## Structural and Activity Alterations of Secreted Plant Phosphatase at Mineral Interfaces: Unraveling Mechanisms Modulating Enzymatic Organic Phosphorus Recycling in Soils

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Plant-derived extracellular enzymes play a critical role in recycling carbon, phosphorus, and nitrogen from organic matter in terrestrial and aquatic systems. The contribution of phosphorus-recycling enzymes such as phosphatases is especially important in obtaining bioavailable phosphorus in the environment because phosphorylated organic compounds (Pore) account for 20-75% of total phosphorus in soils and sediments [1,2,3]. Previous studies have reported that, depending on the mineral composition and enzyme type, adsorption to Fe oxides and clays can lead, on one hand, to a decrease of up to 80% in phosphatase activity [4] and, on the other hand, to the stabilization and increased phosphatase activity of up to 30% compared to free phosphatase enzyme in solution [5]. Therefore, of particular interest is predictive understanding of the fate and transformation of Porg in environmental systems by elucidating the mechanisms leading to mineral-dependent and enzymedependent alterations in enzyme activity. Here we investigated the relationship between the activity of a plant-secreted phosphatase, purple acid phosphatase from sweet potato, and its mechanisms of binding to three representative soil minerals: a clay (illite), a silica (quartz), and an iron oxide (goethite). We observed a 70% decrease in specific enzyme activity in enzymeillite suspensions compared to the free enzyme in solution. Based on attenuated total reflectance-Fourier transform infrared spectroscopy experiments, we attributed this decrease in activity to changes in secondary structures of phosphatase at the illitewater interface (Fig. 1A, B). We have applied the same analysis to probe enzyme interactions with goethite and quartz towards contextualizing the structure-activity relationship underlying mineral-dependent effect on phosphatase activity.

## References

[1] Vincent et al., (2013). Plant Soil, 367(1-2), 149-162.

[2] McLaren et al., (2015). Environ. Sci. Technol. 49(22), 13238–13245.

[3] Ni, Z., Li, Y., & Wang, S. (2022). Wat. Res., 220, 118663.

[4] Huang, Q., & Shindo, H. (2000). Soil Biology & Biochemistry, 32(13), 1885–1892.

[5] Allison, S. D. (2006). Biogeochem., 81(3), 361-373.



Figure 1: (A) Percentage of phosphatase enzyme secondary structures determined by attenuated total reflectance-Fourier transform infrared spectroscopy. (B) Schematic illustration of free (left) and illite-bound (right) phosphatase conformations.