

The Biorecover project: Remining Technologies to Create Novel Critical Raw Material Value Chains

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BIORECOVER
Raw Materials. Sustainable. Safe

(Re)Mining Extractive Waste

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The Biorecover Project

Developing novel biotechnologies for the recovery of critical raw materials from extractive waste streams (from TRL 2 to TRL5)

- **14 project partners from across Europe and South Africa**
 - Mining, microbiology, chemistry, engineering, process development, and automotive OEM
- **Rare earth elements from bauxite residues**
 - Greek aluminum producer supplying feedstock to recover Sc, Y, and REE concentrate for use in high performance alloys and ceramics (bioleaching with siderophores, recovery via microcapsule columns)
- **Platinum Group Metals from low grade ores and industrial byproducts**
 - South African mines and Catalyst manufacturer providing feedstocks to recover Pt and Pd for use in catalysts (bioleaching with cyanogenic bacteria, recovery via engineered proteins or microalgae sorption)
- **Magnesium metal from low grade magnesite ores**
 - Spanish magnesium oxide mine supplying low grade ores for recovery of Mg metal for use in light weight applications and specialty alloys (fungal bioleaching)



Value Chain Impact Assessment

- Modeling current value chains for target raw materials
 - Exploration - Mining – Processing – Distribution – End Uses
 - Building on results of Circular Value Proposition workshop
- Stakeholder mapping to identify key actors in European industry and investigate their ability to extract rent at each stage of the value chain
- Modeling updated value chains if Biorecover process is adopted commercially
 - Emphasis on how stakeholders' business models and market dynamics will evolve
- Ongoing dialogue with industrial partners and experts working in the metal industry

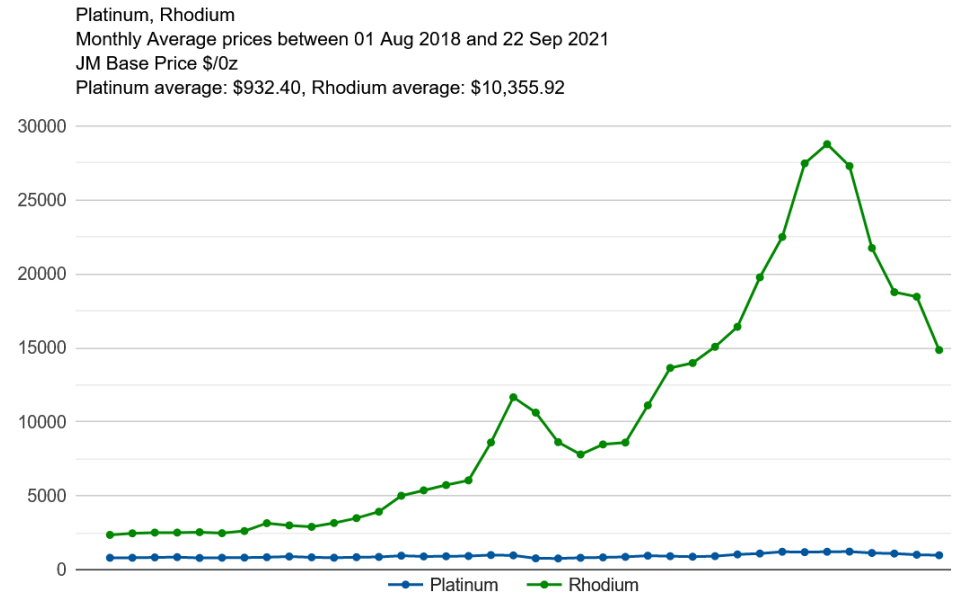
Some quick results – PGM Value Chain



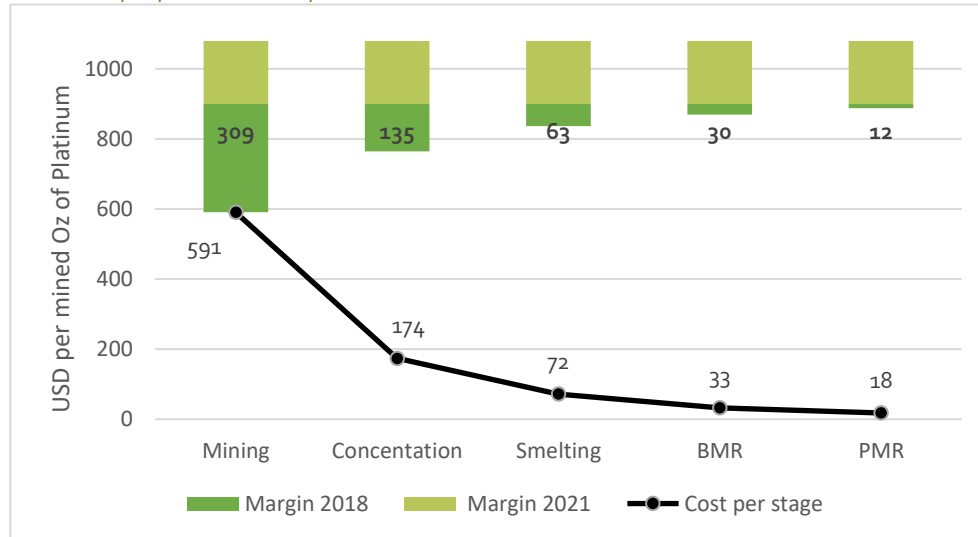
- Geological concentration of resources in South Africa & highly price inelastic demand for co-produced metals allows upstream metal producers to capture value
- Remining with Biorecover could marginally reduce costs of production by processing low grade ores that have already been extracted

Company	Profit Margin 2021	Profit Margin Change 2017 - TTM 2021
Sibanye Stillwater	33%	162%
Anglo American	44%	-3%
JM	7%	-5%
Umicore	9%	-9%
Toyota	18%	-2%
VW	17%	-10%

Source: 10-K filings of companies listed



Source: <https://platinum.matthey.com/>

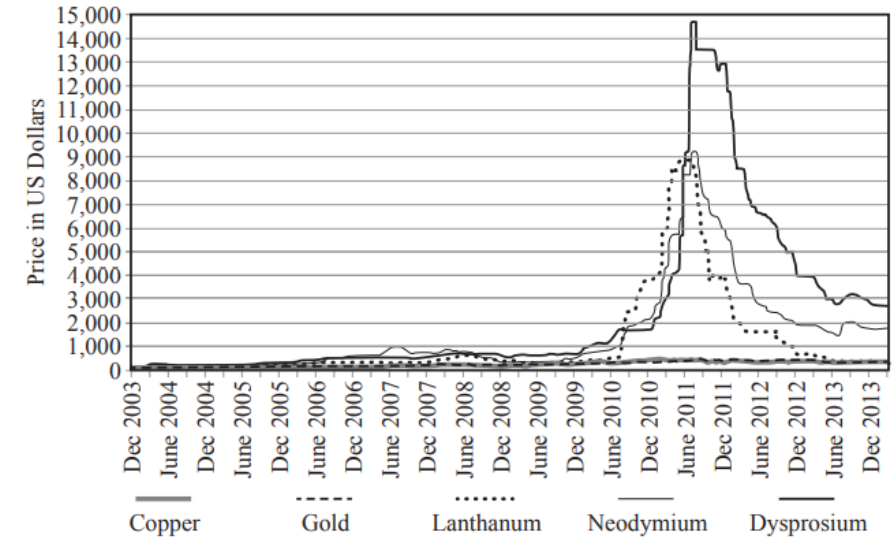


Source: Author and <https://www.angloamerican.com/investors/investor-presentations>

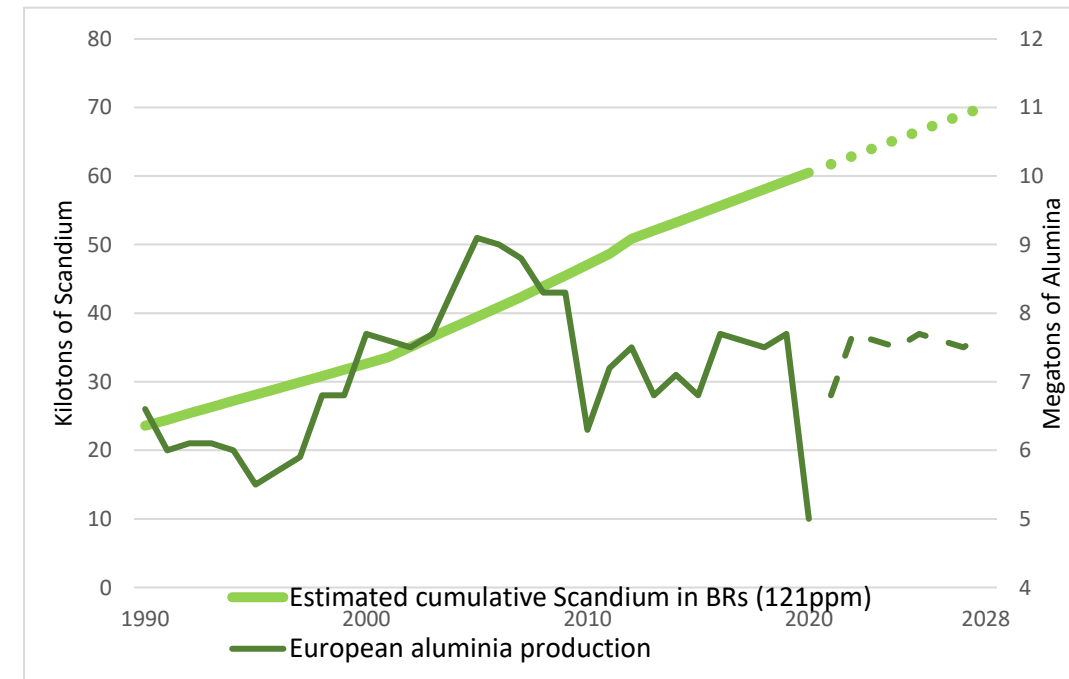
Some quick results – REE Value Chain



- Global market dominated by vertically integrated Chinese value chain - shifting from extraction monopoly towards high-value downstream processing and industrial applications
- Creating a novel European Scandium value chain will require collaboration between supply and demand side (chicken and egg problem)
- Re-mining bauxite residues has a high potential to generate positive environmental, social, and economic impact
 - High concentration of Sc in readily available feedstock
 - Need to generate break-even revenue to valorize BR
 - Symbiosis between Al and Sc industries



Source: Klinger, Julie Michelle. *Rare earth frontiers: From terrestrial subsoils to lunar landscapes*. Cornell University Press, 2018.





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Thank you for your attention!



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