

Contribution of volatile rich material to Earth's accretion

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The planetary formation processes such as accretion and differentiation might have drastically modified the composition of Earth from the building blocks from the original so-called chondritic Earth model, especially on the elemental and isotopic compositions of the volatile elements. Recently, heterogeneous accretion model that describes the growth and evolution of Earth in two different stages from volatile-depleted and volatile-rich material was revised based on isotope geochemical studies (e.g. Nudds et al., 2010). However, the exact percentage and the time sequence of this volatile-rich material accretion need to be constrained. For example, models with ~2% carbonaceous chondrite (CI-CM) material added to a dry proto-Earth will result in estimation of carbon content of Earth to be over 500ppm, which could not be explained by the current silicate mantle composition of Earth. In addition, the modeling result needs to be consistent with the siderophile elements concentration in Earth mantle and the oxidation state of Earth mantle changes through the accretion process.

Therefore, we performed experimental studies on Tagish Lake chondrite (CI-CM), a new type of volatile rich carbonaceous chondrite at different pressure and temperature conditions. Our target is to explore the possible effect of the volatile component on Earth composition through the time sequence of Earth growth, the water budget of Earth at different accretion sequences, and other possible later impact.

Our melting experiment at 12GPa shows that the measured solidus temperature of Tagish Lake meteorite is much lower than CV3 meteorite because of the existence of the large amount of volatile components; however, the measured liquid temperature is very close to that of CV3 meteorite, indicating the loss of volatile component through higher temperature (2000K) heating process. The experimental method we used works well to keep the volatile components (Carbon and Hydrogen) inside the meteorite sample during heating experiments with temperature lower than 2000K. Whether the proto-core has carbon or other volatile element will rely on further experiments at higher pressure.

Keywords: Carbonaceous chondrite, Tagish Lake meteorite, Earth accretion, High pressure and high temperature, partial melting, volatile