Workshop "Soils and Paleosols of Brazil", 24th to 29th August in Campinas/Cananéia, with field trips in the states São Paulo and Minas Gerais, Brazil

Joint IYS event of IUSS Commission 1.6 Palaeopedology and INQUA Project RAISIN

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Mon (24th Aug) - Tue (25th Aug): Pre-Workshop field trip to Ilha Comprida (São Paulo State, Brazil)

Wed (26th Aug): Presentations at Cananéia (São Paulo State)

Thu (27th Aug) - Fri (28th Aug): Post-Workshop field trips to Piracicaba and Itaqueri da Serra (São Paulo State) and Poços de Caldas (Minas Gerais)

Sat (29th Aug, 9 am to 11 am): Final discussion

Pre-workshop excursion (24th to 25th August): Spatial variability of Podzols on Ilha Comprida influenced by soil age, relief and hydrology

Ilha Comprida is a Holocene sandy barrier island. It is 3-5 km wide and 70 km long and stretches along the Cananéia-Iguape coastal plain. The climate is humid-tropical, with 2261 mm MAP. The island developed along a longitudinal vector (ENE-wards) and a transversal vector (SES-wards) into a long and narrow island running parallel to the coastline. Thus, in the cliff along the southern coast, the age of parent material decreases from West to East. Key topics that were discussed during the field trip were the soil-forming factors time and relief, with a special emphasis on hydrology. Soils in the inner part of the island are less well-drained than those exposed in the cliffs. The groundwater level under the swales between the beach ridges is high, and even peat formation can be observed in places. The soil profiles that are nowadays exposed in the cliffs must have started forming as inland soils, thus under less well-drained conditions, too. They got under better drainage conditions when the retreating cliff got closer and finally cut through them. Well-developed Podzols with Ortstein occur especially in the western zones of the island that are characterized by high beach ridges separated by narrow swales, whereas less developed hydromorphic Podzols and Histosols occur in areas with lower beach ridges and wider swales. Apparently, interflow running down from the beach ridges, carrying dissolved organic carbon (DOC) concentrates especially in narrow swales, leading to the formation of thick Ortstein horizons there. This effect is less pronounced in the wider, flatter ridge-swale systems further east.

Take-home messages from the Ilha Comprida field trip

- Hydrology and relief influence the spatial pattern of the morphology of Podzols at a similar order of magnitude as soil age!
- Spatial distribution of Ortstein is largely controlled by DOC fluxes leading to concentration and precipitation of organic compounds in lower landscape positions.
- Rates of soil formation: Under the given conditions (texture: 96-97% sand, climate: humid-tropical) mature Podzols may develop within about one thousand years.
- Micro-organisms eat up SOM of Bh horizons after aeration (regressive pedogenic process).
- There is a close link between the geomorphological development of the island and the soils; erosion changes the hydrology, leads to aeration of soils that were formerly poorly drained
- Influence of parent material: very pure quartz sand together with high permeability of sandy material lead to rapid acidification.
- Vegetation is adapted to acid and nutrient-poor conditions; litter also contains only low amounts of bases and nutrients, resulting in incomplete decomposition.
- Podzols that developed under poorly drained conditions are characterized by a sharp, even E/Bh boundary; they lack a Bs horizon because iron has been reduced and removed under poorly drained conditions (Fig. 1).

Fig. 1. Above: Western part of the south cliff of Ilha Comprida (stop 1): The sharp, even E/Bh boundary indicates Podzol formation under originally poorly drained conditions. Below: Well-aerated Podzols like this one exposed in the west cliff (stop 3) show an irregular E/Bh boundary, with white tongues penetrating into the Bh. Tongues develop due to preferential flow, e.g. along former tree roots.

Post-Workshop excursion (27th to 28th August): Paleosols in the Itaqueri Hill and Poços de Caldas region, including Ferricretes, Silcretes and Bauxite

The first part of the post-workshop excursion focused on the typical palaeosol sequence of the Itaqueri Hill region, including a sequence of Ferralsol – ferricrete – silcrete. Several sites, where typical sections of this sequence are exposed, were visited. The first stop was a lookout point on the landscape that is strongly influenced by the ferricretes and silcretes that belong to this sequence, protecting the underlying parts of the landscape from erosion. At this stop also the yellow ferricrete, forming the surface at the lookout point, was examined. In addition, a profile exhibiting silicified root channels and a thick, dark red Ferralsol near Piracicaba were visited.

Take-home messages from the post-workshop field trip

- Many tropical soils developed in reworked soil sediments or in saprolite of older soils.
- The solum and saprolite of a tropical soil profile do not necessarily belong to the same cycle of soil formation; the solum may have formed much later, just representing the very last cycle of soil formation; an unknown number of soil formation cycles may not be recorded because its products have been completely eroded.
- Laterite formation does not occur at present in this region.
- Rates of soil formation are extremely difficult to assess in tropical landscapes.
- Tertiary paleosols having ferricretes are widespread in Brazil; they formed from different parent materials, through same processes; such soils do not form today in this region.
- Intensity of biological activity in Ferralsols (termites, ants, microorganisms) is important: slight changes will lead to a different profile.
- Factors that control iron oxide formation towards red (hematitic) soils vs. yellow (goethitic) soils:
  1) Strong micro-aggregation leads to good aeration and water permeability, hence to pedogenesis towards red soils; less permeable soils tend to be yellow.
  2) Hematite favors the development of stabile micro-aggregates more than goethite; thus, there is a positive feedback between micro-aggregate development and hematite formation (1⇔2).
  3) In addition, iron availability and original mineralogy are important.
  4) Aggregate formation moreover depends on drainage that in turn also depends on mineralogy and slope morphology.
  5) The same parent material under differing temperature conditions (tropical vs. subtropical) has produced Ferralsols, but with different mineralogy (tropical = hematite vs. subtropical = goethite).