POST-IMPACT HABITABILITY AT THE CHICXULUB CRATER.

E.V. Christou[1,2*] and W. Bach[2], [1]University of Glasgow, School of Geographical and Earth Sciences, UK
[2]MARUM, Department of Geosciences, University of Bremen, Bremen, Germany
*(e.christou.1@research.gla.ac.uk)

Introduction: The origin of the primitive life in the Solar system is still unknown, but strong evidence points to a link with impact-induced hydrothermal environments [1]. This research assesses the habitability at the Chicxulub crater for the post-impact period of hydrothermal activity. Several results of numerical simulations and published research [2,3] record the evolution of the impact-induced hydrothermal system at Chicxulub for a period of more than 2Myr. This communication uses their thermodynamic constraints (temperature, pressure, water flux, enthalpy etc.) to construct geochemical reaction paths and to assess the catabolic energy availability for hydogenotrophy in the subsurface realm of the crater. Considering the upper temperature limit for life at 121°C [4], we investigate regions of the broader crater setting (radius=300 km) where habitable conditions could prevail (T < 121°C). [5] quantified the requirements for energetic habitability in various subsurface environments. [6] emphasized further in scenarios where H2 is the main energy source for supporting subterranean life. By comparing the hydrogen availability in Chicxulub with the energetic requirements of a putative hydrogenotrophic community, we finally assessed the post-impact habitability of the crater {Figure 1}.

Methodology - Modelling: [7] suggests that all ocean crust basement rocks release enough hydrogen to support hydrogenotrophic biomass, as the basaltic and ultramafic rocks interact with circulating seawater. Hydrogenotrophic communities have been inferred for oceanic basaltic and ultramafic crust [7,8,9], for granitic [10] and also for mixed mineralogy environments [11]. Hence, we adopted the same methodology and used the Geochemist's Workbench software [12] to simulate the geochemical reaction paths of the impactite dissolution and to compute the dihydrogen release after water-rock interactions in the crater. Finally, the correlation of the hydrogen availability with the energetic requirements of potential hydrogenotrophic communities at Chicxulub determines the habitability of the crater.

Results: The maximum release of H2 is observed at 30-38Kyr. As the hydrothermal cooling commences, only distant outer rim regions are within the habitable range. The hydrothermal system cools enough after 60 Kyr, so that it renders domains close to the peak ring and the central crater basin habitable. After 2 Myr, hydrogen availability in the setting fulfils, not only the survival and maintenance energetic requirements of the hydrogenotrophic biomass, but more significantly the microbial growth. Thus, we suggest the presented model to determine the catabolic energy availability and habitability of other terrestrial or extra-terrestrial impact-induced hydrothermal environments.

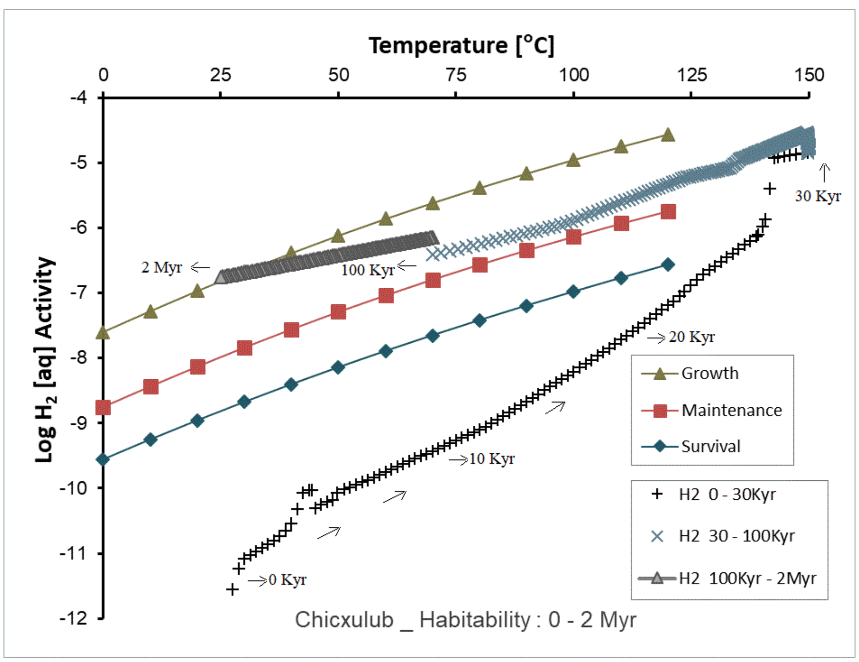

Figure 1. H2 release after impact-glass dissolution and thermal conditions at the Chicxulub Crater, plotted for comparison with the hydrogen demand (after [6]) of hydrogenotrophic microorganisms.

References: [1] Osinski G.R. et al. (2012) *Icarus* 224(2) pp. 347–363. [2] Abramov O. and Kring D.A. (2007) *Meteoritics & Planetary Science* 42: 93-112. [3] Christou E.V. (2018) *University of Bremen* MSc Thesis. [4] Kashefi K. and Lovley D.R. (2003) *Science* 301 (5635):934. [5] Hoehler T.M. et al. (2001) *FEMS Microbiology Ecology* 38(1) 33-41. [6] Hoehler T. M. (2004) *Geobiology* 2: 205-215. [7] Bach W. (2016) *Frontiers in Microbiology* 7:107. [8] Chapelle F.H. et al. (2002) *Nature* 415: 312–315. [9] Edwards K.J. et al. (2012) *Frontiers in Microbiology* 3(8):8. [10] Kotelnikova S. and Pedersen K. (1998) *FEMS Microbiology Ecology* 26: 121-134. [11] Lin L.H et al. (2005) *Geochemistry Geophysics Geosystems* 6(7). [12] Bethke C.M. (1996) *Oxford University Press New York* 397 pp.