Mapping glacial overburden thickness over a kimberlite pipe using passive seismics

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Innovative methods are needed to identify new prospective targets in the Canadian North, such as kimberlite pipes, as many of them are hidden beneath an overburden of glacial sediments. Passive seismics is an emerging new method used to map the thickness of near-surface geological layers. Vibrations from distant earthquakes are used as the source of signal. If passive seismics proves to be a successful exploration method, it will be extremely beneficial as it is low cost, environmentally friendly, and easy to use. A Tromino seismograph was used between July 11-23rd, 2017 to collect passive seismic data over areas of known depth to overburden near Kelvin camp, owned by Kennady Diamonds Inc. and located approximately 300km north-east from Yellowknife, NWT. The seismograph is instrumented with a broad-band three-component velocity sensor that records ambient seismic activity. Measurements at 94 stations were taken using the Tromino. Data was collected along 7 transects across the ~0.5km long Kelvin kimberlite pipe at 50m spacing. Data was also collected above 25 boreholes. To collect data, the seismograph was placed on the surface of the ground and recorded data for 30 minutes. The ground surface consisted of relatively loose sediment and it was challenging at times to place the seismograph into firm ground. Nevertheless, 64 out of the 94 stations returned valid data showing Horizontal-to-Vertical component Spectral Ratios (HVSR) with a well-defined peak corresponding to the fundamental ground resonance frequency, indicating the presence of a strong shear velocity seismic impedance between the overburden and the bedrock. To estimate the depth of the overburden-bedrock interface requires knowledge of the resonance frequency and the shear wave velocity. A velocity-depth profile in the survey area is not available yet in this early phase of the project. As a first step, a literature review was conducted in order to select a realistic constant shear wave velocity to calculate depth to bedrock. The calculated depths were used to create an overburden thickness map which was then directly compared to the map of true depth to bedrock derived from borehole data. The plan for the summer 2018 field season is to use a seismic refraction system with a hammer source and a string of geophones to measure velocity-depth and acquire additional seismic data to further refine these techniques. This will allow a more precise overburden thickness map to be calculated.