Making a soils map from a geopedological map

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Starting point

- **A geopedological map**
  - API with delineations grouped in map units
  - A hierarchical geopedological legend for the map units, e.g.
    - Pi: Piedmont
    - Pi2: Fan
    - Pi21: Alluvium
    - Pi213: apex
  - ... or similar names in another API scheme

Ending point

- Same map units and delineations...
- ... but with information about the *soils* that occur in them, e. g.
  - "Dystri-skeletic Cambisols, gravely silt loam, gently sloping"

Naming soil map units

- **1. Type of map unit:**
  - degree of homogeneity (homogeneous vs. compound): how many ‘different’ soils occurs?
  - (in the case of compound): pattern of the different soils
- **2. Names of soils in the map unit**
  - referring to a classification system and/or local names

Soil classes

- **Central concept**
  - ‘modal pedon’
- **Limits of properties**
  - controls which pedons are allowed into the class

Higher-level classes

- **National or world classification system**
  - World Reference Base (WRB)
  - Soil Taxonomy (US, applied elsewhere)
  - Mückenhausen (D), Référential pédologique (F) etc.
- **Locally-defined higher classes**
  - families, forms (groups of series)

Detailed classes:
The Soil Series

- **A grouping of pedons that are 'similar enough' in their:**
  - characteristics
  - behaviour in the landscape
  - site features, field morphology
- **Therefore, they act 'similarly enough' for all practical land uses**

Three views of the soil series

- **Field**
  - easily recognisable and mappable by the experienced field soil surveyor
- **Properties**
  - a natural and restricted range
- **Interpretation**
  - the information carrier for information to the land user

Correlation of a series to higher-level classes

- **The central concept of the series is classified into (‘correlated to’) a higher-level class**
  - If not, the classification system has a hole
  - We classify the ‘representative’ pedon
- **Some pedons of the series may be correlated to other classes**

Example (ISRIC)

- Mappable series is correlated to Hyperdystri-Umbric Andisols
- Some pedons mapped in the series correlate to Hyperdystri-vitric Cambisol
  - E.g., if the permitted thickness within the series of the andic Ah is 25 to 35cm
  - $\geq$ 30: Andisols; <30 Cambisols
  - Behaviour, landscape relations etc. are ‘similar enough’
  - Splitting the series would be un-natural

Similar soils

- ...with respect to a named soil
- Allow simpler names, avoid too much irrelevant (to user) detail
- Criteria:
  - occur in intimate association on landscape
  - alike in most properties
  - share diagnostic (class) limits
  - do not affect interpretations ‘too much’

Dissimilar soils

- ...with respect to a named soil
- Either:
  - occur on other landscape positions, or
  - differ in more than a few properties, or
  - do not share diagnostic limits, or
  - taken as a whole, behave differently
- Example
  - long, thin poorly-drained depressions (drainage ways) within a broad well-drained terrace

Limiting vs. non-limiting

- Applies to dissimilar soils
  - ... with respect to the named soil
- Limiting: less suited to major land uses
- Depends on purpose of survey
- Not such a useful concept for multi-purpose surveys

Homogeneous vs. compound soil map units

- **Homogeneous**
  - can be managed as a unit
  - there may be some contrasting soils, but not enough to affect most management decisions
- **Compound**
  - At least two contrasting components that must be managed differently

Criteria for homogeneous soil map units - 1

- Based on estimates of the proportion of different kinds of pedons in the map unit
- statistical sampling; problems:
  - often biased location of samples
  - small number of samples wide confidence limits
- geomorphic analysis
  - detailed API within map units
  - measurement of detailed areas

Criteria for homogeneous soil map units - 2

- **Limits**
  - ≥75% in named soil or similar
  - ≥50% in named soil
  - ≤15% dissimilar, limiting pedons (all)
  - ≤10% dissimilar, limiting pedons (any one class)
- **Then called a ‘consociation’**
  - and named for one soil class

Compound map units (1)

- **Association**
  - components occur in a predictable landscape relation
  - can be mapped separately at a ‘realistic’ larger scale
    - USA from 1:24 000 (MLA 2.3ha) to 1:12 000 (MLA 0.6ha)
- **Basic idea**
  - easy to locate the components in the field

Compound map units (2)

- **Complex**
  - fails the ‘predictable’ test for assocation
- **Basic idea**
  - contrasting soils occur in intimate association
  - they have to be managed together, i.e. both have to be taken into account at the same time

Strategy of GP soil resource inventory

- Stratify landscape in a four-level hierarchical legend
  - API
  - Field checks to verify API lines, but not by examining soils
- Characterise strata (API map units) in terms of their soil components
  - Field sampling
- Name strata by their soil components

Field sampling

- Sample areas (blocks) selected on AP
- Field visit to sample area; selection of representative site for each unit
- Full description and sampling of pedon at representative site
  - pit or mini-pit; laboratory samples
- Limited description of augerings near the sampled pedon
  - some idea of local variation

Correlation of the API map unit

- List the representative pedons from field sampling
- Select a 'most representative' one
- See if others are similar enough for a consociation
- If not, select a second 'most representative' from the remaining population, etc.
- Name map unit from representatives

Extrapolation

- Check API in non-sampled areas
- Possibly some widely-spaced supplementary samples

The resulting legend

- structured with GP units
- named as soil units
- serves two purposes
- Example:
  - [using series names] ‘Pi213’: Piedmont, apex of alluvial fan: Chenango
  - [using taxonomic names] ‘Pi213’: Piedmont, apex of alluvial fan: Dystri-skeletic Cambisols

Phases

- Characteristics of the map unit not included in the soil name
  - Detailed soil characteristics of the surface layer
    - texture, thickness, gravels
  - Detailed internal soil characteristics not included in the class definition
    - depth, compaction
  - External characteristics important for land use
    - slope, position, aspect; artificial drainage
- Important for interpretations and use

Use of phases in map unit names

- Locally-defined
  - not part of the classification system
- Consistently-mappable
- Important differences
- Examples
  - Degree of current erosion (‘severely eroded’)
  - Slope and landform (“3-8%, convex’)
  - Surface (‘gravely silt loams’)
  - Artificially drained (‘drained’)

Map scale

- **Basic issue**
  - What can be shown on a map at a given scale?
- **Inverse problem**
  - What scale is needed to show a given level of detail?
- **Conceptual issue**
  - What kind of map units occur at different scales?

Map scale: preliminary definitions

- **Ground vs. map measurements**
  - Linear
    - ground meters   ground km
    - map meters   map mm or cm
  - Area
    - ground m^2 ground ha (10^4 m^2), km^2 (10^6 m^2)
    - map m^2 map cm^2 (10^{-4} m^2), mm^2 (10^{-6} m^2)
  - Area = $Linear^2$
    - 2x scale   4x area, 10x scale   100x area

Showing map scale

- **Scale ratio**
  - 1:50 000
- **representative fraction (RF)**
  - $1/50000 = 0.00002 = 2 \times 10^{-5}$
- **scale number (SN)**
  - 50 000

Location accuracy

- **Maximum location accuracy**
  - 0.25mm (manual)
  - 0.10mm (automatic)
- **Example: 1:50 000**
  - 12.5m manual
  - 5m automatic

Legible delineations

- **Minimum legible delineation (MLD)**
  - Arbitrary; 0.4cm² = 40mm²
  - Other authors use 0.25cm² = 25mm²
- **Optimum delineation (OLD)**
  - 4x MLD
- **Narrow delineations**
  - ≥3mm

Legible areas

- **MLD, OLD converted to ground area**
- **ML<u>D</u>, OL<u>D</u>   ML<u>A</u>, OL<u>A</u>**
- **Simple formula for MLA:**
  - $(SN / 1000)^2 / 250$
- **Example: 1:50 000**
  - MLA 10ha, OLA 40ha
  - Narrowest 150m

Spot and line symbols

- **Purpose**
  - To represent contrasting soils, even if the map scale can't show them as polygons
- **Lines represent narrow delineations**
  - implicit width <3mm
- **Spots represent small areas**
  - implicit size <40mm²

Actual maps

- Distribution of delineation sizes
  - quartiles, minimum
  - average size delineation (ASD)
- Index of Maximum Reduction (IMR)
  - "the factor by which the scale of the map could be reduced before the ASD would become equal to the MLD"
  - IMR = √ (ASD / MLD) = √ (ASA / MLA)
  - At IMR=1, the ASA = MLA
  - Ideal IMR=2, so that ASA=OLA

Cartographic & categorical detail

- **Cartographic**
  - how detailed is the pattern of polygons
  - controlled by the scale
- **Categorical**
  - how detailed are the descriptions of the entities (here, soil units)
  - detailed = limited range of properties
- **Should correspond**

Typical soil maps

- Detailed
  - 1:25 000; mostly consociations of phases of soil series
- Semi-detailed
  - 1:50 000; mostly associations of phases of soil families, some consociations of higher-level groups (not as useful)
- Reconnaissance
  - 1:250 000; mostly associations of higher-level groups