SINKHOLES REVISITED: THE ACTIVE FEATURES SURROUNDING METEOR CRATER ARIZONA.

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Introduction: Active sinkholes surrounding Barringer (Meteor) Crater have been reported for several years [1, 2]. Numerous cavities, depressions, incipient depressions, and closed basins are scattered over the entire area and several distinct sinkhole styles can be recognized. A regional system of joints and parallel fractures influences canyon and stream geometry, and is thought to be responsible for the squared outline of the crater itself [3]. Sinkholes discovered thus far appear aligned with, or enhanced by, these regional fractures.

Four sinkhole zones: Distinctly different forms of sinkholes or surface depressions have developed on the open ground around the crater. In this report we recognize four general areas; northern closed basins, southern funnel piping, eastern and southeastern deep fissures, and western flank near-surface fissures.

North basins: North and northeast of the crater dry channels empty into broad closed basins where spring snow melts and brief summer sheet washes quickly perculate into the porous ground.

South funnel piping: Numerous shallow depressions 1m-3m wide in this area are probably incipient or temporary sites of subsurface sediment removal. A cylindrical vegetated pit 2m deep and 2.5m wide was first brought to our attention by elk hunters in 1998. Over the next few years it grew into a 10m wide shallow funnel (Figure 1, top) with a 0.5m opening draining the bottom. The funnel has continued to widen to a 60m diameter swatch of barren soil surrounding a 2.5m deep steep walled pit about 7m wide. This particular sinkhole is remarkably dynamic. It has filled nearly-completely with fine grained sediments and then drained again (Figure 1 Bottom). The drain hole apparently connects to a buried fracture network, faintly visible on aerial & satellite images, which intercepts the deeply incised Canyon Diablo, a few km to the west.

East and southeast deep fissures: Several steep walled trenches and fissures occur in the red Moenkopi formation east and southeast of the crater. The most prominent example, about 7.5km SE of the crater rim, was detected from a light aircraft [1] and later examined on the ground (Figure 2). The rimless pit is 2.5m wide by 6m long and of unknown depth. To protect livestock, ranchers attempt to plug the gap with farm debris, but the pit fails to remain filled. In addition, a channel etched into the northern wall indicates the sinkhole flushes into a deeper freely flowing reservoire.

Figure 1. (N34.9785, W111.0260) Top to bottom, the southern funnel sinkhole grows over time. South flank of Meteor Crater (top photo) appears in the distance.

Western Flank Fissures: The broad plain sloping gently westward from Meteor Crater is cut by the northward draining Canyon Diablo and is composed mostly of Kaibob dolomites and mixed crater ejecta debris. A thin cap of brittle carbonate is often cracked into a series of parallel, northwest trending surface fractures (Figure 3). Beneath these surface fissures are numerous depressions which appear to channel surface waters into deeper fracture networks leading north-

westward and into Canyon Diablo. A prominently visible suface fissure (Figure 3, both photos) leads westward downslope to where it is intercepted by a long-established reliable water well. Dark rectangle in distance is a surface storage tank, San Francisco Mountains form a jagged horizon more than 60 km away.

Figure 2. Southeastern deep fissure sinkhole. The chasm is 2.5m wide by 6m long. Depth is unknown. Top photo: view to WNW, bottom view to ESE. (N34.9785, W110.9573).

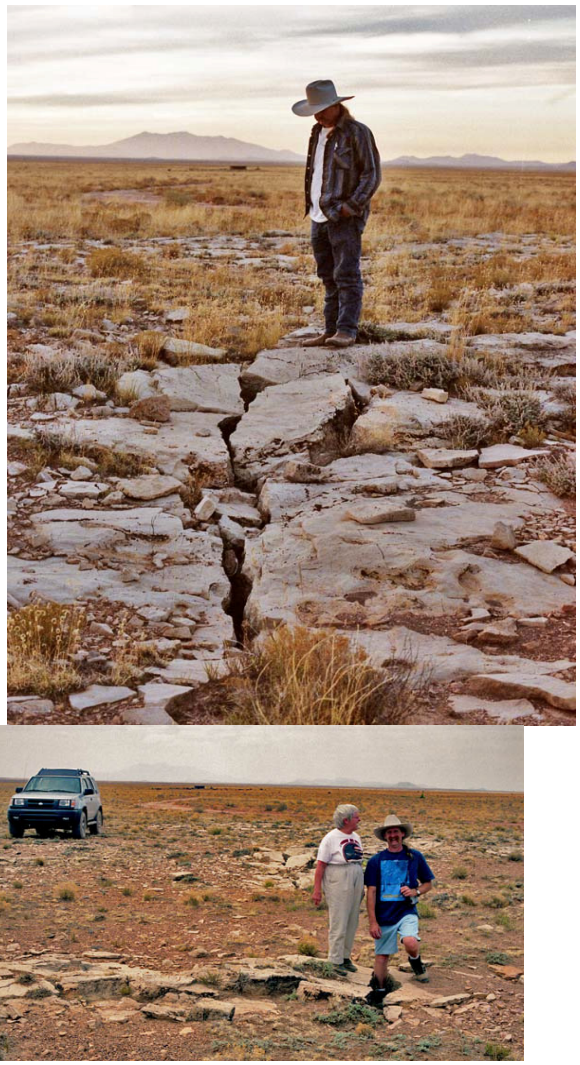

Figure 3. West flank fissures: Linear fractures in the thin capping carbonate (N35.0263, W111.0593).

Conclusions: Impact craters are potential shelters for life forms on otherwise barren planetary surfaces. Meteor Crater's protected mobile subsurface is an accessable analog for possible biological habitats.

References: [1] McHone J. F., Killgore M., and Roddy, D. J. (2002) Active sinkholes at Meteor Crater Arizona. *Meteoritics & Planetary Science*, vol. 37, p.A97. [2] Billingsley, G.H., Block, D., Hiza Redsteer, M. (2014) Geologic map of the eastern quarter of the Flagstaff 30' x 60' quadrangle, Coconino County, northern Arizona. *USGS Scientific Investigations Map: 3279.* [3] Shoemaker, E.M. and Kieffer S.E. (1974) *Guidebook to the geology of Meteor Crater, Arizona*. Arizona State University Center for Meteorite Studies Publication 17, Tempe AZ, 66pp.