Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.22077

Origin and evolution of Earth's water inventory

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Given its formation inside the planetary 'snow line', nascent Earth was long assumed to have been water-deficient during initial formation, with late delivery coming from the outer solar system via planetesimals or pebble accretion. Chondrites, short period comets, and some Kuiper belt objects are consistent with the terrestrial D/ H suggesting them as sources but nebular gas and long period comets cannot be entirely ruled out given possible modifications of their D/ H by processes then operating. It was long assumed that acquired water would have dissolved initially in a magma ocean that would later degas to form a secondary atmosphere (and early ocean) as the mantle crystallized. Alternatively, exoplanet observations suggest that rocky planets commonly form with hydrogen-rich envelopes that are subsequently lost and that reaction of magma with that gas could produce large amounts of primary water. The maximum water storage capacity of the mantle may be as much as 4 ocean masses today or higher but decreases earlier in Earth history with higher mantle potential temperatures. Estimates of the hydrogen storage capacity of the core range up to 100 present ocean masses but the actual amount is essentially unconstrained. Constant continental freeboard provides little constraint on the Archean to present ocean volume but simple parametrized convection models suggests that early global ocean mass cannot have exceeded ~1.5x the present value given what we know about post-Archean subaerial exposure. Hadean zircons yield multiple lines of geochemical evidence implying the existence of liquid water at or near Earth's surface by ~4.3 Ga. Some evidence exists that suggest that a global-scale reservoir may have then existed. It is questionable that a Late Heavy Bombardment occurred in the inner solar system at ~3.9 Ga and thus estimates of volatile species such an event could have contributed to Earth's inventory are largely speculative. Perhaps the most interesting and potentially important aspect of our review of the source and timing of Earth's acquisition of its water is how different it is from the review of this topic in the 2nd edition of the Treatise 10 years ago.