Comets And The Early Earth

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We present evidence for cometary delivery of water and other volatiles to the forming earth. Furthermore, we show that the HDO/H_2O in comets was not altered since the water was formed in the giant molecular cloud, a part of which collapsed to form the solar nebula. The first line of evidence is the Ar/Kr/Xe ratios on Venus, Earth and Mars, as compared with these ratios in meteorites, volcanic rocks, and cometary ices studied in the laboratory. A mixing line can be constructed, with contributions of Ar, Kr and Xe by rocks and by comets formed at ~50K for Earth and Mars and ~30K for Venus. Further evidence for cometary delivery is the D/H ratio in Earth's water, which is about 6 times larger than that of the protosolar value, together with the observed D/H ratio in the water of comets Halley, Hyakutake and Hale- Bopp, which is ~10 times larger than the protosolar value. This HDO enrichment can not be produced by preferential HDO freezing, as we have shown experimentally. Hence, the HDO enriched cometary water had to be formed in the giant molecular cloud and was not altered in the solar nebula. Isotopic enrichment according to $(m_1/m_2)^{1/2}$ was found experimentally for each nobel gas - Ar, Kr, and He, when trapped in cometary ice. This supports the cometary delivery idea, based on the Ar and Kr isotopes in Earth's atmosphere. For Xe, radiogenic production of its various isotopes is required with, perhaps, other mechanisms. The C/N ratio on Earth, which is much larger than the solar value, can also be explained by the experimentally found preferential trapping in cometary ice of CO over N_2. The inventory of Ar, Kr, Xe and C and N compounds compared with water on Earth, if delivered by comets, requires several major impact erosions of the atmosphere during the last stages of Earth's formation.

It will also be argued that life could not have arisen in cometary nuclei.