The neglected early history of Geology: The Copernican Revolution as a major advance in understanding the Earth

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We thank Alessandro Iannace (2011) for his very interesting and thought-provoking comments on our suggestion that geologists might trace the origin of geology back to the Copernican Revolution (Alvarez and Leitão, 2010). Iannace’s concern is that we were forcing geology into the mold of physics, and were ignoring the fact that geology is a historical science with a quite distinct epistemology from physics. This was certainly not our intention, for we completely agree with Iannace on the distinction between historical sciences like geology and ahistorical sciences like physics. However, as discussed below, the science of geology also contains non-historical aspects that deal with configuration and process, and a balanced understanding of our science requires considering all aspects.

So the question appears to be this: Given that geology is a historical science, should the Copernican Revolution be excluded from the history of geology because it did not deal with history, or should it be included because it profoundly transformed the conception of the Earth?

In that transformation, Earth came to be considered a planet. This is a simple phrase but the concepts behind it are complex. It means that the old Aristotelian framework was rejected, that the fundamental distinction between an earthly realm and a terrestrial realm was abandoned, and that Earth and the moving planetary lights in the sky were seen to be equivalent. The Copernican changes of the 17th century had repercussions beyond the fields of physics and astronomy, and made possible the subsequent rise of geology.

The reading of Earth history from rocks came later, beginning with Steno in the 1660s as Iannace stresses, and we agree that this marked the beginning of geology as a historical science. We further note that Steno not only provided the tools for reading Earth history, by formulating the laws of stratigraphy, but that using those tools, he worked out a very creditable geologic history of Tuscany, limited only by his lack of methods for dating rocks (Rodolico, 1971; Alvarez, 2009, p. 74–82).

Steno is widely accepted as the founder of geology as a historical science. Could we also accept the Copernican Revolution as marking the beginning of modern (i.e., post-Greco-Roman) geology in a broader sense?

This is, to some extent, a matter of emphasis and taste. Iannace argues that “a new science cannot be characterized merely by the object of its research, Earth in this case, but requires in addition the utterly original epistemological foundation of its approach to the object itself—an approach that can be summarized in the use of history as the main tool for the investigation of the planet.” While that is a defensible position, it seems to us that an equally defensible, alternative view is that geology is indeed characterized by its object of study, Earth. We suggest that geology had to become a historical science, and the first one, simply because it focused on the historically complex Earth.

Going beyond these reasonable alternative positions, let us raise two additional arguments for accepting the ahistorical Copernican Revolution as part of the history of geology. Our first additional argument is that although geology includes much emphasis on Earth history, other aspects of geology are not primarily historical. In a paper cited by Iannace, Frodeman (1995, note 20), while stressing the historical character of geology, clearly makes this point: “I do not mean to deny the fact that there is another aspect of geological research that emphasizes laws and processes (i.e., physical geology).”

A third focus of geology might be called “configuration”—the study of the geometrical arrangement of parts of Earth. For example, some geologists quantify the shape of Earth’s surface using tools like airborne laser mapping and digital elevation models, or map the sea floor with echo sounding and satellite geodesy. Geophysicists use seismic tomography to map the configuration of layers and seismic-velocity structures within Earth.

Even in the most obviously historical branches of geology, like stratigraphy, geologists begin by determining the configuration of the rocks—measuring sections, studying contacts and faults, and describing rock compositions and textures. It is this geometrical study, combined with what we have learned about the significance of such features as sedimentary structures, that allows us to interpret the history recorded in rocks. We do not usually make a major distinction between configurational, process, and historical geology. Surely, we do not believe that we are being geologists when we make historical interpretations of outcrops, but something else—not geologists—when we measure and describe stratigraphic sections.

The Copernican Revolution focused on configuration—with the Sun at the center of the solar system, with no need for planetary epicycles, and with the Moon, but nothing else, orbiting Earth. And it focused on process—‘all the planets orbiting the Sun, with the gravitational mechanism finally being understood by Newton. As with our modern studies of outcrops and stratigraphic sections, the historical interpretation could not come until later. But we now understand the history of the solar system in a general way, and the history of Earth itself in considerable detail.

Our second additional argument has to do with the need for geologists to interpret the complex evidence we uncover—a task generally avoided in the controlled experiments of physicists. The interpretation of evidence is studied by the philosophical field of hermeneutics, mentioned by Iannace and summarized by Frodeman (1995), who stressed, even in his title, that geology is “an interpretive and historical science.” The role of interpretation in geology is also emphasized by Baker (1999).

The Copernican Revolution involved perhaps the greatest re-interpretation of the Earth imaginable. Before the Revolution, Earth was considered by western scholars to lie at the bottom of the cosmos, forming the “cesspool where all filth and corruption fell and accumulated” (Alvarez and Leitão, 2010, p. 233). After the Revolution, it was understood to be one of the planets, ennobled and perfected, in the words of Galileo (Alvarez and Leitão, 2010). We therefore continue to suggest that geologists could recognize the Copernican Revolution as part of the history of geology without in any way denying the character of geology as a historical science.

REFERENCES CITED