

# HYDRATED LOW-NICKEL STRATOSPHERIC PARTICLES COMPARED TO THE SMECTITE SUBCLASS OF HYDRATED INTERPLANETARY DUST PARTICLES.

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Chondritic interplanetary dust particles [IDPs] are broadly classified as anhydrous and hydrated IDPs. The latter include (i) smectite-type and serpentine-type IDPs [1]. First order classification of hydrated IDP subtypes relies on cluster analysis of electron microbeam spot-analyses in a ternary diagram Mg-Fe-Si (at%) [1] or Mg-Fe-(Si+Al) (at%) [2]. In this manner, smectites were identified in six hydrated IDPs but with (Al+Si)-enriched compositions compared to smectites in other chondritic IDPs [2]. The offset towards high (Si+Al) contents was interpreted as silicone oil contamination [2]. Silicone oil holds particles onto the inertial impact plates used to collect stratospheric particles. Silicone oil contamination is documented in a carbon-rich chondritic porous IDP [3] but a later study of chondritic IDPs found "only negative evidence for such contamination" [4]. This type of contamination occurs at the surface of particles. It is hard to conceive how it effects the interior of low-porous [1] hydrated IDPs.

A new type of hydrated stratospheric particles consists of terrestrial volcanic ash particles with distinctly non-chondritic, high  $\text{SiO}_2$  and  $\text{Al}_2\text{O}_3$ , compositions [5]. The matrix of these particles contains variable proportions of subhedral layer silicate grains and areas of poorly-crystalline layer silicate microcrystallites in an amorphous groundmass [5]. The compositions of micro-phenocrysts in this matrix show no evidence for (Si,Al) enrichment except for rare non-stoichiometric alkali-feldspar in particle L2002\*C2 [5]. Thus, layer silicates in the non-chondritic stratospheric particles are expected to have uncontaminated compositions. I explore the possibility that, based on composition alone, (Al+Si)-enriched smectites in hydrated IDPs [2] could instead have a terrestrial origin.

**EXPERIMENTAL.** Stratospheric particles L2001-18, L2001-20 and L2002\*C2 were prepared for serial-ultramicrotome thin sectioning. Several sections (~100 nm thick) of each particle were analysed using a JEOL 2000FX analytical electron microscope [AEM] equipped with a TN 5500 EDS for *in situ* microanalysis of elements Z>10 using a 15-20 nm size probe in individual mineral grains. The reduced EDS data have a rel. error of <~5% due to counting statistics and the determination of instrument k-factors. The calibrated single crystal and polycrystalline ('ring') selected area electron diffraction [SAED] patterns have a rel. error of ~1.5%

**RESULTS.** The matrix in particle L2001-20 layer silicates, either single-crystals (~1.0  $\mu\text{m}$  x 0.2  $\mu\text{m}$  up to 1.3  $\mu\text{m}$  x 0.6  $\mu\text{m}$  in size) or in continuous areas (up to 4.7  $\mu\text{m}$  x 0.53  $\mu\text{m}$  in size) with an anastomosing texture occur intermingled with areas of layer silicate microcrystallites in an amorphous groundmass. The two matrix textures occur in almost equal proportions. About 75% of the matrix in particle L2002\*C2 is layer silicate micro-crystallites in an amorphous groundmass with randomly dispersed single-crystal layer silicate grains (0.2  $\mu\text{m}$  x 0.04  $\mu\text{m}$  up to 1.8  $\mu\text{m}$  x 0.2  $\mu\text{m}$  in size). Particle L2001-18, that also contains only few microphenocrysts [5], contains rare single-crystal layer silicate grains (0.4  $\mu\text{m}$  x 0.2  $\mu\text{m}$  in size) in a matrix of layer silicate microcrystallites in an amorphous groundmass which, in all three particles, has high  $\text{SiO}_2$  and  $\text{Al}_2\text{O}_3$  and low MgO content and locally contain  $\text{K}_2\text{O}$ .

**LAYER SILICATES.** The majority of microcrystallites (< ~1.0  $\mu\text{m}$  in size) is dioctahedral 2:1 layer silicate with  $d(001) = 0.9 - 1.0$  nm]. Their compositions bracketed by the ideal end-members Al-celadonite-muscovite-pyrophyllite-ferripyrophyllite. Rare muscovite (sericite variety) has 4.6-6.4 wt%  $\text{K}_2\text{O}$  whereas pyrophyllites typically contain ~1.25 wt%  $\text{K}_2\text{O}$ .

The average basal spacing  $d(001)$  of smectites in these three particles is 1.53 nm with a range from 1.47 nm to 1.69 nm. Single-crystal SAED patterns for the largest grains typically show evidence for rotational disorder of smectite layers about an axis parallel to the layers. The disorder is may be due to interaction of smectite grains with the incident electron beam. Stacking faults are observed in  $d(001)$  lattice fringe images. The  $\text{SiO}_2$  content of smectites in the samples ranges from ~31 to ~65 wt% and the  $\text{Al}_2\text{O}_3$  content from ~25 to ~12.5 wt%. That is, a fraction of the layer silicates are compositionally intermediate between smectite *proper* and chlorite. The compositions of individual smectite grains in the hydrated stratospheric volcanic

particles cover the full range from tri- to di-octahedral smectites when plotted in a Mg-Fe-(Si+Al) (at%) ternary diagram [FIGURE 1].

**DISCUSSION.** Smectites that are free of silicon-contamination occur in the matrix of three hydrated, non-chondritic stratospheric particles of explosive terrestrial volcanic origin [5]. Smectites are common to small-sized ( $<2\ \mu\text{m}$ ) terrestrial volcanic ash where occur as (i) accessory ejecta and (ii) are formed during hydrothermal alteration in a neutral or basic environment [6]. The neoformed layer silicates are part of a transformation series involving smectite/mixed layer chlorite-smectite/chlorite [6]. Conceivably, the intermediate smectite compositions ( $\text{SiO}_2/\text{Al}_2\text{O}_3$ ) in the hydrated stratospheric particles represent this trend for neoformed layer silicates in volcanic ash. The distribution of smectite compositions in hydrated IDPs plotted in a Mg-Fe-(Si+Al) (at%) ternary diagram [2] is similar to distributions of smectite compositions from three hydrated volcanic particles [FIGURE 1]. Smectites in these IDPs are considered to be similar to layer silicates in unequilibrated ordinary chondrite [UOC] matrices which is used to postulate an extraterrestrial origin for the hydrated stratospheric particles [2]. I postulate that smectites in some hydrated IDPs [2] are uncontaminated layer silicates similar to smectites in hydrated stratospheric particles of terrestrial volcanic origin. For two of the hydrated IDPs (L2007-3 and L2007-8) [2], this conclusion is supported by chemical analysis which indicate a fractionated character for these two particles that also have a high alkali content [7]. A fractionated elemental abundance pattern and high  $\text{K}_2\text{O}$  content are typical for the group of low-Ni stratospheric particles of terrestrial volcanic origin [5,8].

**CONCLUSION.** The putative origin on small Solar System bodies, such as a UOC parent body, for some smectite-rich hydrated IDPs should be reconsidered. The data available for these particles [2,7] uniquely fit the chemical and mineralogical properties of the newly-emerging group of hydrated, non-chondritic stratospheric particles of terrestrial volcanic origin.

**REFERENCES.** 1. Bradley (1988) GCA 52, 889-900; 2. Thomas et al (1990) Meteoritics 25, in press; 3. Rietmeijer (1987) LPS XVIII, 836-837; 4. Blanford et al (1988) Meteoritics 23, 113-121; 5. Rietmeijer (1991) companion abstract; 6. Dethier et al (1981) US Geol Surv Prof. Paper 1250, 649-665; 7. Lindstrom et al (1990) LPSC XXI, 700-701; 8. Flynn & Sutton (1991) Proc21stLPSC, in press. This work is supported by NASA Grant NAG 9-160.

