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ACRISOLS (AC)

The Reference Soil Group of the Acrisols holds soils that are characterized by accumulation of low activity clays in an argic subsurface horizon and by a low base saturation level. Acrisols correlate with 'Red-Yellow Podzolic soils' (e.g. Indonesia), 'Podzolicos vermelho-amarello distroficos a argila de atividade baixa' (Brazil), 'Sols ferralitiques fortement ou moyennement désaturés' (France), 'Red and Yellow Earths' and with several subgroups of Alfisols and Ultisols (Soil Taxonomy, USA).

Definition of Acrisols

Soils,

1 having an argic horizon, which has a cation exchange capacity (in 1 *M* NH_4OAc at pH 7.0) of less than 24 cmol(+) kg^{-1} clay in some part, either starting within 100 cm from the soil surface, or within 200 cm from the soil surface if the argic horizon is overlain by loamy sand or coarser textures throughout, **and**

2 having less than 50 percent base saturation (in 1 *M* NH_4OAc at pH 7.0) in the major part between 25 and 100 cm.

Common soil units:

Leptic, Gleyic, Vitric, Andic, Plinthic, Umbric, Arenic, Stagnic, Abruptic, Geric, Humic, Albic, Profondic, Lamellic, Ferric, Hyperochric, Skeletic, Vetic, Alumic, Hyperdystric, Rhodic, Chromic, Haplic.

Summary description of Acrisols

Connotation: strongly weathered acid soils with low base saturation; from L. acris, very acid.

Parent material: most extensive on acid rock weathering, notably in strongly weathered clays, which are undergoing further degradation.

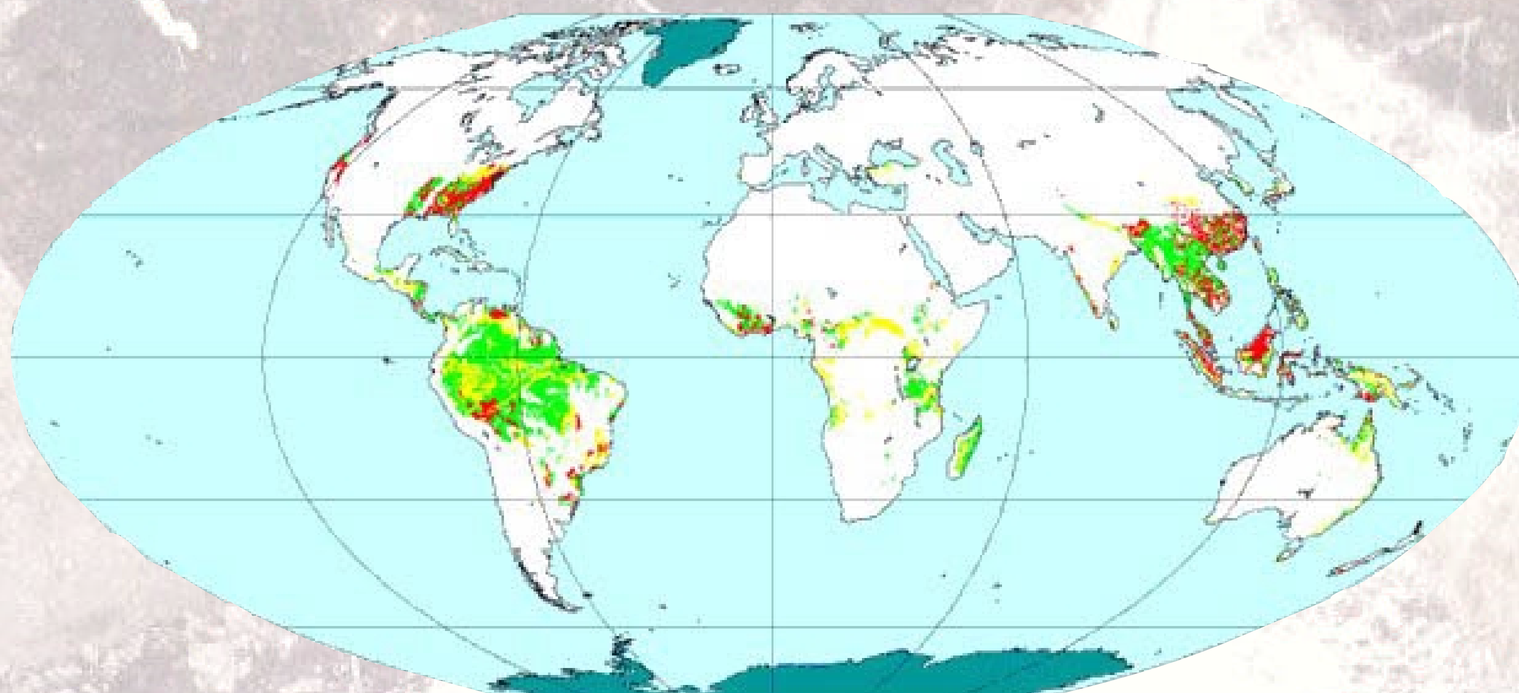
Environment: mostly old land surfaces with hilly or undulating topography, in regions with a wet tropical/monsoonal, subtropical or warm temperate climate. Light forest is the natural vegetation type.

Profile development: AEBtC-profiles. Variations in Acrisols will normally correlate with variations in terrain conditions (drainage, seepage). A shallow A-horizon with dark, raw and acid organic matter grades into a yellowish E-horizon. The underlying argic Bt-horizon has stronger reddish or yellowish colour than the E-horizon.

Use: a general paucity of plant nutrients, aluminium toxicity, strong phosphorus sorption, slaking/crusting and high susceptibility to erosion impose severe restrictions on arable land uses. Large areas of Acrisols are used for subsistence farming, partly in a system of shifting cultivation. By and large, Acrisols are not very productive soils; they perform best under undemanding, acidity-tolerant crops such as pineapple, cashew, oil palm or rubber.

Regional distribution of Acrisols

Acrisols are found on acid rocks, mostly of Pleistocene age or older. They are most extensive in South-east Asia, the southern fringes of the Amazon Basin, the southeastern USA and in both east and west Africa. There are approximately 1000 million hectares of Acrisols world-wide. See Figure 1.



Dominant Associated Inclusions Miscellaneous lands

Figure 1. Acrisols world-wide.

Associations with other Reference Soil Groups

Acrisols are often the dominant soil group on old erosional or depositional surfaces and in piedmont areas in humic tropical regions where they are associated and alternating with Nitisols, Ferralsols and Lixisols. Acrisols are also well represented on ancient shield landscapes in the humid tropics, often alongside Ferralsols in less eroded, flatter areas or in areas that receive weathering material from adjacent uplands. A typical setting would have Acrisols on the eroding slopes of low hills and Ferralsols on nearby stable pediments or uplands. In mountain areas, Acrisols can be found on stable ridge tops, with Regosols and Cambisols on steeper and less stable slopes. In valleys, Acrisols are to be expected on the higher terraces with Luvisols or Cambisols on lower terraces. Old alluvial fans in the humid tropics may have Acrisols on higher parts with Plinthosols in adjacent depression areas.

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Genesis of Acrisols

Acrisols are characterized by their argic B-horizon, dominance of stable low activity clays and general paucity of bases. Formation of an argic illuviation horizon involves

- clay dispersion
- clay transport, and
- clay accumulation in a subsurface horizon.

These processes are discussed in some detail in the chapter on Luvisols. Note that some authors dismiss all clay illuviation horizons in highly weathered soils in the wet tropics as relics from a distant past.

The process of '*ferralitization*' by which sesquioxides accumulate in the soil profile as a result of advanced hydrolysis of weatherable primary minerals was discussed in the chapter on Ferralsols. Subsequent redistribution of iron compounds by '*cheluviation*' and '*chilluviation*' (see under Podzols) is accountable for colour differentiation directly under the A(h)-horizon where an eluviation horizon with yellowish colours overlies a more reddish coloured Bst-horizon (hence the name 'Red-Yellow Podzolics' as used e.g. in southeast Asia).

Characteristics of Acrisols

Morphological characteristics

Most Acrisols have a thin, brown, ochric surface horizon, particularly in regions with pronounced dry seasons; darker colours are found where (periodic) waterlogging retards mineralization of soil organic matter. The underlying albic subsurface horizon has weakly developed structure elements and may even be massive; it is normally whitish to yellow and overlies a stronger coloured yellow to red argic subsurface horizon. The structure of this sesquioxide-rich illuviation horizon is more stable than that of the eluviation horizon. Gleyic soil properties and/or plinthite are common in Acrisols in low terrain positions.

Mineralogical characteristics

Acrisols have little weatherable minerals left. The contents of Fe-, Al- and Ti-oxides are comparable to those of Ferralsols or somewhat lower; the SiO_2/Al_2O_3 ratio is 2 or less. The clay fraction consists almost entirely of well-crystallized kaolinite and some gibbsite.

Hydrological characteristics

Acrisols under a protective forest cover have porous surface soils. If the forest is cleared, the valuable A-horizon degrades and slakes to form a hard surface crust. The crust allows insufficient penetration of water during rain showers with devastating surface erosion (low structure stability!) as an inevitable consequence. Many Acrisols in low landscape positions show signs of periodic water saturation; their surface horizons are almost black whereas matrix colours are close to white in the eluvial albic horizon.

Physical characteristics

Most Acrisols have weak microstructure and massive macrostructure, especially in the surface and shallow subsurface soil that have become depleted of sesquioxides. Bonding between sesquioxides and negatively charged low activity clays is less strong than in Ferralsols. Consequently, the ratio of water-dispersible ‘natural clay’ over ‘total clay’ (see under Ferralsols) is higher than in Ferralsols.

Chemical characteristics

Acrisols have poor chemical properties. Levels of plant nutrients are low and aluminium toxicity and P-sorption are strong limitations. As biological activity is low in Acrisols, natural regeneration, e.g. of surface soil that was degraded by mechanical operations, is very slow.

Management and use of Acrisols

Preservation of the surface soil with its all-important organic matter is a precondition for farming on Acrisols. Mechanical clearing of natural forest by extraction of root balls and filling of the holes with surrounding surface soil produces land that is largely sterile because toxic levels of aluminium (the former subsoil) kill any seedlings planted outside the filled-in spots.

Adapted cropping systems with complete fertilization and careful management are required if sedentary farming is to be practiced on Acrisols. The widely used ‘slash and burn’ agriculture (‘shifting cultivation’) may seem primitive at first sight but is really a well adapted form of land use, developed over centuries of trial and error. If occupation periods are short (one or a few years only) and followed by a sufficiently long regeneration period (up to several decades), this system probably makes the best use of the limited resources of Acrisols.

Low-input farming on Acrisols is not very rewarding. Undemanding, acidity-tolerant cash crops such as pineapple, cashew or rubber can be grown with some success. Increasing areas of Acrisols are planted to oil palm (e.g. in Malaysia and on Sumatra). Large areas of Acrisols are (still) under forest, ranging from high, dense rain forest to open woodland. Most of the tree roots are concentrated in the humous surface horizon with only few tap roots extending down into the subsoil. In South America, Acrisols are also found under savannah. Acrisols are suitable for production of rain-fed and irrigated crops only after liming and full fertilization. Rotation of annual crops with improved pasture maintains the organic matter content.