

## Preface: Evolution of the solar system: New advances in cosmochemistry and planetary chemistry

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The understanding of evolution of solar system has been recently entered a phase of major change with the results of new astronomical observation, several primitive extra-terrestrial samples including returned samples by spacecraft, new development of high precision and high spatial-resolution for isotope analytical techniques. Based on conventional common knowledge for the view of evolution of solar system, we tried to understand where there is consensus within Cosmochemistry; what are the initial isotopic characteristics of our solar system with distance from the Sun; how, when and where CAIs and chondrules formed; and what were the volatile signatures in planetary bodies including Mars, Earth and Moon. This special issue collates the new innovative studies presented in the Theme-23 “Planetary chemistry” and -24 “Cosmochemistry and astrophysics” at the 25th anniversary V. M. Goldschmidt conference held in Prague, CZ in 2015. Remarkably, we are proud that current activity in Cosmochemistry and related fields is so high that this is the third special in Cosmochemistry and Planetary chemistry, following from the previous two special issues dedicated to the Goldschmidt conference 2013 (Tachibana *et al.* (2014) and 2014 (Usui *et al.* (2016)).

Abe *et al.* (2017) reports the petrographic occurrences, abundances, and compositional variations of cosmic symplectites (COS; Sakamoto *et al.*, 2007) in the Acfer 094 ungrouped carbonaceous chondrite. The oxygen isotopic compositions of COS show the most <sup>17,18</sup>O-rich ( $\Delta^{17}\text{O} \sim 90\%$ ) in our solar system. They have identified 314 COS grains in two thin sections of Acfer 094 and COS grain are ubiquitously distributed in the Acfer 094 matrix with  $\sim 600$  ppm surface area abundance. They discuss the origin of COS by oxidation of Fe, Ni-metal and sulfides by <sup>17,18</sup>O-rich water vapor in the outer part of the protoplanetary disk.

Fukami and Yokoyama (2017) report the tellurium (Te) isotope compositions of acid leachates and residues from

three carbonaceous chondrites, Allende, Murchison, and Tagish Lake. Most of the Te isotope compositions in the acid leachates and residues were indistinguishable from that of the terrestrial standard within analytical uncertainties, indicating a homogeneous distribution of Te isotopes in the solar nebula. This suggests that the loss of anomalous Te isotope signatures within carbonaceous chondrites (i.e., presolar phases) in temperature-controlled nebular processes before the onset of parent body formation.

Russell *et al.* (2017) describe an unusual compound chondrule from the Allende (CV3) meteorite. This object had a complex history and demonstrates that CAIs were occasionally, but rarely, melted in the chondrule-forming region. The oxygen isotope systematics of the object indicate there was more than one reservoir in which chondrules formed.

Krot and Nagashima (2017) present evidence showing that most chondrules formed over an extensive period of time and likely formed by bow shocks or magnetized turbulence. Some chondrules from ordinary, CB and CH chondrites however, appear to have formed by impacts. Thus several chondrule formation mechanisms are required to form all the observed chondrule types in meteorites.

Gilmour and Crowther (2017) report a new I-Xe age for the ungrouped achondrite NWA 7325 of  $-1.6 \pm 2.6$  Ma relative to the Shallowater standard. They then derive a new I-Xe age for the Shallowater standard of  $4562.7 \pm 0.3$  Ma, wherein the oldest chondrule I-Xe ages overlap with the oldest Pb-Pb ages of chondrules and CAIs.

Tobita *et al.* (2017) present a new mixing model to reconcile the Sr-Nd-Hf and Pb isotope systematics of Martian basalts (shergottites). They propose that geochemically enriched, intermediate, and depleted shergottites were derived from compositionally distinct mantle sources that had different  $\mu$  (<sup>238</sup>U/<sup>204</sup>Pb) values. Their model implies that the geochemical diversity of shergottites is a result of heterogeneous mantle sources and an assimilated high  $\mu$  crustal component.

Two papers explore the evolution of volatiles in the Moon. Singer *et al.* (2017) report the H isotope composi-

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tions of slowly-cooled olivine mare basalts. They find that by using D/H of olivine-hosted melt inclusions and co-existing apatite, lunar mare basalt magmas most likely assimilated solar wind hydrogen upon eruption/emplacement at the lunar surface.

Greenwood *et al.* (2017) find the highest Cl yet observed for lunar glasses, in the pristine KREEP basalts 15382 and 15386. They determine the F and Cl content of the KREEP basalts and the ur-KREEP component, and find that the Moon likely possesses an order of magnitude less fluorine and chlorine than the terrestrial upper mantle.

Many studies in the past decade have sought to explore the origin and evolution of water in planetary bodies based on the hydrogen isotopic compositions of apatite. However, no investigation has studied hydrogen diffusivity in apatite. Higashi *et al.* (2017) report hydrogen diffusion experiments using a natural Durango fluorapatite carried out under a saturated  $^2\text{H}_2\text{O}/\text{O}_2$  vapor flow at temperatures of 500–700°C. The results show that the hydrogen isotopic compositions of apatite are readily affected by the presence of water vapor through the  $^1\text{H}$ - $^2\text{H}$  exchange reaction without changing the total water content in the crystal.

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