

1989

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### Recommended Citation

Witzke, Brian J. (1989) "Geodes: A Look at Iowa's State Rock," *Iowa Science Teachers Journal*: Vol. 26 : No. 1 , Article 6.

Available at: <https://scholarworks.uni.edu/istj/vol26/iss1/6>

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## GEODES: A LOOK AT IOWA'S STATE ROCK

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Iowa geodes have long been objects of curiosity, their sparkling interiors containing some of the most beautiful crystals to be found anywhere in the Midwest. Although geodes are known from many localities around the world, one of the most productive and famous collecting regions is encompassed within a 35-mile radius of Keokuk, Iowa. Rock collectors commonly refer to geodes from this region as "Keokuk geodes." In keeping with the world-renowned status of the Iowa geodes, the Iowa General Assembly declared the geode as the official "State Rock" in 1967.

The word "geode" is derived from the Latin meaning "earthlike," a reference to their rounded shape. Most Iowa geodes are roughly spherical, often lumpy or cauliflower-like in external form, with diameter typically ranging between about two and six inches. However, specimens up to 30 inches are known. The most prized geodes have hollow interiors, although many geodes are solid objects in which crystal growth has filled most or all of the interior volume. Although the distinction may seem subtle, it is important to contrast geodes with other crystal-lined cavities, or "vugs." Geodes differ from vugs in possessing an outer mineral layer which is more resistant to weathering than the host rock. As such, complete geodes commonly weather out of rock exposures and accumulate in stream bottoms. Crystal-lined vugs would not weather in such a manner.

Geodes from the Keokuk area contain a variety of minerals, but quartz is dominant in most. Quartz is silicon dioxide, the primary mineral in ordinary sand. Beautiful transparent to white quartz crystals cover the walls of many geode cavities. These crystals become larger and fewer in number towards the center of the geode, and terminate in characteristic pointed hexagonal pyramid shapes. Microcrystalline quartz, or chalcedony, whose component crystals are too small to be seen with the naked eye, forms the outer shell in all "Keokuk geodes." Chalcedony layers also encrust the interior walls of many geode cavities, covering the surfaces of the earlier-generation quartz crystals in a variety of colors, including white, gray, blue, yellow and orange. Calcite is a common and attractive calcium carbonate mineral in many geodes, which occurs in a variety of crystal habits and colors. An additional seventeen minerals have been identified in "Keokuk geodes." Some of the more noteworthy include: kaolinite, a white clay mineral; dolomite in saddle-shaped crystals; pyrite or fool's gold, an iron sulfide; and sphalerite, a blackish zinc sulfide.



Photo by Tim Kemmis

Crystals of quartz reflect from the partially hollow interior of this 8-inch diameter geode from the Warsaw Shale of southeastern Iowa.

Iowa's renowned "Keokuk geodes" can be found in specific stream drainages and excavations in parts of southeastern Iowa (especially Lee, Henry and Van Buren Counties), including the area near Geode State Park. Most geodes are derived from strata of the lower Warsaw Formation, a widespread rock unit of Mississippian age. Muds deposited in a shallow sea about 340 million years ago were primarily calcium carbonate and clay, and were subsequently lithified to form the shales, shaley dolomites and limestones that we see today. Fresh geodes can be dug out of exposures of the lower Warsaw Formation, where they are concentrated in certain layers. Where water and streamflow have eroded these strata, concentrations of geodes may accumulate in stream channels. Although the bulk of Iowa's geodes are derived from the Warsaw Formation, geodes also are known from other formations of Devonian and Mississippian age at scattered localities in eastern and central Iowa.

The origins of geodes have vexed geologists for a considerable time, and many hypotheses have been put forward. The most recent geologic research, however, agrees on three general points: 1) Geode precursors were concretions (nodules formed by outward growth around some nucleus) which grew within soft, unlithified sediment. 2) The outer shells of these concretions were replaced subsequently by chalcedony. 3) The interiors of the concretions were dissolved, leaving a hollow space into which quartz crystals could grow. The composition of the original concretions is unclear, though geologists propose they were either limestone or anhydrite, a fairly soluble calcium sulfate mineral related to gypsum.

The minerals now seen inside geodes were transported in ground-water solutions and then precipitated as replacements of the geode walls or as crystalline growths within their hollow interiors. The ultimate source of the mineralizing waters remains speculative. Many common geode minerals, especially quartz, are only weakly soluble. Therefore, substantial volumes of water had to migrate through the lower Warsaw strata to precipitate the observe minerals.

Collecting geodes can be both fun and educational. Once you've located exposures of lower Warsaw strata or a geode-bearing stream course, all that's required is a little patience and a good bricklayer's or rock hammer. A sharp blow with a hammer is usually sufficient to crack open individual geodes, exposing their crystalline interiors to daylight for the first time. Remember that most geode-collecting localities are on private land, and permission must be secured before entering.

### **Subject Bibliography**

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*This article is reprinted from the 1987 issue of Iowa Geology. It is one of 10 articles from this one issue which are of general interest and particular classroom use to Iowa teachers. Iowa Geology is published once each year by the Iowa Department of Natural Resources. It is edited by Jean Prior, who is known for her excellent presentations to teachers. Teachers may be added to the mailing list to receive Iowa Geology (no charge) by sending a request to Prior at the Geological Survey Bureau, 123 North Capitol Street, Iowa City, Iowa 52242.*