Major Soils of the World
- and their physical properties -

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Major soil groupings (1)

- Organic soils (*Histosols*)
- Soils conditioned by man (*Anthrosols*)
- Soils conditioned by parent material (*Andosols, Arenosols, Vertisols*)
- Soils conditioned by topography (*Fluvisols, Gleysols, Leptosols, Regosols*)
- Soils conditioned by time (*Cambisols*)

Major soil groupings (2)

- Soils conditioned by climate:
  - Tropical and subtropical (*Ferralsols, Acrisols, Lixisols, Nitisols, Alisols, Plinthosols*)
  - Arid and semi-arid (*Gypsisols, Durisols, Calcisols, Solonchaks, Solonetz*)
  - Steppe (*Chernozems, Kastanozems, Phaeozems)*
  - Temperate (*Luvisols, Albeluvisols, Podzols, Planosols, Umbrisols*)
  - Cold (*Cryosols*)

Histosols

Influenced by water, resulting in accumulation of organic materials

Histosols

Physical properties:

- High water content
- High organic matter content
- Low bulk density
- High groundwater table
- Low bearing capacity
- Subject to subsidence upon drainage


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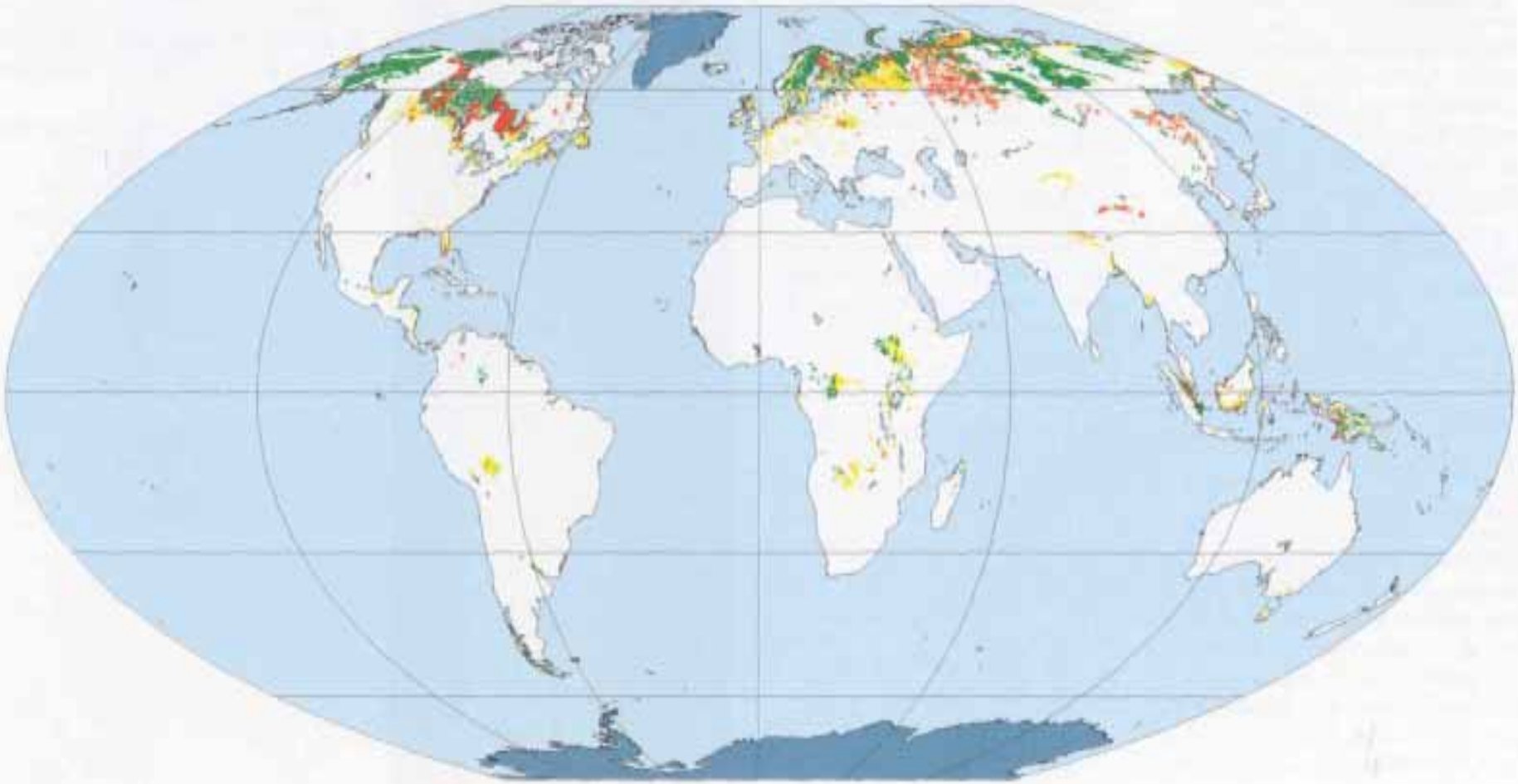
• Distribution of Histosols •



Dominant

Associated

Inclusions

Miscellaneous lands (Glaciers, No data)

Flat Polar Quartic Projection

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Anthrosols

Soils under long-time cultivation, modified to the extent that the original soil has been completely changed

Hortic Anthrosols

Develop under long-continued deep cultivation, intensive fertilization or application of organic residues, resulting in:

- Improved soil structure
- Improved water-holding capacity

Hydragric Anthrosols

Develop under long-continued paddy rice cultivation, resulting in:

- Destruction of topsoil structure
- Development of a slowly permeable plough pan
- Mobilization and leaching of iron and manganese


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Irragric Anthrosols

Develop under long-continued irrigation with sediment-rich water, resulting in:

- Raising of the land surface
- Increased biological activity
- Uniform soil texture

Plaggic Anthrosols

Develop under long-continued addition of farmyard manure mixed with sods, resulting in:

- Raising of the land surface
- Improved soil structure
- Improved water-holding capacity

Terric Anthrosols

Develop under long-continued addition with earthy manures, compost or mud, resulting in:

- Raising of the land surface
- Improved water-holding capacity

Soils conditioned by parent material

- ***Andosols*** *(soils in pyroclastic deposits)*
- ***Arenosols*** *(sandy soils)*
- ***Vertisols*** *(cracking clay soils)*

Andosols

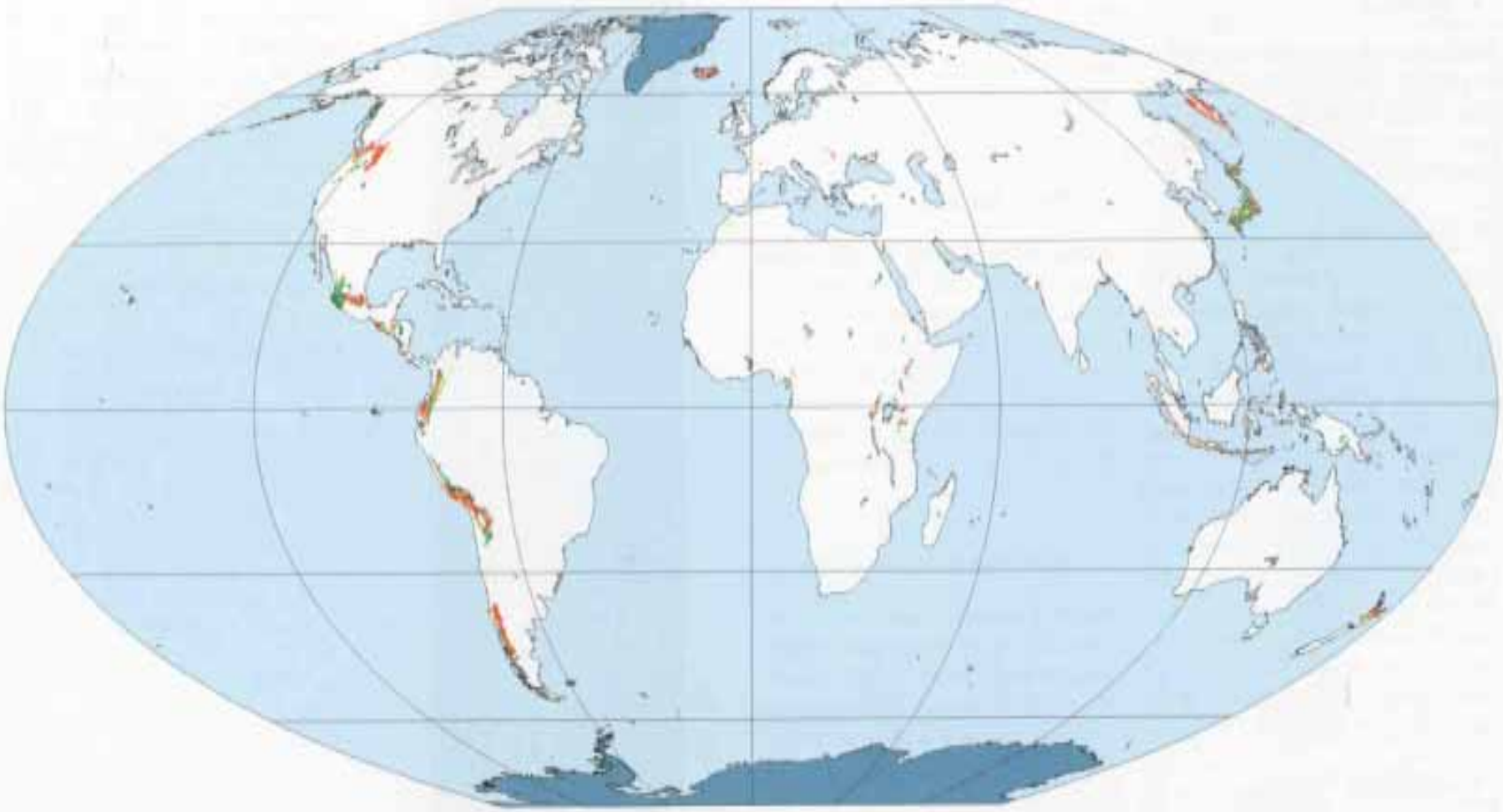
- Rapidly weathering pyroclastic deposits, producing:
  - Under non- or slightly acid conditions such minerals as allophane and imogolite
  - Under acid conditions aluminium-organic complexes

Andosols

Physical properties:

- **Low bulk density** (less than 0.9 kg/dm^3)
- **High water-holding capacity**
- Sometimes "**thixotropic",** i.e. the soil material changes, under pressure or rubbing, from a plastic solid into a liquid stage and back into the solid condition

• Distribution of Andosols •



Dominant

Associated

Inclusions

Miscellaneous lands (Glaciers, No data)

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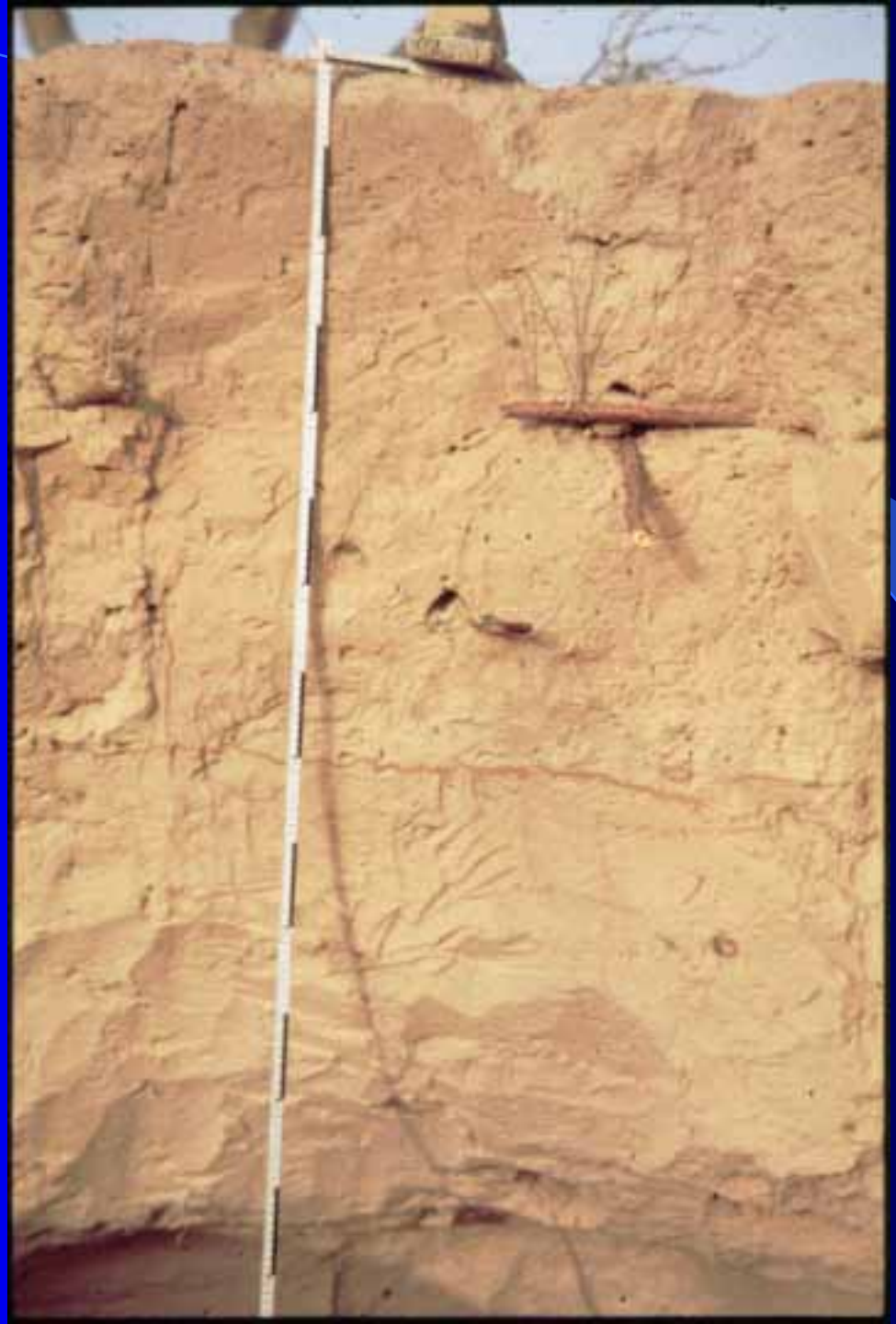
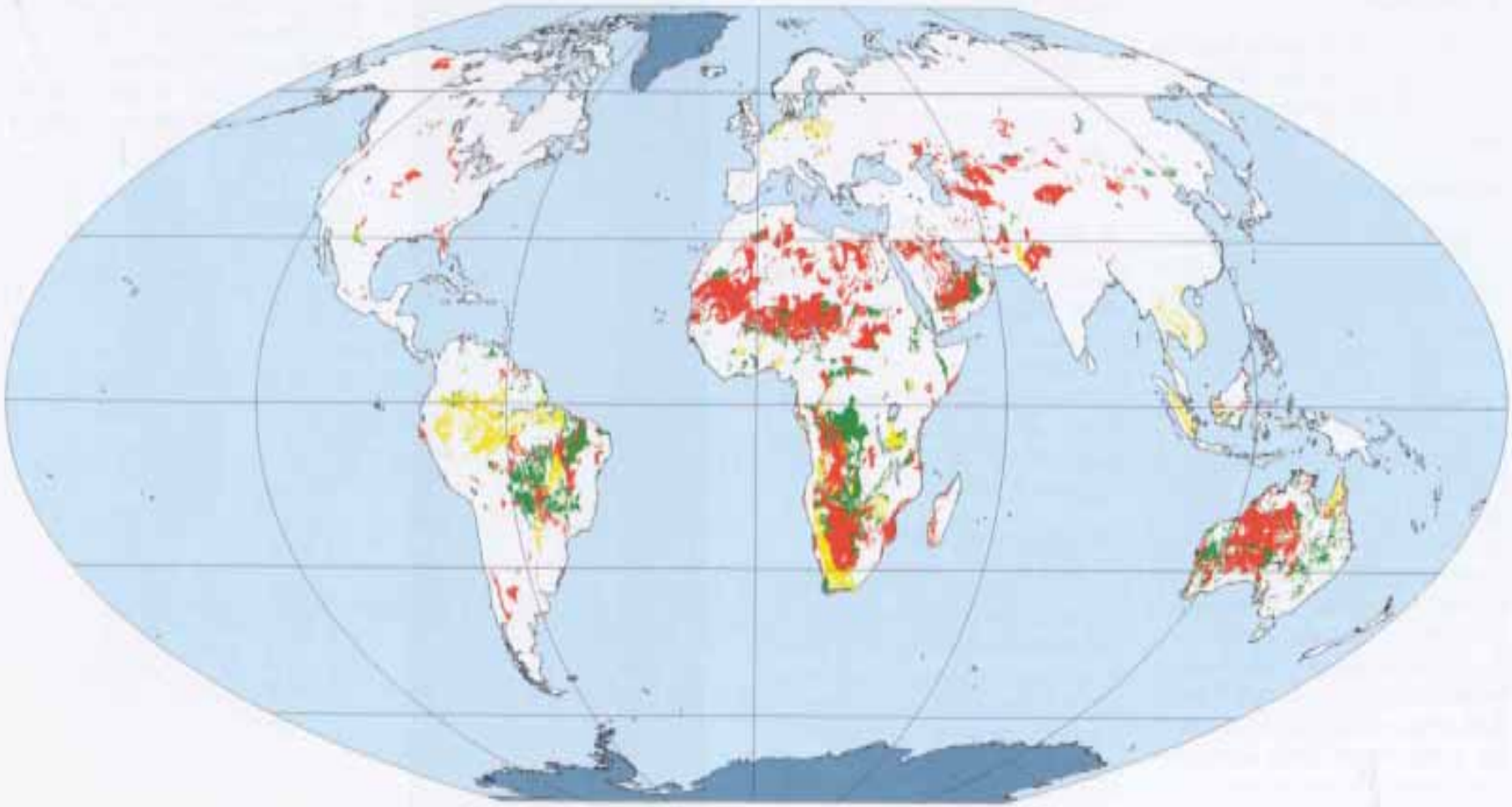
Arenosols

Physical properties:

- **Loamy sand** or **sandy** texture to a depth of 100 cm
- **Low water-holding capacity**
- **Easy to work**



• Distribution of Arenosols •



Dominant

Associated

Inclusions

Miscellaneous lands (Glaciers, No data)

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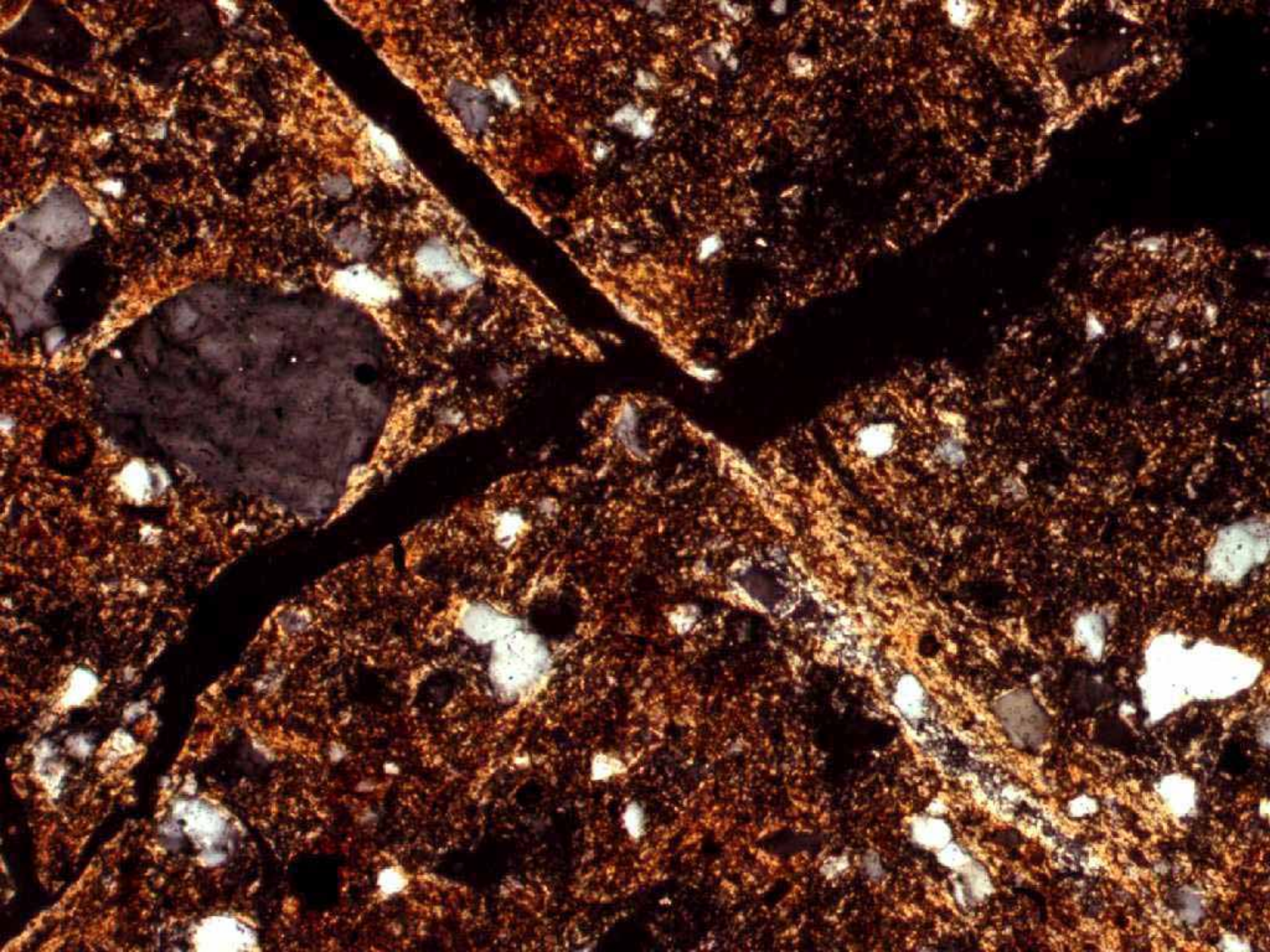
Vertisols

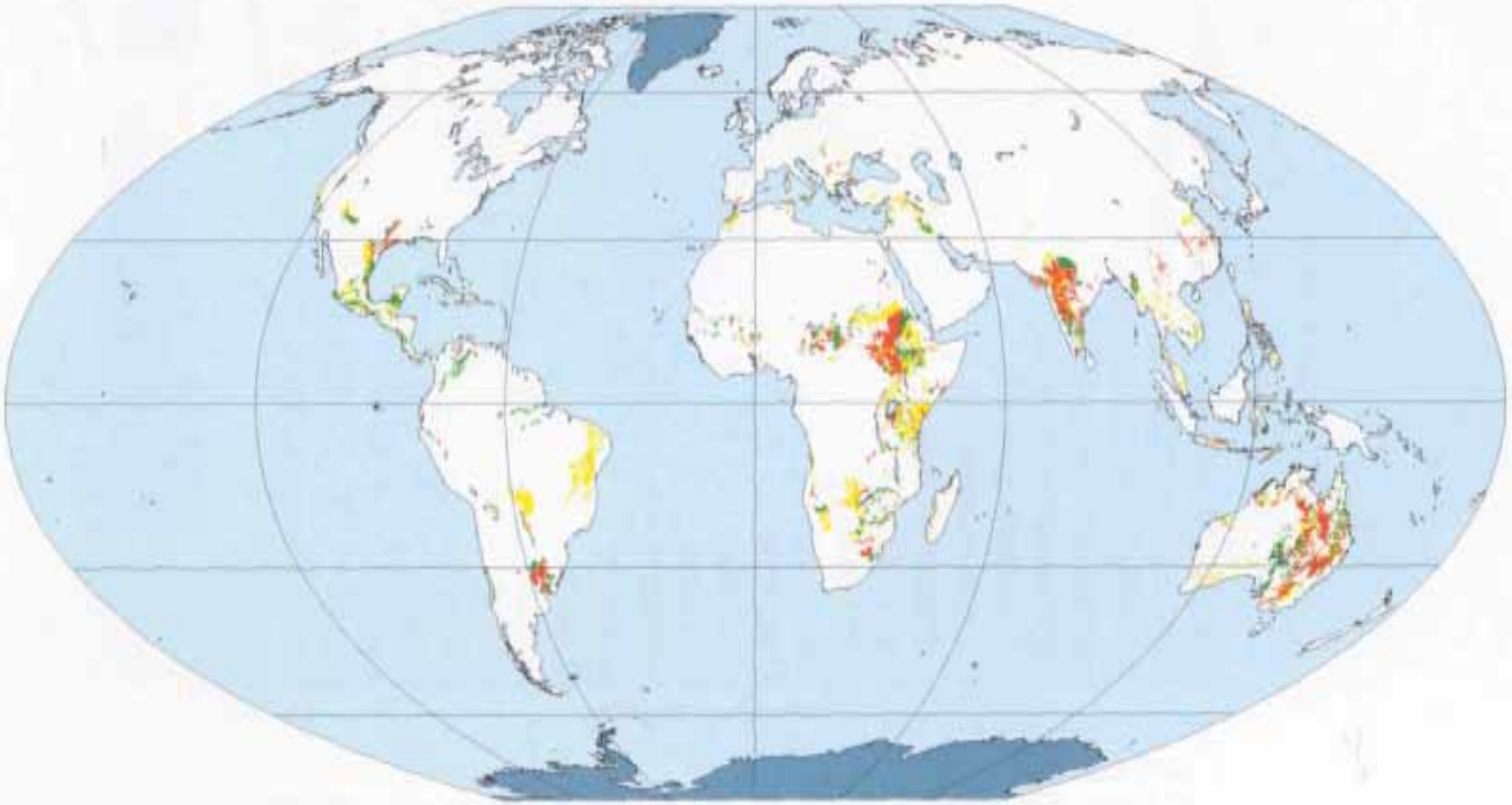
Soils that develop in shrink-swell clays.

Physical properties:

- Wide cracks when dry
- Low porosity (mainly only micropores) and low water transmission capacity
- Irregular surface topography



• Distribution of Vertisols •



Dominant

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Soils conditioned by topography

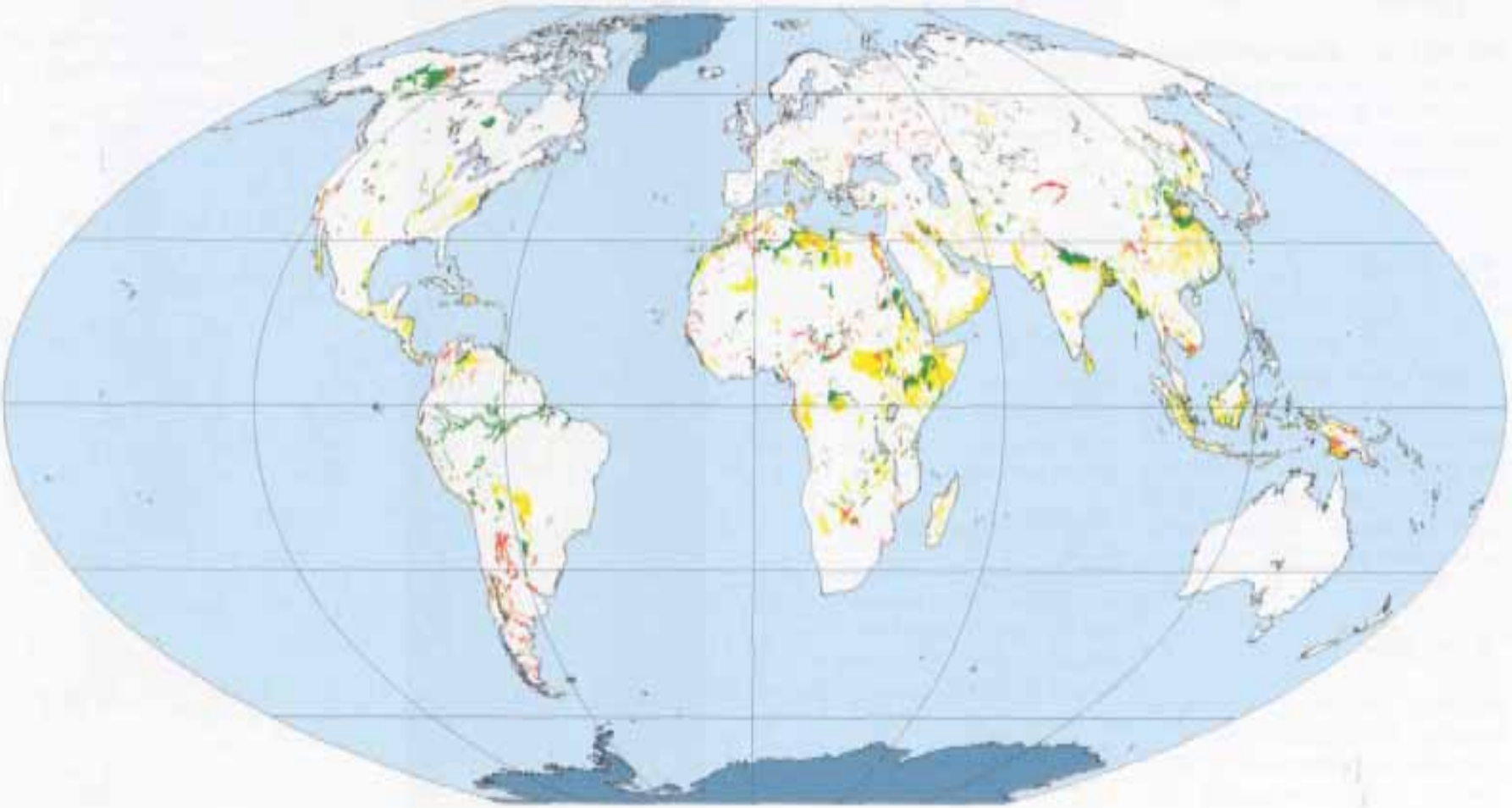
- ***Fluvisols*** *(soils in alluvial deposits)*
- ***Gleysols*** *(wet soils)*
- ***Leptosols*** *(shallow or extremely gravelly soils)*
- ***Regosols*** *(undeveloped, medium textured soils)*

Fluvisols

Soils in (sub-)recent alluvial, marine or lacustrine deposits, receiving at regular intervals new material (or having received this material in the recent past).

They vary widely in texture, from clay to gravel, and have an irregular organic matter content.

• Distribution of Fluvisols •



Dominant

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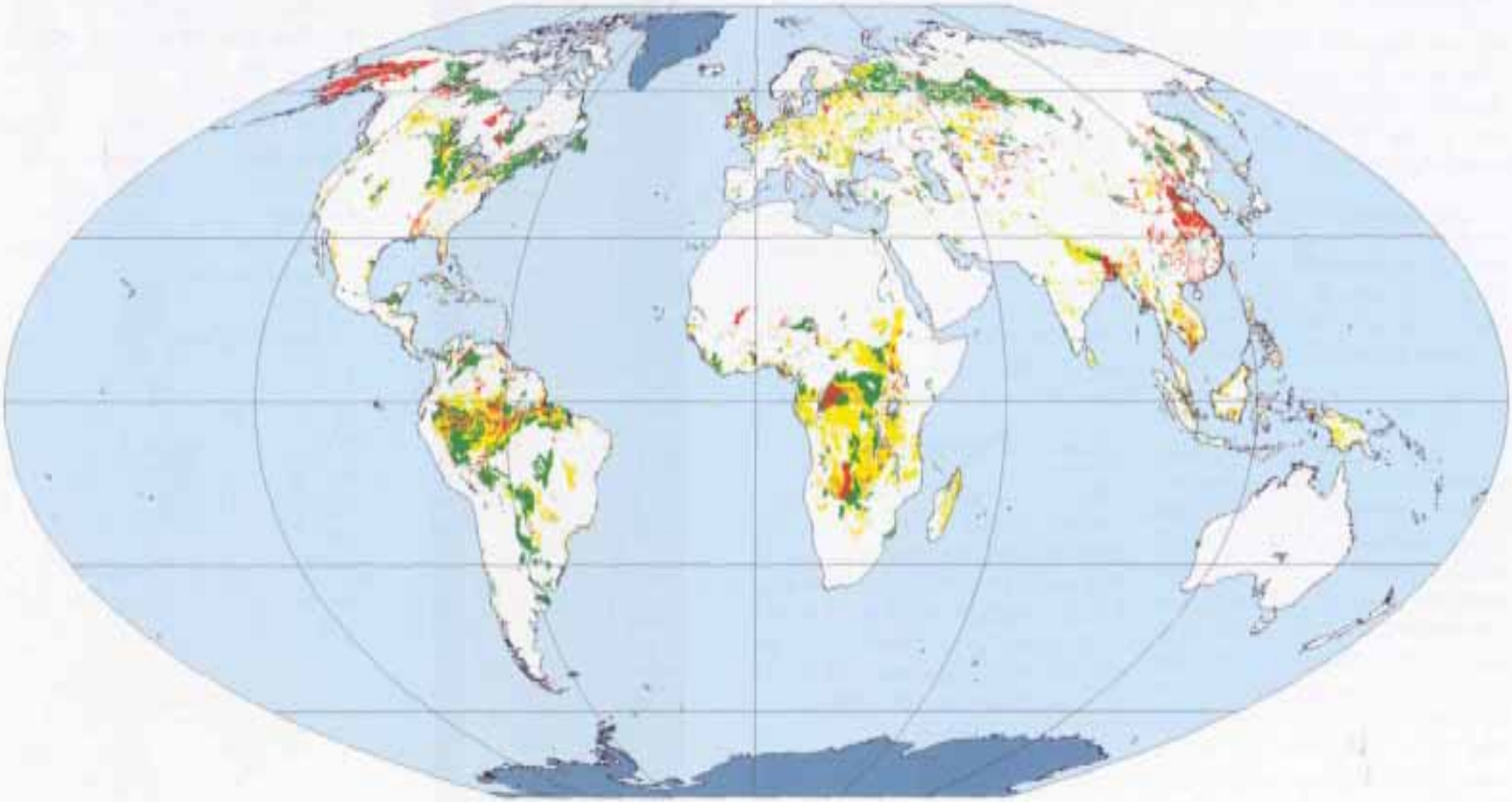
Gleysols

Soils that are permanently or temporarily saturated with groundwater within 50 cm from the soil surface.

Characteristic are features associated with the reduction and oxidation of iron and manganese.

Gleysols have poor internal drainage.

• Distribution of Gleysols •



Dominant | Associated | Inclusions | Miscellaneous lands (Glaciers, No data)

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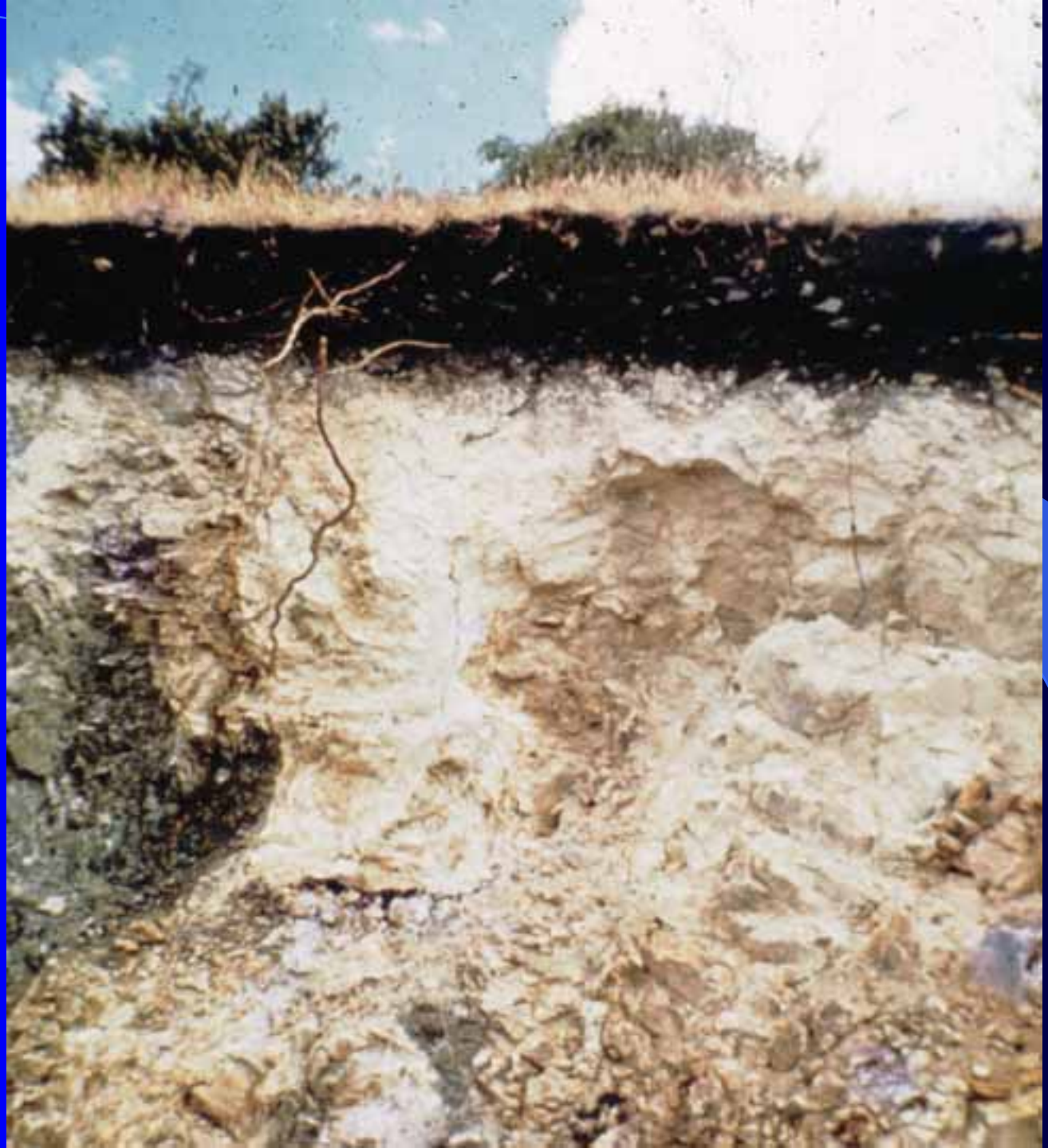
Leptosols

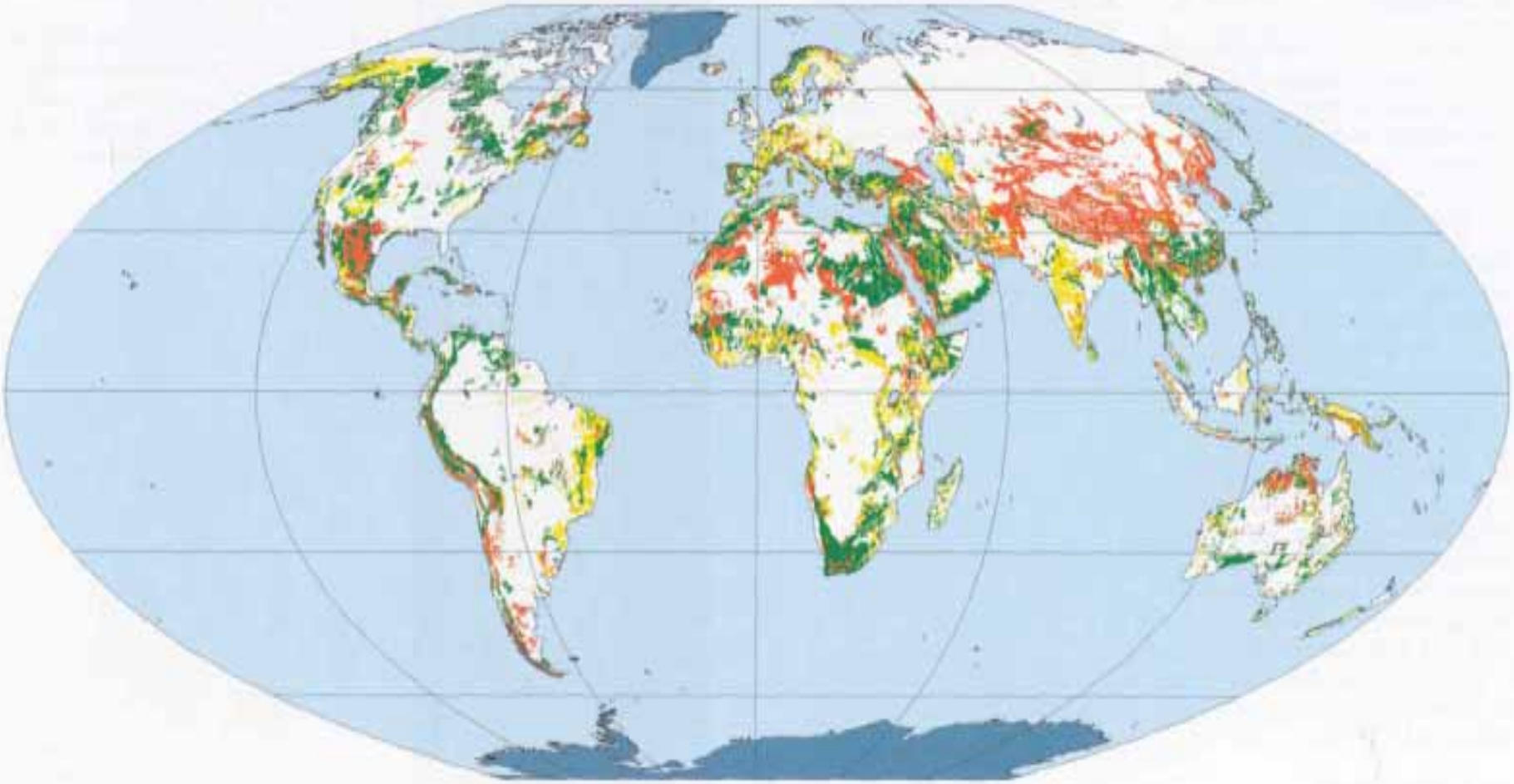
Soils that are either shallow (< 25 cm deep) over hard rock, or that overly highly calcareous materials, or that are extremely gravelly (> 90% gravel, stones or boulders by weight)

Physical properties:

- Low water-holding capacity
- Sometimes prone to erosion



• Distribution of Leptosols •



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Flat Polar Quartic Projection

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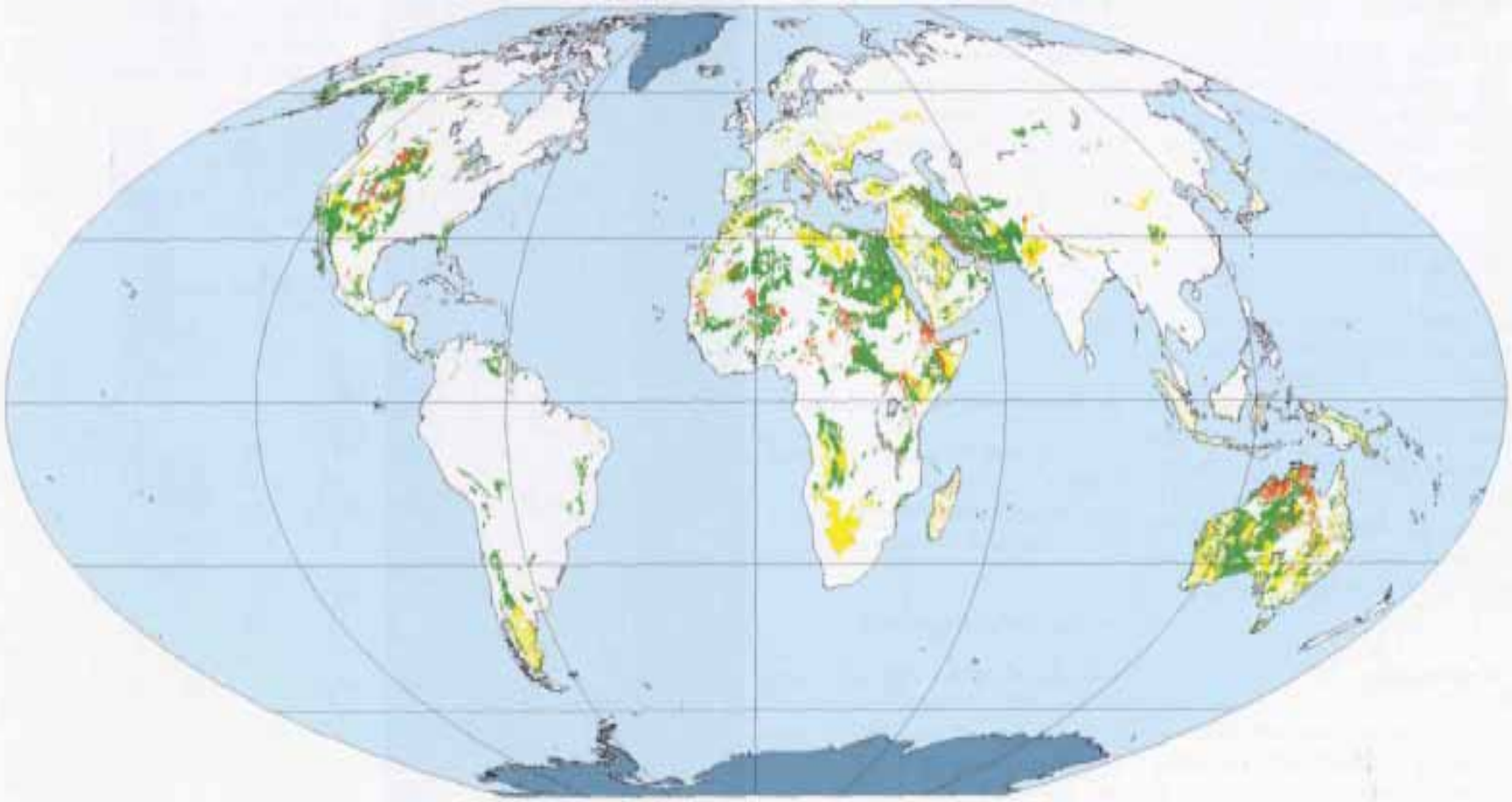
Regosols

Very weakly developed soils in unconsolidated materials that are not very shallow *(Leptosols)*, or sandy *(Arenosols)*, or wet *(Gleysols)*, or that consist of alluvial material *(Fluvisols)*.

Often prone to erosion due to lack of cohesion between the soil particles.

• Distribution of Regosols •



Dominant

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Inclusions

Miscellaneous lands (Glaciers, No data)

Flat Polar Quartic Projection

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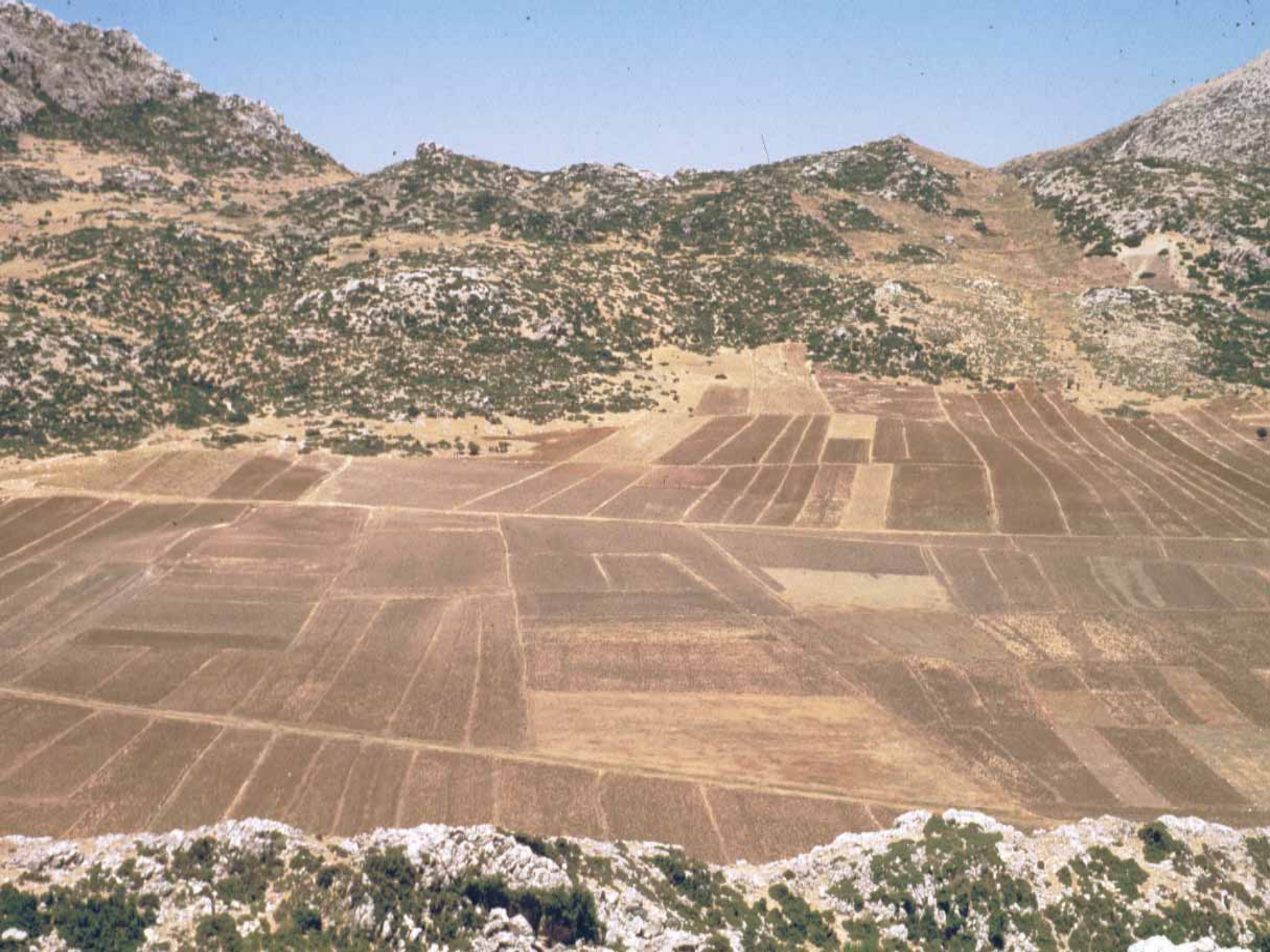
Soils conditioned by time

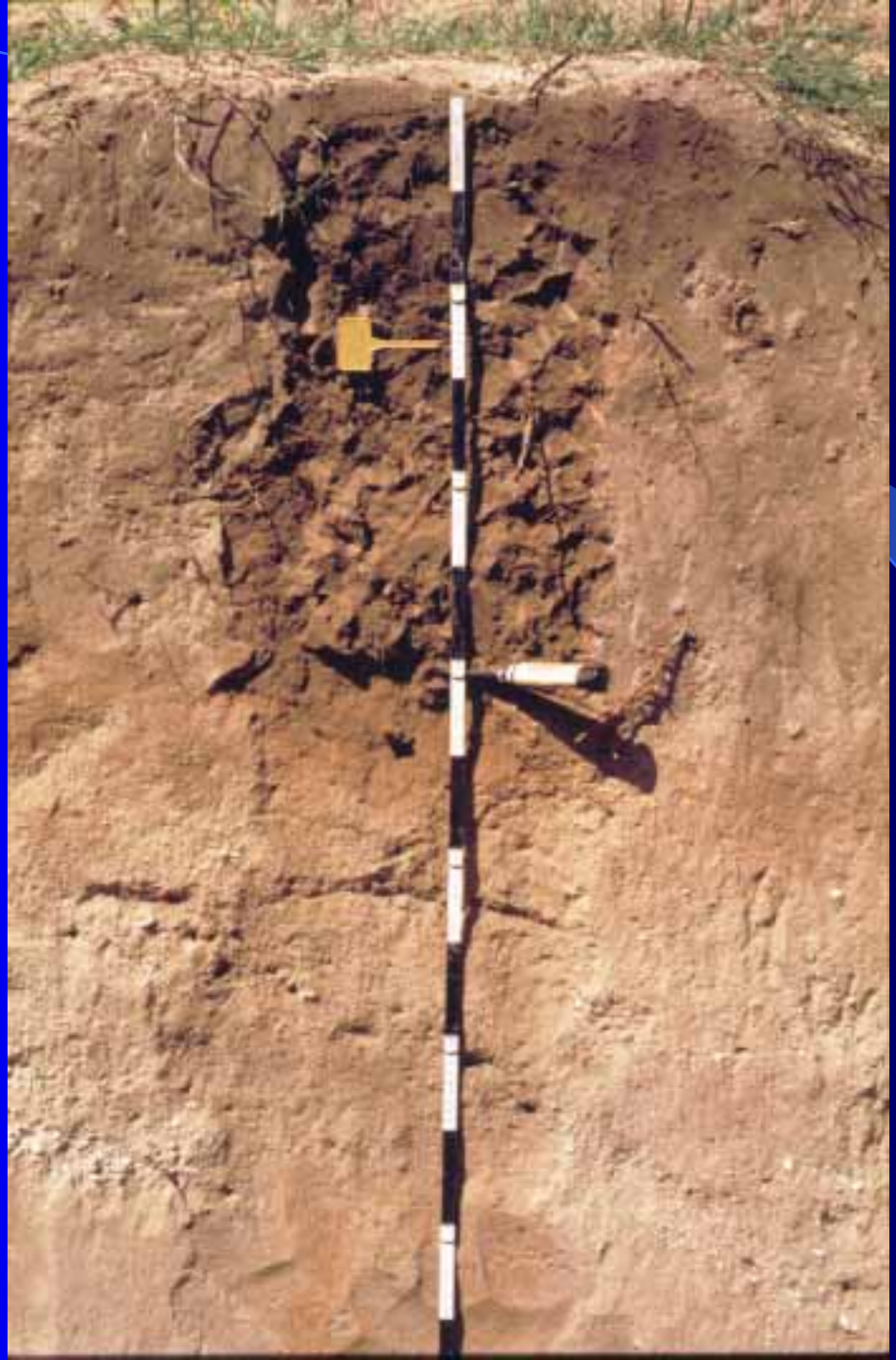
- ***Cambisols*** *(moderately developed soils with beginning horizon differentiation evident from changes in colour, structure or carbonate content)*

Cambisols

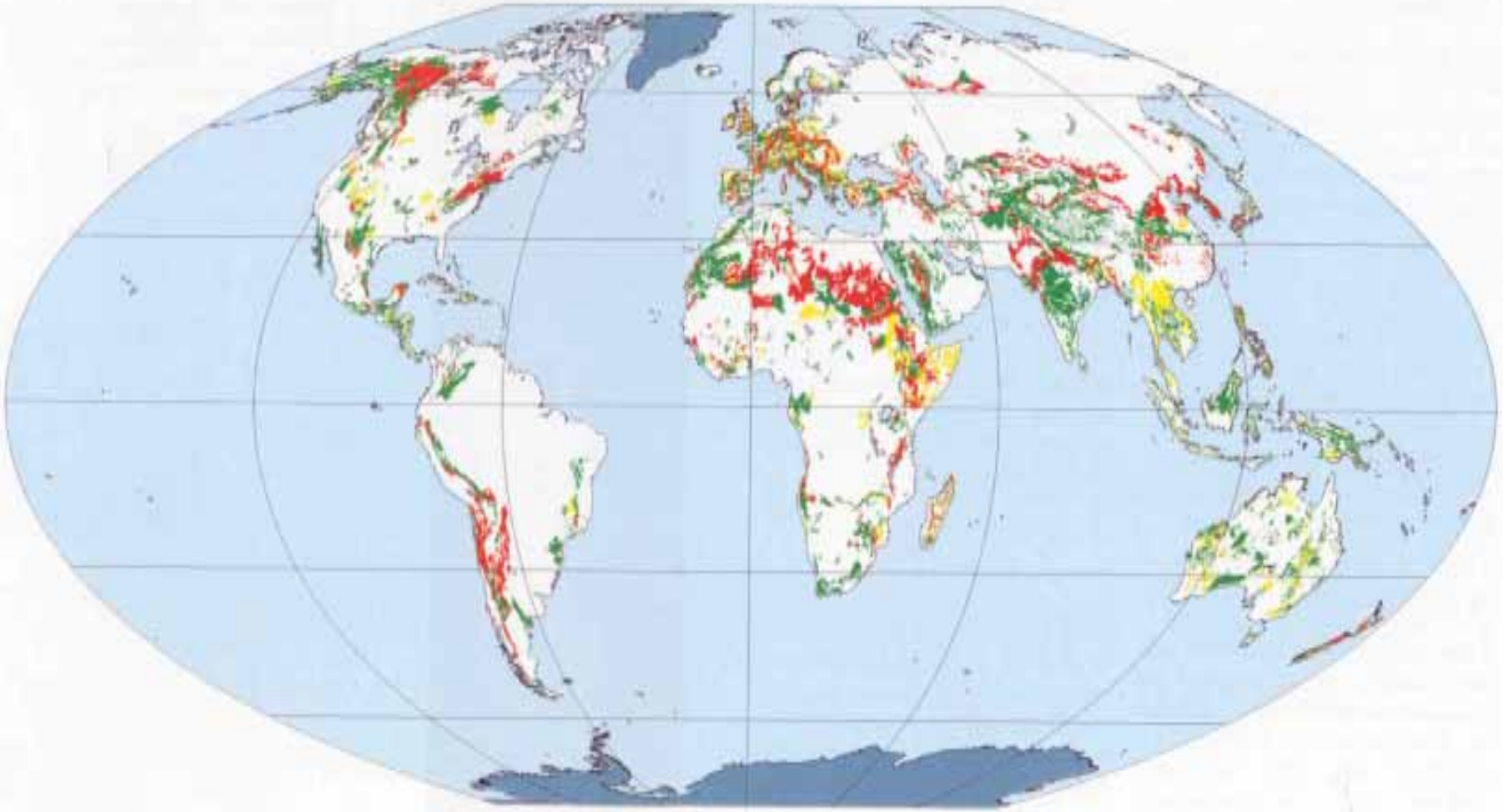
Physical properties:

- Good structural stability
- High porosity
- Good water-holding capacity
- Good internal drainage





• Distribution of Cambisols •



Dominant | Associated | Inclusions | Miscellaneous lands (Glaciers, No data)

Flat Polar Quartic Projection

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Soils conditioned by climate

- Tropical and subtropical (*Ferralsols, Acrisols, Lixisols, Nitisols, Alisols, Plinthosols*)
- Arid and semi-arid (*Gypsisols, Durisols, Calcisols, Solonchaks, Solonetz*)
- Steppe (*Chernozems, Kastanozems, Phaeozems)*
- Temperate (*Luvisols, Albeluvisols, Podzols, Planosols, Umbrisols*)
- Cold (*Cryosols*)

Soils conditioned by tropical and subtropical climates

- ***Ferralsols*** *(strongly leached soils with a "ferralic" horizon)*
- ***Acrisols*** *(strongly leached and acid soils with a low activity "argic" horizon)*
- ***Lixisols*** *(other strongly leached soils with a low activity "argic" horizon)*
- ***Nitisols*** *(soils with a "nitic" horizon)*
- ***Alisols*** *(strongly acid soils rich in aluminium)*
- ***Plinthosols*** *(wet soils with "plinthite")*

Ferralsols

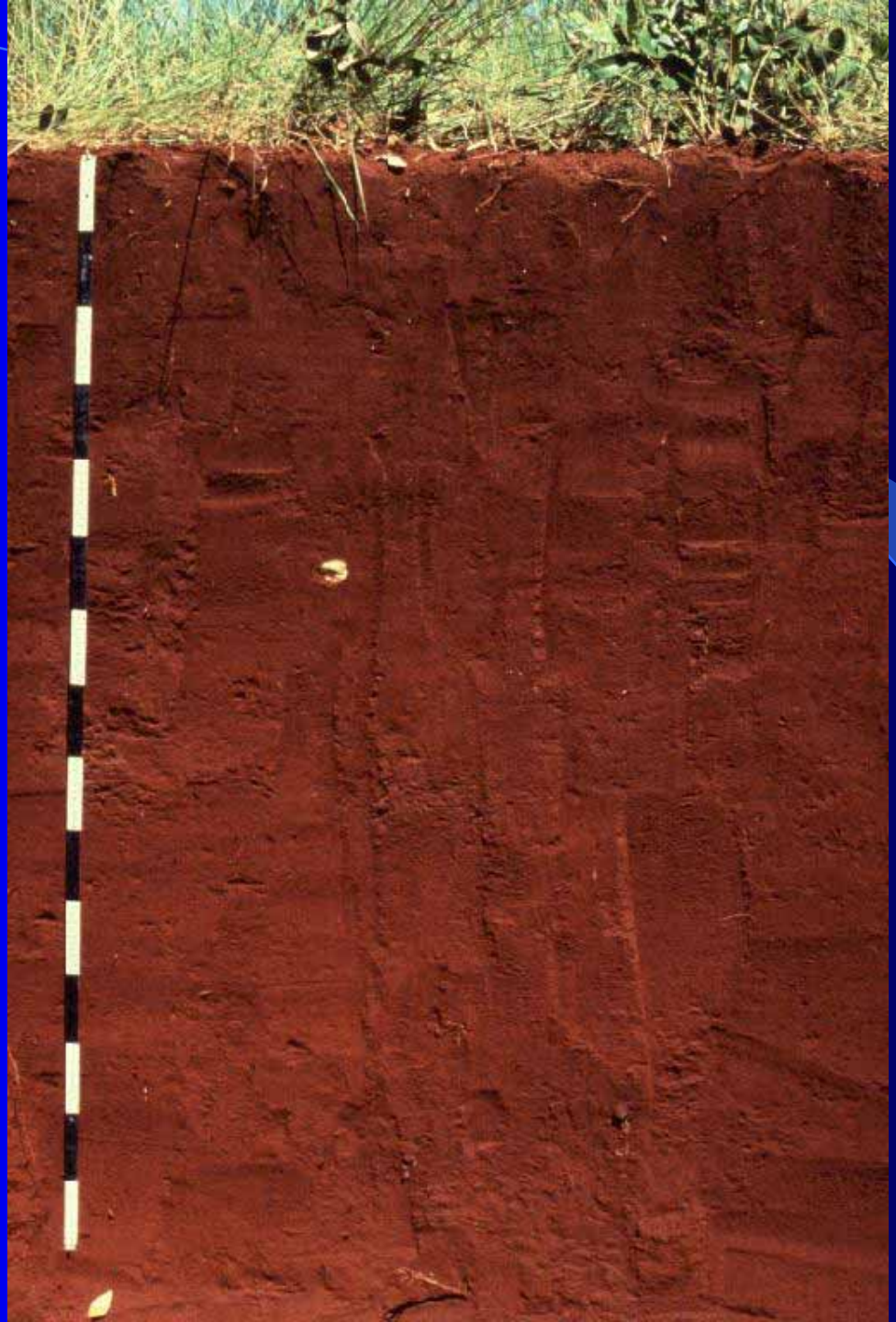
Strongly leached soils with accumulation of:

- Iron(hydr)oxides *(goethite, hematite)*
- Aluminium(hydr)oxides *(gibbsite)*
- Low activity clay *(e.g. kaolinite)*
- Residual quartz and other weathering-resistant minerals

Ferralsols

Physical properties:

- Very stable microstructure (“pseudosand and pseudosilt” textures)
- Good water-holding and water-transmission capacity
- Low bulk density (around 1.0 kg/dm^3)
- Not much prone to erosion

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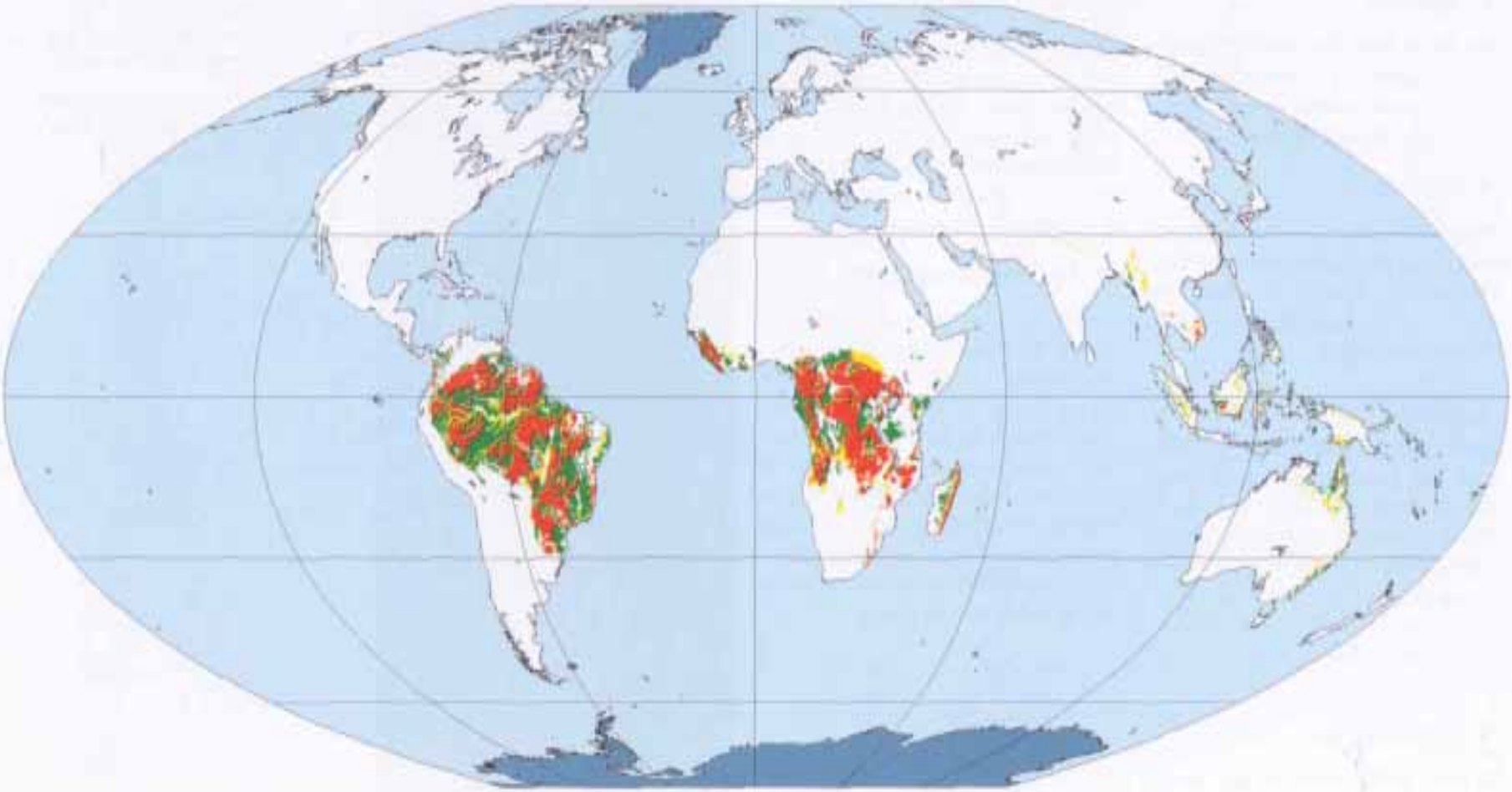
• Distribution of Ferralsols •



Dominant | Associated | Inclusions | Miscellaneous lands (Glaciers, No data)

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Acrisols

Strongly leached soils with

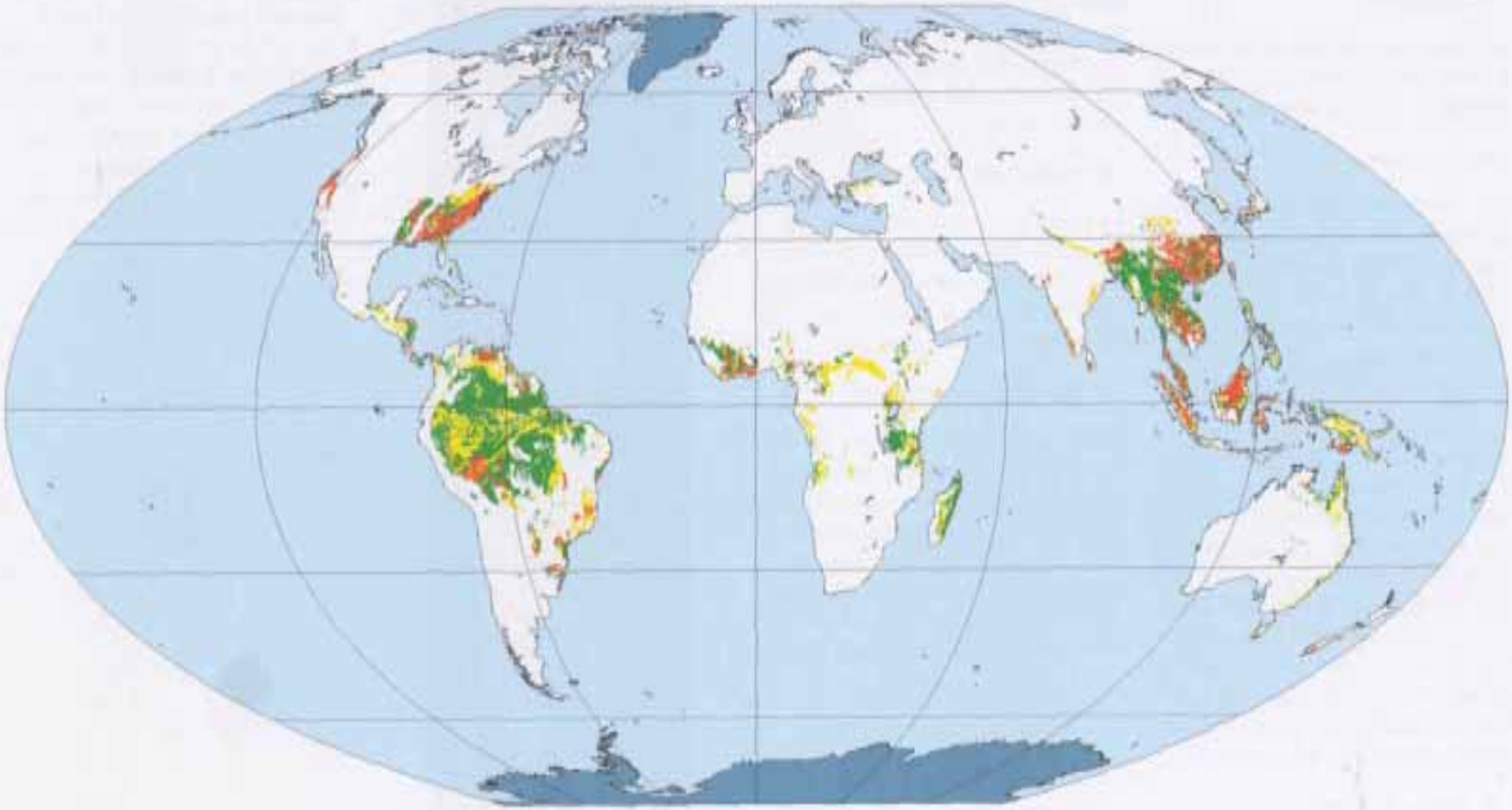
- Pronounced increase in clay content with depth *("argic horizon")*
- Dominance of low activity clay
- Acid to strongly acid soil reaction, indicative of low base saturation

Acrisols

Physical characteristics:

- Weakly developed soil structure, particularly in the upper part of the soil
- Often hard-setting when dry
- Prone to slaking, crusting and erosion

• Distribution of Acrisols •



Dominant

Associated

Inclusions

Miscellaneous lands (Glaciers, No data)

Flat Polar Quartic Projection

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Lixisols

Strongly leached soils with

- Pronounced increase in clay content with depth *("argic horizon")*
- Dominance of low activity clay
- Slightly acid to neutral soil reaction, indicative of moderate to high base saturation

Lixisols

Physical characteristics:

- Weakly developed soil structure, particularly in the upper part of the soil
- Often hard-setting when dry
- Prone to slaking, crusting and erosion


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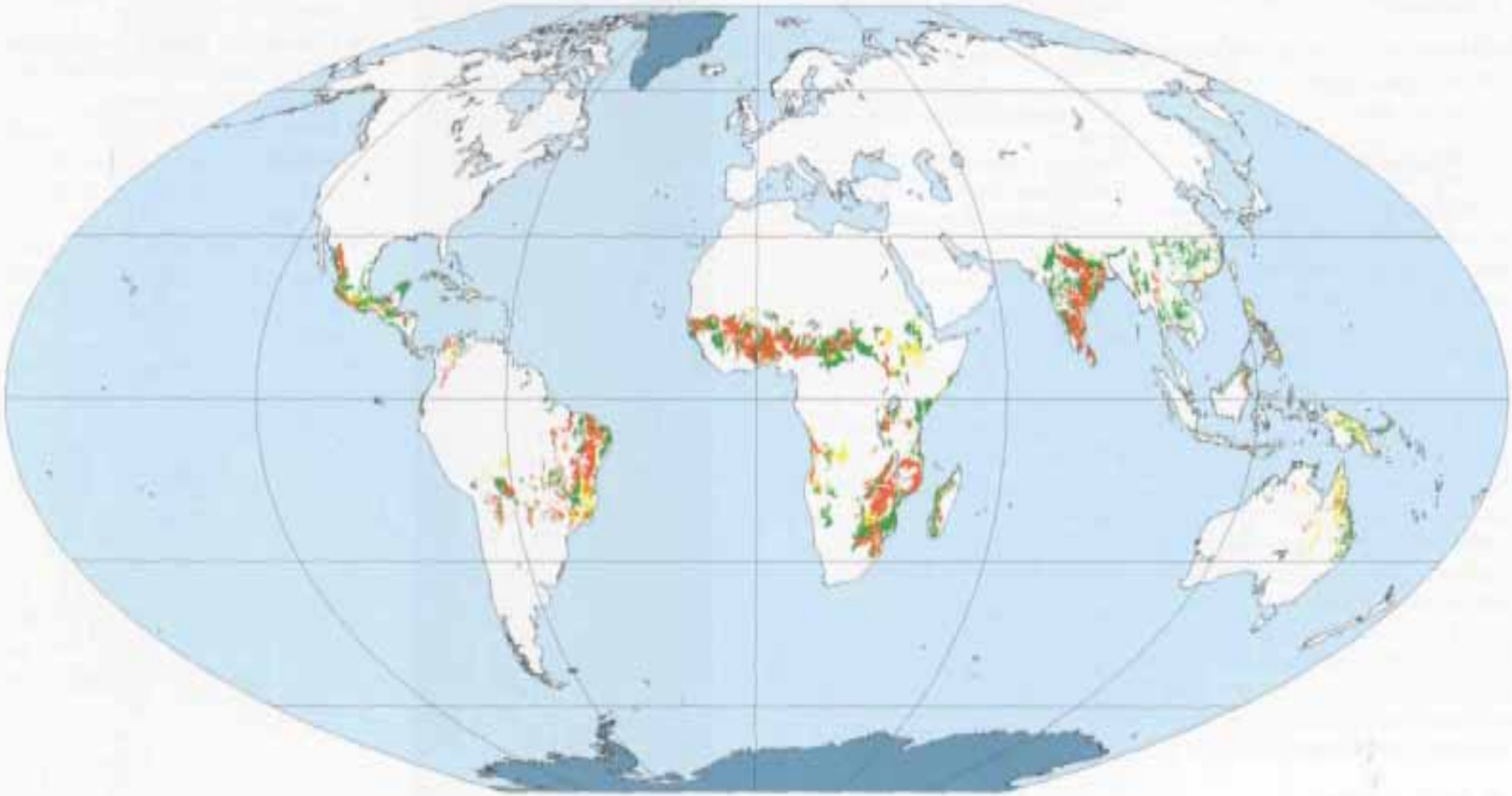
• Distribution of Lixisols •



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Miscellaneous lands (Glaciers, No data)

Flat Polar Quartic Projection

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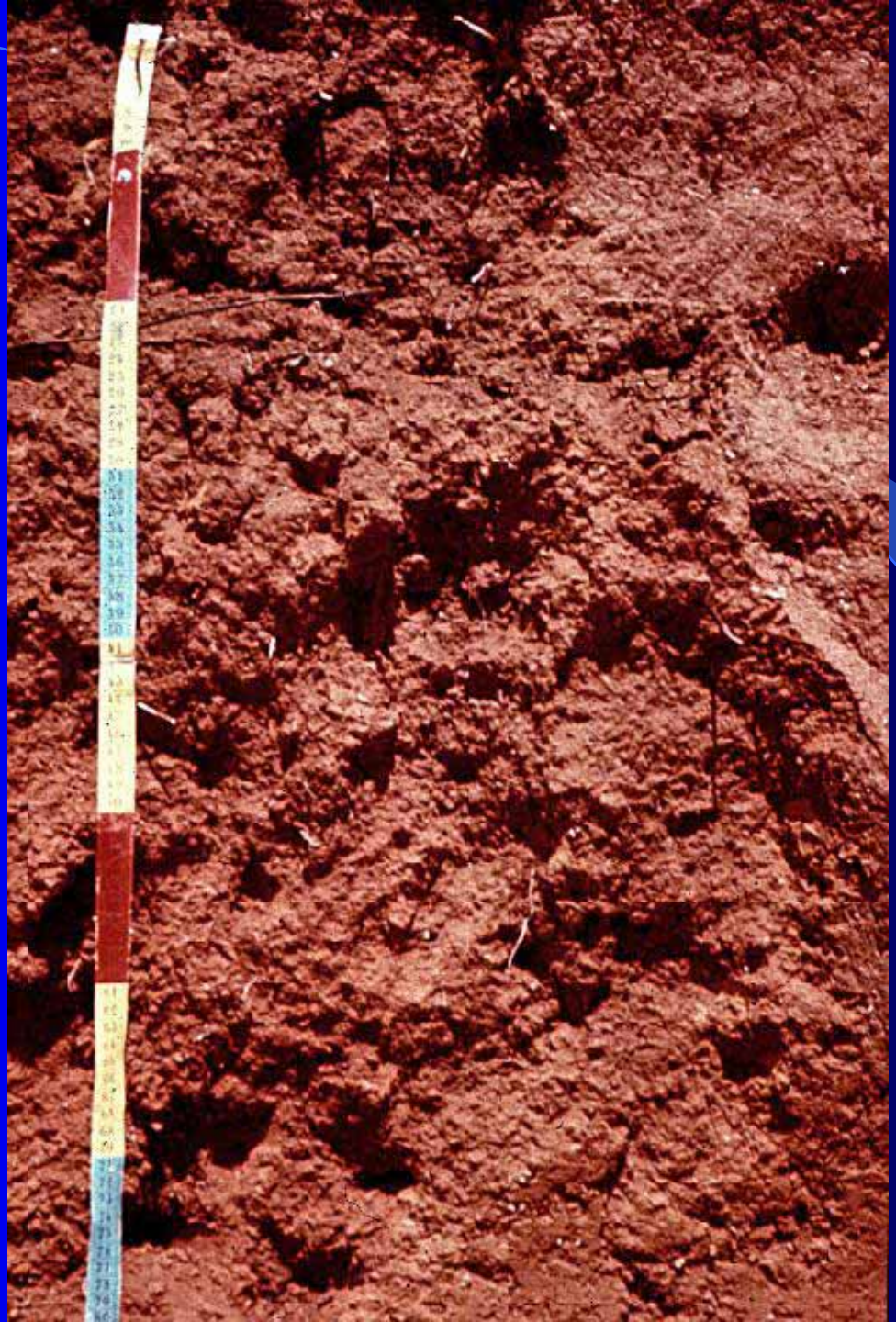
Nitisols

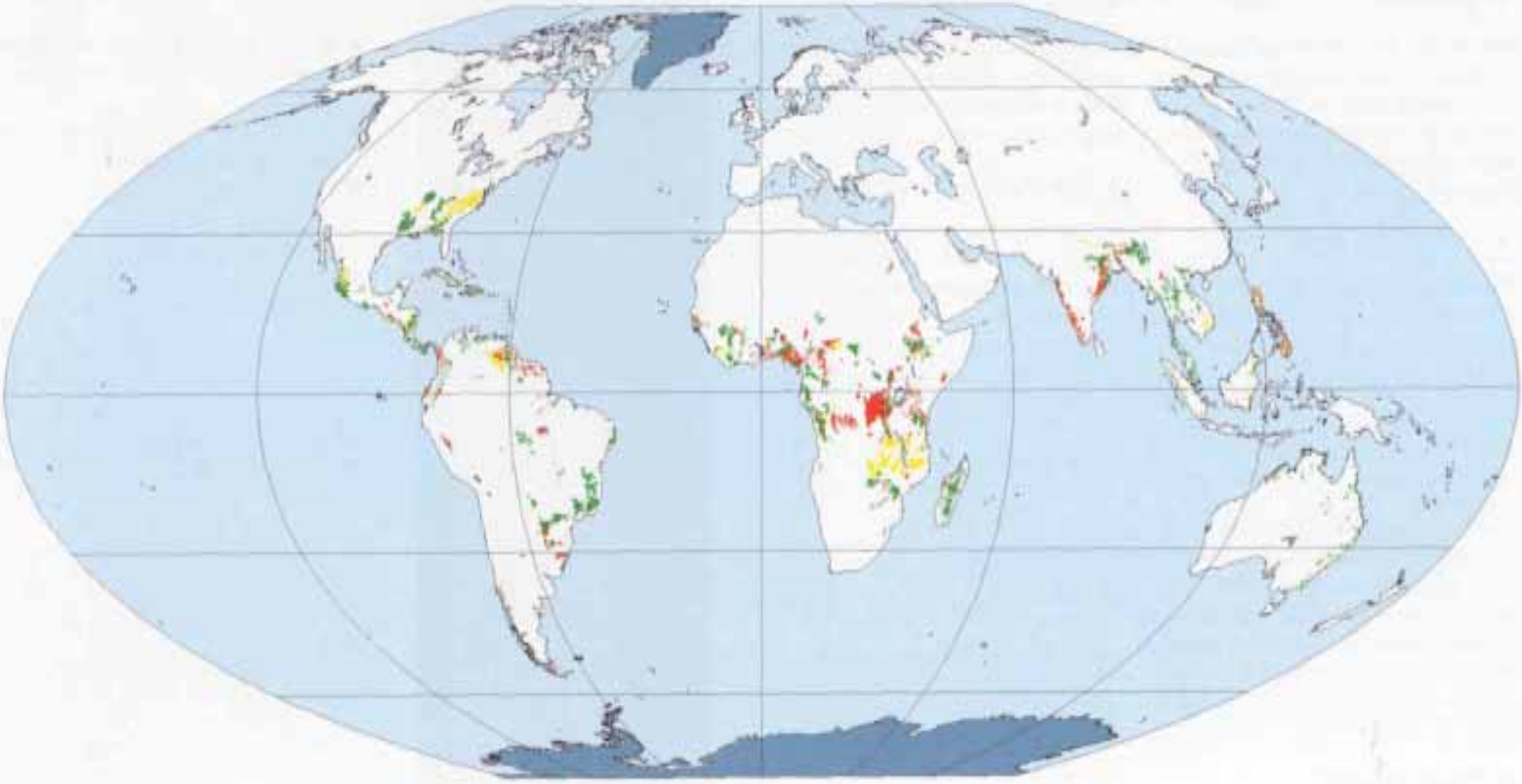
Soils that have strongly developed nut-shaped structure, mainly derived from basic rock.

Physical properties:

- Good water-holding capacity
- Good structural stability
- Not much prone to erosion



• Distribution of Nitisols •



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Miscellaneous lands (Glaciers, No data)

Flat Polar Quartic Projection

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Alisols

Soils with a high amount of exchangeable aluminium, which is released from rapidly weathering clay minerals (e.g. chlorite, vermiculite).

Physical properties:

- Strongly developed soil structure
- Prone to slaking, crusting and erosion


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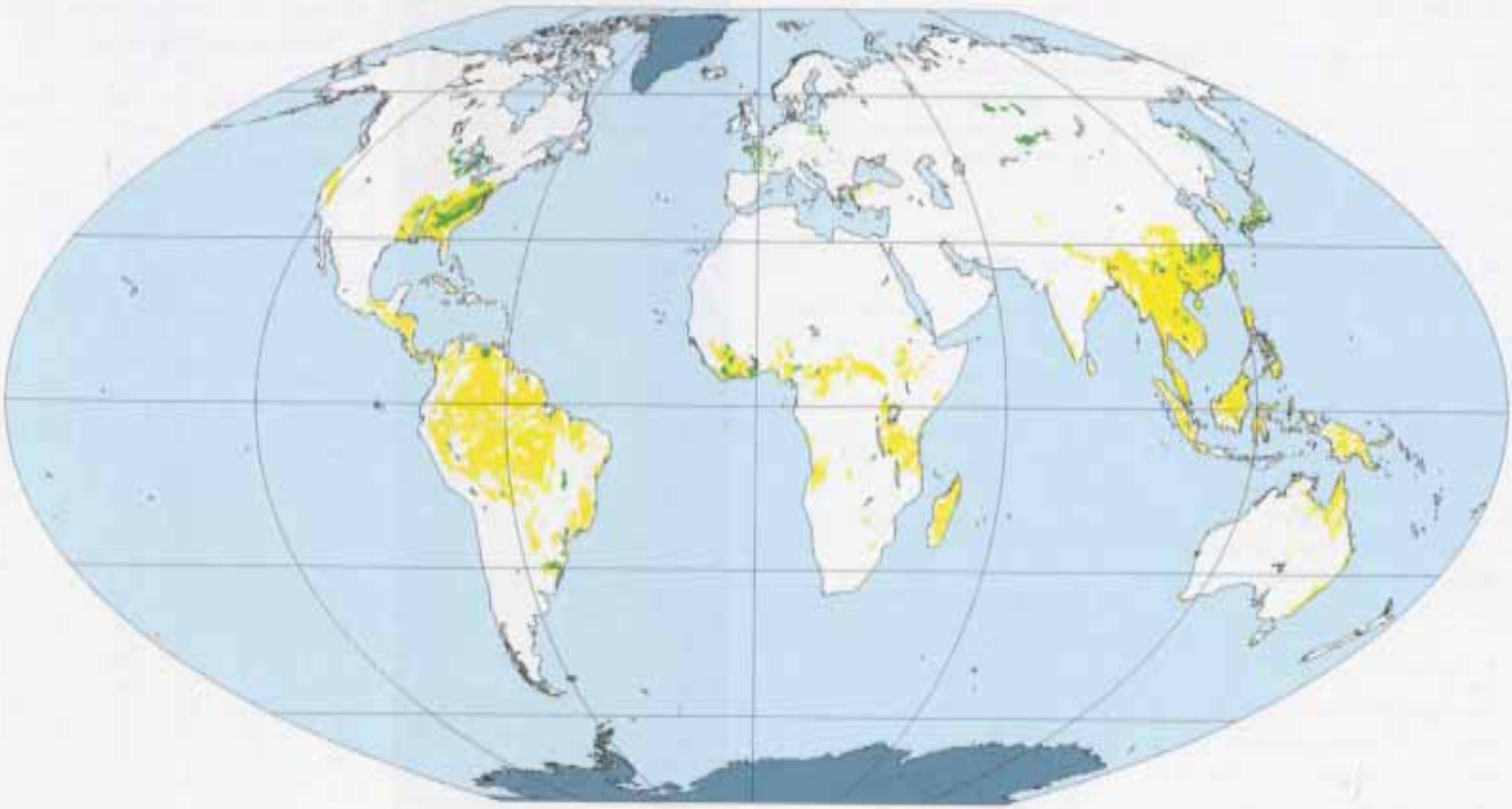
• Distribution of Alisols •



Dominant

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Miscellaneous lands (Glaciers, No data)

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Plinthosols

Wet soils with iron accumulation that irreversibly hardens upon repeated drying and wetting *("plinthite")*:

- Low-lying level positions (valley floors, river terraces)
- Form under the influence of groundwater and lateral waterflow from adjacent uplands

Plinthosols

Physical properties:

- Dense subsoil, obstructing deep percolation of water and inhibiting root penetration (bulk density of plinthite varies from 1.8 – 2.2 kg/dm^3)
- Low water storage capacity if *"petroplinthite"* is close to the surface


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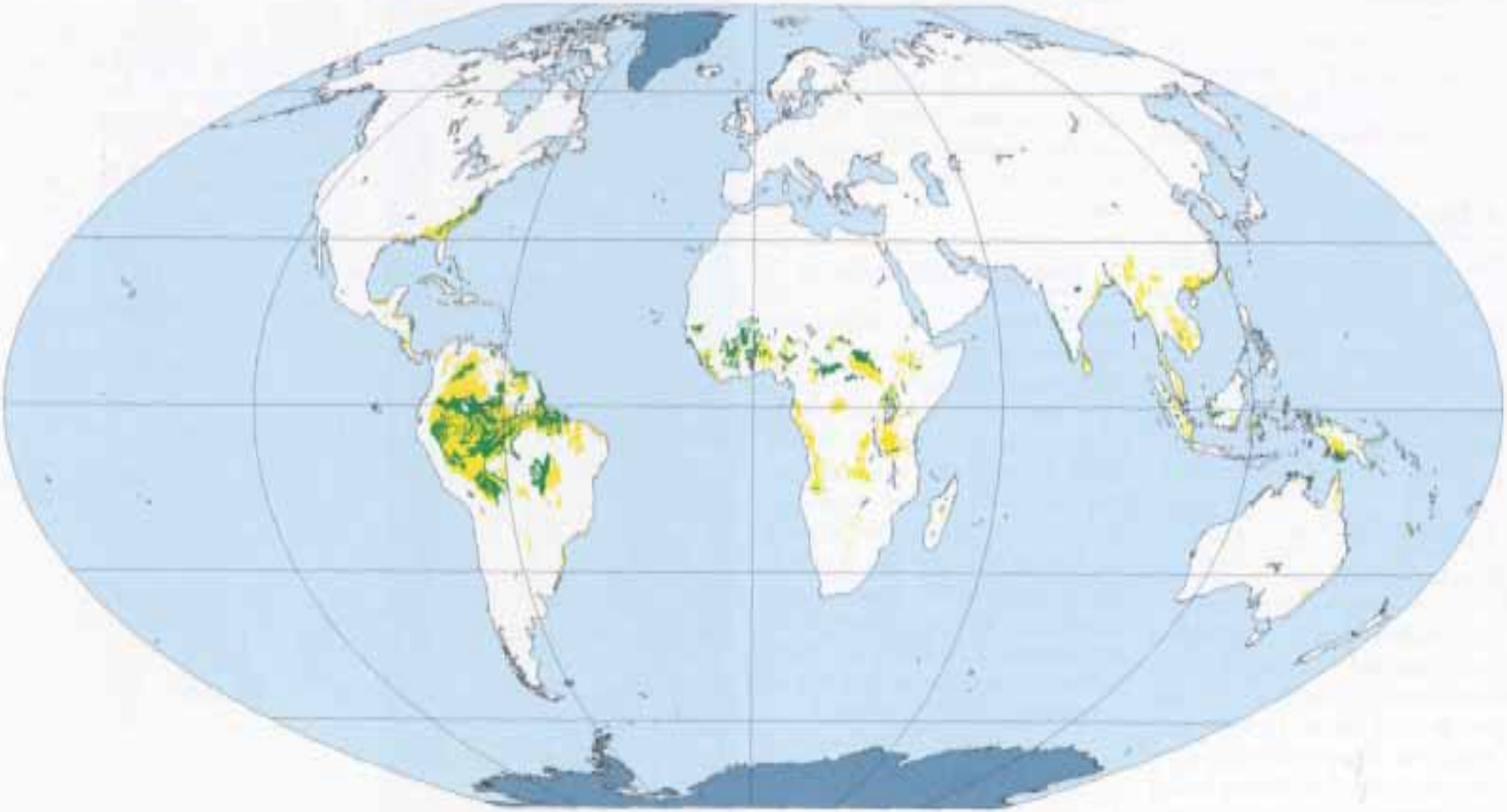
• Distribution of Plinthosols •



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Associated

Inclusions

Miscellaneous lands (Glaciers, No data)

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Soils conditioned by arid and semi-arid climates

- *Gypsisols (accumulation of secondary gypsum)*
- *Durisols (accumulation of secondary silica)*
- *Calcisols (accumulation of secundary calcium carbonate)*
- *Solonchaks (accumulation of soluble salts)*
- *Solonetz (accumulation of sodium)*

Gypsisols

Soils with accumulation of secondary gypsum ($CaSO_4.2H_2O$), forming *"gypsic"*, *"hypergypsic"* or *"petro-gypsic"* horizons:

- Gypsic: > 15% gypsum
- Hypergypsic: > 50% gypsum
- Petrogypsic: hardened gypsum bank

Gypsisols

Physical properties:

- Surface slakes easily and crusts on Gypsisols are common
- Low water holding capacity due to many large pores and caveties after dissolution of the gypsum


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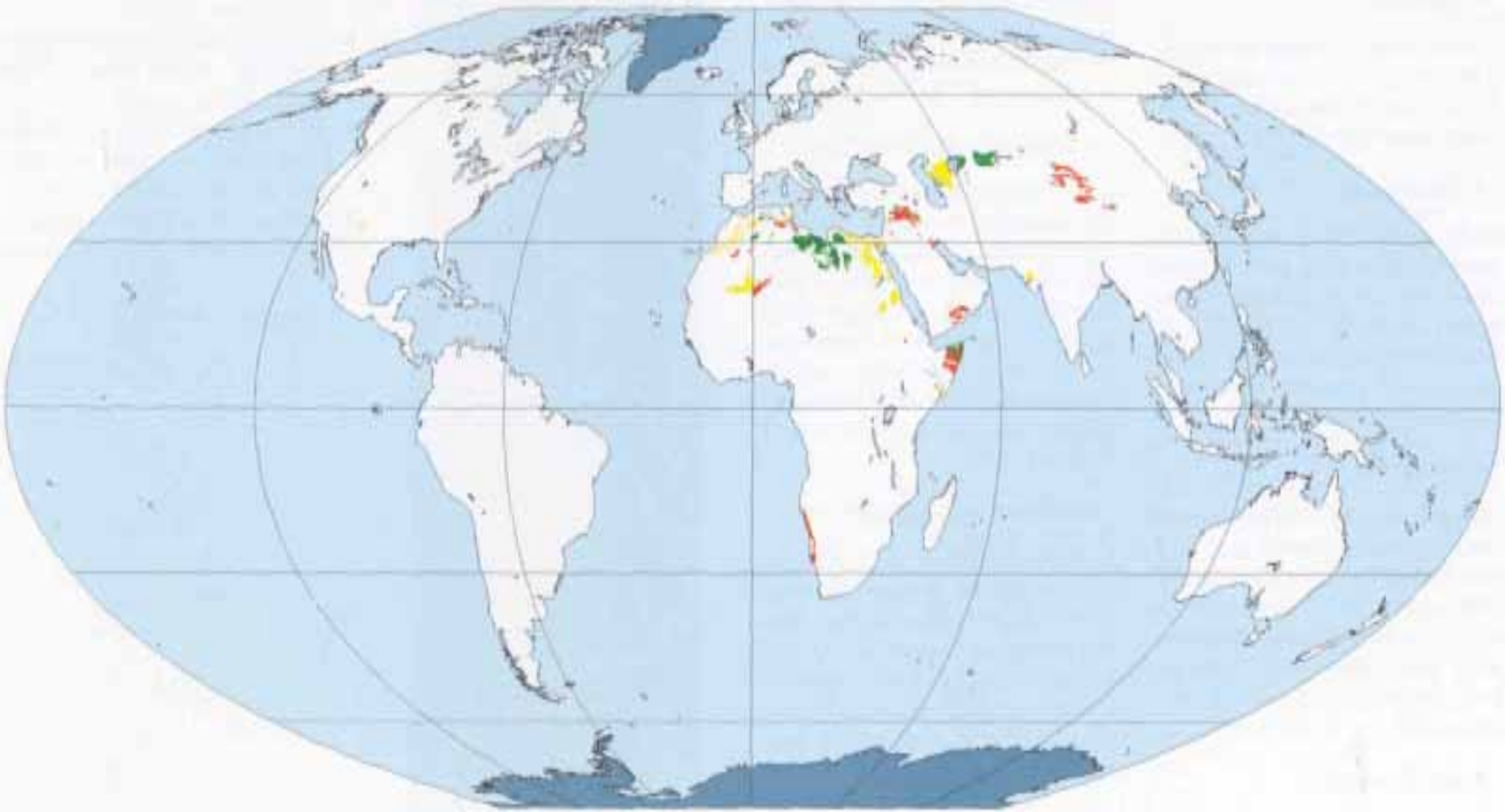
• Distribution of Gypsisols •



Dominant

Associated

Inclusions

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Durisols

Soils with accumulation of secondary silica, forming *"duric"* or *"petroduric"* horizons:

- Duric horizon: accumulation of silica in nodular form *("durinodes")*
- Petroduric horizon: accumulation in hard silica bank *("duripan")*

Durisols

Physical properties:

- Petroduric horizons hamper root penetration, unless they are fractured
- Bulk density of duric horizons varies between 1.3 and 1.7 kg/dm^3, that of the petroduric horizon between 1.6 and 2.0 kg/dm^3

• Distribution of Durisols •

Dominant

Associated

Inclusions

Miscellaneous lands (Glaciers, No data)

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Calcisols

Soils with accumulation of secondary calcium carbonate ($CaCO_3$), forming *"calcic"*, *"hypercalcic"* or *"petro-calcic"* horizons:

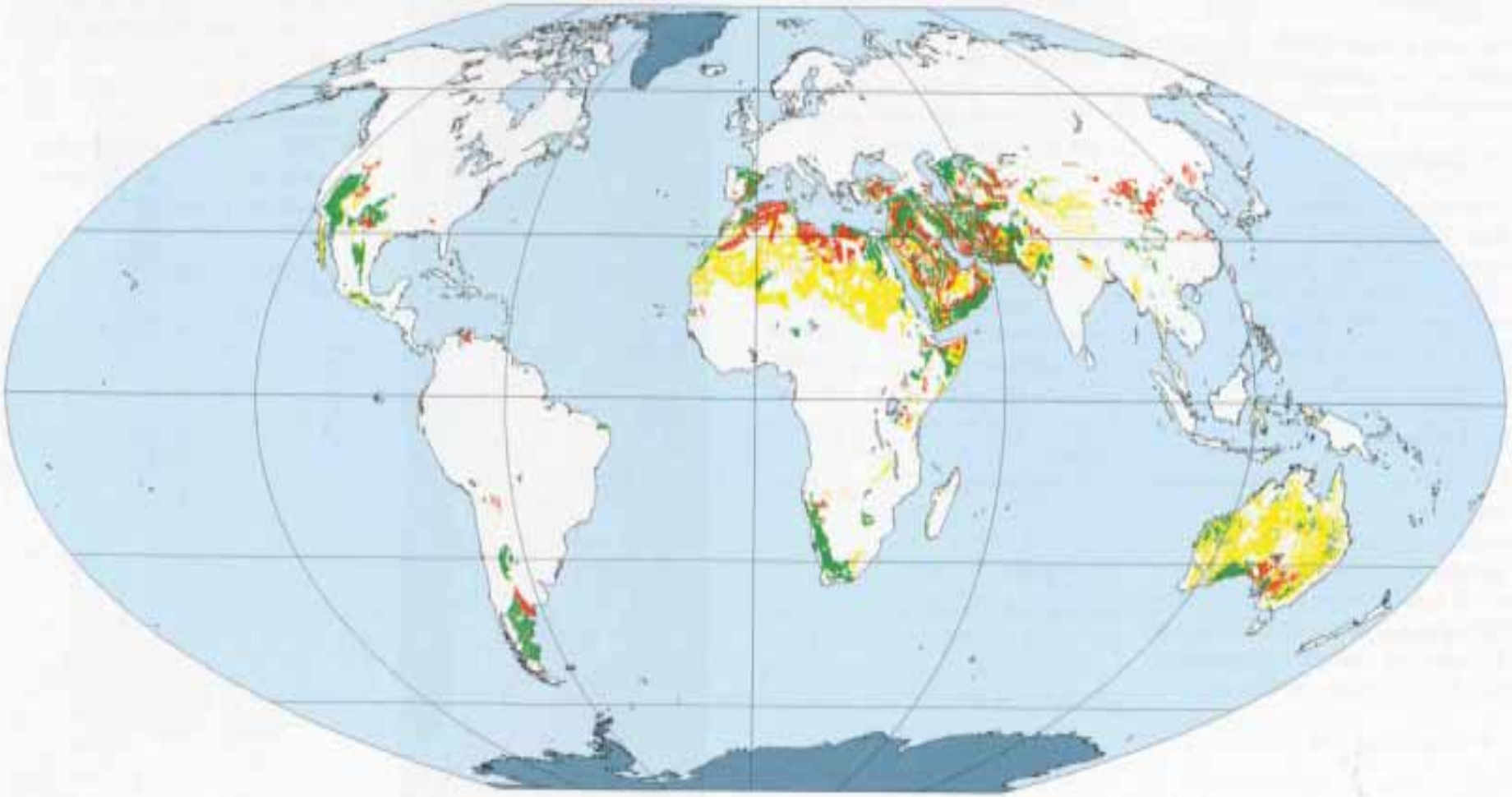
- Calcic: > 15% calcium carbonate
- Hypercalcic: > 50% calcium carbonate
- Petrocalcic: hardened calcium carbonate bank

Calcisols

Physical properties:

- Good water-holding capacity
- Prone to slaking and crusting
- Petrocalcic horizons hamper root penetration, unless they are fractured

• Distribution of Calcisols •



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Solonchaks

Soils with accumulation of salts more soluble than gypsum *("salic horizon")*.

Salinity is measured as EC (mS cm^{-1}) or total salt content (weight %). It affects plant growth as osmotic pressure causes toxic and water stress effects.

Solonchaks

Physical properties:

- Prone to crusting and erosion, because of the dispersion effect of salts

A special type is the “puffed” Solonchak, a soil with a “night – day” rhythm of sodiumsulphate accumulation.


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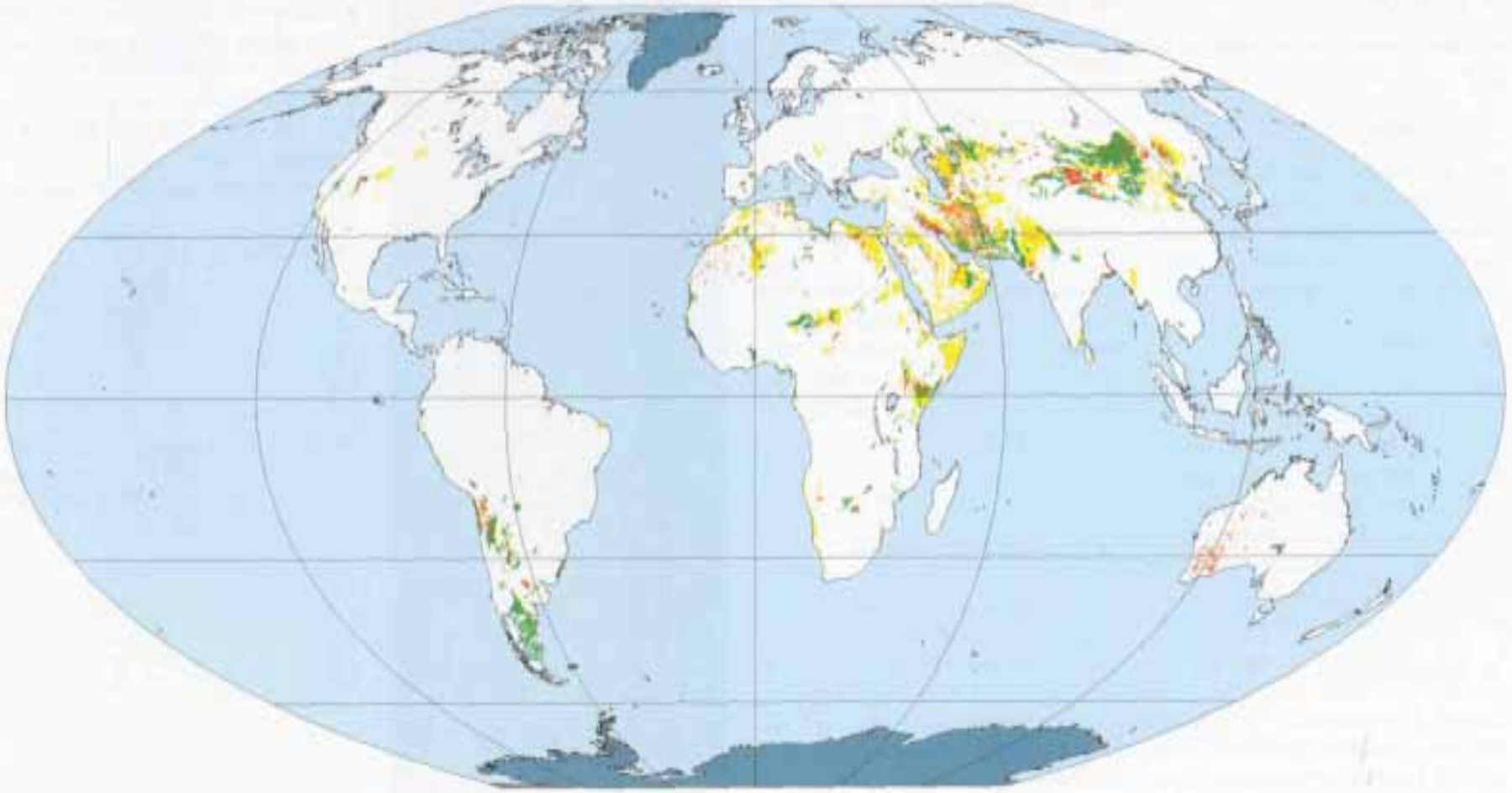
• Distribution of Solonchaks •



Dominant | Associated | Inclusions | Miscellaneous lands (Glaciers, No data)

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Solonetz

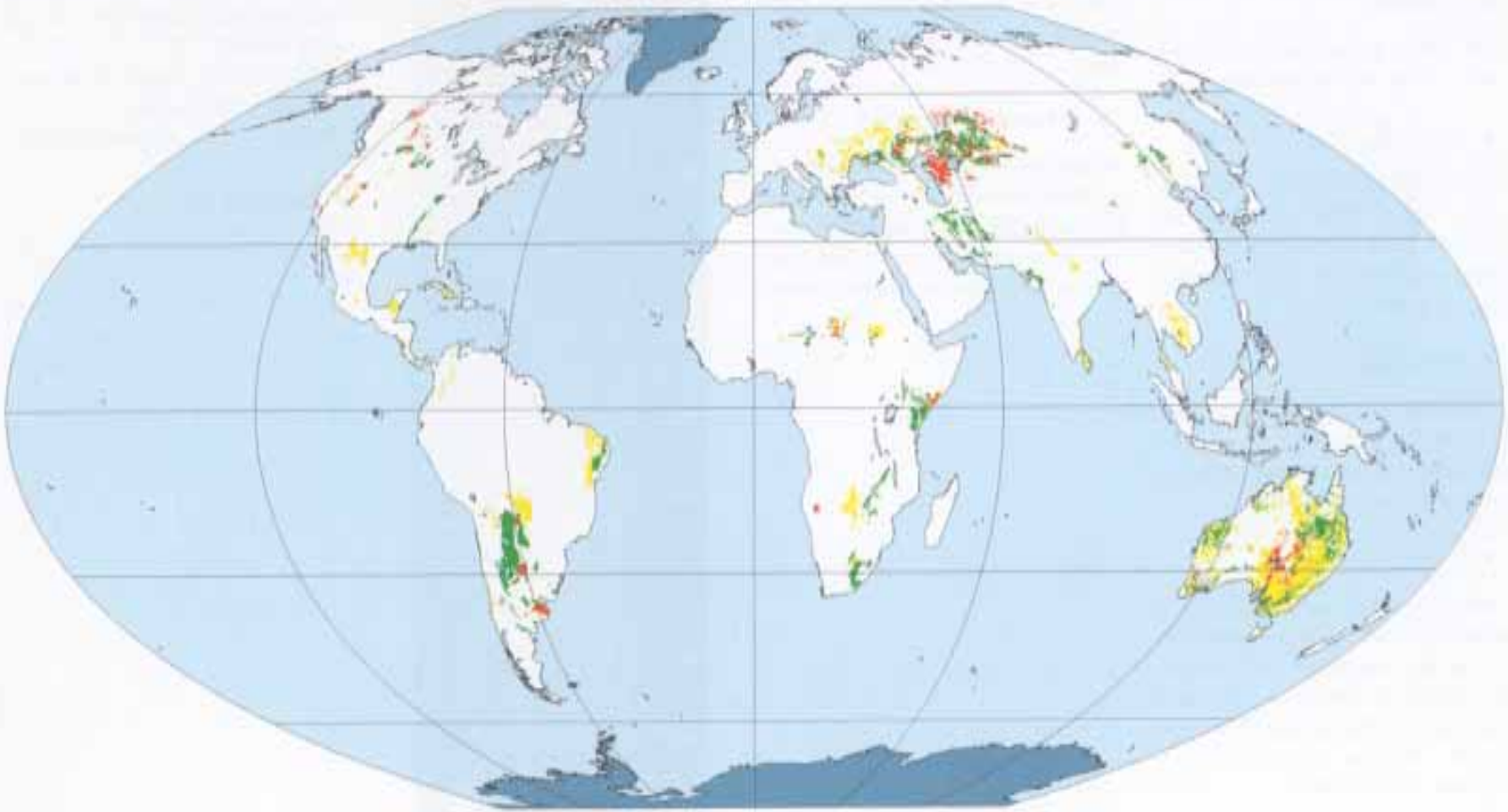
Soils with a high amount of exchangeable sodium (> 15% of the adsorbed cations), accumulated in the subsoil in a so-called “natric” horizon.

Solonetz

Physical properties:

- Dispersion of clay and humus
- Clogging of pores
- Slowly permeable subsoil
- Waterlogging

• Distribution of Solonetz •



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Flat Polar Quartic Projection

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Soils conditioned by steppe climates

Characteristic for soils of the steppes is the accumulation and rapid mineralization of large amounts of organic matter under influence of high, soil faunal activity, and accumulation of variable amounts of carbonates and gypsum.

Three typical soils are recognized, all characterized by a “mollic” horizon:

- *Chernozems*
- *Kastanozems*
- *Phaeozems*

Chernozems

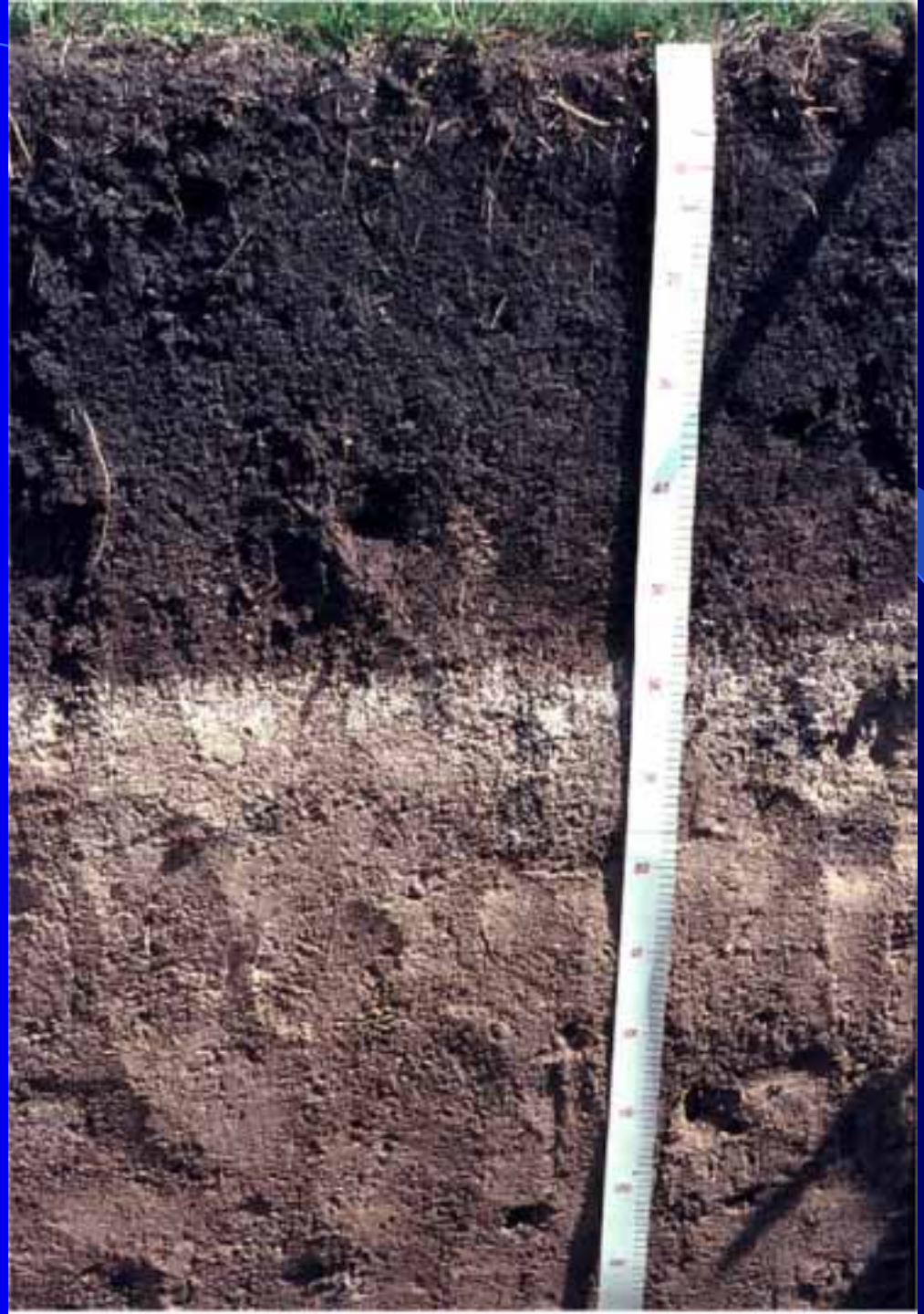
Soils of the tall-grass steppes, with a thick, very dark brown or black, humus-rich surface horizon and accumulation of carbonates within 2 m from the surface.

Chernozems form the central concept of the "steppe soils", bordered by *Kastanozems* on the drier side and *Phaeozems* on the wetter side.

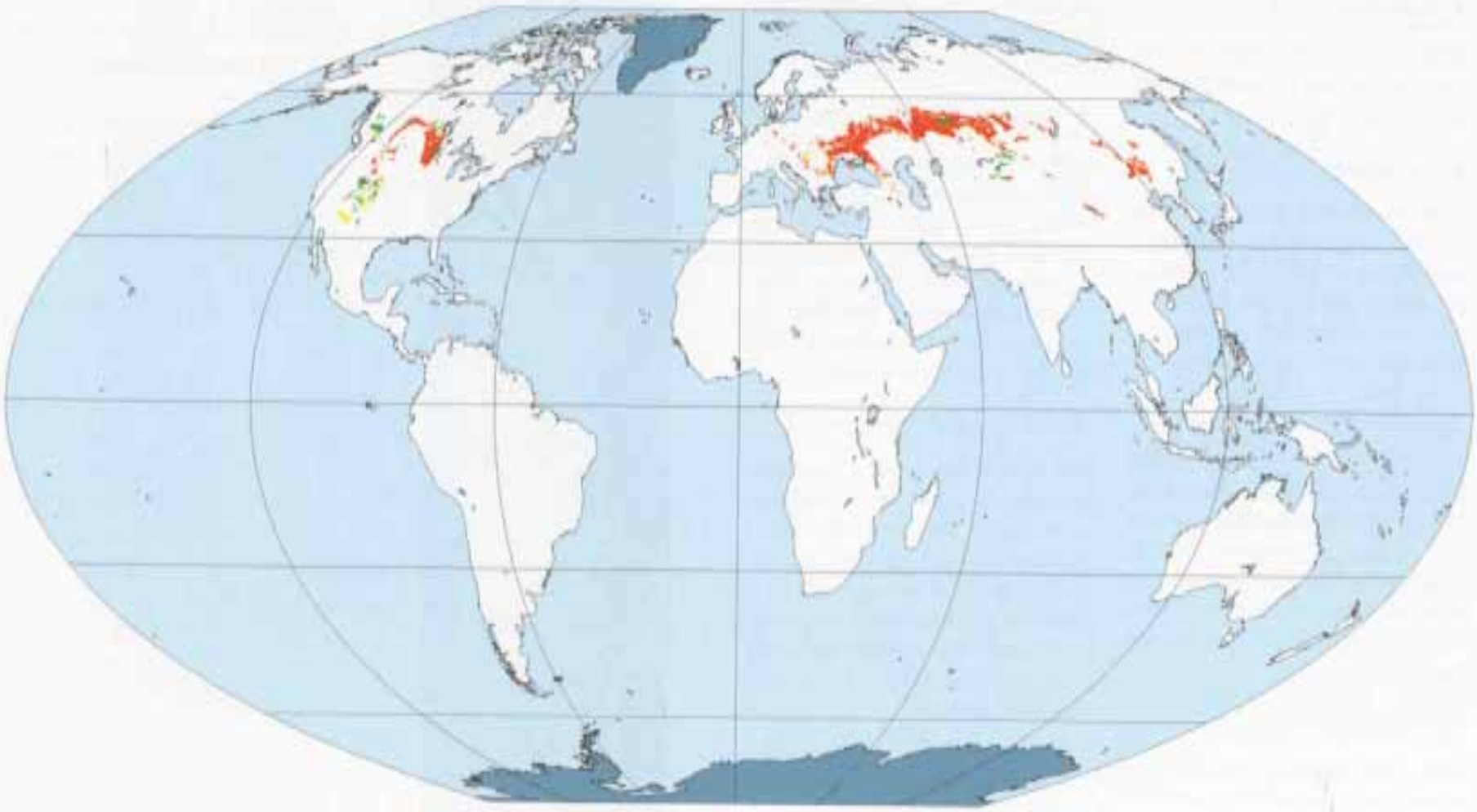
Chernozems

Physical properties:

- High porosity (between 50 and 60 volume percentage)
- Good moisture holding capacity (20 volume percent AWC)
- Stable micro-aggregate structure



• Distribution of Chernozems •



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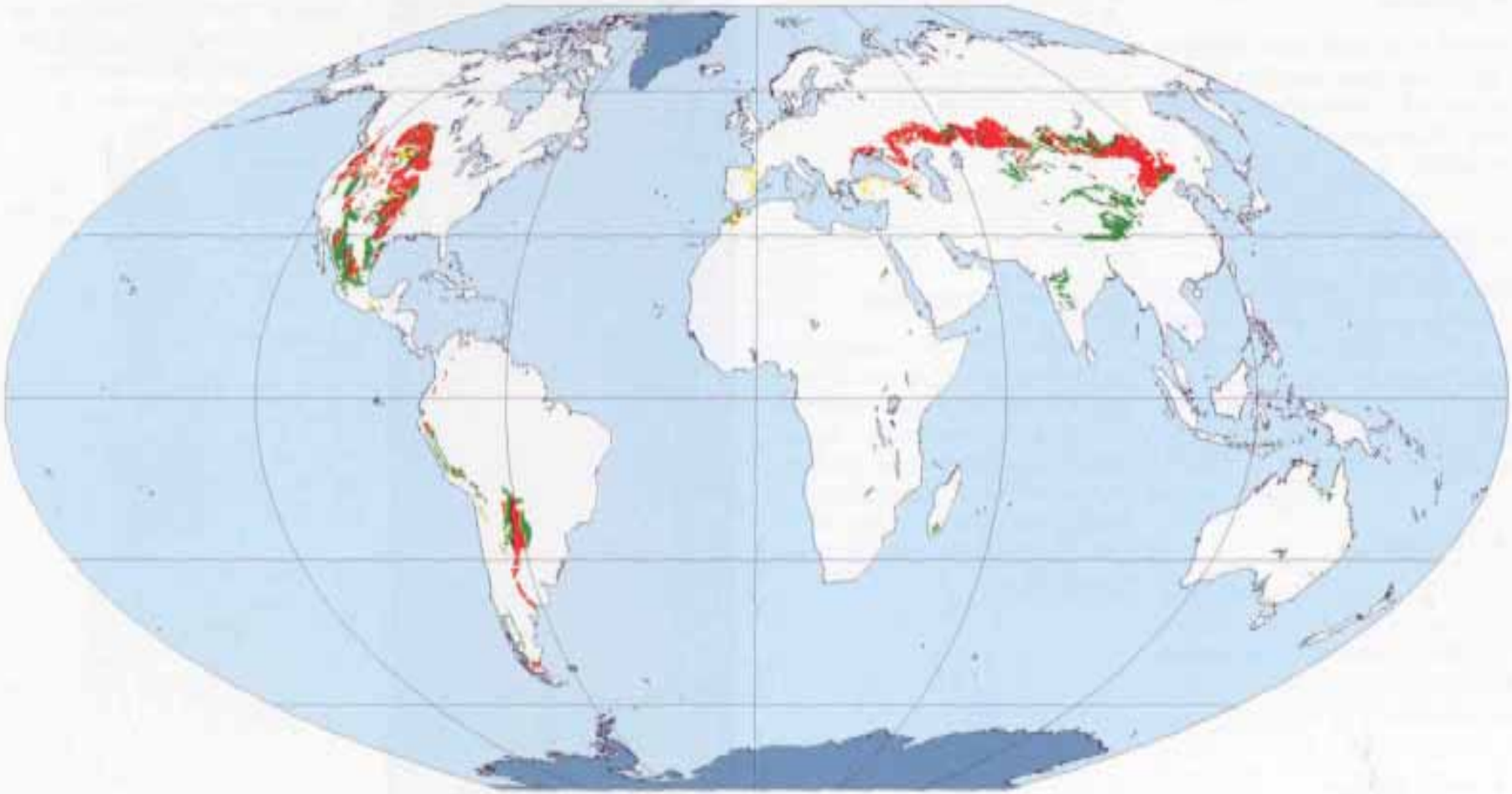
Kastanozems

Soils of the short-grass steppes, chestnut brown in colour, with accumulation of calcium carbonate or gypsum close to the surface.

Surface horizon not as thick and dark coloured as in Chernozems, and physical properties are comparable but slightly less favourable.

• Distribution of Kastanozems •



Dominant

Associated

Inclusions

Miscellaneous lands (Glaciers, No data)

Flat Polar Quartic Projection

FAO-GIS, February 1998

Phaeozems

Soils of the wetter steppes with a dark brown, humus-rich and base-satured surface horizon, but lacking carbonates within 2 m.

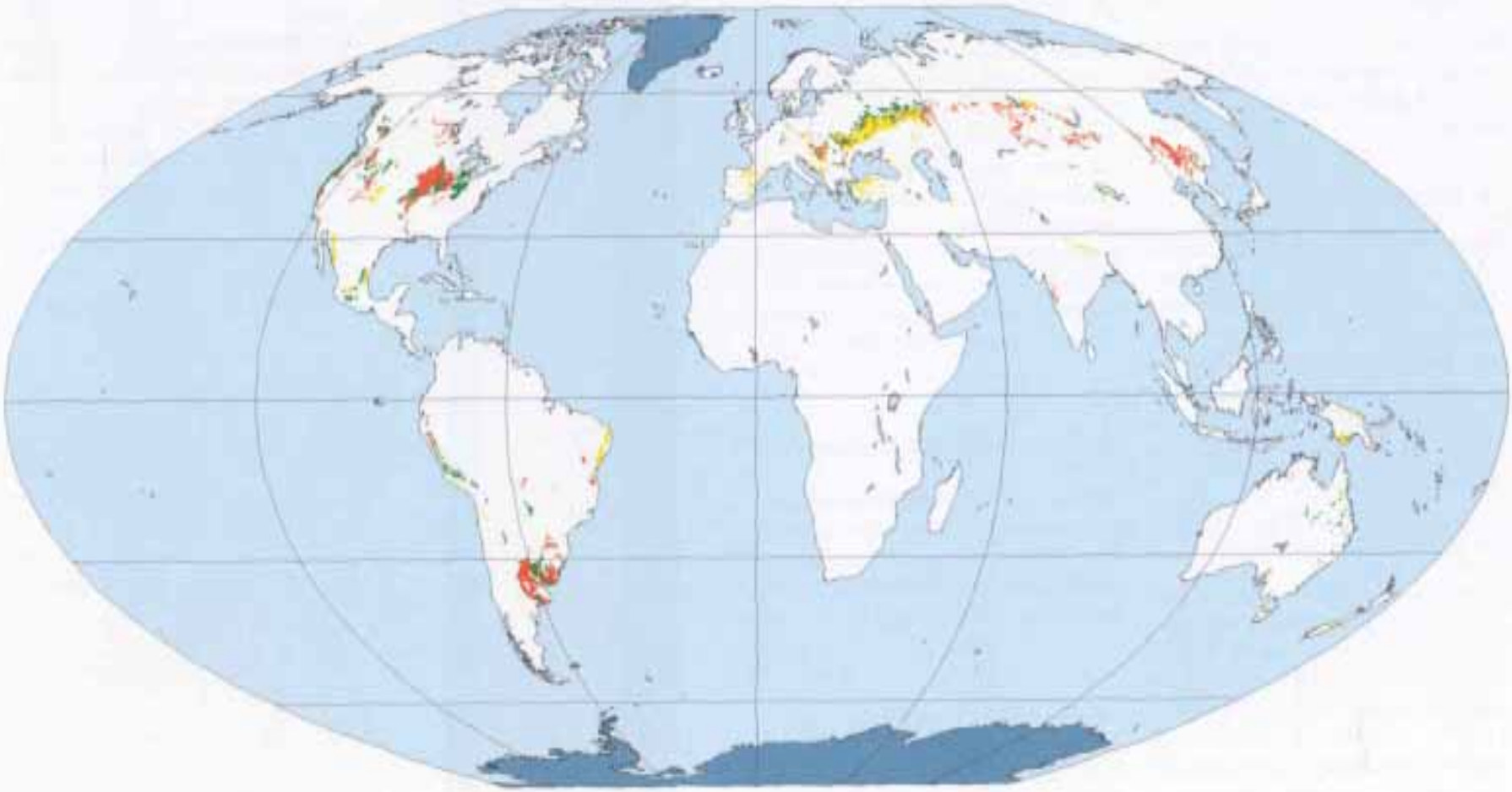
Carbonate removal and accumulation of humus are the two main processes forming *Phaeozems*.

Phaeozems

Physical properties:

- Good moisture holding capacity
- Stable micro-aggregate structure
- Erosion-resistant, even on slopes

• Distribution of Phaeozems •



Dominant

Associated

Inclusions

Miscellaneous lands (Glaciers, No data)

Flat Polar Quartic Projection

FAO-GIS, February 1998

Soils conditioned by temperate climates

- ***Luvisols*** *(soils with an "argic" horizon)*
- ***Albeluvisols*** *(soils with "albeluvic tonguing" and an "argic" horizon)*
- ***Podzols*** *(soils with a "spodic" horizon)*
- ***Planosols*** *(soils with an "abrupt textural change")*
- ***Umbrisols*** *(soils with an "umbric" horizon)*

Luvisols

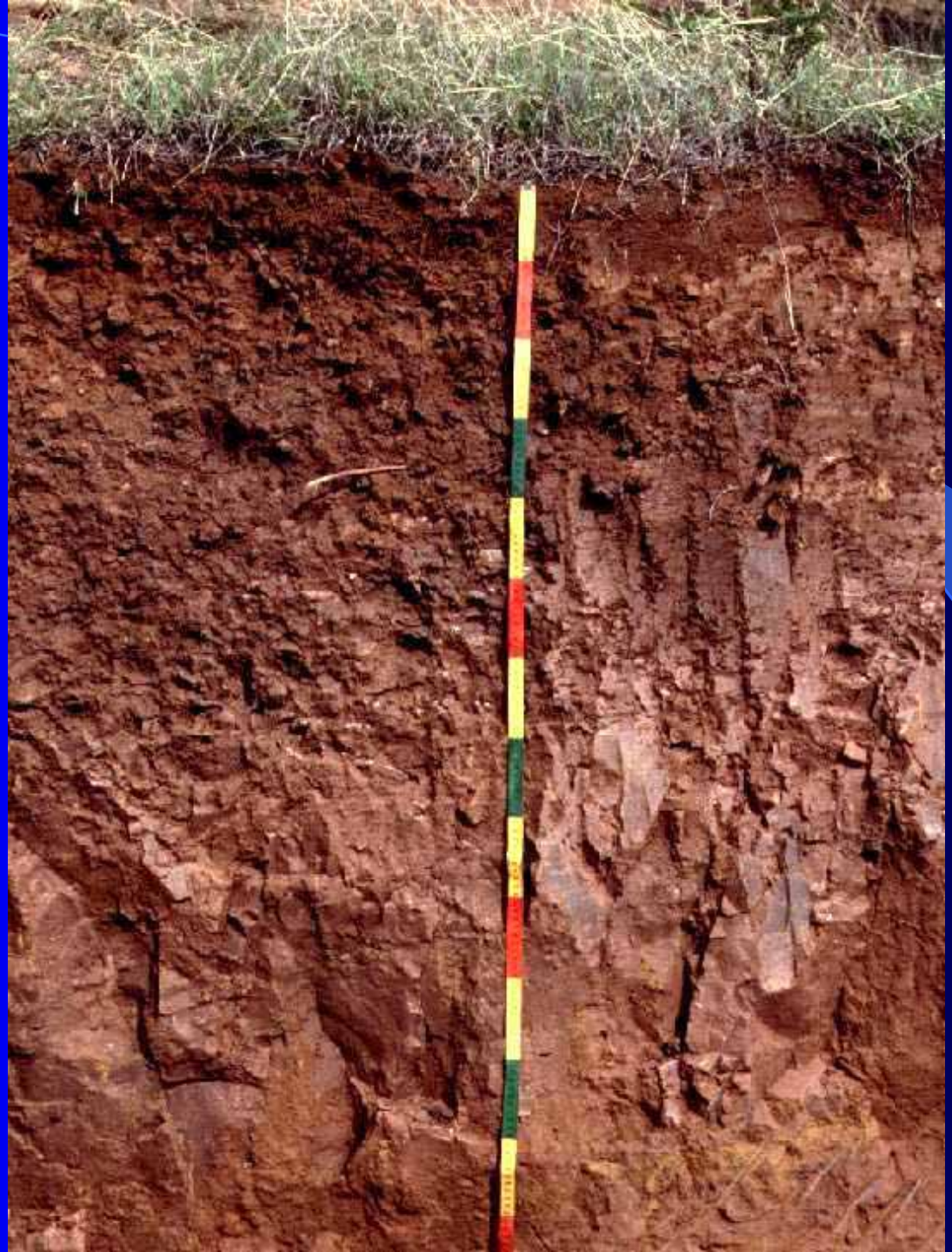
Moderately leached soils with

- Pronounced increase in clay content with depth *("argic horizon")*
- Acid to neutral soil reaction
- Moderate to high activity clay and variable base saturation

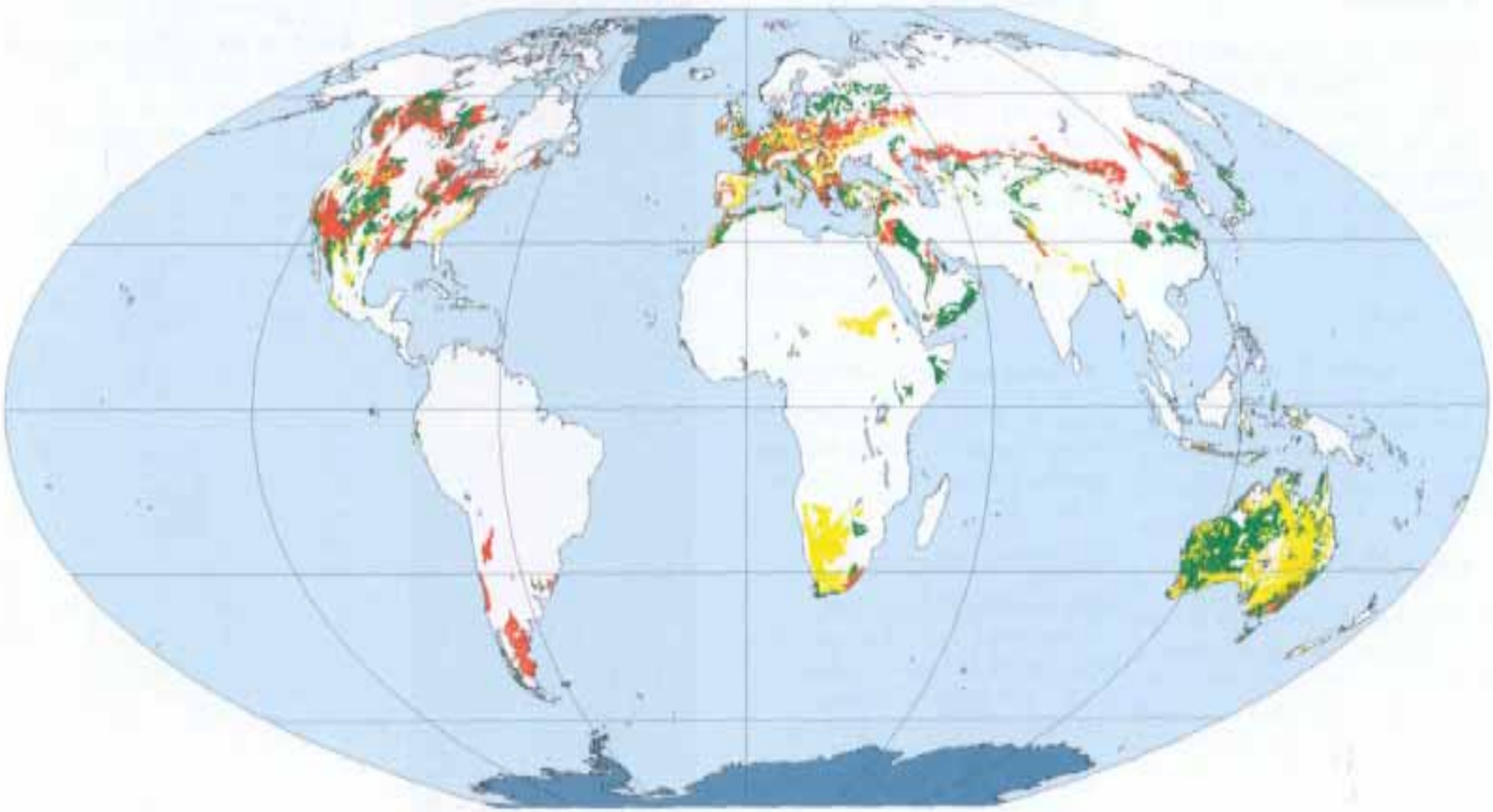
Luvisols

Physical properties:

- Porous and well-aerated topsoil
- Moderate to high available water content
- Subsoil porosity decreases over time due to clay illuviation, reducing water infiltration and inducing water stagnation



• Distribution of Luvisols •



Dominant

Associated

Inclusions

Miscellaneous lands (Glaciers, No data)

Flat Polar Quartic Projection

FAO-GIS, February 1998

Albeluvisols

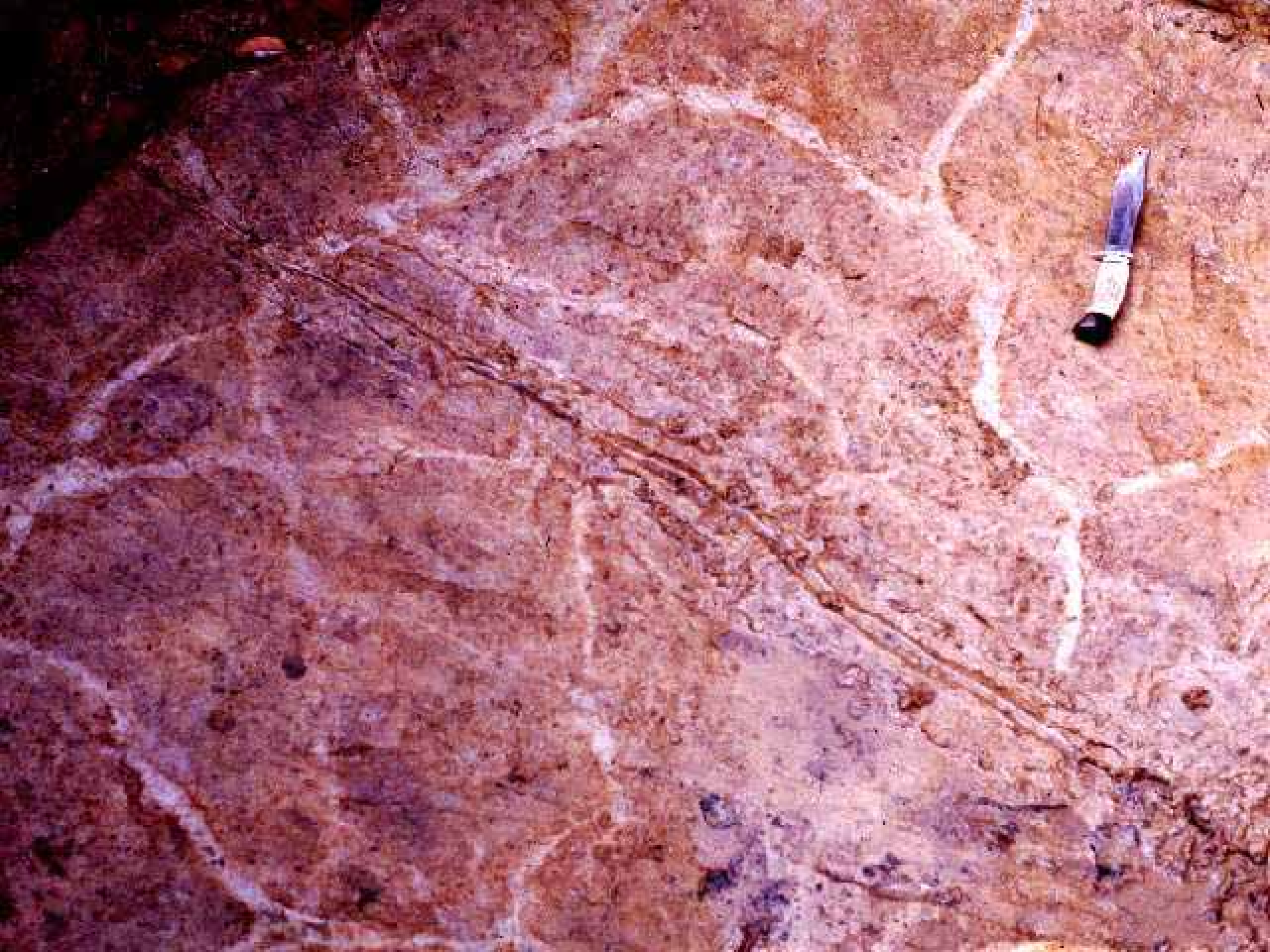
Soils with a pronounced “albic” (white, clay-depleted) horizon tonguing into an underlying “argic” (clay-enriched) horizon.

Considered to be “relict” soils formed under periglacial conditions.

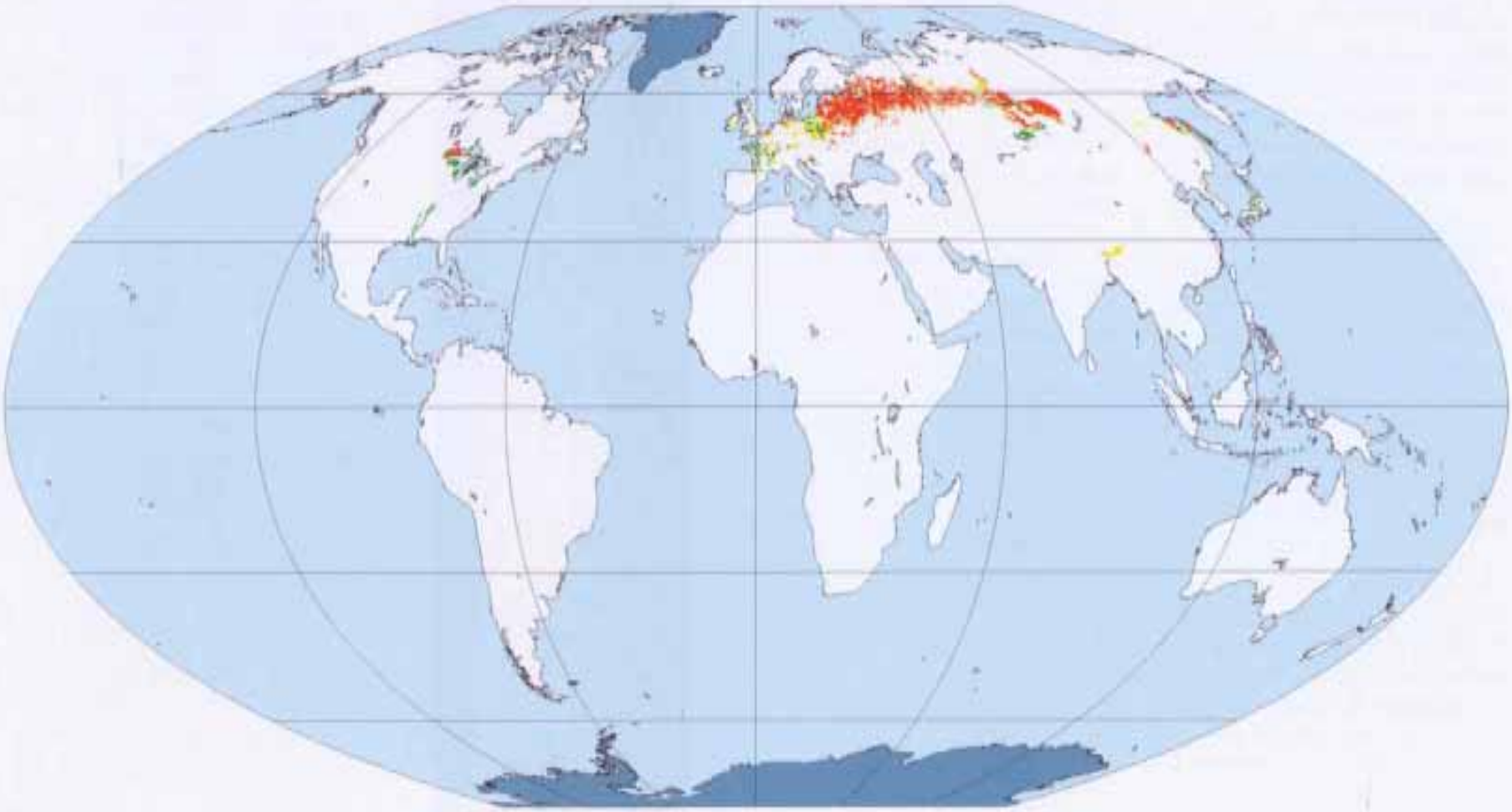
Albeluvisols

Physical properties:

- Poorly structured topsoil
- Dense subsoil, often inpenetrable for roots (“closed boxes”)
- Water stagnation on dense subsoil
- Restricted water movement



• Distribution of Albeluvisols •



Dominant | Associated | Inclusions | Miscellaneous lands (Glaciers, No data)

Flat Polar Quartic Projection

FAO-GIS, February 1998

Podzols

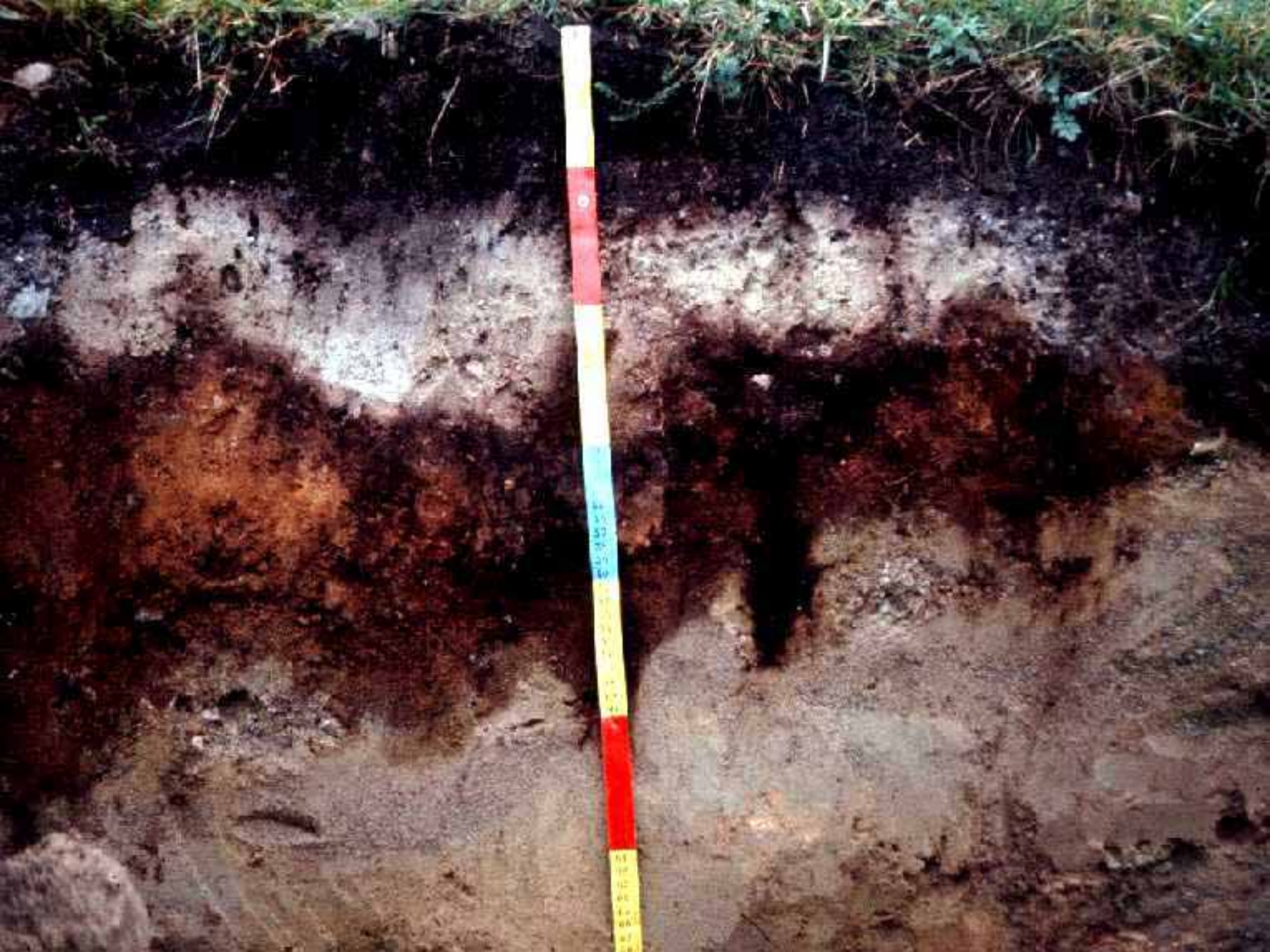
Soils in siliceous parent materials characterized by “cheluviation” processes, i.e. movement of soluble metal-humus complexes (chelates) downwards.

The processes lead to an ash-grey layer near the surface and a brownish to blackish illuvial layer below.

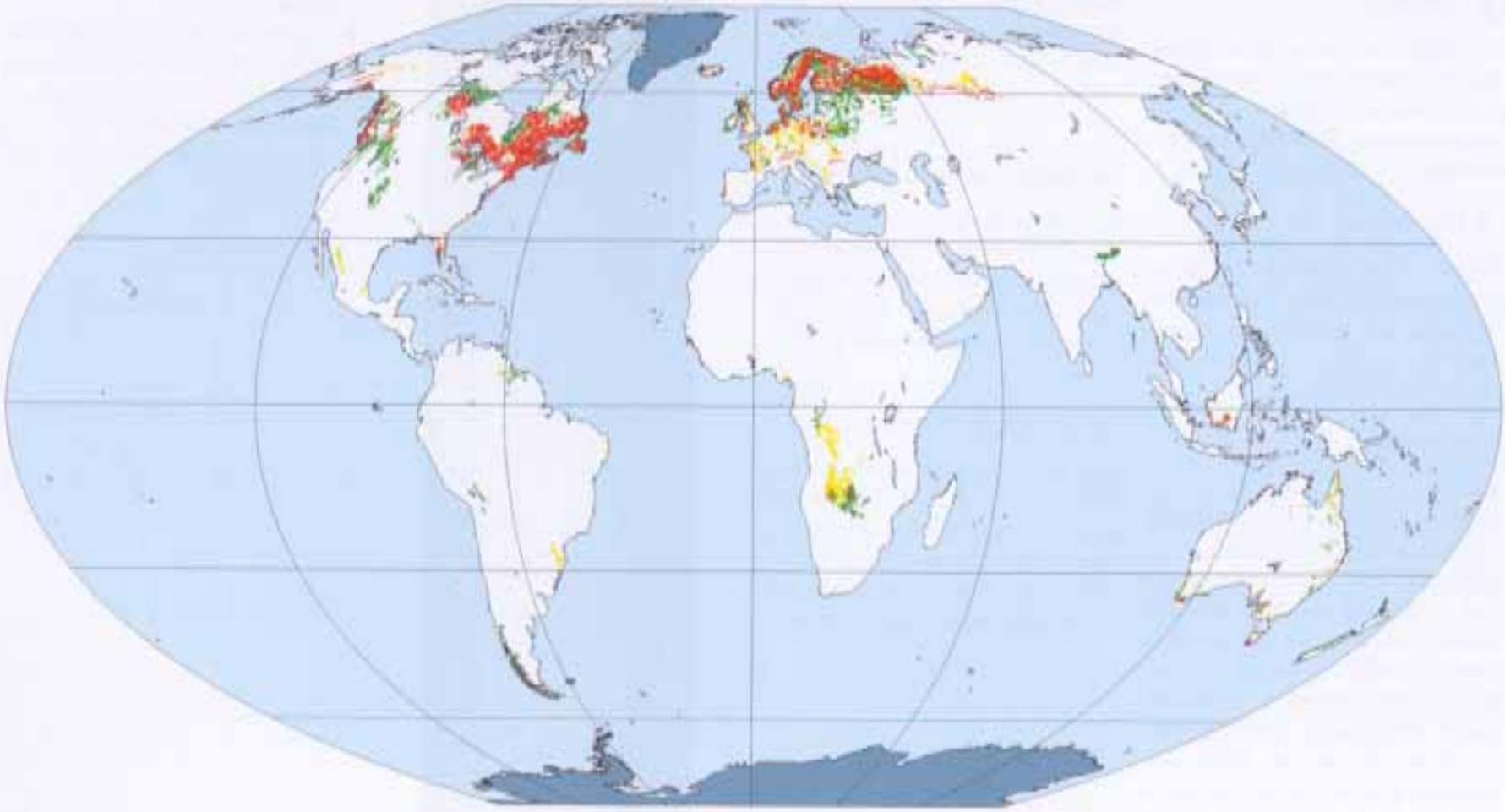
Podzols

Physical properties:

- Sandy texture
- Weak aggregation into structural elements
- Low water-holding capacity
- Illuviation may lead to very dense subsoil ("Ortstein") or iron banks



• Distribution of Podzols •



Dominant

Associated

Inclusions

Miscellaneous lands (Glaciers, No data)

Flat Polar Quartic Projection

FAO-GIS, February 1998

Planosols

Soils with an abrupt textural change and evidence of water stagnation, i.e. a sandy or silty topsoil overlying a clayey subsoil with mottles or iron-manganese concretions just above the abrupt transition.

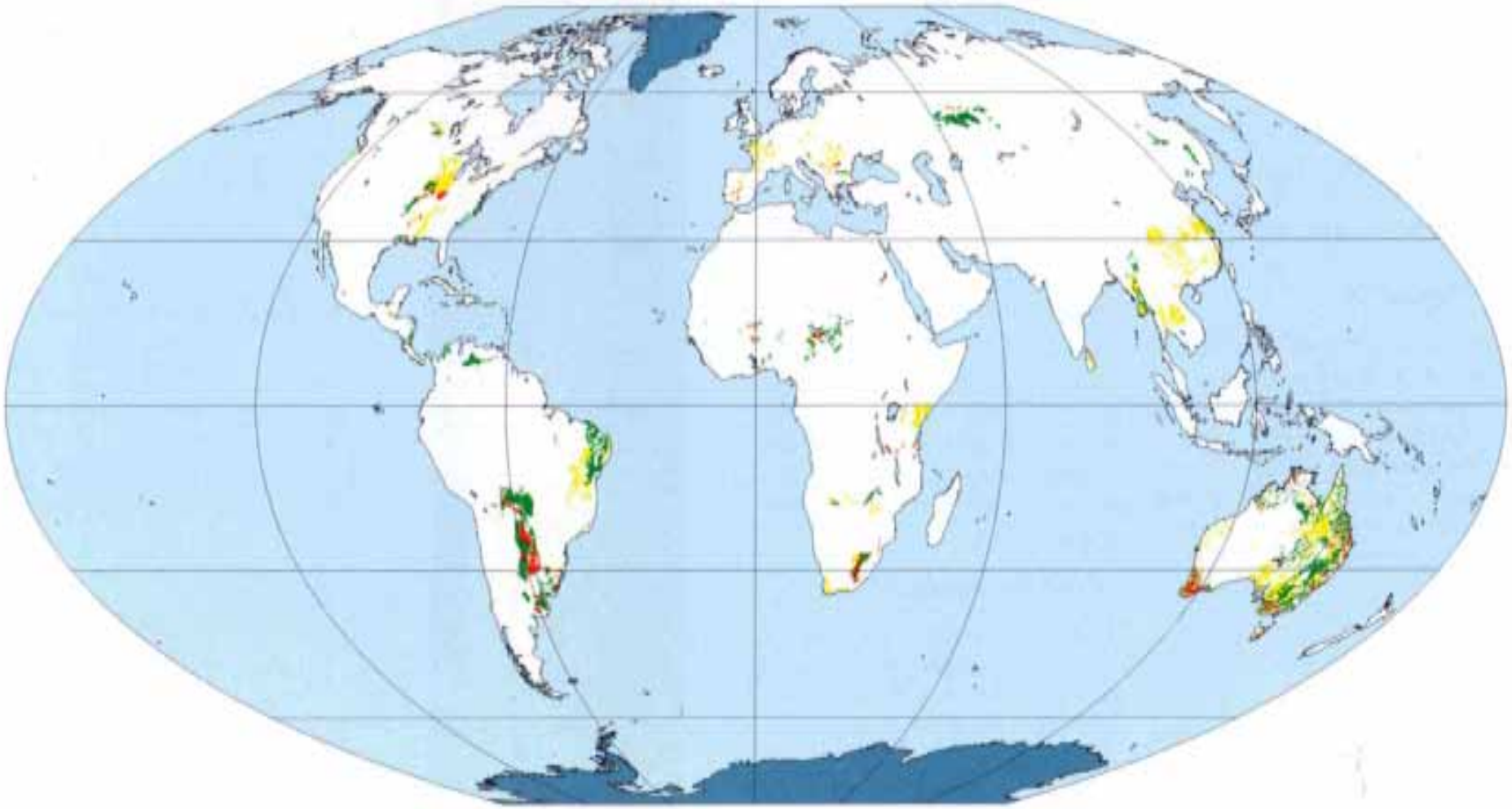
Also known as “duplex soils”.

Planosols

Physical properties:

- Water stagnation during part of the year
- Very weakly expressed and unstable structural elements in the upper part of the soil
- Compact subsoil, impairing root penetration

• Distribution of Planosols •



Dominant

Associated

Inclusions

Miscellaneous lands (Glaciers, No data)

Flat Polar Quartic Projection

FAO-GIS, February 1998

Umbrisols

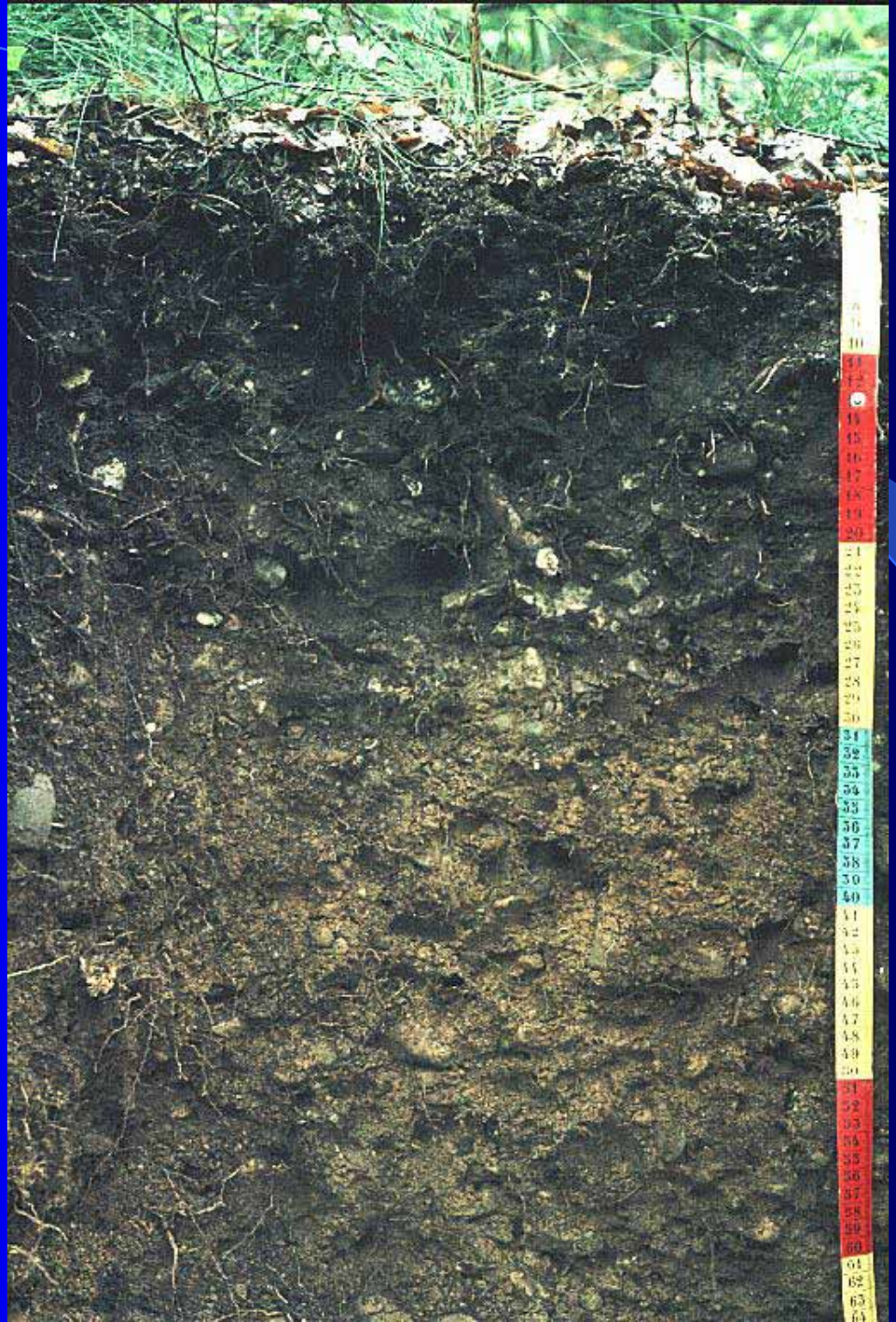
Soils with an acid, dark brown, humus-rich but base-desatured surface horizon.

Umbrisols are the strongly leached counterparts of the *Phaeozems*, mainly occurring over siliceous parent materials and in wet climates.

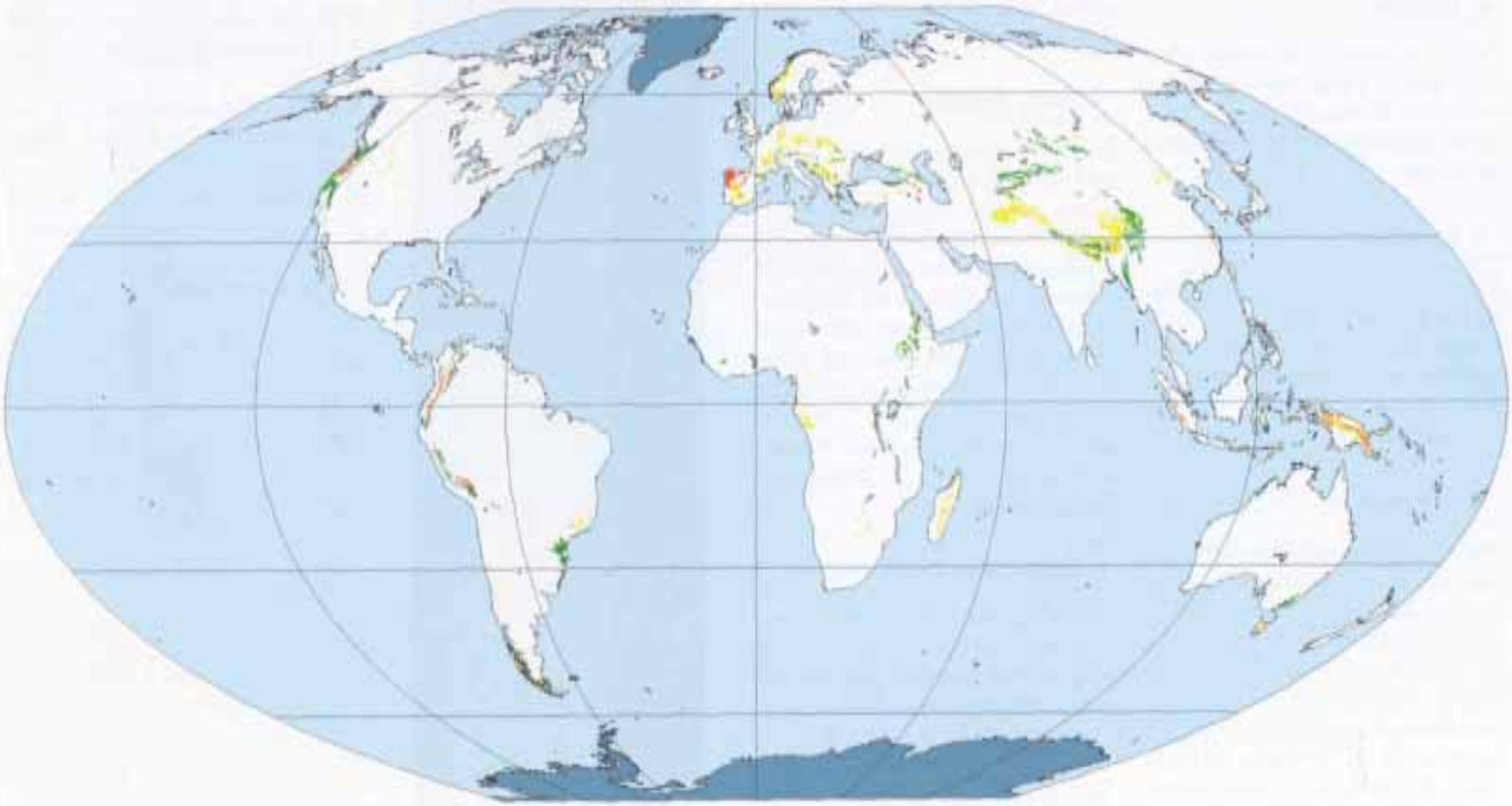
Umbrisols

Physical properties:

- Well drained
- Well aerated
- Prone to erosion if on slopes



• Distribution of Umbrisols •



Dominant

Associated

Inclusions

Miscellaneous lands (Glaciers, No data)

Flat Polar Quartic Projection

FAO-GIS, February 1998

Soils conditioned by cold climates

- ***Cryosols*** *(soils with evidence of frost churning or cryotubation)*

Cryosols

Soils with evidence of freezing and thawing, such as frost heave of coarse materials, cryoturbation and mechanical weathering.

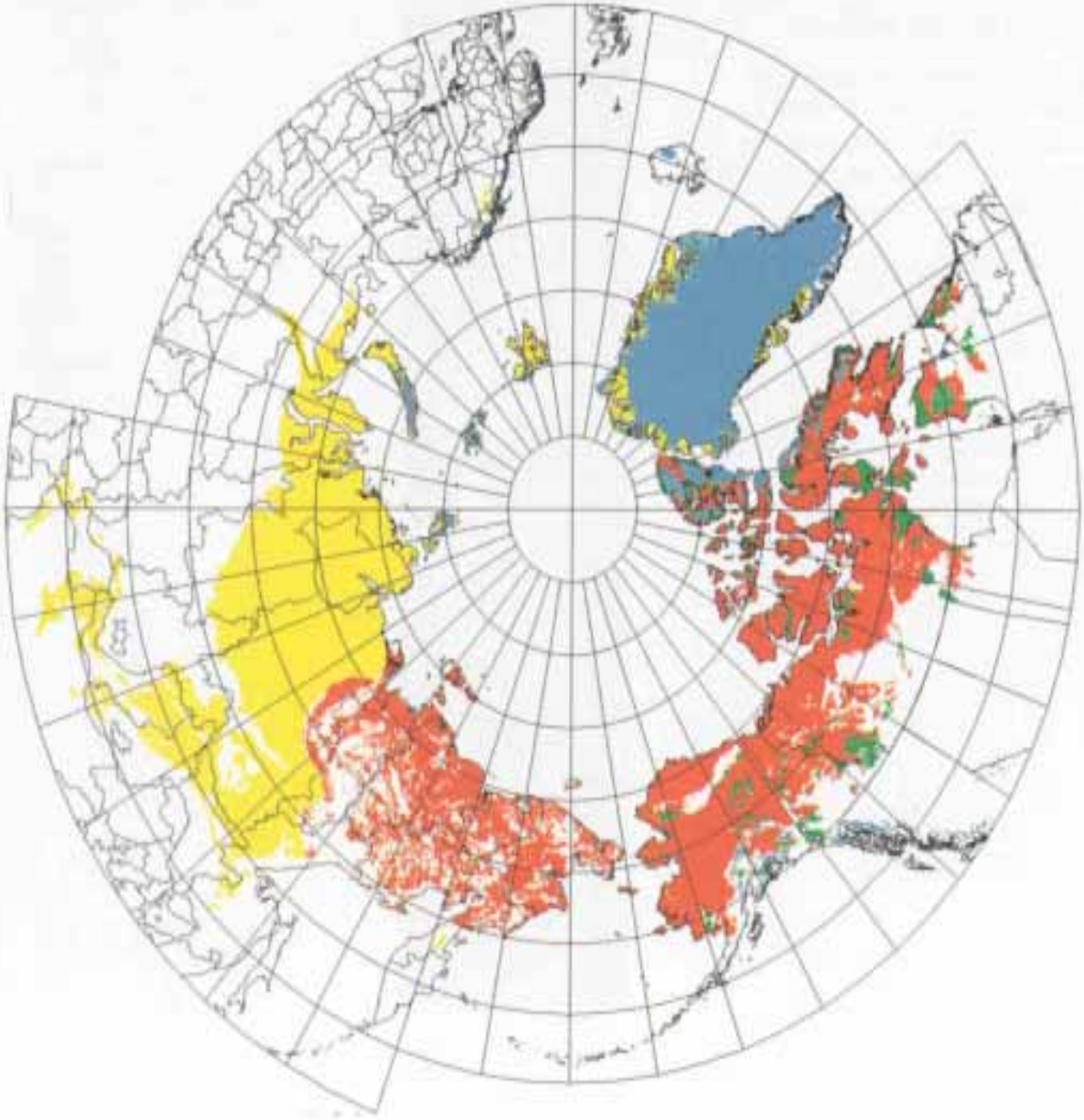
Cryotubation leads to irregular or broken soil horizons; frost heave leads to sorting and polygon formation.

Cryosols

Physical properties:

- Water-saturated during the thawing season, therefore poorly trafficable
- Occurrence of variable amounts of ice in the subsoil

• Distribution of Cryosols in the Northern Hemisphere •



Dominant

Associated

Occurence unspecified

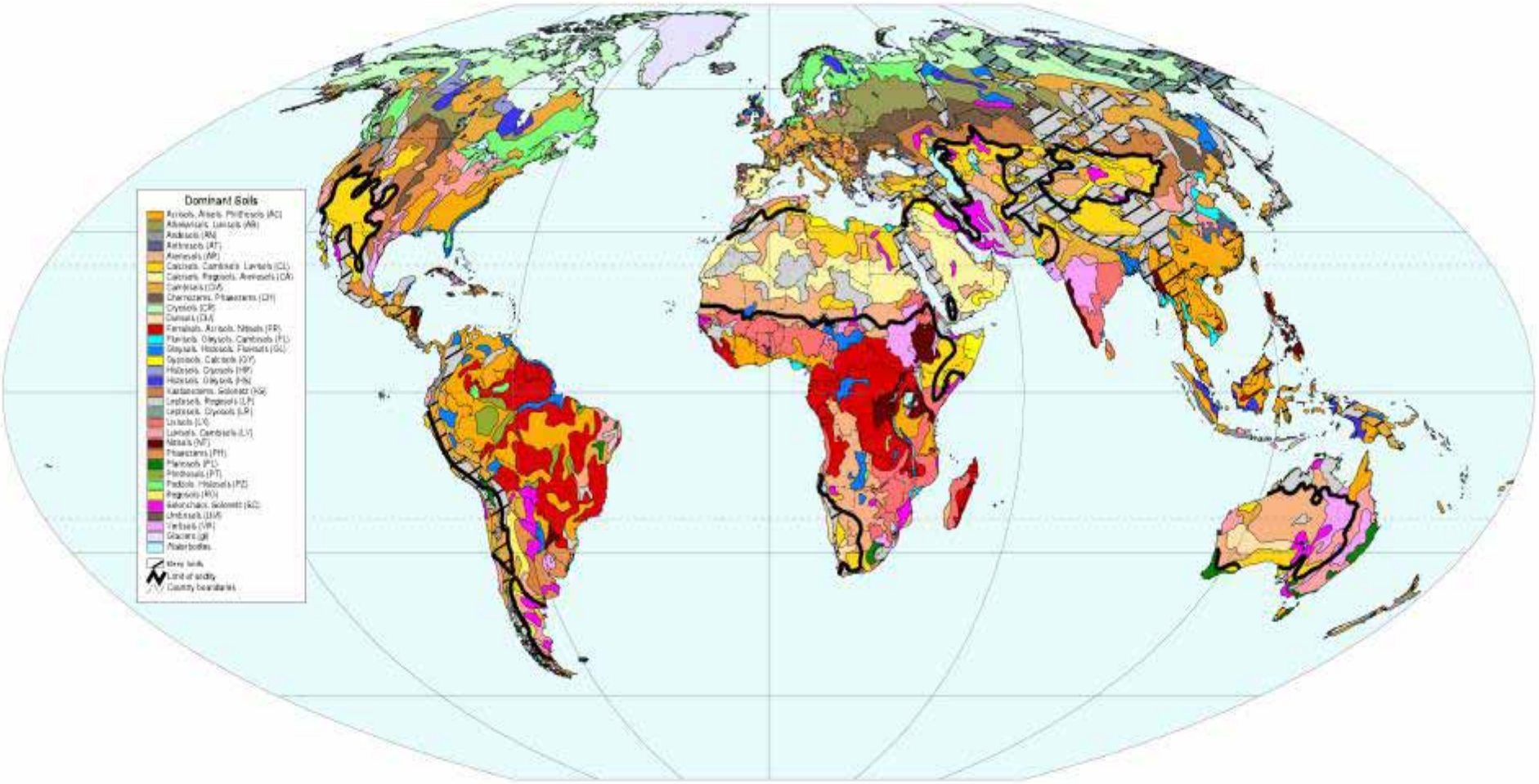
Miscellaneous lands
(Glaciers, No data)

Lambert Azimuthal
Equal Area Projection

After: B. Lacelle, C. Tarnocai, S. Waltman, J. Kimble, D. Swanson & Ye.M. Naumov. 1997. Northern Circumpolar Soil Map. Agriculture and Agri-food Canada, USDA

WORLD SOIL RESOURCES

Food and Agriculture Organization of the United Nations
European Commission - Joint Research Centre
International Soil Reference and Information Centre



Projection Flat Polar Quartic
(Original scale 1:30 000 000 approx)

http://www.isric.org

ftp://ftp.fao.org/agl/agll/docs/wsrr94e.pdf

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