

NEW TYPE 3 ORDINARY CHONDRITES FROM THE SAHARA DESERT.

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In 1989, 1990, and 1991 about 400 meteorites were recovered at different locations in the Sahara desert. So far, about 200 meteorites have been classified (1-4). Among these meteorites we have identified 27 type 3 ordinary chondrites (Table 1): 20 H-group, 5 L-group and 2 LL-group chondrites. Additionally, four chondrites previously classified as H4 chondrites (1-3) have TL sensitivities in the range of chondrites of type 3.7-3.9 (see below). Based on the heterogeneity of olivine and pyroxene, similar metal contents and the degree of weathering the distinction between the type L- and LL-chondrites is somewhat difficult and might not be correct in all cases (see Table 1). Eight of these type 3 chondrites are breccias that consist of clasts of various petrologic types (Table 1).

Weathering: The degree of weathering is variable. However, all chondrites still have metals. Due to weathering the components within the thin sections of most chondrites look "brownish". The metals are coated with films of limonite of various extent. This material also fills cracks and pores within the samples. Some chondrites contain only a negligible amount of weathering products: Acfer-102, -111, -162, -166, -180, and Ilafegh-013.

Olivine and pyroxene heterogeneity: The mean compositions of olivines and pyroxenes, the ranges in composition and the coefficient of variation (CV), which is the standard deviation of the analyses (mol% Fa or Fs) expressed as a percentage of the mean, are listed in Table 1. Based on the CV-values most chondrites belong to the subtypes 3.7-3.9 of the type 3 ordinary chondrites. In many chondrites olivines are almost equilibrated (CV: 2-10), whereas the pyroxenes are still quite heterogeneous in composition (CV: 5-45; Table 1).

Acfer-080 and Tanezrouft-006 should be classified as type 4 chondrites based on the homogeneity of olivine; however, these samples appear to contain a small amount of mesostasis glass (especially Tanezrouft-010). Based on the TL-data these samples must be assigned to the type 3 chondrites (Table 1).

Mesostasis glass was found in all other chondrite. However, the mesostasis of most chondrules from the type 3.7-3.9 chondrites has a very fine-grained crystallization texture. Adrar-003 is an exceptional chondrite among the new Sahara meteorites. Olivine and pyroxene compositions are highly variable (Table 1). The Fa-contents of olivine is as high as 90 mol%. These Fa-rich grains exist as tiny minerals within the matrix and are quite abundant.

Breccias: Six H-group breccias, one L-, and one LL-group breccia are among the ordinary chondrites that contain type 3 components and equilibrated type 4-6 clasts. In some chondrites the abundance of type 3 material is minor (Acfer-160, -163). In these cases only a restricted number of chondrules or chondrule fragments contain unequilibrated olivines or pyroxenes and the CV-value is quite low. The type 3 components always coexist with fragmental material within the finer grained areas of a thin section surrounding the light, type 4-6 clasts. Depending on the sampling during thin section preparation the ratio of fine-grained materials to equilibrated clasts varies on a cm-scale. Thus, the CV-value has no real meaning for a sub-classification of chondritic breccias. One of the most spectacular chondritic breccias is the sample of Acfer-111. This rock has exceptionally unfractionated solar noble gases (5).

Shock effects: Olivine with mosaicism and multiple sets of planar fractures and localized melt products indicate that Ilafegh-013 is the most highly shocked type 3 chondrite found so far. The degree of shock is somewhat variable on the scale of a thin section. Based on the shock classification of (6) it ranges from the upper stage S3 to the lower stage S5, although S4 is predominant. All other type 3 samples from the Sahara desert have experienced a lower degree of shock metamorphism.

TL-data: From 22 samples of Table 1 the TL sensitivity has been obtained. The induced TL peak temperatures and widths are consistent with the assigned types (compare (7)). Since most of the chondrites studied are of the subtype 3.8 \pm 0.1 (Table 1) the TL data suggest considerable pairing (see below). Based on our data Adrar-003 can be classified as an ordinary chondrite of type 3.2. Ordinary chondrites with such a low TL sensitivity are very rare. We have also obtained TL-sensitivities of 4 chondrites not listed in Table 1 that have been classified as type 4 chondrites based on the homogeneity of olivine and pyroxene (1-3). Our data are: Acfer-005: H3.9; Acfer-006: H3.7; Acfer-169: H3.8 and Hammadah Al Hamra-028: H3.8.

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Pairing: Based on our chemical and mineralogical studies we believe that the 27 type 3 ordinary chondrites result from at least 15, but probably more different falls. We suggest pairing of Acfer-028 with Acfer-153 and -171, Acfer-022 with -211, Acfer-162 with -166 and -180 and perhaps Acfer-178 with -210 (uncertain). Based on the TL-data one would expect a higher number of paired samples. The high number of distinct falls is indicated by the following reasons: 1) Different locations of recovery; 2) different distributions of olivine and pyroxene compositions with peaks at different Fa-values (the peak in the Fa-distribution of olivine varies between 14 and 19 mol% for the H-chondrites); 3) variable grain size of components (chondrules, fragments) in the meteorites of one class; 4) different degree of weathering. Other methods (analyses of nuclides) must be used to obtain the real number of distinct falls. Such analyses are in progress.

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(1) The Meteoritical Bulletin, 1990, (ed. F. Wlotzka), Meteoritics 25, 237-239. (2) The Meteoritical Bulletin, 1991, (ed. F. Wlotzka), Meteoritics 26, 255-262. (3) The Meteoritical Bulletin, 1992, (ed. F. Wlotzka), Meteoritics (submitted). (4) Bischoff et al., 1991, Meteoritics 26 (in press). (5) Pedroni and Weber, 1991, Meteoritics 26 (in press). (6) Stöffler et al., 1991, GCA (in press). (7) Sears et al., 1990, LPS XXI, 1121-1122.

Table 1: Classification of type 3 ordinary chondrites from the Sahara desert;

*based on mineralogy and composition of olivine and pyroxene; H. Al Hamra = Hammadah Al Hamra

Sample	Date of find	coordinates	mass	No. of stones	Ol (Fa)			Px (Fs)			class and type*	type TL assignment
					mean	CV	range	mean	CV	range		
Acfer-022	17.11.89	27°31'N/3°50'E	192	1	18.40	13.50	8-21	14.34	28.1	7-23	H3	3.7
Acfer-023	17.11.89	27°31'N/3°55'E	118	1	14.37	9.53	8-17	15.36	58.08	1-32	H3	3.8
Acfer-028	17.11.89	27°40'N/4°15'E	3130	5	17.19	4.62	16-20	15.28	11.7	10-20	H3	3.8
Acfer-039	18.11.89	27°32'N/3°55'E	225	3	23.34	21.66	6-28	16.06	36.82	2-23	L3	3.8
Acfer-066	11. 4.90	27°38'N/4°04'E	517	1	25.02	21.50	9-31	19.41	36.06	3-31	L(LL)3	3.8
Acfer-080	15. 4.90	27°38'N/4°31'E	574	1	24.75	2.07	24-26	19.82	10.40	17-24	L3.9/4	3.9
Acfer-102	20. 4.90	27°40'N/4°28'E	346	2	22.64	5.39	18-25	16.48	36.59	2-25	L3-5 (Breccia)	-
Acfer-111	22. 4.90	27°29'N/3°48'E	987	1	17.16	15.27	7-22	14.52	25.34	2-17	H3-6 (Breccia)	-
Acfer-129	15.11.90	27°36'N/4°12'E	162	1	17.19	16.29	9-21	13.85	53.43	2-30	H3	3.7
Acfer-153	19.11.90	27°32'N/3°57'E	211	1	18.03	11.31	9-21	16.01	5.72	14-18	H3	3.8
Acfer-159	20.11.90	27°30'N/3°56'E	123	1	17.15	30.26	4-31	18.00	39.94	7-34	H3	3.8
Acfer-160	20.11.90	27°28'N/3°43'E	433	1	31.14	2.80	29-34	23.65	14.50	9-28	LL3-6 (Breccia)	3.8
Acfer-162	22.11.90	27°40'N/4°01'E	1281	1	18.60	17.74	16-36	16.20	4.16	14-19	H3-6 (Breccia)	-
Acfer-163	22.11.90	27°42'N/4°21'E	125	1	18.94	3.70	18-22	15.76	19.69	5-18	H3-5 (Breccia)	3.8
Acfer-166	25.11.90	27°31'N/4°14'E	2476	3	18.00	12.33	8-20	16.36	16.01	8-22	H3-5 (Breccia)	-
Acfer-171	26.11.90	27°39'N/4°15'E	313	1	16.04	23.75	2-20	15.88	14.48	9-21	H3	3.7
Acfer-178	27.11.90	27°29'N/3°45'E	488	1	14.73	8.15	13-20	14.06	45.16	4-27	H3	3.7
Acfer-180	27.11.90	27°36'N/4°10'E	103	1	18.05	11.53	11-20	15.40	24.50	4-21	H3-5 (Breccia)	3.9
Acfer-188	28.11.90	27°35'N/4°07'E	252	1	17.13	11.34	15-29	15.76	13.85	13-25	H3	3.9
Acfer-192	29.11.90	27°39'N/4°12'E	219	1	19.67	13.52	17-28	17.13	33.39	4-31	H3-5 (Breccia)	3.9
Acfer-210	7. 4.91	27°29,83'N/3°52,22'E	720	1	15.30	23.88	12-33	15.50	52.06	4-34	H3	3.7
Acfer-211	7. 4.91	27°27,89'N/3°46,90'E	1009	1	18.53	20.35	5-25	17.18	37.49	8-30	H3	3.9
Ilafegh-013	10.89	21°40'N/1°23'E	745	1	18.58	12.60	10-21	17.77	43.46	5-37	H3	3.5
Tanezrouft-006	13.11.89	25°32'N/0°34'E	331	1	16.49	2.92	15-18	14.72	20.20	9-22	H3.9/4	3.7
Tanezrouft-010	10. 4.91	26°04,39'N/0°22,10'E	2500	58	21.83	43.20	1-32	13.98	61.22	3-34	L(LL)3	-
H. Al Hamra-004	15. 2.90	28°57'N/12°28'E	296	1	17.45	6.05	14-20	14.82	16.65	8-19	H3	3.9
Adrar-003	2.12.90	27°08'N/0°12'E	287	1	22.52	90.54	0-90	13.35	61.02	1-41	LL(L)3	3.2