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Sensor Emplacement Techniques and Seismic Noise Analysis for USArray Transportable Array Seismic Stations

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In preparation for deployment of EarthScope's USArray Transportable Array (TA) in Alaska beginning in 2014, the National Science Foundation (NSF) is supporting exploratory work on seismic station design, sensor emplacement and communication concepts appropriate for the challenging high-latitude environment that is proposed for deployment. IRIS has installed several experimental stations to evaluate different sensor emplacement schemes both in Alaska and the lower-48 U.S. The goal of these tests is to maintain or enhance a station's noise performance while minimizing its footprint and the equipment, materials, and overall expense required for its construction. Motivating this approach are recent developments in posthole broadband seismometer design and the unique conditions for operating in Alaska, where there are few roads, cellular communications are scarce, most areas are only accessible by small plane or helicopter, and permafrost underlies much of the northern tundra.

In this study we review our methods used for directly emplacing of broadband seismometers in comparison to the current methods used to deploy TA stations. These primarily focus on using an auger to drill three to five meters, beneath the active layer of the permafrost, or coring directly into surface bedrock to one meter depth using a portable drill. Both methods have proven logistically effective in trials. Subsequent station performance can be quantitatively assessed using probability density functions summed from power spectral density estimates. These are calculated for the continuous time series of seismic data recorded for each channel of the seismometer. There are five test stations currently operating in Alaska. One was deployed in August 2011 and the remaining four in October 2012. Our results show that the performance of seismometers in Alaska with auger-hole or core-hole installations equals or exceeds that of the quietest TA stations in the lower-48, particularly at long periods, and in exceptional cases approaches the performance of the GSN low noise model. The station at Poker Flat Research Range, Alaska co-locates a sensor in a 5 meter deep auger hole with a 2 meter deep TA tank installation typical of the lower-48. The augered seismometer is currently over 20 dB quieter at periods over 40 seconds than the TA tank installation. Similar performance has been observed at other TA stations, which also compare favorably to co-located permanent stations.