

**QUANTIFYING THE RATE OF EROSION OF TERRESTRIAL METEORITE IMPACT CRATERS WITH THE AID OF PALAEOCLIMATE DATA.** Saranya R. Chandran<sup>1</sup>, Devika Padmakumar<sup>1</sup>, Shania James<sup>1</sup>, Varsha M. Nair<sup>1,2</sup>, Subhami Mohan<sup>1</sup>, K.S.Sajinkumar<sup>1,3</sup>, <sup>1</sup>Department of Geology, University of Kerala, Thiruvananthapuram 695581, Kerala, India ([saranyarchandran.geo@keralauniversity.ac.in](mailto:saranyarchandran.geo@keralauniversity.ac.in)); <sup>2</sup>Physical Research Laboratory, Navrangpura, Ahmedabad 380009, Gujarat, India; <sup>3</sup>Department of Geological and Mining Engineering and Sciences, Michigan Technological University, Houghton, MI 49931, USA.

**Introduction:** On the surface of the earth, weathering and erosion are the chief exogenic processes that continuously modify its morphology, affecting both positive and negative relief features. Erosion is chiefly controlled by a combination of several factors such as climate, lithology, slope of the terrain, vegetation, and anthropogenic factors [1]. Rate of erosion of impetuous geomorphological features such as volcanoes and meteorite impact craters can be well documented; but, so far only a limited number of studies exist for the impact craters [1, 2, 3, 4]. As of now a total of ~208 meteorite impact craters are recognized on the surface of the earth [5].

Impact craters that manifest itself in the form of simple and complex craters have positive relief features in the form raised rim and central elevated area (CEA; for complex craters). Over time the raised rim and CEA are subjected to long term erosional processes, which lead to the subsequent wear and tear of the crater morphology. The erosion rate associated with these craters can be quantified by the relief difference between the transient and present-day morphological parameters with the aid of climatic and lithological factors. Palaeoclimate is a major factor determining the state of a crater since it traversed through different climatic realms since its origin owing to tectonic processes.

**Methodology:** The impact craters were selected from the recent literatures [3, 5] and Earth Impact Database. Different parameters such as age, availability of DEM, and the geological province of the craters have been considered in selecting the craters for the study. A total of 22 craters with 11 simple and 11 complex craters are studied here. Palaeoclimate data of the impact craters were obtained using the GPlates software [6, 7]. Rate of erosion associated with the impact craters have been determined using two methods compiling erosion efficacy and relief [2]. Erosion efficacy is a quantitative measure of the extent of erosion of impact craters [2] and the cumulative effect of different climatic zones traversed by each craters have been considered here. Method 1 modified the equation given by Hergarten and Kenkmann [2], taking into account the relief values of primarily three erosive regimes such as shield, orogen and igneous province, where the crater is hosted, and cumulative

erosion efficacy. Method 2 narrowed down the relief features to individual crater morphology. Crater relief has been calculated using a set of crater morphological equations [8, 9, 10, 11, 12]. In method 2 for complex craters, the relief calculations are made by the equations of Grieve and Pesonen [12]. Rate of erosion ( $r$ ) is given as,  $r = \Delta s$  [2], where  $\Delta$  and  $s$  are relief and erosion efficacy, respectively.

**Results:** The simple craters chosen for the study are found to be younger in age and most of them are constrained to single climatic zones, giving more or less accurate erosion values whereas the reverse is observed for complex craters. Temporal extend of each craters in different climatic zones have been compiled. Younger simple craters such as Henbury, Luna, Boxhole, Hickman, Amguid, Lonar, Barringer Tswaing and Pingualuit are restricted to single climatic zones. However, older simple craters like Ouarkiz, Kgagodi, Shunak, and Colônia have traversed through more than one climatic zone. Complex craters such as Zhamanshin, Bosumtwi, El'gygytyn, Bigach, Ries and Steinheim are exposed to single climatic zones whereas Mistastin, Goat Paddock, Beyenchime-Salaatin, Logancha, and Santa Marta crossed multiple climatic zones. In method 1 the highest and lowest erosion rate of simple craters are found for Barringer and Pingualuit craters, respectively whereas among complex craters it is Ries and Steinheim, and Beyenchime-Salaatin, respectively. In method 2, simple craters Colônia and Boxhole show the highest and lowest erosion rates respectively. Meanwhile Bosumtwi crater shows highest erosion rate among complex craters with Bigach crater having lowest value.

**Discussion:** The erosion rates derived from two methods do not show considerable correlation except for a few craters. However within the method 2 similarities can be noticed. Erosion rates are found to be more comparable for younger simple craters confined to single climatic regimes. On comparing with erosion rates of other studies, values obtained for Barringer crater using method 2 stood close to the values shown by Shoemaker and Kieffer [13]. For Lonar crater the calculated erosion rates, using both the methods, are closer, however it is deviated from the previous studies. Boxhole crater show similar erosion

rates in the method 2 with the reported value. For complex craters Zhamanshin and Bosumtwi the calculated erosion rates and reported values are different. Comparing the calculated values with global erosion rates provided by Kenkmann [3] shows that the younger craters are similar to the values provided by Kenkmann [3]. Overall it is estimated that young simple craters shows high values of erosion however old complex craters are showing low erosion rates. Craters in warm temperate climatic zone show high rate of erosion. The erosion rate obtained from method 2 seems more accurate since it is more related to the crater morphology. In method 2 calculations made by the equations of Grieve and Pesonen [12] is more reliable for simple craters. Thus, this study has demonstrated the influence of palaeoclimatic data in deciphering the erosion rates of meteorite impact craters.

Fig. 1. The temporal limit of selected terrestrial simple and complex craters in different climatic zones.

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