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Realism on the rocks: Novel success and James Hutton's theory of the earth

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ABSTRACT

In this paper, I introduce a new historical case study into the scientific realism debate. During the late-eighteenth century, the Scottish natural philosopher James Hutton made two important successful novel predictions. The first concerned granitic veins intruding from granite masses into strata. The second concerned what geologists now term "angular unconformities": older sections of strata overlain by younger sections, the two resting at different angles, the former typically more inclined than the latter. These predictions, I argue, are potentially problematic for selective scientific realism in that constituents of Hutton's theory that would not be considered even approximately true today played various roles in generating them. The aim here is not to provide a full philosophical analysis but to introduce the case into the debate by detailing the history and showing why, at least *prima facie*, it presents a problem for selective realism. First, I explicate Hutton's theory. I then give an account of Hutton's predictions and their confirmations. Next, I explain why these predictions are relevant to the realism debate. Finally, I consider which constituents of Hutton's theory are, according to current beliefs, true (or approximately true), which are not (even approximately) true, and which were responsible for these successes.

1. Introduction

Perhaps the best known, most widely discussed argument for scientific realism is the "explanationist", "abductive", or "no-miracles" argument. According to this argument, the best – indeed, many would argue, the only – explanation for the empirical success of our best scientific theories is that they are true, or at least approximately true. If they are not, then this success would be some kind of "miracle" or "cosmic coincidence" (Maxwell, 1962, p. 18; Smart, 1963, p. 39; Putnam, 1975, p. 73; Brown, 1982; Boyd, 1989, pp. 7–9). An equally well known and extensively debated counterargument is that the history of science is replete with theories which, in their day, were highly successful, but which have turned out *not* to be (even approximately) true (Hesse, 1976, p. 264; Laudan, 1981).

This challenge from the history of science has undermined quite significantly the above inference from success to truth, forcing realists to modify their position in various ways. One strategy is to focus mainly on *novel predictive* success, since this is thought to provide greater warrant for realist commitment than other kinds of success (Musgrave, 1988; Lipton, 1990; Leplin, 1997, pp. 34–135). Another widely adopted modification is to restrict that commitment to only those parts of theories that are/were "responsible for" their success. These, the realist argues, the "working" or "essentially contributing" parts, are (approximately) true. But the parts that are/were *not* responsible, that are/were merely "idle" or "presuppositional", are not supported by the theory's success. There is no reason to believe that *they* are (approximately) true.

This view has been variously termed "*divide et impera* realism", "deployment realism", "selective realism" etc. – for present purposes I shall adopt the latter term. Versions of the position were first developed by Worrall (1989), Kitcher (1993, pp. 140–9), and Psillos (1994; 1999, pp. 96–139). More recent variations have been proposed by, among others, Harker (2013), Vickers (2013), and Peters (2014). The selective realist's version of the explanationist argument, then, is that the best – or only – explanation for the *novel predictive* success of our best scientific theories is that *those constituents of the theories that are responsible for the successful novel predictions* are (at least approximately) true. Just what kinds of constituents are responsible for such predictions, and precisely what this responsibility consists in, are very much open questions and subject to ongoing debate.

Following Vickers (2013, p. 190), Harker (2013, p. 98), and others (e.g., Psillos, 1999, pp. 105–6; Lyons, 2002, p. 70; Carrier, 2004, p. 148), I contend that the best way to assess selective realism is to

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look to the history of science for theories which are no longer considered (approximately) true but which were used to make successful novel predictions. We should examine these theories and their successes individually to determine whether the selective realist's strategy works in each case. To do this, we divide the theory in question into its various constituents. We then (a) consider which of these constituents are and are not, according to current theories,[1] (approximately) true, and (b) determine which constituents were responsible for the theory's success. If the responsible constituents are (approximately) true, then the case will lend support to selective realism. If, on the other hand, the responsible constituents are not (approximately) true, then the case will appear to constitute a "counterexample" to selective realism, rendering the position less plausible.

In this paper, I present a historical case which appears, at least *prima facie*, to constitute such a counterexample. During the late-eighteenth century, the Scottish natural philosopher James Hutton made two important successful novel predictions concerning the existence and characteristics of certain geological phenomena, namely, granitic veins and angular unconformities. Hutton made these predictions on the basis of a theory which, taken in its entirety, would not be regarded as (even approximately) true today. And constituents of Hutton's theory which by present lights are not (even approximately) true appear to have played important roles in his predictions.

The case is potentially very significant. As Saatsi (2012, p. 330) notes, more historical case studies from the special sciences are sorely needed in the realism debate. And although several cases from chemistry and the life sciences have been introduced, there are currently no serious cases from the history of geology being discussed in the literature. Introducing such a case is important, since we want to ensure that different formulations of realism apply equally well to different scientific disciplines, or at the very least we want to know whether we need different realisms for different sciences. To date, little has been said about geology in relation to realism at all. In his famous list of false-but-successful theories, Laudan (1981, pp. 121–2) includes "catastrophist geology". However, it is generally agreed that success in this case was not sufficiently novel to be pertinent to the debate. Elsewhere, Laudan (1984, p. 123) mentions the success that pre-1960s geology enjoyed despite its erroneous commitment to stable continents as a counterexample to realism. Against this, Kitcher (1993, p. 142) argues that the success of pre-1960s geology came in areas where the movement of continents was irrelevant, and that, therefore, the case is unproblematic and in fact supports a selective version of realism. This paper presents a challenge to Kitcher in that the movement of continents in the case of angular unconformities very plausibly *is* relevant.

The paper is divided into four main sections. First, I explicate Hutton's theory of the earth. I then give an account of Hutton's predictions and their confirmation. Following this, I explain why these predictions are relevant to the realism debate. Finally, I consider which constituents of Hutton's theory are and are not (approximately) true, which constituents were responsible for the theory's success, and how the realist might respond to the case.

1.1. Hutton's theory, its formulation, and its constituents

According to Hutton's theory, the earth was divinely contrived for the sole purpose of providing a habitable world. A deist, Hutton believed that God designed the earth such that it would serve its purpose without any further intervention on His part. To this end, he thought, it was designed in a way analogous to an organic body in that it possesses a "reproductive" mechanism which enables it to maintain its purpose. In this system, matter is constantly eroded, washed into the sea, and deposited on the ocean floor. Sediments are then fused and consolidated by heat from subterraneous molten matter and pressure from superincumbent sediment. Periodically, the hot, molten region becomes volatilised, causing it to expand, thereby elevating the strata to form new continents. These continents are then eroded, deposited, consolidated, and elevated to form yet more continents. The process is repeated indefinitely (see Hutton, 1785; 1788; 1795a; 1795b; 1899).

To better elucidate the roles they played in its success, it will be helpful to reconstruct the particular line of reasoning that led Hutton to formulate the various constituents of his theory. Like many Enlightenment thinkers, Hutton was greatly impressed by final causes. That of the earth, he believed, is evidently to provide a habitable world. Its motion, gravitational attraction to the sun, diurnal rotation, proportions of land, sea, and air, for example, are clearly calculated for the purpose of supporting life. That "the necessaries of life" exist in such perfect measure, he emphasised further, attests to the infinite wisdom and beneficence of its Creator (Hutton, 1788, pp. 209–14, 216–7–quotation from p. 213; 1795a, pp. 3–13, 17–8).

A particular "necessary of life" with which Hutton was especially preoccupied was soil. Fertile soil, he noted, is essential for making a planet habitable. Soil, however, consists principally of fragments of rocks eroded by weather and transported down from higher regions to form fertile plains. It is then washed into the sea and replaced with more eroded matter. This matter, therefore, must inevitably become exhausted, reducing the earth to a great spheroid of water, unable to support life. The very process necessary to make the earth habitable, then, will eventually render it *un*inhabitable. He reasoned, however, that if the earth is divinely contrived, then it must possess some mechanism for replenishing the rocks such that they can continue to erode and supply fertile soil. To elucidate how such a restoration might be effected, he contended, we must consider the earth as analogous to an organic body. That is, we must think of it as possessing a reproductive system whereby the broken matter is continually repaired by the same forces responsible for its original formation (Hutton, 1788, pp. 214–6; 1795a, pp. 13–7).

To understand the restoration of land, then, Hutton proposed, we must consider how it was formed. He noted that the remains of marine animals in strata indicate that they formed in the ocean. They must therefore be composed of the same kinds of loose matter that we find on the ocean floor today, and which are evidently fragments of rocks eroded by weather and washed into the sea. This matter must somehow have been consolidated. For this to occur, it must first have been brought to a fluid state and then solidified. There are two possible ways this could be effected: (1) dissolution and crystallisation; or (2) heat and fusion. The former was insufficient, since many substances found in strata are water-insoluble. Heat, therefore, is the only possible cause of consolidation. It, unlike water, is capable of bringing all these substances to a fluid state. Sufficient pressure, moreover, supplied in this case by the weight of superincumbent sediment, will prevent the substances from

[1] This qualification is important. For while we cannot establish whether constituents of a given theory are (approximately) *true*, we can judge whether these constituents have been (approximately) retained in current theories. Since historical challenges to realism appeal to the success of past theories which are not considered (approximately) true in that they do not resemble current theories, all the realist needs to do to respond to such challenges is show that the responsible constituents of the theory in question are sufficiently like constituents of current theories. As is customary in the realism literature, I shall use the terms "approximately true" and "radically false" or "not even approximately true" to refer to constituents which have and have not been (approximately) retained in current theories respectively.