Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.21492

The Composition of Planetary Cores

ANAT SHAHAR

Carnegie Institution for Science

Presenting Author: ashahar@carnegiescience.edu

It could be argued that planetary differentiation is the most dramatic chemical process that a planet undergoes, setting the stage for its subsequent evolution and habitability. The differentiation of planetesimals occurs at a range of temperatures, pressures, oxygen fugacities, and on bodies with varying compositions. As increasing knowledge points to Earth and other rocky bodies being formed from already differentiated planetesimals it is essential that we understand what these planetesimals looked like in order to fully understand how Earth and other rocky planets formed.

Decades of experiments have determined the plausible light elements in the cores of planets based on partitioning experiments, sound velocities, N-body simulations, melting curves, equations of state, isotopic fractionation factors, and more. Motivated by current studies of exoplanets, a new model has recently used a self-consistent thermodynamic model to show that Earth's water, core density, and overall oxidation state can all be sourced to equilibrium between H2-rich primary atmospheres and underlying magma oceans in planetary embryos. Hydrogen derived from the atmosphere enters the magma ocean and eventually the metal at equilibrium. Oxidation of the silicate rocks from solar-like to Earth-like oxygen fugacities also ensues as Si enters the core along with H and O. To add to the model, we have conducted experiments on the solubility of hydrogen in pyrolitic glasses, typical of a primitive mantle composition.

In this presentation, we will give an overview on the current state of understanding light elements in planetary cores. The interactions between the atmopshere, the mantle, and the core of a planetesimal can have profound implications for the evolution of the planet. The only way to truly understand this process and ultimately the habitability of a planet is by combining theory with experiments and eventually observations as well.