LEWIS EVANS' CONTRIBUTIONS TO EARLY AMERICAN GEOLOGY—1743-1755

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Lewis Evans' important work in cartography of the American colonies is now recognized, but his very considerable contributions to early American geology are almost unknown. His observations and theories formed the basis for much better known work of later writers, such as Volney (1804), Mitchill (1818), and others. The subject of this paper is Evans' geological contributions, which have not been noticed by historians of geology, except for the quotation of his physiographic descriptions of the eastern colonies by Mather and Mason (1939, pp. 55-59).

Stevens' (1905, 1920, 1924) monographic studies of Evans' maps have made known his importance to colonial cartography, and recently the details of his life have been given by Wroth (1934, pp. 48-56; 148-66) and by Gipson (1939). The biographical data in this paper are summarized from Gipson.

Lewis Evans was born in 1700 at Llangwnadl, near Pwllheli, Carnarvonshire, Wales. He is known to have been in Pennsylvania as early as 1736. He was a surveyor, draftsman, and map maker. His earliest known map, a manuscript map of a small part of Pennsylvania (The Walking Purchase), is signed and dated 1738. He was well known to Benjamin Franklin, often purchased books from him, and may have on occasion worked for him as draftsman.

Evans travelled widely and observed acutely. In 1743 he made a trip from Philadelphia to Onandoga and Lake Ontario in the company of John Bartram, botanist and natural historian, and Conrad Weiser, interpreter and ambassador to the Indians (Bartram, 1751). He carefully recorded his observations in a journal which was not published until 1776—and then only in part—by Thomas Pownall.

From the journal of 1743 we note Evans' certainty that fossil shells are remains of marine organisms,[1] his recognition of the exhumation of the present Appalachian ridges from a former plain (peneplain!), the erosion of valleys to leave mountains, the linear character of the Appalachian ridges, the Coastal Plain, the former greater extent of the Great Lakes, and isostatic uplift consequent on unloading the earth's crust by partial draining of the lakes (White, 1951). The salient observations are (Pownall, 1776, pp. 29, 30; unchanged in Mulkearn, 1949, pp. 112-116):

> The Stones in all Parts of these Mountains are full of Sea Shells: It is not in the loose Stones scattered through the Vales that these Shells abound only, but

[1] This is all the more noteworthy when we remember that less than 40 years earlier Edward Lhwyd of Oxford, author of the first book on fossils published in England, after 20 years studying and collecting, could not bring himself to believe them to be organic remains (Gunther, 1945).

they are found at the Tops of the Mountains also . . . there could be no Doubt but that the Shells were genuine, and where the Shells were actually of the same Sort as those which I had observed in the Mountains, convinced me that those Shells of the Mountains were real, and had been mixed with and finally incrusted in the Stones where they were found . . .

Various Systems and Theories of the present Earth have been devised in order to account for this Phaenominon. One System supposes that the Whole of this Continent, the highest Mountains themselves, as they now appear, were formerly but one large Plain, inclining with a considerable Slant towards the Sea; that this has been worn into its present Appearance of Ridges, with Vales between them, by the Rains of the Heavens and Waters of the Earth washing away the Soil from the upper Parts, and carrying it down to Seawards. That the Soil thus carried down and lodged in various Places hath in a Series of Ages formed the lower Plains of the Jerseys, Pennsylvania, Maryland, Virginia, and the Carolinas . . . The Downfall of Waters from the melting of the Snow, the Rains, and the swollen Springs is such amongst the Mountains, and the Discharge from thence so great, that the Freshes on the Susquehanna River, where it is a Mile broad, rise 20 Feet, though they are discharged with a violent and precipitate Current. These Freshes carry down with them immense Quantities of Soil which they begin to drop as the Velocity of their Course slackens in gliding over the lower Plains, and which they finally lodge in Bars and Islands at the Mouths of the Rivers where they meet the Sea. Thus have been many very extensive Countries formed at the Mouths of all the great Rivers in the World, and thus at the several Mouths of the many great Rivers ranging so near one another along this Coast may that long continued Range of flat country, which is herein before called the *Lower Plains*, be formed . . .

But we must have recourse to some other Explanation in order to account for the Situation of the Shells on the Tops of the Mountains.

It is easy to shew the Earth and Sea may assume one another's Places, but positively to assert how that hath actually happened in Times past, is hazardous; we know what an immense Body of Water is contained in the great Lakes at the Top of the Country, and that this is damm'd and held up by Ridges of Rocks: Let us suppose these Ridges broken down by any natural Accident, or that in a long Course of Ages a Passage may be worn through them, the Space occupied by the Water would be drained: This Part of America, disburthened of such a Load of Waters, would of course rise, as the immediate Effect of the shifting of the Center of Gravity in the Globe at once or by Degrees, much or little, accordingly as the Operation of such Event had Effect on that Center. . . .

Some such Changes may have come gradually and advanced by such slow Degrees, as that in a Period of a few Ages would not be perceptible; History therefore could take no Notice of them.

Evans' maps (1749, 1752) of Pennsylvania and adjacent states are now vary rare, but facsimiles are included in Gipson (1939). In these maps Evans filled in blank spaces with notes on weather, roads, streams, and geology. His "Remarks on the Endless [Appalachian] Mountains, etc."[2] follow:

These Mountains are about 900 Miles in Length and back of Pensilvania from 70 to 100 Miles right Across; scarce an Acre of 10 of which is capable of Culture. They are not confusedly scatter'd, and here and there in lofty Peaks over topping one another but stretch in long uniform Ridges, scarce half a Mile Perpendicular in any Place I saw them. They furnish endless Funds for Systems and Theories of the World; but the most obvious to me was, That this Earth was made of the Ruins of another; at the Creation Bones and Shells which escaped the Fate of softer animal Substances are find mixt with the old Materials and elegantly preserved in the loose Stones and rocky Bases of the highest of these Hills. These Mountains existed in their present elevated Heights before the Deluge, but not so bare of Soil as now. The further ridges which are much the largest and highest, proceeding from the Inclination of the whole towards the Sea, are of very rich Land, even on the Tops; while the very Vallies, on the hither Side, seem swept of all the Soil.

[2] His statement that "this Earth was made of the Ruins of another" contains the germ of Huttonianism—"For having, in the natural history of this earth, seen a succession of worlds . . . ." (Hutton, 1788, p. 304). It would be interesting to know if Hutton ever saw Evans' maps or "Analysis."

Their Height rendered them no doubt less exposed to that general Devastation, and preserv'd them unhurt, while the Soil and the loose Parts of the lower Hills and Vallies, agitated by a greater Weight of Water, were borne away, suspended in the dashing Waves, and thrown downwards in Stratas of different Kinds, as the Billows roll'd from different Parts; still obvious in our lower Lands Northward and Westward of the Raritan and Delaware. But in N. Jersey on the other Side of these Rivers, the Land is made by an Accumulation of Sand from the Ocean: Digging there ab. 18 foot thro white worn Sand, you come to a Stratum, of Sea Mud mixt with Shells and other Drift Trash; and in some Places vast Beds of Shells of all Sorts, in Pairs, entire 30 Miles from the Sea. Dr. Woodward from infinite examples discover'd, that the World had been in a State of Dissolution. But the Power he ascribes to the Water of the Deluge is too much of a Miracle to obtain Belief. We have glaring Marks of a Deluge of far more recent Date, in which the Compass of Britain might not perhaps have furnished the Dr. with.

In 1755 Evans published his "Map of the Middle British Colonies." It was reprinted with and without acknowledgment for the succeeding 50 years (Stevens, 1904, 1920, 1924). It was used by both sides in the Revolutionary War. The map was so full of geographic data that, except for spot indication of "Coals" and "Freestone," all geologic notes were presented in a separate booklet of 36 pages, "An Analysis of a General Map of the Middle British Colonies . . . ," which could be purchased with the map. The Map and "Analysis" are bibliographic treasures. Fortunately, facsimiles of the map and the "Analysis" are now available (Gipson, 1939). In the preface Evans regrets not being able to include on the map profiles and geologic sections, stating:

But Want of Room in the Plate, has obliged me to leave out, what would have very much assisted my Explanation of the Face of the Country, I mean a Section of it in several Directions; such would have exhibited the Rising and Falling of the Ground, and how elevated above the Surface of the Sea; what Parts are level, what rugged; where the Mountains rise and how far they spread. Nor is this all that a perpendicular Section might be made to represent; for, as on the upper Side, the Elevations, Depressions, outer Appearances and Names of Places may be laid down; on the lower, the Nature of the Soil, Substrata and particular Fossils may be exprest. It was with Regret I was obliged to omit it. But in some future Maps of Separate Colonies, I hope to be furnished with more Room.

We share Evans' regret for the omission. It was not until more than 50 years later that Maclure (1817) presented geologic sections, which do not show all the features Evans proposed to include had there not been "Want of Room in the Plate." Neither these sections, nor "Maps of the Separate Colonies," were published, for Evans died under tragic circumstances the following year. It is likely that at least working drawings of sections were made by Evans. The best chance for their preservation would have been by Sir Thomas Pownall, who had the Evans' diary (or a copy?) and took it to England. The reader can carry as far as he likes any further conjecture on the possible existence of the sections.

In the "Analysis" is a clear statement of the physiographic and geologic provinces of the eastern United States. It is the first attempt at delineating physiographic provinces of the country and is valid today. The description of New England (p. 6) is brief, but west of the Hudson Evans was on surer ground. He describes what we now call the Coastal Plain, the Fall Line, the Piedmont Plateau, the Blue Ridge, the Folded

Appalachians, the Allegheny Front, and the Allegheny Plateau (pp. 6-9) (the modern terms are inserted in brackets):

The Land, South Westward of Hudson's River, is more regularly divided, and into a greater Number of Stages than the other. The first Object worthy Regard, in this Part, is a Rief or Vein of Rocks, of the Talky or Isinglassy Kind, some two or three, or Half a Dozen Miles broad; rising generally some small Matter higher than the adjoining Land; and extending from New-York City South Westerly by the Lower Falls of Delaware, Schuylkill, Susquehanna, Gun-Powder, Patapsco, Potomack, Rapahannock, James River and Ronoak. This was the antient maritime Boundary of America, and forms a very regular Curve. The Land between this Rief and the Sea, and from the Navesink Hills South Westward as far as this Map extends, and probably to the Extremity of Georgia, may be denominated the *Lower Plains* [Coastal Plain], and consists of Soil washt down from above, and Sand accumulated from the Ocean. . . .

From this Rief of Rocks, over which all the Rivers fall [Fall Line], to that Chain of broken Hills, called the South Mountain, there is the Distance of 50, 60 or 70 Miles of very uneven Ground, rising sensibly as you advance further inland; and may be denominated the *Upland* [Piedmont]. This consists of Veins of different Kinds of Soil and Substrata, some Scores of Miles in Length; and in some Places overlaid with little Ridges and Chains of Hills. The Declivity of the whole gives great Rapidity to the Streams; and our violent Gusts of Rain have washt it all into Gullies, and carried down the Soil to enrich the Borders of the Rivers in the *Lower Plains*. These Inequalities render half the Country not easily capable of Culture; and impoverishes it, where torne up with the Plough, by daily washing away the richer Mould that covers the Surface.

The *South* Mountain is not in Ridges like the *Endless* Mountains, but in small, broken, steep, stony Hills; nor does it run with so much Regularity. In some Places it gradually degenerates to Nothing, not to appear again for some Miles, and in others spreads several Miles in Breadth. Between the South Mountain and the hither Chain of the Endless Mountains, (often for Distinction called the North Mountain, and in some Places the Kittatinni, and Pequilin,) there is a Valley of pretty even, good Land, some 8, 10 or 20 Miles wide, and is the most considerable Quantity of valuable Land that the English are possest of; and runs through New-Jersey, Pensilvania, Mariland and Virginia. It has yet obtained no general Name, but may properly enough be called Piemont, from it Situation. Besides Conveniencies always attending good Land, this Valley is every where enriched with Limestone.

The *Endless Mountains* [Folded Appalachians], so called from a Translation of the Indian Name, bearing the Signification, come next in Order. They are not confusedly scattered, and in lofty Peaks overtopping one another, but stretch in long uniform Ridges, scarce Half a Mile perpendicular in any Place above the intermediate Vallies. Their Name is expressive of their Extent, though no Doubt, not in a literal Sense. . . .

There are several Chains of the Endless Mountains which have not come to my Knowledge, and had they been so, might have filled several Places which lie vacant in the Map. But so far as we are acquainted with them, we observe that each Chain consists of a particular Kind of Stone, and each different from the rest; and these Differences continue for their whole Extent, as far as I can learn. . . .

To the North Westward of the Endless Mountains is a Country of vast Extent, and in a Manner as high as the Mountains themselves. To look at the abrupt Termination of it, near the Sea Level, as is Case on the West Side of Hudson's River, below Albany, it looks as a vast high Mountain; for the Kaats Kills, though of more lofty Stature than any other Mountains in these Parts of America, are but the Continuation of the Plains on the Top; and the Cliffs of them, in the Front they present towards Kinderhook. These UPPER PLAINS [Appalachian Plateau] are of extraordinary rich level Land, and extend from the Mohocks River, through the Country of the Confederates. Their Termination Northward is at a little Distance from Lake Ontario; but what it is Westward is not known, for those most extensive Plains of Ohio are Part of them; which continue to widen as they extend further Westward, even far beyond the Mississippi; and its Boundary Southward is a little Chain of broken Hills, about 10 or 15 Miles South of the Ohio River. 'Tis an odd Phaenomenon to observe how

near the Tide comes up Hudson's River to the Heads of Delaware and Susquehanna; when these two Rivers are obliged to go so far to meet it in their own Channels. The Reason is Delaware and Susquehanna have their Heads in the *Plains*, and Hudson's River the Tide at the Foot of them.

Evans' description of the rivers, lakes, and portages is in sufficient detail to be useful as a guide to navigation (pp. 16-31). He described at length the Indian tribes and the territory they occupied (pp. 14-16). He was alarmed over the encroachment of the French in the Ohio Valley and insisted on the necessity of English colonization of that region and of proper treatment of Indian allies (p. 16).

In some conservative quarters his views were regarded as "expansionist" and "war-mongering," which might lead to war with the French. Arguments with the opposition, whom he regarded not only as misguided but even as traitorous to the Colonial interest (pp. 31-32), led to his disfavor in certain quarters. Efforts were made to silence him (Gipson, pp. 75-78) and for a time he was imprisoned. After his release from jail he died on June 11, 1756, "after a lingering Indisposition" (Gipson, p. 77). The "Analysis" closes with a statement of the resources of the Ohio country (p. 32), which he believes through lack of knowledge and governmental inertia (he suggests—and not too delicately—even stupidity) may be allowed to fall to the French:

Ohio is naturally furnished with Salt, Coal, Limestone, Grindstone, Millstone, Clay for Glass-houses and Pottery, which are of vast Advantage to an Inland Country, and well deserving the Notice I take of them in the Map.

Evans deserves an important place in the history of American geology because of his maps with their geological notes; his "Analysis" with geological descriptions; and his journal, with theories on Great Lakes drainage, isostasy, and stream origin. He is perhaps equally important because he furnished geological information in other ways to his contemporaries. He and John Bartram had travelled together to Lake Ontario in 1743 and must have then and often later discussed geology. A comparison of the extracts from Evans' journal with Bartram's published journal (1751) shows that geologically Evans was the more penetrating and that Bartram was the more naive. It seems to me, on the basis of comparison of the journals, that Bartram gained more from Evans than he contributed to him. (Study of Bartram's work in geology is now in progress and my opinion may be changed by fuller investigation.)

An example of the information Evans had, but did not formally publish, is contained in an extensive manuscript account of Pennsylvania drawn in answer to some "Queries proposed by a Gentleman in Europe to his friend in Philadelphia" (Gipson, 1939, pp. 87-137). He described natural resources, the animals and plants, and tells of iron, copper, lead, mineral water, marble, millstones, amethyst, clays, and other mineral resources (Gipson, pp. 104-108).

Evans was certainly familiar with at least some foreign geologic literature for he refers to Woodward (1695) and discussed Burnet (1684) with Bartram (1751). A further

interesting study will be to determine what other scientific literature of the day was known to him.

Evans supplied topographical and geological information to Peter Kalm, the Swedish scientific visitor (Kalm, 1937, pp. 61, 106, 351), and much of the geological information given Kalm by John Bartram (Kalm, 1937, pp. 36, 64, 65, 71-73, 173) may have come originally from Evans, or at any rate certainly must have often been discussed by Evans and Bartram. Kalm's "Travels" was first published in Swedish in 1753 and went through many editions in several European languages. His work had great influence for several decades and is often quoted by travellers such as Schoepf (1787; 1911, vol. 1, p. 300).

We can trace Evans' geologic contributions for 60 years after his death. Kalm widely disseminated them. Books of travels display knowledge of them, as for example that of Smyth (1784). The idea of deposition of sedimentary rock and fossils in inland bodies of water, often attributed to Volney (1804) and to Mitchill (1818), who developed the concept in great detail, appears to trace back to Evans.

It is unfortunate that Evans did not live to publish the planned maps of separate colonies with geologic cross sections. If he had done so his just place in the history of American geology would have been earlier recognized. His belief in a deluge as an explanation of certain geologic features is not to his discredit—this explanation was accepted almost into the middle of the 19th century for more phenomena than even Evans explained by it. His observations were acute and his explanations were, in part, in advance of their day. His theories were presented as such and were not insisted upon, except as observation supported them. His ideas were based on field observations. These are astonishingly correct and his theories no worse, and often better, than those of many who came long after him.

REFERENCES

BARTRAM, JOHN, 1751, Observations on the inhabitants, climate, soil, rivers . . .: London, J. Whiston and B. White.

BURNET, THOMAS, 1684, The Theory of the Earth . . .: London, R. Norton for W. Kettilby (several later editions).

EVANS, LEWIS, 1749, 1752, A map of Pensilvania, New-Jersey, New-York . . .: Philadelphia.

———, 1755, A general map of the middle British colonies . . .: Philadelphia.

———, 1755, An analysis of a general map of the middle British colonies . . . : Philadelphia, B. Franklin and D. Hall.

GIPSON, L. H., 1939, Lewis Evans: Philadelphia, Historical Society of Pennsylvania.

GUNTHER, R. T., 1945, Early Science in Oxford, vol. 14; Life and letters of Edward Lhwyd: Oxford, University Press.

HUTTON, JAMES, 1788, Theory of the Earth . . .: Royal Soc. Edinburgh Trans., vol. 1, pt. 2, pp. 209-304.

KALM, PEHR, 1937, Peter Kalm's travels in North America . . .: edited by A. B. Benson, New York, Wilson-Erickson.

MACLURE, WILLIAM, 1817, Observations on the geology of the United States of America . . .: Philadelphia, Abraham Small; also in Am. Philos. Soc. Trans., 1818, new series., vol. 1, pp. 1-91.

MITCHILL, L. L., 1818, Observations on the geology of North America . . .: pp. 319-431 of Jameson's translation of Cuvier, Essay on the theory of the earth: New York, Kirk and Mercein.

MATHER, K. F., AND MASON, S. L., 1939, A source book in geology: New York, McGraw-Hill.

MULKEARN, LOIS, ED., 1949, POWNALL, T., A topographical description of the United States of America (being a revised and enlarged edition): Pittsburgh, University of Pittsburgh Press.

POWNALL, THOMAS, 1776, A topographical description of such parts of North America as are contained in the (annexed) map of the middle British colonies in North America: London, J. Almon.

SCHOEPF, J. D., 1788, Reise durch einige der mittlern und sudlichen Vereinigten nordamerikanischen Staaten . . .: 2 vols., Erlangen, J. J. Palm. 1788; English translation by A. J. Morrison, 1911, Travels in the Confederation: 2 vols., Philadelphia, W. J. Campbell.

SMYTH, J. F. D., 1784, A tour in the United States of America: 2 vols., London.

STEVENS, H. N., 1905, 1920, 1924, Lewis Evans, his map of the middle British colonies . . .: London, H. Stevens, Son, and Stiles; three editions.

VOLNEY, C. F., 1804, View of the climate and soil of the United States of America . . .: London, J. Johnson.

WHITE, G. W., 1951, Lewis Evans' early American notice of isostasy: Science, vol. 114, pp. 302-303.

WOODWARD, JOHN, 1695, An essay toward a natural history of the earth . . .: London, R. Wilkin.

WROTH, L. C., 1934, An American bookshelf 1755: Philadelphia, University of Pennsylvania Press.