MATRIX MATERIALS OF CARBONACEOUS CHONDRITES: T.R. McKee*, C.B. Moore*, and Sherwood Chang†; *Arizona State University, Tempe, AZ 85281; † NASA Ames Research Center, Moffett Field, CA 94035

Due to the fine grained nature and intimate mixing of the matrix components of carbonaceous chondrites little is known of the detailed nature of the matrix material. Previously postulated identities of matrix phyllosilicates have included serpentine, palygorskite, sepiolite, chlorite, mica, montmorillonite and mixed-layer materials, although none of the identifications have been unambiguous(1). This report presents preliminary results of a survey study of the phyllosilicate and carbonaceous components of C1, C2 and C3 carbonaceous chondrites utilizing high resolution transmission electron microscopy (HRTEM) and energy dispersive X-ray analysis (EDXA). These combined techniques allow more definite identification of matrix components since both structural and qualitative chemical data from the same particles may be related to detailed particle morphology and interparticle relationships. Samples were selected to represent each of the classes of carbonaceous chondrites as well as an alteration sequence within the C2 class.

Fine grained material, collected as dust from the glass storage containers and as scrappings from fresh surfaces, was ultrasonically dispersed in acetone and mounted on holey carbon support films(2). The support films were mounted on copper locator grids to facilitate relocating individual particles for compositional analysis by EDXA after completion of HRTEM observation. The matrix material consists of thin rolled or curled flakes(F), flat sheets(S) and short tubes or spheres(T) (see Fig. 1). These individual particles are often coated with amorphous material(A) presumed to consist of carbonaceous matrix material. In addition, some acetone soluble material may contribute to the coatings. Larger aggregates appear to consist of masses of the individual particles cemented together by amorphous material (Fig. 2).

The HRTEM images (often called "lattice" or fringe images) indicate that all of the various morphologies shown in Figures 1 and 2 have similar basic structures since they all exhibit essentially the same basal spacing of 7Å. Many of the curled or rolled particles show both a circumferential 7Å basal spacing and a radial spacing of 4.5Å similar to those observed previously for the (001) and (020) spacings of tubular chrysotile (3) and halloysite (4). Although the dominant basal spacing observed is 7Å, it is occasionally found with interstratified spacings of either 10Å or a smaller spacing in the range of 4-5Å.

Qualitative EDXA chemical data indicates a surprising amount of homogeneity among the particles of varying morphology (Fig. 3). All of the phyllosilicate particles and aggregates analyzed appear to be ferromagnesian silicates, most with traces of Al and in some cases Cr. The EDXA spectra shown in Fig. 3 illustrate the maximum variation encountered in the Fe and Mg with respect to Si although no consistent correspondence to morphology is apparent. The size of the Cu peaks depends upon the proximity of the Cu support grid. A spectrum from a spheroidal halloysite particle is included for comparison(5).

In summary the carbonaceous chondrite phyllosilicate material studied thus far appears to be predominantly composed of ferromagnesian silicate with variable composition which exhibits a 7Å basal spacing, both of which are consistent with an identification of serpentine. The 10Å interstratification may be either micaceous material or collapsed montmorillonite and the 4-5Å phase is probably brucite. The carbonaceous component of the matrix is predominantly amorphous although a few crystallites have been observed which appear to be poorly graphitized carbon similar to that observed in a chlorite-graphitized carbon mixture produced by low grade metamorphism(6).
Fig. 1 Typical morphologies from Murray matrix material exhibiting $7\AA$ basal fringes.
Fig. 2 An aggregate of Nogoya matrix material with $7\AA$ basal fringes (EDXA spectra from boxed area shown in Fig. 3d).
Fig. 3. Representative EDXA spectra from (a) a halloysite sphere, (b) a particle similar to T in Fig. 1, (c) a group of particles similar to F in Fig. 1 and (d) the boxed area of the aggregate shown in Fig. 2. All spectra obtained at 80 kV with 100 seconds live time.


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