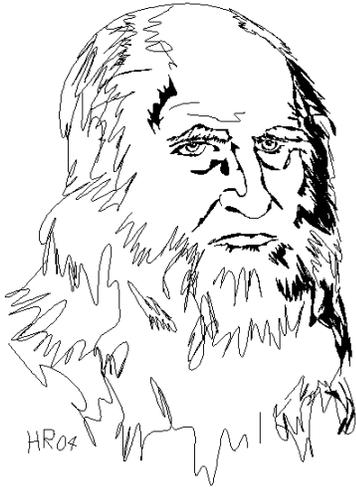


## a32 A catch phrase definition for uniformitarianism <prehistory>



[F]act-collecting has been essential to the origin of many significant sciences, [however] anyone who examines, for example, Pliny's encyclopedic writings or the Baconian natural histories of the seventeenth century will discover that it produces a morass. One somehow hesitates to call the literature that results scientific.

—Thomas S. Kuhn, *Structure*, 1962.<sup>1</sup>

Saussures, Pallases, and Dolomieu were less eager to attract the admiration of their contemporaries by brilliant but fragile edifices, ... They rejected all 'system'; they recognized that the first step to make in divining the past was to establish the present firmly.

—Cuvier, 1800.<sup>2</sup>

The profundity of a revolution in science can be gauged as much by the virulence of conservative attacks as by the radical changes in scientific thought it produces.

—I. Bernard Cohen, *Revolution in Science*, 1985.<sup>3</sup>

Hutton's fundamental assumption, which has remained the most important working principle of historical geology and biology ever since, is the principle of uniformitarianism (often referred to, by a direct translation of the French term for the idea, as the actualistic principle). This notion was not original to Hutton.

**Leonardo da Vinci** (1452-1519) had anticipated it three hundred years earlier, and it had been explicitly formulated by French physician Georg Christian Fuchsel (1722-1773), as follows: 'the manner in which nature at the present time is still acting and producing things must be assumed as the rule in our explanation.' —Ian Johnston, *A Handbook on the History of Modern Science*, 2000.<sup>4</sup>

The revolution in natural science that Hutton began followed from his clear demonstrations of how knowledge of the workings and details of physical Earth could be reconciled with the notion of an unremarkable prehistory, provided that the duration of historical time, by comparison, is trivial. A catastrophe could remove a mountain in an instant: "but the dropping of the gentle rain will do the same, if we extend its operation over a millennium."<sup>5</sup>

Johann Friedrich Blumenbach (1752-1840), uncomfortable with "Catastrophal Theory" promulgated by such as von Buch in Germany, Buffon and Cuvier in France, and (Genevan) Deluc in England, in the light of explanations by Hutton and Playfair of geomorphology and geology invoking processes no different from those yet operating, but aware of the criticism that present small streams seemed manifestly inadequate to explain Alpine valleys with transverse U-shape (now known to have been eroded by glaciers during the Ice Age), was instrumental for a prize proffered in 1818 by the Royal Society of Sciences in Göttingen, Germany, for the best "*investigation of the changes that have taken place in the earth's surface conformation since historic times, and the application which can be made of such knowledge in investigating earth revolutions beyond the domain of history.*" For his day, Carl Ernst Adolf von Hoff (1771-1837) brilliantly met the challenge.<sup>6</sup>

Lyell succeeded in dignifying the term "uniformitarian" (coined pejoratively in the 1830s by William Whewell whose creed was "catastrophism")<sup>7</sup> for Hutton's doctrine that speaks for sensible explanations of the rock record in terms of geological processes still in progress and which, for most, need only that Earth be very old. In this is also the Copernican assumption that we are not observing the system (our world in this case) at a privileged time.

Shades of Roger Bacon's "*Et harum scientiarum porta et clavis est Mathematica*" (Mathematics is the door and key to the sciences),<sup>8</sup> a memorable catch phrase definition for uniformitarianism, imbedded in the lexicon of geology students by Archibald Geikie's inclusion of it in the *Introduction to his Text-book of Geology*, 1882<sup>9</sup> (and already by then a familiar phrase that defines Huttonian geology and paraphrases the subtitle of Lyell's *Principles*)<sup>10</sup>, is: "**The Present is the key to the Past.**" In this, "the Present" refers to all of historical time and all that is factually known by direct observation and from records kept of geological events, processes and rates of change. These historical facts—*the Present*—recorded by human hand (this present knowledge of processes and their consequences), allows us to read—*is the key to*—the rock record of prehistory—*the Past*—written by nature.

The principle of uniformitarianism stresses witnessed processes and change to be examples of those that were in prehistory. What length of witnessed time is our sample?

One could claim as much as two thousand years for the eruptive history of strato-volcano Vesuvius hard by the city of Naples, Italy. Lowered on a rope into its crater in 1638 when it was active, peripatetic Athanasius Kircher (1601/2-1680) having just witnessed a catastrophic eruption in Sicily had seen enough (!) to postulate that all volcanoes are “merely safety valves of Earth’s interior fiery, fluid state.”<sup>11</sup> In 79 CE, a devastating eruption of Vesuvius, then called *Monte* (mount) *Somma* (Spartacus’ rebel army of slaves had sheltered in its vine-covered crater when dormant in 73 CE) buried the commercial city of Pompeii to roof height in ash. Glowing-ash avalanches down its southeastern slope then blew away all above and sealed off the whole—*nuée ardente* would be Alfred Lacroix’s name for such that in 1902 (a first photograph of one there later that year was by Angelo Heilprin)<sup>12</sup> had avalanched as a “pyroclastic flow” in modern parlance down strato-volcano Mont (mount) Pelee’s flank to destroy St. Pierre, Martinique.<sup>13</sup> Torrential rain of condensed volcanic steam triggered ash mudflows (lahars) buried the seaport Herculaneum on its western flank and recently discovered bodies of towns people who had sort shelter in seacliff alcoves that faced away from Somma but had been overwhelmed by an earlier pyroclastic flow.<sup>14</sup> The Pompeian eruptive column, explosions of pyroclastics, and glowing lava flows, were witnessed by Pliny the Elder (Gaius Plinius Secundus, 23/24-79 CE, then admiral of the Roman fleet at Misenum, near Pompeii) from a ship standing out to sea that fateful August 24 morning. Breathlessly recounted (“He hurried to the place from which everyone else was fleeing, steering his course directly for the danger zone.”) in a letter for Tacitus’ *Historiae* by 18 year old Pliny the Younger, the written observations of his grossly corpulent uncle (who exploring ashore later from a rowboat died of a heart attack while fleeing noxious fumes) are the first useful to geology of warning ground tremors before an eruption, an eruption column that reaches high into the stratosphere, pyroclastic flows, ash falls, the effects of the eruption on people, and even tsunamis.<sup>15</sup>

Yet who would care to learn anything that might alter the mental landscape of the Inferno below? Daniel J. Boorstin in *The Discoverers*, 1985, speculates that “enlightened Romans like a Cicero and Seneca and Plutarch probably had ceased to believe the mythic chart of Hades” but to what effect, if any, was Pliny’s complaint “that how strange it was that miners who dig deep pits and broad galleries underground had never come upon the infernal regions.”<sup>16</sup>

So most generous would be to push back the time of witness change to recorded Nile floodings of the Pharaohs’ Egypt and the construction during the First Dynasty of a masonry dam ca. 2925 BCE to control Nile-overflow into the Faiyum Depression and to regulate its water for irrigation there.<sup>17</sup>

Five thousand years of human recorded geological phenomena. Even then, all we have of witnessed time is about one millionth of geologic time. Begin counting the years of the world’s existence one second for each year and you could not complete the task (as it would take 32 years for each billion of which there are four and a half).

We could scale geologic time (4.55 billion years) to a humanly comprehensible length of a year. But on that compressed scale, historical time (5000 years) is reduced to 35 seconds. How reasonable would it be to extrapolate from half a minute of direct observation to know what has transpired in the course of a year? To scale however this is what historical geologists must do (extrapolate from historical time into prehistorical time) and the manifest success of our subject indicates that the history of Earth has indeed been *remarkably uniform*.

Extrapolation, by its nature, even though constants of physics do not change, becomes less reliable the further it goes. Our uniformitarian thinking needs to be adjusted for what we find to be true of conditions that were different in the deep past brought about, incrementally, by noncyclic physical change and evolving life. Soils develop where there are plants that prevent rapid erosion by wind scour and rain runoff. More than half a billion years ago, and before, no plants clothed the land. In the atmosphere, oxygen gas exists because of the burial of plant debris, mostly at sea. The accumulation of carbon, retained in sediments, has been slow and more than two billion years ago there had been no build up of free oxygen (molecular oxygen, O<sub>2</sub>) in the atmosphere.

In our application of uniformitarianism, our philosophy is humbled by life, for we are, to use Stuart A. Kauffman’s words in *Investigations*, 2000, “in a universe that can never, in the vastly many lifetimes of the universe, have made all possible protein sequences even once, bacterial species even once, or legal systems even once.”<sup>18</sup> □