

Why Rare Earth Resources Do Not Create Rare Earth Industries

written by Jack Lifton | July 10, 2026

One of the recurring questions I encounter is why countries possessing abundant rare earth resources have not automatically become major producers of separated rare earths, metals, alloys, or permanent magnets.

The answer is straightforward. Mining and processing are different businesses, requiring different skills, cultures, infrastructure, and measures of success. Mining is fundamentally concerned with extracting minerals economically. Processing is concerned with controlling chemistry, maintaining consistency, and producing materials that manufacturers can qualify and trust. Excellence in one discipline does not automatically confer excellence in the other.

The [global data](#) make the distinction difficult to ignore. According to the International Energy Agency, China accounted for approximately 60% of global mined production of the magnet rare earths—neodymium, praseodymium, dysprosium, and terbium—in 2024. Its share increased to 91% at the refining stage and 94% in the production of sintered permanent magnets. In other words, China's dominance becomes greater, not smaller, as the material moves downstream and the technical requirements become more demanding.

This is the central strategic fact of the rare earth industry. Control of geological resources is not the same as control of industrial production.

The disparity between resources and production is equally revealing. The United States Geological Survey [estimates](#) that Australia possesses 36.3 million tonnes of rare earth reserves, compared with 44 million tonnes in China. Yet Australia produced approximately 29,000 tonnes of rare earths in 2025, while China produced 270,000 tonnes. Brazil holds an estimated 11 million tonnes of reserves but produced only about 2,000 tonnes. Canada has an estimated 830,000 tonnes of reserves and reported no mine production. Geological abundance clearly does not produce an industrial supply chain by itself.

This distinction has often been underestimated by investors and policymakers. Processing is sometimes described as simply another step in the mining business. In reality, it is where the mining industry ends and the advanced-materials industry begins.

Mineral deposits are natural occurrences. Industrial materials are manufactured products.

Between those two statements lies one of the least appreciated realities of the critical minerals economy. Mining extracts naturally occurring mineral assemblages whose composition varies from deposit to deposit and often from one section of an orebody to another. Manufacturing requires materials of exceptional chemical consistency, physical uniformity, and predictable performance. The transformation from one to the other is accomplished through chemical processing, metallurgical control, product qualification, and accumulated operating experience.

Rare earths illustrate this transformation particularly well. Bastnäs site, monazite, xenotime, and ionic adsorption clays contain multiple rare earth elements in different proportions, accompanied by impurities that may include iron, aluminum, calcium, uranium, and thorium. Mining and beneficiation can increase the concentration of the rare earth-bearing minerals,

but they do not produce the individual materials required by manufacturers.

A mixed rare earth concentrate is not neodymium oxide. Neodymium oxide is not neodymium metal. Neodymium metal is not a neodymium-iron-boron alloy, and that alloy is not yet a qualified permanent magnet. Each transformation requires a separate industrial capability, and each introduces new technical, commercial, and quality-control requirements.

Manufacturers do not purchase geological potential. They purchase materials that conform to defined specifications. Neodymium, praseodymium, dysprosium, terbium, yttrium, europium, cerium, and lanthanum may occur together in an orebody, but they perform very different industrial functions. Their commercial value depends upon their separation into individual oxides and, where required, their conversion into metals, alloys, powders, and finished components.

This is technically difficult because the rare earth elements are chemically similar. Their ionic radii change only slightly across the series, their oxidation states are largely identical, and their behavior in solution may differ by only small margins. Commercial separation therefore requires those small differences to be exploited repeatedly through extensive solvent-extraction circuits.

A solvent-extraction plant is not simply a collection of tanks. It is an integrated chemical manufacturing system in which mixer-settlers, pumps, valves, reagents, analytical instruments, control systems, and operating procedures must function continuously and in balance. Variations in acidity, reagent concentration, temperature, flow rate, phase separation, or feed composition may affect product purity many stages downstream.

That is why a successful laboratory process does not necessarily

become a successful commercial plant. A flowsheet demonstrates that a chemical separation may be possible. It does not prove that the process can operate continuously, achieve specification, maintain acceptable recoveries, manage variable feedstocks, control waste streams, and produce material at a cost the customer will accept.

The same principle applies across the critical minerals industries. Battery-grade lithium compounds require impurities to be controlled at very low concentrations. Semiconductor-grade gallium and germanium require still higher purification. Aerospace titanium demands rigorous control of oxygen, nitrogen, hydrogen, and metallic contaminants. Nuclear materials require chemical, metallurgical, and, in some cases, isotopic control throughout production.

The technologies differ, but the industrial requirement is the same: naturally occurring variability must be converted into manufacturing consistency.

Processing facilities therefore represent far more than their installed equipment. They embody organizational knowledge. Operating procedures evolve through experience. Analytical methods become more precise. Engineers learn how variations in feed chemistry affect the circuit. Maintenance teams identify equipment weaknesses. Operators learn to recognize deviations before they become failures. Modifications made over years of production improve recovery, reliability, throughput, and product quality.

Equipment can be purchased. Experience cannot.

This explains why transferring processing technology is more difficult than transferring engineering drawings. A country may acquire a process design, construct a facility, and install modern equipment without possessing the operating culture

required to produce qualified material consistently. The difference becomes visible only during commissioning and commercial operation, when theoretical assumptions meet variable feedstocks, equipment wear, reagent behavior, customer specifications, and production deadlines.

China did not achieve its present position simply because it possesses rare earth deposits or because its production costs were once low. It built an integrated industrial system connecting mines, chemical processors, metal and alloy producers, magnet manufacturers, equipment suppliers, research institutions, trained personnel, and end users. Its share of sintered permanent magnet production increased from approximately 50% in 2005 to 94% in 2024. That expansion reflects two decades of accumulated scale, customer relationships, process knowledge, infrastructure, and manufacturing experience—not geology alone.

The commercial consequences are substantial. During 2021–2024, China supplied approximately 71% of U.S. imports of rare earth compounds and metals. Malaysia, Japan, and Estonia supplied additional material, but some of those imports were themselves derived from concentrates or chemical intermediates originating in China or elsewhere. The apparent geographical diversity of trade therefore overstates the actual independence of the underlying supply chain.

The export controls introduced by China in April 2025 exposed this dependence. When shipments of controlled rare earth products and magnets declined, manufacturers in the United States and Europe encountered immediate sourcing difficulties. According to the IEA, some automakers reduced production rates or temporarily suspended operations. A disruption involving comparatively small volumes of specialized materials was capable of affecting industries whose downstream economic value is

measured in trillions of dollars.

This has important implications for national industrial strategy. Governments frequently emphasize mining because deposits are visible, resources can be estimated, and new projects generate politically attractive announcements. Processing requires longer-term investment in chemical engineering, metallurgy, analytical laboratories, workforce development, equipment maintenance, environmental management, customer qualification, and operating experience. Its progress is gradual, difficult to photograph, and rarely completed within a political cycle.

Yet processing capability ultimately determines whether mineral resources become strategic industrial assets. The rare earth supply chain illustrates the progression clearly. Many countries possess deposits. Far fewer operate commercial-scale separation facilities. Fewer still produce rare earth metals and alloys. Only a small number manufacture high-performance permanent magnets, and fewer again can supply magnets qualified by major automotive, aerospace, defence, and industrial customers.

Each successive stage represents a higher degree of technical complexity, organizational learning, and integration with the customer. This pattern is not unique to rare earths. It characterizes nearly every critical mineral supply chain.

Industrial competitiveness is also rarely secured by a single technological breakthrough. In mature process industries, it results from continuous refinement: higher recovery, lower reagent consumption, reduced energy requirements, improved equipment reliability, faster analytical feedback, better product consistency, higher plant availability, safer operation, and lower environmental impact.

Each improvement may appear modest in isolation. Collectively,

they determine whether a plant operates profitably and whether its products are accepted by customers. Continuous process improvement has often contributed more to lasting industrial leadership than the public announcement of a supposedly revolutionary technology.

The industrial value of a mineral deposit therefore cannot be evaluated independently of the processing technologies, operating knowledge, infrastructure, and customers required to transform it.

Geology defines the opportunity. Mining makes the resource available. Processing creates an industrial material. Manufacturing creates a functional product. Customer qualification determines whether any of it becomes a sustainable business.

Countries that understand these distinctions may succeed in building durable critical minerals industries. Those that continue to treat processing as an appendage to mining will discover that possessing resources is not the same as possessing capability.