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SUPPLY CHAINS · GEOPOLITICAL RISK · APRIL 2026

Critical Materials in **Electronics**

A supply-chain and geopolitical risk map for the rare earths, gases, metals and minerals that the global electronics and semiconductor industry cannot operate without — and the chokepoints that increasingly define them.

GeoTechNexus
Turning Signals Into Solutions

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Research Note · 20+ critical materials

COVERAGE

Electronics & Semiconductors

REEs · Gases · Metals · Minerals

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KEY TAKEAWAYS

- Modern electronics depend on 20+ critical materials — rare earth elements, gases, metals and minerals — with extreme geographic concentration of both mining and refining.
- The core vulnerability is two-layered: raw-material mining concentration plus near-total Chinese dominance of downstream refining and processing.
- China has moved from passive supply dominance to active weaponisation, with export controls now covering gallium, germanium, graphite, tungsten and heavy REEs.
- Helium has entered acute crisis in 2026 with Qatari supply disrupted and the US strategic reserve dismantled, exposing semiconductor fabs to severe price and availability shocks.
- Resilience requires action at both layers — alternative sourcing and Western refining capacity — with realistic timelines of 5–10 years for meaningful change.

Modern electronics depend on a complex web of rare earth elements (REEs) and other critical non-REE materials, many of which are mined in politically unstable regions and processed almost exclusively in China. This report identifies 20+ critical materials, maps them to specific electronic components and compounds, quantifies global production by country, and assesses geopolitical supply chain risk for each.

The overarching vulnerability is not simply geographic concentration of mining — it is China's near-total dominance of downstream refining and processing, which means even ore mined in politically stable countries such as Australia or Canada flows into Chinese facilities before reaching component manufacturers. China has now demonstrated willingness to weaponise this position with active export controls on gallium, germanium, graphite, and tungsten, making supply chain diversification a national security imperative for Western electronics manufacturers.

Part 1 · Rare Earth Elements

The 17 rare earth elements — 15 lanthanides plus scandium (Sc) and yttrium (Y) — are not truly “rare” in crustal abundance but are rarely found in economically mineable concentrations. Their chemical similarity makes separation and purification technically demanding and costly, creating high barriers to entry that reinforce China's dominance.

REEs by Electronic Component

Component	REE / Compound	Function
Permanent magnets (HDD motors, speakers, EV)	$Nd_2Fe_{14}B$ (neodymium-iron-boron), $SmCo_5$ (samarium-cobalt)	Generate powerful magnetic fields in compact form
High-temperature magnets (EV motors, wind turbines)	Dysprosium (Dy), Terbium (Tb) added to NdFeB	Maintain magnet stability at elevated temperatures
Displays & phosphors (LEDs, OLEDs, screens)	Europium (Eu) red/blue; Terbium (Tb) green; Yttrium (Y)	Produce accurate colour in screens and LED lighting
Semiconductors (CMOS, thin-film)	Eu_2O_3 films, Yttrium (Y), Er^{3+}/Yb^{3+} dopants	Improve purity, modify electrical properties
Capacitors (MLCCs)	Lanthanum oxide (La_2O_3), Cerium oxide (CeO_2), Neodymium	Dielectric enhancement, thermal stability
Optical glass & camera lenses	Lanthanum (La), Praseodymium (Pr)	Reduce dispersion, increase refractive index
Fiber optic amplifiers	Erbium (Er^{3+}) in EDFAs	Amplify optical signals in telecom networks
NiMH batteries	Mischmetal (Ce, La, Nd, Pr alloy)	Higher energy density and charge retention
Catalytic converters	Cerium (Ce), Lanthanum (La)	Accelerate emissions-reducing reactions
Frequency control / oscillators	Yttrium (Y) in YIG filters	Microwave and RF filtering in oscillators
MRI / medical imaging	Gadolinium (Gd)	Contrast agent; neutron shielding

EXHIBIT 1 Rare earth elements by electronic application. Mapping of REEs and compounds to specific electronic components and their functional role.

REE Global Production by Region (2024)

Country / Region	Production (MT)	Share	Notes
China	270,000	~69%	Dominant in light REEs; controls ~85% of global refining
United States	45,000	~11.6%	Mountain Pass mine; limited domestic processing
Myanmar (Burma)	31,000	~8%	Key source of heavy REEs (Tb, Dy)
Australia	13,000	~3.4%	Lynas Corp is largest non-Chinese REE producer
Thailand	13,000	~3.4%	Up 261% since 2022; largely processing Myanmar ore
India	2,900	~0.7%	Far below potential despite large beach sand deposits
Russia / Brazil / Vietnam	Various	Remainder	Significant reserves; limited current output

EXHIBIT 2 Global rare earth production by country, 2024. China dominates both mining (~69%) and refining (~85%). Source: USGS Mineral Commodity Summaries 2024–2025.

REE Geopolitical Risk Assessment

CRITICAL RISK **China**

China controls approximately 69% of global REE production and approximately 85% of global refining capacity. Beijing has implemented export licensing for heavy REEs including samarium, gadolinium, terbium, dysprosium, lutetium, scandium and yttrium; licences can be denied for companies linked to defence sectors. Light REEs (neodymium, lanthanum, cerium) now fall under export reporting requirements, signalling potential future restrictions. China is actively using REE dominance as a strategic lever in the US–China technology war.

HIGH RISK **Myanmar**

Myanmar is a critical source of heavy REEs, particularly dysprosium and terbium, essential for high-temperature-resistant magnets. Mining in Kachin State is tied to illegal operations linked to Chinese entities, fuelling both environmental degradation and regional instability. The country's political situation following the 2021 military coup adds significant supply chain unpredictability.

MODERATE RISK **United States**

The US has revived Mountain Pass but remains dependent on China for processing and refining. CHIPS Act and Inflation Reduction Act funding is building domestic capacity, but full independence is years away.

LOWER RISK **Australia**

Lynas Corporation is the most strategically important non-Chinese REE producer, and Canberra maintains close security ties with the US and EU. Production volumes fell between 2021–2024, though expansion is planned.

Part 2 · Helium

Helium is not a rare earth element but is arguably more strategically irreplaceable for electronics manufacturing. It cannot be synthesised, and any helium released to atmosphere is permanently lost to space — making conservation and supply security critical.

Applications in Electronics

- **Semiconductor wafer fabrication** — carrier gas for CVD/PVD deposition, plasma etching diluent, and vacuum leak detection.
- **Crystal growth** — inert protective atmosphere for silicon and germanium crystal growth.
- **Fiber optic cable production** — used in the drying and drawing process.
- **LCD / flat panel display manufacturing** — protective inert atmosphere during production.
- **MRI and quantum computing** — liquid helium cools superconducting magnets to near absolute zero.

Global Helium Production

Country	Share	Source
United States	~47%	Panhandle-Hugoton gas field (TX, OK, KS)
Qatar	~38%	Byproduct of LNG at North Field
Algeria	~5.6%	State-controlled via Sonatrach
Russia	~3.1%	Amur Gas Processing Plant
Australia	~2.5%	Emerging source

EXHIBIT 3 Global helium production by country. The US and Qatar account for ~85% of supply, with no synthetic substitute. Source: USGS, industry analysis.

CRITICAL RISK · APRIL 2026 **Helium**

The helium market is in acute crisis as of April 2026. Qatar — which supplies roughly 38% of global helium — has halted production following attacks on its LNG gas infrastructure linked to the ongoing Iran conflict. The closure of the Strait of Hormuz has simultaneously cut off export routes, causing spot prices to spike 70–100%. The US recently privatised its Federal Helium Reserve, eliminating the historic strategic buffer, and there is now no meaningful global stockpile to absorb the shock. Semiconductor fabs, fiber optic manufacturers, and MRI equipment producers are the most immediately exposed.

Part 3 · Tantalum

Tantalum is extracted from coltan (columbite-tantalite ore) and is critical for capacitors, semiconductor interconnects, and RF filters.

Applications in Electronics

- **Tantalum electrolytic capacitors** — found in smartphones, laptops, tablets, automotive ECUs, medical implants, and aerospace avionics; valued for high volumetric efficiency and thermal stability.
- **Semiconductor diffusion barrier layers** — tantalum nitride (TaN) prevents copper diffusion in interconnects within CPUs, GPUs, DRAM, and NAND flash.
- **RF filters (SAW/BAW)** — lithium tantalate ($LiTaO_3$) substrates in RF filters for 4G/5G, GPS, and radar.
- **Thin-film resistors** — used in analog circuits, aerospace, and medical instrumentation.
- **High-power resistors** — tantalum's extreme melting point (3,017°C) suits high-heat environments.

Global Tantalum Production (2024)

Country	Output (MT)	Share	Notes
DRC (Congo)	~880	~37–41%	Largest producer; mines in active conflict zones
Rwanda	~350–520	~22%	Significant portion is smuggled DRC coltan
Brazil	~210–360	~12%	Mibra mine; politically stable alternative source
Nigeria	~110–192	~6%	Artisanal and small-scale mining
China	~76–94	~4%	Also dominant in refining

EXHIBIT 4 Global tantalum production by country, 2024. DRC and Rwanda dominate, with significant conflict-mineral exposure. Source: USGS, Responsible Minerals Initiative.

EXTREME RISK **Tantalum**

Eastern DRC's tantalum mines sit in active conflict zones in North and South Kivu, where the M23 rebel group has seized control of key mines including Rubaya, one of the world's richest coltan deposits. Armed groups finance their operations through mineral sales, classifying tantalum as a conflict mineral alongside tin, tungsten and gold (the “3TGs”). In February 2025, the Responsible Minerals Initiative warned that it is now “extremely challenging” to responsibly source tantalum from eastern DRC or Rwanda. In early 2026, the DRC reportedly offered the Rubaya mine — still under M23 control — to the US as part of a minerals cooperation framework.

Part 4 · Other Critical Non-REE Materials

Cobalt (Co)

Key compounds & components:

- $LiCoO_2$ (lithium cobalt oxide) — cathode in Li-ion batteries for smartphones, laptops and tablets.
- $LiNiMnCoO_2$ (NMC) — EV battery cathodes.
- $CoSi_2$ (cobalt silicide) — contacts and interconnects in advanced CMOS chips, replacing titanium at smaller nodes.
- CoPt (cobalt-platinum) alloy — magnetic recording layer in hard disk drives.

Country	Production (MT)	Share	Notes
DRC (Congo)	200,800	~85%	Dominant producer; significant artisanal mining
Indonesia	28,900	~10%	Rapidly growing nickel-cobalt complex
Russia	8,700	~3.7%	Norilsk operations
Canada	4,500	~1.9%	Sudbury basin
Australia	3,600	~1.5%	Nickel sulfide byproduct

EXTREME RISK **Cobalt**

The DRC produces ~85% of global cobalt and holds over 60% of known reserves. Mining in Katanga Province involves widespread artisanal and child labour, chronic political instability, and armed group involvement — a continuous compliance and supply chain risk. China controls ~80% of cobalt refining capacity globally, so even cobalt mined in Australia or Canada largely passes through Chinese processing.

Gallium (Ga)

Key compounds & components:

- Gallium nitride (GaN) — power amplifiers, 5G base station RF chips, EV power electronics, fast-charging ICs, radar.
- Gallium arsenide (GaAs) — smartphone RF front-end modules, satellite transceivers, solar cells.
- Gallium phosphide (GaP) — visible and infrared LED emitters.

Country	Share	Notes
China	~94%	Dominant refining capacity
Russia	~1%	Minor producer
South Korea / Germany / Ukraine	Marginal	Small volumes only

CRITICAL RISK **Gallium**

China imposed export licensing controls on gallium in August 2023, tightening them in 2024, with approvals being denied for companies linked to US or allied defence supply chains. China's dominance is structural — rooted in its aluminium industry, which is approximately 7× larger than the US equivalent — making there no near-term substitute source.

Germanium (Ge)

Key compounds & components:

- GeO_2 (germanium oxide) — dopant that raises refractive index of silica fiber cores; present in every meter of single-mode fiber.
- SiGe (silicon-germanium) HBTs — high-speed chips, 5G modems, radar.
- Germanium wafers — substrates for III-V solar cells and compound semiconductors.
- Infrared optics — thermal imaging cameras, military night-vision, automotive LiDAR.

Country	Share	Notes
China	~82–83%	Dominant
Russia	~5%	Minor producer
Canada / Belgium (recycled)	Remainder	Secondary recovery

CRITICAL RISK **Germanium**

China imposed export controls on germanium simultaneously with gallium in August 2023. There is no scalable substitute for germanium in fiber optic production — the entire global internet infrastructure depends on it — and Western refining capacity is negligible. Building meaningful alternative capacity is estimated at 5–10 years minimum.

Indium (In)

Key compounds & components:

- ITO (Indium Tin Oxide) — transparent conductive coating on every touchscreen, LCD, OLED display, and solar panel electrode.
- Indium phosphide (InP) — ultra-high-speed semiconductors for data centre transceivers, 5G chips, and photonic integrated circuits.
- Indium-based solders — low-temperature solders for sensitive components and LED assembly.

Country	Share	Notes
China	~70%	Dominant refined output
South Korea	~10%	Secondary refining hub
Japan / Canada / Belgium	Remainder	Limited supplementary supply

HIGH RISK **Indium**

China controls ~70% of refined indium output, and ITO has no viable substitute as a transparent conductor at commercial scale. Demand is growing rapidly with display and solar panel expansion, while new indium sources are limited.

Tungsten (W)

Key compounds & components:

- Tungsten plugs — fill vertical electrical connections (contacts/vias) between transistor layers in virtually every CPU, GPU and memory chip.
- Tungsten silicide (WSi_2) — thin-film resistors in integrated circuits.
- Tungsten carbide (WC) — drill bits for microvia holes in multilayer PCBs.
- Tungsten X-ray targets — used in X-ray tubes for inspection of electronics.

Country	Share	Notes
China	~83–85%	Dominant
Vietnam	~5%	Nui Phao mine
Russia	~3%	Minor producer

Country	Share	Notes
South Korea (Sangdong proj.)	Emerging	Western-aligned capacity restart

EXTREME RISK · 2026 **Tungsten**

China imposed export controls on tungsten — specifically ammonium paratungstate (APT) and processed tungsten forms — in February 2025. This triggered immediate supply shocks with unprecedented price spikes throughout 2025–2026. The seaborne APT market is experiencing exceptional supply tightness, and Western chip manufacturers are scrambling to qualify alternative sources.

Graphite (C)

Key compounds & components:

- Natural and synthetic graphite anodes — used in nearly all EV and consumer electronics Li-ion batteries.
- Pyrolytic graphite sheets — thermal management in smartphones and laptops.
- Graphite crucibles and susceptors — silicon crystal growth and semiconductor epitaxy processes.

Country	Share	Notes
China	~65–79% mining; ~90% + anode processing	Dominant across the value chain
Mozambique	~12%	Balama mine
Madagascar	~5%	Flake graphite

HIGH RISK **Graphite**

China imposed export controls on graphite anode material in December 2023, directly targeting EV and electronics battery supply chains. Over 90% of battery-grade graphite processing takes place in China, with no Western country currently able to process natural graphite into anode-grade material at scale.

Lithium (Li)

Key compounds & components:

- Li_2CO_3 (lithium carbonate) and LiOH (lithium hydroxide) — electrolyte and cathode precursor in all Li-ion batteries.

- $LiNbO_3$ (lithium niobate) and $LiTaO_3$ (lithium tantalate) — piezoelectric substrates in SAW/BAW RF filters for 5G phones, GPS and timing devices.

Country	Share	Notes
Australia	~47%	Hard rock spodumene
Chile	~30%	Brine extraction
China	~14% mining; ~65% refining	Processing chokepoint

MODERATE–HIGH RISK

Lithium

Mining is relatively diversified, but China dominates downstream processing into battery-grade lithium chemicals — creating a processing chokepoint even where raw mining is not controlled.

Part 5 · Consolidated Risk Matrix

The matrix below summarises the supply-chain concentration and geopolitical risk profile for every material covered in this report. Risk levels reflect a combined assessment of mining geography, refining concentration, active export controls and known conflict exposure as of April 2026.

Material	Primary Compound(s)	Key Component	Top Supplier	Supply Conc.	Geo-Risk
Neodymium (REE)	$Nd_2Fe_{14}B$	Permanent magnets	China 69%	Extreme	Extreme
Dysprosium / Terbium	NdFeB additive	High-temp magnets	Myanmar / China	Extreme	Extreme
Europium / Terbium	Eu_2O_3, Tb phos.	Displays, LEDs	China 69%	High	Critical
Yttrium (REE)	YIG, Y_2O_3	RF filters, semicon.	China 69%	High	Critical
Helium	He (elemental)	Semicon. fab, fibre opt.	US 47% / Qatar 38%	High	Critical (2026)
Tantalum	TaN, $LiTaO_3$	Capacitors, RF filters	DRC 37–41%	Extreme	Extreme
Cobalt	$LiCoO_2$, $CoSi_2$	Batteries, semicon.	DRC 85%	Extreme	Extreme
Gallium	GaN, GaAs	RF chips, power elec.	China 94%	Critical	Critical
Germanium	GeO_2, SiGe	Fibre optics, 5G chips	China 82–83%	Critical	Critical
Indium	ITO, InP	Touchscreens, displays	China 70%	High	High
Tungsten	W plugs, WC	Semicon. contacts, PCBs	China 83–85%	Extreme	Extreme
Graphite	Anode material	Li-ion batteries	China 90%+ proc.	High	High
Lithium	Li_2CO_3, $LiTaO_3$	Batteries, RF filters	Australia 47%	Moderate	Mod–High

EXHIBIT 5 Consolidated supply-concentration and geopolitical risk matrix across the 13 most critical materials in electronics manufacturing. Source: GeoTechNexus analysis.

Part 6 · Strategic Implications

The Two-Layer Vulnerability

The fundamental risk facing electronics manufacturers is a two-layer vulnerability: geographic concentration of raw mining, and near-total Chinese dominance of refining and processing. Even materials mined in politically stable countries like Australia and Canada flow into Chinese processing facilities before reaching component manufacturers. This means supply chain resilience requires action at both layers.

Active Weaponisation of Material Supply

China has moved beyond passive supply dominance to active weaponisation. Export controls now apply to gallium (August 2023), germanium (August 2023), graphite (December 2023), tungsten (February 2025), and rare earth elements including heavy REEs (ongoing tightening). These measures are calibrated responses to Western semiconductor export controls (CHIPS Act, Dutch ASML restrictions), signalling that material supply is now an explicit instrument of geopolitical competition.

Conflict Minerals Compliance

Tantalum and cobalt both carry conflict mineral designations under the EU Conflict Minerals Regulation and the US Dodd-Frank Act Section 1502. As of early 2025, the Responsible Minerals Initiative considers DRC and Rwanda sourcing for tantalum to be “extremely challenging”. Electronics manufacturers across the supply chain — from PCB fabricators to semiconductor distributors — face increasing regulatory requirements for material traceability to the mine level.

Near-Term Priorities for Supply Chain Resilience

- **Qualification of alternative sources.** Brazil for tantalum, Australia/Lynas for REEs, and emerging North American sources for germanium and gallium.
- **Processing infrastructure investment.** Western governments and manufacturers must invest in domestic refining capacity — the true strategic chokepoint — with a realistic 5–10 year timeline for meaningful capacity.
- **Helium conservation and recycling.** With Qatar supply disrupted in 2026, semiconductor fabs should immediately audit helium consumption, implement recovery systems, and assess exposure to spot market pricing.
- **Material substitution R&D.** Long-term resilience requires reducing REE intensity in magnets, developing ITO-free transparent conductors, and advancing GaN-on-silicon as a gallium-efficient alternative.
- **Regulatory compliance readiness.** EU SCIP database requirements and US defence regulations now require full material traceability to the component level — a compliance burden that is increasing across the electronics sector.

Sources: USGS Mineral Commodity Summaries 2024–2025; Responsible Minerals Initiative; Reuters; Modern Diplomacy; Investing News Network; Z2Data; Fastmarkets; RFC Ambrian Research. Report compiled by Steve Carr, GeoTechNexus. April 2026.

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