TRANSFORMATION OF GRAPHITIC & AMORPHOUS CARBON DUST TO COMPLEX ORGANIC MOLECULES IN A MASSIVE CARBON CYCLE IN PROTOSTELLAR NEBULAE.

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Introduction: More than 95% of silicate minerals and other oxides found in meteorites were melted, or vaporized and recondensed in the Solar Nebula prior to their incorporation into meteorite parent bodies [1]. Gravitational accretion energy and heating via radioactive decay further transformed oxide minerals accreted into planetesimals. In such an oxygen-rich environment the carbonaceous dust that fell into the nebula as an intimate mixture with oxide grains should have been almost completely converted to CO. While some pre-collapse, molecular-cloud carbonaceous dust does survive [2], much in the same manner as do pre-solar oxide grains [3], such materials constitute only a few percent of meteoritic carbon and are clearly distinguished by elevated D/H, $^{15}N/^{14}N$, $^{13}C/^{12}C$ ratios or noble gas patterns.

Carbonaceous Dust in Meteorites: We argue that nearly all of the carbon in meteorites was synthesized in the Solar Nebula from CO and that this CO was generated by the reaction of carbonaceous dust with solid oxides, water or OH. It is probable that some fraction of carbonaceous dust that is newly synthesized in the Solar Nebula is also converted back into CO by additional thermal processing. CO processing might occur on grains in the outer nebula through irradiation of CO-containing ice coatings [4] or in the inner nebula via Fischer-Tropsch type (FTT) reactions on grain surfaces [5]. Large-scale transport of both gaseous reaction products and dust from the inner nebula out to regions where comets formed would spread newly formed carbonaceous materials throughout the solar nebula [6].

Formation of Organic Carbon: Carbon dust in the ISM might easily be described as inorganic graphite or amorphous carbon, with relatively low structural abundances of H, N, O and S [7]. Products of FTT reactions or organics produced via irradiation of icy grains contain abundant aromatic and aliphatic hydrocarbons, aldehydes, keytones, acids, amines and amides [8]. The net result of the massive nebular carbon cycle is to convert relatively inert carbonaceous dust from the ISM into the vital organic precursors to life such as amino acids and sugars intimately mixed with dust and ice in primitive planetesimals. ***Since the number of carbon atoms entering the Solar Nebula as dust exceeds the number of atoms entering the nebula as oxide grains, the formation of large quantities of complex organic molecules may represent the largest single chemical cycle in the nebula.***

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