PGES AND QUARTZ GRAINS IN A RESEDIMENTED LATE ARCHEAN IMPACT HORIZON IN THE HAMERSLEY GROUP OF WESTERN AUSTRALIA; Bruce M. Simonson and Darian Davies, Geology Department, Oberlin College, Oberlin OH 44074; Malcolm Wallace and Shane Reeves, School of Earth Sciences, University of Melbourne, Parkville, Victoria 3052; and Scott Hassler, Department of Geological Sciences, California State University, Hayward, CA 94542

The early Precambrian Hamersley Group of Western Australia contains two thick packages of carbonate-rich strata, the Carawine Dolomite and the Wittenoom Formation, that occupy mutually exclusive areas within the Hamersley Basin. Within each of these formations is a single horizon which contains sand- to fine gravel-size particles believed to be distal ejecta from a large bolide impact [1]. In the Carawine Dolomite, the ejecta are restricted to a coarse-grained dolomitic debris flow deposit up to 25 m thick. In the Wittenoom Formation, the ejecta are restricted to a turbidite which is ≤ 1.3 m thick and consists largely of sand-size carbonate and argillite intraclasts. Together, these two horizons constitute a single, unique layer that appears to have been deposited rapidly over an area $\geq 50{,}000$ km^2 by a single high-energy event around 2.5 Ga. Deposition is inferred to have taken place in a series of distinct stages as follows: A) ballistic dispersal of mostly sand-size particles from the impact site to the seafloor in the Hamersley Basin, B) reworking of the newly deposited ejecta in the Hamersley Basin into large symmetrical ripples by impact-generated tsunami waves [2], and C) subsequent erosion and resedimentation of most of the ejecta by one to three large sedimentary gravity flows that moved south and west down the paleoslope of the Hamersley Basin. New data will be presented concerning the two main types of ejecta found in this layer: microkrystites and quartz grains. Specifically, microkrystite-rich samples are enriched in Ir and Ru by an order of magnitude or more relative to the surrounding strata, but other siderophile elements (Pd, Pt, Au, Cr, Co, and Ni) display neither anomalously high concentrations nor chondritic interelement ratios. As for the quartz grains, their petrographic characteristics clearly indicate they are not volcanic in origin, but they do not appear to have planar deformation features like those reported from numerous other impact ejecta horizons.

The most distinctive component of the ejecta consists of devitrified droplets of silicate melt in the form of millimeter-size spherules to more irregular particles up to 1 cm across. These particles consist largely of K-feldspar and display an abundance of quench and devitrification textures, most commonly in the form of peripheral radial-fibrous aggregates that diverge inward. Very similar particles, generally referred to as microkrystites [3], also occur in well-documented ejecta layers such as the Cretaceous-Tertiary boundary layer in Italy [4] and Spain [5] and the Eocene North American strewn field [6]. The two other types of near-spherical particles that occur in the Carawine Dolomite or the Wittenoom Formation can be readily distinguished from microkrystites petrographically. One consists of dolomite ooids and pisoids, which differ from the microkrystites compositionally and display concentric lamellae and/or radial-fibrous sprays that diverge outward rather than inward [7]. In contrast, microkrystites that have been replaced by calcite consist of a mosaic of coarse crystals and show no fibrous textures whatsoever. Accretionary and armored lapilli formed during volcanic eruptions are also common in various stratigraphic units of both the Hamersley Group [8] and the underlying Fortescue Group [9]. Some of these lapilli are not too different from the microkrystites in either external shape or mineralogical composition, but their internal textures are totally different. The lapilli always consist of fine-grained ash rather than pure melt and display massive to concentric textures internally rather than radial or fibrous features. Neither accretionary lapilli nor any other clasts of definite volcanic origin have been observed in the microkrystite-bearing layer described here. Volcaniclastic layers are present in the Wittenoom Formation, but the closest ones to the impact layer stratigraphically are still separated by many meters of non-volcanic sediment (mainly argillite and carbonate).

31 samples from both the ejecta-bearing layer and associated strata in the Wittenoom Formation and Carawine Dolomite were recently analyzed for both major and minor elements, including PGEs. 16 of the samples came from several cores drilled for mineral exploration and the remainder were from surface outcrops. Preliminary results indicate both Ir and Ru display strong anomalies in the microkrystite-rich samples. They reach a maximum of 1.8 ppb and average an order of magnitude or more above the background Ir concentration of < 0.05 ppb observed in host strata (primarily argillites). This is comparable to the Ir anomaly associated with the late Precambrian Acraman impact ejecta layer in South Australia [10]. Other siderophile elements (Pd, Pt, Au, Cr, Co, and Ni) display no anomalies in the Hamersley layer. The only elements which are correlated and have near-chondritic interelement ratios are Ir, Ru, and Ni. Cobalt displays a correlation with Ir, but the interelement relationship is not chondritic. The chalcophile elements display no correlations with Ir and have non-chondritic interelement ratios, which may reflect mobilization and differential migration after deposition.

Quartz grains in an impact ejecta layer are also potentially of interest because planar deformation features such as shock lamellae are frequently cited in support of an impact origin [11]. Over 600 sand-size quartz grains were isolated from the Hamersley layer and examined on a spindle stage in an attempt to locate such features, but the results were almost entirely negative. However, other features of the quartz grains were studied in the process, as well as in standard petrographic thin sections and via cathodoluminescence, that shed considerable light on their provenance. Specifically, ca. 40% of the quartz grains from the impact layer have undulose extinction, which indicates the quartz grains are derived from low to medium-rank metamorphic source rocks [12]. In addition, over 50% of the quartz grains contain either bubble planes and/or rutile needle inclusions that are commonly bent or segmented. Given the great age of this layer, there is a possibility the bubble planes could represent recrystallized planar deformation features, but complex cross-cutting relationships between the rutile needles and bubble planes point to multiple episodes of deformation. The metamorphic provenance of the quartz grains is consistent with the presence of a subordinate amount of microcline with plaid twinning among the tectosilicate grains. In contrast, quartz crystals from volcaniclastic layers elsewhere in the host formations consistently have very low percentages of grains with either undulose extinction or bubble trains, and virtually no rutile inclusions. Given that the event layer contains the only siliciclastic sand for hundreds of meters stratigraphically and hundreds of kilometers laterally in any direction, we believe that these tectosilicate grains were transported into the Hamersley Basin by the same high-energy event which introduced the microkrystites. Given the presumed impact origin of the latter, we are puzzled by the apparent absence of planar deformation features in the quartz crystals.

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