

a27 What was plutonism? < heat engine >

All mountains, islands, and level lands have been raised up out of the bosom of the earth into the position they now occupy by the action of subterranean fires. —Lazzaro Moro (1687-1764), Venice, 1740.¹

For a long while I was troubled with water on the brain, but light and heat have completely dissipated it. —Adam Sedgwick (1785-1873).²

Go and see. —Nicolaus Desmarest who drolly so refused to debate with Neptunists, he having provided in 1763 ample evidence (published in 1777) for the volcanic origin of ancient lava flows in the Auvergne.³

Wherever the junction of the granite with the schists was visible, veins of the former ... were to be seen running into the latter and pervading it in all directions, so as to put it beyond all doubt, that the granite in these veins, and consequently of the great body itself ... must have flowed in a soft or liquid state into its present position. —James Hall, 1790.⁴

Hutton's concept of the rock cycle required a source of energy internal to Earth to drive it and to uplift mountains. His (**Figure a27.1**) field observations persuaded him to classify as igneous some rocks (granite and basalt) which had field associations (see below) with country rock that indicated brought-in heat and mineralizing fluids. By their making room for themselves when intruded as magma, the country rock was elevated, deformed by folding, and any sediments present became "lithified" (we would say metamorphosed). Great internal heat, obvious where there are volcanoes, powered these slow but vast changes. Hutton reasoned that Earth was in fact a giant heat-engine. An insight, not so surprising Nigel Bunce and Jim Hunt suggest considering that his close friends were Joseph Black (a pioneer in research on heat) and James Watt (a steam engineer).⁵

Geologists who interpreted geological field evidence in favor of igneous activity as part of the Huttonian rock cycle became known as *Plutonists* or, what was the same, *Vulcanists*. Geologists who interpreted the same field evidence in favor of a Wernerian aqueous origin became known as *Neptunists*. The debate was real. In France, Nicolaus Desmarest (1725-1815) was persuasive in showing that extinct volcanoes existed there by his comparative studies of their rock and landforms with volcanoes that are active in Italy. The eroded landforms of extinct volcanoes attests to their great age. Volcanism had also not been confined to place.⁶ In Britain, Hutton is credited with proving that granite is igneous. But that was to his satisfaction and was cause for sneering amusement for neptunist Robert Jameson, professor of natural history at the University of Edinburgh. At Glen Tilt, branching veins of red granite extend from a body of it to "traverse" (cut) superincumbent strata of micaceous schist and limestone. Cross-cutting relationships established for Hutton that the granite is younger than the schist. This might be a blow to a strict Wernerian for whom granite is Primitive and schist is Transition but not fatal for a neptunist who would retain at this observational scale only that part of Wernerian theory that would claim an aqueous origin for granite. True one might counter that granite cannot be dissolved in water. But what of the silica precipitated from geyser water in Iceland as documented by Joseph Black?⁷ Given time enough ...

Hutton is credited with proving that basalt is igneous. That basalts were once molten is evident in many areas he visited where country rock is transformed by heat near its contact with them (**Footnote a27.1**). But in 1805 when George Bellas Greenough (1778-1856) visited the same sites he did not see unequivocal evidence of contact metamorphism. However, favoring Hutton's theory (**Footnote a27.2**), he was pleased to later find a coal seam that, near its contact with basalt, is coke.⁸ But association is not proof. False belief can be from the insidious operation of Bayes' Rule.⁹

Hutton felt strongly that laboratory experiments; lacking the possibility of geological time or of mimicking Earth's interior condition, would be misleading. After his death, his young friend James Hall, (1761-1832) a glass maker and member of the Royal Society of Edinburgh, undertook a series of 500 experiments between 1798 and 1805 to show that granite and basalt could originate by the slow cooling of their substance that had been heated to a melt.¹⁰ In the case of granite, the stone that Hall had obtained from a melt of it in 1790 did not have the coarse crystalline appearance of the original. However, his experiments let him (correctly) imagine how a porphyritic rock would form

when, after slow cooling “in the bowels of the earth,” the liquid is forced upward and “being spread thin upon the surface, and exposed to the air, would lose its heat suddenly.” Crystalline whinstone (basalt) melted and allowed to cool slowly over 10 days did recrystallized to an appearance so like the original that Hall could claim success when this result was presented at the “Society” in 1805.¹¹ (Belatedly for naysayers, microscopic examination of the specimen by J. Barry Dawson in 1992 finds that the experimentally fused whinstone was not fully restored, as glass is present.¹²)

By 1820, many of the original points of difference between neptunists and plutonists (or vulcanists) had still not been settled. Nevertheless, interest in arguing for an aqueous origin of rocks that could otherwise be interpreted as igneous or metamorphic waned. Hutton’s theory allowed for a simpler explanation of field observations. Those who persisted in arguing for a young Earth, were called *Catastrophists*. Events outside the mine-run of experiences were a necessary part of their evidential



explanation of prehistory. Geologists who ascribed to Hutton’s vision, which was that secular processes given enough time are responsible for Earth’s observed features, were called *Uniformitarianists*. These belief- appellations were coined in 1837 (pejoratively for “uniformitarianism” and embracingly for “catastrophism”) by mineralogist **William Whewell** (1794-1866) Trinity College, Cambridge, England. Whewell was the last man who was said to know the whole of science for his publications that dealt at length with the history of the inductive sciences. In *On the Philosophy of Discovery*, 1860,¹³ he enlarged upon Francis Bacon’s inductive reasoning spoken for by that philosopher in *Novum Organum*, 1620.¹⁴ In 1858, he had explicitly refuted uniformitarianist thinking, as being any reasonable part of inductive science, by: “I conceive that the assertion of an a priori claim to probability and philosophical spirit in favour of the doctrine of uniformity, is quite untenable. We must learn from an examination of all facts, and not from any assumption of our own, whether the course of nature be uniform.”¹⁵

We disagree, for what else can justify enquiry into *prehistory*? By any rational definition, prehistory is a total blank and so there is nothing *a posteriori* to work forward from. Work back with the a priori assumption of uniformity and for what is found adjust as there is need. The other way around can only begin with a (to borrow M. [Marion] King Hubbert’s [1903-1989] words) “fanciful and incredible scheme of supposed geology and geological history [as] was [say] taught by Werner to his students, who in turn went out into the world zealous to establish the master’s system.”¹⁶ Consider the “rubbish” (a word much used by Charles Darwin) in print in the 1800s. James Andrew (Jim) Secord in *Victorian Sensation*, 2001, reminds us: “Geology, the newest and most controversial of the sciences, became identified [as in Robert Chambers’s skillfully pitched *Vestiges of the Natural History of Creation*, anonymous, and respectable for its issuance in various nine editions, 1844-90, by the prestigious medical publisher Mr. (John) Churchill]¹⁷ with the progressive history of the earth and of life.”¹⁸ Humphry Davy’s *Consolations in Travel*, 1830, offered dialogues on the meaning of science for metaphysics (beyond the physical realm) and religion (unreason that follows from faith). In the third dialogue, the “Unknown,” a stranger, describes his vision of the geological past. It is a story of progress, beginning with Earth “in the first state in which the imagination can venture to consider it,” cooling from original fluidity to become habitable. Tropical animals and plants of simple character are succeeded by shells, fish, reptiles, mammals, and finally human beings. In the early ages there was no order of events similar to the present, “for the crust was thin and the central fire close to the surface. Only gradually, as the planet cooled, did the world approximate its modern state.”¹⁹ Just so. □

Footnote a27.1 “Ammonite [*Paltechioceras*] bearing basalt” found by Richardson ca. 1799 and persuasive of Neptunian origin to him and Kirwan was understood by James Hall, Webb Seymour and John Playfair to be a marine mudstone baked by nearby Portrush Sill when its dolerite was molten.²⁰

Footnote a27.2 When visiting his former teacher Werner in Freiburg in 1816, Greenough declared covertly to William Buckland, he “knows little of the structure even of Germany”!²¹