Chemical evolution of the Solar System: Laboratory experiments and small-body explorations

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The Solar System formed by the collapse of the Sun's parent molecular cloud, containing nuclides synthesized in ancestor stars, ~4.57 billion years ago. The infant Sun was surrounded by a protosolar disk. Silicate dust, ice and organic materials, which are heritages from the interstellar medium, were thermally processed in the protosolar disk (evaporation/condensation, melting/crystallization, gas-solid reaction, annealing, and so on), resulting in the formation of chondritic components and elemental/isotopic fractionations recorded in chondrites and terrestrial planets. Chemically-processed solid components accumulated to form planetesimals, where metamorphism and aqueous alteration subsequently tool place. Planet formation followed in the final stage of the disk evolution. Gas giants captured disk gas prior to the disk dissipation. Terrestrial planets formed in the dry inner region of the disk inside the snow line, but volatiles including water were delivered at some point.

A key to understand the origin and early evolution of the Solar System is undoubtedly the analysis of extraterrestrial samples. However, in order to extract the quantitative information on physical and chemical conditions and the timescale of chemical evolution, laboratory experiments simulating chemical reactions in astronomical environments are critical elements. In this talk, I will address laboratory experiments on circumstellar dust formation, molecular cloud chemistry, formation of chondritic components, and dust evolution in the protosolar disk [e.g., 1-3].

Another key element is to expand our collection of extraterrestrial materials without any collection bias and terrestrial contamination. New sets of samples will be delivered in early 2020's from two primitive near-Earth asteroids, Ryugu and Bennu, by Hayabusa2 (2014–2020) [4] and OSIRIS-REx (2016–2023) [5]. The scientific significance of small-body explorations to understand the Solar-System evolution will also be addressed in the talk.

[1] Tachibana S. *et al.* (2011) *ApJ* **736,** 16. [2] Takigawa A. *et al.* (2015) *ApJS* **218,** 2. [3] Yamamoto D. and Tachibana S. (2016) *Goldschmidt abstracts* **2016**, this volume. [4] Tachibana S. *et al.* (2014) *Geochem. J.* **48,** 571. [5] Lauretta D. S. *et al.* (2014) *Meteorit. Planet. Sci.* **50,** 834.