There is no plume under Iceland or anywhere else.

Since the inception of the plume hypothesis by Morgan in 1971, confirming the original predictions has proved difficult. Evidence for temperatures at “hot spots” that are sufficiently high to drive plumes by thermal buoyancy has been elusive. “Hot spots” are not fixed relative to one-another, many island chains are not time-progressive or are not mutually parallel and seismology does not reliably detect plumes in the lower mantle. The response of the Earth science community has, regrettably, been to change the plume model to fit the observations. Variants of the original classical plume model have thus become so numerous and elaborate that the model in its broadest sense is unfalsifiable and thus unscientific. As a result it is hampering progress because in practice it removes the need to explain new data – they can always be attributed uncritically to “the plume”.

It is pointless to attempt to disprove the plume hypothesis as this is akin to attempting to disprove creationism, and impossible in practice. A promising way forward to encouraging new thinking is to establish and test alternative models. A candidate general model recently developed by a working group of scientists, several of whom recently gave seminars at Woods Hole, is that of Plate Tectonic Processes. This model suggests that magmatic fecundity at a particular location is controlled by lithospheric extension and mantle fusibility. Extension occurs at spreading plate boundaries and intraplate regions such as the Basin Range province and the East African rift. The mantle is heterogeneous, and its fusibility varies laterally as a result of such de-homogenizing processes as mid-ocean-ridge magmatism, the recycling of subducted slabs and delamination of continental mantle lithosphere when supercontinents break up. Where extension occurs, permissive volcanism results. Very-large-volume volcanism results if the mantle beneath is highly fusible, but volumes will be modest if the underlying mantle is refractory. I will discuss this model in the context of Atlantic “hot spots” including Iceland, the Azores, Ascension/St. Helena/Circe and Tristan da Cuhna.

This new approach to the subject of “anomalous” volcanism has much to offer students seeking new problems to solve. These include whether deep mantle plumes of the “Morgan” type are physically possible in the Earth’s mantle, how hot “hot spots” really are, how the volumes of melt in large igneous provinces can be explained and whether they require ponding, what is the relationship between volcanic chains and large igneous provinces, why some chains are time-progressive and others not, how seismic anomalies should be interpreted and what is the origin of OIB. Models based on plate-tectonic processes are required for many other “hot spots” e.g., Afar, Reunion, Keguelen and Easter. They should be established, tests devised, and efforts made to disprove them. The greatest challenge is, perhaps, to take a holistic Earth science view in this work. To do this is very difficult in such a diverse and specialized subject, and requires courage. Nevertheless it is imperative if we are not to suffer the same fate as the legendary blind men who conducted a research project into the morphology of the elephant.

For more information, visit http://www.mantleplumes.org/

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