Refining the U-Pb chronology of the early Solar System

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Chronology of early Solar System processes is based on high-resolution dating of objects such as CAIs, chondrules and differentiated meteorites. Extinct radiochronometers (e.g. ^{26}Al-^{26}Mg) provide high-resolution dating of meteoritic objects, but the robustness of their model ages relies on the accuracy and precision of the U-Pb age of the anchor, taking into account possible ^{238}U/^{235}U variations [1].

We present high-precision U and Pb isotopic measurements using MC-ICPMS of the ungrouped basaltic achondrite NWA 2976, paired with NWA 011 & 2400 [2]. These meteorites show distinctive isotopic characteristics for O, Ti and Cr, suggesting possible affinities to the carbonaceous chondrites [2, 3]. The Al-Mg model age of NWA 2976 is 4564.16 ± 0.23 Ma anchored to D'Orbigny [4, 5]. Thus NWA 2976 has the potential to serve as a time anchor for several short-lived chronometers, and may also provide new constraints on the degree of isotopic heterogeneity in the solar nebula. A total of 7 samples including 2 pyroxene (Px) and 2 plagioclase (Pl) separates, and 3 bulk samples (WR) of NWA 2976 were processed for Pb isotope analyses, and 1 bulk sample was processed for U isotope analyses. Analytical details are given in [1, 6]. The Px and WR residues have the most radiogenic ^{206}Pb/^{204}Pb (1010-2470), while the Pl residues are relatively unradiogenic (130-180). The Pb-Pb internal isochron age is 4564.25 ± 0.55 Ma using the 5 most radiogenic WR and Px samples (^{206}Pb/^{204}Pb>1010) and assuming a ^{238}U/^{235}U ratio of 137.88. The ^{238}U/^{235}U of the WR (relative to the SRM 950a value of 137.88) is 137.791 ± 0.013 (2SD), which translates to a Pb-Pb age of 4563.3 ± 0.6 Ma. This Pb-Pb age for NWA 2976 is concordant with its Al-Mg model ages (based on D'Orbigny and the NWA 2364 CAI as anchors, taking into account adjustments to their Pb-Pb ages due to U isotope variations [7, 8]). This consistency between absolute and relative chronologies in differentiated meteorites and CAIs indicates that the short-lived radionuclides were homogenously distributed in the solar protoplanetary disk.

[1] Brennecka *et al*. (2010) *Science* **327**, 449. [2] Sugiura & Yamaguchi (2007) *LPSC* **38**, 1338. [3] Trinquier *et al*. (2009) *Science* **324**, 374. [4] Spivak-Birndorf & Wadhwa (2009) *MAPS* **44**, 5390. [5] Amelin (2008) *GCA* **72**, 221. [6] Bouvier & Wadhwa (2010) *LPSC* **41**, 1489. [7] Brennecka *et al*. (2010) *LPSC* **41**, 2117. [8] Bouvier & Wadhwa (2009) *LPSC* **40**, 2144.

Metastabilizing aqueous solutions in micrometric cylindrical tubes

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The occurrence of solid salts in pores has well-known damage effects (e.g. [1]). It is here demonstrated that it also changes drastically the topology of the porous spaces and possibly also the properties of the occluded liquid. We performed a series of observations on NaCl precipitation in 75μm cylindrical tubes, evidencing that the solid forms at the liquid-air interface contributing to isolate the remaining liquid column (Fig. 1a). The homogeneous capillary tube is now heterogeneized by the two NaCl 'corks', apparently closing the micro-system on itself. After 6-months observation of such immobile situation, we observed the cavitation of a vapor bubble in the liquid behind the NaCl cork (Fig. 1b). This event demonstrates that the occluded liquid underwent a metastable superheated state, controlled by the very thin capillary plugs certainly persisting, tough invisible, around the NaCl precipitates.

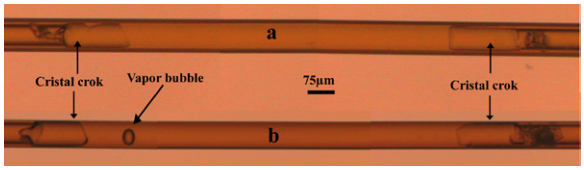

Figure 1: NaCl growing crystals in capillary tubes

These observations show that the salts precipitation not only heterogeneizes a porous medium and changes its transfer properties by isolating micro-volumes of liquid, but also drastically modifies the thermochemical properties of the occluded liquid and so its reactive behaviour with its surroundings.

[1] Scherer G.W. (2004) *Cement Concrete Res*. **34**, 1613–1624.