Geophysical Research Abstracts
Vol. 20, EGU2018-10469, 2018
EGU General Assembly 2018

From induction to deduction: Using the Earth as a natural laboratory

John Armitage
Institut de Physique du Globe de Paris, Paris, France (armitage@ipgp.fr)

Induction is the interpretation of observations from a series of case studies to try and arrive at universal truth. Deduction is the testing of a theory through experimentation. To use the Earth as a natural laboratory, then it has to be our experiment. However, the Earth has no control group, can't be restarted, or bench-marked. It is not a classic experiment, and therefore is it really possible to go beyond the case study? To explore this question I will focus on two examples: (1) The interpretation of stratigraphic patterns. (2) The interpretation of inverse seismic models.

In sedimentology, the cyclical progradation and retrogradation of the shoreline has been interpreted as being due to changing sea-level. However, change in landscape erosion and sediment delivery to the marine environment can also cause a cyclical migration of the shore line. By developing a forward model of sediment transport, it can be shown that while both climate and sea-level change can cause similar shoreline migration, gravel deposition within the terrestrial environment is diagnostically different. This difference in terrestrial deposition can then be used to test the competing hypotheses of what might cause shoreline movement. With this in mind, it was found that it is most likely that the classic Bookcliffs section of cyclical sequences within the Western Interior Seaway of the U.S. were due to sea-level change during the Cretaceous.

In seismology, in the mantle below mid-ocean ridges and volcanic rifts, zones of low seismic wave speed have been interpreted as a signal of high melt retention. This is because melt has been experimentally demonstrated to slow seismic wave propagation. However, attenuation of seismic waves due to scattering and thermal effects will also result in reduced seismic wave speeds. By developing a model that is capable of predicting the melt production, melt chemistry, and the seismic structure of the upper mantle, we test the hypothesis that melt retention is the cause of the low seismic velocity zones. By doing so it was found that in fact the low seismic velocity zone below the East Pacific Rise is most likely due to attenuation.

In both of these examples, the classic study might end with the interpretation. However, in this presentation I will try to argue that we can go beyond interpretation and move towards hypothesis testing. In other words, I suggest that we can use the Earth as the experiment, and with deductive reasoning verify our theories, rather than use inductive reasoning to generalize an interpretation.