ANTHROSOLS (AT)

The Reference Soil Group of the Anthrosols comprises soils that were buried or profoundly modified through human activities such as addition of organic materials or household wastes, irrigation or cultivation. The group includes soils otherwise known as 'Plaggen soils', 'Paddy soils', 'Oasis soils' and 'Terra Preta do Indio'.

Definition of Anthrosols

Soils having

1 a hortic, irragric, plaggic or terric horizon 50 cm or more thick; **or**
2 an anthraquic horizon and an underlying hydragric with a combined thickness of 50 cm or more.

Common soil units:

1 Units characterizing the surface horizon: Hydragric, Irragric, Terric, Plaggic and Hortic.
2 Units characterizing buried horizon(s) or soil: Gleyic, Spodic, Ferralic, Luvic, Arenic, Regic, Stagnic.

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Summary description of Anthrosols

Connotation: soils with prominent characteristics that result from human activities; from Gr. anthropos, man.

Parent material: virtually any soil material, modified by Man through cultivation or addition of material.

Environment: Plaggic Anthrosols are most common in north-west Europe; Hydragric Anthrosols in Southeast and East Asia, and Irragric Anthrosols in the Middle East.

Profile development: influence of Man is normally restricted to the surface horizon(s); the horizon differentiation of a buried soil can still be intact at some depth.

Use: European Anthrosols were traditionally grown to winter rye, oats, and barley but are now also planted to forage crops, potatoes and horticultural crops; in places they are used for tree nurseries and pasture. Irragric Anthrosols occur in irrigation areas where they are under cash crops and/or food crops. Hydragric Anthrosols are associated with paddy rice cultivation whereas Hortic Anthrosols are (mainly) planted to vegetables for home consumption.

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Regional distribution of Anthrosols

Anthrosols are found wherever people have lived for a long time. Plaggic and Terric Anthrosols are largely restricted to north-western Europe where they extend over more than 500,000 hectares (see Figure 1).

Irragric Anthrosols are found in irrigation areas in dry regions, e.g. in Mesopotamia, near oases in desert regions and in parts of India. Hydragric Anthrosols ('paddy soils') occupy vast areas in China and in parts of South and Southeast Asia (e.g. Sri Lanka, Vietnam, Thailand, and Indonesia). Hortic Anthrosols are found all over the world where Man has fertilized the soil with household wastes and manure. The '*Terra Preta do Indio*' in the Amazon Region of Brazil belong to this group.

Figure 1. Plaggic and Terric Anthrosols in northwestern Europe. Source: Pape, 1970.

Associations with other Reference Soil Groups

Anthrosols occur where soil conditions were initially unattractive for food crops cultivation. Hence they occur in association with a wide variety of Reference Soil Groups. Some well-known lateral linkages:

- Plaggic Anthrosols are associated with infertile Arenosols and Podzols in areas with periglacial cover sands in western Europe.
- Terric Anthrosols are commonly found alongside wetland soils such as Fluvisols, Gleysols and Histosols or with acid/unfertile Albeluvisols, Arenosols or Podzols.
- Irragric Anthrosols are associated with typical soils of dry regions such as Calcisols, Gypsisols, Solonchaks and Solonetz, and with Regosols and Cambisols.
- Hydragric Anthrosols occur together with Gleysols and Fluvisols in river systems, with Alisols, Acrisols, Lixisols and Luvisols in upland areas and with Andosols in volcanic regions.
- Hortic Anthrosols can occur alongside virtually any other Reference Soil Group.

Genesis of Anthrosols

Anthrosols have formed as a result of long-continued 'anthropedogenic processes', notably

1. deep working, i.e. below the normal depth of tillage (e.g. in terraced lands in the Mediterranean Region, the Arab Peninsula, the Himalayas and the Andes);
2. intensive fertilization with organic/inorganic fertilizers without substantial additions of mineral matter (e.g. manure, kitchen refuse, compost, night soil);
3. continuous application of earth (e.g. sods, beach sand, shells, earthy manures);
4. irrigation adding substantial quantities of sediment;
5. wet cultivation involving puddling of the surface soil and man-induced wetness.

Note that man-made soils consisting of '*anthropogenic soil materials*' (i.e. unconsolidated mineral or organic materials resulting from land fills, mine spoil, urban fill, garbage dumps, dredgings, etc.) do not qualify as Anthrosols. Such materials lack evidence of pedogenetic change. Soils in anthropogenic soil materials form a separate group within the Regosols, viz. the Anthropic Regosols.

Plaggic Anthrosols

Plaggic Anthrosols have the characteristic 'plaggic horizon' produced by long-continued addition of 'pot stable' bedding material, a mixture of organic manure and earth. The man-made character of the plaggic horizon is evident from fragments of brick and pottery and/or from high levels of extractable phosphorus (more than 250 mg P_2O_5 per kg by 1 percent citric acid).

The formation of (most) plaggic horizons started in medieval times when farmers applied a system of 'mixed farming' combining arable cropping with grazing of sheep and cattle on communal pasture land. During the nights and in wintertime, sheep and cattle were kept in stables with bedding material of thin sods of heath and/or forest litter. Fresh bedding material was regularly provided until the bedding became too thick and had to be removed. It was then spread out on the arable fields as an 'organic earth manure'. This addition of organic earth manure raised the surface level of (only!) arable fields by some 0.1 cm per annum. In places, the system was in use for more than a thousand years, evidenced by a plaggic horizon more than 1 meter thick.

Depending on the composition of the bedding material, the plaggic horizon is black (bedding material from heath lands with Podzols) or brown (from forest litter) in colour. In places, sods from low-lying grasslands were incorporated in the earth manure. This gave the A-horizon a somewhat higher clay content than the deeper solum. Historical records indicate that some 10 hectares of heath land were needed to maintain the nutrient level of one hectare of arable land. Removal of the sods made the heath land susceptible to wind erosion; large tracts of heath land turned to barren shifting sands that went completely out of control (see also under Arenosols).

By and large, the arable fields were situated on favourable sites that were well-drained even before acquiring a plaggic horizon. Winter rye on such locations was less susceptible to frost damage; only in densely populated areas were less well-drained soils used for arable cropping. The configuration of arable fields at higher terrain positions and pastures in nearby depressions can still be seen today. The mixed farming system described produced the world's largest continuous area of Plaggic Anthrosols (see Figure 1).
Note that other types of plaggic horizons occur as well, formed for instance by gradually covering peat soils with layers of bagger from drainage ditches with or without additions of organic manure.

Terric Anthrosols

In parts of western Europe, notably in England and Ireland, calcareous soil materials (e.g. beach sands) were carted to areas with acid Arenosols, Podzols, Albeluvisols and Histosols. Eventually these soils turned into Terric Anthrosols with a man-made surface layer of mineral soil material that has far better properties for arable cropping than the original surface soil.

Irragric Anthrosols

Irragric Anthrosols are formed as a result of prolonged sedimentation of silt from irrigation water. A special case are Irragric Anthrosols in depression areas where dryland crops are commonly planted on man-made ridges that alternate with drainage furrows. The original soil profile of the ridge areas is buried under a thick layer of added soil material. The ridge-and-furrow system is known from such different environments as the wet forests of Western Europe and the coastal swamps of southeast Asia where the ridges are planted to dryland crops and rice is grown in the shallow ditch areas (see also the chapter on Fluvisols).

Hydragric Anthrosols

Hydragric Anthrosols are the result of long-continued wet cultivation. "Puddling" of wetland rice fields (involving destruction of the natural soil structure by intensive tillage when the soil is saturated with water) is done intentionally, inter alia to reduce percolation losses. Puddling makes the surface soil dispersible and produces a surface layer that has uniform aggregates and predominantly vesicular pores when dry. The colour of the puddled layer testifies of prolonged reducing conditions, further evidenced by low hue mottles and iron-manganese cutans on ped faces and pore walls. In the course of time, a plough pan develops underneath the puddled layer; it has a platy structure and is much denser than the puddled layer.

Together, the puddled layer and the plough pan constitute the ‘anthraquic horizon’. Horizons below the anthraquic horizon are modified by redoximorphic processes and show differentiated zones of iron and manganese illuviation from the anthraquic horizon.

Hortic Anthrosols

Hortic Anthrosols are “kitchen soils”. The Hortic Anthrosols on river terraces in southern Maryland, U.S.A., and along the Amazon River in Brazil are well-known examples. These soils have deep, black A-horizons formed in layers of kitchen refuse (mainly oyster shells, fishbones, etc.) from early Indian habitation. Many countries possess small areas of soils that were modified by early inhabitants.

Characteristics of Anthrosols

Morphometric characteristics

Anthrosols are differentiated by their anthraquic, hortic, hydragric, irragric, terric or plaggic surface horizon. Horizons of an underlying buried soil may have become incorporated in the - now - Anthrosol. In some cases (notably in Plaggic or Terric Anthrosols) evidence of human interference such as spade marks is still detectable.

Hydrological characteristics

Plaggic and Terric Anthrosols are well-drained because of their thickened A-horizon; Irragric Anthrosols are mostly well-drained and have an active soil fauna and good porosity. Iron-manganese mottles may be present but are not necessarily indicative of inadequate internal soil drainage; they could just as well be caused by over-irrigation. Hydragric Anthrosols possess a man-made impervious plough pan and are periodically flooded as part of the cropping system. Hortic Anthrosols are well-drained, particularly if occurring near villages, which were established on higher grounds; some have developed from wetland soils and have restricted internal drainage.

Physical characteristics

The physical characteristics of plaggic and terric horizons are excellent: the penetration resistance is low and permits unhindered rooting, the pores are of various sizes and interconnected and the storage capacity of 'available' soil moisture is high if compared to that of the underlying soil material. ‘Mild’ organic matter in the surface soil results in stable soil structures and lowers the soil’s susceptibility to slaking. The upper part of a plaggic or terric horizon may become somewhat dense if tillage is done with heavy (vibrating) machinery.

Irragric horizons have less organic matter but many have an active soil fauna. Silty Irragric Anthrosols have good water-holding capacity; clayey horizons tend to become massive and very hard when dry, and are difficult to till. Hortic horizons are very porous on account of their intense biological activity (characteristically, hortic horizons contain more than 25% earthworm casts), and their high organic matter content.

Chemical characteristics

Plaggic horizons are more acid (pHKCl between 4 and 4.5) and contain more organic carbon (1 - 5 %) than terric horizons. By and large, black plaggic horizons contain more organic matter than brown ones; the C/N ratio is generally between 10 and 20, with the higher values in black soils. Reported CEC values are between 5 and 15 cmol(+)/kg soil; the 'total' phosphorus content is high.

Irragric horizons have a high base saturation; they may contain free lime and can even be alkaline in reaction. Some irragric horizons are saline after accumulation of salts that were dissolved in the irrigation water.

Anthraquic horizons have a (near) neutral soil reaction when submerged. Under reducing conditions, Fe^{2+} and Mn^{2+} may be present in toxic quantities. Most hortic horizons have a high CEC, acquired after long-continued application of organic residues, and are well supplied with nutrients. They have a phosphorus content (0.5M $NaHCO_3$ extractable P_2O_5) of more than 100 mg/kg soil.

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Management and use of Anthrosols

Plaggic Anthrosols

Plaggic Anthrosols have favourable physical properties (porosity, rootability, moisture availability) but many have less satisfactory chemical characteristics (acidity, nutrients). Rye, oats, barley, potato and also the more demanding sugar beet and summer wheat are common crops on European Plaggic Anthrosols. Prior to the advent of chemical fertilizers, rye yields on Plaggic Anthrosols were a mere 700 to 1100 kg per hectare, or 4 to 5 times the quantity of seed used. Today, these soils receive generous doses of fertilizers; average yield levels are 5000 kg rye per hectare, 4500 kg barley and some 5500 kg summer wheat. Sugar beet and potato produce 40 to 50 tons per hectare. Plaggic Anthrosols are increasingly used for production of silage maize and grass; 12 to 13 tons of dry maize silage per hectare and 10 to 13 tons of dry grass are considered normal.

Plaggic Anthrosols are also used for tree nurseries and horticulture. The good drainage and the dark colour of the surface soil (early warming in spring) make it possible to till and sow or plant early in the season. Soils with deep plaggic horizons in The Netherlands were in demand for the cultivation of tobacco until the 1950's.