

"The Insanities of an Exalted Imagination": The Troubled First Geological Survey of Pennsylvania

THE SECOND QUARTER OF THE NINETEENTH CENTURY witnessed a burgeoning demand for basic geological knowledge in the United States. Perhaps nowhere was this more true than in Pennsylvania, possessor of the largest coal and iron deposits in the eastern states. The nascent academic and scientific geology community claimed a special role in this endeavor. "If knowledge is power, so also is wealth," contended the geologists, and no matter how basic or descriptive the research, the commonwealth would ultimately be "greatly enriched" by their efforts.¹ In contrast, capitalists did not pause to await the results of scientific investigation in their haste to assemble an industrial empire, relying instead on common sense, practical experience, and mechanical innovation. In this paper I trace the first geological survey of Pennsylvania, led by University of Pennsylvania professor Henry Darwin Rogers, commenced in 1836 for a five-year term, but not officially completed until 1858. I emphasize the broader frameworks of commerce, politics, and scientific thought that defined and shaped the survey, rather than its specific geological findings. Indeed, these findings were widely considered to be of marginal scientific and economic value even in their time.²

In the early 1830s, Tennessee and Massachusetts became the first states to authorize comprehensive statewide geological surveys. By the end of the decade, fourteen other states had followed suit, Pennsylvania

¹ The quotation is that of Peter A. Brown, corresponding secretary of the Geological Society of Pennsylvania. *Journal of the House of Representatives of the Commonwealth of Pennsylvania* (Harrisburg, 1833), 2:711-13 (hereafter cited as *House Journal*).

² My approach is influenced by David N. Livingstone, *The Geographical Tradition* (London, 1992), 1-4. Also see David N. Livingstone, "Science and Religion: Foreword to the Historical Geography of an Encounter," *Journal of Historical Geography* 20 (1994): 367-83.

among them. The national attitude regarding the funding of internal improvements had changed dramatically during the years leading up to the state surveys, thereby allowing a geological survey to be viewed as a "natural" state function. As late as 1819, President James Monroe had believed that a constitutional amendment would be required to fund such projects as the National Road. In the decade to follow, a considerable number of large-scale public canal and railroad projects were undertaken, almost exclusively by individual states rather than the federal government. In an era of minimal taxation, these projects were primarily funded through bond issues. With a strong money market and good borrowing terms, states found it easy to piggyback smaller initiatives such as geological surveys onto their larger infrastructure projects. New York, Pennsylvania, and Maryland were the leading borrowers in the first years of the internal improvements boom.³

The state geological surveys of the 1830s also coincided with the onset of industrialization in the United States. With the protection afforded by the high tariffs of the Jackson administration, there was a national interest in identifying iron- and coal-bearing lands. An additional impetus for mineralogical research was agricultural decline. Throughout the nation, land that had been continuously farmed since colonial times was beginning to show unmistakable signs of fertility loss. An agricultural science began to develop around the ideas of fertilization and crop rotation, with marl recognized as a valuable natural fertilizer. British geologist William McClure established the link between mineral resources and infrastructure-building when he stated that "limestone, iron, coal and manures support the greatest part of the canals in England," a line frequently quoted by American geologists.⁴ Also coincident with these trends was the ascendancy of geology as a viable academic discipline in the United States. In 1818 the first academic journal centered on geology made its debut, the *American Journal of Science and the Arts*. The American Geological Society was founded the following year, and in 1820 Rensselaer Polytechnic Institute in Troy, New York, was established, the first institution

³ John Lauritz Larson, *Internal Improvement: National Public Works and the Promise of Popular Government in the Early United States* (Chapel Hill, 2001). On borrowing by states, see John Joseph Wallis, "American Government Finance in the Long Run: 1790 to 1990," *Journal of Economic Perspectives* 14 (2000): 61–82.

⁴ This line was used by both Peter A. Brown and Yale geologist Benjamin Silliman in their promotional efforts to obtain a survey for Pennsylvania. *House Journal* (1833), 2:711; (1834), 2:349. Silliman was also the editor of the *American Journal of Science and the Arts*.

in America with an earth science focus.

The state surveys of the 1830s varied in size, scope, and quality, but shared numerous characteristics. Their promoters typically justified them on economic grounds, with ample promises of the discovery of previously untapped sources of mineral wealth. Surveys also offered a means of providing practical education to the public in the form of county or state mineral and fossil collections, and in this sense they were part of a broader educational movement that included the establishment of state libraries, agricultural colleges, and state-funded public school systems. Legislative support for geological surveys tended to come from the same class of legislators who favored internal improvements, but this bloc alone was not always large enough to ensure funding. Legislative debate was sometimes protracted, and in order to secure the votes of as many legislators as possible, it was often necessary to promise equal coverage for the entire state, even though some counties were much more geologically interesting than others.

Survey promoters tended to be representatives of the academic geology community, not always from the state in which a survey was being promoted. Of course, these geologists' motives were more than simply altruistic. Surveys helped establish a means of employment for the increasing number of young, academically trained geologists, and furthered the careers of their mentors. They were also used as a means of pursuing compelling questions about the origins of landforms, the meaning of fossils, and the relationship of rocks across continents, even though such research offered little direct economic return and was not part of the promotional pitch made to legislatures. Indeed, tensions between pure and applied science characterized many surveys. The Indiana survey represented one extreme, with state geologist David Dale Owen taking great care to write reports that were descriptive in nature and accessible to the lay public. At the opposite pole was the New York state survey, the largest and best funded of the surveys. New York state geologist James Hall published little on economic geology, instead preferring to focus on the description, classification, and interpretation of fossil invertebrates. His reports tended to be highly technical and lavishly printed in limited-edition volumes.

The early state surveys were intended by the legislatures to be only short-term undertakings. Many state geologists instead preferred that they be continued indefinitely, and spent much effort trying to obtain

extensions. While they were often successful, the continuation of surveys ultimately depended on the prevailing economic climate. Surveys were established and expanded during flush times, and curtailed and contracted during budget shortfalls. In this respect and many others, the Pennsylvania survey was typical.⁵

Lobbying Efforts and the Conquered Wilderness

A bill signed into law in March 1836 named Professor Henry Darwin Rogers of the University of Pennsylvania as the first state geologist for a term of five years. Rogers had been appointed the very first professor in geology and mineralogy at the University of Pennsylvania a year earlier, and continued to hold that position during his tenure as state geologist.⁶ His appointment as state geologist was the culmination of a several-year lobbying effort undertaken by the Philadelphia-based Geological Society of Pennsylvania. Chartered in 1832, the society's primary purpose was the establishment of a state survey, ideally one that would be conducted by the society itself. As Rogers did not belong to this group, his appointment represented a mixed success.

Upon its founding, the Geological Society sent out a "Circular Letter to Citizens" which made its argument for the establishment of a survey, as well as a general request for any mineral specimens, fossils, or skeletons the public might wish to donate. The society asked the state to subscribe to one thousand copies of a twenty-seven-plate geological atlas at one dollar per plate, and with the resulting twenty-seven thousand dollars promised to provide not only the atlas but a scientific report and a collec-

⁵ The characteristic themes of the early geological surveys are set forth in several articles: Walter B. Hendrickson, "Nineteenth-Century State Geological Surveys: Early Government Support of Science," *Isis* 52 (1961): 357-71; Leonard G. Wilson, "The Emergence of Geology as a Science in the United States," *Journal of World History* 10 (1967): 416-37; and Steven P. Turner, "The Survey in Nineteenth-Century American Geology: The Evolution of a Form of Patronage," *Minerva* 25 (1987): 282-330. See also Michael S. Smith, "The Conflict between 'Practical Utility' and Geology: Denison Olmstead, Elisha Mitchell and the 1823 to 1828 Geologic Surveys of North Carolina," *Southeastern Geology* 38 (1999): 145-54.

⁶ On the University of Pennsylvania, see Martin Meyerson and Dilys Pegler Winegrad, *Gladly Learn and Gladly Teach: Franklin and His Heirs at the University of Pennsylvania, 1740-1976* (Philadelphia, 1978). Rogers came to Penn by way of Dickinson College in Carlisle, Pennsylvania, where he had been fired for endorsing Pestalozzian educational philosophy, which favored science and applied learning over the study of the classics. Patsy Gerstner, *Henry Darwin Rogers, 1808-1866: American Geologist* (Tuscaloosa, Ala., 1994), 18-19.

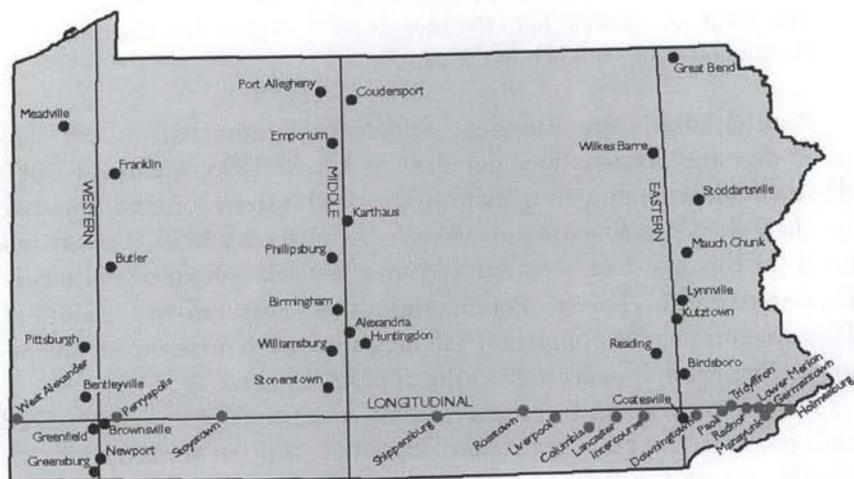


Fig. 1. Proposed Eastern, Middle, Western, and Longitudinal Meridians, 1833.

tions cabinet. In addition, the society proposed the establishment of three meridian lines within the state, "marked at intervals of a mile, or oftener, on suitable posts or stones." The meridian proposal, with its geographically inclusive list of towns and hamlets, may have simply been an attempt to appeal to as many legislators as possible (fig. 1).⁷ But such a listing also promoted the idea that the state was fully settled, the territory conquered, and refined scientific description the next practical step. Such a list of towns would not have been possible twenty years earlier, particularly along the middle meridian, where the names of recent canal settlements and iron furnaces reflected grand ambitions, mimicking both the classical (Alexandria) and the contemporary (Birmingham). Now was the time for a state survey. In the Geological Society's language:

The knowledge of our globe has enlisted the assiduous attention and persevering researches of devotees for years, with great benefit and edification of mankind: May not Pennsylvania add her mite to the common stock? . . . At public and private expense, travels have been undertaken; mountains ascended, before considered inaccessible; their position, their

⁷ All towns listed in the proposal are included in the figure. *House Journal* (1833), 2:714-16. See also Peter J. Lesley, *Historical Sketch of Geological Explorations in Pennsylvania and Other States* (Harrisburg, 1876), 36.

constituent parts investigated. Lakes and rivers have been searched, and their locations marked; but still, though great progress has been made, human knowledge is much in the dark.⁸

Pennsylvania's Euro-American settlement frontier had indeed vanished over the previous four decades. As late as 1790, it consisted of a diagonal line extending roughly from the northeastern corner of the state to where the Ohio River met its western boundary. By 1830, the vast area north of this line had been reduced to a few self-contained pockets in present-day Elk, Forest, Potter, and other northern-tier counties.⁹ Pennsylvania's native population had long since been driven west, excepting a relict band of Seneca along the upper Allegheny.

Environmental and transportation conditions revealed marked changes over the prior generation. In letters written home, James C. Booth, one of the field assistants during the first year of the survey, complained about the "howling of a wolf or panther & the startling rattle of the snake" that recalled prior generations of survey parties. To these sounds, however, Booth added "the solitary, echoing sound of the wood-cutter's axe." While the surveyor may still have been lonely, he was no longer alone. And while most of the survey work was carried out on foot or horseback, Booth reports taking the brand-new canal and railroad system from West Chester to Lewistown as a time-saving move.¹⁰

Rogers's other business frequently took him away from supervising the Pennsylvania survey crew. He was also the state geologist of New Jersey (a much smaller project), and he made regular visits to his brother William, the state geologist of Virginia, as well as to Harrisburg and Philadelphia for administrative purposes.¹¹ While his frequent absences tended to annoy his field assistants, it is remarkable that such regular absences were even possible. His ability to travel between all of these

⁸ *House Journal* (1833), 2:710-12.

⁹ John Florin, *The Advance of Frontier Settlement in Pennsylvania, 1638-1850: A Geographic Interpretation* (University Park, Pa., 1977).

¹⁰ The quotation appears in Gerstner, *Henry Darwin Rogers*, 61. Booth would eventually become the state geologist of Delaware. For comparable letters written by surveyor William Ellicott some fifty years earlier, see William E. Russ Jr., *How Pennsylvania Acquired Its Present Boundaries* (University Park, Pa., 1966). In the first survey season, which Rogers described as a "preliminary reconnaissance," the crew was able to travel from West Chester to Erie and back in two weeks. Henry D. Rogers, *First Annual Report on the Geological Exploration of the State of Pennsylvania* (Harrisburg, 1837).

¹¹ The brothers were very close and frequent collaborators. William later went on to found the Massachusetts Institute of Technology after Henry's death.

places multiple times in a single survey season would have been unthinkable a generation before.

Amid this flurry of settlement, land clearance, and collapsing distances, a new sense of land valuation began to take shape, one in which science could add value to previously unproductive land. How can the farmer walk across his field, wondered Yale geologist Benjamin Silliman, and be oblivious to the fuel, brick, glass, fertilizer, and building materials existing plentifully beneath his feet? Every additional discovery, he noted, "brings into use some section of land, hitherto regarded as entirely valueless . . . [as] barren and dreary wilds, unfit for any of the purposes of man."¹² Yet appeals for funding to discover untapped sources of sand and clay were unlikely to sway a wary legislature. More glamorous emotional appeals were called for. Silliman trumpeted the anticipated discovery of lead, copper, manganese, zinc, cobalt, antimony, gold, and silver, and the representatives of the Geological Society promised that "*almost every variety of metalliferous rocks, which in Europe have yielded for centuries such immense revenues, do exist in the state of Pennsylvania.*"¹³ Geologists also implored Pennsylvania to keep pace with its sister states, notably Massachusetts and Tennessee, the first states to authorize comprehensive state-funded surveys.

None of these appeals amounted to anything, however, as none of the bills introduced on behalf of the Pennsylvania Geological Society ever made it to a floor vote. While it was the Pennsylvania Geological Society that laid much of the groundwork for the eventual survey, it would ultimately be a rival Franklin Institute group that was able to push a bill through and influence the selection of the state geologist. The Franklin Institute was founded in 1824 as a society to raise the profile of the sciences in America, particularly the applied and practical sciences. By the early 1830s, however, its mission began to change. Core members, among them Bank of the United States president Nicholas Biddle, Alexander Dallas Bache (Ben Franklin's great-grandson), and state legislator Charles B. Trego, were casting envious glances toward Europe and mulling over whether American science would ever rival European science in theoretical weight and importance. The members of the Pennsylvania Geological Society, though in some cases overlapping with the Franklin Institute's membership, were considered amateurs and practitioners by this more

¹² *House Journal* (1834), 2:348–52.

¹³ *Ibid.*, 2:350; (1833), 2:717. Emphasis in original.

worldly faction, and not up to the task of conducting a state survey.¹⁴

To the leadership of the Franklin Institute, Rogers was an ideal candidate for state geologist. He was a rising star in the small international geological community with ties to leading figures in London. Rogers first sailed to England in 1832 not for the purpose of practicing geology, but to engage in social reform activities with Harmonist leader Robert Owen, a plan that was quickly abandoned.¹⁵ Within a year, though, Rogers had not only settled upon a new profession, but had become the first American elected to the Geological Society of London and had been invited to present papers at the elite British Association for the Advancement of Science. With these impeccable credentials, Bache and his colleagues arranged first the faculty position at the University of Pennsylvania and then the position of state geologist.¹⁶

Even with the full backing of the Franklin Institute, Rogers had some final lobbying to do in Harrisburg, and an address to the House of Representatives was arranged in January 1836. While Rogers stressed the practical value of the survey, most of his speech was given over to speculative talk of precious-metals discoveries. Rogers began by emphasizing the need for:

a scientific and perfect analysis of our rocks, and a chemical analysis of our minerals . . . in order that we may know to what useful purposes they may be applied. Individual research is . . . inadequate to the magnitude and importance of the subject. . . . It is only after the acquirement of such essential and very useful data that we could expect capitalists to embark their funds in manufacturing.

He also argued that the survey would help the common landowner, "prevent[ing] speculation and monopoly by making every man acquainted with the value of his own soil." Rogers then reported on findings of copper ore of 80 to 90 percent purity near Philadelphia, large quantities of lead awaiting discovery throughout the state, and the possibility of gold along a belt extending from Easton through Berks and northern Lancaster Counties. In case there was any question of why a state geologist should be appointed to locate these precious metals, Rogers cited the

¹⁴ Gerstner, *Henry Darwin Rogers*, 29–34, 43. Also Bruce Sinclair, *Philadelphia's Philosopher Mechanic: A History of the Franklin Institute, 1824–1865* (Baltimore, 1974).

¹⁵ Robert Owen was the father of eventual Indiana state geologist David Dale Owen.

¹⁶ *Ibid.*, 23–27, 31.

case of New York, where eighty-five claims of gold and silver mines had been filed in the past fifteen years: "In every one of them the visions of the fancied discoverers have been disappointed—oftentimes after involving themselves in irretrievable embarrassment."¹⁷

Two months after this apparently effective speech, the House of Representatives considered a Trego-authored bill to establish the survey. It passed by a vote of sixty-nine to sixteen.¹⁸ The Senate concurred days later without a recorded vote, and Governor Wolf signed the bill into law on March 30. The law required Rogers to deliver a comprehensive final report and a geologic map of the state, and to establish a cabinet in every county seat to display the discoveries. It also provided for the employment of two assistants and a chemist. One of these assistants would be Charles Trego, who retired from the legislature to join the survey, where he would remain until 1841. Subsequent amendments eventually expanded the survey staff to twelve.

The modest opposition in the House was centered among the representatives of the German-speaking counties of central and southeastern Pennsylvania. Such opposition was typical for spending bills of the period, and consistent with the limited role for government envisioned by these representatives, even during an era of largely unchecked spending.¹⁹ Pennsylvania's overall credit standing was of the gravest concern for these representatives. Prior to 1826 Pennsylvania carried virtually no debt, but by the mid-1830s its legislature had authorized in excess of \$30 million in bonds. The state canal and rail system absorbed the vast majority of the borrowed funds, but statewide public schools and a state penitentiary system proved costly items as well, as educational and social welfare tasks were brought under the aegis of the commonwealth. By 1835 there were clear signs of approaching the practical limits of borrowing, and that the

¹⁷ *House Journal* (1836), 1:520–24. Of course, while hiring a geologist may improve one's chances of success at locating mineral wealth, even the best geologist cannot find what does not exist, and most of these minerals would receive but one dismissive mention in the entire corpus of survey publications: in the first survey report, their absence in the state was attributed to "traditions, originating sometimes in ignorance, sometimes, probably, in fraud." Rogers, *First Annual Report*, 11. Copper merited one half of a page in the over sixteen-hundred-page final report, a description of a modest nickel and copper mine in Gap, Lancaster County, that employed ten workers. Henry D. Rogers, *The Geology of Pennsylvania: A Government Survey* (Philadelphia, 1858), 2:1022.

¹⁸ *House Journal* (1836), 1:674.

¹⁹ Carter Goodrich, "The Revulsion against Internal Improvements," *Journal of Economic History* 10 (1950): 145–69. On the voting patterns of the representatives from German counties, see Francis P. Boscoe, "A Project of Doubtful Utility: Measuring Legislative Opposition to the Pennsylvania Canal," *Political Geography* 19 (2000): 997–1011.

canal and rail system would fall far short of its promised revenues. Rather than confront these fiscal realities, the state legislature relied on two unexpected sources of revenue to keep spending at a high level: surplus federal funds distributed to the states at the behest of President Jackson, and a rechartering of Biddle's bank as a Pennsylvania bank, on terms highly favorable to Pennsylvania. The unanticipated windfall provided the impetus to authorize the geological survey. The windfall would be short-lived, however, as both the bank and the commonwealth would be bankrupt within six years; the bank would never reopen.²⁰

Catastrophism and Missed Deadlines

Although Rogers had promised both commercial applications and future riches, his personal agenda was located squarely in the tradition of "inventory science," with its methodical emphasis on mapping, classifying, and cataloging.²¹ In his second annual report, Rogers outlined his seven goals for the survey. These included describing the "nature of the various rocks," their areal extent, their superposition, the dip of the strata, the "configuration of the surface," the dislocations of the surface ("which . . . occur to frustrate the hopes, and to baffle the skill of the industrious miner"), and the locations of dispersed and irregularly occurring minerals.²² Though some of these goals may have had some relevance to the land speculator or prospector, inventory science and academic practice emphasized comprehensiveness over prospecting. Systematically delineating between the Carboniferous and Devonian bedrock took precedence over seeking valuable iron ore deposits.

To Rogers, there was not necessarily any conflict between science and economics. In the scientific paradigm of the time, cataloging and classifying had inherent worth, and this inherent worth would inexorably point the way toward practical application. This mindset was a tenet of the

²⁰ These events are detailed in Reginald C. McGrane, *Foreign Bondholders and American State Debts* (New York, 1935). On the greater "Bank War" between Biddle and Jackson, see George Rogers Taylor, ed., *Jackson versus Biddle: The Struggle over the Second Bank of the United States* (Boston, 1949), and Peter L. Rousseau, "Jacksonian Monetary Policy, Specie Flows, and the Panic of 1837," *Journal of Economic History* 62 (2002): 457-88.

²¹ Suzanne Zeller, *Inventing Canada: Early Victorian Science and the Idea of a Transcontinental Nation* (Toronto, 1987), 4-5.

²² Henry D. Rogers, *Second Annual Report on the Geological Exploration of the State of Pennsylvania* (Harrisburg, 1838).

Scottish Enlightenment, which exerted a strong influence on Rogers. His geology was that of the Wernerian, or Neptunist, school, which held that the rocks of the earth were precipitated out of water into distinct strata. This school dominated the geology taught at the University of Edinburgh, and accounted for Rogers's excessive interest in stratigraphy. Rogers's eventual professorship at the University of Glasgow, from 1857 until his death in 1866, is understandable in this regard. The Wernerian model, however, was already on the wane by 1836, due in large part to growing acceptance of Charles Lyell's *Principles of Geology* (1830–1833), which posited vulcanism, or Plutonism, as a rock-forming agent. Lyell also introduced the idea of deep geologic time, wherein gradual, continual processes acting over incomprehensibly long time scales account for the large-scale landforms of the earth.²³

Rogers, in contrast, was a catastrophist, believing that substantial physical features had to have had cataclysmic origins. His theory of how the Appalachian chain was formed in Pennsylvania called for a massive primeval disturbance in southern New Jersey or Delaware, which created an undulating series of wave-like motions in the fluid bedrock, resulting in the ridges and valleys seen today.²⁴ This theory won him few adherents, but like other theories of his, he never abandoned or seriously modified it throughout his career, and it figures prominently in his final report. Speculation and debate over theories of the earth thus suffused intellectually cautious and supposedly neutral inventory science, even in the context of official state publications.

By the time the allocated five years of funding had elapsed, Rogers had only produced five annual progress reports. The fifth of these reports came in at 151 pages and included lengthy results of chemical analysis and an extensive glossary, but the prior editions had been slim volumes mainly describing where the various assistants and sub-assistants had conducted their field investigations over the previous summer. In all,

²³ Kenneth L. Taylor, "The Historical Rehabilitation of Theories of the Earth," *Compass of Sigma Gamma Epsilon* 69 (1992): 334–45. Also Zeller, *Inventing Canada*, 43.

²⁴ Henry Darwin Rogers and William Barton Rogers, "On the physical structure of the Appalachian Chain, as exemplifying the laws which have regulated the elevation of great mountain chains generally," *Transactions of the American Association of Geologists and Naturalists* 1 (1843): 475–531. The AAGN was an organization formed in 1840 out of the defunct Geological Society of Pennsylvania. For discussions of this paper, see Patsy A. Gerstner, "A Dynamic Theory of Mountain Building: Henry Darwin Rogers, 1842," *Isis* 66 (1975): 26–37, and Kevin T. Dann, *Traces on the Appalachians: A Natural History of Serpentine in Eastern North America* (New Brunswick, N.J., 1988).

Rogers produced little during his initial five-year tenure: no mineral discoveries, no final report, no geologic map, and no county mineral cabinets.

Yet Governor Porter, as he stated in his annual address to the legislature in 1841, looked favorably on giving Rogers at least a one-year extension.²⁵ A minority of legislators, led by Representative Richard Brodhead Jr. from Northampton County, launched a fierce campaign to deny this possibility. Despite having been among the loudest pundits in the legislature in the early 1840s, Brodhead's legacy does not rate a mention in various standard histories of either Pennsylvania or Northampton County.²⁶ Yet his role is emblematic of the state's struggle between public improvements and fiscal solvency. Opposed to what he saw as superfluous spending of all kinds, Brodhead routinely entered lengthy statements into the legislative record explaining his disapproval of appropriations bills.

His campaign against the survey was particularly pointed. On January 7, 1841, Brodhead introduced the session's first resolution: to suspend funding of the survey until Rogers complied with all of its provisions. Correctly anticipating inaction, he next introduced a resolution, also unsuccessful, to have himself placed on a committee appointed to consider the survey's fate. Soon thereafter he was one of four dissenters to a motion to give the floor to Rogers for two consecutive evenings to state his case for the continuation of the survey; he also demanded from the state treasurer an accounting of all of the moneys spent on the survey to date.²⁷

In March, the chair of the geological committee presented a bill reauthorizing the survey and repealing some of the survey's requirements, including the establishment of county mineral cabinets. Brodhead responded by entering a lengthy dissenting report into the legislative journal, highlighting Rogers's noncompliance with various survey requirements, accusing Rogers of nepotism (his brother Robert was by then the survey's chemist and another brother, James, was a sub-assistant geologist), and tabulating the whole cost at one hundred thousand dollars, including printing and postage. He concluded:

²⁵ *House Journal* (1841), 2:12.

²⁶ See, for example, Philip Shriver Klein and Ari Hoogenboom, *A History of Pennsylvania* (University Park, Pa., 1980). For Northampton County, see Peter Fritts, *History of Northampton County, Pennsylvania* (Philadelphia, 1877).

²⁷ *House Journal* (1841), 1:21, 281, 327, 358.

The people of Pennsylvania, notwithstanding the deranged state of our monetary system, are about to be called upon to contribute of their substance, and their hard earnings, to pay the interest upon the public debt. . . . The legislature has, during its present session, abolished some unnecessary offices, and the work of reform could, with great advantage to the people, be carried still further.²⁸

His reference to the "deranged" monetary system incorporated the shortage of hard currency, looming depletion of the state treasury, pending bond default, and probable property tax increase that were a consequence of excessive borrowing over the past fifteen years. Once again, the fate of the survey was bound up in the state's credit standing.

The House did not vote on the survey reauthorization bill during the 1841 session, but this inaction did not spell victory for Brodhead. In April, language reauthorizing the survey for one year was inserted in a senate bill entitled "An Act Relative to State Street, in the Borough of Harrisburg." Brodhead made various unsuccessful attempts to amend or strike this clause. Meanwhile, the "State Street" bill mushroomed into an omnibus bill incorporating all kinds of fiscal provisions: the printing of scrip to obviate the currency shortage, an emergency loan of \$3 million, issuance of bonds and security deposits against the loan, the tax increase that Brodhead foretold, and complicated language concerning the bankruptcy of the Second Bank of the United States. This bill, retitled "An Act to Provide Revenue to Meet the Demands on the Treasury, and for Other Purposes," was ultimately narrowly passed by both the House and Senate, with representatives of German counties again forming the opposition.²⁹

Porter vetoed the bill, calling it "the first bill in history in which the necessary expenses of government . . . have been connected with extraneous subjects of questionable character." If indeed this was the first such use of this tactic, the bill rates historical importance; in any case, amid the vast scope of the bill, it would seem that the modest allocation for an additional year of the survey might be overlooked. Instead, several legislators made explicit motions to strike the article that provided for the survey's funding. Representative Steele of Chester County also cited the survey in his justification for voting against the bill, saying that it was "in my view impolitic, extravagant and unjust, to appropriate \$10,200 for the contin-

²⁸ *Ibid.*, 1:514, 2:442-44.

²⁹ *Ibid.*, 1:831, 971

uance of a project which had already cost the State some \$60,000, and which for any practical or economical purpose was of at least doubtful utility."³⁰ With the payment of canal maintenance crews and funding of public schools dependent on the \$3 million loan, the House and Senate mustered enough votes to override the veto. Thirteen representatives entered an apologia for their "yea" votes into the record, claiming they were hamstrung by the prospect of an empty treasury. Brodhead, undeterred by such a prospect, was not among them.³¹

When 1842 passed without closure and only a twenty-page annual report consisting mainly of a plea for still more money, Rogers lost many of his remaining supporters. Several bills were entered on Rogers's behalf, but all were tabled, and part of the one-year funding extension was held up until Rogers posted a bond promising eventual delivery of the final products.³² Absent of funding, Rogers released his assistants but did not abandon the project. Indeed, the survey was intimately tied to his professional research activities. He and his brother made use of the findings of the Pennsylvania and Virginia surveys to advance his catastrophic theory of how the Appalachian chain had been formed. Over the next several years, Rogers spent a total of nine thousand dollars out of his pocket, if his nephew is to be believed, while continuing to lobby the legislature on behalf of renewed funding.³³ He also fell into financial trouble of his own after purchasing an obsolescent cold-blast iron furnace in Armstrong County that had to be abandoned for lack of production and profitability, calling into question the value of a state geologist in guiding capital investment.³⁴ Finally, in 1847, Rogers submitted his final report and map to the state for publication. The state, however, refused to fund their publication, with the refusal led by a dispirited Charles Trego, who was by this time back in the legislature.

The California Gold Rush of 1849 and its accompanying prosperity helped change national attitudes about the value of both geological explo-

³⁰ *Ibid.*, 1:1001, 1028-29, 1041.

³¹ *Ibid.*, 1:1047, 1054, 1059-61.

³² *Laws of the Pennsylvania General Assembly* (Harrisburg, 1844), 7.

³³ W. B. Rogers Jr., *A Few Facts Regarding the Geological Survey of Pennsylvania, Exposing the Erroneous Statements and Claims of J. P. Lesley, Secretary of the American Iron Association* (Philadelphia, 1859).

³⁴ Rogers's principle creditor was Roswell Colt, one of the former directors of the Bank of the United States of Pennsylvania. Rogers eventually managed to pay the balance in full, something Colt could not claim with respect to his own creditors. Gerstner, *Henry Darwin Rogers*, 132-34.

ration and public expenditure. In 1849, only three state surveys remained active, but by 1855 the number had grown to fourteen, now including most of the states that had never previously funded a survey, among them Mississippi, Illinois, and Missouri. The federal government also began consideration of a survey, ultimately funded in 1853, to determine a railroad route from the Mississippi River to the Pacific Ocean.³⁵ In Pennsylvania, a joint committee of the House and Senate convened in 1851 concluded that "at the time of the organization of the Survey, it was estimated that it would occupy at least ten years," and thus was deserving of additional funding. Rogers repeated the use of this ten-year figure in the apologia that begins his eventually published final report, but there is no evidence that a ten-year term was ever envisioned prior to 1851. The additional funding recommended was to be used for a resurvey of the "rapidly developed mining district" and for publishing costs.³⁶

The very existence of a "rapidly developed mining district" revealed the fact that the development of Pennsylvania's natural resources was proceeding quite satisfactorily in the absence of any comprehensive scientific description of the land. Pennsylvania had a virtual monopoly on the anthracite coal industry, and accounted for about half of the nation's iron production between 1830 and 1860. Technological advances in mining were accruing rapidly, emerging from engineering science rather than cataloging science. In contemporary parlance, it was the "practical geologist" who had emerged to fill the pressing requirements of capitalists.³⁷

Efforts to publish the final report proceeded concurrently with the resurvey of the mining districts, but publication was further delayed by the bankruptcies of a series of printing firms. Finally, in 1855, the legislature gave Rogers the entire contract. In exchange for providing one thousand copies of the final report, which was to incorporate all prepared maps, plates, cuts, engravings, and the geological map, Rogers would be given sixteen thousand dollars plus copyright privileges. He overran the cost of this contract as well, requesting, and receiving, several thousand dollars for topographical improvements to the map. Further delays resulted

³⁵ Mary C. Rabbitt, *Minerals, Lands, and Geology for the Common Defence and General Welfare: A History of Public Lands, Federal Science and Mapping Policy, and Development of Mineral Resources in the United States*, vol. 1, *Before 1879* (Washington D.C., 1979); Hendrickson, "Nineteenth-Century State Geological Surveys."

³⁶ *House Journal* (1851), 2:131.

³⁷ Samuel Harries Daddow and Benjamin Bannan, *Coal, Iron, and Oil; or, the Practical American Miner* (Pottsville, Pa., 1866).



Fig. 2. Detail of Geological Map of the State of Pennsylvania, Constructed from Original Surveys, Made between the Years 1836 and 1857, under the Superintendence of Henry D. Rogers, State Geologist. To Accompany the Final Report on the Geological Survey of the State 1858. Historical Society of Pennsylvania.

from his relocation to the University of Glasgow in 1855, with the publishing details left in the hands of his nephew. The revised final report, *The Geology of Pennsylvania*, was finally delivered in 1858.³⁸

And such a report! Over sixteen hundred pages in two volumes, it included exquisite detail of the stratigraphy of every geologic zone in the state (fig. 2). But who was the intended audience? Critical denouncement from the scientific geological community focused on the out-of-date scholarship and suspect theory. To cite but one example, Lyell's notion of deep geologic time had become nearly universally accepted over the quarter century since its introduction. Yet Rogers's stratigraphic scheme scrupulously avoided reference to time, other than that within a single day (table 1).³⁹ The consistency with the literal word of Genesis is uncanny,

Table 1. Rogers's Stratigraphic Scheme

Primal (dawn)
Auroral (daybreak)
Matinal (morning)
Levant (sunrise)
Surgent (mounting day)
Scalent (climbing day)
Pre-meridian (forenoon)
Meridian (noon)
Post-meridian (afternoon)
Cadent (declining day)
Vergent (descending day)
Ponent (sunset)
Vespertine (evening)
Umbral (dusk)
Seral (nightfall)

though there is no evidence that Rogers had any such religious motivation; indeed, he was an early and ardent supporter of the theory of organic evolution.⁴⁰ The response from the commercial sector was also telling. Despite the fact that the final report devoted over six hundred pages to the coal regions, an 1866 directory of the Pennsylvania coal industry remarked that "the ponderous and costly volumes of our State Survey . . .

³⁸ Gerstner, *Henry Darwin Rogers*, 192–94.

³⁹ Rogers, *Geology of Pennsylvania*, 1:vii.

⁴⁰ Gerstner, *Henry Darwin Rogers*, 142–45.

contain a vast amount of useful information and scientific learning, but to the practical industry of our country they remain a dead letter."⁴¹

Substantially over budget, some seventeen years overdue, and rooted in outmoded theories of the earth, the project hardly ranks as a notable achievement in a traditional history-of-science context. Yet it is highly illustrative of the way that the realms of science and politics interacted in the mid-nineteenth century, and of the way that science is as much a product of cultural imperatives as it is about the accumulation of knowledge. The survey casts light on the societal agenda of a time and place in which it was considered vital to catalog the earth's subsurface and eradicate blank spaces from the map in a new and convincing manner, even though it was not altogether clear how this was supposed to be accomplished. The idea that any single individual, over five seasons and with a small team of assistants, could offer dramatic new discoveries and insights to the well-established extractive mineral industries of the state was in the same spirit of vaingloriousness that bankrupted Pennsylvania.

J. Peter Lesley was an assistant to Rogers who was eventually appointed as the second state geologist in the 1870s. Among his projects was a history of the first survey, in which he attempted to excuse the earlier work by highlighting how it was beyond the comprehension of the public: "the truths . . . seemed to clergy and laity alike the insanities of an exalted imagination."⁴² Rogers's original plans to find gold in Lancaster County seem also to fit this description. Put into the context of the political, cultural, and intellectual worlds of 1830s Pennsylvania, however, "insanity" would seem to be an inappropriate term for what was really just a characteristic project. Exalted, on the other hand, does seem to ring true.

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⁴¹ Daddow and Bannan, *Coal, Iron, and Oil*. For other reviews, see, for example, *American Journal of Science* 28 (1859): 149–51, and *Saturday Review of Politics, Literature, Science, and Art* (30 Apr. 1859): 530–31. In contrast, an optimistic assessment of the final report is offered by Anne Millbrooke, "Henry Darwin Rogers and the First State Geological Survey of Pennsylvania," *Northeastern Geology* 3 (1981): 71–74.

⁴² Lesley, *Historical Sketch*, 111.