Grand Canyon super old rocks and its mysteries

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Once upon a time, before the arc-continent clash, the super old rocks of the Elves Chasm were formed, laying the foundation for the Granite Gorge Metamorphic Suite and the Grand Canyon Supergroup (we'll talk about these soon). At this moment, nearly 1.8 billion years ago, the Elves Chasm was still underwater, just below the Mojave Island Arcs.

Island Arcs are chains of volcanic islands located in the border of tectonic plates. An arc-continent collision is when the arc's tectonic plate encounters the continent's tectonic plate. In our case, the Mojave Island and Yavapai Islands Arcs collided with Laurentia, the continent from which North America was formed.

With the arc-continent collision, the arcs were compressed and moved upwards, emerging from the sea. The rocks in these arcs then originated the Brahma and Vishnu Schist, which are part of the Granite Gorge Metamorphic suite. The Vishnu Schists are metamorphic rocks formed from sedimentary rocks, whereas the Brahma Schists were formed from intrusive rocks. The suite also contains Rama Schist and younger igneous rocks. If you are not a geologist, like me, you might struggle with some jargon used by geologists. If that is the case, please read this quick rock guide on the right.

Quick rock guide:

- Intrusive (or igneous) stones are freshly formed rocks that appear when magma cools down. Examples: granite, basalt.
- Sedimentary stones are formed from the deposition and cementation of organic or mineral material. They are basically rocks formed by other rocks parts. Example: Sandstone.
- Metamorphic stones are rocks that suffered a transformation process normally through high temperature and pressure. They can be formed from igneous, sedimentary or other metamorphic rocks. Example: Marble and Schist

The Elves Chasm and the Granite Gorge Metamorphic suite form the Crystalline Basement, also called the Vishnu Basement. This basement hosts the Grand Canyon Super Group, a group of fancy tilted layers preserved in downdropped fault blocks. The Grand Canyon Supergroup is super! Its layers range from 1.25 billion years at its bottom (the Unkar Group) to 742 million years at the Sixtymile Formation (top of the Supergroup). All these layers are formed by sedimentary or intrusive rocks, and despite its proximity with the Vishnu Schists, we find no metamorphic stones in the Supergroup.

Let's take a short break and talk about layers: Rock layers are like Lasagna layers. Older layers were deposited first (at the bottom) and younger layers come later (at the top). When we cook a Lasagna its texture and taste change significantly. This is more or less what happens with metamorphic rocks. The difference is that rock layers are not cooked all at the same time, and some are not cooked at all. Alternate layers of igneous, sedimentary and metamorphic rocks are like alternate cooked and uncooked Lasagna layers. Different ingredients give different tastes, as different minerals give origin to different rocks.

When we see a geological timeline, we wonder how is it possible that geologists know with precision what happened millions or billions of years ago. Geologists use several dating methods and compare the order of rock layers in various places to establish a geological timeline. This becomes trickier when tectonic plates move around and rock layers are whipped out by erosion, causing a discontinuity. This kind of phenomenon is called a geological unconformity, or "missing layers" if you prefer.

The Great Unconformity was observed by John Wesley Powell in the Grand Canyon. It's also known as Powell's Unconformity. Powell saw that after the Vishnu basement (1.8 billion years ago) and the Grand Canyon Supergroup (1.25 to 0.74 billion years ago) the next layer is in the Tonto Group, which appeared 525-550 million years ago. Wait a minute, something is missing! Yes, some layers are missing.

The Great Unconformity, as its name states, it's pretty big. Not only in terms of space but also time. It's extends across Laurentia, the old continent we talked about. Most importantly, it covers a period of 0.2 to 1.2 billion years, depending on the location. In some areas where we see the Tonto Group sitting on top of the

Supergroup, this unconformity is “only” about 200 million years long, but the Supergroup isn’t present everywhere. Where the Tonto group sits directly on the Vishnu basement, the unconformity is about 1.2 billion years long! This is more time than all the subsequent layers of the Paleozoic and Mesozoic combined.

Unfortunately, we cannot know which secrets and scientific truths were hiding in those missing layers, but this is what makes geology interesting. Continents collide and rock layers are eroded, leaving behind unconformities and questions. And if science is made of questions, here we have plenty of raw (and cooked) material.

Sources: Jordan Carey’s PowerPoint presentation, Personal Notes, Wikipedia (https://en.wikipedia.org/wiki/Great_Unconformity)