Geophysical Research Abstracts
Vol. 13, EGU2011-13322-7, 2011
EGU General Assembly 2011

A precise and accurate "astronomical" age of the Ries impact crater, Germany: A cautious note on argon dating of impact material

Alexander Rocholl (1), Maria Ovtcharova (2), Urs Schaltegger (2), Jan Wijbrans (3), Jean Pohl (1), Mathias Harzhauser (4), Jerome Prieto (1), Albert Ulbig (5), Madelaine Boehme (1,6)

(1) University of Munich, Department of Earth and Environmental Sciences, Germany [rocholl@min.uni-muenchen.de], (2) Université de Genève, Section des Sciences de la Terre, Genève, Swizerland [Urs.Schaltegger@unige.ch], (3) Department of Isotope Geochemistry, Vrije Universiteit Amsterdam, The Netherlands [jan.wijbrans@falw.vu.nl], (4) Natural History Museum Vienna, Austria [mathias.harzhauser@NHM-WIEN.AC.AT], (5) Schlagmann Baustoffe, Zeilarn, Germany, (6) University of Tübingen, Institute for Geoscience, Tübingen, Germany [m.boehme@ifg.uni-tuebingen.de]

Accurate and precise dating of meteorite impacts is a prime intent of stratigraphic, paleoclimatic, and paleontological research. Robust age estimates, however, exist only for 11 of 174 confirmed impacts structures (ref. 1) including the Ries crater in Germany, one of the best studied impact structures on Earth. This is probably also the impact site with the highest number of radiometric age determinations. So far, published ages are exclusively based on the analysis of impact-generated melts, i.e. suevite glass and/or moldavites (tektites) (e.g., ref. 2-7) and feldspar melt (ref. 8). However, despite more than 60 individual isotopic age data obtained during 50 years of research there is no consensus as to the accurate age of the impact. For example, 40Ar-39Ar ages range from 15.2 Ma (ref. 2) to 14.3 Ma (ref. 6,7), with the young ages representing most of the recent age determinations. Accordingly, the long-standing estimate of about 15 +- 0.2 Ma (ref. 2,3) has been criticized recently as being too old by more than 0.5 Ma (e.g., ref. 1, 5-8) and only confirmed once (ref. 9). Ages < 14.6 Ma, however, pose severe problems on geophysical and biostratigraphic interpretations. Most significantly and central to the discussion, they are in conflict with a reversed magnetic field during impact (ref. 10,11), because a normal magnetic field persisted from about 14.6 to 14.15 Ma (ref. 12), i.e. impact ages < 14.6 Ma are impossible from a paleomagnetic point of view.

Here, we deduce an astrochronologically constrained Ries impact age of high accuracy and precision. Our multi-disciplinary approach combines U/Pb single zircon dating of volcanic tuffs stratigraphically bracketing the impact layer (Brockhorizon) and 40Ar-36Ar ages of the first autochthonous moldavite found in marine sediments with paleomagnetic data, (bio)stratigraphic evidence, and recent astronomical ages for the magnetic chrons of interest (ref. 12).

The reversed magnetic field during impact designates chrons C5ADr and C5Bn1r as the only possible time windows for the Ries event. 40Ar-39Ar step-heating of the moldavite yielded an age of 14.8 +- 0.2 Ma. U/Pb single zircon dating of two rhyolitic tuff units stratigraphically underlying (15.00 +- 0.02 Ma) and overlying (14.93 +- 0.01 Ma) the impact strata was carried out by state of the art techniques (ref. 13) and high-precision mass spectrometry using the EARTHTIME double Pb–double U tracer solution. The results unequivocally allocate the Ries event to chron C5Bn.1r, with its astronomically dated upper and lower boundaries constraining the impact at 14.94 +- 0.07 Ma. The such derived “astronomical” age is the very first of a Neogene meteorite impact and an unshiftable stratigraphic anchor. The study demonstrates that, in the case of the Ries impact, argon dating alone of impact glasses was not capable to unambiguously provide ages that are in accord with the geological, i.e. paleomagnetic and (bio)stratigraphic context. This could be accomplished only through the combination of different disciplines, dating techniques, and analysed materials.

References:

(1) Jourdan et al., Earth Planet. Sci. Lett 286, 1-13, 2009. (2) Staudacher et al., Geophys. Res. 51, 1-11, 1982. (3) Storzer et al., 4th Ann. Meet. Gesell. Geowiss.,1995. (4) Di Vincenzo, G. & Skála, R., GCA 73, 493-513, 2009. (5) Schwarz, W. & Lippolt, H.J., Meteor. Planet. Sci. 37, 1757-1763, 2002. (6) Laurenzi, et al., Meteor. Planet. Sci. 38, 887-893, 2003. (7) Buchner et al., Int. J. Earth Sci. 92, 1-6, 2003. (8) Buchner et al., Meteor. Planet. Sci. 45, 2010. (9) Abdul Aziz et al., Int. J. Earth Sci. 97, 115-134 (2008). (10) Pohl, J., Neues Jb. Mineral., 268-276, 1965. (11) Pohl et al., In: Gibson, R.L. & Reimold, W.U. (eds.), Large Meteorite Impacts and Planetary Evolution IV. Geol. Soc. Amer. Spec. Paper 465, 329-348, 2010. (12) Hüsing et al., Earth Planet. Sci. Lett. 290, 254-269, 2010. (13) Mattinson, J.M., Chemical Geology 220, 47-66 (2005).