PALEOARCHEAN SPHERULE BEDS IN THE ICDP BARB5 DRILL CORE FROM THE BARBERTON GREENSTONE BELT, SOUTH AFRICA: GEOCHEMISTRY, HIGHLY SIDEROPHILE ELEMENT SYSTEMATICS, AND Os ISOTOPIC SIGNATURES

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Introduction: Large impact events are capable of producing extended spherule layers of a few millimeters to centimeters in thickness. Only a few such spherule layers, mostly of late Archean to early Proterozoic age, are known on Earth. They provide information about an impact event even when the source crater cannot be found. As the first 2.5 billion years of the terrestrial impact history are not documented by any impact structures spherule beds provide the only available information about the collisional history of the early Earth. Spherule beds from the Barberton area have been known for more than 25 years [e.g., 1]. Unlike modern impact deposits, most of these spherule layers show extreme enrichments in Platinum-Group Element (PGE) abundances, but the strongest evidence for a meteoritic origin of at least some of them so far rests on Cr isotope analyses, supporting chondritic signatures [2-4]. Two recently recovered drill cores from the northern Barberton area (CT3 and BARB5) with as many as 20 spherule layer intersections of Paleoarchean age significantly enhance the number of known spherule beds and provide an outstanding opportunity to gain new insight into the early terrestrial impact bombardment. This study focuses on the BARB5 drill core, which includes four spherule horizons. We present bulk element concentrations and PGE data, as well as Os isotope data for spherule layer and country rock samples, in order to assess possible correlations between the closely spaced BARB5 spherule beds, to determine the magnitude and spatial distribution of meteoritic admixtures within them, and to attempt to constrain the number of impact events they represent.

Methods: For 30 samples, including spherule-free country rocks and spherule layers, major and trace element abundances were determined by instrumental neutron activation analysis at the University of Vienna, Austria. Isotope dilution generated PGE analyses for selected samples were performed at the Steinmann Institute in Bonn, Germany. Osmium isotopic abundances were determined using a TRITON thermal ionization mass spectrometer in negative mode at the University of Vienna.

Results: Chromium, Co, and Ni abundances are consistently higher in the spherule horizons compared to the spherule-free country rock samples. Platinum Group Element concentrations, at typically komatiitic levels in the country rocks, range up to chondritic levels in some of the spherule horizons, roughly correlating with the spherule content of the samples. Present day $^{187}Os/^{188}Os$ ratios are significantly less radiogenic in the spherule horizons (ranging from ~0.106 to ~0.172) compared to spherule-free samples (with values up to ~0.317) [5].

Discussion: It is currently not clear whether or not the BARB5 spherule beds are correlated to the well-known spherule beds from the Barberton area [1], or if they represent one or more different units. All of the analyzed BARB5 samples (including spherule-free country rock and spherule layer samples) show a good correlation between Cr and Ir, as all the spherule layers investigated so far do, with an intersection at chondritic abundances. This provides strong support for the presence of a meteoritic component within the BARB5 samples. Komatiitic volcanics are present throughout the Barberton area, providing an ultramafic background that limits the significance of the ^{187}Re-^{187}Os vs. $^{187}Os/^{188}Os$ space usually used to visualize mixing trends between impactites and target rocks. However, compared to the intercalating country rocks (mostly shales and cherts from the Fig Tree group), all spherule layer samples from the BARB5 drill core exhibit on average less radiogenic ^{187}Os isotope signatures and lower ^{187}Re-^{187}Os ratios compared to the spherule-free sedimentary rocks. This further supports the presence of a significant meteoritic admixture within the BARB5 spherule layers.

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