December 2006 Mineral of the Month: Ruby

> "Few gems have the mysterious depth of color, the glittering history, and the aristocratic dignity of the corundum gems."--Walter Schumann, *Gemstones of the World*

PHYSICAL PROPERTIES

Chemistry: Al_2O_3 Aluminum Oxide; ruby variety always contains traces of chromium and sometime iron and titanium
Class: Oxides Subclass: Simple Oxides
Group: Corundum-Hematite
Crystal System: Hexagonal
Crystal Habits: Usually as tapering, prismatic or pyramidal crystals in rough and rounded barrel shapes, often striated. Ruby variety often tabular. Also as granular masses.
Color: Corundum occurs in many colors, including blue, red, pink, yellow, brown, and gray; *Ruby* refers specifically to red or pinkish-red corundum, sometimes with hints of brown, orange, blue, or purple; all other colors are called *sapphire*. Color zoning common.
Luster: Adamantine to vitreous
Transparency: Transparent to translucent
Streak: White
Cleavage: None, sometimes exhibits three-directional parting.
Fracture: Conchoidal to uneven; brittle.
Hardness: 9.0
Specific Gravity: 3.9-4.1
Luminescence: Fluorescent
Refractive Index: 1.757-1.778
Distinctive Features and Tests: Red color (in ruby corundum), extreme hardness, moderately high density, and striations on parting faces.
Dana Classification Number: 4.3.1.1

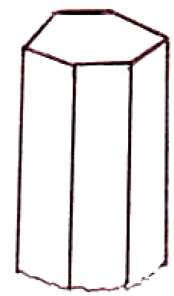

Figure 1 Simple ruby crystal showing hexagonal form.

NAME

The name of this month's mineral, which is correctly pronounced coh-RUN-dum, is derived from the ancient Sanskrit word for ruby, *kuruvinda*. The variety name "ruby" stems from the Latin *rubeus*, meaning reddish, while "sapphire" comes from the Greek *sappheiros*, which is of Semitic origin, akin to the Hebrew word *sappîr*, meaning a precious stone.

Corundum has also been known as "alumina crystal," "alundum," "adamantine spar," "corindin," "corindon," "corundita," "corundite," "dementspath," "soimonite," and "zircolite." The red gem variety is called "ruby" and the orange-yellow variety "padparadschah." The unqualified term "sapphire" generally refers to blue corundum; colorless and all other color varieties are called "sapphire," but with a preceding color-qualifying adjective, as in "pink sapphire." Sapphires in other than blue colors are known as "fancy" or "vari-colored" sapphires.

COMPOSITION

We've written in the past about the original Mineral of the Month Club, operated from about 1972 to 1982 by Russ and Alexandra Filer of Yucaipa, California, who sent specimens similar to our Junior-size minerals–in fact, we know some of you used to belong to their version of the Club! (We were not involved in that Club, as we were still in high school in the early 1970's.) They gave a ruby crystal to all new Club members, something we briefly considered doing at the start, but decided against in case we could not get them on a regular basis. Instead, we've been sending new members the wonderful pocket size DK Rocks & Minerals book. Back in 1996 we when began our Mineral of the Month Club, small, polished ruby specimens were available from Madagascar, and over the years, we've carried natural and polished ruby from India and polished ruby in zoisite from Africa, but it's only from the Karelia Republic that we've ever seen them in matrix in a quantity that would allow us to feature it.

We first fell in love with these matrix rubies in September 2001, and obtained the Junior-size specimens in May 2004, and have been waiting fairly patiently ever since for the Russian collectors to go back to Karelia to obtain more for us. Of course, we could have gone ourselves, but that is another story . . . They finally made their way back this past summer, as seen in the photos on pages nine and ten, and collected the rubies with us in mind. Subsequently, they informed us that they would not be going back for more, as removing the rubies intact from the host rock with hand tools is simply too difficult!

We are calling our specimens "Corundum, variety Ruby" according to the guidelines set forth by the Commission on New Minerals, Nomenclature and Classification (CNMNC) of the International Mineralogical Association (IMA), and this is how you will usually see them labeled when exhibited in competition at major mineral shows. "Corundum" is the officially approved mineral name, while "Ruby" is used as a gem name for reddish corundum, and "Sapphire" for all other colors of corundum.

Corundum is a member of the oxides class of minerals, which consist of metals or semimetals combined with oxygen. Oxides are subdivided into simple oxides (one metal combined with oxygen) and compound oxides (two or more metals combined with oxygen). As shown by its chemical formula Al_2O_3, corundum is a simple oxide that consists only of aluminum (Al) and oxygen (O). The molecular weight of the corundum molecule consists of 52.93 percent aluminum and 47.07 percent oxygen. The balance of the +6 charge of its aluminum cation ($2Al^{3+}$) and the -6 charge of its oxygen anion ($3O^{2-}$) provides electrical stability.

Bonding within the corundum molecule and lattice is primarily covalent, with two aluminum ions sharing electrons with three oxygen ions. In the resulting three-dimensional structure, six oxygen ions surround each aluminum ion, a configuration that explains corundum's hexagonal crystal structure and many of its physical properties. Because its aluminum ions are completely shielded by oxygen ions, corundum exhibits no metallic properties. Corundum's strong, omnidirectional covalent bonding produces no distinct cleavage planes.

Close atomic packing within the corundum lattice accounts for two other important properties: hardness and high density. Because of the close proximity of its ions, corundum's covalent bonding is unusually strong and accounts for its great hardness. At Mohs 9.0, corundum is second in hardness only to diamond among all other natural materials. Because the Mohs scale is somewhat logarithmic in nature, diamond (carbon, C), at Mohs 10.0, is actually 140 times harder than corundum. Corundum is seven times harder than the next hardest mineral—topaz [basic aluminum fluorosilicate, $Al_2SiO_4(F,OH)_2$]—at Mohs 8.0. Although corundum consists of two relatively light elements, aluminum (atomic weight 26.98) and oxygen (atomic weight 16.0), close atomic packing creates a surprisingly high density (specific gravity 3.9-4.1).

The general crystal habits of the ruby and sapphire varieties of corundum are somewhat different. Both form characteristic barrel-shaped and pyramidal prisms. But ruby also forms tabular crystals, a shape that is rare in sapphire. This is caused by traces of chromium that produce the characteristic red color of ruby (see "The Color of Corundum") and slightly distort the crystal lattice, encouraging the development of tabular crystals.

December 2006 Mineral of the Month: Ruby

The Dana classification number 4.3.1.1 identifies corundum as a simple oxide (4). The subclassification (3) defines it by the general formula A_2O_3, in which "A" is a trivalent metal such as aluminum (Al^{3+}), iron (ferric, Fe^{3+}), chromium (Cr^{3+}), or vanadium (V^{3+}), while "O" is divalent oxygen (O^{2+}). Finally, corundum is in the corundum-hematite group (1) as the first (1) of four members. The other corundum-hematite group members are hematite [iron oxide, Fe_2O_3, our June 2002 featured mineral], eskolaite [chromium oxide, Cr_2O_3], and karelianite [vanadium oxide, V_2O_3, named for its discovery in the Karelian schist belt].

Corundum occurs with albite [sodium aluminum silicate, $NaAlSi_3O_8$] in nepheline syenite pegmatites and other pegmatites of silica-poor rocks; with andalusite [aluminum silicate, Al_2SiO_5] and cordierite [magnesium aluminum silicate, $Mg_2Al_4Si_5O_{18}$] in hornfels (fine-grained silicate rocks) of contact metamorphic rock; and with muscovite [basic potassium aluminum silicate, $KAl_3Si_3O_{10}\cdot(OH)_2$], almandine [iron aluminum silicate, $Fe_3Al_2(SiO_4)_3$], and anorthite [calcium aluminum silicate, $CaAl_2Si_2O_8$] in gneiss and hornfels of regional metamorphic rock. Because of its considerable density (specific gravity 3.9-4.1), corundum that has weathered free from host rocks will concentrate in secondary alluvial deposits (placers) that are often of economic importance.

THE COLORS OF CORUNDUM

The brilliant, intense, pure red of ruby is among the most familiar of all gemstone colors. The word "ruby," itself synonymous with "red," is often used to describe bright and deep red colors in everything from flowers and birds' feathers to glass, light sources, mineral crystals, and even wine. As previously explained, corundum occurs in a broad range of colors. Only corundum gemstones with a red, red-purple, or red-brownish hue and a medium-to-dark color intensity are classified as ruby. Corundum colors are created by the manner in which light interacts with valance electrons within the crystal lattice. The exact type of interaction differs in ruby, sapphire, and certain vari-colored sapphires.

When white light containing all visible spectral wavelengths strikes a mineral crystal, four basic things can happen. (1) All wavelengths are evenly and completely absorbed by the crystal lattice, making the crystal appear black. (2) The light is completely transmitted with no absorption at all, making the crystal appear colorless. (3) The light is completely reflected with no absorption at all, making the crystal appear white. (4) Portions of the visible wavelengths are absorbed, while other portions are reflected or transmitted, thus imparting to the crystal a specific spectral color. Crystals that absorb the red end of the spectrum will appear blue, while those that absorb the blue end of the spectrum will appear red. Crystals that absorb both red and blue wavelengths generally appear green, green-yellow, or yellow. Variations in light-absorption characteristics can create any spectral color in mineral crystals, hence the wide range of colors in corundum.

Corundum is an allochromatic (other-colored) mineral, meaning its colors are caused by traces of nonessential elements called chromophores (color-causing agents). Pure corundum is colorless. Colors are imparted when other metal ions of similar ionic radii and electrical charges substitute for aluminum ions. The ions that most often substitute in the corundum lattice are chromium (Cr^{3+}), iron (ferric, Fe^{3+}), and vanadium (V^{3+}). Traces of these elements are the primary chromophores that account for most corundum colors.

Traces of both iron and vanadium create the classic blue of sapphire. Although both these ions can exist in the +3 oxidation state, iron is usually present as the ferrous ion (Fe^{2+}) and vanadium as the vanadium ion (V^{4+}). In corundum, light energy causes a phenomenon known as "intervalence charge transfer," in which the ferrous iron ions lose an electron, while the vanadium ions gain an electron. This produces ferric iron ions in the Fe^{3+} oxidation state and vanadium ions in the V^{3+} oxidation state. These particular ionic

Mineral of the Month Club , 1770 Orville Avenue, Cambria, CA 93428
1-800-941-5594 , www.mineralofthemonthclub.org

energy levels alter the light-absorption characteristics of the corundum lattice, causing it to absorb the red end of the spectrum, while reflecting and transmitting the blue end—the blue color we perceive in sapphire.

In yellow sapphires, the color stems from defects in the crystal lattice called color centers. Color centers are created when natural geophysical radiation displaces electrons from their normal lattice positions. When these energized electrons lose their energy, they come to rest in vacant lattice sites called "traps." These traps absorb both the red and blue ends of the spectrum, while transmitting and reflecting the middle wavelengths which we perceive as yellow.

The characteristic red color of ruby is due neither to iron, titanium, nor color centers, but to the trace presence of the chromium ion Cr^{3+}. As a transition metal, chromium has valance electrons (the electrons that combine with other elements) in more than one orbital shell. Electrons usually move about in energy-sharing pairs, but transition-metal ions, such as those of chromium, often end up with a lone electron in a valance orbital. When a chromium atom, which has an even number of electrons, loses three electrons to form a Cr^{3+} ion, it retains one unpaired electron. In order to satisfy its normal "paired" energy level, this single electron absorbs the violet, blue, green, and yellow portions of the spectrum, transmitting and reflecting only the vivid red that we perceive in ruby. Trace amounts of iron and vanadium ions can cause variations in the pure-red color of ruby. Iron imparts a brownish tinge, while vanadium introduces a slight purplish hue.

Surprisingly, this same trivalent chromium ion Cr^{3+} also creates the intense, bright green color of emerald. Emerald is the green gem variety of beryl [beryllium aluminum silicate, $Be_3Al_2Si_6O_{18}$]. Like corundum, beryl is an allochromatic mineral that is colorless when pure. In beryl, chromium substitutes for aluminum and interacts with light just as it does in the corundum lattice to form electron traps. But because of the different type of molecular bonding within beryl, the trapped, unpaired chromium electrons absorb red, yellow, and blue spectral components, while reflecting and transmitting only the narrow wavelength bands that we perceive as green. Chromium also causes the bright red-orange color of the crocoite we sent you in October, and the intense green seen in the uvarovite garnet we featured in February 2001.

Inclusions, notably those of rutile [titanium dioxide, TiO_2, our June 1999 featured mineral], can also alter the color of ruby and certain other corundum gemstones. Random arrangements of fiber-like rutile crystals will scatter and reflect light to soften colors and create silky effects. But when rutile inclusions are aligned with the hexagonal morphology of the corundum crystal, the result is asterism—the reflection of a six-rayed star. The stone is then known as star ruby or star sapphire. Star varieties of the corundum gemstones are quite valuable and are cut *en cabochon* to best display the reflected star pattern.

COLLECTING LOCALITIES

Common (non-gem) corundum is abundant and widely distributed, but gem varieties are much rarer and have few collecting localities. Only four nations supply most of the world's gem ruby: Myanmar (formerly Burma), Sri Lanka, Tanzania, and Thailand. Myanmar has historically been the most important source and is known for stones of unusual size and quality. The classic sources are Bernardymo, Chaungyi, Kathè, Kin, Kyauk-Pyat-Thet, Ohngaing, Pein Pyit, and Sakangyi at Mogok in Mandalay State. Other sources in Myanmar include Nanyazeik and Tanai in Kachin State, Nam Sèka in Mainglôn State, and Möng Hsu and Narawat in Shan State.

Ruby is mined in Sri Lanka at Ratnapura, Pelmadulla, and Avissawella in Sabaragamuwa Province; at Pollonnaruwa in North-Central Province, and at Munwatte and Elahera in Central Province. In Thailand, the mines at Bang Kha Cha in Chatthaburi Province are also important sources of gem ruby. In Cambodia, ruby occurs in the Ba Key, Bo Kham, Andaung districts of Rattanakiri Province and the Pailin district of Batdambang Province. Tanzania has ruby sources at Songea in Rumuva Region, Mundarara in Kilamanjaro Region, and Naenda and Kisumba in Rukwa Region. Kenya produces small quantities of gem ruby from mines at Voi and Taita Taveta in its Coast Province.

Less abundant sources of gem ruby include the Gloucester Ruby Mine at Barrington Tops, New South Wales, Australia; Chimwadzulu Hill in the Ntcheu district of Malawi; Aliabad and Hassanbad Nala in the Hunza Valley in the Northern Area of Pakistan; and the Sorobi district in Konar, Afghanistan. In Russia, gem ruby has been collected at sites along the Lovozero, Kovdor and Khibiny massifs on the Kola Peninsula in Murmansk Oblast, and in the Republic of Karelia at the Khit Ostrov, Diadina Gora, Varatskoe, Nigrozerskoe, and Notozerskoe localities along the Lukkailaisvaara Massif.

In North America, gem rubies are occasionally found in North Carolina at the Old Cardinal Mine in Franklin County, the Chunky Gal Mine in Clay County, and at several mines in the Cowee Valley of Macon County. A major discovery of gem ruby in 2004 at Fiskenaesset near Nuuk in Kitta Province, Greenland, is now being commercially developed.

JEWELRY & DECORATIVE USES

With their superior hardness (Mohs 9.0), durability, ease of cuttability, relatively high index of refraction, and brilliant colors, rubies are superb gemstones for all jewelry uses. Transparent ruby is faceted into gems, usually in square or round shapes to maximize cutting retention in the often-tabular crystals. Translucent crystals or included crystals of the star type are cut *en cabochon*. Almost all ruby gems are heat-treated to enhance clarity, reduce color-zoning, and intensify color. Because of their rarity, untreated fine ruby gems can be more costly than diamonds of comparable size and quality, and sometimes sell for more than $250,000 per carat. Ruby value is heavily dependent upon color. The most desirable color, called “pigeon’s blood,” is an intense, “pure” red with only a slight hint of blue. Value decreases as color intensity fades and as overtones of brown, blue, or purple become more prominent.

Mineral collectors value ruby specimens, usually as crystals in matrix, for their rarity, color, and crystal habit for both display and study purposes.

HISTORY & LORE

Ruby was one of the first precious gemstones ever mined. Recovered Neolithic stone tools from ruby placers in Myanmar indicate that ruby mining began there many millennia ago. Ruby had its greatest value among the royalty of ancient Hindu cultures, who knew it as *ratnaraj*—literally “the king of precious stones.” Oriental legends say that ruby contains the “spark of life” and is “a drop of the blood from the heart of Mother Earth.” Burmese cultures once believed that rubies ripened with age, that sapphires were “unripe” rubies, and that silky rubies were “overripe.”

According to the Bible book of Exodus, the first stone in the first row of gems on High Priest Aaron’s “breastpiece of judgment” was a ruby, and engraved upon it was the name of one of the 12 tribes of Israel. The “covering” of the king of Tyre mentioned by Ezekiel consisted of ruby and other precious stones, and Edom was Tyre’s “merchant” for precious rubies, commercial Tyre eagerly trading its stores for these and other goods. (Ezekiel 27:2, 16) In the book of Isaiah, when Jehovah God, the husbandly owner of Zion, comforted her and described her forthcoming beauty, He said, in part: “I will make your battlements of rubies, and your gates of fiery glowing stones.”

December 2006 Mineral of the Month: Ruby

During the Middle Ages, rubies were worn to bring good health and guard against wicked thoughts. Medieval physicians, who associated the color of ruby with blood, administered potions of powdered ruby to treat ailments of the heart and blood.

Throughout most of history, "ruby" referred to any red gemstone, including garnet and red spinel. The term "ruby" was not specifically applied to red corundum until after 1800, when researchers learned that corundum was aluminum oxide, and that both ruby and sapphire were color varieties of corundum. In the United States, the tradition of calling any red gemstone "ruby" has led to a plethora of "Ruby Mountain," "Ruby Hill," and "Ruby Creek" place names—most of which really designate garnet occurrences.

The largest-known cuttable ruby was found at Mogok, Myanmar. It weighed more than 400 carats and was cut into three spectacular gems. Other famous rubies include the 167-carat Edwardes ruby displayed in the British Museum in London. The Smithsonian Institution in Washington, D.C. displays the 138.7-carat Rosser Reeves ruby, recognized as the finest star ruby. The American Museum of Natural History in New York City displays both the 100-carat De Long star ruby and the 43-carat, round-brilliant Peace ruby (so named because it was found shortly after World War I). The irregularly cut 105-carat Anne of Brittany ruby is exhibited at the Musée de Louvre in Paris. Large rubies are also found in many European royal-jewel collections, although some, such as the Timur and Black Prince's rubies, are actually spinel.

Ruby was the first precious gemstone ever to be synthesized. Small numbers of synthetic rubies created by a flame-fusion process began appearing in European gem markets in the mid-19th century. In the 1890s, French chemist Auguste Victor Louis Verneuil (1856-1913) greatly improved the process by passing highly pure, powdered aluminum oxide that had been "doped" with chromium through a stream of oxygen into a hot gas flame. After melting, the aluminum oxide crystallized on the tip of a revolving rod as a pencil-shaped crystal called a ruby boule. Verneuil "grew" 15-carat ruby boules in just a few hours, then faceted them into eye-catching, synthetic ruby gems. Soon, millions of carats of "Verneuil ruby" created a panic within North American and European gem markets—until gemologists learned to differentiate them from natural ruby. Large amounts of mass-produced, flame-fusion synthetic ruby are now cut into gems for class rings and midline jewelry items. Today, synthetic ruby is also produced by flux processes, which more closely replicate natural ruby crystal growth and produce gemstones that are difficult to distinguish from natural stones.

Modern metaphysical practitioners believe that ruby inspires love and spirituality, enhances creativity and wisdom, imparts confidence and courage, and stimulates leadership abilities. Ruby is the birthstone for July and the symbolic gemstone for the 40th wedding anniversary, while Star ruby is the gem for the 52nd wedding anniversary.

Seven nations, five of which are important commercial ruby sources, have featured ruby, as both rough crystals and cut gems, on their postage stamps. These issues include the 75-stang stamp of Thailand of 1972, the 5-rupee stamp of Sri Lanka in 1976, the 20-schilling stamp of Kenya in 1977, the 30-schilling stamp of Tanzania in 1986, the 40-afghani stamp of Afghanistan in 1988, the 50-pyas stamp of Myanmar in 1991, and the 375-franc stamp of the Comoro Islands in 1998.

TECHNOLOGICAL USES

Since the 1700s corundum, in varying grit sizes, has been an important industrial abrasive for grinding and polishing metal. Emery, an abrasive mix of corundum with lesser amounts of hematite [iron oxide, Fe_2O_3] and magnetite [iron oxide, $Fe^{2+}Fe^{3+}{}_2O_4$, our April 2003 featured mineral], also has many industrial applications. The importance of natural corundum as an industrial abrasive has declined since the 1950s when abrasive manufacturers introduced Carborundum™, a synthetic silicon carbide (equivalent Mohs hardness 9.4), along with fused, synthetic aluminum-oxide abrasives.

In the 1890s, increasing production of fine watches and similar precision instruments created a strong demand for jewel bearings—tiny, donut-shaped jewels about one millimeter in diameter that function as weight-bearing and friction surfaces. Their hardness and ability to take a fine polish soon made corundum the preferred jewel-bearing material. Ruby was especially in demand, as watchmakers found it easier on their eyes to work with red jewel bearings. Ruby was classified into three commercial categories: gem ruby for faceting into gems; industrial ruby, stones too small or lacking in color to serve as gems, but well-suited for jewel-bearing purposes; and industrial corundum for abrasive use. In 1900 alone, 20 million natural corundum jewel bearings, mostly of ruby, went into fine watches and other precision instruments. Today, all jewel bearings are manufactured from flame-fusion synthetic ruby.

Natural and synthetic ruby crystals were vital to the development of solid-state ruby lasers in 1961. "Laser" is an acronym for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation. In ruby lasers, electrons within the ruby corundum crystal lattice are energized by a microwave energy source. These electrons are then stimulated by a photon source (light) to emit their excess energy as additional photons in the form of an intense, directional, and spectrally pure beam of red light that has many scientific and technological applications.

ABOUT OUR SPECIMENS

Our ruby corundum specimens were collected at Khit Ostrov in Karelia, Russia. Karelia, located in northwest Russia, is one of 21 Russian republics. It borders Finland to the west, the White Sea to the east, and Ladoga and Onega lakes to the south. To the north, Karelia shares a land border with Murmansk Oblast (Murmansk Federal Region) on an east-west line that closely parallels the Arctic Circle. Roughly equal in area to the state of Missouri, Karelia has a population of nearly one million.

The Khit Ostrov corundum site is located on Khit Ostrov (Wolf Island) in Verkhne-Pulongskoe Lake in far northeastern Karelia. This site is ten miles south of both the Karelia-Murmansk border and the Arctic Circle, and the same distance west of the shore of the Kandalaksha Gulf section of the White Sea. Khit Ostrov, which is about a quarter-mile long and close to the lake's north shore, is reached by boat from the small village of Malinovaia Varaaka, three miles to the east.

Khit Ostrov has a similar geology to that of the nearby Kola Peninsula, the large Murmansk peninsula immediately to the north and east. An intensely mineralized region, the Kola Peninsula is a major Russian mining area and the type locality for hundreds of mineral species. It is part of the Baltic Shield (or Fennoscandian Shield), the exposed northwestern section of the East European Craton, a section of the Eurasian tectonic plate. The Baltic Shield, which consists of very old (one-to-three-billion years), intensely metamorphosed rocks, may have been an ancient continent that grew through repeated collisions with neighboring crustal fragments.

In what is now the Kola Peninsula and adjacent northern Karelia, complex fault systems created by tectonic stresses hosted at least five major intrusions of granitic magma. These intrusions, which involved magmas with unusual chemistries, provided the heat necessary for intensive regional and contact metamorphism. Sections of this resulting metamorphic rock form highly mineralized "massifs" with names like Khibiny and Lovozero that are familiar to mineralogists and mineral collectors around the world. Another of these mineralized formations is the Lukkailaisvaara Massif, which extends south of the Kola Peninsula into northern Karelia.

The mountains that were uplifted by these tectonic stresses have long since eroded away to their bases. About 20,000 to 100,000 years ago, five major phases of Pleistocene glaciation scoured the Baltic Shield clean of overlying sediments and left a generally flat region with gentle hills and many lakes and streams. Glacial scouring also exposed the mineralized massifs and their many varied and unusual minerals. Today, northern Karelia has a relatively moderate climate, thanks to the Atlantic Drift, an Arctic arm of the warm-water Gulf Stream. Despite its proximity to the Arctic Circle, the region around Khit Ostrov is forested with low conifers.


Figure 2 Khit Ostrov camp.

The Khit Ostrov site is part of the Belomorian geological province of the Baltic Shield and lies in a mineralized zone called the Lukkailaisvaara Massif. At Khit Ostrov, many rocks are peraluminous, meaning that they contain an excess of aluminum, which is a key to the formation of corundum and other aluminum-bearing minerals. During intensive metamorphism, the rock at Khit Ostrov partially melted into a plastic consistency. As this rock cooled and recrystallized, the first minerals to form were the feldspars, which “locked up” much aluminum. But the residual melt still contained sufficient aluminum to crystallize other aluminum-rich minerals such as corundum [aluminum oxide, Al_2O_3]; andalusite, kyanite, and sillimanite [trimorphs of aluminum silicate, Al_2SiO_5]; and garnet, a group of compound aluminum silicates.

In 1968, members of a geological survey fielded by the state geological department of Karelia discovered the ruby corundum deposit at Khit Ostrov. Within a few years, this same team made similar nearby discoveries at Diadina Gora, Varatskoe, Nigrozerskoe, and Notozerskoe, as well as at several sites not far to the north in Murmansk. The host rock at Khit Ostrov is the kyanite-, garnet-, and mica-rich gneiss of the Chupin Formation. Corundum mineralization is confined to kyanite-rich zones that are hundreds of feet long and about 40-100 feet thick. The matrix rock in which the corundum crystals occur consists primarily of a mix of kyanite, calcite, quartz, and mica.

The Khit Ostrov locality is especially noted for its unusually large, well-developed prismatic and tabular crystals of ruby corundum. These range on average from one-quarter to one inch in length, although specimens as long as 2.5 inches are not uncommon. Many crystals exhibit good transparency and complex, perfectly developed faces. Those with the greatest transparency tend to be tabular, while most included and translucent crystals are prismatic. The color of Khit Ostrov ruby corundum is a distinctive raspberry red with a hint of blue. Crystals often have a slight silky appearance due to reflections from included microcrystals of rutile [titanium dioxide, TiO_2], ilmenite [iron titanium oxide, $FeTiO_2$], and magnetite [$Fe^{2+}Fe_{23+}O_4$].

During the period of Soviet rule, mineral collectors visited the Khit Ostrov ruby corundum deposit only infrequently. But after the fall of the Soviet Union in 1989 and the subsequent relaxing of trade restrictions, growing numbers of mineral collectors, including specimen dealers, made their way to the island. The main zones of corundum mineralization have now been trenched along their entire length. Collectors report that many ruby corundum crystals remain visible in the matrix rock. But it is unlikely that these will ever be collected, because removing undamaged corundum in matrix is simply too difficult and time-consuming.

Figure 3 The rubies are down there!

Step one in collecting involves the trip of more than 900 miles from Moscow to Khit Ostrov, and the setting up of camp, as seen in Figure 2. Next comes mucking out the hole dug during the last visit, as seen in Figure 3. Not a pleasant way to begin! When the host rock is exposed, it's time to break it apart and expose some fresh crystals, as seen in Figure 4. After many hours of backbreaking work, perhaps the reward will be there: a cache of lovely ruby crystals glittering in the sun! (Figure 5.) Perhaps there will be dozens or even hundreds of specimens that someone like Mineral of the Month Club will want to purchase, or maybe, just maybe, the sun will shine on one of those once-in-a-lifetime specimens for which a museum or collector will pay a small fortune! If so, this will at least partially compensate for the backaches, near-frozen extremities, insect bites, claim-owner hassles, equipment and travel costs, and myriad other hardships and problems encountered by professional collectors. Of course, for most of them it is overcoming all these many obstacles that brings satisfaction, as much as the feeling of being the first human to witness the incredible splendor of a newly unearthed mineral treasure! This is what keeps them coming back for more, despite all the difficulties. And as Club members, the price paid for your membership is directly sustaining the work of a number of intrepid collectors the world over, and we hope you find some small satisfaction in that!

Figure 4 Breaking through host rock.

Figure 5 Eureka: Ruby found!

The final step is cleaning and trimming the newly recovered specimens. This is done right at the site, as seen in Figure 6, in order to cut down on the amount of material that must be carefully wrapped and carried out. Finally, the 900-mile return trip to Moscow, and then it's time to start work on the paperwork necessary to export the rubies for sale in the United States.

Our Russian experts state that the matrix on our specimens is composed mainly of oligoclase, a sodium-rich member of the plagioclase feldspar group, along with small crystals of black biotite mica and red almandine garnet. Sometimes it can be difficult to differentiate small garnets from small rubies in the matrix, but only until you turn on the longwave ultraviolet light and the ruby turn bright red! Yes, ruby commonly gives off a red color under the influence of ultraviolet light, and ours are no exception. We did have to hold the specimen close to the lamp, but there is no mistaking the vivid red color, again caused by the chromium that infiltrated the crystal lattice. Amazingly, chromium can also can emerald to react to fluorescent light, giving off a pale red color.

Figure 6 Carefully trimming ruby specimens at Khit Ostrov.

We also enjoyed examining the excellent crystal form and sharp crystal faces with our 10-power jeweler's loupe. On most of the pieces we examined, the prism faces extended right to the top termination, as seen in Figure 7, but some had the additional faces visible near the top in Figure 8. Either way, the terminations are perfectly flat, unless a small garnet or other crystal has grown on top. The excellence of these crystals, the beauty of the delicate color, the interesting and attractive matrix, the mystique of the remote collecting locality at Khit Ostrov, the high value placed on ruby as a gemstone throughout history, its myriad industrial uses, its importance in the first lasers: Is there any reason not to fall in love with ruby?

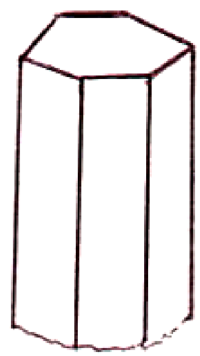

Figure 7

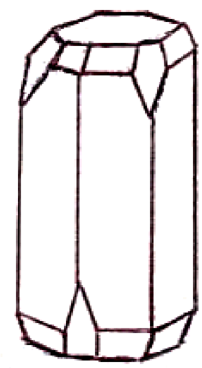

Figure 8

References: *Dana's New Mineralogy*, Eighth Edition; *Encyclopedia of Minerals*, Second Edition, Roberts, et al, Van Nostrand Reinhold Co.; *2004 Fleischer's Glossary of Mineral Species*, Joseph Mandarino and Malcolm Back, The Mineralogical Record Company; *Mineralogy*, John Sinkankas, Van Nostrand Reinhold Co.; *Manual of Mineralogy*, Cornelius Hurlbut and Cornelia Klein, Twenty-first Edition, John Wiley & Sons; *Gems and Jewelry*, Joel E. Arem, Geoscience Press, 1992; *Gemstones of the World*, Walter Schumann, Sterling Publishing Co., 1977; *Ruby and Sapphire*, Richard W. Hughes, RHW Publishing Co., 1997; *The Curious Lore of Precious Stones*, George Frederick Kunz, 1913, Dover Books Reprint; *Simon & Schuster's Guide to Gems and Precious Stone*s, Cipiani, Borelli, and Lyman, Simon & Schuster Fireside Books, 1999; *Gems and Crystal Treasures*, Peter Bancroft, Western Enterprises, 1973; "Colored Gemstones of Africa," Michael Gray, *Rocks & Minerals*, November-December 2001; "Ruby and Sapphire," Joel E. Arem, *Rocks & Minerals*, July-August 1998; "Chunky Gal Mountain Corundum Hunt," Mike Streeter, *Rock & Gem*, March 2006; "Rose Corundum from the Khitostrov Locality of North Karelia," Alexander V. Gromov, *World of Stones*, March-April, 1993; "What's New in Minerals (Ruby Corundum from Khit Ostrov)," Joe Polityka, *The Mineralogical Record*, March-April 1997.