MICROSTRUCTURAL STUDY OF ZIRCON IN RED IMPACT MELT ROCK FROM GOSSES BLUFF, AUSTRALIA.

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Introduction: Gosses Bluff is a ~24 km diameter complex impact structure in central Australia, located 160 km WSW of Alice Springs. The impact age is poorly constrained at between 383-165 Ma [1,2,3]. Target rocks are near horizontal Late Proterozoic to Devonian sedimentary units of the Amadeus Basin [4]. An eroded expression of the ~4.5 km diameter central uplift forms well-preserved ridges that stand ~180-240 m above the surrounding plains [4,5]. The impact structure is well represented with gravity data, showing a ~3 km diameter low over the central uplift, with a gradient corresponding to the ~24 km diameter crater rim [6,7]. While shocked quartz, shatter cones, impact melt, impact breccias and impact glass have all been reported at Gosses Bluff [5], no accessory mineral microstructural studies have previously been done. An anomalous topographic high, called Mt Pyroclast, is located ~3 km south of the central uplift. Mt Pyroclast predominantly consists of tan and pale grey with black-coloured polymict lithic impact breccia and impact melt-bearing breccia [4]. Fieldwork in 2017 identified dark red polymict lithic breccia dykes ranging from 2 cm to 3 m in width that cross-cut the tan-coloured polymict lithic impact breccia; the red dykes are the focus of this study.

Methods: A microscopic analysis of thin sections of the largest identified (3 m-wide) dark red polymict breccia dyke, which cross-cuts the polymict lithic impact breccia at Mt Pyroclast, was analysed in this study. Scanning electron microscopy (SEM) with backscatter electron (BSE), energy dispersive spectroscopy (EDS) and electron backscatter diffraction (EBSD) were used. Analysis was done using the Tescan Mira3 FESEM with Oxford Instruments Symmetry EBSD detector and AZtec Symmetry software, and a Tescan integrated mineral analyzer (TIMA) with four EDS detectors at the John de Laeter Centre (JDLC), Curtin University.

Results and Discussion: The red breccia is matrix supported (60% matrix, 40% clasts) and includes clasts of varying sedimentary compositions, the largest of which (up to 1 cm) is predominantly a porous carbonate which contains a mixture of calcite, dolomite, lechatelierite and other amorphous silica. The clasts are very angular and show very little evidence of reworking. Other than lechatelierite no conspicuous melt particles were observed.

TIMA analysis of one thin section identified 85 zircon grains larger than 10 µm. These grains display a multitude of different microstructures, including: granular neoblastic zircons, many of which preserve crystallographic orientation microstructures that indicate former reidite in granular neoblastic (FRIGN) zircon; grains with evidence of localised dissociation of zircon to zirconia (ZrO_2) and silica (SiO_2) within granular domains along grain margins; grains with {112} deformation twins; and grains with planar deformation bands (PDB). Reidite was identified in several zircon grains, both as lamellae within subhedral non-granular grains, and as granular neoblasts coexisting with zircon within FRIGN zircon.

This presence of reidite in non-granular grains, FRIGN zircon, FRIGN zircon with preserved reidite domains, {112} twins, PDBs, and dissociation textures, all within this section, represents nearly the full spectrum of pressure and temperature conditions reported for zircon from impact environments [8]. Such a wide variety of zircon microstructural responses suggests that the red breccia dykes contain material sampled from a variety of environments within the impact structure, and thus are not necessarily a remobilized/modified version of the dyke host rocks. Ongoing work is focused on determining the nature of the enigmatic dykes, including if the matrix contains evidence of fusion or is entirely clastic. FRIGN zircon grains in the red dyke are appropriate for U–Pb dating and will be targeted for analysis to further constrain the age of Gosses Bluff impact.

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