

About the inclusions in moss agates from the Priday Ranch near Madras, Oregon, USA

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[English translation by Johann Zenz using the DeepL translation software]

When you come across the names Priday Ranch or Richardson Ranch, you tend to think back to the days when you could collect thundereggs yourself, equipped with a white plastic bucket provided by the ranch owners. Payment was then made according to the weight of the finds. The recently published book on thunder eggs from Oregon (Van Cura, 2025) inspired us to put some of our own observations about these agates down on paper.



Collectors at the so-called Moss Bed, one of the main sites for thundereggs with moss agate structures on the Richardson (formerly Priday) Ranch. Situation in 2008.

Johann Zenz photo.

A relatively large number of finds from the Priday Ranch are lithophysae (thundereggs) filled with moss agate. Below are photos of the precursors to such moss agates and of compact, finished thundereggs that have developed from them. The photos provide information about the nature and formation of the “moss inclusions” – in particular, that the “moss plants” already existed when the actual agate formation (SiO_2 deposition) began. This confirms the information provided by Wörner (2010), which also concerns moss agates from Oregon. However, this is only of marginal importance here. The main focus here is on the bizarre patterns that can be observed when magnified sufficiently.

Very peculiar structures can also be observed when viewing individual “moss plants” under a microscope. Please note: When terms such as “moss plants” or “tubes” (in quotation marks!) are used in this note, they refer ONLY to the morphology of the objects. Anyone interested in the various suggestions for the formation of moss agates from the USA should refer to the following sources: Brown (1957), Campos-Venuti (2022), Kile (2002), Pabian & Zarins (1994). A wealth of images can also be found in the monograph by Peter Wörner (2010). The objects shown below come from the Pony Butte and Blue Bed prospecting sites in the Priday Ranch area. The pieces are in the authors' collection.



A moss agate site on the Richardson Ranch. The slowly decaying sign is a reminder of times long past, when generations of collectors visited the ranch and found beautiful agates. Johann Zenz photo.



Fig. 1: Here, an early stage in the formation of moss agate in a thunderegg cavity is documented: a thin, greasy-looking layer of SiO_2 has been deposited on the wall of the rock cavity. A similar layer of the same thickness has been also deposited on the thin brown threads, which can only be faintly seen here in the winding “worms.” (For a few words on the nature of the central dark “threads,” see the text accompanying Fig. 13). Pony Butte. Image width 4.1 cm. Photos, unless otherwise stated: Ulf Thewalt and Gerda Dörfner.



Fig. 2: Similar to Fig. 1, both the cavity wall and the initially present central threads are covered with greasy, shiny SiO_2 . The shine and surface pattern are similar to those of hyalite. The growth of the “worms” obviously came to an end when they hit the bottom of the lithophyse. Where is the top and where is the bottom? The answer can be found in the presence of a remnant of gravitationally deposited white agate at the bottom right of the image. Pony Butte. Image width 2.4 cm.



Fig. 3: Accumulation of parallel “worms” in a thunderegg. Their structure is visible on the broken parts: dark core wrapped in concentric white and colorless SiO₂ encrustations. Pony Butte. Image width 1.6 cm.



Fig. 4: In the case of “worms” with a warty, smooth surface (as in Fig. 2), the internal structure becomes visible when the objects are placed in a suitable liquid, as shown here. The brown material of the “worm core” is obviously crystalline. These are probably crystals of an iron-bearing clay mineral that has been deposited on an existing thread of organic substances. Pony Butte. Image width 3.2 mm.

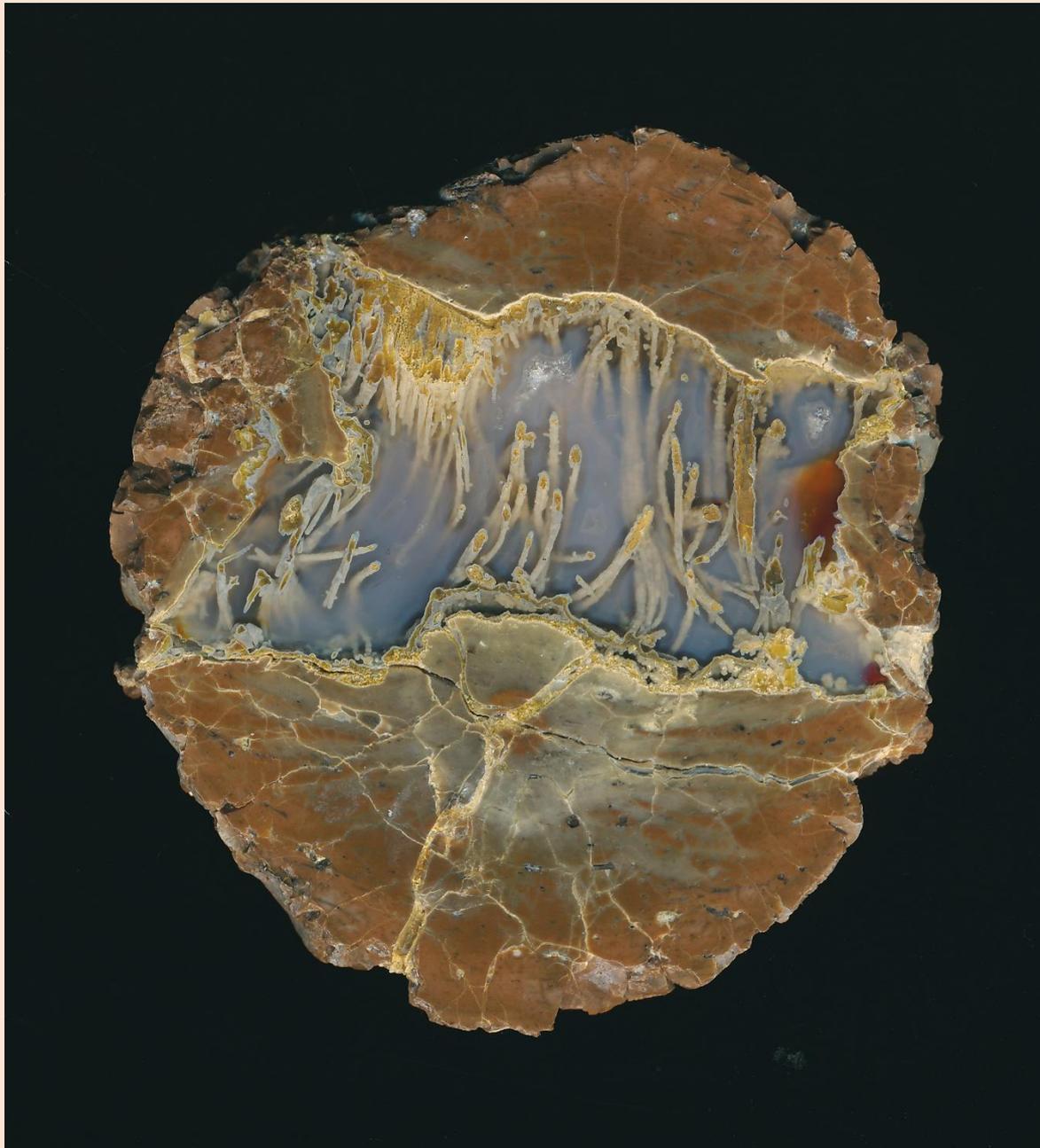


Fig. 5: Typical compact moss agate from the Blue Bed. It can be assumed that it was formed in a thunderegg, such as those shown in Figs. 1 and 2, through continuous chalcedony deposition. Width 4.8 cm.



Fig. 6: Thunderegg with interesting components:

- (1) Bottom left: The white-cloudy surface of a layer package with Onyx Banding.**
- (2) Center: Clusters of bluish shimmering round SiO_2 aggregates.**
- (3) Right of and on (2): several horizontally oriented (probably broken off early and overturned) "worm-like" structures (type as in Figs. 1–3).**
- (4) In the background, bulbous-looking aggregates of a zeolite (?).**

Pony Butte. Horizontal diameter of the cavity is 4.4 cm.



Fig. 7: A multitude of relatively small “worms” form a tangle here, which (probably) grew on the floor of the thunderegg cavity. Pony Butte. Image width 4.6 cm.

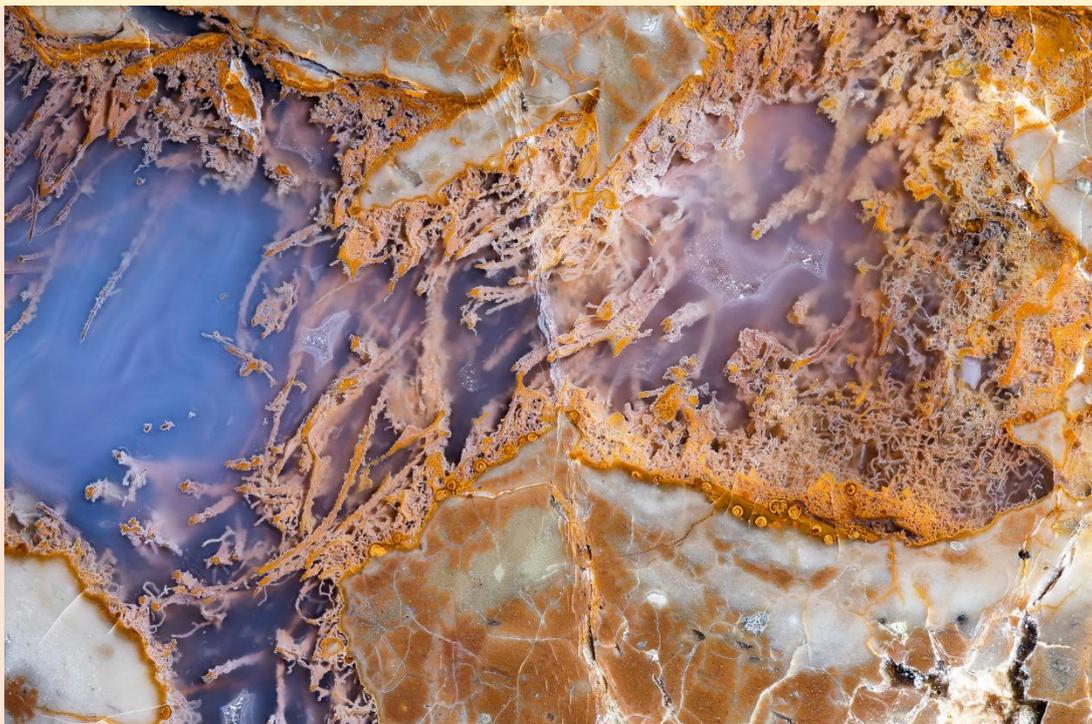


Fig. 8: “Worms” as in the previous figure can be seen here in a finished thunderegg. The colors in the picture are only approximate. Because the stone is very dark, the photo has been brightened considerably; otherwise, the “worms” would be difficult to see. Pony Butte. Image width 4.4 cm. Gerhard Schenk photo.



Fig. 9: It is not clear whether the elongated, relatively thick structure grew from the floor or ceiling of the cavity. It probably developed from a thin “worm” through continuous SiO_2 deposition. Blue Bed. Width 5.9 cm.



Fig. 10: Structures of the type shown in Fig. 9 are enclosed here in a compact, finished thunder egg. Nothing remains of the formerly dark veins. In their place, a few grains of colorless reaction products remain. Blue Bed. Image width 2.6 cm.



Pony Butte deposit. Richardson (former Priday) Ranch. Johann Zenz photo.



The Blue Bed area has been intensively mined. Johann Zenz photo.



Fig. 11: Flat, net-like “growths” are also common. In this image, the nets with little SiO_2 encrustation have grown in the vicinity of the central mound of the thunderegg. Blue Bed. Image width 4.8 cm.

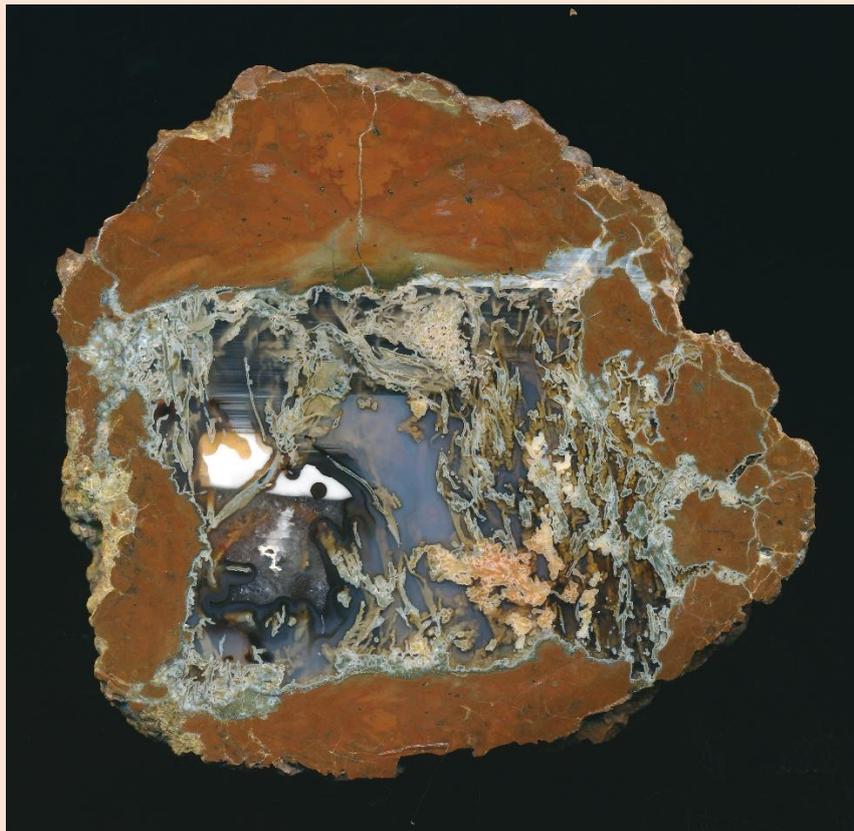


Fig. 12: For comparison with Fig. 11: Finished thunderegg from the Blue Bed, in which isolated, tube-like inclusions occur alongside net-like inclusions. Width 9.5 cm.



Fig. 13: Almost all agates from the Priday Ranch contain “worms,” i.e., tube-like formations: The core is dark (yellow, orange, brown, or red) or discolored, and the shell is usually gray. Iron-oxidizing bacteria were probably involved in the formation of the dark core. The oxidation products were deposited in or on the string-forming bacteria (Schmitt-Riegraf & Riegraf (2015), Konhauser (2007)). The “tube” is nothing more than a thin, cloudy chalcedony band, which also occurs as a wall-parallel band. Pony Butte. Polished section. Image width 3.6 mm.



Fig. 14: This photo suggests that the primary bacterial filaments were very thin. They are clearly encrusted to varying degrees with a yellow-orange mineral (heulandite?). When subsequently embedded in chalcedony, no cloudy SiO₂ material was deposited here, i.e., no “tubes” formed. Pony Butte. Polished section. Image width 1.7 mm.



Fig. 15: Relatively large grains of a yellow mineral (heulandite?) trace the course of former bacterial filaments. Polished section. Pony Butte. Image width 1.8 mm.



Fig. 16: Larger “moss aggregates” often reveal a pattern of many thin threads oriented approximately parallel to each other. Polished section. Pony Butte. Image width 3.6 mm.



Fig. 17: This photo also proves that the yellow-brown veins of the “tubes” (see Figs. 1 and 2) grew before the start of SiO_2 deposition, i.e., before the actual agate genesis. This is because the cloudy chalcedony band, which gives the impression of “tube walls,” also covers the rhyolite inner wall of the geode (upper area in the image) along with the primary deposits of iron oxides, clay, and zeolite minerals. Polished section. Pony Butte. Image width 3.6 mm.



Fig. 18: Here we see bundles of “threads.” It is clear that the colonization of the thunderegg wall by organisms occurred before the actual agate formation (chalcedony deposition). Sheaths around the individual threads are not visible, but sheaths around the thread bundles are. Blue Bed. Polished section. Image width 3.6 mm.

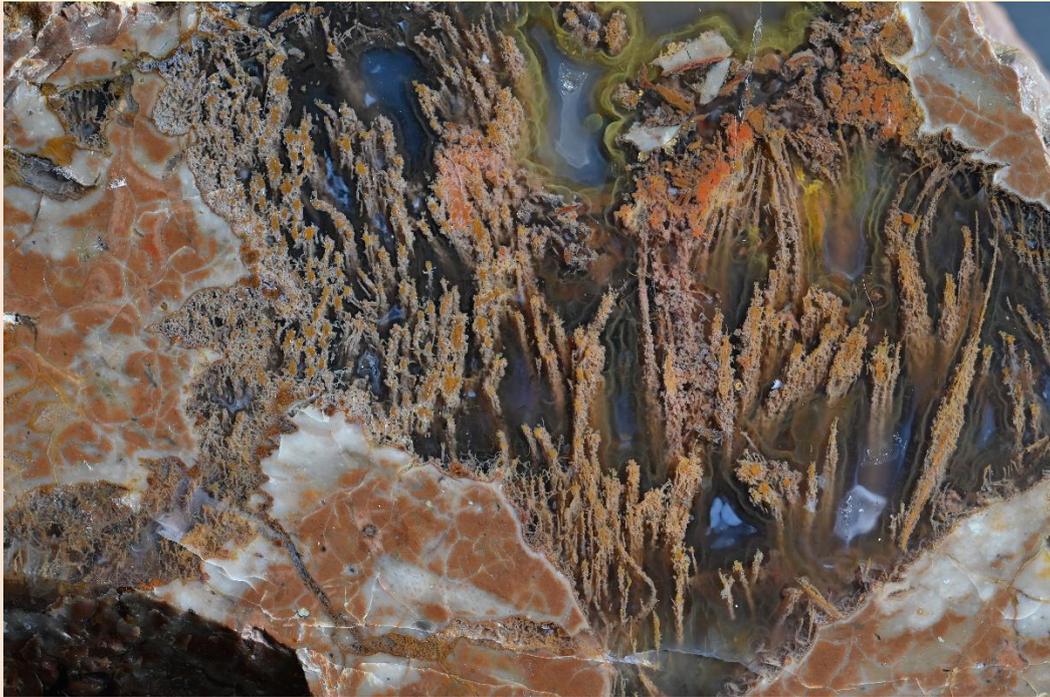


Fig. 19: When viewing these elongated structures, which widen slightly towards the top, under a stereo microscope, one gets the impression that thread-like components are assembled into a larger whole according to a blueprint. This construction principle is more clearly visible in inclusions in agates from the Aouli site (Morocco) (Thewalt & Dörfner 2025). Pony Butte. Image width 5.6 cm.



Fig. 20: In moss agates from the Pony Butte area, patterns resembling three-dimensional dendrites (plumes) can also be found. The dendrite branches are remarkably close together here. These growths were probably also formed with the help of bacteria, likewise before the SiO_2 filling of the thunderegg began. Image width 3.6 mm.

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The Richardson (formerly Priday) Ranch near Madras, Oregon, is now only open as a rock shop. Unfortunately, it is no longer possible to search for agates yourself.
Johann Zenz photo.

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