A NEW LOOK AT THE RIES-STEINHEIM EVENT. Elmar Buchner[1], Martin Schmieder[1], Winfried H. Schwarz[2], Mario Trieloff[2], Fred Jourdan[3], Jo-Anne Wartho[4], Matthijs C. van Soest[4], Kip V. Hodges[4], and Gisela Pösges[5] [1]Institut für Planetologie, Universität Stuttgart, Herdweg 51, D-70174 Stuttgart, Germany, elmar.buchner@geologie.uni-stuttgart.de, [2]Institut für Geowissenschaften, Universität Heidelberg, Im Neuenheimer Feld 234-236, D-69120 Heidelberg, Germany, [3]Western Australian Argon Isotope Facility, Applied Geology & JdL-CMS, Curtin University of Technology, GPO Box U1987, Perth WA 6845, Australia, [4]School of Earth and Space Exploration, Arizona State University, PO Box 871404, Tempe, AZ 85287, USA, [5]Rieskrater-Museum Nördlingen, Eugene-Shoemaker-Platz 1, D-86720 Nördlingen, Germany.

Introduction: The ~3.8 km diameter Steinheim Basin [1;2], located about 40 km southwest of the center of the ~24 km Nördlinger Ries crater (Baden-Württemberg and Bavaria, S Germany), is a complex impact crater with central uplift that is hosted by a sequence of Triassic to Jurassic sedimentary rocks. The impact structure is situated on the Upper Jurassic limestone plateau of the Swabian Alb and is thought to have formed simultaneously [3;4] with the Nördlinger Ries [5;6] during the Miocene by the impact of a binary asteroid [3].

Melt Lithologies in the Steinheim Basin: Shatter cones and shattered belemnites in Upper and Middle Jurassic limestones and sandstones frequently occur in the shocked Steinheim target rocks. Shocked quartz grains in sandstone clasts of the Steinheim impact breccia (regionally referred to as 'Primäre Beckenbrekzie') that is composed of Middle to Upper Jurassic sandstones, marls, mudstones, and limestones were reported by [1;7]. However, no impact melt lithologies have so far been reported from the Steinheim Basin. We recently discovered different types of impact melt (mixed silicate melt [8], lechatelierite, and foamy carbonate melt) in melt particles from the Steinheim impact breccia (drill core B-26 [9]). Furthermore, a pebble of partially molten sandstone was sampled near the top of the central uplift of the Steinheim Basin.

Isotopic Dating of the Ries and Steinheim Events: $^{40}Ar/^{39}Ar$ dating of recrystallized K-feldspar glass particles separated from a partially molten biotite granite clast in impact melt rocks from the Nördlinger Ries crater (Fig. 1, 2) yielded a plateau age of 14.37 ± 0.32 Ma (2δ; MSWD=0.05; p=0.99; n=8; ~95% of ^{39}Ar released; Fig. 3) [10]. The inverse isochron plot revealed no excess argon component; the initial $^{40}Ar/^{36}Ar$ ratio of 288 ± 8 is atmospheric (295.5) within uncertainty. The isochron age of 14.43 ± 0.24 Ma (2δ; MSWD=0.33) is consitent with the plateau age (Fig. 4). This new age for the Nördlinger Ries is the first obtained from a) a monomineralic melt, b) separated from an impact-metamorphosed crystalline target rock clast, and c) in Ries melt rocks, and therefore extends the extensive isotopic age data set for this long-time studied impact structure. The new age agrees very well with the $^{40}Ar/^{39}Ar$ step-heating and laser probe dating results obtained from mixed-glass samples (suevite glass and tektites) but is younger than the previously obtained K/Ar and $^{40}Ar/^{39}Ar$ step-heating ages of ~15 Ma. Thus, the ~14.4 Ma impact age of the Nördlinger Ries crater can be regarded as well-established [e.g.,10-13]. To achieve the first isotopic data for the Steinheim Basin, two dating projects are currently in progress. Firstly, five single idiomorphic zircon crystals were separated from Upper Triassic sandstones (obtained from drill core B-23 in the central uplift of the Steinheim Basin [9]) for (U-Th)/He dating (for technique details see [14;15]) at the Arizona State University, Tempe, USA. (U-Th)/He ages obtained from these grains range from 226.14 ± 8.16 to 281.97 ± 9.36 Ma (2σ), thus indicating that the He systematics in these clear zircon grains were not reset by the Steinheim Basin impact event. Secondly, optically fresh and K-rich domains of the partially molten sandstone from the central uplift of the Steinheim Basin will be dated by the $^{40}Ar/^{39}Ar$ step-heating method at the Western Australian Argon Isotope Facility, Perth, Australia. We expect the $^{40}Ar/^{39}Ar$ dating results in the run-up to the LPSC meeting.

Discussion and Results: The specific alignment of the Steinheim Basin, the Nördlinger Ries crater, and the Central European tektite strewn field had led to the assumption that both impact structures formed simultaneously during the 'Ries-Steinheim event' [3]. The ~14.4 Ma impact age of the Nördlinger Ries crater is well-established [10-13], however, there was no melt suitable for isotopic dating at the Steinheim Basin and (U-Th)/He dating failed to resolve a reasonable age for the Steinheim impact. From a biostratigraphic point of view, it is likely that both craters (and their crater lake infill) formed simultaneously but it cannot be ruled out that the two impact structures are the products of two independent impact events in the Miocene [2]. Due to the recent discovery of melt lithologies in the Steinheim Basin [8] we are currently working on a first set of age determinations for this impact crater. A $^{40}Ar/^{39}Ar$ dating project is in progress in order to either confirm or disprove the formation of the two impact carters by a double impact event. The newly discovered partially molten sandstone, probably the (reworked) remnant of a now widely eroded sheet or lens of impact melt that originally occurred in the central uplift area of the Steinheim Basin, might provide the first isotopic age constraints for the Steinheim impact.

References: [1] Engelhardt W. von et al. (1967) *Die Naturwissenschaften, 54*, 198-199. [2] Heizmann E. P. J. and Reiff W. (2002) *Der Steinheimer Meteor-krater*, Pfeil, München, 160 p. (in German). [3] Stöffler D. et al. (2002) *Meteoritics & Planet. Sci., 37*, 1893-1907. [4] Ivanov B. A. and Stöffler D. (2005) *LPS XXXVI*, Abstract #1443. [5] Engelhardt W. von et al. (1969) *Geol. Bavarica, 61*, 229-295 (in German). [6] Engelhardt W. von (1997) *Meteoritics & Planet. Sci., 32*, 545–554. [7] Groschopf P. and Reiff W. (1966) *Jh. Geol. Landesamt Baden-Württ.,13*, 223-226 (in German). [8] Buchner E. and Schmieder M. (2009) *Meteoritics & Planet. Sci., 44*, A43. [9] Reiff W. (2004) *Landesamt Geol. Rohst. Bergbau Baden-Württ.*, 223 p. (in German). [10] Buchner E. et al. (2009) *Meteoritics & Planet. Sci.* (submitted). [11] Schwarz W. H. and Lippolt H. J. (2002) *Meteoritics & Planet. Sci., 37*, 1757-1763. [12] Buchner E. et al. (2003) *Intern. J. Earth Sci,. 92*, 1-6. [13] Di Vicenzo G. and Skála R. (2009) *Geochim. Cosmochim. Acta, 73*, 493–513. [14] van Soest M. C. et al. (2009) *LPS XL*, Abstract #2041. [15] Wartho J.-A. et al. (2009) *LPS XL*, Abstract #2004.

Fig. 1: Polished section of the partially molten biotite granite (clast in melt rock) recovered from the Polsingen quarry, Nördlinger Ries; bright domains are *in situ* molten and recrystallized K-feldspars.

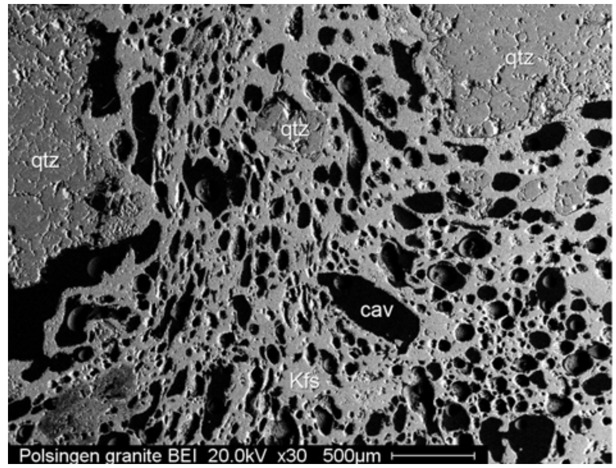

Fig. 2: Backscattered electron image of the biotite granite (thin section); qtz: (ballen) quartz, Kfs: K-feldspar, cav: cavity/vesicle (see also Fig. 1).

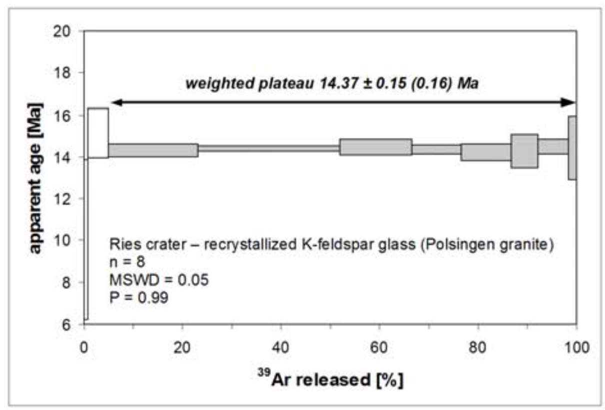

Fig. 3: $^{40}Ar/^{39}Ar$ age spectrum for recrystallized potassium feldspar glass separate from partially molten biotite granite (Polsingen, Nördlinger Ries); uncertainties are at the 1 δ level; error in parentheses includes the error of the age standard.

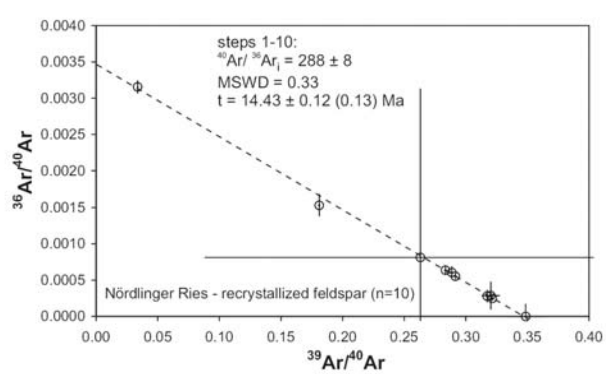

Fig. 4: Inverse isochron plot; all steps (black circles) are included in the plateau fraction; errors as cross symbols; uncertainties are at the 1 δ level; error in parentheses includes the error of the age standard.