Geophysical Research Abstracts
Vol. 17, EGU2015-9536-1, 2015
EGU General Assembly 2015

Weathering and genesis of Soils from Ellsworth Mountains, East Antarctica

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Knowledge on Antarctic soils from the Ellsworth Mountains (EM) are patchy comparatively with Dry Valleys soils from the Transantartic Mountains, and could help understand the genesis of cryogenic soils under extreme dry, cold desert conditions. The EM are a slightly arcuate 350-km-long north-northwest-trending mountain chain is bordered on the west by the polar plateau of West Antarctica and on the east by Ronne Ice Shelf. The range is as much as 90 km wide and constitutes one of the largest areas of exposed bedrock in West Antarctica. The stratigraphic succession in the EM includes strata from Cambriam to Permian in age. The objective of this study is to analyze the properties of soils from EM in order to identify the main factors and processes involved in soil formation under cold desert conditions in Antarctica. The sampling design aimed to represent the different geological substrates (marble-clast conglomerate, graywacke, argillite, conglomerate, black shale, marble and quartzite) as well as altitudinal levels and landforms within the same substrate. We characterized soils from EM regarding their morphological, physics and chemical properties. Soil samples were air dried and passed through 2 mm sieves. After removal of water soluble salts, the samples were submitted to chemical and physical analyses such as: pH in water, potential acidity (H + Al), exchangeable bases, total organic carbon, electric conductivity, soil texture and color. The soils classify, for the most part, in weathering stages 1 to 2. Only in the upper parts of ridges were there traces of soils at weathering stage 3. This indicates that much of the present icefree topography has been overridden by ice within the last few hundred thousand years. Cryoturbation is a widespread phenomenon in this area resulting in intense cryoclastic weathering and patterned ground, forming sorted circles, stripes and gelifluxion lobes. The soil show low horizontation, discrete patches of salt on the surface, and salt crusts beneath the rock fragments. Despite of the low weathering stage of the soil, they have yellowish hue and high chroma values from influence by sulfide material. Boulders on moraines show staining, pitting, spalling, and some striations. All soil are alkaline in reaction, with pHs at the range between 7.5-9.2. Cryptogamic (lichens or mosses) crusts are absent, and the organic matter contents were invariably very low, ranging between 0.13 and 0.38%. Permafrost is continuous and occurs close to the surface, at between 5-15 cm down the top. The available P background is also very low (< 5.3 mg/kg), exchangeable K and Na levels are surprisingly low for Polar Desert soils. Soils are all skelletic, with a predominance of coarse materials. CEC is medium to high, and Ca-dominated, as a result of a strong limestone influence in the moraine parent materials. The main salts present are Ca and Na-sulphate forms, and less cloride forms, and clay sized materials are dominated by salts in all soils, especially below 5 cm depth.