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Seismic refraction tomography in the Texcoco Region, Mexico

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Geophysical studies of early human occupation in the Valley of Mexico are limited. Nevertheless, archaeological remains have been found inside and around ancient Lake Texcoco. The presentation concerns the results of seismic refraction tomography (SRT) surveys of two archaeological sites, Chapingo and San Miguel Tocuila, aimed at locating and determining the nature of early human settlements in the Texcoco region. The sites are at an altitude of 2246 m a.s.l., around 30 km northeast of Mexico City and 4 km apart.

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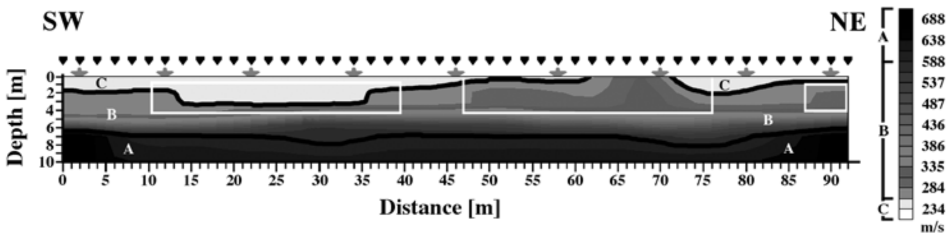

Fig. 1. Example of a seismic refraction tomography profile from the Chapingo site, showing a three-layer lacustrine deposit (A to C), featuring archaeological structures: channel (left), mound (middle) and an undefined structure (right). Asterisks indicate source position and triangles geophone position. Velocity in m/s shown in gray at right

Seismic techniques in archaeological prospection are not very common. However, SRT is a high-resolution and non-destructive geophysical exploration technique that provides data for mapping human settlement and reconstructing the geometry of structures, like walls, mounds, tlatels, pits and ditches, buried in the subsurface (Arciniega-Ceballos *et al.* 2009: 1203–1205; Batayneh 2011: 84–85).

Tlatels, which are widespread in the Valley of Mexico, are pre-Hispanic settlement mounds that are formed of built stonewalls filled inside with rock debris, silty sand and rubble from other structures. The height and size of these mounds were determined most likely by the water-level fluctuations of Lake Texcoco and the use of these sites was either residential, defensive or ceremonial (Arciniega-Ceballos *et al.* 2009: 1200–1201). Applying SRT helped to locate and differentiate between archaeological structures, such as tlatels and channels, and geological structures in the first 10 m below the surface.

SRT is an active non-destructive geophysical method based on recording first-wave arrival, detected with an array of equidistant geophones spread out over a surface at equal increasing distances from the source. In near-surface geophysical studies, impact sources like hammers or bounce weights are commonly used, and the transect length depends on the target depth. In the present survey, an 8 kg sledgehammer and an iron metal plate for better coupling with the soil were used and profile length was varied between 11 m and 46 m. The seismic velocity distribution of the subsurface is obtained from the analysis and modeling of the first-wave arrivals and the travel-times, applying a non-linear regression approach. This analysis takes into account the different layers that the wave travels through and the elastic properties of the earth (Milsom 2003: 207–221; Linford 2006: 2244–2245).

The surveys were carried out using 24 14-Hz vertical OYO Geospace geophones and a 48-channel Geometrics StrataVisor NZ seismometer. To enhance the signal-to-noise ratio three to five traces were stacked at each point source, having a minimum of five point sources per profile.

In the central campus of the Universidad Autónoma Chapingo, two 46 m and four 92 m profiles were made over two adjacent smallholdings, covering an area of 2.9 ha. The SRT results indicated the presence of a variety of transit or irrigation channels (see Fig. 1). The channels were found on all the profiles. Four of these channels could be part of a single channel aligned NE–SW with a width varying from 16 m to 21 m. Structures of irregular shape, interpreted as mounds or dams, were located on three profiles. These structures are 23–29 m wide and 3–4 m high. Trapezoidal structures 1–2 m high and 4–6 m wide were also identified (see examples of

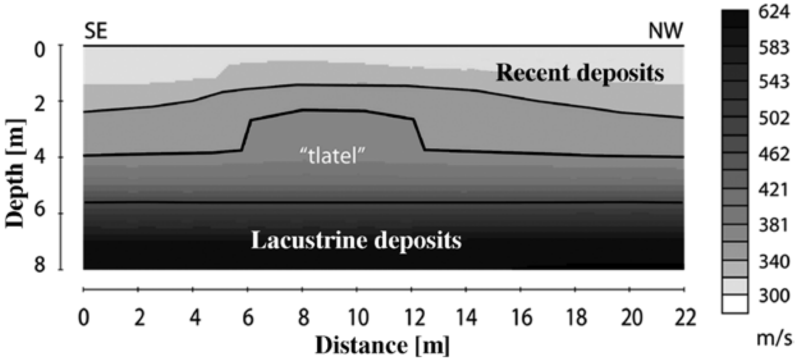

Fig. 2. Example of a seismic refraction tomography profile of a tlatel from the San Miguel Tocuila site. Velocity in m/s is shown in gray at right

both in Fig. 1). The seismic profiles also suggested a series of depressions at a depth of more than 5 m. The depressions are interconnected and are related to an ancient riverbed that ran from east to west (Rosado-Fuentes 2014: 94–102).

In a soccer field at San Miguel Tocuila, four 118 m and one 96 m SRT profiles were performed. A ceremonial tlatel was located in the western part of the field. The width cannot be precised accurately, but the total height was 5 m and there is reason to believe that it was built in three stages (Arciniega-Ceballos *et al.* 2009: 1201–1205). Five profiles, 22 m long and one 11 m long, made in the neighborhood of the Museo Paleontológico de Tocuila located two small tlatels. One was about 6 m long and 2 m high (Fig. 2), the other roughly 4 m long and 1 m high (Vergara-Huerta 2011: 35–48). These sites are characterized by lacustrine sediments and lahar deposits containing paleontological remains (Siebe *et al.* 1999).

Further studies are required and a combination of geophysical exploration methods (e.g., magnetic and ground radar penetration techniques) is recommended. These studies have demonstrated SRT to be a powerful method for locating and differentiating archaeological and geological structures.

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REFERENCES

Arciniega-Ceballos, A., Hernandez-Quintero, E., Cabral-Cano, E., Morett-Alatorre, L., Diaz-Molina, O., Soler-Arechalde, A. and Chavez-Segura, R. 2009. Shallow geophysical survey at the archaeological site of San Miguel Tocuila, Basin of Mexico. *Journal of Archaeological Science* 36: 1199-1205.

Batayneh, A.T. 2011. Archaeogeophysics-archaeological prospection – A mini review. *Journal of King Saud University – Science* 23: 83-9.
Linford, N. 2006. The application of geophysical methods to archaeological prospection. *Reports on Progress in Physics* 69: 2205-57.
Milsom, J. 2003. *Field geophysics of The Geological Field Guide Series. Chichester. England.*
Rosado-Fuentes, A. 2014. *Aplicación de técnicas de exploración geofísica somera en la zona prehispánica de Chapingo, Texcoco, México.* Unpublished BSc thesis, Universidad Nacional Autónoma de México.
Siebe, C., Schaaf, P. and Urrutia-Fucugauchi, J. 1999. Mammoth bones embedded in a late Pleistocene lahar from Popocatepetl volcano, near Tocuila, central Mexico. *Geological Society of America Bulletin* 111: 1550-62.
Vergara-Huerta, F. 2011. *Caracterización de fallas y estructuras someras usando tomografía de refracción sísmics.* Unpublished BSc thesis, Universidad Nacional Autónoma de México.