Reinvestigation of the Bee Bluff Structure South of Uvalde, Texas, 'The Uvalde Crater.'

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Introduction: After a careful, detailed, on-site study of an area near Bee Bluff on the Nueces River in 1979, Wilson and Wilson proposed that the strongly-geologically-disturbed area was a probable impact crater [1]. Four subsequent investigations found evidences of PDF in quartz on-site and at distant locations, but limited data were available that could be directly connected to the local structure [2-4]. The Bee Bluff Crater was removed from the worldwide crater database in November 2003 [5].

Recent on-site study, new samples, calculations, and analysis reported in the present work supports interpretation of the Bee Bluff Structure as an impact crater

Crater site: The crater site is located approximately 20 km south of the city of Uvalde in Zavala County, Texas. It is generally about four km south of the Nueces River High Bridge, and east of Highway 83 between the highway and the Nueces River. Except for the locally disturbed geology there is little, if any, topographic evidence for a crater.

Local geology: The geology immediate to the site was described in detail by Wilson and Wilson [1]. The Geologic Map of Texas [6] shows the crater area to be an isolated island of exposed Carrizo Sandstone with Quaternary Terrace deposits to the south. Indio formation lies generally to the east of the Nueces and is also sparsely distributed throughout the region.

On the east side of the site, the Nueces River cuts through the area beside-or-in the crater and exposes about a one-meter cap of a hardened Indio rock that is underlain by a few-cm thick, nonmagnetic iron-rich mineral, and a soft, loosely-consolidated, ten-meter thick Indio formation. Underneath the soft material exposure, a hard formation is exposed on which the river flows; no sandstone is exposed on the crest of the bluff, termed 'Crater Rim Bluff.'

Deep, disturbed terrain down to 0.8 seconds is shown in a seismic line along Highway 83.

Based on all exposed sandstone breccia including uplifted sandstone blocks south and immediately southwest of the site and other breccia proximal to the site, sandstone overlaying the Indio appears to be one-to-two meters thick.

Given the approximate one-meter thick layers of Carrizo Sandstone and hard Indio formation rocks, a meteorite would fully penetrate the hard caps, leave the white, low-density Indio formation exposed, and expel Indio dust over a wide area. A crater in such a soft material would fill at a rapid rate.

As reported by Jurena, et al [3] and confirmed by the present authors, a central area of white exposure is shown on aerial photographs. The aerial photographs also show a pronounced light colored area in the cultivated area south of the crater, likely a concentrated area of ejected Indio dust. The terrace above the river in that same area is covered with perhaps a meter thickness of a fine-grained, whitish dust.

Calculations: Meteorite-impact conditions and resulting crater dimensions were studied with the Internet-based computer code of Collins, et al [7]. Based on a final crater size of about 2.4 km, and an observed melt-thickness of a few cm, the calculations are found to be consistent with an 80-meter diameter iron meteorite entering the atmosphere at an angle of 45 degrees at a velocity of 17 km/s. The meteorite is expected to fragment and impact at 12.7 km/s over an area of about 400 by 350 meters; no vaporization is predicted. Although details of the fragmentation are not accurately known from the calculation, fragment sizes of several tens of meters would be expected.

The Wilson investigation found thrust-faults and chaotic-terrain at locations 5 km from the impact site. The calculated Richter scale 5.8 earthquake resulting from the impact is sufficient to trigger such faults, particularly in the soft Indio.

Hugoniot calculations: Based on the shock-velocity, particle-velocity relations for iron, Brown, et al. [8], and for Coconino sandstone, Ahrens et al [9], an iron impact at 12.7 km/s produces an impact pressure of 300 GPa (3 mbar), with a target-penetration velocity of 9 km/s. Temperatures certainly exceed melt temperature for all local target materials after release of pressure.

It is important to recognize that the thin cap of high-density rocks would receive prompt high pressure release waves from the low-density Indio below the hard cap. Local to the penetration, radial release waves of large magnitude would substantially alter the physical conditions controlling impact metamorphism; prompt release results in prompt melting.

The high-shock impedance rock cap would also be expected to concentrate and channel the high-pressure waves moving radially outward from the impact sites. At the edge of the sandstone formation on the south side of the site uplifted sandstone blocks are numerous. Located near the shock-impedance change, high-pressure waves reflected back into the sandstone would be expected to cause the observed uplift. The blocks are thus perhaps best identified as autothronous.

Impactite samples: A scientifically rich assortment of samples has been recovered proximal to the crater site. Most of the samples have been recovered from the Torres RediMix site south and east of the crater location. In preparing this work site, Mr. Torres pushed the overlaying layers of rock into the center of his work area. Here a rich assortment of Indio and Carrizo sandstone breccia are present. Immediately west of this site, across the road, an array of sandstone breccia are located along the fence, having been removed from the cultivated field. Several key samples are recovered from below Crater Rim Bluff where they have fallen from the upper terrace due to river erosion of the soft Indio.

The Wilson investigation had previously found a large field of nonmagnetic, iron-rich samples with mottled surfaces. They are also found at both the Torres and Crater Rim Bluff sites. They are very dense and sufficiently hard to scratch glass; the samples show features not previously observed in sedimentary structures.

Polyclast, polymict samples of low-density are abundant. These samples are apparently Suevite. The high-porosity of the Uvalde Suevite likely results from the vaporized, hydrated iron oxide minerals.

An extraordinary 300-kg impact-metamorphized, breccia sample was discovered at the Torres site. This breccia contains features directly attributable to distinguishing features of impact-induced, high-pressure and high-temperature shock compression. The processes of melting; modest lithification; strong lithification; and chaotic high temperature clast mixing are evident. Impact and bottom surfaces are clearly delineated.

An amazing aspect of the 300 kg sample is a cavity within which spherical vapor condensates rest on the bottom surface.

Prominent among the samples are numerous nonmagnetic, iron-rich structures (hematite streak) initially sited between the sandstone and hard Indio. Located within two-meters of the impact surface, they would certainly have experienced temperatures greater than melt. The melted iron-rich structure (hematite streak) is typically found on top of the Suevite.

As the 300-kg sample preserves the local history of the shock-compression processes together in their configuration during the impact processes, we identify the sample as 'The Uvalde Impact Crater Rosetta Stone.' The geological history of perhaps a billion nanoseconds, ballography, is recorded there. ('Ballo' is the Greek prefix for shock or impact.)

Conclusion: It should be emphasized that the locally-disturbed geology is unlike any other sedimentary structures studied by the second author over a long, career in sedimentology. Almost, if not all of the presently observed deformation, is post depositional.

The rich array of impactite samples of the present work, along with previously observed quartz PDF structures show clear, distinct evidence for the impact of a small iron meteorite. Detailed study of the Uvalde Crater Rosetta Stone promises to provide extraordinary detail on shock-compression processes in small craters. The thin, hard cap, nearby planar edges of the target formations, and fragmented impacts are critical features for identification of the structure as an impact crater.

References:

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