Breccia pipes in the Grand Canyon change our understanding of its origin

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The Grand Canyon in the western US is where many of the cherished ideas of long-age geology were developed and are illustrated. Teachers, tour guides, and park rangers standing on the Canyon's rim or in a lecture hall routinely recite the layers, inserting their long-age assumptions. Creation geologists recognize that these assumptions of age are totally contrary to the Bible's account of Noah's Flood. But, do we realize that the physical evidence also contradicts the secular geological explanation of breccia pipes?

The Grand Canyon breccia pipes are chimney-like structures a few tens to hundreds of metres across filled with heat-altered breccia starting in the Redwall or Mauv Limestone and tunnelling upwards as far as the Chinle Formation (figure 1) some 800–1,400 m (2,600–4600 ft) above. There are over 1,300 breccia pipes or possible breccia pipes located on the Colorado Plateau in and around Grand Canyon (figure 2).[1] Two are well-known locations to many visitors. The Last Chance Mine, which operated from 1892–1907, was a copper mine in the Grandview breccia pipe. The current top of that pipe exits the Redwall Limestone near the neck of Horseshoe Mesa, with a second entrance at the bottom of the Redwall entering the lowest level of the mine. The second, the Orphan Mine, operated from 1893–1953 as a copper mine, and from 1953–1969 as a uranium mine.

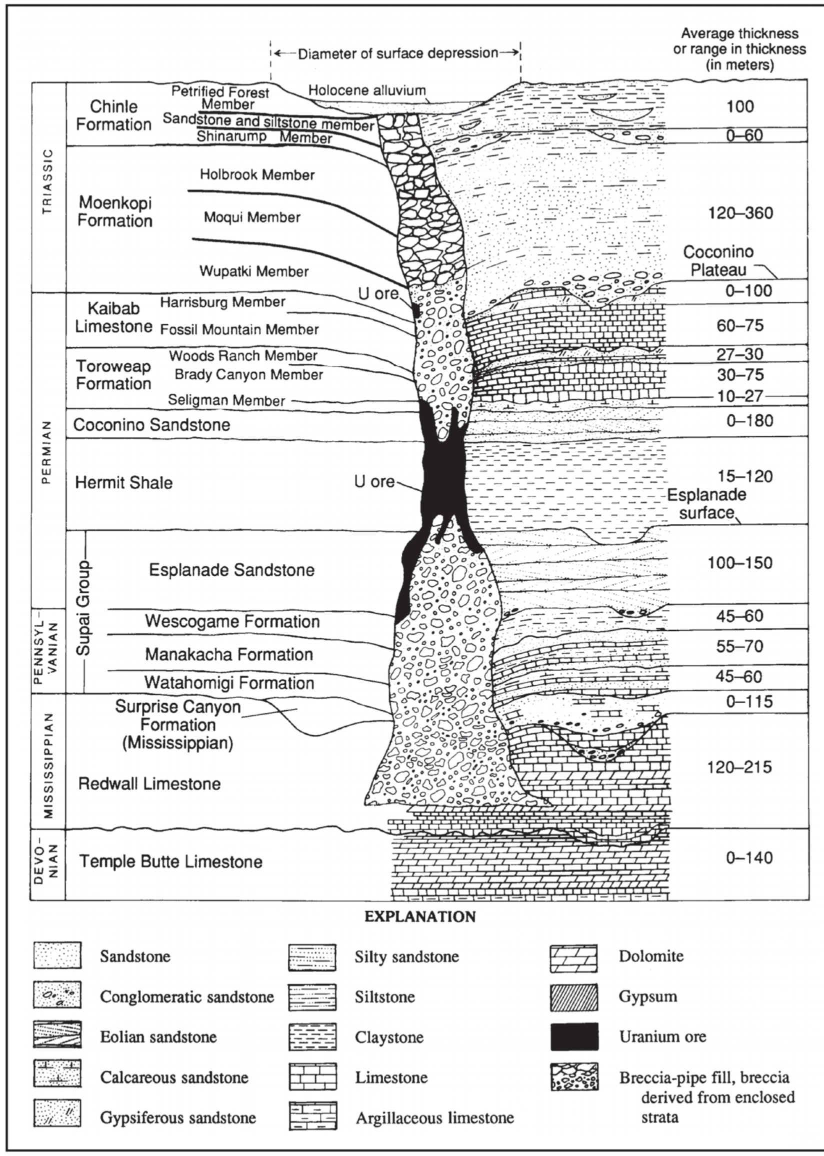

Figure 1. Commonly used cross section of a breccia pipe. Schnebly Hill Formation only occurs in the Sedona area (after Wenrich and Aumentemodreski[15].)

The Orphan Mine is also in a breccia pipe, located between Maricopa and Powell Points, with the mine tunnels extending under Powell Point. While concentric layering in the Orphan breccia pipe can be seen extending upwards, the mine operated primarily in the Supai Formation, where both copper and uranium ore are believed to be secondary minerals to the breccia pipe's formation.

Secular researchers routinely refer to the pipes as "solution-collapse" structures.[2] However, this basically just assumes they are of a geologically recent origin while largely ignoring their mechanisms of formation. However, this is not consistent with the evidence.

Secular model of breccia pipe formation

The standard secular explanation for the origin of the breccia pipes on the Colorado Plateau may stem from the 1880s major collapse within

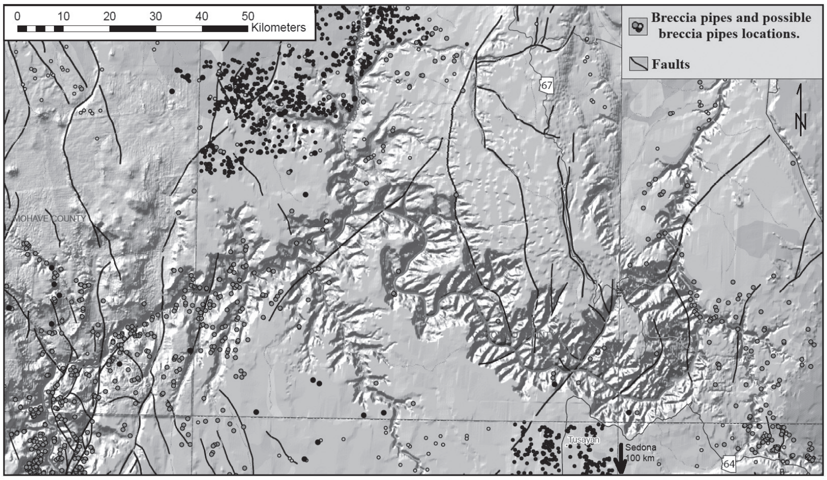

Figure 2. Locations of breccia pipes and possible breccia pipes in north-western Arizona, US. Sedona is 100 km to the south of arrow. (Image, detail from Spencer *et al.*[1])

the Hermit Shale of Devils Kitchen Sinkhole at nearby Sedona, Arizona.[3] They are believed to have developed in steps. First, karst caves formed in the Redwall Limestone. Next, these caves grew through collapse of the very thick overlying sandstone of the Supai, then moving up into the more poorly cemented Hermit Shale. Eventually, the invading water is believed to have allowed chimneys to grow through all of the strata until they emerged at ground level as a sinkhole. Based on two pipes near the western edge of the Colorado Plateau, some caves are believed to have extended downward from the Redwall into Mauv limestone beneath.[4]

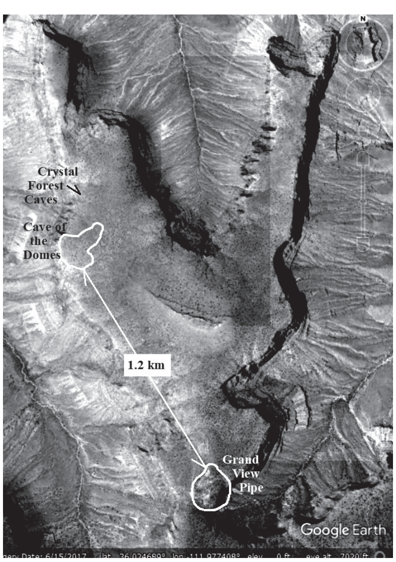

Figure 3. Google Earth image of Horseshoe Mesa showing the relative location of the Grandview breccia pipe, Cave of the Domes, and Crystal Forest Caves (2017, 36.024689 N, -111.977408E; accessed 25 May 2018).

However, there are several problems with this model for breccia pipe formation:

1. Many of the layers that the pipes go through are sandstone and do not have any appreciable limestone to dissolve.
2. No known cave system in the Redwall Limestone extends below the midway point of the formation. Rather, they are restricted to the upper Redwall, but at least the two in the Mauv had to originate below the midway point of the Redwall.
3. Existing cave systems form horizontally, yet the Orphan and Grandview breccia pipes are vertical chimney structures with very little horizontal spreading.
4. Breccia in the pipes and large collapsed blocks in sinkholes are not similar types of rubble. Breccia are sub-rounded cobbles or smaller, and collapse blocks are 5–9 m^3 (200–300 cu ft) of solid sandstone.
5. Existing caves and pipes show no connection, emphasizing that they must have formed at two different times.
6. Observed shape of sinkhole interiors do not match the funnel shape in the country rock around the tops of all known pipes and many sinkholes.

When an entire breccia pipe is seen that does not end in a sinkhole, its chimney extends upwards through several formations (figure 1). Throughout much of the Colorado Plateau, that extension includes at least four separate 12+ m thick sandstones in the Supai and the extremely thick Coconino sandstone.[5] Karst caves do not form in sandstones.

In Horseshoe Mesa's limestone there are four caves (figure 3). The Cave of the Domes is large, and the three Crystal Forest Caves are much smaller. Some of the three Crystal Forest Caves are thought to be connected. However, none of them connect with Cave of the Domes through any sizable passage, although they are at apparently the same level of the limestone, and none connect to any known breccia pipe (figure 3). Most of the known canyon caves are isolated and do not form larger networks. All canyon caves occur on a fairly level horizontal plain. Many karst caves do form at several levels (Carlsbad Caverns, New Mexico; Mammoth Caves, Kentucky), but they do not have the hollow-tube-chimney form that the Grandview and Orphan breccia pipes exhibit.

The breccia samples from pipes exhibit other differences from the blocks of rubble from Devils Kitchen Sinkhole collapse. The rocks that fell in the 1880s and 1989 cave-ins were large angular blocks of red sandstone. However, breccia in the two pipe's mines are small (1 mm to 25 cm, 0.04 in to 10 in) sub-rounded pieces of white or dark-brown sandstone and limestone. A calcite coating may turn a cobble white on the outside, but turning red sandstone to white or dark brown on its inside requires considerable heat (350–400°C, 650–850°F minimum[6]) to

Figure 4. Stylolites in Mississippian Limestone of Indiana. Very similar styolites occur in the Redwall Limestone.

change the red iron oxide to partially reduced (brown) or free (white) iron.[7]

Rethinking the Redwall formation in Flood geology

Some researchers have claimed that the Redwall Limestone formed in a significant depth of water.[8] However, liquid water could not exist at the temperatures associated with turning the red sandstone white or brown.[6,7] As such, a rethinking of the formation of the Redwall is needed.

It appears the Redwall experienced a high-temperature compaction event. Stylolites (figure 4) form where significant collapse results from pressure.[9] This is usually modelled as a dissolution event accompanying dewatering.[10] But, it could also have resulted from the collapse of the calcispheres, small rounded 'fossils'[11] making up a high proportion of the Redwall Formation that were part of the original depositional form of the Redwall's limestone.[12] Calcispheres form as a loose crystallized structure[13] compressing into much less space at high temperatures. There is also strong evidence in the Redwall's chert that it was deposited as silica peloids with microcrystalline limestone inclusions.[8] Additionally, McKee and Gotschick found limestone and dolomite alternating and intertonguing even to the grain level.[8] Such close association between chert, limestone, and dolomite without even microscopic pathways for water to carry magnesium or silica for replacement suggest they each precipitated as crystalline aggregates or spherical clusters of crystals, much like snow changes from flakes to hail pellets, and did not go through lengthy diagenetic chertification and dolomitization.

Collapse is a gravity-driven process, with seismic movement stimulating additional compaction where gravity-driven processes prevail. With temperatures too great to allow liquid water involvement,[6,7] the breccia pipe chimneys have many characteristics of gas escape structures, where gases developed inter- or intra-strata and then pushed their way through the non-lithified material while it was in a plastic phase.

Examining the top of a breccia pipe as illustrated in figure 1, all post-Redwall layers slope down into the pipe. This is also true for Devils Kitchen Sinkhole, where the Schnebly Hill Formation slopes down to meet the Hermit Formation over half of the breccia pipe's circumference[14] forming half of a funnel. Wenrich and Aumentemodreski remark that the funnel-shape depression is a good way of locating potential breccia pipes which lie concealed under alluvium that has collected in the depression.[15] The Orphan Mine pipe is a bowl of concentric fractured rings inside and outside the pipe. In contrast, the Grandview pipe atop Horseshoe Mesa is a small hill. This suggests gases erupted after the Canyon was formed, but very close to the timeframe of the deposition of the Kaibab and Chinle Formations. When bubbles of gas were released, the top was exposed approximately where it is today, and the funnel formed immediately. That means pipes now ending at the surface in the Kaibab or Chinle, had Kaibab or Chinle exposed when they erupted. This may suggest a short timespan between the deposition of these formations and formation of the canyon. This also suggests breccia pipes offer specific time constraints to both the deposition and the erosion processes that limits them drastically.

The sinkholes in the Sedona area all show a 'bell' shape in the brecciated top of the pipe[3] when the gas was stopped by a thick layer that had cooled beyond its plastic stage. That cooling may have accelerated when immediate erosion exposed it to the atmosphere or surface water. Nonetheless, at present this is speculative, and the basis for this will need further elucidation.

Creation implications

The breccia pipes suggest a catastrophic origin for both the pipes themselves and the surrounding sedimentary rock. To account for outgassing, all the relevant layers, many of which extend for hundreds of kilometres, would have been deposited in mere hours. The breccia pipes themselves would have formed in *minutes*. The timing, scope, and destructive force implied by these breccia pipes suggests only one event can explain them: the global Flood of Noah.

References

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2. Wenrich, K.J. and Sutphin, H.B., *Lithotectonic setting necessary for formation of a uranium-rich solution-collapse breccia-pipe province, Grand Canyon region, Arizona*, Open-File Report, 89-0173, US Geological Society, Denver, Colorado, 1989.
3. Lindberg, P.A., *Sedona sinkholes and groundwater flow: the geological history of their evolution*, Arizona Geological Survey Contributed Report CR-10-C, p. 5, 2010.
4. Wenrich and Sutphin, ref. 2, p. 2.
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6. 350°C is where Si starts to become mobile, and 850°C is where the limestone starts to calcine. Satyendra, Calcining of Limestone, ispatguru.com/calcination-of-limestone, 2 May 2013.
7. Iron compounds start to breakdown about 1000–1100°C (experiment with ceramics kiln), except hematite requires excess of 1400°C.

8. McKee, E.D. and Gotschick, R.C., *History of Redwall Limestone of Northern Arizona*, Geological Society of America, Memoir 114, 1969, cites the water depth at 3–4 m (10–12 ft) (p. 569), but most Flood modellers, referring to Genesis 7:17–20, put the depth in excess of '15 cubits upwards'.
9. Carrio-Schaffhauser, E., Raynaud, S., Latière, H.J., and Mazerolle, F., Propagation and localization of stylolites in limestones; in: Knipe, R.J. and Rutter, E.H. (Eds.), *Deformation Mechanisms, Rheology and Tectonics*, Geological Society Special Publication No. 54, pp. 193–199, 1990.
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11. These may in fact be better called 'chemical precipitates' or 'condensates'. However, secular researchers refer to them as 'fossils' assuming they are somehow of biological origin, like most oolites are assumed to originate. However, this is at present speculative, and needs further research.
12. Hess, A.A., *Chertification of the Redwall Limestone (Mississippian), Grand Canyon National Park, Arizona*, M.Sc. Thesis, University of Arizona, p. 85, 1985.
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