Pseudomorphs

Wolves in Sheep's Clothing… and sometimes… Sheep in Sheep's Clothing

COPPER PSEUDOMORPH CUPRITE, RUBTSOVSKOYE DISTRICT, ALTAI KRAI, RUSSIA

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Introduction

Pseudomorph is a general term for minerals that formed initially in their usual way but then underwent some alteration (usually) into a completely new mineral while retaining the shape and size of the original mineral. These are generally labeled as **current existing mineral** pseudomorph (or "after" or "PM") **previous, no longer existing** mineral. As in the title photo, copper (the mineral you are viewing) pseudomorphs a previous and no longer present cuprite. The copper has replaced the cuprite so slowly that it has kept the original shape of the cuprite. The term pseudomorph literally means false shape and was termed by Rene Just Hauy (a famous, famous mineralogist) in 1801. He noticed that sometimes he had a specimen of a mineral in the wrong crystal habit and began to study why. The term pseudomorph is an umbrella term and encompasses different subtypes of pseudomorphs and different processes that result in this phenomenon.

Figure 1. The gray octahedrons are cuprite from Rubtsovskoye Mine in Russia. Note the gunmetal gray color, the smooth crystal surfaces, and the overall sharpness of the octahedrons. Jordi Fabre specimen and photo

Figure 2. Native copper from Rubtsovskoye Mine in Russia. Note the coppery color, the lack of larger structures – only tiny worm like crystals of coppers from this area.

Figure 3. Copper pseudomorph cuprite from Rubtsovskoye Mine in Russia. Note that the tiny copper crystals are now in distinct octahedrals (orange circle.) Overall, they are rough edged and have lost some detail and sharpness as they were replaced.

Rubtsovskoye Mine Copper PM Cuprite Mechanism

This mine is in south central Russia, near the border with Kazakhstan. It was a massive sulfide deposit from volcanics with a large oxidation zone where cuprite and other minerals were found. Within the oxidation zone, the cuprite Cu_2O was acted on by low temperature hydrothermic fluids that contained a reducing agent. This specifically was ferrous iron (Fe^{2+}). This reduced the oxygen off the cuprite and onto itself, leaving behind copper (2Cu.)

Recognizing Pseudomorphs

To really appreciate pseudomorphs, you will need to recognize stereotypical minerals in their typical forms. We have spent a couple of years studying the 7 different crystal systems and good representations of each of these, but this topic will still challenge these lessons. One of the best ways to recognize that a specimen may be a pseudomorph is to see that a larger shape is not smooth and homogeneous, but is instead filled in with smaller crystals, usually in a coarse fashion that has less detail than a primary formation. A good approach can be to look at typical examples of both the old and new minerals individually, then look at the pseudomorph. I think that this is especially helpful if you can find Images of all 3 from the same location (as in the example above.) Probably the most common pseudomorph in collections is malachite pseudomorph azurite. Although this occurs in many copper deposits around the world, a good locality to demonstrate this pseudomorph is from Milpillas, Mexico.

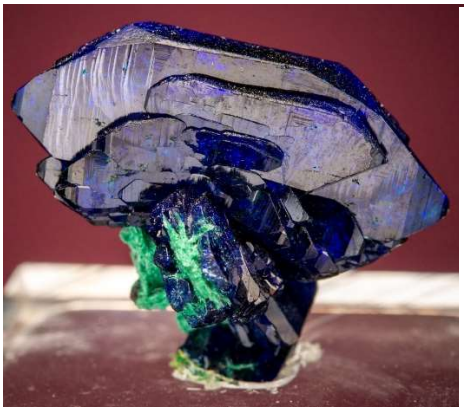

Figure 4. The deep blue blades of azurite from Milpillas Mine, Mexico show peaked double terminations, and overlap in lustrous, sharp form. Note the gunmetal gray color, the smooth crystal surfaces, and horizontal striations on the

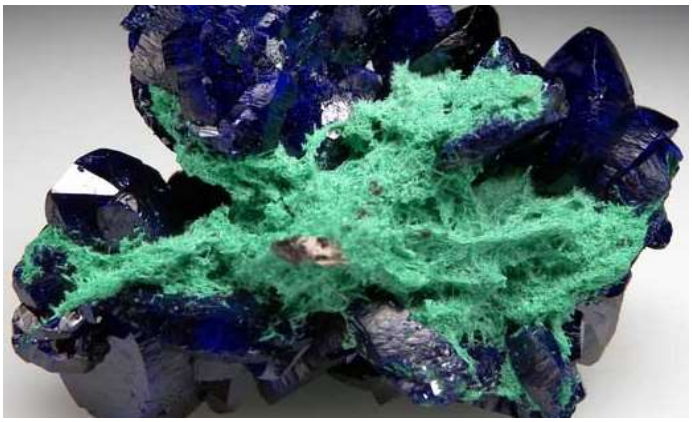

Figure 5. Primary malachite which has formed directly in the deposit from Milpillas Mine, shows small green fibrous crystals that spread out in all directions without a clear form. Note the blades of deep blue azurite around it. Marin Mineral specimen and photo.

Figure 6. This is a picture of secondary malachite, which means it formed as a pseudomorph after azurite (instead of directly as in the previous photo. This piece is also from Milpillas Mine. The green malachite now has a bladed structure and even has kept the peaked terminations. Close examination of the green surfaces shows that these are not smooth but composed of many tiny and coalesced crystals. On the top right, you can see an area of azurite that has not pseudomorphed and is still blue and lustrous.

Milpillas Mine Malachite PM Azurite Mechanism

The Milpillas Mine in Mexico is about 30 miles south of the border of Arizona. It is a huge copper deposit with a large and famous oxidation zone which produced thousands of gorgeous azurite and malachite crystals. Both minerals are copper carbonates, but malachite is slightly more stable under neutral and basic geologic conditions. Azurite formed first when things were acidic and as conditions became more neutral or basic, the azurite slowly turned into malachite atom by atom, which is why sometimes both can still be seen in one crystal.

Another Example

See if you can recognize what mineral is present and what mineral was replaced. What are the possibilities based on the shapes? Answers are on the next page.

Figure 7.

Figure 8. These are clear cubes of fluorite from Maramures County in Romania. Ion Coteaewscu specimen and photo

Figure 9. Banded chalcedony (variety of quartz) in lovely blue and white colors. Chalcedony often forms bands with subtle color variations (think of agates.) Credit for specimen and photo are at the top of the photo. This and the specimen in Figure 7 are from Triesta, Maramures County, Romania. The piece in Figure 7 is Chalcedony Pseudomorph Fluorite. The subtle color bands are from the chalcedony banding and are NOT fluorite phantoms.

Triesta, Romania Chalcedony PM Fluorite Mechanism

These neat specimens are found by farmers occasionally when they plow their fields. They are considered classics in the mineral world – especially Europe- and their source has not been found nor worked commercially. Fluorite is not found specifically in these areas (only nearby in the same county) so whatever conditions caused these to change were reasonably widespread. This pseudomorph combination is unique to this area. What is known is that this is a metasomatic replacement where there is simultaneous volume for volume replacement of the fluorite by quartz. It is rare for these to have banding, especially so well mimicking the banding of fluorite.

Condition Changes Affecting Pseudomorphs

Conditions can change for specimens, especially in situ within their place of development. Geologic conditions can be unstable at the time of formation – pressure or temperature changes, substrate changes, geologic movement – the possibilities are almost endless. These changes can all change the course of an already formed mineral. In addition, changes can be made over a very long-time course – erosion and weathering can cause oxidation or exposure to water resulting in deterioration or alteration in unstable minerals. Changes can even occur after the piece is mined and stored. Here is a very common example and cautionary tale for mineral lovers. (This is a fine and extreme example of "pyrite rot." You can also find this in many museums that store their sulfides in wooden drawers. Wood is a wet material and increases humidity which increases the rate at which pyrite decays into mixed iron sulfides (rust.). You can see this process in action at the UWM Thomas Greene Museum (sadly.) Many of their pyrites have lost their luster and have a yellowish powder forming on and under them. In a couple of decades, the pyrite will be all dust.

Figure 10. Pyrite from Chivor Mine, Columbia. Note the sharp striations, golden color, and shiny luster of pyrite. It has nice interpenetrant twinning too

Figure 12. Goethite from Tharsis, Spain. It is the most common iron oxide (there are many…) and form as a breakdown of iron minerals like pyrite and pyrrhotite. Note the waxy dull texture and luster. It also form as massive or botryoidal masses

Figure 13. Goethite Pseudomorph Pyrite from Chivor Mine, Columbia. Yep, its fully rusted out, but note how perfectly it kept the original shape. A classic and (inexpensive!) pseudomorph

Pseudomorphs Are All Around

Pseudomorphs arecommon in the mineral kingdom, and there are many more probably unrecognized. A mineral can even pseudomorph itself, with subsequent generations replacing earlier ones or a high temperature / pressure variant can change into a more stable one as the mineral cools. Minerals can also pseudomorph fossils, petrified wood, and bone. There is even a copper pseudomorph of a person. (You can google the image, but it is somewhat disturbing and disrespectful so I will not include it here.)

Figure 14. Aragonite PM Belemnite, Germany

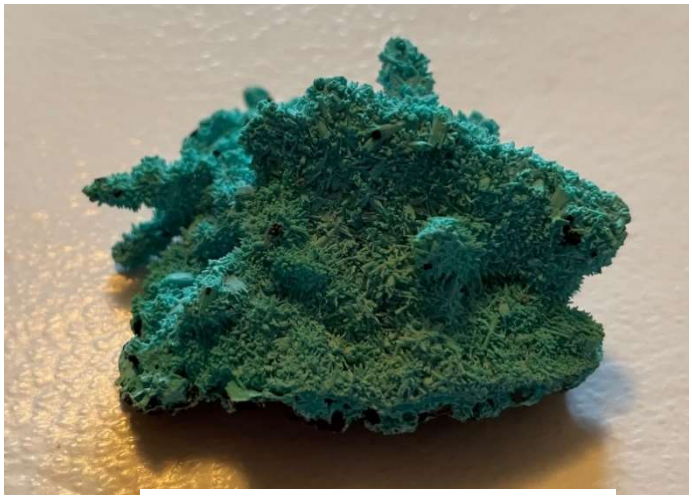

Figure 15. Chrysocolla PM Malachite PN Azurite from Luputo Mine, Congo

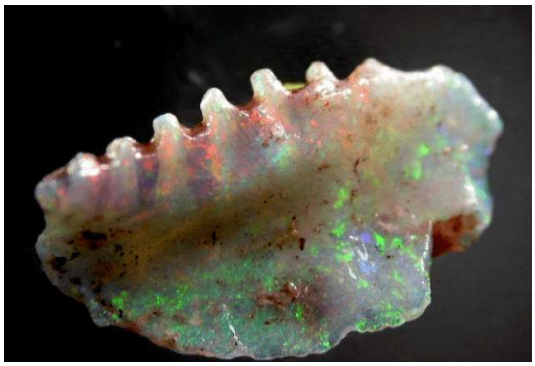

Figure 16. Precious Opal PM dinosaur bone

Figure 17. Rust Pseudomorph Car