Anniversaries

Published 200 years ago

ALEXANDRE BRONGNIART'S *MÉMOIRE SUR LES TERRAINS DE SÉDIMENT SUPÉRIEURS CALCARÉO-TRAPPÉENS DU VICENTIN* (1823)

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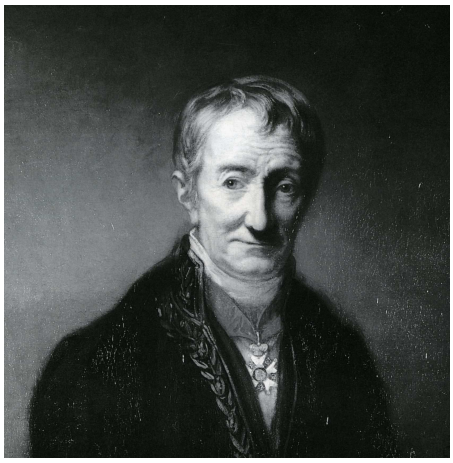

Figure 1. Alexandre Brongniart, portrait by Emile Wattier, 1847. Source: Wikimedia commons.

History is full of steppingstones, large and small, positive and negative. In the geosciences, Alexandre Brongniart's 1823 *Mémoire* on the correlative relations between the Tertiary rocks of the low-lying Paris Basin and the alpine heights of Northern Italy is a significant step in biostratigraphy and the development of earth history. It advanced appreciation of fossils as time markers, while at the same time negating a number of then-prevalent ideas about how the Earth works. It also demonstrated the power of field observations and accumulated facts to lead to noteworthy large-scale theories. So, it deserves a bit of 200-year-old birthday cake.

Significant anniversaries are a pleasure to celebrate. And understanding the roots of a concept is a valuable enterprise. For anyone interested in the evolution of the geosciences, 1823 is a noteworthy year, and Alexandre Brongniart (1770-1847) was a significant contributor. Known for teaming with Georges Cuvier (1769-1832) as they decoded the stratigraphy, structure, and paleontology of the Paris Basin, Brongniart also tied the findings of their epochal work with the geology of Italy and other European countries.

This is not the place to delve into Brongniart's (Figure 1) productive life or recount the range of his contributions. If interested, you might pursue the biographies cited below. Although less celebrated than his illustrious coworker Georges Cuvier several introductory points should be made about his geological visions. As Gohau (1990) commented, Brongniart was a founder of biostratigraphy. He advocated field work, careful observation, and strong classification as keys to recognizing order in nature. Counter to some prevailing thoughts, Brongniart stated that not all mountains and not all crystalline rocks are ancient, mere elevation is not a key to age of rocks, sedimentary rocks originate in different environments of deposition, the age of the Earth is immense, and a worldwide geologic column can be built using biotic succession. While he could not explain the powers that generated mountains, he realized that earth dynamics were immense, commenting that the Alps were but "*wrinkles*"! He also is a good example of a scientist steeped in the "facts first" mentality, with disdain for "hypothetical theories." But he concluded that with adequate insight it was possible to use observations

and facts to generate large-scale theoretical constructs that could contribute to scientific progress (Bork, 2013).

The focus of this celebration is Brongniart's 1823 masterful book on *Mémoire sur les terrains de sédiment supérieurs calcaréo-trappéens du Vicentin, et sur quelques terrains d'Italie, de France, d'Allemagne, etc., qui peuvent se rapporter à la même époque.* (The "sédiment supérieur" refers to our Tertiary.) The book was beautifully illustrated (Figure 2) with drawings of fossils from the Paris Basin intercalated with fossils from the mountains of Italy. One key power of the conceptual insights was to show the value of paleontology as a way to link time over large distances, an early demonstration of correlation of rock units. Two years before the 1823 memoir, Brongniart presented powerful arguments about the power of fossils. As Ellenberger (1994) commented, "*In 1821, largely thanks to Brongniart, the decisive step had been taken: it is the faunas that date the formations, even if the lithologies are different.*" (Throughout this paper, my translations will be in *italics*.) Yet biotic elements changed markedly in small vertical intervals, a clue to evolution through time. Another key power was to demonstrate that strata of similar ages could occupy both a low-lying basin and impressive mountains. (No, there is no claim that a 200-year-old book used plate tectonic mechanisms to explain topography.) Thirdly, the text and illustrations gave readers valuable insights into the potential to generate a coherent picture of earth history. Even today, the power of Brongniart's words and pictures can strike 21st-century readers as impactful. Lastly, a personal note is that my copy of the 1823 tome, gifted to me by petroleum geologist Edgar Wesley Owen, included Brongniart's handwritten dedication *To Mr. Parker Cleaveland, on the part of the author*, and it featured Cleaveland's nameplate on the inner cover. Cleaveland, a professor at Bowdoin College in Maine, corresponded with Brongniart about mineralogy, giving us a potent example of international interchange of ideas by pivotal figures in France and the United States (Bork, 1999).

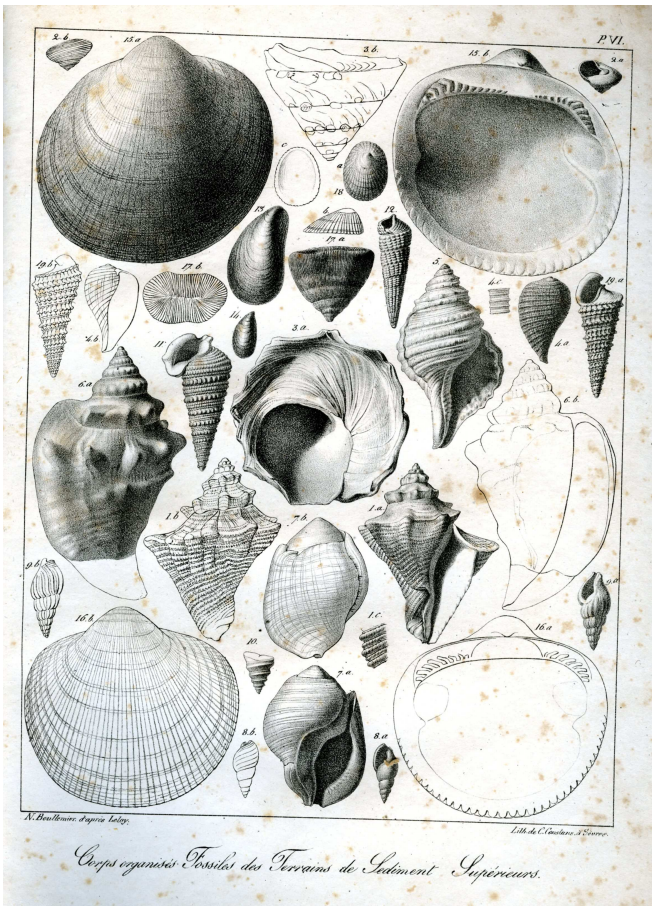

Figure 2. Plate VI, Fossiles des Terrains de Sédiment Supérieurs, in Brongniart, 1823.

Precursor Work

Our focus is on Brongniart's 1823 *Mémoire*, but it is important to at least mention the depth and breadth of his professional contributions. He and Cuvier began working together on the geology of the Paris Basin in the early years of the nineteenth century. Their publications (1808, 1811, 1822) now have the status of classics. A less-known reality is that in 1800 Brongniart was appointed Director of Sèvres porcelain manufacture by Lucien Bonaparte,

Minister of the Interior, and Napoleon's younger brother. That was his "day job" for his adult life (1800–1847). He was gifted in art and in science, he 'saved' French porcelain after the Revolution negatively impacted aristocratic purchases, and later in life published important treatises (1844) on porcelain manufacture. In 1807 his two-volume *Traité élémentaire de minéralogie* was published. It was widely used in the French education system and, as noted above, was a key reference source as Parker Cleaveland created the first major mineralogy text in the United States. Brongniart's ability in mineralogy was rewarded in 1822 with receipt of the Chair in Mineralogy at the *Muséum d'histoire naturelle* in Paris.

Travel was an enriching aspect of Brongniart's life, beginning in 1790, at age 20, with a trip to England, repeated in 1802, during the Peace of Amiens. Service in the French military paid double dividends as Alexandre spent 1793–1794 in the Pyrenees, escaping The Terror of the post-Revolutionary era and learning more about natural history. He and Déodat Dolomieu (1750–1801) traveled into the Alps in 1795. The volcanic region of Auvergne was visited in 1808, and Normandy in 1811. In due course he traveled in Norway, Sweden, Germany, and Bohemia.

In sum, Brongniart was in a position to use his backgrounds, travels, and variety of professional publications as he undertook preparing his 1823 classic volume.

The 1823 Book

Brongniart began by citing facts and observations, as was the mode during the era of "Positive Geology" (1810–1840, per Ellenberger, 1994). Observations and detailed descriptions are the key first steps in advancing science, he affirmed, whether speaking of minerals or strata. He then submitted "reflections" which he felt were relevant to the alpine area of Northern Italy which was little-known at the time. An initial assertion was that the beds were related to the Tertiary strata of the Paris Basin. The same fossil genera (beautifully illustrated in striking plates) were found in France and Italy. He then asserted that many countries have rocks assignable to "sédiment supérieurs" (Tertiary), as demonstrated by the similarity of their contained fossils – even if elevations and specific lithologies differed, or when the Italian rocks were "troubled" (folded and faulted). (Figure 3) Furthermore, the sedimentary units were often intercalated with volcanic rocks, countering the view of Werner. The sweep of his vision is visible in follow-up comments about the scale of the planet's geology. "*THUS, we should not be astonished by finding Tertiary strata on the top of the Alps -- mountains are, after all, just wrinkles on the Earth's surface*." And, while admitting the majesty of mountains, it takes "*proportionally little effort in the bosom of the Earth to raise the Alps.*" The cause of all that power was a mystery in 1823, but the jump from dry facts to mega-conclusions was a clue to Brongniart's ability to illuminate and utilize 'facts' while taking theoretical leaps.

The trip and field work done in Northern Italy were undertaken in 1820, accompanied by his son Adolphe-Théodore (1801–1876), who became a renowned botanist and a founder of paleobotany. It was gratifying to Alexandre Brongniart that William Buckland (1784–1856) concurred with his conclusions about the Tertiary origins of the beds in Paris and northern Italy. Thomas Webster (1814) applauded the Paris Basin work, stating, "*Among the geological researches which have lately been made in various parts of the globe, none have been more interesting than those of MM Cuvier and Brongniart in the environs of Paris."* Cuvier and Brongniart had demonstrated (1822) that marine beds in the Paris Basin were separated by gypsum deposits of lacustrine nature. That simple observation carried significant theoretical weight at the time because it firmly negated the Wernerian vision of a monotonic retreat of a universal sea from the land. The famous Monte Bolca strata, near Verona, Italy, were also

Tertiary but had spectacular fish fossils that did not occur in the Parisian units. Nor were the trap rocks (basalts) frequently found in Italian Tertiary strata exposed in the Paris Basin. The willingness to provide observations, even when they did not have an overarching explanation characterized Brongniart's writing. Observed facts could, in time, lead to meaningful insights: "*It may be useless to publish conjecture in physics, chemistry, etc., where one can do an experiment, but it is valuable to publish conjecture in geology because it aids the advance of the science as contemporaries try to verify it."* (Brongniart, 1827)

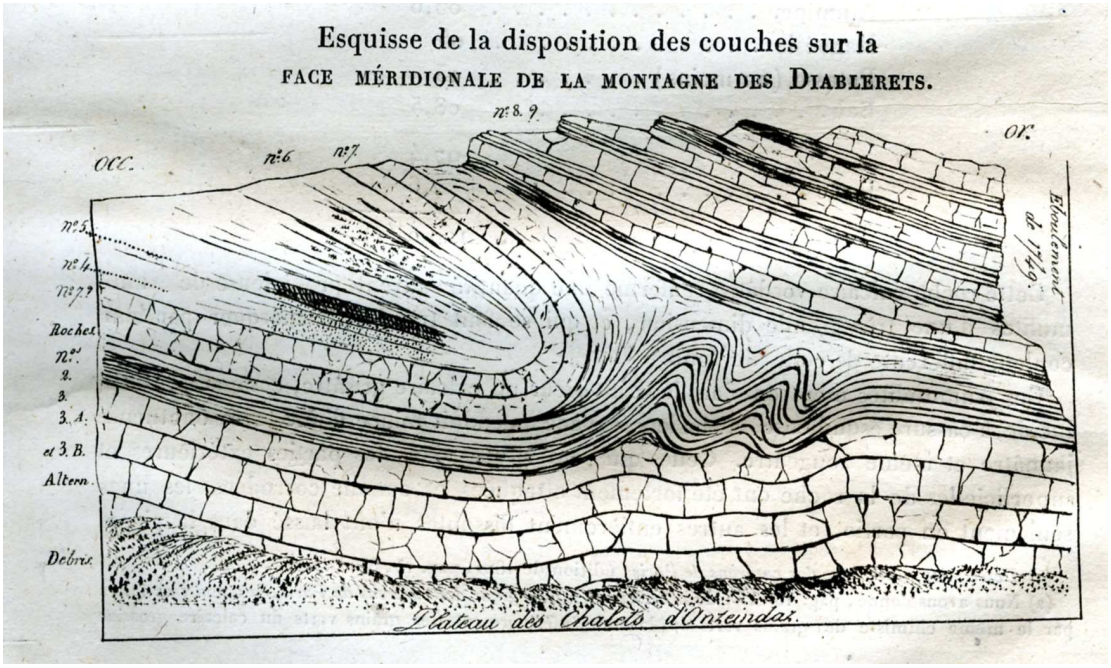

Figure 3. Sketch of folded beds in the Diablerets area. (Brongniart 1823, p. 47)

Concluding the First Part of the book, Brongniart made the potent point that, "*These observations serve as a new, very remarkable, application of this geological rule, that vertical distances, however small they are, generate great differences, while horizontal distances cause almost none*." The stage was thus being set for recognizing the power of horizontal correlation of beds having identical fossil species, while drawing attention to morphological changes in a small vertical (short temporal) sense. Such observations and facts were being presented prior to Darwin's theory of evolution.

In the Second Part of the 1823 memoir, Brongniart considered strata from Turin, Mayence (Mainz, in the Rhineland-Palatinate of Germany), the Pyrenees, the Alps and other areas containing rocks correlated to the Paris Basin. A repeated note is that the fossils and often the lithologies were the same even though the elevations of the low-lying Paris Basin and the mountains of Italy were markedly different, with peaks on occasion reaching 10,000 feet. The awareness that Tertiary rocks, including ophiolites and presumably 'ancient' metamorphic rocks, were commonly found on mountain tops destroyed the concept of Werner and others that all mountains were ancient ("Primitive"). A structural diagram highlighted the similar nature of the Tertiary beds, while documenting their contrasts in elevation. He noted that the lack of ammonites and belemnites indicated that Cretaceous rocks were not being discussed. Cautious, as always, Brongniart admitted that he had not actually been in every place mentioned, but "*such is now the confidence that one can have in the rules of geology deduced from the nature of fossils (corps organisés) that even if I haven't been on site...it suffices to*

have numerous specimens given to me recognized with great probability to which formation they belong."

Concluding the second part of the book, Brongniart stressed that, "*Even though the rocks of the Alps are at a great elevation, their incorporated biota indicates that they are identical to the lower beds of the calcaire grossier around Paris*." Observation and field work really could lead geoscientists to fundamental theoretical conclusions.

CONCLUSIONS

Brongniart's 1823 *Mémoire* expanded on the important work of Cuvier and Brongniart in the Paris Basin in the early years of the 19th century. It illustrated the power of fossils and biostratigraphy to relate geographically separated areas, and to decode earth history. By using careful observations and adhering to a "facts first" methodology, Brongniart was able to build potent "theories" that greatly aided the evolution of the geosciences. His steppingstones made a pathway to the future.

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