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THE METEORITE PARENT-BODY ALTERATION MODEL AND THE INCOMPATIBLE REALITY.

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Meteorites and, in particular, chondrites frequently contain objects that have signs of beginning, advanced, or almost complete changes in their mineralogy or mineral chemistry, a metamorphosis that is commonly referred to as "alteration." Such changes are to be expected to be omnipresent in meteorites because these rocks are the products of a large variety of processes that were operating in the solar nebula. Adaption of mineral assemblages and mineral chemistries to changing physicochemical conditions is a natural process that, of course, must have been working also in the solar nebula with its widely varying temperature and pressure regimes. Until the final product was formed, the constituting matter had to evolve from temperatures above the boiling point of most phases or compounds to temperatures below the freezing point of volatile constituents, such as H_2O, CO, CH_4, CO_2, etc. Equilibration of solid phases with a gaseous environment depend on the grain size of the solids, diffusivities of the species considered, and the changes in temperature. Thus, equilibrium is rarely achieved in meteorites, as amply shown by the nature of unequilibrated chondritic meteorites. Incomplete response to varying environmental conditions is often interpreted as low-temperature alteration within the parent body.

The attempts to stay in equilibrium with the environment cannot be successful for all phases under all circumstances. More likely, we can expect unsuccessful attempts and, actually, we can observe many such examples in almost all meteorites. This normal sequence of events, as documented by unsuccessful equilibration, has, however, commonly been interpreted as unlucky "secondary alteration." The place where such bad things can happen best is widely believed to be the meteorite's parent body, where it was exposed to conditions it was not designed for.

All meteorites show signs of unsuccessful attempts to reach equilibrium either with their peers, or with the environment, or both. Even the best "equilibrated" OCs, for example, have a number of phases that are out of equilibrium with their colleagues. This fact is usually repressed by meteoriticists, perhaps because it simply doesn't fit the model. Carbonaceous chondrites had less luck and that's why they are rich in examples of unsuccessful attempts of constituents to reach equilibrium with each other and a progressing, changing world. That world is commonly believed to be a planetary or planetesimal world for reasons that remain in the dark. This way we arrived at a pretty curious situation: the solar nebula, the parent of all meteorites, which had to change its conditions drastically during its evolution, is not eligible as the culprit in ruining our meteoritic constituents. According to widespread belief, they rather must emerge from the nebula in an immaculate state and subsequently become exposed to the bad and destructive world of parent bodies.

Naturally, observations can be interpreted in an alternative way and, actually, we are forced to interpret most of them in a different way when we consider all observations. For example, most CCs consist of constituents (chondrules, aggregates, etc.) set into a fine-grained carbonaceous matrix. These constituents usually bear the scars of incomplete equilibrium with some environment that, apparently, was quite different from that in which they originally formed. If this new environment was the one that was created locally in the parent body then one can expect that constituents of similar mineralogical and textural type should react in the new environment in a similar way, with the result that they become "altered" to similar degrees. In nature this is clearly not the case. The rule is rather that constituents of a given CC show all sorts of different "alterations" and rarely the same intensity. Almost totally hydrated objects are located right next to almost unchanged ones, highly sulfidized ones are next to unchanged, metal-rich ones, highly oxidized objects bearing magnetite are approaching or even touching nonoxidized ones, etc. What is even more impressive is the widespread survival of highly reactive phases, which were formed in strongly reducing environments, in the highly oxidizing environment of CCs (low-Ni metal, phosphides, sulfides of lithophile elements, etc.). Furthermore, hydrous objects (like anhydrous ones) commonly display delicate growth and aggregation features and a very large compositional variety on a micrometer scale. Moreover, because, e.g., serpentinization of olivine or pyroxene should produce at least two products, the serpentine and either a Mg mineral (Mg hydroxide or carbonate in the case of olivine) or free silica (or a Si-rich mineral in the case of pyroxene) we can expect to find them at the place of the crime, but they are never where they should be. Actually, the phases that theoretically should accompany the hydrosilicates are missing in almost all cases. Why?

THE ALTERATION OF NICKEL-BEARING SULFIDES DURING THERMAL METAMORPHISM ON ORDINARY CHONDRITE PARENT BODIES.

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Introduction: Sulfurization of FeNi alloys under solar nebula conditions produces Ni-bearing sulfides [1,2]. These sulfides have several distinctive characteristics including pentlandite [$(Fe,Ni)_9S_8$] inclusions within monosulfide solid solution [mss, $(Fe,Ni)_{1-x}S$] crystals, increasing Ni content with distance from the remnant metal, multilayer sturctures, and oriented sulfide crystals. The extent to which some (or all) of these features are altered by thermal metamorphism is unknown, but important to quantify so we can distinguish nebular from parent-body processes in the meteorite record. We performed experimental simulations of dry thermal metamorphism of an ordinary chondrite parent body to determine the effect of this process on sulfide chemistry and morphology.

Experimental Method: The starting material of the thermal metamorphism experiments was composed of silicates with the normative mineralogy of LL chondrite silicates [3], filings from the Canyon Diablo (CD) Fe meteorite, and Ni-bearing sulfides produced by gas-solid reaction between CD metal and H_2-H_2S gas [1]. These