U/PB DATING OF ZIRCON FROM THE SUVASVESI IMPACT STRUCTURES, FINLAND.

W. H. Schwarz[1,2], G. Breutmann[1], A. K. Schmitt[1], M. Trieloff[1,2], T. Ludwig[1], M. Hanel[1], E. Buchner[3,4], M. Schmieder[5,6], L. J. Pesonen[7] and J. Moilanen[8], [1]Universität Heidelberg, Institut für Geowissenschaften, Im Neuenheimer Feld 234-236, 69120 Heidelberg, Winfried.Schwarz@geow.uni-heidelberg.de, [2]Klaus-Tschira-Labor für Kosmochemie, Im Neuenheimer Feld 234-236, 69120 Heidelberg. [3]HNU-Neu-Ulm University of Applied Sciences, Wileystraße 1, 89231 Neu-Ulm, [4]Universität Stuttgart, Institut für Mineralogie und Kristallchemie, Azenbergstraße 18, 70174 Stuttgart, [5]LPI, 3600 Bay Area Boulevard, Houston 77058, [6]NASA–SSERVI, [7]Department of Physics, University of Helsinki, P.O. Box 64, 00014 Helsinki, [8]Katajarinteentie 1 as. 1, 88270 Vuolijoki.

Introduction: The two Suvasvesi impact structures (Finland), both covered by lakes, forming an apparent crater doublet, were analysed by *in-situ* U/Pb dating of zircon grains. Two samples are from a drill core into the northern structure (depth 228-240 (N1) and 240-252m (N2)) – which previously confirmed an impact origin (e.g. [1]) and three samples (S1, S2, S3) from an occurrence of glacially transported impactite boulders near Kaituransalo and Mannamäki, ~3 km SE of the centre of the Suvasvesi South [e.g. 2-5]. Suvasvesi North is embedded in Archean-Proterozoic (~2.7-1.88 Ga) crystalline and metamorphic rocks, whereas Suvasvesi South is entirely located in Paleoproterozoic (~1.88 Ga) crystalline rocks (e.g. [2,4]). Paleomagnetic results suggested either an age of ~230-250 or ~770-790 Ma for the north crater (e.g.[1,2]). A Permian age was proposed for south crater, invoking simultaneous formation (e.g. [4]). First isotopic dating of samples N1, N2 and S1 yielded Ar-Ar step heating ages for Suvasvesi North of ~85 Ma and for Suvasvesi South of ~710 Ma, indicating that two separate impacts formed the craters [5].

Samples: All samples show the typical characteristics of shock metamorphic overprint, e.g. clasts of melted feldspars, quartz with PDFs, kinkbanded mica or shocked apatite as well as zircon grains shocked to variable degrees (see e.g. [4,5]). The drill core samples N1 and N2 are fragments of a dark, pyroxene-rich, crystalline impact melt rock. Surface samples S1 and S3 are clast-rich, yellowish-grey to brown, impact melt rocks with devitrified and locally altered feldspathic melt domains; S3 is rich in calcite. Surface sample S2 is a suevitic impact breccia that contains melt particles and lithic clasts in a particulate groundmass. Zircon grains in all 5 samples show a broad range of morphological and textural features. Zircon grains in samples N1, N2 and S3 commonly show spongy internal textures, locally with faint relict zoning. In contrast, zircon grains in sample S2 display well-developed zoning in backscattered electron and cathodoluminescense images, whereas the zircon grains in sample S1 show spongy textures to well-developed zoning – with cracks common in the zircon grains of all samples.

Results: The zircon crystals were analysed *in-situ* using the Heidelberg CAMECA IMS 1280-HR (HIP). Both samples from Suvasvesi North (N1, N2) yielded discordant arrays of ages with a lower intercept of <100 Ma (N1) and ~70-90 Ma (N2), respectively, and an upper intercept at ~ 1.8 Ga consistent with the Ar-Ar ages of ~85 Ma [5] and the Proterozoic age of the crystalline target rocks. Samples S2 and S3 from Suvasvesi South also yielded lower intercept ages of <100 Ma (S2) and 70-90 Ma (S3) and upper intercept ages of ~1.8-2.0 Ga, again in agreement with ages obtained for Suvasvesi North. In contrast, sample S1 yielded a much older lower intercept age of ~600-750 Ma (upper intercept at 1.8-2.2 Ga) in agreement with its Ar-Ar age of ~710Ma [5].

Discussion: Zircon U/Pb ages obtained for 4 of the samples (N1, N2, S2 and S3) define discordia with lower intercept ages of <100 Ma. Sample S1 deviates from this pattern with a much older lower intercept age of ~700 Ma. Considering that both impact structures were likely formed in separate events, only the U/Pb age obtained for sample S1 agrees with the Ar-Ar age of the Suvasvesi S impact, whereas samples S2 and S3 seem to represent younger impactites apparently linked to the Suvasvesi N impact. This in turn, suggests the glacial till exposed in the Mannamäki–Kaituransalo area may contain a mixed population of impactites produced by the two Suvasvesi impacts [4,5]. An alternative interpretation is that a double impact formed the two craters ~85 Ma ago, and the age for S1 of ~600-750 Ma was caused by a pervasive hydrothermal event (as known e.g from U-rich Paleoproterozoic zircons in central Sweden during the Caledonian orogeny [6]), leaving the zircon undisturbed during the impact. However, as the 'older' sample S1 is an impact melt breccia that was initially likely hotter than the particulate groundmass domain of suevitic sample S2 with impact-reset zircon, this is considered rather unlikely. We, thus, tentatively uphold the proposed scenario of two separate impacts, supported by the consistency between Ar-Ar and U/Pb results.

References:

[1] Pesonen L. J. 1995. *Annales Geophysicae, Part III, Space and Planetary Science*, 13 (Supplement III):C 741. [2] Werner, S.C. et al. 2001. *Meteorit. Planet. Sci*. 36, A223 (supplement). [3] Lehtinen M. et al. 2001. *33rd Lunar and Planetary Science Conference*, abstract #1188. [4] Donadini F. et al. 2006. In: Biological Processes Associated with Impact Events, Impact Studies, edited by Cockell C., Koeberl C., and Gilmour I. Berlin: Springer. pp. 287 – 307. [5] Schmieder M. et al. 2016, *Meteoritics & Planetary Science*, 1–15. [6] Högdahl K. et al. 2001. *American Mineralogist*, 86, 534–546.