Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 762

A New Scenario for Forming the Solar Planetary System; Dynamics, Cores and Chemistry

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Solar System studies customarily assume a single contracting solar nebula (SCSN) and the percolative formation of iron cores. Both are seriously flawed and impose unwarranted constraints. The 5º 59 min tilt (modern data) of the planetary 'invariable plane' relative to the solar equator, and the mainly close conformity to it, demands an independent dynamical origin for planetary material (1; 2). An SCSN-generated planetary system could not subsequently be tilted without major disruption. SCSN limits the nebular pressure in the disc. It doesn't offer distinct high-temperature sites for CAI and chondrule formation or for the former to precede the latter, and yet keep some CI material cool.

Instead, it is proposed that the proto-Sun, some time after thermonuclear ignition, 'flew' into another dust cloud from which the planetary material and an outer addition to the proto-Sun (an unmixed star) were acquired. This, in principle, copes with the presence of planets around a pulsar and how Vega (>100 Ma old) has a disc. The universality, high mass-rates and early start-up of stellar winds is increasingly evident. Their physical mechanism is not understood but clearly they are not confined to a 'T-Tauri phase'. One thing seems clear: that radial electric fields are important. Only thus can the very strong ionic and coronal emission dependence on ionic charge:mass, especially light-isotope enhancements (3), be explained.

Applied to the acquisition dynamics in the dust cloud, it will be shown that, after a pressure-raising shock close to the proto-Sun, an in-at-the-poles, out-at-the-equator flow pattern would develop. The quasi-equatorial outflow, preserving some of its originally deviant rotation axis direction, would spiral outward as a thick disc, driven by the response of its now-ionised component to the electric field effect. The inner part of the poles-to-equator flow would be heated, losing volatiles (e.g. K), and constitutes a site for CAI formation. The outer part of the flow would be dust-shielded, remaining fairly cool, and preserve the CI composition. The mass flow into the disc is not the 'once for all' of SCSN but is relatively unconstrained and provides for late input of short-life isotopes. On exit from the cloud the polar flow would reverse (Herbig-Haro objects)(4), the unused disc remnants being spirally-driven progressively outwards. Chondrite CAIs sample the final accretion onto asteroids, so their ~4566 Ma age marks the last material processed by close-solar passage; older CAIs were accreted earlier.

The cores-by-percolation model constrains planetary accretion scenarios to assume that most occurred *in vacuo* after nebular disc departure. The proposed model terminates core genesis at the moment of nebular departure.

The percolation model is invalidated by the mantle's preservation of a nearly chondritic Ni:Co. Even if their partition coefficients do even up at CMB pressure, most melting and segregation would have been at low pressure. Its essential corollary, the provision of a water-rich 'late veneer' after core completion, is denied by the Moon, which never experienced a late veneer (5) although it was already in Earth orbit by then (6).

The core genesis model must work all the way from Mercury to Jupiter's inner satellites. In the high-opacity disc the protoplanet acquired an accretion-rate controlled temperature largely independent of orbit radius. FeO in erupted magmas at convective upwellings was reduced to Fe, carried to downwellings and 'subducted', the Fe dropping off at the bottom. With the Fe was FeS and C (from initial Fe_3C), confirming S and C as core dilutants. Water from this reaction gave the early Earth a wet mantle, now recognised in komatiites. Transfer of mantle chalcophiles and siderophiles across the CMB was initially impeded by expulsion of silicate dross from the core and was later shut off by the build-up of subducted primitive crust to form D", leaving a time-window for transfer, evident in the Hf-W data.

Chondrules are seen as nebula-present products of impact between interstitially melted asteroids. Some iron meteorites are not core fragments but surface-reduced magmatic FeO etc., with eucrites representing eruptions after nebular departure. The presence of interstitially melted protoplanets, giving planetesimal capture a tidal dimension and speeding it up, is amply demonstrated by the predominance of prograde satellites now in orbit. Triton's retrograde orbit shows that tidal action soon ended. Clearly, construction of the planetary system was largely complete by the time the disc remnants were expelled.

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