In-Situ Cathodoluminescence Feature of Zircons In thin-Sections of Impact Layer, Barberton Belt, South Africa. X. C. Che[1], H. Q. Xie[1], M. Z. Ma, L. Q. Zhou[1], T. Long[1] and D. Y. Liu[1, 2], [1]Beijing SHRIMP Center, Institute of Geology, Chinese Academy of Geological Sciences, Beijing, 102206, China (E-mail: cxc@bjshrimp.cn), [2]Shandong Institute of Geological Sciences, Jinan, 250013, China

Introduction: The Impact history is the key to understanding planetary habitability [1, 2, 3, 4]. The Crater evidence from the Lunar surface shows that the Earth-Moon system suffered intense bombardment during the first billion years or more [5]. Nevertheless, Earth's impact records are hard to follow because the Craters of Hadean/Archean on the Earth were erased by erosion and resurfacing.

The Barberton greenstone belt from South Africa includes eight known layers (S1-S8) that consist of sand-sized spherules formed by the condensation of vaporized rock cloud by giant impact [6, 7]. Those impact layers are the direct evidence of Paleoarchean impact events on the Earth. 13 of 50 zircons (50-100 μm) were picked from 15 kg S1 layer samples, which yielded a $^{207}Pb/^{206}Pb$ age of 3470.4 ± 2.3 Ma, which represents the oldest impact record can be found on our Earth [8], Zircons in S5 represent a single population with an age of 3234 ± 5 Ma that is the youngest age of the multi-impact events [7]. However, a large number of small zircons (< 30 μm, more than 70% of zircon population) can be found in thin-section which hard to pick out by heavy liquid process [9]. Therefore, we have investigated the in-situ cathodoluminescence(CL) feature of zircons in thin sections from the impact layer.

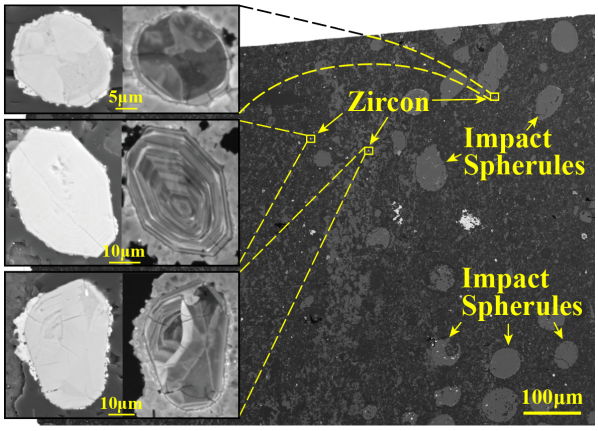

Figure 1. BSE mapping of impact spherules layer, and the BSE/CL images of three detrital zircons.

Analytical Methods: The BSE (at 20kV, 8.8mm WD, 1 minute), EDS (at 20kV, 8.8mm WD, 1 minute) and CL (at 10kV 13.1mm WD, 12 minutes) images of every single zircon grain from thin-sections were acquired through the OXFORD X-Max N[20] and Gatan Mono CL4 attached to ZEISS MERLIN Compact field emission scanning electron microscope, the Th/U ratios analyzing was performed on the SHRIMP II at the Beijing SHRIMP Center, Chinese Academy of Geological Sciences.

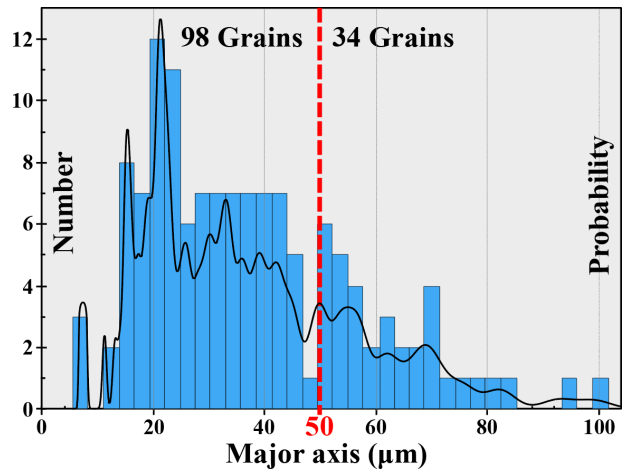

Figure 2. Histogram of size data of 132 Zircon grains, the red dashed line is the 50 μm boundary.

Results and Discussion: The Impact spherules layer was sampled on Barberton Belt, South Africa (S 25°54'54.4"/E 031°01'08.5"). This sample was strongly altered, and almost all Zircon grains are enclosed and/or filled by the xenotime. The altered mineral accelerates xenotime development compared with the xenotime developed on the side of quartz (Fig. 1).

A total of 132 Zircon grains have been identified in five thin-sections, far more than that yielded by the heavy liquid process. The prominent probability peak of grain size is about 22 μm (Fig. 2), and the big grains (50-100 μm) accounts for merely 25.7% (34/ 132). Most of the zircon grains are euhedral (Fig 3), only 3/132 grains appear obviously rounded (Fig 3F), which interpreted as locally derived detritus produced [9]. 58/132 grains have different degrees of fractures (Fig. 3D, 3I). The two features can be related to the impact tsunami waves. However, all of the zircon grains present no clear planar fractures (PFs) [10], except one grain (1/132, Fig. 3E), which shows a plausible PFs feature but needs further investigation.

From the cathodoluminescence images, 88/132 zircon grains show good crystal morphology and clear oscillatory zoning, as is the case of magmatic zircon (Fig. 1, 3F, 3H). 101/132 grains were partly or wholly recrystallized (Fig. 1, 3G).

Cathodoluminescence images exhibit that the 54/132 Zircon grains have the dark overgrowth rim from a few microns to dozens of micron range (Fig. 3A, 3B, 3C), and the in-suit fracture of overgrowth zircon demonstrates the rim must grow before diagenesis (Fig. 3C). The overgrowth rims have the Fe and Al bearing inclusion and have relatively low zirconium content high uranium content compare with the core. Metamorphic zircon occurs as overgrowths commonly with low Th/U (< 0.1) [11]. However, the Th/U ratios from the overgrowth rim of those zircons are 0.15-0.88, but that similar to the zircon formed in impact melt on the moon [12]

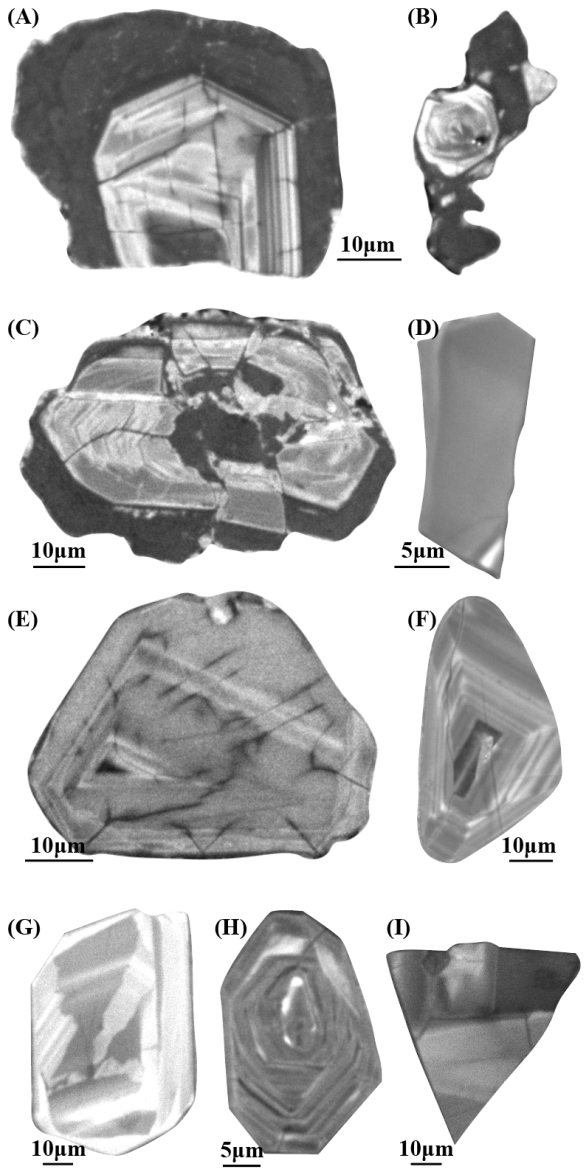

Figure 3. The cathodoluminescence feature of zircon grains in thin sections from S1.

Conclusion: Comprehensive the data of grain size, BSE, EDS, and CL images of zircon grains from the impact layer, the origins of zircons are complex and variety, so that needs to redate all types of zircon population to broaden the understanding of the oldest impact events on the Earth. There is also some plausible evidence from the morphology and Th/U ratios, which can be related to the impact that requires further research with new techniques.

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