

February 2007 Mineral of the Month: Lazulite

“Of all the species found in the Rapid Creek area, certainly the one that has received the most attention is lazulite. No other locality in the world produces specimens of comparable quality and quantity.”—*Mineralogical Record*, July-August 1992

PHYSICAL PROPERTIES

Chemistry: $\text{MgAl}_2(\text{PO}_4)_2(\text{OH})_2$ Magnesium Aluminum Phosphate Hydroxide (Basic Magnesium Aluminum Phosphate, Magnesium Aluminum Hydroxyphosphate), containing iron

Class: Phosphates, Arsenates, and Vanadates

Subclass: Basic Anhydrous Phosphates

Group: Lazulite

Crystal System: Monoclinic

Crystal Habits: Usually bipyramidal or tabular, twinning common. Also granular, massive, and compact.

Color: Deep blue, sky blue, azure blue, greenish-blue, light blue; rarely green or yellowish-green.

Luster: Vitreous to dull

Transparency: Transparent to opaque

Streak: White

Cleavage: Distinct in one direction

Fracture: Uneven, brittle

Hardness: 5.5-6.0

Specific Gravity: 3.1-3.4, varies with iron content

Luminescence: None

Refractive Index: 1.615-1.645

Distinctive Features and Tests: Best field marks are light- to dark-blue colors, bipyramidal crystal habit, and frequent association with quartz. Lazulite is often confused with other blue minerals such as vivianite, which is harder and more dense, and sodalite and lazurite, which have lower specific gravities. Blue corundum is much harder. Unlike azurite, lazulite does not react with acid.

Dana Classification Number: 41.10.1.1

NAME

The name of this month's mineral, which is correctly pronounced LAZH-you-lite, stems from the German *lazurstein*, or “blue stone.” The base word *lazur-* derives from the Arabic *lazaward*, meaning “heaven,” or “blue.” Because of previous uncertainty about its chemical composition and confusion with other blue minerals, lazulite has acquired many alternative names, including “azure spar,” “blue spar,” “blue opal,” “blue zeolite,” “blue feldspar,” “lazulith,” “lazulita,” “lazulit,” “blauspat,” “klaprothite,” “klaprothine,” “tyrolite,” “tetragophosphate,” “mollite,” “vorausite,” and “berkeyite.”

Because of both color and phonic similarities, lazulite is often confused with lazurite, a complex basic sodium calcium sulfosilicate with the chemical formula $(\text{Na,Ca})_8\text{Si}_6\text{Al}_6\text{O}_{24}(\text{SO}_4)_2\text{S}_2\text{Cl}_2(\text{OH})_2$. Lazurite, the mineral that imparts the blue color to lapis lazuli, is chemically and mineralogically unrelated to lazulite.

COMPOSITION

Lazulite is another of the minerals we never thought we would be able to feature—too rare and too expensive. When the opportunity arose, we jumped on it! We also acquired a large lot of gormanite $[\text{Fe}^{2+3}\text{Al}_4(\text{PO}_4)_4(\text{OH})_6 \cdot 2\text{H}_2\text{O}]$, another rare and fascinating phosphate mineral from the Yukon, but

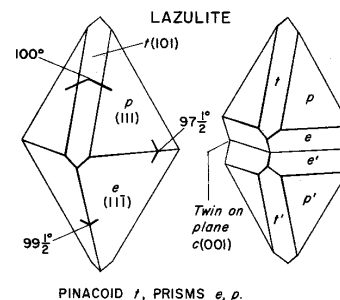


Figure 1. Lazulite crystals, including twinned crystal on right. Image from *Mineralogy* by John Sinkankas, used by permission.

February 2007 Mineral of the Month: Lazulite

ultimately returned it, as the quality was lacking. This is the second rare Yukon phosphate we have featured, after augelite in April 2005. We have uploaded our augelite write-up to our web site and you can find it by clicking on "Sample Write-ups" at the top of our home page. The augelite write-up contains information on several of the other rare minerals found at this marvelous, remote locality.

Lazulite's chemical formula $\text{MgAl}_2(\text{PO}_4)_2(\text{OH})_2$ identifies its elemental components as magnesium (Mg), aluminum (Al), phosphorus (P), oxygen (O), and hydrogen (H). The molecular weight of lazulite consists of 8.04 percent magnesium, 17.86 percent aluminum, 20.50 percent phosphorus, 52.94 percent oxygen, and 0.66 percent hydrogen.

The molecules of chemical compounds consist of positively charged ions called *cations* and negatively charged ions called *anions*. The compound cation in lazulite, which consists of one magnesium ion (Mg^{2+}) and two aluminum ions (2Al^{3+}), has a collective electrical charge of +8. Lazulite's compound anion consists of two different radicals (groups of atoms that act as entities in chemical reactions)—two phosphate radicals [$2(\text{PO}_4)^{3-}$] and two hydroxyl radicals [$2(\text{OH})^{1-}$] with a collective charge of -8. The resulting balance of cationic and anionic charges imparts electrical stability to the lazulite molecule.

As a phosphate, lazulite is one of nearly 300 members of the Phosphates, Arsenates, and Vanadates class of minerals. The basic building blocks of these minerals are the phosphate radical $(\text{PO}_4)^{3-}$, arsenate radical $(\text{AsO}_4)^{3-}$, and vanadate radical $(\text{VO}_4)^{3-}$. All form tetrahedral structures with four oxygen ions surrounding the ion of a metal or semi-metal (vanadium is a metal; arsenic and phosphorus are semi-metals). In the phosphate ion, the phosphorus ion (P^{5+}) is surrounded by, and bonded covalently to, four oxygen ions (4O^{2-}). Because the resulting collective -3 charge is distributed evenly over the four oxygen ions, the phosphate radical can bond ionically with many metal cations.

In lazulite, two phosphate ions bond ionically to one magnesium and two aluminum ions to form the intermediate, octahedral-shaped magnesium aluminum phosphate radical $[(\text{MgAl}_2(\text{PO}_4)_2)^{2+}]$. These radicals, which are unstable because of their +2 charge, covalently bond into chains of octahedra that establish lazulite's monoclinic crystal structure. In spaces between these octahedra, hydroxyl ions $[(\text{OH})^{1-}]$ bond ionically to alternating metal ions to complete the molecule and to provide electrical balance. Monoclinic crystals have three axes of different lengths, two of which are perpendicular. The third axis makes an angle so that the crystals characteristically look like bipyramidal orthorhombic crystals that have been deformed in one direction. This is apparent in lazulite crystals, in which basic bipyramids appear as distorted octahedrons that are flattened to nearly tabular form. Because the covalent bonding *along* the octahedral chains is strong, while the lateral ionic bonding *between* the chains is weak, lazulite exhibits distinct cleavage in the one direction along its ionic-bonding plane.

At Mohs 5.5-6.0, lazulite's hardness is roughly equal to that of turquoise [basic hydrous copper aluminum phosphate, $[\text{Cu}^{2+}\text{Al}_6(\text{PO}_4)_4(\text{OH})_6 \cdot 4\text{H}_2\text{O}]$]. This hardness is somewhat directional, being greatest along the planes of strong covalent bonding. Although moderately hard, the weak ionic bonding present also makes lazulite brittle. Lazulite's relatively low density (specific gravity 3.1-3.4) is due to the light atomic weights of its elemental components.

Lazulite forms in granite pegmatites, replacement deposits, and quartz-rich metamorphic rocks. In pegmatites and hydrothermal replacement deposits, lazulite occurs with quartz [silicon dioxide, SiO_2], muscovite [basic potassium aluminum silicate, $\text{KAl}_3\text{Si}_3\text{O}_{10}(\text{OH})_2$], hematite [iron oxide, $\text{Fe}^{3+2}\text{O}_3$], and topaz [basic aluminum fluorosilicate, $\text{Al}_2\text{SiO}_4(\text{F},\text{OH})_2$]. Lazulite is also associated with quartz and muscovite in the schist of regional metamorphic rocks. Lazulite is among the few blue minerals that intergrows with quartz.

February 2007 Mineral of the Month: Lazulite

The Dana mineral-classification number 41.10.1.1 identifies lazulite as a phosphate with hydroxyl or halogen anions (41). The subclassification (10) then defines it by the general formula $(A^{2+})(B^{3+})_2(XO_4)_2Z_q$ in which “A” and “B” are such divalent or trivalent metals as magnesium, aluminum, copper, or iron (ferric and ferrous); “ (XO_4) ” is a phosphate, arsenate, or vanadate radical; “Z” is a hydroxyl or halogen ion; and “q” is a variable quantifier. This general formula is clearly reflected in the lazulite formula $MgAl_2(PO_4)_2(OH)_2$. Finally, lazulite is a member of the lazulite group (1), as the first (1) of four members. The other members include scorzalite [basic iron magnesium aluminum phosphate, $(Fe^{2+},Mg)Al_2(PO_4)_2(OH)_2$]; hentschelite [basic copper iron phosphate, $Cu^{2+}Fe^{3+2}(PO_4)_2(OH)_2$]; and barbosalite [basic iron phosphate, $Fe^{2+}Fe^{3+2}(PO_4)_2(OH)_2$]. Lazulite is most closely related to scorzalite, with which it forms a solid-solution series. In the lazulite-scorzalite series, iron (ferrous, Fe^{2+}) substitutes for magnesium (Mg^{2+}). Scorzalite, the rarer end-member of the series, is darker, denser, and less transparent than lazulite. The lazulite formula $MgAl_2(PO_4)_2(OH)_2$ reflects theoretical chemical purity, for all specimens contain at least some iron. Technically, lazulite becomes scorzalite when the weight of iron exceeds that of magnesium.

As an idiochromatic (self-colored) mineral, lazulite's basic blue color is due to its essential chemical composition and crystal structure, rather than any accessory chromophores (coloring agents). Shifts in the blue color of lazulite are caused by varying amounts of iron, which impart darker, greenish hues. Lazulite is strongly pleochroic, exhibiting different colors when viewed in different directions. Pleochroism is caused by the directionally different absorption of white light in doubly refractive crystals. Double refraction (or birefringence), which occurs to some degree in all crystals, refers to the bending of light in two slightly different directions. The degree of double refraction is measured as the difference between a crystal's highest and lowest refractive indices. In lazulite, the refractive indices are 1.615-1.645. Thus, its degree of double refraction is 0.030. This is relatively high, and the resulting pleochroism is seen as a shift from near colorless to deep blue with the rotation of the crystal.

COLLECTING LOCALITIES

Although uncommon, lazulite occurs in small quantities in many locations. Very few, however, provide quality specimens. Our specimens come from lazulite's classic locality—the Rapid Creek/Big Fish River area in the remote northeastern corner of Canada's Yukon, as described in *About Our Specimens*.

Lazulite was discovered in Austria at Fressnitzkogel Mountain at Krieglach, Styria, a site that still yields specimens today. Austria has the greatest number of lazulite occurrences, and other Styrian sources include the Trailbach pit at Trailbachgraben, Geisshübler Berg at Fischbach in the Fischbachen Alpen, Granegg Mountain at Krieglach, and the Langenwang and Hönigsberg pits at Mürzusschlag. In the Salzburg area, lazulite is found at Eiskogel Mountain at Werfen, Gerzkopf Mountain at Radstadt, and Leutachkopf Mountain and the Stocker Tunnel in the Hohe Tauern Mountains.

Lazulite is collected in Germany at the Gerscheit pegmatite quarry at Reichmannsdorf, Thuringia, and the Kreuth quarry at Vohenstrauß, Bavaria. Lazulite also occurs at the Otov pegmatite in Karlovy Vary, Böhmen, Czech Republic; the Kutemajärvi Mine at Orivesi, Finland; Bolna, Rana, Norway; the Cabeço da Mua mine at Torre de Moncorvo, Portugal; the Västanaå iron mine and Glasbruket Quarry at Skåne, Sweden; the Stockhorn pit at Zermatt, Switzerland; and Monte Folgorito, Pietrasanta, Tuscany, Italy.

In Africa, lazulite is collected at the Sahatany pegmatite field at Vakinankaratra, Antananarivo Province, Madagascar; in Australia at the Kanmanatoo Mine in the Mt. Lofty Range of South Australia; in Brazil at the Sopa Mine at Diamantina, Minas Gerais; and in Russia at the Chudnoe lead-gold deposit at Grubenpendity Lake in the Northern Region's Komi Republic.

February 2007 Mineral of the Month: Lazulite

In the United States, the best lazulite specimens come from the Graves Mountain Mines at Graves Mountain in Lincoln County, Georgia. Lazulite is also found in North Carolina at the Clubb Mountain kyanite deposit at Lincolnton in Gaston County, the Carolina Pyrophyllite Mine at Staley in Randolph County, and the Standard Mineral Co. Mine at Cabin Creek in Moore County. Other occurrences include the White Cap Mine in the Pennington Mining District of Keystone County, South Dakota; the Ryan-Purcley sillimanite property in the Kings Mountain Mining District in York County, South Carolina; the Scotty pegmatite quarry at Newry, Oxford County, Maine; the Branchville mica quarry at Branchville, Fairfield County, Connecticut; the American Progress Mine in the Bare Mountain Mining District, Nye County, Nevada; the Charles Davis and Palermo No. 1 mines at Groton in Grafton County, New Hampshire; the Champion Mine at Laws in Mono County, California; and Madera Canyon in the Santa Rita Mountains of Pima County, Arizona.

JEWELRY & DECORATIVE USES

Lazulite is a semi-precious gemstone that would enjoy much greater popularity and familiarity if it were more abundant. Its gem attributes include rarity, unusual blue colors, and an ability to polish to a high, vitreous luster. Despite some difficulty in cutting because of its distinct, one-directional cleavage, lazulite crystals are faceted into gems both for jewelry and collector purposes. Because lazulite crystals are small and often heavily included, faceted gems rarely exceed one-half carat in weight. Despite only a moderate hardness of Mohs 5.5-6.0, lazulite gems are often mounted in gold rings, pendants, and brooches that sell in higher-end price ranges.

Massive or granular lazulite in matrix is an ornamental stone that is fashioned into small paperweights, spheres, and carvings. A 2.5-inch sphere of lazulite in a quartz-siderite matrix is valued at \$500! In our twelve years of traveling to gem and mineral shows, we have rarely seen objects made from lazulite offered for sale, part of the reason for its high value. Much of lazulite's appeal as an ornamental stone lies in the contrast of its vivid blue colors with those of other matrix minerals.

Mineral collectors value lazulite for its range of blue colors, interesting crystal habit, and the rarity of fine specimens. Specimens are usually composites, in which lazulite is associated with quartz, rutile [titanium dioxide, TiO_2], kyanite [aluminum silicate, Al_2SiO_5], and various garnet and phosphate minerals. Top-quality, 3x4-inch lazulite specimens easily command \$500 or more on specimen markets.

HISTORY & LORE

German chemist Martin Heinrich Klaproth (1743-1817) identified lazulite as a new mineral species in 1795, after studying specimens obtained from Fressnitzkogel Mountain at Krieglach, Styria, Austria. The mineral was initially known as *lazurstein* ("blue stone"), in reference to its color, but was later named klaprothite, after its discoverer. When the current name "lazulite" was adopted in the late 1800s, the chemical composition of the mineral was still uncertain. Lazulite was once thought to be a hydrous mineral similar to the zeolites, hence the name "blue zeolite." Mineralogists finally proved that lazulite was a basic mineral containing hydroxyl ions in the 1920s.

Mineralogists had long realized that lazulite contains varying amounts of iron. The 1947 discovery of the mineral scorzalite [basic iron magnesium aluminum phosphate, $(\text{Fe}^{2+}, \text{Mg})\text{Al}_2(\text{PO}_4)_2(\text{OH})_2$] revealed that lazulite was also the magnesium-rich end member of the lazulite-scorzalite solid-solution series. The basic atomic configuration of lazulite was determined in 1959, then refined by diffuse-reflectance spectroscopy methods in 2002.

February 2007 Mineral of the Month: Lazulite

COLLECTOR GEMS

Only faceting and polishing can reveal the true color, full brilliance, and play of light of gemstone crystals.

Crystals of more than 100 minerals have been faceted into gems that fall into two categories: jewelry gems and collector gems. Most faceted gems are used in jewelry and sold through mainstream jewelry outlets. Because they are purchased primarily for their visual appeal, they tend to be somewhat generic. Collector gems are intended for study, display, and collecting purposes. These one-of-a-kind stones are available only through specialized dealers and are often accompanied by detailed information regarding origin, mineralogy, and history.

In terms of overall wearability, availability, affordable price, and general familiarity, only about a dozen gemstones are suited for general jewelry use. These make up the bulk of all faceted gems and include the precious, or "cardinal," gems—diamond [carbon, C], sapphire and ruby [corundum, aluminum oxide, Al_2O_3], and emerald [green variety of beryl, beryllium aluminum silicate, $\text{Be}_3\text{Al}_2\text{Si}_6\text{O}_{18}$]. Other popular jewelry gems include topaz [basic aluminum fluorosilicate, $\text{Al}_2\text{SiO}_4(\text{F},\text{OH})_2$], aquamarine [blue variety of beryl], and amethyst [purple variety of quartz, silicon dioxide, SiO_2].

To stand up everyday wear, jewelry gems should have a hardness of at least Mohs 7.0. Some mineral crystals have sufficient hardness, but are much too rare to serve as mainstream gemstones. Examples of these are honey-yellow andalusite [aluminum silicate, Al_2SiO_5], vivid-blue benitoite [barium titanium silicate, $\text{BaTiSi}_3\text{O}_9$], and the pale-blue cordierite variety known by its gemstone trade name, iolite [magnesium aluminum silicate, $\text{Mg}_2\text{Al}_3(\text{AlSi}_5\text{O}_{18})$]. These and other similar mineral crystals are sometimes faceted in limited quantities as collector gems.

Many more colorful gemstones, both rare and abundant, fall below Mohs 7.0 in hardness and are also cut into collector gems. Lazulite is a good example. Lazulite has a marginal hardness of Mohs 5.5-6.0, but cuts into brilliant gems similar in color to blue sapphire. Faceted lazulite is more popular as a collector gem than as a jewelry gem.

Other relatively soft gemstones that make stunning collector gems include red rhodochrosite [manganese carbonate, MnCO_3], green-yellow brazilianite [basic sodium aluminum phosphate, $\text{NaAl}_3(\text{PO}_4)_2(\text{OH})_4$], and dark-green diopside [calcium magnesium silicate, $\text{CaMgSi}_2\text{O}_6$]. Abundant minerals such as fluorite [calcium fluoride, CaF_2], which has soft purple, green, and yellow hues, are also cut into unusual collector gems. Collector gems are even cut from such ore minerals as yellow-orange sphalerite [zinc sulfide, ZnS], red cuprite (copper oxide, Cu_2O), golden chalcopyrite [copper iron sulfide, CuFeS_2], and honey-colored cassiterite [tin oxide, SnO_2]. Collector gems can have colors and brilliance that sometimes exceed those of the mainstream jewelry gems.

Interest in collector gems continues to rise. Collector gems are often exhibited in "combination displays" side-by-side with rough mineral crystals of the same species. Unlike the colors of many jewelry gems, the colors of collector gems are never enhanced. Collector-gems prices, like those of conventional jewelry gems, range widely from less than \$100 to thousands of dollars per carat. Rarity is an important factor in pricing. Fine collector gems are often accompanied by information about origin by locality and specific mine, date of mining, chemical analysis, cutting data, and even previous owners. All in all, fine collector gems can be much more interesting than conventional jewelry gems.

February 2007 Mineral of the Month: Lazulite

Lazulite's honors include designation as the official gemstone of the Yukon. In 1961, the mineral was featured on the 30-centimes postage stamp of Switzerland. In 2002, *Canadian Rockhound*, considering collector interest, aesthetic appeal, uniqueness, and overall collecting and mineralogical importance, ranked lazulite third among Canada's top ten collectible minerals. The entire list can be found in our augelite write-up, which we have uploaded to our web site—click on “Sample Write-ups” for the link.

Fanciful lore regarding lazulite includes a belief that it was created when “Mother Earth” captured bits of the shattered blue sky after an upheaval of the universe. According to modern metaphysical practitioners, lazulite brings clarity and purity to the energy of the universe, facilitates meditation by promoting tranquility and sanctity, and alleviates stress.

TECHNOLOGICAL USES

No technological uses for lazulite have yet been developed, although the mineral has served as the model for its own synthesis in the study of crystal structure.

ABOUT OUR SPECIMENS

Our lazulite specimens come from one of North America's most remote mineral-collecting localities—the Rapid Creek/Big Fish River area in the northeastern corner of Canada's Yukon. This site is located 225 miles above the Arctic Circle, 150 miles east of the Alaska-Yukon border, 600 miles northeast of Fairbanks, Alaska, and just ten miles south of the shore of the Beaufort Sea. The locality is within the Dawson Mining District, which should not be confused with the more familiar Klondike gold-rush town of Dawson 500 miles to the south. The nearest town, Aklavik, “barren-ground grizzly place” in the Inuit language, is located in the Northwest Territories 75 miles to the southeast. Fort McPherson, Northwest Territories, population 800, lies 150 miles to the southeast and is linked to the town of Dawson by the 420-mile-long, graded-gravel Dempster Highway. The Rapid Creek/Big Fish River collecting area is in the northern Richardson Mountains, a north-south-trending range with summits as high as 5,300 feet. Vegetation at the site is limited to scrub tundra with sparse stands of stunted spruce on the lower, south-facing slopes.

The origin of the abundant phosphates at the Rapid Creek/Big Fish River locality is traced back to Paleozoic time some 600 million years ago, when the region was the floor of a deepwater sea. The deep sediments that accumulated on the sea bottom contained huge amounts of microcrystalline fluorapatite (our featured mineral in May 2003 and May 2006) from the shells and bones of a profusion of marine life. These sediments eventually lithified into formations of iron- and phosphorus-rich shales that later became laced with veins of hydrothermal quartz.

Finally, some 55-65 million years ago at the boundary of Cretaceous and Tertiary periods, the same continental tectonic stresses that uplifted the 5,000-mile-long Rocky Mountains also uplifted the Richardson Mountains. The quartz-laced, phosphate- and iron-rich Paleozoic marine shales rose about 5,000 feet during the formation of these fault-thrust mountains. Subsequent erosion finally exposed the Paleozoic shales and their trove of phosphate minerals

More than 70 minerals, including many unusual phosphates that are closely associated with quartz and siderite [iron carbonate, $\text{Fe}^{2+}\text{CO}_3$], have been identified at the Rapid Creek-Big Fish River locality. Along with lazulite, these minerals include vivianite [hydrous iron phosphate, $\text{Fe}^{2+3}(\text{PO}_4)_2 \cdot 8\text{H}_2\text{O}$], wardite [basic hydrous sodium aluminum phosphate, $\text{NaAl}_3(\text{PO}_4)_2(\text{OH})_4 \cdot 2\text{H}_2\text{O}$], goyazite [basic hydrous strontium aluminum phosphate, $\text{SrAl}_3(\text{PO}_4)_2(\text{OH},\text{H}_2\text{O})_6$], augelite [basic aluminum phosphate, $\text{Al}_2\text{PO}_4(\text{OH})_3$],

February 2007 Mineral of the Month: Lazulite

brazilianite [basic sodium aluminum phosphate, $\text{NaAl}_3(\text{PO}_4)_2(\text{OH})_4$], kulanite [basic barium aluminum iron phosphate, $\text{BaFe}^{2+}\text{Al}_2(\text{PO}_4)_4(\text{OH})_3$], and gormanite [basic hydrous iron aluminum phosphate, $\text{Fe}^{2+3}\text{Al}_4(\text{PO}_4)_4\text{OH}\cdot 2\text{H}_2\text{O}$]. The Rapid Creek/Big Fish River area is the type locality for ten mineral species. And six unknown minerals, including five phosphates, are being considered for acceptance as new mineral species. The origin of Rapid Creek/Big Fish River specimens is often confusingly cited as Kulan Camp, Crosscut Creek, Lake Creek, Stoneman Camp, Young's Creek, Grizzly Bear Creek, and the Dawson Mining District.

The Richardson Mountains saw little mineral exploration until the late 1950s, when two things accelerated prospecting in the northern Yukon. The first was the growing use of helicopters to ferry prospectors to remote and inaccessible areas. The second was the discovery of oil on the Yukon's Eagle Plains near the Arctic Circle, an event that prompted the Yukon government to begin building the Dempster Highway from the town of Dawson to Fort McPherson. In 1959 at the Rapid Creek/Big Fish River area, an exploration geologist found small, but spectacular, crystals of a strange blue mineral that mineralogists at the University of Alberta at Edmonton identified as lazulite.

In 1968, the discovery of huge oil fields at Prudhoe Bay, Alaska, 450 miles to the west-northwest, again sent prospectors and geologists rushing northward. In the early 1970s, prospectors began searching the northern Richardson Mountains. Among them was Alan "Al" Kulan (1921-1977), already a legend among Yukon prospectors. In 1953, Kulan discovered the Vangorda base-metal deposit at Faro in the south-central Yukon. The Vangorda deposit became the Anvil Mine which, by 1970, ranked as the world's largest open-pit lead-zinc mine.

At the Rapid Creek/Big Fish River area, Kulan was intrigued by the abundance of unusual phosphates, especially lazulite. He collected many specimens that were identified and studied in depth by mineralogist Dr. Donald Gorman, now professor emeritus of mineralogy at the University of Toronto, for whom gormanite is named. Kulan's beautiful specimens caused mineralogists, collectors, and gem-cutters to redefine their concepts of lazulite. Previously, Austria had provided the best lazulite crystals, although these rarely exceeded one-quarter inch in size. But Kulan's specimens, the finest ever found, included clusters of one-inch crystals with a deep-azure color. To further encourage research into lazulite and related phosphate minerals from the Rapid Creek/Big Fish River locality, Kulan made generous cash contributions to the mineralogy department of Queen's University at Kingston, Ontario. One of Kulan's phosphate specimens was eventually confirmed as a new species and named in his honor—kulanite [basic barium iron aluminum phosphate, $\text{BaFe}^{2+2}\text{Al}_2(\text{PO}_4)_4(\text{OH})_3$]. In 1974 at Whitehorse, the territorial capital, Kulan, always eager to promote Yukon minerals, presented a museum-grade lazulite specimen to Yukon commissioner James Smith who gratefully accepted the gift on behalf of all territorial residents.

By 1975, Kulan was making regular collecting trips to the Rapid Creek/Big Fish River area during the brief Arctic summers. Because this area had never been mined, he collected all his specimens by hand-excavating quartz seams on steep and unstable slopes of weathered shale. Kulan's superb specimens introduced top-quality lazulite to collectors around the world and encouraged gem-cutters to facet the first lazulite collector gems. In February 1976, the territorial government formally decreed lazulite as the official Yukon gemstone. (At the time, lazulite was the only Yukon gemstone. Geologists later discovered commercial quantities of gem-quality emerald near Ross River in the southeastern Yukon.)

Sadly, Al Kulan was shot to death by a deranged Yukon resident at Ross River on September 12, 1977. Kulan's contributions to mining and minerals were not formally recognized until after his death. In 1988, the Yukon Prospectors' Association inducted Kulan into the Yukon Hall of Fame and engraved his name on a plaque at the ten-foot-tall bronze statue of a prospector in Whitehorse. And on January 20, 2005, Kulan was inducted into the prestigious Canadian Mining Hall of Fame at the University of Toronto.

February 2007 Mineral of the Month: Lazulite

In 1978, the Yukon government, citing environmental and native land-claim issues, withdrew the Rapid Creek/Big Fish River area from unauthorized visitation. These restrictions remain in effect today. Visiting the Rapid Creek/Big Fish River locality and adjacent areas of the Richardson Mountains still requires permission from the Yukon government. Because permission is rarely granted, collecting opportunities are very infrequent.

Fortunately for all of us, one group of Canadian collectors recently made a couple of trips to Rapid Creek, providing us with the augelite specimens we sent in 2005, and these wonderful lazulites, as well. This is probably the last mineral we will feature from this amazing locality, as most of the others are far too rare, not found in the kind of quantity we need.

The intense color of lazulite's dark blue crystals is probably the first thing that draws us to this rare phosphate mineral. It is easy to see why connoisseurs would desire to have a faceted lazulite in their collection, to marvel at this richness of the color! Increasing amounts of iron substituting for magnesium in the crystal causes this deep shade of blue, which can almost appear black and opaque in some specimens. Like most minerals, the lazulite crystals are small, and require magnification to be viewed in all their glory. Lazulite crystals up to one inch have been recovered from Rapid Creek, although these are few and far between, and command the kind of price that few of us can afford.

Examination with a jeweler's loupe or a microscope will allow us to see plainly the well-formed crystal faces, with their sharp edges and terminations, as seen in the drawings in Figure 1. The drawings, of course, are of ideal lazulite crystals, the way they would form in perfect growth conditions, rarely seen in nature. Our specimens show smaller crystals that somewhat resemble the drawings, but are flattened to nearly tabular form, as described in *Composition*. Also, they tend to lay flat on the matrix, which makes them more difficult to see. Speaking of the matrix, most Rapid Creek lazulite is found in fracture fillings in and on sandstone, as ours are. Be sure to examine all sides of the matrix, as you may observe small crystals of quartz, dark brown siderite, or some of the other rare phosphate minerals that Rapid Creek and Big Fish are famous for! Yes, this locality is so well-loved by collectors that the *Mineralogical Record* devoted an entire issue (July-August 1992) to "Yukon Phosphates."

You may also observe the twinning plane depicted in Figure 1. This is known as the composition plane, the plane on which both halves of the twin meet. This is often a good way to identify twins, as two faces, one on each twin, are exactly opposite from each other and mirror each other. (For an in-depth discussion of twinning, see our September 2004 write-up on Japan-Law Twinned Quartz. Contact us if you need a copy.) Certainly, there is a lot to see and a lot to appreciate when it comes to the intense color and fascinating properties of this beautiful blue mineral. And we are grateful to have this opportunity to add one to our collections!

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