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The influence of penguin activity on the Nitrogen-Phosphorus cycle in the Ross Sea region

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As the limiting nutrient elements, nitrogen (N) and phosphorus (P) play important roles in forming biological organisms, promoting primary productivity, and changing ecological community structures. Until now, the research on the N and P cycle and the mechanisms in eutrophic lakes under human influence have been in-depth. However, in Antarctica, the research is still scarce. Adélie penguin, as the most important advanced predator in Antarctica, feeds mainly on krill in the ocean, while rearing and colonizing on land, which has important impacts on the N and P cycle in the fragile Antarctic terrestrial ecosystem.

In this study, soils and lacustrine sediments in the Ross Sea, Antarctica, which were heavily influenced or uninfluenced by penguin activities, were analyzed for N and P forms, N isotopes of NH_4^+ and NO_3^-, and O isotope of NO_3^-. Combined with the basic physicochemical properties, elements, and mineralogical analysis results of XRD, SEM/EDS, the mineralogical and morphological characteristics in sediments were discussed for the influence of penguin activities. The results show that penguin bio-transport inputs a large amount of N and P into soils and lacustrine sediments, Especially Ca-P, Mg-P, and NH_4^+. Mineralogical results such as XRD and SEM/EDS showed that the surface morphology of mineral particles heavily influenced by penguin activities was different from that in the natural environment. Phosphorus input from penguin guano forms a large amount of struvite ($MgNH_4PO_4$ $6H_2O$) and other relatively stable minerals in aquatic environments. The results of TN and NH_4^+-N isotopes showed that the sediments influenced by penguin activities were more positive (about +30~40‰) than uninfluenced soils and sediments, which would be affected by the form of struvite. The N and O isotopes of NO_3^- were more complicated in the sediments, which may be related to the nitrification and denitrification processes in soils and sediments. The results of this study provide an important scientific basis for further understanding of the N and P cycle in the Antarctic affected by penguin activities under climate change.