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Research paper

The possible source of the causal time arrow in geo-historical explanations

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ABSTRACT

My argument in this article, will be that nature, in general, and human nature in particular, suggests that, in principle, it is possible to derive the causal time arrow from several physical time arrows existing in nature and appearing to be unidirectional and irreversible phenomena. A more concrete argument will be that the assumption of a causal time arrow to which geologists resort in all geo-historical explanations, apparently originates in geo-historical time arrows concealed in unidirectional and irreversible physical-geological processes. I will illustrate this claim with a few examples of geo-historical explanations in the theory of plate tectonics, most of which are based on irreversible geo-physical processes. My final argument is a broader, of an epistemological nature, according to which the causal time arrow assumption used in logical-causative explanations in everyday life and in science, apparently “derives” in a way from the geo-historical time arrow. I will base this argument on the causal relationship and mutual influence that occurs in nature between geo-historical and evolutionary processes in animals, including developmental processes of the human brain and mind. From this reductionist argument, nicely integrated in the framework of evolutionary epistemology (EEM), it is possible to derive a wider naturalistic argument according to which, on principle, the laws of geo-historical physics can be reduced to the laws of logic and causality.

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1. Introduction

The question of ‘what is time?’ has preoccupied and troubled many philosophers from time immemorial. Even today, many are concerned with this question, and, in fact, the puzzle of time remains unresolved. Therefore, instead of dealing with the question of whether time really exists or is just a figment of our thoughts, I will deal mainly with its basic and common-sense property, that differentiates between past and future - the asymmetric property, or in the metaphorical description, the time arrow - the unidirectional and irreversible geo-historical time arrow, based mainly on the laws of physics and geology. To achieve this goal, I will focus on the actualist logic, at the basis of geo-historical explanations that enables geologists to reconstruct the geological past of the Earth. First, I will argue that this logic, among other things, is based on the fundamental metaphysical principle according to which the cause

always precedes the effect in time. Furthermore, this claim can be based on the geo-historical time arrow that empirically reflects geo-physical processes temporally irreversible. I can support this argument by several examples. Finally, I will argue a causal relation in a biological-physical sense between the geo-historical time arrow and the biological time arrow. In the last part of the article I will attempt to present an argument based on the Darwinian view of nature, that supports the central argument of this paper, concerning the possibility of reducing the geo-historical time arrow which is physical in essence, to the causal time arrow, that constitutes the solid base for any scientific and nonscientific explanation. From this reductionist argument, which is well integrated into the framework of evolutionary epistemology (EEM), we can derive a wider naturalistic argument claiming that, on principle, it is possible to reduce the geo-historical laws of physics to the laws of logic and causality.

2. The logical-causal argument structure in geo-historical explanations

One of the major challenges of modern science that is based on an empirical approach, is to explain the significance of allegations

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relating to the past. The verification process based on traces of the past is no more than our interpretation. The actualist approach in modern geology¹ supposedly solves the problem by claiming that geological past events on Earth have current and future effects, and those can be verified directly by the geologist. The current actualist method assumes that on the basis of observations of geological phenomena that occur in the present, we can reconstruct and explain the geological past of the Earth in an analogical way (or with the help of analogies). In this sense, the geo-historian thinks back (towards the past) and thus, supposedly, artificially inverts the time direction of the geo-historical processes that occur in nature. *What could justify the use of analogical explanations to reconstruct the geological past of the Earth from observations of geological events taking place in the present and from traces left by the geological past?*

The analogical inferences are not applicable to conclusions that arise from assumptions on the basis of logical necessity, but are regarded as the most probable or the least probable. In geo-historical explanations, high probability is achieved thanks to the uniformity principle² assumed by geologists, which conceals the fundamental generalization about causality that claims that the causal relationship between geological causes and outcomes does not change significantly over time, and therefore, we may assume that the same causes lead to the same outcomes³. Specifically, in order to produce an analogy between two entities is to start, by pointing out one or more attributes and revealing the similarity between them. An analogical inference is based on similarity of two or more things, and projecting this similarity on some other aspect of these things. In other words, an analogy is produced through the observance of common features between certain things and the conclusion that another similar feature can also be found in them. Such simple inductive inferences accompany our daily thinking regularly and without them we could not survive.

In a rather simple way, the pattern of arguments (inferences) by analogy can be described as follows⁴:

Premise A – thing A contains features 1, 2, 3,

Premise B – thing B contains features 1, 2, 3,

Premise C – it is found that thing A also contains feature 7.

Conclusion – therefore thing B also contains feature 7.

Since in geology we deal, among other things, with processes and geological phenomena that occurred a long time ago, the analogical inferences play a large role in our profession, and their level of complexity exceeds even that of most natural sciences⁵ that are not concerned with “deep time”⁶. In geo-historical explanations, in addition to the similarity between the features of geological phenomena and events, geologists are also looking for similarities between causal laws that generally comprise an explanation of the mechanism operating in the geological process. In this sense, they assume that the causal mechanism that produces the geological phenomena, does not change significantly (the

uniformity principle) and, therefore, the relationship between cause and outcome in two similar geological phenomena does not change over time⁷. Such a causal law permits the actualist to argue legitimately that, on the basis of observations of outcomes and process in the present, the geologist is able to reconstruct the past. Thus, actualism assumes that outcomes can explain or prove the causes just as causes can explain and prove the outcomes. *How can we justify this claim? Or how can we justify that the causes originated from the outcomes?* Like in the “chicken and egg” paradox, there’s a certain kind of circularity – causes explain the outcome and outcomes explain the causes⁸. However, we must keep in mind that contrary to the causes to which geologists mostly have no direct access, outcomes possess certainty and this accounts for their importance in geo-historical explanations. Typically, geologists are able to identify outcomes in the present quite clearly, but they do not have direct access to the past so the causes remain speculative. Geologists try to derive the causes from the outcomes, because empirically the outcomes are accessible and in this sense they are the most certain thing they have. This is similar to the scientific method presented by Descartes in his famous book “A Discourse on the Method” (Kenaz, 2010, p. 40–50, 90–107), since in the science of geology, causes cannot prove outcomes, but only explain and clarify them. The role of the causes is to explain or clarify the outcomes and the role of the outcomes is to test, validate, support and confirm the causes. Therefore, in order to explain causes, geologists assume them by a process of selecting the best hypothesis, which is sometimes called IBE – inference to the best explanation⁹. In this sense, an unproven, logically invalid “jump” of hypotheses (causes) emanating from facts (outcomes). In fact a recognized problem or question arises here¹⁰: *how can we prove the hypothesis which explains observations solely on the basis of outcome which are singular observation?* In practice, in order to circumvent the difficulty and enable practical geological work to proceed, the actualists construct the past by building a theoretical conceptual system (uniformity principle) connecting the facts to the causes¹¹. With the

⁷ For a more in-depth discussion about the methodologies of geo-historical inferences and planetary sciences inferences, see: Peirce (1867, 1883), Chamberlin (1890, 1904, 1897), Gilbert (1896), Engelhard and Zimmermann (1988) and Baker (2014). However, it must be remembered that analogical inferences are nothing more than inductive inferences, and in this sense they are not logically valid in a deductive sense.

⁸ The circularity of causality was already known to skeptical philosophers in ancient Greek. About this circularity see for example: Barnes (1990, p. 58–89).

⁹ About this process, see e.g., Peirce (1867, 1883), Chamberlin (1890, 1904, 1897), Gilbert (1896), Kitts (1977), Baker (2014), Kravitz (2012, 2013) and Cleland (2013). It should be emphasized that what I say here is not unique to just geology. In all scientific observations we can observe the outcome, but the cause is always a best hypothesis which we can test. The big difference is that in geology it is difficult to replicate the conditions needed to test that causal hypothesis and moreover geologists tend to eliminate multiple hypotheses when working in the field, at least according to the classic works on the philosophy of geology.

¹⁰ Here I am referring to the famous problem of induction raised by David Hume. About this issue, see: Bonjour (2009, p. 47–69), Feldman (2003, p. 130–141).

¹¹ Using the uniformity principle geologists, in fact, are trying to turn the conditional sentences “if C occurred then E occurred” to an essential conditional sentence that event C is an essential condition for event E. In other words, they try to make the pattern of the sentence to patterns of the form “Event E occurred only if event C occurred” or “If event C and only event C occurred then event E occurred.” In these sentences if event C occurred then necessarily event E occurred but the converse case does not necessarily exist (in normal conditional sentences the first section is a sufficient condition for the final section and the final section is a necessary condition for the first section). For further details, see: Kravitz (2013, p. 29–32). I will hereby clarify some of the concepts, such as “sufficient condition” and “obligatory condition.” Sufficient Condition – Event H is a sufficient condition for the occurrence of event I only, and only if when event H occurs, event I too occurs, i.e., it is enough that H occurs for I to occur. Obligatory Condition – Event H is an obligatory condition for the occurrence of event I, only, and only if without the occurrence of event H, event I cannot occur, i.e., if H does not occur, I too cannot occur.

¹ For a more in-depth discussion regarding the historical development of this approach, see Romano (2015).

² For a more in-depth discussion regarding the historical development of this principle, see Romano (2015).

³ It is crucial to note here that the uniformity principle is applied in order to provide logical necessity for inferences to the past. However, this need to have logical necessity in explanation is an issue for the rational reconstructions made by philosophers. In practice working geologists are far more interested in the fruitfulness of their proposed explanations (hypotheses) than in their logical necessity.

⁴ It should be noted that is not exactly how geologists use analogy in practice. In practice the use of analogy combines the inductive premises illustrated with an abductive inference that forms a causal hypothesis. For more details about this inference, see Kravitz (2013).

⁵ Concerning the methodological and epistemic differences between historical science and experimental science, see Cleland (2002).

⁶ About the role of analogical reasoning in geology, see Baker (2014).

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