PYRITE: CRYSTALS TO CONCRETIONS

Pyrite [iron disulfide, FeS_2] is among the most collectible of all minerals, thanks to its abundance, affordability, and brassy-yellow crystals that gleam with a bright, eye-catching, metallic luster. Pyrite crystallizes in the isometric (cubic) system and is best known for its well-developed, sharp-edged, cubic crystals.

Those familiar cubic crystals are not all that pyrite has to offer. Because the double-sulfur ion $2S^{2-}$ in its molecule tends to disrupt the development of perfect, cubic symmetry within its crystal lattice, pyrite also occurs in such modified cubic forms as 4-faced tetrahedrons, 8-faced octahedrons, 12-faced dodecahedrons, and 24-faced cubic trapezohedrons, along with many very complex combinations of these forms. All pyrite crystals achieve their largest size and highest levels of development in hydrothermal-vein or replacement-type environments where open space permits unrestricted crystal growth.

Many sedimentary, metamorphic, and igneous environments, however, do not provide the space necessary for free crystal growth. In these environments, pyrite is unable to develop as macrocrystals and instead occurs as unremarkable, tiny, individual grains or granular bodies consisting of aggregates of grains. Although these grains have pyrite’s internal cubic structure, they do not have any discernible, external cubic shape.

Many of pyrite’s most unusual forms develop in sedimentary environments in which open space is neither available nor completely absent, but instead restricted. As relatively abundant elements, both iron and sulfur are present in many sedimentary environments, iron as a common component of inorganic sediments and sulfur as a component of organic remains. Not surprisingly, pyrite is common in layered, coal-shale deposits that originate from intermixed strata of organic matter and inorganic sediments. Within such coal-shale formations, pyrite often is found as interesting spherical or flattened concretions.

The word “concretion” is derived from the Latin *con*, “together,” and *crescere*, “to grow,” and refers to sections of sedimentary rock in which crystallizing minerals have displaced surrounding sediments or filled the pores between sediment grains. Concretions can be spherical, ovoidal (egg-like), elongated, flattened, or irregular in shape. They range in size from microscopic to three or four feet in diameter. Concretions form within sediment layers soon after deposition and usually, but not always, before the sediments have lithified or turned to rock.

Common in such sedimentary rocks as shale, siltstone, mudstone, and sandstone, concretions form when minerals that have dissolved in groundwater precipitate around a nucleus. Pyrite concretions begin their development when iron- and sulfur-rich groundwater precipitates pyrite around carbon particles to form tiny “seed” crystals. These seed crystals then promote further pyrite precipitation which, in proper conditions of chemistry and temperature, slowly accumulates into concretions.

Interestingly, this deposition process exerts considerable amounts of mechanical energy. When this process occurs in recently deposited sediments that are unconsolidated or loose, the energy of the crystal-growth process is actually sufficient to physically displace the surrounding sediments. This creates the necessary space, however restricted, for the continued growth of the concretion. But this space restriction, of course, prevents the crystallizing pyrite from developing its characteristic, external cubic form. Instead, the tiny pyrite crystals become elongated and interlocked, and grow with a radiating, internal structure into bodies with external shapes that are spherical or ovoidal.

The best-known type of pyrite concretion is the disk-like “pyrite sun” or “pyrite dollar” which, with its thin, flat, round shapes, brassy color, and bright luster, is a perennial favorite in rock shops. Pyrite suns also form by precipitation in coal-shale, sedimentary environments, but only in strata that has already lithified. Because the surrounding hard rock prevents spherical growth, these concretions can only develop laterally along the directions of least resistance which, in this case, are the horizontal laminations within the coal-shale seams—hence the flattened, disk-like shapes of pyrite suns.

Pyrite *concretions* form differently than pyrite *nodules*. Nodules (from the Latin *nodus*, or “knot”) are sometimes similar in appearance to concretions. They do not form from concretionary precipitation, however, but occur when a mineral, such as pyrite or calcite [calcium carbonate, $CaCO_3$], replaces another mineral or a mass of organic matter. In pyrite nodules, which are generally spherical, the pyrite is most often present in dull-colored, massive or granular forms. Pyrite concretions, on the other hand, consist of bright, lustrous, tiny interlocked crystals in more complex and interesting shapes.

Absence, availability, or restriction of growing space are the key factors that determine whether pyrite will form unremarkable grains, well-developed cubic and modified-cubic crystals, or such collectible concretionary forms as “suns” and “dollars.”

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