RHENIUM

(Data in kilograms of rhenium content unless otherwise noted)

Domestic Production and Use: During 2007, ores containing rhenium were mined by five operations (two in Arizona, one each in Montana, New Mexico, and Utah). Rhenium compounds are included in molybdenum concentrates derived from porphyry copper deposits, and rhenium is recovered as a byproduct from roasting such molybdenum concentrates. Rhenium-containing products included ammonium perrhenate, perrhenic acid, and metal powder. The major uses of rhenium were in petroleum-reforming catalysts and in superalloys used in high-temperature, turbine engine components, representing an estimated 20% and 60%, respectively, of the end use. Bimetallic platinum-rhenium catalysts were used in petroleum-reforming for the production of high-octane hydrocarbons, which are used in the production of lead-free gasoline. Rhenium improves the high-temperature (1,000° C) strength properties of some nickel-based superalloys. Rhenium alloys were used in crucibles, electrical contacts, electromagnets, electron tubes and targets, heating elements, ionization gauges, mass spectrographs, metallic coatings, semiconductors, temperature controls, thermocouples, vacuum tubes, and other applications. The estimated value of rhenium consumed in 2007 was about $84 million.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production[1]	3,400	5,900	7,100	8,100	7,300
Imports for consumption	14,500	20,200	28,900	38,700	44,500
Exports	NA	NA	NA	NA	NA
Consumption, apparent	18,400	26,100	36,000	46,800	51,800
Price,[2] average value, dollars per kilogram, gross weight:					
Metal powder, 99.99% pure	1,090	1,090	1,070	1,260	1,330
Ammonium perrhenate	790	710	680	840	780
Stocks, yearend, consumer, producer, dealer	NA	NA	NA	NA	NA
Employment, number	Small	Small	Small	Small	Small
Net import reliance[3] as a percentage of apparent consumption	81	77	80	83	86

Recycling: Small amounts of molybdenum-rhenium and tungsten-rhenium scrap have been processed by several companies during the past few years. All spent platinum-rhenium catalysts were recycled.

Import Sources (2003-06): Rhenium metal: Chile, 91%; Germany, 6%; and other, 3%. Ammonium perrhenate: Kazakhstan, 59%; Germany, 12%; Netherlands, 11%; Estonia, 4%; and other, 14%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-07**
Salts of peroxometallic acids, other— ammonium perrhenate	2841.90.2000	3.1% ad val.
Rhenium, etc., (metals) waste and scrap	8112.92.0600	Free.
Rhenium, (metals) unwrought; powders	8112.92.5000	3% ad val.
Rhenium, etc., (metals) wrought; etc.	8112.99.9000	4% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Prepared by **Michael J. Magyar [(703) 648-4964, mmagyar@usgs.gov, fax: (703) 648-7757]**

RHENIUM

Events, Trends, and Issues: During 2007, average rhenium metal price, based on U.S. Census Bureau customs value, was about $1,330 per kilogram, about 6% more than that of 2006. Rhenium imports increased by about 15% owing to continued strong demand for superalloys in the gas turbine engine market and improved demand in the catalyst market. Rhenium production in the United States decreased by about 10% owing to reduced imports of byproduct molybdenum concentrates for roasting in the United States. Byproduct molybdenum production from five of the six working copper-molybdenum mines maintained production levels near capacity in 2007; one mine did not operate its molybdenum circuit in 2007. The United States continued to rely on imports for much of its supply of rhenium, and Chile and Kazakhstan supplied the majority of the imported rhenium. Exports of rhenium from Kazakhstan resumed in late 2006 after a dispute over payments for past utilities usage and rhenium-bearing residues was settled. Stockpiled quantities of low-grade APR were imported into the United States from Kazakhstan in early 2007, but they did not reach the market immediately, as the material had to be reprocessed and upgraded before use. Owing to strong demand, APR spot prices continued to rise, reaching $5,000 per kilogram in January, $7,000 per kilogram in April, and $9,000 per kilogram in September.

Owing to the scarcity and minor output of rhenium, its production and processing pose no known threat to the environment. In areas where it is recovered, pollution control equipment for sulfur dioxide removal also prevents most of the rhenium from escaping into the atmosphere.

World Mine Production, Reserves, and Reserve Base:

	Mine production[4]		Reserves[5]	Reserve base[5]
	2006	2007		
United States	8,100	7,300	390,000	4,500,000
Armenia	1,200	1,200	95,000	120,000
Canada	1,700	1,700	32,000	1,500,000
Chile[6]	19,800	22,900	1,300,000	2,500,000
Kazakhstan	8,000	8,000	190,000	250,000
Peru	5,000	5,000	45,000	550,000
Russia	1,400	1,400	310,000	400,000
Other countries	2,000	2,000	91,000	360,000
World total (rounded)	47,200	49,500	2,500,000	10,000,000

World Resources: Most rhenium occurs with molybdenum in porphyry copper deposits. Identified U.S. resources are estimated to be about 5 million kilograms, and the identified resources of the rest of the world are approximately 6 million kilograms. In Kazakhstan, rhenium also exists in sedimentary copper deposits.

Substitutes: Substitutes for rhenium in platinum-rhenium catalysts are being evaluated continually. Iridium and tin have achieved commercial success in one such application. Other metals being evaluated for catalytic use include gallium, germanium, indium, selenium, silicon, tungsten, and vanadium. The use of these and other metals in bimetallic catalysts might decrease rhenium's share of the existing catalyst market; however, this would likely be offset by rhenium-bearing catalysts being considered for use in several proposed gas-to-liquid projects. Materials that can substitute for rhenium in various end uses are as follows: cobalt and tungsten for coatings on copper X-ray targets, rhodium and rhodium-iridium for high-temperature thermocouples, tungsten and platinum-ruthenium for coatings on electrical contacts, and tungsten and tantalum for electron emitters.

[e]Estimated. NA Not available.

[1]Based on estimated rhenium contained in MoS_2 concentrates assuming 90% recovery of rhenium content.

[2]Average price per kilogram of rhenium in pellets or ammonium perrhenate, based on U.S. Census Bureau customs value.

[3]Defined as imports – exports + adjustments for Government and industry stock changes.

[4]Estimated amount of rhenium recovered in association with copper and molybdenum production.

[5]See Appendix C for definitions.

[6]Estimated rhenium recovered from roaster residues from Belgium, Chile, and Mexico.