# Rebuttal to Dan Hurd on Thunderegg Formation

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Dan Hurd is a Youtube and TikTok blogger, that posts several interesting mining videos usually some location X somewhere in North America he won't specify, and he talks about the geology of the site. He now has some 1.3 million followers so a response to his comments of 9-27-2024 on Facebook is worthwhile as it promotes a number of 1800's era tropes on how geodes/thundereggs form. The highlights of his post from facebook.com/reel/379594898534827 are:

1. Thundereggs form in perlite.
2. Perlite is compressed volcanic ash.
3. Over millions of years water percolated down in the ash bed creating a mud.
4. As this mud dried out it compressed it and shrank, creating voids in the mud.
5. Water coming in (weathering) was high in quartz from this ash.
6. The water with dissolved quartz started depositing in the pockets, hardening the ash around it.
7. This process made spheres of silicated perlite with a hard shell. In the center is always a void with the quartz.
8. This process laid down layers of the quartz and/or opal inside.

His discussion is really this simple and in quick fashion describes his idea how geodes (for Oregon miners and apparently he was in Oregon at the time, called thundereggs), which is the tech of the 1800's. This tech is widely used in geology and chemistry and physics as it promotes bland, simplistic notions that Europeans proposed at the time with just observation and no scientific instruments except microscopes and some other basic measurement tools. These tropes get repeated as they are easy to conceptualize and make writing science books fast and cheap. Let us review each item one at a time.

1. **Thundereggs form in perlite.** This is promoted and is the basic idea of Robert Colburn (the Geode Kid) whose major thesis on this idea the author publishes. This work lays down a great set of observations and some speculations based on the microscopy and refractive index and basic chemistry of the time up to the 1970s when he began writing his works in a story series. It turns out the author has laser infrared spectroscopy that allows looking at the composition of minerals in detail, focusing on silica and feldspar mineral groups, that form the basis of lava composition. All lavas are a silica and a feldspar, that change with the lava type. What does study for over a decade of these rocks show? The crumpled rock Hurd dug in to get his geodes is a decomposed mix of quartz and feldspar and is not perlite. Perlite is hydrated obsidian glass, but the host material of these geodes from any site in the world has no perlite.
2. **Perlite is compressed volcanic ash.** No, compressed volcanic ash is tuff, but perlite is hydrated obsidian glass, not found around geodes. The confusion comes from the caprock over geode deposits which is obsidian and perlite. The rocks may be tilted, and those are then considered obsidian dykes. While obsidian is a marker for the water necessary to form geodes, close is not good enough, the geodes are not in obsidian or perlite. The confusion is that small orbs of cristobalite can form in obsidian, but these never expanded to form geodes. They remain as we find them as orbs of powdered cristobalite.
3. **Over millions of years water percolated down in the ash bed creating a mud.** First, when the phrase "millions of years" or its cousin "billions of years" is used in any science setting, be aware it is social slang that means "and then magic occurs," and is a social substitute for understanding what occurred. Many geologic and astronomical structures are explained with this. Even in biology, evolution occurs because DNA exists and over millions of years, magic happens but DNA alteration of any plant or animal so far, appears to just make diseases. Water does not percolate in ash to make mud. It makes caliche, a combination of mostly calcite and some quartz as weathering moves carbonates on a scales thousands of times more soluble than quartz. The whole reason our beaches of the world outside of coral atolls are quartz, is that quartz is so totally insoluble

with weathering, it only gets to the beaches by mechanical grinding and water transport in rivers. This whole notion silica moves to and fro in solution readily from weathering is bunk and needs to stop. No agate occurs anywhere on earth in any granite, schist, shale, or serpentine rocks, although they all have voids, all have quartz, and are all subjected to weathering. The agates are only formed in volcanic rocks that includes volcanic ash. Agates in ash form nodules, silica with no shells whatsoever, ever.

4. **As this mud dried out it compressed it and shrank, creating voids in the mud.** Voids in ash with silica migration forms nodules with septarians structures, but never geodes/thundereggs.
5. **Water coming in (weathering) was high in quartz from this ash.** Yes, water percolating through ash is high in silica. On land it forms nodules and silcrete (silica layers below the surface a few feet), and ash dumped in the ocean forms chert and mixed tidal water with some fresh water forms cherty agates, agates with chert (fine grained quartz) host rock around them, but not shells around them.
6. **The water with dissolved quartz started depositing in the pockets, hardening the ash around it.** The shells of all geodes are lava as andesite, dacite, or most commonly rhyolite. Some geode shells are feldspar. No shells are perlite or silicified ash. The reason gets to how geodes really form. As lava cools, the feldspar and quartz separate, aided by water. The feldspar goes into the shell or remaining country rock and the silica accumulates into spheroids due to surface tension. High silica content left over captures some of the host lava. A byproduct of this geochemical reaction is the clay celadonite that is deposited in the outermost shell, allowing the geodes to be separated from the country rock, but some can get mixed into the central silica, and then we call it tube and moss agate.
7. **This process made spheres of silicated perlite with a hard shell. In the center is always a void with the quartz.** What defines a thunderegg so very common to Oregon geodes is that the centers are solid quartz. Geodes are named when a central void of substantial size remains in the center, usually a third of the central rock cut area.
8. **This process laid down layers of the quartz and/or opal inside.** Layers of deposited quartz is called chert. There is no granular quartz in agates so that they never can be called cherts. He confuses layers with the whole process of how agates really form. In short, cooling lava separates quartz and feldspar. The cooling occurs with water which is supercritical, a gas over 374 C with pressure. This gas and absorbed silica from this separation (called exsolution) creates the vapor deposition where quartz as fibers is deposited on void walls. The supercritical fluid comes out of the melt as the rock cools, forming the voids. It also occurs if a breach causes decompression of the lava, hence forming of geodes in dykes. Without this supercritical fluid state, water cannot create wall silica deposition. There is no such thing as sticky physics for water, but in supercritical fluid all the physics changed most notably there is no more surface tension to control the water movement and restrict crystallization. As the system cools and goes subcritical, there is no more supercritical fluid obviously, so what is it? It separates into water and water vapor gas. This water forms the waterlines Hurd and so many others confuse with intruding deposition and the top forms quartz crystal pockets in the vapor.

**Conclusion:**

Hurd mined a weathered rhyolite deposit, probably a domal structure, and confused that with how all agates of the world must form, ignoring for example, crushing solid andesite lava to get out agates in Laguna Mexico. Tractor demolition jackhammers are used to extract the agates, which is why so many are fractured. No groundwater circulation ever existed to make them. Agates in lava form in supercritical fluid conditions and cherty agates in the ocean embayments form obviously in hot but subcritical conditions, which is why 95% of the inclusions and structures of lava agates are not found in cherty agates. A complete study of agate inclusions, structures, and host rock tells the full story that so many scientists and geologists like Hurd just don't care to consider, but is the basis of over 10 years of the author's work. With 23 books so far, you can get a hint how complex the geology of agates really is.