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Cueva Tecolotlán, Morelos, México; An Unusual Erosional Cave in Volcanic Agglomerates

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Abstract

Tecolotlán cave, located near the town of Cuentepec, Morelos, with a surveyed length of 870 meters and a vertical extent of 105 meters, is one of the longest erosional caves known in non-calcareous conglomerates. It is contained in volcaniclastic deposits, mainly lahars and fluvial conglomerates and a few intercalated ash layers belonging to the Cuernavaca formation, which constitute the Buenavista volcaniclastic fan, which has its apex at the Sierra Zempoala volcanic complex and extends south to the limits with the state of Guerrero.

This volcaniclastic fan has been eroded by numerous streams running almost parallel to the south, which have excavated deep "barrancas" or gullies. In particular the "barranca" of the Río Tembembe is over 100 meters deep near the location of the cave.

The cave captures the drainage of a surface stream, and is developed along a single passage which for almost 600 meters follows a single fracture, oriented almost east-west. This passage is a subterranean canyon, two to five meters wide and three to over 20 meters high, typically vadose in its configuration, with several vertical pits or cascades along its length. Deep plunge pools have developed at their bases. The only chamber is located under a collapse which formed a skylight almost 40 meters high, but no collapse debris remain, as they have been flushed out by the torrential floods that sweep the cave during the rainy season.

The final portion of the cave changes completely in morphology when the passage abandons the main fracture to develop along the contact between two different debris flow deposits. The huge canyon turns into a small round tube, slightly incised in its floor, which mimics a phreatic passage in karstic caves. The cave resurges 12 meters up the wall of a small tributary of the Río Tembembe canyon, and almost 45 meters above the river level.

The lithology in which the cave is developed prevents solution from playing an important role in the generation of the cave, which owes its origin entirely to mechanical erosion, probably aided in the beginning by a process similar to piping in unconsolidated deposits. The morphology of the final portion would seem to indicate that the cave started its development when the Río Tembembe was at its level or just above it.

Introduction

Although karstic phenomena in conglomerates is relatively common, in almost all cases described, either the matrix or the blocks are calcareous in nature, and few if any described caves are developed in volcanic aglomerates of andesitic nature. A recently mapped cave, developed in the Buenavista volcaniclastic fan to the south of the Zempoala volcano, in central Mexico (Figure 1), seems to have developed by erosion, possibly aided by a process similar to piping, along a fracture, but its morphology perfectly mimics an active stream cave in a karstic environment.

The Buenavista volcaniclastic fan

The Buenavista volcaniclastic fan (BVF) is a conspicuous geomorphologic unit to the south of the Zempoala volcano, in central México (Figure 2). It was first mapped by Fries (1960), who described the Cuernavaca Formation as a series of thickly bedded conglomerates with sub rounded andesitic blocks up to metric in size, interbedded with fluvial sands and mud, and occasional thin ash layers.

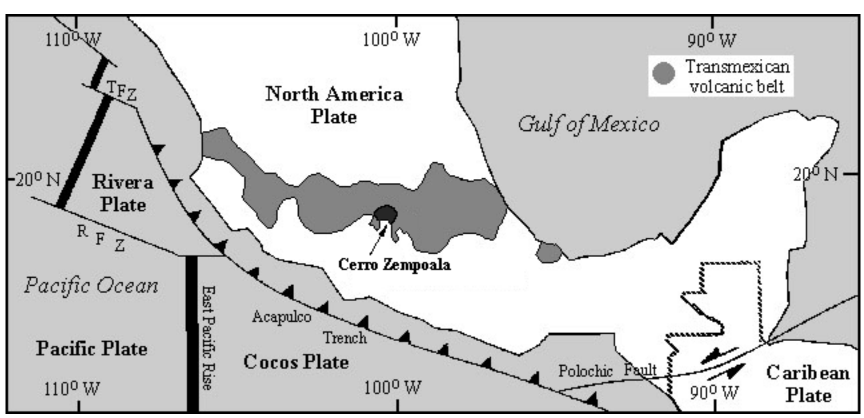

Figure 1. Map showing the tectonic setting and location of Volcan Zempoala, in the central portion of the Transmexican Volcanic Belt.

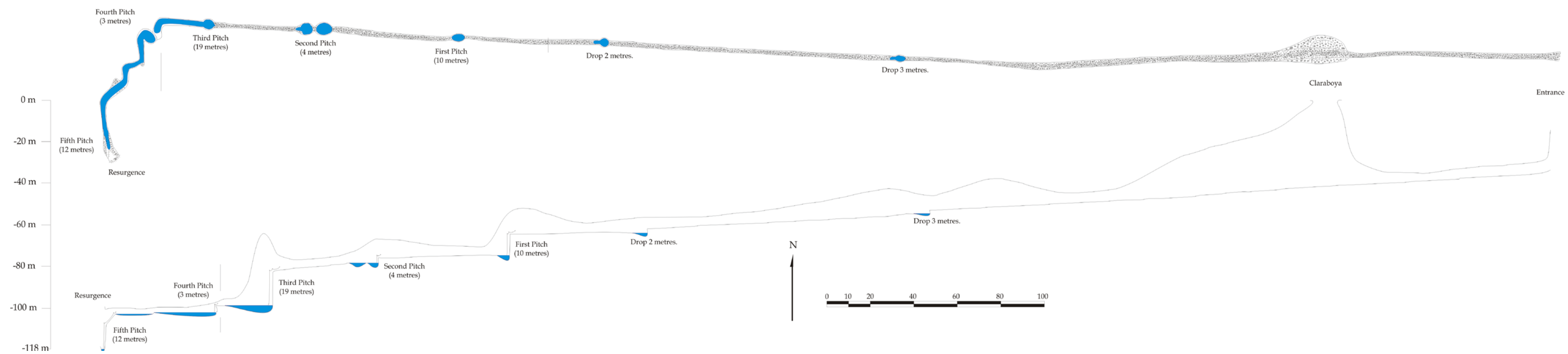

Figure 2. Plan and profile views of Cueva de Tecolotlán. A larger version of this map appears in the supplemental material on the CD.

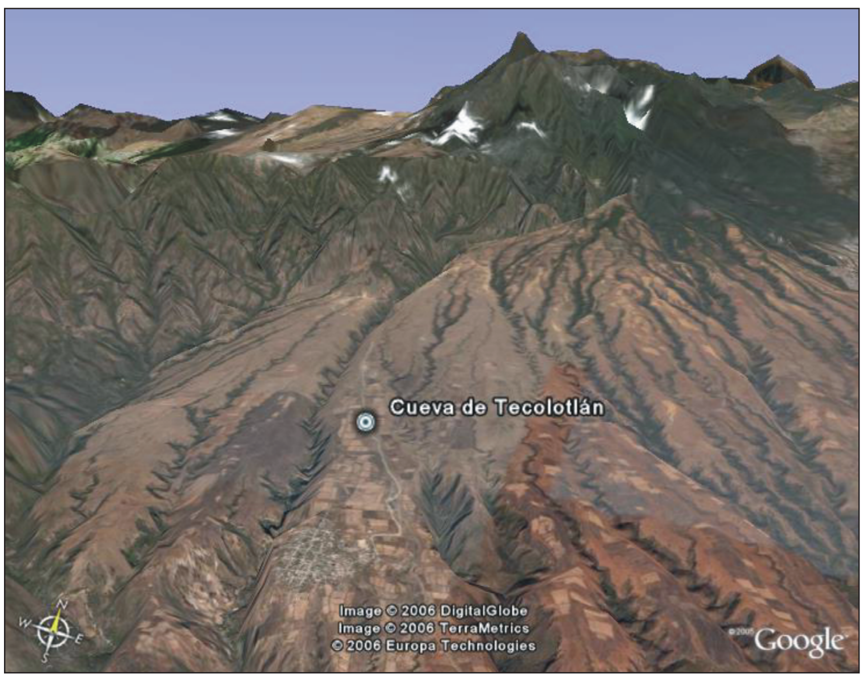

Figure 3. Upper portion of the Buenavista volcaniclastic fan, with the location of Cueva Tecolotlán. The Cerro Zempoala volcano can be seen at the apex of the fan. The canyon which drains its west slopes and then cuts through the fan is the Río Tembembe

Figure 4. Location of the three entrances of Cueva Tecolotlán.

Figure 5. Entrance sink of Cueva Tecolotlán. Two cavers can be seen on the left slope. The average dip of the fan can be seen from the slope of the road behind the cave entrance.

Ortiz-Pérez (1977) believes that the fan was formed in response to climate changes during the Pleistocene deglaciation of Zempoala volcano, although no proof of such a glaciation is given.

Recent studies show that this volcano collapsed to the southwest sometime during the Pliocene (Capra et al., 2002). The resulting horseshoe-shaped crater probably directed Pleistocene eruptive products (pyroclastic and debris flows) towards the south, creating the huge volcaniclastic fan. Since the end of activity at Zempoala volcano, fluvial erosion has excavated numerous deep ravines on the surface of the Buenavista fan, the largest of which, Cañón del Río Tembembe, drains the southern flank of the Cerro Zempoala and then cuts south through the entire fan (Figure 3). The cross section of the valley is V-shaped, with a rim to rim distance of about 200 meters on average, and about 100 meters deep, but at the bottom of the V is a vertical walled gorge 20 to 70 meters deep.

Cueva Tecolotlán

The entrance to the cave is at the end of a small ravine whose headwaters are barely a kilometer away (Figure 4), and which has carved into the conglomerates to a depth of 30 meters at the cave entrance (Figure 5), which is a 2 meters wide and 5 meters high tunnel that heads almost west following prominent fractures, almost vertical, which are clearly visible in the cliff above the entrance (Figure 6). After nearly 100 meters, the passage reaches the bottom of a 40 meter high skylight formed by ceiling collapse in a widening of the passage to almost 20 meters in width. No collapse blocks remain in the floor, so all the material emptied from this room has been carried away by the seasonal stream. The controlling fractures are again visible in the walls of the skylight chamber (Figure 7).

The passage continues perfectly straight, shaped like an underground

Figure 6. The actual entrance is triangular in shape and follows a near vertical fracture.

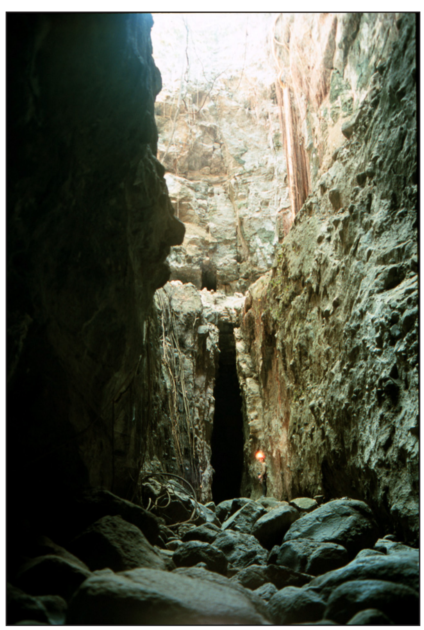

Figure 7. On the skylight walls the vertical fractures that control the cave development are clearly visible.

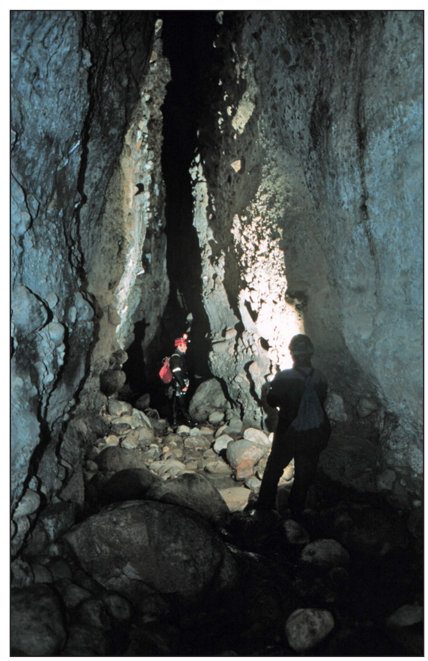

Figure 8. Most of the passage is a tall, canyon-shaped passage. The large andesitic subrounded blocks on the walls form part of the debris flow deposits in which the cave is excavated.

Figure 9. Plunge pool at bottom of third drop. The large andesitic subrounded boulders that form the host rock are perfectly visible.

Figure 10. Rounded cross-section of the lower passage of the cave. Notice the change in lithology which is the stratigraphic contact which controlled the development of this portion of the cave.

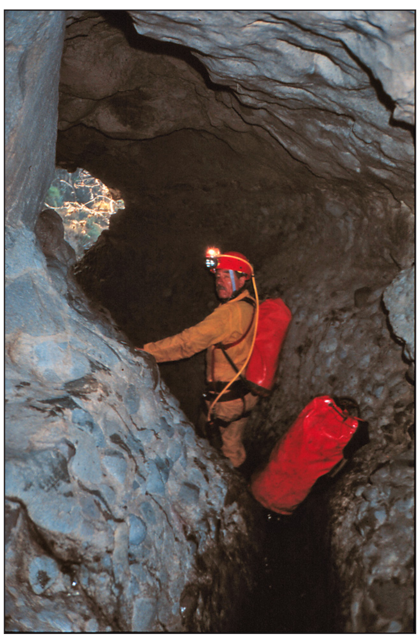

Figure 11. Hourglass cross-section of the lower passage of the cave. Notice the entrenchment of the floor below the phreatic original passage.

Figure 12. Resurgence hanging 12 meters above the floor of a small tributary of the Río Tembembe. Notice the lithology of the Cuernavaca Fm, in which the cave is hosted, is a sequence of volcanic debris-flow deposits of probable *laharic* origin, interstratified with fluvial conglomerates, ash-flow deposits and thin air fall ash layers.

canyon (Figure 8); two hundred meters beyond the skylight, a three meter climbable drop is found, followed a hundred meters later by another two meter climbable drop. Sixty meters later, a deep 10 meter pitch is found (Figure 9). Fifty meters later a second pitch, four meters deep, is found. All drops and pitches are followed by deep, round plunge pools where swimming is necessary.

A third pitch of 9 meters follows after another 50 meters. The plunge pool at the bottom is followed by a narrow canal, and suddenly the passage turns left, quitting the fractures that controlled its development to this point, and meandering instead along an ill-defined bedding plane between two conglomerate deposits, marked by a <1 centimeter thick ash layer. The passage consequently diminishes in size, turning into an almost round tunnel which perfectly mimics a phreatic tube in karstic caves (Figure 10), 1 to 2 meters wide and 1 meter high. As the passage aproaches the exit, a small trench is developed in the floor (Figure 11). This ends at the resurgence, which is a hole hanging 12 meters above the

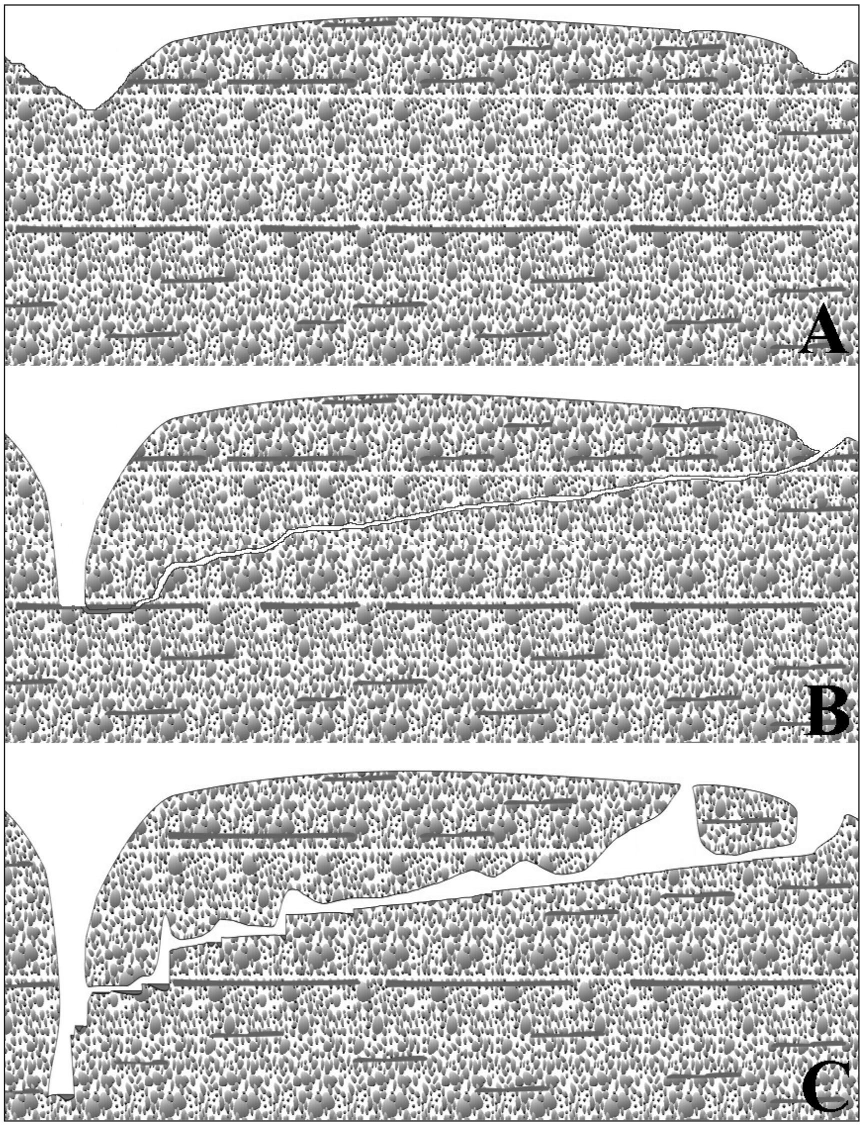

Figure 13. Geological cross-sections showing the development of Cueva Tecolotlán. The first stage would be the formation of the Tembembe valley almost to the level of the cave. When erosion first breached the ash layer between conglomerate deposits, it allowed water filling the fractures to start flowing through the contact that marks the bottom portion of the cave, probably aided by some sort of piping, at least at the beginning, but soon fluvial erosion took over, excavating the upper canyons and cascades along the fractures (second stage). Finally, as the Tembembe river eroded the deep gorge below the resurgence, the cave drained its "phreatic" portion, but stream erosion continues to be active every rainy season.

floor of a surface tributary of the Rio Tembembe, and still 45 meters above the present level of the river (Figure 12).

The lithology in which the cave is developed prevents solution from playing an important role in the generation of the cave. The morphology of the final portion would seem to indicate that the cave initiated its development when the Rio Tembembe was essentially at its level, which coincides with the change in slope of the valley flanks. The excavation of the cave might have been aided, at least in the beginning, by a process similar to piping in unconsolidated deposits. Above the cave the morphology of the cave is essentially that of a vadose canyon.

Since the inception of the cave, the Tembembe has excavated a vertical-walled canyon at least 45 meters deeper. The slope change in the valley walls probably reflects rejuvenation of the relief, and the deepening of the valley drained the cave (Figure 13).

References

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