

## April 2005 Mineral of the Month: Augelite

*"In little more than a decade, the Rapid Creek and Big Fish River area has achieved world prominence as an important locality for phosphate minerals. A unique geological environment has produced a unique suite of minerals, several of which were previously unknown to science."— Mineralogical Record, 1992*

### PHYSICAL PROPERTIES

Chemistry:  $\text{Al}_2\text{PO}_4(\text{OH})_3$  Aluminum Phosphate Hydroxide (Basic Aluminum Phosphate)

Class: Phosphates, Arsenates, and Vanadates

Subclass: Anhydrous Phosphates Containing Hydroxyl or Halogen Ions

Group: Augelite

Crystal Group: Monoclinic

Crystal Habits: Small-to-microscopic tabular and platy crystals exhibiting an overall triangular shape; also massive. Crystal size rarely exceeds 6 millimeters (approximately one-quarter inch).

Color: Colorless or white to pale shades of blue, green, yellow or pink.

Luster: Vitreous on crystal faces; pearly on cleavage surfaces.

Transparency: Transparent to translucent

Streak: White

Refractive Index: 1.57-1.58

Cleavage: Good in two directions

Fracture: Conchoidal

Hardness: 4.5-5.0

Specific Gravity: 2.7

Luminescence: None

Distinctive Features and Tests: Augelite is often difficult to recognize, especially as tiny, transparent, colorless crystals. The best field indicators are crystal habit, generally triangular crystal shape, mineralogical associations, and mineralogical environment.

Dana Classification Number: 41.6.8.1

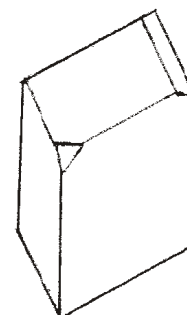


Figure 1 Augelite crystal.

### NAME

The name "augelite" derives from two Greek words: *augitēs*, meaning "shining," a reference to the mineral's bright, vitreous luster on crystal faces and pearly luster on cleavage surfaces; and *lithos*, or "stone." Its correct pronunciation is AW-geh-lite (first syllable rhymes with "paw"). Augelite has also been known as "augelit," "amfihalit," and "amphithalite."

### COMPOSITION

Our 110<sup>th</sup> featured mineral is our sixth coming from the world's second largest nation, Canada, and our first from its Yukon Territory. Minerals from Canada we have featured are apatite from Ontario in October 1998, vesuvianite from Quebec in 2000, gypsum from Manitoba in May 2001, eudialyte from Quebec in April 2002, and biotite from Quebec in July 2004. Other phosphate group minerals we have featured are apatite from Canada (October 1996) and from Russia (May 2003), pyromorphite from a new find in China (July 2002), vanadinite from the classic locality in Morocco (November 2001), Utah variscite (April 2000), and vivianite from a new find in Bolivia (November 2004). Although this month's specimens are smaller than most we feature, we are delighted to be able to showcase this beautiful and rare phosphate, with crystals about as large as they get, with the possible exception of those found at the Champion Mine near Laws in the White Mountains of California's Mono County.

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Augelite's chemical formula,  $[\text{Al}_2\text{PO}_4(\text{OH})_3]$ , identifies this mineral as aluminum phosphate hydroxide (or basic aluminum phosphate), which contains the elements aluminum (Al), phosphorus (P), oxygen (O), and hydrogen (H). Augelite's molecular weight is made up of 26.99 percent aluminum, 15.49 percent phosphorus, 56.01 percent oxygen, and 1.51 percent hydrogen. The augelite molecule consists of a double aluminum cation  $[(\text{Al}^{3+})_2]$  bound to a phosphate anion  $[(\text{PO}_4)^{3-}]$ , with three anionic hydroxyl  $[(\text{OH})^{1-}]$  radicals bound to the aluminum cations. The molecule's collective cationic charge of +6 balances the collective anionic charge of -6.

Augelite is a member of the Phosphate, Arsenates, and Vanadates class of minerals, which includes some 700 distinct mineral species, most of which are rare. Within this class, nearly 430 minerals contain the phosphate ion  $[(\text{PO}_4)^{3-}]$  or **radical** (a group of bonded atoms that acts as an entity in chemical reactions). The phosphate radical, the basic building block of phosphate minerals, consists of an ion of the semi-metal phosphorus (semi-metallic elements exhibit both metallic and nonmetallic properties) surrounded by four equidistant oxygen ions that form the corners of a tetrahedron. The net -3 charge of the phosphate radical is distributed evenly across the four oxygen ions. The ability of the negatively charged phosphate radical to bond ionically with many positively charged metallic and semimetallic ions explains the large number of phosphate-mineral species.

The Dana mineral-classification number of 41.6.8.1 establishes augelite as an anhydrous phosphate containing either hydroxyl or halogen ions (41). Augelite is subclassified (6) by the general formula  $(\text{A})_2\text{XO}_4(\text{Z})_3$ , in which A is a trivalent metal cation; X is a phosphorus, arsenic, or vanadium ion with a +5 charge; and Z is a hydroxyl or halogen ion. Finally, augelite belongs to the augelite group (8), in which it is currently the only member (1). The Dana classification system is designed to accommodate new mineral species as they are approved by the International Mineralogical Association (IMA) each year. A newly discovered anhydrous-phosphate mineral that meets the above criteria will, upon IMA approval, be assigned the Dana Classification Number 41.6.8.2.

Augelite, which is quite rare, forms primarily in granite pegmatites and in high-temperature, hydrothermal veins under specific conditions of temperature, pressure, and chemistry. It also occurs to a lesser extent in alteration environments where phosphate-bearing rocks in aluminum-rich sediments have undergone hydrogen metamorphism. Augelite is often associated with such other aluminum- and phosphate-bearing minerals as andalusite (aluminum silicate,  $\text{Al}_2\text{SiO}_5$ ), lithiophyllite (lithium manganese phosphate,  $\text{LiMnPO}_4$ ), and triphylite (lithium iron phosphate,  $\text{LiFePO}_4$ ).

Augelite is an idiochromatic, or "self-colored," mineral, meaning that its color is determined by its essential mineral components or by the nature of its crystal structure. Nevertheless, the presence of trace impurities in idiochromatic minerals can alter the basic color. When pure, augelite is colorless. But it also occurs in pale blues, greens, and pinks, colors that are created by small amounts of chromophoric (color-producing) elements, most often iron, manganese, and lithium that substitute for aluminum in the augelite crystal lattice. Even if chromophoric elements are present in quantities too low to impart their own colors, their presence may distort the positioning of the aluminum ions within augelite's crystal lattice in a manner that creates pale yellow hues.

Augelite is a good molecular model to illustrate certain concepts of atomic bonding and electron interaction. The augelite molecule and crystal lattice are held together by three types of atomic bonds: covalent, ionic, and hydrogen. Before examining these bonds, let's first review some basic electron theory. The number and configuration of electrons in atoms explain why certain elements do or do not react with other elements. Electrons are positioned around the nucleus of atoms in well-defined energy levels, called orbitals or "shells," each holding a limited number of electrons. Very light elements, such as hydrogen or

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helium, have only one shell and can achieve electrical stability with only two outer electrons. Other elements with two or more shells achieve stability with eight outer electrons in a so-called “stable octet.” Elements with less than eight outer electrons react readily with other elements by gaining, losing, or sharing electrons.

The elemental components of augelite—aluminum, phosphorus, oxygen, and hydrogen—have 3, 5, 6, and 1 outer electron(s) respectively. In the phosphate radical  $[(\text{PO}_4)^{3-}]$ , a phosphorus atom covalently bonds to four oxygen atoms. In covalent bonds, shared electrons hold together two nonmetallic atoms or, in the case of augelite, a nonmetallic (oxygen) and a semi-metallic (phosphorus) atom. But despite these strong covalent bonds, the phosphate radical is three electrons short of achieving electrical stability. This gives it a net charge of -3 and the ability to form ionic bonds.

Ionic bonds are the forces that hold atoms of metallic elements together with nonmetallic elements or radicals. In ionic bonding, cations (positively charged ions) donate electrons, while anions (negatively charged ions) accept electrons. Using augelite as an example, aluminum readily gives up its three outer electrons to become a cation with the symbol  $\text{Al}^{3+}$ . Because unlike charges attract one another, the +3 charge of the aluminum cations strongly attracts the -3 charge of the phosphate anion. This triple-charge attraction is so strong that *two* aluminum ions actually join with each phosphate radical. The result, however, is an unstable aluminum-phosphate ion  $[(\text{Al}_2\text{PO}_4)^{3+}]$  to which the “extra” aluminum ion imparts a +3 charge. This positive charge makes possible another ionic bonding sequence, this time with hydroxyl radicals, to form a complete augelite molecule.

Hydroxide minerals contain at least one hydroxyl ion  $[(\text{OH})^1-]$ . The presence (or absence) of hydroxyl ions in a mineral depends upon the chemistry of the mineralogical environment together with specific temperature-pressure conditions at the time of formation. Hydroxyl ions consist of a hydrogen ion ( $\text{H}^{1+}$ ) covalently bonded to an oxygen ion ( $\text{O}^{2-}$ ). In augelite, three hydroxyl ions, with their collective -3 charge, bond ionically to the two aluminum ions with their collective +3 charge, thus completing the electrically stable augelite molecule.

Size differences in ions often result in asymmetrical molecular structure. Even if they are electrically balanced, asymmetrical molecules or ions maintain residual electrical charges that cause them to function as tiny dipole magnets. Hydrogen bonding, also called polar bonding, occurs when a residual positive charge on a hydrogen ion is drawn to an opposite charge on another molecule or ion. Hydrogen bonding does not rely on electron sharing or donation, but on weak attractive forces. In augelite, hydrogen bonding occurs between the residual positive charges on hydroxyl hydrogen ions and the residual negative charges on the oxygen atoms of the phosphate radicals in adjacent molecules.

Augelite crystals consist of repeating structures of phosphate, aluminum, and hydroxyl ions held together by strong covalent and ionic bonds, and reinforced by weak hydrogen bonds. Because ionic-bond forces are omnidirectional, every aluminum cation is surrounded by phosphate and hydroxyl anions in a periodic, closely packed crystal structure. Because the aluminum atoms are shielded, augelite shows no obvious metallic properties, such as conductivity or metallic luster. Close atomic packing accounts for augelite's density. Despite being composed of light elements, augelite's specific gravity of 2.7 is a bit higher than that of quartz. Because of its combined covalent and omnidirectional ionic bonds, augelite has no perfect cleavage planes. Its two good cleavage directions indicate planes in which weak hydrogen bonding is most prominent. Finally, the combination of strong covalent and ionic bonding accounts for augelite's moderately high hardness of Mohs 4.5-5.0.

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### *COLLECTING LOCALITIES*

Although augelite is rare, it has a relatively broad distribution and a fair number of collecting localities. In the United States, augelite crystals exceeding a quarter-inch in size are found at the Champion Mine near Laws in the White Mountains of California's Mono County. New England sources include the Strickland Quarry at Portland, Middlesex County, Connecticut; and the Bell Pit near Newry, Oxford County, Maine. Collectors have found nice specimens in New Hampshire at the Palermo No. 1 Mine at Groton in Grafton County and at the G. E. Smith Mine near Newport in Sullivan County. In the West, augelite occurs in South Dakota's Tinton pegmatites in Lawrence County and at Keystone in Pennington County. Nevada's augelite sources, both in Eureka County, include the Carlin Gold Mine near Elko and the Gold Quarry Mine in the Maggie Creek Mining District.

Augelite's type locality, the Vestanå iron mine at Nästum, Kristianstad, Sweden, continues to produce specimens today. Another noted European source of augelite is Rotriegel Ridge in the Fischbacher Alpen area of Styria, Austria. In Japan, augelite occurs in the Hinomaru-Nako mine in Honshu's Yamaguchi Prefecture. The best-known African sources are the Rubindi and Buranga pegmatites in the Gatumba district of Rwanda's Gisenyi Province.

South America's augelite sources include the Pasto Buena mining district of Pallasca Province in Peru's Ancash Department. In Brazil, nice specimens have come from the Sapucaia pegmatite mine in the Conselheiro Pena district, Minas Gerais, and the Vaca Morta quarry near Macaúbas in Bahia. Among Bolivia's augelite sources are the Kami Mine, Ayopaya Province, Cochabamba Department; the Itos and San Jose mines at Oruro in Cercado Province, Oruro Department; the Cerro Tanza area in the Atocha-Quechisla district and the Siglo Veinte mine at Llallagua, Bustillo Province, both in Potosí Department

### *JEWELRY & DECORATIVE USES*

Small crystal size, rarity, pale colors, and relative softness (Mohs 4.5-5.0) preclude augelite's use as a gemstone. Still, it is occasionally faceted into collector gems that usually weigh less than two carats. One connoisseur of rare gemstones was delighted to cut a flawless, colorless gem augelite weighing just 1.44 carats! Because of its rarity and mineralogical interest, augelite enjoys strong collector demand and commands high prices, with small, quality specimens selling for about \$40 each.

In a 2002 *Canadian Rockhound* article titled "Canada's Top Ten Minerals," four expert authors ranked Canadian minerals according to their aesthetic value, collector interest, uniqueness, and overall collecting and mineralogical importance. Among Canada's 161 significant minerals, augelite from the Yukon's Rapid Creek locality narrowly missed selection as one of Canada's "top ten." Lazulite from this locality was ranked #3, while vesuvianite, which we featured in March 2000, was ranked #7. The full ranking is:

1. Serandite from Mont-Sainte Hilaire
2. Catapleite, also from Mont-Sainte Hilaire
3. Lazulite from Rapid Creek
4. Weloganite from the Francon Quarry, St. Michel, Montreal Island, Québec
5. Grossular garnet from the Jeffrey Mine, Asbestos, Québec
6. Cubanite, from various localities through Canada
7. Vesuvianite, also from the Jeffrey Mine
8. Titanite, from southern Ontario and Quebec
9. Silver, again from a number of localities
10. Gold, from various localities

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The apatite and gypsum we have featured from Canada in the past were also listed as runners-up, as was wardite from the Yukon.

### *HISTORY & LORE*

Swedish chemist and mineralogist Christian Wilhelm Blomstrand (1826-1897) identified augelite as a distinct mineral species in 1868 after studying specimens collected from the type locality at the Vestanå iron mine, Nästum, Kristianstad, Sweden. But until the 1930s, when quarter-inch crystals were discovered at a mine site in California's Mono County, mineralogists believed that augelite existed only as very tiny crystals or in massive form.

According to modern metaphysicists, augelite aids in contemplation and digestion, and is favored by artisans for its ability to help sustain artistic creativity and productivity.

### *TECHNOLOGICAL USES*

Augelite is far too rare to have value as an ore. However, the laboratory study of augelite using X-ray diffraction and electron-microscopy techniques has contributed significantly to the understanding of complex atomic bonding in minerals.

### *ABOUT OUR SPECIMENS*

Canada is made up of ten provinces and three territories, including the mineral-rich Yukon Territory, where our specimens were unearthed. The Yukon is sandwiched between Alaska and the Northwest Territory, north of British Columbia. With a population of just 28,000 spread over more than 186,000 square miles, it is an understatement to call the Yukon sparsely populated. Whitehorse in the south is its capital, and with a population of 19,000 is designated as the only city in the Yukon, all others are towns. The Yukon is most famous for its 1896 gold rush in Dawson, west central Yukon, with writer Jack London among the prospectors. In the ten years following, more than \$100,000 in gold was mined. During the latter half of the twentieth century, mining for silver, lead, zinc, and copper was prominent and profitable.

The Rapid Creek/Big Fish river collecting area is in the Richardson Mountains in the northeast, where the Yukon meets the Northwest Territory, along the Beaufort Sea. The collecting area is north of the Arctic Circle, a frozen tundra (treeless area between the icecap and the tree line of Arctic regions, having a permanently frozen subsoil that supports only low-growing vegetation such as lichens, mosses, and stunted scrubs.) Its proximity to the top of the world means fifty-six days of 24-hour daylight every year, in late June, July, and early August, and thirty days without sunlight, mostly in December, with an average temperature of 15°. It's a land of caribou, moose, wolves, and grizzly bears, and enormous swarms of mosquitos. The nearest towns are Aklavik, meaning "Barren-ground grizzly place," about 70 kilometers to the southeast, and Inuvik, "Place of people," about 120 kilometers to the east, both in the Northwest Territory.

The mineralogical history dates to 1959, when a geologist looking for gas and oil reserves in the remote northeast of the Yukon found a beautiful, unusual blue mineral on Rapid Creek. Testing done at the University of Alberta in Edmonton proved it to be lazulite [ $\text{MgAl}_2(\text{PO}_4)_2(\text{OH})_2$ ], subsequently designated the official gemstone of the Yukon, the most beautiful of the rare phosphates found here. The excitement of the discovery faded until the early 1970's, when a geologist mapping the area found lazulite and other exceptional phosphate minerals, and particularly when a Yukon prospector named Al Kulan recognized the area's potential. By 1975, Kulan had formed a small collecting group, and many fine specimens,

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including a number of colorful new minerals began coming to light. In 1976, lazulite was proclaimed the official gemstone of the Yukon, and many specimens were reaching shows in the United States, where they were eagerly snapped up by appreciative collectors. Specimen production slowed down sharply after Kulan was murdered by a crazed local in 1977. By the late 1970's, collecting at Rapid Creek and surrounding areas was prohibited by the Yukon legislature and the Department of Indian Affairs and Northern Development, and collecting has taken place only sporadically since, as permission to collect is nearly impossible to obtain.

When access is allowed, site collecting includes danger from local wildlife as well as fast arriving storms that quickly turn creeks and rivers into torrents. Crystals of the various minerals are found here in fractures and openings in the local rock, evidence that they crystallized out of mineralizing solutions once active in the area. Why are so many rare phosphates found in the vicinity? Because of thick layers of **phosphorite**, a sedimentary marine rock usually composed of microcrystalline fluorapatite in the form of laminae, pellets, oölites, nodules, and skeletal, shell, and bone fragments— in other words, the remains of marine creatures, phosphorus being an essential component of living systems. A tremendously thick accumulation (three thousand feet deep west of Rapid Creek) of ancient sea life provided the phosphorus component of most minerals at Rapid Creek, combining with iron, aluminum, and other metals to form the rare and colorful phosphates described below. The iron and other cations come from various rock types native to the area, including bedded ironstone, shale, and sandstone. More details on the geology of the area can be found in the July-August 1992 *Mineralogical Record* in an issue devoted entirely to Yukon Phosphates, available online as a back issue at [minrec.org](http://minrec.org).

Now let's look at some of the minerals from this unique occurrence. First we'll start with some of the new minerals discovered here, including:

**Baričite**  $[(\text{Mg}, \text{Fe}^{2+})_3(\text{PO}_4)_2 \cdot 8\text{H}_2\text{O}]$  was originally thought to be vivianite, which is found here, but testing proved it to be a new magnesium analog of vivianite, difficult to differentiate from vivianite. It occurs as pale, gray-blue cleavage plates. The name honors Dr. Ljudevit Baric, former Director of the Mineralogical Museum and Professor of Mineralogy, University of Zagreb, Zagreb, Croatia.

**Gormanite**  $[\text{Fe}^{2+}_3\text{Al}_4(\text{PO}_4)_4(\text{OH})_6 \cdot 2\text{H}_2\text{O}]$  is named for Professor Donald Gorman of the University of Toronto, and is found as flattened, blue, radial sprays on fracture surfaces, as inclusions in quartz (like to see that!), and as radial aggregates of elongate blue-green crystals. It is the ferrous iron analog of souzalite  $[\text{Mg}_3\text{Al}_4(\text{PO}_4)_4(\text{OH})_6 \cdot 2\text{H}_2\text{O}]$  and can only be differentiated by expensive analysis.

**Kulanite**  $[\text{BaFe}^{2+}_2\text{Al}_2(\text{PO}_4)_3(\text{OH})_3]$  and penikisite  $[\text{BaMg}_2\text{Al}_2(\text{PO}_4)_3(\text{OH})_3]$ , two minerals that belong to the bjarebyite mineral group, are named for prospector Alan Kulan and one of his partners at Rapid Creek, Gunar Penikis. Kulanite is found as tiny green, blue-green, blue, and black-green crystals, while penikisite is found as tiny blue crystals.

**Garyansellite**  $[(\text{Mg}, \text{Fe}^{3+})_3(\text{PO}_4)_2[(\text{OH})_{1.5}(\text{H}_2\text{O})_{1.5}]]$  forms a series with another rare mineral called kryzhanovskite  $[\text{Fe}^3, \text{Mn}]\text{Fe}^{3+}_2(\text{PO}_4)_2(\text{OH})_3$ . It is named in honor of H. Gary Ansell in recognition of his pioneering work in the mineralogy of Rapid Creek and forms as small platelets of kryzhanovskite-garyansellite.

**Rapidcreekite**  $[\text{Ca}_2(\text{SO}_4)(\text{CO}_3) \cdot 4\text{H}_2\text{O}]$ , of obvious name origin, is a rare mineral containing both the sulfate and carbonate radicals, and occurs as coatings and divergent tufts of colorless, acicular crystals up to 2 mm in length.

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It is quite likely that other new minerals may still come to light from Rapid Creek. Next, let's look at the rare minerals found as fine specimens at Rapid Creek:

**Arrojadeite** [ $\text{KNa}_4\text{Ca}(\text{Fe}^{2+}\text{Mn}^{2+})_{14}\text{Al}(\text{PO}_4)_{12}(\text{OH},\text{F})$ ], found as olive-green to clove-brown or yellow crystals about 5mm to 1.5 cm, is named for Brazilian geologist Miguel Arrojado Ribiero Lisbôa.

**Brazilianite** [ $\text{NaAl}_3(\text{PO}_4)_2(\text{OH})_4$ ] is found as sharp, lustrous yellow-green crystals over 1 cm in size, in a variety of crystal habits, some of which are difficult to distinguish from our augelite.

Stellate aggregates of cream-white crystals of **collinsite** [ $\text{Ca}_2(\text{Mg},\text{Fe}^{2+})(\text{PO}_4)_2 \cdot 2\text{H}_2\text{O}$ ] are rarely encountered at Rapid Creek. Collinsite was first discovered at François Lake, British Columbia, Canada.

Series members **childrenite** [ $\text{Fe}^{2+}\text{Al}(\text{PO}_4)(\text{OH})_2 \cdot \text{H}_2\text{O}$ ] and **eosphorite** [ $\text{MnAl}(\text{PO}_4)(\text{OH})_2 \cdot \text{H}_2\text{O}$ ] are found as flattened, radiating sprays up to 4 cm across and as smaller freestanding crystals in some of the quartz veins.

Tabular white crystals of **gorceixite** [ $\text{BaAl}_3(\text{PO}_4)_2(\text{OH},\text{H}_2\text{O})_6$ ] 1-2 mm in size are occasionally found, with some reaching 5 cm across.

**Goyazite** [ $\text{SrAl}_3(\text{PO}_4)_2(\text{OH},\text{H}_2\text{O})_6$ ] occurs as very fine crystals, white to pink rhombohedrons up to 1 cm across.

**Messelite** [ $\text{Ca}_2(\text{Fe}^{2+},\text{Mn}^{2+})(\text{PO}_4)_2 \cdot 2\text{H}_2\text{O}$ ] is another very rare phosphate sometimes found here as radial, globular, tan to white spherical aggregates up to 2 cm in diameter.

**Vivianite** [ $\text{Fe}^{2+}3(\text{PO}_4)_2 \cdot 8\text{H}_2\text{O}$ ], our November 2004 featured mineral, is also encountered regularly here, as fine, long, thin, blue-green crystals, as is the much rarer mineral **metavivianite** [ $(\text{Fe}^{2+},\text{Fe}^{3+})_3(\text{PO}_4)_2 \cdot 8\text{H}_2\text{O}$ ], as drab olive-green to gray or gray brown pieces, perhaps as a pseudomorph formed by the oxidation of vivianite.

**Wardite** [ $\text{NaAl}_3(\text{PO}_4)_2(\text{OH})_4 \cdot 2\text{H}_2\text{O}$ ], of which the *MR* says: "No other locality has produced such an abundance of fine specimens," is found as colorless to white, pale yellow to brown crystals with a pronounced pseudo-octahedral habit.

**Whiteite-(CaFeMg)** [ $\text{CaFe}^{2+}\text{Mg}_2\text{Al}_2(\text{PO}_4)_4(\text{OH})_2 \cdot 8\text{H}_2\text{O}$ ] was named for former Smithsonian curator John S. White, and is found as white to tan crystals as blocky, twinned crystals in fan-like growths resembling stilbite, our May 1999 featured mineral.

And last but not least, the most beautiful of the minerals found here, **lazulite** [ $\text{MgAl}_2(\text{PO}_4)_2(\text{OH})_2$ ], which first brought attention to the area, and is found as intensely colored crystals ranging from yellow-green to blue-green and pale blue to a dark, Prussian blue. The *MR* states that no other locality in the world has produced specimens of comparable quality and quantity. Gems are occasionally cut from this lazulite, though they are very small, usually less than a quarter carat, because most lazulite crystals are included.



Figure 2 Collecting wardite from a slope at Rapid Creek.

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It was the perceived gem potential of lazulite that first drew prospectors and collectors to the area.

This is not to diminish the attractiveness of our featured mineral, which is prominently featured in the *MR* issue. "Good augelite crystals are known from relatively few places worldwide and those from the Rapid Creek area rank among the best," says the article, noting also that twin crystals are occasionally found. Lovely needle quartz and brown crystals of siderite in a number of crystal forms are found with many of the rare minerals, the *MR* noting that this would be an outstanding locality for siderite were it not overshadowed by the desirability



Figure 3 Rapid Creek camp.

of the rare phosphates. Other, more common minerals also found here include barite, dolomite, fluorapatite as white to colorless to lovely light purple crystal groups, pyrite, aragonite, goethite, gypsum, jarosite, and many other lesser-known minerals. In addition, nodule containing other rare phosphates as fillings are found at the nearby Big Fish River locality, and who knows, perhaps we'll obtain a large lot of these in the future and delve into its fascinating setting. Interestingly, two of the most common phosphate minerals, wavellite and variscite, are not found here at all. Obviously, conditions were not right for their formation, so all the rarer phosphates formed instead.

If you took the time to analyze the above list, no doubt you noticed that almost all the minerals form here as small crystals, including our augelite specimens. Yet, they are still highly valued by serious collectors, as reflected by prices you may see for them at shows or on the internet. Another reason why Rapid Creek specimens are costly is the expense of collecting them. As noted, permission to collect is currently difficult to obtain; collecting conditions are hazardous; and access and specimen removal is only by helicopter, at costs of 2000.00 Canadian per hour!

We hope this information heightens your appreciation for your lovely augelite specimen and for the other rare phosphates found in this unique locality. Most likely, none of us will have occasion to visit this remote, inaccessible locality north of the Arctic Circle, but if you do, please write an account of your trip to share with all!

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Figure 4 Setting up camp at Rapid Creek.



Figure 5 End of a successful day of collecting, before mosquitoes arrive.