Behavior of selected volatile species during the Giant Impact and in the protolunar disk

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The history of the early Earth was dominated catastrophic events; the last Giant Impact was energetic enough to transform the proto-Earth and the impactor Theia, into a protolonar disk or synestia. The Earth – Moon couple condensed upon cooling from this object.

Here we study the behavior of a series of volatiles, like He, H, CO, and CO_2 in the silicate component of the disk. We approximate this compoenent to be the bulk silicate earth (BSE0, denoted in the following as pyrolite. We introduce He, CO, and CO_2 as molecular species in to the melt; we introduce H by subsituting Mg in various amounts.

At high density He remains unbonded to the silicate framework, as expected and behaves ballistic; H remains as hydroxyl up to high pressure; C shows a complex bonding pattern, with various degrees of polymerization and self-polymerization.

At low density and high temperature bubbles spontaneously separate from the melt. These bubbles are populated mainly by the volatile components; we can clearly identify the presence of molecular species. We discuss in detail the composition of the gas bubbles, and compute the fractionation of volatiles between the gas and the melt.

Using these results we can estiamte the amount and distribution of volatiles throughout the protolunar disk.

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