UNUSUAL EQUILIBRATED CARBONACEOUS CHONDRITES AND CO3 METEORITES FROM THE SAHARA; D. Weber[1], R. N. Clayton[2], T. K. Mayeda[2] and A. Bischoff[1], [1]Institut für Planetologie, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany, [2]Enrico Fermi Institute, University of Chicago, Chicago, IL 60637, USA.

Among the 222 meteorites recovered in the libyan Sahara in 1994 and 1995 [1], at least fourteen samples were recognized as carbonaceous chondrites. Based on find locations, oxygen isotopes, petrographic features, and the chemical composition of olivine and pyroxene they represent at least four distinct falls. One of the samples is equilibrated and could be classified as a C4 chondrite, another shows equilibrated matrix olivines, and at least two meteorites can be assigned to the CO3 chondrite group.

Hammadah al Hamra 073 - an equilibrated C4 chondrite:
The sample HH073 shows equilibrated olivines both in chondrules and matrix with a fayalite content of about 17.9 mol% (Table 1). Only a few forsteritic olivines are present, mostly as relict minerals inside large chondrules. However, by measuring statistically the chemical composition of olivines, there is only a little chance of detecting a forsterite-rich grain. Pyroxenes are not as equilibrated as the olivines (Table 1). The meteorite HH073 exhibits a chondritic texture containing abundant chondrules with a size up to 1000 µm. Highly irregularly-shaped objects rich in anorthite were found. In addition, refractory inclusion-like objects are present including the phases (Cr-)hercynite, ilmenite, and anorthite. Considering the chondrule/matrix-ratio, the low Ni-content in olivines, and the olivine and pyroxene compositions, a relationship of HH073 to the CK meteorites can be excluded. Although information on the chemical composition of the bulk meteorite is still not available, similarities to the unusual carbonaceous chondrites Coolidge and Loongana 001 are suggested [2]. However, it appears that the chondrule/matrix-ratio in Coolidge is higher than in HH073. Comparing the oxygen isotopes of HH073 with those of other carbonaceous chondrites, CO, CK chondrites [3] and Coolidge ($\delta^{18}O$=-1.4‰; $\delta^{17}O$= -5.2‰; [4]) are slightly richer in ^{16}O than HH073 (Table 1). The latter plots in the broad CV range but based on petrographic characteristics a strong relationship between CV chondrites and HH073 can be ruled out.

Dar al Gani 055 - a C3 chondrite with equilibrated matrix olivines:
Petrologically, Dar al Gani 055 is a type 3 carbonaceous chondrite containing unequilibrated olivines and pyroxenes within the main lithological components such as chondrules or fragments. The analysed olivines and pyroxenes within these components show a wide range in chemical composition ($Fa_{0.4-32}$; $Fs_{0.6-6}$)with a mean value of $Fa_{14.9}$ and $Fs_{2.6}$, respectively (Table 1). In both cases, the percent standard deviation is larger than 50 indicating a petrologic subtype lower than 3.5. In contrast, matrix olivines within DG055 are equilibrated showing a composition of $Fa_{30.5\pm0.5}$. This composition is similar to that known from CK chondrites [e.g. 5,6]. Usually, CK chondrites (petrographic type 4 to 6) exhibit completely equilibrated olivines, but some members of this chondrite group, classified as CK3, are present having unequilibrated chondrule olivines but equilibrated matrix olivines. A good example is Camel Donga 003 containing matrix olivines with $Fa_{33.8}$ and chondrule olivines with $Fa_{0.3-34}$ [7]. The low modal abundance of Ca,Al-rich inclusions and olivine aggregates also suggests a relationship of DG055 with the CK chondrites. However, some features of DG055 resemble those from CV chondrites, e.g. the chondrule size or the textural appearance of the matrix. The oxygen isotopes of DG055 fall into the CV and CK spread (Table 1) and do not give further information with respect to the classification of this meteorite. So far, due to the lack of chemical data of the bulk meteorite, we can not unambiguously

decide, whether Dar al Gani 055 should be classified as a CK3 meteorite, as a CV-related chondrite or as an ungrouped unusual C3 chondrite.

Hammadah al Hamra 043 - a CO3 chondrite:
Based on petrographic and chemical characteristics, the sample HH043 can be assigned to the CO3 chondrite group. In detail, these characteristics are the relatively small chondrule size, the occurrence of abundant CAIs, the chemical composition of olivines and pyroxenes (Table 1), and the oxygen isotopic composition (Table 1). Olivines and pyroxenes within chondrules and fragments are highly unequilibrated ($Fa_{0.1-62}$ and $Fs_{0.7-3.5}$; mean: $Fa_{14.9}$ and $Fs_{1.7}$; petrologic subtype: <3.5). Matrix olivines show a range in chemical composition between Fa_3 and Fa_{40}. It cannot be ruled out that matrix olivines show a peak in their Fa-distribution, because it is difficult to decide whether the analysed olivines of the matrix are a primitive matrix component or are related to fragmented chondrules, inclusions, mineral fragments, etc.

Dar al Gani 006, 023, and 025 - CO3 chondrites:
Considering the petrographic and chemical features, the samples DG006, DG023, and DG025 are CO3 chondrites. The oxygen isotopes of DG023 and DG025 fall within the rather narrow range for CO chondrites [3], whereas DG006 exhibits slightly higher values for $\delta^{17}O$ and $\delta^{18}O$ (Table 1) either indicating that the previously defined range for CO3 must be extended or that DG006 has to be considered as an ungrouped CO-related chondrite. Bulk chemical analyses are in progress and may give convincing hints in respect to the classification of this meteorite.

Due to the different find location of the samples DG006, 023 and 025 compared to that of HH043, pairing between the Dar al Gani COs and the latter meteorite seems to be impossible. Besides the CO3 chondrites mentioned in this study, at least nine other meteorites from the Dar al Gani region are recognized as carbonaceous chondrites. At first sight, it appears that most of them are also COs. Pairing among these samples or among some of them seems to be very probable. Detailed investigations (e.g. bulk chemical analyses, analyses of ^{26}Al, ^{10}Be, and noble gases) of these meteorites are in progress and may give important information about pairing.

References: [1] Weber and Bischoff (1996) this issue; [2] Kallemeyn and Rubin (1995) Meteoritics **30**, 20; [3] Clayton (1993) *Ann. Rev. EPS* **21**, 115; [4] Clayton *et al.* (1977) EPSL **34**, 209; [5] Scott and Taylor (1985) JGR **90**, C699; [6] Kallemeyn *et al.* (1991) GCA **55**, 881; [7] Wlotzka (1993) Meteoritics **28**, 146.

Table 1: Oxygen isotopes, chemical composition of olivine and pyroxene, and suggested classification of carbonaceous chondrites from the libyan Sahara; *19 measurements, 2 analyses show $Fs_{>19}$

meteorite:	$\delta^{18}O$ (‰)	$\delta^{17}O$ (‰)	Fa (mol%)	Fs (mol%)	class
Hammadah al Hamra 073	+1.21	-3.13	17.9±0.3	8.5±2.8	C4
Dar al Gani 055	-1.18	-4.73	0.4-32	0.6-6	C3
Hammadah al Hamra 043	-0.84	-4.55	0.1-62	0.7-3.5	CO3
Dar al Gani 006	+0.82	-3.45	0.4-42	0.7-5	CO3
Dar al Gani 023	-1.23	-4.97			CO3
Dar al Gani 025	-0.98	-4.75	0.4-52	0.9-9*	CO3