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The environmental impacts of volcanic ash emission

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Volcanic ash particles may instigate a range of physical and chemical impacts in receiving environments, but the significance of these impacts may depend on the residence time of the ash particle in that environment. Ash may be deposited in permanent sinks, such as soil or aquatic sediment; temporary sinks, such as vegetation surfaces; or may travel through transitional environments such as the atmosphere or lake, river andor ocean waters. As ash residence time in permanent or temporary sinks increases, the significance of the physical and chemical properties of the bulk particle increases. With sufficient time and without erosion, ash deposits reshape the geomorphology of entire regions, and by weathering, act as a soil forming factor. As ash particle residence time decreases, the significance of the ash surface increases. In vegetation systems, where ash may remain emplaced for several months without erosion, there may be some limited impact from leaching of acids and salts stored on ash surfaces, but overloading and obstruction of the photosynthesising surface areas may have greater significance. In transitional environments, the significance of the ash surface is greater still. In water columns, soluble salts on the surface are rapidly leached, releasing bioavailable nutrients into solution. In nutrient limiting waters, such as the open ocean, these may cause primary productivity blooms which may impact on atmosphere-ocean carbon dioxide exchange. The potential significance of the ash surface in the atmosphere is unknown but based on the reactions which may occur at mineral dust surfaces, it is hypothesised that the vast total surface areas produced by volcanic ash emission also offer sites for heterogeneous chemical reactions. There remain many uncertainties surrounding the interactions which may occur at the ash-environment interface, many of which stem from a limited understanding of the nature of the ash particle surface and the reactions, and interactions which may occur there from fragmentation to deposition. With a thorough understanding of the ash-environment interface, the potential impacts occurring in any well constrained environment may be more accurately determined.