Regional Conference on Geomorphology, Rio de Janeiro, Brasil, July 17-22, 1999

Bananal Field Trip Report

TROPICAL GEOMORPHOLOGY AND QUATERNARY LANDSCAPE EVOLUTION ALONG THE SOUTHEASTERN BRAZILIAN PLATEAU (PARAIBA DO SUL RIVER BASIN)

Text and photographs by Piotr Migon

The field trip to the middle part of the Serra do Mar mountains around the little lovely town of Bananal immediately followed the conference and lasted for three days, from 23 to 25 July 1999. Outstanding guidance was provided by three Brazilian colleagues, Claudio Limeira Mello, Maria Naise de Oliveira Peixoto, and Isabela de Oliveira Carmo, all based at the Federal University of Rio de Janeiro, helped by some junior researchers. We were also presented with a comprehensive guide-book to the trip (64 pp.), arranged in nine sections, discussing various aspects of Pleistocene and recent landform evolution of in SE Brazil.

The trip involved seven principal stops, all within the distance of about 15 km from Bananal, at which the following issues were discussed:

1. **Cafundo** - thoroughly weathered Late Tertiary fluvial gravel deposits, locally deformed by faults indicating ongoing tectonic activity in the Serra do Mar.
2. **Lavapés** - hilly landscape and morphological levels; bioturbations and stonelines; landslides. [BRA 3/11]
3. **Bom Retiro** - relief inversion and amphitheatral valley head formation; Holocene slope evolution and palaeosols. [BRA 3/23]
4. **Campinho** - high river terraces; history of Holocene erosion and accumulation; 'drowned landscapes'. [BRA 3/26]
5. **Bela Vista** - landslides in weathering mantles; gully erosion. [BRA 3/32]
6. **Porto Alegre** - rampa complex development; stream capture. [BRA 3/42]
7. **Sao Joaquim** - interdigitation of Holocene alluvial and slope deposits indicative of complex landscape evolution.

However, we have seen much more than this. Common interest in geomorphology and maximum organisational flexibility (again thanks to both the organisers and the driver!) allowed us to stop at many exciting stops passed en route and to look at deeply weathered gneissic hills near the town of Barra Mansa [BRA 2/41] and in other places as well, small normal faults cutting through Holocene deposits, stone lines in a variety of topographic settings, perfect meandering rivers, differences in slope micro-morphology caused by differences in land use (role of grazing!), waterfalls and landslides of different ages [BRA 3/46], tectonically deformed Tertiary and Quaternary sediments in the

intramontane corridor of Paraiba do Sul near Resende, to name just a few. Weather was co-operating nicely and we had the chance to experience both a short-lasting tropical storm at Bela Vista farm and wonderful vistas over the Serra da Bocaina on the last day.

For understanding the Holocene landscape evolution the concept of a 'rampa' landform and its development through time becomes central. In general, rampa complexes are concave topographic features inserted into a multi-convex topography of deeply weathered hills. They comprise two segments. The upper one is an amphitheatre-like hollow and is the product of gully erosion and landsliding. Downslope it grades into a slightly inclined depositional surface, underlain by colluvium. At the distal end colluvium sheets may interfinger with alluvial deposits. Local base level controls the development of rampas. Lowering of base level induces erosion within the depositional segment and hence evacuation of material, resulting in concave rampas. On the other hand, aggradation by successive sheets of colluvium produces concave-plane hollows as shown by the photograph [BRA 3/29].

Excellent geomorphology during the day was then replaced by various social activities as evenings were approaching. Food at the hotel was first class (as was the hotel itself), beer in local bars was good and refreshing, walking around the town proved perfectly safe. And Bananal has actually much to offer to a keen visitor, for example there is here an old railway station built of steel plates, unfortunately long disused, lovely colonial buildings dating back to the times of coffee boom, or the old farmacy.

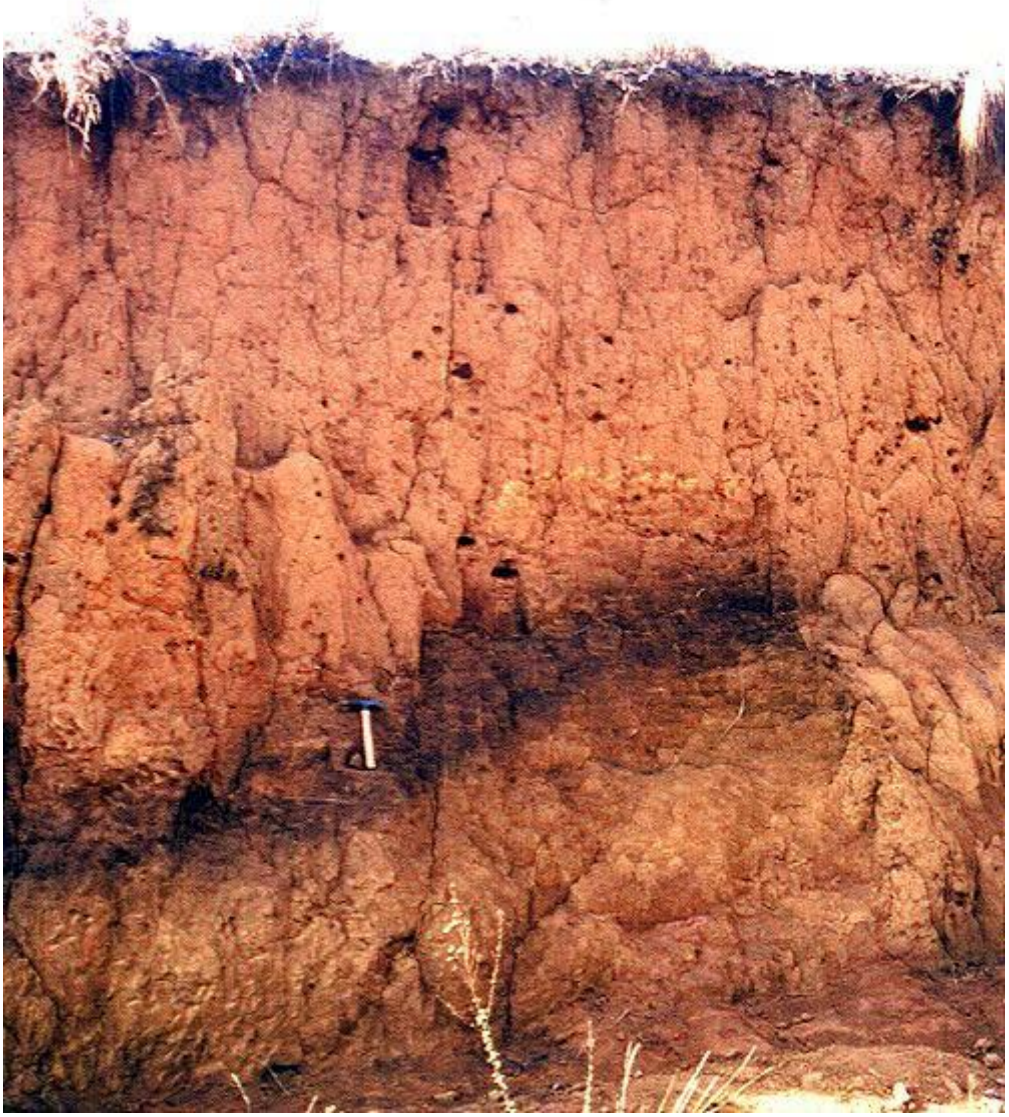
We spent three wonderful days in Bananal, covered a lot of ground, had fun trying to hide from the heavy rain (not at all successful) and took tens of photographs. But the principal success of the organisers was that we learnt how the subtropical landscape here in SE Brazil works. Piece by piece, they were building for us the fascinating story of weathering, mass movements, slope erosion and fluvial processes, controlled by structure and tectonic regime, all working together to produce the marvellous hilly scenery in the piedmont of the Serra do Mar.

Many thanks!

Photographs:

BRA 3/11: Stonelines are ubiquitous on the hills around Bananal (here above Lavapés). They are essentially thin (usually less than 20 cm) stringers of resistant clasts which follow the slope at depth of 0.5 to c. 2 m; often there is more than one stoneline at a site. There exist many theories as to how stonelines develop and what is their significance, although as Donald Johnson frequently pointed out during our trip, soil fauna perhaps plays a crucial role in the development of the superficial sediment layer, including the stonelines.

back



BRA 3/23: At Bom Retiro it is possible to demonstrate that the process of stripping and 'rampa' formation was intermittent. Two colluvial bodies, a few metres thick each, are separated by a distinct palaeosol horizon (hammer) dated for 9700 BP. The subsequent massive deposition of colluvium, recorded throughout the region, is called the 'Manso event' and taken as the evidence of significant environmental change in the early to middle Holocene.

back

BRA 3/26: The area around Campinho provides a splendid example of what the Brazilian colleagues call the 'drowned landscape'. Hilly compartments, usually weathered throughout, are being progressively 'drowned' in an alluvial fill of first- and second-order valley. Stripping of weathering mantle from the slopes is so fast that the capacity of rivers to transport this material further away is insufficient. Therefore the colluvial-alluvial fill accumulates, valleys become choked up with the sediments, and valley floors aggrade. At Campinho the thickness of Holocene alluvial infill, the top part of which is seen in the road cut, is about 12 m. However, at this site at present erosion seems to prevail over aggradation.

back

BRA 3/32: At Bela Vista we were shown a marvellous example of gullying and 'rampa' dissection. Here the gully is developing within the first-order valley filled by colluvial deposits washed down from the surrounding slopes. The gully is 5-10 m deep and has several branches that develop independently from each other. Headward erosion accomplished mainly by pipe collapse and earth falls is very fast; in the last 15 years the rear scarp has retreated by a few hundreds of meters. Note the horse rider for scale.

back

BRA 3/42: Deforested interfluves near Porto Alegre allowed us to see the hilly landsurface of Bananal in its wider

geomorphic context. Mountain ridge of Serra da Bocaina forms the skyline. Within the hilly landscape numerous degraded landslide scars and depositional 'rampas' can be identified.

back

BRA 2/41: Best places to appreciate the depth of weathering in the piedmont of Serra do Mar are road cuts such as this one located west of Barra Mansa. Precambrian gneiss is weathered down to at least 20 m though the original rock structure is still preserved despite weathering. From this area depths of 'immature' sandy weathering in excess of 50 m have been reported and are indicators of very rapid advance of weathering front the rate of which is not matched by mineralogical evolution of the saprolites. This is perhaps the way the weathering system responds to uplift and rapid erosional differentiation of relief in the humid sub-tropical environment. Weathering is also important for assessing the potential of superficial processes. Deeply weathered slopes, especially if stripped of woodland vegetation, are prone to rapid gully erosion and many deep-seated landslides occur within the saprolite.

back

BRA 3/46: Reduction of strength of rock due to deeply penetrating weathering enhances susceptibility of slopes to landsliding. This photograph was taken on the road going from Bananal westwards and shows two landslides of different ages. The one on the right is a good example of slump and, judging from the very fresh appearance of the rear scarp, is very recent. To the left is the scar of an older landslide, partly vegetated but also subjected to shallow translational sliding and gullying. The landslide mass has now a smooth evened surface and the form approaches the depositional 'rampa' stage. Low earth mound in the foreground testifies to the important role played by soil organisms in forming the structure of the superficial layer.

back

BRA 3/29: A typical 'rampa' near Bananal. Two segments of different origin can be recognised. The upper one is a hollow within the convex slope, moulded by landsliding, gully erosion and sheet wash. The lower one is a gently

concave surface sloping down towards the nearby valley floor and underlain by colluvial deposits. Absence of clear signs of recent slope instability suggests that this particular feature has already been fossilised.