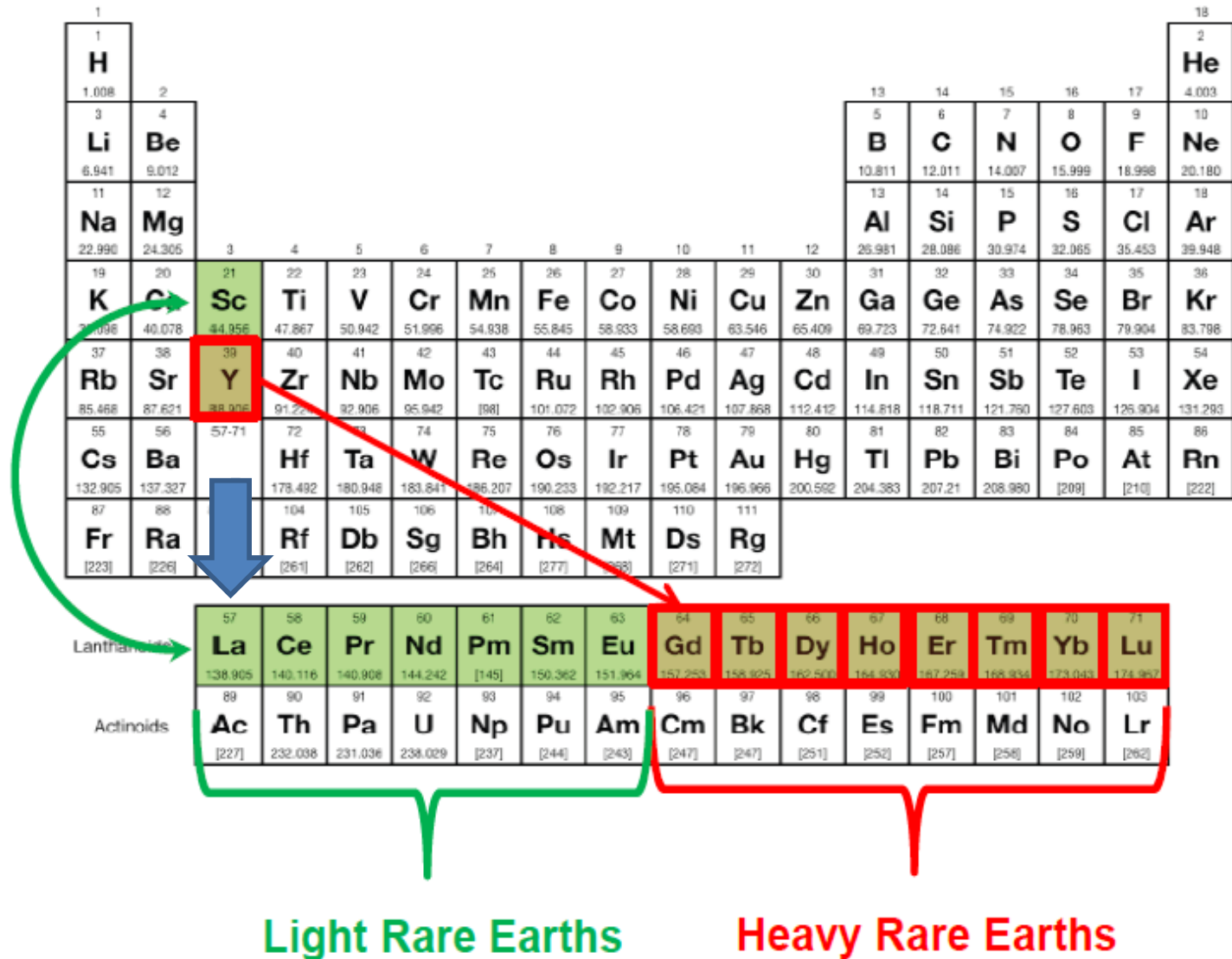


Recovery of REE from wastes of acid mine water treatment

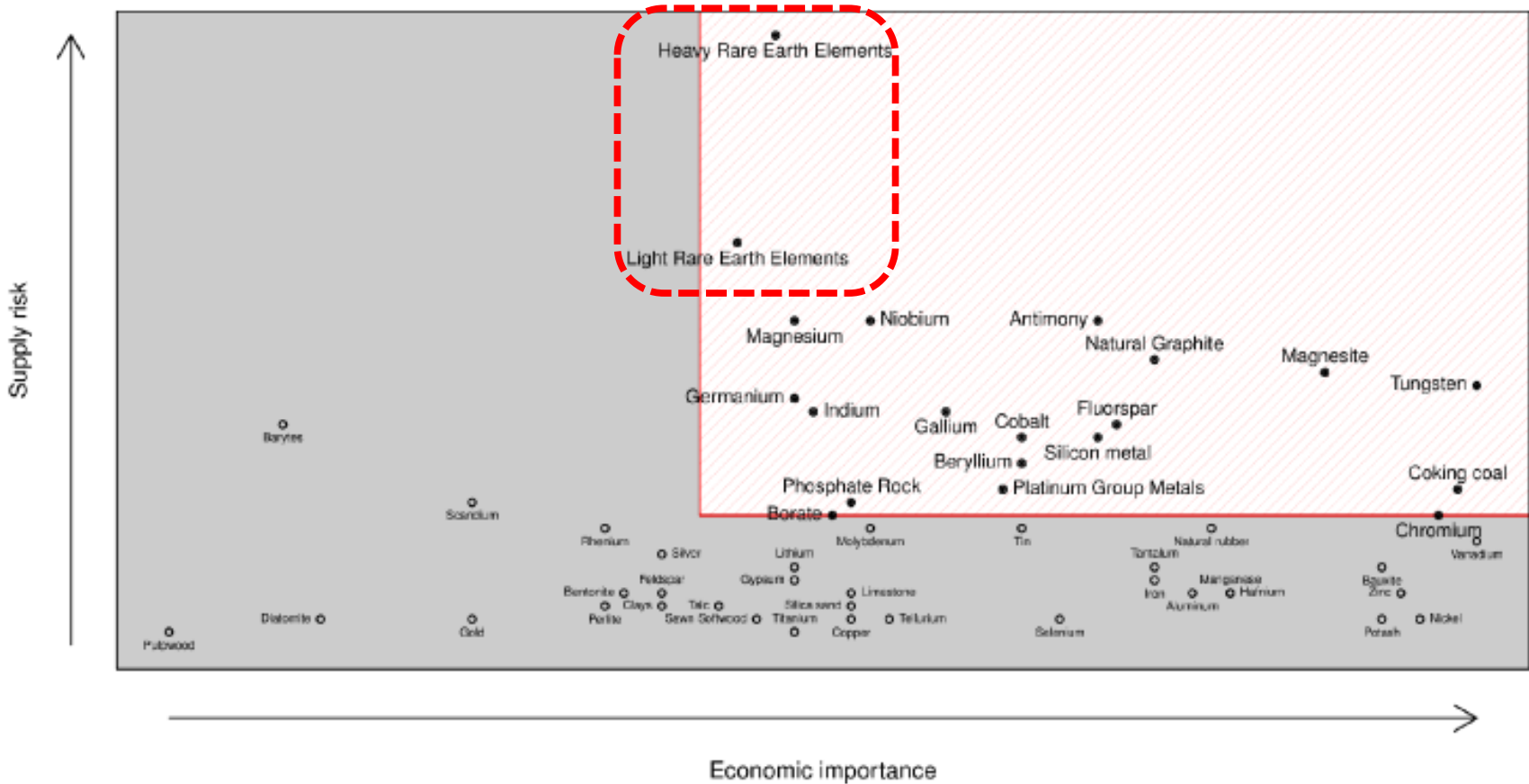
Carlos Ayora

Institute of Environmental Assessment and Water Research
CSIC, Barcelona

Rare Earth Elements

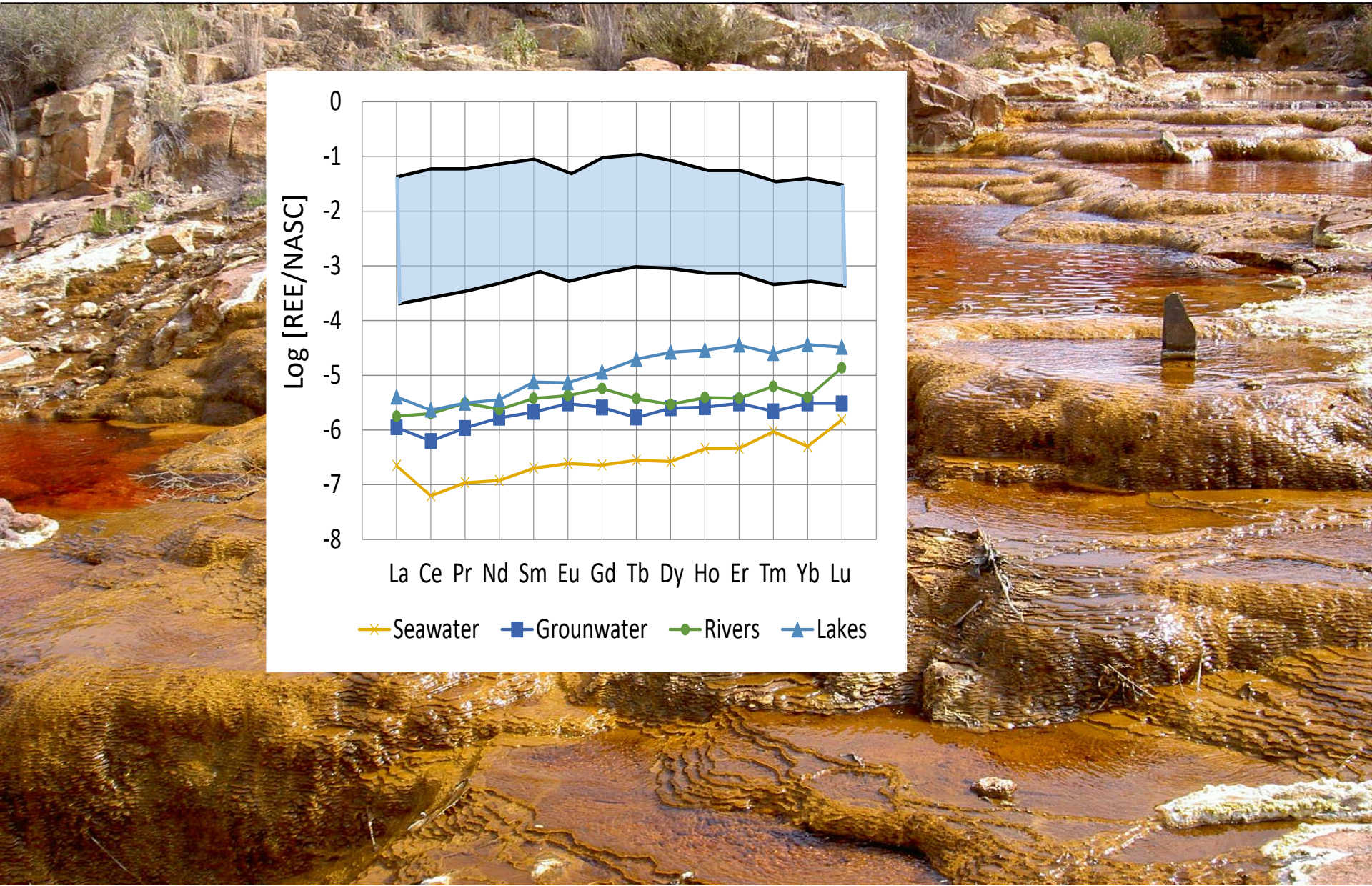
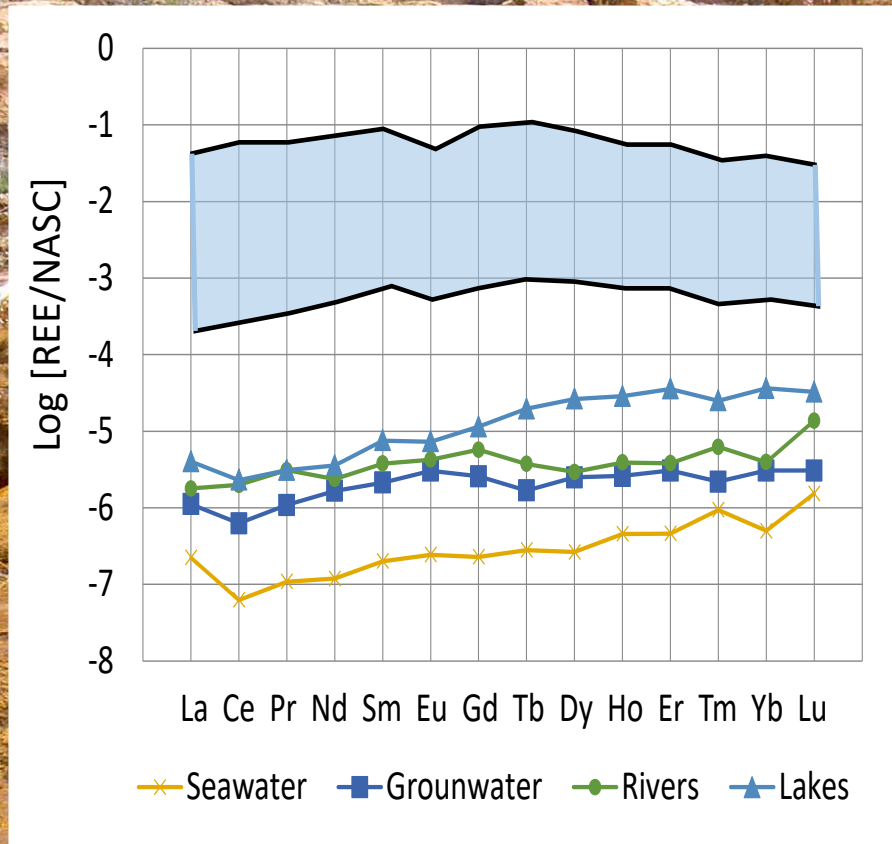


Rare Earth Elements

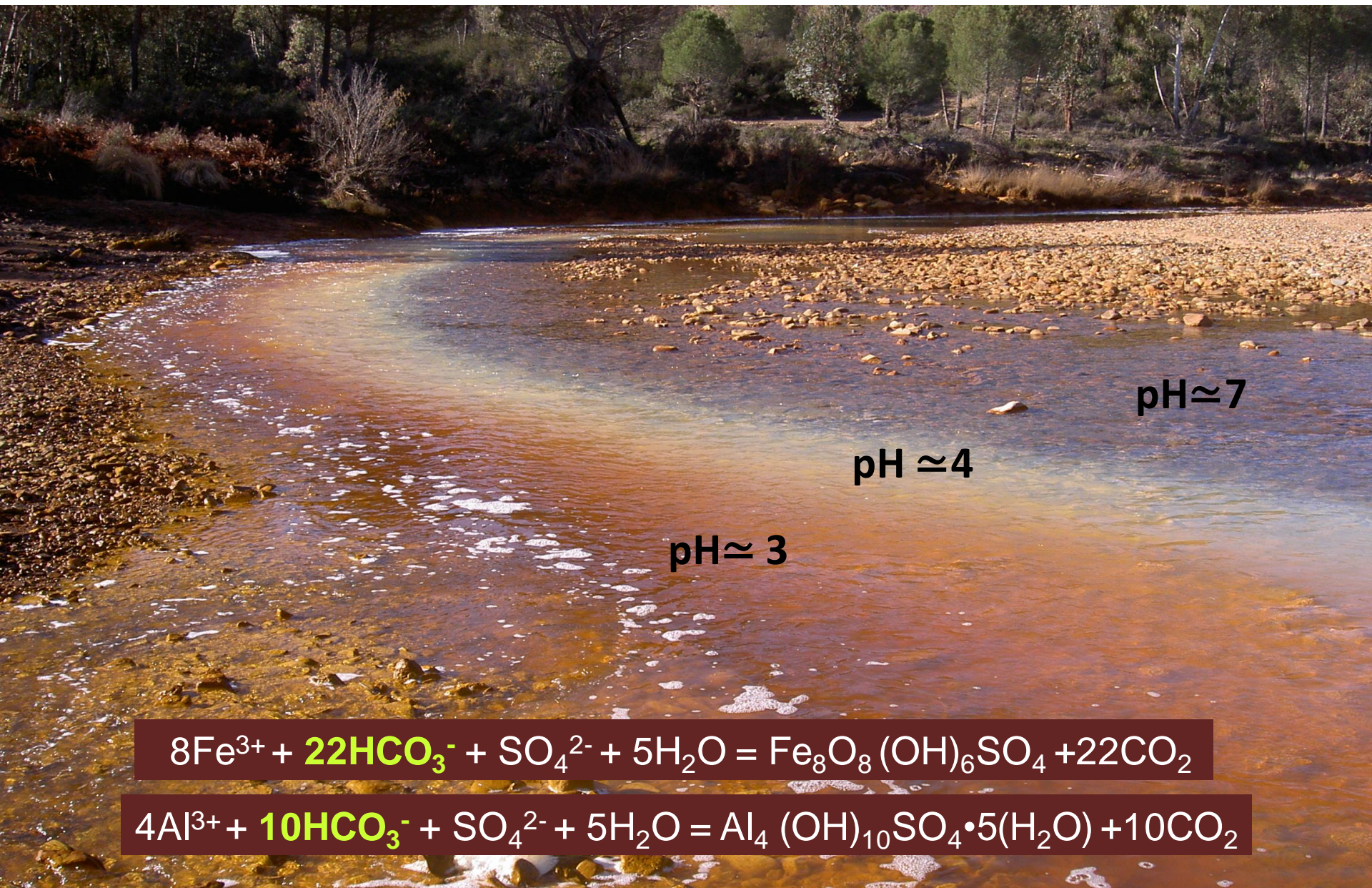


European Commission (2014). Critical raw materials for the EU Report of the Ad-hoc Working Group on defining critical raw materials. European Commission, Enterprise & Industry, May 2014.

Acid Mine Drainage



REE in mixing waters



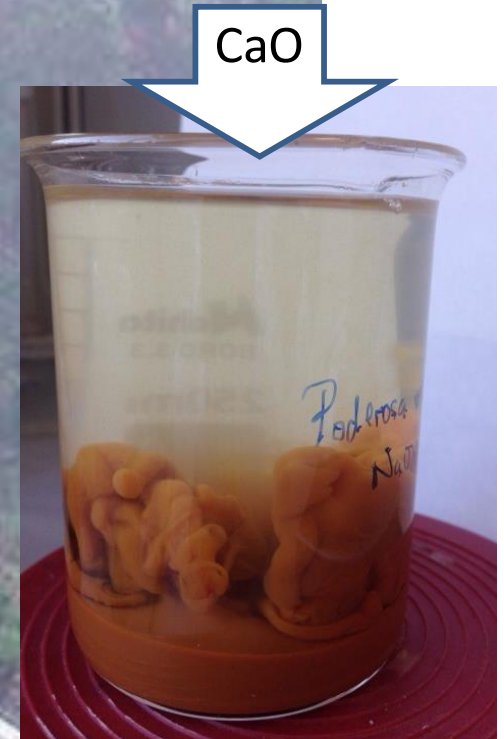
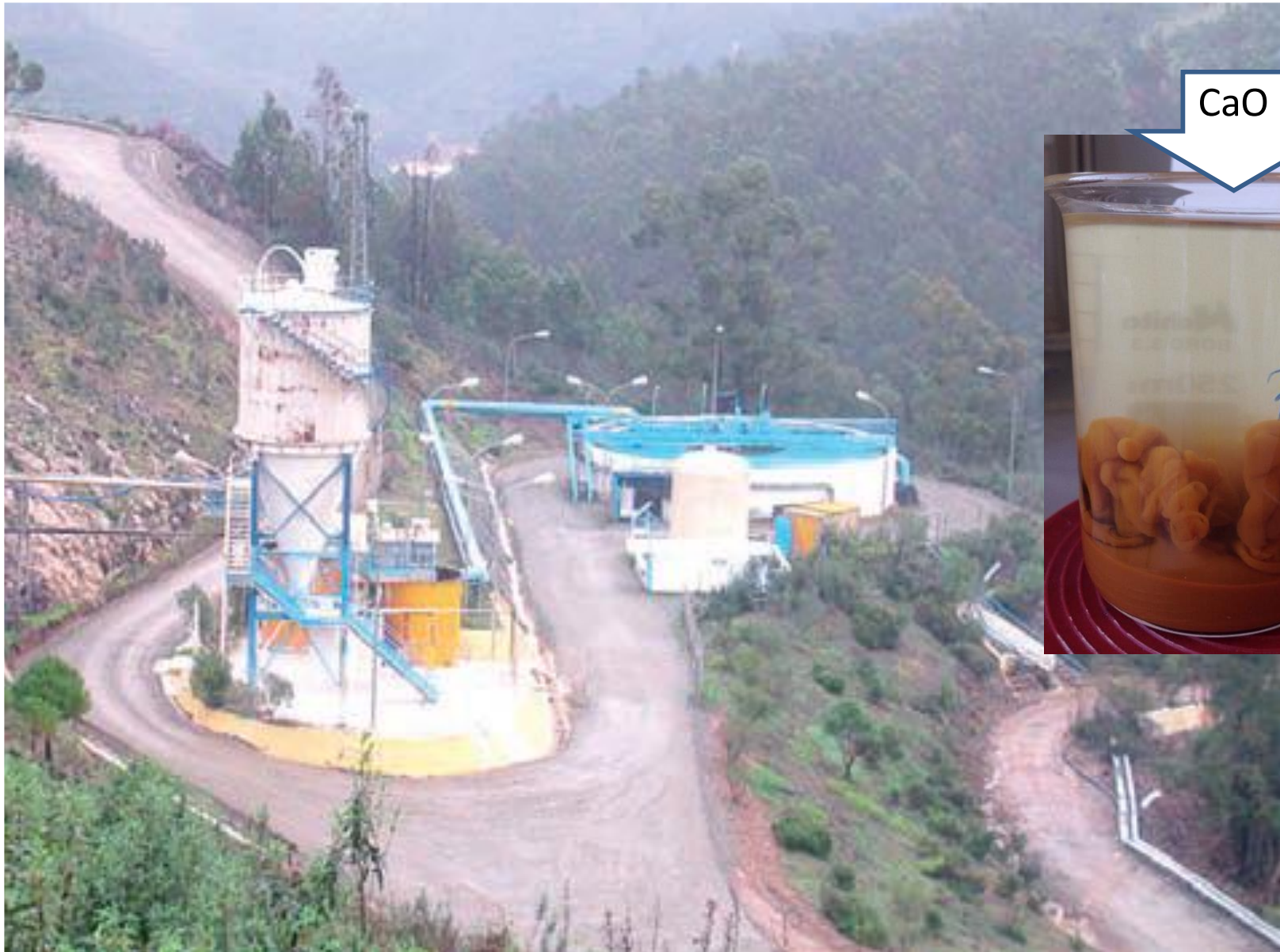
pH \approx 7

pH \approx 4

pH \approx 3



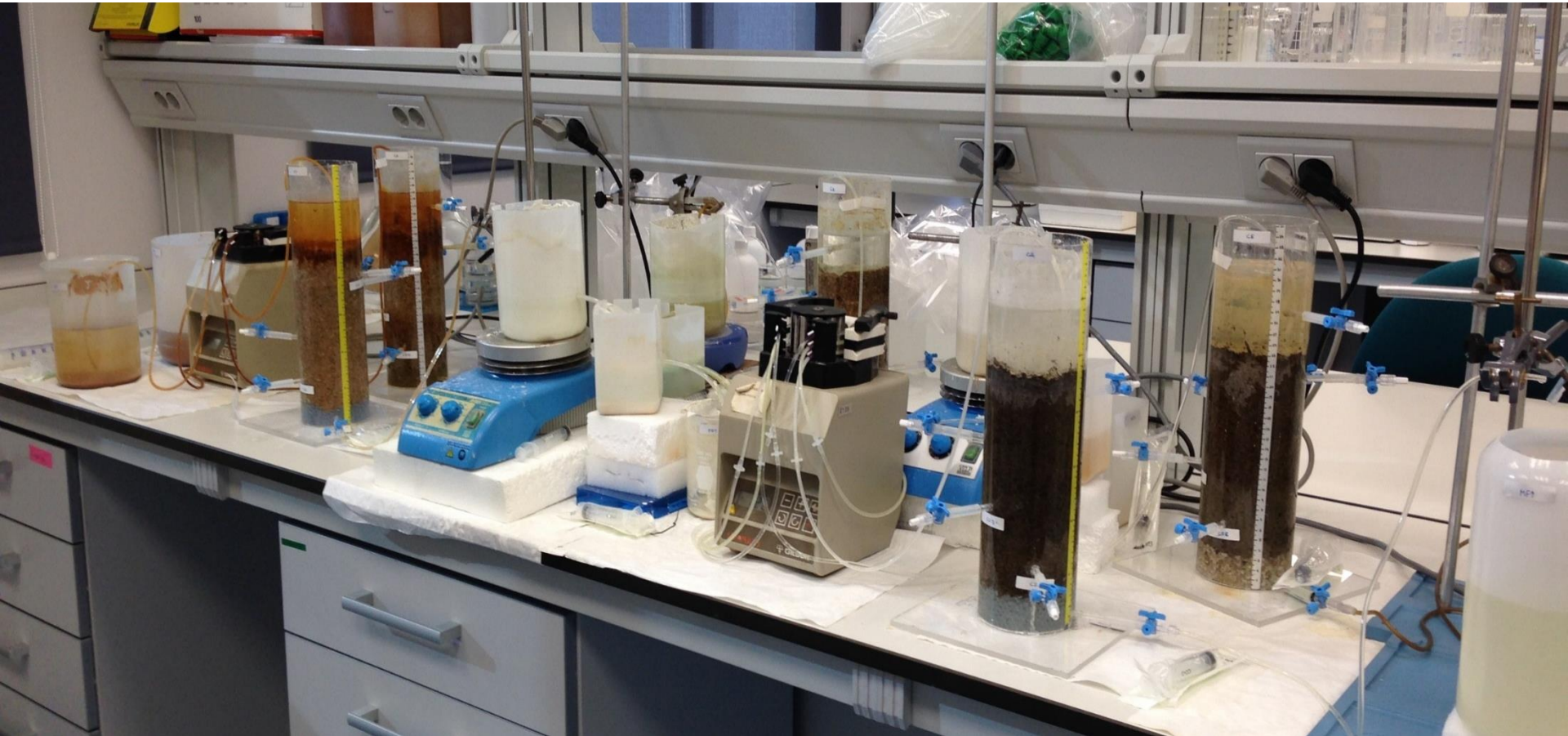
Mina Aguas-Teñidas treatment plant



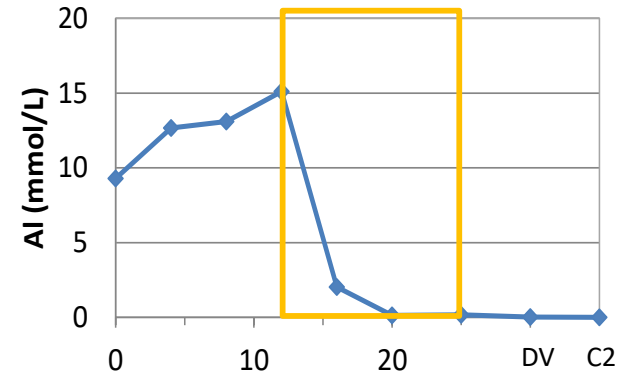
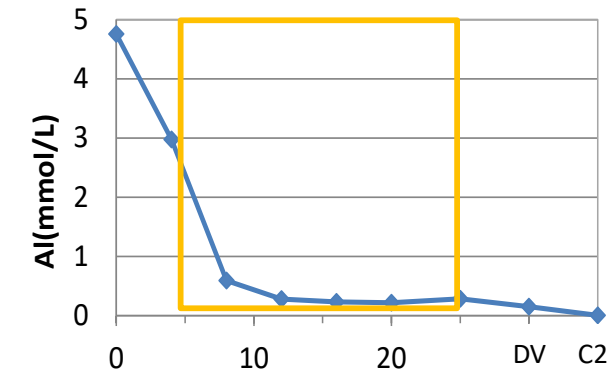
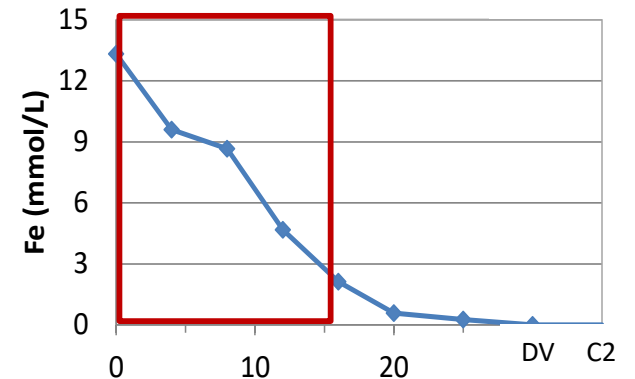
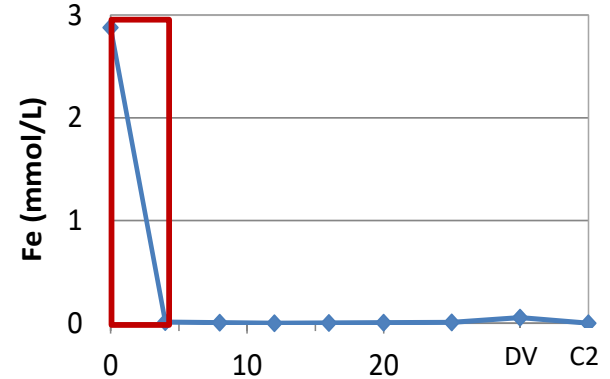
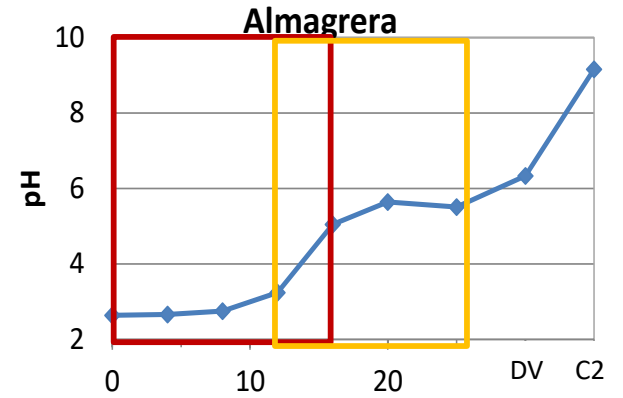
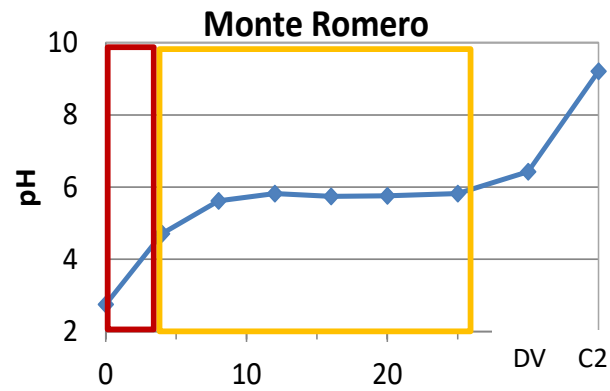
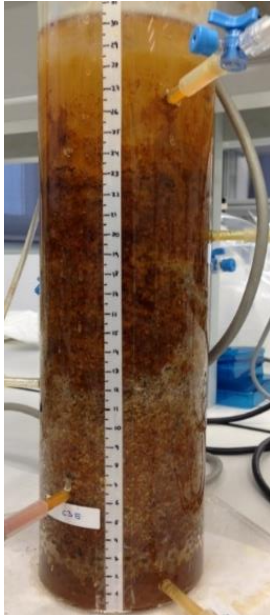
Mina Esperanza II passive treatment



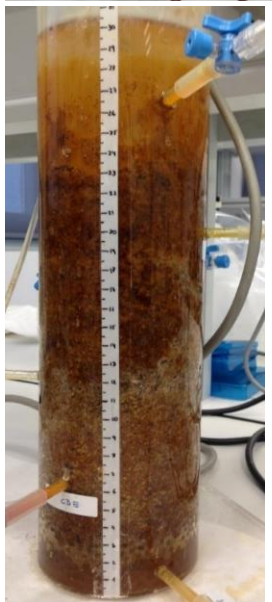
REE in passive treatments: column experiments



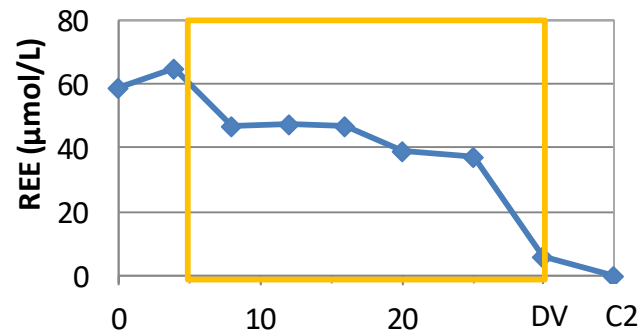
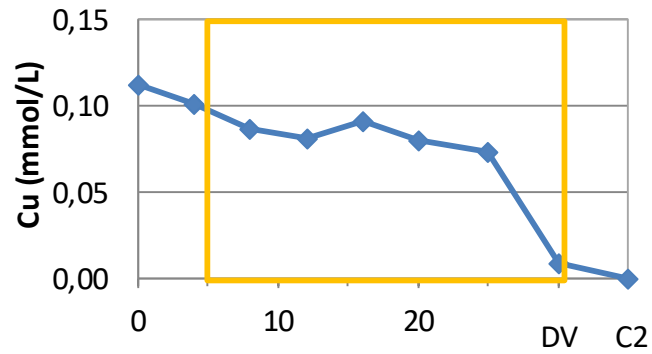
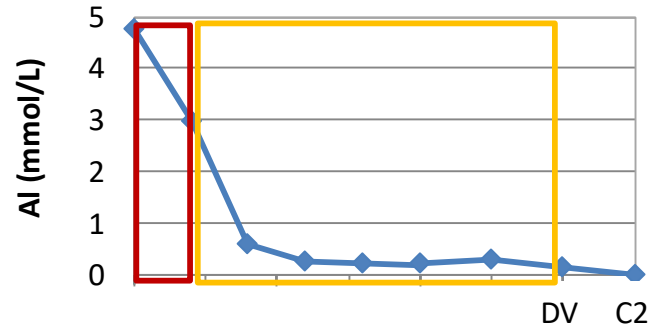
REE in passive treatments: column experiments



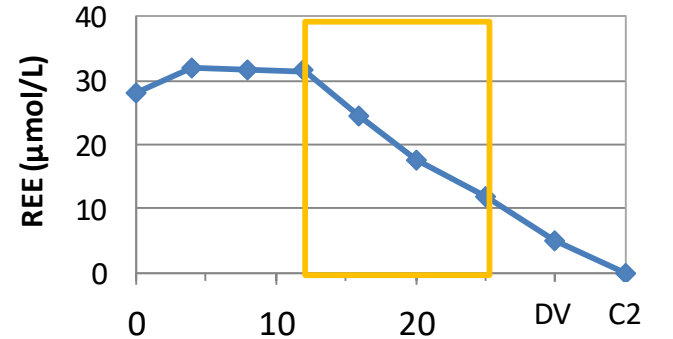
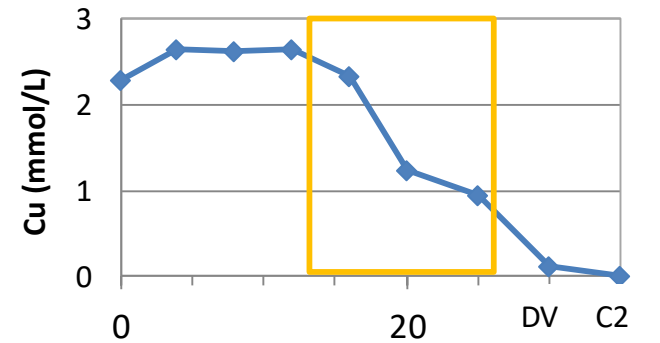
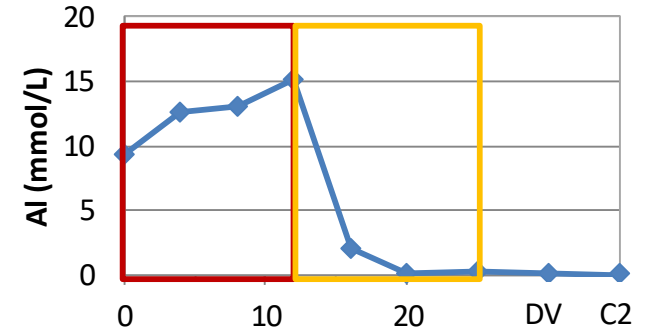
REE in passive treatments: column experiments



Monte Romero

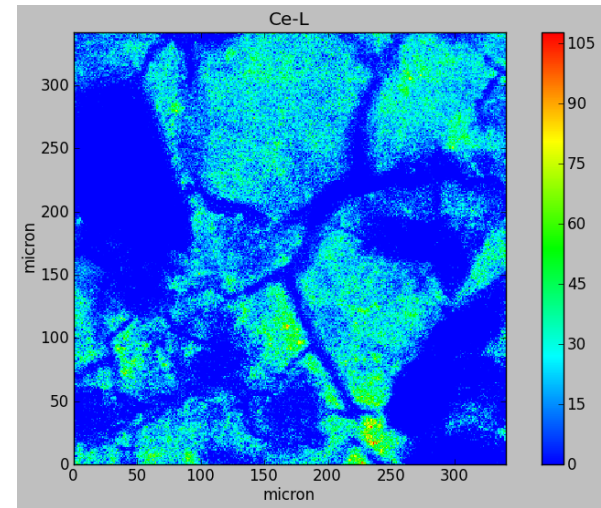
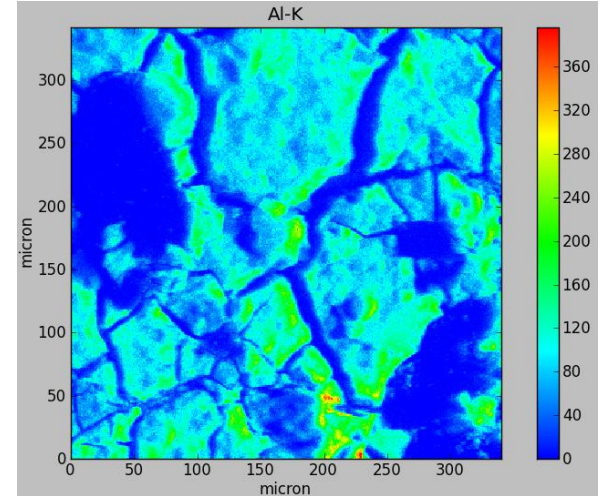
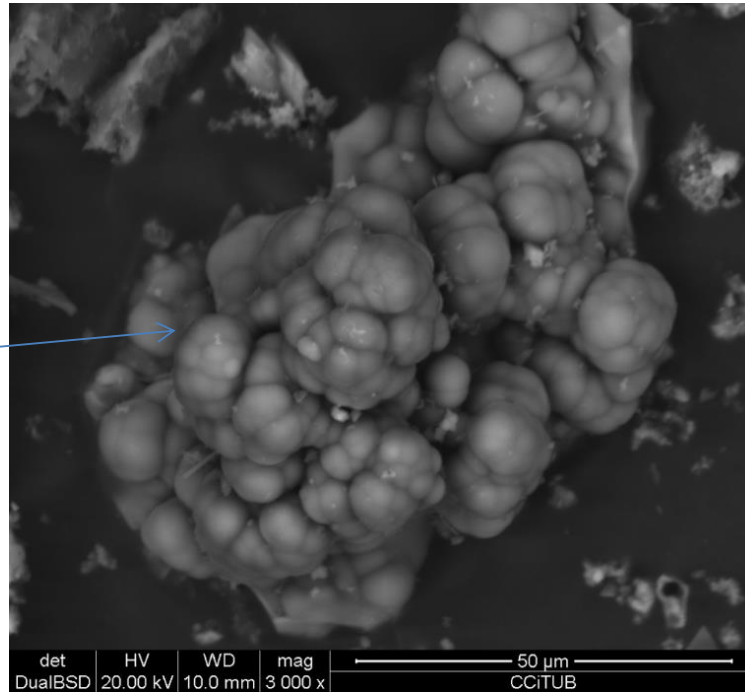
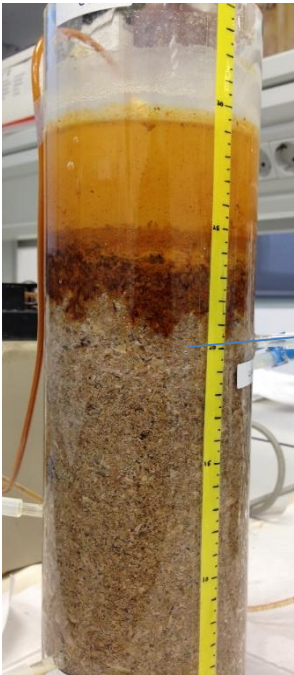
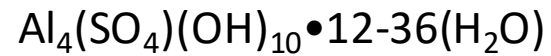


Almagrera



REE in passive treatments: column experiments

Basaluminite

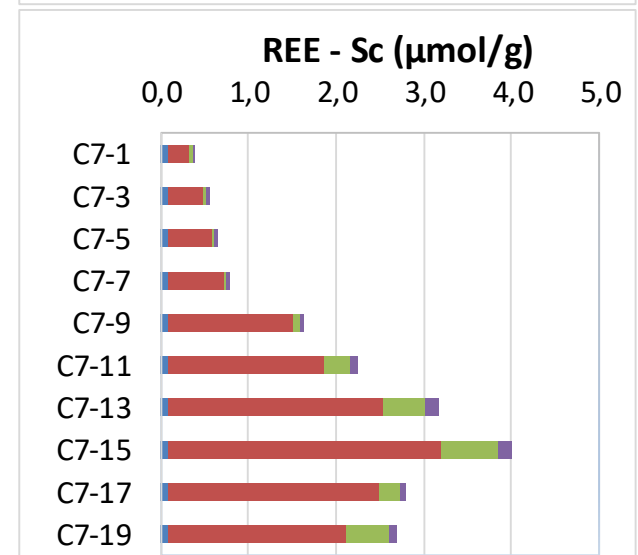
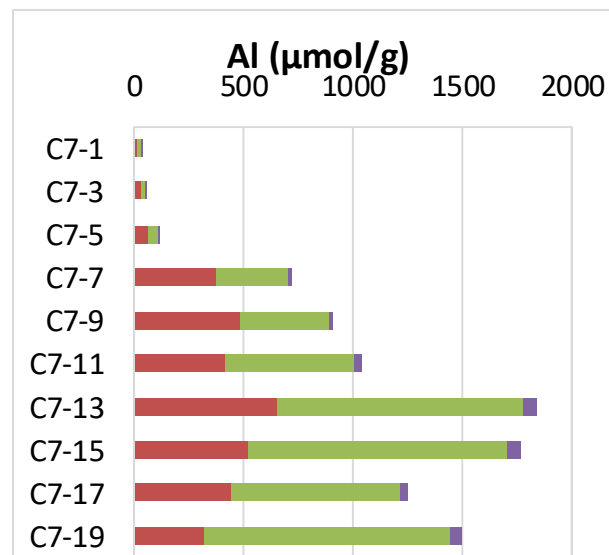
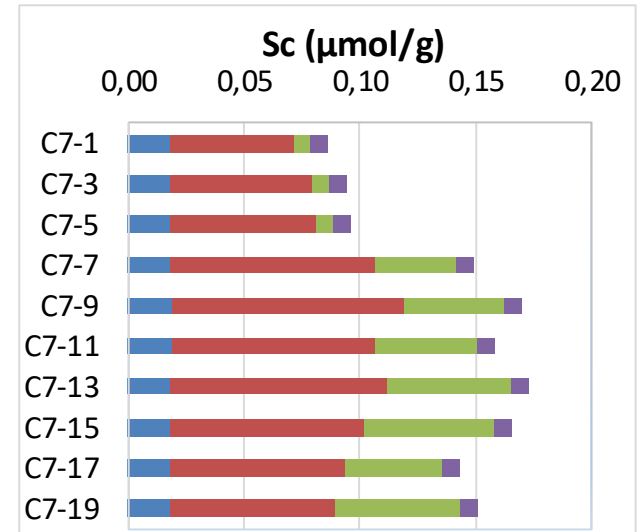
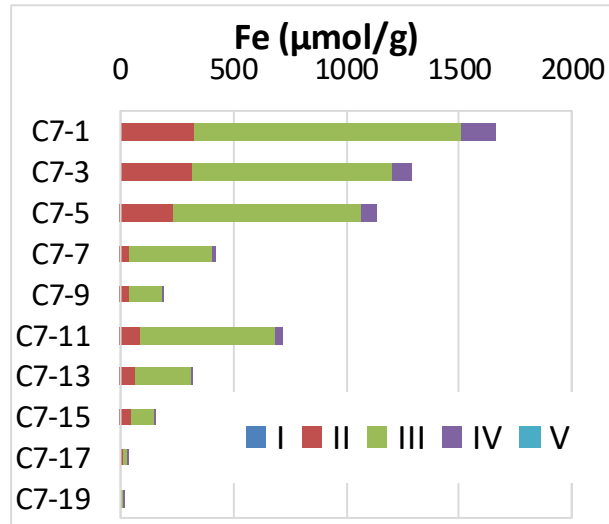


Incident energy 7.05eV, 1x1μm pixel, counts/100ms

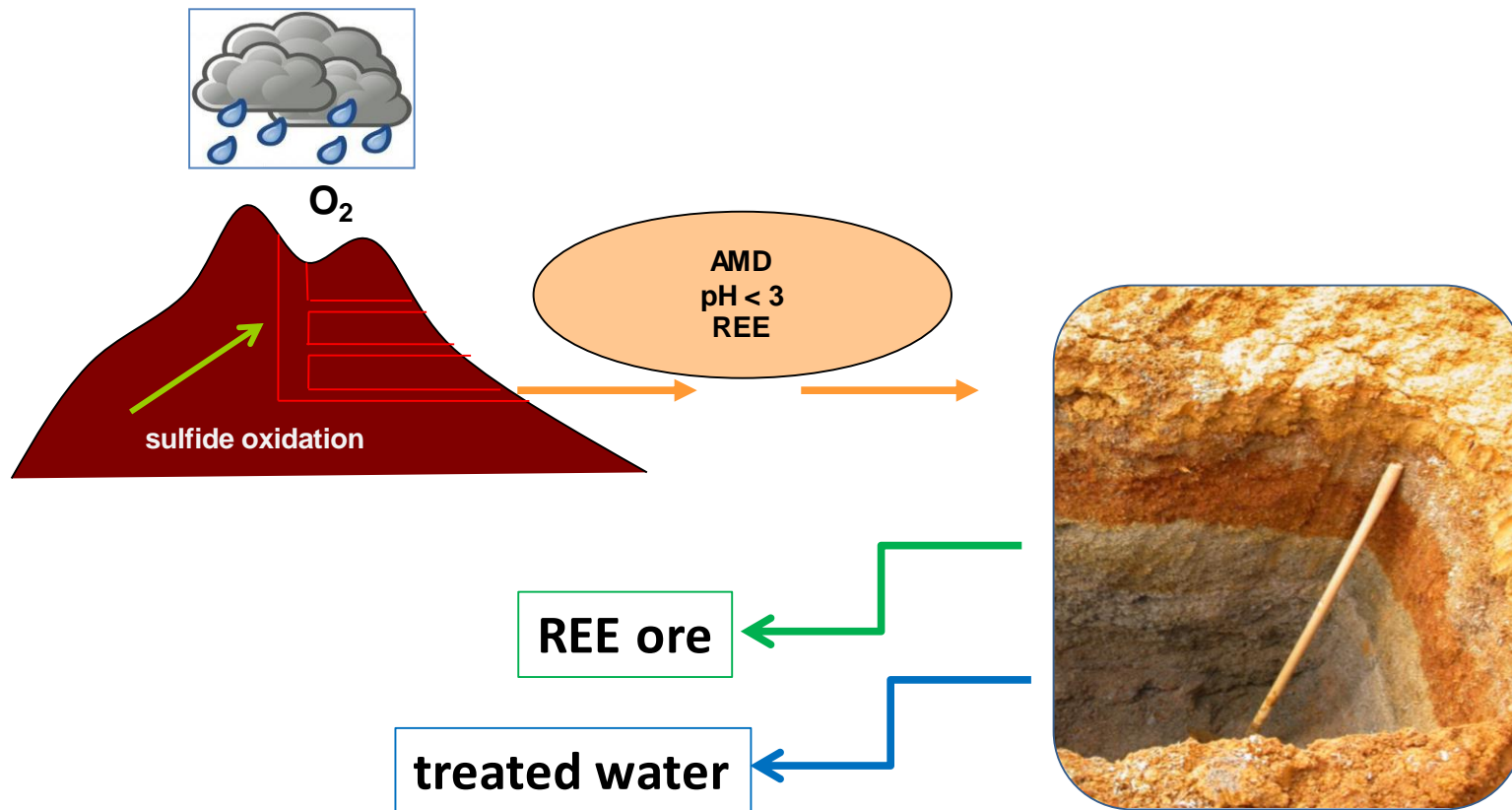
REE in passive treatments: column experiments

Sequential
Extractions

Mina Poderosa



REE at field-scale: continuous cycling



REE at field-scale: heap leaching

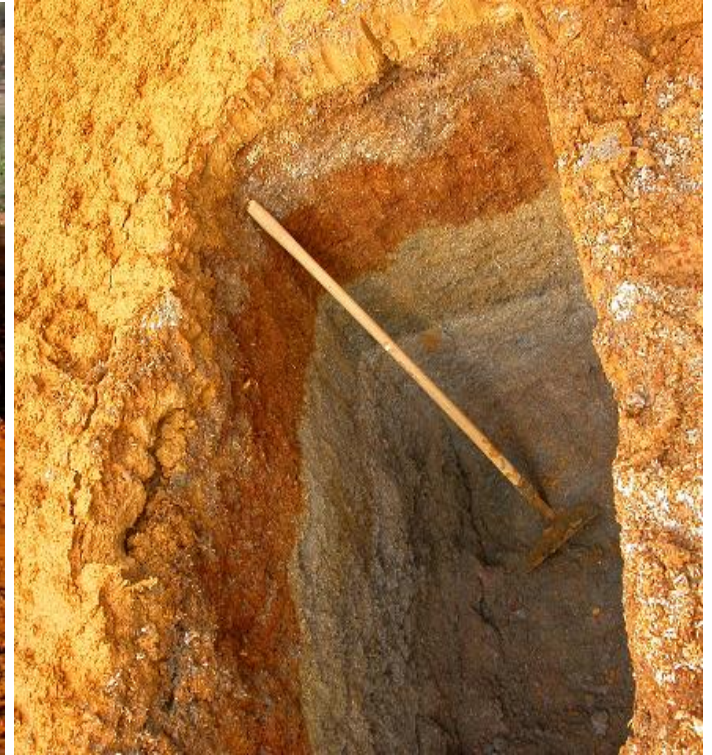


G. Agricola (1556) De re metallica



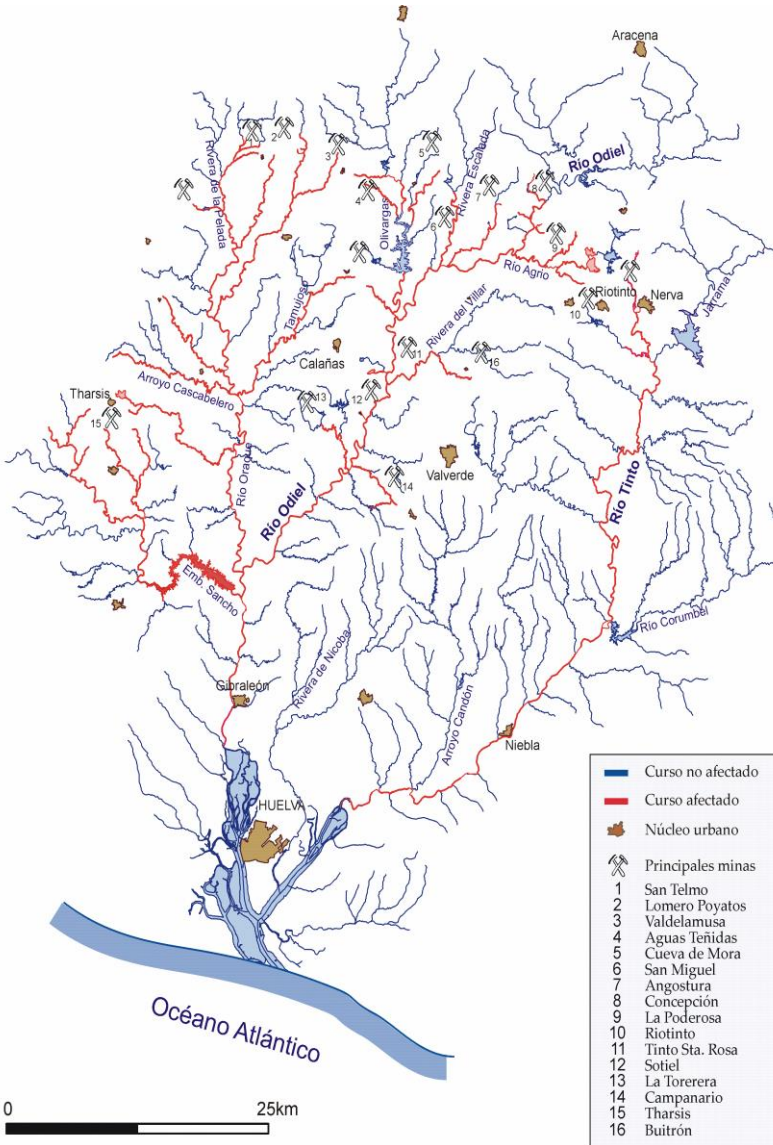
Cuajone Cu mine, Chile

REE in field-scale passive remediation systems



	Q (L/s)	Al mg/L	REY mg/L	Al t/y	Basal t/y	REE t/y	REE ₂ /O ₃ t/y	Calculated rate %	Measured rate %
Mina Esperanza	1	148.1	0.9	4.67	20.08	0.03	0.04	0.17	0.30
Mina Monte Romero	1	134.9	7.4	4.25	18.28	0.23	0.30	1.65	1.44

AMD from Iberian Pyrite Belt

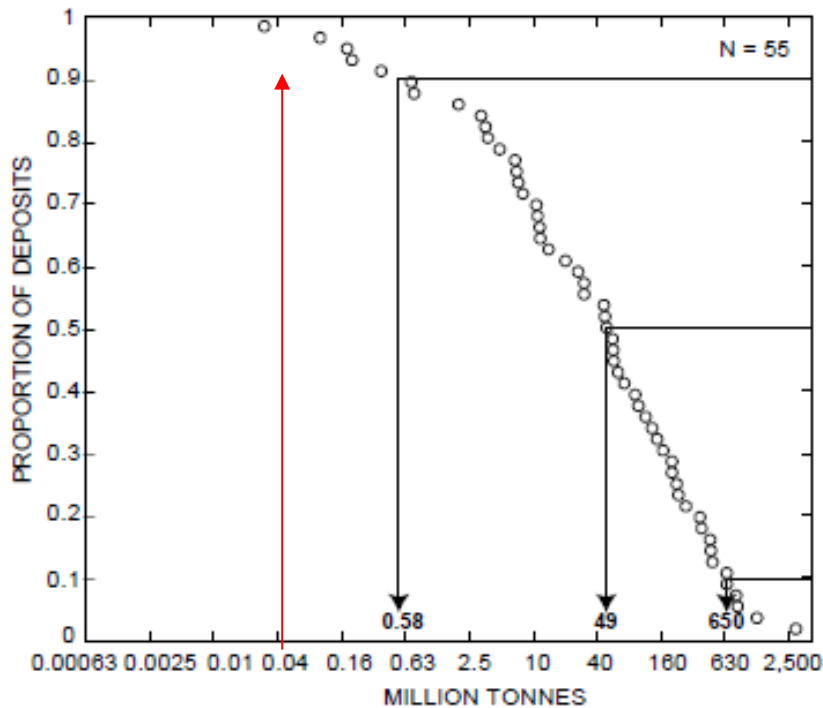


Extrapolation from 40 AMD sources with variable REE content:

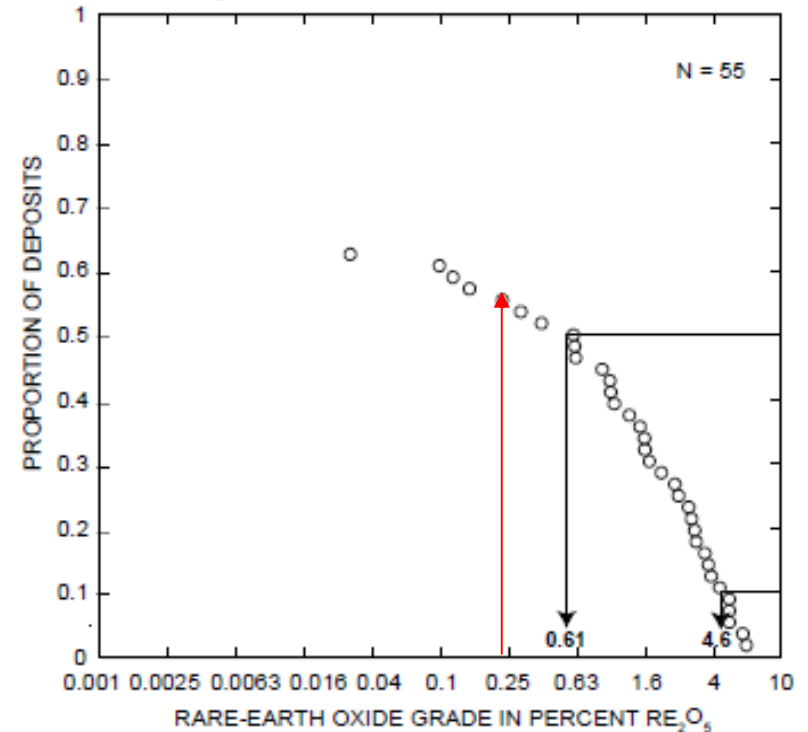
- 40 kton/year of Basaluminitite
- **100 ton/year of REY_2O_3**
- REY_2O_3 grade: 0.23%



REE in Iberian Pyrite Belt



40.000 t/y basaluminite



0.23 % RE₂O₃

REE in Iberian Pyrite Belt

World Mine Production and Reserves: Reserves for Russia were revised based on Government reports.

	Mine production ^e		Reserves ⁹
	<u>2017</u>	<u>2018</u>	
United States	—	15,000	1,400,000
Australia	19,000	20,000	¹⁰ 3,400,000
Brazil	1,700	1,000	22,000,000
Burma (Myanmar)	NA	5,000	NA
Burundi	—	1,000	NA
China	¹¹ 105,000	¹¹ 120,000	44,000,000
India	1,800	1,800	6,900,000
Malaysia	180	200	30,000
Russia	2,600	2,600	12,000,000
Thailand	1,300	1,000	NA
Vietnam	200	400	22,000,000
Other countries	—	—	4,400,000
World total (rounded)	<u>132,000</u>	<u>170,000</u>	<u>120,000,000</u>

Iberian Pyrite Belt

100 t/y REE₂O₃

renewable

CONCLUSIONS

AMD could be a supplementary source of REE

- the rates are comparable-smaller than exploration targets
- the annual tons are small
- the reserves are renewable
- do not contain U-Th

Mining these resources improves the environment:

- it improves the quality of water for other uses (agriculture)
- it improves the downstream ecosystems

Socially acceptable:

- it can be mined by small companies from the region
- it does not modify the landscape



Kiitos!