ZIRCONS IN NORTHWEST AFRICA 7034: RECORDERS OF CRUSTAL EVOLUTION ON MARS. R. Tartèse1, M. Anand1,2, F. M. McCubbin1, A. R. Santos2 and T. Delhaye4, 3Planetary and Space Sciences, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK. 2Department of Earth Sciences, The Natural History Museum, Cromwell Road, London, SW7 5BD, UK. 3Institute of Meteoritics, University of New Mexico, 200 Yale Blvd SE, Albuquerque, NM, 87131, USA. 4Plateforme NanoSIMS/OSUR, Université de Rennes 1, Campus de Beaulieu, 35042 Rennes Cedex, France (Romain.Tartese@open.ac.uk)

Introduction: The Earth-Moon system underwent an important stage of crust building ~ 4.3-4.4 Gyr ago based on the ages of the oldest detrital terrestrial zircons and those determined for rocks from the lunar highlands crust [1-4]. This time period now seems to correspond to an important period of crust building on Mars as well, as recently confirmed by U-Pb dates on zircons from the martian meteorite Northwest Africa 7533 (NWA 7533; [5]). In this contribution, we report results of the U-Pb dating study that was carried out, using the NanoSIMS 50 ion probe, on zircons and baddeleyites in the paired meteorite Northwest Africa 7034 (NWA 7034; [6]). A parallel effort using an ims-1280 ion probe for U-Pb dating is presented at this meeting [7].

Analytical techniques: Zircon and baddeleyite grains were located using back-scattered electron (BSE) images and X-ray maps of a polished thin section of NWA 7034 using secondary electron microscopy (SEM) at the Open University, UK. U-Pb analyses were carried out using the Cameca NanoSIMS 50 at the University of Rennes 1, France. A general description of the instrument and its configuration for dating purposes is given in Tartèse et al. [8]. A 1 nA O primary beam was rastered over 2 µm × 2 µm or 3 µm × 3 µm areas, depending on the target size and zoning features of the grains. A mass resolving power of ~5000 was achieved, which was sufficient to isolate the major HfSi interferences from the Pb isotopes. The vacuum in the analysis chamber remained constant for the entire session at ~ 4 × 10⁻⁹ torr. Analyses were carried out using the NanoSIMS combined mode: the magnetic field was switched to measure background (203.5), 204Pb, 206Pb and 207Pb in an up-mass sequence on the detector EM#2, and species 90Zr16O, 238U and 238U16O were simultaneously acquired when the magnetic field rested to measure 206Pb. Before analysis, the probe was rastered over 6 µm × 6 µm areas for ~ 5 min to remove any potential surface contamination. Secondary ions were then collected for 14 cycles, resulting in a total analysis time of ~ 23 min. Automatic centering was performed on the 90Zr16O peak at the beginning of each analysis and repeated half way through each run. The ion signals were processed using the NanoSIMS DataEditor software (Frank Gyngard, Washington University, St Louis, USA), and isotope ratios were calculated from total counts. Standards used for data reduction were zircon 91500 [9] and Phalaborwa baddeleyite [10].

Results: Zircon grains analysed yielded the following results: NWA 7034 meteorite contains a population of old zircons, dated at 4.37 ± 0.07 Ga (2σ; Fig. 1) through the upper intercept of a discordia anchored at ~ 1.5 Ga. This younger date probably corresponds to an important event in the history of NWA 7034, since this event 1) has disturbed the U-Pb systematics in old zircons and 2) promoted crystallisation of a second generation of zircons. More specifically, U-Pb data obtained on these ‘young’ zircons define a second discordia whose upper intercept yielded a date of 1.57 ± 0.03 Ga (2σ; Fig. 1), which thus represents the age of this important disturbance event. This second discordia passes through the origin, indicating possible recent Pb loss for these young zircons, likely related to the ejection of NWA 7034 from Mars ~ 5 Myr ago [11].

Interestingly, preliminary K-Ar dating carried out on whole rock yielded a date of 1.55 Ga [11], identical to the young U-Pb zircon age. Finally, the old age obtained on zircons is consistent with data published by Humayun et al. [5], who reported U-Pb dates for zircons in the paired meteorite NWA 7533 using the SHRIMP ion probe employing a 7 µm primary beam, and obtained an old age of 4.43 ± 0.03 Ga. On the oth-

Fig. 1: 206Pb/238U vs. 207Pb/235U concordia diagram for U-Pb data obtained on zircons in Martian meteorite NWA 7034.
er hand, the ~1.7 Ga disturbance age they reported was not seen in our study.

Five analyses were performed on 2 baddeleyite
grains located in the matrix of NWA 7034, and yielded
two distinct upper intercept dates of 4.41 ± 0.02 Ga and
4.31 ± 0.05 Ga (Fig. 2), both discordia passing through
the origin, suggesting that these grains suffered recent Pb-loss. On the other hand, U-Pb systems
in these two baddeleyite grains have not been affected
by the ~ 1.5 Ga event identified in zircon U-Pb data.
These U-Pb dates obtained on baddeleyites are more
precise than on zircons due to higher U and Pb contents.
The ‘old’ date obtained on zircon is identical to
both baddeleyite dates considering uncertainties. How-
ever, the baddeleyite data indicate at least two episodes
of magma generation in the ~ 4.4-4.3 Ga interval.

Discussion: NWA 7034 is one of the newest addi-
tions to the martian meteorite clan. This meteorite was
originally described as a monomict basaltic breccia,
and has many similarities with geochemical dataset
acquired by various orbital, lander, and rover missions
[6]. Furthermore, it shares geochemical linkages with
the shergottites, providing a modern link between the
mission and shergottite dataset. This meteorite also
yielded a Rb-Sr whole rock isochron age of 2.1 Ga [6],
and was considered critical for understanding martian
surface conditions from the transition from the early
to middle Amazonian epoch. Upon further examination
of NWA 7034, it has become clear that it is a polymict
basaltic rock with a mixture of highly rounded and
angular clasts of varying size. NWA 7034 is poorly
sorted with lithic clasts ranging from larger than 1 cm
to grains that are clay-sized. The meteorite has some
textural features indicative of being an impactite (pre-