LA-ICP-MS and textural analyses of impact spherules from the 2.54 Ga Bee Gorge spherule layer, Western Australia

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Introduction: Impact ejecta deposits are rather rare in the sedimentary record of the Earth but the well-preserved Archean to Paleo-Proterozoic marine deposit in Western Australia and R.S.A. contain up to m-thick impact ejecta layers [1]. While source craters are unconstrained, wide regional distribution and the spherules size argue for large-scale impact events [2].

Rationale, samples & techniques. Two major issues are discussed in the context of these large-scale ejecta layers: (i) where was/is the source crater and what was the composition of the target there, and (ii) how can we interpret the textures of the spherules in terms of temperature, time, and deposition regime. We have analyzed samples S64-1 and Y52-ID, from the the Bee Gorge spherule layer, Hamersley Basin, W.A., using light and electron microscopy, electron microprobe, and laser-ablation mass spectrometry.

Results & discussion. – *Texture and deformation features of the spherules*. As described [3] acicular to lath-shaped K-feldspar is the major phase in the spherules; typically forming an outer rim with radially grown xx or – less frequently – randomly oriented needles in a kind of meshwork. Of special interest are pairs of deformed spherules which appear to be fused together ("agglutinated" [3]) prior to incorporation in their host sediment, and the distinction from deformed spherules, coalescent by compaction and probably pressure solution. We found spherule clusters consisting of 10 or more sub-µm-sized spherules with deformed outlines. The main characteristics of these clusters, making up about 10 vol% of the layer, are: (i) Composed of ≥ 90 vol% of spherules; (ii) very few inter-spherule material; (iii) close-fit textures with mutual spherule deformation; (iv) coexistence of deformed and undeformed spherules; (v) size-sorted spherules, and (vi) few admixed spherule fragments.

If textures of the observed spherule clusters are not due to post-depositional compaction, they can probably be interpreted as result of collision and sticking of melt droplets during ejection, leading to mutual viscous deformation, followed by rapid cooling. If this is correct, a certain fraction of spherules must have passed the water column during deposition already in the shape of clusters. The entire ejecta layer consists of similarly sized spherules which is also true for the spherule clusters. Obviously size sorting have occurred already during flight prior to cluster formation and is not the result of reworking and sorting in the sediment. Interestingly, spherule (chondrule) clusters with the same textural properties have been recently described from unequilibrated ordinary chondrites [4].

Geochemistry. K-spars in and at the outer rim of the spherules, and the matrix show very different trace element budgets, indicating that the matrix represents background sedimentation (Fig.1). In the spherules very rarely low signals for Pt, and Ir were recorded. Except for PG elements, our data on very small volumes are in good agreement with previous results [1].

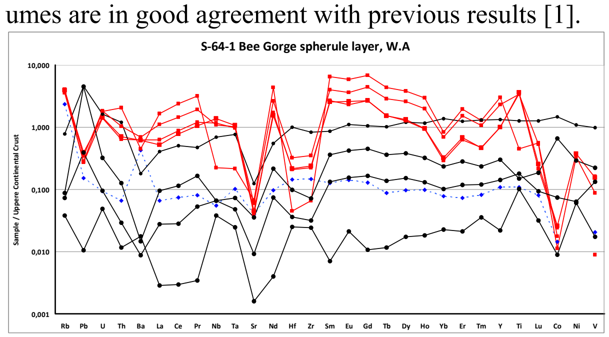

Fig. 1. Element distribution (LA-ICP-MS data) in the K-spar volumes of the spherules (**red**), the spherule center (**blue**), and the fine-grained matrix (**black**) normalized to UCC [5].

In line with [6], we interpret the K-spars xx as pseudomorphs after plag which probably crystallized during cooling of the impact melt droplets similar as proposed for microkrystites. The trace element budget of different spherules is quite similar, indicating a common source, and only minor changes during alteration. If trace element budget is primary, it can not be matched directly to a common crustal lithology but we concur with [1] that the a target basaltic in composition is likely the source for the Bee Gorge spherules.

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