

Critical Minerals Causal Engine

Appendix — Knowledge Graph Renders

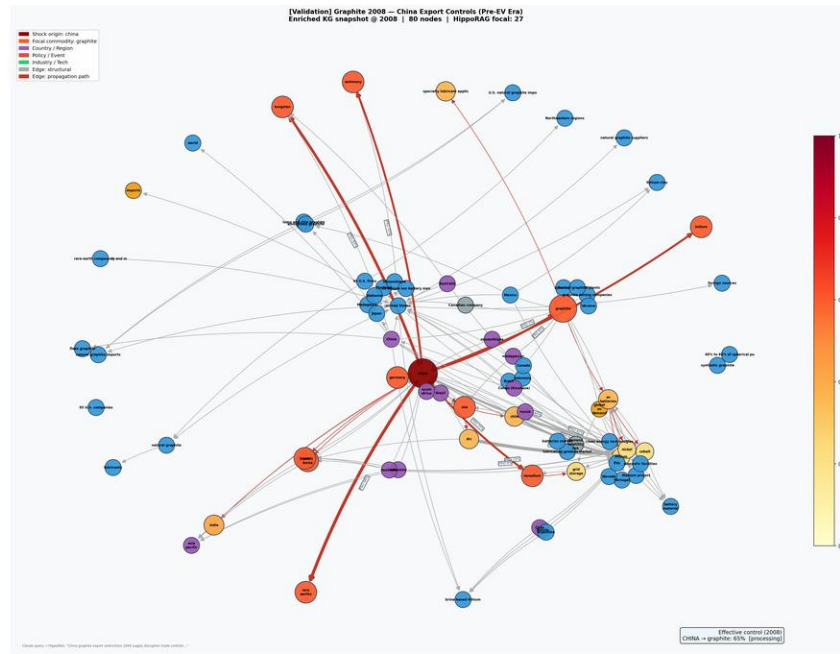
Each render: enriched KG snapshot at the indicated year, with shock origin (dark red node), focal commodity, and 1-hop subgraph.
Edges annotated with year-specific PRODUCES / PROCESSES shares.
Effective control box (bottom-right) shows binding stage and percentage.

Contents:

- Graphite (4 renders)
- Rare Earths (4 renders)
- Cobalt (4 renders)
- Lithium (3 renders)
- Nickel (4 renders)
- Uranium (3 renders)
- Cross-cutting predictive (2 renders)

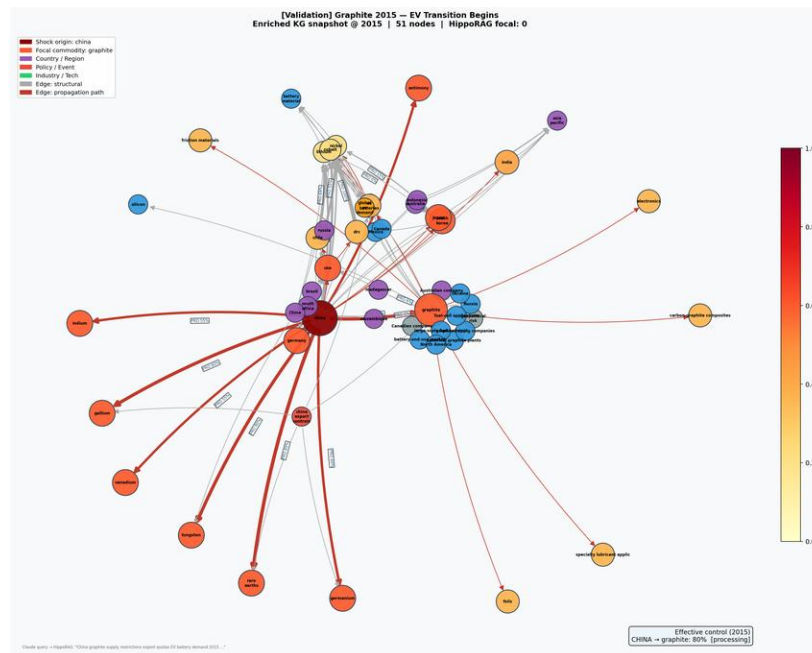
Graphite · 2008

Historical episode — China export quota — pre-EV cycle



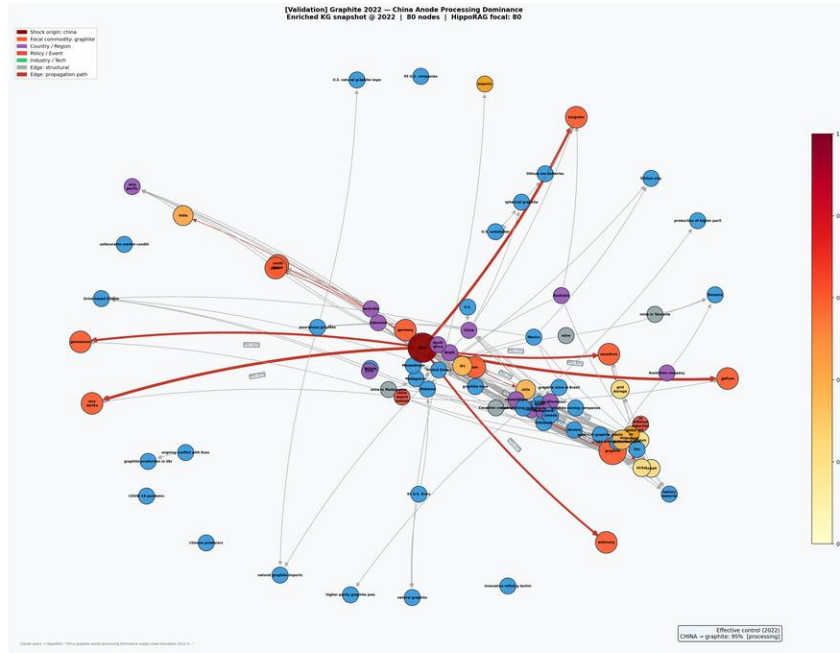
Graphite · 2015

Temporal snapshot — EV transition begins



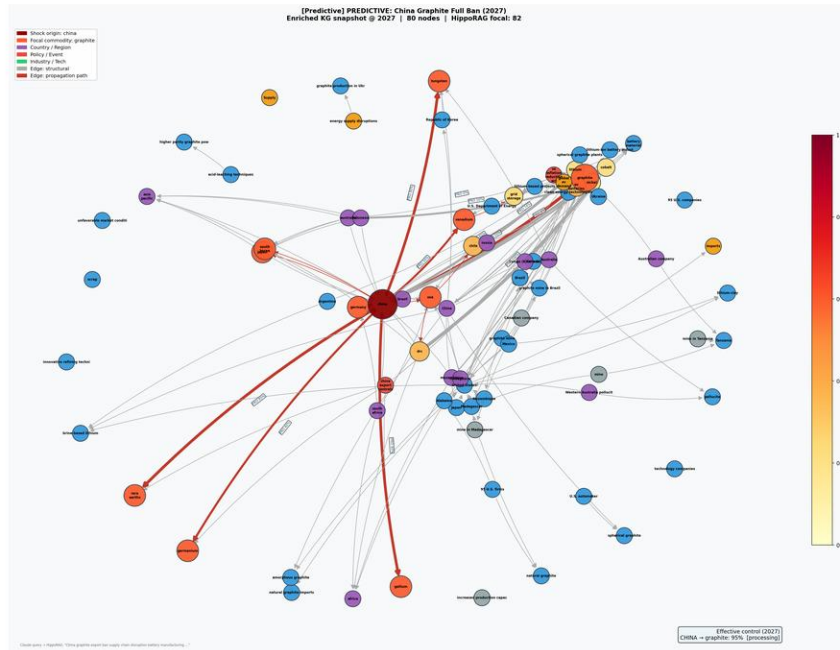
Graphite · 2022

Historical episode — China anode processing 95% lock-in



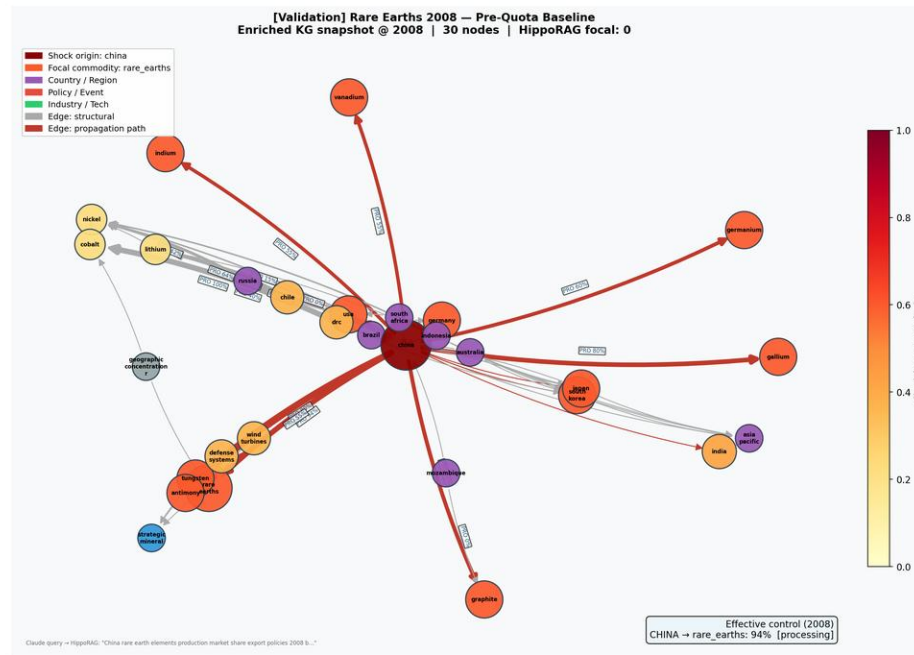
Graphite · 2027

Predictive scenario — PREDICTIVE: full ban scenario



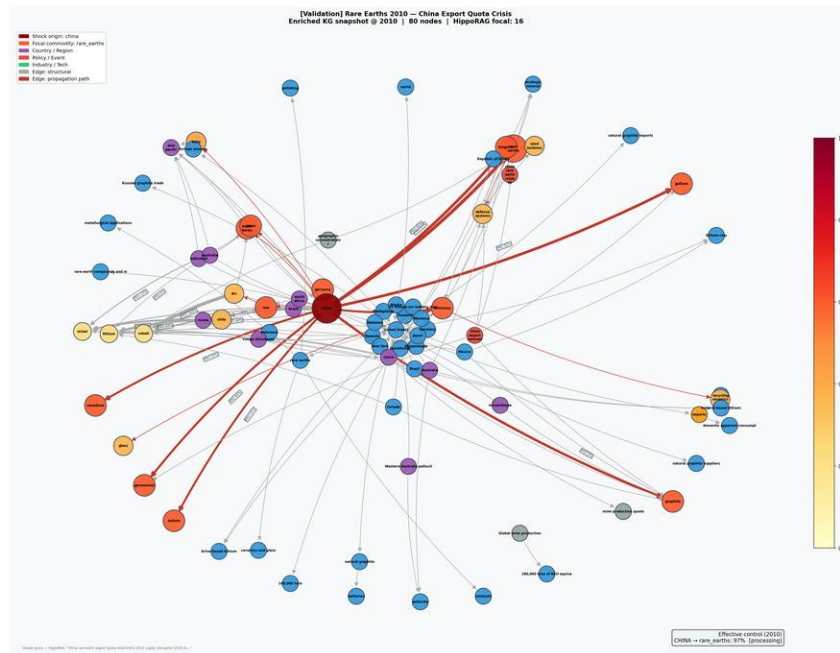
Rare Earths · 2008

Temporal snapshot — Pre-quota baseline



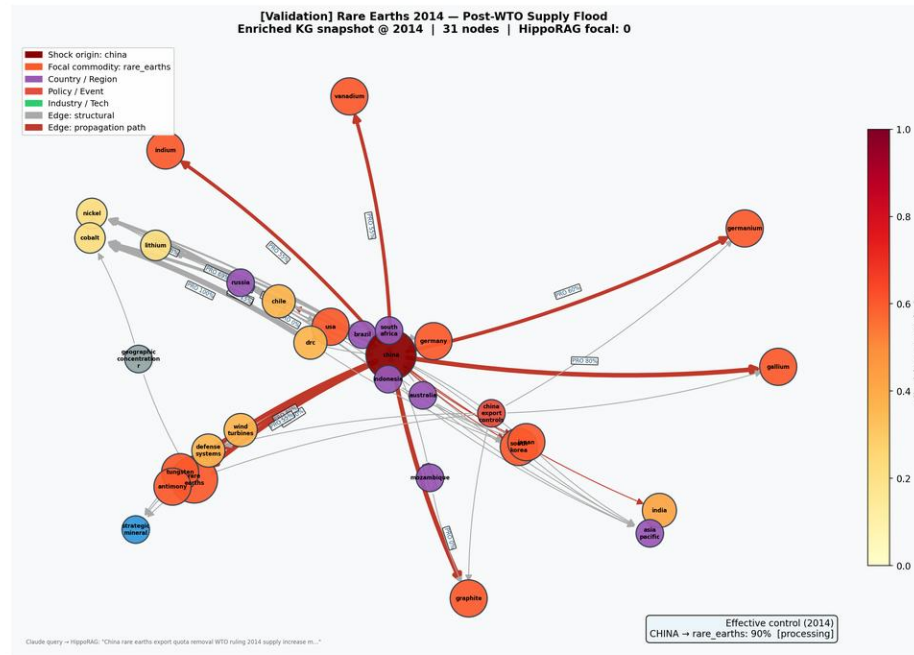
Rare Earths · 2010

Historical episode — China export quota crisis



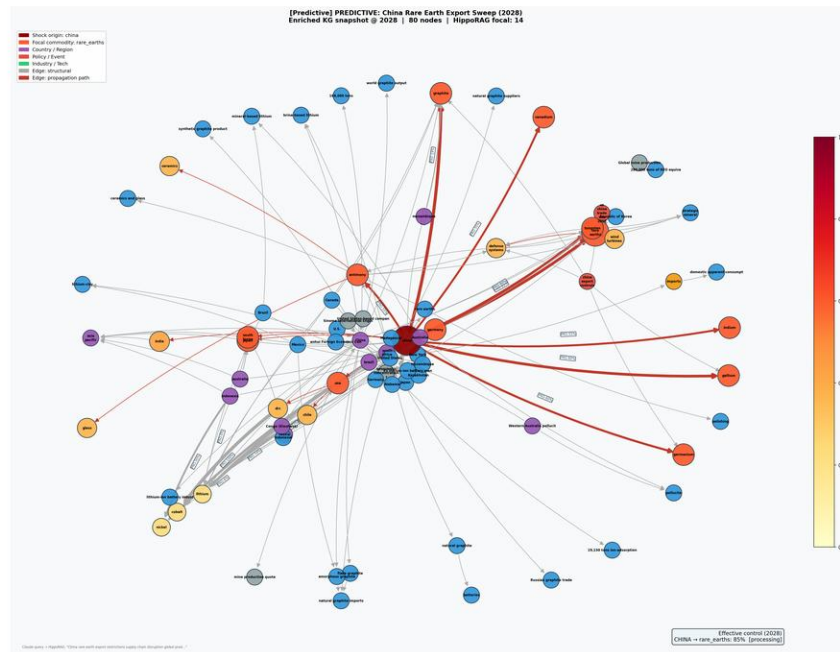
Rare Earths · 2014

Temporal snapshot — Post-WTO supply flood



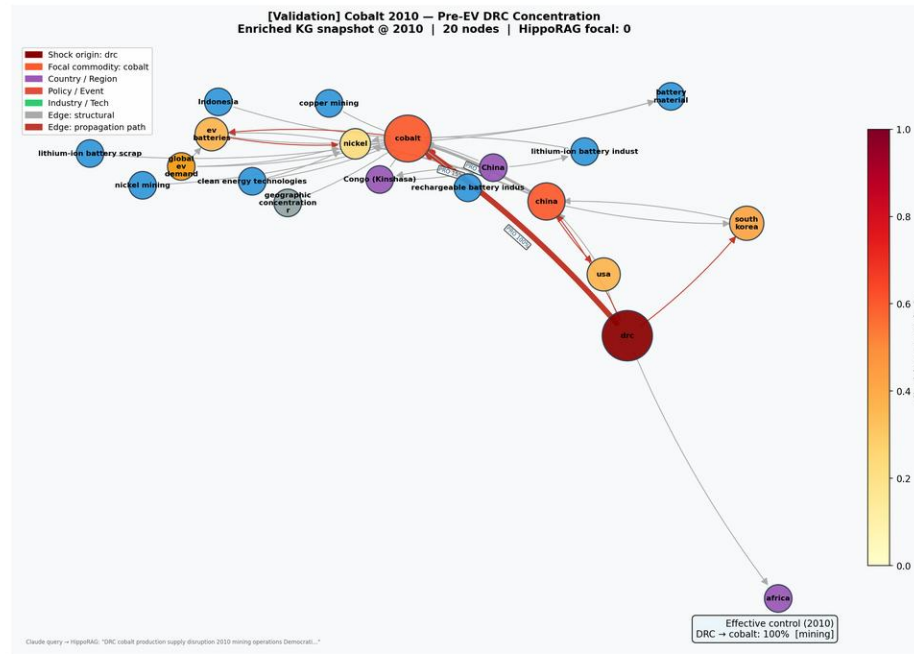
Rare Earths · 2028

Predictive scenario — PREDICTIVE: export sweep



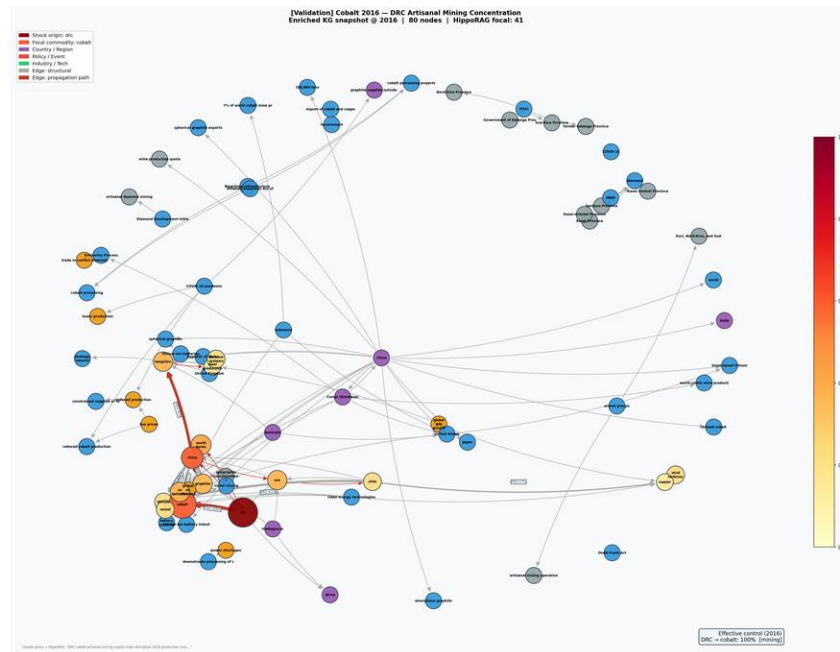
Cobalt · 2010

Temporal snapshot — Pre-EV DRC concentration



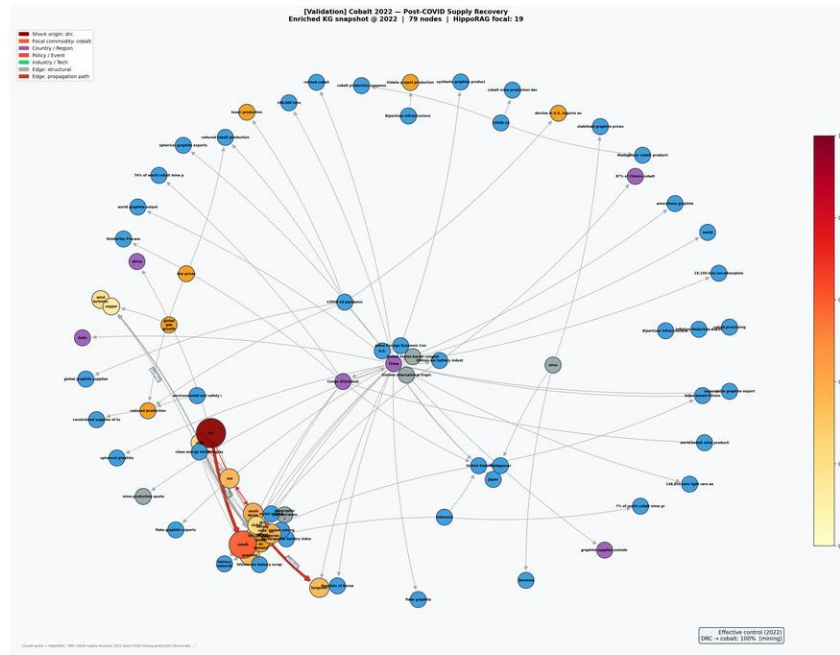
Cobalt · 2016

Historical episode — DRC artisanal concentration



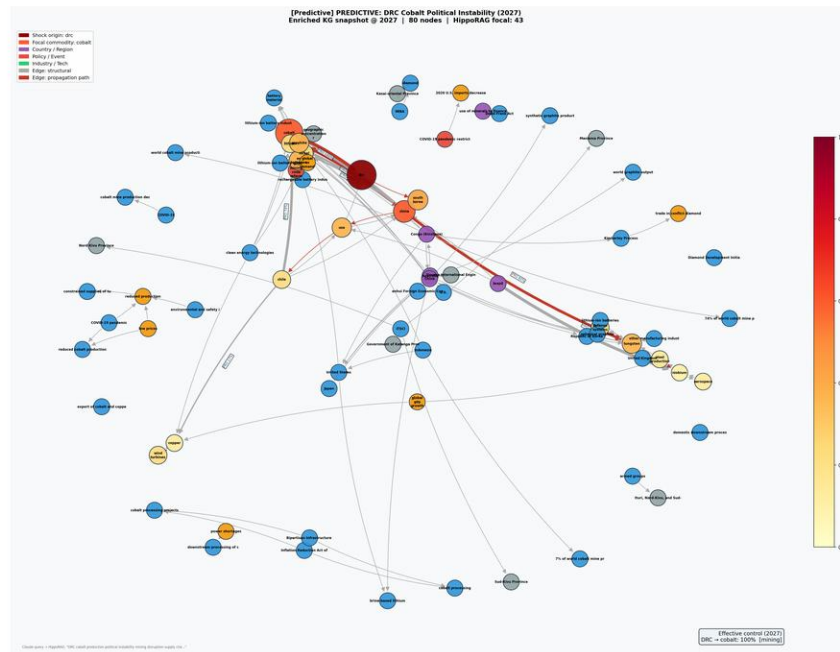
Cobalt · 2022

Historical episode — Post-COVID recovery



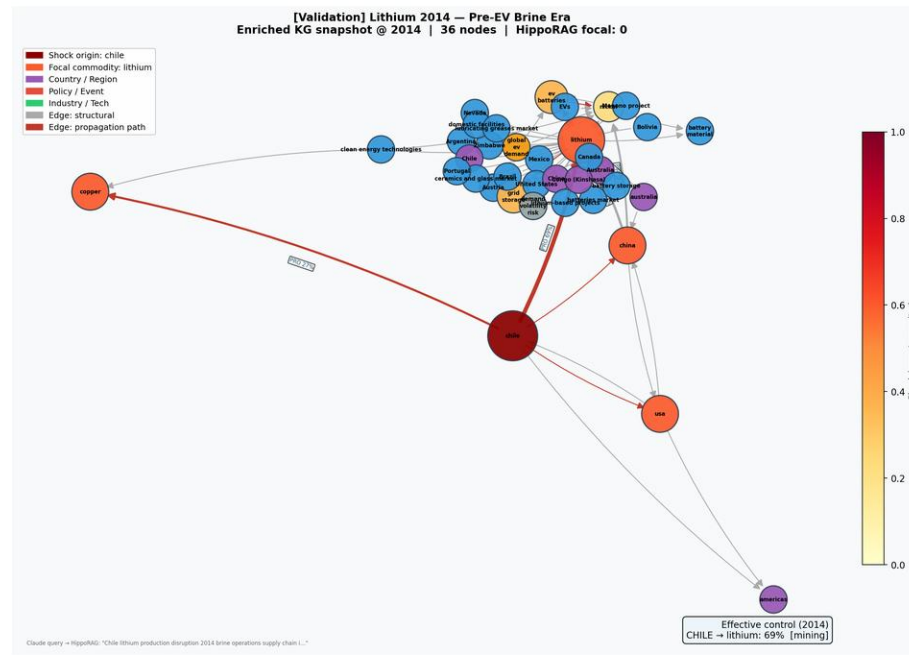
Cobalt · 2027

Predictive scenario — PREDICTIVE: DRC instability



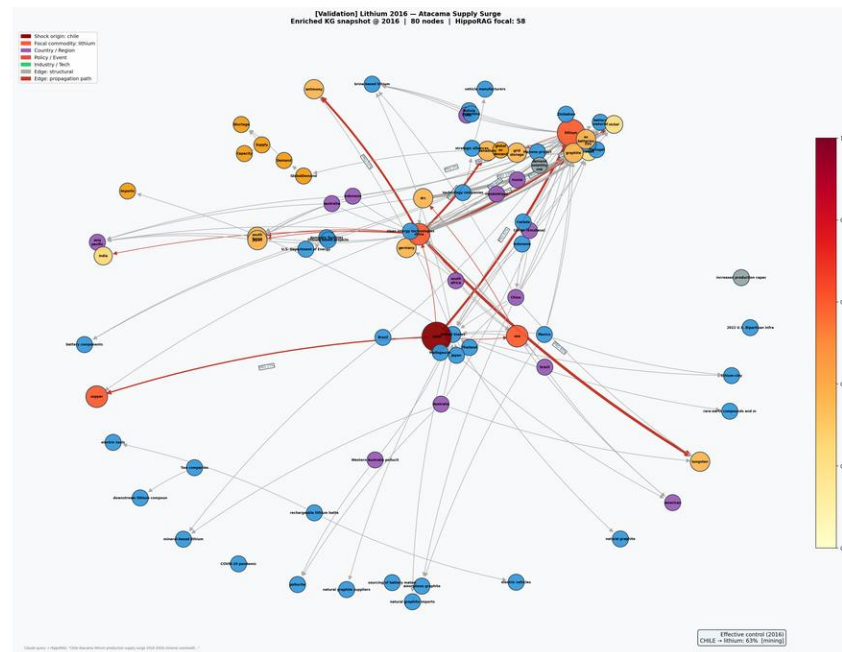
Lithium • 2014

Temporal snapshot — Pre-EV brine era



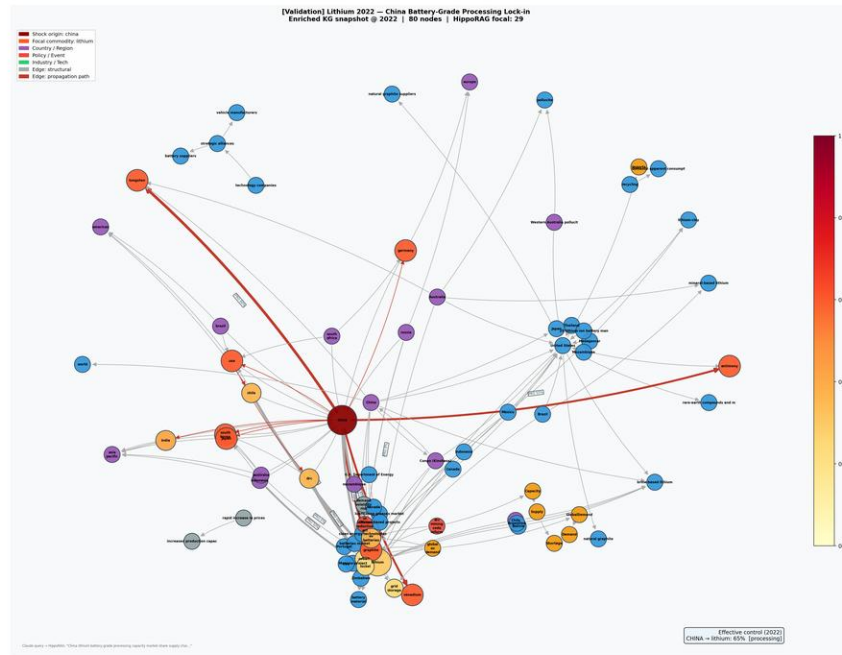
Lithium • 2016

Historical episode — Atacama supply surge



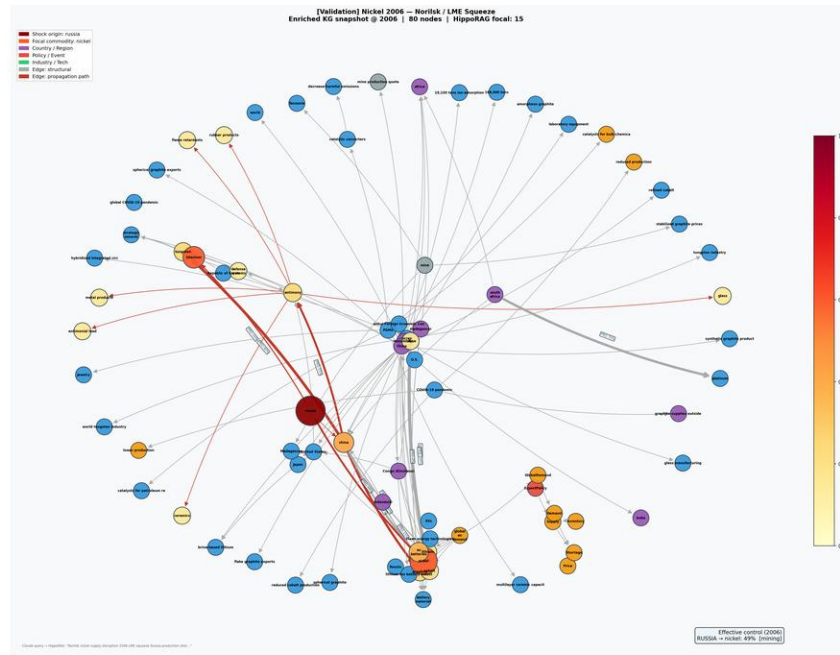
Lithium · 2022

Historical episode — China processing lock-in



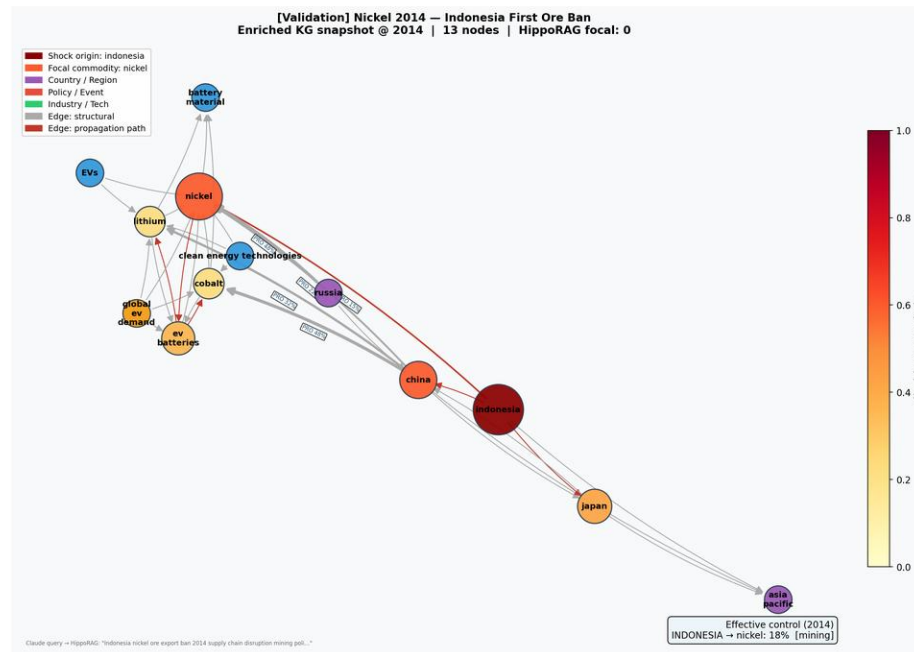
Nickel · 2006

Historical episode — Norilsk / LME squeeze



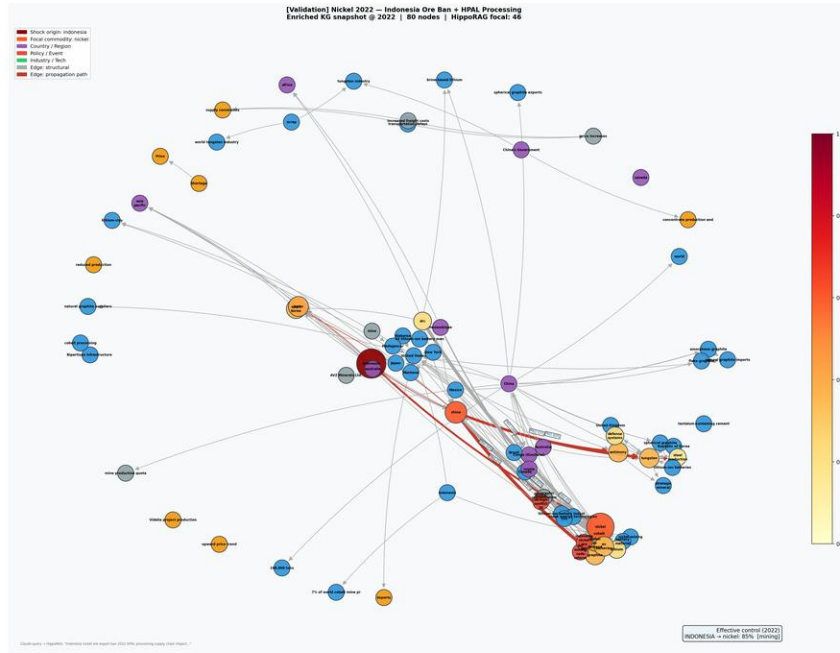
Nickel · 2014

Temporal snapshot — Indonesia first ore ban



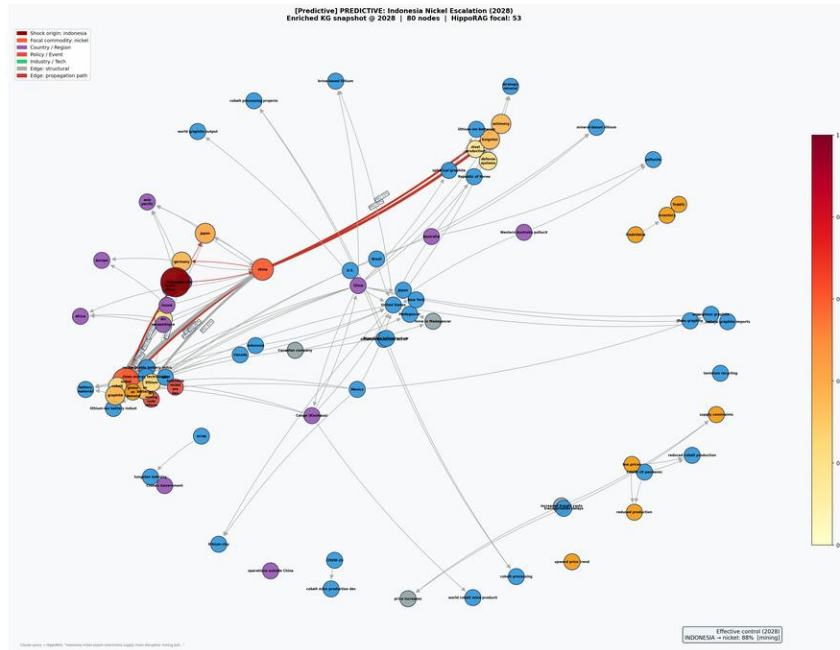
Nickel • 2022

Historical episode — Indonesia ban + HPAL



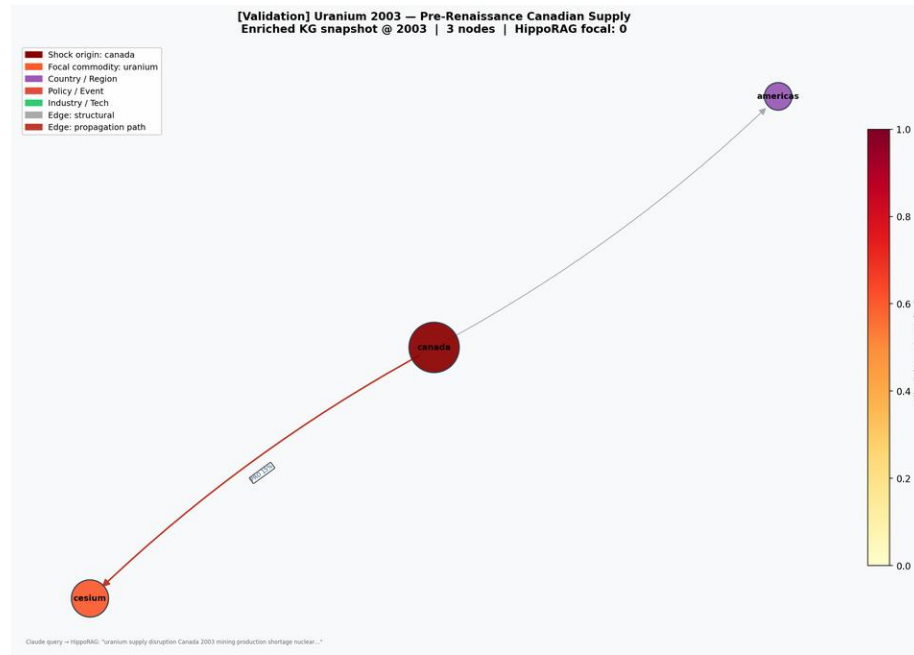
Nickel • 2028

Predictive scenario — PREDICTIVE: escalation



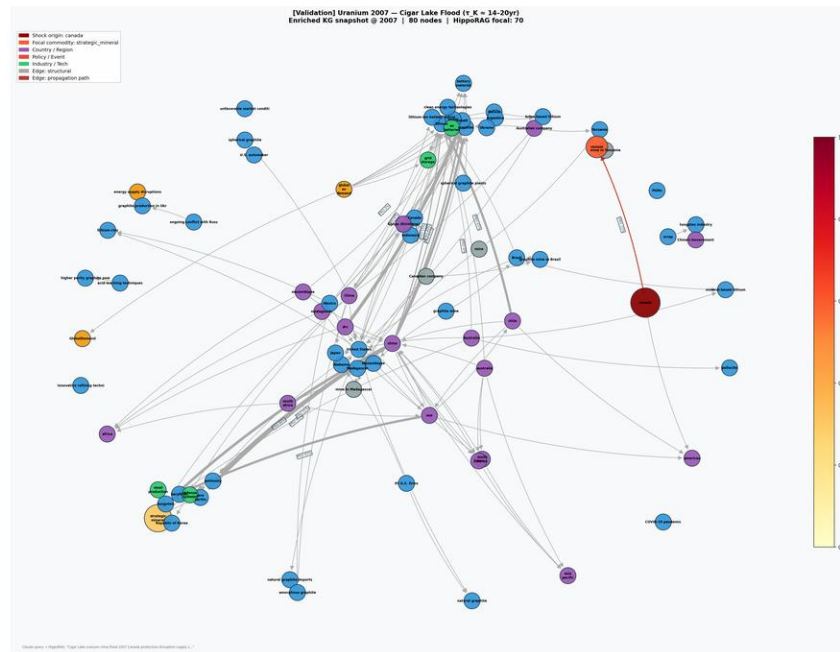
Uranium · 2003

Temporal snapshot — Pre-renaissance Canadian supply



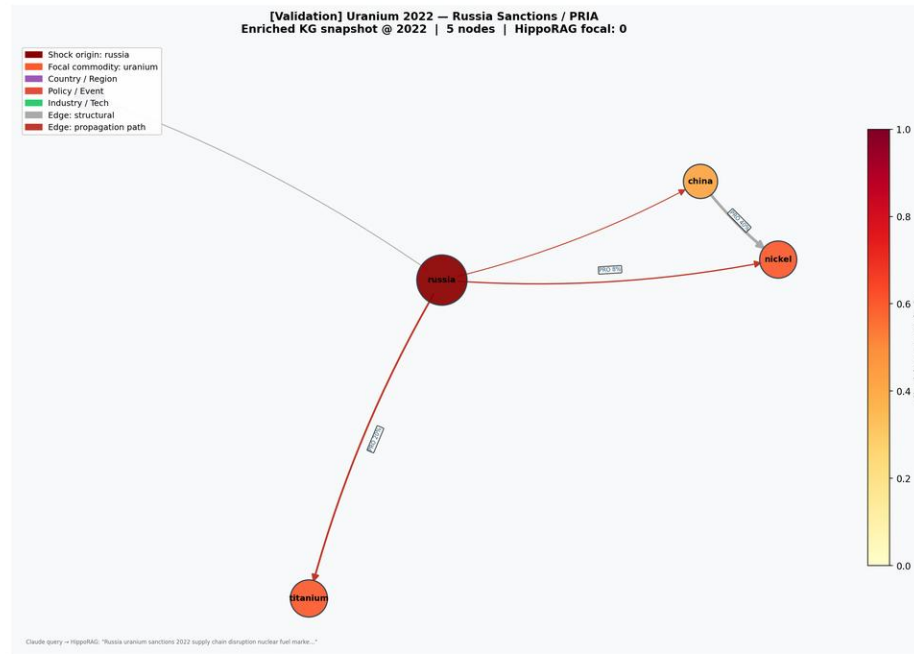
Uranium · 2007

Historical episode — Cigar Lake flood



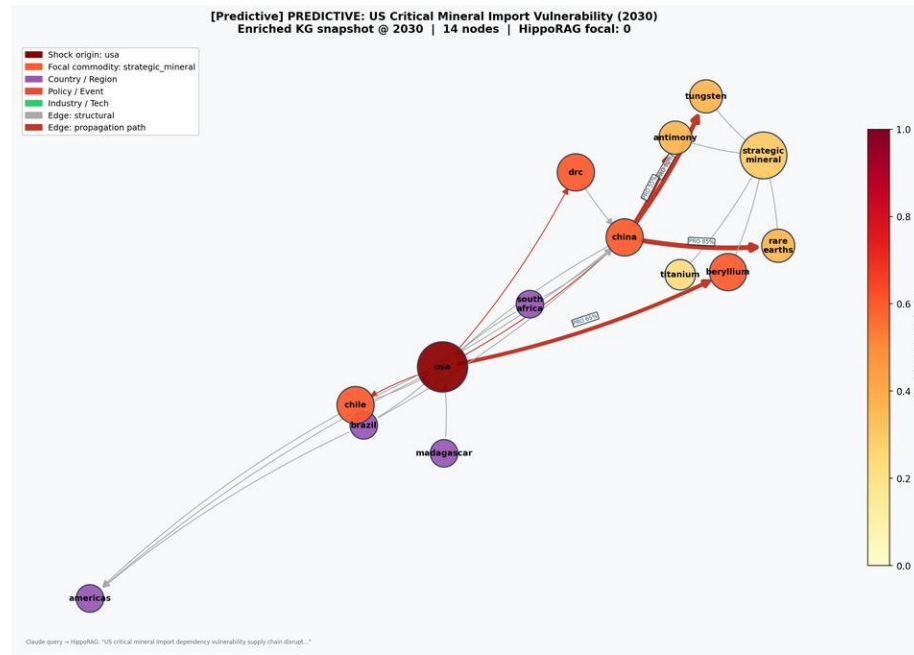
Uranium · 2022

Temporal snapshot — Russia sanctions / PRIA



Cross-cutting predictive · 2030

Predictive scenario — PREDICTIVE: US import vulnerability



Cross-cutting predictive · 2030

Predictive scenario — PREDICTIVE: China full-sweep

