Science in Early America

Print Culture and the Sciences of Territoriality

CONEVERY BOLTON VALENCIUS, DAVID I. SPANAGEL, EMILY PAWLEY, SARA STIDSTONE GRONIM, AND PAUL LUCIER

Where was science in the early American republic? Generations of scholarship suggested either that there was not very much—early Americans were too busy making farms to think very abstractly—or that what there was took place in the general vicinity of lightning storms. Until relatively recently, most historians of American science drew from twentieth-century modalities of science: Scientists were men, professionals formally trained in a specialist discipline, working in a purpose-built structure with sensitive instruments and talking mostly with one another. Their primary income came from their research, the legitimate fruits of which were to be formally published in professional journals, typically employing a jargon that might be fully legible only to an elite subset of colleagues. In keeping with Cold War norms, which placed theoretical physics at the top of the hierarchy of knowledge, historians also prized particular kinds of science: "pure" or "basic" research that could be

Conevery Bolton Valencius, David I. Spanagel, Emily Pawley, Paul Lucier, and Sara Stidstone Gronim are all historians of American science. This collaborative article, like the intellectual work it documents, was created through correspondence of many years. The authors are grateful to groups of colleagues, especially the American Society for Environmental History, where this exploration began; the 2015 Grassroots Modernities Conference; the anonymous and insightful reviewers; and the Independent Women Scholars Salon, in particular colleagues Lara Friedenfelds, Martha Gardner, Joy Harvey, Susan Lanzoni, Rachael Rosner, Kara Swanson, and Nadine Weidman.

Journal of the Early Republic, 36 (Spring 2016)

reduced to universal formulas and that had no immediate commercial use.[1]

Judged by these criteria, American scientific work before the mid nineteenth century seemed derivative or inconsequential, struggling to imitate the breakthroughs and insights of European thinkers and theorists. The few exceptions were what we might term "founders' knowledge": that is, the achievements of notables like Benjamin Franklin and Thomas Jefferson, whose scientific imagination and diligence were often cast as exceptional in a society of farmers and draymen.[2]

---

1. Ideological, political, and social circumstances in the natural and social sciences: Audra J. Wolfe, *Competing with the Soviets: Science, Technology, and the State in Cold War America* (Baltimore, 2013). "Pure" science: I. B. Cohen long ago challenged the pure/applied science distinction up until the Civil War, though he underlined its relevance thereafter. I. Bernard Cohen, "Science and the Growth of the American Republic," *The Review of Politics* 38 (July 1976), 359–98 (esp. 377–84); more recently, Paul Lucier, "The Origins of Pure and Applied Science in Gilded Age America," *Isis* 103 (Sept. 2012), 527–36. For a previous era's arguments, see "Science and the Social Order" and "Science and Democratic Social Structure," both in Robert K. Merton, *Social Theory and Social Structure* (New York, 1968), 591–615; and Richard Harrison Shryock, "American Indifference to Basic Science during the Nineteenth Century," *Archives Internationales d'Histoire des Sciences* 1, no. 5 (1948), 50–65. Subsequent discussions of scientific roles and identities include Joseph Ben-David's classic *The Scientist's Role in Society: A Comparative Study* (Englewood Cliffs, NJ, 1971); Michael Aaron Dennis, "Historiography of Science: An American Perspective," in *Companion to Science in the Twentieth Century*, ed. John Krige and Dominique Pestre (Amsterdam, 1997), 1–26; Steven Shapin, *The Scientific Life: A Moral History of a Late Modern Vocation* (Chicago, 2008); and Paul Lucier, "The Professional and the Scientist in Nineteenth-Century America," *Isis* 100 (Dec. 2009), 699–732.

2. Little changed in basic conceptual framework between A. Hunter Dupree's landmark *Science in the Federal Government* (Cambridge, MA, 1957) and Robert Bruce's *The Launching of Modern American Science, 1846–1876* (New York, 1987). Both considered the establishment of the Smithsonian Institution in 1846 as the significant starting point. The Smithsonian's own official historian Nathan Reingold implicitly agreed with this formula, in top-notch microstudies focusing on the subsequent emergence of professionalism in American science: Reingold, ed., *Science in Nineteenth-Century America: A Documentary History* (New York, 1964); Reingold, ed., *Science, American Style* (New Brunswick, NJ, 1991); and Reingold, ed., *Science in America Since 1820* (New York, 1976). Post-World War II scholars of early American science did pursue ambitious research projects investigating colonial, Jeffersonian, and Jacksonian eras of American science: Dirk Struik, *Yankee Science in the Making* (Boston, 1948); Louis B. Wright, "Scientific

In the last few decades, historians have strongly challenged the assumptions that undergirded this research. We now know, for instance, that household almanacs, the most widely printed material of the eighteenth and nineteenth centuries aside from the Bible, conveyed a wealth of information about the natural world. At their core almanacs were a calendar, typically offering one page per month with each day printed in a column down the left side of the page. These calendar pages featured astronomy as a prominent topic. Calendar pages tracked times of sunrise and sunset and the phases of the moon, and many offered more: the positions of the planets, the passage overhead of bright, familiar stars like Sirius, the changing patterns of constellations like the reappearance of the Pleiades each spring. An additional page described the lunar and solar eclipses expected for the coming year. By 1800 at least one almanac maker was aware of Uranus, William Herschel's recently discovered planet. By that year, printers in fifty-six cities and towns—from Portland, Maine, to Augusta, Georgia, to Frankfort, Kentucky—offered sixty-four distinct almanacs in English, with an additional eleven in German. Generally written by modestly educated men for an audience of the literate but not learned, almanacs are a rich source of evidence for the availability of scientific information offered to the general public in early America.[3]

Interest and Observation," in *The Cultural Life of the American Colonies, 1607–1763* (New York, 1957), 216–37; Edward T. Martin, *Thomas Jefferson, Scientist* (New York, 1962); George Daniels, *American Science in the Age of Jackson* (Tuscaloosa, AL, 1968); John C. Greene, *American Science in the Age of Jefferson* (Ames, IA, 1984); I. Bernard Cohen, *Benjamin Franklin's Science* (Cambridge, MA, 1990); and I. Bernard Cohen, *Science and The Founding Fathers: Science in the Political Thought of Jefferson, Franklin, Adams, and Madison* (New York, 1995). These scholars followed well-established mid-twentieth-century conventions about what science is and where historical evidence about science can therefore be found. More recent scholarship has portrayed founding intellects embedded in intellectually lively contexts; for example, Joyce Chaplin, *The First Scientific American: Benjamin Franklin and the Pursuit of Genius* (New York, 2006); Lee Alan Dugatkin, *Mr. Jefferson and the Giant Moose: Natural History in Early America* (Chicago, 2009); and Tom Shachtman, *Gentlemen Scientists and Revolutionaries: The Founding Fathers in the Age of Enlightenment* (New York, 2014).

3. Milton Drake, *Almanacs of the United States* (2 vols.; New York, 1962); almanacs printed before 1820 can often be found full-text in the databases *Early American Imprints*, Series I, Evans (1639–1800) and *Early American Imprints,* Series II, Shaw-Shoemaker (1801–1819); for more information about print runs: Peter Eisenstadt, "Almanacs and the Disenchantment of Early America," *Pennsyl-*

The broader subfield of the history of science, meanwhile, has contributed analytic tools to put sources such as almanacs into a broader context. The body of natural knowledge we call science, they have demonstrated, was produced not only by recognizable "scientists," but by the "invisible technicians" who made experiments possible, and by women "computers," indigenous informants and collectors, skilled enslaved workers, merchants, apothecaries, and alchemists. Science was made not only in laboratories but also in pubs, at soirees, in workshops, and on mountainsides and at sea; in commercial spaces and as a form of rational recreation. Deploying these new frameworks, historians of the early United States have begun to uncover a much wider and deeper scientific world, and to show how pervasively scientific ideas and controversies illuminated and animated the intellectual and public life of Americans during the late eighteenth and early nineteenth centuries.[4]

vania History 65, no. 2 (1998), 147; Uranus (listed as Herschelium Sidus): Isaac Briggs, *The Palladium of Knowledge: or, the Carolina and Georgia Almanac . . . 1800* (Charleston, NC, n.d.); for almanac calculations: J. C. Eade, *The Forgotten Sky: A Guide to Astrology in English Literature* (Oxford, UK, 1984), 1–37; for the significance of time: Alison A. Chapman, "Marking Time: Astrology, Almanacs, and English Protestantism," *Renaissance Quarterly* 60, no. 4 (2007), 1257–90; for almanacs in the seventeenth and eighteenth centuries: Sara Stidstone Gronim, *Everyday Nature: Knowledge of the Natural World in Colonial New York* (New Brunswick, NJ, 2007).

4. "Invisible technicians": Steven Shapin, *A Social History of Truth: Civility and Science in Seventeenth-Century England* (Chicago, 1994); "computers": Margaret Rossiter, *Women Scientists in America: Struggles and Strategies to 1940* (Baltimore, 1982); and Jennifer S. Light, "When Computers Were Women," *Technology and Culture* 40 (July 1999), 455–83. Recent works on alternate sites of scientific activity: Steven Johnson, *The Invention of Air* (New York, 2008), 59–61; Susan Scott Parrish, *American Curiosity: Cultures of Natural History in the Colonial British Atlantic World* (Chapel Hill, NC, 2006); Anya Zilberstein, "Making and Unmaking Local Knowledge in Greater New England," *Journal for Eighteenth-Century Studies* 36 (Dec. 2013), 559–69; David N. Livingstone, *Putting Science in Its Place: Geographies of Scientific Knowledge* (Chicago, 2003); and Katherine Pandora, "Popular Science in National and Transnational Perspective: Suggestions from the American Context," *Isis* 100 (June 2009), 346–58. Classic works include Anne Secord, "Science in the Pub: Artisan Botanists in Early Nineteenth-Century Lancashire," *History of Science* 32 (Sept. 1994), 269–315; Andrew Cunningham and Perry Williams, "De-centering the 'Big Picture': The Origins of Modern Science and the Modern Origins of Science," *British Journal for the History of Science* 26 (Dec. 1993), 407–32; and Adi Ophir and Steven

Looking attentively at how print culture interacts with intellectual frameworks shows us how we can follow these avenues to gain a fuller picture of scientific activity in the early United States. Scientific work took place not in isolation but rather in many and overlapping sources. Print shows us who made knowledge, how it moved, and what it meant.

Print culture offers the best avenue into knowledge in the early national period because writing played a much larger role in common culture in the United States than it did in many other societies of the late eighteenth and early nineteenth centuries. Literacy rates were remarkably high. In 1850, for instance, for every single illiterate white person in the northern states, 156 could read. Southern states' white illiteracy was much higher—at a ratio of 1:16—but literacy was nonetheless substantial. Almost four million enslaved people were legally excluded from literacy, but even among these, many—perhaps a tenth of all slaves—gained some access to the written word. The ubiquity of cheap print and a literate populace enabled early American scientific discussion to be exceptionally vigorous and broadly participatory across a variety of regional cultures. American readers absorbed, argued with, and sometimes reacted

---

Shapin, "The Place of Knowledge: A Methodological Survey," *Science in Context* 4, no. 1 (1991), 3–22. Critiques of a simple diffusionist model of scientific communication trickling from high to low: Roger Cooter and Stephen Pumfrey, "Separate Spheres and Public Places: Reflections on the History of Science Popularization and Science in Popular Culture," *History of Science* 32 (Sept. 1994), 237–67. Connections to artisanal knowledge: Heinz Otto Sibum, "Reworking the Mechanical Value of Heat: Instruments of Precision and Gestures of Accuracy in Early Victorian England," *Studies in History and Philosophy of Science Part A* 26 (Mar. 1995), 73–106; and Pamela H. Smith, *The Body of the Artisan: Art and Experience in the Scientific Revolution* (Chicago, 2004). Science in the vernacular: Brian Frehner, *Finding Oil: The Nature of Petroleum Geology, 1859–1920* (Lincoln, NE, 2011); Katherine Pandora, "Knowledge Held in Common: Tales of Luther Burbank and Science in the American Vernacular," *Isis* 92 (Sept. 2001), 484–516; Katherine Pandora and Karen A. Rader, "Science in the Everyday World: Why Perspectives from the History of Science Matter," *Isis* 99 (June 2008), 350–64; Elizabeth Keeney, *The Botanizers: Amateur Scientists in Nineteenth-Century America* (Chapel Hill, NC, 1992); Jeremy Vetter, "Introduction: Lay Participation in the History of Scientific Observation," *Science in Context* 24 (June 2011), 127–41; Conevery Bolton Valencius, *The Lost History of the New Madrid Earthquakes* (Chicago, 2013), 175–215; and Deborah R. Coen, ed., *Witness to Disaster: Earthquakes and Expertise in Comparative Perspective*, special issue of *Science in Context* 25 (Mar. 2012), esp. Valencius, "Accounts of the New against the written word—often producing their own indignant words. The availability of a reasonably inexpensive and effective mail delivery system, a decentralized constellation of numerous small rural printers and a shared rhetoric of democratic values and Protestant literacy all contributed essentially to the diversity of ways in which people who could write and read were well-equipped to express their thoughts about contemporary science in early America.[5]

Printed texts can give us a more nuanced understanding of the scale and boundaries of scientific community. Where a previous generation of historians looked for familiar credentials and found only a tiny cadre of experts scattered among colleges and concentrated in places like the Coast Survey (established in 1807) and the Smithsonian Institution (founded in 1846), we are able to see a broader range of participants in science by systematically examining categories of authorship and publication. Following the movement of printed texts can also help uncover populations of readers who were engaged users and active shapers of scientific information. Susan Lindee's study of the use of a popular chemical text of the 1830s, for example, uncovered the widespread study of decidedly *un*domestic science in female seminaries. Where Lindee followed one single, material text (a book), we seek to trace the ephemeral but important movement of text through a range of genres, finding connections among newspapers, almanacs, and reports, as well as more rarefied and predictable journals.[6]

Madrid Earthquakes: Personal Narratives across Two Centuries of North American Seismology," 17–48.

5. Slaves' literacy: James McPherson, *Battle Cry of Freedom: The Civil War Era* (Oxford, UK, 1988), 20. Further, people who escaped to freedom proved themselves determined to acquire literacy about as fast they acquired shoes. See Appendix 1, Ronald J. Zboray, *A Fictive People: Antebellum Economic Development and the American Reading Public* (Oxford, UK, 1993), 196–200. Recent literature in the history of science underscores our attempt to show the close interrelation between the production of scientific knowledge and its forms of communication: James A. Secord, "Knowledge in Transit," *Isis* 95 (Dec. 2004), 654–72; Bernadette Bensaude-Vincent, "A Historical Perspective on Science and Its 'Others,'" *Isis* 100 (June 2009), 359–68; and James A. Secord, "Foreword," in *Science in Print: Essays on the History of Science and the Culture of Print*, ed. Rima D. Apple, Gregory J. Downey, and Stephen L. Vaughn (Madison, WI, 2012).

6. A generation ago, print was not a focus of scholarship (the table of contents of *Osiris* volume 1, from 1985, *Historical Writing on American Science,* includes

This fluid movement of words and ideas across genres and realms of knowledge presents a chief challenge to writing the history of science in early America. Such a challenge invites collaboration. We come together as five historians of American science, drawing on recent scholarship to offer examples from print culture that demonstrate the sometimes startling variety of scientific work and scientific community in early America. Participants in the doing of science in early America were a remarkably diverse lot who worked within widely dispersed networks. Our investigation into varied and overlooked forms of print culture illustrates a dynamic interplay of mutual influences among readers and writers of American science in the early national period. Moreover, the subjects of early American scientific investigation suggest a configuration of environmental interests—in fertile and saleable lands, agriculturally beneficent weather, healthy and productive soil, and useful waterways—that we suggest can be usefully characterized as the "sciences of territoriality." In such scientific investigation, writers and readers wrestled with the relationship between intensely local knowledge of specific places and overarching principles. Their discussions of science interwove in complex ways with commerce, politics, and religion in the expanding United States. Seeking to build on and elaborate recent exciting work by many

---

nothing on print culture). Researchers instead focused on individuals and institutions; for example, Edmund Berkeley and Dorothy Smith Berkeley, *George William Featherstonhaugh: The First U.S. Government Geologist* (Tuscaloosa, AL, 1988); Chandos Michael Brown, *Benjamin Silliman: A Life in the Young Republic* (Princeton, NJ, 1989); A. Hunter Dupree, *Asa Gray, 1810–1888* (Cambridge, MA, 1959); Patsy Gerstner, *Henry Darwin Rogers, 1808–1866: American Geologist* (Tuscaloosa, AL, 1994); Stanley M. Guralnick, *Science and the Antebellum American College* (Philadelphia, 1975); and Edward Lurie, *Louis Agassiz, A Life in Science* (Chicago, 1960). On social and cultural context of Smithsonian and the Coast Survey: Mary Ann James, *Elites in Conflict: The Antebellum Clash over the Dudley Observatory* (New Brunswick, NJ, 1987); and Hugh Richard Slotten, *Patronage, Practice, and the Culture of American Science: Alexander Dallas Bache and the U.S. Coast Survey* (Cambridge, UK, 1994). The Smithsonian's first Secretary, Joseph Henry, was a key figure in the American scientific scene; see Albert E. Moyer, *Joseph Henry: The Rise of an American Scientist* (Washington, DC, 1997); and Nathan Reingold, et al., eds., *The Papers of Joseph Henry,* vols. 1–5 (Washington, DC, 1972–1988); Marc Rothenberg, et al., eds., *The Papers of Joseph Henry*, vols. 6–8 (Washington, DC, 1992–1998), and vols. 9–11 (Sagamore Beach, MA, 2002–2007). M. Susan Lindee, "The American Career of Jane Marcet's Conversations on Chemistry, 1806–1853," *Isis* 82 (Mar. 1991), 9–23.

colleagues, we sketch the diversity, plethora, and vitality of the sites and venues in which early Americans were making, thinking about, and creating science.[7]

Written texts demonstrate what animated ambitions and intellectual fire—and much of that motivation in early American culture revolved around what we are calling the sciences of territoriality. Many people in the early republic found questions in the environmental sciences to be deeply compelling. Investigations into the earth's history, resources hidden beneath its surface, patterns of weather, and the predictability of natural cataclysms were widely and avidly discussed by religious and political leaders, land speculators and mineral resource investors, and ordinary citizens.

Like the American state, American science during the nineteenth century was intent upon the acquisition of territory and its incorporation into market networks. This drive made sciences of environmental investigation and appraisal—including natural history, agricultural chemistry, and geology—arenas full of promise, excitement, and potential profit. Personal improvement, civic zeal, and patriotism dovetailed in the search for new resources for a new state. These priorities created a market for the expertise needed to produce documents such as geological maps and consulting reports, as well as gazetteers and medical geographies. The sciences of territoriality became areas of focus for scientific thinkers in the United States.[8]

---

7. Nathan Reingold identified the "geophysical tradition" in his *Science in Nineteenth-Century America;* also see James Rodgers Fleming, *Meteorology in America, 1800–1870* (Baltimore, 1990). Networks of correspondence: Daniel Goldstein, "'Yours for Science': The Smithsonian Institution's Correspondents and the Shape of Scientific Community in Nineteenth-century America," *Isis* 85 (Dec. 1994), 572–99.

8. On the political economy of the earth sciences in the antebellum United States, see for example, Joyce E. Chaplin, *An Anxious Pursuit: Agricultural Innovation and Modernity in the Lower South, 1730–1815* (Chapel Hill, NC, 1993); Benjamin R. Cohen, *Notes from the Ground: Science, Soil, and Society in the American Countryside* (New Haven, CT, 2009); James X. Corgan, ed., *The Geological Sciences in the Antebellum South* (Tuscaloosa, AL, 1982); Gerstner, *Henry Darwin Rogers*; Greene, *American Science in the Age of Jefferson*, 218–52; Robert M. Hazen, "The Founding of Geology in America: 1771 to 1818," *Geological Society of America Bulletin* 85 (Dec. 1974), 1827–1833; Richard William Judd, *The Untilled Garden: Natural History and the Spirit of Conservation in America, 1740–1840* (New York, 2009), 131–55; Paul Lucier, *Scientists and Swindlers:*

Such focus on sciences of environmental description and appropriation is similar to trends in European states of the same period. Yet print culture also reveals what is distinctly American, against a background history of science that has been created largely from European patterns. The huge distribution of print culture across space formed a wider-spread and far less hierarchical American scientific culture than the systems that emerged in European states. Knowledge of territory depended on a dispersed network of knowledge makers. This fact, generally true of imperial knowledge, took a particular form in the United States, where rapid settlement filled the landscape with potential authors who often had access to local sources of print. Newspapers and local journals in particular were powerful sites—unlike in many other parts of the world, literate people in many places were able to publish their observations and speculations about nature. The geographical imperative of early America and the profusion of print culture together deeply shaped early epistemological hierarchies in the United States.[9]

Consulting on Coal and Oil in America, 1820–1890 (Baltimore, 2008); Mary C. Rabbitt, *Minerals, Lands, and Geology for the Common Defense and General Welfare, Vol. 1: Before 1879* (Washington, DC, 1982); Margaret Rossiter, *The Emergence of Agricultural Science: Justus Liebig and the Americans, 1840–1880* (New Haven, CT, 1975); Steven Stoll, *Larding the Lean Earth: Soil and Society in Nineteenth-Century America* (New York, 2002); David I. Spanagel, "Great Convulsions and Parallel Scratches: The Era of Romantic Geology in Upstate New York," *Northeastern Geology and Environmental Sciences* 17, no. 2 (1995), 179–82; Spanagel, *DeWitt Clinton and Amos Eaton*: *Geology and Power in Early New York* (Baltimore, 2014); George W. White, "Early Geological Observations in the American Midwest," in *Toward a History of Geology: Proceedings*, ed. Cecil J. Schneer (Cambridge, MA, 1969); Valencius, *Lost History*. Environmental history explores relationships between power, knowledge systems, and territorial claiming; see "Interactive Landscapes," in *Whither the Early Republic: A Forum on the Future of the Field*, ed. John Lauritz Larson and Michael A. Morrison (Philadelphia, 2005), based on a special issue of *Journal of the Early Republic* (Summer 2004); and "State of the Field: American Environmental History," *Journal of American History* 100 (June 2013), 94–120.

9. For European states, see for example Richard Drayton, *Nature's Government: Science, Imperial Britain, and the "Improvement" of the World* (New Haven, CT, 2000); Fredrik Albritton Jonsson, *The Enlightenment in the Highlands: Natural History and Internal Colonization in the Scottish Enlightenment, 1760–1830* (Chicago, 2005); Lisbet Koerner, *Linnaeus: Nature and Nation* (Cambridge, MA, 1999); and Alix Cooper, " 'The Possibilities of the Land': The Inventory of 'Natu-

Though it can reveal much, we are conscious that this focus on print conceals key features of early American science. Examining words captured in print allows us only a limited view of science's oral culture—the kinds of spectacular demonstration in which an itinerant lecturer might make a dead ox's eyes fly open with an electrical jolt or the forms of parlor teaching in which young ladies sitting primly on an overstuffed settee could discuss recent breakthroughs in biology or electricity. Print culture also conceals women like Mary Churchill Baird, whose contacts and networks and supportive labor were crucial to the success of her husband, naturalist Spencer Fullerton Baird. The written word can hide the knowledge making of indigenous and enslaved people, whose knowledge of animals, plants, and landscapes formed the foundation of natural history, almost invariably without credit. At the same time, some of our examples reveal that the decentralized nature of scientific culture means that more of those voices may have been audible than we realize.[10]

To follow early Americans in their scientific curiosity, we employ their categories. We use early Americans' sense of what we would now term "science": systematic work of observation, data collection, theorizing about natural causes, or experimental production of knowledge. These activities were typically categorized as either natural philosophy or natural history, but were mainly pursued in the context of seeking "useful" knowledge. Few people who were engaged in observation, data collection, and argument about fundamental causes of phenomena bothered to be particularly articulate about what they called their activities. We regard their activities as science to identify what they did, not what they said. By showing how interest in science-making informed many walks

ral Riches' in the Early Modern German Territories," *History of Political Economy* 35 (Suppl., 2003) 129–53.

10. James Delbourgo, *A Most Amazing Scene of Wonders: Electricity and Enlightenment in Early America* (Cambridge, MA, 2006); Sally Gregory Kohlstedt, "Parlors, Primers, and Public Schooling: Education for Science in Nineteenth-Century America," *Isis* 81 (Sept. 1990), 425–45; Debra Lindsay, "Intimate Inmates: Wives, Households, and Science in Nineteenth-Century America," *Isis* 89 (Dec. 1998), 631–52; Parrish, *American Curiosity*; K. S. Murphy, "Translating the Vernacular: Indigenous and African Knowledge in the Eighteenth-century British Atlantic," *Atlantic Studies* 8 (Mar. 2011), 29–48. See also the dissertation by Christopher Michael Parsons, "Plants and Peoples: French and Indigenous Botanical Knowledges in Colonial North America, 1600–1760," PhD diss., University of Toronto, 2011; and Valencius, *Lost History*, 175–272.

of life, and by revealing how scientific conversations bled without boundary into other forms of debate, conversation, and exchange in early United States, we hope to reorient and reframe the role of science in American history.[11]

Not all natural knowledge of the early republic still stands as science. Some of it was vile, and some of it we now see as inaccurate. One main area of focus for a few well-published authors, for instance, concerned what they regarded as the science of racial difference. Such work in racist medicine belongs in the family tree of the history of science in early America, an undeniable part of the lineage even if demonstrably flawed both as scientific and as ethical judgment. Nineteenth-century race theory calls our attention to how thoroughly science was interwoven with commerce and moral order. It also indicates how tightly science was interwoven with medicine and understandings of the human body. As other historians have amply demonstrated, theories of race were enmeshed with territorial claiming: The slavery of Africans, the advance of the cotton frontier, and the seizing of Native American lands are all related to the articulation of scientific ideas of different peoples. We seek here to invite further work on neighboring scientific endeavors that are less well studied, or that have not yet been put into conversation with one another.[12]

---

11. Natural history and natural philosophy among early American scientific activities: Delbourgo, *A Most Amazing Scene of Wonders*; Sara S. Gronim, *Everyday Nature: Knowledge of the Natural World in Colonial New York* (New Brunswick, NJ, 2007); Richard William Judd, "A 'Wonderfull Order and Ballance': Natural History and the Beginnings of Forest Conservation in America, 1730–1830," *Environmental History* 11 (Jan. 2006), 8–36; Judd, *The Untilled Garden*; Andrew J. Lewis, *A Democracy of Facts: Natural History in the Early Republic* (Philadelphia, 2011); Judith Magee, *The Art and Science of William Bartram* (University Park, PA, 2007); Katherine Pandora, "Popular Science in National and Transnational Perspective," *Isis* 100 (June 2009), 346–58; Emily Pawley, "Accounting with the Fields: Chemistry and Value in Nutriment in American Agricultural Improvement, 1835–1860," *Science and Culture* 19 (Dec., 2010), 461–82; Charlotte M. Porter, *The Eagle's Nest: Natural History and American Ideas, 1812–1842* (Tuscaloosa, AL, 1986); Spanagel, *DeWitt Clinton and Amos Eaton*; Conevery Bolton Valencius, *The Health of the Country: How American Settlers Understood Themselves and Their Land* (New York, 2002).

12. Racial theory, early colonial period: Joyce E. Chaplin, *Subject Matter: Technology, the Body, and Science on the Anglo-American Frontier, 1500–1676* (Cambridge, MA, 2001); James Delbourgo, "The Newtonian Slave Body: Racial

To lay forth this invitation, we investigate how the sciences of territoriality—the search for value in specific places, and the investigation of the taut relationship between the intensely local and the overarching global—took form in several categories of early American print culture. We discuss materials explicitly dedicated to scientific communication—scientific and agricultural journals, maps, consulting reports, and manuals—to illustrate varying levels of scientific activity and examine what motivated early Americans to invest in their own versions of these modes of technical communication. We then emphasize the scientific ideas and discussions found in more generalized forms of early American print culture, especially newspapers. Throughout, we trace the ways that scientific writing dealt with wondrous events such as earthquakes as well as the mundane realities of farming and mining. Our examples are typical, not exhaustive. Throughout, our aim is to illuminate how worlds of scientific conversation not yet fully recognized in our histories nevertheless animated life throughout the early republic.

The most recognizable technical medium of print culture in the early American republic was the scientific journal, a periodical dedicated to sharing research findings and disseminating news of interesting or perplexing field observations of nature in North America. Traditional historiography has emphasized the dearth of such scholarship. We wish to emphasize its heterogeneity, impact, and resilience.

Enlightenment in the Atlantic World," *Atlantic Studies* 9 (June 2012), 185–207; Robert Pierce Forbes, "'The Cause of This Blackness': The Early American Republic and the Construction of Race," *American Nineteenth Century History* 13 (Mar. 2012), 65–94. Early republic: Bruce Dain, *A Hideous Monster of the Mind: American Race Theory in the Early Republic* (Cambridge, MA, 2002); Reginald Horsman, *Race and Manifest Destiny: The Origins of American Anglo-Saxonism* (Cambridge, MA, 1981); William Ragan Stanton, *The Leopard's Spots: Scientific Attitudes toward Race in America, 1815–59* (Chicago, 1960); Valencius, *The Health of the Country*, 229–58; Harriet A. Washington, *Medical Apartheid: The Dark History of Medical Experimentation on Black Americans from Colonial Times to the Present* (New York, 2006); John Wood Sweet, *Bodies Politic: Negotiating Race in the American North, 1730–1830* (Baltimore, 2003); and the classic Stephen Jay Gould, *The Mismeasure of Man* (New York, 1981). Health, environments, sciences in the nineteenth century: Linda Nash, *Inescapable Ecologies: A History of Environment, Disease, and Knowledge* (Berkeley, CA, 2006); Nicolaas

Early Americans held firmly to the patriotic notion that North America demanded a home-grown science. American nature did not always conform to rules laid out in European geology, botany, or zoology texts. Practitioners of the natural sciences, operating in what they saw as the New World, were quick to suggest that new theoretical solutions might emerge from the unique properties and features of American natural history. Members of the founding generation were eager to celebrate the knowledge to be gained in a new nation. In particular, Dr. Samuel Latham Mitchill began publishing his *Medical Repository* on a quarterly basis in 1797. Like many early efforts, the title belies the sweeping scope of this journal, which encompassed topics that would now be classified as areas as diverse as economic geology, hydrology, climatology, and physiology. Others—especially the prolific Benjamin Silliman—laid out the promise of new American sciences. Among these endeavors, researchers connected a wide range of phenomena in their efforts to understand and assimilate resources new to them.[13]

The *American Mineralogical Journal* was launched in New York City in 1810 by the Edinburgh-educated, American-born Dr. Archibald Bruce. Like Mitchill's *Medical Repository,* Bruce's journal was to be a "collection of facts," but he intended it to compare favorably with journals then being promoted in Germany and France, which contained detailed renderings of the geology and mineralogy of "particular districts." Bruce recognized that Europeans were engaged in a concerted effort to elucidate the history of mines, the improvement of metallurgical methods, and the dissemination of knowledge regarding useful applications of minerals to serve the needs of human health and industry. He

A. Rupke, ed., *Medical Geography in Historical Perspective* (London, 2001), esp. Valencius, "Histories of Medical Geography," 3–30; Valencius, *Health of the Country.*

13. The content of the *Medical Repository* was far more eclectic than the title might suggest: Articles ranged widely across branches of natural history. Similarly, the terms "natural historian" and "geologist" were used almost interchangeably in early-nineteenth-century scientific reports, since these titles implied a broad interest and expertise in the study of terrestrial phenomena. A "geologist" might specialize in a subfield and be called, for example, a "conchologist" because his expertise was confined to mollusks. Broad linkages of natural history: Nicholas Jardine, James A. Secord, and Emma Spary, eds., *Cultures of Natural History* (Cambridge, UK, 1996).

supposed that Americans could both profit by and contribute to this endeavor.[14]

Bruce's journal brimmed with detailed physical descriptions and rudimentary chemical analyses of various mineral specimens gathered throughout the Atlantic seaboard states and from the interior as far as Kentucky and Louisiana. Reproducing a widespread contemporary practice, the *American Mineralogical Journal* also reprinted nuggets of "scientific intelligence" imported from abroad. In its first volume these included the Geological Society of London's instructions for geological investigation, a report of an eruption of Mount Vesuvius (September 10, 1810), meteor impacts in France (November 25, 1810) and in Russia (March 1, 1811), and a brief notice describing the world's then-largest galvanic battery at London's Royal Society (July 2, 1813). These reprinted notices of minor events abroad highlight the uneven way American publications reported on American phenomena: The journal made no mention of the tumultuous New Madrid earthquakes that roiled the lower Mississippi valley in 1811 and 1812. Yet even when actual coverage faltered, the aspiration to describe American sciences of American places endured as a central and important goal.[15]

Few such journals survived for long. Ultimately, the loss of his professorship and declining health kept Bruce from continuing to publish new

14. John C. Greene, "Introduction" to reissued compilation *The American Mineralogical Journal, Vol. I* (1814; repr. New York, 1968), vii; [Archibald Bruce], [preface], *American Mineralogical Journal* 1, no. 1 (1810), iii. European context: Alex Csiczar, "Broken Pieces of Fact: The Rise of the Scientific Journal in the Nineteenth Century," PhD diss., Harvard University, 2010. Societies: Simon Baatz, *Knowledge, Culture, and Science in the Metropolis: The New York Academy of Sciences, 1817–1970* (New York, 1990); Alexandra Oleson and Sanborne C. Brown, eds., *The Pursuit of Knowledge in the Early American Republic: American Scientific and Learned Societies from Colonial Times to the Civil War* (Baltimore, 1976).

15. "Geological Inquiries," *American Mineralogical Journal* 1, no. 1 (1810), 43–52; "Eruption of Vesuvius," *American Mineralogical Journal* 1, no. 2 (1811), 120–21; "Meteoric Stones Lately Fallen in France and Russia," *American Mineralogical Journal* 1, no. 3 (1812), 187–89; and "Galvanic Battery," *American Mineralogical Journal* 1, no. 4 (1813), 258–59. Reviewing and reprinting practices in contemporaneous European journals: Marilyn Butler, "Culture's Medium: The Role of the Review," in *The Cambridge Companion to British Romanticism*, ed. Stuart Curran (Cambridge, UK, 2010), 120–47.

issues after 1814, though the journal had garnered respect and brought attention to American mineralogy among European readers. Bruce's premature death from a stroke in 1818 spelled the permanent demise of the *American Mineralogical Journal.* Nevertheless its organizational structure and goals persisted within American publishing. That same year, Benjamin Silliman, a professor of chemistry and natural history at Yale College, sought to establish an enduring means for sharing scientific discoveries and novel ideas inspired by American natural history. Originally titled the *American Journal of Science and the Arts*, it became widely known simply as "Silliman's *Journal,*" as it rose to be the preeminent organ of scientific communication in the United States. The journal projected from the beginning a self-conscious continuity of purpose and style: "It is designed as a deposit for *original American communications*; but will contain also occasional selections from Foreign Journals, and notices of the progress of Science in other countries." Silliman aspired to join the ranks as an equal player to his European counterparts, with no small measure of proprietary national pride:

> The interesting travels of Lewis and Clark have recently brought to our knowledge several plants and animals before unknown. Foreign naturalists are frequently exploring our territory; and for the most part, convey to Europe the fruits of their researches, while but a small part of our own productions is examined and described by Americans: certainly this is little to our credit, and still less to our advantage.

Self-conscious about being located on the periphery of European cultural achievements, articles in the early issues of Silliman's *Journal* tended to imitate the forms and rhetoric of European science, but defiantly promoted the uniqueness of North America's plants, animals, and places. The corpus of American scientific theory and practice, as expressed through these communications, emphasized both the particularity of North American natural history phenomena and the advantages North American geography offered for formulating or testing universal systems of natural knowledge.[16]

---

16. [Benjamin Silliman], "Plan of the Work," *American Journal of Science* 1, no. 1 (1818), v; [Silliman], "Introductory remarks," *American Journal of Science* 1, no. 1 (1818), 5. It was common for "curious gentlemen" to present authoritative reports on a wide variety of subjects to members of early national cultural institutions, such as the American Philosophical Society in Philadelphia, the American

American publications like Silliman's show the emergence of new theoretical debates about American territory and by writers in North America. Meteors in particular prompted extensive scientific conversation: Benjamin Silliman's announcement of a meteor that hit Weston, Connecticut, in 1807, discussed in numerous newspaper articles and in a pamphlet he published, had established his scientific reputation in the United States and elsewhere. The nature and origin of meteors (whether they were purely a terrestrial atmospheric phenomenon like ordinary weather or the aurora borealis, or traces of earth's interaction with other celestial objects), continued to provide a source for animated discussion and empirical research throughout the first 15 years' worth of Silliman's *Journal.* With the spectacular Leonid meteor showers of November 1833, Yale professor Denison Olmsted carried out a strenuous and systematic attempt to collect and calibrate observations from all over the United States. He reported his data and analysis in an extensive pair of articles, which culminated in the startling conjecture that some "nebulous body" must lie between the Earth and the Sun, with an orbital period of precisely 182 days. (Regardless of his virtuosic mathematics, subsequent astronomers never found Olmsted's hypothetical sunward belt of objects.)[17]

Academy of Arts and Sciences in Cambridge, and the Literary and Philosophical Society of New York, as well as in articles submitted to the class of periodicals featured in this section. On editorial motivations and challenges, see Donald DeB. Beaver, "Altruism, Patriotism, and Science: Scientific Journals in the Early Republic," *American Studies* 12, no. 1 (1971), 5–19; Berkeley and Berkeley, *George William Featherstonhaugh*; S. W. Jackman, "The Tribulations of an Editor: Benjamin Silliman and the Early Days of the American Journal of Science and the Arts," *New England Quarterly* 52 (Mar. 1979), 99–106; Simon Baatz, "'Squinting at Silliman': Scientific Periodicals in the Early American Republic, 1810–1833," *Isis* 82 (June 1991), 223–44; and Brown, *Benjamin Silliman,* 304–22.

17. Meteor of 1807: Brown, *Benjamin Silliman*, 221–29. Denison Olmsted, "Observations on the Meteors of November 13th, 1833," *American Journal of Science* 26 (July 1834), 132–74, quotation on 172. For preceding articles on the same topic, see William G. Reynolds, "Outline of a Theory of Meteors," *American Journal of Science* 1 (Mar. 1819), 266–76; Rufus Graves, "Account of a Gelatinous Meteor," *American Journal of Science* 2 (Nov. 1820), 335–37; [various], "Notices of Meteors in 1822," *American Journal of Science* 6 (Jan. 1823), 315–25; Charles Upham Shepard, "Analysis of the Meteoric Iron of Louisiana, and Discovery of the Stannifereous Columbite in Massachusetts," *American Journal of Science* 16 (Jan. 1829), 217–24; and J. J. Littrow, "On the Collision of Two Com-

Silliman's *Journal* provided the venue for debates which revolved around controversial claims regarding geological processes—especially the origins of rocks—and the implications of those processes for the earth's history. Americans had, after all, many things to say about the two leading European systemic theories: Neptunism, which sought to trace all rock types to the chemical precipitation or subsidence of materials once suspended in water, and Vulcanism, which looked to the interior heat of the planet for the formation of the basalts, granites, and gneiss (supposed to be among the oldest rocks on every continent). Similarly, reports of the convulsively transformative processes of volcanic eruptions and seismic activity drew great notice. For example, American debates about the causes that form prairies (those relatively treeless landscapes that seemed quite unnatural to European American culture) are what finally broached allusions to the Mississippi valley earthquakes of 1811–12: "The 'father of rivers' bears strong marks that . . . its course had been altered by some more powerful convulsion of nature; for its mighty current runs strongly against the seven bluffs below its conjunction with the Ohio . . . seeming still to contend for its ancient channel. The prairies themselves . . . present the appearance of having been lifted up, and they are, in fact, considerably higher than the surrounding country." This author's fascination with "the expansive heavings of earthquakes" exemplifies a tendency among some early American scientific observers to generally describe places and phenomena and then leap to conclusions about causes.[18]

Disciplinary boundaries were loose and flexible during this era of scientific activity, and individuals could navigate easily between "science" and "culture." For example, American scientific researchers contributed

ets and the Comet of July, 1831," *American Journal of Science* 24 (July 1833), 346–48; Denison Olmsted, "Observations on the Meteors of November 13th, 1833," *American Journal of Science* 25 (July 1834), 363–411.

18. W. W. McGuire, "On the Prairies of Alabama," *American Journal of Science* 26 (July 1834), 93–98, quotation on 97. Debate on the origins of prairies was ongoing since the first volume of Silliman's journal. One argument was that water, not careless fire-spreading Indians, had created the prairies: Caleb Atwater, "On the Prairies and Barrens of the West," *American Journal of Science* 1 (Jan. 1818), 116–25. Reply, cautioning Americans not to jump to new theories to account for surprising discoveries: A. Bourne, "On the Prairies and Barrens of the West," *American Journal of Science* 2 (Apr. 1820), 30–34.

notices to contemporary literary magazines such as *The North American Review,* founded in Boston in 1815. Barriers to entry into direct competition with established journals were, simultaneously, relatively low. Naturalists living in remote frontier locales in Ohio and Kentucky, such as Constantine Rafinesque and Dr. Daniel Drake, launched their own scientific periodicals in the 1820s. The transplanted English geologist George William Featherstonhaugh attempted a more direct challenge to Silliman. His abortive *Monthly American Journal of Geology and Natural Science,* a Philadelphia-based journal, lasted only one year (1832). Yet this profusion of scientific journals, if not their individual success, attests to a widespread impulse to disseminate scientific knowledge within the early American republic.[19]

19. Examples of geological matters appearing in the *North American Review* include Louisa Davis Minot, "Sketches of Scenery on Niagara River," *North American Review* 2 (May 1816), 320–29; and George W. Featherstonhaugh, "Geology," *North American Review* 33 (Apr. 1831), 471–90. Rafinesque only managed to publish one volume (1820–21) of the Lexington, Kentucky-based *Western Minerva: or, American Annals of Knowledge and Literature*, before it folded. Drake's *Western Journal of the Medical and Physical Sciences* fared somewhat better, taking up where the *Ohio Medical Repository* left off in 1827 and was published monthly until 1840 when Drake moved to Louisville, Kentucky, and founded the *Western Journal of Medicine and Surgery.* The scholarly literature on and by Rafinesque is vast and complicated: Charles Boewe has produced a definitive work. See Boewe, *The Life of C. S. Rafinesque: A Man of Uncommon Zeal* (Philadelphia, 2011). For Drake's career as a medical journalist, see Mary Louise Marshall, "The Versatile Genius of Daniel Drake," *Bulletin of the Medical Library Association* 31 (Oct. 1943), 291–318; and E. F. Horine, "Daniel Drake and the Origin of Medical Journalism West of the Allegheny Mountains," *Bulletin of the History of Medicine* 27, no. 3 (1953), 217–35. Henry Schoolcraft's reports on geography, mineralogy, and paleontology from early expeditions in the upper Mississippi valley reached out to parallel audiences: Henry R. Schoolcraft, "Narrative Journal of Travels," and "A Memoir of the Geological Position of a Fossil Tree," *The North American Review* 15, no. 36 (1822), 224–50; Schoolcraft, "Remarkable Fossil Tree," *American Journal of Science* 4, no. 2 (1822), 285–91; and Henry R. Schoolcraft, "Notice of Recently Discovered Copper Mine on Lake Superior . . . ," *American Journal of Science* 7 (Jan. 1824), 43–49. Articles analyzing American Indian linguistics and culture by Schoolcraft's political patron, Michigan's territorial governor Lewis Cass, might be considered examples of natural history writing, since he treated Native peoples rhetorically like any other objects to be found in the wild lands of the continental interior, and subjected to a scientific gaze. See [Lewis Cass], "Indians of North America," *North American Review* 22 (Jan.

Scientific ideas also flourished in a category of print culture frequently overlooked by historians who focus mostly on words: geological maps. Geological maps embodied scientific theory as well as observations. Historians of geology have long investigated these objects, but outside of that subfield there is less recognition that American citizens living in the nineteenth century were profoundly interested in questions of Earth's history. Popular discourse proliferated as once highly theoretical debates over the formation of different rocks by heat or water were translated into issues having a very practical impact, such as how to find valuable minerals. The birth circumstances for different types of rocks and soils mattered in an agricultural society. A new science emerged, one dedicated to the idea that good agricultural conditions and desirable minerals were predictably situated, if only one could discern the correspondence between these phenomena, their "parental" bedrock geology, and other clues about the past history of large-scale erosion processes. Geologists promoted theories to explain how and when the North American continent had been visited by powerful mountain-building and eroding forces. What became more controversial over time was not the idea that such forces had operated, but rather that their consequences had accumulated gradually over a time scale whose vastness was previously unimagined.

Promises of material prosperity brought state legislators and their leaders to consider funding scientific investigations. States began to establish geological surveys from the 1820s on; among newer territories in the West the initiation of a scientific inventory sometimes came even before statehood (though a permanent federal role in western exploration only began with the creation of the U.S. Geological Survey in 1879). The products of those public investments, namely survey reports and geological maps, incidentally performed a discursive function as tools for discovering and disseminating provocative theoretical views in geology. At the same time, their social relevance was magnified because scientific entrepreneurs had promised to deliver both knowledge and systematic

1826), 53–119; [Cass], "Policy and Practice of the United States and Great Britain in Their Treatment of Indians," *North American Review* 24 (Apr. 1827), 365–443; and [Cass], "Removal of the Indians," *North American Review* 31 (Oct. 1830), 396–442.

practices that would prove economically useful. A small sample serves to demonstrate not only how American knowledge of earth's history changed, but also how controversial theories gained currency via the utility of maps as tools of environmental exploration.[20]

In 1809, Scottish geologist William Maclure published an ambitious map of American bedrock geology east of the Mississippi River. The map shows, for example, that the transition between Neptunist theorist Abraham Gottlob Werner's oldest and youngest rock categories ("primitive" and "alluvial") manifests as a geological discontinuity between the mountainous zone and the sandy coastal plain. Along this boundary, widely known as the Fall Line, rivers typically exhibited roughness (rapids and waterfalls), so that (until canals could be built using lock technologies) navigation for any river flowing from the Appalachians eastward across the Piedmont was confined below the Fall line. This map also illustrates American innovation: Maclure published this map six years before William Smith's famous 1815 geological map of England.[21]

Maclure spent the next decade improving the accuracy, expanding the reach, and elucidating the mineralogical and economic value of the map.

20. Historians of cartography have been quick to point to social dimensions of mapmaking; for example, Gregory H. Nobles, "Straight Lines and Stability: Mapping the Political Order of the Anglo–American Frontier," *Journal of American History* 80 (June 1993), 9–35; Susan Schulten, *Mapping the Nation: History and Cartography in Nineteenth-Century America* (Chicago, 2012), 79–118; Sean Patrick Adams, "Partners in Geology, Brothers in Frustration: The Antebellum Geological Surveys of Virginia and Pennsylvania," *The Virginia Magazine of History and Biography* 106, no. 1 (1998), 5–34; Michele L. Aldrich, *New York State Natural History Survey, 1836–1845: A Chapter in the History of American Science* (Ithaca, NY, 2000); Benjamin R. Cohen, "Surveying Nature: Environmental Dimensions of Virginia's First Scientific Survey, 1835–1842," *Environmental History* 11 (Jan. 2006), 37–69; Gerstner, *Henry David Rogers*; Walter B. Hendrickson, "Nineteenth-Century State Geological Surveys: Early Government Support of Science," *Isis* 52 (Sept. 1961), 357–71; Sally Kohlstedt, "The Geologists' Model for National Science, 1840–1847," *Proceedings of the American Philosophical Society* 118 (Mar. 1974), 179–95; Andrew John Lewis, *A Democracy of Facts: Natural History in the Early Republic*; Rabbitt, *Minerals, Lands, and Geology*.

21. William Maclure, "Observations of Geology of the United States of America, Explanatory of a Geological Map," *Transactions of the American Philosophical Society* 6 Part 2 (1809), 411–28; Simon Winchester, *The Map That Changed the World: William Smith and the Birth of Modern Geology* (New York, 2001).

Revised and reissued in 1817, Maclure's work featured a new subtitle, which explicitly promoted geology's political relevance by asserting that the erosion of different rock types affects comparative soil fertility of different regions. The 1817 map (see Figure 1) invested even greater emphasis on the practical considerations of a primarily agricultural society. For example, besides the food preservative salt, already noted on the 1809 map, a barely discernible green thread running along the Appalachian ridge from Cherokee country in northwest Georgia was extended to the city of Albany, New York, to show to coastal inhabitants how far inland one needed to go to find the useful mineral fertilizer gypsum.[22]

Six years before the comprehensive New York natural history survey was even launched (in 1836), Amos Eaton, the founding professor of the Rensselaer School in Troy, New York, produced a geological map of the state. He did so only because English-born geologist George William Featherstonhaugh had applied in 1828 for public funds to produce a geological map of New York. Featherstonhaugh had previously ridiculed Eaton's geological theories of diluvial flooding and Eaton's innovative attempts to develop an original system of nomenclature, but now threatened to put data painstakingly gathered by Eaton into a simplified visual form. Amos Eaton had always considered geological "sections" (diagrams showing cuts into the earth's rock layers along a line) to be far more accurate and informative than crudely colored maps, such as the one Maclure had published. But in order to avoid being scooped by his competitor, Eaton produced this map in 1830 (see Figure 2). Eaton had laboriously examined and carefully analyzed the route of the Erie Canal throughout the preceding decade, and his map showed a detailed rendering of the sedimentary layers of fossil-bearing rock in western New York. It also showed some pure guesswork. Eaton drew imaginary banded stripes across the Adirondack province, for example, by extrapolating from observations of the bedrock around the perimeter only. A

22. William Maclure, *Observations on the Geology of the United States of America* (Philadelphia, 1817); reissued virtually simultaneously as "Observations of Geology of the United States of America; Remarks on the effect produced on the nature and fertility of soils, by the decomposition of the different classes of rocks; and an application to the fertility of every state in the union, in reference to the accompanying geological map," *Transactions of the American Philosophical Society*, n.s., 1 (1818), 1–91. See George W. White, "William Maclure's Maps of the Geology of the United States," *Journal of the Society for the Bibliography of Natural History* 8, no. 3 (1977), 266–69.

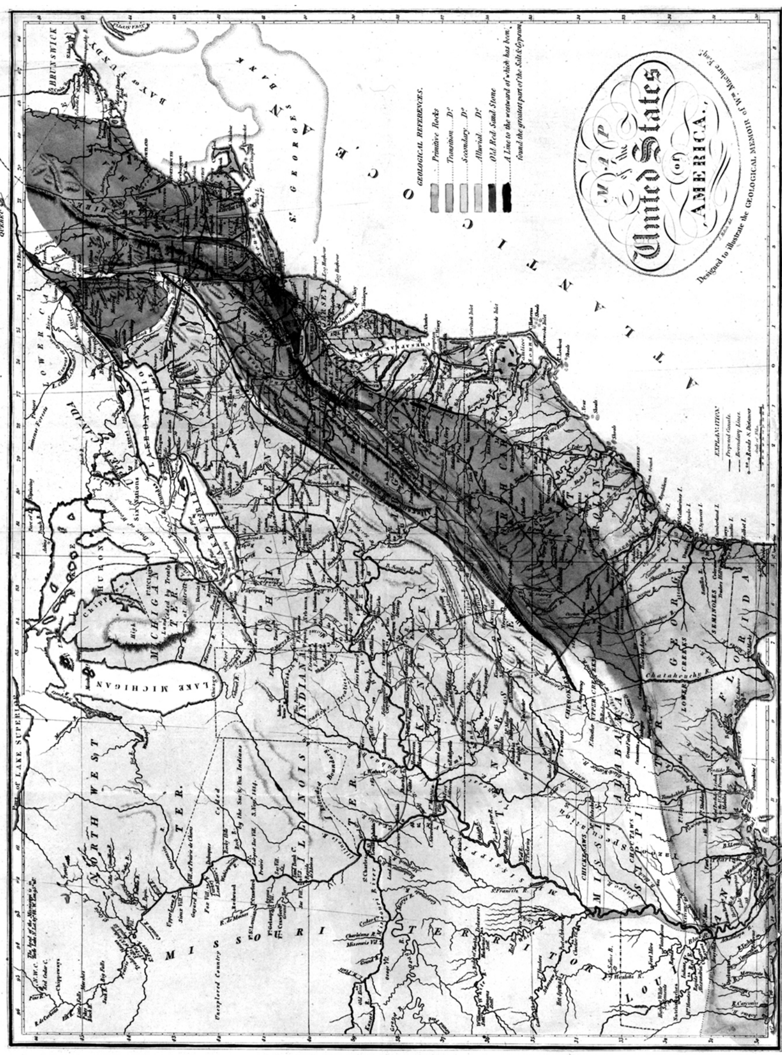

Figure 1: William Maclure, *Map of the United States* (1817). Image source courtesy of Cecil Schneer (University of New Hampshire), accessed online at http://www.unh.edu/esci/WilliamSmiths-StrataIdentified/images/usmap.jpg (July 17, 2015).

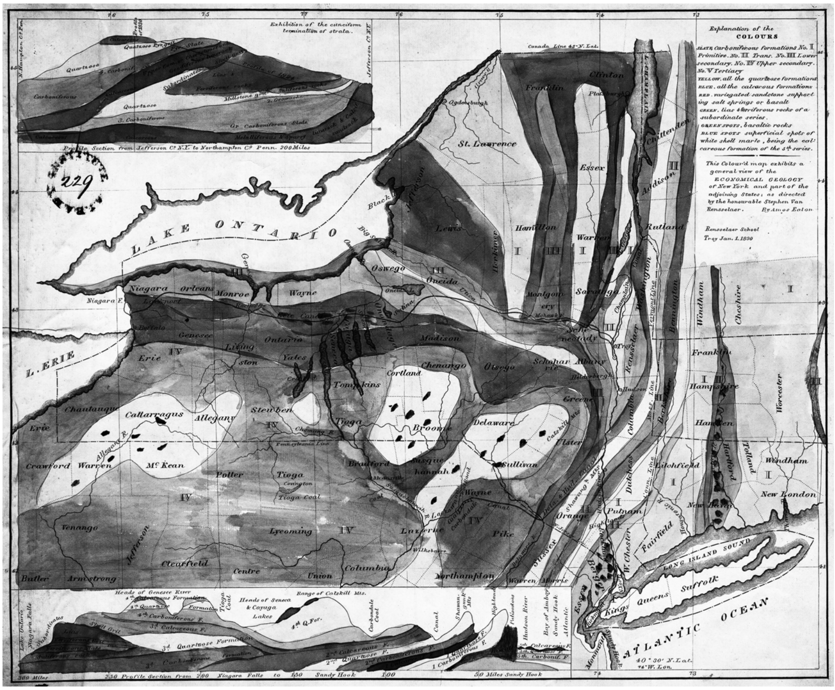

Figure 2: Amos Eaton's 1830 map of the Economic Geology of New York State. Image source courtesy Gerald Friedman, Northeastern Science Foundation, Troy, NY.

political gamble lay at the heart of this bid to present a map of the entire state. Eaton hoped to impress legislators regarding the value of geological mapping. Otherwise, what could have induced this champion of extensive field work to venture such a blind and reckless claim about the interior of the state?[23]

23. Circumstances surrounding Eaton's 1830 map: Aldrich, *New York State Natural History Survey,* 42; and Spanagel, *DeWitt Clinton and Amos Eaton*, 146–48. As subsequent generations of American geologists would establish, the Adirondack province is geologically unrelated to the rest of the Appalachian mountain range, and represents instead an uplifted portion of the much older Precambrian shield rock (sometimes referred to as the Canadian shield or the Laurentian shield); see Philip B. King, *Precambrian Geology of the United States; an Explanatory Text to Accompany the Geologic Map of the United States*, Geological Survey Professional Paper 902 (Washington, DC, 1976), 29. Amos Eaton's *Economic Geology of New York State* (1830), from Aldrich, *New York State Natural History Survey,* 13.

Over the next twenty years, geological ideas shifted precipitously, while the techniques used to represent newly acquired geological knowledge evolved more gradually. James Hall, one of Amos Eaton's students, became New York State Paleontologist. He also enjoyed productive stints of service as State Geologist for both Iowa and Wisconsin. In an 1843 map (see Figure 3), Hall demonstrated a fundamentally new understanding of North American sedimentary strata, based on characteristic fossil remains, which now permitted the geologist to identify regions that could possibly contain coal. In this example, promising sites for this valuable mineral resource so essential to industrial development are shown as the large gray ovals: one running along the western Appalachians from Pennsylvania to Tennessee, and two others centered on Illinois and Michigan, respectively.[24]

By juxtaposing these three generational snapshots of geological mapping activity in the United States, we can see how new developments in geological theory, the evolution of map-making techniques, increasing levels of precision and detail of knowledge inscribed upon the maps, and shifts in the intended practical applications of stratigraphy all transpired within the bounds of antebellum American scientific culture and practice. Revolutions in American regional and continental transportation systems, expansion of mining and the gathering of resources and materials necessary for chemical and industrial manufacturing, and the successful investigation of North America's mysterious and jumbled geological (glaciated) past would all depend directly on the kinds of scientific knowledge that geologists and hydrographers encoded onto maps, profiles, diagrams, and nautical charts.[25]

Geological maps were not abstract productions. They were meant to support land sale, mining, and regional development. In similar ways across forms of print culture, science played an important role in the commercial development of the early republic. Chemists and geologists, in particular, were engaged in research and development for a broad

---

24. Standard biography remains John Mason Clarke, *James Hall of Albany, Geologist and Palaeontologist, 1811–1898* (Albany, NY, 1921; repr. New York, 1978). Use of the fossil record: Martin J. S. Rudwick, *Bursting the Limits of Time: The Reconstruction of Geohistory in the Age of Revolution* (Chicago, 2005).

25. Early makers and sellers of maps and atlases: Erwin Raisz, "Outline of the History of American Cartography," *Isis* 26 (Mar. 1937), 373–91. Coal maps and their distribution: Lucier, *Scientists & Swindlers,* 369–407.

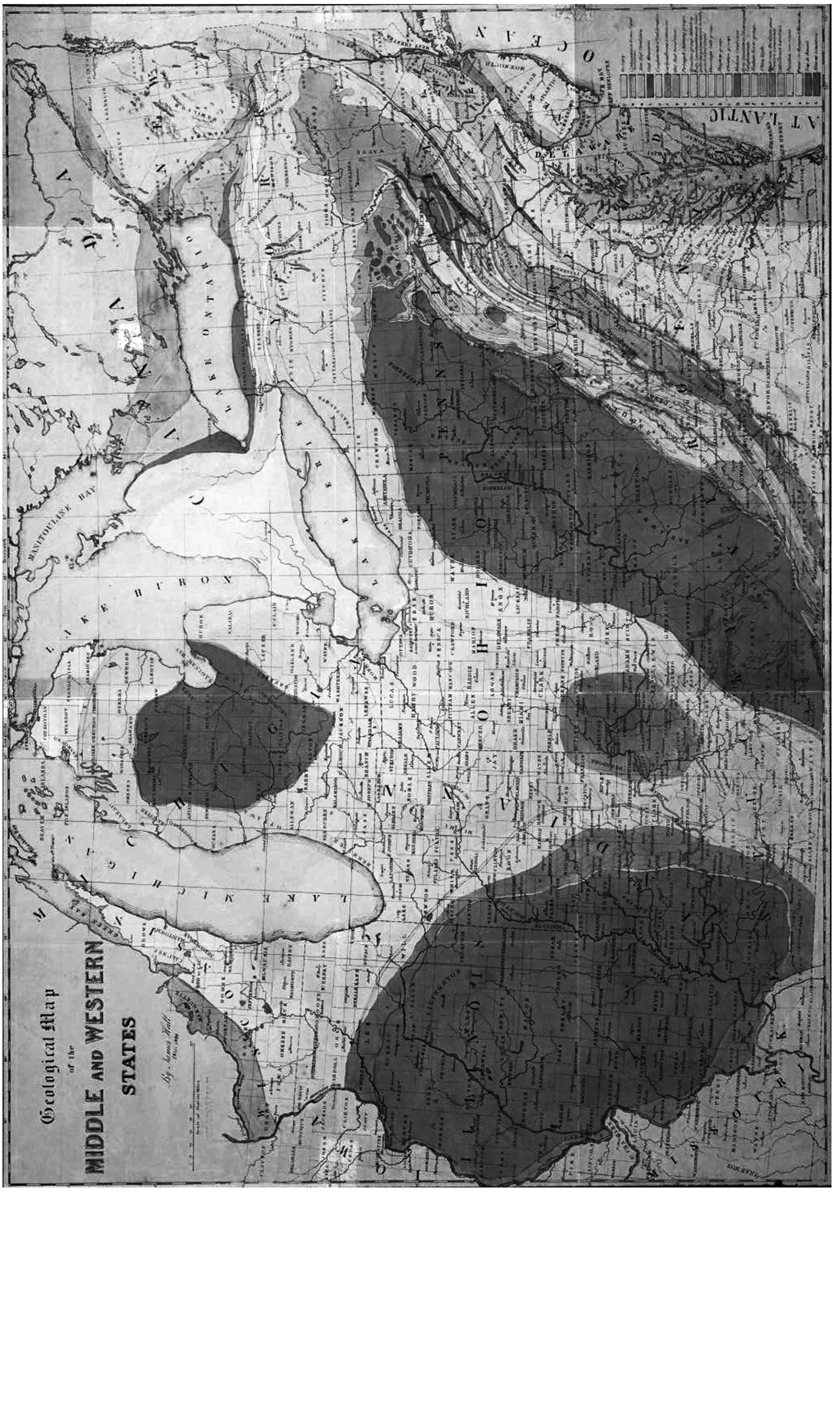

Figure 3: James Hall, *Geology of the Middle and Western States, from Geology of New York. Part IV. Comprising the Survey of the Fourth Geological District* (Albany, NY, 1843). Image source courtesy Phillip Huber (Geoscience Books), accessed online at http://www.raregeologybooks.com/sitebuildercontent/sitebuilder pictures/Hallmap.jpg (June 4, 2014).

range of commercial activities, including mining, manufacturing, farming, communications, and transportation. Companies and capitalists relied on science, not in the way of establishing industrial laboratories but rather in the manner of individual engagements or commissions. Such engagements characterized a new kind of commercial relation—one that emerged in the early nineteenth century and co-evolved with the developing economy of the early republic—namely, consulting.[26]

Consulting was a new scientific practice, largely American in creation and character, whereby men of science (for it was exclusively men who consulted) played an active and influential role in the establishment or reorganization of new private enterprises. Consultants brought the latest findings and methods of science to bear on problems posed by business. At the same time, American researchers benefitted from these new commercial questions. Such commercial science had cultural import: Americans shared valuable natural knowledge through various printed media in the early republic.[27]

The beginnings of scientific consulting can be traced back to the first decade of the nineteenth century, when, in May 1810, Colonel Thomas

---

26. That assertion would have been quite controversial a generation ago. Until recently, the role of science in industry and its contributions to invention and innovation were regarded as features of the *late* nineteenth century and early twentieth century. By this older interpretation, the relations of science and capitalism were defined by the industrial research at the laboratories of General Electric, AT&T, and DuPont or by new science-based technologies like the telephone, chemical dyes, and electricity. Recent historical work, however, has brought to light a great deal of commercial involvement by men of science in the *early* nineteenth century. Traditional treatment of science and capitalism: David A. Hounshell, "The Evolution of Industrial Research," in *Engines of Innovation: U.S. Industrial Research at the End of an Era*, ed. Richard S. Rosenbloom and William J. Spencer (Boston, 1996), 13–85. Examples of the shift in scholarship on the commercial ties of chemists and geologists: Cohen, *Notes from the Ground*; Lucier, *Scientists and Swindlers;* Lucier, "Commercial Science," in *Blackwell Companion to the History of Science*, ed. Bernard V. Lightman (Forthcoming 2016); Rossiter, *Emergence of Agricultural Science*; Leslie Tomory, *Progressive Enlightenment: The Origins of the Gaslight Industry, 1780–1820* (Cambridge, MA, 2012).

27. For more on scientific consulting: Jack Morrell, *John Phillips and the Business of Victorian Science* (Aldershot, VT, 2005); Colin A. Russell, *Edward Franklin: Chemistry, Controversy, and Conspiracy in Victorian England* (Cambridge, UK, 1996); Crosbie Smith and M. Norton Wise, *Energy and Empire: A Biographical Study of Lord Kelvin* (Cambridge, UK, 1989).

H. Perkins and Isaac Davis, proprietors of a lead mine near Northampton, Massachusetts, consulted Benjamin Silliman, then a Yale professor but not yet editor of a famous scientific journal, about the prospect. Silliman visited the site, interviewed company officers, surveyed the mine and its surroundings, collected samples, and ran a series of chemical analyses in his laboratory at Yale. He then wrote up a favorable report for Perkins and Davis, which he later revised and published as a scientific article in the first issue of Archibald Bruce's *American Mineralogical Journal* (1814). For his services, Silliman received $50 in gold; and, in return, the proprietors received expert advice, which they used to develop a rich lead and silver mine that operated until the mid-1840s.[28]

Silliman's first engagement thus proved to be a success, financially and scientifically for him as well as commercially for the proprietors. He received three more commissions that summer. News of Silliman's consulting services spread among the business classes of New Haven and beyond, and by the 1820s Silliman was so keenly sought by New England companies and capitalists that he had to turn down commissions. Over the next decade, Silliman would expand his expert purview to the mid-Atlantic states. By the early 1830s, he was traveling as far as the coalfields of eastern Pennsylvania and the gold mines of the Virginia Piedmont. Silliman could command upwards of $1,400 for such engagements, a lucrative boost to his modest Yale salary of $1,100.[29]

More importantly, Silliman's consulting became the model for the proper relations between science and commerce in the early republic. As a leader of the American scientific community, Silliman popularized and legitimated consulting. To engage in scientific consulting became a practice worthy of a professor and a man of science. During the first half of the nineteenth century, most consultants were college professors who taught natural history, geology, or chemistry and were regarded as the

28. Benjamin Silliman, "Particulars Relative to the Lead-Mine Near Northampton (Massachusetts)," *American Mineralogical Journal* 1 (May 1810), 63–69. See also Brown, *Benjamin Silliman*, 258–59; Lucier, *Scientists and Swindlers*, 110.

29. Benjamin Silliman, *Report on the Coal Formation of the Valleys of Wyoming and Lackawanna* (New Haven, CT, 1830); Silliman, *Report on the Gold Mine of Culpepper County* (Fredericksburg, MD, 1836); Silliman, *Report of the Gold Districts of the Virginia and New England Mining Company* (Fredericksburg, MD, 1836). Fees: Paul Lucier, "Commercial Interests and Scientific Disinterestedness: Consulting Geologists in Antebellum America," *Isis* 86 (June 1995), 245–67.

local scientific experts on call. Silliman showed that there was nothing inappropriate or unethical in accepting the calls. Fees for expertise was a respectable moral economy resting on a common cultural assumption that knowledge was useful and therefore should be used. The practice of consulting thus served both selfish and selfless ends.[30]

Silliman's early engagements provided a model for how print culture mediated the practice of consulting as it developed over the next few decades. In broad outline, consulting was itself a business transaction. Although the initial inquiries and agreements took the form of letters between proprietors and professors, most commissions also required the consultant to make a report, a detailed evaluation of the property or project. Sometimes these reports were given orally (for instance, when a mining prospect was *not* promising), but generally the consultant was expected to write up the evaluation, just as Silliman did for Perkins and Davis.

Beginning in the 1820s, with the introduction of steam-powered presses, favorable reports were often printed as pamphlets. The print runs typically numbered less than 200, but these private publications became the key to the widespread circulation of commercial science. The cultural significance of commercial science can be understood by the care and concern put into publishing the consulting reports. The consultant, not the company or the capitalists, guided the report through the press. Men of science undertook to make sure their work was printed correctly, without interference, thereby ensuring the trustworthiness of the science and the reputation of the man of science. These privately published pamphlets thus functioned as one medium through which the American public came to know science, men of science, the practice of consulting, and, more generally, the usefulness of science in commercial enterprise.[31]

From a historical perspective, the appearance of published consulting reports marked a new literary genre, distinct from scientific articles and

---

30. Service ethos of American men of science: John C. Greene, "Protestantism, Science, and American Enterprise: Benjamin Silliman's Moral Universe," in *Benjamin Silliman and His Circle: Studies on the Influence of Benjamin Silliman on Science in America*, ed. Leonard G. Wilson (New York, 1979), 11–27; Slotten, *Patronage, Practice, and the Culture of American Science*.

31. Mechanics and morals of consulting engagements: Lucier, *Scientists and Swindlers*, 108–42.

popular accounts of science. First, and obviously, the reports were addressed to a different audience—the companies and capitalists who engaged the consultant. As such, they were written in a vocabulary and style understandable and accessible to non-scientifically trained readers. The reports tended to be shorter in length than scientific articles, mainly because they omitted references to other scientific authors and works and left out discussions of theoretical points. On the other hand, consulting reports often included definitions of terms, explanations of methods, and discussions of concepts that would have been considered unnecessary for scientific readers. The reports also contained a wealth of locally specific details about time, place, and participants (for instance, company officers and workers), as well as short narratives about travel conditions, surroundings, or other interesting and perhaps commercially valuable resources. In short, these reports encapsulated practical, useful, commercial science, a type of science characteristic of America and the early republic.

Circulation of these consulting reports increased still further by the standard habit of enfolding them into business prospectuses. This promotional practice brought the commercial results of consulting engagements directly to the attention of men of business and other wealthy Americans interested in new business ventures. The object of such prospectuses was to attract capital investment. The inclusion of consulting reports, however, was not mere puff or publicity palaver; rather the reports were vital to potential investors as a guarantee of the scientific soundness of the property or project. In short, the reports functioned as scientific insurance.[32]

But the insurance was term-limited. Or, to put it another way, the business prospectus had a short shelf life. Designed to attract investors or to help in reorganizing a manufactory or to develop a mine, its usefulness to business classes came to an end once the capital was secured or the project got underway. The science in consulting reports was much more long-lasting. And it was the science—practical, commercial, and readable—that was the valuable substance of the report. Typically, men of science sent copies of their pamphlets to their colleagues (which is why most consulting reports are often found among the collected papers

32. Charles T. Jackson, ["On the Importance of the Science and Art of Mining"], *Proceedings of the Boston Society of Natural History* 2 (1846), 110–14.

of scientific researchers, not in business archives, since the companies disappeared long ago). Consulting reports were often subsequently cited in other scientific works—books, articles, surveys, and other government documents.

Of course, the other way to make public the results of a private engagement was to write a scientific article. Silliman had set the example by publishing an account of his Northampton lead mine survey, and it would become commonplace for consultants to publish accounts of their engagements in scientific journals, especially, after 1818, when Silliman founded *The American Journal of Science*. In that forum, Silliman published extensive accounts of his own engagements in the anthracite fields of Pennsylvania and in the gold mines of Virginia. He also published results of the chemical analyses of minerals done at the Yale laboratory. Likewise, the *Journal of the Franklin Institute*, established in 1826 in Philadelphia, carried numerous articles based on the engagements of geologists and chemists for Pennsylvania anthracite coal companies, and was a main source of technical information generally in the early United States. In these scientific media, the results from privately financed science became part of the public/printed discussion of men of science.[33]

Finally, the popularity of such commercial science can be judged by the number of excerpts printed in newspapers. Local papers often carried summaries of consulting reports precisely because they were accessible to the public and brought scientific discoveries to notice. For this reason, respectable chemists and geologists wanted to prevent the circulation of unwarranted claims. No man of science wanted to be associated with swindling sensationalism—especially the discovery of gold! In general, though, it was only natural and interesting to readers to learn of local developments in science and commerce such as the opening of a new coal mine. And beginning in 1845, *Scientific American* kept its readers updated, weekly, on the latest developments in the relations between

33. Benjamin Silliman, "Notice of the Anthracite Region of the Lackawanna and of the Wyoming on the Susquehanna," *American Journal of Science* 18 (July 1830), 308–28; Silliman, "Remarks on Some of the Gold Mines, and on Parts of the Gold Region of Virginia, Founded on Personal Observation, Made in the Months of August and September, 1836," *American Journal of Science* 32 (July 1837), 98–130. Influence of the *Journal of the Franklin Institute:* Bruce Sinclair, *Philadelphia's Philosopher Mechanics: A History of the Franklin Institute, 1824–1865* (Baltimore, 1974).

science and commerce often through brief summaries of consulting reports.[34]

By the 1850s, the private practice of scientific consulting had a conspicuous public place in American cultural life. The consulting report was a unique genre of commercial science that embodied the very practical nature of early American science. It was both economical and theoretical and written in a style and language that was accessible to nonscientific readers. Through the publication of consulting reports as pamphlets, in business prospectuses, as revised scientific articles, and in newspaper excerpts, American businesses and the general public became familiar with the methods and findings of men of science. Science thus became readily accessible to a large population of literate Americans in the early republic through these commercial publications.

Where consulting chemists and geologists inventoried territorial riches in their reports, the thousands of "improving agriculturists" worked toward territorial transformation, spreading a new landscape of exotic species westward and restoring and reconfiguring the exhausted lands of the East. Consultants worked to carve out a professional niche as men of science, but "improvers" were a more varied coalition, encompassing wealthy to middling farmers, breeders, nurserymen, agricultural machinery makers, and agricultural warehouse owners. Because farmers managed complex landscapes and dozens of kinds of organisms, improving attention was also more diffuse, drawing on geological surveys, chemical analyses and accounts of nutrition, minute entomological or botanical descriptions, discussions of gross animal anatomy, and veterinary science.[35]

---

34. See, for example, the important role of newspapers and *Scientific American* in the lengthy scientific and commercial controversy over kerosene in Paul Lucier, "Court and Controversy: Patenting Science in the Nineteenth Century," *British Journal for the History of Science* 29 (June 1996), 139–54.

35. Agricultural improvement: Chaplin, *An Anxious Pursuit*; Cohen, *Notes from the Ground*; Donald Marti, "To Improve the Soil and the Mind," PhD diss., Ann Arbor, 1979; Margaret W. Rossiter, "The Organization of Agricultural Improvement in the United States, 1785–1865," in *The Pursuit of Knowledge in the Early American Republic: American Scientific and Learned Societies from Colonial Times to the Civil War*, ed. Alexandra and Sanborn C. Brown Oleson (Baltimore, 1976), 279–97; Stoll, *Larding the Lean Earth*; Tamara Plakins Thornton, *Cultivating Gentlemen: The Meaning of Country Life among the Boston Elite, 1785–1860* (New Haven, CT, 1989).

When Abraham Lincoln's wartime administration eventually created the Department of Agriculture in 1862, that founding act represented not only recognition of the rural nature of much of the United States in the nineteenth century, but a ratification of existing American practices of communication and experimentation within agricultural sciences. Following agricultural journals, we can see the deep penetration of a global network of texts deep into what seem to be provincial spaces and uncover an area of print culture that not only appropriated cosmopolitan knowledge but also created and circulated experiments of its own.[36]

As signified by the mocking label "book-farmer," improving agriculturists were marked by their devotion to print. Agricultural print ran from expensive hand-painted books of fruits to cheap digests, free pamphlets, and catalogues. However, journals were the most important source of agricultural print. Appearing in a brief burst in the 1810s and 1820s, agricultural journals took off in the late 1830s, benefitting from government postal subsidies for newspapers; from the new, cheap, paper-making technologies and steam presses of the 1820s; and from the enormous expansion of the agricultural societies of the late 1830s. By 1841, the New York breeder J. M. Sherwood wrote to the improving author Henry S. Randall, "I find agriculture publications are rising up like mushrooms and whether they will live any longer is to be seen."[37]

Changes of title and swaps and short-lived journals make it difficult to know the total number, but one bibliographer lists sixty-three lasting titles in the U.S. between 1810 and 1860. While the largest number of agricultural journals came from the northeast and Middle Atlantic states, substantial voices in the 1830s and 1840s emerged from around the nation: Illinois, Iowa, Maine, Alabama, and Mississippi all had multiple titles. This throng of papers was bound together by correspondence, by copy exchange, and by a web of personal relationships. The common nineteenth-century newspaper practice of reprinting copy from one's rivals made links between journals yet more tangible. New York journals frequently printed copy from their colleagues in Virginia, in New

36. Department of Agriculture: Cohen, *Notes from the Ground,* 8.

37. J. M. Sherwood to Henry S. Randall, Dec. 2, 1841, Folder, 1840–1842, Henry S. Randall Papers, Cortland County Historical Society, Cortland, New York. For the general expansion of journals at this time, see Richard John, *Spreading the News: The American Postal System from Franklin to Morse* (Cambridge, MA, 1998), 38–41; Zboray, *A Fictive People,* 9–11.

England, and from the increasing numbers of papers in the West, as well as from British and even French journals. A popular article could travel thousands of miles beyond its original pool of subscribers, establishing a national or even an international conversation.[38]

A quick glance at tables of contents in the agricultural journals dispels any notion that the conversations of geologists and chemists were of interest to only a tiny audience of cognoscenti. Agricultural journals often drew copy from surveys, maps, and reports, spreading them to a much larger group of subscribers—in 1837, for example the weekly *Genesee Farmer* gave a full-page digest of the most recent number of "this excellent work of which every American has reason to be proud, Silliman's *Journal,*" and then reprinted, in full, an article on spontaneous combustion. Agricultural societies commissioned lectures from the younger Benjamin Silliman and from the spreading group of "chemical lecturers," who often combined their public speaking with consulting, particularly during the soil-analysis craze of the late 1840s. Agricultural journals powerfully argued for state-supported geological surveys and state chemists and defended them once they were established. The absence of a copyright treaty between Great Britain and the United States during the mid nineteenth century widened access to scientific texts—translated in Britain, works like those of the German chemist Justus von Liebig or the British agricultural geologist James F. W. Johnston were pirated in serial form, as were articles from the agricultural journals' powerful British counterparts. This system of intellectual borrowing meant that ideas moved rapidly across the Atlantic, making recent agricultural science available to a wide audience.[39]

38. Stephen Conrad Stuntz, *List of the Agricultural Periodicals of the United States and Canada Published During the Century, July 1810 to July 1910* (Washington, DC, 1941).

39. "This excellent work": "Silliman's Journal," *The Genesee Farmer and Gardener's Journal* 7 (Nov. 25, 1837), 2. Ariel Ron has usefully examined the effect of improvement on the formation of state institutions in "Summoning the State: Northern Farmers and the Slaveholding Republic," paper delivered June 9, 2015 at Grassroots Modernities: Nature, Agriculture and Improvement in the Atlantic World, Yale Center for the Study of Representative Institutions; *Subscriptions for the Cultivator and the Horticulturist* [Broadside] (Albany, NY, 1847), Manuscripts and Special Collections, New York State Library, Albany; "Advertisement," *Genesee Farmer* (New York) 10 (1849), 132.

The boundaries of this audience are hard to determine, though they were likely in the hundreds of thousands. In making their case to advertisers, agricultural journals gave out remarkable circulation figures: For example, in the mid-1850s the *Country Gentleman* boasted a circulation of 20,000, the *Rural New Yorker* of Rochester claimed 26,000, and the *Genesee Farmer* claimed 20,000. Although such subscription figures were doubtless inflated, they also doubtless only represented a fraction of readers. Like most rural periodicals in the antebellum period, agricultural journals circulated through a wide neighborly exchange network. The *American Agriculturist* claimed, on investigation, to have found that the twenty-two copies of their journal sent to a single rural post office had reached 107 families and passed through the hands of 506 people. One reader, A. H. Burdick, a former printer turned farmer, wrote an angry letter to the *Genesee Farmer* on the subject of "newspaper borrowing": "When I have endeavored, with all the magical skill of which the publisher is master, to persuade my neighbors to become interested patrons of the 'Genesee Farmer,'" he wrote, "it is mortifying, it is *soul-stirring* to be met with the cunningly-devised response—'*Oh I can borrow your paper!*'" Such informal networks may have frustrated publishers, but they also amplified the effect of improving texts. Moving even further, improving texts were excerpted as filler in agricultural almanacs and in small-town and metropolitan newspapers. Three almanacs in 1800 gave advice on combatting the Hessian fly, for example, and one 1840s almanac offered practical agricultural chemistry in the form of a note on "Use of Sulphuric Acid as a Manure."[40]

40. Circulation: Robert Russell, *North America Its Agriculture and Climate, Containing Observations on the Agriculture and Climate of Canada, the United States, and the Island of Cuba* (Edinburgh, 1857); Sally McMurry, "Who Read the Agricultural Journals? Evidence from Chenango County, New York 1839–1865," *Agricultural History* 63, no. 4 (1989), 1–18. Liebig in America: Rossiter, *Emergence of Agricultural Science*; Charles Rosenberg, *No Other Gods: On Science and American Social Thought* (Baltimore, 1997); Pawley, "Accounting with the Fields." "Mortifying": A. H. Burdick, "Newspaper Borrowing," *The Genesee Farmer and Gardener's Journal* 8 (June 2, 1838), 173. Hessian fly: *Farley & Goss' Almanac, or Vermont Calendar . . . 1800* (Peacham, VT, n.d.); *The Farmers Almanac . . . 1800* (Greensburg, PA, n.d.); *The Republican Calendar . . . 1800* (Washington, PA, n.d.); Philip J. Pauly, *Fruits and Plains: The Horticultural Transformation of America* (Cambridge, MA, 2007), 33–50. Manure: Pawley, "Reading the Man of Signs."

While farmers rarely recorded their responses to these texts, references to the material treatment of journals make clear that seemingly ephemeral journals had long lives. Readers often remade printed matter into forms they found more useful or more durable. Farmers like Moses Eames and the Weeks brothers described taking their agricultural journals to the local book binder to have them made more durable. When several numbers of his volume were destroyed by clumsy-fingered neighbors, Burdick complained he could no longer have it perfectly bound into a "cheap and beautiful *textbook*, as it were, of 416 pages." Other farmers saved relevant knowledge by pinning relevant articles into their account books; the Poughkeepsie farmer Alexander Coffin's diary began with pinned-in references to British sheep experiments, and James McLallen copied in calculating tables from his journals. Such practices echo those of many who used daybooks, almanacs, family journals, or domestic health guides as a kind of cut-and-paste compilation of accumulated wisdom.[41]

While it is important to notice the ways that cosmopolitan knowledge moved through agricultural journals into American rural spaces, it is perhaps even more important to notice how rural voices both spoke back and engaged in their own conversations. As much as access to cosmopolitan articles, American essays, submitted often by readers themselves, were a central attraction of the journals. Each volume of the *Cultivator*, its editors boasted, contained "contributions from over 300 correspondents." Far from simply echoing metropolitan notions, correspondents engaged each other in extended debates crucial to their community. Thus, for example, the much-discussed (putative) transmutation of wheat into chess (the weed known in some regions as cheatgrass) drew in disputants from the nurseryman and botanist David Thomas to the apple grower Oliver Chapin, leading them to question mutability of the living systems they managed.[42]

41. Moses Eames, Diary, Mar. 12, 1836; Levi Weeks, Diary, July 7, 1855, May 6, 1851; Alexander Coffin, Farmer's Diary, Apr. 1851–Dec 1862, Inner Cover, Dutchess County Historical Society, Poughkeepsie, NY; James McLallen, Diary/Daybook & House ledger, Mar. 18, 1850; Moses Eames Diary, Mar. 12, 1836.

42. J. M., "Letter 1," *Genesee Farmer and Gardener's Journal* 3 (Mar. 30, 1833), 99; Experimenter, "Communications for the Genesee Farmer: Experiments," *Genesee Farmer and Gardener's Journal* 1 (Aug. 5, 1831), 244; Alson

Correspondents also engaged in an experimental tradition that simultaneously deployed and complicated knowledge from other scientific print genres. Thus, for example, an article that defended the Maryland State Geologist also described "a very striking experiment" by Outerbridge Horsey that tested the effects of lime on the "very thin silicious soil" of "the Maryland Tract" by liming one half of a field and comparing yields. Through such experiments, improvers argued, the geological fate written into particular soils could be challenged by novel chemistry and new fertilizers.[43]

While some experiments, like the one above, deployed elaborate accounting systems and recognizable controls, others seem simpler. Moses Eames's first 1836 experiment, which was promptly published, was one paragraph long, contained a scrap of his weather diary, and then informed the readers briefly "On the morning of the 5th, I put a small quantity of quicksilver into a saucer and had the pleasure of seeing it freeze solid." Such simple experiments, which appear frequently throughout the agricultural press, might seem easy to dismiss. Yet they suggest the relative openness of the agricultural publishing culture: Eames, when he wrote this letter was only twenty-seven, one of ten children in a farm family in a county near the border with Canada. Further, seen in the context of other such seeming scraps, they were a part both of a trans-Atlantic culture of weather diary-keeping, and a broader conversation about possible changes of climate (changes that many observers ascribed to earthquakes and other terrestrial tumult). With access to medical mercury if not to a thermometer, Eames could comment on the continuing cold of northern winters, something that many observers expected cultivation to mitigate. General acceptance of possibilities of newly cultivated territories depended in part on such scraps, which readers use to assemble into a broader picture.[44]

Ward, Diary, July 10, 1845, 47; Edward Johnson, Diary 1851–1856, Friday, June 18, 1852, Thursday, June 3, 1852, New York State Library, Albany.

43. "Annual Report of the Geologist of the State, For 1839," *The American Farmer, and Spirit of the Agricultural Journals of the Day* 2 (June 17, 1840), 28.

44. Moses Eames, "Rutland, Jefferson co., February 8, 1836," *Genesee Farmer and Gardener's Journal* 6 (Mar. 12, 1836), 87. Similarly: Willis Gaylord, "On Farm Management," in *Transactions of the New-York State Agricultural Society, Together with an Abstract of the Proceedings of the County Agricultural Societies, for the Year 1842* (Albany, NY, 1843); Dwight H. Bruce, *Onondaga's Centennial. Vol. I* (Boston, 1896), 922–32; "Death of Willis Gaylord," *Cultivator* 1 (May

Historians looking at the agricultural journals often focus on the rural circulation of texts from recognizable sciences like geology and chemistry and the support of a new geological and chemical professionalism, developments that seem (and indeed are) momentous. However, improvers themselves operated in a different set of expectations about the nature of science. They were used to reading and assembling a range of scrappy texts, and gave credence to a wider array of voices. For them, the journals offered not only a link to the metropolitan scientific worlds across the ocean or in cities, but also a conduit through which to communicate their own experimenting practices.

A wide range of readers in the early United States used seemingly subject-specific publications, from geological maps to scientific quarterlies to agricultural journals, for a wide range of reasons. Any effort to understand the breadth of scientific work in early America has to confront the extent of such sources. In commonplace household writings, too, historians can see evidence of widespread engagement with scientific work and scientific ideas.

By the early nineteenth century almanacs reflected rising interest in the sciences of territoriality. Agricultural advice proliferated. Like the editors of agricultural journals, almanac makers attributed some of this advice to printed sources, other advice was credited to correspondents, and much was left unattributed. Almanacs also printed excerpts from letters describing the agricultural and commercial potential of territory where Americans were settling. As with consultants' reports and geological maps, discussions of mineral discoveries and the productive uses to which they could be put were offered as evidence of the accelerating

1844), 137. Study of climate: Jan Golinski, "American Climate and the Civilization of Nature," in *Science and Empire in the Atlantic World*, ed. Dew and Delbourgo (New York, 2008), 153–74; James Rodger Fleming, *Historical Perspectives on Climate Change* (Oxford, UK, 2005); James Rodger Fleming, Vladimir Jankovic, and Deborah R. Coen, eds., *Intimate Universality: Local and Global Themes in the History of Weather and Climate* (Sagamore Beach, MA, 2006); Fredrik Albritton Jonsson, "Climate Change and the Retreat of the Atlantic: The Cameralist Context of Pehr Kalm's Voyage to North America, 1748–51," *William and Mary Quarterly* 72 (Jan. 2015), 99–126; Gillen D'Arcy Wood, *Tambora: The Eruption That Changed the World* (Princeton, NJ, 2014); Valencius, *The Health of the Country*, 159–90; and Anya Zilberstein, *A Temperate Empire: Making Climate Change in Early America* (Oxford, UK, forthcoming).

productivity of the nation. Careful descriptions of unusual natural phenomena like whirlwinds schooled readers in habits of thought that emphasized "facts." The material included in almanacs, then, show how common were the scientific forms seen as useful knowledge in the early republic.[45]

The sciences of earth and sky similarly figure largely in early American newspapers—as they did in early American life. Because of their frequency of publication, newspapers provided a venue for scientific information and discussion, even for forceful debate, especially when unusual events provided the stimulus for discussion of fundamental natural principles. One such set of unusual events were the earthquakes beginning in December 1811.[46]

The New Madrid earthquakes rocked central North America repeatedly in the winter of 1811–1812. Centered in the Missouri boot-heel and named for the once-Spanish settlement near their epicenters (but pronounced, in defiant Americanism, "new MAD-rid"), the New Madrid quakes shook not only the central floodplain of the Mississippi River but much of the eastern United States. Even moderate earthquakes are felt more powerfully and at longer distances in eastern North American than in the West: The New Madrid earthquakes of the Mississippi Valley were perceived up much of the length of the Ohio, along lowlands in parts of Georgia, in portions of the southeastern seaboard, along the lower northeast, and even into "upper Canada." Individuals, families, and communities in far-scattered locations heard rumbling noises, felt the earth move, calmed alarmed animals, repaired cracked chimneys, and picked up

45. Emily Pawley, "Reading the Man of Signs, or, Farming in the Moon," http://common-place.org/vol-14/no-04/notes/; erudite attribution and acknowledgement of correspondents: Thomas, *The Farmer's Almanac . . . 1806*; letter on the potential around Chillicothe, Ohio: *Cramer's Pittsburgh Magazine Almanac . . . 1811* (Pittsburgh, PA, 1810), 51; focus on minerals: "Minerals, &c—Late Discoveries," *Cramer's Pittsburgh Magazine Almanac . . . 1810* (Pittsburgh, PA, 1809); whirlwind: Amasa Holcomb, *An Almanac . . . 1807* (Hartford, CT, 1806), 20; schooling in "facts" is a reference to Andrew J. Lewis, *A Democracy of Facts: Natural History in the Early Republic* (Philadelphia, 2011). Almanacs also offered extensive medical advice: Thomas A. Horrocks, *Popular Print and Popular Medicine: Almanacs and Health Advice in Early America* (Amherst, MA, 2008).

46. Newspapers in early American science: Pandora, "Popular Science in National and Transnational Perspective," 354–55; and Valencius, *Lost History,* 14–58; 106–44; 175–215.

crockery that had clattered to the floor. Afterward, they wanted to know *why* they had felt what they did.[47]

To discuss the quakes, many people used the main source of the era: newspapers. Read aloud, read privately, exchanged, used to pack goods, used as insulation and then reread, the extraordinary proliferation of American newspapers both carried scientific texts into American homes and propelled provincial accounts and theories into a national conversation. As in journals of natural history and agriculture, practices of cutting and pasting in newspapers provided a way for many in the early United States to learn about scientific discussions elsewhere. Soon after its publication, for instance, the article in Silliman's *Journal* tracing Alabama prairies to ancient New Madrid earthquakes was reprinted whole by a Washington, D.C., newspaper, the *Daily National Intelligencer.*[48]

Readers scanning a local rag for news of land sales, war with Britain, or agitation among Indian tribes along the Mississippi could easily also discover links between current science and long-standing debates in natural history. In February of 1811, well before the New Madrid quakes struck, readers of several newspapers could read the same snippet reporting on current theories of "naturalists" about "the causes of earthquakes." Reflecting contemporary divisions in geology, the synopsis acknowledged that "Some ascribe them to Water, others to Fire, and others to Air; and all of them with some reason." In 1811, however, new science suggested new possibilities: "modern electrical discoveries" have explained that "the sudden extensive agitation, both of land and water, occasioned by *Earthquakes*, can only be effected by that property which is called ELECTRICITY." Earthquakes occurred when a "non-electrick cloud" approached a portion of the earth that was "in a higher electrified

47. History and current science of these earthquakes: Valencius, *Lost History.*

48. Newspapers generally in the early United States: Daniel Walker Howe, *What Hath God Wrought: The Transformation of America, 1815–1848* (Oxford, UK, 2007); 226–27, 232; Gordon S. Wood, *Empire of Liberty: A History of the Early Republic, 1789–1815* (Oxford, UK, 2009), 478; Richard John, *"Spreading the News."* Newspapers used to pack goods, then, at destination point, smoothed out, pieced together, and read for news: Jeannie M. Whayne, "A Shifting Middle Ground: Arkansas's Frontier Exchange Economy and the Louisiana Purchase," in *A Whole Country in Commotion: The Louisiana Purchase and the American Southwest*, ed. Patrick G. Williams, S. Charles Bolton, and Jeanne M. Whayne (Fayetteville, AR, 2005), 73.

state." The result: a "shock, produced between the cloud and many miles in compass of solid earth, must be an earthquake; and the snap from the contract [sic] be the noise attending it." Many Americans would later conclude that the New Madrid quakes they felt the following winter were electrical, in large measure because of such reports.[49]

Conversation through newspapers fostered a dispersed network of knowledge makers. A notice in the *Augusta Herald* advised its Georgia readers in 1800 that the Connecticut Academy sought "a regular series of facts" on various aspects of the natural world, including "the variations of the thermometer and barometer; extraordinary change of weather, and storms of all kinds; state of the seasons; unusual tides; celestial appearances; earthquakes; unusual number of insects; commencement, progress, and termination of epidemic diseases among men and other animals; and other remarkable physical phenomena." The announcement requested precision in timing and exactitude in keeping records. Correspondents who sent in reports after the New Madrid earthquakes could well have been responding to this call and others like it.[50]

The sensationalism of novelty shows the frustrations of a would-be intellectual elite with the scientific enthusiasms of the larger reading public. During the digging of the New York canals newspapers would sometimes announce with great excitement that canal-diggers had unearthed

49. "The Prairies of Alabama," *Daily National Intelligencer,* July 30, 1834, Newsbank. Quotation from "Earthquakes," *Salem Gazette* (MA), Feb. 5, 1811, Newsbank. The same brief article was, characteristically, reprinted elsewhere, as for instance in *Poulson's American Daily Advertiser* (Philadelphia), Feb. 15, 1811, Newsbank. For other examples of earthquake science aimed at general readers: "Theory of Earthquakes (News) from the *London Lit. Gaz.*," *Daily National Intelligencer* (Washington, DC), Nov. 9, 1822, Newsbank. On electricity in early America: Chaplin, *The First Scientific American*; James Delbourgo, "Electrical Humanitarianism in North America: Dr. T. Gale's *Electricity, or Ethereal Fire, Considered* (1802) in Historical Context," in *Electric Bodies: Episodes in the History of Medical Electricity*, ed. Paola Bertucci and Guiliano Pancaldi (Bologna, 2001), 117–56; Rebecca Herzig, "Subjected to the Current: Batteries, Bodies, and the Early History of Electrification in the United States," *Journal of Social History* 41, no. 4 (2008), 867–85; Delbourgo, *A Most Amazing Scene of Wonders*; Michael Brian Schiffer, *Draw the Lightning Down: Benjamin Franklin and Electrical Technology in the Age of Enlightenment* (Berkeley, CA, 2003).

50. "From the *New-York Magazine,*" *Augusta Herald* (GA), May 14, 1800, 3, Newsbank.

living creatures deep underground—even in otherwise solid rock! One particularly famous torpid toad showed brief signs of life after being blasted out of solid rock near Lockport, New York. Geologist Amos Eaton distrusted the reliability of canal laborers who discovered this enigmatic toad and other similarly entombed but living creatures, and he decried the rank sensationalism of such discoveries. His skepticism was of a piece both with well-grounded distrust of hoaxes perpetrated in the pages of American newspapers and the fear of swindles in commercial science. Yet such skepticism nonetheless highlights the role of scientific discussion—here, about the nature of the vital force in living organisms—even in highly popularized accounts.[51]

In newspapers, skeptics and savants could offer evidence for their own ideas against such skepticism or disparagement of their observation. One witness to the more dramatic effects of the New Madrid earthquake shocks found his veracity questioned. Skeptics cast doubt on William Leigh Pierce's now-well-documented account of sand blows, episodes of liquefaction near the quakes' epicenters that shot up not only sand but pieces of local lignite. The affronted Pierce wrote with indignation from Savannah, Georgia that his critics could "examine for themselves" in "the Library Room of this city" the pieces of coarse coal ejected from the earth during the recent shocks. Even in the comparatively rural South, scientific evidence could be put symbolically on display through the medium of the news.[52]

Newspapers were a venue for scientific theorizing, as well as scientific

51. Torpid toad: Spanagel, *DeWitt Clinton and Amos Eaton,* 94–95.

52. William Leigh Pierce, in Robert Smith, *An Account of the Earthquakes Which Occurred in the United States, North America, on the 16th of December, 1811, the 23d of January, and the 7th of February, 1812* . . . (Philadelphia, 1812), 31–37; also Pierce, *An Account of the Great Earthquakes, in the Western States, Particularly on the Mississippi River; December 16–23, 1811, Collected from Facts* (Newburyport, MA, 1812); and Pierce, "Earthquakes," *Georgia Journal*, Mar. 25, 1812, 3, cols. 1–3, accessed through the CERI Compendium, Center for Earthquake Research and Information, University of Memphis/United States Geological Survey, http://www.ceri.memphis.edu/compendium/search/farfield.html, last accessed June 2, 2014; see Valencius, *Lost History,* 14–58; 175–215. Martin Rudwick argues that the exchange of specimens often took the form of "paper proxies"—illustrations, maps or descriptions that stood for an object. Rudwick, *Bursting the Limits of Time*, 387. Pierce's assertion served perhaps a similar rhetorical purpose.

observation and evidence. Many newspaper accounts, for instance, debated the role of comets—especially the dramatically visible comet of the fall of 1811—not only in earthquakes but in a range of phenomena, from disease to weather disturbances. Other observers sought to find in the New Madrid quakes evidence for other geological theories.[53]

In a discussion of the New Madrid quakes, an anonymous report published in the Washington, D.C., *Intelligencer* in 1812 drew on very old theories of subterranean channels within the earth, as well as on early-nineteenth-century demonstrations of the power of steam. "The writer of this has long been convinced," argued the unnamed author, "that the earth is perforated beneath its surface with innumerable water-channels, small and great, running in every direction, chiefly horizontally, or nearly so, and intersecting each other." Citing springs of fresh water as evidence, the author argued that "subterraneous rivers, perhaps as numerous as those on the surface of the earth" may also exist. At times, these subterranean channels might be left dry because of drought. In such cases, might they not fill with "air, or mephitic vapors"? The writer continued,

> Now suppose a great heat to be generated in some place or places, beneath the surface of the earth, say from chymical combinations . . . —suppose the metallic substances and sulphur beneath a vast stratum of coal to generate a heat sufficient to fire the superincumbent combustible (and coal is often found to form the bed of rivers)—or suppose any material, capable of burning, to be set on fire—what should be expected? Why, the steam from the boiling waters, and the gaseous matter from other consuming substances, which would be generated in immense quantities (particularly when a river falls into the fiery cavern).

Such a mechanism would explain heavings of the earth, as well as the shaking force of earthquakes. Indeed, argued the author, the low elevation of the Mississippi argues for this explanation in the case of the recent earthquakes. Further, the debris and forests shot upwards explosively in sand blows would be explained by subterranean explosion of steam or other vapors. Even the roaring noise of an earthquake could be that of hugely escaping steam. The widely reported flashes of light "might be

53. For instance: "Comets," *The Native American* (Norwich, CT), Apr. 22, 1812, Newsbank.

the old mephitic vapors, which had stagnated for ages in those subterraneous channels and caverns, taking fire." In such accounts, observers argued for theories of the earth based on the physical record of the recent New Madrid earthquakes.[54]

Newspapers show the vigor and passion with which early Americans across many regions debated natural phenomena. In 1812, the newspaper of a small town in Georgia sputtered with debate for months about the scientific causes of seismic movement. Perhaps as an outgrowth of the call a dozen years earlier for accounts of natural phenomena, editors of the *Augusta Herald*, in Augusta, Georgia, sparred with correspondent "J. E." in 1812 over the theory that disequilibrium of electricity between sky and earth could have caused the New Madrid earthquakes. In a spirited reply to the editor's criticisms of an initial report, J. E. argued for the aurora borealis as an electrical phenomenon, defined and defended the essential two requisites of a scientific hypothesis, quoted experiments with electricity by Joseph Priestley, and cited the *Encyclopedia Britannica's* account of a Royal Society report from 1785 of an "explosion of the electric fluid from the earth." J. E.'s basic argument (well-buttressed if roundabout even by nineteenth-century standards) was that the New Madrid earthquakes were caused by electricity crackling from the equator to the poles.[55]

The editors reprinted J .E.'s long harangues, but they ultimately disdained J.E.'s argument for electrical causes. They explained that,

> Electricity, the agent which our ingenious correspondent supposes imployed to produce earthquakes, is as competent perhaps as any other secondary power to produce the effect attributed to it—it seems however not to be free from difficulty.

---

54. "Another Conjecture of the Cause of the Earthquakes," *National Intelligencer* (Washington, DC), Mar. 28, 1812, Newsbank.

55. "J. E.," "Observations on the Physical Causes of Earthquake," Feb. 27, 1812, *Augusta Herald* (GA); rebutted by the editors in an untitled article "We observed in a former paper . . ." 5 Mar. 1812; then on Apr. 2, 1812, the paper ran both J. E.'s continued argument *and* the editors' long reply (headed "To the editors of the *Augusta Herald* . . ." and "We insert with pleasure . . ."), all available through the CERI Compendium Historian John Greene argued that science in America, as in Europe, developed only in cities, but such exchanges demonstrate that small settlements in the South could also sustain scientific inquiry and debate. Greene, *American Science in the Age of Jefferson*, 27, 107. The wide-ranging quality of such debates indicates what James Delbourgo has termed the "freedom of a creative eclecticism" in early America, because scientific investigators were far

Among other difficulties, the editors doubted whether the explanation was founded on accurate geological understanding:

> If there is a continual absorption of the electric fluid in the equatorial regions, on what principle is it, that it seeks an outlet at the poles of the earth, and why does it not escape from other parts with equal facility, when it is known and admitted, that every part of the earth is provided with conductors for it?—Or why when obstructed at the poles as suggested, does not so subtle a fluid escape other ways with similar ease, as it is usually supposed to do at the poles, and without producing agitations and convulsions? And is not the supposition of a current of electrical fluid passing from the equitorial [sic] regions through the poles of the earth, rather an ingenious hypothesis, than matter of evidence?

Having pointed out problems with the electrical theory of earthquakes on natural scientific grounds, the editors then concluded, "in the case of earthquakes, as in many other cases, we pass lightly over *second* causes, and seek their true origin where only it can be found, in the will of HIM, who of old laid the foundations of the earth, and whose handiwork the firmament displays." Such integration of contemporary science and everyday theology typifies the wide-ranging concerns of American scientific thinking. Newspaper editors in the early nineteenth century might end by pointing to the heavens, but to get there they argued about how electricity would flow through the earth.[56]

The useful anonymity of print culture also prompts us to recognize the possible breadth of scientific participants. Like many writing into newspapers as well as agricultural journals and other kinds of print culture, "J. E." was identified only by initials (other authors went in for fanciful pseudonyms). Such cloaking of identity reminds us that women were among those who contributed earthquake reports and similar natural scientific observations. We cannot trace most such correspondents, so we need to be mindful that though the world of named scientific correspondents was overwhelmingly male, the world of the scientifically

---

from metropolitan centers of intellectual orthodoxy. Delbourgo, *A Most Amazing Scene of Wonders*, 204.

56. "We observed in a former paper . . . " [editorial], *Augusta Herald* (GA), Mar. 5, 1812, CERI Compendium.

curious and active involved anonymous and even furtive women as well.[57]

Even as the role of print culture in the early republic is well remarked, its role in scientific discussion and education has remained underdeveloped. Yet in the late eighteenth and early nineteenth centuries many Americans had the combination of literacy, interest, and relative geographic isolation that made exchange via print a key form of American scientific discussion. By the1880s, partly because of the growth of much more specialized and exacting science disciplines and their attendant specialist presses, newspaper coverage of science was falling off. For historians of the early United States, however, science cannot be a separate and distant topic: It was integrated throughout forms of print culture and discussion.[58]

Many other forms of print culture could be similarly fruitful as sources for the history of science in the early United States. Children's primers, suggests Katherine Pandora, contained rich and often up-to-date scientific content—an insight that also suggests a great deal about women's scientific education. The ever-present gazetteers and travel guides of the expanding early United States contain many references to current scientific ideas. In one 1823 *Gazetteer of the States of Illinois and Missouri; Containing a General View of Each State,* for instance, the author notes that the New Madrid earthquake felt like the shocks of a galvanic battery. The author of this travel guide bases that observation both on exciting,

57. One woman health reformer gained medical knowledge by furtively reading books owned by a fellow boarder and by her older brother (who hid the books when he found out); "Mary Gove Nichols, a Women's Health Reformer, Explains Why She Became a Water-Cure Practitioner, 1849," in *Major Problems in the History of American Medicine and Public Health*, ed. John Harley Warner and Janet A. Tighe (Boston, 2001). A few New Madrid accounts are noted as written by women—for instance, Smith, *An Account of the Earthquakes*, 50. Looking at late-nineteenth-century work, Daniel Goldstein notes that many women conducted correspondence through male relatives: Goldstein, "'Yours for Science,'" esp. 581. Natural scientific discussions and demonstrations as a socially acceptable outlet for scientifically curious women: Delbourgo, *A Most Amazing Scene of Wonders*, 110–15; and Spanagel, *DeWitt Clinton and Amos Eaton*, 72–74.

58. "Introduction," in Sally Gregory Kohlstedt, Michael M. Sokal, and Bruce V. Lewenstein, eds., *The Establishment of Science in America: 150 Years of the American Association for the Advancement of Science* (New Brunswick, NJ, 1999), 35.

new demonstrations of galvanic batteries in the previous decade and on an article published in the *American Journal of Science* in 1821. Later the author cites Daniel Drake, the well-known physician and natural scientific observer based in Cincinnati responsible for some of the early scientific journals of the West.[59]

Correspondence, too, is a rich realm of scientific discussion. In a letter back to his Rhode Island firm, one trader working with Mississippi Valley Indian tribes described the recent earthquakes. He wrote that they had been felt in the "Creek nation of Indians" and that "Near a Place [called] New Maddred on the Mississippi five or Six Hundred miles above this, the Banks of the River with a considerable Quantity of Land adjacent Sunk." It would be easy to pass over this excerpt as a usual report of news that might affect commercial prospects in that part of the Union. Yet in a casual aside, this trader went further. He continued, "Several Boats & Cargoes & Some lives were Lost but its not likely this [land subsidence] caused the Commotion of the Earth—But the Commotion may have caused this." Other unremarked passages in business correspondence might demonstrate similar reasoning about causes and effects of natural phenomena.[60]

What other overlooked forms of print record might usefully reveal scientific theorizing? Family chronicles in places like the household Bible sometimes record meteor showers, eclipses, and other events, in ways

---

59. Lewis C. Beck, *A Gazetteer of the States of Illinois and Missouri . . .* (Albany, NY, 1823). Katherine Pandora, "The Children's Republic of Science in the Antebellum Literature of Samuel Griswold Goodrich and Jacob Abbott," in *National Identity; The Role of Science and Technology*, ed. Carol E. Harrison and Ann Johnson, *Osiris* 24, no. 1 (2009), 75–98. See also Kohlstedt, "Parlors, Primers, and Public Schooling"; Kohlstedt, *Teaching Children Science: Hands-On Nature Study in North America, 1890–1930* (Chicago, 2010); and Kim Tolley, "Science for Ladies, Classics for Gentlemen: A Comparative Analysis of Scientific Subjects in the Curricula of Boys' and Girls' Secondary Schools in the United States, 1794–1850," *History of Education Quarterly* 36, no. 2 (1996), 129–53.

60. M. Terrell, Natchez, LA, to firm of Brown & Ives, Providence, RI, 1812, Brown family business papers, John Carter Brown Library, Brown University, Providence, RI. Scientific content in American correspondence: Valencius, *Lost History,* 175–215. Comparison with elite European correspondents: Martin J. S. Rudwick, *The Great Devonian Controversy: The Shaping of Scientific Knowledge among Gentlemanly Specialists* (Chicago, 1985); and Rudwick, *Bursting the Limits of Time*, 46, 289.

that scholars might profitably investigate to find how ordinary Americans understood or interpreted such events. Even the cheaply published books of regional humor that became popular in the early-nineteenth-century South and West may offer suggestions about how ordinary people regarded phenomena such as earthquakes or lightning, whose startling properties often provided fodder for comic writers and tale-tellers.[61]

The sciences of water, not only hydrology and coastal mapping but also the development of innovative watercraft, offer a related and rich area of investigation. New scholarship on the histories of civil and military engineering, as well as workshop tinkering, is promising: American engineering, in the form of the American system of mass production of interchangeable parts, the cotton gin, and steam-powered ships of war, arguably reshaped much of the world well before the twentieth century. Early American mathematics has a fascinating and largely underdeveloped history. Mathematical tables, for instance, became a staple of American almanacs, which helpfully supplied their readers with tables of anything from distances between places to interest calculations. The introduction of a specifically American currency in the new republic made currency conversion tables virtually ubiquitous in almanacs by 1800. The widespread numeracy of young men who gained employment as surveyors is a significant but underappreciated aspect of American intellectual culture.[62]

61. An earthquake in 1834 provides the basis for a humorous story in Joseph G. Baldwin, *The Flush Times of Alabama and Mississippi: A Series of Sketches* (San Francisco, 1901), 153–76.

62. Pandora, "Popular Science in National and Transnational Perspective," 346–58; in the later nineteenth century, Frehner, *Finding Oil*; Nash, *Inescapable Ecologies*; Nash, "Traveling Technology? American Water Engineers in the Columbia Basin and the Helmand Valley," in *Where Minds and Matters Meet: Technology in California and the West*, ed. Volker Janssen (Berkeley, CA, 2012), 135–58; and Seth Shulman, *The Telephone Gambit: Chasing Alexander Graham Bell's Secret* (New York, 2008). Typical mathematical tables showed dollar conversions for foreign currencies and the comparative exchange value of various federal coins in different U.S. states: Nathanael Low, *An Astronomical Diary, or Almanac . . . 1806* (Boston, 1805); Silvio A. Bedini, *Thinkers and Tinkers: Early American Men of Science* (New York, 1975); Patricia Cline Cohen, *A Calculating People: The Spread of Numeracy in Early America* (Chicago, 1982); Robert Garson, "Counting Money: The US Dollar and American Nationhood, 1781–1820," *Journal of American Studies* 35 (Apr. 2001), 21–46; John R. Van Atta, *Securing the West:*

Many important aspects of scientific thought are insufficiently captured in this emphasis on print culture. The invention, creation, collection, and use of scientific instruments was a crucial part of educational systems in many regions of the early United States (one of William Tecumseh Sherman's first moves as superintendent of a new military school in Louisiana in the 1850s was to purchase "philosophical and chemical apparatus"), and the widespread interest in scientific instrumentation of many kinds deserves even more investigation. Scientific associations, too, were widespread, quarrelsome, and fertile sites for scientific discussion. Similarly, following the printed word fails to reveal what we might call the "tent culture" in knowledge, that is, the connections between scientific demonstration, itinerant lecturers, and religious and political oratory. We hope by mapping certain key aspects of early American scientific work to invite additional inquiry into many more.[63]

Further, exploring the integral connections between the sciences of territory and endeavors such as the racist medicine of early America might offer new insights. Authors like Samuel Morton and Josiah Nott claimed to demonstrate the superiority of European-descended peoples and the inferiority of everyone else—especially those descended from Africans. In beautiful, well-illustrated, painstakingly precise atlases, Morton purported to show the inferior cranial capacity of non-European ethnic groups. Just as early American geological maps were persuasive in part because they were visually striking, these atlases—though poorly grounded and morally poisonous—were compelling to many because of their grace of line and high production value. Both kinds of atlas—of bodies of land and bodies of people—made possible appropriation, whether of Indians' land or of Africans' bodies. Similarly, just as geological consulting work was considered valuable knowledge because it created commercial worth, racist medicine was considered by many

Politics, Public Lands, and the Fate of the Old Republic, 1785–1850 (Baltimore, 2014).

63. William Tecumseh Sherman, *Memoirs of General W. T. Sherman* (New York, 1990), 166. For the phrase "tent culture," the authors thank Joy Harvey. See Valencius, *Lost History*, 175–215; on associations, Drew Gilpin Faust, *A Sacred Circle: The Dilemma of the Intellectual in the Old South, 1840–1860* (Philadelphia, 1986).

Americans to be valuable knowledge because it buttressed chattel slavery. The sciences of territoriality informed understanding of body as well as place, at a time when both could hold highly specific market value.[64]

What emerges from these examples of scientific discussion in early American print culture? First, early American history does feature recognizable scientific figures, such as the indefatigable Benjamin Silliman, who engaged in the kinds of journal creation, elite publication, university-based education, and institution-building that may be easily recognizable on the family tree of history of science. Yet such figures had a far broader reach than we may have anticipated, as their seemingly elite writings were quoted and remixed in a vernacular publishing world in which snippets traveled far from their point of origin. Then, too, people such as Silliman were doing more than we used to recognize, engaging in commercial business consulting that both recognized and propagated scientific concepts. Such researchers engaged with a substantial and diverse audience, through a variety of journals as well as other forms of widely popular media, and their audiences are an important element of the conversation, as ordinary people in many places engaged in experimentation, argued with concepts, and sent off observations. At the same time, concepts traveled through images, as well as words: Through maps and visual representation, ideas about subsurface minerals shaped American territorial claiming. The sciences of territoriality were of tremendous public concern. Ordinary people argued over concepts such as climatic change and the causes of mighty earthquakes. Their discussions were based on broadly dispersed observations from far-ranging locales. The sciences of territoriality in the United States reflect a particular combination of vast geographical expanse and widespread newspapers and common press. What looks familiar to many of us in early American almanacs

64. Samuel George Morton, *Crania Americana; or, A Comparative View of the Skulls of Various Aboriginal Nations of North and South America: To Which Is Prefixed An Essay on the Varieties of the Human Species* (Philadelphia, 1839); Josiah Nott, *Types of Mankind: or, Ethnological researches, Based upon the Ancient Monuments, Paintings, Sculptures, and Crania of Races, and upon Their Natural, Geographical, Philological and Biblical History,* 2nd ed. (Philadelphia, 1854).

as little bits and pieces were in fact pieced together in a patchy quilt of ongoing knowledge about the natural world.

Following texts reveals a broad population of experts—contributing to Silliman's *Journal* might mark one as a man of science in a manner familiar today, but the list of reliable consultants was marked, not by graduate degrees but by names made familiar on the first pages of consultants' reports. Then as now, printed texts and priority also determined hierarchy within these communities, as the Featherstonehaugh–Eaton race to produce a geological map reminds us. However, the broad, decentralized nature of American print production and the absence of clear hierarchies of expertise meant that the boundaries of the community of known authors were porous. Always hungry for material, newspapers and agricultural journals opened paths of authorship to a range of authors, including anonymous correspondents, whose initials and pseudonyms reveal complex networks of credibility and exchange but may mask an unexpected diversity. Copied and pasted into exchange columns, articles from seemingly provincial or local voices could reach a national audience.

Paying attention to multiple genres also shows material connections between natural knowledge-making and other social forms; thus, consulting reports, made with the help of geological maps, were reprinted as articles in the scientific journals. It also shows us that the boundaries of learned readership, like learned authorship, were less confined than we might have assumed. Articles from scientific and agricultural journals appeared in almanacs and were quoted in newspapers, and articles from the scientific press commonly drew on eyewitness reports from local newspapers.

Many long-acknowledged aspects of early American society shaped American science in ways we are only now beginning to understand. The mad rush to claim land, the institution of race-based slavery, and the astoundingly widespread literacy of early American life were not mere accessories to American scientific thinking: They shaped scientific imagination and conclusions. Thinkers focused on geographical and agricultural sciences innovated in form and content. They articulated whole sciences of racial difference, in all their snarled intricacy.

Printed networks, circulating broadly in dispersed networks of knowledge makers, also created new forms. Agricultural authors describing local conditions were one such group. Widespread and accessible media created not just scientific awareness, but scientific participation: the New

Madrid earthquakes could only become a national event with the testimony of many witnesses. The multiplicity and relative accessibility of such sites of information exchange gave witnesses the opportunity to theorize, and the lack of hierarchy gave those theories weight.

Yet as these brief examples suggest, early American science, particularly in its territorial and environmental sciences, served political and economic purposes in the early United States. Much of early American science was directed toward making investments show a good return. Geological theorizing was directed at creating mines or guiding land purchase, platting roads or digging canals; astronomy was intended to time agricultural endeavors or to guide ships to safe harbor. People engaged in science in order to get the most out of their land, or to get the best land. This does not mean that what they did was somehow not science.

Finally, and more generally, these few examples suggest the extent to which modern expected hierarchies of knowledge-making—theoretical over experiential, urban over rural, academic over commercial—were reversed in this period. Making knowledge worth something was a practical matter in early America—and, simultaneously, often an intellectually compelling one as well. Agricultural improvers and traveling businessmen contributed to the systematic exploration and explanation of the natural world, adding to a scientific vocabulary shared by many across diverse and overlapping forms of print communication.

This exploration has not been exhaustive. Rather, we hope it is exhortatory. Early Americans were actively engaged in working with each other on scientific exploration of the world. Our examples offer a beginning to be built upon—much as the practices of natural history in early America were themselves always understood as ongoing, subject to further field work, and enlivened by the give and take of vigorous and excited debate by many across the townships, port cities, plantations, and small farms of early American life.