Diagnostic Subsurface Horizons

- Currently ‘19 Subsurface Horizons’ recognized by Soil Taxonomy; Some are formed below the surface of the soil, although they may be exposed.

1.) **Agric** (ager, field) forms directly under a plow layer and has silt, clay, and humus accumulation as thick, dark lamellae.

2.) **Albic** (albus, white, ‘E Horizon’) a light-colored E Horizon, common under forests. *(Common in the UP!)*

3.) **Argillic** typically this is a B Horizon formed from the illuviation of soil clays.
   - Must be at least 15cm thick, Have 1.2 times as much Clay as above it,
   - Clay shows as argillians (clay skins) on soil peds.

4.) **Calcic** typically a B Horizon by the illuviation of calcium or magnesium carbonates (at least 15% carbonates).
   - Appears as white chalky zone (small nodules; at least 15 cm thick)
   - U.S. Great Plains & West

5.) **Cambic** ‘B Horizon’ with weak indications of either ‘spodic’ or ‘argillic’ horizon, but doesn’t qualify as either.

6.) **Duripan** (hard pan) ‘B Horizon’ that is cemented by alluvial silica, and will not dissolve in water or hydrochloric acid.

7.) **Fragipan** (fragile, brittle, pan) Layer or horizon that is very dense, brittle when moist, hard when dry. Will dissolve in water.

8.) **Glossic** transitional horizon at least 5 cm thick, usually occurs between an overlying albic/underlying argillic, kandic, or natric horizon or fragipan. (15-85% albic materials)

9.) **Gypsic** calcium sulfate (gypsum) enriched, at least 15 cm thick, contains 5%
   - more gypsum than underlying horizons.
   - Not cemented; Found in Arid Areas

10.) **Kandic** low activity clays and Fe and Al with an abrupt textual change (Tropics)
   - Clay skins may not be present

11.) **Natric** (natrium, sodium) Argillic horizons but has prismatic or ‘columnar peds’ and 15% sodium.
   - Egyptian Mummification Process!

12.) **Oxic** “Highly Weathered Horizon” at least 30 cm thick and contains less than 10% weatherable minerals.
   - Very high Fe and Al oxides and low activity silicate clays (kaolinite)
   - Common in wet tropical/subtropical settings

13.) **Petrocalcic** ‘cemented calcic horizon’, may form a concrete-like layer.
   - Common in dry areas with older surfaces

14.) **Petrogypsic** cemented gypsic horizon.
   - Roots cannot penetrate the horizon (common 60% gypsum)

15.) **Placic** single layer, thin (2-10 mm thick), dark reddish brown to black in color, iron or manganese pan, within 50 cm of the surface.

16.) **Salic** atleast 15 cm thick, secondary ‘soluble salt’ enriched!
   - Found in Arid Regions

17.) **Sombric** Dark organic matter-rich forms illuviation humus
   - Found in cool, high altitude areas of the Tropics and Sub-Tropics

18.) **Spodic** (wood, ash) illuvial accumulation of free Fe and Aluminum sesquioxides and/or organic matter, usually under an albic horizon.
   - Russia = ‘Podsol’
   - Commonly found in ‘humid continental climates’ under ‘acidic vegetation’ (pine)
   - *Most common ‘B Horizon’ in the UP!*

19.) **Sulfuric** (sulfuric) Mineral or organic horizon that has a PH < 3.5
   - Toxic to plant roots
   - Has a yellow mottles of jarosite (sulfur minerals)
   - Forms as a result of artificial drainage/oxidation of sulfide-rich mineral or organic materials.
   - Sometimes occurs with drainage of wetlands.
Other Diagnostic Features
Abrupt Textural Changes

**Durinodes** (hard circular concentrations/nodes)

**Gilgai** (microlrelief basin/knolls) common in clay rich soils

**Plinthite** (irreversibly hardened) red/yellow, gray, white mottles
- Sesquioxide-rich ironstone hardpan or aggregate

**Slickensides** (polished/grooved surfaces produced by one soil mass sliding past another)

Diagnostic Contacts to Non-soil Material

**Lithic Contact** – boundary between soil / continuous coherent materials (rock) that is very hard (>3 moh.)

**Paralithic Contact** – boundary between soil/continuous coherent (rock) moderately to weakly hard (>3 moh.)

**Petroferric Contact** – boundary between soil and indurated layer of iron-cemented material.

Dynamic Diagnostic Soil Properties (Moisture & Temperature)
Based on established depths (10-90 cm deep) to which a known amount of water will wet in a certain amount of ‘time’, under certain ‘temperatures’.

6 Moisture Regimes

**Aquic** (WET) soil is saturated with water for at least enough time so that reducing conditions exist (no gaseous oxygen), which results in ‘gleying/mottling’
- The UP!
  - Artificial drainage is required for growing crops

**Aridic / torric** (DRY) in most years (6/10) these soils are both dry more than half the growing season/moist for less than 90 consecutive days.
  - Common in Arid Climates

**Perudic** precipitation exceeds evaporation in every month of the year.
  - Water will move through this soil in all months
  - Harvesting/Curing a crop is difficult!

**Udic** most years, soil is not dry for 90 consecutive days
- The UP!
  - Soil moisture is sufficiently high in most years for plant growth
  - Common in humid climates

**Ustic** soils are dry for 90 or more cumulative days
  - Soil moist for at least 90 - 180 cumulative days
  - Dry half the time

**Xeric** soil is moist in some part more than one half the days, dry for more than 45 consecutive days, moist > 45 consecutive days.
  - Mediterranean / S. California (Dry summers/Moist winters)
  - Most crops grown in the Spring
Soil Temperature Regimes
Each soil has certain temperature characteristics that can be measured over the course of several years.

- Mean annual/mean Summer Temperatures
- Difference between Summer/Winter

**Perigelic** – mean annual soil temperature < 0°C (Permafrost)

**Cryic** – mean annual soil temperatures 0°C – 8°C, Summer temperatures < 15°C

**Frigid** – mean annual soil temperatures 0°C – 8°C, Summer temperatures > 15°C The UP!

**Mesic** – mean annual soil temperature 8°C – 15°C

**Thermic** – mean annual soil temperature 15°C – 22°C

**Hyperthermic** – mean annual soil temperature > 22°C (Tropics)

**Iso** – (Prefix used with Frigid, Mesic, Thermic, and Hyperthermic to show difference between the mean Summer/Winter temperature less than 5°C)

Soil Taxonomy System
6 Hierarchical Categories, Highest (broadest) to Lowest (specific)
- Order, Suborder, Great Group, Subgroup, Family, and Series
- Versatile & Adaptable
- Since 1975 2 have been added (Andisols & Gelisols)
- New ‘Series’ continue to be added (Wetlands)
- Old ‘Series’ to be reevaluated/tested (Kalkaska Series?)

**SOIL ORDERS** – (First broadest category based on major soil forming processes.)
- 12 Soil Orders
- Names end with “sols”
- Name starts with ‘Latin names’

**Alfisols** (alf-nonsense, Marbut’s Pedalfer) major diagnostic subsurface horizon including argillic, natric, and kandic; high to medium base saturation.

**Andisols** (and-Japanese/blacksoil) from volcanic materials.

**Aridisols** (id-aridus/dry) dry soils, ochric epipedon, sometimes argillic or natric subsurface horizons.

**Entisols** (ent-recent) little profile development ochric epipedon is common. (least developed) (MOST COMMON)

**Gelisols** (el-gelid, very cold) permafrost, often with cryoturbation.
Histosols (ist-histos, tissue) peat/muck > 20% organic matter.
Inceptisols (ept – inceptum/beginning) young soil with few diagnostic features, oehric or umbric epipedons, cambic subsurface horizons.

Mollisols (oll – mollis, soft) mollic epipedon, high base saturation, dark soils, some with argillic or natric subsurface horizons.
Oxisols (ox-oxide) oxic subsurface horizons, highly weathered.
Spodosols (od-spodos, wood ash) spodic subsurface horizon. The UP!
Ultisols (ult-ultimust, last) argillic or kandic horizons, low base saturation.
Vertisols (ert-verto, turn) high in swelling clays, deep cracks.

SUBORDERS
- 2nd level classification (63 suborders)
- Based on soil moisture/temperature/parent material regimes, etc.
- Has 2nd part to the name (Formative Element)

GREATGROUPS
- Subdivisions of suborders based on; (kind, arrangement, and degree of expression of horizon)
- More than 300 Great Groups!
- 3rd part to the soil name

SUBGROUPS
- More than 1,300 subgroups!
- Names used as adjectives (ex: Ty’pic’)

FAMILY
- Subdivisions of subgroups (8,000!)
- Originally intended to be used for major interpretation for growing plants.
- Most based on;
  - Subsoil particle-size/distribution classes (ashy, fragmental, sandy, clayey, etc.)
  - Subsoil mineralogical classes (gypsic, carbonatic, magnesic, etc.)
  - Cation exchange capacity of the clays (superactive, active, semiactive, subactive)
  - Soil temperature regimes
  - Depths

SERIES
- Series are subdivisions of families, and the ‘most specific’ unit of the classification system.
  - Over 19,000 in the US!!!!
  - Names based on geographic place names (nearest town, river, county) where series was first recognized.
  - No specific limiting criteria, often based on; (kind, thickness, arrangement of horizon, color, texture, etc.)
  - Mappable unit in the soil surveys.

Phases
- While not an official category within soil taxonomy, Phases are recognized within a series, denoting slope, surface-texture, or presence of rocks, etc.
- For example;
  - Rubicon Sand, 0 – 6% slopes
  - Witbeck Very Stony Muck, extremely boulder
  - Charlevoix Sandy Loam, 0 – 4% slopes

Soil Water
HYDROLOGIC CYCLE – earth has 1,400 million km$^3$ of water involved in the cycle. (Oceans/Atmosphere)
- ‘Movement’ or in ‘Storage’ (Oceans)
- Surface = runoff or infiltration, interception

Interception occurs when precipitation falls upon vegetation.
- Tree canopies, stems, crop, etc.
- As much as 50% of precipitation can be intercepted
- Thick deciduous forests (less erosion)
- Will then be evaporated
- STEM FLOW – water that reaches the ground, picks up nutrients!
**Infiltration** – process in which free water (precipitation) enters a soil's surface and fills soil pore spaces, becomes soil water.

- **INFILTRATION RATE** – rate at which water enters the soil.
- **INFILTRATION CAPACITY** – maximum rate water can enter a soil.
- \( I = Q \) (volume of water) \( A \) (soil exposed) \( T \) (time exposed)

**Runoff** – amount of water arriving at the ground surface exceeds infiltration capacity/rate.

- **SHEET EROSION/FLOW** - Water accumulates in low areas & moves across sloped surface.
  - Factors:
    - **Antecedent Soil Moisture Conditions**
      - Soils are moist, pore space is already filled when next storm hits.
    - **Timing of Precipitation Events**
      - Soil frost, Frozen top soil and Desert Areas make infiltration not possible, More Runoff!
        - PESHEKEE RIVER, Whitewater Rafting Story
    - **Soil Structure**
      - Loose and open structure = more infiltration
      - Platey structures present = infiltration is slow
    - **Soil Textures**
      - Coarser soil (bigger) = more infiltration
      - Finer Soils = smaller infiltration rates
    - **Slope**
      - Steep slopes = less infiltration
    - **Vegetation Cover**
      - Plant cover will cut down water reaching the ground
        - Add surface runoff by adding surface roughness
          - Natural Forests = very low runoff/high infiltration
          - Tall Grass Prairie = low runoff/high infiltration
          - Most Crops = high runoff/low infiltration
          - No Vegetation = highest runoff/lowest infiltration
    - **Landuse**
      - URBAN – paved, roof tops, high runoff, flash flooding
      - LOGGING – compaction, removes vegetation, lessen seasonal restrictions
      - AGRICULTURE – no natural vegetation, more open soil, lessened by use of crop cover, conservation farming techniques.

**Percolation & Groundwater Zones**

- **Percolation** – water moving “downward” through the soil profile.
  - “PERC TEST” – percolation rate of water entering the soil per. Hour.
  - Spring/Early Summer (important for Septic Tanks/Drain fields)

**Groundwater Zones**

Septic Systems aside, in natural soils, some of the downward percolating water will eventually be lost due to groundwater drainage or be taken up by plant roots.

- **Vadose** – often unsaturated zone above the water table.
  - May include soil/regolith
  - Critical to plant growth! (evaporation, percolating, etc.)
  - Amount of wetness depends on water present.
    - SATURATION – pore spaces filled with water
    - FIELD CAPACITY – 50% water, 50% air, perfect for plants!
    - WILTING POINT – plants removed from enough water.
    - HYGROSCOPIC COEFFICIENT – water held in soil colloids, plants dead!
Capillary Fringe – water pulled upward from water table during times of low rainfall.
- Life or Death in ‘desert settings’!

Groundwater – zone where the soil/sediment pores are completely saturated.
- Actually flows slowly (downhill, mirrors grounds surface)
- Shallow groundwater (recharged by percolating water from above)
- Deep groundwater (further away recharge sources)
- OGALLALA AQUIFER (Great Plains)

Aquifer – groundwater confined to porous geological deposits (outwash plains)
- Deep groundwater will take form
- Porous sandstone = excellent example
- Circular Irrigation Patterns (Well in the center for crops)

Aquiclude – zone relatively impervious to groundwater flow (Springs)
- Clay layers, Shale, Granite

Water Table – top surface of ground water.

If Removal exceeds Recharge = Water table Drops! (Cities, Farming, Industry)

Salt Intrusion – pulling saltwater from wells (BAD!)

Groundwater Pollution – chemicals/pollution getting into groundwater (agricultural fields, landfills, septic tanks).

Soil Aeration & Wetlands

Soil Aeration – under well-drained conditions, molecular oxygen readily accepts electrons & is a strong oxidizing agent. (Reddish Colors in ‘B Horizon’)
- Under conditions of oxygen deficiency, however, soil microorganisms can use other chemicals (Fe$_3^{+}$ & Mn$_4^{+}$) as electrons acceptors and reduce them to lower valence forms. (Blues/Grey, GLEY colors in Histosols)
- Also influences Microbial Breakdown of organic residues…..
  - Reduces conditions; slows the rate of decay
  - Soil gases affected (CO$_2$ prime product released by oxidation)

Wetlands & Wetland Delineation

Wetlands – areas that are typically ‘poorly drained’, ‘poorly aerated soils’ and specialized ‘hydrophytic vegetation’, together forms a terrestrial ecosystem.
- 14% of the world’s ice free land area (Canada, Alaska, Russia)
- Major environmental issue (drained, removed, and destroyed)
- In the U.S., half have been destroyed! (Converted to cropland / cities (USDA, COE)
- Stringent rules for Preservation!

Wetland Delineation – (Boundaries) much time, $, and effort is spent each year to determine the geographic location and extent of wetlands.
- Boundary between wetlands / Bodies of Water
  - (Rooted emergent plants = wetlands; not deep water)
- Dry side Boundary between wetlands / Dry Land
  - (Most impacts hard to define!)
3 Characteristics: Wetland Hydrology, Hydric Soils, Hydrophytic Plants

1.) Wetland Hydrology

**Residence Time** – presence of poorly drained settings where water is collected below/above groundwater surface for a period of time.
- Longer = Wetlands
- Weakly developed shorelines may develop in times of high water.
- Variation **hydroperiods** may be daily, seasonal, decades, etc.

2.) Hydric Soils

- Commonly found within the order Histosols, in Aquic suborders and subgroups, and/or in Aquic Soil Moisture Regimes (SMR).
- Defined as soils that are;
  - Subject to periodic saturation
  - Undergo reducing conditions at substantial times of the year
  - Exhibit hydric soil indicators
- Thick dark surface layers, not completely-decomposed
- Redox Depletions
  - Zones where reduction has removed or depleted the iron coating from mineral grains, results in blue/gray (GLEYING)
- Redoximorphic Features
  - Mottled zones, where low chroma reduced areas contrast with reddish oxidized areas of the soil, signals fluctuating water table.
  - Manganese nodules (hard black nodules)
  - Oxidized root zones (reddish castings)

3.) Hydrophytic Plants

- Have evolved specialized mechanisms to live in saturated soils.
- Mechanisms;
  - Arechyma features (allow the plant to send oxygen to roots)
  - Buttress Root bases for support (Common in Cyprus)
  - Shallow root systems, pick up any available oxygen
  - 'Knees' roots that allow them to access atmospheric oxygen (Mangroves)

Soil Mapping & Soil Surveys

Phases;

- **INITIAL PHASE** – learning as much as possible about the study area!
  (Climate, geology, geomorphology, ecology)
- **CREATION of the MAPPING LEGEND** – list of all possibilities that may be encountered while mapping the soils in a given area.
- **SECOND PHASE** – FIELDWORK – a team of soil scientists trained in the making of field profile descriptions and soil mapping is turned loose in the study area.
  - Spatial boundaries are traced…
- **DELINEATION SOIL MAP UNITS/BOUNDARIES** – finding the geographic limits of the soil mapping units in the legend (boundaries)
  - Soil auger, Coring, or Probing (can’t dig soil pits everywhere!)
- **THIRD STAGE** – **SOIL REVIEW/DRAFT MAPS** – Soil mappers will host a gathering of soil mappers and researchers to review the work to date.
- **FOURTH STAGE** – **FINAL MAPS** – trying to create a series of final maps that typically are published in a soil survey.
  - 'Orthophotos' (air photos; distorted & exaggeration takes them out)
- **LINE CORRECTIONS** – before mapping, maps can be completed, must link up in terms of the line segments.
- **SOIL SURVEY DOCUMENT** – prepare a written report that describes the sustainability of each mapping unit for various land uses.
High-Tech Tools for Soil Mapping

**Aerial Photographs** – used in concert with soil pits & auger holes, most import tools for soil mappers.

- Vertical Images usually taken from an airplane using sophisticated mapping camera that use oversized film.
- 9X9 prints made directly from negatives…..
- Most common *Panchromatic* (all visible light, black & white / cheapest)
- Infrared Images used for Mapping Vegetation.
- Allows Stereographic Viewing (3D), reveal proxy indicators of soil types (Vegetation)

**Stereographic Viewing** – aerial photographs are often taken as a series of overlapping images.

- Produces a 3D Model which allows you to see topography, trees, etc.!

**Proxy Indicators** – indirect indicators of the presence of certain features of properties or conditions.

- Learn what surface characteristics indicate
- Red Pines = Sandy textural soils
- Hardwoods = loamy textures
- Forested Wetlands = Histosols / Aquents / Aquods

**'LiDAR’** (Light Detection and Ranging)

- Airborne Laser mapping that directly measures the shape of the earth’s surface.
- 1,000 points per. Second!!!! Accurate up to ½ an Inch!!!!!
- Can work through tree canopies (can penetrate underground)
- Help create DEM’s!

**GPS** (Global Positioning System)

- Helps knowing your exact location while in the field (auger holes)

**Satellite Imagery** – imagery using electro-optical scanners housed in Satellite platforms.

- Records radiation at band ranges
- Worse than aerial photography, but can take pictures under bad weather conditions!
- Produces ‘MODIS IMAGES’

**GPR** (Ground Penetrating Radar)

- Sends pulses of energy downward into the ground
- Constructs a cross-section through the soil (non-invasive)

Soil Surveys are “a systematic examination, description, classification, and mapping of the soils in a given area.”

Joint efforts (National Cooperative Soil Survey) & (USDA Natural Resources Conservation Service), and other Federal Agencies.

Different levels of detail dependent of scale (detail), and person mapping.

**RECONNAISSANCE LEVEL** – (5th Order Survey): Satellite Mapping

Mapping Units (Legend)

- **Phase** – subdivisions of a series that is based on some important characteristics that influence the use of soil. (Slope, Texture, Erosion, Stoniness)

- **Consociations** – micro-variations in soil forming factors, will include ‘inclusions’ of similar soils and ‘contrasting’ soils…..

- Consists 50% of a single phase, and the other 50% similar soils!

- <15% soil inclusions (wetlands, outcrops)

- **Soil Complex** – ‘2 or 3 contrasting soils’ in an intermingled pattern, so complex that soils can’t be exactly separated while mapping.

  (Example: KEWEENAW – KALASKA COMPLEX, 1-12% Slope, Dissected)

- **Soil Association** – a grouping of soils that typically occur together on the landscape, but could be mapped separately. Used in 3rd Order Surveys or ‘General Soil Maps’ (BROAD!)

- **Undifferentiated Group** – 2 or more soils that could be mapped separately, but are mapped as one unit because similar interpretations can be made for use & management. Lacks the word “Complex”

  (Example: GREENWOOD and DAWSON SOILS/MUCK)
Major Parts

1. General Soil Mapping – typically a 4th order soil map of the county printed in color, etc.
2. Detailed Map Sheets – 2nd order soil maps consisting of individual sheets. (1:24,000)
   orthophotos keyed to an index map.
3. Interpretive Information – report portion of the survey (descriptions)
   -GIS is how it is now packaged (Web-Based WSS)

SOIL GEOGRAPHY
Looking at Location, Distribution, and Pattern of occurrence of various kinds of soil.
MOST in the WORLD = ENTISOLS (16.3%, degraded)
MOST in the US = MOLLISOLS (22.4%, greatest agriculture soil)

ALFISOLS – (high base status soils with Argillic Horizons)
- Well developed ‘B Horizon’, Argillic
- Fairly Fertile
- Forests develop = O, A, E, and B Horizons
- 10% of the Earth’s ice free surface (Older Landscapes)
- Broadleaf Deciduous Forests (North America, China, Europe)
- Grass/Broadleaf Forests (Africa, South America, California)
- Broadleaf/Evergreen Trees (Africa, Australia)
- PODZOLIZATION – leaching (Clay rich B Horizon)
- Uses: Crops, Hayland, Pasture, Range, and Forests

ANDISOLS – (soils with andic soil properties; Volcanic)
- Ash, Pumice, Cinders (Adopted 11th Soil Order in 1989)
- Less than 1% of Earth’s ice free area
- Iceland, Pacific Ring of Fire, Rift Valley, Africa, Europe, U.S. Northwest
- Steep Slopes / High Elevations
- Old! (Holocene & before)
- Uses: High Elevation Forests, Steep Slopes limit Farming, Timber harvesting, Farming (Japan, Hawaii, South America)
**ARIDISOLS** – (soils of Dry Regions)
- Dry more than 90 consecutive days a year!
- Ochric A Horizons, Calcic B Horizons
- Found in cool temperature deserts & warm subtropical deserts
- Covers 12% of the Earth’s ice free area
- Northern Africa, Middle East, Central Australia, Patagonia, U.S. Southwest
- Old! (Up to 1 million years old!)
- Crusts (cemented surface)
- Pavements (sand blasted surface)  
  **VEUTIFACTS**
- Uses: Surprisingly fertile (but lack water), Range, BLM Land
- **SALINIZATION** – leaves salt after irrigation!

**ENTISOLS**
- Little or no evidence of development of Pedogenic Horizons
- Horizons are lacking, but plant growth is evident, unconsolidated
  Parent Materials are functioning as soils.
- Only Ochric A Horizons, Sometimes Albic E Horizons, and overlying C Horizons
- 16% of Earth’s ice free surface (GROWING)  **LARGEST!**
- Young land surfaces (fresh deposits)
  - Very slow (too cold, dry, or wet)
  - Continually being disturbed (hill slopes, human related)
  - Being disrupted by continual deposition (active Eolian landscapes)
  - Difficult, exceptional resistance of Parent Material to weathering
  - Africa, Middle East, U.S. Southwest, Central Australia
- **MELANIZATION** – adding organics, darkening, making an A Horizon
- Uses: Erosion by water/wind/mass wasting make steep hilly slopes;
  Engineering problems, Flooding Hazards, Some use for Range, Delta Farming.
GELISOLS
- Contains Permafrost (continuously below 0°C) within 100 cm or 200 cm of surface.
- If CRYOTURBATION (soil disturbance/frost) is found within 100 cm of surface.
- Patterned Ground (ice wedged polygons & stone nets)
- Found in the Northern Hemisphere, Antarctica, and High Elevations
- 8.6% of land (DROPPING)
- Can be fairly Old
- Soil Genesis: gains, losses, transformations, and translocations
  - Organic Material is ‘Very Slow’!
    - Scott’s South Pole (1910-13), Horse Manure still there!
    - Some areas greater, higher sunlight (near Oceans)
- Uses: Fragile! (impacts stay for a long time!), Dust accumulations may heat up quicker & melt gelisols, Mining & Petroleum extract resources, reacting to Global Warming! (Histosols).

HISTOSOLS (Organic Soils)
- Commonly Saturated
- Typically profiles consist of thick O Horizons, Overlying C Horizons
- Peats/Muck (water is restricted due to flow)
- Canada, Scandinavia, Russia, Eastern UP!
- Holocene in age
- 1% of Earth’s ice free land area
- Organic accumulations, Redox features, Redoximorphic features…
- Uses: Produce Crops, Forested Wetlands, Wildlife, Recreation Activities
  - Mined for Potting materials (Russian & Britain)
  - Many areas drained; Organic material oxidation (Fire!)
    - Florida (Histosols down 3 cm a year!)
**INCEPTISOLS** (Embryonic Soils / Few Diagnostic Features)
- *Wastebasket Soil*; Ochric epipedons / Albic horizons in Entisols
- In equilibrium unless a change (Mixture of the above)
- Steeply Sloping (Not in Arid Areas!), Cooler temperature zones, Valley delta deposits (River Terraces).
- 10% of the Earth’s ice free surface
- Europe, Alaska, China, U.S. Appalachians
- Leaching (Humid Environments), No one process happening!
- Uses: Productive agriculture (rice = river terraces), Woodland, Pasture, Recreation, Wildlife, Pasture

**MOLLISOLS** (Grassland Soils of Steppes & Prairies)
- Dark, Fertile, Grassland Vegetation (Thick A Horizon)
- Lowland Hardwood, well drained Forest Soils
- Short-Grass Steppe & Tall Grass Prairie
- U.S. Great Plains, Argentina, Central Asia, Ukraine, Russia, Mongolia
  - PRODUCTIVE! (Has caused Conflict!)
- 7% of the Earth’s ice free surface
  - **Melanization** – darkening of the soil by additions & decomposition of organic matter, dominant pedogenic process.
  - Allows grass roots to go into soil.
- Eluviation & Illuviation
- Uses: Food Production (Highly Productive) (Erosion = Farming!)
  - Wheat, Corn, Beans, Beets
  - Rangeland (Western U.S.)
  - Not much natural vegetation (Still in Mongolia)
OXISOLS  (Low-Activity Soils; MASSIVE ‘B HORIZON’)
- Mineral soils with an oxic horizon within 1.5 meters of the surface
- Surface exceeds 40% clay (Kandic Horizon)
- Most contain less than 10% weatherable material
- Most weatherable soil type!
- 7.5% of Earth’s ice free land area. (Inter-Tropical Region)
- Central Brazilian Plateau & Congo
- On Highly weathered transported material
- Stable ‘Upland’ Summit Positions
- Very Ancient (Millions of years old!!)
- Tropical Rainforest, Semi-Deciduous, Savana
- Secondary iron oxide / well drained (cemented hard!)
- MELANIZATION / HUMIFICATION
- Rapid Decomposition!!!!
- Disturbed by animals readily
- Uses: Cultivation / Grazing (Indigenous People)
  - Sugarcane, Pineapple, Bananas, and Coffee

SPODOSOLS  (Subsoil Accumulations of Humus/Sesquioxides)
- Contains Spodic Horizon, Illuvial accumulations of Organic Matter with aluminum, with or without iron.
- Typical O Horizon, Thin A Horizon, Heavily leached E Horizon!
- 2.5% of Earth’s ice free area
  - The UP!
- Found in Humid Boreal zones, Needleleaf Trees (Acidic)
- Northern Great Lakes, Southern Canada, Russia, Scandinavia, Even Florida!
- Course textured parent material (sand)
- PODZOLIZATION – forestry, pasture, hay, some cultivated crops
  - Potatoes, ‘Blueberries’, Rutabaga, Red Clover, Oats
ULTISOLS (Low Base Status Soils)
- Saturation <35% at 2 meter depth
- Typical O, A, and well developed Bt Horizons!
- Fragipans
- Hilly developed ‘Alfisol’
- Highly weathered (just under oxisols)
- Found generally on old landscapes (Not Glacial Terrain!)
  - Humid, Subtropical, Savanna
- 9% of Earth’s ice free area
- Southeast Asia, Eastern Australia, Southeast U.S., East Africa, South Brazil
  - PODZOLIZATION dominates (leeched; Old!)
- Clay accumulation (LESIVAGE) Well developed B Horizon
- Uses: Terracing (needs fertilization) Abandoned Farms
  - Agriculture & Timber

VERTISOLS (Shrinking & Swelling Dark Clay Soils)
- Highly expanding clay, Deep wide Cracks!
- Shrinking when drying, Swell when wet
- Australia, Deccan Plateau (India), Sudan, Egypt, Chad, Puerto Rico, Taiwan
- U.S. in the Mississippi Valley, Texas
- 2% of Earth’s ice free area
- Uses: Agriculture, Range

U.S. Soil Geography
MOLLISOLS – Great Plains
ULTISOLS – Southeast
ALFISOLS – Midwest
ARIDISOLS – Southwest
SPODOSOLS – Northeast, Great Lakes, Florida
ENTISOLS – West
INCEPTISOLS – Appalachians
ANDISOLS – Pacific Northwest
GELISOLS – Alaska
Michigan Soil Geography
ALFISOLS – Southern Half of the LP (Farming)
- Climate = Dfa (cold winters, hot summers)
- Vegetation = Deciduous Forest
SPODOSOLS – Northern LP & the UP (Forested)
- Climate = Dfb (cold winters, warm summers)
- Vegetation = Mixed Forest
ENTISOLS – Formed dunes, beach ridges, young river deposits
HISTOSOLS – Suprists, former wetlands, (Delta & Menominee Co.’s)
INCEPTISOLS – Drained former glacial lakes
MOLLISOLS – Southern LP, wet plains, coastal grasses

Soil Archaeology
Archaeology – the study of part human behavior.
- Study of artifacts, refuse, and other features left behind.
- Geoarchaeology – using geosciences to answer archaeological questions.

On Site;
- Stratigraphy – soils represent times of surface stability and are often found in buried context within stratified archaeological sites. (i.e. – Paleosoils)
- Dating – developing indices allow establishment of surface ages, giving maximum possible age of archaeological material (i.e. – Soil Artifacts Context Model using the POD Index)

-Paleoenvironmental Reconstruction – certain soil types correlate closely with particular environmental conditions, allowing their use as proxy indicators of climate, drainage, vegetation cover, etc.

SOILS MODIFIED BY HUMANS
Through: Compaction, Digging, Planting, Additions
- Leave traces in the soil profile = features

Hearth – (firepit) common prehistoric campsites & villages.
- Material of fire breakup into soil and ash stains in the sand.

Pits – excavated by prehistoric people for disposal of refuse, caching food, or other purposes.
- Up to 100 cm. below the surface.

Post Mold – (holes) created when wood posts are into the ground.

Soil – Artifact Context Model (Anderton, 1999)
- Method for providing a relative age established for archaeological sites that have no diagnostic artifacts/datable carbon.
- Need to examine the relationship between soil horizons/artifacts and features;
- Artifacts/Features that cut across soil horizons - (Artifact = Postdates; Younger)
- Artifacts/Features that are cut across by soil horizons – (Artifacts = Older!)

ARCHAEOLOGICAL (Site Prospecting)
- Information is collected; (Remote Sensing, Research, Geoarchaeological Applications)
- Look for marks (Shadow Marks, Soil Marks, Positive Crop Marks, Negative Crop Marks)