April 2008 Mineral of the Month: Silver

Which is the most beautiful of all metals? Gold? Platinum? Silver? Which reflects the most light and conducts the most energy? We invite you to make your decision after reading about this month's mineral.

PHYSICAL PROPERTIES

Chemistry: Ag Silver, often containing gold and mercury, along with lesser amounts of arsenic, copper, and antimony.
Class: Native Elements
Subclass: Metallic elements other than platinum-group metals
Group: Gold
Crystal Class: Isometric (Cubic)
Crystal Habits: Crystals (rare) include cubes, octahedrons, and dodecahedrons, often as groups of parallel cubes or octahedrons; also as grains, scales, plates, sheets, wires, and in massive, reticulated, dendritic, and arborescent forms. Twinning common, especially in arborescent forms.
Color: Silver-white to gray-white on fresh surfaces; tarnishes to yellow, gray, brown, gray-black, and black.
Luster: Metallic
Transparency: Opaque
Streak: Silver-white to light lead-gray, usually shiny.
Cleavage: None
Fracture: Hackly, with jagged, torn surfaces; malleable and ductile.
Hardness: 2.5-3.0
Specific Gravity: 10.1-11.1
Luminescence: None
Distinctive Features & Tests: Best field marks are malleability, black tarnish, specific gravity, and association with silver-sulfide minerals.
Dana Classification Number: 1.1.1.2

NAME

The modern English word "silver" derives from the Old English *seolfor* and the Old High German *silbar*, both of which were in use before 1100 A.D. Other names for silver include "native silver," "white gold," and "plate." The Spanish word for silver is "*plata*"; native silver is "*plata nativa*." Silver appears in contemporary European mineralogical literature as *silber*, *argent*, and *argento*. "Electrum" refers to a natural silver-gold alloy. Other varietal names are mercury-rich "silver amalgam," arsenic-rich "arsenian silver," antimony-rich "antimonian silver," and copper-rich "cuproarquerite." Silver is one of the few words in the English language with which nothing truly rhymes.

COMPOSITION

This is the sixth time that we have featured a native element as our Mineral of the Month, the other five being gold (Dana's 1.1.1.1 in December 1999), copper (Dana's 1.1.1.3 in December 1998), diamond (Dana's 1.3.6.1 in March 2003), and sulfur (Dana's 1.3.5.1 from Mexico in August 1997, and from Bolivia in May 2004). Such are described as "native," a term used in chemistry and mineralogy to describe metals occurring in nature pure or uncombined with other elements. Native elements are rare among minerals. Of the approximate 4,400 recognized mineral species, only 21 semi-metals, nonmetals, and metals occur in native form in significant quantities. Of the 46 metals on the periodic table of elements, only the 13 least reactive occur in native form, including gold [Au], silver [Ag], and copper [Cu], and the six platinum-group metals platinum [Pt], palladium [Pd], osmium [Os], rhodium [Rh], ruthenium [Ru], and iridium [Ir]. Small amounts of tantalum [Ta], lead [Pb], mercury [Hg], and iron [Fe] also occur in native form.

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Silver's chemical symbol, Ag, derives from the Roman word for the metal, *argentum*. Silver is a lustrous, white metal that is only a bit harder than gold. With an atomic weight of 107.8, silver is roughly half as dense as gold, but twice as dense as copper or iron. With its relatively low melting point of 962˚ C. (1,763˚ F.), silver is quite workable. In its malleability (ability to be shaped) and ductility (ability to be drawn into wire), silver is second only to gold. With a low level of chemical reactivity, silver is a noble metal that resists oxidation and corrosion. However, because it does react with sulfur dioxide [SO_2] and hydrogen sulfide [H_2S], all silver objects eventually tarnish. In native silver, this tarnish appears as a surface film of black acanthite [silver sulfide, Ag_2S].

Silver is a transition metal, one of 27 metallic elements that exhibit properties midway between the most and least electropositive elements and have valance electrons in two shells instead of one. With an atomic number of 47, the silver atom has a nucleus of 47 protons and 61 neutrons surrounded by 47 electrons, which are positioned in five orbitals or shells. The first or inner shell has 2 electrons, the second shell 8, the third and fourth shells 18, and the fifth or outer shell only 1 electron. The interaction of energy with this single outer electron gives silver the highest electrical conductivity, thermal conductivity, and reflectivity of any metal (see "Silver and Its Single Outer Electron"). Silver has oxidation states of 0, +1 and +2. It can give up its outer electron to create the +1 oxidation state, give up an additional electron from its fourth shell to create the +2 oxidation state, or retain all its electrons to create the 0 oxidation state. The chemically stable 0 oxidation state enables silver to exist as a native metal.

Silver crystallizes in the isometric (cubic) system in a close-packed structure. Within its lattice, a silver atom is located at each corner of a cube and in the center of each of the cube's six faces. Each atom is therefore surrounded by 12 identical atoms. This close-packed cubic structure explains silver's high density (specific gravity 10.1-11.1), which varies with the amount of gold and other metals present. The silver lattice is held together entirely by metallic bonding that is based on moving, free electrons. When two or more silver atoms are brought together in close packing, their single outer electrons move freely throughout the lattice. Metallic bonding is the attraction between positively charged atomic nuclei and the collective negative charge of the free-moving electrons. Metallic bonding explains many of silver's properties. When shearing forces are applied to silver, metallic bonding enables lattice sections to slip along their atomic planes to cause deformation rather than to fracture, providing silver with great malleability (ability of being extended or shaped by hammering or by pressure from rollers) and ductility (ability to undergo change of form without breaking.) As an example of silver's ductility, a single troy ounce of the metal can be drawn into a hairlike fiber 8,000 feet long!

In crustal abundance, silver ranks 66th among the elements, making it considerably more abundant than gold (75th). But because of silver's higher chemical reactivity, native silver is much rarer than native gold. Silver, which is widely distributed but usually only in small amounts, is emplaced by high-temperature hydrothermal solutions in sulfide or native form in vein-type deposits in igneous and metamorphic rocks. Irregular masses and sheets of native silver occur with native copper and chalcocite [Cu_2S] in basaltic volcanic rocks, and with quartz [SiO_2], uraninite [UO_2], and nickeline [NiAs] in hydrothermal veins. Native silver also occurs in natural alloys, most often with gold, lead, copper, and palladium. Under specific conditions of chemistry, heat, and pressure, small amounts of native silver sometimes form from the chemical reduction of silver compounds. Because of similar atomic radii, ionic charge, and crystal structure, silver and gold easily substitute for each other in a complete solid-solution series. The ideal end members of this series are pure silver and pure gold, while the intermediate stages are a continuous, graded succession of gold-silver and silver-gold alloys. All native gold contains at least some silver, and sometimes a great deal. On the other hand, most native silver, especially secondary silver that has been reduced from silver compounds, contains little gold. Silver also enters into a rarer, complete solid-solution series with palladium, and partial solid-solution series with mercury and with copper.

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The Dana mineral classification number 1.1.1.2 first identifies silver as a native element (1). The subclassification (1) then defines it as a metal other than those of the platinum group. Silver is next assigned to the gold group (1) as the second (2) of three members, the other members being the closely related metals gold (1) and copper (3). We have now featured all three of Dana's first minerals!

SILVER AND ITS SINGLE OUTER ELECTRON

Electrons of silver atoms are arranged in five energy shells, the outermost containing a single electron. The manner in which this outer electron interacts with energy explains why silver exceeds all other metals in light reflectivity, electrical conductivity, and thermal conductivity. Other metals, including copper and gold, also have a single outer electron. But in the silver atom, the single outer electron is delicately balanced between the attraction of its positively charged nucleus and its distance from that nucleus. This outer electron is thus very weakly held and easily breaks loose from the atom as a negatively charged, free electron that leaves behind a positively charged silver ion, according to the formula $Ag \rightarrow Ag^{+1} + e^{1-}$.

Silver's free electron accounts for the metal's bright, white gleam. As the most reflective of all metals, silver atoms absorb only four percent of incident visible light (a form of electromagnetic energy). The other 96 percent of the incident light energizes silver's weakly held outer electrons, boosting them to higher energy levels. Unable to retain this excess energy, the electrons instantly release it. A silver surface exposed to light is therefore in a state of continuous atomic-ionic flux, with the outer electron of each atom vibrating millions of times per second as it absorbs and releases energy. This energy is released in the form of visible light of uniform wavelengths across the visible spectrum to create the white gleam that makes silver so popular in jewelry, tableware, and decorative objects. Silver's white gleam is enhanced by a bright, metallic luster that is caused by the manner in which light is reflected from the surface of the pool of free-moving electrons.

The behavior of silver's outer electron also explains its high electrical conductivity. The silver lattice essentially consists of positive silver ions in a sea of moving, free electrons. When additional free electrons are introduced as an electrical current at one end of a silver wire, free electrons can be immediately removed from the opposite end, whether these electrons are of atomic or electrical origin. The result is that electrical current "flows" almost unimpeded through a silver wire. And when thermal energy (heat produced by vibrating atoms and energized electrons) is introduced to one end of a silver mass, the fluid pool of free electrons quickly transmits the energy throughout the lattice, energizing electrons and causing atoms to vibrate at the opposite end.

Silver's outer electron is also responsible for the well-known light sensitivity of many silver compounds. Light-sensitive photographic films contain microscopic silver halide crystals consisting of positive silver ions, negative halide ions, and free electrons. For reasons that are still uncertain, silver ions exposed to light attract free electrons and are thus reduced to atoms of metallic silver that form an invisible, or latent, image. These latent images can be developed chemically to produce visible, negative images—the principle behind the light sensitivity of conventional photographic films and papers.

Silver's ability to readily ionize by losing its outer electron makes it a superb catalyst, a material that accelerates chemical reactions without undergoing permanent change itself. Because positively charged silver ions are weakly attracted to negatively charged oxygen ions, they "capture" atmospheric oxygen and make it available for oxidation-type chemical reactions. Silver catalysts are vital to the manufacture of a wide range of products from plastics to automotive antifreeze.

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Thanks again to its ability to lose its outer electron, ionize, and bind weakly with oxygen, silver has remarkable antimicrobial properties. When silver contacts the cell walls of microorganisms, its weakly bound oxygen ions strip off hydrogen ions to form water, thereby disrupting cellular metabolism and disintegrating cell walls—the reason why colloidal silver (aqueous suspensions of microscopic silver particles) is an effective infection treatment. Silver and silver-salt particles have many health-related uses as the key ingredient of everything from burn ointments to swimming-pool and drinking-water sanitizing agents. Paints and powder coatings containing silver bactericides are now applied to interior hospital surfaces, restaurant tables and counters, and other places where bacterial growth is problematic. All these remarkable properties of silver are caused by the metal's single outer electron and its ability to bounce back and forth in atomic-ionic flux.

COLLECTING LOCALITIES

Our native silver specimens come from a new source, the Huangtongxiang Mine in Lujiang County, Chaohu Prefecture, Anhui Province, in the People's Republic of China. Other Chinese sources are the Hongda Mine at the Xiaonqinggou silver-manganese deposit in Lingqui County, Datong Prefecture, Shanxi Province; and the Jinding zinc-lead-silver deposit in the Lanping Basin, Lanping County, Nujiang Prefecture, Yunnan Province. Russian specimens come from the Dalnegorsk Mine at Primorskiy Kray, Magadianskaya Oblast', in the Far-Eastern Region.

The lead-silver mines of the Kongsberg district at Kongsberg, Baskurud, Norway, provide Europe's best native silver specimens. Other specimens are found in Spain at the Hiendalaencina Mine in the Hiendalaencina district near Guadalajara, Castile-La Mancha, and the Balcoll Mine at Falset near Tarragona, Catalonia; in Germany at the Sauschwart, Rappolo, and Neujahr mines at Neustädtel in the Schneeberg district, Erzegebirge, Saxony; in France at the Les Farges Mine at Ussel near Corrèze, Limousin; in Austria at the Annaberg mines in the Turnitzer Alpen region of Lower Austria; and in England at numerous mines in the Callington district of Cornwall.

Bolivia has several native silver sources, notably the Itos Mine at Ciudad Oruro, Cercado Province, Oruro Department, along with the Cerro Rico mines at Potosí, Nor Lípez Province, and the Llallagua Mine at Llallagua in Bustillos Province, both in Potosí Department. Peruvian specimens are collected at Huanzala Mina in the Huallanca district, Dos de Mayo Province, Huánuco Department. Australian sources include the Consols and South mines at Broken Hill in New South Wales; and the Breens, Copper, and Coet mines at Marble Bar in Ashburton Downs in Western Australia. The best African source is the Kombat Mine in the Grootfontein district of Otjozondjupa, Namibia.

Mexico is famed for native silver specimens from the Caballo, Nevada Valenciana, and San Antonio mines at Batopilas in the Andres del Río district of Chihuahua. Batopilas was the only locality we thought might produce enough specimens for us to be able to feature this noble metal, until this major find in China. Other Mexican localities are the Santa Rosalía mines at Mulegé in the Boleó district of Baja California Sur; the Realto mines at Fuerte in Sinaloa; the San Luis district mines at Fresnillo, Zacatecas; and the Ojuela Mine in the Mapimi district of Durango, where our upcoming May 2008 specimens of adamite were found. In Canada, British Columbian localities include the Sally and Ross Roy mines at Wallace Mountain, and the Bell and Highland Ball mines at Beaverdell, both in the Greenwood Mining Division; and the Silver Tunnel at Brandywine Creek in the Vancouver Mining Division. Other Canadian sources are the Smallwood, Silver Bear, and Norex mines in the Camsell River area of the Northwest Territories, and the Silver Islet Mine in Sibley Township in the Thunder Bay district of Ontario.

In the United States, Upper Michigan is famed for native silver specimens from the many copper-silver mines of Keweenaw, Ontonagon, and Houghton counties. We have sold a few of these “half-breeds” over the years, nuggets containing both silver and copper. Arizona localities include the Shattuck, Czar, Holbrook, Campbell, and Cole mines in the Warren district near Bisbee in Cochise County; and the Purple Passion Mine in the Red Picacho district near Wickenburg in Yavapai County. Among Colorado’s sources are the White Raven Mine near Ward in Boulder County; the Amethyst and nearby mines at Creede in Mineral County; the Molly Gibson and Smuggler mines at Aspen in Pitkin County; the Cimarron and Bradley lodes in the Telluride district of San Miguel County; and the El Dorado Mine in the Mt. Sneffels district and the Black Girl Mine in the Paquin district, both in Ouray County. The Leadville Mining District in Lake County, Colorado, has yielded fine specimens from the First National, Matchless, and A.Y. mines. Idaho’s native silver localities in Shoshone County’s Coeur d’Alene district are the Bunker Hill, Sierra Nevada, Sullivan, and Sunshine mines at Kellogg; the Hercules, Standard-Mammoth, and Tiger-Poorman mines at Canyon Creek; and the Midnite Mine at Burke.

Other notable U.S. localities are the Colorado Hill Mine in the Monitor-Mogul district and the Exchequer Mine in the Silver Mountain district, both in Alpine County, California. Nevada’s sources include the White Caps Mine in the Manhattan district in Nye County; the Mexican, Gould & Curry, and Consolidated Virginia mines in the Comstock district of Storey County; and the Renegade, Gold Center, Butte, and Green Hill mines in the Olinghouse district of Washoe County. In New Mexico, native silver occurs at the Black Hawk and Alhambra mines in the Black Hawk district in Grant County; and the Kelly and Juanita mines in the Magdalena district in Socorro County.

JEWELRY & DECORATIVE USES

Because it takes a lustrous polish, is easily workable, resists oxidation and corrosion, and has sufficient rarity to command a premium price, silver is a widely used jewelry and decorative metal. About three times as much silver as gold is used in jewelry making, a ratio that may increase as the price of gold continues to rise. Most jewelry is made using sterling silver or standard silver, an alloy of 92.5% silver with 7.5% copper. Sterling silver is harder than pure silver and has a lower melting point (893˚ C) than either pure silver or pure copper. This is the metal of choice for southwestern U.S. style jewelry, and jewelry made in Mexico, Bali, Italy, and many other places. “Britannia silver” is an alternative hallmark-quality standard containing 95.8% silver, often used to make silver tableware. Fine quality musical instruments, such as flutes, are sometimes made from sterling silver. As the price of silver continues to rise, from about $5.30 per ounce in January 2000 to $17.21 per ounce as of this writing, some investors buy and hold silver in the form of coins, rounds, and bullion bars. Our specimens may well increase in value as times goes by.

Native silver, on the other hand, is seen in jewelry only occasionally, and then usually as crystallized or heavy wire forms that have been chemically cleaned, polished, and mounted in pendants and pins. For an unusual jewelry use related to our specimens, see “About our Specimens.”

Its rarity, combined with a broad variety of fascinating forms, makes native silver one of the most collectible of all minerals. Some collectors have built extensive, specialized silver collections based on such factors as locality and sizes and forms of specimens.

HISTORY & LORE

Native silver has been known since antiquity and anthropologists believe it was the third metal, after gold and copper, to be collected and used. The oldest known silver ornaments date to the fourth millennium B.C. and were fashioned from native silver. By observing the small amounts of native silver that were sometimes associated with galena and acanthite, early metallurgists learned to smelt silver from certain nonmetallic minerals, which represented a quantum leap in the understanding of minerals. By 3000 B.C., the main source of silver had shifted from native metal to the smelting of silver-bearing minerals.

As a precious metal, silver is mentioned often in the Bible, for its monetary and decorative value and symbolically in a number of senses, such as at Ecclesiastes 12:6, Isaiah 60:17, Daniel 2:32, and 1 Corinthians 3:12. The patriarch Abraham bought a family plot using silver for payment, weighing out the appropriate amount, as coins had not as yet been invented. Silver was also used by the Israelites in the construction of the movable tabernacle and later in the great temple of Jehovah in Jerusalem. Of course, the Bible clearly points to the possession of Scriptural knowledge as of greater value than that of even the precious metals gold and silver.

The ancients who associated the rich, yellow color of gold with the sun also linked the clean, white color of silver to the moon. Because of its clean, bright color that symbolized purity and the mysticism that surrounded its lunar associations, silver became prominent in medieval folklore and medicine. In eastern Europe, silver was thought to repel vampires. According to medieval legends from the mountains of Austria, only weapons made of silver could slay werewolves. Silver was also important in alchemy. Because lead and gold often both contained appreciable amounts of silver, alchemists theorized that base metals slowly "matured" into precious metals, and that silver was the transitional metal that could promote the transmutation of lead into gold. Medieval apothecaries and physicians used silver and its compounds extensively in medicinal potions, especially those intended to treat liver and spleen ailments.

Native silver usually occurs as small wires, flakes, and masses, although not always. In 1427, German miners at Schneeberg, Saxony, unearthed a 5-foot-wide, 12-foot-long mass of native silver that weighed 20 tons. The largest mass of native silver ever recorded was found in 1904 at Cobalt, Ontario. Officially called the Lawson Vein, but better known as the "Silver Sidewalk," this massive vein was 2 feet wide, 300 feet long, 180 feet deep and consisted of 75-percent-pure native silver. When mined out, the Lawson Vein yielded 9,000 metric tons of silver. The largest mass of native silver in the United States came from the Smuggler Mine in Aspen, Colorado. Mined in 1892, it weighed 2,350 pounds and consisted of 93-percent-pure native silver.

Modern metaphysical practitioners believe that silver mirrors the soul, reduces negative energies, and increases intuitive and psychic energies. It is also thought to attract, enhance, and preserve the positive energies of gemstones, and to improve and bring eloquence to speech.

Specimens of native silver have been featured on two 1998 postage stamps, the 600-franc stamp of Central Africa and the 3.40-krone stamp of Norway. Silver is the traditional precious-metal gift for the 25th or "silver" wedding anniversary.

TECHNOLOGICAL USES

Native silver is a minor ore of silver. Eighty percent of all newly mined silver is a by-product of gold, copper, lead, and zinc mining. Over the centuries, silver has seen extensive use as a monetary, coinage, jewelry, and ornamental metal, as well as a store of wealth and as dentistry amalgam. But many technological uses now exist for silver, notably in the fields of photography, electronics, chemical manufacturing, optics, and medicine. Today, 41 percent of the silver supply goes to industry for the manufacture of electrical and electronic switches, chemical catalysts, silver-oxide batteries, brazing alloys, and conductors for solar photovoltaic cells. Another 33 percent is taken up by the manufacture of photographic and X-ray films and plates, 25 percent by jewelry and ornamental uses, and the small remaining percentage by the minting of silver commemorative and bullion coins.

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About 20,000 metric tons (620 million troy ounces) of silver are recovered from precious- and base-metal ores each year. The current price of refined silver is close to $18 per troy ounce, the highest in 27 years. Peru, Mexico, China, and Australia are the leading producers of newly mined silver.

ABOUT OUR SPECIMENS

As mentioned previously, our specimens come from a new locality for native silver—the Huangtongxiang Mine in Lujiang County, Chaohu Prefecture, Anhui Province, in the People's Republic of China. Anhui Province is located in east-central China and is bisected by the Yangtze River. One of 16 Anhui prefectures, Chaohu is bounded on the south by the Yangtze River. Lujiang, one of Chaohu's five counties, covers 900 square miles (about the size of Rhode Island) and has a population of 1.3 million. The Huangtongxiang (pronounced hwang-tong-ZHANG) Mine is located near the town of Huangtun, 250 miles due west of the major Chinese port city of Shanghai.

Chaohu Prefecture, which includes parts of the middle and lower Yangtze Valley, is one of eastern China's most important metal-mining areas. Regional mineralization occurs along the Tancheng-Lujiang Fault, which parallels the Yangtze Valley to the north. This mineralization was emplaced about 135 million years ago in late Jurassic and early Cretaceous time, when hydrothermal solutions associated with magmatic intrusions and volcanic activity invaded the well-fractured Tancheng-Lujiang Fault. This created what is now known as the Lujiang polymetallic zone, a complex mineralized area with 200 known metal occurrences. The main occurrence is the extensive Shaxi copper-gold deposit; adjacent areas are rich in molybdenum, zinc, lead, and silver. The "Silvermine Belt" is a lead-silver-zinc zone that trends east-west across Lujiang County. This belt consists of complex networks of vein-type deposits from one to nine feet thick. The primary ore minerals are galena [lead sulfide, PbS], argentiferous (silver-bearing) galena, and acanthite [silver sulfide, Ag_2S]. Ores contain about eight percent lead, four percent zinc, and between 2.5 and 12 troy ounces of silver per metric ton. Most of the silver is present as sulfides, but some native silver occurs in erratic pockets.

The Huangtongxiang Mine is one of two dozen small, underground silver-lead mines in Lujiang County, where miners occasionally find pockets filled with native silver. Until recently, miners, unaware of the specimen value of native silver, considered the wires as just another type of ore. But in 2001 in the Huangtun Mine near the town of Huangtun, miners blasted into a large pocket that contained an estimated 100 pounds of corkscrew-shaped native silver wires, some as long as seven inches, and all tarnished gray-black, bronze, or metallic-white. Because of the unusual sizes, miners collected the native silver wires as curios. Recalling an old folk belief that silver could ward off evil, the miners and their peasant neighbors fashioned

Figure 1. The road to Huangtongxiang silver mine.

the native silver wires into necklaces, bracelets, and anklets for children. Western visitors found it odd that poor peasant children should be so heavily adorned in silver, and reported its use to Chinese mineral dealers, who quickly descended upon Huangtun to buy up all the native silver that still was available. These specimens were widely claimed at gem-and-mineral shows in Europe and the United States in 2005.

Figure 2. Our Chinese silver specimen supplier captioned the photos for us!

Noting the high level of collector interest in the Huangtun Mine specimens, dealers began regularly visiting the Lujiang silver-lead mines, encouraging miners to collect any native silver that they found in the ore veins. But no new finds were made at the Huangtun Mine. The next find instead came in 2006 at the nearby Huangtongxiang Mine when miners blasted into small pockets of native silver, collected all the wires, and sold them to dealers. Miners found additional pockets in early 2007. The Huangtongxiang Mine, a relatively small mine that employs only 40 miners, has since become China's leading source of native silver specimens. Huangtongxiang native silver is now marketed through dealers in the city of Changsha, 300 miles to the southwest.

The Huangtongxiang Mine is one of 150 small, underground silver-lead mines now operating in China, where silver production has boomed in the past 15 years. In 1993, China produced just 130 metric tons (4 million troy ounces) of silver per year; today, it produces 2,600 metric tons (80 million troy ounces) and ranks third in the world behind Mexico and Peru. In Lujiang County, Chinese exploration geologists are now searching for new silver-lead deposits at depths greater than 1,500 feet. Initial assessments of the geology at the Huangtongxiang Mine indicate a high probability of ore deposits at depth. Currently, the lowest levels of the Huangtongxiang Mine are about 1,000 feet. If the mine is modernized and deepened, as expected, the prospects of finding additional native silver deposits appear excellent.

Adding a native silver specimen to our collection would be exciting, no matter what crystal habit it assumed–but this wire crystal form is quite extraordinary! Why does it crystallize this way? Mineralogists believe native silver forms in two ways. The first way is directly from primary, hydrothermal emplacement. When superheated, metal-bearing hydrothermal solutions invade host rocks, depositing metal-sulfide minerals such as pyrite [FeS_2], sphalerite [ZnS], and galena [PbS]. If the superheated solution contains sufficient silver, the silver-containing metal-sulfide acanthite [Ag_2S] will be deposited. But in proper conditions of chemistry and temperature, any excess of silver ions remaining in solution after sulfides have been deposited can precipitate as native silver. In this instance, native silver occurs in association with sulfide minerals.

However, most native silver forms as a secondary mineral through alteration of the original sulfides. In the presence of free atmospheric oxygen and with proper conditions of chemistry and temperature, circulating groundwater can chemically reduce the silver sulfides, removing sulfur and freeing silver ions. These silver ions remain in solution until changes in the mineral environment cause them to precipitate as native silver.

Native silver can form either as masses or as crystals. Masses form in environments where there is not enough space for crystal development. When the cavity is large enough for free crystal growth, crystallized silver forms. Yes, each of our individual silver wires is actually a single crystal! The silver wire crystal begins growing when a bit of native silver precipitates on the face of a preexisting mineral crystal. As we learned, the silver ions are joined together by metallic bonding and are thus surrounded by a pool of free-moving electrons with a negative charge. This attracts additional, positively charged silver ions to form a small but growing mass. The tip of this mass, because of its pointed or rounded shape, exerts the greatest negative charge and attracts more new silver ions than do the flatter sides. Thus, crystallized native silver grows mainly not by extending its width, but rather its length, to form wires that can be long and delicate.

Figure 3. Caption would be redundant!

Native silver wires are never straight, but always curved in shapes ranging from gentle arcs to tight coils, corkscrews, and “bird’s-nest”-like tangles. The reason is that continually changing conditions of chemistry, temperature, and flow of the solutions preclude the growth of perfectly straight wires. Remember that metallic bonding, unlike other types of atomic bonding, is inherently flexible. As native silver wires grow, they inevitably assume a subtle bend. When linear objects are bent, their outer convex surfaces become greater in area than do their inner concave surfaces. In native silver wires, this subtle bending enables the free-electron pool to exert a slightly greater negative charge along their outer convex surfaces. Subsequently, silver ions accumulate more rapidly on the outer curves. This uneven accumulation along the sides stresses the entire native silver structure to perpetuate the curve toward the innerside—hence the arc, coil, and corkscrew shapes seen in native silver wires! You might like to mount your wire to an acrylic stand with a bit of mineral tack so it will stand up and display the beauty of it crystal form to the fullest extent.

Silver was one of the minerals we never thought we would be able to feature, because of the high cost of wire silver and the large quantity we need. We are absolutely delighted to be able to do so! And what are your answers to the questions that introduced this write-up?

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