RUBIDIUM

(Data in metric tons of rubidium oxide unless otherwise noted)

Domestic Production and Use: Rubidium is not actively mined in the United States; however, occurrences are known in Alaska, Arizona, Idaho, Maine, South Dakota, and Utah. Rubidium is also associated with some evaporate mineral occurrences in other States. One company recovered and stockpiled for sale approximately 200 tons of rubidium as part of ongoing reclamation projects in Arizona, Idaho, and Utah. Rubidium is not a major constituent of any mineral; it is produced in small quantities as a byproduct of cesium, lithium, and strontium mining. Rubidium concentrate is produced as a byproduct of pollucite and lepidolite mining and is imported from other countries for processing in the United States. The United States sources the majority of pollucite from the largest known North American deposit at Bernic Lake, Manitoba, Canada.

Applications for rubidium and its compounds include biomedical research, electronics, specialty glass, and pyrotechnics. Specialty glasses are the leading market for rubidium; rubidium carbonate is used to reduce electrical conductivity, which improves stability and durability in fiber optic telecommunications networks. Biomedical applications include rubidium salts, used in the treatment of epilepsy, thyroid disorder, and antishock agents; rubidium-82, a radioactive isotope, is used as a blood-flow tracer in positron emission tomographic imaging; and rubidium chloride is used as an antidepressant. Rubidium atoms are used in academic research, including the development of quantum mechanics-based computing devices, a future application with potential for relatively high consumption. Quantum computing research uses ultracold rubidium atoms in a variety of applications. Quantum computers, which have the ability to perform more complex computational tasks than traditional computers by calculating in two quantum states simultaneously, were expected to be in prototype phase within a decade.

Rubidium's photo emissive properties make it ideal for electrical-signal generators in motion-sensor devices, night-vision devices, photoelectric cells (solar panels), and photomultiplier tubes. Rubidium is used as an atomic resonance-frequency-reference oscillator for telecommunications network synchronization, playing a vital role in global positioning systems (GPS). Rubidium-rich feldspars are used in ceramic applications for spark plugs and electrical insulators because of their high dielectric capacity. Rubidium hydroxide is used in fireworks to oxidize mixtures and produce violet hues. The U.S. military frequency standard, the United States Naval Observatory (USNO) Time Scale, is based on 48 weighted atomic clocks, including four USNO rubidium fountain clocks.

Salient Statistics—United States: U.S. salient statistics, such as consumption, exports, and imports, are not available. Some concentrate, which was sourced primarily from Canada, was exported to the United States for further processing. Industry information during the last decade suggests an annual domestic consumption rate of approximately 2,000 kg.

No market price for rubidium is published because the metal is not traded in commercial quantities. In 2014, one company offered 1-gram ampoules of 99.75%-grade rubidium (metal basis) for $80.30 and 100 grams ampoules of the same material for $1,472.00, a 4% increase from that of 2013. The price for 10-gram ampoules of 99.8% rubidium formate hydrate (metal basis) was $56.20, a 4% increase from that of 2013. The price for 10-gram ampoules of 99.8% and 99.975% rubidium chloride (metal basis) was $55.10 and $209.00, respectively.

Recycling: None.

Import Sources (2010–13): The United States is 100% import reliant on byproduct rubidium-concentrate imports, most of which was thought to be imported from Canada.

Tariff: Item	Number	Normal Trade Relations 12–31–14
Alkali metals, other	2805.19.9000	5.5% ad val.
Chlorides, other	2827.39.9000	3.7% ad val.
Bromides, other	2827.59.5100	3.6% ad val.
Nitrates, other	2834.29.5100	3.5% ad val.
Carbonates, other	2836.99.5000	3.7% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Prepared by **Candice C. Tuck [(703) 648–4912, ctuck@usgs.gov]**

RUBIDIUM

Events, Trends, and Issues: Domestic rubidium occurrences will remain uneconomic unless market conditions change, such as the discovery of new end uses or increased consumption for existing end uses, which in turn would lead to increased prices. No known human health issues are associated with naturally occurring rubidium, and its use has minimal environmental impact.

As reported in 2014, one underground mining operation at Bernic Lake, Manitoba, Canada, experienced a fall of ground in early 2013, in the area of the mine's crowning pillar, following a similar event in 2010. A site review was conducted in April 2013, by a third-party engineering consulting service, which indicated the crown pillar had a 55% probability of substantive, progressive failure within the next year and a 25% probability failure occurring in the next 6 months. Monitoring equipment had been installed to monitor the mines stability. Development alternatives that could require 2 to 3 years to complete were being assessed to allow for continued long-term mining operations. Collapse of the mine would result in enduring mining delays and, potentially, mine closure. In Argentina, one company began bulk sampling and drilling to determine resource estimates for a cesium and rubidium deposit. The deposit underwent pre-feasibility studies with expected reserves estimates to be complete by yearend 2014. Initial studies indicated a cesium-to-rubidium ratio of 8:1.

Developments continued in quantum computing and related fields of research, including a method for connecting particles, which would be used as a switch in computing processes and internet connections. The process involves a photon of light and a rubidium atom altering the quantum state of one another, a substantial discovery integral in moving quantum computers towards the prototype stage. The National Institute of Standards and Technology developed a microfluid chip that produces and detects xenon gasses, using rubidium atoms to polarize the xenon atoms and enhance the signal strength. The chip could be used as a smaller and cheaper replacement for some instruments, like magnetic resonance imaging, which rely on nuclear magnetic resonance.

An accelerometer, based on the quantum interference of rubidium utlracold atoms, was being developed for use on submarines in the Royal Navy, among similar developments in other countries. The device would allow submarines to track their own locations within a 1-meter error in a 24-hour period; submarines can currently only navigate using traditional GPS, which requires surfacing. The technology, upon miniaturization, could also be adapted for use to explore oil or mineral deposits and as gravity scanners, which can create density maps of an object's contents.

World Mine Production and Reserves: One mine in Canada produced rubidium ore as a byproduct, which was processed as concentrate; however, production data for that mine are not available. The principal sources of global rubidium reserves, lepidolite and pollucite, can contain up to 3.5% rubidium oxide and 1.5%, respectively. The rubidium-bearing mineral reserves are found in zoned pegmatites, which are exceptionally coarse-grained plutonic rocks that formed late in the crystallization of a silicic magma. Mineral reserves exist globally, but extraction and concentration are cost prohibitive. Production is known to occur periodically in Canada, Namibia, and Zimbabwe but production data were not available. Rubidium is also mined in China, but information regarding reserves and production is unavailable.

	Reserves[1]
Canada	12,000
Namibia	50,000
Zimbabwe	10,000
Other countries	8,000
World total	80,000

World Resources In addition to several significant rubidium-bearing zoned pegmatites in Canada, similar pegmatite occurrences have been identified in Afghanistan, China, Denmark, Germany, Japan, Kazakhstan, Namibia, Peru, Russia, the United Kingdom, and the United States, and Zambia. Minor amounts of rubidium are reported in brines in northern Chile and China and in evaporites in France, Germany, and the United States (New Mexico and Utah).

Substitutes: Rubidium and cesium can be used interchangeably in many applications because they have similar physical properties and atomic radii. Cesium, however, is more electropositive than rubidium, making it a preferred material for some applications.

[1]See Appendix C for resource/reserve definitions and information concerning data sources.