Russia and Scandium's Scant Scale

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Scandium, a rare earth element, is primarily used in aluminum alloying and other specialty applications. This metal is one of the elements listed on the USGS 2022 List of Critical Minerals. The Russia-Ukraine war has the potential to disrupt supplies of this metal. Beyond Russia and Ukraine, only a few other nations are producers of scandium such as China and Kazakhstan. This executive briefing provides information on scandium's uses, sources, market, and trade data to help put this situation into context.

Scandium: Scandium is an input for a variety of niche applications. It is a key alloying material in certain high-performance aluminum alloys. Incorporation of scandium in aluminum alloys improves the mechanical properties of the metal, offering increased corrosion resistance, tensile strength, and the ability to make weldable components. Scandium-aluminum alloys were key materials in the production of advanced aerospace materials in the former USSR, and these alloys are still used in Russian MiG aircrafts today.[1] Outside of specialty markets, scandium-alloyed aluminum is used in the manufacture of certain sporting goods, such as lacrosse sticks.[2]

Extraction and refinement of scandium occurs only as a byproduct of other beneficiation processes and only on a small scale. While classified as a rare earth, scandium is modestly abundant in the Earth's crust (concentration is approximately 22 parts per million [ppm]), and it is the fifth most abundant rare earth element. Substantial reserves of scandium exist across Asia, Africa, Europe, Australia, and the United States, but only a handful of countries have active sourcing operations. Although scandium's concentration is similar to that of copper (~30 ppm), which is extracted globally on a substantial scale, it is not economically viable to solely mine scandium, as it does not generally exist in concentrated ores. Scandium is sourced from a variety of sources, including cobalt, nickel, titanium, uranium, zirconium, and other rare earth production operations. Reportedly, Russia is one of the three largest producers of scandium. As of 2019, the latest year for which foreign mining data is available, Kazakhstan, Russia, and Ukraine were producing scandium (largely as byproduct of uranium operations), and China had at least two firms producing scandium (downstream of iron, rare earth, titanium, and zirconium production).[3] While the United States has mined and refined scandium in the past, and there are reportedly plans to do so again in multiple states, there is presently no capacity in operation.[4]

Market, Russia, and Trade: Global supply and consumption of scandium only amounts to 15–25 metric tons per year, and as the market is niche, it is difficult to gather scandium-specific data. It is not included in any large metal exchange, and the non-public contracts between purchasers and producers make it difficult to estimate current and historic prices.[5] Over the past five years, price estimates for scandium oxide range from $3,000–$5,000 per kilogram, and in 2010, costs reached as high as $7,000 per kilogram. Other scandium compounds (e.g., scandium oxide or scandia) fetch several hundred dollars per gram.

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[1] MiG is an abbreviation for the Russian Aircraft Corporation based on its Soviet predecessor, the Mikoyan and Gurevich Design Bureau. MiG aircraft have been contracted and delivered to countries outside Russia.

[2] Other applications include certain solid oxide fuel cells, light sources, ceramics, and electronic components.

[3] Russia also reportedly maintains a Cold War-era scandium stockpile. Some additional capacity is either operational or in the testing phase in the Philippines (from nickel mining), Greece, Finland, Canada, and Australia.

[4] Scandium has been listed in the USGS 2022 final List of Critical Minerals (87 FR 10381, February 24, 2022).

[5] Since 1999, USGS supplied pricing data for scandium metal and scandium compounds has been based on prices from Alfa-Aesar, a chemical supply company.

Scandium is typically traded as either a pure metal or as a higher purity (greater than 99.9 percent) chemical compound.[6] U.S. imports of scandium metals and alloys enter under 10-digit HTS statistical reporting number 2805.30.4090, and certain scandium containing compounds enter under numbers 2846.90.2015, 2846.90.2082, and 2846.90.8075, but none exclusively cover scandium.[7] A handful of economies have export classification numbers specific to scandium metal and its compounds, including Russia, China, the European Union, Kazakhstan, and Ukraine.[8] Of those, only Russia reported trade for scandium metal from 2017–21, and no national statistical authorities reported trade specific to alloys of scandium in these years. Based on the available data, the United States is the primary (if not the only) market for scandium metal exports from Russia (table 1).

Table 1: Russian exports of scandium and certain scandium containing compounds to the United States, by quantity (kilograms) and value (dollars), 2017–2021

	Scandium Metal (Quantity)	Scandium Metal (Value)	Scandium Metal Exports to U.S., share of total (percent)	Scandium Compounds (Quantity)	Scandium Compounds (Value)
2017	14	199,820	100	5	14,420
2018	54	757,800	100	3	17,131
2019	60	819,000	97	5	32,725
2020	130	1,746,780	100	2	52,840
2021	420	5,557,980	95	7	179,870

Source: Official export statistics from Russia under Russian export classification numbers 2805.30.4000 and 2846.90.3000, as reported by national statistical authorities in the Global Trade Atlas database, accessed April 22, 2022.

Notes: Compounds represents trade of scandium containing salts (e.g., scandium oxide). There was no recorded trade during this period under the scandium-specific export classification numbers for China, Kazakhstan, or Ukraine.

Conflict and Outlook: Based on what can be gleaned from the available trade data, it's possible that the present conflict between Russia and Ukraine will affect scandium metal supplies in the United States.[9] As with other commodities sourced from Russia, the potential for a substantial shortfall for downstream U.S. manufacturers and end-users of scandium becomes more likely as the war continues.[10] Moreover, the war is likely disrupting operations and production in Ukraine, intensifying global supply shortages. However, in the long-term, the potential development of scandium sources in other nations, including proposed U.S. projects, may help offset future supply shocks.

Sources: Benton, "Australian Mines," May 17, 2020; Duyvesteyn and Putnam, "Scandium," May 2014; Emsley, "Unsporting Scandium," November 2014; Kay, "The Scandium Price," June 11, 2018; Lasley, "Scandium," September 2021; Strategic Metal Investments, "Scandium Price," accessed April 14, 2022; USGS, "Scandium," January 2022; Williams-Jones and Vasyukova, "The Economic Geology of Scandium," June 2018; Johnston, "Supply of Critical Minerals," April 19, 2022.

[6] Purity needs wholly depends on the application. For aluminum end-users, a master alloy of two percent scandium in aluminum is produced as an intermediate.

[7] These reporting numbers are unlikely to capture all scandium compounds imports into the U.S.

[8] Exported under 2805.30.4000 (Russia, Turkey), 2805.30.1800 (China), and 2846.90.3000 (all listed).

[9] Unit value calculations based on Russian national export statistics do not match reported information about scandium prices. This situation highlights the ambiguity of the global scandium market, and it is unclear what fraction of global production is represented by Russian exports to the United States

[10] U.S. legislation revoking Russia's most favored nation status may also nominally increase prices, as the U.S. duty rate for scandium metal under HTS 6-digit subheading 2805.30 and scandium compounds under 2846.90 would increase from 5 to 31.3 percent and free to 25 percent ad valorem, respectively.