AN $^{57}$Fe MÖSSBAUER STUDY OF THE METAMORPHIC SEQUENCE IN UNEQUILIBRATED ORDINARY CHONDRITES. O. N. Menzies¹, P. A. Bland¹ and F. J. Berry². ¹Planetary and Space Sciences Research Institute, The Open University, Milton Keynes MK7 6AA, UK, ²Department of Chemistry, The Open University, Milton Keynes MK7 6AA, UK.

Introduction: Unequilibrated ordinary chondrites (UOCs), along with carbonaceous chondrites, are some of the most primitive materials in the solar system [1]. However, heterogeneic silicate compositions and fine-grained matrix make analysis difficult by conventional means.

Previous work [2] has shown that $^{57}$Fe Mössbauer spectroscopy can be used to identify chemical compositional differences in equilibrated ordinary chondrites, particularly by looking at Mössbauer parameters ascribed to olivine. The technique also provides information on the abundance of Fe-bearing phases in chondrites. Therefore we chose to use Mössbauer spectroscopy to study mineral abundance, olivine chemistry and equilibration in UOCs.

Methods: A series of 18 UOCs collected in the Antarctic, and also several falls were examined by Mössbauer spectroscopy. Approximately 100mg of powdered meteorite was placed in a lead sample holder. The spectra were recorded at 298K with an $^{57}$Fe Mössbauer spectrometer using a $^{57}$Co/Rh source. Spectra were fitted with a constrained non-linear least squares fitting programme of Lorentzian functions.

Results and Discussion:

Mössbauer parameters. Three parameters reflecting the chemical environment of electrons at the nucleus are observed by Mössbauer analysis. One, quadrupole splitting (QS), gives an indication of the symmetry of the Fe site [3] and we have shown it to be correlated with silicate chemistry in chondrites [2].

The QS value for each chondrite was plotted against the degree of equilibration, or class. QS values increase with metamorphism. Figure 1 shows this relationship strengthened by the addition of equilibrated ordinary chondrites and UOC falls.

The widths of olivine doublets in Mössbauer spectra can be correlated with degree of homogeneity [4]. We would expect a large line width for more unequilibrated samples. This observation is observed when line width is plotted against degree of equilibration, i.e. the graph is inverse to Figure 1.

Mineralogy trends. Mössbauer spectroscopy gives information about the proportion of total Fe found in each Fe-bearing mineral component. These figures can be roughly correlated to wt% values although the major trends can still be observed from the Mössbauer values [5].

Graphs plotting the ‘amount’ of each mineral against degree of equilibration for the Antarctic UOCs show some interesting relationships. The data was confirmed once again by looking at UOC falls, which show similar trends.

The percentage of silicates increases with equilibration and varies inversely with a paramagnetic Fe$^{3+}$ component, probably Fe-bearing clay. FeNi metal and troilite remain relatively constant. Antarctic H chondrites do not show these trends possibly due to increased terrestrial alteration [6].

Ferric Fe is indicative of oxidative weathering in a hydrous environment [7]. It is important to be aware that these Antarctic meteorites are all finds and have therefore been undergoing alteration for some time. However, the fact that clear trends in the mineralogy are observed with increasing equilibration and are confirmed by analysis of falls, suggests pre-terrestrial alteration. It indicates that there is significant primary phyllosilicate in most UOCs. During parent body metamorphism, phyllosilicates were dehydrated and converted to ferromagnesian silicates.