KASTANOZEMS (KS)

The Reference Soil Group of the Kastanozems accommodates the 'zonal' soils of the short grass steppe belt, south of the Eurasian tall grass steppe belt with Chernozems. Kastanozems have a similar profile as Chernozems but the humus-rich surface horizon is less deep and less black than that of the Chernozems and they show more prominent accumulation of secondary carbonates. The chestnut-brown colour of the surface soil is reflected in the name 'Kastanozem'; common international synonyms are '(Dark) Chestnut Soils' (Russia), (Dark) Brown Soils (Canada), and Ustolls and Borolls in the Order of the Mollisols (USDA Soil Taxonomy).

Definition of Kastanozems

Soils having

1 a mollic horizon with a moist chroma of more than 2 to a depth of at least 20 cm, or having this chroma directly below the depth of any plough layer, **and**
2 concentrations of secondary carbonates within 100 cm from the soil surface, **and**
3 no diagnostic horizons other than an argic, calcic, cambic, gypsic, petrocalcic, petrogypsic or vertic horizon.

Common soil units:

Anthric, Vertic, Petrogypsic, Gypsic, Petrocalcic, Calcic, Luvic, Hyposodic, Siltic, Chromic, Haplic.

Summary description of Kastanozems

Connotation: (dark) brown soils rich in organic matter; from L. castanea, chestnut, and from R. zemlja, earth, land.

Parent material: a wide range of unconsolidated materials; a large part of all Kastanozems have developed in loess.

Environment: dry and warm; flat to undulating grasslands with ephemeral short grasses.

Profile development: mostly AhBC-profiles with a brown Ah-horizon of medium depth over a brown to cinnamon cambic or argic B-horizon and with lime and/or gypsum accumulation in or below the B-horizon.

Use: the principal arable land use is the production of small grains and (irrigated) food and vegetable crops. Many Kastanozem areas are used for extensive grazing. Drought and (wind and water) erosion are serious limitations.

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Regional distribution of Kastanozems

The total extent of Kastanozems is estimated at about 465 million hectares. Major areas are in the Eurasian short grass steppe belt (southern Ukraine, southern Russia, and Mongolia), in the Great Plains of the USA, and in Mexico, southwestern Brasil, and the pampa regions of Northern Argentina, Uruguay and Paraguay. Figure 1 shows the worldwide occurrence of Kastanozems.

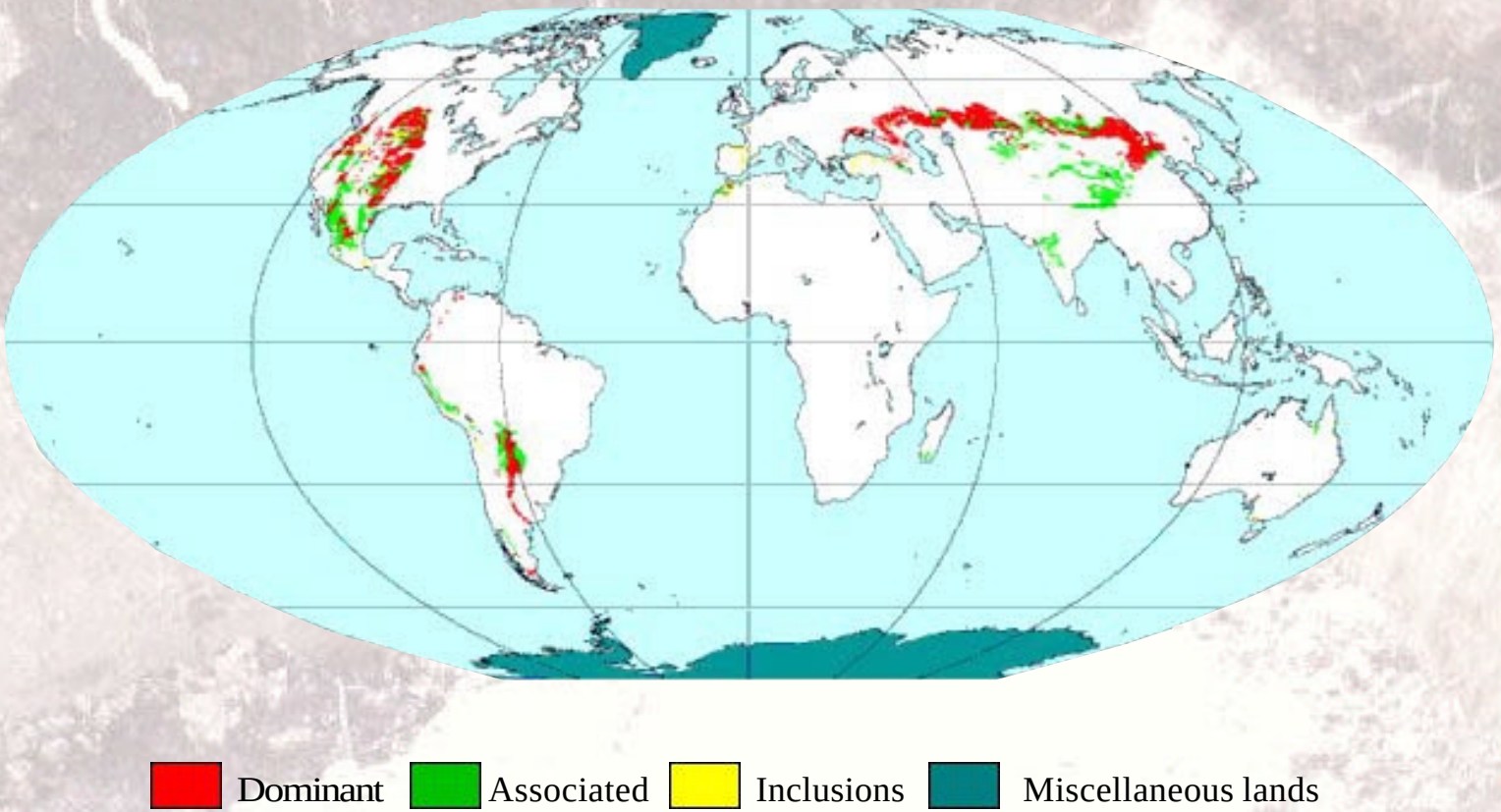

Figure 1. Kastanozems worldwide.

Associations with other Reference Soil Groups

The Kastanozems of the Northern Hemisphere border on the Chernozem belt in the cooler and less arid north, and on areas with Calcisols and Gypsisols in the warmer and drier south (where they may also occur adjacent to Solonchaks and Solonetz). In the warmer and less arid subtropics, Kastanozems are associated with Phaeozems.

Genesis of Kastanozems

The climax vegetation of the Kastanozem belt is a short grass vegetation, scanty, poor in species and dominated by ephemers (early ripening species). The aboveground dry biomass amounts to only 0.8-1 tons/hectare, whereas the dry root mass amounts to 3-4 tons/hectare. More than 50 percent of all roots are concentrated in the upper 25 cm of the soil and there are few roots that extend down to deeper than 1 metre. The greater part of the vegetation dies each summer. This specific type of vegetation has conditioned the formation of Kastanozems. Surface soils are less deep than those of Chernozems (under tall grasses) and are brown rather than black. The organic matter content of the Ah-horizon of Kastanozems is typically between 2 and 4 percent and seldom exceeds 5 percent.

Downward percolation of water in spring leaches solutes from the surface to subsurface and subsoil layers. Lime accumulates at a depth of approximately 1 metre; gypsum accumulation occurs in drier regions, commonly at a depth between 150 and 200 cm, and in the driest Kastanozems there may be a layer of salt accumulation deeper than 200 cm below the surface.
A clay illuviation horizon *may* be present as deep as 250-300 cm below the soil surface. The occurrence of argic B-horizons in Kastanozems is still ill understood. They may be fossil, as claimed by some Russian soil scientists, but there are also theories of a more recent formation, through 'normal' translocation of clay, or by destruction of clay or fine earth near the surface and reformation at greater depth.

Climatic gradients in the Kastanozem belt are reflected in pedogenic features. In Russia, the darkest surface horizons occur in the north of the Kastanozem belt (bordering the Chernozems) whereas soils with shallower and lighter coloured horizons are more abundant in the south. The differentiation between horizons is clearer in the north than in the south in line with decreasing length and intensity of soil formation as conditions become more arid.

Characteristics of Kastanozems

Morphological characteristics

The morphology of dark Kastanozems is not very different from that of the southern (drier) Chernozems whereas the light Kastanozems of the south grade into Calcisols. The northern Eurasian Kastanozems have Ah-horizons of some 50 cm thick, dark brown and with a granular or fine blocky structure, grading into cinnamon or pale yellow massive to coarse prismatic B-horizons. In the drier south, the Ah-horizon is only 25 cm thick and colours are lighter throughout the profile.

Argic B-horizons are reported to have a "more intense coloration" in Luvic Kastanozems. Accumulations of lime and/or gypsum separate the Kastanozems (and Chernozems) from Phaeozems and are particularly prominent in Kastanozems of the southern dry steppes. Krotovinas occur in almost all Kastanozems but are less abundant than in Chernozems.

Hydrological characteristics

Kastanozems have an intermittent water regime. The soils dry out to great depth in the dry season and are often incompletely moistened in wet periods. The low total precipitation sum and low non-capillary porosity of Kastanozems explain why run-off (losses) during and after heavy showers can be considerable. A 'dead dry horizon' occurs below the limit of wetting; this horizon receives neither percolation water from above nor capillary rise from below and is 'physiologically dead'.

Physical characteristics

The physical properties of Kastanozems are slightly less favourable than those of Chernozems but otherwise comparable. The lower humus content of the surface layer, particularly in the lighter Kastanozems, is associated with weaker micro-aggregation, which manifests itself in less pore volume (40-55 percent), less moisture storage capacity, denser packing of the soil and a lower permeability to water.

Chemical characteristics

Kastanozems are chemically rich soils with a cation exchange capacity of 25-30 cmol(+)/kg dry soil, and typically 95 percent base saturation percentage or more. The majority of all adsorbed cations are Ca^{2+} and Mg^{2+}-ions; ESP-values of 4 to 20 have been reported.

The C/N-ratio of the organic soil fraction of the surface horizon is around 10, as in Chernozems. The soil-pH is slightly above 7.0 but may increase to a value around 8.5 at some depth. Accumulations of lime and gypsum are common; the accumulation horizon contains 10 to 20 percent more secondary carbonates than the deeper solum. More easily soluble salts may have accumulated deeper down, deeper in dark Kastanozems than in the lighter soils of the drier steppe. The salt content of the accumulation layer is commonly between 0.05 and 0.1 percent and does not seriously inhibit the growth of crops. In places, salt levels may reach 0.4 percent and more.

Management and use of Kastanozems

Kastanozems are potentially rich soils; periodic lack of soil moisture is the main obstacle to high yields. Irrigation is nearly always necessary for high yields; care must be taken to avoid secondary salinization of the surface soil. Small grains and (irrigated) food and vegetable crops are the principal crops grown. Wind erosion is a problem on Kastanozems, especially on fallow lands.

Extensive grazing is another important land use on Kastanozems but the sparsely vegetated grazing lands are inferior to the tall grass steppes on Chernozems and overgrazing is a serious problem.