



## Interpretation during “teachable moments”

Karl Karlstrom and Laura Crossey

Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM 87131.

Visitors to the rim and river often experience new wonder and curiosity as they try to comprehend the scale and beauty of Grand Canyon’s iconic landscapes; this offers teachable moments for interpreters. Sometimes visitors hardly know how to formulate their questions, such as: “*what’s behind those walls?*”, or “*does that rock (e.g. 10-mile rock) go the bottom of the river?*”. The concept of “Multiple Learning Hierarchies” for interpreters takes the view that the moments of curiosity are important opportunities to help move everyone from their present level of understanding to a higher level, without embedding new misconceptions as you clear up others. It is a challenge and “job security” for interpreters at all levels to also move themselves to next levels of understanding. Here are soundbites for each learning level.

**LEVEL MINUS 1- MY RELIGION DENIES SCIENCE:** Everyone is entitled to their own religious beliefs, but the Park is responsible to use scientific knowledge to manage its resources. The scientific method allows different creation and evolution stories to be tested and re-tested. For example, the time dimension of Geology is built on global scientific teamwork (for centuries) that has observed a repeated time-progression of evolving life forms in sedimentary rocks that has led to the Geologic timescale. Once radioactivity was discovered in 1911 by the Curies, geologists already “knew” which rocks were likely to be the oldest and used the new technology to date them as over 3 billion years old. Now, our best age for the solar system and Earth is 4.567 billion years. Most rocks can be dated by multiple *independent* cross-checking methods; Test, Test, reTest—that is the scientific method.

**LEVEL ZERO- I DON’T KNOW AND DON’T CARE ABOUT GEOLOGY OR SCIENCE:** Non-geology questions often have geologic underpinnings. *Q. How deep is Grand Canyon. A. It gets up to a mile deep and has been carved by the Colorado River. Q. Why are the layers different colors. A. Each has its own geologic story and the reddish layers represent iron oxide coloration (like rust).*

**LEVEL ONE- I AM A LITTLE CURIOUS ABOUT WHAT I AM SEEING:** Misguided questions can be turned to new information and discussion: *Q. What’s behind those walls? A. There is just more and more rock of similar type extending as layers for miles behind what you*

*see. Q. Does that rock go the bottom of the river. A. That is not an outcrop but rather it fell off from its host layer, up there, which is part of how Grand Canyon gets wider. Perhaps the most basic geomessage to give these visitors is: It's a young canyon carved into very old rocks.*

#### LEVEL 2- I HAVE SOME GEOLOGY KNOWLEDGE BUT I'M NOT SURE HOW ACCURATE- I HEAR MORE CONTROVERSIES THAN AGREEMENT:

Geology can be confusing for those who do not have a foundation in geology or science. Biology seems easier for people such that terms like pine tree, juniper tree, cholla and chub are fine, but words like metamorphic, igneous, sedimentary, unconformity, and orogeny seem esoteric. Try to use geo terms in context so the meaning goes with the word, e.g. it was so hot deep in the Vishnu Mountains that magma was moving through cracks and turning into an igneous rock we call granite. Vishnu Schist was once a sedimentary rock but when buried to 20 km depths and squeezed, metamorphic mineral grew (like garnet) and the rock became a metamorphic rock called schist. The “illions” problem can cause eyes to glaze over, with a million, billion, or trillion of anything. The human heart beats billions of times in an average human lifetime so a heartbeat for us is like a year for mother Earth. The age of Grand Canyon debate, at this level, needs to emphasize that all models agree that the Canyon and landscapes are young (6 or 70 million years), yet Canyon rocks go back almost 2 billion years.

#### LEVEL 3: I HAVE BASIC AND ACCURATE GEOLOGY TRAINING AND I WANT TO HELP OTHERS LEARN MORE:

Go for it.

LEVEL 4- I AM A RESEARCHER WHO CREATES NEW KNOWLEDGE ABOUT GRAND CANYON: I have a list of top soundbites that have resulted from the last 3 decades of research in Grand Canyon. They are listed in six “chapters”, old- to- young, and are all backed by peer-reviewed papers in the published geoscience literature. I'll send this and any pdfs to anyone that asks. Email [kek1@unm.edu](mailto:kek1@unm.edu).

Time metric units

Ga = giga annum= billion years, like gigabyte

Ma= mega annum= million years, like megabyte

ka= kilo annum= thousand years, like kilometer

Of the nine 0.5-billion-year segments of Earth history, Grand Canyon (GC) informs about half  
4.5-4.0 Ga- formation and early meteorite bombardment of Earth

4.0-3.5 Ga- early continents, early seas, early single celled life

3.5-3.0 Ga – early continents (GC grains), early seas, single celled life

3.0-2.5 Ga – assembly of supercontinent of Kenorland

2.5-2.0 Ga- rifting of Kenorland, Great Oxidation Event

2.0-1.5 Ga- assembly of supercontinent of Nuna (GC)

1.5-1.0 Ga- assembly of supercontinent of Rodinia (GC)

1.0-0.5 Ga- breakup of Rodinia (GC), Snowball Earth, first heterotrophs (GC), earliest animals

0.5- 0.0- assembly and break up of Pangea (GC), evolution of animal life (GC)