manufactured goods and the growing trend of exotic raw material demand, for some elements **recycling is too complex, too costly, and not in the position to be economically viable to satisfy the growing demand**. Anyway, to be ready 10 years from now to close the loop of the goods used for the energy transition, we need to develop recycling at the pace of the industry growth beginning the virtuous circle even if not profitable enough. **Finally, to follow the industry needs we need mining**.

2. Opportunities in our country

There are those who say that in Italy we are unlucky because we do not have the extensive mineral resources that other countries enjoy. Perhaps this statement is partially true as we do not have large deposits that can allow us to exploit them in large volumes for the export market as it happens for Russia, Australia, China, and some African countries but we can say that we have enough to stay in the game.

In fact, the scope that we must pursue **is to re-enter this primary economic sector** and to innovate in the value chain from minerals to applications changing the "old mining" paradigm. In other words, our strategic objective is to reduce dependence on foreign countries and guarantee our industries the **new materials** to be able to plan their long-term investments.

Our old geologists know very well that the presence of minerals in Italy is relevant in many areas and started before Christ: from Sardinia and Sicily to Piedmont to Tuscany and Lazio. We know that the Etruscans in *Colline Metallifere* and the Phoenicians in west Sardinia extracted Silver, Gold, Copper, Tin, Lead and Zinc already in the VIII century before Christ. To remark on our culture in mining it is worth remembering that the first mining code in history was drawn up in Massa Marittima in 1311. **How could this happen if our country did not have mineral wealth?**

As you will see from this orientation dashboard, called "the wheel of metal companionality" (Fig 1and Fig 1bis) we can associate the principal host elements indicated in the inner circle with companion elements that appear in the outer circle at distances proportional to the percentage of their primary production. By using this dashboard, **we can infer where we can find "rare minerals" associated with the traditional deposits** exploited in the past centuries like Sphalerite (Lead), Magnetite (Iron), Blende (Zn), Cassiterite (Sn), Bauxite (Al) and so on ...

In our country, we can find all the main minerals containing the elements indicated in the centre: the issue is that we have almost stopped all the mines in the last century (Fig 2 – Ispra inventory) and **sterilized most of the areas** (Fig 3 e 4-*Parchi Minerari e Naturali*) , in some cases also creating geopark and museums even if there are still important resources to be exploited. With the **exit of our main national industries** from the mining sector and the **consequent interruption of the creation of professionals in the mining sector** (with the elimination of specialized universities for Mining Engineering and Geology in exploration and mining), we have lost momentum, critical size, and of course human and financial capital. Moreover, the geo-mining scientific material produced by companies and universities at the time (50s -80s) was so vast that has nothing to compare with the recent one. But of course, **the literature produced at that time has no mention of the mineralization of today's interest.**

Coming back to the "Wheel of companionality", the associated minerals, requested by the energy transition, have the characteristic of **being present in significantly lower quantities** (in fact we speak of ppm) compared to the main ones (expressed in % indicated in the centre, except for gold and platinum).

This means that to extract a few kg of exotic elements we need to mine, treat, and address inert of 1-5 ton minimum.

Moreover, the refining plant must address, not as in the past one or two metals/minerals **but tens of elements to justify the mining effort.** This implies **high investment costs and high process complexity** because we have the ethical obligation to manage the environment and the safety of workers in a responsible way: not everywhere in the world this principle was followed like in the 70s 80s when we closed our mining operation for example.

The need for **big capital investment requires that big companies** start to play their role and the State is determined to support this challenge. The challenge is also to **create a district that is specialized in these new technologies** from **mining to applications** including machinery, software, engineering, recycling, and science of materials to cover the whole process.

The last big innovation that the mining sector must bring in this new century is the change of the paradigm Mining=Negative Impact.

The Mining sector must henceforth be seen as the harmonious union of multiple disciplines to allow a **positive Anthropization of the Territory** caring about the Natural Architecture to improve the landscape, the Water management and storage for local needs and renewable Energy for better use of land. This multidisciplinary activity, which also includes the valorization of mineral resources for the national industries, will be at the service of the local community by providing **energy, water, jobs, and culture in harmony with the landscape** (not *sustainable* but *positive*).

3. Conclusions

In summary, in Italy there are the natural resources, the technological attitude, the human potential and the overall capacity for a new Mining Industry focused on Positive Anthropisation and on Final high-tech applications.

We just need to find the courage to rebuild the tissue of this strategic industry by working together without abandoning hope and **moving from words to facts.**

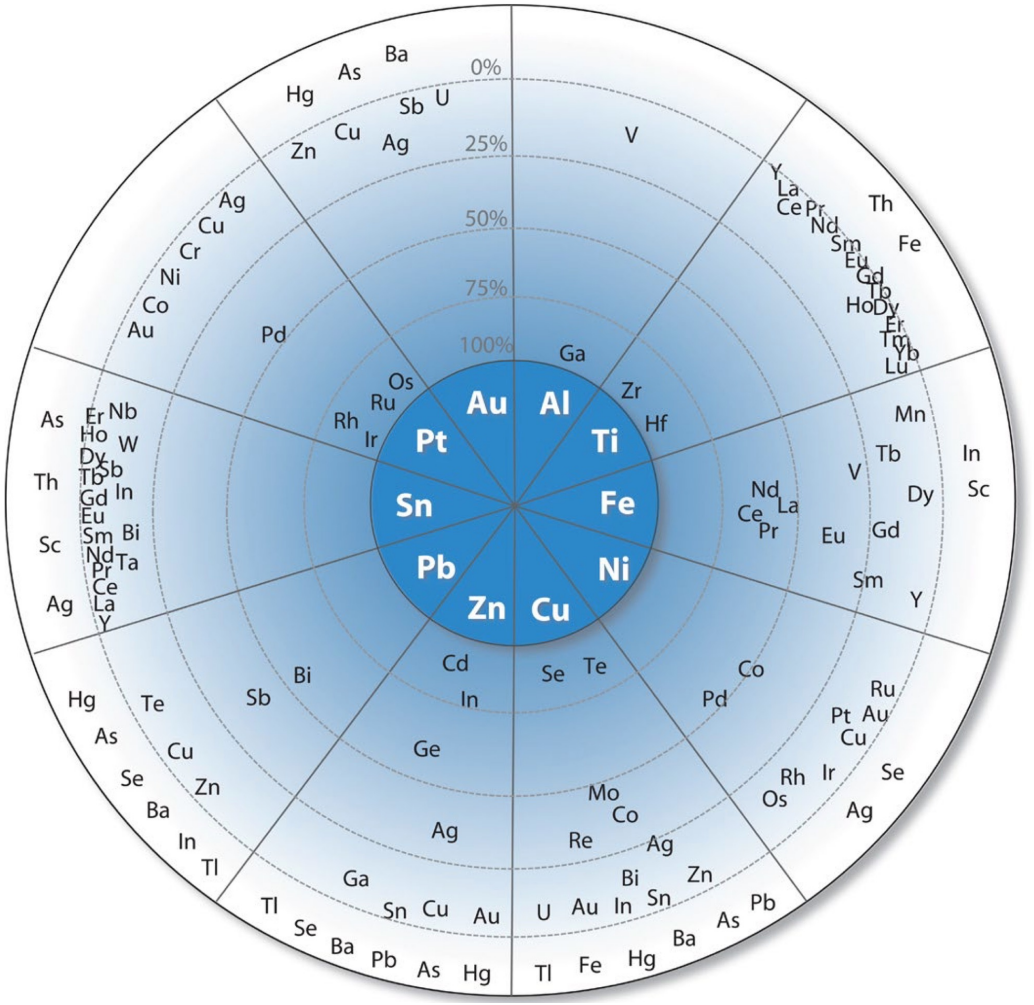
MOVING FROM WORDS TO FACTS

Allegato presentazione C.Baccani OMC 25 Ottobre 2023

The-wheel-of-metal-companionality

Main-metals-are-in-the-inner-circle .

https://www.science.org/doi/pdf/10.1126/sciadv.1400180



EU and USA official reports on CRM:

https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials_en

https://www.energy.gov/eere/articles/us-department-energy-releases-2023-critical-materials-assessment-evaluate-supply

Fig.1 Allegato presentazione C.Baccani 25 Ottobre 2023

Companions Minerals

Main metals extraction in Blue.

https://www.science.org/doi/pdf/10.1126/sciadv.1400180

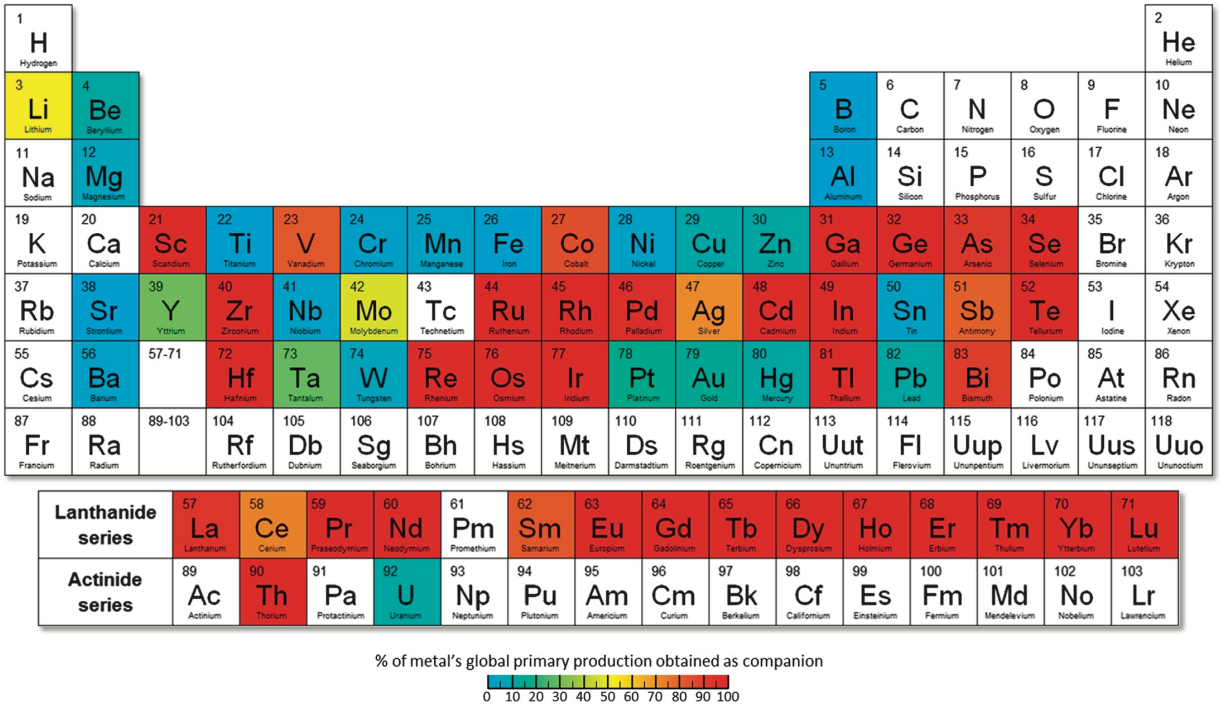


Fig.1bis Allegato presentazione C.Baccani 25 Ottobre 2023

Ispra Report

Sono stati censiti 3.006 siti in particolare: Sicilia (761 siti), Sardegna (438), Toscana (413) e Piemonte (378).

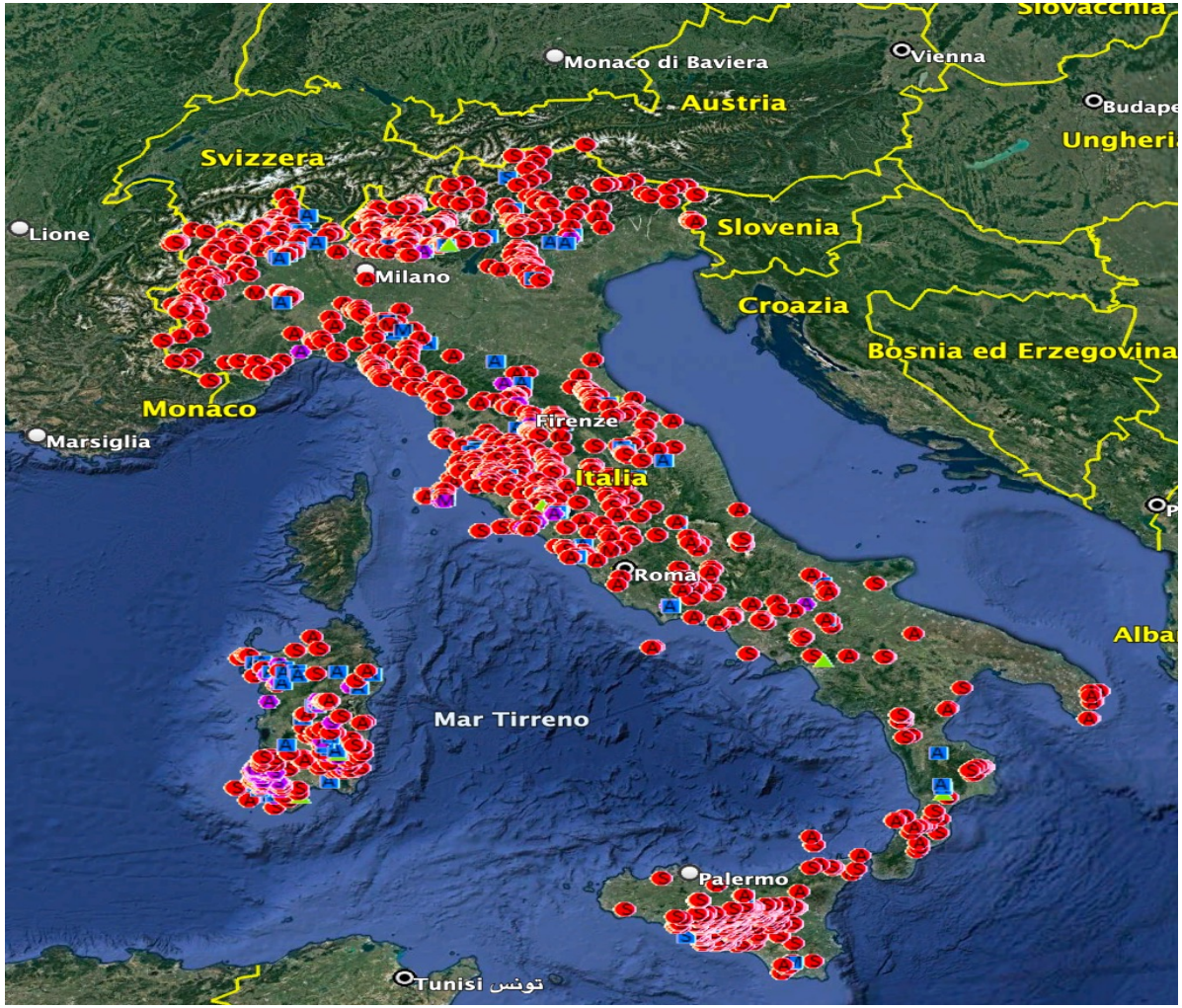


Fig.2 Allegato presentazione C.Baccani 25 Ottobre 2023

La Mappa dei più importanti Parchi Minerari (REMI)

https://www.parks.it/mappe/ap.php

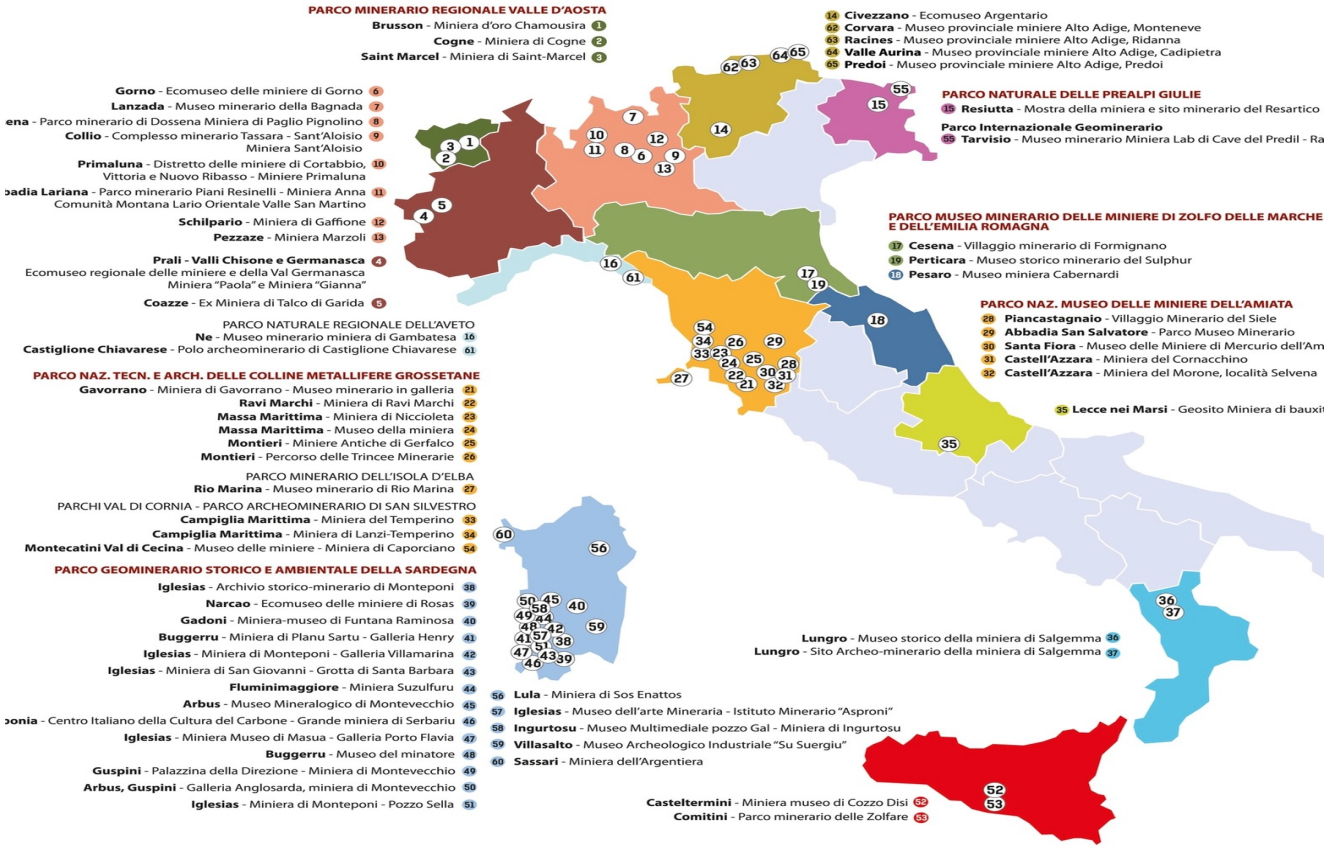


Fig.3 Allegato presentazione C.Baccani 25 Ottobre 2023

La Mappa dei Parchi e Luoghi protetti

https://www.isprambiente.gov.it/it/progetti/cartella-progetti-in-corso/suolo-e-territorio-1/miniere-e-cave/progetto-remi-rete-nazionale-dei-parchi-e-musei-minerari-italiani/i-membri-della-remi

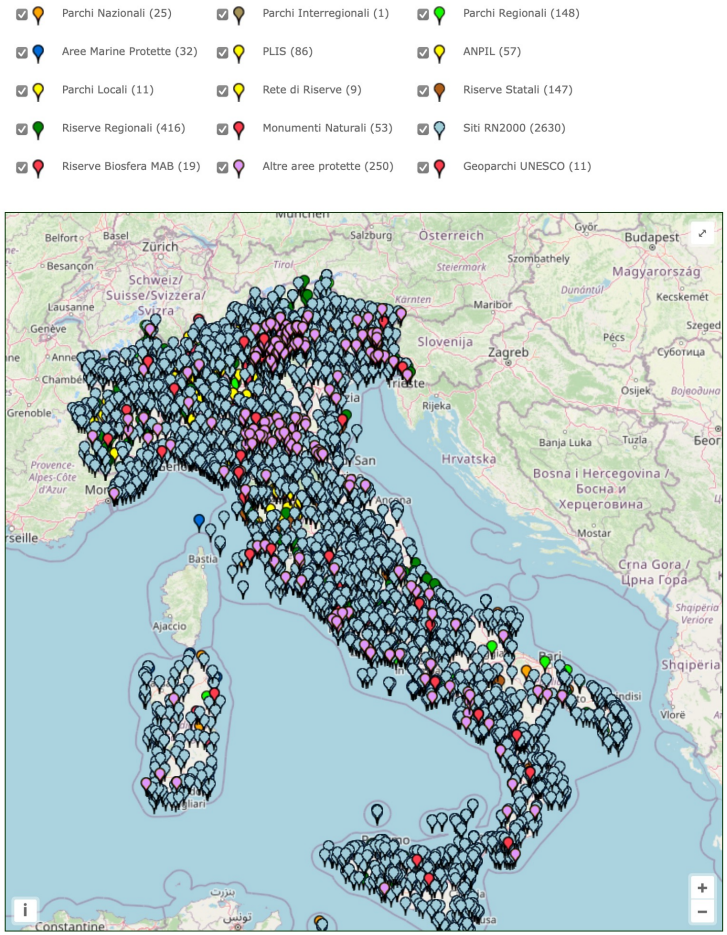


Fig.4 Allegato presentazione C.Baccani 25 Ottobre 2023