Mineral of the Month September 2014

LAZURITE (LAPIS LAZULI)

Lazurite is the primary mineral in the gemstone lapis lazuli. Our specimens were mined in Afghanistan's Kokcha Valley, the classic locality for lazurite and the world's premier source of lapis lazuli. Our write-up explains the complex chemistries of lazurite and lapis lazuli, and recounts the long history of Afghan lapis lazuli.

OVERVIEW

PHYSICAL PROPERTIES:

Chemistry: $(Na,Ca)_8Si_6Al_6O_{24}[(SO_4),S,Cl,(OH)]_2$ Basic Sodium Calcium Aluminum Sulfate Chlorosilicate (Sodium Calcium Sulfate Chloroaluminosilicate Hydroxide)
Class: Silicates
Subclass: Tectosilicates
Group: Sodalite
Crystal System: Isometric (Cubic)
Crystal Habit: Usually in granular, compact, or massive form; crystals are rare and occur as dodecahedrons and occasionally as cubes.
Color: Azure-blue to violet-blue, occasionally greenish-blue.
Luster: Dull to greasy
Transparency: Usually opaque; rarely translucent.
Streak: Pale blue
Refractive Index: 1.502-1.522
Cleavage: Poor in six directions
Fracture: Uneven, brittle.
Hardness: 5.0-5.5
Specific Gravity: 2.4-2.5
Luminescence: None
Distinctive Features and Tests: Best field marks are occurrence in metamorphic environments, deep-blue color and association with pyrite [iron disulfide, FeS_2]. Can be confused with lazulite [basic magnesium aluminum phosphate, $MgAl_2(PO_4)_2(OH)_2$], which is softer and more dense, and with sodalite [sodium aluminum chlorosilicate, $Na_8Al_6Si_6O_{24}Cl_2$], which is a paler blue and has a coarser grain.
Dana Classification Number: 76.2.3.4

NAME: The name "lazurite," pronounced LAH-zhur-ite, stems from the Greek *lazulith*, literally "blue stone," and the Arabic *lāzaward*, variously meaning "sky," "heaven," or "azure," both alluding to the mineral's blue color. Alternative names for lazurite are "cyaneus," "ultramarine," "lasurite," "Lasurstein," "lapis lazuli," "lapis stone," "sapphis," and "sapphirus." In European mineralogical literature, lazurite appears as *lazurit* and *lazurita*. Lazurite is often confused phonetically and mineralogically with lazulite and azurite [basic copper carbonate, $Cu_3(CO_3)_2(OH)_2$]. Lazurite is also confused with lapis lazuli (LAP-iss LAH-zhu-lee), literally meaning "blue stone." Known familiarly as "lapis," lapis lazuli is a blue gemstone and a decorative stone in which lazurite is the primary mineral component and the cause of its blue color.

COMPOSITION & STRUCTURE: Lazurite consists of approximately 13.5 percent sodium, 7.8 percent calcium, 15.8 percent aluminum, 16.3 percent silicon, 6.0 percent sulfur, and 38.1 percent oxygen, along with small, variable percentages of chlorine and hydrogen. The crystal lattice of lazurite, which is a framework silicate or tectosilicate, is based on a modified tectosilicate structure in which alumina ions alternate with silica ions to form an aluminosilicate. Lazurite forms from the high-grade, contact metamorphism of silica-poor, marine limestone that contains available sulfur and chlorine. The host rock of lazurite is usually marble, which is a metamorphosed and recrystallized form of limestone. Minerals frequently associated with lazurite include pyrite, calcite, and diopside. Lazurite rarely forms crystals and usually occurs in massive form as a component of lapis lazuli, which is a rock consisting of about eight different minerals.

COLLECTING LOCALITIES: Our lazurite specimens are from the Kokcha Valley, Badakhshān Province, Afghanistan. Lazurite also occurs in Tajikistan, Russia, Chile, Sweden, Italy, and Canada. In the United States, lazurite is found in Colorado, California, New York, and Arkansas

HISTORY, LORE & USES: Lazurite, which is not a gemstone itself, is the primary component of, and the cause of the blue color in, lapis lazuli. Lapis lazuli, a gemstone and a decorative stone, is a rock consisting of an indeterminate mixture of minerals that includes 20-40 percent lazurite. Higher percentages of lazurite produce the most intensely colored and most valuable lapis lazuli. Lapis lazuli may be the first gemstone ever mined in quantity. Afghanistan's deposits have been systematically mined for at least 6,000 years and have yielded fine lapis lazuli that was widely traded, first throughout central Asia and the Middle East, then in China, and later in Europe. Powdered, refined lazurite is made into ultramarine, an intense, blue pigment used in specialty inks, lacquers, and paints. Modern metaphysical practitioners believe that lapis strengthens the physique and spirit, enhances love and fidelity to maintain marital bonds, and aids in spiritual evolution and in connecting with higher realms.

ABOUT OUR SPECIMENS: Our lazurite/lapis lazuli specimens are from the Sar-e-Sang district in the Kokcha Valley, Badakhshān Province, Afghanistan. The Kokcha Valley lapis mines are one of the world's oldest gemstone sources. Located high in the rugged Hindu Kush range in northeastern Afghanistan on steep mountainsides at elevations of about 10,000, they are accessible only via dangerous foot trails. Each of the district's seven mines have narrow, inclined or declined tunnels that lead to underground galleries. The one mine that is currently active and is the source of our specimens has two tunnels that access a 150-foot-high underground gallery. Although mechanical rock drills have been used in the past with limited success, most mining is still conducted by manually drilling with hammers and hand steels to prepare the marble host rock for blasting. After blasting, the miners carefully search the shattered, marble host rock for faint blue coloration that might indicate a nearby occurrence of lapis. During each mining season, which extends only from late June through early November, at least 10 tons of lapis lazuli (and probably much more) are recovered and shipped. Although the Afghan government is attempting to direct the shipment of newly mined lapis lazuli to the capital city of Kabul, most lapis (including our own specimens) is smuggled across the border into Pakistan and sold for higher prices.

COMPREHENSIVE WRITE-UP

COMPOSITION & STRUCTURE

Because of the difficulty of acquiring lazurite/lapis lazuli specimens in sufficient numbers for our members, this is only the second time in 18 years that we have featured lazurite as our Mineral of the Month. Lazurite and lapis lazuli must be discussed together, because lazurite's primary occurrence is as the primary mineral component of the gemstone lapis lazuli and the cause of its blue color.

Lazurite's chemical formula $(Na,Ca)_8Si_6Al_6O_{24}[(SO_4),S,Cl,(OH)]_2$ shows that it contains eight elements: sodium (Na), calcium (Ca), silicon (Si), aluminum (Al), sulfur (S), chlorine (Cl), oxygen (O), and hydrogen (H). Lazurite's molecular weight is made up of approximately 13.5 percent sodium, 7.8 percent calcium, 16.3 percent silicon, 15.8 percent aluminum, 6.0 percent sulfur, 38.1 percent oxygen, and small amounts of chlorine and hydrogen. Percentages are not exact because of lazurite's variable chemical composition.

Lazurite is not to be confused with the phosphate mineral lazulite [basic magnesium aluminum phosphate, $MgAl_2(PO_4)_2(OH)_2$]. Lazurite is a member of the silicate mineral group, in which silicon and oxygen are combined with one or more metals or nonmetals. The basic silicate structural unit is the silica tetrahedron $(SiO_4)^{4-}$, in which a silicon ion is surrounded by four, equally spaced oxygen ions positioned at the four corners of a tetrahedron (a four-faced polyhedron). In the silicates, silica anions and metal cations join together in repeating chains to form seven types of structures: independent tetrahedral silicates (nesosilicates); double tetrahedral silicates (sorosilicates); single- and double-chain silicates (inosilicates); ring silicates (cyclosilicates); sheet silicates (phyllosilicates); and framework silicates (tectosilicates). Lazurite is a framework silicate or tectosilicate. The lazurite crystal lattice is based on a modified tectosilicate structure, in which aluminum ions Al^{3+} alternate with silica ions Si^{4+} to form the aluminosilicate tetrahedron $[(Si,Al)O_4]^{4-}$. This arrangement is reflected in lazurite's chemical formula $(Na,Ca)_8Si_6Al_6O_{24}[(SO_4),S,Cl,(OH)]_2$, in which six $[(Si,Al)O_4]^{4-}$ tetrahedra make up the aluminosilicate radical $(Si_6Al_6O_{24})^{6-}$.

Lazurite's complex chemical formula $(Na,Ca)_8Si_6Al_6O_{24}[(SO_4),S,Cl,(OH)]_2$ can be understood by separating it into cations and anions. All molecules are composed of cations (positively charged ions) and anions (negatively charged ions). Lazurite's compound cation and compound anion both contain radicals, which are groups of atoms of different elements that act as entities in chemical reactions. Lazurite's chemical formula can be broken down into three main groups: the compound cation $(Na,Ca)_8^{14+}$ and the two compound anions $(Si_6Al_6O_{24})^{6-}$ and $[(SO_4),S,Cl,(OH)]_2^{8-}$. The total +14 cationic charge balances the total -14 anionic charge to provide the lazurite molecule with electrical stability. When expressed mathematically, however, this balance is not rigid. Within the cation, commas separate the symbols for sodium and calcium, indicating that the proportions of the sodium ion Na^{1+} and the calcium ion Ca^{2+} are variable. The actual cationic charge varies between +8 and +16. And because the proportions within the $[(SO_4),S,Cl,(OH)]_2^{8-}$ anion are also variable, its anionic charge varies from -2 to -10. Because the collective cationic and anionic charges vary proportionately with each other, the lazurite molecule maintains electrical stability despite its variable chemistry. The exact formula for an individual lazurite specimen would, therefore, vary with the chemical environment and physical conditions that existed when it formed.

Within the lazurite lattice, the silica $(SiO_4)^{2-}$ and alumina $(AlO_4)^{5-}$ tetrahedra covalently share all four of their oxygen ions to create a repetitive, three-dimensional framework of alternating, four- and six-membered rings that surround hollow cavities. Within these cavities, the negative charge of the combined aluminosilicate radical $(Si_6Al_6O_{24})^{6-}$ ionically attracts and holds positively charged sodium and calcium ions to form the incomplete lazurite molecule $[(Na,Ca)_8Si_6Al_6O_{24}]^{8+}$. This positively charged, incomplete molecule then ionically attracts the negatively charged, complex radical $[(SO_4),S,Cl,(OH)]_2^{8-}$, which formed as a metamorphic product and incorporated the sulfur, chlorine, and water that were present in the original marine-sediment environment. This addition completes the lazurite molecule that is represented by the formula $(Na,Ca)_8Si_6Al_6O_{24}[(SO_4),S,Cl,(OH)]_2$.

Because of the strong covalent bonding of its shared oxygen ions, lazurite has a substantial hardness of Mohs 5.0-5.5 and no pronounced cleavage planes. Lazurite's low specific gravity of 2.4-2.5, which is unusually low for dark-colored minerals, is explained by its intermolecular cavities and the light atomic weights of its elemental components. The structure of alternating four- and six-membered rings causes lazurite to crystallize in the isometric or cubic system, with three mutually perpendicular axes of equal length. While chemically simple minerals tend to crystallize in the isometric system, lazurite is an exception. Because its complex and variable chemistry disrupts the symmetry of its crystal lattice, lazurite occurs mainly in granular, compact, and massive forms. Lazurite crystals, which are rare, are crudely formed, 12-sided dodecahedrons and cubes.

Lazurite is an idiochromatic or "self-colored" mineral, meaning that its color is caused by its essential chemical composition and the light-reflecting properties of its crystal lattice. The lazurite lattice absorbs most white-light wavelengths and reflects only a narrow band of blue wavelengths to create its distinctive, deep-blue color. The intensity of this blue color varies with the amount of sulfur present and, to a lesser extent, with the amount of calcium present.

The Dana mineral classification number 76.2.3.4 identifies lazurite as a tectosilicate with an aluminosilicate framework (76). The subclassification defines it as a member of the feldspathoids (2), a group of aluminosilicate minerals with a relatively low silica content. Lazurite is then assigned to the sodalite group (3) as the fourth (4) of eight chemically similar members. This group's most abundant member is sodalite [sodium aluminum chlorosilicate, $Na_8Al_6Si_6O_{24}Cl_2$], which is similar in color and form to lazurite.

Lazurite forms from high-grade, contact metamorphism of silica-poor, marine limestone that contains available sulfur and chlorine. Lazurite's host rock is usually marble, a metamorphosed and recrystallized limestone that consists mainly of calcite [calcium carbonate, $CaCO_3$]; associated minerals include pyrite [iron disulfide, FeS_2] and diopside [calcium magnesium silicate, $CaMgSi_2O_6$]. Lazurite most often occurs as a mineral component of lapis lazuli (see "Jewelry & Decorative Uses"). Lapis lazuli, or "lapis" as it is familiarly known, is a rock consisting of an indeterminate mixture of lazurite and a number of minerals. Lapis lazuli contains between 20 to 40 percent lazurite. The higher percentages produce the most intensely colored and most valuable gemstones. Other significant mineral components of lapis lazuli are calcite; sodalite [sodium aluminum chlorosilicate, $Na_8Al_6Si_6O_{24}Cl_2$]; haüyne [sodium calcium aluminosilicate sulfate, $Na_6Ca_2Al_6Si_6O_{24}(SO_4)_2$]; diopside [calcium magnesium silicate, $CaMgSi_2O_6$]; pyrite [iron disulfide, FeS_2]; augite [calcium sodium magnesium iron titanium oxyaluminosilicate, $(Ca,Na)(Mg,Al,Fe,Ti)(Si,Al)_2O_6$]; muscovite [basic potassium aluminosilicate, $KAl_3Si_3O_{10}(OH)_2$]; enstatite [magnesium silicate, $Mg_2Si_2O_6$]; and nosean [hydrous sodium aluminosilicate sulfate, $Na_8Al_6Si_6O_{24}(SO_4)\cdot H_2O$].

COLLECTING LOCALITIES

The world's premier source of lazurite is the Sar-e-Sang district in the upper Kokcha Valley, Badakhshān Province, Afghanistan. Lazurite also occurs along the Lyadzhavadara River in the Viloyati Mukhtori region in adjacent Tajikistan. Russian specimens are found at the Tuluti and the Malo-Bystrinkoye lazurite deposits in the Tounkinskaya Valley and the Slyudyanskoe lazurite deposit at Slyudyanska, both near Lake Baikal in Irkutskaya Oblast', Eastern-Siberian region. Chilean sources include the Flor de Chile Mine near Ovalle and the Flor de los Andes Mine near El Polvo, both in Lamari Province, Coquimbo Region. In Italy, lazurite occurs at Ariccia in the Alban Hills, Roma Province, Latium; the Novelle and San Vito mines in the Somma-Vesuvius Complex, Naples Province, Campania; and the Foldite and Tephrite outcrops at Mt. Vulture, Potenza Province, Basilicata. Swedish specimens come from the Sunnerskog Mine at Vetlanda in Småland.

Canadian specimens are collected at Kimmirut on Baffin Island in Nunavut Territory. Notable sources in the United States are the Blue Wrinkle lapis mine on Italian Mountain in Gunnison County, Colorado; the Edwards Mine at Edwards and the St. Joe No. 3 and ZCA No. 4 mines at Balmat, both in the Balmat-Edwards zinc district, St. Lawrence County, New York; Granite Mountain near Little Rock, Pulaski County, Arkansas; and the Bighorn lapis deposit in Cascade Canyon in the San Gabriel Mountains, San Bernadino County, California.

JEWELRY & DECORATIVE USES

Although lazurite is not a gemstone in itself, it is the primary mineral component of, and the cause of the blue color in, the gemstone lapis lazuli. The term "lapis lazuli," introduced into the English language in the 15^{th} century, stems from the Latin *lapis*, meaning "stone," and the Medieval Latin *lazulum*, meaning "blue" or "azure." Lapis lazuli has no crystal structure or cleavage, an uneven fracture, a dull luster, a fine grain, a light-blue streak, and a specific gravity of 2.6-2.9. With a Mohs hardness of 5.0-5.5, it takes a fine polish. Classic lapis lazuli is opaque and has an even, intense, "royal" blue color and is often flecked with glittering bits of brassy pyrite. Lapis is fashioned into beads for use in necklaces, earrings, and bracelets, and into cabochons for mounting in rings and pendants. As a decorative stone, it is carved into figurines, amulets, ornaments, vases, and mosaic inlays. Lapis prices vary widely by grade. Lower grades with mottled, light-blue colors sell by the ounce. Higher grades can cost one dollar per gram ($28 per ounce). "Superfine" lapis, which is the highest grade, sells for as much as $100 per gram—a very high price for a semiprecious gemstone.

"Swiss lapis" and "German lapis" consist of white or gray chalcedony [microcrystalline quartz, SiO_2] or white howlite [basic calcium borosilicate, $Ca_2SiB_5O_9(OH)_5$] that have been dyed blue. Another imitation consists of a mix of fragmented, synthetic blue spinel [magnesium aluminum oxide, $MgAl_2O_4$], blue cobalt oxide (CoO), and pyrite sintered together by heat and pressure. In the 1970s, French chemist Pierre Gilson (1900-1997) introduced a popular and realistic lapis imitation consisting of a mix of synthetic ultramarine pigment, hydrous zinc phosphate, and bits of pyrite. "Reconstructed lapis" consists of tiny chips of natural lapis cemented together. Low grades of lapis lazuli, which are poorly colored and streaked with white calcite, are often color-enhanced with potassium ferrocyanide ($K_4Fe(CN)_6$) or organic blue dyes.

Pure lazurite is rare and is collected for its intense blue color. In the most valuable and desirable specimens, blue lazurite crystals contrast with a matrix of white marble. Lazurite crystals rarely approach two inches in size and are usually much smaller. Fine specimens of one-inch lazurite crystals can cost $1,000 or more.

HISTORY & LORE

Just as lazurite and lapis lazuli are mineralogically entwined so, too, are their history and lore. Lapis lazuli may have been the first gemstone ever mined in quantity. Until the early 1800s, Afghanistan's Kokcha Valley was the only significant source of lapis lazuli. The Kokcha Valley deposits were mined sporadically in prehistory, and then mined systematically since about 4000 B.C. Afghan lapis was widely traded, first throughout the Middle East and Egypt, then in China, and finally in Europe. Most of this lapis was fashioned into jewelry and decorative objects; the ancient Egyptians also used powdered lapis as eye shadow. The royal-blue striping of the funeral mask of Egyptian king Tutankhamen (ca. 1370-1352 B.C.) is Afghan lapis lazuli. The Bible includes lapis lazuli as one of the 12 gems in the jeweled breastplate of Aaron, the first high priest of the Hebrews. The Roman scholar Pliny the Elder (Gaius Plinius Secundus, A.D. 23-79), who knew lapis as *sapphirus*, described it as "a blue stone sprinkled with specks of gold" and "a fragment of the starry firmament." The ancient Romans also considered lapis to be a powerful aphrodisiac. Medieval physicians prescribed elixirs of powdered lapis to free the soul from envy and fear, keep the limbs healthy, and help heal ulcers and boils.

By 650 A.D., Afghan artists were using powdered lapis as a blue pigment in the paints that decorated mosques. Lapis pigment later reached Europe, where it became known as "ultramarine"—literally "beyond the sea" and alluding to its exquisite, deep-blue color. During the Renaissance, European artists used ultramarine-based blue paints on frescoes, while engravers used ultramarine-based, blue inks on illuminated manuscripts. Extracting ultramarine, or pure lazurite, from powdered lapis lazuli was difficult. Chemists and alchemists tried many complex separation methods using oils, waxes, and chemical reagents, but achieved only limited success. The scarcity of pure ultramarine pigment made it literally worth its weight in gold.

Ultramarine actually became known as “blue gold,” and its price remained exorbitantly high until the early 1800s, when French chemists synthesized ultramarine by roasting a mix of charcoal, kaolin clay, and sodium sulfate.

At one time, mineralogists recognized lapis lazuli as a separate mineral species. But in 1890, Norwegian geologists Waldemar Christopher Brøgger (1851-1940) and Helge Bäckström (1865-1932) determined that it was really a rock of variable composition. Brøgger and Bäckström also showed that its blue color was due to a previously unknown mineral which they named “lasurite.” In 1892, the American mineralogist Edward Salisbury Dana (1849-1935) changed this name to “lazurite” in his landmark 6th edition of *Systems of Mineralogy*. In 1929, Dutch chemist Frans Maurits Jaeger (1877-1945) used X-ray diffraction techniques to reveal lazurite’s basic atomic structure.

Lapis lazuli appeared on the 37-afghani postage stamp of Afghanistan in 1988 and the 150-peso stamp of Chile in 1996. Lapis lazuli is an alternate birthstone for December. According to metaphysical beliefs, lapis strengthens the physique and spirit, builds self-confidence, and facilitates spiritual evolution and connecting with higher realms. It is also a calming influence in daily life and enhances love and fidelity to maintain the bonds of marriage.

TECHNOLOGICAL USES

Pure lazurite, which is obtained from lapis lazuli, is the blue pigment known as natural ultramarine (see “History & Lore”). Lazurite is extracted from lapis lazuli by various chemical and physical processes and then refined to a high purity. Natural ultramarine is a specialty blue pigment used in traditional artist’s paints, certain plastics, and in the metal lacquers seen on quality cloisonné jewelry and fine writing instruments. Because of its unique and readily identifiable crystal properties, natural ultramarine is also the pigment used in “security inks” for currency and financial certificates.

LAPIS LAZULI: THE PRIDE OF AFGHANISTAN

Few nations are as closely associated with a single gemstone as Afghanistan is with lapis lazuli. All Afghan lapis comes from a single source—the Kokcha Valley in Badakhshān Province. Artifacts fashioned from Kokcha Valley lapis lazuli has been recovered from 10,000-year-old tombs in central Asia. Systematic lapis mining began in the Kokcha Valley some 6,000 years ago. Gemologists agree that Afghan lapis is the finest in the world. By some estimates, the Kokcha Valley, despite its extremely difficult mining conditions, has accounted for 95 percent of all the lapis mined throughout history. The Kokcha Valley mines are located at elevations of about 10,000 feet in some of Asia’s most rugged mountains (see “About Our Specimens”). These mines are accessible only via rough, dangerous trails, and heavy snowfall and bitterly cold winters limit the mining season to about four months each year. Furthermore, the Kokcha Valley region has been plagued by political instability, with control shifting frequently between invading armies, insurgents, warlords, bandits, and corrupt government officials.

The Kokcha Valley lapis deposits did enjoy on significant historical advantage—proximity to the ancient caravan route that linked China with the Middle East. Along with gold, spices, and silks, Afghan lapis was a major commodity in the caravan trade. And though while booming demand for lapis lazuli in China, the Middle East, and Europe sustained mining in the Kokcha Valley, few people, apart from miners and traders, ever actually saw the mines. Passing near the Kokcha Valley in 1271, the Venetian traveler and author Marco Polo (1254-1324) wrote, “There is a mountain . . . where the finest azure [lapis lazuli] in the world is found.” But even the celebrated Marco Polo was denied access to the mines.

John Wood, a Scottish naval lieutenant working with the British East India Company, visited the Kokcha Valley in 1838. In his memoir *A Personal Narrative of a Journey to the Source of the River Oxus*, published in London in 1841, Wood recounted entering a narrow, steeply inclined shaft that led to an underground gallery 12 feet high, 12 feet wide, and 200 feet long. Huge blocks of loosened, overhead rock posed a constant danger, and Wood noted that many mine sections bore the names of miners who had died in the frequent rockfalls. Wood also recounted how miners broke the rock by heating it with fires to “soften” it, then manually hammering it apart. Citing the high elevations, dangerous trails, sheer cliffs, and omnipresent bandits, Wood concluded: *If you do not wish to die, avoid the narrow valley of the Kokcha*.

Afghanistan fell under the realm of British influence in the mid-19th century. After becoming independent in 1919, the nation established a monarchy that lasted until a 1973 military coup introduced an ongoing period of political instability. After a Communist coup in 1978, Soviet troops arrived to support the new regime. During the ensuing civil war, the government and its Soviet allies controlled the cities and major transportation routes, while Afghan guerrillas controlled rural areas. Soviet troops departed in 1989 and the pro-Soviet government fell to the rebels three years later. In 1995, the Taliban, an Islamic militia, took control of the country and installed a strict fundamentalist regime. Meanwhile, mujahideen rebel groups united as the Northern Alliance and retreated to the mountains. In 2001, the United States, suspecting that the Taliban had trained the terrorists who attacked New York City’s World Trade Center and the Pentagon in Washington, D.C., on September 11th, responded with military action. American troops removed the Taliban from power, and installed, and have since supported, a moderate Afghan democratic government.

Lapis lazuli has been one of the few Afghan commodities that could earn hard currency in international trade. In the past, newly mined lapis lazuli was shipped to the capital city of Kabul to be fashioned into gems and decorative objects or sold as rough. From the 1920s to the 1960s, the Afghan monarchy retained large quantities of fine lapis in a government reserve similar to the gold treasuries of other nations. But this traditional lapis trade was disrupted by the 1979 Soviet occupation. Despite the Soviet military presence, mujahideen nationalist guerillas of the Northern Alliance retained control of the Kokcha Valley and began taxing lapis production to obtain funds to purchase weapons. Rather than sending newly mined lapis to Soviet-controlled Kabul, the mujahideen instead began smuggling it across the border into Pakistan. Ironically, the Soviet presence indirectly helped to somewhat modernize Afghan lapis mining. Miners, who previously could not afford explosives, now had an inexhaustible supply obtained by disassembling countless thousands of unexploded Soviet land mines.

In recent years, the influence of the Northern Alliance has declined in the Kokcha Valley and the central government has exercised somewhat greater control. Corrupt regional government officials, however, are routinely bribed by miners who choose not to report production amounts and who smuggle most of the newly mined lapis into Pakistan where it sells for substantially higher prices than would be paid in Kabul. Afghanistan is thus deprived of mine-production taxes, as well as the jobs that would result from an expanded lapidary industry in Kabul. The United States Geological Survey, which compiles and publishes data on the global mining industry, now lists the Kokcha Valley lapis-lazuli mines as "government-owned" and estimates annual production at 9,000 kilograms (19,841 pounds). This figure represents only the officially taxed production; total production is believed to be much higher.

With large reserves of lapis lazuli remaining in the Kokcha Valley, the current national government hopes to modernize the mines. It has already negotiated with several European and Asian mining companies, offering potentially lucrative, long-term mineral leases in exchange for constructing mine-access roads and increasing production. But obstacles include continued government corruption and Northern Alliance threats to disrupt government-controlled mining operations. Prospective foreign mining companies are also concerned about a potential rise in political instability that may occur after the announced withdrawal of United States troops from Afghanistan at the end of 2015.

ABOUT OUR SPECIMENS

Our specimens were mined at the Sar-e-Sang district in the Kokcha Valley, Badakhshān Province, Afghanistan, the world's premier source of lapis lazuli and the type locality for lazurite. A landlocked, arid nation in central Asia, Afghanistan is roughly the size of the state of Texas and has a population of 27 million. It is bordered by Turkmenistan to the northwest, Uzbekistan and Tajikistan to the north, China to the northeast, Pakistan to the east and south, and Iran to the west. The capital city, Kabul, has a population of one million. The central and eastern parts of Afghanistan are dominated by the rugged topography of the Hindu Kush, one of the world's highest mountain ranges.

The province of Badakhshān is in northeastern Afghanistan. The provincial capital, Feyzābād, population 100,000, is located at an elevation of 4,000 feet on the lower Kokcha River, and has an economy based on cultivating and milling rice and wheat, herding, and weaving. Although Feyzābād is only 200 air miles north of Kabul, the driving distance over rough, winding roads is more than 400 miles, and the journey can take several days. Feyzābād summers are hot and dry, while its winters are bitterly cold, with heavy snowfall that often closes roads and isolates the city. The lapis mines are 50 miles south of Feyzābād and much higher in elevation. From Feyzābād, a rough, unpaved road leads 20 miles along the Kokcha River to the tiny settlement of Jurm. A pack trail continues south for another 30 miles, climbing through the Kokcha River canyon to the mining camp of Sar-e-Sang at an elevation of 7,500 feet at the edge of the Hindu Kush massif. The rocky, barren, and steep terrain at Sar-e-Sang provides habitat for wild hogs, mountain sheep, and wolves.

Mineral of the Month September 2014

At Sar-e-Sang, the original basement rock was marine limestone, a sedimentary rock consisting mainly of calcite [calcium carbonate, $CaCO_3$]. But the uplifting of the Hindu Kush massif some 30 million years ago generated the heat and pressure necessary for intensive regional metamorphism that recrystallized the limestone into marble. Within a 1,200-foot-thick, mica-rich stratum of this marble, lazurite in varying concentrations occurs in lens-shaped bodies that are typically 3 to 6 feet thick, a few hundred feet long, and 60 or more feet wide. Along with calcite and lazurite, these lenses also contain pyrite [iron disulfide, FeS_2]; forsterite [magnesium silicate, Mg_2SiO_4]; diopside [calcium magnesium silicate, $CaMgSi_2O_6$]; phlogopite [basic calcium magnesium aluminosilicate, $KMg_3AlSi_3O_{10}(OH)_2$,]; sodalite [sodium aluminum chlorosilicate,$Na_8Al_6Si_6O_{24}Cl_2$]; haüyne [sodium calcium aluminosilicate sulfate, $Na_6Ca_2Al_6Si_6O_{24}(SO_4)_2$]; augite [calcium sodium magnesium iron titanium oxyaluminosilicate, $(Ca,Na)(Mg,Al,Fe,Ti)(Si,Al)_2O_6$]; muscovite [basic potassium aluminosilicate, $KAl_3Si_3O_{10}(OH)_2$]; enstatite [magnesium silicate, $Mg_2Si_2O_6$]; and nosean [hydrous sodium aluminosilicate sulfate, $Na_8Al_6Si_6O_{24}(SO_4)\cdot H_2O$]. Lapis lazuli in varying commercial grades, along with occasional lazurite crystals occur near the core of these lenses.

The rough camp of Sar-e-Sang is a seasonal home for lapis miners. The mines are located on a nearby steep cliff at elevations of about 10,000 feet. The district's seven mines, all reached only by dangerous, steep foot trails, have narrow, inclined or declined tunnels that lead to underground galleries. The only mine that is currently active has two access tunnels and an underground gallery 150 feet high—testimony to the huge amount of rock that has been removed over the centuries. The interior walls are blackened by smoke from fires that were once used to heat and help break the rock. Most mining is still conducted by manually drilling with hammers and hand steels. After the drill holes have been loaded and blasted, miners search the marble fragments for blue coloration that might indicate a nearby lapis-bearing lens. After finding a lens—which is largely a matter of luck—the miners drill tight patterns of holes and blast as lightly as possible to break the lapis into the 50-pound blocks that are preferred by buyers.

Miners then backpack these blocks down the mountain to Sar-e-Sang and load them onto horses or mules for the continued descent in the Kokcha River canyon to Jurm. Trucks then haul some of the lapis to Kabul; most, however, is smuggled across the border to the gemstone markets at Peshāwar, Pakistan. Either journey takes almost a week. In order to mine at Sar-e-Sang, Afghan entrepreneurs must pay government officials for permission, then hire local miners, and finally pay additional fees to the Northern Alliance to "guarantee" the safe shipment of the lapis, especially if it is going to Pakistan. Mining begins in late June and ends in early November, with snow hindering operations during the first and last few weeks of the season. About 10 tons of lapis, and probably much more, are mined each season (see "Lapis Lazuli: The Pride of Afghanistan"). The mine price of one pound of quality, rough lapis is about $50. In the gem markets of Peshāwar, Pakistan, that same amount will sell for $500.

Our specimens of lapis lazuli were mined in the Kokcha Valley, then smuggled into Pakistan. After these specimens had been imported into the United States, their locality was still erroneously listed for a time as "Pakistan." These specimens are natural lapis lazuli and have not been altered in any way. Their intensity of the deep blue color indicates a lazurite content of at least 35 percent. Their hardness of Mohs 5.0-5.5 enables them to take the fine polish that brings out the deep-blue color and makes finished lapis gems and decorative objects so distinctive and attractive. Your specimen consists of deep-blue lapis lazuli, a coarsely crystallized, gray-white marble and glittering specks of brassy pyrite. The slight white streaking within the blue lapis is calcite. Your specimen of the gemstone lapis lazuli is a keepsake from one of the world's oldest and most storied mining districts—the Sar-e-Sang district in the Kokcha Valley, Badakhshān Province, Afghanistan.

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