DURISOLS (DU)

The Reference Soil Group of the Durisols is associated with arid and semi-arid environments and accommodates very shallow to moderately deep, moderately well to well-drained soils that contain cemented secondary silica (SiO_2) within 100 cm from the soil surface. Durisols are internationally known as “hardpan soils” (Australia) or “dorbank” (South Africa) or as “duripan phase” of other soils, e.g. of Calcisols (FAO).

Definition of Durisols

Soils having a duric or petroduric horizon within 100 cm from the surface.

Common soil units:
Petric, Leptic, Vertic, Gypsic, Calcic, Luvic, Arenic, Hyperduric, Takyric, Yermic, Aridic, Hyperochric, Chromic, Haplic.

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Summary description of Durisols

Connotation: soils with hardened secondary silica; from L. durus, hard.

Parent material: mainly alluvial and colluvial deposits of all texture classes.

Environment: level and slightly sloping alluvial plains, terraces and gently sloping piedmont plains in arid, semi-arid and Mediterranean regions.

Profile development: AC- or ABC-profiles; eroded Durisols with exposed petroduric horizons are common in (gently) sloping terrain.

Use: most Durisols can only be used for extensive grazing. Arable cropping of Durisols is limited to areas where irrigation water is available (a continuous petroduric horizon at shallow depth must be broken up).

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Regional distribution of Durisols

Extensive areas of Durisols occur in Australia, in South Africa/Namibia and in the USA (notably Nevada, California and Arizona); minor occurrences have been reported from Central and South America and from Kuwait. Durisols are a new introduction in international soil classification and have not often been mapped as such. A precise indication of their extent is not (yet) available. Figure 1 presents a sketch map of their main occurrences.

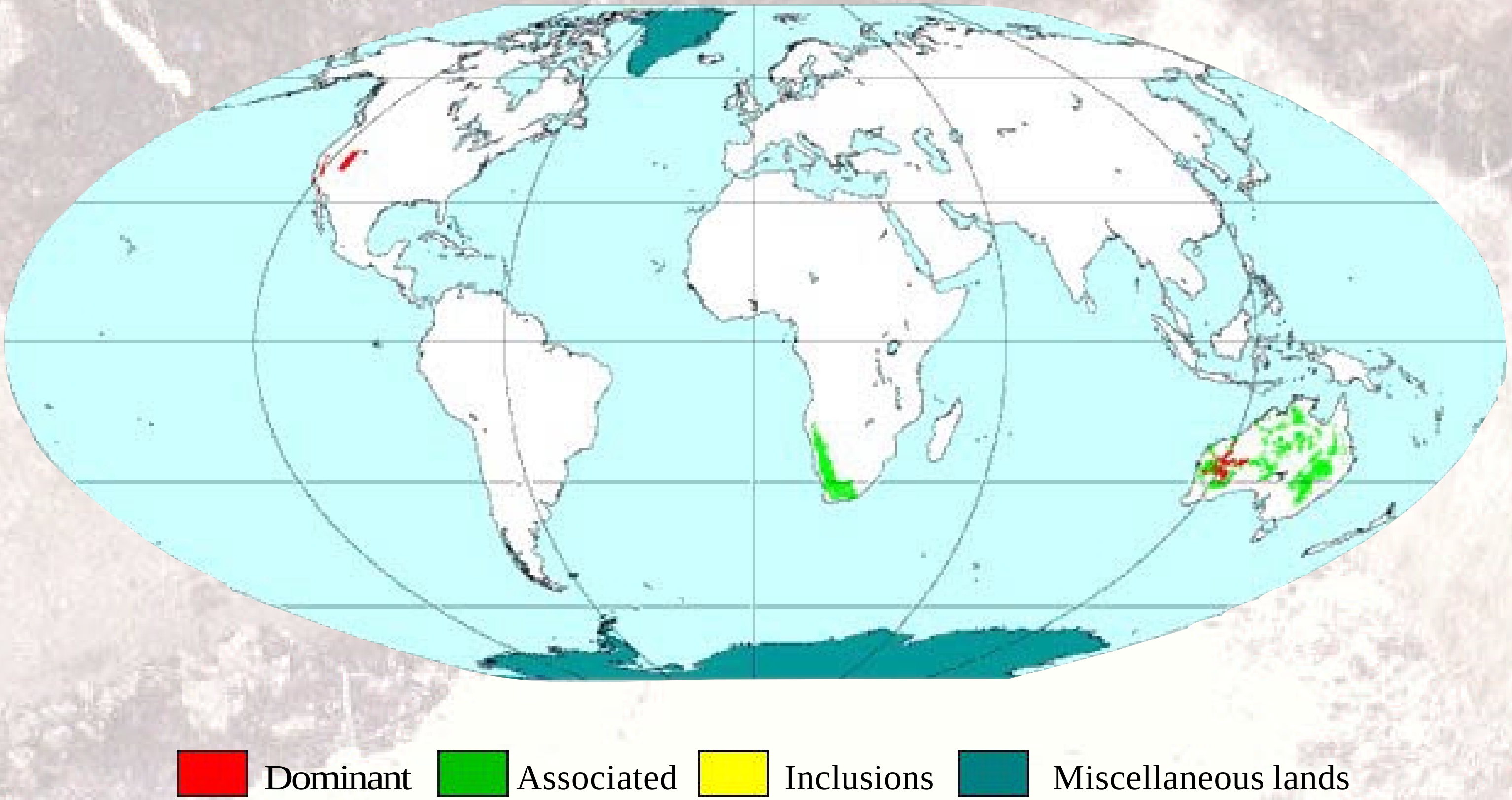

Figure 1. Durisols worldwide.

Associations with other Reference Soil Groups

Durisols are confined to dry regions, where they occur in association with Gypsisols, Calcisols, Solonchaks, Solonetz, Vertisols, Arenosols, Cambisols and, more rarely, Planosols or Kastanozems. In places, Durisols occur together with Andosols. In areas with silica-capped mesas, Durisols may be found in lower parts of the landscape.

Genesis of Durisols

Most Durisols have formed in strongly weathered alluvial or colluvial parent material. It is generally believed that duric and petroduric horizons have formed by downward translocation of clay and silica, despite the normally very low annual rainfall sum,. Periodic flooding and wetting of the surface soil during occasional heavy downpours promote leaching and acidification of the upper soil layer; the leached silica accumulates deeper in the soil where it hardens as the soil dries out. The consistent occurrence of a cemented hardpan (a petroduric horizon, often referred to as a ‘duripan’) at shallow depth, even beneath surfaces on which new soil material regularly accumulates, is accepted as evidence that silica translocation is still taking place. The consistent positive correlation between the depth of the hardpan and the permeability of the overlying soil is a further indication that hardpan formation is not a paleo-feature.

Duric and petroduric horizons, with their active cementation, must not be confused with ‘silcrete’, i.e. hardened, silica-cemented lumps or continuous layers of soil material that formed under a different climate than that of today. Most silcrete stems from the (early) Tertiary. It is commonly associated with silica-rich parent rocks such as quartz sandstone, but occurs also on weathered igneous rocks that lost most of their soluble constituents, and in the lower layers of strongly leached, red, tropical soils. In places, silcrete has become exposed after erosion of the surface soil; the hardened silcrete cap protects the soil from further erosion.

Characteristics of Durisols

Morphological characteristics

Most Durisols are well drained, medium to coarse-textured soils. They have either a petroduric horizon or a duric horizon within 100 cm from the surface. A petroduric horizon is a subsurface horizon cemented by secondary silica (presumably amorphous and microcrystalline forms of SiO_2). They commonly contain accessory cements, chiefly calcium carbonate and iron oxides. A duric horizon contains indurated nodules, (sometimes called 'durinodes') that are cemented by silica. Dry fragments of a petroduric or duric horizon do not slake upon prolonged soaking in water or in hydrochloric acid.

Petroduric horizons range in thickness from 10 cm to more than 4 m. Two main morphological types are distinguished, i.e. massive 'duripans', and 'duripans' with a platy or laminated structure. The plates or 'laminae' are between a few mm and 15 cm thick. Pores and the surfaces of the plates are coated with amorphous 'opal' or microcrystalline silica. Roots tend to grow in between the plates or form a mat on top of the petroduric horizon. Rodents are capable of burrowing through the pan(s); their burrows are later filled in with soil material from all horizons. Roots and water can enter the underlying horizons through these passages, which improve root growth and soil moisture retention.
The 'durinodes' in a duric horizon show normally a pattern of roughly concentric layers when viewed in cross section. Duric horizons are less common than petroduric horizons of which they are considered to be the predecessor.

A typical Durisol profile consists of a red (brown) to grayish brown, non-calcareous surface soil on top of a duric or petroduric horizon. Durisols may have an argic, cambic or calcic horizon above the (petro)duric horizon. If unconsolidated materials underlie the (petro)duric horizon, these are normally weakly structured and calcareous or gypsiferous. In many instances the material is calcareous immediately below the (petro)duric horizon and gypsiferous at greater depth.

Hydrological characteristics

The water storage capacity of Durisols with a petroduric horizon depends mainly on the depth and composition of the soil above the 'duripan'. The petroduric horizon is a dense layer and obstructs vertical water movement. Data on soil moisture stored between 333 and 15,000 hPa soil suction (wrongly defined as 'available' soil moisture), suggest that any value between (almost) 0 and 15 % moisture may be expected. In less cemented duric horizons one may find between 5 and 15 % 'available' moisture.

Physical characteristics

The texture class of petroduric and duric horizons can range from sand to sandy clayloam. Textures finer than sandy clayloam are rare; sandy loam appears to be the most common material. The bulk density of petroduric and duric horizons is between 1.2 and 2.0 kg dm^{-3} but values between 1.3 and 1.7 kg dm^{-3} are most common. Petroduric horizons tend to be denser (bulk density between 1.6 and 2.0 kg dm^{-3}) than duric horizons.

Petroduric and duric horizons are normally (but not exclusively) 'massive', i.e. without structure. The dry consistence of 'duripans' is typically hard to extremely hard. The dry consistence of duric horizons varies between soft and very hard but 'durinodes' are usually hard to extremely hard.

Chemical characteristics

The $pH_{(H2O)}$ of petroduric and duric horizons may be as low as 5.0 or as high as 10.0 but values are typically between 7.5 and 9.0. The electrical conductivity is typically less than 4 dS m^{-1}; higher values are not uncommon ("Hyposalic" and "Salic" soil units). Many Durisols have high levels of exchangeable sodium and low contents of carbon and extractable iron. The (nominal) base saturation is usually well in excess of 50 %.

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Management and use of Durisols

The agricultural use of Durisols is limited to extensive grazing (rangeland). Durisols in ‘natural’ environments generally support enough vegetation to contain erosion but elsewhere erosion of the surface soil is widespread.

Stable landscapes occur in dry regions where Durisols were eroded down to their resistant ‘duripan’. Durisols may be cultivated with some success if sufficient irrigation water is available. Note that a petroduric horizon may need to be broken up, or removed altogether, if it forms a barrier to root and water penetration. Excess levels of soluble salts may affect Durisols in low-lying areas. Hard ‘duripan’ material is widely used in road construction.