

MINERALOGICAL AND CHEMICAL CONSTRAINTS ON PARENT BODIES FOR HYDRATED INTERPLANETARY DUST PARTICLES; K. L. Thomas¹, L. P. Keller², W. Klöck³, and D. S. McKay². ¹Lockheed 2400 Nasa Rd. 1, Houston, Tx 77058, ²NASA/JSC SN14 Houston, TX 77058, ³University of Munster, D-4400 Munster, Germany.

INTRODUCTION. Chondritic hydrated interplanetary dust particles (IDPs) make up a significant fraction (37%) of all IDPs [1]. If hydrated IDPs are derived from asteroidal sources as proposed by others[1], then their mineralogy and chemistry potentially provides information regarding relationships to known chondrite groups.

Anhydrous and hydrated IDPs contain a variety of anhydrous grains including silicates, sulfides, oxides, and minor carbonates; only hydrated IDPs contain abundant phyllosilicates. Previously others have compared the chemistry and mineralogy of hydrated IDPs to various chondrite classes [1-4]. In this study, we combine our observations of the mineralogy, mineral chemistry, and texture of 13 hydrated IDPs in order to derive a more complete picture of the origin and evolution of hydrated IDPs.

EXPERIMENTAL. We used analytical transmission electron microscopy to study microtomed thin sections (<100 nm thick) of 13 hydrated IDPs (10 smectite-type and 3 serpentine-type) and several chondrite matrices including: CI (Orgueil and Ivuna), CM (Murchinson), UOCs (Semarkona and Bishunpur), altered CVs (Kaba and Vigarano), and altered CO (Lancé). Characteristic basal spacings of the phyllosilicates were determined by high resolution imaging. Quantitative analyses of various phases were determined using energy-dispersive x-ray spectroscopy (EDS).

RESULTS. It is well known that hydrated IDPs fall into two main categories: smectite- and serpentine-type [e.g., 5]. Our data from 13 hydrated IDPs combined with literature data on an additional 35 hydrated IDPs [5-7] indicates that smectite-type IDPs predominate over serpentine-type in the ratio of ~5:1. The emphasis of this report we will focus on the smectite-type particles.

Typically, smectite-type IDPs are dominated by either fine- (5 of 10) or coarse-grained (4 of 10) smectite; although one contains an even mixture. Smectite compositions are variable, from end member saponite to an Fe-bearing saponite with $\text{Fe}/(\text{Fe}+\text{Mg}) = 0.3$. Most anhydrous grains in smectite-type IDPs range in size from 10- to 300-nm and comprise up to 50% (but typically 25 to 30 %) of the area of our thin sections. Fine-grained (<300 nm in dia.) silicates (olivines and pyroxenes) are present in most smectite-type particles, however low Fe, Mn-enriched (LIME) olivines and pyroxenes occur in 2 of the 10 particles [8]. Fine-grained Fe-Ni sulfides are ubiquitous in smectite-type IDPs, although coarse-grained sulfides (usually ~3 to 4 μm ; up to 8 μm in dia.) also occur. The sulfides contain up to 30 wt. % Ni. Carbonates are rare in our samples; only one IDP contains a Mg-Fe carbonate.

Serpentine-type IDPs contain a mixture of fine and coarse serpentine. Serpentine is magnesian with $\text{Fe}/(\text{Fe}+\text{Mg})$ ratios of 0.15 to 0.35, and comprises nearly 90% of the area of the thin sections. One IDP contains LIME olivines [9]; one contains Fe-Ni sulfide grains (Ni up to 17 wt%). Most anhydrous grains in the serpentine-type particles are <200 nm.

DISCUSSION. The mineralogy and mineral chemistry of smectite IDPs is most consistent with the altered matrices of UOC (Semarkona) and CV chondrites. The composition of smectite in Semarkona and altered CV matrices is similar to that of smectite-type IDPs. There are a number of similarities in the mineralogy and chemistry of anhydrous grains in matrices of Semarkona, altered CVs, and smectite-type IDPs: olivine, pyroxene, and fine-grained Fe-Ni sulfide compositions overlap in all three groups. LIME olivines and pyroxenes occur in some smectite-type IDPs and also in Semarkona matrix [8,9].

We note that the mineralogy of smectite IDPs is quite distinct from CI1s [e.g., Orgueil]. CI1s contain a 50:50 mixture of intimately intergrown serpentine and smectite [5], an assemblage

Parent Bodies for Hydrated IDPs: Thomas, K.L.

that has not been observed in any hydrated IDP thus far. In addition, CI1s are virtually free of anhydrous silicate grains; although rare LIME olivines have been reported in Ivuna [9].

We have also compared the major element compositions of hydrated IDPs to those of chondrite matrices (Table 1) [data from 2, 10, 11]. We note that no individual chondrite group is an exact match for the bulk composition of hydrated IDPs; the agreement is especially poor for Mg, Fe, Na, and S. The ratio of Mg/Si in carbonaceous chondrite matrix is too high while that for Semarkona is too low. The ratio of Fe/Si for hydrated IDPs is higher than that of CI and Semarkona matrix, but lower than that of CM, altered CV and CO matrices. Na/Si is depleted relative to hydrated IDPs in all chondrite matrix groups except for Semarkona. S/Si is high for hydrated IDPs relative to all chondrite groups, but does not correlate with higher Fe/Si and Ni/Si ratios. We propose that the major element composition of hydrated IDPs is most closely matched by a combination of altered CV and Semarkona matrix in equal proportions (Tab. 1); this is a better match than CI matrix. This result combined with particle mineralogy suggests that smectite-type IDPs are probably derived from parent bodies that resemble those of Semarkona and altered CV chondrites.

CONCLUSIONS. Of the hydrated IDPs studied in detail, smectite-type are more abundant than serpentine-type, in the ratio of 5:1. We conclude that the mineralogy, mineral chemistry, and bulk composition of smectite-type IDPs are most similar to altered matrices of Semarkona (UOC) and CV chondrites.

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TABLE 1. Element/Si ratios for selected chondrite matrices and hydrated IDPs (data from 1, 10, 11).

	Na/Si	Mg/Si	Al/Si	S/Si	Ca/Si	Fe/Si	Ni/Si
Hydrated IDPs	0.051	0.824	0.082	0.341	0.021	0.742	0.032
CI	0.016	0.920	0.094	0.129	0.011	0.539	0.047
CM	0.038	0.957	0.121	0.194	0.029	0.935	0.057
CV (altered)	0.034	0.989	0.112	0.081	0.080	0.899	0.046
CO (Lancé)	0.020	1.080	0.130	0.018	0.029	1.042	0.037
UOC (Semarkona)	0.123	0.459	0.117	0.050	0.025	0.598	0.027
50 Semarkona: 50 CV	0.078	0.724	0.114	0.065	0.053	0.748	0.036