ESP (2) second year bachelor

UNIFORMITARIANISM AND CATASTROPHISM

James Hutton was a gentleman farmer who lived in Scotland in the late 1700s. Although trained as a physician, he never practiced medicine and, instead, turned to geology. Hutton observed that a certain type of rock, called sandstone, is composed of sand grains cemented together (Fig. 1). He also noted that rocks slowly decompose into sand, and that streams carry sand into the lowlands. He inferred that sandstone is composed of sand grains that originated by the erosion of ancient cliffs and mountains.

Hutton tried to deduce how much time was required to form a thick bed of sandstone. He studied sand grains slowly breaking away from rock outcrops. He watched sand bouncing down streambeds. Finally he traveled to beaches and river deltas where sand was accumulating. Hutton concluded that the sequence of steps that he had observed must take a long time. He wrote that.

on us who saw these phenomena for the first time,
the impression will not easily be forgotten. . . .
We felt ourselves necessarily carried back to the
time . . . when the sandstone before us was only beginning
to be deposited, in the shape of sand and
mud, from the waters of an ancient ocean. . . . The
mind seemed to grow giddy by looking so far into
the abyss of time.

Hutton's conclusions led him to formulate a principle now known as **uniformitarianism**. The principle states that geologic change occurs over long periods of time, by a sequence of almost imperceptible events. Hutton surmised that geologic processes operating today also operated in the past. Thus, scientists can explain events that occurred in the past by observing changes occurring today. Sometimes this idea is summarized in the statement "The present is the key to the past." For example, we can observe today each individual step that leads to the formation of sandstone. Even though it would take too long for us to watch a specific layer of sandstone form, we can infer that the processes occur slowly—step by step—over great periods of time.

If we measure current rates of geologic change, we must accept the idea that most rocks are much older than human history. Taking his reasoning one step further, Hutton deduced that our planet is very old. He was so overwhelmed by the magnitude of geological time that he wrote, “We find no vestige of a beginning, no prospect of an end.”

William Whewell, another early geologist, agreed that the Earth is very old, but he argued that geologic change was sometimes rapid. He wrote that the geologic past may have “consisted of epochs of paroxysmal and catastrophic action, interposed between periods of comparative tranquility.” Whewell was unable to give examples of such catastrophes. He argued that they happen so infrequently that none had occurred within human history.

Today, geologists know that both Hutton’s uniformitarianism and Whewell’s **catastrophism** are correct. Thus, over the great expanses of geologic time, **slow, uniform processes are significant, but improbable, catastrophic events radically modify the path of slow change.**

Figure 1 Sandstone cliffs rise above the Escalante River, Utah.

Gradual Change in Earth History

Within the past few decades, geologists have learned that continents creep across the Earth's surface at a rate of a few centimeters every year. Since the first steam engine was built 200 years ago, North America has migrated 8 meters westward, a distance a sprinter can run in 1 second. Thus continental motion is too slow to be observed except with sensitive instruments. However, if you could watch a time-lapse video of the past few hundred million years—only a small chunk of geologic time—you would see continents travel halfway around the Earth.

Catastrophic Change in Earth History

Chances are small that the river flowing through your city will flood this spring, but if you lived to be 100 years old, you would probably see a catastrophic flood. In fact, many residents of the Midwest saw such a flood in the summer of 1993, and California residents experienced one in January 1995 (Fig. 2).

When geologists study the 4.6 billion years of Earth history, they find abundant evidence of catastrophic events that are highly improbable in a human lifetime or even in human history. For example, giant meteorites have smashed into our planet, vaporizing enormous volumes of rock and spreading dense dust clouds over the sky. Similarly, huge volcanic eruptions have changed conditions for life across the globe. Geologists have suggested that these catastrophic events have driven millions of species into extinction.

Figure 2 Torrential rains caused the Russian River in California to flood in January 1995. In this photograph,Tom Monaghan is salvaging a few possessions and wading across the second-story balcony, awaiting rescue. (Corbis/Bettmann)