Meeting our future mineral resource needs sustainably: A socio-technical transitions perspective

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An update on my PhD project - work in progress...

...with special thanks to my friends in the geoethics community for their support and encouragement
We will continue to need metals and other mineral resources...

...for low-carbon energy and transport, smart technologies, global development...

...but the social and environmental impacts of mining can be enormous
Mineral supply chains are long, complex and opaque – so how can miners, manufacturers, investors and consumers cooperate?
Many responsible mining/supply schemes...

...but these are rarely visible far down the supply chain, let alone by consumers!
Responsible sourcing

• Manufacturing companies looking to de-risk their supply chains (‘supply chain due diligence’) – or even to leverage them to effect wider positive change

• Upstream intermediaries put under pressure to meet customer demand for higher standards

• An emerging shared priority – but not (usually) joined up with responsible mining

• Should include ‘secondary resources’ (from recycling, etc) – but rarely considered together
A circular economy?

Design/manufacture

Recycling sector

Retailer

Re-use/repair/recycling

Consumer/householder/LAs

Clue: something is missing from this picture!
So why not just recycle?

Ironbridge, 1781 – residence time of resources in infrastructure can be long!

...achieving these goals will require minerals resources too!
A (more) realistic circular economy model
A (more) realistic circular economy model

Aha! The need for material inputs to the circular economy is recognised – but still a marginal externality to be minimised...
Moving towards a circular economy

Core principles:
• Preserve and enhance natural capital
• Optimise resource yields
• Foster system effectiveness

Building blocks or stumbling blocks?
• ‘Circular design’
• Transforming business models
• Decoupling value creation mechanisms from consumption of finite resources
Responsible mining and the circular economy – shared principles and drivers

• Maximising resource efficiency (including energy and water inputs, resource recovery rates, benefit derived per unit of resource)

• Minimising waste (and its impacts), and extracted resources from waste streams

• Material stewardship – from the ground, through the supply chain and (multiple loops of) usage to end of life

• Common need for traceability and certification of materials

• Decoupling resource-dependent products, services and activities from their (negative) social, environmental and economic impacts

• Need to rethink traditional business models and identify new value creation opportunities

• Need to match (business-oriented) actor objectives with (sustainability) system objectives
Responsible mining and the circular economy – shared opportunities

• Extraction of resources from mine wastes (including tailings, waste rock, mine waters) ‘in real time’, i.e. as they are produced

• Extraction of resources from legacy mine wastes

• Applying mining know-how to ‘end-of-life’ resource recovery (e.g. the ‘urban mine’)

• Co-production of mineral resources with other resources (other metals, energy...)

• Co-processing of multiple waste/resource streams, e.g. CEReS project – exploring opportunities to use acidic metal-rich run-off from coal mining waste to recover copper from e-waste

• Innovation in energy and water efficiency, waste minimisation, etc...
A holistic view of responsible mineral resource management – can we bring these elements together?

Circular economy / secondary resource production / recycling etc

Linear supply chains / primary resource production / mining
My theoretical and structural framework

• Socio-technical sustainability transitions

• ‘Multi-level perspective’ (MLP – see next slide) – but with an open mind about structures and mechanisms, given this is a novel area of application

• ‘Toolbox’ of themes and concepts from multiple literatures – socio-technical transitions (including re linked/nested transitions), circular economy, sustainable supply chains, sustainable mining

• Initial mapping of what the transition to a (more) sustainable new minerals economy should look like, and system-level drivers and objectives (sample images only shown here)
Socio-technical transitions and the multi-level perspective

• Socio-technical configurations – technologies embedded with actor practices, regulation, industry networks, markets, meanings...

• ‘Lock-in’ and path dependency – how can radical new technologies emerge and break through?

• Multi-level perspective (MLP) – interaction of protected innovation 'niches', which are shaped by (but may break through into) socio-technical regimes, which in turn interact with wider political, social and economic landscapes – see Geels (2002) and many subsequent publications

• Initially mostly applied to energy and transport

• More recent work has broadened this focus, questioned (over-specified and under-determined) mechanisms, and considered additional factors and alternative modes of change

• Health warning – not previously applied to mineral resources, so some mechanisms/theory may not apply...

Research approach

• 3 case studies – organisations in different parts of the ‘resources ecosystem’ with a commitment to responsible/sustainable sourcing and supply of minerals (metals) from mined and CE sources:
  • A mining company (also involved in developing CE activities)
  • A global technology (services and manufacture) company
  • Aluminium Stewardship Initiative (certifies sustainability standards across the whole supply chain, including reprocessing/recycling)

• How are they working towards more sustainable sourcing, supply and stewardship of mineral resources (current and planned activities)?

• What are the drivers, barriers, dependencies, opportunities and risks?

• Interviews within lead organisations and across their networks; documentation
Abductive analysis

• Combines deductive and inductive approaches
• Iterative...
  • ...emergent concepts and themes from my data
  • ...a priori concepts and themes from literature (socio-technical transitions, but also from other relevant bodies of literature, e.g. circular economy, sustainable production and consumption, supply chain due diligence)
• ‘Pattern matching’ or ‘double-fitting’ of observations and elements of theory
• Feed back to further data collection (new and existing interviewees), further data analysis, further theory searching
• How can emerging theory inform understanding of observations and cases?
• How can observations, and concepts and themes derived from these, inform theory?
Expected outputs

• Theoretical:
  • Initiate development of a socio-technical sustainability transition framework for mineral resources, to support future research and practice
  • Contribute to wider theoretical and methodological debates in transitions scholarship, especially with respect to novel areas of application

• Practical:
  • Refine ‘mapping’ of the transition to a sustainable new minerals economy – an empirically and theoretically informed picture of what it should look like and how we should be trying to get there
  • Improve understanding of potential transition pathways for case study organisations and relationship to emergent system-level transition pathways
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