Characterisation of Shock Deformation at the Spider Impact Structure, Western Australia.

Morgan A. Cox[1] Aaron J. Cavosie[1], Katarina Miljković[1], Phil A. Bland[1], Thomas Kenkmann[2] and Zacchary N. P. Hoskins[1]

[1]School of Earth and Planetary Sciences, Curtin University, Perth, Australia. [2]Institute of Earth and Environmental Sciences—Geology, Albert-Ludwigs-Universität (ALU) Freiburg, Albertstraße 23B, Freiburg 79104, Germany.
Email: morgan.cox@student.curtin.edu.au

Introduction: The Spider impact structure is ~13 x 11 km in diameter and is located 430 km NE of Broome in the Kimberley, Western Australia. The impact is suggested to have been oblique based on the unusual morphology of faulted metasedimentary rocks in the central uplift. Rocks include the Pentecost (1704±14 to 1774±9 Ma) and Warton (1704±7 to 1786±14 Ma) sandstone radiating out from the central uplift [1,2,3,4]. The location of Spider is remote and difficult to access, and also requires both state and local authorization and hence, few studies have been made at the site [1,2]. Well-developed shatter cones and shocked quartz data have been described from the structure [1,2,5], yet no detailed microstructural analysis of shock deformation has been documented. Accessory phases are widely used minerals in studying impact structures, as they form diagnostic microstructures during hypervelocity impact [4,6,7]. Zircon forms {112} deformation twins at ~20 GPa [4] and the phosphate mineral xenotime (YPO_4) has been discovered to form shock microstructures at pressures below 20 GPa [6]. Here we present a study of shock deformation in zircon and xenotime from shatter cones in metasandstone collected from the Spider structure during authorized field work in 2017.

Methods: Ten samples were collected from the Spider central uplift, inlcuding shatter cones in quartzite, and enigmatic breccia. Samples were collected from the center of the uplift along a transect towards the down-range direction, to the south/eastern edge of the central uplift. Outcrops where samples were collected contain abundant shatter cones with cones sizes ranging in length from ~5 cm to 30 cm. Shatter cones are extensive throughout the entire central uplift and are well-developed. Thin sections were analysed using transmitted and reflected light microscopy along with electron backscatter diffraction (EBSD) methods at Curtin university.

Results and Discussion: Quartz grains contain planar fractures, feather features and planar deformation features (PDFs). PDFs are abundant throughout all sections; u-stage measurements along with maximum orientations per grain will be presented at the meeting. Zircon, monazite and xenotime grains within 7 thin sections were analysed by EBSD to characterize shock deformation microstructures. Multiple xenotime overgrowths on zircon grains were observed, with some xenotime grains containing {112} deformation twins in up to two orientations. Zircon grains also contain {112} deformation twins in up to three orientations in single grains, along with planar deformation bands and misorientation within grains up to 35°. Twin lamellae range in width from ~50 nm up to ~200 nm and are locally developed within regions of grains. The planar microstructures in both xenotime and zircon are cross-cutting, with multiple parallel fractures that occur across and throughout the grains. Samples from the center of the uplift are extremely heterogeneous with differences in porosity and shock deformation observed (i.e., zircon grains are shocked in some rocks and unshocked in others from outcrops within 10 m of each other).

References: [1] Shoemaker, E. and Shoemaker, C. (1996) *AGSO J. Australian Geology & Geophys.*, 16, 379–398. [2] Kenkmann, T. and Poelchau, M. (2013) *Large Meteorite Impacts and Planetary Evolution V*. [3] McNaughton, N. et al. (1999) *Science,* 285, 78–80. [4] Timms, N. et al. (2017*) Earth-Sci. Rev., 165,185*–202. [5] Lehmann, T. 2010. Petrographie und Stoßwellenmetamorphose des Spider-Impaktkraters, Westaustralien *unpubished Diploma thesis* Freie Universität Berlin. [6] Cavosie, A. et al. (2016) *Geology*, 44, 803–806. [7] Erickson, T. et al. (2016) *Geology*, 44, 635–638.

Acknowledgements: We gratefully acknowledge Jodie at Barnett Roadhouse, and Debborah Donation (the elder) for permission and assistance in accessing the Spider impact structure to conduct our field study. Financial support was provided by the Eugene Shoemaker Impact Cratering award (MA Cox, 2016), and funding was also provided by TIGeR, Curtin University.