Soil-Forming Processes and their Rates:
Workshop and Field Trip in the Mojave Desert, 26-31 Oct 2014

Main organizer: Eric McDonald, co-organizers: Daniela Sauer, Bruce Harrison

After a small welcome reception in the evening of Sunday, October 26, we had a one-day workshop at the Desert Research Institute in Las Vegas (Monday, Oct 27), where eight papers on soil development and paleosols from eight different parts of the world (see third page of this report for details) were presented and discussed. The workshop was held in the same format as in 2012 and 2103, allowing 30-45 minutes for presentations and 10 minutes discussion after each presentation. Like in previous years, this extended time allowed for each presentation led to very intensive and fruitful discussions that continued during coffee breaks and lunch break.

In the evening of Monday (Oct 27) the group traveled from Las Vegas to the Desert Studies Center, located in the Mojave Desert, near the Providence Mountains. Tuesday (Oct 28) and Wednesday (Oct 29) were devoted to soil formation in well-dated sequences of alluvial fans coming from the Providence Mountains. On the first day, we examined soils on alluvial fans composed of sediments predominated by granitic rock, whereas on the second day we studied soils on alluvial fans of same ages but different parent material, namely sediments comprising volcanic rock and limestone.

Eric McDonald and Bruce Harrison introduced the general soil-forming processes in these arid environments, and the group compared and discussed soil formation in the two soil chronosequences on different parent materials. Spending two days in this landscape and allowing enough time at each soil profile (much more time than on most field trips) again led to very intensive and deep discussions and helped the participants to develop a better understanding of the landscape development and dynamics, the formation of the alluvial fans, major soil-forming processes taking place under the given environmental conditions, influence of past (at times more humid) climates on the soils, and the effects of differences in parent materials on soil formation.

In the evenings of Monday and Tuesday, we continued with the workshop after dinner with additional presentations. These presentations focused on desert soils in the Mojave and in other deserts, and on dating of parent materials of soil formation by using cosmogenics and luminescence.

On Thursday (Oct 30), the group traveled to Death Valley, with stops at Badwater Basin and Devil's Corn Field, and lunch break at Furnace Creek Ranch. In the afternoon, we reached Panamint Valley, where we studied several soils formed in dated parent materials near the ghost town Ballarat, on the eastern flank of Panamint Valley. We stayed overnight in Ridgecrest, SW of Panamint Valley and came back on the next day (Friday, Oct 31) to explore soils formed in dated parent materials on the western flank of Panamint Valley. Numerous shattered clasts, both in the soils and in the desert pavement, demonstrated impressively the results of physical weathering. Hydration /dehydration of salt crystals were assumed as main process of clast shattering; however, other possible processes were discussed as well. Especially the older soils (in the age range of 60-85 ka) had intensively reddish-brown colors and were characterized by distinct clay illuviation (compared to the younger soils that had created some discussion about presence / absence of clay coatings among the group). The older soils clearly reflected periods of more humid climate during Pleistocene.

Selected outcomes of the discussion about important soil-forming processes in deserts

- formation of desert pavement: not by deflation but by accretion of dust that is trapped between pebbles; the rougher the surface, the more efficient the dust trap; pebbles pop up when gas bubbles under them are entrapped during water infiltration; hence, they stay at the surface as dust progressively accumulates in the soil;
- optimum clast size for formation of desert pavement: 2-5 cm; if too small: air under pebbles may escape without causing great pressure and uplifting the pebbles; if too large: pebbles pop up less frequently because of their greater weight;
- formation of Av horizon: air, possibly also carbon dioxide from microbial activity, gets entrapped by infiltrating water;
- Av horizon develops columnar structure; hence, its surface shows a polygonal pattern
- dust that is trapped between pebbles forming the desert pavement may be washed down the cracks and accumulate below the Av horizon, or, if it arrives in the center of a polygon, it may accumulate on top of it;
- development of Av horizon decreases water infiltration capacity of soils;
- desert pavement is not static: it is obvious that gravel moves downslope (pebbles pop up during water infiltration by gas bubbles entrapped under the pebbles, fall back somewhat downslope, according to gravity); in addition, the distribution of rock varnish on pebbles indicates that pebbles are also turned around

Group at Badwater Basin, Death Valley.

Group studying a 30ka-old soil in Panamint Valley. Photo: Alessandro Batezelli (Brazil).

Trying to understand the landscape setting and evolution. Photo: Alessandro Batezelli (Brazil).

Oral presentations of the workshop

Monday, October 27

8.30-8.45: Opening of the workshop by *Eric McDonald* and *Daniela Sauer*

Rates of soil-forming processes in cold regions

8.45-9.40: *Paul Sanborn:* The imprint of time on Canadian soil landscapes

9.40-10.20: *Maria Bronnikova, Andrey Panin, Elya Zazovskaya:* Rates of humus rejuvenation and real age of soils: the problem and its particular solution using a ^{14}C data set for soils and sediments in a permafrost-affected intermountain basin, the South of Siberia

Rates of soil-forming processes humid-temperate regions

10.40-11.35 *Peter Finke, Tom Vanwalleghem, Emmanuel Opolot, Jozef Deckers, Jean Poesen:* Using a soil formation model to identify causes of observed soil variability patterns in a forested loess area in Belgium

11.35-12.15 *Daniela Sauer, Siri Svendgård-Stokke, Ragnhild Sperstad, Rolf Sørensen, Markus Fuchs:* A soil chronosequence of 31 pedons on beach sand in Vestfold, S Norway

Rates of soil-forming processes in tropical regions

1.15-2.10: *Emily J. Beverly, Steven G. Driese, Daniel J. Peppe, Lisabeth Arellano, Nick Blegen, J. Tyler Faith, Christian A.Tryon:* Paleoenvironmental reconstruction of a semi-arid Late Pleistocene paleocatena from the Lake Victoria Region, Kenya

2.10-2.50: *Jean Pierre Nguetnkam, Daniela Sauer, Selina Tenzer, Thilo Rennert:* Morphology and physico-chemical characteristics of a soil chronosequence on Mount Cameroon (Central Africa): Evidence of soil deepening and differentiation with age

3.10-3.50: *Pauline Yawoa D. Da Costa, Kodzo A.Togbé:* Topographic influences on the soil development in the Precambrian crystalline basement and the coastal sedimentary basin of Togo

3.50-4.30: *Alessandro Batezelli, Francisco S. B. Ladeira, Camila Tavares Pereira, Karla Evenny Brito Da Silva:* Sedimentary cycles and pedogenesis in a Late Cretaceous alluvial plain of the Bauru Basin – Southeastern Brazil

Evening talks at the Desert Studies Center (Zzyzx) on Tuesday and Wednesday

Rates of soil-forming processes in deserts

Elizabeth Solleiro Rebolledo, Sergey Sedov, Tamara Cruz: Palaeosols in the north of Sonora, Mexico: implications for the duration of pedogenesis in arid landscapes

Marina Lebedeva, Dmitrii Golovanov, Konstantin Abrosimov:
Micromorphological diagnostics of soil, aeolian and deluvial processes according to the peculiar fabric of crusty horizons in different-aged extreme aridic soils of Mongolia

José Luis Antinao: Dating soils with cosmogenics and OSL

Eric V. McDonald, José Luis Antinao, John C. Gosse, Edward J. Rhodes:
Comparing rates and processes of soil development between subtropical and arid regions using well-dated chronosequences

J. Bruce J. Harrison: Geomorphic surfaces and soil variability