

Phytolith Stock of a 26-yr Volcanic Ash Soil in Tarlac, Philippines

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ABSTRACT:

Volcanic ash soils derived from pyroclastic materials are deposited by explosive eruptions. As such, their geographical distribution closely matches that of active volcanoes. Owing to their excellent fertility, volcanic ash soils support productive agriculture in many parts of the world. In Southeast Asia, including the Philippines and Indonesia, they are used for cash crop production such as rice, sugarcane and banana. However, these regions are also prone to frequent volcanic ash deposition. When the ash deposit is thick enough, complete burial of the surface soil may occur and a new soil will eventually form upon weathering and organic matter accumulation in the fresh ash.

The impact that soil burial by ash tephra has on the biogeochemical cycles of key elements, such as C and Si, in the soil-plant system is not well known. This study focused on Si in a rice-cultivated area affected by the 1991 Plinian eruption of Mt. Pinatubo in the Philippines. Silicon is not an essential element but its presence has been shown to improve rice resistance to biotic and abiotic stresses. Rice is a well-known accumulator of Si in phytolith (BSi) form. Here we assessed the phytolith (BSi) stocks in the modern soil that has been developing from the fresh dacitic ash deposited in 1991, and in the older (~800 yrs) volcanic ash soil that was buried by this deposit.

BSi was extracted through densimetric separation using a heavy liquid (Na-polytungstate) from the soil's silt-size fraction. The method also allowed the extraction of the volcanic glass (GSi) component from the amorphous Si (ASi) fraction due to similar density ($\sim 2.3 \text{ g cm}^{-3}$) with BSi. The estimated percentage abundance of BSi and GSi were based on abundance per surface unit expressed in percent and qualitatively rated using AFCOR (Abundant, Common, Frequent, Occasional, Rare) description. The average ASi [BSi + GSi] stocks of the surface soil, ash, and buried soil horizons were **47, 11 and 294 g m⁻²**.

Phytolith assemblage of the surface soils have frequent to abundant total BSi (rice + other grasses) [2.0-4.4 %] with rare to occasional occurrence of rice BSi [0.12-0.8 %] and frequent to abundant GSi [2.3-4.4 %]. Buried soils were dominated mainly with total BSi [4.4-5.0 %], with occasional rice BSi [0.6-1.5 %] that is 70% higher than the surface soil, and with rare to occasional GSi [0.1-0.9 %].

Knowing that the modern soil has received rice straw biomass for the past 12 years, we determined the rate of BSi accumulation on the surface (newly developed) soil of the 26-yr ash deposit. We also computed the theoretical BSi stock of the ash-buried soil. Using mass balance equation, the predicted rice BSi accumulation in the modern soil was 10 times higher than the measured value. The rice BSi stock of the ash-buried soil was also higher by a magnitude of 5 from the actual BSi extracted. The results suggest that accumulation of BSi in a young volcanic ash soil being lower than the predicted value either incurred losses via leaching and dissolution or Si uptake by rice is low in ash-affected soils resulting to lower BSi recycled into the soil.

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