

## **Providing solar system water and high planetary angular momentum, using a return to Ringwood's core formation model, supported by the behavioural evolution of the mantle**

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Longstanding problems of the Solar System are:- the mean specific angular momentum (a.m.) of SS planetary materials is  $>10^5$  times the Sun's, and the origin of SS water. I have shown [1] that during a cool secondary stage of SS formation the nebular flow would be outward and could sufficiently build up each protoplanet's a.m. as it grew, moving outward too, in the flow. So attaining the high a.m. requires completion of growth during nebular presence, ruling out the post-nebula growth in cores-by-percolation models.

Those models do nothing for the origin of SS water, which is low in star-forming clouds. Ringwood's model (1960-1978) uses the nebula to reduce hot FeO erupted at the protoplanet's surface; the Fe is then 'subducted' to form the core. For Earth this would generate  $>400$  ocean volumes of reaction water, a SS benefit foreseen by Ringwood. The heat required is internal (accretion, gravitation, radiogenic) so orbital distance is immaterial; important for the cores in the Galilean moons. The inferred outward nebular motion implies the close-in nucleation of protoplanets, shielded from stellar heat by nebular dust opacity. Many exoplanets are close-in too.

Asteroids being too small for convective overturn, meteoritic irons must come from unsubducted positions, not cores. Ringwood-mode core formation made the early-Earth's mantle as wet as it could hold, seen in its behaviour and petrology. But at  $\sim 2.5$ Ga, its drying-out by ocean production reached a critical loss of water-weakening in the presence of interstitial melt [2], halting convective motion for  $\sim 270$ Ma [3,4], during which oxygenic life won its battle against MOR effusions, depositing BIF and oxygenating the atmosphere, which is why we are here [3,5]. The restart was in the 2-layer mantle mode that prevails today, with deep-keeled cratonic tectospheres of stiffened mantle [5].

### References (with titles)

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