SUSPECTED EARTH IMPACT SITES (SEIS) – RECENT DEVELOPMENTS AND REMOTE SENSING INVESTIGATIONS. D. Rajmon[1] and B. Shaulis[2], [1]Shell Int'l. E&P (Houston, TX, david.rajmon@shell.com), [2]University of Houston (Houston, TX).

Introduction: The Suspected Earth Impact Sites database [1] contains basic data for over 600 proposed impact sites classified in several categories according to available evidence and perceived probability of impact origin. The strength of the database lies in the amount of collected data and in the rigorous documentation of the data sources. New updates of the database are published several times a year. The development of SEIS began with rapid collection of the proposed structures from various published databases and "exploration" papers. Majority of these publications lack detailed documentation of their data sources and many original proposals are poorly supported. The more recent development of SEIS has therefore focused on detailed documentation of original published data sources, improvement of data accuracy and precision, and assessment of the probability of impact origin. Currently, about half of the sites listed in SEIS has been reviewed and contains at least some references to the original publications. Recently discovered compilation of proposed impact structures by [2] appears to be the source of data for various published databases. The reference to this paper thus provides link to the original references for the majority of the remaining structures in SEIS.

Impact proposals for a large number of the listed structures are often based on their circular shape or other vague observation without any detailed information or even the most basic considerations of alternative origin. With the advent of various internet applications bringing large remote sensing datasets at our fingertips almost anyone can rapidly investigate the basic geological characteristics of these proposed structures. Our initial trials showed that even a small amount of work put in basic geological screening can reject a number of these proposed impact structures. This work can be an excellent exercise for geoscience students.

Method: We studied several structures proposed by [3, 4] based on circular appearance on X-SAR and visible satellite images, and several structures proposed by various authors. We verified the location of the X-SAR structures through personal communication with R. Gorelli. We used satellite optical imagery (available through Google Earth, Terraserver etc.), digital elevation model (Google Earth), satellite radar imagery (X-SAR data from http://isis.dlr.de) and internet searches.

Results: *X-SAR 14a (lat. -27.625°, lon. 16.186°).* [3, 4] considered the structure of certain impact origin; published diameter 3.77 km, age 3.7±0.3 Ma asigned based on an assumption that the structure formed at the same time with nearby Rotter Kamm impact structure. Our observations: A dark oval feature 3.5 by 4.5 km in diameter on X-SAR (radar) data mantling a linear ridge. Satellite image and DEM data reveal a linear ridge with a cliff up to 60 m tall, surrounded by a mantle with a surface sloping down radially away from the ridge, dropping additional 80-100 m of elevation from the base of the cliff. The extend of this morphological mantle coincides with the dark mantle on the X-SAR image. This mantling feature is best interpreted as a colluvium (an appron of material eroded from the ridge). The rock forming the ridge appears the same as the rock forming a cliff front parallel to the ridge and located ~5 km to the NE. The cliffs display morphology and a colluvium mantle of the same scale and appearance on both the satellite radar images as the proposed impact structure. These observations clearly rule out impact origin of this feature.

X-SAR 11 (lat. 32.356°, lon. -112.865°). Less than 1.1 Ma age was estimated [3, 4] based on geological and geographical considerations without further explanation. We found that this location is actually an open pit mine in Ajo, Arizona, USA.

X-SAR 1 (lat. 31.325°, lon. 15.672°). Proposed by [3, 4]. The feature is a broad topographic high on a coastal plain surrounded by a circular valley, with two streams flowing from SW side of the structure around the topographic high in opposite directions. The relative relief between the valley and the structure center is ~20 m. The diameter of the valley is ~16 km. Another feature with very similar characteristics is immediately to the SE (lat 31.233, lon 15.769) and with a diameter 8.5 km. We could not find any other similar structure. These features, however, do not show any other characteristics pointing toward impact origin and they could just be a result of interplay of regional tectonic style and river erosion.

X-SAR 17 (lat. 59.064°, lon. -97.549°). A circular lake 1.6 km in diameter. Our investigation did not find any additional evidence for, or against, the impact origin.

X-SAR 16 (lat. 56.406°, lon. -102.99°). The structure turned out to be the confirmed impact structure Deep Bay.

El Baz (lat. 24.2155°, lon. 26.3995°). A circular crater, about 4 kilometers in diameter found by [5] in Landsat images among the linear dunes of the Great Sand Sea, Egypt. "The crater lies on Nubia series sandstone, it has a sharp and crenulated rim crest, a terraced wall, a discontinuous inner structure (approximately 1.6 kilometers in diameter), and a few rim blocks" [5]. [5] noted partial erosion of the rim, rough textured deposit up to 2 km beyond the rim in the NE qudrant and mentioned that the structure could be an impact crater or a diorite intrusion. Various publications mentioning the Nubian sandstone place it in the Lower Cretaceous, the base of the lower Cretaceous calibrated with [6] thus sets the maximum age of the structure at 145 Ma.

Inspection of the satellite images and elevation data on Google Earth did not find any evidence for terraces in the wall. The rim appears rather irregular in a map view and rounded in a side view, particularly SE quadrant coud be described as lobate (3 lobes). The material in this SE quadrant appears dark similar to the rest of the rim and to other knobs is the surrounding area creating an impression of a low shadowed terrain inside an elevated rim. In fact, the whole SE quadrant is elevated relative to the rest of the structure and to the apparent rim. Lighter material covers the lower lying parts of the structure, eolian sediment forms sparse dunes on the elevated SE quadrant and mantles on the outside thinly at the slope heel. The parts of the SE quadrant edge eroded to a greater depth are located closer to the center of the structure. If this was an eroded rim of a crater one would expect much smaller step out of the rim line and outward rather then inward the crater. There is a large number of similar circular, irregular and lobate structures in the surrounding area over 150 km away from the El-Baz structure. Those typically have a flat, smooth interior and a low rising rim. While these rims are sometimes higher than the interior, often the rims appear to mark an edge of overall elevated interior. These are often acompanied with knobs of a dark material, similar to the one found in the El-Baz structure. El-Baz and all other similar structures thus appear to be a result of some other process than impact, perhaps volcanic or hydrothermal. However, see the recently investigated Gilf Kebir crater field [7], which correspods to the areas east and south of the El Baz structure.

Uri (lat. 21.288°, lon. 19.343°) and Oun (lat. 21.741°, lon. 19.345°). Impact origin proposed by E. González (pers. comm., 2006) on the basis of morphology as visible on satellite images. Uri consists of two concentric oval ridges separated by a through. The outer ridge has a diameter ~5 km. Subdued concentric pattern extends beyond the outer ridge with maximum diameter ~11 km. Oun consists of two concentric ridges forming an oval core with an overall positive topography surrounded by a concentric ring trough filled with sand and an outer discontinued ring ridge. The crest of the outer discontinued ridge has a diameter 9 km. Several linear features in the vicinity appear to have a positive morphology, some radial to the structure, some following regional fracture pattern. They may be volcanic dykes. The regional fracture pattern appears radially and tangentially oriented to an erosional remnant of another two circular structures ~30 km to the north of Oun, strongly suggesting origin via loading of crust with massive volcanoes. There are also many smaller and much less eroded volcanic cones to the west of Uri. Both Uri and Oun structures thus appear to be eroded stratovolcanoes.

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