GYPSISOLS, DURISOLS, and CALCISOLS

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Definition of Gypsisols

Soils having

- A *gypsic* or *petrogypsic* horizon within 100 cm from the soil surface
- No diagnostic horizons other than an ochric or cambic horizon, an argic horizon permeated with gypsum or calcium carbonate, a vertic horizon, or a calcic or petrocalcic horizon underlying the gypsic or petrogypsic horizon
Gypsic horizon

Results from accumulation of secondary gypsum (CaSO$_4$.2H$_2$O).

It contains $\geq 15$ percent gypsum (if $\geq 60$ percent gypsum, horizon is called *hypergypsic*), and has a thickness of at least 15cm.
The petrogypsic horizon

- contains $\geq 60$ percent gypsum
- is cemented to the extent that dry fragments do not slake in water and the horizon cannot be penetrated by roots
- has a thickness of 10cm or more
Genesis of Gypsisols

Main soil-forming factor is:

**Arid climate**

Main soil-forming process is:

- Precipitation of gypsum from the soil solution when this evaporates. Most Gypsisols are associated with sulphate-rich groundwater that moves upward in the soil through capillary action and evaporates at the surface.
Classification of Gypsisols (1)

- **Strong expression qualifiers:** hypergypsic and petric

- **Intergrade qualifiers:** calcic, duric, endosalic, leptic, luvic, and vertic

- **Secondary characteristics qualifiers,** related to defined diagnostic horizons, properties or materials: aridic, hyperochric, takyric, and yermic
Classification of Gypsisols (2)

- **Secondary characteristics qualifiers**, not related to defined diagnostic horizons, properties or materials: *arzic, skeletic, and sodic*

- **Haplic qualifier**, where none of the above applies: *haplic*
Example of a Gypsisol (1)

Yermi-Calcic Gypsisol (Endoskeletic and Sodic), Israel

![Image of a soil profile with a bar graph showing the percentage of gypsum and CaCO₃ at different soil depths.]

- 0-2cm: % gypsum, % CaCO₃
- 2-6cm: % gypsum, % CaCO₃
- 6-21cm: % gypsum, % CaCO₃
- 21-38cm: % gypsum, % CaCO₃
- 38-50cm: % gypsum, % CaCO₃
- 50-78cm: % gypsum, % CaCO₃
- 78-94cm: % gypsum, % CaCO₃
- 94-126cm: % gypsum, % CaCO₃
- 126-150cm: % gypsum, % CaCO₃

% gypsum
% CaCO₃

Yermi-Calcic Gypsisol (Endoskeletic and Sodic), Israel
Example of a Gypsisol (2)

Yermi-Epipetric Gypsisol, Namibia
Distribution of Gypsisols (1)
**Distribution of Gypsisols (2)**

*Gypsisols* cover some 100M ha or 0.7% of the Earth’s land surface. They occur mainly in hot desert regions, such as in and around Mesopotamia, the Arabian Peninsula, the Libyan and Namib deserts, central Asia, southeast and central Australia, and southwest USA.
**Associated soils**

**Gypsisols** occur associated with Calcisols, Durisols, Arenosols, Regosols, Leptosols in desert regions. Where saline groundwater comes near to the surface, Gypsisols occur in association with Solonchaks.

Other RSGs may also show accumulation of gypsum, notably Vertisols, Solonchaks, Gleysols and Kastanozems.
Definition of Durisols

Soils having a *duric* or *petroduric* horizon within 100cm from the soil surface.
The **duric** horizon has

- ≥ 10 volume percent durinodes which:
  - do not break down in concentrated HCl but do break down in concentrated KOH after HCl treatment
  - are firm of very firm, and brittle when wet, both before and after acid treatment
  - have a diameter ≥ 1cm

- thickness ≥ 10cm
Petroduric horizon

The petroduric horizon has

- Cementation or induration > 50 percent
- Evidence of silica accumulation
- < 50 volume percent of its mass slaking in 1M HCl, but > 50 volume percent slaking in concentrated KOH
- Lateral continuity
- Thickness of ≥ 10cm
Genesis of Durisols

Main soil-forming factor is:

(Semi-)arid climate

Main soil-forming processes are:

- Dissolution of silica in the upper part of the soil and translocation to lower layers
- Precipitation in amorphous or micro-crystalline forms of SiO$_2$ in lower layers
Classification of Durisols (1)

- **Strong expression qualifiers:** hyperduric and petric

- **Intergrade qualifiers:** arenic, calcic, gypsic, leptic, luvic, and vertic

- **Secondary characteristics qualifiers,** related to defined diagnostic horizons, properties or materials: aridic, hyperochric, takyric, and yermic
Classification of Durisols (2)

- **Secondary characteristics qualifiers**, not related to defined diagnostic horizons, properties or materials: *chromic*

- **Haplic qualifier**, where none of the above applies: *haplic*
Example of a Durisol (1)

Chromi-Epipetetic Durisol, South Africa

Note: here the petroduric horizon has a laminated (platy) appearance; petroduric horizons may also have a massive appearance
Example of a Durisol (2)

Luvi-Endopetric Durisol (Chromic), USA

“San Joaquin Series, the California State Soil”

← Petrodural horizon (also called “duripan”), silica and sesquioxide cementation in > 90 percent of matrix
Distribution of Durisols (1)
The extent of *Durisols* is not precisely known. They occur mainly in Australia, South Africa and Namibia, and in the southwestern USA.
Associated soils

Being soils from the semi-arid regions, *Durisols* are associated with Gypsisols, Calcisols, Solonchaks, Solonetz, Vertisols, Arenosols and Cambisols.
Calcisols

*Calcisols* comprise soils with accumulation of secondary calcium carbonate ($\text{CaCO}_3$).

They mainly occur in arid, semi-arid, Mediterranean and steppe climates.
Definition of Calcisols

Calcisols have:

- A *calcic* or *petrocalcic* horizon within 100cm from the soil surface

- No diagnostic horizons other than an ochric or cambic horizon, an argic horizon which is calcareous, a vertic or gypsic horizon
Calcic horizon

Results from accumulation of secondary carbonates.

It contains $\geq 15$ percent calcium carbonate equivalent (if $\geq 50$ percent calcium carbonate equivalent, horizon is called hypercalcic), and has a thickness of at least 15cm.
Petrocalcic horizon

The *petrocalcic* horizon

- Has a calcium carbonate equivalent $\geq 50$ percent (by weight)
- is cemented to the extent that dry fragments do not slake in water and roots cannot enter
- Has extremely hard consistence when dry
- has a thickness $\geq 10\text{cm}$, or $\geq 2.5\text{ cm}$ if laminar and rests directly on bedrock
Genesis of Calcisols

Main soil-forming factor is:

**Semi-arid and dry sub-humid climate**

Main soil-forming process is:

- Precipitation of carbonates from the soil solution when this evaporates.
Classification of Calcisols (1)

- **Strong expression qualifiers:** hypercalcic and petric

- **Intergrade qualifiers:** endosalic, gleyic, leptic, luvic, and vertic

- **Secondary characteristics qualifiers,** related to defined diagnostic horizons, properties or materials: aridic, hyperochric, takyric, and yermic
Classification of Calcisols (2)

- **Secondary characteristics qualifiers**, not related to defined diagnostic horizons, properties or materials: *skeletic and sodic*

- **Haplic qualifier**, where none of the above applies: *haplic*
Example of a Calcisol (1)

Endovertic Calcisol, Italy

![Image of soil profile]

- 225-250cm
- 190-205cm
- 150-170cm
- 120-135cm
- 70-90cm
- 40-55cm
- 10-30cm

% calcium carbonate equivalent

10-30cm: 25%
40-55cm: 30%
70-90cm: 25%
120-135cm: 30%
150-170cm: 25%
190-205cm: 20%
225-250cm: 15%
Example of a Calcisol (2)

Luvic Calcisol, Turkey

![Image of soil profile]

Bar chart showing the percentage of clay and CaCO3 in different soil layers:
- 0-15 cm
- 15-50 cm
- 50-75 cm
- 75-100 cm
Distribution of Calcisols (1)
Distribution of Calcisols (2)

Calcisols cover some 800M ha worldwide, or 6.3 percent of the Earth’s land surface.

They are found mainly in the arid and semi-arid (sub)tropics and the Mediterranean region.
**Associated soils**

*Calcisols* occur in association with Gypsisols and Durisols in the desert and semi-arid regions, in depressions in association with Gleysols, Solonchaks and Vertisols, and in the Mediterranean region with Luvisols and Cambisols.

In steppe regions *Calcisols* may grade into Kastanozems and Chernozems.