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Coupling of climate and seabird activity significantly affected soil development in Antarctica

ZHANGQIN ZHENG[1], CAN LIU[1], YULU XUE[1], PENGCHENG JU[2], JIHUA HAO[1] AND XIAODONG LIU[1]

[1]University of Science and Technology of China

[2]Northwest University

Presenting Author: zzq123@mail.ustc.edu.cn

Seabird brought a large part of nutrients (nitrogen, phosphorus etc.) to coastal regions, greatly fertilizing soils and promoting pedogenesis and eco-systems' evolution. Antarctica continent received the highest N and P inputs worldwide by colonization of numerous penguins, especially in Ross Sea region and Antarctica Peninsula. Nevertheless, how this pedogenesis proceed after guano excreted and which types of phosphorus (Ca-P or Fe/Al-P?) dominating in ornithogenic soils is still controversial and not fully elaborated in Antarctica, especially under the background of global warming. Here, we sampled soils with or without impact by penguin activities from Ross Sea region, and Antarctica Peninsula, and analyzed chemical properties, micro-morphological, and mineralogical features of the soils at different stage of pedogenesis. P *k*-edge X-ray absorption near edge structure (XANES) spectroscopy was used to finely analyze phosphorus species in the soil samples. Our results suggested that soils from Ross Sea region and Antarctica Peninsula represent are apparent spatial difference. Guano brought in more Ca, Mg, and P in the soils from Victoria Land, which is different with results from Maritime Antarctica (P, Ca, K) at Antarctica Peninsula. The results from XANES revealed that Ca-P and Mg-P are major species in ornithogenic soils from Ross Sea region, but Fe/Al-P content significant increases in soils from Antarctica Peninsula. Struvite and apatite were found the major P-bearing minerals in ornithogenic soils from Ross Sea, but signal of struvite decreased at Antarctica Peninsula. The soils from current or ancient penguin colonies also showed obvious difference in mineralogy and P species in Ross Sea. The ancient ornithogenic soils seem to have more stable secondary minerals like Calcite, which may be related to degradation of uric acid. We implied that relative humid, warmer and acidic climate seems not conductive to the preservation of struvite (Mg-P), but promotes the formation of Fe/Al-P although Ca-P is brought by fresh guano primally. In brief, climate condition (temperature, humidity etc.) play a vital role on the phosphatization process, phosphorus cycle, and evolution of eco-systems.