Where are the diamonds? - using a giant battery

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Short (400 char):

Using a geological model representative of targets found in diamond exploration, we illustrate the capability of our DC-IP package to image electrical conductivity and chargeability distributions in the subsurface to help us answer: “Where are the diamonds?”. The modular SimPEG framework allows us to simulate and invert DC and IP data in a cooperative manner.

Long (300 Words):

Geophysical methods such as direct current (DC) resistivity and Induced Polarization (IP) allow geophysicists to develop physical property models of the subsurface which can be interpreted to characterize buried structures, such as diamond-bearing kimberlites. In a DC survey, using a battery or a generator to inject currents in the subsurface, we can measure anomalous voltage differences between electrodes on the surface, which are due to the conductivity contrasts in the subsurface. IP surveys are sensitive to electrically chargeable materials. In chargeable materials, polarization charges remain even after the source current is shut-off, generating IP signals in the form of voltage decay curves, which are measurable at surface electrodes. Thus, DC and IP signals sense different physical properties (conductivity and chargeability), although they are generated by the same injected currents and are measured using the same receiver electrodes. For this reason DC and IP data are often collected in tandem, with the goal of imaging subsurface conductivity and chargeability distributions from the measured voltages. This combined process is known as DC-IP inversion.

In this process, the DC data are first inverted to obtain a conductivity model. Then using the sensitivity function generated in the DC inversion, IP data are inverted to obtain a chargeability model. To perform the DC-IP inversion, we leverage the modular geophysical inversion framework and software package, SimPEG. SimPEG provides numerical discretizations on a number of different meshes (ie. Cylindrical, Tensor, OcTree), as well as the inversion machinery, such as optimization routines. Specific to the DC-IP problem, we implement the ‘physics engines’ for the DC and IP problems. The modularity of SimPEG enables common aspects of the DC and IP problems, such as the sensitivities and survey setup, to be treated consistently and shared between the methods. We illustrate the implementation of our DC-IP inversion package using a 3D geological model that is characteristic of diamond exploration targets. This poster is a part of a community effort, using diamond exploration as motivation, to explore the integration of a large spectrum of geophysical methods using SimPEG. With numerical simulation and geophysical inversion, we show how using DC and IP data contribute to the "big picture" of the subsurface that we use to drive exploration decisions.