Navajo Sandstone in Zion National Park and the Formation of Moqui Balls − Failure of the Young-Earth Creationists' Flood Geology Model

Lorence G. Collins

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Email address: lorencecollins@gmail.com

Introduction

The Jurassic Navajo Sandstone in Arizona and Utah occurs in the stratigraphic column of the Grand Staircase (**Figure 1B**) north of the Grand Canyon (**Figure 1A**) and is Mesozoic in age.

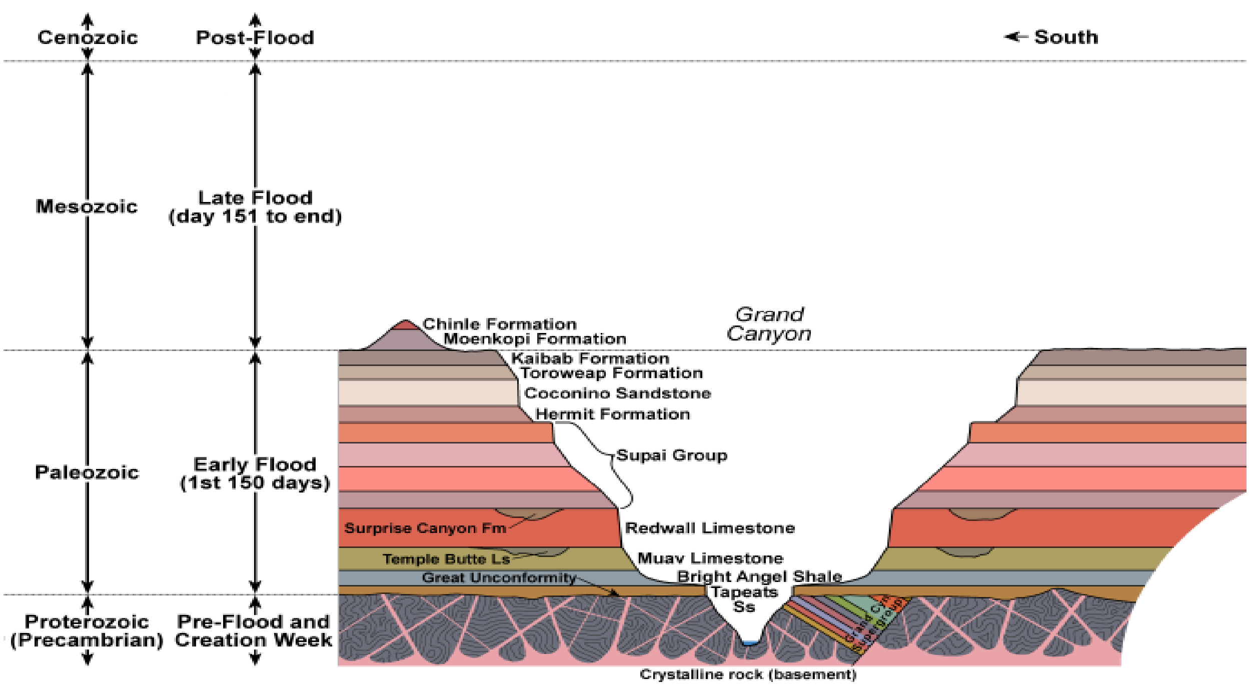

Figure 1A. Grand Canyon stratigraphy showing the Paleozoic age of sedimentary rocks in the canyon area that supposedly were deposited in the early part of Noah's flood (first 150 days) in the young-Earth creationists' Flood Geology model.

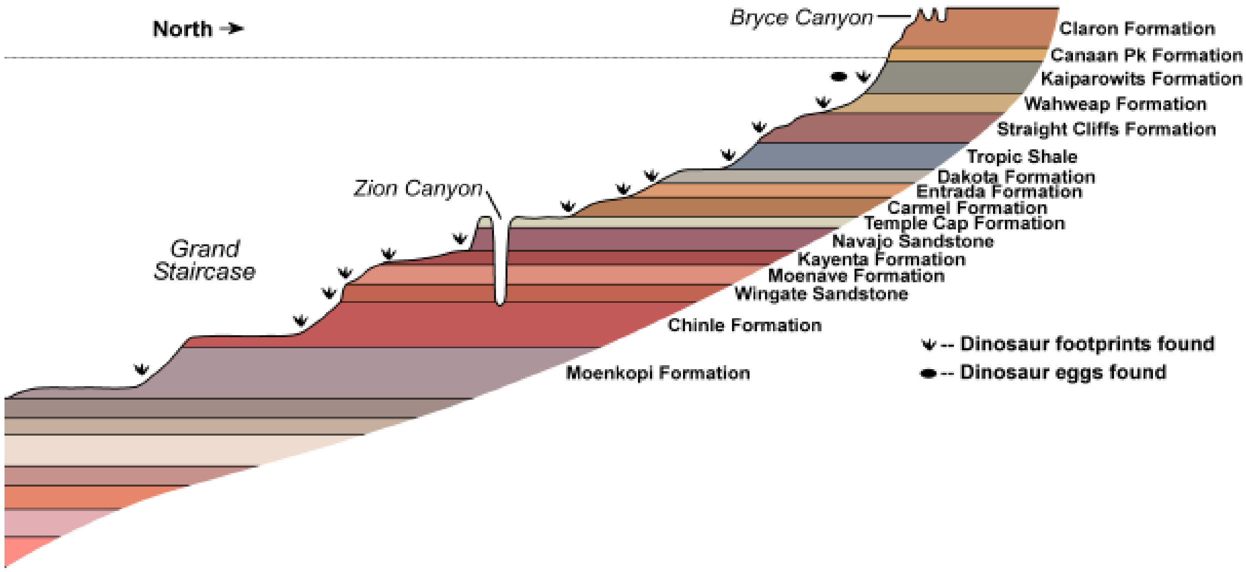

Figure 1B. Mesozoic stratigraphic formations of sedimentary rocks north of the Grand Canyon area in the Grand Staircase. The position of the Navajo Sandstone (purple), which is cut by Zion Canyon, is about half way up the column. According to the Flood geology models, rocks of Mesozoic age are Late Flood deposits (day 151 to end of the flood). Source: Grand Canyon book (Hill, et al., 2016).

Characteristics of the Navajo Sandstone

The Navajo Sandstone ranges from 2,000 to 2,400 feet thick. Its eolian sand grains are well sorted and fine-grained, and in most places this formation is brown to red. In many places it is massive without cross-bedding, but in other places it exhibits dune cross-bedding with angles of dip greater than 30 degrees (**Figure 2**) and locally shows giant cross-bedding (**Figure 3)**.

Figure 2. Cross-bedding in Navajo Sandstone, Horseshoe Bend area, Glen Canyon, Arizona. The photo has some layers with low angle of dip, but some are clearly more than 30 degrees that exists in wind-created sand dunes.

Figure 3. Giant dune cross-bedding in Navajo Sandstone in Coyote Buttes area near Zion National Park, Utah. Some dip angles are more than 30 degrees.

Moqui Balls in the Navajo Sandstone

An aspect of the Navajo Sandstone that is generally not known by many young-Earth creationists or discussed by them is the formation of Moqui balls (or Moqui marbles). Where wind transported sand grains to create the Navajo Sandstone, tiny grains of black magnetite (iron oxide; $FeOFe_2O_3$ or Fe_3O_4) were also carried by the wind, and this magnetite became further oxidized to red hematite (another crystalline form of iron oxide; Fe_2O_3) that gives the brown (**Figure 2**) or bright red (**Figure 3**) colors to the rocks.

$$4Fe_3O_4 \quad + \quad O_2 \quad = \quad 6Fe_2O_3$$
4 magnetite + 1 oxygen = 6 hematite

The hematite acts as a cement to hold the rock together and helps make it resistant to erosion (**Figures 2** and **3**). But in some places the Navajo Sandstone is white at the top of the formation (**Figure 4**).

Figure 4. Navajo Sandstone, Zion National Park. The upper part shows white sandstone while the lower part is still reddish. Source of image: Lance Weaver, Utah Geological Survey.

The whiteness of the upper part of the Navajo Sandstone (**Figure 4**) is because fluids subtracted iron from former iron-bearing hematite cement as well as iron from detrital iron-bearing silicates (Chan et al., 2005) and moved and concentrated this iron as hematite and limonite (goethite, hydrated iron oxide, $Fe_2O_3 \cdot n\ H_2O$) in spherical masses called Moqui balls (**Figures 5** and **6**) (Reiners et al., 2014). In some places these Moqui balls range up to baseball size (10 cm in diameter).

Figure 5. Moqui balls in the Navajo Sandstone in Snow Canyon State Park, southwest Utah. In most places where Moqui balls occur the rock is white, but locally weathering has stained the rock red, as in this image.

These balls later weather out and collect on outcrop depressions in the sandstone formation (**Figure 6**). However, as indicated above (**Figures 2** and **3**) in other parts of the Navajo Sandstone these sandstone rocks are reddish with red hematite (Fe_2O_3) cement from top to bottom of the formation and lack Moqui balls.

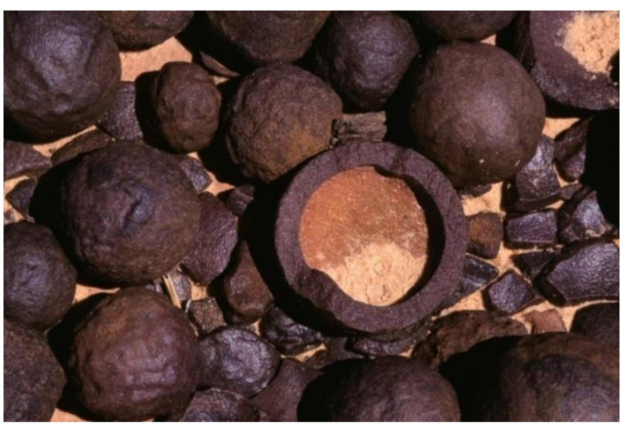

Figure 6. Moqui balls; one broken, showing interior.

The following links provide an article by Marjorie Chan and her students (Chan et al., 2005) and another article (Geology In) that provide even better photographs of Moqui balls in the white portions of the Navajo Sandstone and a more thorough explanation of their origin. Their studies show that the Moqui balls were formed at ages that range from 300, 000 years ago to 5 million years ago which is "a sharp contrast to the 190-million-year-age of the Navajo Sandstone."

http://www.geologyin.com/2017/11/how-utahs-mysterious-moqui-marbles.html

https://www.rocksandminerals.com/moqui.pdf

Some of the leached-out iron from the hematite cement and detrital iron-bearing iron silicates has also moved to seams (fracture openings) in the lower parts of the formation.

Failure of the Young-Earth Creationist Flood Geology Model

What is significant here is that the process of hydrating magnetite to hematite and then later altering detrital iron-bearing silicates by subtracting iron from the hematite and the detrital iron-bearing silicates so this iron can migrate to hematite and limonite (goethite) would not be a process that could be explained by young-Earth creationists in their Flood geology model (Reiners et al., 2014). That is, how would Noah's Flood water have this capability, say, in one month's time, (a) deposit magnetite grains with the sand grains in the Navajo Sandstone formation, (b) somehow introduce huge volumes of oxygen into this water to oxidize the magnetite to hematite, and, then, (c) locally change the pH of the water so that the water could dissolve iron from the hematite and detrital iron-bearing silicates and move the iron to the spherical Moqui balls? And how would some of this dissolved iron move down to lower parts of the formation to be deposited in seams (fractures) in the Navajo Sandstone formation? That is, sandstone being deposited from water should be relatively soft, saturated with water in pore spaces, and unable to be fractured. Moreover, what process during Noah's flood would cause water carrying dissolved iron to move downward? Shouldn't compression and consolidation of the Navajo Sandstone formation cause the water to be squeezed upward? That is, the deposition of overlying Mesozoic Cretaceous sedimentary layers should force contained water in this formation upward toward lower pressure and not downward toward regions of higher pressure.

Finally, because it is clear that the Navajo Sandstone is formed by eolian deposition, the great volume and thickness of this formation could not have been produced by blowing wind in one month's time.

See also: http://www.csun.edu/~vcgeo005/Nr62Horseshoe.pdf

Additional evidence that the Navajo Sandstone has an eolian origin are reports of ventifacts with wind-eroded triangular facets being found in this sandstone (Gilluly and Reeside, 1928; Baker et al., 1936; Kinney, 1955; and Harshbarger et al., 1957).

The Coconino Sandstone also has areas where upper levels are white and lower levels are reddish, but these white places do not have Moqui stones, and there is a different explanation for this. See: http://www.csun.edu/~vcgeo005/Nr62Horseshoe.pdf

References

Baker, A. A., Dane, C. H., and Reeside, Jr., J. B., 1936, Correlation of the Jurassic Formations of parts of Utah, Arizona, New Mexico, and Colorado, *U.S. Geological Survey Professional Paper* 183, 66 p.

Chan, M. A., Bowen, B. B., Parry, W. T., Ormö, J., and Komatsu, G., 2005, Red rock and red planet genesis: Comparison of Earth and Mars concretions, GSA Today, v. 15, n. 8, p, 4-10.

Geology In, How Utah's Mysterious Moqui Marbles Formed?

Gilluly, J., and Reeside, Jr., J. B., 1928, Sedimentary rocks of the San Rafael Swell and some adjacent areas in eastern Utah, *U.S. Geological Survey Professional Paper* 150D, p. 61-110.

Harshbarger, J. W., Repenning, C. A., and Irwin, I., 1957, Stratigraphy of the uppermost Triassic and the Jurassic rocks of the Navajo country, *U.S. Geological Survey Professional Paper* 291, 74 p.

Hill, C., et al., (editors), 2016. The Grand Canyon − Monument to an ancient Earth – Can Noah's flood explain the Grand Canyon? *Kregel Publications*, 239 p.

Kinney, D. M., 1955, Geology of the Uinta River and Brush Creek-Diamond Mountain areas, Duchesne and Uinta Counties, Utah, *U.S. Geological Survey, Oil and Gas Investigation Map DM* 123.

Reiners, P. W., Chan, M. A., and Evenson, N, S., 2014, (U-Th)/He geochronology and chemical compositions of diagenetic cements, concretions, and fracture filling oxide minerals in Mesozoic sandstone of the Colorado Plateau, Geological Society of America Bulletin, v. 126, p. 1363-1383.