EARTH'S OLDEST PRESERVED EXTRATERRESTRIAL IMPACT DEPOSIT? EVIDENCE FOR A LARGE IMPACTOR 3.48 BILLION-YEARS-AGO (DRESSER FORMATION, PILBARA CRATON, AUSTRALIA). M. J. Dobson[1], T. Schulz[2], C. Koeberl[2], K. A Campbell[1], M. Rowe[1], M. J. Van Kranendonk[3], A. Stopic[4], J. Havig[5], B. L. Teece[3,6], D. Guido[7], F. Westall[8], F. Foucher[8], T. Hamilton[5], A. Hamilton[1], B. Charlier[9], F. Gerber[9], and J. Lang[1]. [1]School of Environment, Waipapa Taumata Rau- The University of Auckland, Auckland, New Zealand (m.dobson@auckland.ac.nz) [2]Department of Lithospheric Research, University of Vienna, A-1090 Vienna, Austria (toni.schulz@univie.ac.at, christian.koeberl@univie.ac.at) [3]School of Biological, Earth and Environmental Sciences, University of New South Wales, Sydney, Australia. [4]Australian Nuclear Science and Technology Organisation, Lucas Heights, Sydney, Australia [5]College of Biological Sciences, University of Minnesota, USA. [6]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, USA [7]CONICET and Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Instituto de Recursos Minerales (INREMI), Argentina [8]CNRS, Centre de Biophysique Moléculaire Orléans Cedex 2, France [9]School of Geography, Environment and Earth Sciences, Victoria University of Wellington, Wellington, New Zealand.

Introduction: Our understanding of the early Earth immediately after the wake of the Hadean bombardment/accretion period is restricted by the potential for preserving Archean rocks. Earth's active tectonism, erosion, and metamorphism have erased evidence of the late heavy bombardment, with the oldest widely accepted preserved impact being the 2.23 Ga Yarrabubba structure in Western Australia [1]. No impact structures have been identified in Archean rocks (3.0 - 3.5 Ga). Instead, research on Archean bolide events has focused on impact ejecta layers due to their higher preservation potential. The oldest impact-derived layers identified thus far range in age from 3.4 to 3.2 Ga and are found in the Pilbara Craton in Australia and the Barberton Greenstone Belt (BGB) in South Africa [2].

Currently, there are 16 outcrop and 19 proposed drillcore impact spherules reported from Archean rocks globally [3-6]. The oldest identified impact spherule deposits in the geological record are dated at 3.47 Ga in both the Antarctic Chert Member (ACM) of the Mount Ada Basalt, Pilbara Craton, Western Australia [7], and the 3.45 Ga Hoogenoeg Formation, Barberton Greenstone Belt (BGB), Kaapvaal Craton, South Africa [8]. A multitude of large bolide impacts are inferred for the early Archean, based on modeling, and therefore the paucity of recorded impact layers means they (1) have not been preserved in the geological record or (2) have not yet been discovered.

Here we present recently discovered spherule-rich layers within clean drillcore samples from the ~3.48 Ga Dresser Formation, Pilbara Craton in Western Australia collected in 2019.

Results and Discussion: Four spherule horizons of 0.2 – 8 cm thickness were identified in the cores. Stratigraphic correlation across two separate drillcores suggests the deposits represent up to three distinct spherule horizons. Samples show petrographic textures (spherical and dumbbell shapes, quenched features, radial crystal splays, internal scalloped textures, and off-centered vesicles) similar to other Archean to Phanerozoic impact spherule beds. Spherule diameters range from 0.15 – 1 mm, but most are 0.3-0.6 mm in diameter, similar to BGB S1 spherules [8]. µXRF EPMA, and Raman mapping of the spherules indicate that rims are predominantly Ti-rich (anatase, with minor rutile), with minor Fe and Ba [8]. Interiors consist of quartz or secondary sericite and/or carbonate, plus anatase. Low concentrations of Ni-Cr spinel are present in some horizons, which is important as previous work on BGB spherules suggests that the dominant carrier phase for an extraterrestrial component lies in Ni-Cr spinel [9]. One spherule horizon occurs in a chert matrix with clotted carbonaceous matter. Instrumental neutron activation analysis (INAA) data yield Ir contents ranging from below detection limit (<1 ppb) to up to 24 ppb. Preliminary $^{187}Os/^{188}Os$ isotopic analysis of the Ir 24 ppb horizon shows chondritic $^{187}Os/^{188}Os$ ratios (~0.12) and Os and Ir concentrations above the level for the upper continental crust. These results are distinct from $^{187}Os/^{188}Os$ results obtained on drillcore cherts and ultramafic volcaniclastic sandstones, which, in part, exhibit supercrustal $^{187}Os/^{188}Os$ ratios in conjunction with crustal-like Os concentrations in the ppt range. Further $^{187}Os/^{188}Os$- and HSE analyses on the spherule-rich and non-spherule-bearing horizons from the Dresser Formation are currently being undertaken and results will be presented at this meeting.

Conclusions: Textural and preliminary geochemical results suggest an impact origin for three spherule-rich horizons in the 2019 Dresser drillcores- representing the oldest evidence of a potential bolide impact in the geologic record of Earth.

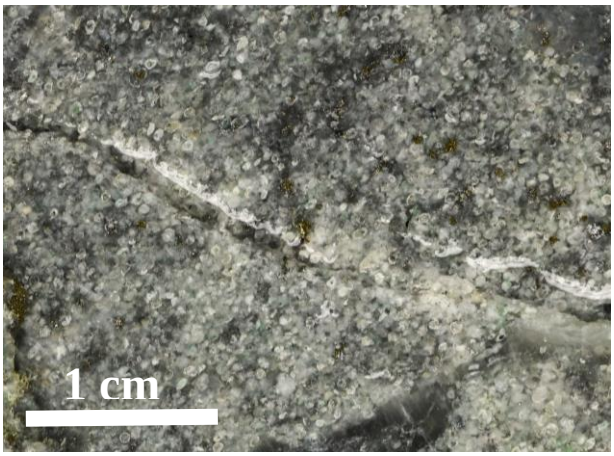

Fig 1: Polished core slab view of spherule horizon 1A22A

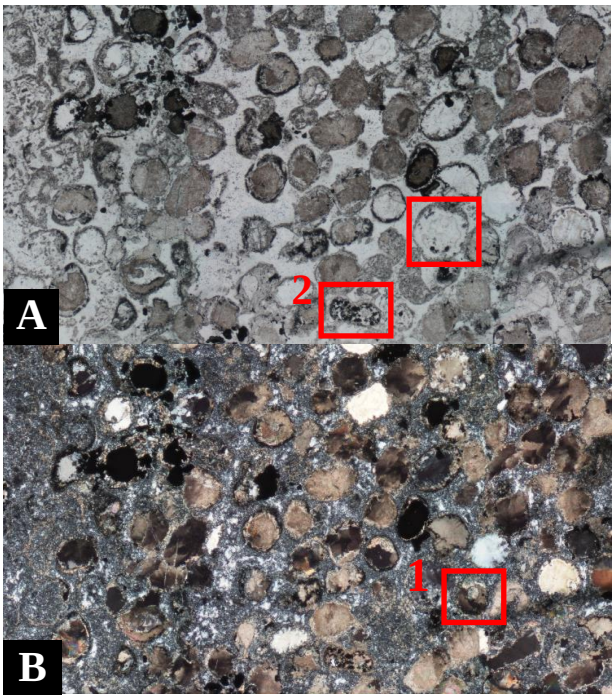

Fig 2: Petrographic images of spherule deposits in 1A22A. Spherules are altered by secondary sericite and/or carbonate; those containing internal scalloped textures, dumbbell shapes, and internal vesicles are indicated in red. **A) Plane polarised light (**PPL); **B) Cross-polarised light (**CPL micrographic overview photo of 1A22A.

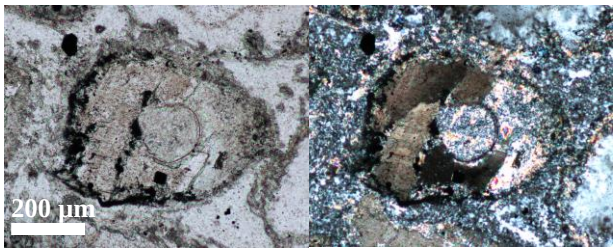

Fig 3: Microphotographic image of spherule labeled 1 in Fig 2 B. Spherule contains internal circular vesicle and is replaced by secondary dolomite. Left: PPL, Right: CPL.

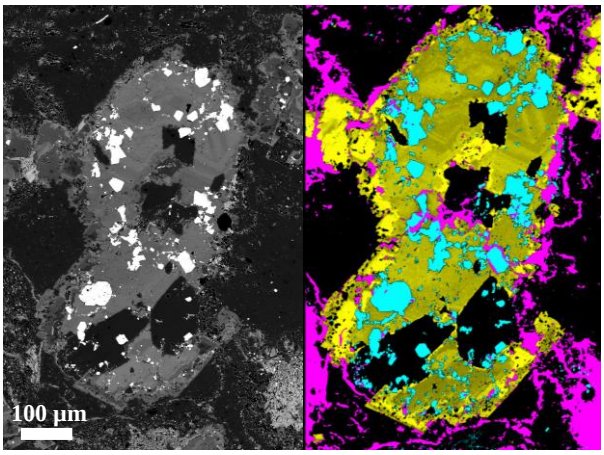

Fig 4: BSE and WDS images of dumbbell-shaped spherule labeled 2 in Fig. 2A. Blue = Ti (secondary anatase); Yellow = Mg (secondary dolomite); Purple = Al (secondary sericite).

Acknowledgments: This research was supported in part by the Royal Society of New Zealand Marsden Fund; Australia's Nuclear Science and Technology Organisation - Australian Institute of Nuclear Science and Engineering Postgraduate Research Award, awarded to MJD; and the Lunar Planetary Institute Eugene and Carolyn Shoemaker Impact Cratering Award, awarded to MJD. BLT conducted her research at the Jet Propulsion Laboratory, California Institute of Technology under a contract with the National Aeronautics and Space Administration (80NM0018D0004).

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