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Soil development along elevational transects on granite, andesitic lahar and basalt in the western Sierra Nevada, California

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Soil development along three elevational transects, consisting of granite, andesitic lahar and basalt, were investigated on the western slopes of the Sierra Nevada, California to assess the effects of climate on soil properties and processes. The transects, each consisting of four to seven soils, spanned elevations between 150 to 2900 m with mean annual temperatures (3-17 C) decreasing and precipitation (33-150 cm) increasing with increasing elevation. All sites were characterized by a Mediterranean climate with warm to hot, dry summers and cool to cold, wet winters. Vegetation progressed from oak woodland/annual grasslands at low elevations to mixed conifer forest at mid elevations and subalpine mixed conifer forest at high elevations. Soil pH and base saturation decreased with increasing elevation with the largest decrease found on granite. Solum carbon pools ranged from 2 to 25 kg m-2 with the highest contents found in soils formed on andesitic lahar and in mid-elevation soils corresponding to the highest ecosystem net primary productivity. The degree of weathering and mineral assemblages exhibited a strong threshold change at the elevation of the permanent winter snowline (1200-1500 m). Measures of chemical weathering (e.g., clay and Fe oxide production) increased in a near-linear fashion to the winter snowline where they abruptly decreased by about 10-fold. The clay mineralogical assemblage in the rain-dominated weathering zone was dominated by kaolin minerals and was remarkably similar among all parent materials. Within the snow-dominated weathering zone, clay mineralogy was dominated by allophanic materials (allophone/imogolite) on the andesite and basalt compared to hydroxy-Al interlayered 2:1 layer silicates and gibbsite on the granite. Clay translocation resulting in the formation of argillic horizons was only found in the rain-dominated zone. With increasing elevation, soil development followed the order: Alfisols → Ultisols → Inceptisols (granite)/Andisols (andesite/basalt) → Inceptisols/Entisols. Weathering, mineralogical transformations, soil development and net primary productivity are limited by water availability at low elevations, whereas low soil temperature is the major limitation at high elevations.