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Genesis of petroduric and petrocalcic horizons in Latinamerica volcanic soils

Paul Quantin
Dijon, France (quantin.paul@orange.fr)

Introduction. In Latinamerica, from Mexico to Chile, there are indurated volcanic soils horizons, named 'tepetate' in Mexico or cangahua in the Andes Mountains. Apart from original volcanic tuffs, these horizons were produced by pedogenesis: either through a former weathering of volcanic ash layers into fragic and later to petrocalcic horizons; or after a former soil formation through a second process of transformation from clayey volcanic soils to silicified petroduric horizons. This oral presentation will briefly deal with the formation of petroduric horizons in Mexico and petrocalcic horizon in Ecuador.

Petroduric horizon genesis in Mexico. A soil climato-toposequence, near to Veracruz (Rossignol & Quantin, 1997), shows downwards an evolution from a ferralic Nitisol to a petroduric Durisol. A Durisol profile comports these successive horizons: at the top A and E_g, then columnar B_{tg-sim}, laminar B_{t-sim} , prismatic B_{sim}, plinthite C_g, over andesite lava flow. Among its main features are especially recorded: clay mineralogy, microscopy and HRTEM. These data show: an increase in cristobalite at the expenses of 0.7 nm halloysite in $E_g$siltans, laminar B_{t-sim}, around or inside the columns or prisms of B_{tg-sim} and B_{sim}horizons. HRTEM (Elsass & al 2000) on ultra thin sections reveals an 'epigenesis' of clay sheets by amorphous silica, to form successively A-opal, Ct-opal and microcrystalline cristobalite. From these data and some groundwater chemical analyses, a scenario of duripan formation from a past clayey Nitisol is inferred: clay eluviation-illuviation process ♢ alternate redoximorphy ♢ clay degradation, Al leaching and Si accumulation, to form successively A-opal, Ct-opal and cristobalite.

Petrocalcic horizon genesis in Ecuador. A soil climato-toposequence on pyroclastic flows, near to Bolivar in Ecuador (Quantin & Zebrowski, 1997), shows downwards the evolution from fragic-eutric-vitric Cambisols to petrocalcic-vitric Phaeozems, at the piedmont under semi-arid climate. A complex soil profile of petrocalcic Phaeozem, derived from 4 pyroclastic layers, shows among its successive horizons: in layer 3 the 'upper cangahua' with petrocalcic features and in layer 4 the 'lower cangahua' with hard fragipan properties. The features of the petrocalcic cangahua differ from a Mexican fragipan (Hidalgo & al 1997) by: a hard calcrete, higher alkalinity, stability in water after HCl and NaOH treatment, 2-4% of 'free silica'. The macro and micro-morphology shows: the laminar calcite crust, at the top of cangahua, with alternate micrite-sparite layers; downwards, microcalcite infillings in the voids of a prismatic structure, invading the groundmass by epigenesis of clay sheets, together whith microcrystalline opal. From these data this scenario is inferred: after a former weathering of volcanic glass to form a clayey matrix, as well amorphous silica and microcalcite coatings and infillings, then a second process, perhaps due to drier climate, produced the laminar crust formation, by invasion of microcalcite in the matrix.

Conclusion. The petrocalcic horizon in Ecuador was produced by two processes: from a former phase of weathering giving a fragic horizon to a second producing the accumulation of calcite and some opal over and inside the matrix, due to climate change. The petroduric horizon in Mexico, is the product of a very complex soil transformation, from a former clayey Nitisol, through four successive processes: clay eluviation-illuviation, alternate redoximorphy, clay degradation, finally a progressive silicification over and inside the groundmass, probably due to pedoclimate change.

References

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