Revista Mexicana de Astronomía y Astrofísica, Volumen 1, Abril 1974.

POSSIBLE METEORITE CRATER IN MEXICO

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Received 1974 March 4

RESUMEN

Un cráter circular cuyas dimensiones son 1,180 m de diámetro, 92 m de profundidad y con un borde que se eleva a 35 m, se encontró en el estado de Puebla, México. Se discuten los argumentos que conducen a proponerlo como de origen meteorítico probable y se presentan los resultados topográficos y geológicos que se han obtenido.

ABSTRACT

A circular crater, with present depth of about 92 meters from the rim to the floor and with a diameter of 1,180 m, has been found in the state of Puebla, México. Several arguments are discussed that point to the meteoritic origin of this crater. Topographical and geological results are presented.

Key words: METEORITE CRATERS—MAARS.

I. INTRODUCTION

This paper summarizes research that has been done on this crater. Research was initiated in October 1972, following the proposed working hypothesis of a meteoritic origin.

The crater was photographed from an airplane because of its beauty and uncommon appearance. This aerial picture, taken in 1959 by S. de la Peña (Figure 1—Plate 4), when first seen by this author, suggested the possible meteoritic origin of the structure. This was due to its morphological and topographical characteristics, and its striking resemblance to Wolf Creek crater and other explosion meteorite craters on the Earth's surface (Figure 2—Plate 4).

The crater was not found until March 1973 because its exact location had been forgotten. We searched for the general region of the country that would fit with the particular topography, climate, and vegetation shown in the picture. The first approximation was based on the information that it was located in the region known as Oriental-Perote. There we met Mr. Marcos Argüello of Tlachichuca, Puebla, who was able to identify a very well-known feature with the aerial view of it. Therefore, the expedition was led by Mr. Argüello to the exact location of the crater.

Known only to the inhabitants of the region and far from main roads, lies the crater; its original name is Jalapasquillo de Tepetitlán. We renamed it Tepexitl, a word that means "abyss" in Nahuatl. Figures 3 and 8—Plates 5 and 7 show the outer rim and a general view of the interior of the crater, respectively.

In view of its morphology, we propose an explosive meteorite impact as the mechanism to explain its formation. If our hypothesis is confirmed, it could provide evidences of how the powerful shock waves, due to the explosion, were propagated in the specific material of the area, giving rise to such a permanent structure. The study will, also, provide some data about shock metamorphism in bed rocks, impact cratering mechanics, mean bombardment

rates, erosion rates (Dence 1972) and evolution of the crater shape due to endogenic and surface processes (Pike 1971).

These data, plus further geophysical and geological investigations made in the crater, could be used in the comparative studies of similar features on the surfaces of the Moon, Mars, and Mercury.

II. DESCRIPTION

The crater is a bowl-shaped and almost circular structure with a complete, raised and overturned rim. The bottom, below ground level, is roundish and flat. Present depth is about 92 meters from the rim to the floor and the largest diameter measured is 1,180 meters; the shortest diameter is 966 meters. The top of the rim, a flat and narrow surface, is 2 to 5 meters wide, with a measured circumference of 3,190 meters. It could be considered almost horizontal; the rim rises slightly, following a southern direction and the level of the datum plane is higher on the NNE side than on the SSW side. The height of the rim varies from 18 to 35 meters. The outer slopes of the rim are about 13° and the inner walls of the crater have slopes of about 23°.

The crater has an interior feature which is a ridge that is neither a central peak nor an anular ring. The ridge starts near the midpoint of the SE radius and ascends until it reaches the top of the rim. The ridge has the same composition as the rim, but is not a part of the rim that slid down because: first, the rim is complete; second, if this ridge would be removed from the crater, the rim would remain unaltered. This ridge can be seen in Figures 1, 4 and 8 (Plates 4, 6 and 7).

In the inner and outer walls of the rim, the vegetation differs from that of the datum plane and, also, from that of the crater floor. This fact is very noticeable because in the slopes of the rim there are *Cactus, sp.,* and *Yucca sp.,* in particular the latter; while in the landscape that surrounds the crater there are *Quercus sp., Pinus sp.,* and carefully cultivated fields. The effort made to cultivate the bottom of the crater implies that it is, also, good sowing ground. The distribution of this particular vegetation, a characteristic of calcareous soil, around the crater rim, is the same in its outer and inner slopes. It could be explained by an explosive phenomenon that overturned layers of the subsoil.

It is also evident in the aerial photographs, shown in Figures 1 and 4 (Plates 4 and 6) that the albedo of the rim is different from that of the surrounding landscape.

The rim is made of unconsolidated and fragmented diverse material. This material is formed by alternate layers of breccia with litics of porphyritic andesite, basalt, perlitic glass, pomez, tuff, volcanic ash and scoria. Some fragments are striated, others contain iron. Rim stratification dips radially outward, as can be seen in the tilted crater walls shown in Figures 5 and 9 (Plates 5 and 7).

The first observation of surface samples shows that the crater is not a doline. It is neither a karst formation, a volcanic cone, a reef, nor a subsidence cauldron. However, we have not yet found any meteoritic fragments.

The crater is very much like Moon craters; its diameter, depth from rim to bottom and rim height, are very similar to those of the Pretoria Salt Pan, for which interesting evidences of its impact origin have been given (Milton and Naeser 1971). The Pretoria Salt Pan is a nearly circular crater. The diameter is about 1,140 m, the floor is 60 meters below the general ground level and the rim is 16 – 60 meters in height.

The Tepexitl crater, also, has similar dimensions and a strong morphological resemblance to Wolf Creek crater, whose origin has been shown to be meteoritic (see for example Dence 1972; Krinov 1966). The Wolf Creek crater has been widely studied as can be seen in the references of O'Connell's (1965) Catalogue. In the SW outer rim of Wolf Creek crater, meteoritic fragments were discovered. Its diameter is 853 meters, it is 46 meters deep and its rim rises 18 – 30 meters above the surrounding desert (Krinov 1963). See Figure 2 (Plate 4).

In accordance with Dence (1965) and Krinov (1963), Tepexitl crater can be classified as a possible simple hypervelocity crater. It is, probably, Quaternary because it has an apparent and raised rim the preservation of which indicates a young age (Dence 1972; Milton and Naeser 1971). Also, the morphology of the crater and the nature of its rim are

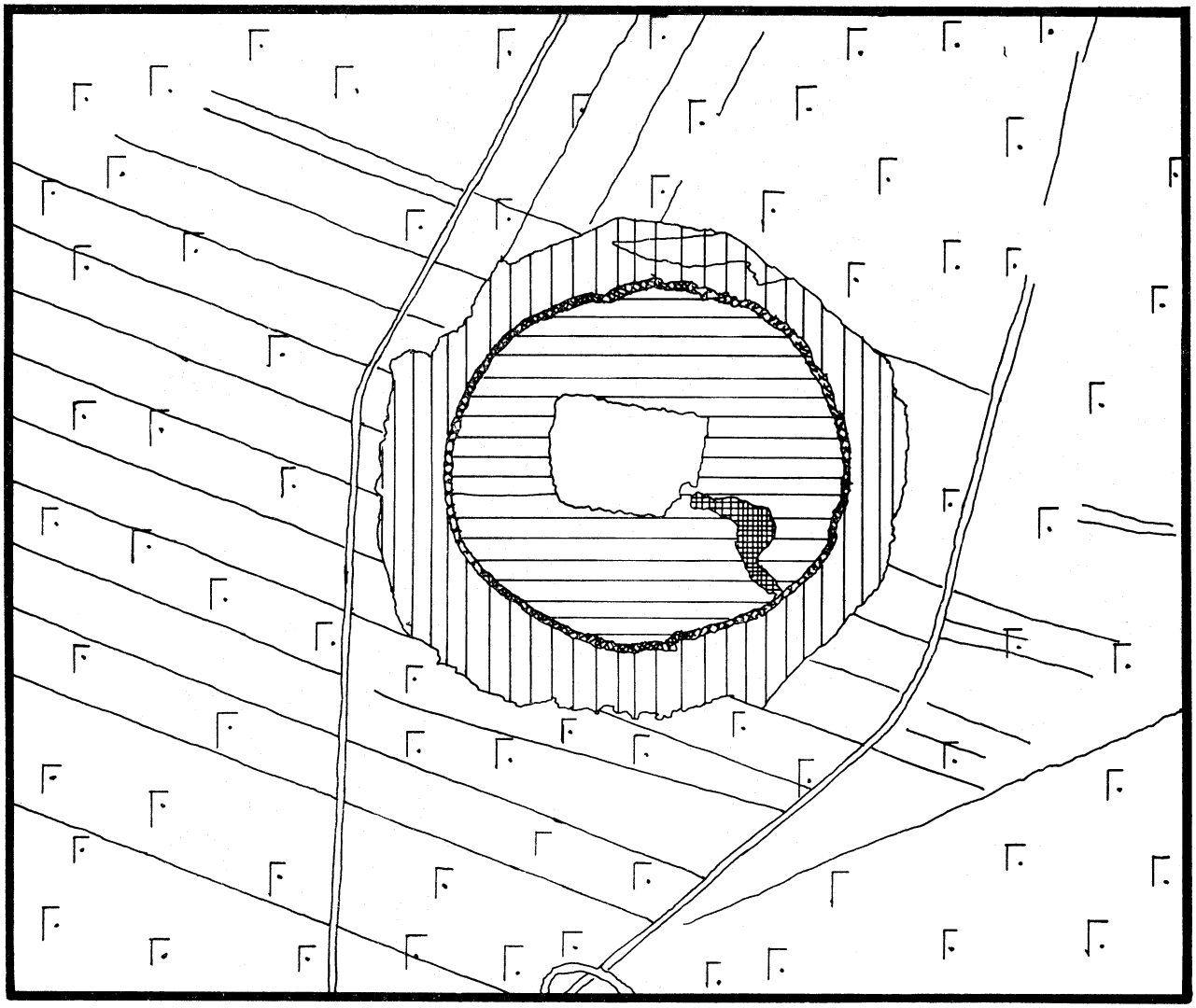

FIG. 6. Elements of the crater.

evidences in favor of an explosive origin which has occurred after the formation of the valley.

This is the first description of Tepexitl crater. The region in which the crater is located had been studied since the last century (Ordóñez 1905, 1906) but the crater itself is not mentioned. This could be due to the fact that it is not easily accesible. To this author's knowledge, there is no mention of this crater elsewhere in the literature.

Tepexitl crater is located at latitude 19°13′ N, longitude 97°26′ W; about 80 km to the E of Puebla City, approximately 15 km to the NNW of Tlachichuca, Puebla.

This region is the western part of the highest peak of Mexico, the volcano Pico de Orizaba.

From a morphological point of view, the crater is an isolated structure. Its elements are described in Figure 6. A comparison of the Tepexitl crater with other meteorite craters is seen in Figure 7.

To the NW of Tepexitl crater are Las Derrumbadas, twin peaks 800 meters high above the datum plane near the crater, whose mean altitude is 2,400 meters. Las Derrumbadas are of ryolitic composition (Ordóñez 1905). They can be seen in Figure 9 (Plate 7).

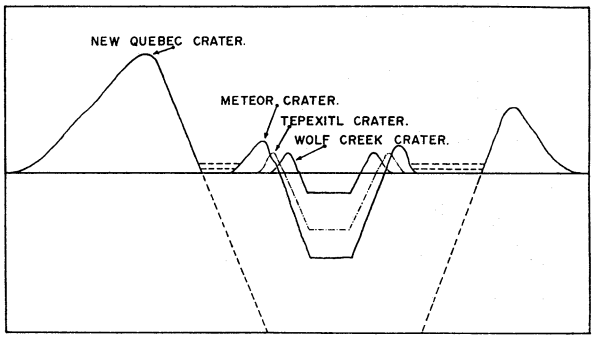

FIG. 7. Size of Tepexitl crater compared with that of Meteor Crater, New Quebec crater and Wolf Creek crater. Vertical scale is exaggerated. Adapted from Meen (1951).

To the SE of the crater a folded limestone hill with fossils (rudistes) can be noticed. It is called Cerro de la Campana, Figures 1 and 4 (Plates 4 and 6).

The region is, therefore, volcanic and in it there are many volcanic cones. Also, there are many limestone outcrops and, in particular, several very interesting features named generically Jalapascos or Jalapasquillos, some of which were described by Ordóñez (1905, 1906).

A summary of data obtained is included in Table 1 following the criteria adopted in O'Connell's Catalogue (O'Connell 1965) to describe these structures.

TABLE 1

DATA OF TEPEXITL CRATER

Characteristics	Description
Name	TEPEXITL CRATER, Mexico
Location	19°13′ N, 97°26′ W, about 1 km NNW of Tepetitlán Farm and about 15 km NNW of Tlachichuca, Puebla.
Number of craters	One reported now, others under investigation.
Size	*Diameter* / *Depth* / *Rim Height* 3,868 ft / 213–303 ft / 60–115 ft 1,180 m / 57–92 m / 18– 35 m
Age	Quaternary
Evidence	Circular crater with raised, overturned rim, similar to known meteorite craters, mainly to Wolf Creek crater and to Pretoria Salt Pan. No meteoritic material has been found.
Remarks	Proposed by Maupomé in 1972 as of probable meteorite origin when first seen in an aerial photograph taken in 1959. The site was localized on March 1973, after four months of search. The crater has an interior radial ridge that is neither a central peak nor an anular feature. Laboratory tests are in process. Its original name is Jalapasquillo de Tepetitlán.
References	
First	Maupomé, 1973. Preliminary results presented on August 1973, to Commision 22, International Astronomical Union. This crater is not mentioned in any Meteorite Crater's literature (Baldwin 1949; Krinov 1963, 1966; O' Connell 1965; Millman 1971; Dence 1972). Nor is it mentioned in a description of the region in which it is located (Ordóñez 1905, 1906).

III. DISCUSSION

There is only a small number of known meteorite craters of large size on the Earth, therefore, it is very important to study the possibility of the meteoritic origin of structures of explosive nature. In fact, Commission 22 of the International Astronomical Union, at its XV General Assembly held in Australia in August 1973, recommended that the investigation of this crater be continued.

The results obtained, so far, are in accordance with some of the criteria proposed to decide in favor of a possible meteoritic origin of the crater (Millman 1971; Dence 1972; Krinov 1966 and others). It is a bowl-shaped and nearly circular structure, of explosive origin, with a raised overturned rim, similar to known meteorite craters. The slopes of its inner wall are steeper than the outer rim slopes. The nature and composition of the rim, the outward tilting of the crater walls and the dips of its strata are evidences supporting our suggestion that this structure is of possible explosive meteorite origin.

We should mention that the possibility of a non-meteoritic origin for Tepexitl crater still exists. One of the strongest arguments in favor of this possibility is that it is located in a volcanic region. Another argument is the fact that it forms part, apparently, of the group of Jalapascos (Ordóñez 1905, 1906), those similar structures mentioned above, some of which have been proposed as maars (Shoemaker 1962; Ohngemach 1973) propositions that do not include Tepexitl crater.

The comparative studies of Tepexitl crater with those of undoubted volcanic cones, and with the other features that also exist in the region will help us to decide whether or not a volcanic origin can be ruled out.

The study of some other craters in this same region, which have called our attention, was started at the same time as our investigation of Tepexitl crater. The means used to study the other craters were a topographical survey, surface geology and photographic recording of the sites. A stereoscopic inspection of aerial photographs of the region, has revealed some other interesting sites in the neighborhood of Tepexitl crater. Some of them had already been visited in our field expeditions. Further results of this research will be published in the future. This investigation will, also, help to finally establish the origin of Tepexitl crater itself and to establish the origin of the other sites that are now under our investigation.

It is important to note that in the past the explosive structures on Earth (some maars and cryptoexplosive sites) were thought to be of volcanic origin; however, no convincing evidence has been advanced to confirm such a proposition. Furthermore, recently Storzer *et al.* (1971) have shown that Ries Kessel and Steinheim Basin, formerly described as cryptovolcanic formations of volcanic origin, are indeed of meteoritic origin and are related with a third structure, the Stopfenheim crater.

These possibilities lead, again, to the long-standing world-wide discussion about the origin of all of those craters on the surfaces of the Earth and the Moon.

The geological studies were made by geologist M. F. Campa de Alvarez, Instituto Mexicano del Petróleo. The topographical survey was made by A. Rayo.

This work was carried out due to the effort and enthusiasm of a group of young colleagues of the Instituto de Astronomía: J. Cantó, J. Fierro, A. Lazcano, Z. Malacara, J. Quisbert, M. Rosado and M. Tapia.

I would like to thank Drs. P. Pishmish, M. Peimbert and G. Massieu for their encouragement as well as for many fruitful discussions.

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