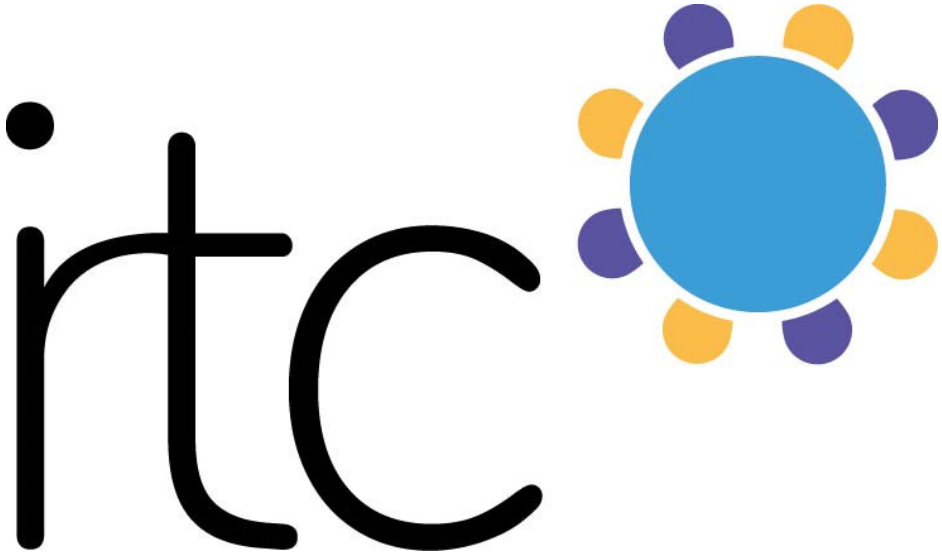
HOW METHODOLOGY DETERMINES WHAT IS CRITICAL



June 19, 2018

Resources for Future Generations Conference, Vancouver

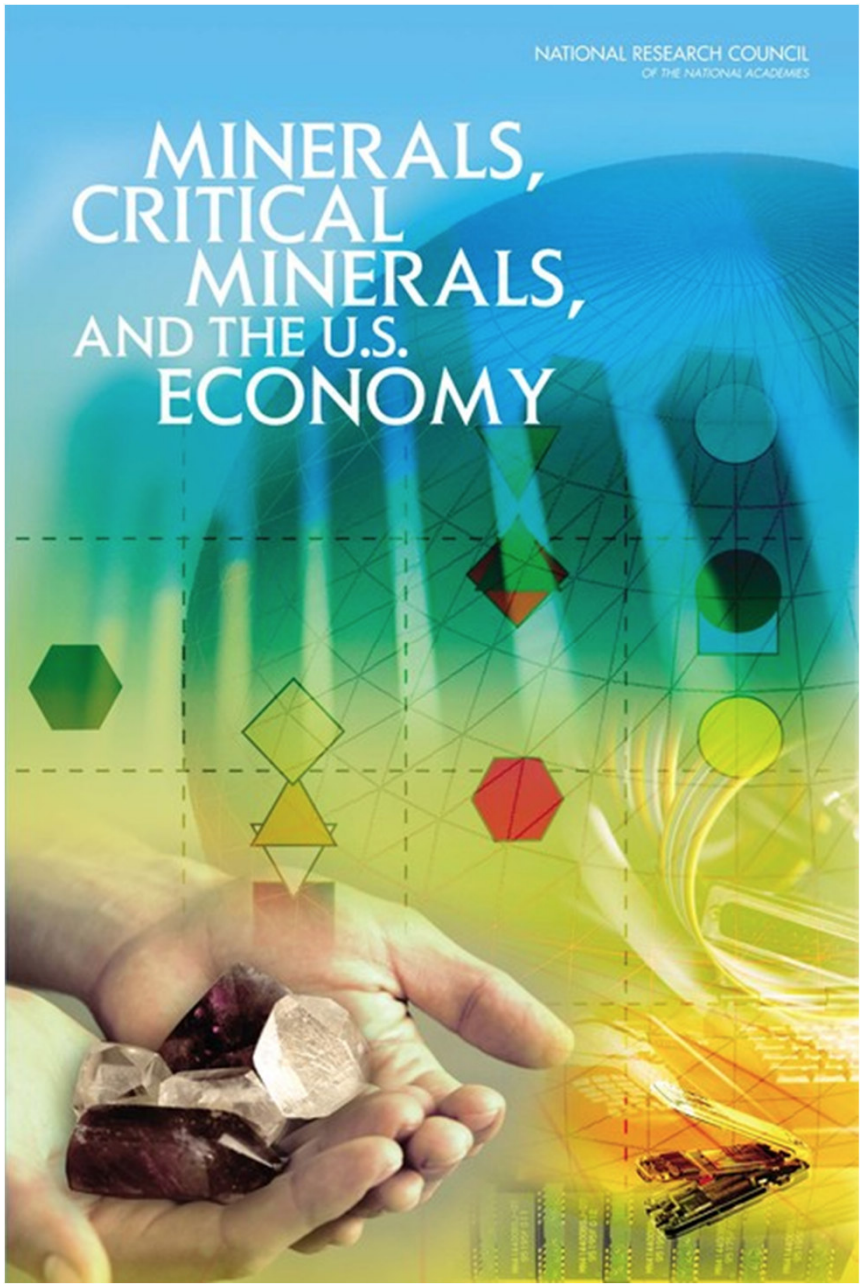
eit RawMaterials
Connecting matters

US National Research Council
2008

Rod Eggert

Colorado School of Mines &

Critical Materials Institute


NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES
MINERALS, CRITICAL MINERALS, AND THE U.S. ECONOMY

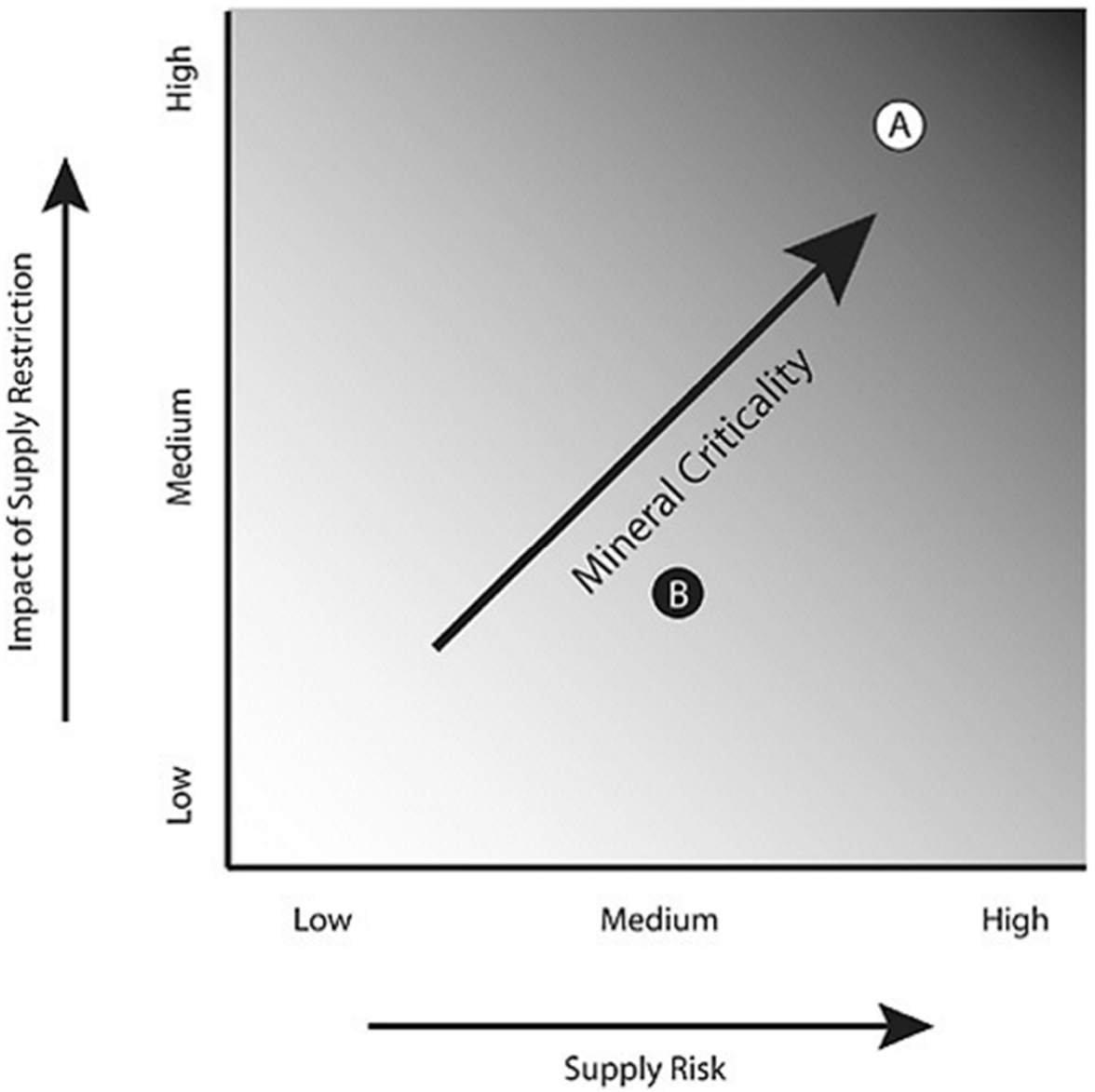
Committee

- Rod Eggert, chair, Colorado School of Mines
- Ann Carpenter, US Gold
- Stephen Freiman, Freiman Consulting
- Tom Graedel, Yale
- Drew Meyer, Vulcan Materials
- Terence McNulty, McNulty & Associates
- Brig Moudgil, University of Florida
- Mary Poulton, University of Arizona
- Leonard Surges, Natural Resources Canada

- Elizabeth Eide, NRC staff

Goal and Scope

- Identify & review nonfuel minerals “critical” for the domestic economy and emerging technologies
- Etc.



Source: National Research Council 2008

Factor explanation
Horizontal Axis

- Short to medium term (up to a decade)
  - Lack of production diversity, demand shocks in small markets, co-production, recycling
- Long term (more than a decade)
  - Investments in R&D and education throughout the material supply chain (exploration → recycling)

Factor explanation
Vertical Axis

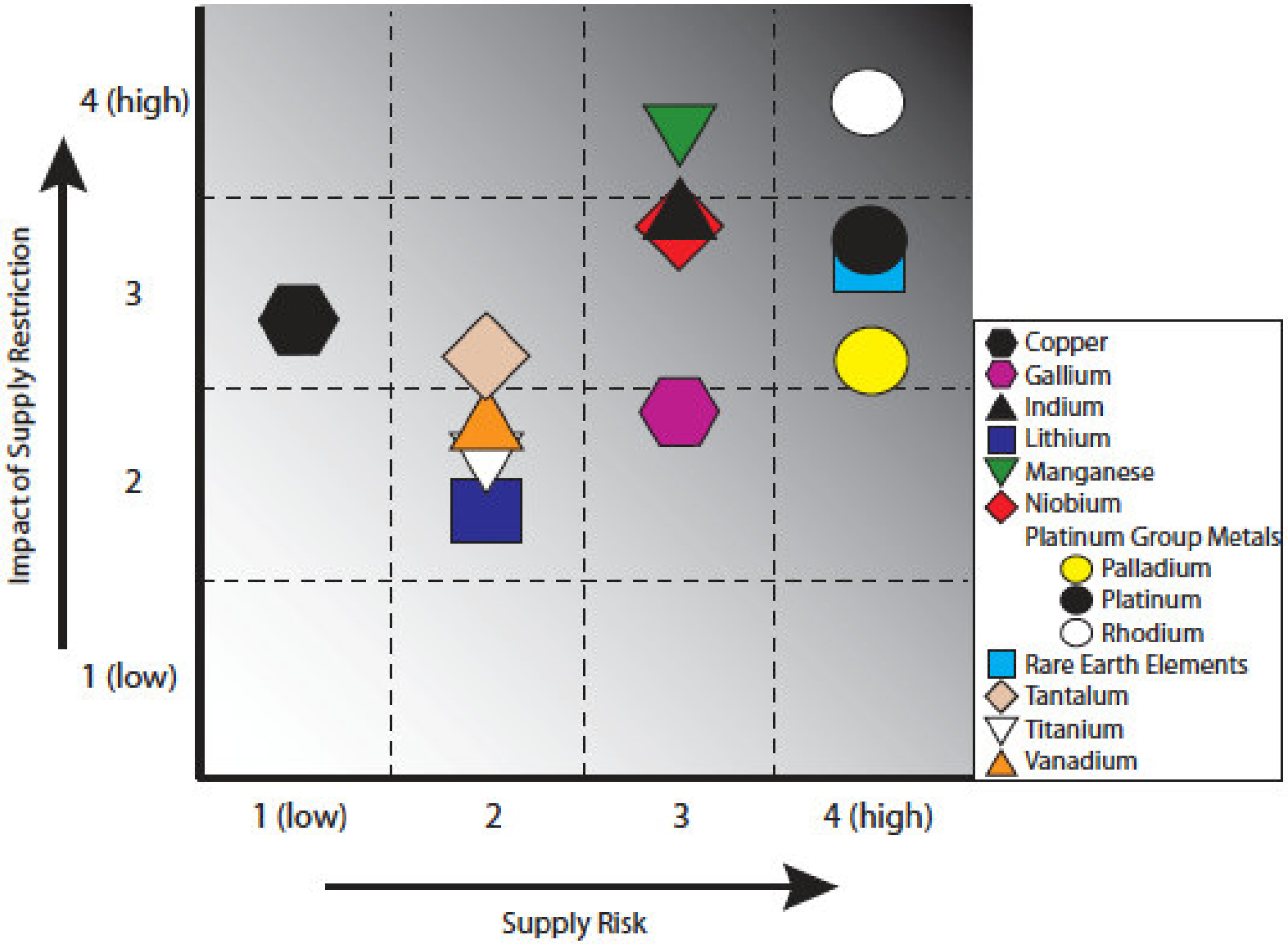
- Focus on:
  - Size of end-use sectors
  - Substitutability
- A struggle
  - How to score the vertical axis?

Aggregation

- Horizontal axis
  - Subjective
- Vertical axis
  - Weighted by size of end-use sector

Results

- Not a definitive list
- Rather a preliminary evaluation of 11 materials or families of materials
  - Short to medium term



Source: National Research Council 2008

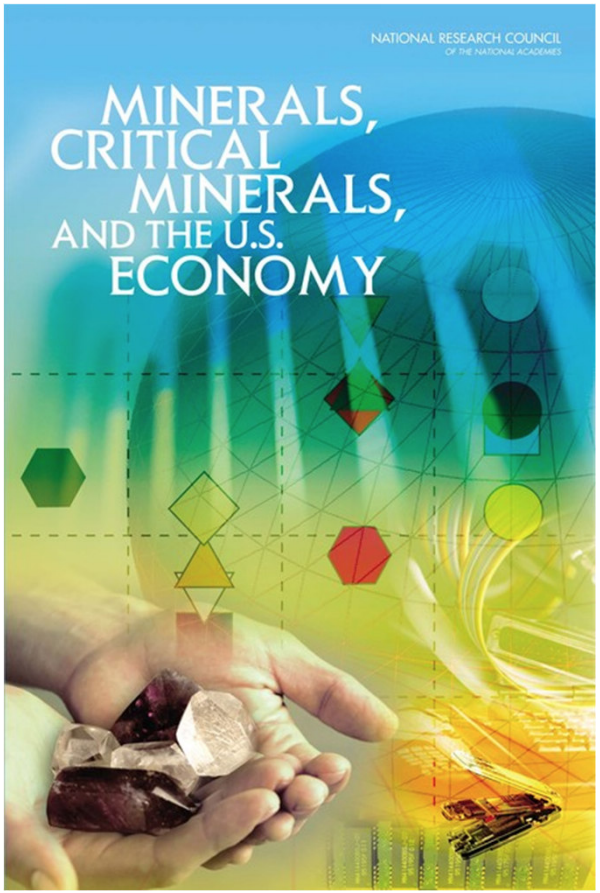
Unique features

- A framework capable of being adapted and customized to particular circumstances
- Emphasis on:
  - Dynamic nature of criticality
  - Importance of defining the time frame (short, medium, long terms)
- Warning: *import dependence* and *reserves* are potentially (very) misleading indicators of supply risk

Limitations

- Subjective scoring, based on quantitative inputs
- How to score the vertical axis?
- Under-appreciation of *supply-chain* risks

Questions?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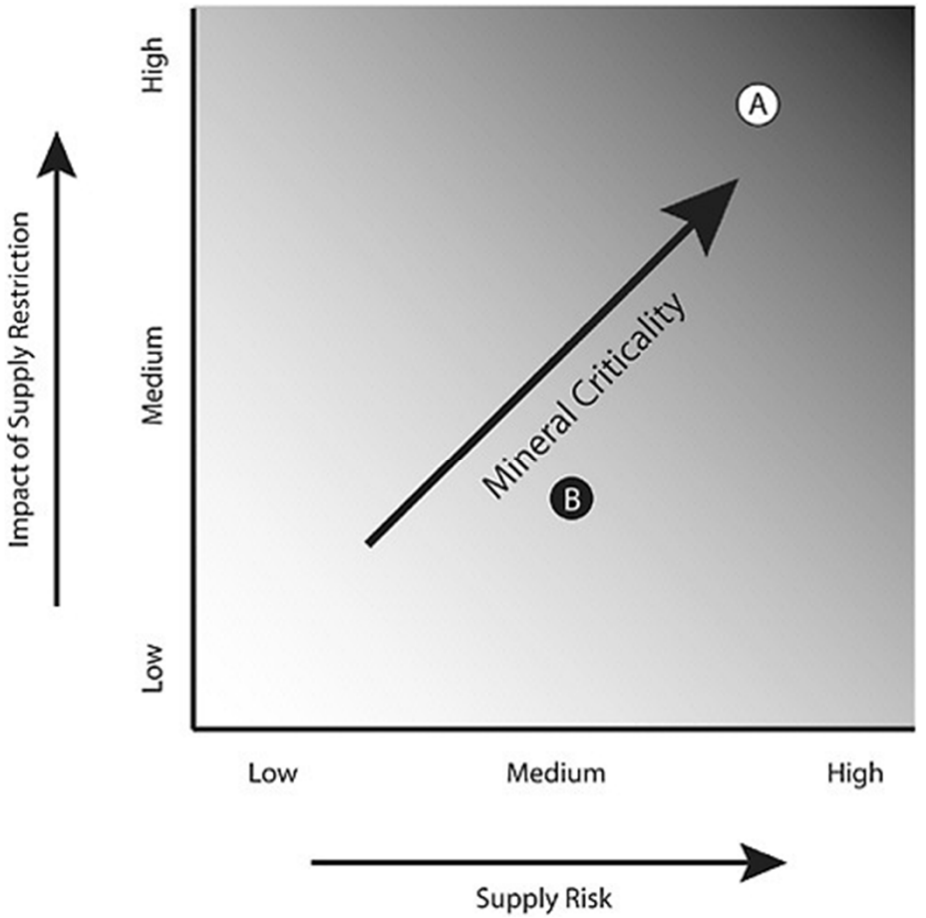
High
Medium
Low
Impact of Supply Restriction
A
B
Mineral Criticality
Low
Medium
High
Supply Risk