c17 Wm. "Strata" Smith (1769-1839) < principle of faunal succession >

> I have oftentimes wished for a mappe of England coloured according to the colours of the earth; with markes of the fossiles and minerals. —John Aubrey, 1685.
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> The idea of such a map seems to have been first suggested by Dr. Martin Lister, in a paper on 'New Maps of Countries, with Tables of Sands, Clays, &c.' printed in the Philosophical Transactions, in 1683. —John Britton, 1847.[1]

The facies problem limits the extent to which a stratum can be traced laterally by the lithology that it shows locally. Also, the distinctive strata of a system are not always in outcrop. So, deciding that exposed strata of less-than-distinctive lithologies belong to this or that system is a problem of correlation (***Footnote c17.1***) that originally seemed to have no solution. However, William Smith (***Figure c17.1***) found one, and provided exemplars of its great economic importance.

At the beginning of the 19th century, geologists communicated what they knew of a localities' strata, in tabular form. The strata were numbered, or lettered, in the order of youngest to oldest. In England, a description of the strata near Bath, England was dictated by Mr. William Smith to Reverends Joseph Townsend and Benjamin Richardson. Collaboratively, deep into the night after supper at Great Pulteney Street with this Oxfordshire blacksmith's orphan-at-eight eldest son, mostly self-educated, powerfully built, ambitious yeoman, they honoring science over class, magnanimously took on the recording task that Smith with his already developed beautiful hand and drafting skills could easily have done alone. In *The Map that Changes the World*, 2001, Simon Winchester reconstructs: "Richardson and Townsend sat at the dining table, now cleared of all china and glassware. A large piece of paper, the size of a blotting sheet, was placed on the surface. Townsend took out his quill pen and sand-shaker. Smith gave him a ruler, and with this he drew five long lines across the page—one horizontal, four vertical. Above the horizontal line, and in the five boxes thus created by the intersections with the vertical rules and the paper edges, Townsend then wrote, according to Smith's dictation, the words 'Strata, Thickness, Springs, Fossils, Petrifactions, &c, &c.' and finally, 'Descriptive Characters and Situations.'"[2] The originality of his *Table of* [23] *Strata* (published in 1799) was that the strata were identified by "extraneous or organized fossils" (***Footnote c17.2***) with precedence over rock type. Thereafter, attention to fossils, organic in form and by inference organic in origin, as distinguishing features of stratified formations became standard (*c.f.* Farey, 1806)[3] as also in Georges Cuvier and Alexandre Brongniart's 1811 table and pictorial cross section of strata of the Paris Basin, France.[4] In England, Etheldred Benett (1776-1845) commissioned the first recorded measured section at the Upper Chicksgrove Quarry, Tisbury in Wiltshire. This "first female geologist" donated a published version of this section (signed by her in 1815) to the Geological Society of London Library. Fossil collecting and illustrating absorbed her.[5]

William Smith (as in France had Giraud-Soulavie independently in 1779)[6] saw that fossil assemblages are not the same at successive levels and, most importantly for his use and for geology when he shared it, some (index) fossils that characterized one level, and are not repeated at different levels, can be found at widely separated places. In France, Cuvier interpreted the fossil record as evidence of a succession of creations of life with catastrophic extinctions ending each. In his comfortable vision, the world was brought to its present perfection by the final punishing catastrophe, which was the Noachian Flood. In England, Smith professed no grand theory to explain or champion. As a practical man in charge of the excavation of canal routes through the Midlands of England, he found that he could often use fossils to assign strata to a position in his *Table of 34 Strata* (published in 1815) although their lithologies differ from place to place and, when seen in isolated outcrop, their lithologies are less-than-distinctive:

> ... Fossil Shells had long been known amongst the curious, collected with care, and preserved in their cabinets, along with other rarities of nature, without any apparent use. That to which I have applied them is new, and my attention was the first drawn to them by a previous

> discovery of regularity in the direction and dip of the various Strata in the hills around Bath; for it was the nice distinction which those similar rocks required, which led me to the discovery [originally published in 1799] of organic remains peculiar to each Stratum. ... [7]

Application of this empirically realized solution to the problem of correlation on a regional scale, made possible Smith's crowning achievement: the publication in 1815 of the first modern geologic map (***Footnote c17.3***) of England and Wales.[8]

Smith's principle of faunal succession that has enabled time-correlation of strata around the world, was an *empirical* inference from fossils occurrences that he observed in sedimentary strata. ❑

Figure c17.1 **William Smith** (1769-1839) "a bluff and hearty, muscular-looking man, full of energy, restless, talkative, jumpy, untidy–-and invariably to be spotted scurrying hither and yon, always scurrying, and carrying great bundles of papers, maps and charts under his arm," writes Simon Winchester. "A very talkative man, with all the enthusiasm of the slightly dotty. He chattered so much about the passion for landscape and rocks that drove him that he soon picked up the nickname 'Strata' Smith from the barmaids and fellow passengers and those who dined beside him." [2]

In 1831, Smith received the first Wollaston Medal from the Geological Society of London, its highest honor, awarded each year for outstanding achievement in geology. Geologist Adam Sedgwick, then President of the Society, presented the award to Smith with these words:

> "If, in the pride of our present strength, we were disposed to forget our origin, our very speech betrays us: for we use the language which he taught us in the infancy of our science. If we, by our united efforts, are chiselling the ornaments and slowly raising up the pinnacles of one of the temples of nature, it was he that gave the plan, and laid the foundations, and erected a portion of the solid walls, by the unassisted labour of his hands." [9]

(Sedgwick in his work used Smith's method of indicating dip of outcrop by shading a stratum from pale at its top to dark at its base. And he observed with wry admittance to his own unshakable Yorkshire (Dent village) roots, that Smith is responsible for introducing many terms "arbitrary and somewhat uncouth," which have become the verbal currency of British geology.)[10]

Footnote c17.1 *Correlation* is the establishment of a correspondence. In geological mapping, correlation can be to establish that isolated stratigraphic units, or successions, were once physically continuous. *Physical-correlation* is most suited to large-scale mappings of a mine site or a small field area (in larger regions, facies problems increasingly intervene). A radically different way to correlate, is to establish that isolated stratigraphic units, or successions, are the same age. *Time-correlation* results in the type of geologic map that is now standard for small-scale maps of large regions.

Footnote c17.2 Werner's fame-making first publication, *On the External Characters of Fossils*, 1776, describes only what now are called *minerals*.[11]

Footnote c17.3 Standard (time-correlation) geologic maps are still prepared as was Smith's (though shading to indicated dip has been discontinued in favor of solid colors for formations and placing on these, strike and dip symbols.

Traditionally, physical-correlation and time-correlation geologic maps are completed to aid prospection for earth-materials (sands and gravels, building stones, salts, and ores), and energy resources (coal, oil and gas, uranium, and geothermal). More recently, geologic maps are also compiled to aid geologic risk/cost assessment (slope stability, swelling clay, for example), groundwater, paleontological resource studies, academic research, recreation, and land-use planning.

Geologic data are now routinely digitized and utilization of Geographic Information System (GIS) and Information Technology (IT) is standard.[12] Geologic maps show the relationship between bedrock and surficial units "as they face the sky." Derivative maps are for bedrock, surficial geology, engineering geology, and geologic hazards. Milton (Milt) A. Wiltse in 2002 wrote: "With proper planning, mappers can produce unique geologic maps or 'views' for individual customers."[13]