The Probability for Independent Impacts of the Ries and Steinheim Craters. N. Schmedemann[1], H. Hiesinger[1], [1]Institut für Planetologie, Westfälische Wilhelms Universität, Münster, Germany (nico.schmedemann@uni-muenster.de).

Introduction: During the Miocene two sizable impact craters formed in a region of what is today southern Germany near the city of Nördlingen/Bavaria. Biostratigraphic and radiometric analysis indicated both craters to be of a similar age of about 15 million years [1]. Recent work [2] on sediment layer dislocations due to seismic activity in up to 180 km distance of the impact craters indicates an offset in crater formation time by about 500 ka, which would argue for two independent impacts. Here we approach this issue by cratering statistics and calculate the probability for the case that the two impact craters Nördlinger Ries and Steinheim crater are two independent impacts.

Methodology: For our statistical analysis we use the terran crater formation rate [3]. We assume the impacts occur randomly in time but over sufficiently long time scales at a constant rate, similar to the radioactive decay of instable isotopes and spatially isotropic on the surface of a given planetary body. In this case the Earth. In the cumulative crater frequency, we consider craters equal to or above a certain crater diameter. Thus, in the case of the two craters at hand the smaller Steinheim crater, with a diameter of 3.8 km provides the required crater diameter for the calculation. The terran crater formation rate for this specific crater diameter is not given by [3] but we find values for 1 and 5 km crater diameter and use those values instead. The number equivalent for crater formation rate given by [3] is the mean time interval between respective events worldwide, which can be converted into the number of such craters that formed since the Steinheim/Ries impact events and for comparison the number of craters that formed within 500 ka as given as time offset between both craters by [2]. We further calculate the probability that both craters formed at their observed distance of approximately 40 km as ratio between the area of a circle with radius equal to the distance between the two craters and the whole surface area of the Earth. This ratio is then multiplied with the previously calculated number of at least Steinheim crater sized craters that are expected to form during the given time period. Thus, we find the probability that both craters formed at their observed distance as independent events as a result of random impacts.

Results: For ≥1 km diameter craters we find a mean time interval of 1600 years. The age of the craters is about 14.6 Ma. Thus, we expect about 9125 craters ≥1 km to form worldwide. Now we calculate the probability that one of these craters is forming within 40 km of the other. The area of a circle is calculated as area=π*radius². Thus, for a radius of 40 km we find an area of about 5027 km². The surface area of the Earth is about 510×10^6 km². Thus, we find a ratio of 9.86×10^{-6}. After multiplication with the number of 1 km craters or larger that formed during the last 14.6 Ma, we find a probability of about 9 % that the Steinheim crater and Nördlinger Ries could have formed independently within a distance of 40 km, if only one of them is 14.6 Ma. If we do this calculation with a crater diameter of 5 km or larger we find only 133 craters to form within 14.6 Ma worldwide based on [3]. This converts into a probability of only 0.13 % that both craters formed independently within 40 km distance. Now we add the constrain of a formation within the proposed time offset for both craters of ~500 ka by [2]. The probabilities shrink even further as there formed only 313 craters ≥1 km and 5 craters ≥5 km worldwide. This converts in probabilities of ~0.3 % and $\sim5\times10^{-3}$ % for ≥1 and ≥5 km craters, respectively to form within a radius of 40 km. Therefore, we find it highly unlikely that both, the Ries and Steinheim craters formed independently of each other. It is much more likely (1-mentioned probabilities) that both craters formed by the impact of a binary asteroid maybe not much unlike asteroid (65803) Didymos, which is the target of the recently launched DART probe [4].

References:

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