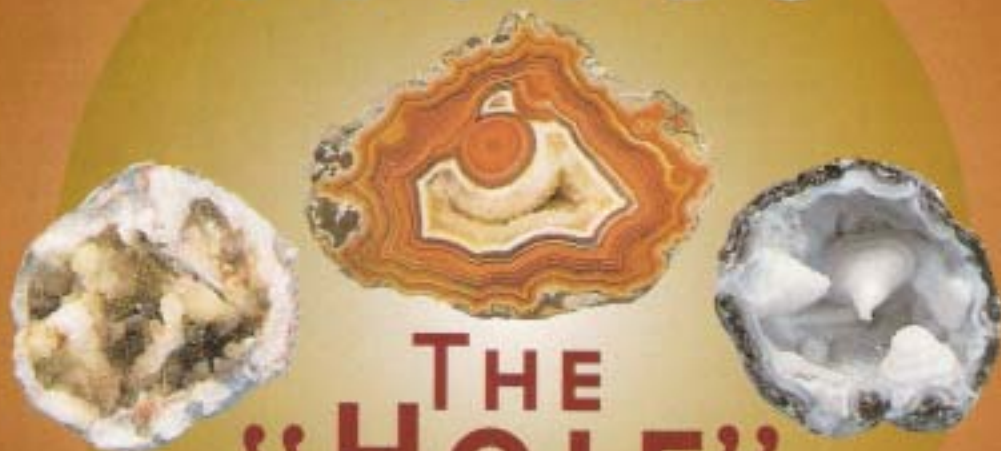


GEODES



THE "HOLE" STORY

PART 1 OF 2

Everything you've always wanted to know about these more or less hollow rocks.

BY SID ANN FRAZIER, Foreign Correspondents

1. What's a geode?

Everybody who's spent a little time at a gem show or a rock shop knows what a geode is: they're those roundish rocks you saw in half to find filled with sparkling little crystals, right?

Yes and no. Many people think "Keokuk" (see Question 2) when they think "geode," but the trouble with using the geodes from this one locality to define geodes in general is that the Keokuk geodes occur in sedimentary rocks, and there are a lot of crystal-containing, hollow nodules generally called geodes that occur in igneous rocks, too, particularly in lavas and massive, glassy, volcanic ash deposits (see Question 3).

CLOCKWISE FROM LEFT: CRYSTALS of milrite and pyrite line this 2.7-cm-wide classic Keokuk quartz geode from Halls Gap, Kentucky; Jimmy Vacek collection. COLORFUL agate and sparkling drusy crystals line the interior of this "coconut" geode from Laguna, Chihuahua, Mexico; 11.2 cm across; Houston Museum of Natural History collection. QUARTZ geode from Rancas, Mexico; 3.6 cm wide; Jimmy Vacek collection. Photos © Jeff Scovil.

2. What are Keokuks?

Keokuk is actually a town and a county in the state of Iowa. Keokuk geodes are roughly spherical quartz formations that have drab, knobby outsides but hollow interiors that are lined with sparkly quartz crystals all pointing toward the center. The geodes range in size from very small (pea-size is reported, but we've never seen any nearly so small) to two or three feet in diameter; most that we have seen range from baseball to basketball size.

Found within a 40- to 50-mile radius of the town of Keokuk in a number of sites on either side of the Mississippi River in Iowa, Illinois, and Missouri, these geodes have been well known since the mid-19th century when A. H. Worthen, Director of the Geological Survey of Illinois, sent choice specimens by the barrel to museums the world over. So abundant are Keokuk geodes that Iowa farmers were supposed to have used them to build silos — and in one alleged usage, a service station! Southeastern Iowa boasts a Geode State Park, and in area yards you really can see geode flowerpots, birdbaths, rock gardens, and other (sort of) utilitarian or decorative objects. In 1967, the Iowa legislature officially named the geode its state rock.

The Keokuk geodes are found in the Warsaw (geological) formation, a sequence of highly fossiliferous shales and limestones, of Mississippian age — roughly 250 million years old, formed back when dinosaurs were still no more than a gleam in God's eye. Although the formation is named for exposures at Warsaw, Hancock County, Illinois, it outcrops over at least eight states, and was named in 1857 by James Hall, pioneer American geologist and paleontologist. Hall referred to its bottom layers as the "geode bed," which he described as "soft shaly or marly [with fine grained calcite] with geodes of quartz chalcedony" (Wilmarth, M. G. 1938, 2276).

3. How do Keokuk-type geodes form?

This question has occupied the attention of some of America's best geologists since well back in the last century — with some peculiar results. Early workers thought the geodes from the Keokuk area (see Question 2) might be infillings of cavities originally occupied by sponges, a theory that attracted so many adherents that one S. J. Wallace named an entire sponge genus,

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Often called Bristol stones or potato stones, the famous Dulcote nodules from the Mendip Hills in Somerset, England, have also been shown to be replacements of anhydrite nodules formed in a *sabkhas* environment. The very limpid quartz crystals found inside them have been known as "Bristol diamonds" since at least the 16th century.

4. What's the difference between a nodule and a geode?

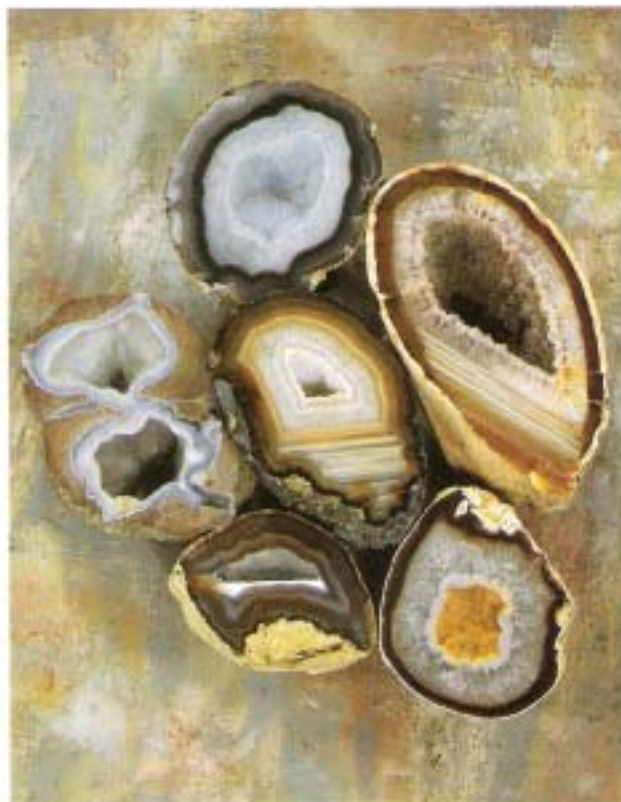
A nodule has 100 percent fewer cavities.

That's one way of answering the question: "Does a geode have to be hollow?" Actually, this quip might better reflect current opinion if the answer were 74 percent, as we shall soon see.

Almost any definition of a geode includes the stipulation that it be hollow. However, as anyone who has ever dug at a geode locality knows, not all of those roundish rocks that are supposed to be lined with beautiful crystals turn out that way when you open them. At least some turn out to be solid mineral matter, or as Dad used to call them with astonishing technical precision: duds. (Actually, he usually threw in several Anglo-Saxon adjectives to describe what kind of duds they were!)

Other authority figures besides Dad also seem to assume that some geodes are not hollow. Because some Keokuk-type geodes contain crystals of some of the most important sulfide ore minerals on which our metal-based civilization depends — pyrite (iron sulfide), sphalerite (zinc sulfide), chalcocite (iron and copper sulfide), and rarely millerite

Continued on page 75



Some agate geodes have centers lined with druses, layers of small, uniform, sparkly crystals. These geodes are from Brazil. Photo © Harold and Erica Van Peit.

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More recently, sedimentary petrologists have uncovered convincing evidence that Keokuk geodes and others from similar environments are silica replacements of the mineral anhydrite (named for its composition, anhydrous

Geodes . . .

(continued from page 46)

(nickel sulfide) — geologists who study these ore deposits have described these geodes. In their writings, they have referred to the possibility of filled — that is, not hollow — geodes. In addition, popular writers on mineral collecting commonly refer to the good geodes as the hollow ones with crystals and the others as those that are solid.

In an effort to establish a consensus, we examined 70 authoritative definitions of geodes and found that 52, or 74 percent, specified hollowness; 15 (21 percent) said that they could also be solid; and three (four percent) said that they could be filled with earth or clay (one percent got rounded off). You could say that all Keokuk-type geodes were hollow at some point in their careers but that some are filled with mineral matter now.

Scientists don't make the rules, they just try to figure them out, and Nature's rules seem to have lots of loose ends. How much easier it is for the guys on the committees who make the rules for the National Football League!

5. Where can I hunt for my own geodes?

For this question, we turned to *Lapidary Journal's* own June Culp Zeitner, who told us that right across the border

from Keokuk, Iowa, in Wayland, Missouri, is the Sheffler geode mine, which produces classic Keokuk geodes that anyone can hunt for a fee. Call the rock shop at 660-734-6443 for details.

About nine miles west of Scenic, South Dakota, a National Grasslands site produces small geodes, about an inch or

Geodes on Display

Want to see a lot of geodes? A fine display is planned for this month's San Francisco Gem & Mineral Show held July 31-August 1 at the San Francisco County Fair Building (formerly the Hall of Flowers), Golden Gate Park, 9th Avenue & Lincoln Way. And just in case you still want to know more about geodes by then, go hear Si Frazier's talk on them on Saturday at 11:30. He'll be delighted to take additional questions!

two across, filled with quartz crystals and chalcedony. "Some of them are pinkish on the outside," June commented. "I'd like to get someone to tumble-polish them and drill them for me, so I could string them as beads." The locality is near where the railroad tracks lie close beside Highway 44. For further details, she suggests contacting the gem and mineral club in Rapid City.

Clubs are often a good source for finding a locality and checking on its collecting status; to contact the club, look in the Clubs section of the *Annual Buyers' Directory*, May issue of *Lapidary Journal*, arranged by state and then city. Other sites with geode potential and the area club to contact are: a site on private land in Knoxville, Tennessee (Knoxville club); a site near Jackpot, Nevada (Reno club); Rockhound State Park, on public land in New Mexico (Deming club); Pagosa Springs, Colorado (Durango club); between Grand Junction and Delta, Colorado (Grand Junction club); and Challis, Idaho, on the Salmon River (Boise club).

If you're not that picky about the exact definition of a geode and just want something with crystals inside a roundish rock, June also reminded us that some of the Oregon thunderegg localities near Ashland produce hollow-centered things as well as filled nodules (Grants Pass club) and that in Utah, the Dugway geodes may be more like concretions but what the heck (Salt Lake City club)!

Even if you know where a locality is, always be sure to check before going to see whether that or any site is open to collecting and if so, under what circumstances you will be allowed to collect. ♦

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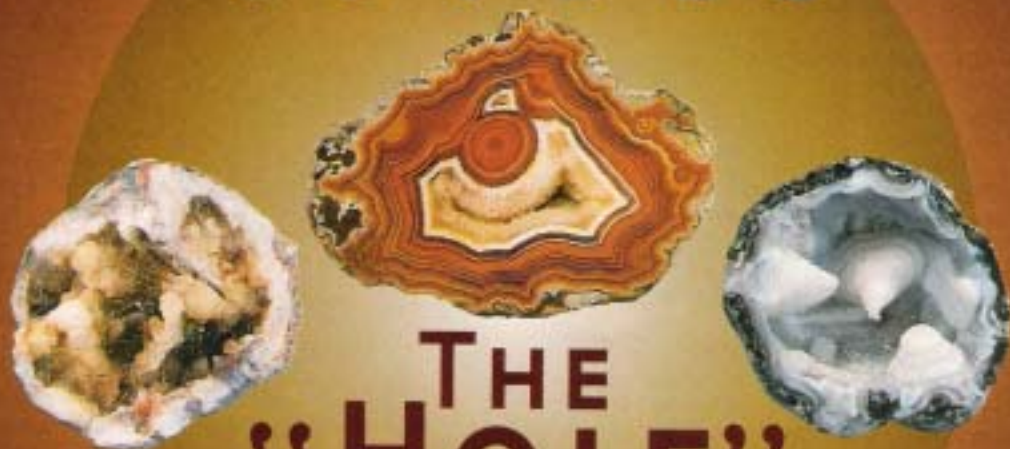
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GEODES



THE "HOLE" STORY

PART 2 OF 2

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BY SI & ANN FRAZIER, Foreign Correspondents

6. What are amethyst cathedrals?

Very popular as decorative objects, these are amethyst-lined geodes that bear an outline somewhat reminiscent of Gothic cathedrals, with small bases and sides that curve gracefully up to a small apex. "Cathedrals" are seldom less than a foot high and some giants are taller than a man. The description seems to have originated with dealers in Brazil, source of these dramatic geodes, who call more equidimensional or irregularly shaped specimens simply amethyst geodes. Sliced lengthwise and with their interior rims of agate polished, most cathedrals offered on the market weigh 10 to 100 pounds, and some weigh several hundred.

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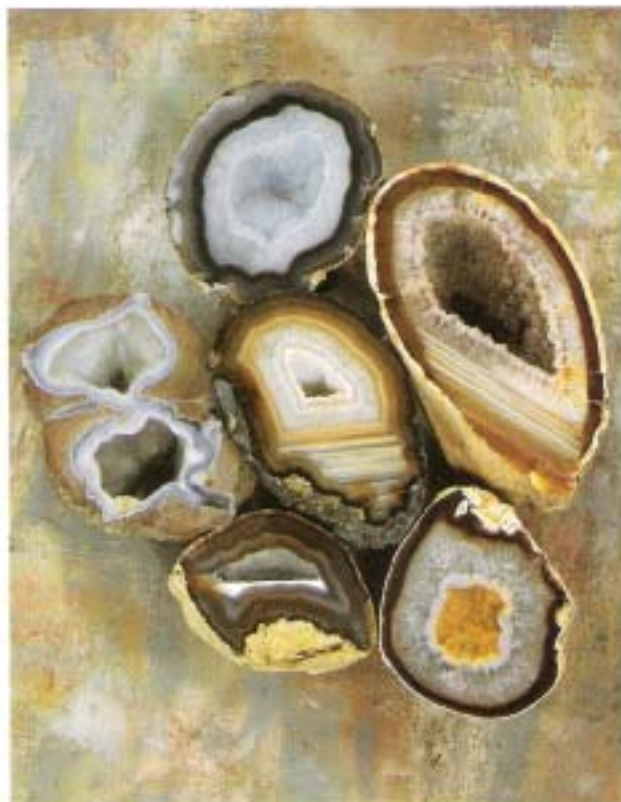
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Continued on page 75



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axis rather than the horizontal "a" axis, as is true of nearly all other chalcedony. No one has been able to explain this weird behavior, but thin slices of the wavy material have been used to make very attractive pendant pieces, which not only look good but make good conversation pieces, too.

If anyone can supply any information about this strange geode occurrence or the origin of the term "coco," we would dearly love to hear it. Send comments to: Si & Ann Frazier, 6331 Fairmount Avenue, Suite 306, El Cerrito, California 94530.

9. What are coconuts?

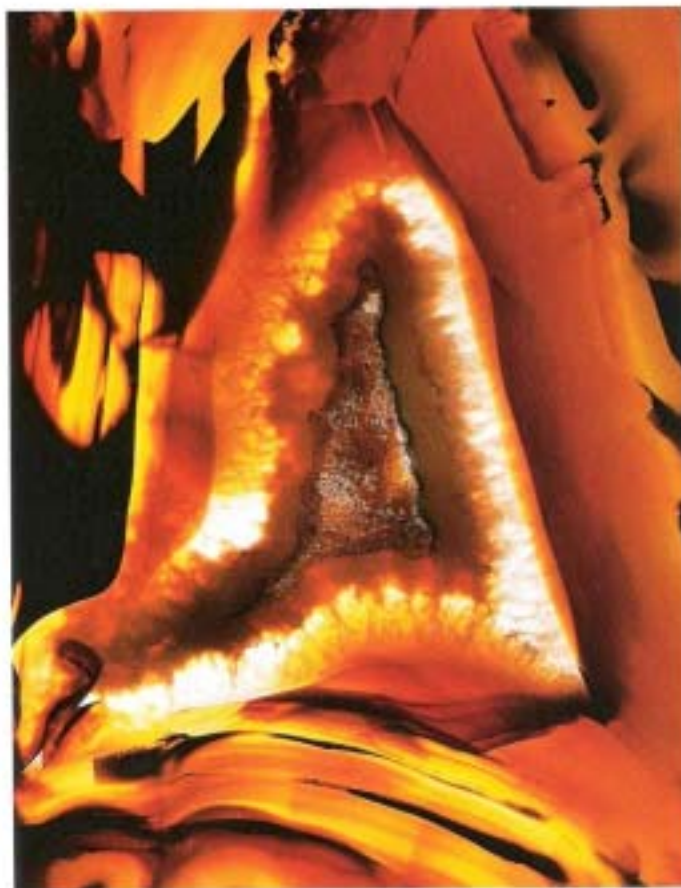
Roundish nodules of rock that contain agate, quartz crystals, and sometimes very tiny crystals of a number of rare minerals, so-called coconuts not only vaguely resemble the coconut fruit, they also look a lot like the classic Keokuk geodes (see Question 2), but they have quite different origins, occurring in igneous rather than sedimentary rocks.

Found in northern Chihuahua, Mexico, in what is now a bentonite clay, coconuts formed as fillings of gas bubbles in a volcanic glass. The glass formed as a thick accumulation of air-laid hot glass shards (volcanic ash) that fused together to form what geologists call a vitrophyre. As the glass cooled and began to crystallize, gases were released and formed the round bubbles that would eventually house the geodes, and the glass altered to the clay.

Dr. Peter Keller, who did his Ph.D. thesis on this area, estimates that 8 million years elapsed between the formation of the vitrophyre with its big bubbles and the time when nearby intrusions of rhyolite (silica-rich rock) lava caused groundwater to circulate and build up silica in the cavities, lining the coconuts with crystals (Keller, P.

1977, 99). Since both formed in very similar manners, coconuts and thundereggs are closely related geologically, although coconuts lack thundereggs' starlike pattern and jasperlike matrix of silicified rhyolite.

In his excellent book on the agates of northern Mexico, Brad Cross estimates that over 75,000 pounds of coconuts are mined each year from the two-square-mile area "about 22 miles east-northeast of Laguna Enciñillas" (1996, 99). If any-



An agate geode from Brazil shown against a background of brilliant agate patterning. The Brazilian agate geode is the source of most of the commercial jewelry world's carnelian, red-and-white agate, and when dyed, black, green, and blue onyx. Photo © Harold and Erica Van Pelt.

thing, we suspect this estimate to be low: back in the 1960s when we ordered as much as a half ton at a time for our shop, the dealers made it clear that they were doing us a big favor by accepting and processing such a small order!

Cutting coconuts was like putting silver dollars into a slot machine: would this one be a winner? Some were lined with beautiful, sparkling amethyst or smoky quartz crystals, while others were solid agate. Frequently, the agate was tightly banded, alternating highly translucent layers with those that were

opaque. When properly cut, such an agate would "wink" at you. We called it shutter or Venetian blind agate; in agate-cutting Idar-Oberstein, Germany, it is called *Wäglar*.

Besides amethyst, Dr. Adolf Pabst, mineralogy professor at the University of California, Berkeley, identified goethite needles with various microscopic crystals perched on them, including ramsdellite apparently pseudomorphous after groutite. Using some of

Pabst's work as well as that of Dr. F. T. Jones, two U.S.G.S. scientists eventually identified at least 17 minerals in these geodes. (All are described in Cross's book and an article by Robert Finkelman et al. in the *Mineralogical Record*; a summary by R. Finkelman was also published in the *Lapidary Journal*).

10. How can you tell if an unopened geode will be hollow?

In the late 1960s, dealers from El Paso, Texas, who imported "coconuts" from Mexico (see Question 9), began to offer "guaranteed hollow coconuts" at sharply advanced prices, usually with return privileges if a geode turned out to be a dud. We never got to return any — something we found pretty amazing. Everybody knows that you can make an educated guess by judging the "heft" of a nodule — and everybody who's tried it also knows that you won't always be correct. How did they do it?

We puzzled over this until finally the late Warren Jones told us how he sorted coconuts by the truckload quickly and accurately. He started by building a pond into which he dumped oil-well-drillers mud, a mixture of clay and ground barite, to raise the density of the slimy pond. Next, he sawed some coconuts in half; graded them as fine, thin-shelled hollows, semi-hollows (smaller central cavity), or solids; painted the shells blue, red, or green, accordingly; and glued the graded geodes

Continued on page 88

back together.

Then he put these samples into the pond and carefully adjusted the density of the fluid just so (barite to raise it, clay to lower it) to separate the different color-keyed coconuts according to how well they floated (or didn't). Finally, he'd dump in a truckload of untested geodes and let gravity do its thing: all he'd have to do then was scoop out the geodes that floated well on top and put them into the "guaranteed hollows" pile, and offer them for sale.

11. How many kinds of geodes are there?

The main types of geodes are 1) Keokuk-type, 2) amygdules, 3) thundereggs — but there are others, or other types of nodules that might be construed as geodes.

Besides Keokuk-type (see Question 2), other hollow nodules might include (in declining importance): amygdule-type (gas cavities in basaltic rocks); thunderegg-type (cavities in spherulites in perlitic volcanic glass formed by the accumulation of shards of volcanic ash); polyhedroids (agates formed in the interstices of tabular calcite crystals); fossils (cavities in fossils or animals or plants); solution cavities in sedimentary rocks (not the usual

sort of geode but cropping up often enough in the geological literature); and veins (cavities lined with crystals are usually called vugs, but in the older literature have also been called geodes).

Even some eagle stones could easily be interpreted as what we would now call geodes, although some we now call ironstone concretions have a more interesting history. Called "rattlestones" or "rattle boxes," the most highly prized were those in which a pebble or crystals could be heard rattling around in the central cavity. In a rather obvious case of the application of sympathetic magic, such stones were thought to be particularly appropriate talismans for pregnant women, recommended to avoid miscarriage and to ease the pains and difficulties of childbirth. ♦

Bibliography

- Blankenburg, H.J. (1988) Achat, Eigenschaften, Genese, Verwendung. Leipzig: VEB Deutscher Verlag für Grundstoffindustrie.
- Chown, T. M., and J. E. Elkins (1974) The origin of quartz geodes and cauliflower cherts through the siccation of anhydrite nodules. *Journal of Sedimentary Petrology*, Vol. 44, September, 885-903.
- Cross, Brad (1996) The agates of northern Mexico. Edina, Minnesota: Burgess International Group, Inc.
- Finkelman, Robert B., et al. (1972) A scanning electron microscopy study of minerals in geodes from Chihuahua, Mexico. *Mineralogical Record*, Vol. 3, No. 5, 205-212.

Finkelman, Robert B. (1974) A guide to the identification of minerals in geodes from Chihuahua, Mexico. *Lapidary Journal*, February, 1742-1744.

Fisher, Irving S. (1977) Distribution of Mississippi geodes and geodal minerals in Kentucky. *Economic Geology*, Vol. 72, No. 5, 864-869.

Fleener, Frank L., and Ben Hur Wilson (1948) Notate's Pandora boxes. *The Mineralogist*, September, 402, 404, 406.

Hodgkin, R. R. (1978) The geological setting of the nodules of Dulcote, Somerset. *The Journal of Gemmology*, Vol. XVI, No. 2, April, 77-85.

Hayes, John B. (1964) Geodes and concretions from the Mississippian Warsaw formation, Keokuk region, Iowa, Illinois, Missouri. *Journal of Sedimentary Petrology*, Vol. 34, March, 123-133.

Hill, John (1748) *A History of Fossils*. London: Thomas Osborne.

Keller, Peter Charles (1977) *Geology of the Sierra del Gallego area, Chihuahua, Mexico*. Austin, Texas: University of Texas at Austin, 124 pages, plus maps. An unpublished Ph.D. thesis.

Murray, R. C. (1964) Origin and diagenesis of gypsum and anhydrite. *Journal of Sedimentary Petrology*, Vol. 34, September, 512-523.

Siedlecki, Anep (1972) Lengthy-low chalcidony and nests of sulphates — evidences of evaporitic environments in the upper Carboniferous and Permian beds of Bear Island, Svalbard. *Journal of Sedimentary Petrology*, Vol. 42, December, 812-816.

Sizate, Stephen R. (1959) The fabulous Keokuk geodes. Vol. 1. Des Moines, Iowa: Wallace-Hornstead Co.

Tucker, Maurice E. (1976) Quartz-replaced anhydrite nodules ("Bristol Diamonds") from the Triassic of the Bristol District. *Geological Magazine*, Vol. 113, 569-576.

Van Tuyl, F. M. (1916) The geodes of the Keokuk beds. *American Journal of Science*, Vol. XII, Fourth Series, 34-42.

Wilenath, M. Grace (1938) *Lexicon of geological names of the United States (including Alaska)*. United States Geological Survey Bulletin 690.



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