July 2001 Mineral of the Month: Astrophyllite

"*In the tedious grey landscape, amongst cliffs covered in grey lichens and moss, there was an entire varicolored array of rare minerals: blood red or cherry eudialyte, flecks of astrophyllite sparkling like gold, bright green aegerine, violet fluoric spars, golden sphene . . . and it is impossible to convey this medley of colors that nature granted to this grey corner of the Earth*."– Alexander Fersman, Russian mineralogist and scholar

PHYSICAL PROPERTIES

Chemistry: $(K,Na)_3(Fe^{2+},Mn)_7Ti_2Si_8O_{24}(O,OH)_7$ Potassium Sodium Iron Manganese Titanium Silicate Hydroxyl
Class: Silicates Subclass: Inosilicates Group: Astrophyllite
Dana's: Chains with Side Branches or Loops
Crystal System: Triclinic
Crystal Habits: As blades up to 6" long and in stellate aggregates; As foliated masses
Color: Golden yellow to bronze
Luster: Submetallic to pearly
Transparency: Translucent in thin splinters
Streak: Yellow
Refractive Index: 1.831-1.880
Cleavage: Perfect in one direction, poor in another
Fracture: Uneven
Hardness: 3-4
Specific Gravity: 3.3-3.7
Luminescence: None
Distinctive Features and Tests: Readily fusible into a black magnetic ball; Soluble in hydrochloric acid and sulfuric acid
Dana Classification Number: 69.1.1.1

NAME

Astrophyllite was first found at Låven Island, near Brevik, Langesundfjord, southern Norway in 1854. The strange sounding name comes from the Greek words *aster*, meaning "star," and *fýllon*, meaning "leaf," in allusion to its common crystal forms, as explained later. The pronunciation is å-STROF′-il-līt; if you remember to place the accent on the second syllable, you will find it easy to pronounce correctly.

COMPOSITION

Astrophyllite is one of the minerals that is not usually found in specimens large or attractive enough to garner much attention, so that only the true mineral lover appreciates it. Did you take note of its unique chemistry? A typical astrophyllite crystal contains about 6.70% potassium (K), 1.31% sodium (Na), 7.29% titanium (Ti), 7.32% manganese (Mn), 22.33% iron (Fe), 17.12% silicon (Si), 0.13% hydrogen (H), and 37.78% oxygen (O) in an atomic structure consisting of sheet-like layers. There is a weak attraction between certain of the layers, which accounts for astrophyllite's perfect cleavage in one direction, similar to mica. (See the September 1997 Star Mica write-up under Composition.)

Astrophyllite and the other minerals in its group are usually found in certain geologic environments, known as nepheline syenites and syenite pegmatites. The term **nepheline syenite** describes a **plutonic**

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(pertaining to igneous rock formed deep in the earth) rock composed mainly of alkali feldspar and the mineral nepheline [$(Na,K)AlSiO_4$]. (The alkali feldspars are sodium-rich or potassium-rich aluminosilicates, including microcline [$KAlSi_3O_8$], orthoclase [$KAlSi_3O_8$], albite [$NaAlSi_3O_8$], anothoclase [$(Na,K)AlSi_3O_8$], and sanidine, a K-Na feldspar with a disordered Al-Si arrangement.) Nepheline syenites also commonly contain other minerals rich in sodium and/or potassium, iron, and magnesium, such as minerals of the amphibole group (such as hornblende) and the pyroxene group (such as aegerine.) Other minerals commonly found in nepheline syenites include sodalite [$Na_8Al_6Si_6O_{24}Cl_2$], sphene (a synonym for titanite [$CaTiSiO_5$]), opaque oxides, and apatite group minerals. Rare minerals are frequently found in such an environment, as we will see.

What is a **syenite pegmatite**? A pegmatite is an intrusion of magma that flows into cracks and other openings in a rock mass, and slowly cools, a perfect environment for the formation of excellent crystals with well-formed faces and terminations. Many of the world's finest crystal specimens come from pegmatites. (See the September 1997 Star Mica write-up under *Other Interesting Facts* for an explanation and a diagram.) When the composition of the pegmatite is rich in alkali feldspar, as noted above, it is called a syenite pegmatite. So when we hear the term syenite, we might think of a granular rock of light color and even texture composed mainly of alkali feldspar.

As you will note from the box on the next page, there are six other minerals with a similar atomic structure to astrophyllite, and as a result, similar crystal forms and properties, that form in similar environments. Some form by the natural alteration of astrophyllite! Actually, a seventh will soon be added, a new mineral called niobokupletskite [$K_2Na(Mn,Zn,Fe)_7(Nb,Zr,Ti)_2Si_8O_{26}(OH)_4(O,F)$]. With a crystal structure that is able to accept such a wide range of elements, we should not be surprised if other group members are added later! Astrophyllite also forms a complete series with kupletskite.

COLLECTING LOCALITIES

As mentioned under *Name*, our 65th featured mineral was originally discovered in Norway. In the United States, small astrophyllite needles penetrating smoky quartz crystals were found in a small pegmatite in Coos County, New Hampshire, in 1986, along with about 120 flawless or nearly flawless topaz crystals, ranging in color from blue to blue-green and even bicolored blue and golden brown. (This is an example of the kind of find we are hoping to see more of at the East Coast Gem & Mineral Show in August!) At Washington Pass, Okanogan County, Washington, small needles of astrophyllite and acmite have been found in smoky quartz. Other American localities include Magnet Cove, Arkansas, the "most mineralized five miles in Arkansas," where your compass goes haywire due to the high concentration of magnetic rocks and minerals! The locality is famous for titanium-rich minerals such as rutile, brookite, anatase, and perovskite, among many other minerals. St. Peter's Dome, El Paso County, Colorado, also provides nice specimens.

Elsewhere in North America, astrophyllite is found at the famous Mont St. Hilaire, a few miles southeast of Montreal in the Province of Quebec, Canada. Here are found large, chocolate brown plates of astrophyllite, as well as columnar or acicular, tan to brown crystals, often enclosed in a matrix of analcime and/or natrolite. This is where the aforementioned new astrophyllite group mineral niobokupletskite was discovered. We would love to feature minerals from both Magnet Cove and Mont St. Hilaire so we could consider in detail both of these phenomenal sites!

Worldwide localities include eastern Greenland; Pontevedra, Spain; Dara-i-Pioz, Tien Shan, southern Tajikistan; Mt. Charib, Egypt; Iles de Los, Guinea; Pilansberg, Transvaal, South Africa; and of course, the famous Kola Peninsula, Russia, as detailed in *About Our Specimens*.

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Astrophyllite Group Members

Trigonal slicates of general formula $A_3B_7C_2Si_8O_{24}(O,OH)_7$, where A = Ca, Cs, (H_3O), K, Na; B = Fe^{2+}, Mg, Mn^{2+}; C = Nb, Ti, Zr

Species	Chemical Formula	Source of Name, Year of Acceptance
Astrophyllite	$(K,Na)_3(Fe^{2+},Mn)_7Ti_2Si_8O_{24}(O,OH)_7$	See *Name*
Cesium-kupletskite	$(Cs,K,Na)_3(Mn,Fe^{2+})_7(Ti,Nb)_2Si_8O_{24}(O,OH, F)_7$	Composition and relationship to kupletskite, 1971
Hydroastrophyllite	$(H_3O,K,Ca)_3(Fe^{2+},Mn)_{5-6}Ti_2Si_8(O,OH)_{31}$	Composition and relationship to astrophyllite, 1974
Kupletskite	$(K,Na)_3(Mn,Fe^{2+})_7(Ti,Nb)_2Si_8O_{24}(O,OH)_7$	In honor of Russian geologists Boris Mikhailovich Kupletski (1894-1964) and Elsa Maximilianova Bohnshdedt Kupletskaya (1897-1974), 1956
Magnesium astrophyllite	$(Na,K)_4Mg_2(Fe^{2+},Fe^{3+},Mn)_5Ti_2Si_8O_{24}(O,OH,F)_7$	Composition and relationship to astrophyllite, 1963
Niobophyllite	$(K,Na)_3(Fe^{2+},Mn^{2+})_6(Nb,Ti)_2Si_8(O,OH,F)_{31}$	Niobium in composition and foliated habit, as in astrophyllite
Zircophyllite	$(K,Na,Ca)_3(Mn,Fe^{2+})_7(Zr,Nb)_2Si_8O_{27}(OH,F)_4$	Zircon in composition and foliated habit, as in astrophyllite

JEWELRY & DECORATIVE USES, TECHNOLOGICAL USES

No references were found for astrophyllite either as a gemstone or as an ore of titanium for industrial applications. Most likely, it is not found in enough of a quantity or quality to be considered for such uses. However, last year in Tucson, we did meet up with a Russian dealer who had taken specimens like ours and cut cabochons from them, and lately we have seen striking spheres and eggs made the same way. The contrast of the brown blades of astrophyllite against the creamy white albite was quite striking! Perhaps astrophyllite does have a future as a gemstone, at least in this matrix!

HISTORY & LORE

Again, no references were found regarding the history of this overlooked mineral, though crystal power believers have come to appreciate astrophyllite. They ascribe to it the power to help view oneself from the outside, to help one recognize inherent self-esteem, and to help one recognize that one has no

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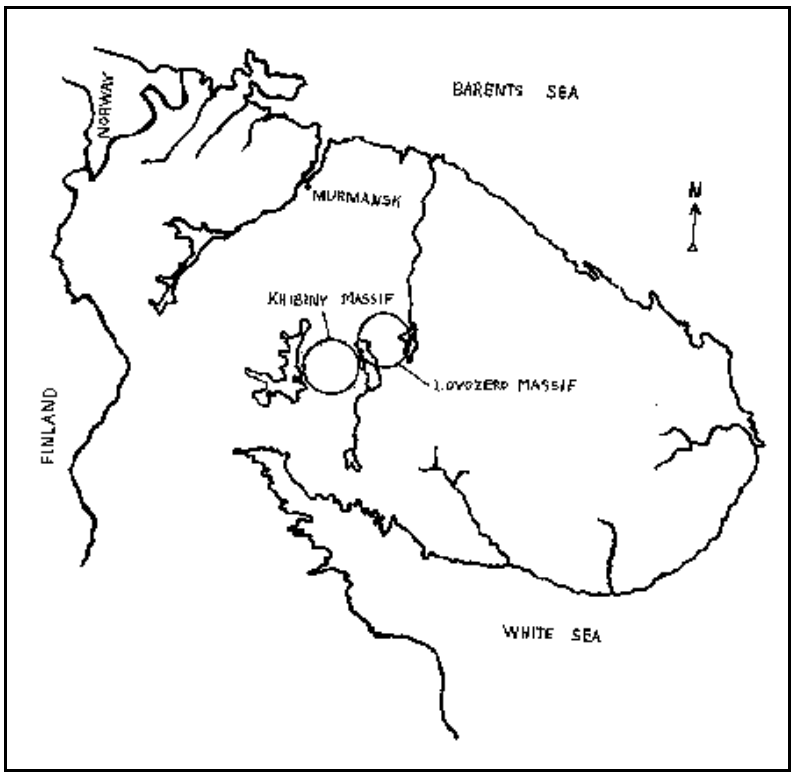
limitations. In addition, it is said to show that as one door closes, another one opens, and to assist in absolving one from responsibility and in purging from one's life that which should be eliminated so that one can develop and progress.

ABOUT OUR SPECIMENS

The Kola Peninsula has an area of about 40,000 square miles, most of which lies above the Arctic Circle, in the northwestern corner of Russia. As you can see from the map, the Barents Sea lies to the north and east, the White Sea to the south, with the borders of Finland and Norway to the west. Murmansk is the principal city, and is the world's largest city north of the Arctic circle. The Peninsula has been highly modified by the action of glaciers and ice sheets, that is, **glaciated**. The Russians have a word for the treeless plains characteristic of Arctic regions, with black muck soil, permanently frozen subsoil (permafrost), and low-growing vegetation: *tundry*, from which our word tundra is derived. This is a land of harsh winters and short summers, with little snow or rainfall.



Kola Peninsula

In 1887, Finnish geologist Wilhelm Ramsay (1865-1928) spent time exploring the rocks of the Kola Peninsula. His attention was immediately grabbed by the Khibiny Mountains and the Lovozero Mountains, or as the Russians called them, the Khibiny Massif and the Lovozero Massif, or simply, Khibiny and Lovozero. (See map.) These two mountainous regions would become centers for intense geological study for decades, particularly Khibiny, which has the tallest peaks on the Peninsula, at three thousand feet high. Ramsay would return in 1897 and 1898 for more study. In 1920, Russian mineralogist and scholar Alexander E. Fersman (1883-1945) and other scientists were traveling by train though the Khibiny area and were forced by engine trouble to make an unexpected stop. They decided to take advantage of the opportunity to do some field work on the slopes of the Khibiny Mountains. What Fersman saw on that date changed the course of his life, and moved him to spend as much time as possible investigating the mineral treasures of the Khibiny Massif, of which he wrote in his biography: "*Of all the experiences of the past, of all the varied landscapes and social activities, the strongest influence in my life has come from the Khibiny– from the scientific works that for almost 20 years have captivated my mind, possessed my existence, strengthened my will, and aroused new scientific concepts, desires,*

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and hope. Only through persistence and only through great effort on the Khibiny have we been able to achieve results in this land of wonder, this land, which, as if in a fairy tale, has revealed to us her riches." From the beginning, Khibiny was revealing new mineral treasures, most of which were named for the pioneering mineralogists working there: fersmanite for Fersman, ramsayite for Ramsay, kupletskite for B.M. Kupletsky, among many others. (Ramsayite was accepted as a new mineral, but in the 1940's it was discovered than an error had been made in its chemical formula; the formula was the same as for the previously accepted mineral lorenzite, so ramsayite was discredited.) Eventually, more than eighty new minerals would be discovered at Khibiny!

A.E. Fersman (standing, second from right) with minerologists and students, Kola Peninsula. All photos courtesy of KolaNet, http://alphais.inep.ksc.ru

Yet these scientists knew that the region had more to offer than an abundance of new species. They were convinced that industrially valuable ores could be found too. And they were right! In 1923, enormous deposits of apatite were discovered, and by 1929, a mine now known as the Korovsky Mine was established on Mount Kukisvumchorr in Khibiny. By 1931, a factory was producing phosphate from the apatite ore; it would become the world's largest supplier of raw phosphate. Soon, other valuable ores were coming to light from all over the Kola Peninsula, including nickel ore, iron ore, aluminum ore, mica, and numerous rare elements. "It would seem that the periodic table was projected onto the white contours of this peninsula of treasures," as Russian writer E.A. Kamenev put it.

Breaking apart apatite ore

By 1930, at Fersman's insistence and under his direction, a permanent research center was built in the Khibiny on the shore of picturesque Lake Malyi Vud'yavr. Fersman named this center "*Tietta*," from a Lapp word meaning "science, knowledge, and school." He donated his personal library of ten thousand books to the center, and soon Tietta became a kind of Mecca for Russian scientists, mineralogists, geologists, and chemists, as a museum, library, and laboratories were added. In 1951, after Fersman's death, a Geological Research Institute was officially established there. Later, Russia's largest mineral museum was named in his honor. The Fersman Museum in Moscow has over 135,000 specimens in its collection, including 2300 of the roughly 4000 minerals known, and many gorgeous objects of Russian lapidary art. It certainly would be a wonderful place to visit shoud any of us have the opportunity.

Tietta

A.E. Fersman

Another glance at the quote at the beginning of the write-up gives us a clue as to which minerals caught the eye of early collectors. The Kola Peninsula has produced many outstanding specimens of the minerals mentioned in the quote, as well as amethyst druses, natrolite, amazonite, almandine garnet, kyanite, corundum, and zircon, and the rare minerals lovozerite, lomonosovite, murmanite, and many, many others. Our May 2000 staurolites came from the Keivy Plateau, to the east of Khibiny. Over two hundred minerals have been identified in Khibiny alone, and over six hundred on the

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Peninsula! A person could devote their entire collection to Kola minerals.

On the Kola Peninsula, astrophyllite is rare in the Lovozero Massif, and is occasionally found as inclusions in quartz in alkaline granite pegmatite near Rov Gora. In the Khibiny Mountains, it is found in Hackman Valley, Mount Saami, and especially on Mount Eveslogchorr. On its western slope, one may find the appropriately named Astrophyllite Stream, signifying one's nearness to the astrophyllite deposit, where most of the best specimens are found. Here are many veins of astrophyllite/white albite feldspar just waiting to be collected! (If you venture to collect here, do not forget to obtain the necessary licence--as one Russian writer says, "They do not pity mineralogical offenders here!")

Specimens of great beauty have been unearthed here, gracing museum and private collections worldwide. The astrophyllite from Mount Eveslogchorr usually forms as thin blades in various patterns, and the Russians gave them names accordingly: "Asterisk Astrophyllite," "Rain Astrophyllite," "Sun Astrophyllite." Do you see one of these habits in your specimen? Actually, these habits are indicated by the technical terms used in the *Physical Properties* section of the write-up. As "Crystal Habits," we find: "As blades up to 6" long and in stellate aggregates; As foliated masses." It is easy to see that our specimens tend to be made up of numerous thin blades. "Stellate aggregates" means "starlike intergrowths," another easily observable form in astrophyllite, part of the inspiration for its name. "Foliated masses" tells us to expect an intergrowth of crystals consisting of thin, leaf-like layers, the other inspiration for the name. Our specimens do not show this form, but specimens from other localities do.

The matrix of most of our pieces consists of white albite feldspar crystals, just what one would expect from the nepheline syenite found in much of Khibiny, as explained earlier. A careful examination may reveal some poorly-formed faces on the albite crystals. The albite shows a nice pinkish-red color under shortwave ultraviolet light, while the astrophyllite shows no reaction. Occasionally, crystals of other minerals may be seen, including some brown eudialyte crystals and thin needle-like black crystals that may be aegerine.

Many Russian mineralogists believe that Khibiny astrophyllite is the world's finest. We wholeheartedly agree, and are glad to able to add its distinctive beauty to our collections!

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