GOBABEB, A NEW CHONDRITE: THE COEXISTENCE OF EQUILIBRATED SILICATES AND UNEQUILIBRATED SPINELS

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Gobabeb, an ordinary chondrite, was found near Gobabeb, South West Africa in 1969. Chemically and petrographically it belongs in the H4 group. But, in addition to almost homogeneous silicates and chromites, it contains rare, non opaque spinels that vary greatly in composition from grain to grain. A similar association in an "almost equilibrated" portion of the Mezö-Madaras chondrite has been interpreted as evidence against the hypothesized metamorphic homogenization of ordinary chondrites. A comparison of the chromites and variable spinels from Mezö-Madaras and Gobabeb suggests, instead, that cation exchange is simply slower in the variable spinels than in the chromites. Based on the evidence to date, the survival of these highly variable spinels is not incompatible with a metamorphic episode for both these meteorites.

INTRODUCTION

In 1969 a stony meteorite was found by Mr. Eric Holm, then a staff member of the Namib Desert Research Station at Gobabeb, South West Africa (23° 33′S, 15° 02′E). The find site is ~8 miles SSE of Gobabeb, on the flank of a sand dune, 100 meters high. The total recovered weight was reported to be ~27 kilograms, composed of a single main mass of 23 kilograms plus a number of lesser fragments. This is only the second stony meteorite recovered from South West Africa. We report herein a brief chemical and petrographic description of two small fragments that were forwarded to our laboratory for identification and examination, with particular emphasis on the rare, chemically variable spinels it contains and the significance of these spinels with respect to the thermal histories of the so-called "equilibrated" chondrites.

We have been unable to correspond with the original finder or to locate the remainder of the material from the find site. The two fragments sent to us, weighing a total of 25 grams, have been accessioned into our collection as the Gobabeb meteorite, USNM No. 5744.

MACROSCOPIC DESCRIPTION

The unbroken surfaces of the fragments are coated with a thick layer, up to 3 mm, of desert varnish, testifying to a considerable terrestrial age.

substantial amounts [illegible] and metal, both of which appear to be relatively unaffected by terrestrial oxidation. Chondrules are readily observable on the fractured surfaces.

CHEMISTRY

Electron microprobe analyses of Gobabeb olivines, low-Ca pyroxenes, and various spinels are shown in Tables 1 and 2. The instrument used was an ARL microprobe, model SEMQ, utilizing an accelerating potential of 15 KV, a sample current of 0.15 μA, and three 10-second counts per spot. Results have been corrected using internal standards and procedures outlined by Bence and Albee (1968) and Boyd, *et al.* (1967-1968). Standards used were analyzed olivine, fayalite, enstatite, hypersthene, chromites (2), manganite, ilmenite and vanadium metal.

The compositional variations between individual olivines and pyroxenes illustrated in Table 1 do not significantly exceed the present limits of our instrumental precision, as determined by repeated analyses of standards and unknowns under identical conditions of instrumental operation. For the pyroxenes, however, some of the observed variation is real, for a few grains do show slight zoning toward more calcic compositions from center to edge, from 0.4% CaO to 1.3% CaO. The average iron contents of the olivine and pyroxene correspond to Fa_{18} and Fs_{16} respectively. These values place the meteorite in chemical group II (Keil and Fredriksson, 1964). The chromites are definitely slightly variable in composition, from grain to grain, with average elemental values again corresponding to the H group chromites studied by Bunch *et al.* (1967). As only one spot per grain was analyzed we cannot comment on the homogeneity of individual chromites.

The meteorite also contains non-opaque spinels that exhibit extreme chemical variations from one grain to the next; *e.g.*, Al_2O_3 values ranged from 20.8 weight percent to 48.5 weight percent for those spinels analyzed. Since these spinels are rare and our analyses few, the true range may well exceed our reported values. In fact we were able to locate and analyze only a total of six such spinels in the sections examined. Of the three grains upon which we performed more than one spot analysis, two were found to be essentially homogeneous, within the limits of our instrumental precision, while the third grain showed some random variation from spot to spot, Table 2. There was no apparent zoning of this grain.

For all practical purposes, the analyses of these variable spinels can be represented by varying amounts of the three end members spinel ($MgAl_2O_4$), chromite ($FeCr_2O_4$) and hercynite ($FeAl_2O_4$), Fig. 1. Structurally, they are normal spinel solid solutions exhibiting simple Fe-Mg and Cr-Al substitutions in the A and B sites respectively. For comparison, the Gobabeb average

Table 1
Electron Microprobe Analyses of Olivine, Pyroxene and Chromite from the Gobabeb Meteorite

	Olivine			Pyroxene			Chromite		
	Wt. % (Av. of 32)	Range	SD	Wt. % (Av. of 29)	Range	SD	Wt. % (Av. of 15)	Range	SD
SiO_2	39.1	38.4-39.6	0.44	56.2	55.2-57.0	0.45	NA	–	–
TiO_2	0.07	0.02-0.22	0.06	0.10	0.03-0.21	0.05	1.64	1.25-1.85	0.18
Cr_2O_3	NA	–	–	NA	–	–	57.3	54.5-58.9	1.1
Al_2O_3	<0.1	–	–	0.21	0.08-0.53	0.12	6.4	6.1-6.8	0.2
V_2O_3	NA	–	–	NA	–	–	0.78	0.71-0.81	0.03
FeO	17.1	16.6-17.5	0.41	10.8	10.3-11.5	0.28	30.4	29.0-32.2	0.9
MnO	0.34	0.33-0.36	0.01	0.35	0.22-0.39	0.03	0.68	0.56-0.74	0.03
MgO	42.9	42.3-43.6	0.40	30.8	29.4-31.7	0.49	3.3	2.9-4.0	0.3
CaO	<0.1	–	–	0.52	0.20-1.30	0.33	NA	–	–
Total	99.5			99.0			100.5		

SD = Standard Deviation
NA = Not Analyzed

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Name:	*FENBARK*
Place of find:	Approximately 25 miles NNW of Kalgoorlie, Western Australia, a quarter of a mile on a bearing of 8° from Mt. Ellis trigonometrical station, in the general vicinity of the Fenbark group of gold-mining leases. 30°26′25″S, 121°15′25″E.
Date of find:	May 19, 1968.
Class and type:	Stone. Olivine-bronzite chondrite (H5).
Number of individual specimens:	1
Total weight:	1.861 kg
Circumstances of find:	Found by A. A. Skinner, K. J. Erbe and F. C. Bray, members of a nickel-prospecting syndicate.
Source:	G. J. H. McCall and W. H. Cleverly. 1969. The Credo and Fenbark meteorites, new finds of common chondrites from north-west of Kalgoorlie, Western Australia. *Mineralogical Magazine* 37, *281-285.*

DISCOVERY OF THE *GOBABEB*, SOUTH WEST AFRICA, STONY METEORITE

Name:	*GOBABEB*
Place of find:	About 8 miles SSE of Gobabeb. 23°33′S, 15°02′E.
Date of find:	1969
Class and type:	Stone. Olivine-bronzite chondrite (H4).
Number of individual specimens:	One 23 kg mass plus a number of fragments.
Total weight:	Approximately 27 kg.
Circumstances of find:	Found on the flank of a 100-meter high sand dune by a member of the Namib Desert Research Station at Gobabeb.

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Source:	R. F. Fudali and A. F. Noonan. 1975. A new chondrite from South West Africa: the coexistance of equilibrated silicates and unequilibrated spinels. *Meteoritics*, 10, 31-39.

DISCOVERY OF THE *HARDTNER*, KANSAS, STONY METEORITE

Name:	*HARDTNER*
Place of find:	Hardtner, Barber County, Kansas, U.S.A. 37°4′N, 98°39.7′W.
Date of find:	Recognized 1972.
Class and type:	Stone. Olivine-hypersthene chondrite.
Number of individual specimens:	1
Total weight:	13 kg
Circumstances of find:	Plowed up in field which had been terraced.
Source:	Glenn I Huss, American Meteorite Laboratory, P.O. Box 2098, Denver, Colorado 80201.

DISCOVERY OF THE *ISNA*, EGYPT, STONY METEORITE

Name:	*ISNA*
Place of find:	About 100 km SW of Isna, on the Nile River near Luxor, Egypt. 24°50′N, 31°40′E.
Date of find:	1970
Class and type:	Stone. Carbonaceous chondrite (C3, Ornans subtype).
Number of individual specimens:	1
Total weight:	23 kg
Circumstances of find:	Found by Mohammad El Hinnawi of the Geological Survey of Egypt; main mass is preserved at the