

Testing Geological Hypotheses Using Particle Physics

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Installations of muon and neutrino observatories are yielding an increasing spirit of collaboration between particle physicists and Earth scientists interested in leveraging their resources and techniques and to apply them to major outstanding scientific problems in both fields. This comes at a very good time, as experimental methods and seismological analysis has increasingly illuminated the frontier of Earth's deep geological structure, leading to new ideas and hypotheses regarding the evolution of Earth since its formation. Particle geophysics offers unique new tools to test hypotheses regarding the geological evolution of the entire Earth, some of which should help to break through non-uniqueness hurdles that arise using more traditional approaches. Here we discuss some of the frontier problems in Earth science, and describe some potentially novel approaches that may lead to breakthroughs in our understanding of our planet. One already well-known application involves detection of anti-neutrinos generated by naturally occurring radioactive decay processes in Earth's interior, the strength and distribution of which is sensitive to different hypotheses regarding Earth's origin and evolution. Other approaches, which will be made possible using the high energy detectors in Antarctica, is the determination of the electron density inside the Earth. This is especially useful, since the electron density is sensitive to the molar fraction of elements in solution inside bodies like the core, while seismology is only sensitive to the weight percent of those solutes. Here we show how combining this independent information will help to solve major questions such as the composition of the core.

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