DEFORMED QUARTZ FROM THE FIRST DRILL CORES AT THE ILKURLKA CIRCULAR GEOPHYSICAL ANOMALY IN WESTERN AUSTRALIA: A POSSIBLE IMPACT STRUCTURE. R. R. Quintero and A. J. Cavosie, Space Science and Technology Centre, School of Earth and Planetary Science, Curtin University, Perth, WA, Australia. Corresponding author: r.quinteromendez@postgrad.curtin.edu.au

Introduction: There are currently 31 confirmed impact structures documented in Australia, 14 of which are located in Western Australia [1]. The Ilkurlka structure is a ~15 km diameter buried geophysical anomaly located within the Officer Basin in Western Australia. The origin of this regional magnetic and local gravity anomaly is currently unknown. A range of origins, including salt dome, igneous intrusion, or a meteorite impact crater can be hypothesized. As the feature has been described as having a ring-like gravity anomaly, Ilkurlka has been previously identified as a possible impact structure [2,3]. Two boreholes drilled by Maria Resources in 2019 (BH01 and BH02) targeted the circular gravity anomaly, and were investigated in this study.

A survey of quartz, zircon and other accessory minerals from samples spanning the two boreholes was conducted to search for microstructural evidence of deformation uniquely produced by impact processes (e.g., deformation twins, high-pressure phases, and crystal-plastic deformation). The minerals quartz and zircon are excellent recorders of diagnostic microstructures that result from shock metamorphism caused by hypervelocity impact [4,5].

Geology: The buried Ilkurlka structure is located in the Officer Basin, a ~8 km thick Neoproterozoic intracratonic basin that extends ~400,000 km^2 from the eastern margin of Western Australia through South Australia [6]. Basin infill consists of mixed sequences of carbonates, evaporites and siliciclastic rocks of shallow marine to coastal depositional environments which overlie older Proterozoic and Archean rocks [6,7]. In Western Australia, the Cambrian Table Hill Volcanics overlie the basinal sequence [6].

Samples and Methods: Six samples from core BH01 and fourteen samples from core BH02 were surveyed. The two cores, totaling 561.6 and 615.2 m, recovered siliciclastic sedimentary rocks typical of the Officer Basin, including sandstones, siltstones, and evaporites; no igneous rocks were encountered. Highly deformed sedimentary breccias are locally present (**Fig. 1**). Scanning electron microscopy, including backscattered electron (BSE), energy dispersive spectroscopy (EDS), and electron backscatter diffraction (EBSD), was performed in the John de Laeter Centre at Curtin University.

Figure 1. Examples of deformed and brecciated sedimentary rocks from two boreholes. (a) Half core from BH01; note vertical rock fragments; and (b) quarter core from BH02.

Results: Boreholes BH01 and BH02 contain sandstones with variably deformed quartz grains. Some samples have grains with relatively few fractures, whereas other samples consist of grains that are almost all intensely fractured. Observed deformation features include quartz grains with sub-planar fractures (**Fig. 2a**), grains with a high density of fractures in random orientations, shattered grains, concussion fractures (**Fig. 2b,c**), and fractures that off-set grains, indicating some element of shear stress (**Fig. 2d**). No planar fractures or planar deformation features have been identified thus far. The concussion fractures appear to be Hertzian fractures that emanate from grain-to-grain contacts and can be followed continuously across up to 6 adjacent quartz grains. Other evidence of mineral deformation includes kink bands in biotite. No evidence of deformation was detected in zircon grains (n=23) analyzed by EBSD. Most samples preserved what is interpreted as primary porosity, in whole or in part; in no samples was all primary porosity destroyed.

Discussion: Macro- and microscopic evidence of deformation is present in both boreholes (**Figs. 1,2**). Concussion fractures in quartz, such as the ones observed in in sandstones and siltstones from BH01 and BH02, have been reported in shock-metamorphosed sandstone samples from several impact craters, including Meteor crater, Wabar crater, and the Douglas crater field [8-10]. Concussion fractures in quartz have also been observed in hypervelocity impact experiments of sandstone conducted by MEMIN [11]. Kink bands in biotite are known to occur in shock-deformed rocks [e.g. 12] and have been produced in dynamic shock experiments that simulate impact conditions [13]. However, kink bands also occur in micas under tectonic stress regimes, as has been shown in recent experiments [14].

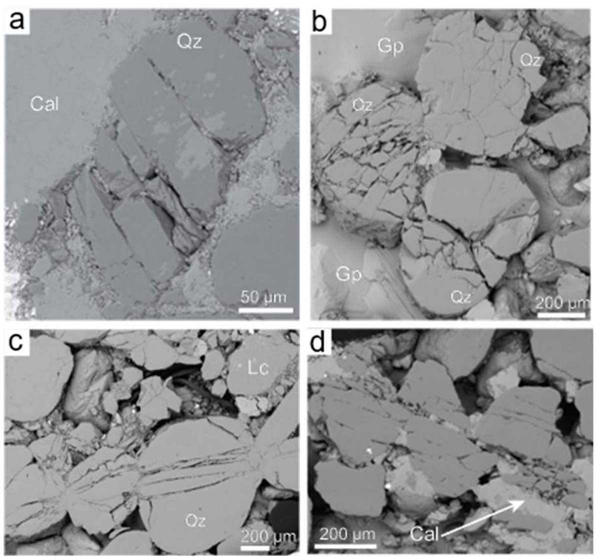

Figure 2. BSE images showing examples of deformation styles observed in detrital quartz grains from Ilkurlka core samples: a. sub-planar fractures; b. concussion fractures at grain contacts, and randomly orientated fractures; c. concussion fractures spanning four detrital quartz grains; and d. displaced quartz grains displaying apparent sinistral off-set, consisting of sub-parallel fractures spanning multiple grains. Cc= Calcite, Gp= Gypsum, Lc= Lithic clast, Qz= Quartz.

The results of this survey document the presence of pervasive deformation features at various scales in both cores, but are not currently sufficient to uniquely confirm a meteorite impact origin for the Ilkurlka ring structure, although they do not discount the impact hypothesis. Our results for Ilkurlka sandstone samples, considered in an impact context, would imply that the studied samples represent at most shock stage 1a [15], given the preservation of porosity. At present, the origin of the Ilkurlka ring structure remains unknown.

An expanded petrographic analytical survey is currently in progress to continue searching for evidence of diagnostic shock deformation features in quartz, such as planar deformation features and feather features, as well as deformation features in other minerals.

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