# Discovery of possible traces of asteroid impact within the fossil-bearing carbonaceous chert from the 3.4 Ga Strelley Pool Formation, Pilbara Craton of Western Australia - a preliminary study

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Large asteroid impacts are thought to be a common feature of the Archean in particular as a result of the Late Heavy Bombardment (LHB). One line of supporting evidence is the presence of "impact layers" containing silicate spherules that were formed by condensation of rocks vaporized by bombardment events. Two Early Archean impact layers with ages of 3.47 and 3.46 Ga have been identified from the Pilbara greenstone belt, Western Australia (Glikson et al., 2016; Lowe and Byerly, 1986). In contrast 5 separate impact layers with ages of 3.47 to 3.24 Ga have been identified in the Barberton greenstone belt, South Africa (e.g., Lowe et al., 2014; Byerly et al., 2002). Such extraterrestrial impacts likely influenced the Earth's early environment, including crustal deformation, terrain amalgamation, evaporation of significant volumes of ocean water, and even triggering the development of a modern-like plate tectonic regime (Lowe et al, 2014). It is also reasonable to assume that the early life was influenced significantly by these impacts (Lowe et al., 2003). The early evolution of life might have been accelerated as a consequence of adaptation to such environmental agitations (Kozawa et al., 2018; Oehler et al., 2017). Thus, a close association of traces of life, such as microfossils with cellular preservation, and of impact events recorded in Archean sedimentary successions is of special interest.

In this study we describe the new discovery of traces of asteroid impacts in the ca. 3.4 Ga Strelley Pool Formation (SPF) in the Panorama greenstone belt of the Pilbara Craton, Western Australia. Spherules of possible impact origin were identified in carbonaceous black chert 15 cm thick from which morphologically diverse microfossils have been described (e.g., Sugitani et al., 2013) (Fig. 1). Evidence for an asteroid impact includes the presence of a thin sedimentary layer rich in silicate spherules (Fig. 2) associated with enrichment of platinum-group elements (PGE) (Fig. 3a). However, our detailed analyses revealed that PGE-enrichment is more conspicuous in the lower horizon and are associated with $^{178}Os/^{188}Os$ initial values close to 0.1. In contrast, spherule-rich layers have significantly higher $^{178}Os/^{188}Os$ values ~1.0 (Fig. 3b). One exception is a sample from the upper portion, which has an unusually low value. It is also noteworthy that the spherule-rich layer is enriched in Al and Ti (Fig. 3c). There is a clear higher contribution by clastic materials to this layer, and this feature may explain the apparent contradiction between the PGE-enrichment and Os isotopic values described above. In either case, the layer contains abundant volcanic fragments and clasts in which spherules tend to occur. This occurrence suggests that the spherules were likely reworked from the original site of deposition. A layer composed of carbonaceous grains including rip-up clasts that is found just below the spherule-rich layer (Fig. 1) indicates a steep high-energy depositional environment. This layer contrasts with the fine parallel lamination of carbonaceous chert layers seen at the other horizons, which indicates a quiet depositional environment. We infer that the original impact layer is present below the examined carbonaceous black chert layer and that a high-energy environment related to volcanic activity caused reworking of the spherule-rich deposits, which were transported to the present site of deposition. If this is the case, the high PGE concentrations and the significantly low $^{187}Os/^{188}Os$ initial ratios of the lower cherty samples could be explained as representing the aftermath of an impact event associated with precipitation of vaporized PGE from the atmosphere to the sediment.

 

*References*

Byerly et al. (2002) Science 297, 1325-1327; Glikson et al. (2016) Precam. Res. 279: 103-122; Kozawa et al. (2018) *Geobiology* DOI: 10.1111/gbi12319; Lowe et al. (2014) Geology 42: 747-750; Lowe et al. (2003) Astrobiology 3: 7-48; Lowe and Byerly (1986) Geology 14, 83-86; Oehler et al. (2017) Precambrian Research 296, 112-119; Sugitani et al. (2015) Geobiology 13, 507-521.

Keywords: Archean, microfossils, asteroid impact, platinum group elements, osmium isotope

**Fig. 1**

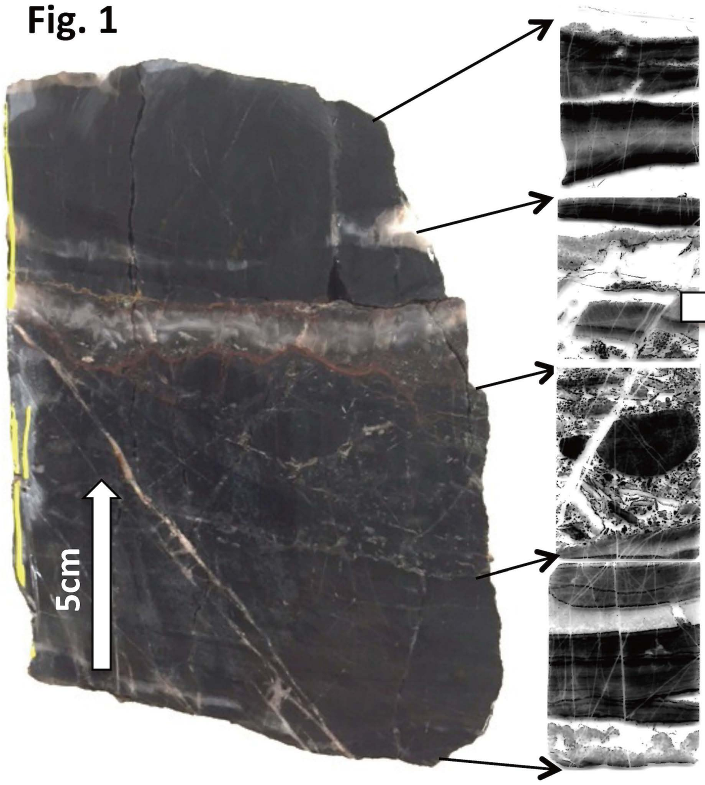


**Fig. 2**


**Fig. 3**