Journal of African Earth Sciences 112 (2015) 339–352

Contents lists available at ScienceDirect

Journal of African Earth Sciences

journal homepage: www.elsevier.com/locate/jafrearsci

Prospecting for possible impact structures in Morocco

Souad Chaabout [a, *], Hasnaa Chennaoui Aoudjehane [a], Wolf Uwe Reimold [b, c], David Baratoux [d, e], Nasrrddine Youbi [f, g]

[a] Hassan II University Casablanca, Faculty of Sciences, G. A. I. A. Laboratory, BP5366 Maârif, Casablanca, Morocco
[b] Museum für Naturkunde Berlin, Leibniz Institute for Evolution and Biodiversity Science, Invalidenstrasse 43, 10115 Berlin, Germany
[c] Humboldt–Universität zu Berlin, Unter den Linden 6, 10099 Berlin, Germany
[d] Géosciences Environnement Toulouse, University of Toulouse, Institut de Recherche pour le Développement & CNRS, 14, Avenue Edouard Belin, 31 400 Toulouse, France
[e] Institut Fondamental d'Afrique Noire Cheikh Anta Diop, Dakar, Senegal
[f] Department of Geology, Faculty of Sciences-Semlalia, Cadi Ayyad University, Prince Moulay Abdellah Boulevard, P.O. Box 2390, Marrakech, Morocco
[g] IDL-FCUL – Instituto Dom Luiz, Faculdade de Ciências da Universidade de Lisboa, Campo Grande, Lisbon, Portugal

ARTICLE INFO

Article history:
Received 13 November 2014
Received in revised form
30 July 2015
Accepted 2 August 2015
Available online 6 August 2015

Keywords:
Impact structure
Morocco
Circular structures

ABSTRACT

The current terrestrial impact crater record includes 188 accepted structures (http://www.passc.net/EarthImpactDatabase and Ferrière et al., 2015). This number continues to increase slowly but quite regularly. The heterogeneous distribution of impact structures is strongly influenced by the knowledge about impact cratering of exploration geologists, who have to be familiar with the possible field evidence for impact structures – and ultimately with the recognition criteria accepted for confirmation of new impact structures. For remote and poorly explored areas, satellite imagery is a powerful tool to identify circular structures that, at all scales, could be considered possible candidates for impact structures. Here, we present the results of a first systematic survey of circular structures over the Moroccan surface area (a total of 710,850 km^2) using the imagery available through the Google-Earth software. Structures whose origins could not be elucidated from available geological data were then visited to determine their origin (impact or non-impact). Thirteen sites with one or more circular structures were investigated but none of them could be associated with an impact event. Instead, our results illustrate the diversity of geological processes that can produce circular structures, including magmatic and tectonic processes, bio-construction, and even anthropogenic activity. It also demonstrates that circular structures are very common in surface imagery of the Earth but are generally not associated with impact events. This result questions whether this simple approach for the search of impact structures should be extended to other parts of the world. It also emphasizes that remote sensing imagery should not be used in isolation of other data.

1. Introduction

About 50 years of planetary exploration, in addition to the study of terrestrial impact structures, have demonstrated that impact cratering by asteroids and comets is a fundamental geological process that has affected all bodies of our solar system since their formation (e.g., Melosh, 1989; French, 1998; Reimold and Koeberl, 2014). On Earth, the largest impact structures (Vredefort, Sudbury, etc) are associated with considerable crustal disturbances. Most extreme cases have led to the development of igneous complexes (i.e., impact melt bodies) resulting from the melting of impacted rocks, and at least one impact event has – likely decisively – participated in a major biological extinction: the Cretaceous–Paleogene, (K–Pg) extinction event, also known as the Cretaceous–Tertiary (K–T) extinction, was triggered by the Chicxulub giant bolide impact (Schulte et al., 2010). Impact structures are also of economic interest, as they are sometimes associated with ore deposits or hydrocarbon resources (Reimold et al., 2005; Reimold and Koeberl, 2014).

To date, 188 impact structures have been confirmed on Earth (http://www.passc.net/EarthImpactDatabase and Ferrière et al., 2015), but only 11 confirmed impact structures are currently known in the Arab world (Chabou, 2009; Youbi et al., 2011).

* Corresponding author.
E-mail address: chaabout_souad@hotmail.com (S. Chaabout).

http://dx.doi.org/10.1016/j.jafrearsci.2015.08.002
1464-343X/

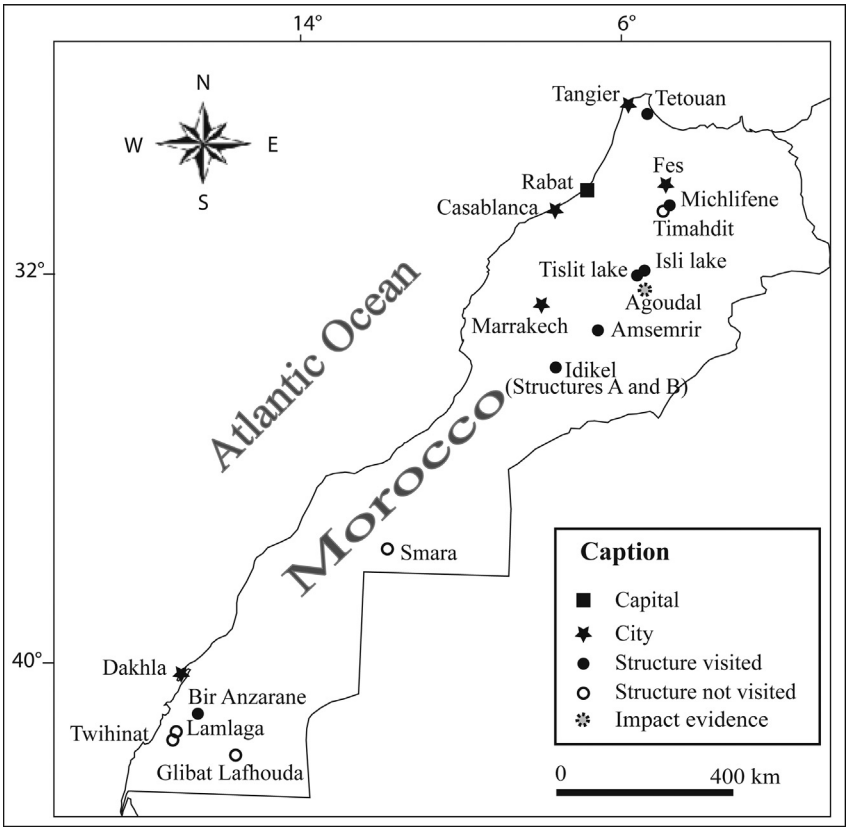

Fig. 1. The geographic locations of 13 sites containing 1 or more circular structures that were investigated in Morocco.

However, there is a considerable number of suspected impact structures, for which confirmation has not been achieved yet. Many of these suspected or confirmed impact structures are buried under layers of sediments, or are deeply eroded. A large number of proposed impact structures is located on the African continent (Reimold and Koeberl, 2014) and awaits field investigations. High-resolution, modern geological mapping of Africa is still far from complete. A further increase of confirmed impact structures on this continent is expected.

Morocco covers a total area of 710,850 km^2, with 266,779 km^2 of

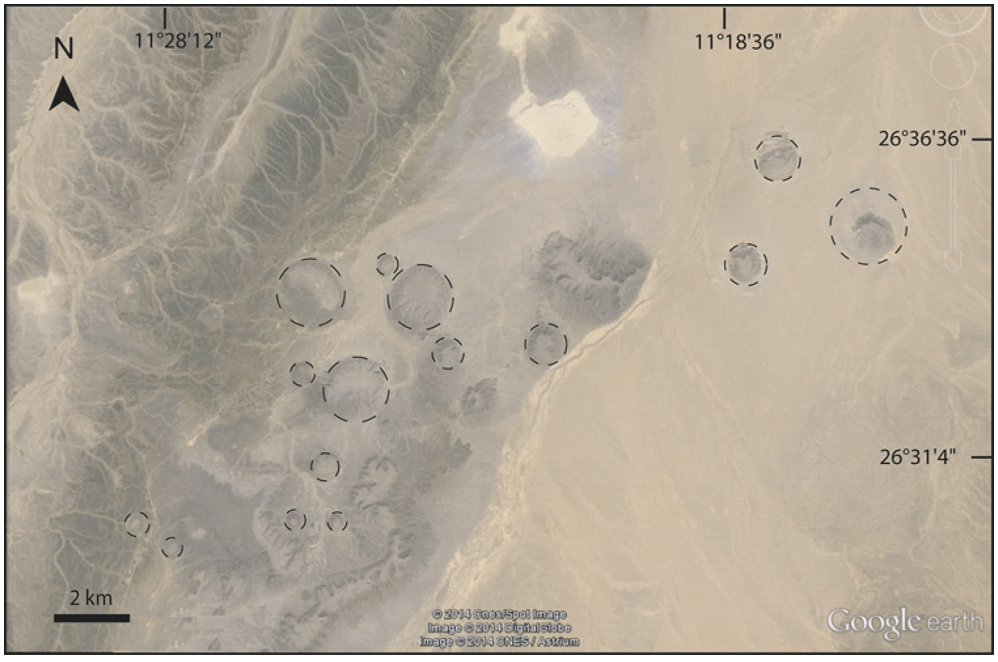

Fig. 2. Google-Earth image of the Smara site showing the 15 circular and sub-circular structures.