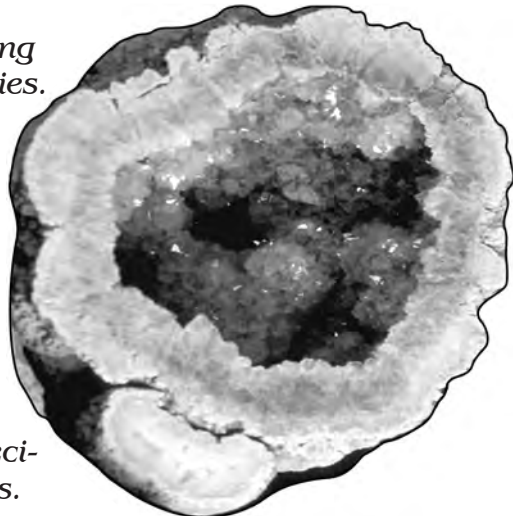
Illinois State Geological Survey

Geobit 3

GEODES—Small Treasure Vaults in Illinois



Geodes, a term derived from a Greek word meaning earth-shaped, are irregular, roughly spherical bodies. They can be oblong or shaped like invertebrate fossils (e.g. crinoid calyx). Some are hollow and lined with beautiful layers and clusters of various mineral crystals, but others are completely filled by inward-growing crystals. Hollow geodes, relatively lightweight compared with those completely filled, are more desirable because they generally contain a greater variety of minerals that have grown well-formed crystals. Some of Illinois' most beautiful and unusual mineral specimens can be found in the crystal linings of geodes.

Where we find geodes

Geodes found in Illinois range from less than 1 inch to more than 2 feet in diameter, but 3 to 5 inches is the average. They generally occur in limestone, a calcium carbonate ($CaCO_3$), or in dolomite, a calcium-magnesium carbonate ($CaMg(CO_3)_2$). Although geodes can be found in carbonate-rich rocks throughout the state, one of the most famous geode collecting areas in the country is in a region of western Illinois and adjacent parts of Iowa and Missouri. The region encompasses about a 70-mile radius from the towns of Warsaw, Hamilton, and Nauvoo.

What's in a geode?

A typical geode from western Illinois has an outer shell of chalcedony, a type of cryptocrystalline quartz composed of silicon dioxide (SiO_2). Once the outer shell forms, mineral-rich water still inside the shell may cause more quartz to be deposited and other minerals to form toward the center. Chalcedony, much harder than the host rock of limestone, helps to preserve the specimen during weathering. As the weaker host rock is eroded, the geodes "weather out" and remain behind. They generally are easy to see because of their shape and the texture of their outer shell.

The micro-environment inside the shell is an excellent place for crystal growth. Temperature and pressure changes, as well as evaporation, cause the mineral matter to precipitate. More solutions rich in minerals may seep into the geode later, adding to the quartz crystals or forming other minerals. In addition to the chalcedony of the outer shell, the insides of some geodes are lined with a pronounced bumpy, mammillary form of blue-gray chalcedony. Some specimens also have excellent clear quartz crystals. Ankerite, aragonite, calcite, dolomite, goethite/limonite, gypsum, and marcasite/pyrite are the other minerals most commonly found. Occasionally, dark bronze, fine, hair-like masses are found inside; these may be millerite (NiS) or a filament-like form of pyrite.

Perhaps the most fascinating geodes are those that contain petroleum, which may be under enough pressure to squirt out when the geode is broken. The enclosing rock north of Nauvoo, where these unusual geodes are found, no longer contains any significant oil. So what is the source of oil in these geodes? What is the origin of the other minerals? We don't know for sure. Perhaps trace amounts of some of the elements that make up the rarer minerals were present in shale layers associated with the carbonate strata. As a matter of fact, the most prolific zone for collecting geodes in western Illinois is in the lower part of the Warsaw Shale of the Valmeyeran Series (middle series of the Mississippian System). These sedimentary strata were deposited in shallow seas that covered what is now the midcontinent about 350 million years ago.

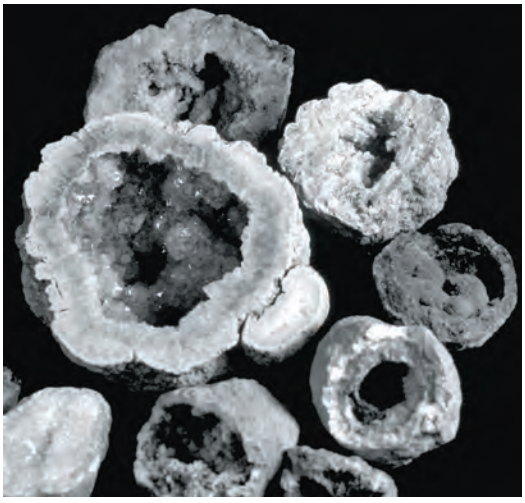
How geodes form

Geologists have proposed several theories to explain the conditions and processes that form geodes, but none seems to be entirely adequate to explain all geode features. In discussing the origin of the western Illinois geodes, Hayes (1964) noted that any theory proposed must explain why the geodes are

- essentially confined to a specific stratigraphic interval, the lower part of the Warsaw Shale;
- usually associated with particular lithologies (clayey, shaley dolomite, and dolomitic mudstone);
- located in specific zones or beds rather than scattered randomly;
- fairly uniform in size in a particular zone and round, at least initially;
- enveloped by laminations in the bedrock that exhibit some thinning of layers above and below the specimen.

As limey sediments accumulated in shallow midcontinental seas, rounded cavities that are characteristic of geodes could not have existed at the interface or contact of water and sediments. Nor could they have existed during the earliest stages of sediment compaction and cementation. Therefore, some feature of a different texture than the host limestone had to be present. This feature either caused geodes to form or was transformed into a geode. Hayes hypothesized that the only features in the rocks that shared enough characteristics with geodes to serve as precursors were calcite concretions (small zones in the original sediment strongly cemented by calcite). The size and shape of these concretions, their position in the limestone, and their relation to the surrounding rocks are strikingly similar to those of geodes. In several exposures in the region, rock samples may be found that display all stages of the transition from concretion to geode. Hayes suggested that calcite concretions formed where organic materials (remains of the living tissues of plants or animals) accumulated with carbonate-rich sediments under quiet-water conditions. The organic matter decomposed, causing an oxygen-poor (anaerobic), alkaline environment (pH >7) to develop in the sediments. These conditions encouraged calcite to precipitate from solutions in sediments.

The formation of many features seen in geodes may involve a step-by-step replacement of these concretions by quartz and other minerals. Changes in the chemical composition and acidity (pH) of water in the sediments caused chalcedony to replace the calcite at the outer margins of the concretions. This process caused the formation of a calcite-concretion core surrounded by a hard, but slightly permeable, shell of chalcedony. Further changes in the composition and pH of the water percolating slowly through the sediment caused the core concretion inside the geode eventually to dissolve, leaving a hard, hollow cavity in which more chalcedony, quartz, or other minerals could precipitate.



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References

Cote, W.E., D.L. Reinertsen, G.W. Wilson, and M.M. Killey, 1970, Hamilton–Warsaw Area, Hancock County: Illinois State Geological Survey, Geological Science Field Trip Guide Leaflet 1970E and 1971B, 22 p. plus attachments.

Hayes, J.B., 1964, Geodes and concretions from the Mississippian Warsaw Formation, Keokuk region, Iowa, Illinois, Missouri: Journal of Sedimentary Petrology, v. 34, no. 1, p. 123–133.

Wathen, B., 1992, The gems of Hancock County: The Nature of Illinois, Vol. VII, No. 1, p. 22–24.

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