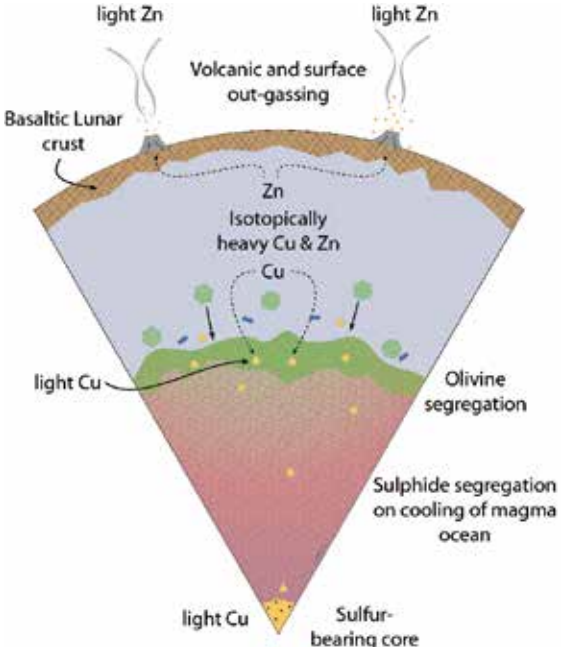
Research Adds New Insight in the Formation of Moon

The research team led by Prof. HUANG Fang from the School of Earth and Space Sciences of University of Science and Technology of China(USTC), has accurately measured the copper and zinc isotope equilibrium fractionation coefficient between silicate melt and metal melt, providing new proof for the analysis of moon core component and the formation process of the moon in collaboration with scientists form the UK and Ireland. Experiments were done with a high-precision copper-zinc isotope analysis method established by the team, using knowledge of temperature and high-pressure experimental petrology. Result has been published in *Geochemical Perspective Letters*.

The big collision hypothesis, the most convincing hypothesis on the origin of the moon so far, argues that the moon came into being in the big collision 4.5 billion years ago between a Mars-sized planet and the primitive earth. Post-collision debris spattered into the space, gathered at the Lunar Orbit and formed hot melting lunar magma ocean (LMO), and finally differentiated from within the structure of the lunar nucleus, mantle and lunar crust during LMO cooling. It's generally believed that volatilization during the big collision would change the moon's elemental and isotopic composition, but still little knowledge on lunar sphere differentiation, especially the formation of the moon core has been acquired due to lack of understanding of element and isotope geochemistry.

Cu and Zn are both volatile and siderophile-sulfophilic, so are able to restrict volatilization effects during the big collision and the nuclear-mantle differentiation process simultaneously. Study on these elements can tell the influence of moon core differentiation on the element composition of the moon.

The research found that, sulfur-containing metal melts are significantly richer in light Cu and Zn isotopes than silicate melts, while sulfur-free metal melts and silicate melts have smaller fractionation. This result explains the difference in the composition of stable metal isotopes between the Earth and the Moon.



Elements volatile during the lunar magma ocean (LMO) cooling. (Image credit: HUANG Fang, USTC)

The larger Zn isotope fractionation between the moon and the earth clearly reflects the influence of the volatilization process. Besides, although the volatility of Cu is weaker than that of K and Ga, the difference in Cu isotope composition between the moon and the earth is greater than that of K and Ga. The reason might be that the Cu isotopic composition of the moon is not only influenced by volatilization during the big collision, but also by the separation of sulfur-containing metal melts from the LMO during the formation of lunar nuclei, while K and Ga do not enter the lunar nuclei, so were not affected by the formation of lunar nuclei. This work suggests that the moon core probably contains sulfur as well, which is of great significance for understanding the volatile composition of the moon, the condensation of the lunar nucleus, the maintenance of the lunar magnetic field, and the late accumulation between the earth and the moon.

(USTC)

Reference

Y. Xia, E. S. Kiseeva, J. Wade, F. Huang, The Effect of Core Segregation on the Cu and Zn Isotope Composition of the Silicate Moon. *Geochemical Perspectives Letters* 12, 12 (2019). doi: 10.7185/geochemlet.1928.