DOUBLE AND MULTIPLE IMPACT EVENTS ON EARTH – HYPOTHESES, TESTS, AND PROBLEMS

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Background: At least four double systems of closely spaced impact structures may exist on Earth, namely the Ries-Steinheim crater pair (Germany, ~14.8 Ma [1]), the Clearwater East/West system (Canada, ~290 Ma [2]), the Gusev-Kamensk system (Russia, ~50 Ma [3]), and the Suvasvesi North/South doublet (Finland, <1.88 Ga [4]). On a global scale, the Chicxulub (Mexico) and Boltysh (Ukraine) craters were likely struck within a couple thousands of years around 66 Ma [5], similar to the ~36 Ma Popigai (Russia) and Chesapeake Bay (USA) craters. A giant impact crater chain comprising at least five large impact structures (Manicouagan and St. Martin, Canada; Rochechouart, France; Obolon, Ukraine; and Red Wing Creek, USA) was proposed to have formed at ~214 Ma [6]. Clustering of crater ages suggests that even more of such (meteorite shower-related?) impact systems might exist, e.g., the Ordovician Lockne, Tvären (Sweden), and Kärdla (Estonia) structures (all ~461 Ma [7]).

Recent Data: Evidence for double and multiple impacts on Earth is challenged by various critical factors, most importantly precision and accuracy of impact ages, but also the geochemical fingerprints of the impactor which allow to constrain if one or several types of meteoritic material were involved. Widely considered the 'model' double crater system on Earth, the Nördlinger Ries and Steinheim craters are characterized by a well-established age data set for the Ries, whereas only stratigraphic and some very poor isotopic data are available for Steinheim [8]. Both craters, moreover, seem to feature different impactor traces [9]. Ar-Ar ages notably differ in the case of the two Clearwater structures [10], the ages of which are constrained by Rb-Sr data [2]. Similarly, an Ar-Ar age of >700 Ma for Suvasvesi South [11] is in conflict with two new Ar-Ar results of ~85 Ma for melt rocks from the Suvasvesi North drill core [4]. Re-dating of the Rochechouart (~203 Ma) [7;12] and Obolon (<185 Ma) [13] impacts contradicts the ~214 Ma Late Triassic 'Manicouagan-age' multiple impact event, along with a recent Ar-Ar melt rock minimum age of ~225 Ma for St. Martin.

Conclusions: The alleged terrestrial double/multiple impact crater systems are still questionable. Only a combination of robust impact ages and preferably a consistent set of geochemical impactor trace data can ultimately resolve the existence of doublet/multiple impact crater systems in the geologic record.

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