It’s about Time: Forty Years of Geologic Work in the Grand Canyon- Rocky Mountain Region

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Understandings of Geologic Time and Earth processes are assuming increasing importance as human populations exceed 7 billion on our small planet. Cognition of geologic time provides the vital and difficult-to-comprehend connection between human time scales, societal needs, and the million-year heartbeat of the Earth. Grand Canyon, the Colorado Plateau, and the Rocky Mountains provide important geologic laboratories; this talk describes the main contributions made by one geologist in his > 40-year-effort to study the rocks and landscapes of this iconic geologic region. The themes of the talk are deep time and the supercontinent cycle as recorded in the Grand Canyon region. Chapter 1 involves the assembly of this part of the continent 1.8-1.4 billion years ago and our connection with the supercontinent of Nuna. Chapter 2 involves a record of the assembly (1.0 billion years ago) and break up (0.75 billion years ago) of the next supercontinent, called Rodinia. Chapter 3 involves deposition of the flat-lying sedimentary rock layers from 540 to 65 million years ago, with continental scale rivers that flowed from the Appalachian mountain range to southwestern U.S. during the plate collisions that assembled Earth’s most recent supercontinent, Pangea. Chapter 4 includes the relatively young stories of the uplift of the region from sea level to our present elevation of > 1.5 km, deep erosion of Canyonlands and Grand Canyon, and formation of the Rocky Mountains and Rio Grande rift. Our recent synthesis paper resolves the 140-year-long debate about the age of Grand Canyon via a “paleocanyon solution” in which integration of the Colorado River took place through partially carved older paleocanyons and the Colorado River and its side canyon tributaries have carved and widened about 75% of the Grand Canyon in the last 5–6 million years. Our “Young Canyon” model for Grand Canyon argues that the rugged landscapes of the Southwest have been carved by mantle-driven uplift of the region that is still ongoing. At present, Grand Canyon is a 1.6 km deep incised aquifer system that provides a laboratory for studying groundwater and paleohydrology of this arid region. Quantitative forecasting of the effects of climate change (diminishing surface flows affecting recharge rates) on water quality depends on our understanding of fault conduits and fluid mixing processes. Improved geoscience public education is essential as human societies expand on our planet of limited resources. The Trail of Time Geoscience Exhibition at Grand Canyon was designed and installed by a UNM team led by Karl Karlstrom and Lauria Crossey (1995 to 2010), with support from the National Science Foundation and Grand Canyon National Park. Winner of the 2011 Award from the National Association of Interpretation, The Trail of Time encourages many of the Park’s 5 million annual visitors to ponder, explore, and understand the magnitude of geologic time and the stories encoded by Grand Canyon rocks, landscapes, and waters.