Where are the diamonds? - using explosions

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Short (400 char):
We implement seismic imaging and inversion in a framework called Zephyr, compatible with the SimPEG project. Processing of seismic recordings by waveform inversion lets us image physical property contrasts and differentiate rock types for a typical geophysical model from a diamond exploration setting. Combining this with other geophysical methods lets us make informed geological inferences.

Long (300 words):
Seismic imaging and waveform inversion are some of the tools most commonly used to investigate earth structures in oil and gas settings. The same tools can also be applied in a mineral exploration setting (such as diamond exploration) to image fractures and differentiate rock types, and thereby inform a geological model. In a mineral exploration setting, these tools are most useful when combined with other geophysical methods and geological information; the SimPEG project is designed to bring together several of these methods into a common framework. Zephyr is a related project that implements seismic Full-Waveform Inversion (FWI), and ties in with SimPEG.

Controlled seismic energy can be created at the Earth's surface or in a borehole, e.g., with dynamite. Elastic waves propagate out from this source of energy, and are measured by a receiver array. The seismic field data (recordings of ground motion) carry information about the parts of earth that the waves passed through. By simulating the physics of the experiment, we can create equivalent data that we expect to match the field recordings. When they don't, we update our model of the Earth accordingly.

Using Zephyr and SimPEG, we aim to reconstruct the velocity at which P-waves (primary, compressional or pressure waves) travel through rocks in a realistic synthetic example based on a diamond rich kimberlite setting. The P-wave velocity is related to the rock's resistance to deformation and its density, both of which vary depending on the chemistry, mineralogy and emplacement history of the rock. Diamond-bearing kimberlite rocks from the Earth's mantle have physical properties that differ from the granite background rocks that host them. Kimberlite rocks exhibit much lower P-wave velocity than the surrounding rocks, which makes them a prime target for full-waveform inversion. In addition, small mafic dikes exhibit even faster velocities than the granite rocks, and act as a particular challenge for imaging. Information about these features—gleaned from seismic inversion and other geophysical methods—is critical to successfully evaluating prospects and informing mineral exploration. This information is best considered in an integrated workflow, and SimPEG and Zephyr aim to make that task simpler. This poster is a part of a community effort, using a diamond exploration example as motivation, to explore the integration of a large spectrum of geophysical methods using SimPEG.