

**ANHYDROUS SILICATE EVOLUTION: HIERARCHICAL DUST ACCRETION AND PLANETESIMAL PROCESSING.**

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**Introduction:** The grain sizes and compositions of constituents in aggregate IDPs, including the pure-silicate principal components (PCs), and the dimensions and ablation chemistry of cometary meteoroids define a continuum of evolution of non-chondritic dusts during hierarchical dust accretion and recycling in planetesimals in the early solar system. I will assume that (1) presolar ferromagnesian-silica PCs were the original dusts [1], and (2) Fe(Ni)-sulfides formed when Fe(Ni) oxides reacted with circumstellar H<sub>2</sub>S gas.

**Condensation and Initial Accretion:** Constraints from vapor phase condensation experiments indicate that pure-silicate PCs in the matrix of aggregates IDPs are amorphous, non-stoichiometric, metastable silicates with well-defined compositions. First, the condensed solids, 'MgSiO', 'FeSiO', silica-bearing Fe- and Mg-oxides, and pure SiO<sub>2</sub>, MgO and Fe-oxides, formed ~100 to 500nm-sized Mg-rich, ferromagnesian-silica agglomerates, *i.e.* the Si-rich smectite dehydroxylate PCs. Next, these PCs and condensed silica-bearing Fe-oxides and pure Fe-oxides agglomerated into compact amorphous ferromagnesian-silica dust. These Fe-rich, Fe/Fe+Mg >0.35, serpentine-dehydroxylate PCs required external energy to facilitate the assimilation of pure-Fe-oxide nanocrystals [1]. Speaking of only carbon-free dusts, both ferromagnesian-silica PCs were the materials from which all crystalline dusts in aggregate IDPs evolved in both chemical complexity and grain size.

**Thermal Processing:** Upon heat treatment the amorphous PCs will initially yield crystalline olivine and pyroxene plus an amorphous phase [2]. The amorphous phase in Mg-rich PCs is silica with minor Ca ± Al ± Na ± K. These nm-sized, crystalline or amorphous grains are unstable with a strong tendency towards thermodynamic equilibrium. Adjustments among identical silicates and oxides will be relatively easy, *e.g.* formation of a micron-sized olivine crystal from a cluster of nm-sized olivines. Similar growth of amorphous, minor element-bearing dusts would yield, for example, micron-sized, crystalline or amorphous aluminosilicates. Thermal decomposition of such amorphous dusts produced the first mineral assemblages of plagioclase plus Mg,Fe-olivine and pyroxene and others depending on the original minor elements. At this stage of silicate evolution the first 'new' minerals were produced.

**A role of Planetesimals:** Formation of larger, up to mm-sized "more-complex" silicates, *e.g.* Ca,Al-bearing Mg,Fe-silicates (Ti-diopside), required thermal processing of increasingly crystalline precursors in an environment that facilitated diffusion-controlled processes. Such conditions existed in planetesimals that either became part of rubble-piles or in collisions introduced their *in situ* evolved minerals among the other accreting solar nebula dusts.

**Predictions:** For example, comet nuclei will contain micron- to mm-sized forsterite grains delineating hierarchical accretion as well as nm-sized forsterite annealed in amorphous dust during perihelion. Comet nuclei have a wide variety of anhydrous silicates, including those identified around young stellar objects [3], with a correlation between chemical complexity and increasing grain size.

**Conclusions:** The high 'chemical energy' of the condensed dusts inherited by the pure-silicate PCs was the driving force behind the initial silicate dust evolution. The sizes and compositions of the anhydrous silicates in comet nuclei record the onset of mineralogical activity in the solar system that was lost in the meteorites.

**References:** [1] Rietmeijer F. J. M. (2002) *Chemie der Erde*, 62, 1–45. [2] Rietmeijer F. J. M. et al. (2002) *Icarus*, 156, 269–286. [3] Molster F. J. (2000) *Ph.D. thesis*, 278p., *Univ. of Amsterdam*.