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Radiometric signatures of Impact structures: application to impact crater studies in West Africa

Baratoux, D.[1,2], Niang[3], B, Pathé-Diallo[3], D., Ndiaye[3], P.M., Sarr, B.[2], Boamah, K.[4], Bouley[5,6], S., Reimold, W.U.[7,8], Jessel M.W.[9]

[1]GET, University of Toulouse, CNRS & IRD, 31 400, France (david.baratoux@get.obs-mip.fr).
[2]IFAN Ch. Anta Diop, Dakar, Senegal.
[3]Université Ch. Anta Diop, Geology Dept., Dakar, Senegal.
[4]Geological Survey Department of Ghana.
[5]GEOPS – Géosciences Paris Sud, Univ. Paris-Sud, CNRS, 91405 Orsay, France.
[6]Institut de Mécanique Céleste et de Calcul des Ephémérides 7501 Paris, France.
[7]Museum für Naturkunde – Leibniz Institute for Evolution and Biodiversity Research, Invalidenstrasse 43, 10115 Berlin, Germany.
[8]Humboldt Universität zu Berlin, Unter den Linden 6, 10099 Berlin, Germany.
[9]Center for Exploration Targeting, The University of Western Australia.

The surface rock concentrations in K, Th and U may be mapped at various scales by airborne or orbiting gamma ray spectrometers measuring the natural activity of ^{40}K, ^{232}Th and ^{238}U. These data are commonly used for geological mapping and mineral exploration, particularly also for the West African Craton (WAC) where outcrop conditions are poor. Global K and Th maps have also been produced by orbiting satellites for extra-terrestrial bodies (Mars, Mercury, the Moon, Vesta). However, those planetary surfaces are, unlike Earth's, dominated by impact cratering records, implying that surface K, Th and U concentrations may be largely affected by impact processes and impact-generated hydrothermalism (where subsurface volatiles are available). Observations of K – Th – U signatures at terrestrial impact structures are limited to only two cases: Bosumtwi in Ghana [1] and Serra da Cangalha in Brazil [2]. The observed anomalies are not understood, which limits the potential use of this data when interpreting extra-terrestrial radiometric data. K–Th-U concentrations vary over several orders of magnitude in the terrestrial crust. These three elements are considered useful tracers of crustal differentiation and secondary processes, as they are concentrated in melts during magmatic processes, and also are not equally mobile during alteration. Therefore, they may also be good tracers of shock-induced vaporization or melting, shock metamorphism, and impact-related hydrothermal alteration. However, the scientific value of radiometric data for impact research has yet to be demonstrated. Radiometric data are, thus, generally not considered in studies of impact structures or for the search and identification of new impact structures. We are analysing the K, Th, and U signatures associated with impact structures in West Africa (Bosumtwi, Ghana) and Australia (all exposed craters > 1 km where radiometric data are available at various scales. The objectives are 1) to provide new insight into the modification of the distribution of these chemical elements in the terrestrial crust by the impact process itself (e.g., excavation, ejecta emplacement, central uplift formation) and in relation with impact-generated hydrothermal systems; and 2) to derive useful implications for the use of K–Th–U radiometric surveys for the search and characterization of impact structures, with special application to the WAC Craton.

References:

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