Soil

• residuum resulting from weathering over an extended period of time

• has vertical layers called soil profile from surface down to fresh parent material

• time to develop soil profile varies with intensity of weathering processes & character of original material

• soil profile reflects environment under which it formed, & serves as basis for classification of soils & interpretation of past conditions
soil profile, Peruvian Andes foothills

alpine soil, Ecuadorean Andes highlands
Generalized soil profile has three layers

A horizon: most organic matter; clays & mobile compounds leached down, or eluviated

B horizon: transitional, illuviated zone; accumulation & concentration of materials from A horizon, including clays & Fe

C horizon: underlying parent material essentially unmodified by soil-forming processes; regolith

can also subdivide A, B, and C horizons on the basis of internal variations
The three soil horizons are distinguished by

- **color** (black, brown = organic matter; yellow, red = ferric Fe; gray, white = SiO₂, CaCO₃)
- **texture**
- **structure**
- **organic content**
- **moisture**
- **% clay**

**Texture:** the relative proportions of different particles sizes of:
- **clay** < 0.002 mm
- **silt** 0.002-0.05 mm
- **sand** 0.05 – 2.0 mm

**Structure involves aggregates called peds** (blocky, columnar, platy, granular, etc)

**Organic matter:** litter (dead leaves, branches) & humus (amorphous residue from decomposed litter)
soil formed in cover sediments on upraised coastal platform, northern California

Pleistocene & Holocene soils, northern Mexico
climate is dominant at the largest scale – within a regional climate zone, other factors cause subtle variations in the generalized profile

Many soils are polygenetic; they developed under more than one set of controlling factors

The basic unit in soils mapping is the soils series, defined by a number of profiles with similar properties, & named for a geographic entity like a nearby county or town

Soil catena – association of soils varying systematically according to topography or parent material
interdune compound soils, dune field, northeastern Colorado
loess cap
argillic (clay-rich)

compound soil 65-70,000 years old
Pedogenic regimes: general trends of soil development under specific climatic & vegetational controls

Three basic pedogenic regimes

1) podzolization: processes resulting in the removal of iron &/or aluminum from A to B horizons
humid temperate climates, especially forest vegetation;
acidic soils
gray-brown (cool) to yellow-red (warm)
end products are resistant primary minerals (quartz), Fe & Al hydrates, and kaolinitic clays
Deciduous forest, southern Poland, podzolization
2) laterization: high precipitation & temperature, intense leaching & oxidation; tropics
different than podzolization in that
a) organic accumulation is inhibited
b) silica is leached, leaving only Fe & Al hydrated oxides in gibbsite
most true laterites are ancient rather than modern soils tend to be red

mottled laterite soil, southern India
reprecipitated lateritic iron, nw Australia
3) calcification: occurs in subhumid to arid regions where precipitation is insufficient to drive soil water down to the water table. Ions mobilized in A horizon reprecipitate in B horizon. Depth of carbonate zone is a function of annual precipitation, & approximates the vertical depth of leaching.

calcified soil in the Mojave Desert, CA
caleche required hundreds of thousands of years to develop; overlain by loess cap
partial clast coatings, New Mexico

carbonate root casts, nw Australia

cemented colluvium, Arizona

New Mexico
Soil in southwestern Texas (arid/semiarid) formed on fluvial gravels, with well-developed A and B horizons.
The relative thickness & maturity of soil profiles developed on similar parent material in the same climatic zones is used to infer the age of the landform & the length of time of surface stability. This is complicated by polygenetic soils & by variations in soil-forming factors with time.

Paleosols: soils formed on a past landscape, can be buried: covered by younger alluvium or rock relict: never buried exhumed: buried & then re-exposed by erosion

Engineering considerations (e.g. Benton Formation & bentonite)
Chadwick & Davis (1990): Soil-forming intervals caused by eolian sediment pulses in the Lahontan basin, nw Nevada

series of soil profiles on high shoreline features at NV-CA border in profiles of each age, amount of silt & clay increased systematically as the area of upwind interpluvial playa increased – eolian dust fall is source of fines in these soils

influx of eolian dust concentrated in two brief intervals pulses of fine sediments generate soil-forming intervals during which fine particles infiltrate into clast-supported alluvial piedmont sediments

inaccurate to assume constant, gradual development of soil properties without considering paleoenvironmental influence
The Importance of Small Creatures (Natural History, 8/94)

* in the Negev desert of Israel, snails < 1 cm long gouge the rocks, leaving 0.5-2 mm deep grooves of fresh rock

* the snails do this to get at layers of green algae & fungi in the upper portion of the rock, but they digest only 5% of what they eat – the remainder is excreted in small coils of powdered rock and undigested lichen

* about 20 snails per square meter: they expose fresh rock, & minerals that the lichens need

* snails annually graze 4-7% of total rock surface area in the Negev, turning about 800 lbs of rock into soil per acre of desert (eolian input is 220-420 lbs/acre): snails also fertilize soil: ~ 5% of the dry weight of snail feces is nitrogen = 3 lbs N/acre annually