Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)
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PPS06-10 Room:102A Time:May 20 12:00-12:15

Where is all the CO in Protostellar Systems?

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The material falling into protostellar systems is a mixture of gas plus organic coated silicates and carbonaceous dust grains. CO is the most abundant molecular species after H2 and its place in protostellar nebulae has been monitored for many years. As carbon coated grains enter the high temperature regions of the inner nebula or encounter high temperature shocks, copious quantities of CO should be generated as silicates are vaporized or annealed. Similarly carbonaceous grains in the oxygen rich environment of the hot inner nebula, in lightning discharges or in nebular shocks should generate CO. Finally, carbonaceous grains incorporated into growing planetesimals should continuously emit CO, especially as radioactive heating begins to melt their interiors. If the mass of carbonaceous materials is of the same order of magnitude as the oxygen rich dust a significant increase in the concentration of CO should be observed. Where is this excess CO?

Considerable work has been done on the potential for Fischer-Tropsch type reactions to occur on grain surfaces in protostellar nebulae, starting with the work of Anders and colleagues between 1967 - 1980 (e.g. Hayatsu and Anders, 1980) and proceeding through more recent work by Llorca and Cassanova (2000) or Hill and Nuth (2003) and Nuth et al., 2008). It appears that such processes are efficient enough to remove the excess CO that should be generated during the formation of planetary systems. This implies the existence of a large-scale carbon cycle that could be converting both carbonaceous grain coatings as well as more graphitic solid grains into organic materials, thus seeding many newly formed planetary systems with the seeds of life.

References

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Keywords: Protostellar Nebula, Carbon Monoxide, Carbon Grain Coatings, Planetesimal Evolution, Thermal Processing