

Editorial

Discussion on “the Incompleteness Fallacy: The Stratigraphic Record Is Not an Imperfect Archive of Earth’s History” (Hessler, 2023)

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The Incompleteness Fallacy: The stratigraphic record is not an imperfect archive of Earth’s history (Hessler, 2023): Discussion

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The title of Hessler’s commentary (Hessler, 2023) asserts that “the stratigraphic record is not an imperfect archive of Earth’s history”, but she argues that there exists an “incompleteness fallacy” about the record because of our incorrect assumptions and expectations.

The stratigraphic records cannot speak for itself, but human descriptions make it sound hopelessly scratched: incomplete, imperfect, shredded, full of holes, and even unfaithful.

To see nature as imperfect, we must have an expectation for how nature should behave, and we are disappointed. Objectively, though, nature cannot be flawed. Stratigraphy is not missing anything. It simply exists as the collective product of earth processes across time and geography. What *is* imperfect is our expectation for a perfect stratigraphic record, and whatever we mean by that.

When we say that the geologic record is lacking, we set up a false dilemma around how we would like the record to be.

We see experiments and models as more rigorous than observations from ‘incomplete’ sections. We present a neat, controlled view of the world that is not true.

Where science has progressed it is because, since the scientific method was first enunciated by Francis Bacon in the 1620s, its study has been based on empirical observation and rigorous hypothesis testing, not concerns about the “unfaithfulness” or “imperfection” of the data. Such value judgments play no part of objective science practice.

Models have certainly gotten us into trouble, when they have outrun the data or are based on flawed observation. Geology in general, and stratigraphy in particular, has succeeded over the years by making “careful, systematic observations necessary to produce quality facts” (the summation of Bacon’s methods, as provided by Google), and then analyzing these facts objectively in the light of ever more so-

phisticated hypotheses based on a gradually improved understanding of how the Earth works. (Miall, 2013, 2022). This is inductive, observational science, followed by hypothesis creation and testing — the “hermeneutic circle” in other words, as I helped to write some time ago with reference to a major controversy around sequence stratigraphy (Miall and Miall, 2001).

Hessler provides a paragraph that succinctly sets out the basis of modern stratigraphic observation and data collection, and then argues that the stratigraphic record is not flawed, contradicting her earlier argument that geology is messy, and then explains this by suggesting that it is our experiments and theories that are mostly flawed.

We can only get closer to some kind of accuracy by looking at what the stratigraphic record for what it is, not want we want it to be.

This is, of course, the basis of geological field work: making careful observations and then trying to interpret them in their field context. I would suggest that “stratigraphic incompleteness” is real, and has, in fact, bedeviled the science of stratigraphy ever since we tried to quantify it. Incompleteness is a fact, but it is measurable, quantifiable, and explainable. It has now been largely explained on the basis of multiple geological processes, an approach that opens the door to some remarkably sophisticated interpretations of the sedimentary record in deep time. I would argue that I, and several other researchers have, in recent years, made fundamental advances towards a more complete understanding of what is, unquestionably, a fragmentary and incomplete stratigraphic record. This was done by trying to understand the true nature of the incompleteness, first by documenting it carefully, and then by proposing interpretations based on our current knowledge of geological processes of sedimentation and accumulation. (Miall, 2015, 2016; Bhattacharya et al., 2019; Holbrook and Miall, 2020; Miall et al., 2021).

Another remarkable body of work on how stratigraphy is generated has been carried out by Chris Paola and his research group, working with his sophisticated Experimental Earth Surface Dynamics Project. Scaled physical models of delta formation, sequence generation, and other major stratigraphic processes, have provided significant insights

into the generation of the stratigraphic record that explain both active deposition and its absence through time (Paola, et al., 2001, 2009, 2018). The science has also benefited significantly from the numerical modeling of Peter Burges and his colleagues (e.g., Burgess, 2016; Bradford et al., 2022). These are just a few of the examples of the modern objective scientific work under way to explore and understand the stratigraphic record.

To conclude, there is no “incompleteness fallacy”. It is a concept that ignores the hard, practical science that is actually being done.

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REPLY: Miall, A., 2024. The incompleteness fallacy: the stratigraphic record is not an imperfect archive of Earth’s history (Hessler, 2023): Discussion

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Incompleteness is not a fact. Erosion and nondeposition are facts. *Incompleteness* and *completeness* are just words and using them is a choice.

The original editorial (Hessler, 2023) was about language. Not only words and their use, but also the attitudes behind the language choices we make, and where that leads us.

One objective of doing “hard, practical science” (Miall, 2024) is to communicate using direct, logical language. In the case of the stratigraphic record, incompleteness is a poor choice of words. Incompleteness labels anything less than constant deposition a deficiency. At the same time, inconstant deposition is an essential feature of natural systems. Inconstant deposition cannot be at once essential and a deficiency.

Completeness is an equally incoherent measure of stratigraphic interdependencies. It states a preference for growth in one process (clastic deposition) over other processes (e.g., erosion, nondeposition), despite the fact that deposition in one place and time requires erosion and nondeposition in another. It disregards chemical processes. Completeness reduces a working system to a one-dimensional fantasy.

Science is more than a collection of individual, empirical observations. Science explores new ways of thinking as part of a system, except that system is not value-free: language, power, and priorities have been its driving forces for centuries.

Writing in Latin and English, from his positions as legal counsel to Elizabeth I and Lord Chancellor to James I, Francis Bacon’s views on nature and science reinforced the resource-control mindset that was developing in England at the time: where elite laboratories would let “the human race [to] recover that right over nature which belongs to it by divine request” (Bacon, *Novum Organum*, Bk. 1, Aphorism 129; trans. Spedding et al., eds. *Works*, 1875). Bacon’s language about nature was spectacularly metaphorical, gendered, and patronizing:

She [Nature] is either free and follows her own course of development as in the heavens, in the animal and vegetable creation, and in the general array of the universe; or she is driven out of her ordinary course by the perverseness, insolence, and forwardness of matter and violence of impediments, as in the case of monsters; or lastly, she is put in constraint, molded, and made as it were new by art and the hand of man; as in things artificial. (Bacon, *De*

Augmentis Scientiarum, Bk. 2, Ch. 2; trans. Spedding et al., eds *Works*, 1875)

Bacon was writing four hundred years ago, as a lawyer in his particular time and country. But in light of modern perceptions of Bacon as a father of the “scientific method,” it is reasonable to question, based on his rhetoric and social position, the priorities behind his narrow (Cleland, 2001) vision for science, and whether those influence us today. In fact, there was a straight line between Bacon’s metaphors and his scientific ideal—dominion over nature via the controlled experiment—where nature’s disorder would be made orderly (i.e., useful to England) by the “hand of man” in a laboratory (Merchant, 2008).

The way scientists talk about nature reflects our mindset toward it, shapes how we study it, and influences how societies see and use our work. As explained in Hessler (2023) and reiterated here, words like *incomplete* or *imperfect* do not objectively or usefully describe the stratigraphic record, but they appear in our manuscripts, proposals, and lectures as a way to say *there is something wrong with how nature works*. For a language choice in a “hard” science, this seems counterproductive, labeling what can be observed in natural settings, e.g., the data we need for realistic models and experiments, as not good enough. However, as Bacon’s legacy shows, the logic behind the fallacy is power and persuasion, and we should be alert to how our language might be driving our observations (and priorities) into artificial corners, and further from the natural environment.

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