Geophysical Research Abstracts
Vol. 18, EGU2016-15691, 2016
EGU General Assembly 2016

Archean spherule classification of CT3 drill core, Barberton Greenstone Belt (South Africa) based on petrography and mineral chemistry

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The impact history of the Early Archean Earth is not well documented. The oldest known impact structure is about 2 Ga years old; impact-related signatures in Precambrian rocks are scarce. The possible impact signature might be the Archean spherule layers that occur in the Barberton Greenstone Belt (BGB), Kaapvaal Craton, South Africa, and in the Pilbara Craton Western Australia, with ages of 3.2-3.4 and around 2.5 Ga [1]. These spherules were interpreted as impact-generated and ballistically emplaced silicate melt droplets [2]. This study is focused on petrographic and mineralogical characteristics from a set of newly drilled Archean spherule layers in drill core CT3 from the northeastern part of the BGB. The investigation of the three main intervals (A, B, and C, which include 2, 13, and 2 individual spherule layers, respectively) within CT3, contains the classification of spherules based on their shapes, textural features, deformation types, and mineral content. All of the intervals show spherule variation in those features. Therefore, the classification helps to understand if the spherules underwent processes such as tectonic deformation or if multiple impact events occurred in the area, which both might a reason of spherule layer duplications.

The aim of the work is to differentiate various spherule types and the groundmasses in which they are embedded. The spherules within 17 identified spherule layers have been examined by optical microscopy (polarized and reflected) and secondary electron microscopy and were classified by shape and textural features. Subsequently, mineral phases and the chemical composition of the spherules and their matrices were investigated by using electron microprobe analysis.

Regarding the shapes of the spherules they were divided into two main groups: undeformed and deformed. Undeformed spherules have spherical to ovoid as well as tear-drop shapes; deformed spherules were further subdivided into three main groups; flattened, crushed/collapsed, and sheared. The spherules, size range between ~0.5 and ~2.5 mm, show needle-like, barred, and zoned (layered) textures. The main mineralogy of all spherules is of secondary origin, i.e. result of alteration, and includes fine-grained phyllosilicates, K-feldspar, oxide minerals, and minor carbonates. The mineral contents vary due to deformation and alteration. Compositionally, the spherules were subdivided into three different types, Al-rich spherules, K-rich spherules, and K/Al-rich spherules. All spherule types are either embedded in a sericitic or shale groundmass. According to these results, the layers were classified by their similar features. Although similarities exist between different intervals, no macroscopic evidence was observed to explain layer duplications between different intervals. Only within the B interval, the reason of the high number of spherule layers is concluded to be the result of tectonic folding.

References: [1] Lowe D.R., Byerly G.R., and Kyte F.T., 2014, Geology, 42, 747-750 [2] Simonson B.M., and Glass B.B., 2004 An. Review of Earth and Planetary Sci. 32:329-361.