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Investigating mineral weathering and soil carbon storage across a Patagonian climate by vegetation pedogenic matrix

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Tephra-derived soils retain more organic carbon (C) than soils formed from any other parent material, but past work probing the mineralogical mechanisms behind such retention have been limited (mainly) to the tropics. Here we present results of our work evaluating the effects of both precipitation and vegetation type on soil weathering and organic C storage in young, tephra-derived soils in a temperate climate. We conducted our investigation across five sites in the Patagonian Andes that vary from 250 mm to 2200 mm mean annual precipitation. At each of the sites are paired plots of natural vegetation, which changes from grasses to closed-canopy forest with increasing precipitation, and stands of *Pinus ponderosa* planted in monocultures about 35 years ago. Soils were collected from both vegetation types across the gradient to the depth of auger refusal and were extracted with 0.5 M HCl for 24h to target the combined exchangeable and adsorbed metals, and secondary short-range-ordered mineral phases. Our results indicate that pine afforestation has resulted in lower concentrations of extractable K ($p < 0.1$) and Ca ($p < 0.01$) within the top 0 – 30 cm in the planted pine soils. Other elements, while not affected by vegetation type, did respond to the rainfall gradient. Al, Si, P, and Mn all increased in the surface soils with rainfall ($p < 0.01$), indicating the development of short-range-order volcanic mineral phases that retain nutrients such as P and Mn. Furthermore, soil C increases in the soils across the gradient, and addition of Al, Si, and Ca in the linear model to describe soil organic C explained more of the total variance than rainfall and vegetation type alone, indicating the importance of secondary minerals and cation bridging to soil C retention. Importantly, the lower concentration of Ca in planted pine soils may signal a permanent decrease in the potential soil C stored in afforested soils due to a lower capacity for cation bridging. Our results reflect changes in tephra-derived soils during the early stages of weathering in a temperate climate and the potential impacts of afforestation on soil development and C storage.