# U-PB DATING OF ZIRCON WITH PETROGRAPHIC SETTINGS FROM THE MARTIAN REGOLITH BRECCIA NWA 7034

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**Introduction:** NWA 7034 is the first regolith breccia from Mars, consisting of various lithic clasts, large mineral fragments and find-grained matrix [1,2]. It represents martian crustal rock and contains high water up to 6000 ppm [1]. A Rb-Sr whole-rock-mineral isochron of NWA 7034 gave an age of 2089±81 Ma with initial $^{87}Sr/^{86}Sr$ ratio of 0.71359±54 [1], which indicative of origin from an enriched reservoir. Zircon grains are common found in NWA 7034 and its paird meteorites. A zircon U-Pb age was reported 4428±25 Ma, with identification of a later disturbing event at 1712±85 Ma [2]. The same zircon U-Pb age of 4439±14 was reported by [3]. In addition, the authors achieved another concordant upper intercept age of 1441±37 Ma in a ~100 μm zircon, and a third intermediate group with an upper intercept age of 4333±38 Ma and a lower intercept age of 1434±65 Ma [3]. All phosphates gave a consistent lower intercept age of 1345±47 Ma [3]. In order to clarify zircon U-Pb ages of NWA 7034, we carried out a detailed petrographic study of NWA 7034, and conducted a high lateral resolution U-Pb dating with NanoSIMS 50L.

**Experiments:** Petrography was carried on a polished section of NWA 7034 using a FE-SEM. CL and laser Raman spectra were measured to reveal possible zonings and crystallographic information of zircon grains. The zircon U-Pb dating was carried out with a NanoSIMS 50L as described by [4], except that the data were acquired as images with a size about 10 x 10$\mu m^2$. After measurement, the counts of interesting areas of the images were selected to do the U-Pb dating plot. The main advantage of the image method is avoidance of large U-Pb fractionation when the sputted pits got deep, hence the lateral resolution of zircon U-Pb dating can be improved to ~2 μm. Furthermore, distribution of key trace elements, e.g. P, Y, Ti, can be acquired together with U-Pb dating.

**Results:** NWA 7034 has a typical texture of breccia, mainly consisting of igneous clasts and fine-grained matrix. Three petrographic settings of zircon grains were found in this study: (1) Euhedral grains in orthoclase- and apatite–bearing basaltic clasts. They are small, 3-20 μm, and interstitial to pyroxene and or enclosed in orthoclase; (2) Single fragmensts in the fine-grained matrix; (3) Complex fragments in the fine-grained matrix, but significant heterogeneous under FE-SEM. One of the complex fragment, Zr#62, has a glass-like centre and a discontinuous crystal rim. The glassy center remains small crystal relicts, and the crystal rim is fractured. The vitrified nature of the center was confirmed by Raman spectra. CL mapping reveals the difference, showing a bright rim and a dark center. CL zonings were also found in zircon grains in the basaltic clasts and other single fragments. Trace element mapping depicts correlations of P with Y and U, which are similar between the grains in basaltic clasts and the single fragments in the matrix, a substitution of xenotime common for zircon [5]. The three complex zircon fragments have distinct trace elements. Furthermore, Y, U and P are very enriched in the glassy areas, but poor in the crystal relicts. All analyses of the zircon grains in basaltic clasts have a concordiant age of 4424±46 Ma, except for a few analyses somewhat shifted to a reverse discordiant line and one analysis showing disturbance. The single fragments in the matrix have the same concordiant age of 4461±37 Ma, without evidence for disturbance. The complex fragments also give a same concordiant upper intercept age of 4465±73 Ma, but with a lower intercept age of 1634±93 Ma. In fact, most analyses of the glassy areas of Zr#62 plot on the concordiant line at age of 1724±70 Ma.

**Discussion:** Most of the zircon grains have an same age of 4.42-4.46 Ga, recording the early formation of Martian crustal rock. The similar trace elements and U-Pb concordiant ages of zircon grains in basaltic clasts and in the matrix indicate that the former is likely the source of the latter. The vitrification of the complex fragments in the matrix was not due to impact metamorphism, but damaged by irradiation. Significant disturbance of U-Pb system was found only in the vitrified zircon, because of easy loss of Pb during the later event at 1724±70 Ma, which was probably related to the formation of this meteorite. The large sizes and distinct trace elements of the complex fragments suggest that they probably crystallized from a distinct magma but at the same time or from a residual melt of the same magmatism.

This work was supported by Natural Science Foundation of China (Grants: 41430105, 41490631 and 41573057).

**References:** [1] Agee C. B., et al. 2013. *Science* 339: 780-785. [2] Humayun M., et al. 2013. *Nature* advance online publication: [3] Yin Q. Z. and al. e. 2014. *Lunar and Planetary Science Conference* 45th: #1320. [4] Yang W., et al. 2012. *J. Anal. At. Spectrom.* 27: 479-487. [5] Yang W., et al. 2016. *Contributions to Mineralogy and Petrology* 171: 1-16.