



# 2008 Minerals Yearbook

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## GERMANIUM

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**Domestic table was prepared by Shonta E. Osborne, statistical assistant.**

In 2008, germanium was recovered from zinc concentrates at two zinc mines and produced at two refineries in the United States. Germanium-bearing concentrates were produced at two zinc mines in Alaska and Washington, owned by Teck Cominco Ltd. (Vancouver, British Columbia, Canada). The germanium-bearing concentrates were exported to Canada for processing. Two refineries in New York and Oklahoma produced germanium dioxide, germanium metal, and germanium tetrachloride from manufacturers' scrap, and post-consumer scrap and processed imported germanium compounds.

Germanium is a hard, brittle semimetal that first was used about one-half century ago as a semiconductor material in radar units and as the material for the first transistors. Today, it is used principally as a polymerization catalyst for polyethylene terephthalate (PET), a commercially important plastic; as a component of glass in telecommunications fiber optics; as a lens or window in infrared night-vision devices; and as a semiconductor and substrate in electronics circuitry and solar cells.

## Legislation and Government Programs

As a strategic and critical material, germanium was included in the National Defense Stockpile (NDS) in 1984. Sales of germanium metal were significantly lower in 2008 compared with those in previous years. In January, the Under Secretary of Defense for Acquisition, Technology, and Logistics established a working group to review current stockpile disposal policy and to determine whether the stockpile is properly configured to meet the future needs of the military. In conjunction with the formation of this working group, sales of certain commodities, such as germanium, were curtailed in order to maintain a goal level of stockpile inventory for the future. The Defense National Stockpile Center (DNSC) reported that germanium metal sales in calendar year 2008 were 102 kilograms (kg) compared with 6,902 kg in calendar year 2007. In calendar year 2008, the germanium was sold in November and December at an average price of \$1,433 per kilogram. As of December 31, 2008, the total inventory of germanium metal held by the NDS was 16,448 kg.

During fiscal year 2008 (October 1, 2007, through September 30, 2008), the DNSC sold 714 kg of germanium metal at an average value of \$1,225 per kilogram. In mid-October 2008, the Duncan Hunter National Defense Authorization Act for Fiscal Year 2009 (Public Law No. 110-417) was approved by Congress and signed into law by the President. Following the passage of this bill, the DNSC announced that it would resume weekly sales of germanium via the Basic Ordering Agreement Sales Program. The Annual Materials Plan for fiscal year 2009 (October 1, 2008, through September 30, 2009) allowed for the sale of up to 8,000 kg of germanium metal (Defense National Stockpile Center, 2008a, b, p. 1-2, 7-8).

## Production

Domestic refinery production of germanium was estimated by the U.S. Geological Survey (USGS) based on data provided by North American producers. The USGS estimated that U.S. refinery production of germanium from fly ash, imported primary material and germanium compounds, and new scrap in 2008 was 4,600 kg.

Teck Cominco produced germanium-containing zinc concentrates at its Red Dog zinc-lead open pit mine in Alaska and its Pend Oreille zinc-lead underground mine in Washington State. Approximately 25% of the zinc concentrate produced at Red Dog and 100% of the concentrate produced at Pend Oreille was sent to the company's metallurgical complex in Trail, British Columbia, Canada. The zinc concentrates were then treated in roasters or pressure-leach facilities to extract germanium and other byproducts. In December, Teck Cominco announced that it would be temporarily closing its Pend Oreille operations in early 2009 owing to reduced metal demand and the decline in zinc prices. The shutdown followed a previously announced decision to reduce refined zinc production at the Trail facility (section on Canada under "World Review"). Teck Cominco indicated that, during the Pend Oreille closure, it would continue to produce germanium and other byproduct metals from an existing residue stockpile. In 2007, Teck Cominco produced about 40,000 kg of germanium at its Trail facility. The company did not release 2008 germanium production information but did state that it had achieved a refined germanium production record through improved recovery initiatives (Teck Cominco Ltd., 2008a, b, p. 98; 2009, p. 21).

In 2008, Umicore Optical Materials USA Inc. (a subsidiary of Umicore s.a., Brussels, Belgium) continued production of germanium metal and compounds at its plant in Quapaw, OK, and remained the leading domestic producer of germanium and germanium-base materials. Umicore produced germanium from fly ash, germanium concentrates, scrap generated internally or by the fiber-optic industry, and imported germanium compounds. The Quapaw facility refined the raw material into germanium tetrachloride (used as an additive in the manufacture of optical fibers), germanium metal [used to manufacture blanks (lenses and windows) for infrared (IR) devices], and proprietary [chalcogenide glass (GASIR®)] lenses (designed for large-scale commercial and military infrared optical systems). In late June, Umicore announced that it planned to expand its germanium substrate (wafer) production capacity in Quapaw by building a new 3,720-square-meter plant adjacent to its existing production facility. When completed, the \$51 million expansion project was expected to nearly double Umicore's global wafer production capacity to 900,000 substrates per year. Construction of the new plant began in mid-October and was expected to be completed by spring 2010. The company stated that the production capacity

was being added in anticipation of rapid growth in the terrestrial concentrator photovoltaic market during the next 12 years (Umicore s.a., 2008).

Germanium Corp. of America (a subsidiary of Indium Corp. of America, Clinton, NY) produced germanium products, including germanium dioxide, germanium metal, and germanium tetrachloride, at its facility in Utica, NY.

In October, Strategic Resource Acquisition Corp. (SRA) (Toronto, Ontario, Canada) announced that it would be placing the Middle Tennessee Zinc Mining (MTM) complex near Gordonsville, TN, on care-and-maintenance status owing to the state of the credit market and declining zinc prices. In 2007, SRA had announced plans to restart operations at the idled mining complex and had anticipated that the mines would be able to produce significant amounts of byproduct germanium and gallium. SRA commenced mining activities at the Gordonsville mine and mill in April and was expecting to have two of the other zinc mines in the complex operational by fall 2008. According to SRA, indicated resources at the MTM complex were 12.5 million metric tons (Mt) of ore grading 3.35% zinc, 0.04% germanium, and 0.05% gallium. The company negotiated an agreement to sell germanium- and gallium-rich smelter leachates to Recapture Metals Ltd. for processing, but no germanium or gallium was recovered in 2008 (Strategic Resource Acquisition Corp., 2008a, b).

In July, Australian exploration company PacMag Metals Ltd. reported that widespread germanium had been identified through surface sampling at the company's Sentinel project in southwestern North Dakota. The Sentinel project, spanning more than 101 million square meters of private land in North Dakota, targeted multiple high-grade uranium-molybdenum mineralization zones. Results from 50 surface samples taken at the site in July indicated that germanium dioxide was present at an average concentration of 80 parts per million (ppm) in addition to uranium and molybdenum. The company planned to continue a drilling and sampling program at Sentinel in 2009 and ultimately would determine whether open pit mining at the site would be economically and environmentally feasible (PacMag Metals Ltd., 2008).

## Consumption

The USGS estimated that domestic consumption of germanium increased to 54,500 kg in 2008 from 52,400 kg in 2007 owing to continued growth in infrared optic, fiber-optic, and solar cell applications. Worldwide, the end-use pattern was estimated to be as follows: catalysts for polyethylene terephthalate (PET), 35%; infrared optics, 30%; fiber optics, 20%; and electronics, solar applications, and other uses (such as phosphors, metallurgy, and chemotherapy), 15%. The domestic end-use pattern was significantly different, however, with infrared optics accounting for 50%; fiber optics, 30%; electronics and solar applications, 15%; and other uses (phosphors, metallurgy, and chemotherapy), 5%. Germanium was not used in PET catalysts in the United States.

Germanium was used in the manufacture of lenses and windows for infrared optical systems owing to its transparency to part of the infrared spectrum and high refractive index. Germanium is easily machinable, relatively strong, resistant

to atmospheric oxidation, and able to withstand exposure to chemicals and moisture. The lenses and windows manufactured from germanium are often incorporated into thermal imaging systems that detect infrared radiation and convert it into an electronic signal, which is then processed and displayed on a video screen. Umicore's electro-optic materials group produced a wide variety of optical-grade germanium blanks and finished optics (polished and coated) at its production facility in Quapaw for use in infrared optical devices. According to the company, sales of germanium blanks in 2008 increased from those in the previous year owing to demand from the defense sector (Umicore s.a., 2009, p. 26).

Domestically, infrared imaging devices continued to be used extensively by the military and law enforcement agencies for border and maritime patrol, Federal drug interdiction, force protection, search-and-rescue operations, surveillance and reconnaissance, and targeting applications. Thermal-imaging systems containing germanium-base optics were used in helicopters, fixed-wing aircraft, ships, land vehicles, and observation towers. The proliferation of mounted thermal weapon sights (TWS) for use by individual soldiers had a significant impact on overall germanium consumption owing to the great quantities of units placed into operation. The U.S. Army awarded multiple long-term, contracts for the acquisition of tens of thousands of new TWS over the next several years. Recent advances in night-vision technology have led the Army to incorporate the continuous use, day and night, of these infrared devices in ongoing missions in Afghanistan and Iraq. The current generation of TWS used on machine guns, mounted-weapon systems, and rifles significantly improved surveillance and target acquisition capabilities in extremely adverse battlefield conditions. Demand for these types of infrared devices was expected to continue to be strong over the next several years as they increasingly become a staple requirement of all branches of the military. The Army's technology procurement request for fiscal year 2009 included \$466 million allocated to acquiring new night-vision devices and \$417 million for additional TWS (Keller, 2008).

In 2008, a handful of automobile manufacturers were providing infrared night-vision systems, primarily intended for detecting pedestrians and animals in the roadway at night, as optional equipment on some luxury vehicles. FLIR Systems, Inc. (Wilsonville, OR), a leading manufacturer of thermal imaging systems sold to commercial, industrial, and government markets, and partner Autoliv Inc. (Stockholm, Sweden) has manufactured night-vision systems for select BMW models since 2005. In late 2008, a second generation of the night-vision system, which incorporated significant quality improvements from the previous system, was introduced. The new system utilized infrared technology to scan the road for pedestrians that were more than twice the distance from the vehicle than the typical headlight range and alerted the driver of the potential danger. FLIR and Autoliv were anticipating that several additional automobile manufacturers would introduce night-vision systems within the next few years (Autoliv Inc., 2008).

In the fiber-optic sector, germanium was used as a dopant (a substance added in small amounts to the pure silica glass core to increase its refractive index, preventing signal loss while not

absorbing light) within the core of optical fibers used by the telecommunications industry. Demand for fiber optics in North America continued to grow in 2008 and was driven by fiber-to-the-home (FTTH) installations. According to a study released by the Fiber-to-the-Home Council, more than 13.8 million homes in North America had fiber-optic cable running to the premises by yearend 2008, an increase of about 45% from the 9.5 million homes that had FTTH access in the previous year. Corning Inc. (Corning, NY), a leading producer of fiber-optic cable, reported that, in 2008, fiber-optic cable sales increased slightly from those in 2007 owing to volume gains in fiber-to-the-premises products. Services provided over fiber-optic cable were geared toward high-speed internet connectivity, telecommunications services, television, video-on-demand, and home security (Fiber-to-the-Home Council, 2008; Corning Inc., 2009, p. 29).

Globally, the number of countries where FTTH had established a significant market presence had nearly doubled during the past 18 months. The countries with the greatest market penetration rates of FTTH and fiber-to-the-building installations by yearend 2008 were the Republic of Korea, 44%; Hong Kong, 28%; Japan, 27%; Taiwan, 12%; Sweden, 9%; Norway, 8%; Slovenia, 7%; and the United States, 5% (Fiber-to-the-Home Council, 2009).

Germanium substrates continued to be favored for use in space-based photovoltaic solar cells, used in the majority of new satellites launched. Germanium substrates were smaller in size, more efficient at converting light into energy, and provided greater power output than the most common alternative substrate, silicon. Germanium substrates constitute the building blocks of multilayer solar cells. Ultrathin layer combinations of materials are “grown” on top of the germanium substrate, each capturing a specific part of the solar spectrum and converting it into electricity (Umicore s.a., 2008, p. 14). The use of these substrates in terrestrial applications, where they were typically coupled with concentrator technology (lenses and mirrors that concentrate solar beams), had increased gradually during the past few years and was expected to continue to grow through 2020. By yearend 2008, more than 20 terrestrial-based solar power systems that utilized concentrator photovoltaic technology had been installed worldwide. When combined with a lens concentrator, a single multijunction solar cell measuring 1 square centimeter has the ability to produce the same amount of electricity as several larger silicon solar cells. Although these multijunction solar cells deliver greater rates of energy conversion and power output than other solar cell technologies, they tend to be more expensive owing to the cost of raw materials. Major germanium substrate producers have begun to develop larger, thinner substrates for use in terrestrial applications that increase cell yield while reducing overall cost. Umicore indicated that global sales of germanium substrates in 2008 had increased from those of the previous year owing primarily to growth from the satellite sector (85%) and, to a lesser extent, from the terrestrial market (15%) (Umicore s.a., 2009, p. 5). Another leading germanium substrate producer, AXT Inc. (Fremont, CA) reported that its global revenue from germanium substrates in 2008 was \$4.2 million, which was 91% greater than that in 2007. The company attributed the increased revenue to growing demand for both space- and terrestrial-based solar applications in China and Germany (AXT Inc., 2009, p. 42).

In 2008, the U.S. Department of Defense, Defense Advanced Research Projects Agency increased funding for the ongoing Very High Efficiency Solar Cell (VHESC) Program. The objective of the VHESC program was to demonstrate at least 50% efficiency in an affordable and manufacturable photovoltaic device. A consortium comprising scientists from universities, research institutes, and solar-cell manufacturers was working to meet the goals that were set forth by the program. The photovoltaic device to be developed by the program would provide soldiers in the field with a new source of portable power for electronic equipment, reducing battery reliance. Batteries can create logistical problems for the military owing to the need to supply soldiers in the field with regular deliveries of replacement units. Solar-powered devices would also eliminate the added weight associated with carrying spare batteries in packs. Delivery of the first integrated soldier system device, such as a flashlight or radio with integrated solar cells, was to occur in fiscal year 2009 (U.S. Department of Defense, 2008, p. 214–215).

According to the Solar Energy Industries Association (SEIA), installed solar capacity in the United States was 9,180 megawatts in 2008, a 16% increase from that in the previous year. The United States was the third leading installer of new photovoltaic solar capacity in 2008, behind Spain and Germany. The SEIA’s survey of manufacturers indicated that 2008 domestic photovoltaic module production increased by about 60% from that in the previous year. California, Hawaii, Maryland, North Carolina, Ohio, Oregon, and Pennsylvania led the United States in new photovoltaic installations in 2008. Federal and local governments created public policies that attempted to encourage long-term investment in photovoltaic technologies by residential and commercial consumers. The Emergency Economic Stabilization Act of 2008, enacted in Congress in early October, extended a 30% solar investment tax credit (ITC) for 8 years, lifted a \$2,000 cap for residential photovoltaic installations, allowed application of the tax credits against the alternative minimum tax credit, and removed the prohibition against utilities use of the ITC. Several State and local governments introduced new policies that provided grants, loans, and rebates to offset the costs of installing solar systems (Solar Energy Industries Association, 2009, p. 5).

In the polymerization catalysts sector outside the United States, germanium dioxide use as a catalyst for PET production remained relatively stable. Japan continued to be the leading consumer of germanium for this application. Substitutes, including antimony trioxide and titanium, had the potential to replace the relatively expensive germanium as a catalyst in the future, but there was no evidence of that happening on a wide scale in 2008 (Asian Metal Ltd., 2009).

## Prices

The price increases of 2007 continued into the first half of 2008. Prices declined from that point on and ended the year below 2008 peaks owing to the slowdown in the global economy. Globally, germanium suppliers faced a market with fewer interested buyers and what was perceived as an excess supply of material by yearend. Free market prices for germanium dioxide in 2008, published by Metal-Prices

Ltd., began the year at about \$920 per kilogram, increased to \$1,020 per kilogram by midyear, and then declined to \$920 per kilogram by yearend. The free market prices for germanium metal began the year at \$1,300 per kilogram and increased to \$1,425 per kilogram by yearend 2008.

Based on DNSC sales, the price of zone-refined germanium metal sold in December 2008 was \$1,429 per kilogram (Defense National Stockpile Center, 2009).

### Foreign Trade

According to the U.S. Census Bureau, imports for consumption of germanium metal (wrought, unwrought, and waste and scrap material) increased to approximately 40,200 kg in 2008 from 25,400 kg in 2007. Increased imports from Belgium and China accounted for the majority of the overall change. Belgium, China, Russia, and Germany, in descending order of quantity, accounted for 98% of imports into the United States in 2008 (table 1). The estimated germanium content of the germanium dioxide imported in 2008 was about 27,400 kg compared with 27,000 kg in 2007. Canada accounted for 62% of total germanium dioxide imports; Germany, 16%; Belgium, 15%; and China, 7%.

Domestic exports of germanium metal and articles thereof, including waste and scrap, were 17,900 kg in 2008 according to the U.S. Census Bureau. Belgium, Canada, and China accounted for about 83% of germanium exported from the United States in 2008. The estimated germanium content of germanium dioxide exported from the United States in 2008 was less than 100 kg.

### World Review

In 2008, the world's total supply of germanium was estimated to be about 140 metric tons (t). The recycling level remained about the same and supplied about 30% of the world's total supply of germanium.

Beginning in 2001, there was a growing surplus of germanium owing to a major downturn in the fiber-optic market. By yearend 2003, production and consumption were nearly equal, followed by lower production and moderate demand growth in 2004, which resulted in a tight supply that continued through 2005. In 2006, production decreased, while consumption strongly rose, resulting in a deficit. Prices of germanium metal and germanium dioxide in 2007 had increased to record levels. Supplies of germanium continued to be tight owing to strong demand coming from the fiber-optic and infrared technology sectors through the first half of 2008. Prices declined and producer stocks rose during the final months of 2008 owing to weakened global economic conditions. Worldwide, the vast majority of germanium production was concentrated in Canada and China.

**European Union.**—In September, researchers that were part of the FULLSPECTRUM solar electricity project achieved a European record of 39.7% energy conversion efficiency from a multijunction solar cell. The solar cells were made out of more than 30 single layers of different metals, including gallium, indium, and phosphorus, deposited on germanium substrates. The FULLSPECTRUM project, which was sponsored by the European Commission, was established to bring together researchers from academia and industry to develop solar cells

capable of converting 100% of the sun's spectral range into electricity. Many of the current solar-cell technologies in use convert a narrow portion of the sun's spectral range into energy. The group was attempting to increase conversion efficiencies and utilize concentrator technologies in order to make solar cells more cost-effective alternatives to conventional methods of power generation. The European Union had established the goal of producing more than 20% of its energy from renewable sources, such as sun, water, and wind by 2020 (European Commission, 2008; Metal-Pages Ltd., 2008c).

**Belgium.**—Umicore produced germanium metal, germanium tetrachloride for fiber optics, germanium substrates, and germanium optical products at its refining and recycling plant in Olen. Umicore also maintained a research and design facility in Olen. In 2008, Umicore's Advanced Materials Division reported strong growth in sales of germanium substrates owing to increased demand from the satellite sector. New satellite-based applications, such as digital television and radio and global positioning systems, have led to greater global reliance on satellites than in the past. Umicore also announced that, in response to customer demand, it would begin producing larger germanium substrates in 2009. These substrates were to be about 6 inches in diameter and would allow solar-cell manufacturers to reduce processing costs owing to the ability to extract more devices from each wafer. Sales of blanks for infrared optics in 2008 were also greater than those in the previous year, but deliveries of GASIR assemblies, which contained less germanium than standard blanks, declined during the same time period (Umicore s.a., 2009, p. 27).

**Canada.**—In November, Teck Cominco announced that it was implementing a comprehensive debt reduction plan and it intended to significantly reduce spending in response to global economic conditions. Teck Cominco planned to reduce refined zinc production at its Trail complex by 20% for a period of at least 6 months. This curtailment in production had the potential to affect production of minor metals associated with zinc concentrates, which included cadmium, germanium, and indium (Metal-Pages Ltd., 2008a).

In December, mineral exploration company War Eagle Mining Co. Inc. (Vancouver) signed a letter of intent with SaskPower International Inc. and Saskatchewan Power Corp. to sample fly ash from SaskPower's coal-generating plant sites and to test the fly ash for germanium content during a 1-year period. According to the agreement, if War Eagle was able to successfully extract germanium from the fly ash and deemed the process to be commercially viable, the two parties would negotiate a purchase agreement for the fly ash. SaskPower was the principal supplier of electricity in Saskatchewan and operated three coal-fired powerplants. War Eagle had been conducting similar tests of fly ash at a coal gasification plant in Spain (War Eagle Mining Co. Inc., 2008b).

Overland Resources Ltd. (West Perth, Western Australia, Australia) continued working towards development and eventual mineral production at the Andrew zinc deposit in the Yukon Territory. Overland had exercised an option to acquire the rights to the deposit in July 2007 and had begun a diamond drilling program at the site at yearend 2007. In March 2008, the company released a resource estimate based on results from

the first phase of the drilling program. The reserves totaled an estimated 5.04 Mt at 7.47% zinc, 1.72% lead, 5.43 grams per metric ton (g/t) silver, and 17.43 g/t germanium. More than 83% of the resource was classified as measured or indicated. Overland proceeded with a second phase of the drilling program that lasted through September and was to be used to recalculate the resource estimate in early 2009. In 2009, the company expected to continue assessing the feasibility of developing the deposit while initiating the mine permitting process (Overland Resources Ltd., 2009, p. 4).

**China.**—China continued to be the leading global producer of germanium metal and germanium compounds. The germanium reserve base in China was estimated to be about 3,100 t and was spread throughout 11 Provinces and regions. In 2008, six to seven major producers accounted for the majority of the estimated 85 to 100 t of germanium metal and germanium compounds produced in China. About 44% of this production was in the form of germanium metal, 42% was germanium dioxide (metal content), and 14% was in the form of other compounds. Germanium-bearing coal ash (65%) and zinc ore (35%) were the sources for the Chinese germanium production. Production levels were steady throughout the first half of 2008 in response to strong domestic and foreign demand for germanium coupled with tight global supply of raw materials. During this time period, germanium metal prices in China increased from about \$1,200 per kilogram in January to a peak of about \$1,500 per kilogram in June. The germanium market slowed significantly by the end of the summer. Suppliers were forced to lower prices as demand for germanium weakened and stocks rose. This downturn continued through yearend as the global financial crisis worsened. By December, the Chinese price for germanium metal was down to about \$1,160 per kilogram. In the fourth quarter of 2008, germanium producers began to make plans to scale back production levels of germanium in response to the weakened market conditions. In December, Xilingol Tongli Germanium Co. Ltd., a leading Chinese germanium producer, announced that it had planned to reduce output of germanium dioxide by 50% in early 2009. China exported about 48 t of germanium metal in 2008, a 10% decline from that in 2007. The leading destinations for the exported germanium metal, in descending order of magnitude, were Germany, the United States, and Belgium (Metal-Pages Ltd., 2008e; Mikolajczak, 2008; Asian Metal, Ltd., 2009).

Nanjing Germanium Co., Ltd. (Nanjing, Jiangsu Province), a leading producer and distributor of gallium, germanium, and indium, completed the construction of a new germanium substrate plant in October. The company was expecting to have manufacturing equipment installed by February 2009 and to begin production of germanium substrates by June 2009. At full capacity, the facility was expected to have the capacity to produce up to 50,000 wafers per year for use in solar cells (Likui, 2009).

In 2008, Chinese consumption of germanium for use in infrared devices was estimated to be about 8 t. About one-half of this germanium consumed domestically was then exported in the form of infrared optical systems, lenses, thermal imaging devices, and window blanks. Chinese producers had also started to produce infrared lenses made from chalcogenide glass, which contains less germanium material than standard infrared optical

lenses. The average annual growth rate of the Chinese infrared germanium market during the next 5 years was expected to be about 20% owing to continued economic development. Consumption of germanium by the fiber-optic industry grew in 2008 owing to continued development of the communications infrastructure. Demand was driven by new fiber-to-the-premises installations and construction of third generation (3G) wireless telecommunications bases (Likui, 2009).

**Japan.**—Teijin Fibers Ltd. (Osaka) announced that it had licensed its proprietary technology for the production of its titanium-base polyester polymer, called PURITY, to Asia's largest manufacturer of polyester for PET bottle resin production. Unlike the more commonly used polymers in Asia, PURITY did not contain any heavy metals, such as antimony and germanium. Japan was the primary global consumer of germanium for use as a catalyst for PET production. The company claimed that, unlike other existing catalysts that do not contain heavy metals, this product does not appear yellowish or cloudy, making it ideal for use in bottles. Teijan had further plans to consign production of heavy-metal-free polyester fibers and bottles on an original equipment manufacturer basis (Teijin Fibers Ltd., 2008).

**Namibia.**—British Virgin Islands mineral exploration company Emerging Metals Ltd. was investigating the possibility of extracting germanium from the slag stockpiles near the town of Tsumeb. In January, Emerging Metals purchased an option to acquire processing and ownership rights to the Tsumeb slag stockpiles from Ongopolo Mining Ltd. [a wholly owned subsidiary of Weatherly International plc (London, United Kingdom)]. The slag stockpiles produced by the Tsumeb smelter complex, which Weatherly had operated from 1963 through 1996, were rich in residue and rare metals (gallium, germanium, and indium). A report prepared by an independent mine analysis firm stated that the lead blast furnace slag stockpile contained 2 Mt with a reported average germanium analysis of 260 ppm and a zinc analysis of 9.03% as an indicated resource. The company planned to conduct a bankable feasibility study that was expected to last 18 months and then potentially move into a production phase. Emerging Metals expected that the project would be relatively straightforward and inexpensive because there would be no mining involved (Emerging Metals Ltd., 2008, p. 42–43; Metal-Pages Ltd., 2008b).

**Spain.**—In November, War Eagle announced that it had successfully completed the first phase of its investigation into the recovery of gallium and germanium from fly ash that was generated at the ELCOGAS S.A. (Madrid) Puertollano powerplant. War Eagle concluded from the results of the first phase of testing, which concentrated on leaching mechanisms, that gallium and germanium could be recovered from the fly ash. The second phase of the investigation was to include a feasibility study that would analyze the entire process of large-scale metal leaching and recovery and was scheduled to last 3 months. ELCOGAS had produced nearly 12,000 metric tons per year (t/yr) of fly ash at Puertollano and held an international patent on the recovery of metals from fly ash. As part of the agreement, ELCOGAS granted War Eagle permission to use its patented procedures for recovering gallium and germanium (War Eagle Mining Co. Inc., 2008a).

**Ukraine.**—Titanium producer Zaporozhye Titanium and Magnesium Plant (ZTMP) reported that it had utilized a minimal amount of its germanium production capacity owing to a lack of availability of germanium-bearing raw material in 2008. Germanium dioxide production in 2008 at the plant was about 2.5% of capacity, and monocrystalline germanium production was even lower. ZTMP did not release annual totals but typical annual germanium production had been estimated to be between 5 and 20 t (Metal-Pages Ltd., 2009).

**United Kingdom.**—In October, Eternal Silver, a new jewelry collection made with a tarnish-proof silver alloy called Argentium 970–Pure Silver, was introduced to the public by a major jewelry retailer. The tarnish-resistant alloy that was developed by Argentium International (Haslemere, Surrey) comprised copper, germanium, and silver and was considered to be harder, stronger, and more versatile than sterling silver. The germanium that is added to the alloy migrates towards the surface over time and produces a protective coating that prevents the copper from oxidizing, which strengthens the jewelry. Jewelry produced with Argentium also appears whiter than that made with sterling silver owing to the greater silver content of the alloy (Metal-Pages Ltd., 2008d; Mortished, 2008).

## Outlook

Global germanium consumption is likely to remain fairly constant during the next several years owing to the growth that is expected in the major end-use sectors. Germanium-based optical blanks and windows that are incorporated in infrared devices are expected to continue to be heavily utilized by military and law enforcement agencies. Global demand for fiber-optic cable, led by the emerging Asian economies, had been forecast to increase at a compound annual growth rate of 8% through 2012 (Mikolajczak, 2008). Global support for the utilization of more solar energy during the next several years should increase demand for germanium substrates that are used to manufacture high-efficiency multijunction solar cells. As energy conversion efficiencies continue to improve, terrestrial-based photovoltaic systems will be more viable options for large-scale power generation. The current global economic slowdown could delay some of this potential growth.

On the supply side, reductions in global production of zinc that had been announced in 2008 could reduce the quantities of byproducts, such as germanium, that are available in the near future. Several germanium recovery projects that were in the early stages of development could potentially bring more germanium to the market if demand continues to grow.

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TABLE 1  
U.S. IMPORTS FOR CONSUMPTION OF GERMANIUM METAL, BY COUNTRY<sup>1,2</sup>

Country	2007		2008	
	Gross weight (kilograms)	Value	Gross weight (kilograms)	Value
Belgium	10,100	\$9,250,000	18,300	\$9,830,000
Canada	1,300	974,000	173	175,000
China	4,410	4,080,000	14,000	17,300,000
France	--	--	22	36,700
Germany	4,990	7,080,000	1,890	3,830,000
Hong Kong	--	--	503	380,000
Israel	25	40,400	--	--
Russia	4,510	5,700,000	5,280	7,770,000
United Kingdom	2	4,810	62	257,000
Other	27	26,800	13	32,700
Total	25,400	27,200,000	40,200	39,600,000

-- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Data include wrought, unwrought, and powder, but exclude germanium dioxide.

Source: U.S. Census Bureau.