Issue #10: Igneous Intrusions

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Figure 1. Sierra Nevada Batholiths photo over Yosemite National Park.

Assertions:

1. We observe large igneous bodies at the surface today that formed in the Mesozoic several kilometers below as molten magmas at high temperatures.
2. As the magmas were emplaced, the sedimentary rocks were folded and metamorphosed. (Folding solid rock does not happen quickly).
3. Large bodies known as batholiths had their magmas cool and most of the material above them eroded away.
4. In the Sierra Nevadas, the batholith was cooled and at the surface by mid-Cretaceous.
5. Flood geology models (FG) predict that within one year, many events took place along the Sierra Nevada area, including:
    a) Deposition of kilometers of sediment
    b) Batholiths intruded into flood rocks, folding the overlying rocks
    c) Deposition of many layers of volcanic ash

d) Cooling of the batholith and erosion of most of the overlying rocks and large amounts of granite

6. Trees growing today would have had to start during the flood or immediately afterward as we know that they started almost 5000 years ago.

7. The many events and time required go way beyond the one-year model and far beyond the 6-10,000 years allowed in YEC timelines.

Key assumptions:

a) intrusive bodies were molten at temperatures we can estimate today.

b) it took some time to form and to cool and we can roughly estimate that.

c) Clasts from intrusive rocks were cooled and hardened before they were deposited in ancient streams.

Discussion:

Issue #9 discussed volcanos and lavas on the surface. In this one, we examine igneous rocks that formed beneath the surface, in this case several kilometers. Davis Young and Ralph Stearley in the classic book, "*The Bible, Rocks and Time*" examined the Sierra Nevada range in California that is cored by a massive igneous complex of "batholiths" (**Figures 1 and 2**). First, it means that one or more large bodies of molten magma that were between 600 and 1,200°C in the subsurface have cooled and solidified. If these had cooled at the surface, there would have been only microscopic crystals present, such as form today when lava cools at the surface. Young and Stearley (2008) powerfully demonstrated that batholiths in California whose dimensions and properties are well documented, cooled from 750–825°C and this required a very long time. Borrowing their analogy, it takes a long time for a cooked turkey to cool, especially when left in the oven. Bigger birds take longer to cool than smaller birds and bigger batholiths took longer to cool than smaller ones. Calculations and modeling demonstrate that some of the California batholiths may have required upwards of 600,000 years to cool to their present temperature. There may be options that reduce this time, but not by enough to fit the FG models.

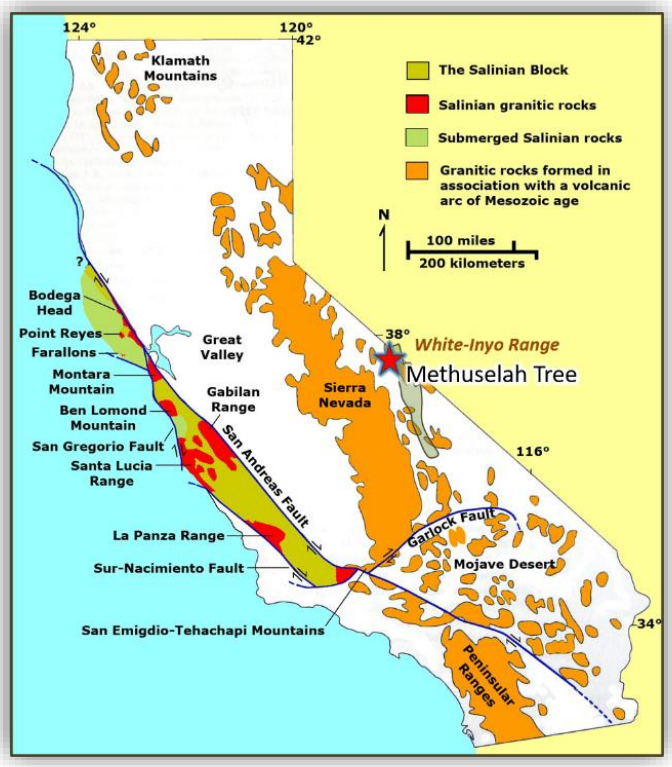

Figure 2. Geologic map showing Sierra Nevada Batholith region with the White – Inyo Mountain Range and the location of the Methuselah Tree there.

Here are some observations taken largely from "*Plutonism in the Central Part of the Sierra Nevada Batholith, California*" by Paul C. Bateman, USGS Professional Paper 1483, published 1992.

The Sierra Nevada batholith is one segment of the Mesozoic batholith chain that encircles the Pacific Basin. This complex includes "*hundreds of separate granitic plutons*" that range in map area from less than 1 km2 to over 1000 km2. They were emplaced in "*strongly deformed but weakly metamorphosed strata ranging in age from Proterozoic to Cretaceous*". The rock folding and faulting took place in multiple episodes, including regional deformation in the Paleozoic. These batholiths "*provided heat required to cause fluids to circulate and concentrate gold, copper, and other minerals in veins*" in some regions. These were heavily eroded and led to the placer deposits exploited during the 1849 gold rush. The gold-rich gravels dated at least back to the Eocene (Early Cenozoic). (Many FG models place this in the late flood!)

The intrusions were mainly granitic but also include other types such as gabbros. The sediments above them were at least 3.5 to 7 km thick. Sediments exposed in the adjoining area are almost 9 km thick for the Proterozoic to Permian pre-batholith section. Large amounts volcanic material came to the surface through the Triassic and particularly during late Jurassic and Cretaceous periods though it is not always possible to tie intrusions to the extrusions probably because so much has been eroded away today.

"*The source magmas for the granitoids were generated in the lower crust as a result of the rise of basaltic magma and heat from the mantle*." Modern large magma chambers of similar size to the large chambers from the Sierra Nevada are believed to exist today under the Long Valley Caldera and the Coso volcanic field. The evidence in the Sierra Nevada points to the sediments in and around the batholiths being deformed by the "*forcible intrusion of plutonic rocks*". The evidence show that the intrusions 'ballooned', expanding as they were emplaced. This deformed the older sediments and earlier volcanic rocks. How hot was the rock? "*A magmatic temperature of 1,000 °C would be reached if the temperature at the contact was 750 °C and the ambient temperature of the wallrocks 150 °C*". Large bodies at these temperatures hold a huge of heat energy. Yet today, the heatflow is low, especially for granitic regions, again an indication of the passage of much time.

Later we will look at YEC proposals, but relevant to these is the fluid content of the bodies. "*The almost complete absence of hydrothermal effects, the restriction of miarolitic cavities to a few small, fine-grained masses of leucocratic granite, and a dearth of pegmatite dikes and quartz veins indicate that most Sierran magmas were* ***undersaturated with water*** *at levels presently exposed when they were emplaced and remained undersaturated during most of their periods of crystallization*"; "*An initial water content of about 2 percent or less for these Sierran magmas seems reasonable*."

Timing:

> **Regardless of the radiometric dating, an important timing constraint for some of the intrusions is the fact that clasts of the granite have been found as part of mid-Cretaceous conglomerates. That tells us that the granite was emplaced well below the surface at the time, cooled and subsequently the rock above it eroded away. Streams eroded into the cool granite, weathering out clasts. This sedimentary breccia was buried, lithified and then eroded into so that we can observe it today.**

Fiske and Tobisch (1978) described the setting for this: In the Cretaceous, there existed a rugged land surface with "*steep-walled gullies and small canyons*". The gullies were filled with conglomerate that is made up largely of various types of volcanic rocks and some clasts of "*coarsely crystalline granitic rocks*". I do not see how this could have been accomplished in a flood model.

Another piece that is relevant to this issue and understanding the time involved found in the nearby White Mountains, where thick Paleozoic rocks that range from Cambrian through Devonian in age are found. (Nelson, Hall, and Ernst 1991). These rocks include classic Cambrian deposits with the wonderful Cambrian explosion of life and the early reef deposits. They include tidal deposits and mudcracks in rock that was deposited as shaly sand, buried and lithified into sandstone and metamorphosed into quartzite. After deposition, the rocks were involved in three phases of mountain building. In the Jurassic, granitic plutons were formed. During the Cenozoic, the region was uplifted and eroded deeply and many volcanic eruptions took place. Then the area was uplifted again in the late Cenozoic with much folding and faulting. **Then in approximately 2769 BC (4,789 years ago), the oldest tree in the world, at least as dated so far, began growing (appropriately, the Methuselah Tree).** (https://www.usda.gov/media/blog/2011/04/21/methuselah-bristlecone-pine-thought-be-oldest-living-organism-earth#:~:text=Over%204%2C789%20years%20old%2C%20the,of%20California%2C%20Nevada%20and%20Colorado.)

Think about what these demand for FG. The flood would have had to deposit the Proterozoic and Paleozoic rocks. These would have been folded and metamorphosed while the plutons were emplaced as very hot, partially melted rocks in multiple phases of intrusions and deformation. Then kilometers of such rocks had to be eroded away and the batholiths solidified and cooled. The Methuselah Tree didn't start growing on hot rock or in water. It started on a high cool mountain. The area probably looked much like it does today. The tree started growing in soil. Soil takes time to develop. **Too many events, too little time**. To complicate matters, the tree rings from trees such as the Methuselah Tree are calibrated back to far earlier. Wikipedia reports:

> *"Another **fully anchored chronology which extends back 8500 years exists for the bristlecone pine in the Southwest US (White Mountains of California**). In 2004 a new calibration curve INTCAL04 was internationally ratified for calibrated dates back to 26,000 Before Present (BP) based on an agreed worldwide data set of trees and marine sediments.[8] The part of the new calibration curves that relies on tree-ring evidence (IntCal04) dates back to 12,410 calendar (cal) yr B.P." (*emphasis added*)*

YEC explanations:

Several YEC authors have recognized this issue and tried to address it. Examples include Dr. Andrew Snelling, Dr. John Woodmorappe and Dr. Tas Walker (see below for links). Each propose that plutons can be filled quickly and they are probably correct, although how quickly is probably debatable. Plutons including batholiths do not extend down to the lower crust as a wide body all the way down. Typically, they are drawn in modern textbooks with very narrow bases. (**Figure 3**) If hot magma moved slowly up through narrow dikes, the magma would have cooled and probably solidified. This does not mean that the plutons had to fill in one short pulse. Plutons show complex flow patterns and presumably were filled by many events over time. Bateman noted that in the Sierra Nevada, the deformation involved

upward force. This ballooning and the metamorphism took time. The writers all cite sources that are all talking about processes that took years to accomplish emplacement, usually thousands of years.

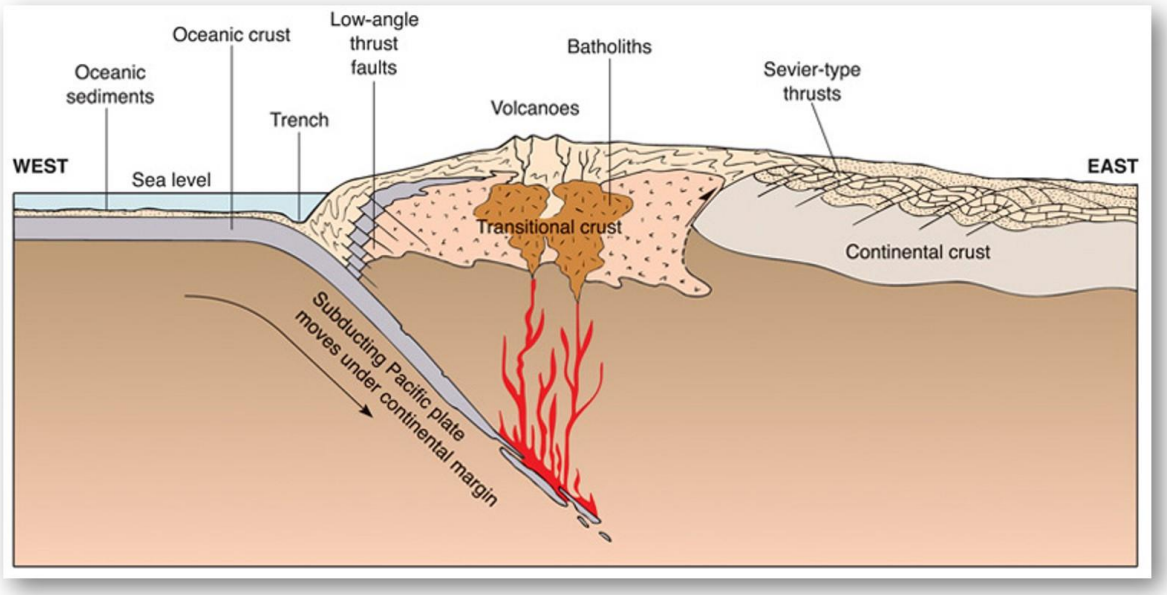

Figure 3. Model of the Sierra Nevada batholith emplacement as a part of plate subduction associated with plate collision in plate tectonics: http://plate-tectonic.narod.ru/sierraphotoalbum.html

Cooling:

Snelling and Woodmorappe (1998) claim that large batholiths can be cooled quickly. They make many valid points. Plutons are fractured as are all rocks. Certainly, water moving out of fractures would take heat away through convection. However, the rocks have to cool to the point where fractures can be sustained and much heat must dissipate for that to happen. Rapid crystallization of the magma would itself have generated considerable heat. Also, their assumptions for the water content seem to be higher than supported in the Sierra Nevada complex, making less available for convection.

The scale of the Sierra Nevada batholith complex involved so much volume with so much heat that it is not credible to dissipate that heat in a few thousand years under any scenario. Further, the Cretaceous granite clasts would demand that for FG to be viable, the rock had to cool and many other things had to happen in significantly less than 1 year. That is well beyond any natural phenomena. As Hanson, 1993 showed, "*Geologic relations and geochemical data show that the Ritter Range pendant records > 100 million years of fluid-rock interactions that reflect the evolution of arc crust in the Sierra Nevada batholith.*"

I definitely believe that God can and does use miracles that supersede natural laws. However, the YEC authors claim that scientific data supports their interpretation of a global flood through a series of cause and effects that are recognizable though they were ultimately driven by God. There is no reason to doubt that God has the power to cause batholiths to pop up and cool quickly with no physical reason. That is not their claim however. They propose that this chain of events are consistent with physical laws and processes but that is not the case.

References:

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"Geology Café" has a great general site with information about igneous rocks here: https://geologycafe.com/class/chapter7.html