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# Soil characteristics and fallout and environmental radionuclides on different geomorphological features in Elephant Island for assessing environmental changes in maritime Antarctica

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Soils in ice-free areas of Elephant Island (South Shetland Islands, Antarctic Peninsula region) have been forming since the last deglaciation in an Antarctic maritime climate that is warmer and more humid than in interior Antarctica. The studied ice-free areas correspond mostly to coastal promontories and the underlain materials are composed of metamorphic rocks. A soil survey was carried out in the largest ice-free areas at the western coast of the island at Stinker Point and Lindsey Cape, as a part of a broader study on soils and geomorphology in maritime Antarctica. A soil sampling campaign was undertaken with the aim of characterizing soils developed on different geomorphic features and to investigate the processes involved in their development following the glacial retreat, that started in the area probably later than 4000 yr BP. Study sites have glacial deposits and raised marine surfaces and they include areas with different mosses and lichens coverage. Profiles were located at altitudes ranging from 30 to 90 m a.s.l. at Stinker Point and at 140 m a.s.l. at Lindsey Cape. A total of 8 soil profiles of variable depths were sampled at depth increment intervals of 5 cm until rock outcrop (15-30 cm). Distinctive geomorphic features have been described at the study sites to assess the extent of the relationship between soil characteristics and geomorphology.

The main soil properties analysed were: pH, electrical conductivity, carbonate content, bulk density, soil texture and soil fertility indicators (organic matter and soil organic carbon content, nitrogen, available phosphorous and potassium). Analyses of stable elements and activities of fallout (FRN's) and environmental radionuclides (ERN's) were also performed in the interval samples. The studied Cryosols are stony with no clear horizon differentiation and the soil texture is mostly silty loam. The soils have in general low contents of organic matter (0.3-2.7 %), carbon (0.16 – 1.6 %) and nitrogen ($<$ 0.33 %). Available K and P contents and N vary largely among the profiles in relation to ornithogenic activity. Carbonate contents are very low ($<$ 1.0 %) and average electrical conductivity is 0.14 dS m$^{-1}$. The pH ranges between 3.9 and 8.6 and variation from acid to alkaline profiles is related to the profile position. The major elements Al, Fe, Ca and Na, were the most abundant in that order, followed by Mg, K, Mn and then Pb, Ba and Sr whereas Cr, Zn, Li, Co, Ni and Cd are present as trace elements. In two profiles on intermediate marine platforms, the FRN's concentrate at the topsoil, where $^{137}$Cs and $^{210}$Pb$_{ex}$ activities are 11 and 20 Bq/kg, respectively. The depth distribution of ERN's is quite homogeneous, especially for $^{226}$Ra and $^{232}$Th activities, whereas larger variations are observed for $^{40}$K and to less extent for $^{238}$U. The absence of $^{137}$Cs and depleted levels of $^{210}$Pb$_{ex}$in soils on till materials of moraines is likely related to the age of ice retreat but soil disturbance can not be disregarded. Cryogenic processes triggering the mechanical disintegration of bedrock by freezing-thaw cycles within the soil active layer and wetting-drying are main processes involved in soil development in Elephant Island. This research provides information on past environmental changes of interest to understand the soil response to actual changes.