

Sierra Norte de Puebla Field Trip: 2-5 November 2003
Regional Geomorphology Conference (International Association of Geomorphology)
Mexico City, 27 October - 5 November 2003

Sunday morning at 8:00 a.m. always seemed rather early for a fieldtrip departure, but all three fieldtrip coaches set off without too much delay from alongside Mexico City's main Cathedral. The dozen or so international geomorphologists had plenty of room on board as we headed across the mountain range that defines the eastern side of the former lake basin now occupied by Mexico City. The first half of the fieldtrip was concerned with geomorphological features and processes within the east-central part of the Trans-Mexican Volcanic Zone, where many small cinder cones / scoria cones / tuff cones of Tertiary and Quaternary age rise from the extensive high inter-montane basin floors between ranges often formed from much larger volcanoes. Although some of the large volcanoes are extinct, many are considered merely dormant, and the beautiful Popocatepetl [Photo 1] is currently active though settling down following its frequent eruptions during the late 1990s. The main objective of Day 1 was to visit the northern middle slopes of La Malinche Volcano [Photo 2]. This is a 4,500 m high andesitic stratovolcano of Tertiary-Quaternary age and now extinct. Rising from the extensive plain northeast of Puebla city, most of the middle slopes are forested. Large parts of the forests were burnt during the dry season in 1998 that was exacerbated by that year's ENSO event (El Nino Southern Oscillation). Jorge López-Blanco showed us some of the damaged areas of forest and explained a number of studies involving several sites concerned with vegetation recovery and geomorphic responses that include changes to bulk soil properties as well as erosion and transport of soil particles. A brief diversion to obtain a general view over the plain north of La Malinche also introduced us to a crop of black corn [Photo 3], before we returned to the coach to travel back to Tlaxcala for the night.

*Photo 1**Photo 2**Photo 3**Photo 4*

Day 2 began with a lengthy drive from Tlaxcala to the far (east) side of La Malinche Volcano. This day was not so much about specific research, instead simply providing an opportunity to view a variety of volcanic landforms unfamiliar to some of the participants. In the morning we visited the Xalapaxco tuff cone on the eastern flank of La Malinche Volcano. This feature is unusual as its surface is characterised by the presence of ten separate explosion craters of varying sizes, one of which is visible on the right of [Photo 4]. Unfortunately we had insufficient time to explore any of the craters close-up, but there was

much discussion about the huge debris fan on which the tuff cone is located, and how this fan related to the geomorphic features of the upper part of the volcano and their uncertain origins (glacial activity or volcanic collapse?).

Lunch, and a brief appraisal of the architecture [Photo 5] in Huamantla town was followed by a journey northeast across the plain to briefly view the Alchichica crater lake, the largest on the lacustrine plain [Photo 6] with its limestone shoreline associated with the high mineral content of the lake water. Half an hour further south we visited a cluster of tuff cones at Atexcac and climbed one of them to obtain a detailed view of a more recent crater lake [Photo 7]. Here there was discussion of the stability of the crater walls and of erosion on the outer slopes, and general admiration of the fine views of Pico de Orizaba Volcano [Photo 7 - left of centre, background], the third highest mountain in North America at 5,749 m (18,855 feet). We returned to the coach as dusk fell, and travelled for another two hours in the dark to our next overnight stop at Teziutlán, a town that revealed more fine architecture in the morning [Photo 8].



Photo 5

Photo 6

Photo 7

Photo 8

We were now east of the Sierra, on the upper part of the dissected terrain that forms the slope down towards the Gulf of Mexico coastline, where slope instability was the theme for the second half of the fieldtrip. The main issue in this part of Mexico is the great thicknesses of pyroclastic deposits that mantle the hillslopes, and the general lack of awareness among local residents and officials of the potential risk of slope collapse. On 4 October 1999, 300 mm of rain fell in this part of Mexico, triggering hundreds of landslides of varying sizes and impacts. Another 330 mm of rain fell the next day. Day 3 of the fieldtrip therefore began with a visit to La Aurora cemetery in Teziutlán, where a landslide on the slope below the cemetery [Photo 9] devastated a residential district [Photo 10] and killed 200 people. The slope comprised sandy loam textured pyroclastic material up to 30 m deep. The same day, 4 October 1999, part of a street in the Valle Dorado district of Teziutlán collapsed into a gully [Photo 11]. The La Bandera block slide (sackung) above the town, formed on interbedded limestones and shales, provided a nice illustration of the role of larger scale, long term mass movements in the development of the landscape [Photo 12].



Photo 9

Photo 10

Photo 11

Photo 12

Travelling northwest from Teziutlán, we paused to take in the view from a lay-by overlooking the town of Tlatlauquitepec [Photo 13] and to examine the thinly bedded and highly fractured limestone that forms many of the higher ridges in this region [Photo 14]. At our next stop, however, the town of Zacapoaxtla [Photo 15] is built on up to 50 m thickness of pyroclastic sediments overlying basaltic lavas. Down by the river, one of the 4 October 1999 landslides [Photo 16] destroyed 20 houses, but new houses were subsequently built on the toe deposit. This was perhaps of even more concern than the many buildings sited on the top edge of this valley slope. Close examination of an exposed section through the in-situ material adjacent to the toe deposit [Photo 17] revealed wet sandy silt with an ash layer above (pen for scale), suggesting that perched groundwater might be a likely occurrence. Up the hill in the town, another mass movement into the head of a gully took one house with it, but the new concrete wall holding up a road and several other houses is already showing signs of stress, and the blocks of flats at one side of the gully head [Photo 18] are displaying structural cracks due to continuing slow subsidence. With many houses in the residential 'suburbs' built on an ancient landslide [Photo 15], lunch in this town included much discussion of the landslide factors, processes, hazards and awareness among the local people. After lunch we travelled to the delightful little town of Cuetzalan [Photo 19], perched on a topographic spur high above the slopes descending towards the Gulf of Mexico. A brief visit to the church at the far end of the town revealed evidence of ground slippage there with cracks in the concrete roads and stone walls, and buttresses supporting the downslope side of the church.



Photo 13

Photo 14

Photo 15

Photo 16



Photo 17



Photo 18



Photo 19



Photo 20



Photo 21

After breakfast on Day 4 we were taken to a site up the hill above Cuetzalan where a hotel was being built on the top edge of a very steep slope [Photo 20] of pyroclastic sediment [Photo 17] over thinly bedded, fractured limestone [Photo 14]. As a party of geomorphologists, some of whom specialise in landslide research, we were invited to assess the scheme and comment to a local official who showed us round the site. We were relieved to be informed that construction of the swimming pool on the side of the slope (where Photo 20 was taken from) had already been abandoned, but the structural cracks in the incomplete concrete frame did not bode well for the long-term future of the development. Somehow, despite the fabulous views, we couldn't recommend staying there... The most effective remedial measures concerned management of runoff water from the road and hillslopes behind and above the hotel.

The rest of the day was concerned with getting a few members of the party back to Mexico City airport in time for evening flights back to Europe, but we did have time to stop for lunch in Puebla city [Photo 21] on the way. There wasn't much time to look round, but as the main square was being dug up for major repairs we couldn't really appreciate the city centre anyway. With fine views of Popocatepetl after lunch, we made it to the airport with plenty of time to reflect on the significant and immediate geomorphic problems arising directly and indirectly from the volcanic activity that characterises central Mexico. Popocatepetl remains a direct threat to Puebla city and, possibly, Mexico City, should its eruptive activity increase again, and the legacy of past eruptions covering the hillslopes to the east presents a rather more insidious and less predictable threat to local populations. Mexican geomorphologists will be kept busy for a long time!

The fieldtrip was superbly organised and led by Irasema Alcántara-Ayala, Jorge López-Blanco and José Juan Zamorano, with additional contributions from a resident of Teziutlán and a regional disaster management official, Ruben Acebo Zarate. Thanks are extended to these, our hosts, on behalf of all the participants, and from myself to the other participants for lively and entertaining discussion and debate throughout this excellent fieldtrip.

Alan Dykes