What Makes a Material Critical?

written by Jack Lifton | July 10, 2026

Nothing in nature is inherently critical. Criticality arises only when industrial society becomes dependent upon a material whose function cannot be economically replaced.

Governments throughout the world regularly publish lists of what they describe as *critical minerals*. These lists influence national policy, industrial strategy, research priorities, international trade, and, increasingly, investment decisions. They are cited by governments, corporations, universities, financial institutions, and the media as though their meaning were universally understood.

Yet a careful examination reveals an interesting fact. They are seldom lists of minerals. Instead, they generally identify chemical elements, groups of elements, metalloids, and occasionally industrial materials considered strategically important to modern economies. This apparent inconsistency is neither accidental nor trivial. It reflects the fact that different scientific disciplines, industries, and institutions describe the same industrial system from entirely different perspectives.

To a geologist, monazite is a mineral. To a chemist, neodymium is a chemical element. To a metallurgist, neodymium is a reactive metal produced by reducing its compounds from highly stable chemical forms. To a materials scientist, neodymium is only one constituent of a carefully engineered magnetic alloy. To a manufacturing engineer, that alloy is simply one step in producing a permanent magnet whose dimensions, magnetic properties, and long-term reliability must satisfy demanding production tolerances.

To an original equipment manufacturer, the permanent magnet itself is merely one component within an electric traction motor, a robotic actuator, an aircraft control system, or a magnetic resonance imaging device.

To society, these distinctions are largely invisible. The consumer purchases an automobile. A wind turbine. A smartphone. A medical imaging system. A guided missile. A robot. A data center.

Modern technology conceals the remarkable industrial transformation that makes these products possible. Every participant in that transformation describes the process in different terms because each is at a different stage of creating industrial value.

The geologist is not wrong. Neither is the chemist. Nor the metallurgist. Nor the manufacturing engineer. Each sees only one portion of a much larger industrial system.

We need to establish a common language through which these different perspectives may be understood as complementary rather than competing descriptions of the same industrial transformation. That transformation begins with chemistry.

Every naturally occurring substance consists ultimately of chemical elements defined by their atomic structure. Geological processes operating over immense periods of time concentrate some of those elements into minerals sufficiently enriched to become potential industrial resources. Mining extracts those minerals from the Earth’s crust. Chemical processing separates the valuable elements from their associated mineral compounds.

Metallurgical processes reduce those elements to their metallic state or otherwise convert them into forms suitable for further industrial use.

Materials engineering transforms those metals and compounds into engineering materials possessing carefully controlled composition, purity, and microstructure.

Manufacturing converts those engineering materials into functional materials, components, and assemblies whose performance satisfies increasingly demanding industrial requirements.

Finally, original equipment manufacturers integrate those components into products that society purchases for their useful work.

At each successive stage, energy is expended. Knowledge is accumulated. Uncertainty is reduced. Value is created.

This progression is the central theme of our industrial civilization.

It also explains why the term “critical minerals” is simultaneously useful and misleading. It is useful because geological resources are the indispensable starting point for every industrial supply chain. It is misleading because minerals themselves are rarely purchased by the industries that ultimately create economic value.

Automobile manufacturers do not purchase monazite. Semiconductor manufacturers do not purchase gallium-bearing ores. Battery manufacturers do not purchase spodumene. Aircraft manufacturers do not purchase rutile.

They purchase qualified engineering materials whose properties have been demonstrated, whose manufacture has been mastered, and whose supply has been earned through years of reliable industrial performance. The distinction is fundamental.

Industry does not consume minerals.

Industry transforms minerals into materials.

Those materials become critical only when industrial society depends upon the functions they perform and when those functions cannot be economically replaced within the required time, cost, or performance constraints.

Criticality, therefore, does not originate in geology. It emerges from industrial dependence. Recognizing that distinction changes the questions we ask. Instead of asking, “Where are the critical minerals?” we begin asking, “Which industrial capabilities are indispensable?” Instead of asking, “Who owns the resource?” we ask, “Who can consistently manufacture qualified materials?”

Instead of asking, “How many tonnes are in the ground?” we ask, “Which manufacturers depend upon those materials, and how long would it take to replace them?”

These are not geological questions.

They are industrial questions.

Sorting It Out: Critical Minerals or Crucial Materials?

Critical Minerals Institute Unveils 2026 Watchlist: Rhenium (Re) and Indium (In) Added, Tungsten (W) Elevated to Top 5 as

Supply Chain Risks Intensify