May 24, 2021

Carbonate Minerals

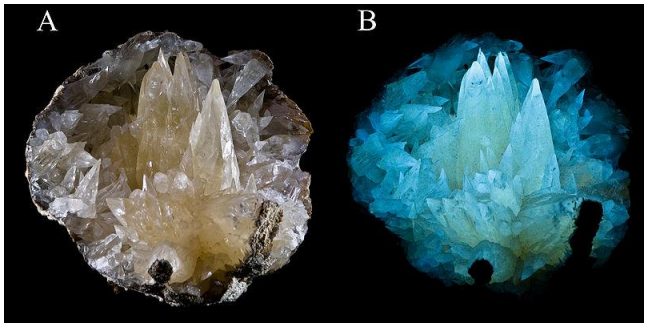

Figure 1 - Calcite Under Regular & UV Light

We'll continue on with the examination of rock forming minerals associated with sedimentary rocks with a look at carbonate minerals. Carbonate minerals are the main components of rocks such as limestone, marble and dolomite as well as ore minerals such as Cerrusite (lead carbonate) and Malachite (copper carbonate).

Many carbonate minerals, especially calcite and aragonite, are precipitated by living creatures either as part of their metabolism, in the case of algae, or to form their shells and structures, in the case of invertebrate animals. The accumulation of discarded shells, coral structures, and algal precipitates creates limestone rocks. Diagenesis and metamorphosis of limestone leads to the other carbonate rocks and minerals. Carbonate rock and minerals can also be the result of chemical weathering and alteration of minerals.

Another interesting feature of carbonate minerals is that they tend to fluoresce under ultraviolet light, as in Figure 1, above. Figure 2 shows a variety of minerals fluorescing under ultraviolet light.

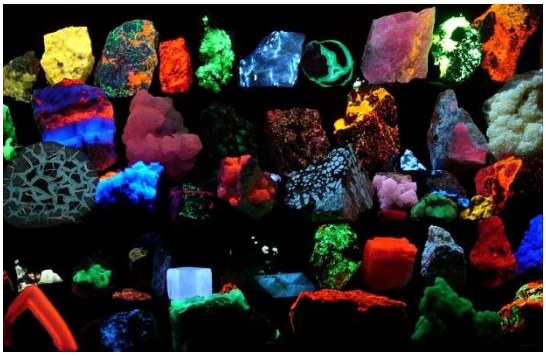

Figure 2 - Mineral Fluorescence

Calcite and Aragonite

Figure 3 - Aragonite

Calcite and aragonite are different crystal forms of calcium carbonate, $CaCO_3$. Both generally originate as chemical and/or biochemical precipitates. Calcite is the more common form, so we'll look at it first.

Calcite is one of the most widespread minerals on the surface of the earth and originates as a chemical or biochemical precipitate. It has a trigonal crystal structure, a Moh's Hardness of 3, and is white, yellow or grey in colour. Calcite effervesces with an acid solution. Calcite fluoresces under ultraviolet light with a variety of colours from pink to red to blue.

Calcite is the primary mineral in chalk, limestone and marble. It occurs as a cement in some sandstones and argillaceous rocks such as marl. Chemically precipitated calcite forms rocks such as travertine and the hydrothermal calcite filling in amygdaloid rocks. Hydrothermal precipitation of calcite can also form sunstone, or Iceland Spar, which is an optically clear calcite that has the ability to polarise light. This ability to polarise light allowed Icelandic sailors to see the location of the Sun through overcast skies, thus aiding their navigation on the ocean.

Figure 4 - Iceland Spar

Aragonite is generally precipitated from sea water, mostly by living organisms. It differs from calcite in having a orthorhombic crystal structure. It is also only metastable. Over time argaonite converts to calcite. Aragonite is found in the shells of many invertebrates such as molluscs and cephalopods. In some cases, both aragonite and calcite are found in different layers of the same shell. Pearls are made out of aragonite. Aragonite shows yellowish white to pink and occasionally blue or green fluorescence under ultraviolet light.

Dolomite

Figure 5 - Pink Dolomite

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The term *dolomite* refers to both the mineral and the rock made of that mineral. The mineral is named after the Dolomite Mountains in Italy and the French geologist, Déodat Gratet de Dolomieu.

Dolomite, $CaMg(CO_3)_2$, is generally light grey, light brown or white in colour although pink examples, like that in Figure 4 are known to occur. Like calcite, it has a trigonal crystal structure. The feature that distinguishes calcite from dolomite is that dolomite only weakly effervesces with an acid solution. Dolomite shows yellowish white to red fluorescence under ultraviolet light.

The mineral dolomite is generally formed by diagenetic changes to limestone after deposition. In the diagenesis, some of the calcium in the $CaCO_3$ of the calcite is replaced with magnesium, usually through reaction with magnesium compounds carried by groundwater. The diagenesis of limestone to make dolomite is a huge subject, many books and papers have been written on the subject. A *Google* search on dolomite diagenesis returned about 378,000 results, so if this subject interests you, it is a deep rabbit hole of research.

Magnesite

Figure 6 - Magnesite
Credit: Rob Lavinsky, iRocks.com – CC-BY-SA-3.0

Magnesite, $MgCO_3$, is similar to calcite in that it has a trigonal crystal structure and is dull white or yellow coloured. Like dolomite, it only weakly effervesces with acid. Magnesite shows yellowish white to bluish white fluorescence under ultraviolet light.

The distinguishing feature of magnesite is its association. Magnesite is the alteration product of magnesium rich igneous and metamorphic rocks and is usually found in association with serpentine, talc and/or chlorite rocks.

Siderite

Figure 7 - Siderite
Credit: Géry PARENT, public domain

An iron ore mineral, siderite, $FeCO_3$, is a various shades of yellow and brown in colour. It most commonly occurs in bedded sedimentary rocks and appears to be the result of the weathering of carbonate in the presence of dissolved iron.

Malachite and Azurite

Figure 8 - Azurite on Malachite

Malachite, $Cu_2(CO_3)(OH)_2$, and Azurite, $Cu_3(CO_3)_2(OH)_2$, are both copper carbonates and important copper ores. Malachite is bright green in colour and azurite is blue. Both are found as secondary minerals formed by the chemical weathering of copper bearing minerals, such as chalcopyrite, by dissolved carbon dioxide in water.

In addition to their use as copper ores, some specimens of malachite and azurite are used as gemstones. Malachite is also used as a stable green pigment for paints.

Cerrusite

Figure 9 - Cerrusite
Credit: Rob Lavinsky, iRocks.com – CC-BY-SA-3.0

Cerrusite, $PbCO_3$, is a lead carbonate used as a lead ore. Clear, white, gray, blue, or green in colour. Cerrusite fluoresces yellow and yellowish white under ultraviolet light. It is another mineral formed by weathering, in this case the weathering of minerals containing lead like galena.

Rhodochrosite

Figure 10 - Rhodochrosite and Quartz
Credit: Rob Lavinsky, iRocks.com – CC-BY-SA-3.0

A manganese carbonate, rhodochrosite, $MnCO_3$, is typically pink in colour. Rhodochrosite fluoresces red under ultraviolet light.

Rhodochrosite is often formed by high temperature alteration, metasomatism, of manganese rich minerals and it found in association with other manganese minerals such as rhodonite and spessartine. It also occurs in hydrothermal veins and in some pegmatites. Rhodochrosite is best known as a gem mineral.

More Carbonate Minerals

Other carbonate minerals that might be of interest include:

- Ankerite, $Ca(Fe^{2+},Mg)(CO_3)_2$,
- Huntite, $CaMg_3(CO_3)_4$,
- Smithsonite, $ZnCO_3$,
- Strontianite, $SrCO_3$, and
- Witherite, $BaCO_3$

Most of these minerals occur as the result of hydrothermal alteration of other minerals.

Standard Caveat

The purpose of my weblog postings is to spark people's curiosity in geology. Don't entirely believe me until you've done your own research and checked the evidence. If I have sparked your curiosity in the subject of this posting, follow up with some of the links provided here. If you want to, go out into the field and examine some rocks on your own with the help of a good field guide. Follow the evidence and make up your own mind.

In science, the only authority is the evidence.