EARTHQUAKE
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ESM OUTREACH UPDATE

Mardy Zimmermann Outreach Coordinator

With schools just starting, there were no outreach programs this month.

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Mineralogy of Greenland – Part Two

By Harvey Jong

Last month we presented some background on Greenland's geological setting along with a few noteworthy mineral deposits. This article will continue the exploration of Greenland's mineralogy by reviewing some gemstone and fluorescent mineral occurrences. However, before describing these minerals, we will examine some aspects of mineral collecting in Greenland.

Mineral Collecting in Greenland

In Greenland, there is currently no privately owned land, and all rights to any land use is administered by the Government of Greenland. A license is required to collect, explore, or exploit minerals, and the goverrnment's Mineral Resource Authority typically grants such licenses to commercial prospectors or mining companies. Licenses involve granting fees that vary from DKK 27,300-39,700 ($4,235-$6,159), expire in three to five years, and are associated with yearly exploration commitment payments [DKK 910-9,090 ($141-$1,410)-per km^2] based on the license area and age. Approval to export minerals is also required.

The license fees, which were established in 2009, along with the government's policy of allowing only permanent residents to collect minerals and confiscating samples collected without special permission have discouraged amateur mineral collecting. Government officials were unwilling to negotiate a "triviality limit" when casual collectors would need permission, and this led to the closure of the Mineralogical Society of Greenland, an enthusiast organization promoting Greelandic rocks and minerals (Brichet, 2020).

Ujarassiorit

While discouraging artisanal collecting/mining, the Mineral Resource Authority sponsors the Ujarassiorit, an annual national mineral hunt open to Greenland residents. This competition was established in 1989 as a way to use local knowledge to find new mineral deposits while also creating interest in geology and minerals.

Tax-free cash prizes are offered as incentives which include:

- First prize: DKK 50,000 ($7,762)
- Second prize: DKK 20,000 ($3,105)
- Third prize: DKK 10,000 ($1,550)
- Plus ten encouragement prizes: DKK $1,000 ($155)

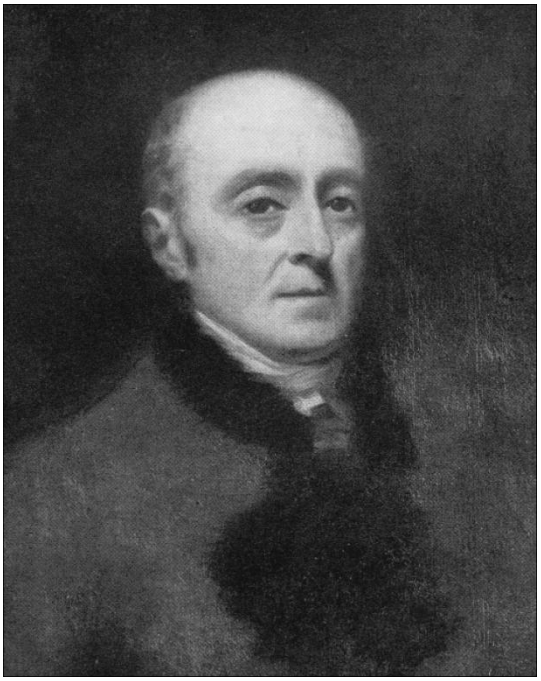
From 1989 to 2020, a total of 29,916 samples have been submitted, and 5,352 have been analyzed for their mineral content.[1]

Karl Ludwig Giesecke (Sir Charles Lewis Giesecke) (1761-1833)

One of Greenland's earliest and best known mineral collectors was Karl Ludwig Giesecke, a German actor, playwright, and

[1] Government of Greenland, Mineral Resources Authority, https://govmin.gl/ujarassiorit/

mineralogist, based in Copenhagen, Denmark.



Karl Ludwig Giesecke (1761-1833)
Henry Raeburn (1756-1823) drawing, - PD, via Wikimedia Commons
Portrait created ca. 1813

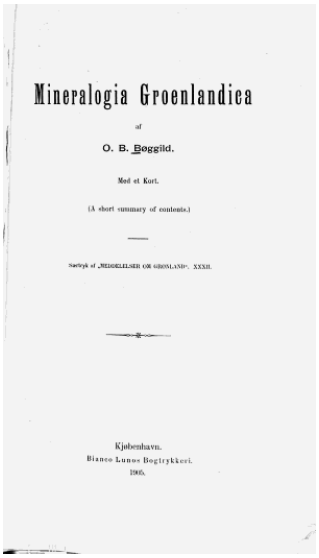
Giesecke obtained approval from Danish king Christian VII to explore the geology of Greenland. He arrived in 1806 for what was originally planned as a two to three year visit. However, due to the Napoleonic wars in which the British navy seized the Danish fleet, this stay was extended to seven years.

During this time, Giesecke endured many difficulties including harsh winters, illness, and losing a large amount of the minerals that he collected. He tried to send his finds back to Copenhagen, but the cargo was captured by a French ship, which was later intercepted by the British and eventually auctioned for just £40 (Wyse Jackson, 1996). He revisited many sites around Greenland to collect replacement samples. These specimens were either sold to private collectors or donated to universities and represented an important source of information about the geology and mineralogy of Greenland.

Mineralogy of Greenland and Ove Balthasar Bøggild (1872-1956)

After Giesecke's pioneering collecting efforts, the study of Greenland's minerals developed rapidly which led to the publication of the *Mineralogia Grøenlandica* in 1905 by Ove Balthasar Bøggild (1872-1956), a Danish geologist, mineralogist, and crystallographer. Bøggild served as a professor of mineralogy and geology and the director of the Geological Museum at the University of Copenhagen for more than 30 years. His research interests included not only Greenlandic minerals but also analyzing seafloor sediments, dating volcanic ash layers, the structure of iron meteorites, and shell structure of mollusks. He coined the term "labradorizing/labradorescence" for the iridescence observed in feldspars, such as labradorite (anorthite).

Labradorescence of a Labradorite Specimen
Prokofiev photo, - CC_BY_SA-3.0, via Wikimedia Commons


Mineralogia Groenlandica

af

O. B. Bøggild.

Med et Kort.

(A short summary of contents.)

Kjøbenhavn.
Bianco Lunos Bogtrykkeri.
1905.

Title page of the *Mineralogia Grønlandica* Image from Google Books digitized version, -PD, via google.com

This 625-page work was the first attempt at describing Greenland's mineralogy and presented in great detail the 162 known minerals at the time. It provided exact information on localities, notes from discoverers, and published references. The volume became a "classic" reference that was revised as an English version in 1953.

Gemstones

As mentioned in last month's article, diamonds and rubies have been the main focus of gemstone exploration activities. Such efforts, however, entail risks as evidenced by Greenland Ruby, the company involved with mining the Aappaluttog ruby occurrence, suspending operations and filing for bankruptcy.[2]

In addition to diamonds and rubies, a number of occurrences of colored gemstones and semi-precious gem materials have been reported by the Geological Survey of Denmark and Greenland (GEUS) (Ghisler and Secher, 2021). These occurrences reflect samples in the GEUS collections and include both minerals and rocks. Some items, such as nuummite and tugtupite, have been recognized in limited way by the gem trade, while others have been described for their potential gem applications. The following table lists the mineral or rock name, composition, and color/appearance.

Name	Composition	Color/ Appearance
Apatite	$Ca_5(PO_4)_3(Cl/F/OH)$	Greenish yellow/ transparent
Beryl (aquamarine)	$Be_3Al_2(Si_6O_{18})$	Bluish green/ semi-transparent
Cancrinite	$(Na,Ca,\square)_8(Al_6Si_6O_{24})(CO_3,SO_4)_2 \cdot 2H_2O$	Pink & bluish gray /opaque
Chiolite	$Na_5Al_3F_{14}$	Snow white to colorless/transparent to translucent
Chrome diopside	$Ca(Mg,Cr)Si_2O_6$	Emerald green/ opaque
Chrome Hornblende	$A_nCa_2(Z^{2+}_{5-m}Z^{3+}_m)(Si_{8-(n+m)}Al_{(n+m)})(OH,F,Cl)_2$	Emerald green/ opaque
Coal (jet)		Black/opaque
Cordierite	$(Mg,Fe)_2Al_3(AlSi_5O_{18})$	Gray to purple/ opaque to transparent
Corundum	Al_2O_3	Red and pink/ opaque to semi-transparent to transparent
Cryolite	Na_2NaAlF_6	White/ opaque to transparent
Diamond	C	Colorless/ transparent
Epidote	$(CaCa)(AlAlFe^{3+})O[Si_2O_7][SiO_4](OH)$	Yellow green/ opaque
Eudialyte	$Na_{15}Ca_6Fe_3Zr_3Si(Si_{25}O_{73})(O,OH,H_2O)_3(Cl,OH)_2$	Brownish red/ opaque to semi-transparent

[2] Hilde-Gunn Bye, Mining Company Greenland Ruby Declared Bankrupt, *High North News*, September 27, 2024, https://www.highnorthnews.com/en/mining-company-greenland-ruby-declared-bankrupt

Feldspar (moonstone)		Bluish white & gray/ opaque
Fluorite	CaF_2	Purple, green, & yellow/ opaque to semi-transparent
Fuchsite	$K(Al,Cr)_3Si_3O_{10}(OH)_2$	Green/ opaque
Garnet		Brownish red to red/ opaque to semi-transparent
Gold	Au	Yellow/ opaque
Greenlandite	Aventurine	Green/ Semi-transparent
Hematite (bloodstone)	Fe_2O_3	Black, silvery gray/opaque
Isua stone	Banded iron	
Kakortokite	Alkali feldspar, eudialyte, arfvedsonite	Coarse texture, white, red & black/opaque
Kornerupine	$Mg_3Al_6(Si,Al,B)_5O_{21}(OH)$	Green/ transparent
Kyanite	$Al_2(SiO_4)O$	Greyish blue/ Opaque to semi-transparent
Lazurite (lapis lazuli)	$Na_7Ca(Al_6Si_6O_{24})(SO_4)(S_3) \cdot H_2O$	Ultramarine blue/ opaque
Manganese Epidote (thulite)	$\{Ca_2\}\{Al,Mn^{3+}_3\}(Si_2O_7)(SiO_4)O(OH)$	Pink/opaque
Microcline (amazonite)	$K(AlSi_3O_8)$	Bluish green/ opaque
Naujaite	Nepheline syenite	Greyish green/ opaque
Nuummite	Metamorphic rock with iridescent orthoamphiboles	Brownish black/ opaque
Obsidian	Volcanic glass	Black/opaque
Olivine (peridot)	M_2SiO_4 Where M = Ca, Fe, Mn, Ni, Mg	Olive green/ transparent
Prehnite	$Ca_2Al_2Si_3O_{10}(OH)_2$	Yellowish green/semi-transparent
Quartz	SiO_2	
(amethyst)		Light purple/ transparent
(clear quartz)		Colorless/ Transparent
(praisolite)		Green/ transparent
(rose quartz)		Light pink/ Transparent
(smoky quartz)		Brown/ transparent
(agate)		Reddish brown, white/opaque
(chalcedony)		White, bluish white, brown/ opaque to semi-transparent
(jasper)		Red/opaque
Sapphirine	$Mg_4(Mg_3Al_9)O_4[Si_3Al_9O_{36}]$	Blue/opaque
Satellite stone	Sodalite & natrolite	Blue gray & orange/opaque
Serpentinite	Rock made mainly or one or more serpentine group minerals	Dark green/ Opaque to semi-transparent
Siderite	$FeCO_3$	Yellow brown to dark brown/ Semi-transparent
Sodalite	$Na_4(Si_3Al_3)O_{12}Cl$	Blue, yellow, green/ opaque
Spinel	$MgAl_2O_4$	Red/opaque
Tremolite	$\square Ca_2Mg_5(Si_8O_{22})(OH)_2$	Brown/opaque

Tugtupite	$Na_4BeAlSi_4O_{12}Cl$	Pink/opaque
Tourmaline		Black/opaque
Ussingite	$Na_2AlSi_3O_8OH$	White to pink/ Semi-transparent

A few noteworthy gemstone occurrences are presented below in alphabetical order. Examples include common gemstones along with those unique to Greenland. Note that the descriptions and location information is based on a report by Ghisler and Secher, 2021.

Apatite

Apatite
Jakob Lautrup/GEUS photo from (Ghisler and Secher, 2021)
Singertaat, Southeast Greenland
Prismatic, clear, green-ish yellow apatite crystals have been found in the Singertaat intrusion in the Skjoldungen alkaline province in Southeast Greenland. Crystals may be up to 10 cm (3.94 in) long and 3 cm (1.18 in) across.

Cancrinite

Cancrinite
GEUS photo from (Ghisler and Secher, 2021)
Left: Kangilinguit/Grønnedal, South Greenland
Right: Singertaat, Southeast Greenland
Cancrinite has been reported at two locations in Greenland, and both occurrences involve carbonate trench intrusions. In South Greenland at the Grønnedal complex, pink cancrinite is found with blue sodalite. Cancrinite from Southeast Greenland appears as bluish-gray grainy masses.

Cryolite

Cryolite
GEUS photo from (Ghisler and Secher, 2021)
Ivittut, Southwestern Greenland
Greenland's only known cryolite occurrence is located at Ivittut which was mined from 1854 to 1987. Pure cryolite is white or colorless, while a mixture of cryolite, chlorite, and fluorite is blue-green and has been called ivigtite. The rarity of transparent crystals along with the hardness of 2.5 limits its use as a faceted gemstone.

Given the mineral's resemblance to ice, it has appeared as novelty pieces, such as tumbled stones or carved figures (polar bears).

Eudialyte/Kakortokite

Eudialyte
GEUS photo from (Ghisler and Secher, 2021)
Sørensen's Island, Greenland
Greenland is the type locality for eudialyte, and the first samples were collected by Giesecke at the Ilimassaq intrusion complex in South Greenland in 1806.. Large dark red crystals often occur in nepheline syenite. The combination of black arfvedsonite and sodalite is known as kakortokite which has been used as a lapidary material.

Kakortokite
GEUS photo from (Ghisler and Secher, 2021)
Killavaat Alannguat, South Greenland

Feldspar var. Moonstone

Feldspar var. Moonstone
GEUS photo from (Ghisler and Secher, 2021)
Kunaat, Greenland
Feldspars occur widely throughout South Greenland, and the Igaliku complex hosts syenite pegmatites with feldspars/moonstones that exhibit the Schiller effect.

Fuschsite

Fuchsite, Chromite, and Plagioclase
GEUS photo from (Ghisler and Secher, 2021)
Qaqqat Aculerit, Greenland
The area around of Qeqertarssuatsiaat (Fiskenaesset) in southwestern Greenland includes several occurrences of emerald green rock containing fuchsite, chromite, feldspar (anorthosite), and epidote.

Garnet

Garnet
GEUS photo from (Ghisler and Secher, 2021)
Takisup Qeqertarsua, Greenland
Red or brownish garnet is commonly found in Greenland's metamorphic rocks, such as mica schist and gneiss. One significant location is near Takisup Qeqertarsua in southwestern Greenland where well-developed crystals up to several cm have been found.

Greenlandite (Aventurine Quartz)

Greenlandite Rough
James St. John photo, - CC_BY_SA-2.0, via Wikimedia Commons
Greenlandite consits of alternating layers of green and white quartzite with thicknesses varying from millimeters to centimeters. The green color is due to the presence of fuchsite, a chromium-bearing mica. It occurs at several places in the Nuuk Fjord area and has the distinction of being one of the oldest gemstones on Earth with an age of about 3.8 billion years old.

Cut & Polished Greenlandite
GEUS photo from (Ghisler and Secher, 2021)
Isukasia, Greenland
The first occurrence of greenlandite was found near the ice sheet at Isukasia in the Nuuk Fjord area in 1967. Greenlandite is a local gemstone name which is not recognized internationally.

Kornerupine

Kornerupine Crystal

Geological Museum photo from (Secher and Appel, 2007)
Fiskenæsset area, Greenland
Crystal is 23 cm (9.1 in) long

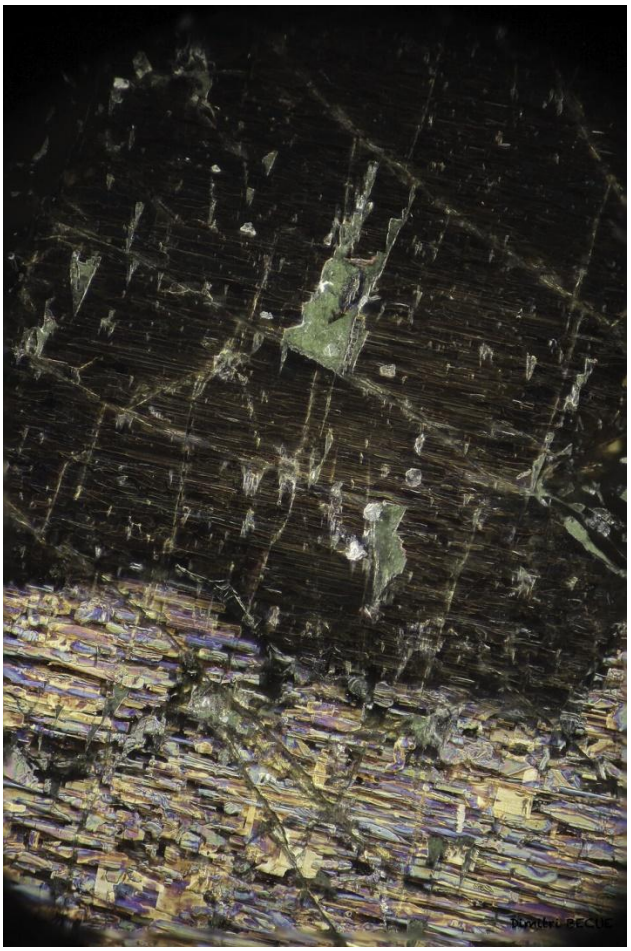
Kornerupine Cabochon and Faceted Stone
GEUS photo from (Ghisler and Secher, 2021)
Qaqqatsiaq, Greenland
Kornerupine is a rare silicate mineral found with sapphirine in metamorphic rocks around Qeqertarssuatsiaat (Fiskenaesset) area in southwestern Greenland. Gem quality material occurs at Qaqqatsiaq as bottle-green crystals up to 23 cm (9.1 in) long.

Microcline (Amazonite)

Microcline (Amazonite)
GEUS photo from (Ghisler and Secher, 2021)
Torssukataq, Nunarssuit, South Greenland
Occurences of amazonite have been reported in South Greenland near Qaqortoq/Julianehåb and in Southeast Greenland near Tasiilaq/Ammassalik. It may be associated with beryl or black tourmaline. Approximately 100 km west of Qaqortoq/Julianehåb in Nunarssuit, the amazonite occurs in dense masses or fist-sized crystals in a red granite pegmatite.

Nuummite

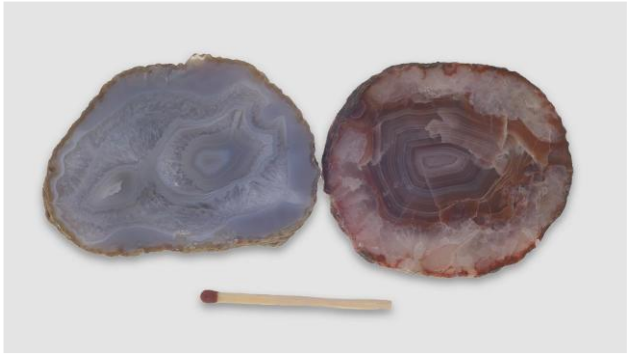
Nummite is a metamorphic rock that consists of two amphibole minerals - anthrophyllite and gerdite. It exhibits an iridescence due to interference of light between layers of the two minerals. Multi-color flashes appear against a brown to black background and may vary from gold to blue with violet to green and orange to red being less common. Nuummite was discovered in 1982 and named for the Nuuk region which includes eight localities.



Close-up of a Nuummite Sample
Dimitri BECUE photo, CC_BY_SA-4.0 International, via Wikimedia Commons
Nuuk, Greenland
Photo captured with a microscope, 240X

Nuummite Cabochon
122eregrgts photo, - CC_BY_SA-4.0 International, via Wikimedia Commons

Quartz



Quartz var. Agate
GEUS photo from (Ghisler and Secher, 2021)
Siorapaluk, Northern Greenland
Agate was discovered several thousand of years ago by Greenland's Paleo-Inuits who used it in making tools and arrowheads. At Siorapaluk, Greenland's northernmost inhabited settlement, reddish brown or gray banded agates occur in vugs in weathered basaltic rocks.

Quartz var. Chalcedony (Ice-Blue)
GEUS photo from (Ghisler and Secher, 2021)
Illorsuit, Greenland
White to grayish chalcedony is known occur in areas with Paleocene volcanic layers (65 ma). At Illosuit Island in Western Greenland, a light blue variety has been found and given a local name ice-blue.

Quartz var. Jasper
GEUS photo from (Ghisler and Secher, 2021)
Arsuk Glacier, Greenland
Red jasper has been found at a number of locations in Greenland including loose

moraine deposits along the edge of the ice sheet in South-West Greenland; as loose pebbles on Disko Island, Western Greenland; and as large blocks in front of the Arsuk glacier north of Ivittuut, South Greenland.

Sodalite

Sodalite
GEUS photo from (Ghisler and Secher, 2021)
Kangilinguit, Greenland

Sodalite was first described in 1811 using samples collected at the Ilímaussaq intrusive complex in South Greenland. Colors of the silicate mineral include blue, green, and yellow, and the blue variety has been found in an area near Kangilinguit in southwestern Greenland. The sodalite from this location is associated with pink cancrinite which leads to an attractive combination for gemstones.

Sodalite fluoreses orange to yellowish-white under long wave ultraviolet (uv), and some material may be tenebrescent (reversible color change). (See section on fluorescent minerals.)

Tugtupite

Tugtupite
GEUS photo from (Ghisler and Secher, 2021)
Kuannersuit/Kvanefjeld, South Greenland

Tugtupite Gemstones
Photo courtesy of William Rohtert
Part of the Smithsonian's National Museum of Natural History tugtupite gemstone suite
Largest faceted gemstone is 3 ct

Tugtupite was discovered in 1957 and given a provisional name of "beryllium sodalite". In 1962, the rare silicate was named after its type locality, Tugtup agatakorfia in South Greenland. It is tenebrescent, and original samples were described as changing from white to light pink when exposed to bright sunlight. A deeper red tugtupite was later found at Kvanefjeld, South Greenland in 1965 which attracted interest as a gemstone. It is often referred to as Greenland's national gemstone.

Tugtupite occurs in hydrothermal veins and may be associated with albite, analcime, aegirine, sphalerite, neptunite, and pyrochlore. It exhibits a strong bright red to

orange red fluorescence under shortwave uv, pinkish-white with midwave, and orange with longwave. (See section on fluorescent minerals.)

Fluorescent Minerals

Currently, 52 fluorescent mineral occurrences have been reported.[3] Most of these minerals have been found in South Greenland's Ilímaussaq Complex.

Ilímaussaq Complex
GEUS photo from (Poulsen, 2015)

The Ilímaussaq Complex is a large layered, 1.2 million year old intrusion that consists mainly of syenitic and nephline syenitic rocks (coarse-grained igneous rocks with a composition similar to granite, but deficient in quartz). It has an abundance of rare-earth elements, zirconium, beryllium, and uranium, and trace amounts of these elements may serve as impurities that activate fluorescent responses. According to mindat.org, 242 minerals have been found in the area, and this total includes 38 type minerals. More species continue to be discovered given ongoing exploration activity.

The following table lists fluorescent mineral names, formulas, and responses. Note that abbreviations are used for the different ultraviolet light sources: LW for longwave (365 nm), MW is midwave (310-320 nm), SW is shortwave (254 nm). Only the main response color and relative strength are included.

Name	Formula	Fluorescent Response
Albite	$NaAlSi_3O_8$	LW,MW: red/very weak SW: red/weak
Analcime	$Na[Al\ Si_2O_6]\ H_2O$	LW,MW/SW: green
Arfvedsonite	$Na\ Na_2\ (Fe_4^{+2}\ Fe^{+3})\ Si_8\ O_{22}\ (OH)_2$	LW: orange/strong
Barylite	$BaBe_2Si_2O_7$	SW: violet pink
Beryllite	$Be_3SiO_4(OH)_2\ H_2O$	LW: bluish/medium MW,SW: bluish white/ medium
Britholite-(Ce)	$(Ce,Ca)_5(SiO_4,PO_4)_3\ (OH,F)$	LW: green/strong
Calcite	$CaCO_3$	Listed in (Cole, 2004) without specific response
Catapleiite	$Na_2Zr(Si_3O_9)\ 2H_2O$	Listed in (Cole, 2004) without specific response
Cerussite	$PbCO_3$	LW: yellowish white/weak MW,SW: yellow/medium
Chabazite-Ca	$(Ca_{0,5},K,Na)_4[Al_4Si_8\ O_{24}]\ 12H_2O$	LW,SW: green/strong
Chkalvoite	$Na_2BeSi_2O_6$	LW,SW: green
Cookeite	$LiAl_4(AlSi_3O_{10})(OH)_8$	LW,SW: yellowish white/weak
Corundum	Al_2O_3	LW: red/very strong MW: red SW: red/medium
Cryolite	Na_3AlF_6	LW: bluish white/very weak SW: pink/very weak
Diopside	$CaMgSi_2O_6$	LW: blue/weak SW:

[3] Based on fluomin.org database and Cole, 2004.

		blue/strong
Elpidite	$Na_2ZrSi_6O_{15}$ $3H_2O$	LW,MW,SW: yellowish green
Evenkite	$C_{23}H_{48}$	LW,SW: blue/strong
Fluorapophyllite	$KCa_4Si_8O_{20}(F,OH)$ $8H_2O$	LW: yellowish white MW: blue SW: greenish
Fluorite	CaF_2	LW: blue/very strong MW,SW: blue/medium
Gaidonnayite	$Na_2ZrSi_3O_9$ $2H_2O$	LW,MW,SW: green
Genthelvite	$Zn_4Be_3(SiO_4)_3S$	LW: green/weak MW: pink/medium SW: green/medium
Gibbsite	$Al(OH)_3$	LW,MW,SW: yellowish white
Gmelinite-Ca	$(Ca_{0,5},Sr_{0,5},Na,K)_4[$ Al_8 $Si_{16}O_{48}]$ $22H_2O$	LW,SW: yellow
Halloysite	$Al_2Si_2O_5(OH)_4$ $2H_2O$	LW:yellowish white SW: greenish white
Hydrocerussite	$Pb_3(CO_3)_2(OH)_2$	LW: yellowish white
Leucophanite	$(Ca,RRE)CaNa_2Be_2$ $Si_4O_{12}(F,O)_2$	LW: violet pink/strong MW: violet pink/very strong SW: pink/strong
Leucosphenite	$BaNa_4Ti_2B_2Si_{10}O_{30}$	LW: yellowish white/medium SW: yellowish white/strong
Lorenzenite	$Na_2Ti_2Si_2O_9$	LW: greenish white MW,SW: yellowish white/strong
Lovdarite	$K_4Na_{12}[Be_8Si_{28}O_{72}]$ $18H_2O$	LW: green/very weak SW: green/strong
Microcline	$KAlSi_3O_8$	LW: green/weak MW: blue, weak SW: red/medium
Montmorillonite	$(Na,Ca)_{0,3}(Al,Mg)_2S$ $i_4O_{10}(OH)_2$ nH_2O	LW,SW: yellowish white
Natrolite	$Na_2[Al_2Si_3O_{10}]$ $2H_2O$	LW: greenish white/weak MW: green/medium SW: green/strong
Nenadkevichite	$Na_{8-x}Nb_4(Si_4O_{12})_2(O,OH)_4$ $8H_2O$	LW,SW: green/weak MW: green/medium
Nepheline	$Na_3KAl_4Si_4O_{16}$	LW: orange SW: yellowish white
Okenite	$Ca_{10}Si_{18}O_{46}$ $18H_2O$	LW,SW: bluish white
Pectolite	$NaCa_2Si_3O_8(OH)$	LW: yellowish white/strong MW: pink/strong SW: orange/weak
Polylithionite	$KLi_2AlSi_4O_{10}F_2$	LW: yellowish white/weak MW: yellowish white/medium SW: yellowish white/strong
Prehnite	$Ca_2Al_2Si_3O_{10}(OH)_2$	LW: yellowish white MW: pale yellow SW: bluish white

Prosopite	$CaAl_2(F,OH)_8$	LW: bluish white SW: blue
Quartz	SiO_2	Listed in (Cole, 2004) without specific response
Rosenbuschite	$(Ca,Na)_{12}(zr,Ti)_4(Si_2O_7)_4(O_4F_44)$	LW,SW: yellowish white
Sodalite	$Na_8Al_6Si_6O_{24}Cl_2$	LW: orange/very strong SW: yellowish white/medium
Sorensenite	$Na_4Sn^{+4}Be_2(Si_3O_9)_2 2H_2O$	LW: bluish white SW: yellowish white/weak
Sphalerite	ZnS	
Steenstrupine-(Ce)	$Na_{14}Mn^{2+}_2Fe^{3+}_2Ce_6Zr(Si_6O_{18})_2(PO_4)_6(PO_3OH)(OH)_2{\cdot}2H_2O$	SW: green
Tugtupite	$Na_4AlBeSi_4O_{12}Cl$	LW: orange MW: pinkish white SW: cherry red/very strong
Ussingite	$Na_2AlSi_3O_8(OH)$	LW: green/weak SW: green/medium
Villiaumite	NaF	LW: red/medium MW: orange red/ medium SW: red/weak
Vinogradovite	$Na_4Ti_4(Si_2O_6)_2[(Si,Al)_4O_{10}]O_4 \cdot (H_2O,Na,K)_3$	SW: yellowish/strong
Vitusite-(Ce)	$Na_3(Ce,La,Nd)(PO_4)_2$	LW: red SW: blue
Vuonnemite	$Na_{11}Ti^4Nb_2(Si_2O_7)_2(PO_44)_2O_3(F,OH)$	LW: greenish white/weak MW: pale yellow/weak SW: greenish yellow/strong
Zircon	$Zr(SiO_4)$	Listed in (Cole, 2004) without specific response

Fluorescent Mineral Localities in Southern Greenland
Dr. Blofeld map, - CC_BY_SA-2.0, via Wikimedia Commons

Some notable examples of fluorescent minerals are presented in the following section. Images of specimens under white light, longwave UV, midwave UV, and shortwave UV are arranged side-by-side for comparison.

Polylithionite

Polylithionite with Eudialyte

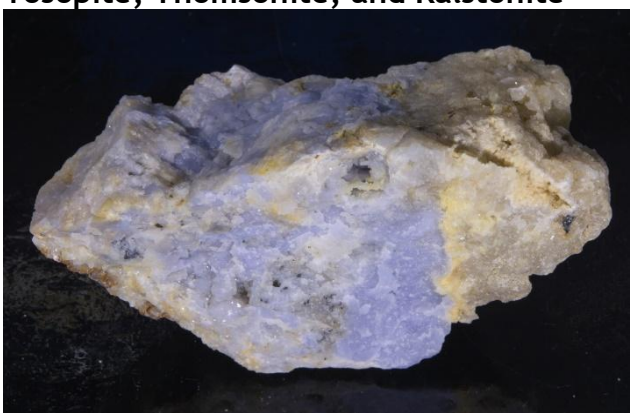
White Light

Shortwave

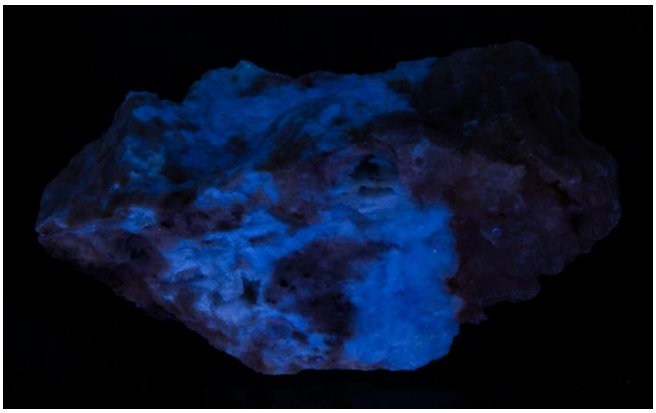
Chris Clemens photos, - CC_BY_SA-3.0, via naturesrainbows.com
Kangerluaurssaq fjord, Illĭmaussaq complex, Narsaq, Greenland
7.7 x 7.3 x3.4 cm
Polylithionite is a lithium-bearing mica that fluoresces yellowish white under shortwave, midwave, and longwave UV. No activator has been identified for this response.

Prosopite

Prosopite, Thomsonite, and Ralstonite



White Light



Shortwave

Mark Cole photos, - CC_BY_SA-3.0, via naturesrainbows.com
Ivigtut, Greenland
Prosopite may form as an alteration product in cryolite-bearing pegmatites. Its bluish

fluorescent response has been attributed to trivalent rare-earth element impurities, such as Ce^{3+}, Sm^{3+}, and Eu^{3+}.

Sodalite
Sodalite var. Hackmanite

Natural under White Light

Tenebrescent Color under White Light

Longwave

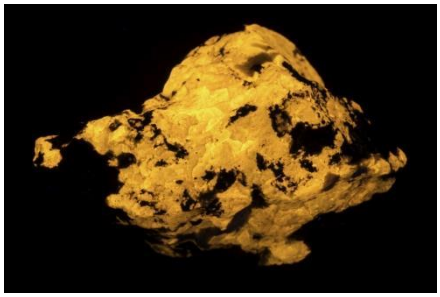
Shortwave

Dennis Michael photos, - CC_BY_SA-3.0, via naturesrainbows.com
Ill'maussaq complex, Greenland

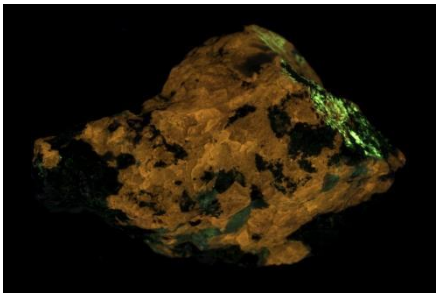
4.6 x 3.8 x 2.4 cm
Sulfur impurities in the form of disulfide ions (S_2^-) are responsible for the distinctive bright yellow fluorescence of sodalite. A variety of sodalite, known as hackmanite, may also exhibit tenebrescence which is a reversible color change that involves F- centers. F-centers are crystal lattice defects where missing chlorine atoms attract free electrons to maintain overall charge neutrality, and the trapped electrons cause selective color absorption. The sodalite appears light pink to purple, but this color will fade with exposure to sunlight. The coloration can be restored with a UV light which traps electrons in the lattice vacancies (Robbins, 1994).

Emerald Green Sodalite

White Light



Longwave



Shortwave

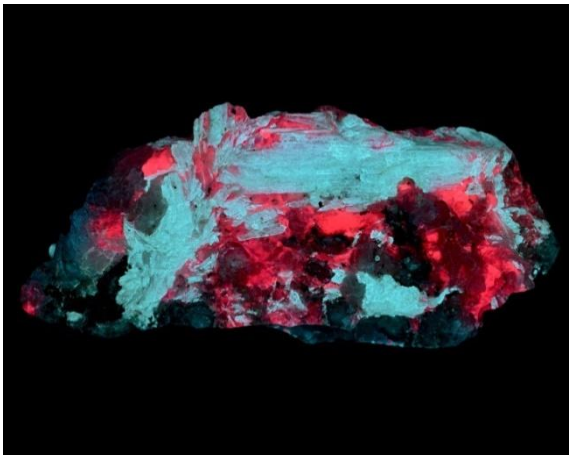
UV Studio photos, - CC_BY_SA-3.0, via naturesrainbows.com
Tunulliarik Fjord, Illĩmaussaq complex, Greenland
A limited amount of emerald green sodalite was found on the north shore of Tunulliarik Fjord. It has a very bright longwave response but is not tenebrescent.

Sørensenite
Sørensenite with Tugtupite

White Light

Longwave

Midwave



Shortwave

Dennis Michael photos, - CC_BY_SA-3.0, via naturesrainbows.com
Kvanefjeld, Ilímaussaq complex, Kujalleq, Greenland
Sørensenite is a rare silicate that was first discovered at the Ilímaussaq complex. Its fluorescent response is brightest under shortwave UV, and the TiO_6 ion group has been identified as the activator.

Tugtupite
Tugtupite with Analcime

White Light

Longwave

Shortwave

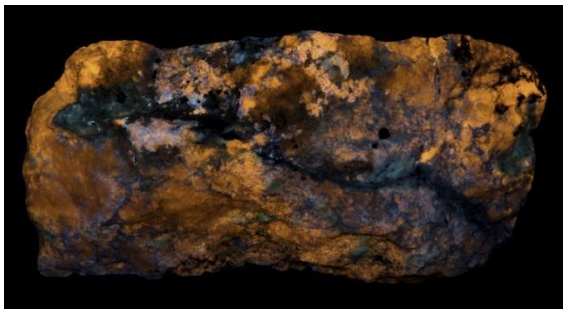
Dennis Michael photos, - CC_BY_SA-3.0, via naturesrainbows.com
Ilímaussaq complex, Greenland
4.2 x 2.8 x 2.6 cm
Tugtupite is closely related to sodalite where beryllium takes the place of some of the aluminum atoms in the sodalite structure. Like sodalite, tugtupite's fluorescence is due to disulfide ions (S_2^-) ion impurities, and it is phosphorescent and tenebrescent. Tugtupite is sometimes referred to as the "King of Fluorescent Minerals" due to its very bright cherry red shortwave response[4].

[4]Tugtupite, GeoGallery, National Museum of Natural History, Smithsonian Institution, https://www.naturalhistory.si.edu/explore/collections/geogallery/10026711

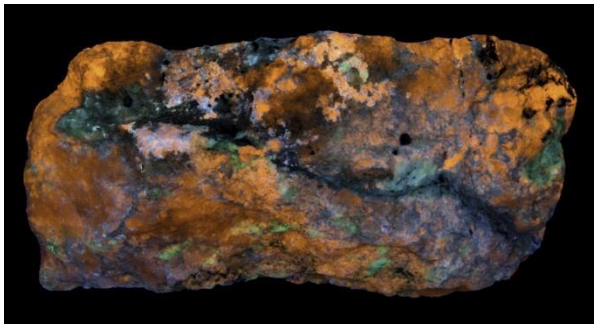
Ussingite

Ussingite and Sodalite

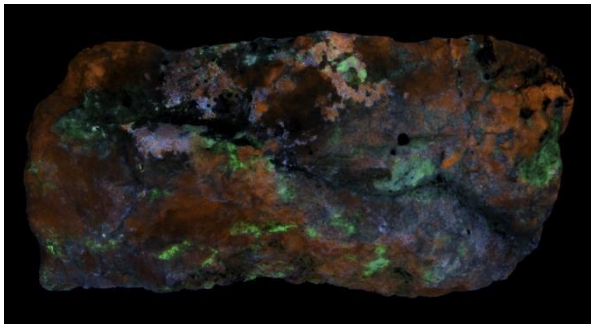
White Light



Longwave



Midwave



Shortwave

UV Studio photos, - CC_BY_SA-3.0, via naturesrainbows.com
Tunuliarfik, Illĭmaussaq complex, Greenland
7 x 3 x 2.5”
Ussingite is another type mineral that was found in the Illĭmaussaq complex. Uranyl ions $(UO_2)^{2+}$ have been identified as the activator of its green fluorescence.

Multicolor Fluorescent Specimens

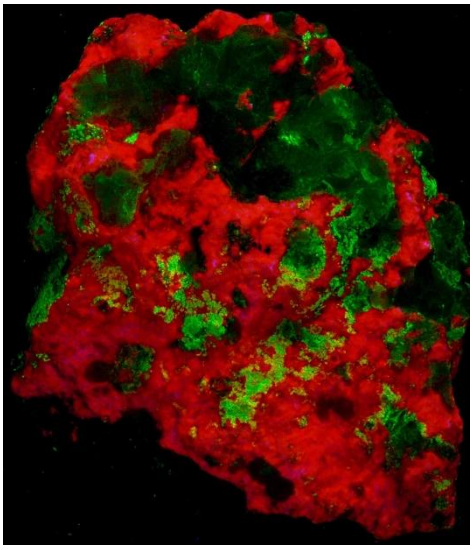
Many fluorescent specimens involve combinations of different minerals that glow different colors. Samples with up to seven colors have been reported, but some colors may not be apparent under all wavelengths of ultraviolet light.

The term “Fantasy Rock”, which was created by Greenland mineral collector and dealer Mark Cole, has been used to refer to some specimens found on the Taseq Slope in the Ilímaussaq Complex. A typical Fantasy Rock usually includes the combination of fluorescent tugtupite, sodalite, analcime, and chkalovite[5].

[5] Clemens, Chris. “Greenland fantasy rock, a spectacular, multi-colored fluorescent treat from the Taseq Slope.” Nature’s Rainbows, September 29. 2019. https://www.naturesrainbows.com/post/2019/09/29/greenland-fantasy-rock-a-spectacular-multi-colored-fluorescent-treat-from-the-taseq-slope

Two-Color Fluorescent Specimens

Tugtupite with Analcime



White Light **Shortwave**

Mark Cole specimen and photos, - CC_BY_SA-3.0, via naturesrainbows.com
Taseq Slope, Illĩmaussaq complex, Greenland
Analcime is an aluminosilicate, and the presence of disulfide ions (S_2^-) produces its bright green fluorescent response.

Chkalovite and Sodalite var. Hackmanite

White Light **Longwave**

Midwave

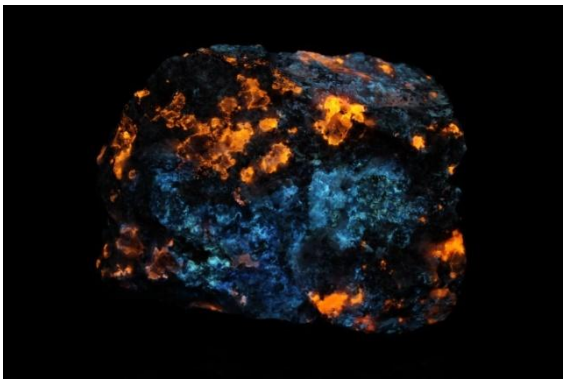
Shortwave

Mark Cole? photos, - CC_BY_SA-3.0, via naturesrainbows.com
Tunuliarfik, Illĩmaussaq complex, Greenland
Chkalovite is often associated with tugtupite. Its green fluorescence is due to uranyl ion $(UO_2)^{2+}$ impurities.

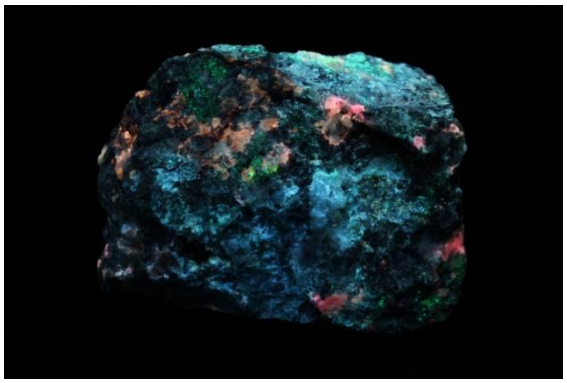
Three-Color Fluorescent Specimens

Tugtupite, Chkalovite, and Analcime

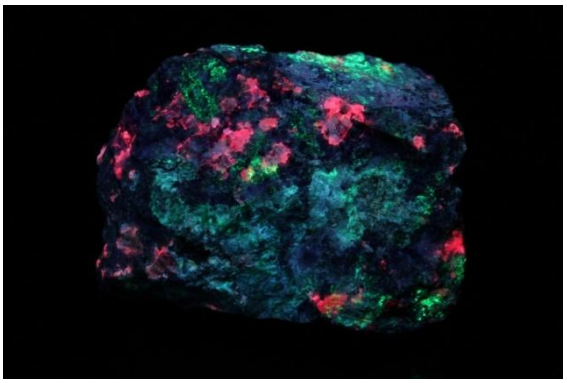
White Light



Longwave



Midwave



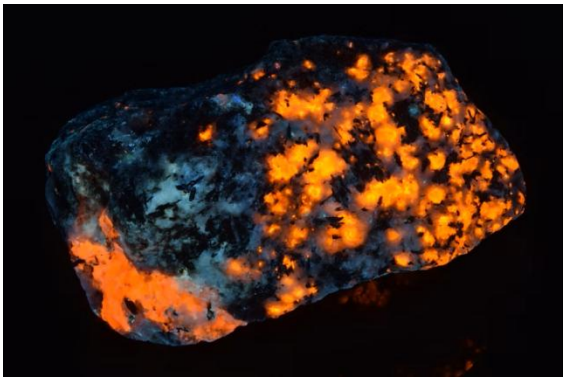
Shortwave

Frédéric Messier Leroux photos, - CC_BY_SA-3.0, via naturesrainbows.com
Taseq Slope, Illĭmaussaq complex, Kujalleq, Greenland
8 x 5.9 x 5.1 cm

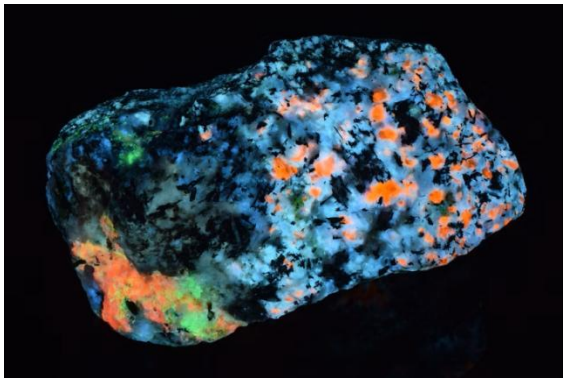
Four-Color Fluorescent Specimens

Tugtupite, Analcime, Sodalite, and Chkalovite

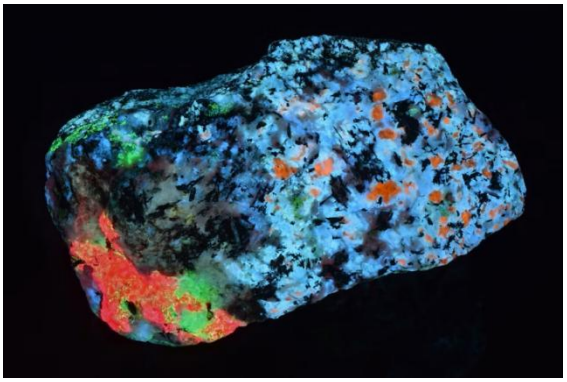
White Light



Longwave



Midwave

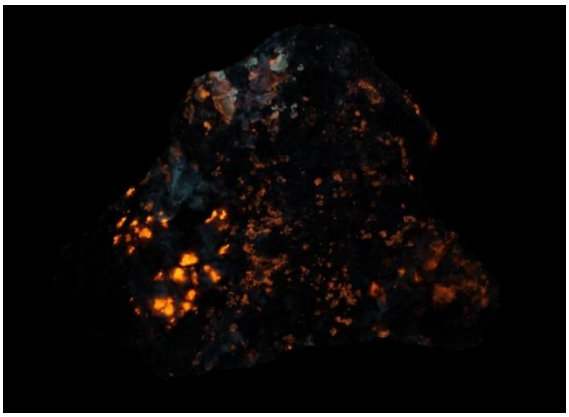


Shortwave

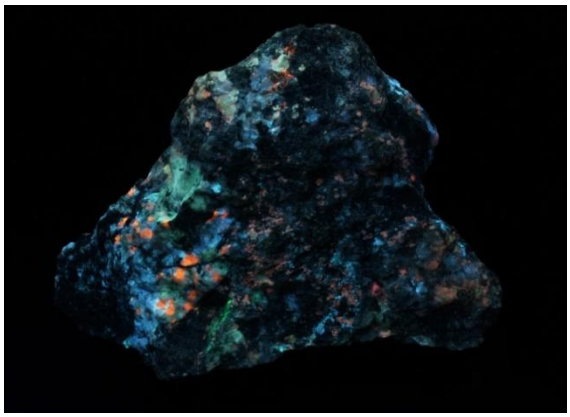
Chris Clemens photos, , - CC_BY_SA-3.0, via naturesrainbows.com
Taseq Slope, Illĭmaussaq complex, Kujalleq, Greenland

Five-Color Fluorescent Specimens
Tugtupite, Chkalovite, Sodalite, Analcime, and Natrolite

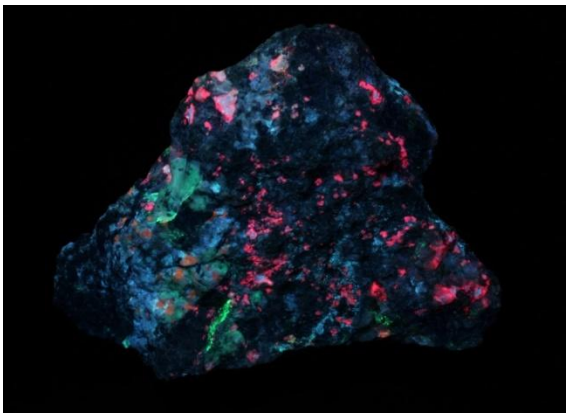
White Light



Longwave



Midwave



Shortwave

Frédéric Messier Leroux photos, - CC_BY_SA-3.0, via naturesrainbows.com
Taseq Slope, Illĭmaussaq complex, Kujalleq, Greenland
11.5 x 8 x 3.3 cm

References

Bøggild, O.B. (1953) The mineralogy of Greenland. Denmark: C.A. Reitzel publisher, 442 p.

Brichet, N. (2020) A piece of Greenland? making marketable and artisan gemstones. *Anthropological Journal of European Cultures*. 29(1): 21 p.

Cole, M. (2004) Fluorescent minerals of the Ilimaussaq Complex, Greenland. *Journal of the Fluorescent Mineral Society* 25: 1-26.

Ghisler, M. and K. Secher (2021) Gemstones from Greenland in the sample collections of the Geological Survey of Denmark and Greenland. Geological Survey of Denmark and Greenland (GEUS) Report 2020/50, 86 p. (In Danish, except for abstract)

Poulsen, M.D. The geological history and mineral deposits in Greenland – a status on current projects. Presentation at Geosciences Information for Teachers (GIFT) workshop, Vienna, Austria, April 14, 2015.

Robins, M. (1994) Fluorescence: gems and minerals under ultraviolet light. Phoenix: Geoscience Press, 374 p.

Secher K. and P. Appel (2007) Gemstones of Greenland. *Geology and Ore,* (7), Geological Survey of Denmark and Greenland (GEUS), 12 p.

Secher K. and O. Johnsen (2008) Minerals in Greenland. *Geology and Ore,* (12), Geological Survey of Denmark and Greenland (GEUS), 12 p.

Wyse Jackson, P.N. (1996) Sir Charles Lewis Giesecke (1761-1833) and Greenland: a recently discovered mineral collection in Trinity College, Dublin. *Irish Journal of Earth Sciences* 15: 161-168.

◊ ◊ ◊

Please join ESM board members Shirley Cote and Harvey Jong who will have geology displays on the rock cycle and volcanoes on October 18th between 9-4 during the Festival in the Mountains, a fundraiser for Save Our Mountains Foundation. In addition, board member Doug Duffy will have chain making, lapidary and silversmithing demonstrations.

Arizona Rocks 147

Text and Photographs by Ray Grant
(One photograph from Google Earth)

Ship Rock, a volcanic neck, or plug, is in New Mexico, but only a few miles from the Arizona border. The Navajos call it the “Rock with Wings”, because of the dikes that radiate out from the rock. It is located in a fairly remote area, so not many people get there. I made a special trip a couple of years ago to see it because it was on my list of places to visit.

In Arizona Rocks number 54 and 55 in 2017, I wrote about the Navajo Volcanic Field and Ship Rock is part of this volcanic field. Agathla Peak and Church Rock are volcanic necks in Arizona that formed in the same way as Ship Rock which is the most spectacular of these formations. These volcanos were active about 27 million years ago. Since the eruptions, erosion has removed up to several thousand feet of the of the softer rock, The harder rock in the necks is very unusual. It is minette a variety of lamprophyre. It has phenocrysts of biotite in a fine-grained rock with possible hornblende, augite, olivine, and orthoclase.

So, most of the volcanos are gone, leaving only the igneous rock that was the volcano’s vent and that filled cracks going out from the volcano forming these spectacular landforms.

All photos are of Ship Rock, including the satellite photo from Google Earth

Pinal Museum and Society News

351 N. Arizona Blvd., Coolidge, AZ

Pinal Geology and Mineral Society next meeting

September 17, 2025

Meetings are the third Wednesday at 7pm, doors open at 6:00

www.pinalgeologymuseum.org

Ray Grant ray@pinalgeologymuseum.org

Pinal Geology and Mineral Museum

No club meetings in summer and

museum open Fridays & Saturdays from 10 - 4 until September

admission is free.

Groups can arrange special visits please call 520-723-3009.

Pinal Geology and Mineral Museum

351 N Arizona Blvd., Coolidge, Arizona

Mystery Mineral Day

Saturday September 27, 10 to 4

Free Admission

Rock and Mineral Identification

(Up to five per person)

See next page for details

Pinal Geology and Mineral Museum
351 N Arizona Blvd., Coolidge, Arizona

Mystery Mineral Day

Saturday September 27, 10 to 4

Free Admission

Rock and Mineral Identification
(Up to five per person)

What to Expect:

Visitors can bring up to 5 items for identification. Our team of experts will be on hand to help you discover the origins and characteristics of your specimens.

This is a fantastic opportunity for rock and mineral enthusiasts of all ages to learn more about their collections.

Why Attend?

Engage with knowledgeable professionals who can provide insights into your specimens. Explore our extensive exhibits, including fossils, meteorites, and mineral displays. Enjoy a day filled with discovery and education in a family-friendly environment.

More information (520)723-3009, www.pinalgeologymuseum.org

AZ Mining, Mineral & Natural Resources Education Museum Update August 2025

https://ammnre.arizona.edu/

Catie Carter Sandoval
cscarter@email.arizona.edu
703.577.6449

Help support the museum at:
http://tinyurl.com/SupportMM-NREMuseum

The food rocks are back on display at the Sun City Mineral Museum! We recently re-installed the "Rockhound Cafe" display at Sun City after a summer hiatus while they completed museum renovations. The cafe features plates of delicious rock and mineral food including a pancake breakfast, hamburger lunch and steak dinner - and also several sides, drinks and desserts. As you may know, this collection is part of the Banquet of Rocks, which was originally on display at the Arizona Mining & Mineral Museum. We encourage you to visit the Sun City museum to see this and our other new display of historic Arizona minerals sometime soon.

Sun City Mineral Museum Director Carol in front of the Rockhound Cafe display.

Plates of food in the exhibit including breakfast, lunch and dinner.

The steak dinner features a chalcedony steak, agate fried chicken, peridot green peas (Joe and Eliz Chan Collection), fossil burrow corn, and quartz potatoes.

The delicious cookies and candy are made from chert, sandstone, granite, agate, and other rocks and minerals.

Sun City Rockhound Mineral Museum
Sundial Recreation Center
14801 N. 103rd Ave.
Sun City, AZ 85351

The museum offers private party tours for schools, clubs and individuals. We'd love to show off our museum to your club or private group. If you are interested, please contact the museum at scrockmuseum@gmail.com.

Please take a minute to check out our new website at scrockmuseum.com.

C. Sandoval photo

Winter Hours
October – April
10 am to 1 pm
Closed Thurs., & Sunday
Summer Hours
May-September 10am-1pm
Saturdays only

Museum Refreshed and Reimaged
By Carol Bankert-George Museum Director

This past month the museum has worked weekly on refreshing, reimaging, and creating new displays. With the help of Dana Slaughter from the Pinal Geology and Mineral Museum, he identified potential museum quality donated specimens for display.
We filled two display cabinets with new items and repositioned other specimens. We have coined the phases, Refreshed Displays, Reimaged Displays and Newly Curated Displays.

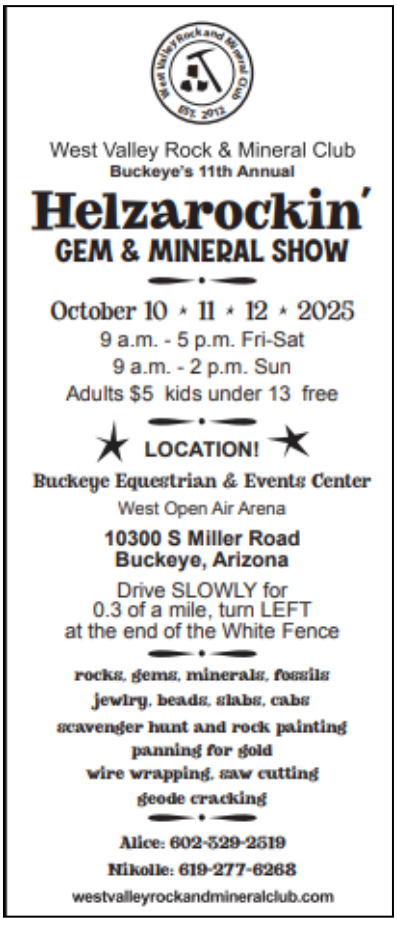
We have refreshed all our Arizona displays moving them in our map of Arizona room. Highlights of refreshed displays include our Jade and Mexican specimen displays. Newly curated includes a display of Tri-State minerals. There is just too much to mention! If you have not visited, it is worth the time and admission is always FREE!

October 1st of this year marks our 35th anniversary of the museum. Stay tuned for information on upcoming October events.

Museum intern Ferris Luna working with Dana Slaughter of Pinal Geology and Mineral Museum. They collected minerals from the Tri-State area (Missouri, Oklahoma, and Kansas) found throughout the museum and place them together for a new display.

Some of the specimens from the new Tri-State display.

Arizona Rock and Gem Shows



Apache Junction Rock & Gem Club
Meetings are on the 2nd Thursday
Next Meeting: September 11, 2025, 6:30 pm
www.ajrockclub.com
@ Club Lapidary Shop
2151 W. Superstition Blvd., Apache Jct.

Daisy Mountain Rock & Mineral Club
Meetings are on the 1st Tuesday
(unless a Holiday then 2nd Tuesday)
Next Meeting: September 2, 2025, 6:30 p.m.
www.dmrmc.com
@ Anthem Civic Building
3701 W. Anthem Way, Anthem, AZ

Maricopa Lapidary Society, Inc
Meetings are on the 3rd Tuesday
Next Meeting: September 16, 2025, 7:00 pm
www.maricopalapidarysociety.com
@ North Mountain Visitor Center
12950 N. 7th St., Phoenix, AZ

Mineralogical Society of Arizona
Meetings are on the 3rd Thursday
(Except June & December)
Next Meeting: September 18, 2025 @ 6:30
@ Franciscan Renewal Center, (Piper Hall),
5802 E. Lincoln Drive, Scottsdale, AZ
www.msaaz.org

Pinal Geology & Mineral Society
Meetings are on the 3rd Wednesday
Next Meeting: September 17, 2025, 7:00 pm
www.pinalgeologymuseum.org
351 N. Arizona Blvd., Coolidge

West Valley Rock & Mineral Club
Meetings are on the 2nd Tuesday
Next Meeting: September 9, 2025, 6:30 pm
www.westvalleyrockandmineralclub.com
Buckeye Community Veterans Service Center
402 E. Narramore Avenue, Buckeye, AZ

Gila County Gem & Mineral Society
Meetings are on the 1st Thursday
(unless a Holiday then the next Thursday)
Next Meeting September 4, 2025, 6:30 pm
www.gilagem.org
Club Building
413 Live Oak St, Miami, AZ

Wickenburg Gem & Mineral Society
Meetings are on the 2nd Friday
(February & December on the 1st Friday)
Next Meeting: September 12, 2025, 7:00 pm
www.wickenburggms.org
@ Coffinger Park Banquet Room
175 E. Swilling St., Wickenburg, AZ

ESM's Meeting Notice

ESM's next meeting will be at North Mountain Visitor Center, 12950 N. 7th St., Phoenix, on Tuesday, TBA 2025, at 6:30 p.m.

BECOME A MEMBER!
Join the Earth Science Museum's

IS IT TIME TO RENEW YOUR MEMBERSHIP?
Please renew today! ☺☺☺

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ESM Earth Science Investigation Team Membership Form

_____ New Member _____ Renewal

Membership levels:

_____ ESI Family $20

_____ ESI Individual $10

Membership benefits:

- Monthly e-newsletter *Earthquake*
- Official team membership card
- Knowledge that your contribution is making a difference in earth science education.

MANY THANKS TO OUR MAJOR DONORS!

AZ Leaverite Rock & Gem Society

Flagg Mineral Foundation
www.flaggmineralfoundation.org

Friends of the AZ Mining & Mineral Museum

Maricopa Lapidary Society
http://maricopalapidarysociety.com/

Mineralogical Society of AZ
www.msaaz.org

Payson Rimstones Rock Club
https://www.rimstonesrockclub.org/

Sossaman Middle School

White Mountain Gem & Mineral Club
www.whitemountain-azrockclub.org

Sun City Rockhound Club & Mineral Museum
https://suncityaz.org/recreation/clubs/rockhound-club-mineral-museums/

Wickenburg Gem & Mineral Society
http://www.wickenburggms.org
www.facebook.com/pages/Wickenburg-Gem-and-Mineral-Society/111216602326438

West Valley Rock and Mineral Club
http://www.westvalleyrockandmineralclub.com/

Staples Foundation
www.staplesfoundation.org

Anita Aiston	Will & Carol McDonald
Peter & Judy Ambelang	Debbie Michalowski
Stan & Susan Celestian	Janet Stoeppelmann
Russ Hart	Dennis & Georgia Zeutenhorst

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We're on the Web!

Visit us at:

www.earthsciencemuseum.org

Mission
Our Mission is to excite and inspire all generations about earth sciences through educational outreach.

Vision
We envision a community where students and the general public have curiosity about, passion for, and understanding of the underlying principles of earth sciences.

For more information about the ESM, how to become a member or how to arrange for a school visit or Community function, go to: www.earthsciencemuseum.org.

NOTICE:
ESM's next meeting will be at North Mountain Visitor Center, 12950 N 7th St, Phoenix, on Tuesday, TBA 2025, at 6:30 p.m.

THANK YOU FOR YOUR CONTINUING INTEREST & SUPPORT!!!

Earth Science Museum
3215 W. Bethany Home Rd.
Phoenix, AZ 85017