

a29 Actualism < rates of change, physical constants >

Don't try to sell me on death, Odysseus, / I'd rather be a hired hand back up on earth,
Slaving away for some poor dirt farmer, / Than lord it over all these withered dead.
—Achilles' reply to Odysseus' effusive greeting in Hades, in *Odyssey*.¹

By the end of the 19th century, all mainstream geologists could be called *uniformitarianists*.² That is they approached the discovery of prehistory with the Huttonian philosophy that had been succinctly stated by John Playfair in 1802:

Amid all the revolutions of the globe the economy of Nature has been uniform, and her laws are the only thing that have resisted the general movement. The rivers and the rocks, the seas, and the continents have been changed in all their parts; but the laws which describe those changes, and the rules to which they are subject, have remained invariably the same.³

But philosophical complacency was not possible, for, to counter the Sunday School appeal of *catastrophism* effectively, Lyell had stressed that processes operated at the *same* rate in the past as they do today. Lyell recognized that this has *not* been the case in historical times. The climate has changed over the decades. Beaches eroded in times of storm by plunging waves and are then rebuilt by spilling waves. Volcanic activity has waxed and waned. Lyell was therefore at pains to emphasize: 1) Through the operation of secular (slow acting and incrementally bringing about change) processes, mountains can come and go; oceans retreat and encroach; climates chill and warm (which is the uniformitarian principle in its simplest form), and 2) an ahistorical uniformitarian principle that cyclical change is real. But unique events such as the Noachian Flood (**Footnote a29.1**) are not.

Lyell's stand left geology with the paradigm of a steady-state Earth that provides for variance only if this is cyclic and so, in the long term, has a uniformity of state—the (false) law of nonprogressionism.⁴ Later, to distance uniformitarianism from this untenable theme (**Footnote a29.2**), geology's paradigm was recast sometime during the middle of the 20th century as *actualism*. Actualism admits that: 1) rates of geological change can have been different in the past (But how can one know the limits to the magnitude or duration of processes and how much these may have changed given that historical time has been so brief?), and 2) emphasizes that only the physical constants and how the laws of nature act have remained the same.

Unfortunately, as a principle, actualism is utterly uninspiring. Its “unrestrained mechanisms” is no guide and its “uniformity of laws” is a statement that for scientists at the bench, is redundant.



Inspiring, as regards the latter, would be the reverse statement, and throughout the 1960s a particular distraction was that the universal constant of gravitation, G , is *not* a constant. Paul Dirac in 1937 from cosmological arguments had proposed that G is an inverse function of the age of the universe. In 1956, R. H. Dicke hypothesized that in consequence of the decrease in the force of gravity, Earth has expanded. To test this, he suggested that geologists and oceanographers should look for cracks in the ocean floor which would result from an internal swelling of Earth.⁵ The late **Samuel (Sam) Warren Carey** (1911-2002) yet posited this in his anachronistic (1996) book: *Theories of the Earth and Universe—A history of Dogma in the Earth Sciences*.⁶ And Lester Charles King (1907-1989): *Wandering Continents and Spreading Sea Floors on an Expanding Earth*, 1983, is found washed up on the same shoal.⁷

As Gordon Kane says, “We already have our world, and we know it is described by consistent laws—otherwise, it would fall apart. If the equations for the stability of atoms changed with time or were inconsistent with the equations for the forces, atoms would not keep existing and

forming the world. Only consistent equations have solutions. (Indeed, it is often remarked that it is ‘amazing’ that our world is comprehensible scientifically. But is that really surprising? Our world must behave according to mathematical regularities if it is to exist for some time. Given that these regularities exist, we can learn what they are.)”⁸ Actualism makes witty Ambrose Bierce’s (1842-1914) definition of “Pray, *verb*: To ask that the laws of the universe be annulled in behalf of a single petitioner confessedly unworthy.”

Every physical theory, to quote Hans Christian von Baeyer, “possess some numerical parameters whose values cannot be derived but must be measured in the laboratory, then inserted into the theory as input. When the theories are fundamental those numbers are called *constants of nature*, and serve as the empirical anchors for the bare mathematics.”⁹ As such, “you have to keep in mind,” points out Barry N. Taylor who since the 1960s has been a leader in assessing the values of constants, that they “are invented by man to help him describe the natural world that he sees.”¹⁰ A sentiment echoed by T. W. Körner:¹¹ “Mathematicians look at the rich complexity of the real world and replace it with a simple system which, at best, palely reflects one or two aspects of it.”

The constants of nature are constrained to tight tolerances. Better than one part in 10^{15} in some cases. Three constants underlie all: the newest is h (**Planck’s constant**), c (celerity - the speed of light in a vacuum) with centuries of narrowing precision from Ole Roemer’s realization in 1691 that distance could account for observed deviations of 11 and 22 minutes for Jupiter moon eclipses from the times predicted (which had assumed that light took no time to travel) to the value adopted by the 17th General Congress of Weights and Measures in 1983 of 299,792,458 m/s (defined), and G (Newton’s constant) the oldest (and flabby one) for which universal constant of gravitation an ingenious apparatus designed by Jens H. Gundlach and Stephen M. Merkowitz, in 2000, yielded a value of 6.6742×10^{-11} meter³ / kilogram second² with a scandalous (in physics, since Albert Abraham Michelson’s boast in 1903 that “our future discoveries must be looked for in the sixth place of decimals”) uncertainty of ± 0.0001 .¹²



Max Planck (1858-1947)

In 1900, Plank postulated that emission and absorption of electromagnetic radiation is not a continuum of radiative energy but exists as individual units, or quanta,¹⁴ The amount of energy in each quantum is directly proportional to the frequency of the radiation. The proportionality factor is a universal constant h (Planck’s constant) he calculated to be $6.55 \cdot 10^{-27}$ erg · sec (best current value: $6.6260755 \cdot 10^{-27}$ erg · sec.)¹⁵

Geoscience with its deep time perspective has the potential of testing, aboard this planet, the assumption that fundamental physical constants are, all of them, time-space invariant. The risk of actualism is that the assumption of invariance built into measurement, such as in radiometric dating, could warp otherwise independent geological data and controls, such as rates of weathering, sedimentation, volcanism, the physical evolution of Earth in general, and the evolution of life.

The observed flatness of our post-inflationary expanding universe requires astrophysics to favor the anthropic principle:

There was a young man of Cadiz
Who inferred that life is what it is,
For he early had learnt,
If it were what it weren’t,
It could not be that which it is.

—Anonymous limerick (cited by Gardiner).¹³

For those who take as given present technology, there is no surprise value in being told that the laws and constants of the exact sciences are laws and constants. This was *not* so in the 18th and 19th centuries when these were unknown or were being formulated, measured, and presented as evidence of the Divine which agent could repeal the same, with or without notice, to enact miracles (water to wine!), and when an acceptable mission of geology (a la William Buckland¹⁶) was to fill in the narrative gap between the first and the second verses of Genesis. To escape that mind set, Huttonian philosophy, clearly, had heuristic value.

When miracles and myth held sway, Huttonian philosophy was stressed to make geology an inductive science, viz: “We must read the transactions of time past in the present state of natural bodies, and, for the reading of this character, we have nothing but the laws of nature, established in the science of man by his inductive reasoning.”¹⁷ To counter catastrophism for all, except for the explosive origin of volcanic mountains, Hutton adduced the law of gradualism. This essential component to what became known as uniformitarianism, was carried forward by John Playfair (1748-1819), James Hall (1761-1832), William Henry Fitton (1780-1861), and Ami Boué (1794-1881). These few Huttonians were amid Wernerians who had made their purported understanding, which they called *geognosy* (literally: *Earth knowledge*), of ore occurrences, a deductive science. The difference: An inductive science uses organizing principle uniformitarianism that includes actualism to group observables and is historical when the relative ages of these can be inferred. A deductive science fits observables to a model and to what can be deduced to be a necessary part of it. For pioneer geological prospecting, the expediency and simplicity of deductive geognosy was a boon.¹⁸ But did not Jean-Jacques Rousseau remark: “Men will always prefer a worse way of knowing to a better way of learning.”¹⁹ For the more thoughtful only inductive geology would do. (Plate tectonics theory has made Earth Systems Science a deductive science, and this may not be a good thing.)

Today, there is a return in historical geology to the acceptance of uniformitarianism (shorn of Huttonian eternalism and Lyellian nonprogressionism) for its instructional value as when Hutton first realized its revolutionary implications. Uniformitarianism is a philosophy that impels a realization of Earth’s great age. By imperfect prompting, it makes lively our practical quest to know prehistory.

Footnote a29.1 The Deluge²⁰

Do you know [said Mole], I’ve never been in a boat before in all my life. Is it so nice as all that?
—Kenneth Graham, *The Wind in the Willows*.²¹

Genesis is not alone in its description of a world flood:²²

Greek myth has Zeus, grown impatient with the evilness of mankind, move to destroy the world by flooding it. The god Prometheus advises his son Deucalion to build and board a ship. At the flood’s height, Deucalion makes landfall on the top of Mount Parnassus. In fact, Deucalion was a King of Greece, as a list of these on a column ‘Parian Marble’ found island of Paros records. The same places him as a contemporary of Pharaoh Thutmose III, 1490-1439 BCE.

An ancient Mesopotamian flood tale, dated to around 1634 BCE recounts how Atrahasis, upon premonition, builds a boat and houses aboard his family and all kinds of animals and seeds. During a storm, which rages for seven days and nights, all is inundated. In the calm that follows, Atrahasis releases birds from his ark. He watches for those that do not return. Upon the assumption that they found dry land, he follows their lead and makes landfall on a mountain rising out of the sea.

A council of the gods harkening to Enil’s complaint that “The uproar if mankind is intolerable and sleep is no longer possible by reason of the babble,” cause an exterminating flood. The god Ea forewarns Utnapishtim and instructs him in the building of a boat. He and all aboard this ark survive. This tale is told in the Babylonian *Gilgamesh*, composed around 2000 BCE.

William Ryan and Walter Pitman in *Noah’s Flood* (1998), suggest that all tales as the above may make reference to the same event. But that event, they posit, occurred around 7000 BCE. Samples of seafloor sediments record that it was then that the Mediterranean overflowed into basin of the Black Sea. Formerly this had been a freshwater lake that had equilibrated river and precipitation inflow with evaporation at a level thousands of feet below sealevel. (Sealevel stabilized at its present elevation by 6000 years ago and had been rising as a result of glacier melting since the Ice Age that ended abruptly 11,800 years ago.) Ryan and Pitman claim evidence from drill-core samples that the first agriculturalists were inhabitants of Black Sea basin before the flood. Their thesis is that the flood-forced diaspora of these ur-farmers spread their skills, and flood stories, throughout eastern Europe and western Asia.²³ Too simplistic: Mediterranean foraminifera species immigrants enter Black Sea sediments as early as 9,500 years before present which is evidence, says Valentina Yanko-Hombach in 2004, that “Noah’s flood legend has nothing to do with the Black Sea.”²⁴

Footnote a29.2 In fairness, Lyell never advocated a “law.” Rather, he advocated the “principle” that geologists, to be scientific, should carry out their investigations *as though* visible causes are the same kinds as those that have acted in the past, and of the same degree of intensity.²⁵