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A reflection seismic study of the Alnö alkaline and carbonatite igneous complex

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The Alnö igneous complex in central Sweden is one of the largest (about 5 km by 5 km) of the few well-known alkaline and carbonatite intrusions in the world. It contains a wide variety of lithologies, including alkaline silicate igneous rocks (Ijolite, Nephelinesyenite, and Pyroxenite) and a range of carbonatite dykes with a variable composition (Kresten, 1990). Alnö island is the type locality for Alnöite, a melilite-bearing basic rock that occurs as dykes and contains a complex mineral assemblage with phenocrysts from the deep crust and the upper mantle. Geochronological measurements suggest an age of 553-590 Ma for the main intrusion. The depth extent, dip and dip direction of the carbonatite rocks have been inferred from surface geological mapping, but lack depth-constraints. Our research aims to improve understanding of the intrusion mechanism(s) and the geometry of the Alnö intrusion and through that of alkaline and carbonatite intrusions in general.

We have acquired three high-resolution reflection seismic profiles over the main intrusion during winter 2011. Densely sampled surface gravity and magnetic data were also collected along the seismic profiles and on the sea-ice with gravity measurements indicating a strong positive Bouguer anomaly of about 20 mGal over the main intrusion. Petrophysical measurements including compressional- and shear-wave velocities, anisotropy of magnetic susceptibility (AMS), and density data were gathered from oriented samples of representative lithologies.

For the seismic data, nearly 400 active channels were employed with a geophone spacing of 10 meters. A mechanical hammer was used for generating the seismic waves and was activated at most geophone positions. Since the acquisition took part in winter, we also extended the profiles out on the sea-ice close to the shore. The geophones were planted in the frozen ground/ice and covered by snow resulting in improved signal-to-noise ratios. The main profile is about 10 km long (NW-SE direction) and is crossed by two semi-perpendicular profiles of about 5 km length each.

Preliminary results indicate that the main intrusion is highly reflective and several steeply dipping reflections are reaching to the surface. Therefore correlation with surface geology appears feasible and the seismic data will provide a framework along which potential-field data, point-wise measurements of physical rock properties and surface geological observations can be modeled in 3D. This will allow the construction of a detailed 3D geological model for the Alnö intrusion.