FIRST EVIDENCE OF SHOCK DEFORMATION AT YALLALIE, A PROPOSED IMPACT STRUCTURE IN WESTERN AUSTRALIA

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Introduction: Impact cratering is a significant and widespread geological process throughout the solar system. In order to confirm an impact structure, diagnostic evidence of shock deformation, i.e. shatter cones and/or shocked minerals, or traces of meteoritic anomalies must be documented [1]. Yallalie is a proposed impact structure, situated 200 km north of Perth, Western Australia, within the Paleozoic-Mesozoic Perth Basin. Previous studies have documented a buried 12 km circular, multi-ringed geophysical anomaly [2,3]. The age of the crater has been suggested to be Mesozoic, as determined by overlying sedimentary units and clasts incorporated within proximal breccia [2]. Here we report the results of a search for shocked quartz from rock samples and shocked detrital zircon sampled from surface sites around the Yallalie structure.

Results and Discussion: Samples of both rock and colluvium were collected in order to examine accessory phases and quartz for shock microstructures. Samples include sandstone and colluvium proximal to allocthonous Mungedar breccia, exposed ~4 km west of the center of the Yallalie structure. Colluvium samples were sieved and run through heavy mineral separation. Zircon grains were hand-picked onto sem stubs and surveyed using a scanning electron microscope, in order to identify planar microstructures on grain surfaces. A total of 3000 zircon grains were surveyed, with grain morphologies ranging from subhedral to euhedral, and ranging in length from ~40-300 µm. A total of 22 zircon grains were found to have features that are straight/planar, extend across the grain, cross-cut other features, occur as multiple parallel features in same orientation, and thus may represent evidence of shock deformation [1,4]. Studies of these zircon grains are ongoing.

Thin-sections prepared from sandstone contain three quartz grains that preserve potential shock microstructures. Two of the quartz grains contain multiple planar, parallel fractures (PFs) which cross-cut the grains (Fig. 1a). PFs in quartz result from low intensity shock <10 GPa [1,5,6,7,8]. The third quartz grain exhibits a ballen microstructure (Fig. 1b), which has been identified in previous studies to record retrogression of shock produced polymorphs, and can be used to potentially constrain an impact environment [10]. In annealing and pressure experiments, ballen silica has been shown to form at temperatures >1200 °C [11] and pressures ~30-35 GPa [12]. These extreme conditions are are rare outside of hyper-velocity impact events. Thus, the presence of both PFs and ballen texture in quartz represent the first documented shocked mineral evidence supporting the hypothesis that Yallalie is an impact structure.

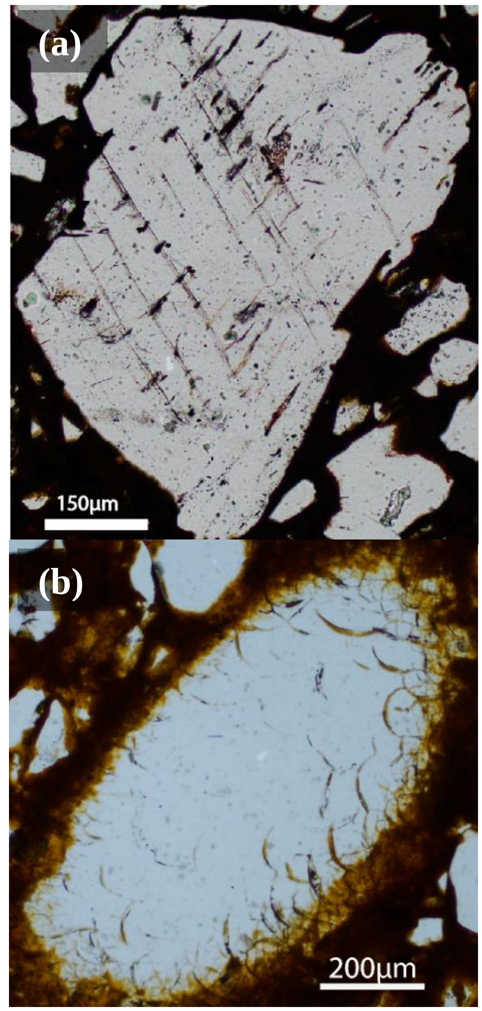

Figure 1.- Shocked quartz grains from the Yallalie impact structure. (a) Grain with PFs. (b) Grain with ballen texture

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