

Mineral resource management and renewable energies: GEO Contribution to
a low carbon energy future

Impact of Energy Transition on Mineral Resources

Stéphane Chevrel – Thierry Ranchin



MinPol GmbH

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MINES ParisTech

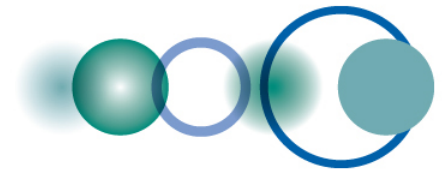


PSL 

**MinPol GmbH - Agency for
International Minerals Policy**

GEO XV Side event “Energies and
mineral resources management:
What GEO can bring to SDG 7”
Kyoto, October 30, 2018





Layout

- **Introduction**
 - SDG7
 - GEO-VENER initiative
 - CA EO data for managing Mineral Resources (CA-06)
- **Mineral demand for renewable energies**
- **A global issue**
 - Minerals in developing countries
 - Environmental and societal impacts
 - Links with SDGs
- **How can GEO contribute?**
 - Examples
- **Conclusion**



GROUP ON
EARTH OBSERVATIONS

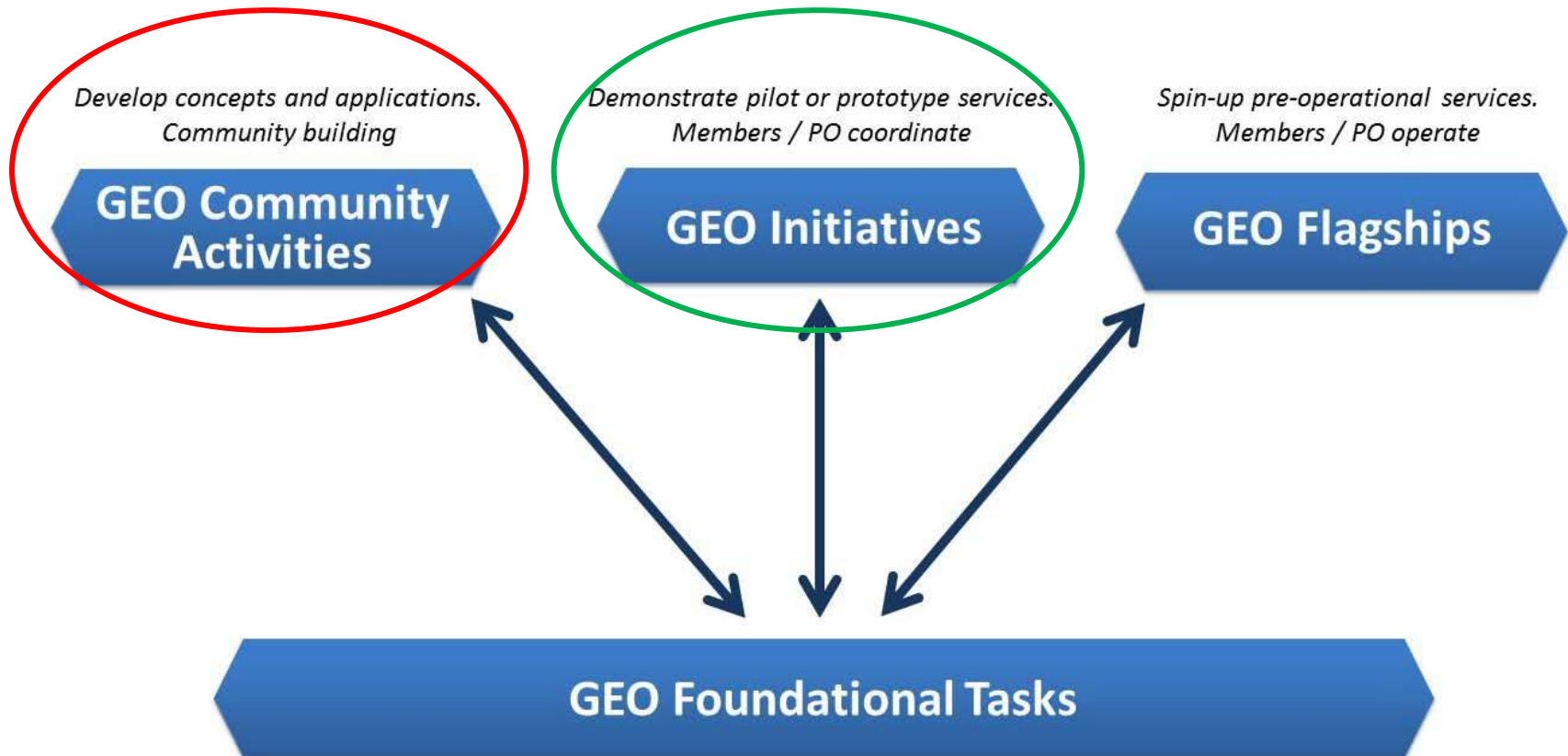
The Energy and Minerals SBA



- SBA introduced at GEO XII in Mexico City as per 2016-2025 Strategic Plan

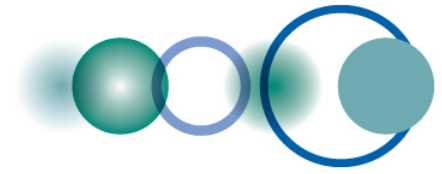
CA-06 : EO data for managing mineral and non-renewable energy resources.
PoC: S. Chevrel (MinPol)

GI-10 (now GEO-VENER): EO data and renewable energies. PoC: T. Ranchin (MinesParisTech)



GEO Foundational Tasks

Coordinated by GEO Secretariat



SDG goal 7

« Ensure access to affordable, reliable, sustainable and modern energy for all »

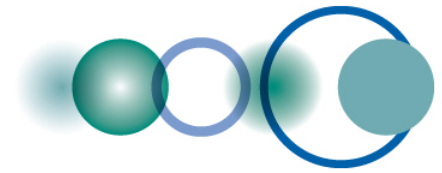


Target 7.2:

By 2030, increase the share of renewable energy in the global energy mix.

Indicator:

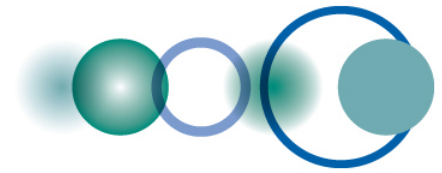
7.2.1 Renewable energy share in the total final energy consumption



GEO Vision for Energy

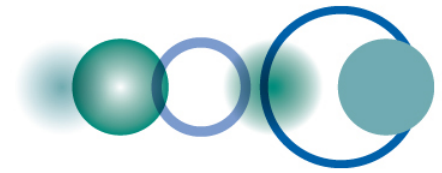
Background

- **Contribute to GEO Energy and Minerals Resources SBA and Energy SDG7**
 - Support the development of Earth observation products and services for energy management.
 - Consider information to support end-to-end energy production systems (including planning, generation, transmission, distribution, and integrated operations).
 - Promote collaboration between users and providers of Earth observation and information.
 - Encourage the use of Earth observation and information for informed renewable energy policy planning in developing and developed countries.
- **Focus on Renewal Energy (RE)**



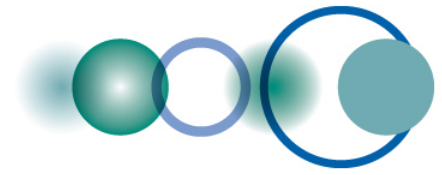
GEO vision for Managing Mineral resources

- Develop tools and Information for the Resource Assessment, Monitoring and Forecasting of Geological Resources (including mineral and fossil resources, raw material and groundwater);
- Develop tools for impact monitoring of mining operations;
- Identify and foster implementation of strategic measures for the competitive, reliable and sustainable management of geo-resources exploitation and treatment of re-usable materials.



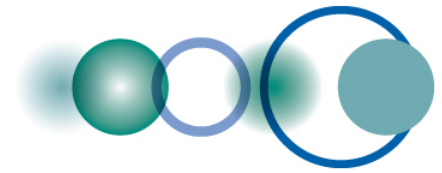
GEO VENER's Objectives

- Contribute to SDG7: Ensure access to affordable, reliable, sustainable and modern energy for all
- Pursue expansion of current Essential Renewable Energies Variables (EREV) to apply to all forms of RE
- Conduct Gap Analysis – RE community observation requirements, ongoing research, GEOSS discovery and broker analysis
- Develop EO Products and Services for all RE
- Development of in-situ meta-networks for RE
- Build on webservice-energy.org (GEOSS community portal) as the focal point for RE



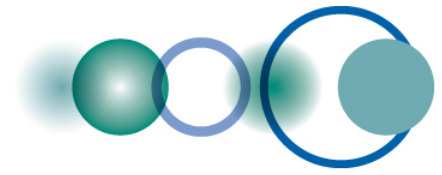
CA-06's objectives

- Improved development of integrated EO-based products to meet stakeholder requirements and engagement at regional (mining basin) to site levels;
- Foster their use in responsible mining initiatives, both at governments and company levels
 - SLO perspective;
- Develop methodologies and tools for illegal mining activities monitoring;
- Develop methodologies for mapping secondary resources from identified mining wastes.

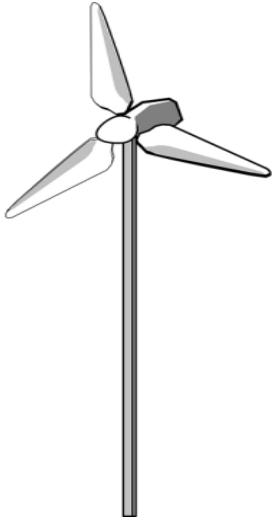


Development of low carbon energy needs mineral resources

- “a transition to a low carbon society, [is] a change that will require vast amounts of metals and minerals”.
- Mineral resourcing and climate change are inextricably linked, not only because mining requires a large amount of energy, but also because ‘the world cannot tackle climate change without **adequate supply of raw materials to manufacture clean technologies**’” (Ali et al. 2017, Nature, 367).

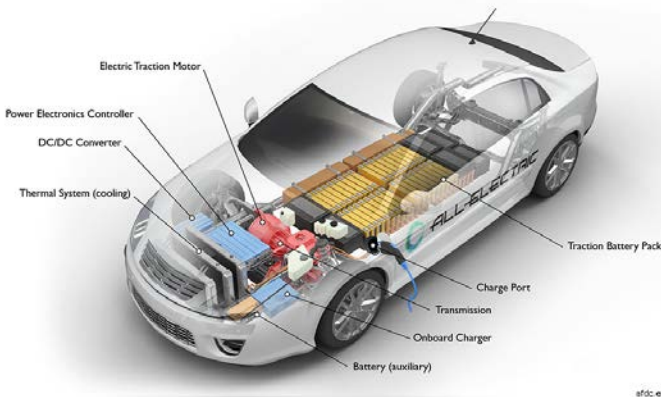


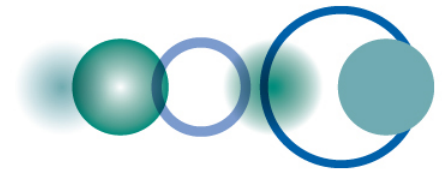
Examples



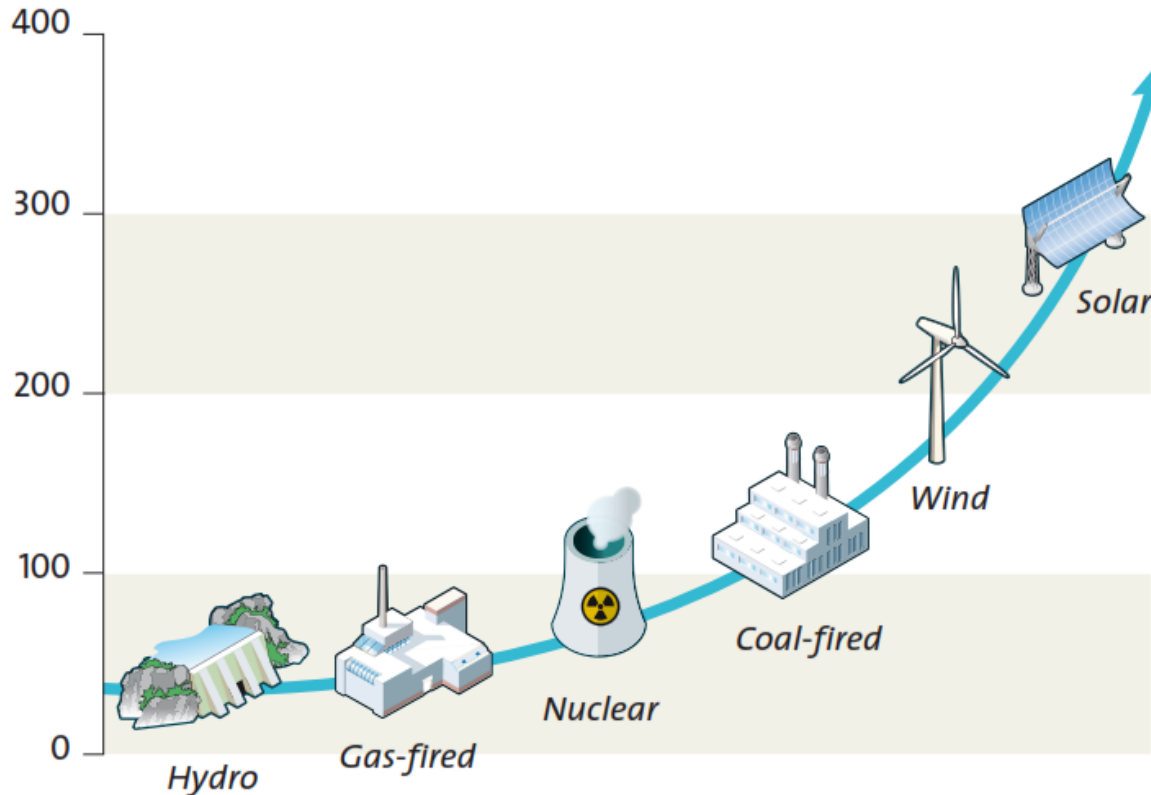
- According to the Northwest Mining Association, a single 3-MW wind turbine needs:
 - 335 tons of steel
 - 4.7 tons of copper
 - 1,200 tons of concrete (cement and aggregates) [~600 yards]
 - 3 tons of aluminum
 - 2 tons of rare earth elements
 - aluminum
 - zinc
 - Molybdenum
- “the future electric vehicle market could create a huge increase in demand for copper and cobalt for electric motors” (Economist 2014)

All-Electric Vehicle



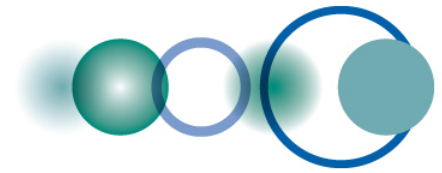


Renewable energies require more raw materials...



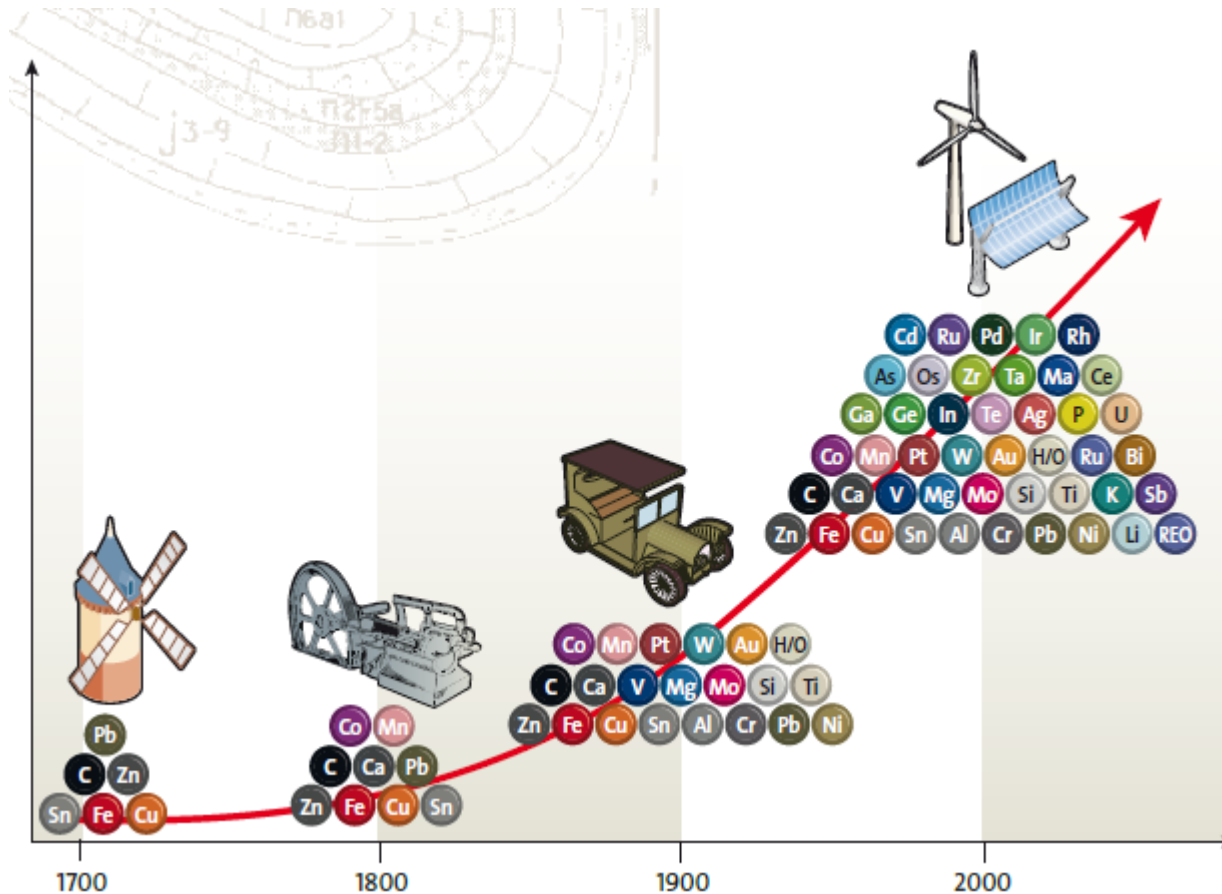
- The material intensity for renewable energies is particularly high

Steel intensity for different power technologies, in tones per MW
(Albanese *et al.*, 2011, *Investor Seminar*).



... and more metals



























































- Increase in the complexity of metal assemblages in generic products





A Mendeleiev table more and more solicited

- Nearly all elements today are used in the energy sector

1 H 																	2 He				
3 Li 	4 Be  	<i>Raw materials for energy</i>														5 B 	6 C   	7 N	8 O	9 F	10 Ne 
11 Na 	12 Mg															13 Al  	14 Si 	15 P	16 S	17 Cl	18 Ar 
19 K	20 Ca	21 Sc	22 Ti 	23 V 	24 Cr 	25 Mn  	26 Fe  	27 Co  	28 Ni  	29 Cu  	30 Zn 	31 Ga  	32 Ge	33 As	34 Se 	35 Br	36 Kr 				
37 Rb	38 Sr	39 Y  	40 Zr 	41 Nb 	42 Mo 	43 Tc 	44 Ru 	45 Rh 	46 Pd 	47 Ag 	48 Cd 	49 In  	50 Sn	51 Sb	52 Te 	53 I	54 Xe 				
55 Cs	56 Ba 	*	72 Hf 	73 Ta 	74 W  	75 Re 	76 Os	77 Ir	78 Pt 	79 Au 	80 Hg  	81 Tl	82 Pb 	83 Bi	84 Po	85 At	86 Rn				
87 Fr	88 Ra	**	104 Rf	105 Db	106 Sg	107 Sg	108 Hs	109 Mt	110 Ds	111 Rg	112 Uub	113 Uut	114 Uug	115 Uup	116 Uuh	117 Uus	118 Uuo				

Raw materials for energy

Chemical elements used in different technologies relevant to the energy sector

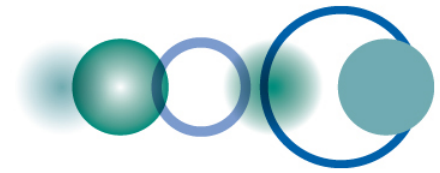
P. Christmann – BRGM, in Geosciences n° 15

- Energy storage
- Connectors
- Energy saving
- Catalysors
- Electricity production and transport
- Nuclear power plants
- Photovoltaic
- Permanent magnets
- Lightening

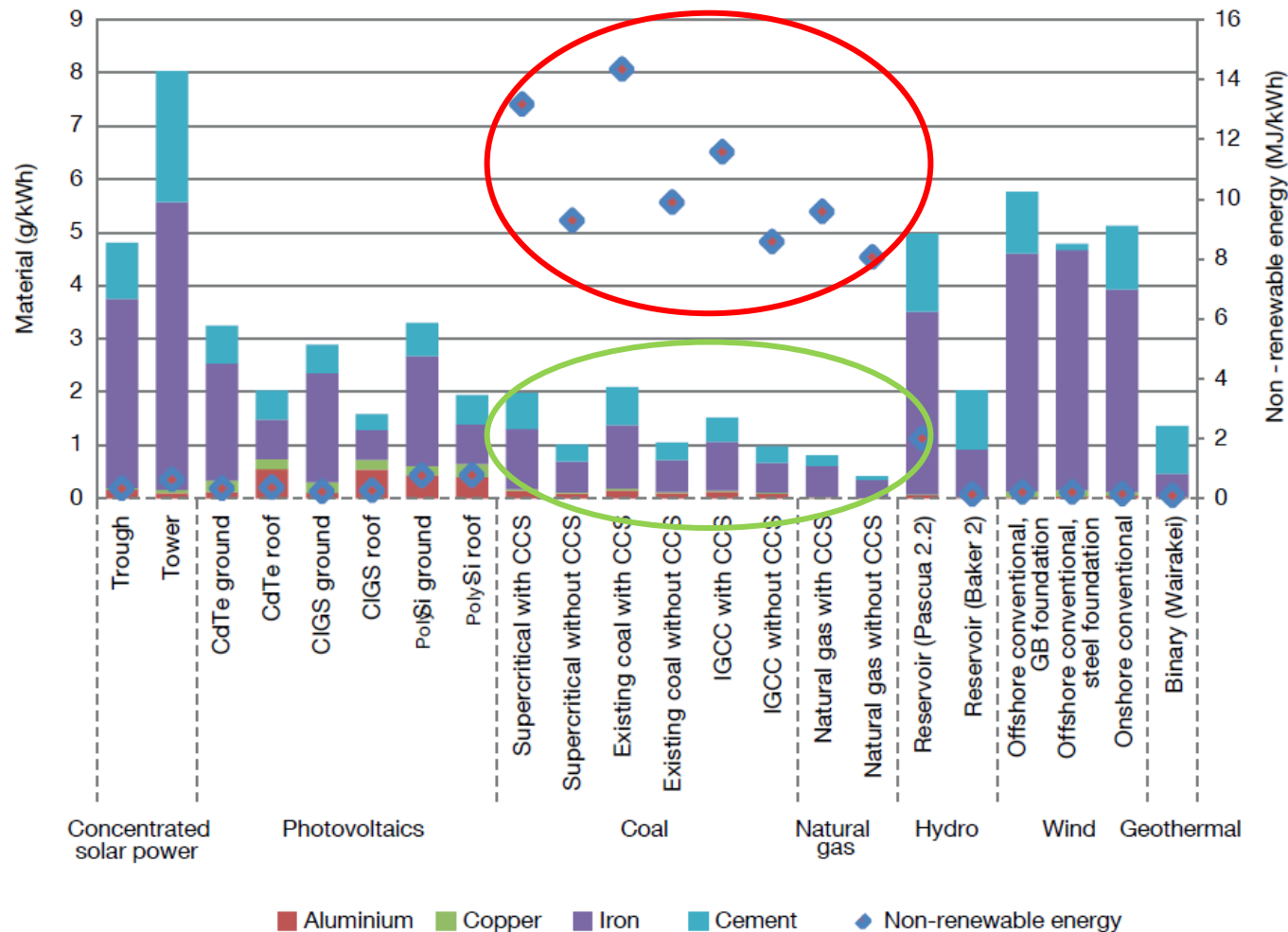
Lanthanides
REEs

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Actinides



Non renewables vs. renewables



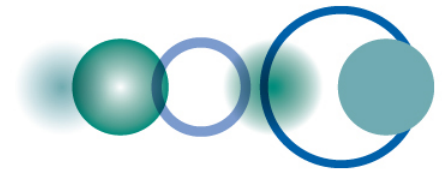
- Fossil technologies have **high cumulative non-renewable energy demand (CED)** and **low bulk material requirements**
- And... the inverse!

Source: Green Energy Choices: the benefits, risks and trade-offs of low-carbon technologies for electricity production, UNEP, International Resource Panel, 2016



Commodity demand may vary according to 2050 global warming scenari

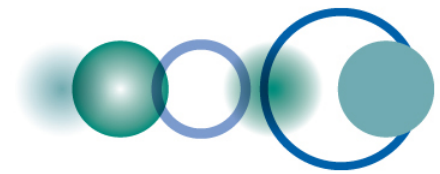
- 2050 scenari
 - 2°C (2DS), 4°C (4DS) and 6°C (6DS) global temperature increase goals for 2050
- Metals which could see a growing market include aluminum, cobalt, copper, iron ore, lead, lithium, nickel, manganese, PGMs, REEs, silver, steel, titanium and zinc.
- low carbon technology requirements, and hence relevant metals demand, rises rapidly between the 4DS and 2DS scenarios.
- e.g. electric storage batteries, where the rise in relevant metals grow in demand from a relatively modest level under 4DS to more than 1000 percent under 2DS



Minerals – a global issue

- Non-renewable mineral resources play a dominant role in 81 countries that collectively account for*:
 - a quarter of world GDP,
 - half of the world's population,
 - and nearly 70 percent of those in extreme poverty.
- Those low-income countries focus on resource extraction and processing activities as fundamental to their economic growth plans.
- This comes however at significant environmental and societal costs
- Needing adapted responses
 - Responsible mining initiatives, SLO
 - Effective governance
 - Stakeholder engagement

* <http://www.worldbank.org/en/topic/extractiveindustries/overview>



*Empowered lives.
Resilient nations.*



**COMMITTED TO
IMPROVING THE STATE
OF THE WORLD**

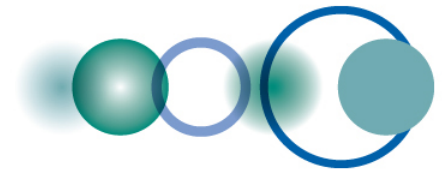
With the support of:



White Paper

Mapping Mining to the Sustainable Development Goals: An Atlas

How responsible
mining can
positively contribute
to the UN SDGs

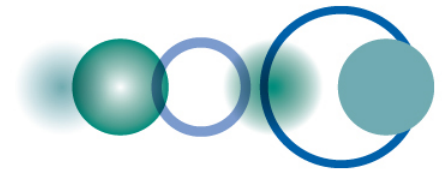


e.g.

	1 NO POVERTY	2 ZERO HUNGER	3 GOOD HEALTH AND WELL-BEING	4 QUALITY EDUCATION	5 GENDER EQUALITY	6 CLEAN WATER AND SANITATION	7 AFFORDABLE AND CLEAN ENERGY	8 DECENT WORK AND ECONOMIC GROWTH	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	10 REDUCED INEQUALITIES	11 SUSTAINABLE CITIES AND COMMUNITIES	12 RESPONSIBLE CONSUMPTION AND PRODUCTION	13 CLIMATE ACTION	14 LIFE BELOW WATER	15 LIFE ON LAND	16 PEACE, JUSTICE AND STRONG INSTITUTIONS	17 PARTNERSHIPS FOR THE GOALS
EARTH OBSERVATIONS FOR MANAGING MINERAL RESOURCES																	

SDG 1 – End Poverty: “Mining generates significant revenues through taxes, royalties and dividends for governments to invest in economic and social development.”

SDG8 – Decent Work and Economic Growth: “Mining can change the lives of local communities, offering opportunities for jobs and training, but also contributes to economic and social inequities if not appropriately managed.”



How can GEO contribute?

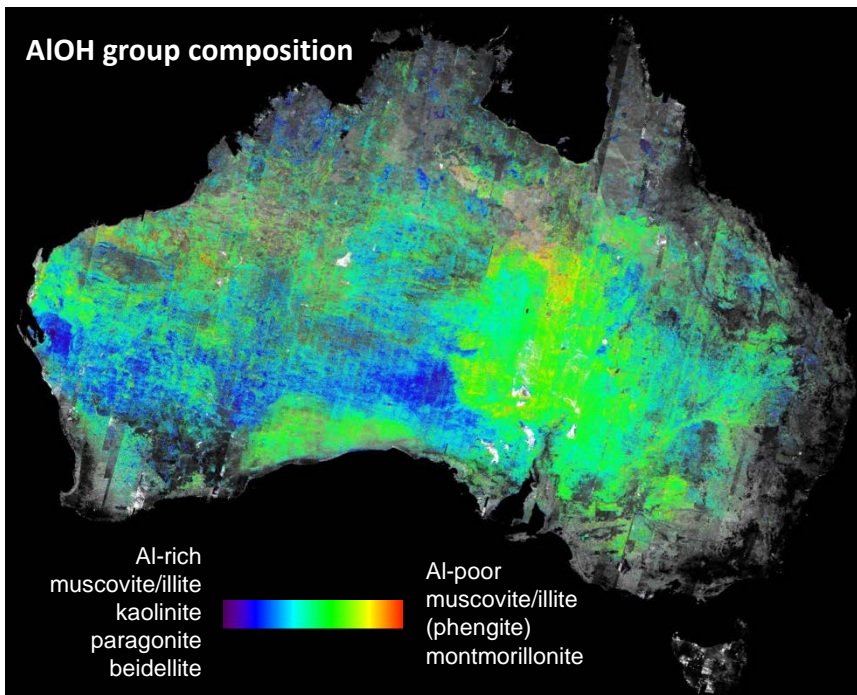
- EO for management of minerals can provide global reach, non-invasive, scalable, temporal, accurate maps and models of land surface composition and condition at all stages of the resource development cycle from exploration and discovery through to mine closure.
- Help in achieving the UNDP SDGs
- Minerals in GEO well positioned to work with the UNDP and WEF to help harness this array of EO technologies to develop and deliver those critical information products that will have greatest SDG impact.



A global Geoscience map?

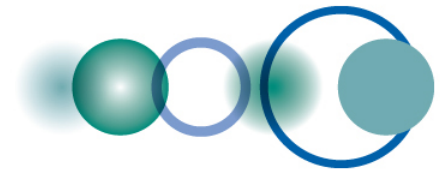
ASTER Geoscience Map of Australia CSIRO 2012

- **17 Geoscience maps were created from more than 3000 ASTER scenes**



Potential extension to the rest of the world

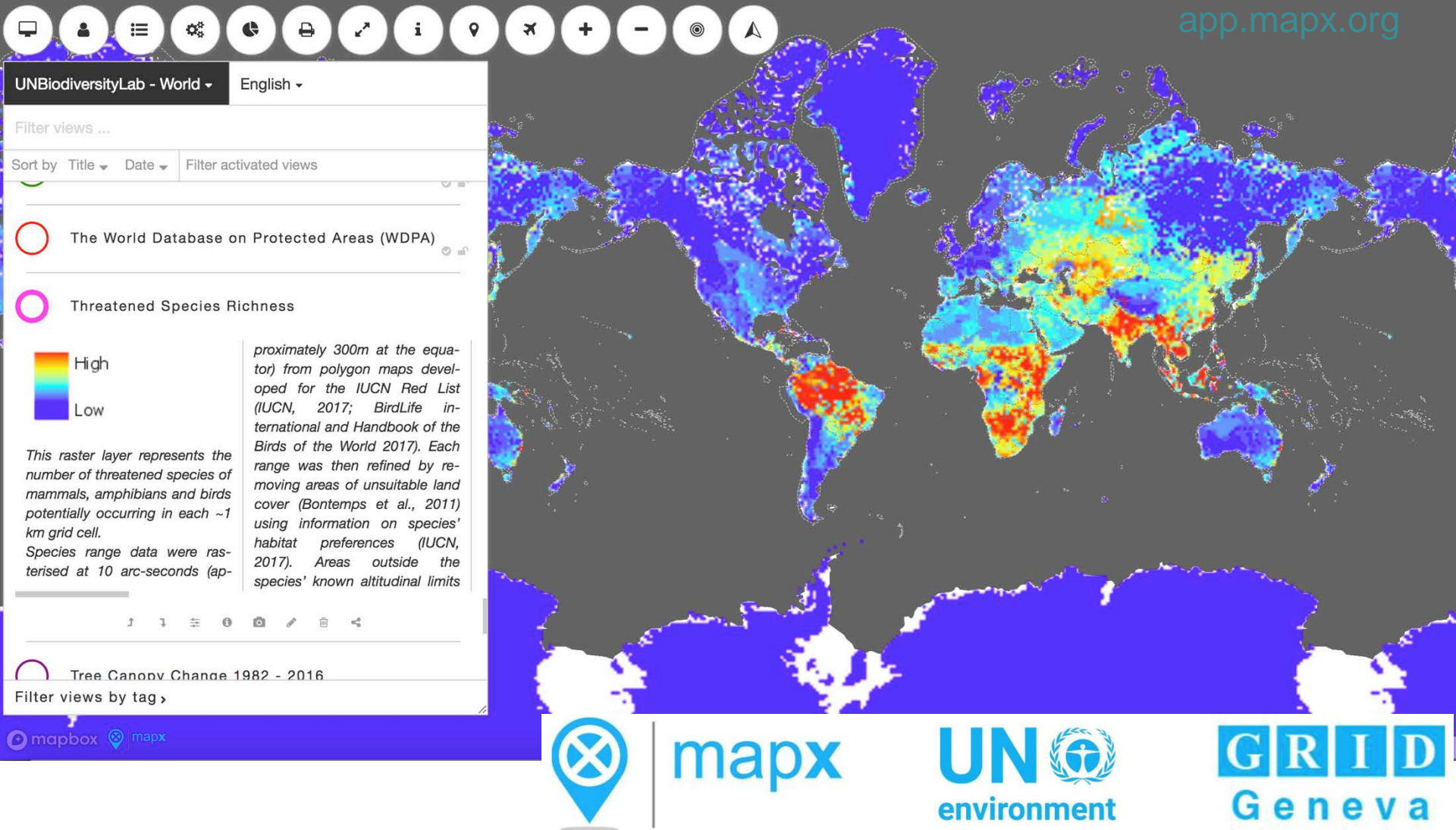
- Data exists
- Methodology ready
- Team exists (JPL, CSIRO,...)
- Proposal submitted to NASA for funding, but funding rejected..
- Other funding opportunities?



An open geospatial platform to manage, analyze and visualize data on natural resources and the environment

www.mapx.org

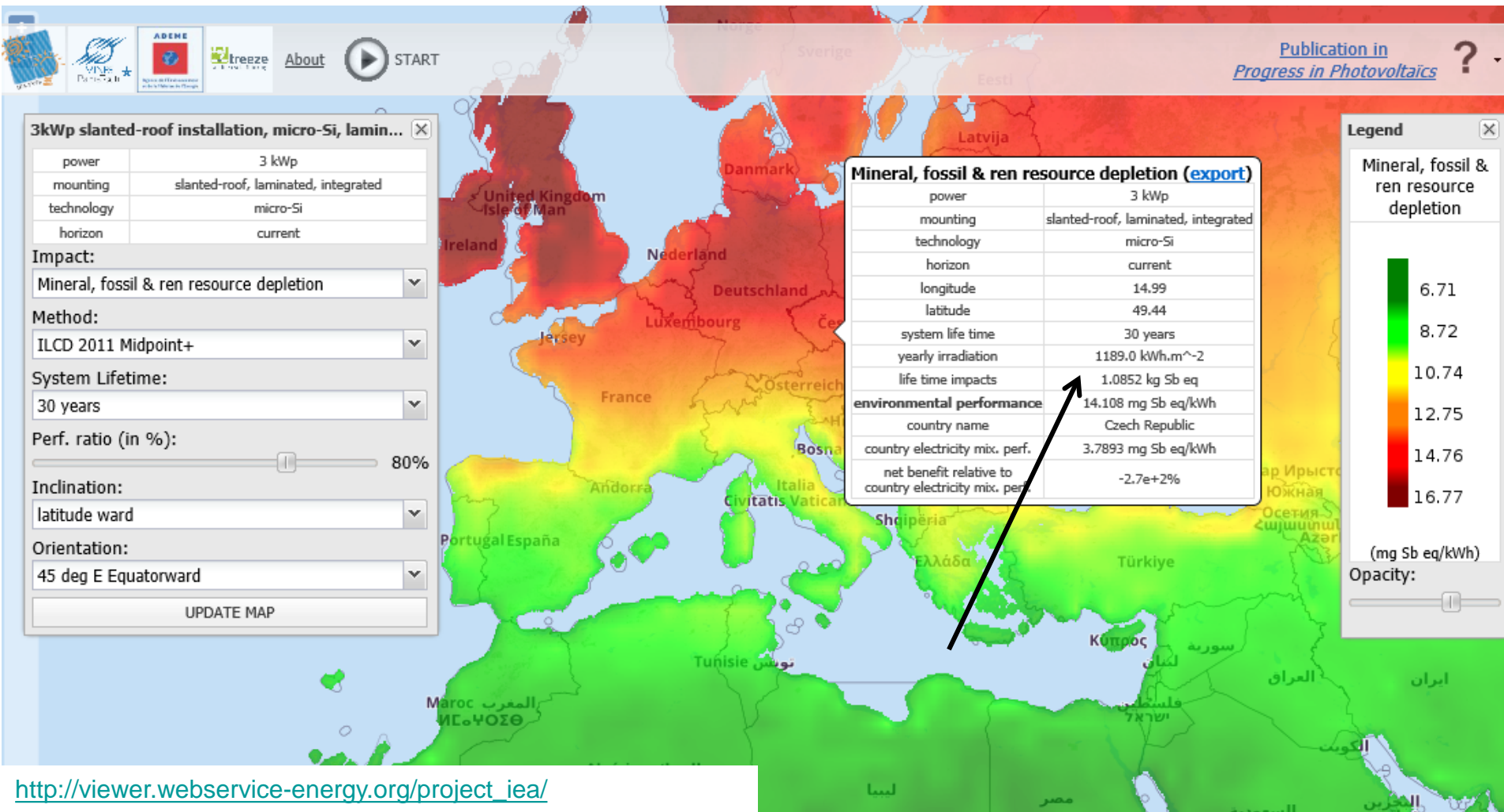
app.mapx.org

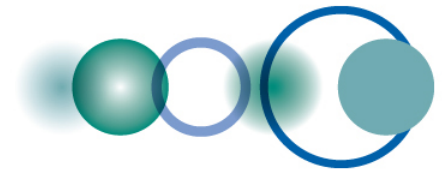


Environmental Impact Assessment Web Service for Photovoltaics



- Web-based interactive service to assess the current and prospective (2050) environmental performance of PVs systems
- Mineral, fossil & renewable resource depletion expressed in mg Sb equivalent per kWh





Mineral Resources and Renewable Energies ?

- Mineral resource development as a complement and not competitor, to a greener, more sustainable future. (Riccardo Puliti, Senior Director and Global Head Energy and Extractives Practice Group, The World Bank)
- Significant gaps exist in providing current and robust data on mapping relevant mineral/metal resources in developing country regions: Africa, Latin America, and Asia (WB)*.
 - e.g. survey gaps in Africa

And

- Use of Earth observation and information for informed renewable energy policy planning in developing and developed countries.
- Development of Earth Observation products and services for energy and mineral management

But

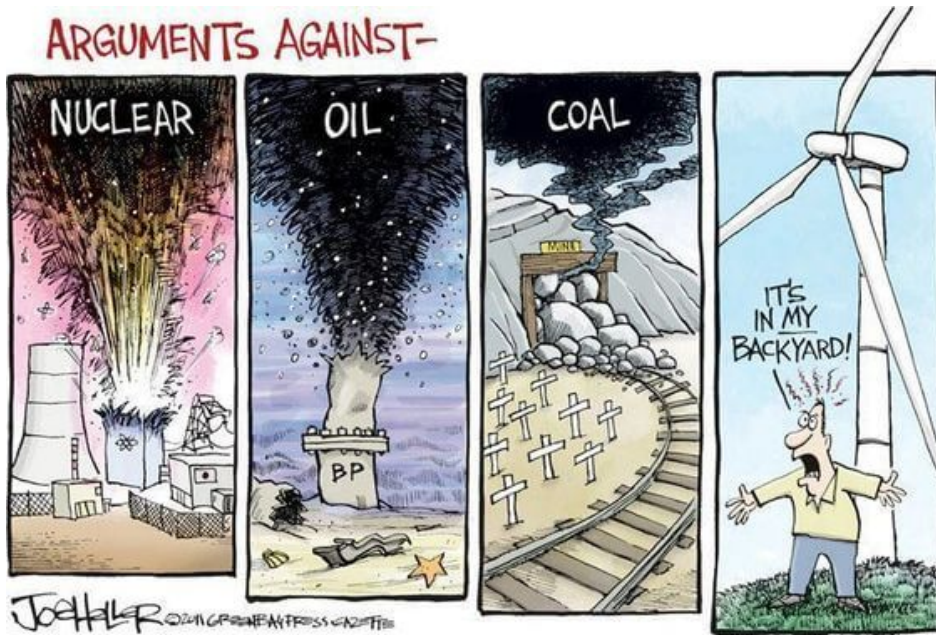
- Minerals lack dedicated EO systems and rely on systems from other SBAs

Hence

- The “mineral community” strongly advocates for operational hyperspectral spaceborne missions ensuring a global systematic coverage at no (or marginal) costs and at “decent” spatial resolution

*See for instance <https://mrdata.usgs.gov/general/map-global.html#home>

Thank you for your attention!



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WHERE THE MINERALS ARE



Figures refer to proportion of world reserves available for extraction given current technology, whether economic or not. Reserves below 5% not shown.



Mineral Resources

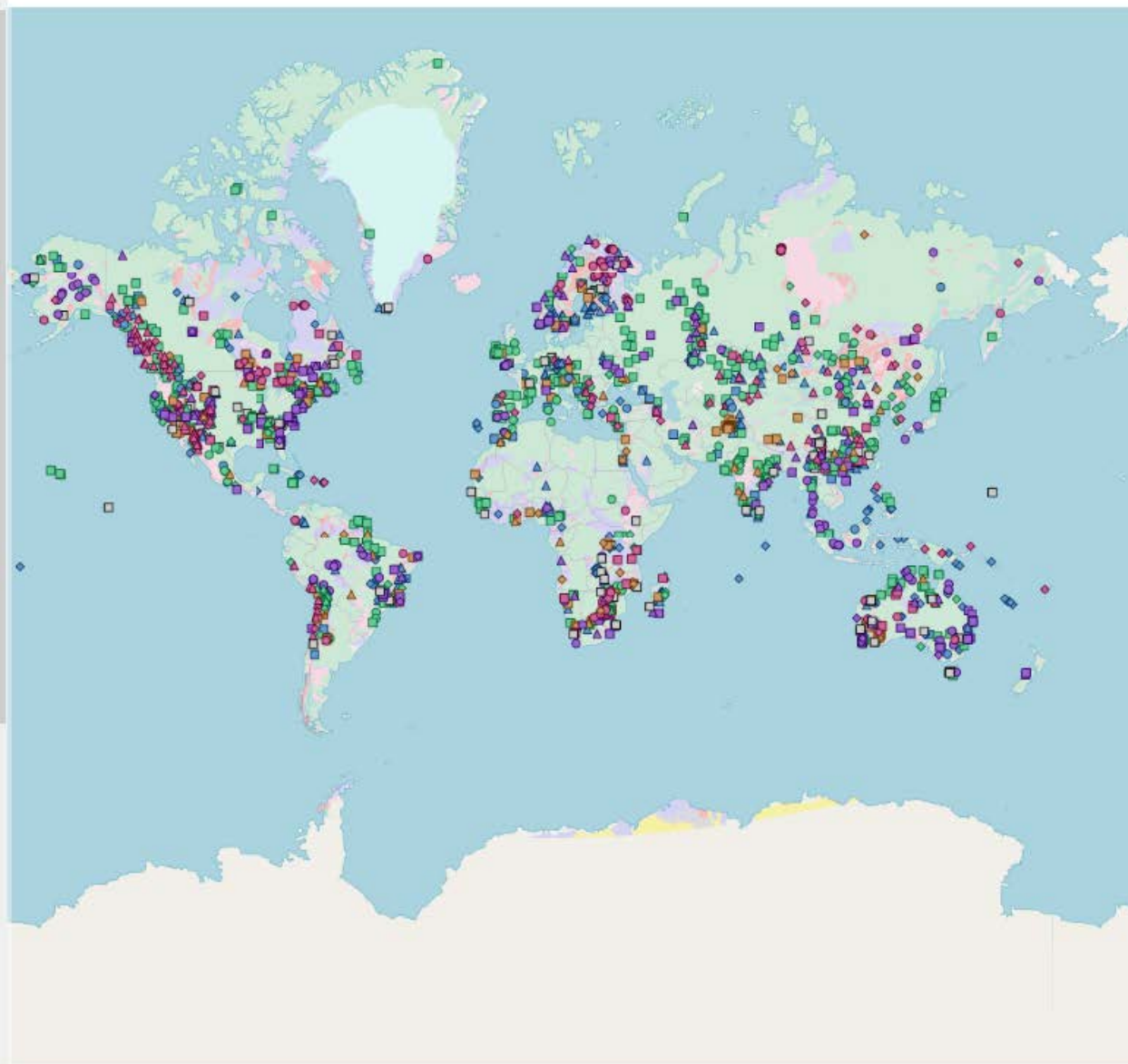
- ☐ Mineral resources (MRDS)
- ☐ Major mineral deposits of the world
- ☒ Critical minerals

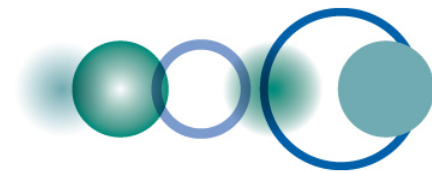
Global Cu Assessment

- ☐ Porphyry Cu permissive tracts
- ☐ Porphyry Cu deposits
- ☐ Sediment-hosted Cu permissive tracts
- ☐ Sediment-hosted Cu deposits

Mineral Deposit Types

- ☐ Volcanogenic Massive Sulfides
- ☐ Sediment-hosted Zn-Pb
- ☐ Sed-Ex and MVT
- ☐ Porphyry Cu
- ☐ Sediment-hosted Cu
- ☐ Ni-Cr PGE
- ☐ Carbonatites
- ☐ Rare Earth Elements
- ☐ Ni-Co Laterites
- ☐ Asbestos (US)
- ☐ Phosphates
- ☐ South Asian Phosphates
- ☐ Podiform Chromite
- ☐ Sediment-hosted Au
- ☐ Evaporite-hosted Potash





Mapping and Assessing the Performance of Extractive Industries

www.mapx.io
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