

G470/570 Regional Landscapes of Oregon

Basics of Soils and Rock Weathering

I. SOIL BASICS

A. Soils Defined

1. Soils represent the weathered mantle of unconsolidated surficial material that covers land surfaces.
2. Mixture of mineral and organic matter derived from the physical, chemical, and biologic weathering of bedrock.

B. Weathering - disintegration and decomposition of rock at or near the surface of the earth, fragmenting rock into particles via physical and chemical processes

C. Soil Forming Factors

1. Climate - climate refers to amount of rainfall and temperature
2. Organic activity (animals / plants) - Organic activity refers to style of plant growth, microbial activity, and burrowing organisms.
3. Relief / topography - Relief / topography refers to the steepness of slope.
4. Parent material -Parent material refers to the source of weathered material upon which the soils are formed
 - a. (e.g. bedrock = igneous, sedimentary, metamorphic; surficial regolith = colluvium)
5. Time - Time refers to the residence time of the soil material, essentially the length of time that the soil has been forming without physical interruption.

NOTE: All of these factors contribute to soil characteristics. These are so inter-related that it is difficult to separate out the influences of any one of them. For example, the topography of an area influences the rainfall, the insolation, the drainage, and runoff. All of these factors interact to determine the vegetation and, in turn, all will affect weathering and soil formation. Since the five soil-forming factors are of interest to geomorphologists, the work of the soil scientist and geologist is mutually beneficial. The soil scientist must understand the surface geology to interpret the soils, and the geomorphologist must understand the soils to interpret the surficial geology.

II. SOIL COMPOSITION

A. Inorganic Mineral Matter

Comprises the bulk of soil composition in the form of mineral matter. The inorganic fraction of soil is classified according to grain size and mineral composition. Mineral components include:

1. clay-sized particles consisting of hydrated aluminosilicates known as clay minerals.
 - a. clay mineral properties include: colloidal size (>molecules but smaller than can be viewed with unaided eye), great surface area, sheet-like aluminosilicate crystal structure, net negative ionic charge between clay silicate sheets, high cation exchange potential, high capacity for water retention

2. sand and silt sized particles that may vary in mineral composition according to the composition of the parent bedrock. Quartz, feldspar and mica are common rock-weathered derivatives.

3. Rock Fragments

4. Mineral Fragments

inorganic mineral constituents in soil may either be derived from direct weathering of underlying bedrock or from aerosolic accumulation (i.e. wind blown deposits)

B. Organic Matter: comprises less than 5% of total soil composition, however plays a major role of influencing biochemical soil processes, and rendering soil a highly effective growth medium

1. organic soil constituents include: dead and undecomposed plant and animal tissue, more fully decomposed organic humus, living plant and animal organisms including roots, burrowing organisms, microorganisms and bacteria.

soil bacteria are responsible for the composting/decomposition process as well as serving as an inoculant for the stimulation of plant nitrogen fixation from the atmosphere.

plant litter- leaf material, root matter and stems

humus- dark colored (brown or black), gelatinous, chemically decomposed (hence chemically stable) organic matter.

Humic and organic matter is important for loosening soil texture and improving water retention capacity of soil, hence improving it as a growing medium

III. SOIL PROPERTIES

A. Color: Indicative of chemical and mineralogic nature of soil

1. 175 gradations of soil color recognized (Munsell color chart)
 - a. Black = humic content
 - b. Red or Yellow = iron oxide staining
 - c. Gray or White = indicative of ion leaching or depleted soils
White in arid climate = alkali precipitates (carbonates)

B. Texture: based on sieve analysis identifying sand, silt and clay composition of soil

1. Loam = equal admixtures of each
2. clay loam, silty clay, sandy clay, sand loam, silt loam, etc.
 - a. effects engineering properties of soil/moisture-drainage

C. Structure: shape and character of aggregate soil masses or "peds"

1. size, shape and cohesion of peds influences drainage, aeration, soil porosity, and soil permeability

IV. Geologic Parent Materials of Soils

A. Consolidated Bedrock

1. Igneous
 - a. Volcanic
 - (1) Basalts
 - (2) Andesite
 - b. Plutonic
 - (1) Granite
2. Sedimentary
 - a. Clastic
 - (1) Conglomerate / Breccia
 - (2) Sandstone
 - (3) Siltstone
 - (4) Shale / Claystone
 - b. Nonclastic
 - (1) Limestone
3. Metamorphic
 - a. Greenstone
 - (1) metamorphosed / altered basalt
 - b. Blueschist

B. Unconsolidated Surficial Deposits (specific to Oregon, and elsewhere)

1. Regolith - all unconsolidated to semi-consolidated material at the Earth's surface that results from physical and chemical weathering
 - a. Alluvium - river-transported deposits
 - (1) sand, gravel, silt, clay
 - b. Colluvium - mass-wasting deposits, gravity-transported deposits
 - (1) diamicton - poorly sorted sediment from clay to boulders, mixed together
 - c. Residuum - in-situ weathered regolith that has experienced little to no surface transport
 - d. Debris Flow Deposits - diamicton
 - (1) transitional between alluvial and colluvial
 - e. Glacial Drift
 - (1) Tills - poorly sorted glacial diamictons
 - (2) Stratified Drift
 - (a) Outwash - glacio-fluvial deposits
 - f. Dune Sediments
 - (1) back beach zone
 - (2) desert ecosystem
 - g. Coastal Deposits
 - (1) Beach sediments (sands and gravels)
 - (2) Back-bay / tidal sediments (silt + clay = "mud")
 - h. Volcanogenic Sediments

- (1) Pyroclastic deposits
 - (a) cinder cones
 - (b) ash deposits
 - (c) ash flow tuff

V. Soil Profiles

A. Soil Horizons: Through the weathering process, soil tends to segregate into vertically characteristic layers in response to chemical and physical processes

1) Horizons: distinctively recognizable soil layers with unique chemical and physical properties

2) Soil growth and formation viewed as progressing in a downward direction, i.e. thickness of soil profile increases from surface downward with time (thickening downward).

B. Soil Profile: characteristic horizons

1. O horizon: immediate surface layer composed of organic matter

2. A horizon: organic + mineral horizon, dark brown to black in color

3. E horizon: zone of leaching or "eluviation", lighter in color, leached of iron and aluminum.

4. B horizon: zone of accumulation or "illuviation", receiving zone of transported iron, aluminum and clay from above, often a reddish clayey horizon.

5. C horizon: regolith or unconsolidated parent material, below root zone, weathered bedrock, in decay

6. R horizon: consolidated bedrock

VI. SOIL TAXONOMY/SOIL CLASSIFICATION - USDA CLASSIF. SYSTEM

Soil Orders

A. Entisols: Soils without distinct horizons, immaturely developed, "recent" soils

B. Vertisols: soils subject to clay swelling (hydration) with dessication cracking upon drying,

C. Inceptisols: soils with weakly developed horizons, "Brown Forest Soils"

D. Aridisols: desert soils with carbonate horizon (caliche)

E. Mollisols: soils with dark, organic rich A horizon, moist, "Chestnut" soils

F. Spodosols: "podzolic" soils, northern latitude soils

G. Ultisols: highly leached soils, red soils, southern climates

H. Oxisols: "laterites" tropical, highly leached soils

I. Histosols: highly organic "peat" soils, bog soils

VII. SOIL MAPS

A. General

1. Soil composition and distribution are important with respect to agricultural practices and land development.
2. The U.S. Soil Conservation Service (now part of the "Natural Resource Conservation Service") is the federal agency that is primarily responsible for the analysis and preservation of this valuable resource.
 - a. As a result, county soil surveys and soil maps have been prepared for most regions of the U.S.

B. Map Preparation

1. Soil surveys are conducted by using
 - a. topographic maps,
 - b. air photos,
 - c. ground surveys,
 - d. soils excavations
 - e. geologic maps.

Note: Soil map units are delineated primarily on the basis of material composition (i.e. texture of the soil) and topographic configuration (steepness of slope, flood-prone areas, etc.). Other parameters include color and soil chemistry. Soil maps are typically published on air photos and created for individual counties and conservation districts. See the attached example of a soil survey map for Polk County, OR. A brief comparison of soils and topographic maps suggests that soils are not randomly distributed, but are intimately related to topography and geologic setting.