

Soils and subduction: On the ring of fire, biosphere processes are directly influenced by asthenosphere processes

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The tropical portion of the Pacific ring of fire is a place of rapid soil formation and weathering, enormous biodiversity and intense human activity. Soil properties there are related to the nature of volcanic ejecta and the degree of weathering, determined by climate and time. However, here we show an additional, previously unreported factor. In an area of uniform parent material (air-fall tephra) and climate (humid tropical), and allowing for various degrees of weathering due to age of the deposits, we found a gradient in soil properties that was related to depth in the asthenosphere from which the magma originated. Composition of magma erupting from individual volcanoes is determined by depth to the Benioff-Wadati zone, which can be located by depth of earthquake foci (10s to 100s of km deep). With increasing depth to the Benioff-Wadati zone under the volcano from which parent material originated, soils had increasing pH, Ca and Mg contents and Mg/Ca ratios, and decreasing contents of P and K. Streams had increasing concentrations of bicarbonate and ratios of Ca+Mg/Na+K. Soil organic C content and P retention were high in the presence of poorly crystalline Fe oxides, which was related to magma source and weathering. Thus asthenosphere processes have a direct influence on plant nutrition, biodiversity, agricultural productivity, human nutrition, water quality and carbon cycling in this dynamic region.