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Study of frozen ground conditions in Byers Peninsula of Livingston Island (Maritime Antarctica) based on electrical and geomorphological data

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Permafrost conditions in the South Shetland Islands (Maritime Antarctica) appear to be marginal to discontinuous, until ca. 20 - 40 m a.s.l., becoming continuous at higher altitudes. However, the presence of permafrost in certain areas of the archipelago is not well understood. That is the case in Byers Peninsula in Livingston Island, the largest ice-free area in the South Shetland Islands. Some studies have shown that in Byers Peninsula permafrost conditions exist in the central plateau at altitudes above 45 m a.s.l., with an active layer thickness of 0.9 - 1.5 m.

Geoelectrical methods are an effective method to detect permafrost distribution and permafrost conditions in polar environments. With the purpose of better understanding the existence (or absence) of permanent frozen conditions in Byers Peninsula, a geophysical survey using an electrical resistivity tomography methodology was conducted in late January 2015. The snowy conditions during the cold season in 2014 in Byers Peninsula imposed a late snow melt in 2015, which must be taken into account when interpreting the data related to frozen conditions inferred from the geoelectrical survey.

In the same direction three overlapping electrical resistivity tomographies of 78 m each were done along a profile which ran from the coast to the highest marine terraces. For each tomography 40 electrodes were used in a Wenner configuration; adjacent electrodes were 2 m apart. The three electrical resistivity tomographies were combined in an electrical resistivity model which represents the distribution of the electrical resistivity of the ground to depths of about 13 m along 158 m. The software RES2DINV [1][2] was used for inverting the apparent electrical resistivity values into a two-dimensional model of electrical resistivity of the ground (Fig. 1).

Several patches of high electrical resistivity are found along the two-dimensional geoelectrical model, which are interpreted as sporadic permafrost. On average, electrical resistivities tend to increase inland. As observed in other polar maritime environments, electrical resistivity values as low as 1000 Ωm may be indicative of the presence of permanent frozen conditions in the area. This may suggest the lower limits of sporadic permafrost in the Byers Peninsula, significantly lower than in other ice-free environments in the South Shetland Islands.

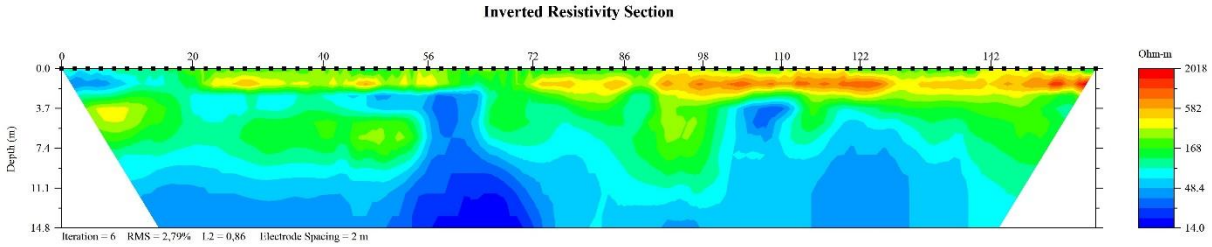

Figure 1: Two dimensional electrical resistivity model for the study area. The sea is at 0 m.

References:

[1] Loke, M.H. and Barker, R.D. (1995). Least-squares deconvolution of apparent resistivity. Geophysics, 60: 1682-1690

[2] Loke, M.H. and Barker, R.D. (1996). Rapid least-squares inversion of apparent resistivity pseudosections using a quasi-Newton method. Geophysical Prospecting, 44: 131-152