SEARCH FOR POTENTIAL IMPACT CRATERS IN CHINA. Zhiyong Xiao\textsuperscript{1,2}, 1China University of Geosciences (Wuhan), 2Macau University of Science and Technology (zyxiao@cug.edu.cn).

Introduction: It is well realized now that impact cratering is significant to the evolution of the Earth system, such as the origin and future of human civilization, triggering of plate tectonics, and benefits to economic geology [1]. Due to the fast surface weathering rate and active plate tectonic on the Earth, only 191 impact craters have been discovered on the Earth, and most of them are preserved in areas that have been relatively stable during the last ~2 billion years [2]. So far, only the ~1.8 km diameter Xiuyan crater has been discovered within the China mainland [3], an area occupying ~6.4% of the Earth’s surface. The distribution of the presently identified terrestrial impact craters, and the cratering history of the inner solar system bodies [4] indicate that many more impact craters, especially those less than ~6 km should be preserved at Earth’s surface [5]. Besides possibly buried impact structures, Hergarten and Kenkmann [6] estimated the possible number of preserved impact craters on the Earth’s surface, and their method yielded about 13–20 additional impact craters with diameters ranging from a few hundred meters to about 6 km that should be exposed at the surface within China.

Indeed, several structures in China have been interpreted to be impact craters [7] based mainly on morphological similarities, i.e., negative topographic features that have circular or quasi-circular rims. The impact origin of the Taihu Lake ($D$=65 km) was proposed based on its quasi-circular morphology [8]. Although hypothesized shocked quartz and shatter cones have been reported [e.g., 9], their identities are not well accepted [10]. The Longdoushe ($D$=3 km), Duolun ($D$=170 km), Baisha ($D$=3.5 km), Shanghewan ($D$=30 km), Hong Kong granitic arc ($D$=11 km), and Luoquani ($D$=1.8 km; [11]) structures are other quasi-circular structures that have been suggested to be impact craters in China, among which only the Luoquani structure has been confirmed, now named as the Xiuyan impact crater, after drilling found planar deformation features in quartz [3].

A research project granted by China University of Geosciences (Wuhan) and lead by the author is to search for potential impact craters in China. Here the logic of performing the search and preliminary results are introduced.

Crater hunting method: The search strategy in our project is to assume that all circular structures are not formed by impact cratering, and our work is to rule out the other possibilities to recognize high-possibility examples.

The first step of the project is to review previously suggested potential impact craters in China using updated regional geological data and new high-resolution remote sensing data. The second step is to search for other circular structures in remote sensing software such as 91MAP (currently GoogleEarth is not accessible in China mainland; 91MAP is a powerful tool that can easily load different online data sources). Several basic criteria have to be referred before evaluating the likelihood of an impact origin, for example: (1) the unique occurrence of similar-sized circular features; (2) high-resolution satellite images (e.g., ArcGIS online) and topography data (e.g., ASTER) could confirm the circular morphology and 3D topography; (3) distinct vegetation or surface roughness compared with areas outside of circular feature; (4) radial or concentric distributed river, faults, or vegetation. If a candidate can pass all these basic criteria, regional geological maps (mainly 1:250,000 and occasionally 1:50,000) and mapping reports are referred to study the interior and exterior strategy, lithology, and structural deformation. Regional geological background is critically important, and has been successfully used to exclude a large number of beautiful folding structures. Finally, if laboratory study could not completely rule out the impact origin, field investigations will be arranged. In general, this strategy is similar with that used in the course SCREENING EARTH taught by Thomas Kenkmann et al. [12] at the University of Freiburg. The third step, which is carried out together with the second step, is to study interpreted seismic data from oil companies, which previous studies have used these data and found a possible buried impact crater at Xinjiang.

Negative potential impact craters: So far, all the previously interpreted impact structures have been reviewed, and none of them is likely to have an impact origin. 6 of these craters have been visited via field investigations and sample analyses. Two negative cases are shown below.

The Duolun basin is the largest one (diameter ~70 km; Fig. 1) among the proposed impact structures in China. It is located at the boundary between the Hebei province and Inner Mongolia. Three potential topographic rings have been interpreted, and impact breccias, impact glass, and thick impact melt sheets have been reported both within and outside of the basin [13]. However, their identities were purely based on morphological study, and have not been tested against methods used in modern Earth impact crater study. Two independent field trips and sample analyses were conducted to the Duolun basin by a German and Chi-
The results show that the abundant igneous materials are uniformly late Mesozoic volcanic materials, and the circular morphology is likely the remnant of a previous volcanic caldera, or it can be formed by a combination of tectonic and volcanic activity [14].

Mongolia. This feature was first noticed by previous mining surveyor. With intact but broad elevated rims, the present rim-to-floor depth is 8–20 m. Regional geological background and geomorphological comparison suggest that this feature is likely not formed by processes such as salt diapir, karst, aeolian, glacial, or volcanic activity. Its unique occurrence in this region and the well-preserved morphology are most consistent with being a Cenozoic impact crater. Two field expeditions to this crater employed both drones and iron detector did not find conclusive evidence for the impact origin, such as shock metamorphic features and iron-rich meteorites [17].

**Fig. 1.** Digital elevation map of the Duolun basin shown by SRTM data [14]. The black curves mark the previously interpreted rings.

The ~4 km diameter Baisha circular structure in Hainan has been regarded as an impact crater. Shatter cones, impact melt bearing breccia, column joints of melt sheets, and meteorite remnants are reported from this crater [15]. However, field investigation found that this opera-shaped negative depression (Fig. 2) is actually formed by the different erosion rates between the Cretaceous sandstones and lately intruded Granite porphyries. Regional stratigraphy study suggests that the hypothesized impact cannot be younger than the exposed sandstones, but the sandstones exhibit uniform altitudes through the surface to a depth of >200 m, which has been verified by recent drilling project [16].

**Fig. 2** The Baisha structure at Hainan.

**The Most promising case:** The Hailar potential impact crater is so far the most promising candidate that have been studied (Fig. 3). It is a circular depression with a rim-to-rim diameter of about 300 m at Inner Mongolia. This feature was first noticed by previous mining surveyor. With intact but broad elevated rims, the present rim-to-floor depth is 8–20 m. Regional geological background and geomorphological comparison suggest that this feature is likely not formed by processes such as salt diapir, karst, aeolian, glacial, or volcanic activity. Its unique occurrence in this region and the well-preserved morphology are most consistent with being a Cenozoic impact crater. Two field expeditions to this crater employed both drones and iron detector did not find conclusive evidence for the impact origin, such as shock metamorphic features and iron-rich meteorites [17].


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