Concepts of Soil Genesis

• Processes vs. Factors

• Simultaneous Processes

• Distinctive Regimes
Concepts of Soil Genesis

• Processes act through space and time
  – Space
  – Changes in volume
    • Inflation and deflation

  – Pedon Scale Inflation
    • Additions of OM
    • Changes in bulk density
    • Eolian Deposition
Concepts of Soil Genesis

– Pedon Scale Deflation
  • Erosion
  • OM decomposition

– Landscape Scale
Concepts of Soil Genesis

• Processes act through space and time
  – Time
    • Dynamic vs Static

• Scale of observation

• Defining $t_0$
  – Varies for different soil features
  – May be driven by climate and/or vegetation change
Concepts of Soil Genesis

• Simultaneous Processes
  – Multiple working hypotheses to deal with multiple variables

  – Generally multidisciplinary
    • geology/mineralogy interaction with biology

  – Conclusions drawn from most supportable hypothesis
Concepts of Soil Genesis

• Soils as synthographs of natural history
  – Key processes – dissipation of energy
    – Form of energy dissipating process will change as the soil matrix changes
    – Same type/rate of energy input realized as different processes depending on current “state” of the soil system
Pedogenic Trajectory

Fig. 7.3 A general scheme illustrating the genetic and lithologic linkages among the 12 soil orders in Soil Taxonomy. This scheme illustrates only a few possible genetic pathways. Soils could evolve along different pathways, regress or remain within one order for millennia.
Concepts of Soil Genesis

• Soils are clay factories
  – Dominant component of Soil Taxonomy
  – Recognizes long term stability of landscape
  – Invariant temporally in human time scale
  – Processes
Concepts of Soil Genesis

- Genesis can’t be sole basis of classification
  - Convergence
  - Divergence
  - Classification based on quantifiable properties
  - Soil genesis is useful to predict soil properties
Pedogenic Models

• Conceptual Models
  – Essential tools in soil science
  – Simplified descriptions of natural systems
  – Provide insight into soil system dynamics and system interrelationships
  – Basis and foundation for soils research and study
  – Testable models
Pedogenic Models

• Functional-Factorial Model
  – V.V. Dokuchaev
    • Russian Chernozems
  – Soils formation function of interplay of several state variables
  – Does not include processes
Pedogenic Models

• Functional-Factorial Model
  – V.V. Dokuchaev

\[ P = f(k, o, g, v) \]

\( k \) – climate; \( o \) – organisms; \( g \) – parent material; \( v \) – age; later added time

Wilde (1949)

\[ S = f \int (g, e, b) \, dt \]
Pedogenic Models

• Functional-Factorial Model
  – Hans Jenny
  – Factors of Soil Formation 1941

  – Soil definition (from Joffe 1936): “The soil is a natural body, differentiated into horizons of mineral and organic constituents, usually unconsolidated, of variable depth, which differs from the parent material below in morphology, physical properties and constitution, chemical properties and composition, and biological characteristics.”

  – Anisotropy – vertical and horizontal
Pedogenic Models

• Functional-Factorial Model
  – Soil system – physical system, functions as a natural body in an ecosystem, integral part of an ecosystem

  – Open systems – material and energy may be added and/or removed

  – System definition
Pedogenic Models

• Functional-Factorial Model
  – System boundaries
  – Arbitrary separation
  – Still struggle today on boundary between soil and not soil
Pedogenic Models

• Functional-Factorial Model
  – Define system state – quantifiable properties

  \[ F(s_1, s_2, s_3, \ldots) = 0 \]

  – Change in \( s_1 \) = change in state
  – Dynamic – scale of change
    • Soil moisture

Instead of quantifying \( s \) – quantify factors leading to \( s \)
Pedogenic Models

• Functional-Factorial Model

intermediate states

Parent Material → Soil (mature)

• Soil Forming Factors
  – PM
  – Topography
  – Climate
  – Organisms

\{ Passive
\{ Active
Pedogenic Models

• Functional-Factorial Model
• \[ s = f(cl,o,r,p,t) \text{ or } S = f(cl,o,r,p,t) \]

• Independent factors
  – For a given set of factors the soil system is fixed
  – Only one type of soil exists under a fixed set of conditions
  – Jenny proposed factorial method of solving this equation
    • Sequences – vary one property while holding all others constant