Lava Tubes of the Naolinco Lava Flow, El Volcancillo, Veracruz, México

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Abstract

Six caves up to nearly a kilometer long have been discovered on the Naolinco lava flow, which was emmited by El Volcancillo 870 years ago and reached a length of about 50 kilometers. All of the caves seem to be remains of a master tube which probably fed most of the lavas that form the flow. Of particular interest is the fact that at least two of the caves capture and carry surface streams of considerable size. The water does not return to the surface until the spring known as El Descabezadero, the birthplace of the Actopan River.

Las Lajas Cinder Cones and lava flows

North of Cofre de Perote a series of small eruptive vents are called the Las Lajas Cinder Cones. Over a dozen volcanic vents have been recognized and some of them have been dated (Siebert and Carrasco-Núñez, 2002). La Joya cinder cone complex is one of the oldest, and produced about 20 km^3 of basaltic flows that extend about 14 kilometers SE to underlie the city of Xalapa, capital of the state of Veracruz, about 42,000 years B.P. Many younger volcanic vents and lava flows exist in the area (Fig. 1).

El Volcancillo

The youngest lava flows dated by Siebert and Carrasco-Núñez (2002) originated from El Volcancillo (2,700 m.a.s.l.), a twin crater located 4 kilometers southeast of the town of Las

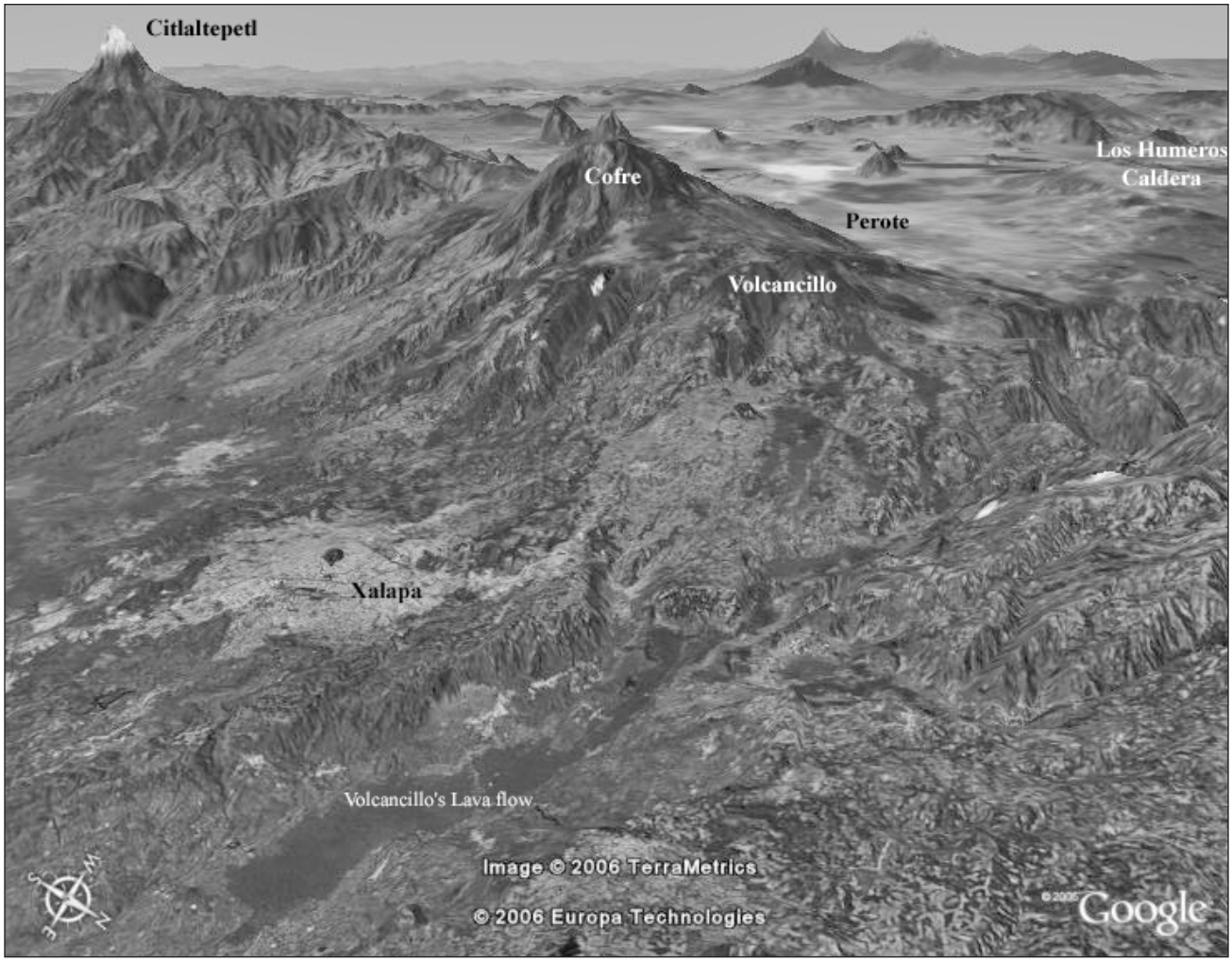

Figure 1. Las Cumbres volcanic complex and the Volcancillo lava flows.

Vigas which erupted 870±30 y.B.P. The cone complex straddles a sharp crested ridge between two valleys carved into the slope of Las Lajas volcano, a subsidiary cone of Cofre de Perote. It fed two lava flows that traveled down different drainages. The Toxtlacoaya A'a flow, originating from the southeastern crater, has a length of approximately 12 kilometers, while the Río Naolinco pahoehoe flow, which originated in the northwestern crater, traveled over 50 kilometers.

Toxtlacoaya lava flow

The eastern crater occupies the summit of a steep sided scoria cone that is breached in two places on its southern side. Large lava benches surround the inner crater and mark the highest stand of a former lava lake which overflowed the breach, generating a short lava flow which shortly stopped at the end of the first steep slope. We believe that most of the Toxtlacoaya lava flow issued not from the breached upper cone but from a pair of vents at the northeastern base of the cone, based on lava flow morphology. The lava flow crusted over forming a large lava tube with a big skylight, 20 meters in diameter, which overflowed frequently forming a small shield. Quarrying of a lower entrance and the building of an Oleoduct collapsed most of the cave, leaving a semi-natural rock arch giving the cave its name, Cueva del Arco (Figure 2)

Siebert and Carrasco-Núñez (2002) claim that the 35 meter thick lava pile visible on the walls of Cueva del Arco (Figure 3), actually 45 meters, according to our survey, represent the minimum thickness of the lava

Figure 3. Cueva del Arco. Notice the two cavers, one on rope and the other at the bottom.

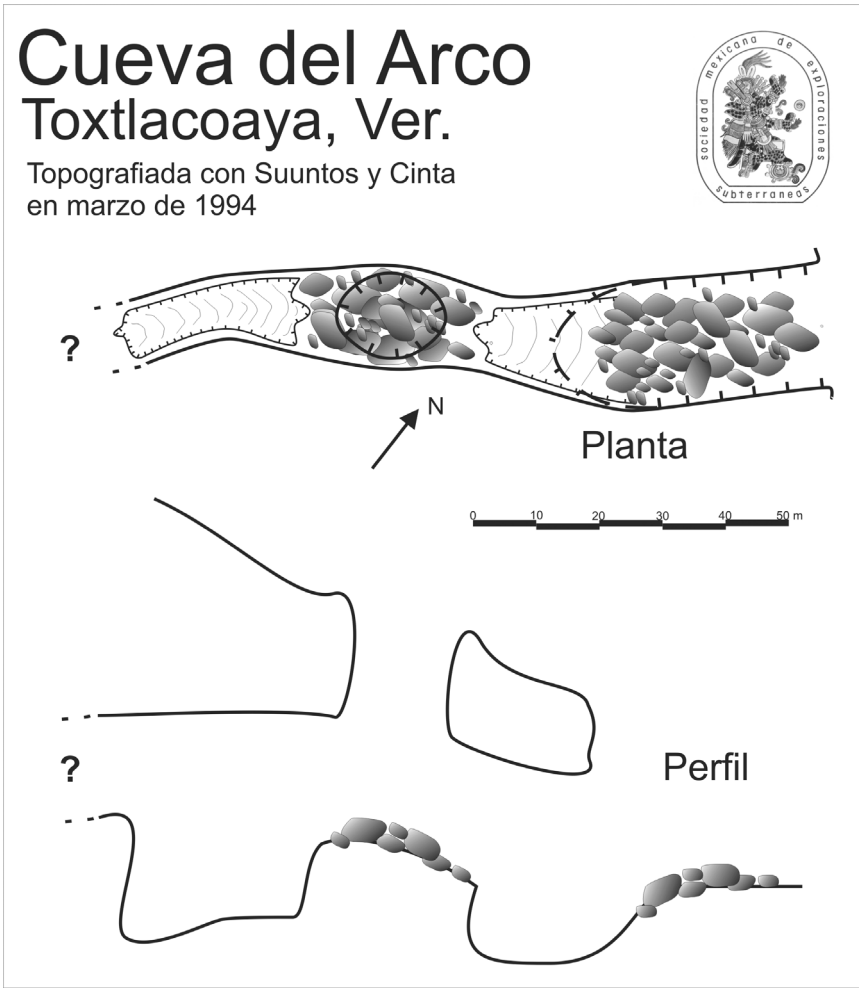

Figure 2. Map of Cueva del Arco.

flow, and do not consider that the tube could have been originally much smaller, and the present height was caused by thermal erosion, as suggested by the passage cross section.

Naolinco lava flow

The western or main crater is 200 meters wide and 90 meters deep. It partially truncates the eastern scoria cone and was produced by collapse of a small lava lake that overflowed the western scoria cone. In both craters we find the same sequence of events: building of a scoria cone by lava fountaining, followed by the emission of lava which formed a lava lake. In the western crater, the scoria cone was overtopped over an arc of 180º by pahoehoe sheet flows, which were truncated by the crater collapse. The uppermost entrance to Cueva de El Volcancillo is exposed in the upper northern wall, and marks the main outflow of the Río Naolinco lava flow.

The whole of the Río Naolinco lavas were fed through lava tubes, as evidenced by numerous primary inflation structures such as tumuli, pressure ridges, inflation

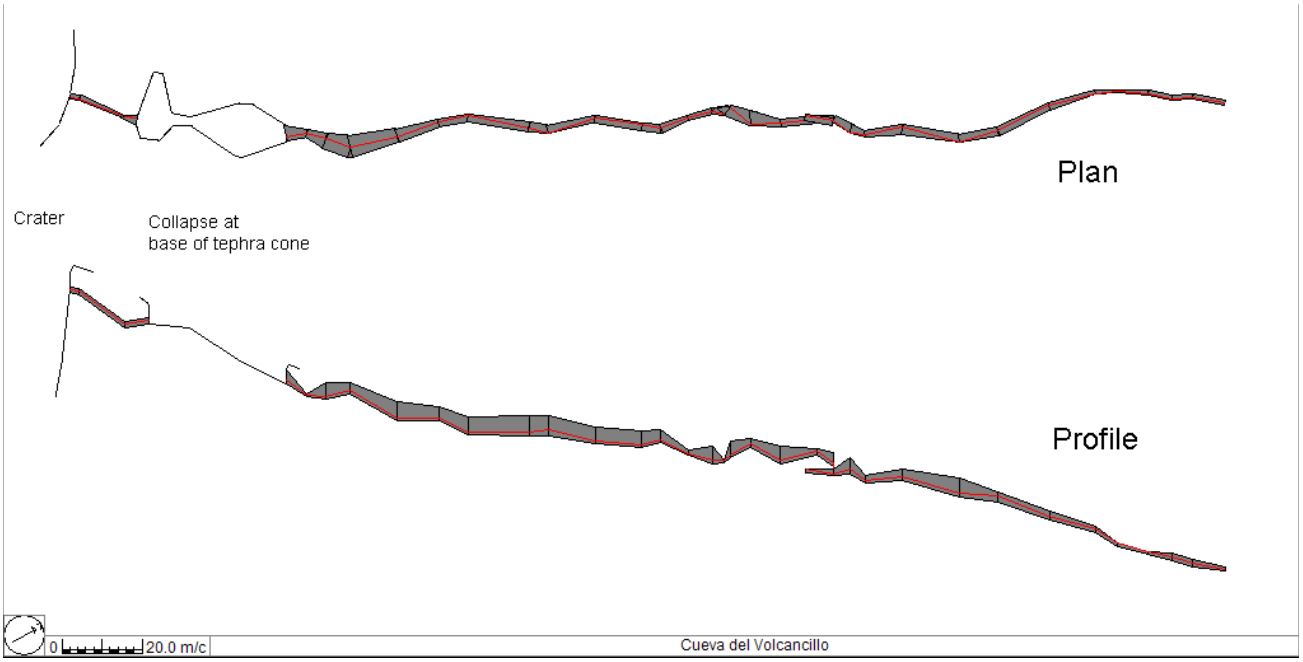

Figure 4. Plan map of Cueva del Volcancillo.

clefts and ropy textures throughout. After 15 kilometers and a steep fall near the town of Tlacolulan, the lavas entered the deep valley of the Naolinco River and followed it for nearly 35 kilometers. The lava flow ends at a narrow canyon west of the town of Chicuasen at an altitude of 360 meters, immediately beyond the popular Descabezadero Cascades, the birthplace of the Actopan River, which comes out at the contact of the lava flow with underlying conglomerates. With over 50 kilometers in length, it is one of the longest lava flows recognized in México.

To date, 6 different caves have been discovered on this lava flow, but not all have been surveyed properly, or even completely explored. They are possibly all part of what must have been a large master tube which probably fed most of the lava. Undoubtedly, many more caves probably exist and await discovery, exploration and mapping. The known caves will be described downflow:

Cueva de El Volcancillo: This cave is located right at the north side of the west crater. It is a tube segment 685 meters long, in two sections separated by a large collapse. The upper one goes for less than 50 meters between the crater wall and the surface collapse, after which the entrance to the main cave is encountered (Figure 4). It is a beautiful master tube with up to three superposed levels separated by the growth of wall *levees*. In those sections where the *levees* do not join, their surface texture is especially beautiful (Figure 5). After nearly 350 meters, a small skylight entrance is encountered, below which is a seven meter pitch which can be rigged with a wire ladder and a safety rope. Shortly afterwards the cave ends in breakdown.

Cueva de la Escalera: Located near Cueva de El Volcancillo, it is the probable downflow continuation of the same tube beyond the breakdown. It is a collapse of the ceiling of a large and deep tube, but it has not been entered yet.

Cueva del Río Huichila: This cave is a large segment of a master tube, beautifully preserved in sections, and with the added interest of containing a substantial river. It has been explored for 625 meters (Figure 6), through numerous pools which required swimming and frequent

Figure 5. The beautiful wall *levees* in Cueva de El Volcancillo.

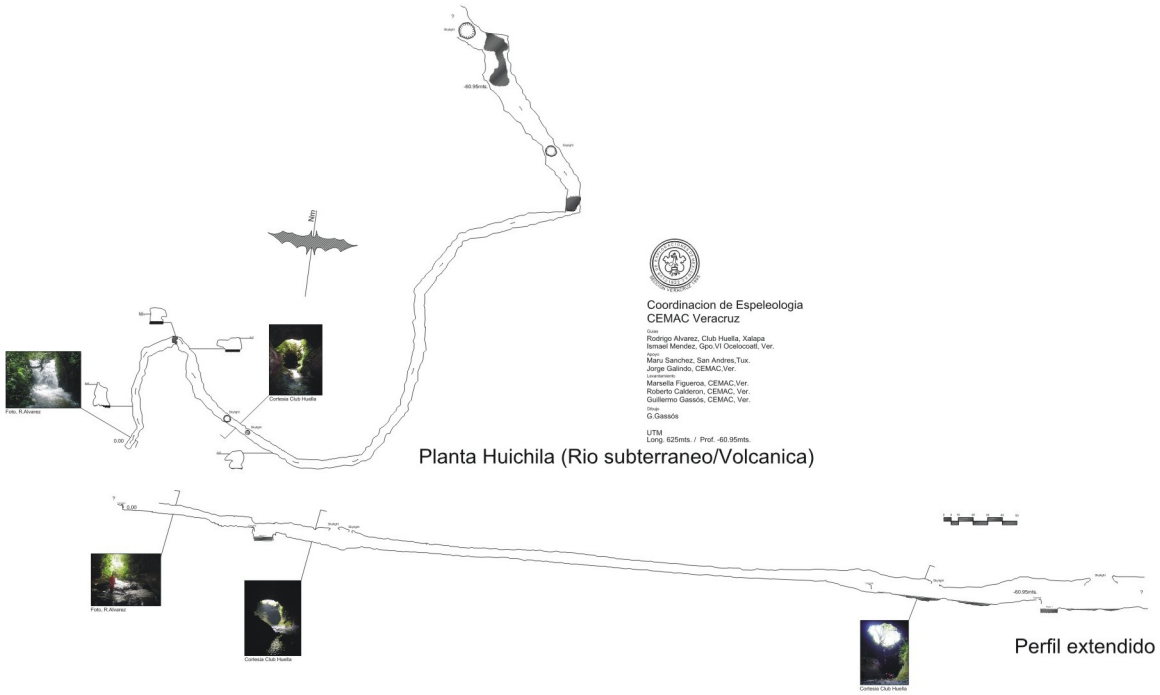

Figure 6. Plan and profile of Cueva del Río Huichila.

rapids that have to be climbed around, to a skylight, but the cave continues unexplored beyond (Figure 7).

Cueva de El Tirantes: Small cave 278 meters long (Figure 8). It is located in the back "*patio*" of the "*El Gavilán*" restaurant on the Naolinco road, near the town of La Virgen, Municipio de Jilotepec, and was named in honor of the owner, a former AAA Wrestling referee. Unfortunately, one of the passages receives waste from bathrooms located above.

Cueva de La Higuera: This tube is relatively narrow but quite long at 625 meters. It has been explored to a breakdown choke but it may continue beyond (Figure 9). The entrance is in front of the "*El Gavilán*" restaurant, south of the previous cave. Both these caves are also known as Cueva de La Virgen, the name of the nearest town.

Cueva de Tengonapa: This lava tube is located near the town of the same name, in the Municipio of Tlacolula. It has been surveyed for 477 meters between two skylight entrances, but continues beyond in both directions (Figure 10). The upper portion contains two paralel and superposed tubes that lower down merge into a canyon shaped master tube over 10 meters in height. In the upper levels trash and vegetation from floods can be found, and locals relate that during the

Figure 7. The Huichila River under one of the skylights in the cave.

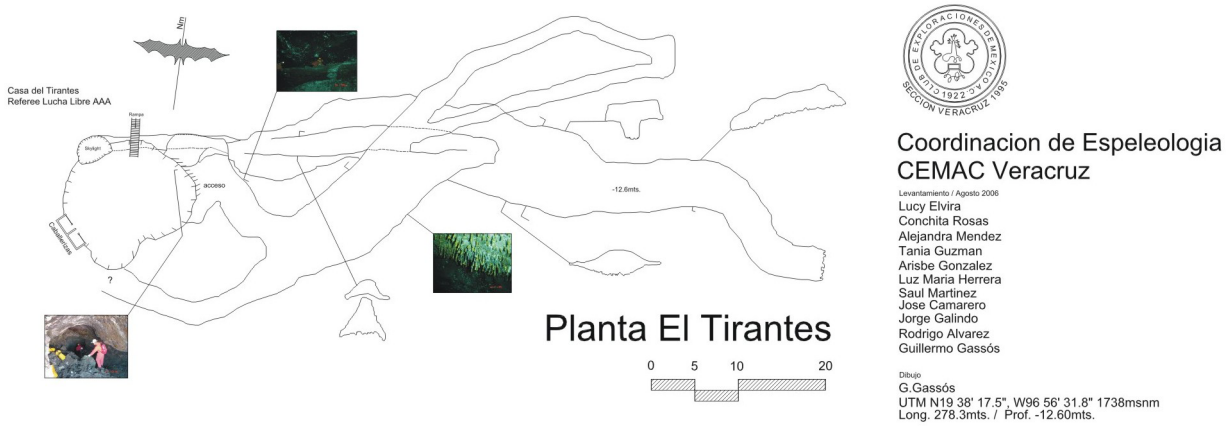

Figure 8. Plan and profile of Cueva de El Tirantes.

Figure 9. Plan and profile of Cueva de la Higuera.

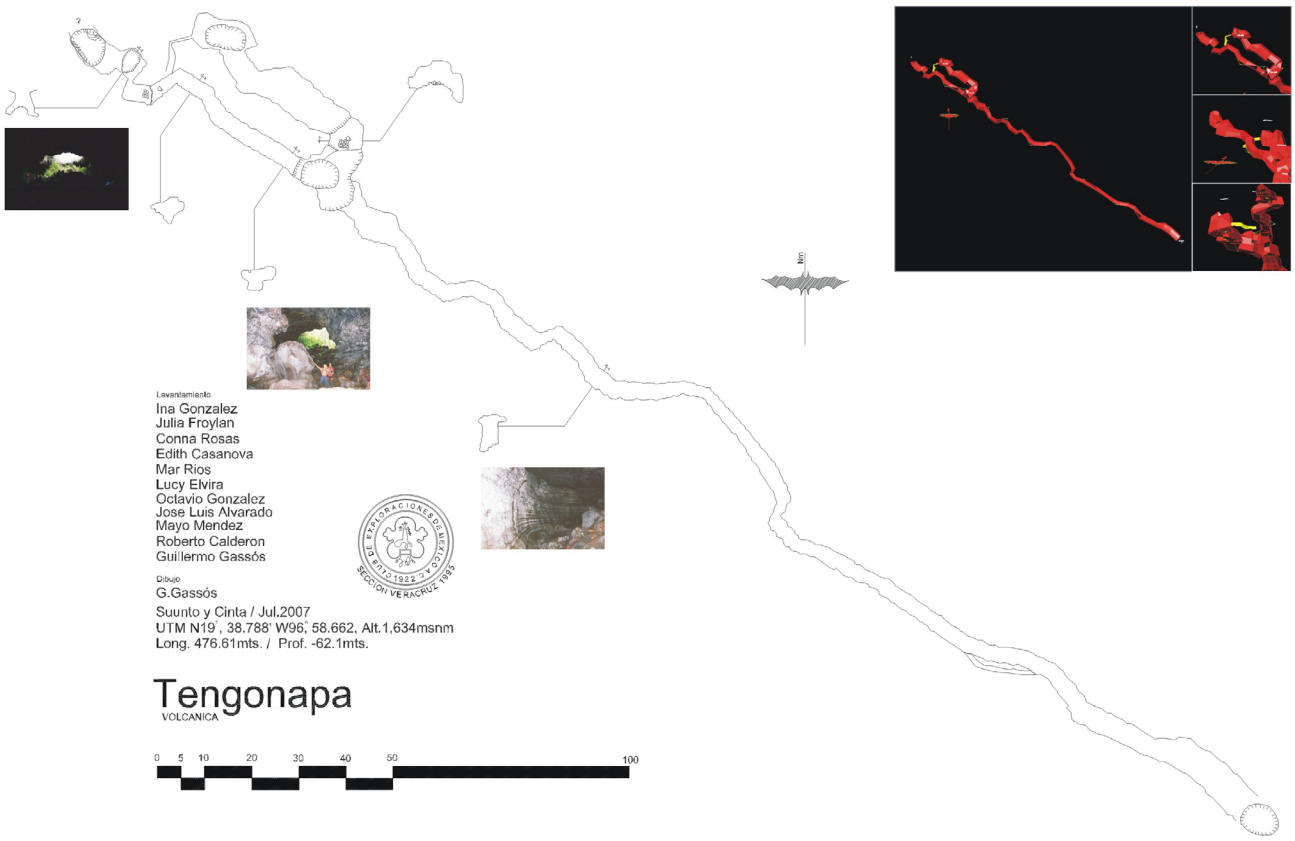

Figure 10. Plan and profile of Cueva de Tengonapa

Figure 11. El Descabezadero, birthplace of the Río Actopan and terminus of the Naolinco lava flow.

rainy season a river flows through the cave and washes away any trash they throw inside.

The presence of active streams in several of the caves is unusual. No springs are known except for El Descabezadero, at the downstream end of the lava flow, which gives birth to the Actopan River, so the water from the above caves probably resurges there (Figure 11). The known instances of pollution of some of the caves is therefore more problematic than usual, since those contaminants could easily be transported by the cave streams, polluting the entire Actopan basin.

References

Siebert, L. and Carrasco-Núñez, G., 2002, Late-Pleistocene to precolumbian behind-the-arc mafic volcanism in the eastern Mexican Volcanic Belt; implications for future hazards: Journal of Volcanology and Geothermal Research, V. 115, p. 179-205.