Oxygen isotopes and water in the inner solar system

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Bulk O-isotope compositions of the terrestrial planets (Earth, Moon, Mars) and their possible building blocks – different chondritic and achondritic planetesimals – are ^{16}O-depleted relative to the postulated ^{16}O-rich ($\delta^{17,18}$O ~ -50‰) initial composition of the protosolar molecular cloud or protoplanetary disk (Clayton, 2002; Yurimoto & Kuramoto, 2004; Young & Lyons, 2004; Krot et al., 2005) that may have been recorded by refractory inclusions and rare chondrules in primitive chondrites. According to these models, the UV photolysis of CO preferentially dissociates C^{17}O and C^{18}O in certain zones of the disk or molecular cloud. If this process occurs in the stability field of water ice, the released ^{17}O and ^{18}O are incorporated into water ice, while the residual CO gas becomes enriched in ^{16}O. Subsequent enhancement of water ice relative to CO gas in the disk midplane outside the snow line, followed by radial migration of icy bodies towards the proto-Sun and their evaporation at the snow line led to significant enrichment in ^{16}O-depleted water, which then spread through the inner solar system (Cuzzi & Zahnle, 2004). Bulk O-isotope compositions of chondrites are narrower than those of their components and are largely defined by compositions of chondrules and matrices, suggesting that both experienced extensive O-isotope exchange during transient heating events in an ^{16}O-poor gas. None of the known chondrites represents the postulated initial O-isotope composition of the disk, suggesting that thermal processing of dust in an ^{16}O-poor gas was a fundamentally important process in the inner solar system. Aqueous alteration experienced by some chondrite groups (CI, CM, CV, CO) modified their bulk O-isotope compositions to a relatively small degree. Bulk O-isotope compositions of the terrestrial planets and different achondrite groups are uniform relative to chondrites, suggesting extensive homogenisation during planetary igneous processes.

References

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The contribution of comets to water on Mars and Earth

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The oxygen-carbon inventories at the Earth's surface already suggest that comets cannot be the major source of the Earth's oceans (Owen and Bar-Nun) a conclusion confirmed by the difference between D/H in cometary H_2O and in SMOW (Meier and Owen). How much water comets could have brought depends on the D/H in the other sources of water accumulated by the planet. The noble gas abundances and isotope ratios will provide clues as to the fraction of Earth's volatiles that comets actually delivered, once these powerful discriminators have been evaluated in comets. Meanwhile, there are intriguing clues that comets may have delivered heavy noble gases to both Earth and Mars, making the possible recent delivery of water to the surface of Mars long after the planet's accretion especially interesting. This possibility is based on the isolation of the Martian lithosphere and the values of D/H in SNC minerals.

References

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