U-Pb AND Pb-Pb DATING OF SMALL ZIRCONS IN EUCRITES. Q. Zhou[1], Q. Z. Yin[2], F. Y. Wu[1], Q. L. Li[1], X. H. Li[1], Y. Liu[1] and G. Q. Tang[1]. [1] State Key Laboratory of Lithospheric Evolution, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, 100029, China (zhouqin@mail.iggcas.ac.cn). [2] Department of Geology, University of California, Davis, One Shields Avenue, Davis, CA 95616, USA (qyin@ucdavis.edu).

Introduction: Basaltic eucrites are crustal materials believed to represent the products of mantle melting on its parent body, widely believed to be the asteroid 4 Vesta [1-2]. The age of the igneous event that generated basaltic eucrites [3-5] is of primary importance to constrain the evolutionary history, including melting and differentiation processes of Vesta. Our understanding of the eucrite-Vesta connection is expected to improve substantially as NASA's Dawn mission has just arrived Vesta in July 2011 for a year-long orbiter observation. Improving chronological information of basaltic eucrites in our collection and strengthening meteorite connection with the basaltic flood plain on the surface of Vesta with anticipated higher resolution images to be returned from Dawn Mission will be both timely and highly desirable.

With this goal in mind, here we report our preliminary results of U-Pb and Pb-Pb ages of zircons from five basaltic eucrites, including Béréba, Cachari, Caldera, Camel Donga and Juvinas.

Experiment: In-situ isotopic analysis of U-Pb and Pb-Pb systems were performed on a large radius magnetic sector multi-collector Cameca IMS-1280 ion microprobe at the Institute of Geology and Geophysics, Chinese Academy of Sciences in Beijing. The procedures for Pb isotopic analysis of small zircons are described in Zhou et al. [6] and references therein. In order to obtain the spot size at the 3-4 μm lateral scale and acquire the precision as the conventional SIMS U-Pb isotopic measurements with a spot size >>10 μm, we have developed some new technologues in this study, including (1) The primary oxygen ion beam was tuned in Guassion mode of which the primary ions have energy distribution like Gaussian distribution in order to maximize the energy density at the center of a small spot size; (2) The oxygen flooding technique which introduces the oxygen into sample chamber enhancing the secondary Pb^+ ion yield, thus improving the precision of $^{207}Pb/^{206}Pb$ measurement; (3) Nuclear Magnetic Resonance controller was used in multi-collector measurements to stabilize the magnetic field. Using the above new techniques, we are able to successfully date zircon grains with a typical spot size < 3×5 μm to meet the challenges of small zircons and other suitable U-rich minerals often found in eucrite and other extra-terrestrial materials to expand our knowledge of the evolutional history for early Solar System.

Petrography: Eucrites, including Béréba, Cachari, Caldera, Camel Donga and Juvinas, are a coarse-grained and granular in texture. They are composed mainly of plagioclase and pyroxene with minor amount of tridymite, chromite and ilmenite. Zircons as accessory minerals are associated with ilmenite in most cases and have subhedral shape with typical size of <10μm.

Results: Five measurements of U-Pb isotope composition were obtained on zircon grains in Béréba, and the $^{207}Pb/^{206}Pb$ ages are plotted in Fig. 1. The weighted mean of $^{207}Pb/^{206}Pb$ ratios is 0.618 ± 0.008, translating to ages of 4551 ± 20 Ma (uncertainties are reported at 95% confidence level, with a student t-factor applied for limited number of repeat analyses) [7].

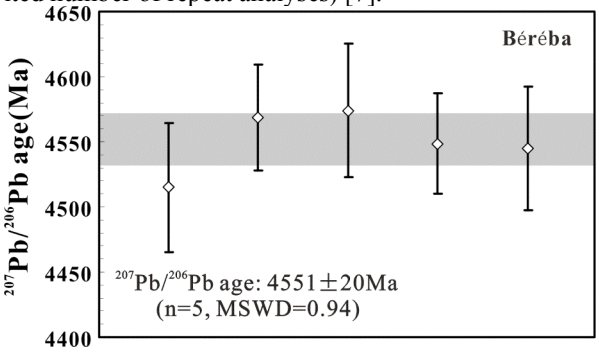

Fig. 1. The average Pb-Pb age for zircon grains in Béréba.

Three measurements of U-Pb and seventeen Pb-Pb isotope compositions were obtained on zircon grains in Cachari, and the $^{207}Pb/^{206}Pb$ ages are illustrated in Fig. 2. The weighted mean of $^{207}Pb/^{206}Pb$ ratios is 0.618 ± 0.006, translating to ages of 4550 ± 11 Ma [6-7].

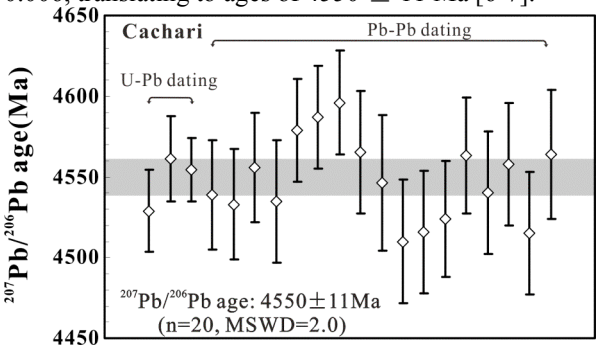

Fig. 2. The average Pb-Pb age for zircon grains in Cachari.

Four measurements of U-Pb isotope composition were obtained on zircon grains in Caldera, and the $^{207}Pb/^{206}Pb$ ages are present in Fig. 3. The weighted mean of $^{207}Pb/^{206}Pb$ ratios is 0.613 ± 0.034, translating to ages of 4542 ± 81 Ma. Due to the limited number of zircon

grains available for analyses, the error of weighted average $^{207}Pb/^{206}Pb$ age is much larger comparing to the other eucrites.

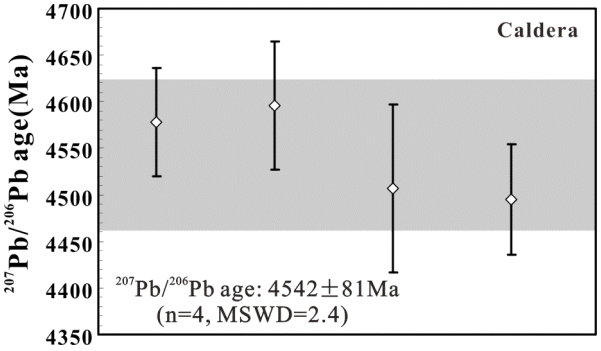

Fig. 3. The average Pb-Pb age for zircon grains in Caldera.

Thirty six measurements of U-Pb isotope composition were obtained on zircon grains in Camel Donga, and the $^{207}Pb/^{206}Pb$ ages are plotted in Fig. 4. The weighted mean of $^{207}Pb/^{206}Pb$ ratios is 0.610 ± 0.004, translating to ages of 4533 ±10 Ma which is apparently younger than the other four eucrites.

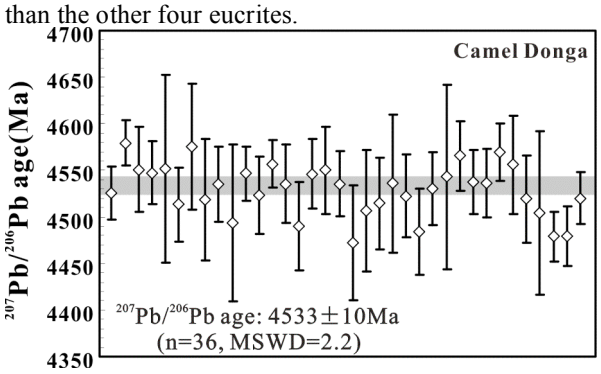

Fig. 4. The average Pb-Pb age for zircon grains in Camel Donga.

Twenty measurements of U-Pb isotope composition were obtained on zircon grains in Juvinas, and the $^{207}Pb/^{206}Pb$ ages are presented in Fig. 5. The weighted average $^{207}Pb/^{206}Pb$ age of 4546 ±15 Ma (n=36) in our studies is much more reliable than the result of 4527 ± 24 Ma (n=2) with an microprobe of SHRIMP [8] due to the more number of analytical points.

The results for U-Pb and Pb-Pb dating of zircons in five eucrite, including Béréba, Cachari, Caldera, Camel Donga and Juvinas, are summarized in Fig. 6. There is no obvious discrepancy for the $^{207}Pb/^{206}Pb$ ages from different eucrites. The final weighted average $^{207}Pb/^{206}Pb$ age of 4542 ± 6 Ma was obtained for the five eucrites in this study.

Conclusions: The new dating technique developed in this study makes it possible to date zircon grains at a scale of <5 μm. We hope the technique will stimulates more investigations for a wide range of U-rich minerals with very small grains in meteorites. Using this method, we have obtained the weighted mean of $^{207}Pb/^{206}Pb$ age of 4551 ± 20 Ma for Béréba, 4550 ± 11 Ma for Cachari, 4542 ± 81 Ma for Caldera, 4533 ± 10 Ma for Camel Donga and 4546 ± 15 Ma for Juvinas, respectively. Considering the unique property of zircon that it is resistant to reset the U-Pb isotopic systematics at high temperatures, we conclude that the eucrite zircons from our result would record the peak basaltic volcanism at ~4545 Ma on Vesta (Fig. 6), which is consistent with the previous studies [3-5, 7]. However the error bar of 6 Ma (Fig. 6) in this study is much reduced than the previous investigation combined, demonstrating the needs to acquire more data in order to refine the age of peak basaltic volcanism on Vesta.

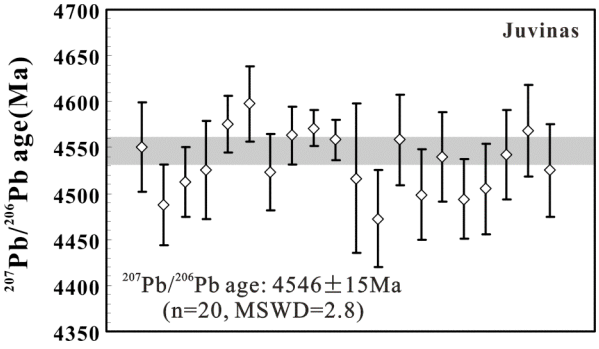

Fig. 5. The average Pb-Pb age for zircon grains in Juvinas.

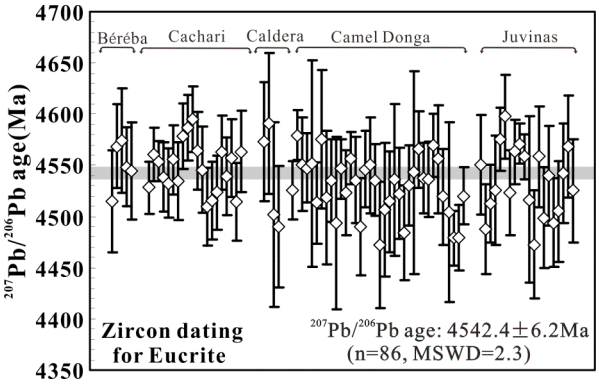

Fig. 6. The summary of average Pb-Pb age for zircon grains in Eucrite.

References: [1] Drake (2001) *MAPS, 36,* 501. [2] Binzel and Xu (1993) *Science 260,* 186. [3] Ireland and Wlotzka (1992) *EPSL, 109,* 1. [4] Misawa et al. (2003) *GCA, 69,* 5847. [5] Misawa et al. (2003) *GCA, 69,* 5847. [6] Zhou et al. GCA Submitted [7] Zhou et al. (2011) *LPS XLII,* A5752. [8] Lee et al. (2009) *GCA, 73,* A737.