## Introduction

- Energy-critical minerals (ECM) are required for emerging sustainable energy sources. Although supply networks have seen robust research activity, there are no global measurements of the life-cycle composition of ECM trade flows or their evolution over time.
- Our objective is to expose multiple types of inconsistencies in recent 20 years from ECM related public datasets, relying on source countries’ *import-export logs* within a single dataset and across multiple datasets. The basic units we focus on are total export quantity (kilograms) and trade value ($) (USD).

## Research Objects

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Source Countries (SICs indicated in blue)</th>
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<tbody>
<tr>
<td>Cobalt</td>
<td>Australia, Canada, Cuba, DR Congo, New Caledonia, Norway, Philippines, Russia</td>
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<tr>
<td>Lithium</td>
<td>Argentina, Bolivia, Brazil, Canada, Chile, China, Namibia, Portugal, Russia, US, Zimbabwe</td>
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<tr>
<td>Niobium</td>
<td>Brazil, Canada, China, DR Congo, Germany, Nigeria, Russia, Zambia</td>
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<tr>
<td>Platinum Group Metals</td>
<td>Belgium, Germany, Russia, South Africa, UK, US</td>
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<tr>
<td>Rare Earth Elements</td>
<td>Brazil, China, France, India, Japan, Malaysia, Thailand, UK, US, Vietnam, (Myanmar)</td>
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<tr>
<td>Tantalum</td>
<td>Australia, Bolivia, Brazil, Canada, China, DR Congo, Ethiopia, Mozambique, Nigeria, Russia, Rwanda, Zambia</td>
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</tbody>
</table>

## Datasets

- **UN Comtrade**: a repository of official international trade statistics and relevant analytical tables. We used it to study the inconsistency in single dataset.
- **USGS**: information on minerals-related issues, including minerals conservation, sustainability, availability, material flow, and the economic health of the U.S. minerals industry. We used to study the inconsistency between multiple datasets: UN Comtrade versus USGS.

## Preliminary Studies & Examples

1. **Clear Inconsistency between UN Comtrade Export Log and USGS Import Log for all commodities.**
   - Germany Platinum Annual Export to USA Quantity: UN Comtrade VS USGS

2. **Clear Inconsistency in Export Log of Source Countries in UN Comtrade.**
   - Commodity: Lithium; Niobium; Platinum; Tantalum.
   - Comparison between: Brazil, Canada, Niobium, export quantity to world.

3. **For “Rare Earth Element” commodity, the quantity is unreported in UN Comtrade.**
   - China Rare Earth Element Annual Global Export Quantity & Trade Value (2016-2020)

4. **Mismatch between Quantity and Trade Value in UN Comtrade in all commodities.**
   - Russia Niobium Annual Global Export Quantity & Trade Value

5. **Missing Data in UN Comtrade.**
   - Russia Niobium Annual Global Export Ratio: Trade Value / Quantity

6. **Large Annual Fluctuations in both Quantity and Trade Value.**
   - Russia Niobium Annual Global Export Quantity Trend Difference to Next Year

## Future Work

1. Exploring potential reasons which cause the inconsistencies.
2. Normalizing the data for incoming machine-learning research.

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