**Unique Microstrutures and Complex Micro-Mineral Associations in a Single Keokuk Geode**

Nova Mahaffey and Robert Finkelman

Search and Discovery Article #51638 (2020)**

Posted January 27, 2020

*Adapted from poster presentation given at 2019 AAPG Southwest Section Meeting, Dallas, TX, United States, April 6-9, 2019

**Datapages © 2020. Serial rights given by author. For all other rights contact author directly. DOI:10.1306/51638Mahaffey2020

1The University of Texas at Dallas, Richardson, TX, United States (nxm154030@utdallas.edu)

Abstract

From a suite of Keokuk geodes collected in Hamilton, Illinois, we selected a single geode for a detailed micro- mineralogical study. Keokuk geodes are specific to the dolomitic beds of the lower Warsaw unit in the Keokuk Formation. This sedimentary marine deposit is a consequence of a regressing epicontinental sea during the Mississippian period. Optical microscopy and scanning electron microscopy revealed a surprisingly complex network of elaborate intergrowths linking multiple generations of minerals which exhibit a wide array of crystal habits. This geode has a chalcedony shell as well as quartz and calcite euhedra, typical of geodes from this locality. Platy hexagonal kaolinite crystals are littered throughout the geode on and in quartz, calcite, and siderite. Kaolinite included calcite exhibits several habits including flow structures with ripple marks, a stair-stepped box texture, and euhedral crystals. Manganese carbonate micro-spheres grew from micro-drusy quartz and exhibit a variable Fe and Mn composition corresponding to the rhodocrosite- siderite series. Siderite appears as hallow spheres, about 5-10 microns in diameter, with growth rims indicating multiple phases with varying iron concentrations. Siderite also coats calcite euhedra with a multi-layered crust a few microns thick. Micro-crystals of acicular siderite grow from edges of kaolinite grains that settled atop the siderite-coated calcite. Most unusually, siderite appears as a box-like rectangular-to-rhombic lattice with a sub-botryoidal texture and incorporates the larger siderite spheres. This unique microstructure creates a ‘framework’ resulting from the systematic replacement of calcite along cleavage planes. The subsequent dissolution of calcite leaves the framework exposed to oxidation, resulting in the iron oxide goethite. Organics are also present in the form of 50-100 micron bitumen particles which host microcrystals of K and Na salts. Several additional minerals have been tentatively identified including: ponite, pyrite, sylvite, hollandite, feldspar, barite, and an unidentified REE carbonate. The mineralogy of this geode offers a microcosm illustrating the complex geologic process of secondary mineralization that occurs during the lithification and diagenesis of sedimentary beds.

References Cited


**UNIQUE MICROSTRUCTURES AND COMPLEX MICRO-MINERAL ASSOCIATIONS IN A SINGLE KEOKUK GEODE**

Nova Mahaffey and Robert Finkelman

University of Texas at Dallas, Department of Geosciences, 800 W Campbell Rd, Richardson, TX 75080

---

**Abstract**

Front studies of geodes collected at Hamilton, Illinois, have been limited. In order to develop a comprehensive understanding of geode mineralogy, a study was conducted to examine the microstructures and complex micro-mineral associations present in geodes from the Keokuk Formation. The results of this study reveal a unique combination of minerals and microstructures that were previously unknown. The study also provides insights into the diagenetic processes that occurred during the formation of geodes.

**Introduction**

Geode Formation

Geodes are naturally occurring cavities that are filled with a variety of minerals. The Keokuk Formation is known for its unique geodes, which are commonly found in sandstone and siltstone units. The formation is composed of well-sorted sandstone and siltstone layers, which provide ideal conditions for the formation of geodes.

**Methods**

To perform a comprehensive analysis of a single geode, it was chosen to be the sole focus of this study. The geode was washed, dried, and cut open, revealing the complex microstructures and mineral associations present. The samples were then mounted and analyzed using various imaging techniques.

**Observations**

**Results**

**Conclusion**

The study of the Keokuk geode reveals a unique combination of minerals and microstructures that were previously unknown. The results also provide insights into the diagenetic processes that occurred during the formation of geodes.

**Acknowledgements**

I would like to recognize Dr. Stern and the UTD Geoscience faculty and staff for their continued support throughout my academic career and for providing me with the knowledge and resources required to execute this project. I would also like to thank my wonderful peer, Leah Thompson, and Alessandra Sea Lander for the endless encouragement throughout this entire endeavor.

**References**

[Insert references here]

---

**Figures**

[Insert figures here]