Zeitschrift: Schweizerische mineralogische und petrographische Mitteilungen = Bulletin suisse de minéralogie et pétrographie

Band: 57 (1977)

Heft: 2

Artikel: The Utzenstorf stony meteorite

Autor: Bevan, A.W.R. / Easton, A.J.

DOI: https://doi.org/10.5169/seals-44429

Schweiz. mineral. petrogr. Mitt. 57, 169–173, 1977

The Utzenstorf Stony Meteorite

By *A. W. R. Bevan* and *A. J. Easton* (London)*)

Abstract

The Utzenstorf, canton Bern, Switzerland, meteorite fell at 7 p.m. on August 16, 1928 at 47° 7′ N., 7° 33′ E. This olivine-bronzite, or H-group chondrite contains olivine ($Fa_{18.3}$), orthopyroxene ($Fs_{16.4}$), kamacite, taenite, troilite, chromite, phosphate and native copper. A chemical analysis with total Fe = 28.75% (wt) and $(Fe+Mn) \times 100 : (Fe+Mn+Mg) = 17.5$ (mol.%), is presented. On the basis of bulk composition, mineralogy and texture, Utzenstorf is classified as an H 5 chondrite.

INTRODUCTION

On 16 August, 1928 at 7 p.m. local time a bright fireball travelling east to west and "about the size of the Moon" was seen by a number of witnesses in the area of the town of Utzenstorf, canton Bern, Switzerland. The fireball was visible for about four seconds and was accompanied by five or six detonations in rapid succession. Eleven days later, on the farm Stigli (lat. 47° 7′ N., long. 7° 33′ E.), a farmworker discovered three interlocking fragments of black crusted stone totalling 3422 grams in a hole approximately 25 cm deep. Some soil was adhering to the fragments which were washed clean under running water.

On 17 September, after reading a report of the fall in a local paper, Ernst Scheidegger, a teacher in Bern, travelled to Utzenstorf and returned the same day with the largest fragment of 2764 grams. He deposited it at the Naturhistorisches Museum where it was recognised as a meteorite (from Gerber, 1929 and Hey, 1966).

When fitted together the three fragments formed an incompletely crusted, orientated individual approximately 22 cm × 14 cm × 8 cm which had broken on impact. Some small fragments had obviously become detached during atmospheric flight but these were not found.

---

*) Department of Mineralogy, British Museum (Nat. Hist.), London SW 7 5 BD.

The meteorite was described, analysed and figured by HUTTENLOCHER and HÜGI (1952) who classified it as an olivine-bronzite chondrite, and gave details of petrography and fusion crust. The present study reports a new chemical

Table 1. *Chlorination analysis of the Utzenstorf meteorite (B.M. 1975, M. 14)*

Non-magnetic attacked (sulphides)

	wt%
Fe	3.55
Mn	(12 ppm)
S	2.04
Cr	(6 ppm)
Ti	(34 ppm)
Ga	(<1 ppm)
Ge	(<1 ppm)

Magnetic attacked (Ni-poor metal and schreibersite)

Fe	17.79
Ni	1.26
Co	0.085
Ge	(10 ppm)
Ga	(1.3 ppm)
P	n. f.

Metal composition (kamacite)

Fe	93.0%
Ni	6.6%
Co	0.4%
Ge	(52 ppm)
Ga	(6.8 ppm)

Magnetic unattacked (Ni-rich metal)

Fe	0.42
Ni	0.43
Co	(17 ppm)
Ge	(1.03 ppm)
Ga	(0.35 ppm)

Metal composition (taenite)

Fe	49.3%
Ni	50.5%
Co	0.2%
Ge	(121 ppm)
Ga	(41 ppm)

Non-magnetic unattacked (silicates, phosphates, oxides)

SiO_2	35.93
TiO_2	0.28
Al_2O_3	1.46
Cr_2O_3	0.50
Fe_2O_3	0.67
FeO	8.38
MnO	0.28
MgO	23.06
CaO	1.70
Na_2O	0.85
K_2O	0.10
P_2O_5	0.24
NiO	0.06
H_2O^+	0.40
C	0.30
Ge	(0.5 ppm)
Ga	(1 ppm)
Total	99.79
Total Fe = 28.75%	

CIPW norm

Olivine	Fo	22.91
	Fa	6.34
Hypersthene	En	22.45
	Fs	5.43
Diopside	Wo	2.93
	En	2.13
	Fs	0.53
Plagioclase	Ab	7.18
	An	0.00
	Or	0.61
Apatite		0.41
Chromite		0.74
Ilmenite		0.53
Magnetite		0.97
Kamacite		19.14
Taenite		0.85
Troilite		5.59
Rest		0.76

n.f. = not found
Analyst: A. J. EASTON

analysis (Table 1) using an improved version of the chlorination technique of Moss et al., (1967), and electron microprobe analyses of selected minerals in the meteorite (Table 2).

Table 2. *Electron microprobe analyses of selected minerals from the Utzenstorf meteorite*

	Olivine	Orthopyroxene	Chromite 1)	Chromite 2)
SiO_2	39.51	57.07	–	–
TiO_2	–	0.18	2.06	1.83
Al_2O_3	–	0.19	6.91	7.13
V_2O_5	–	–	0.85	0.89
Cr_2O_3	–	0.02	57.46	56.99
FeO	17.28*)	10.83*)	28.18*)	28.51*)
MnO	–	–	1.46	1.48
MgO	43.34	30.93	3.46	2.87
CaO	0.03	0.60	–	–
Total	100.16	99.82	100.38	99.70
	($Fa_{18.3}$)	($Fs_{16.2}En_{82.6}Wo_{1.2}$)		

1) Chromite associated with metallic nickel-iron.
2) Chromite in matrix.
*) Total Fe as FeO.
– = not looked for.

Analytical conditions: Cambridge Instruments 'Geoscan' microprobe. Standards employed, independently analysed minerals and pure metals, and the results were corrected according to the method outlined by Sweatman and Long (1969) and using the BM-IC-NPL computer program compiled by Mason, Frost and Reed (1969). Analyst: A. W. R. Bevan.

MACRO AND MICROSCOPIC FEATURES

The meteorite is a grey crystalline chondrite. Terrestrial oxidation has turned the crust a dark brown colour and has also penetrated the interior producing patches of rust around metal particles. The oxidation, and relatively high bulk Fe_2O_3 content (0.67% wt) for an observed fall can probably be attributed to weathering as a result of heavy rain during the period between fall and recovery and to its being washed under running water. On a cut surface a few chondrules up to 2 mm can be distinguished; also abundant metal particles that are evenly distributed.

In thin section, numerous poorly defined chondrules commonly 0.4 mm across, and chondrule fragments, composed essentially of olivine or orthopyroxene occur in a microcrystalline matrix. The chondrules display a variety of morphological types including radiating pyroxene chondrules, and barred, and porphyritic olivine chondrules. Clinobronzite and plagioclase grains are rare and occur as small crystallites in the matrix. Metallic nickel-iron, troilite, chromite, phosphate and native copper are also present.

Nine olivine grains and six orthopyroxene grains were analysed by electron microprobe and found to be homogeneous with mean compositions $Fa_{18.3}$ and $Fs_{16.2}$ $En_{82.5}$ $Wo_{1.3}$ respectively. The olivine composition is consistent with that (Fa_{18}) obtained for Utzenstorf by MASON (1963) using X-ray diffraction.

Metallic nickel-iron is the most abundant opaque phase occurring as irregular and sometimes rounded grains up to 1 mm in size. Kamacite (α-Fe, Ni) with 6.6–6.8% Ni is more abundant than taenite (γ-Fe, Ni) with 48.9–49.5% Ni (analyses by electron microprobe). Cores of some taenite grains have decomposed to plessite ($\alpha+\gamma$-Fe, Ni). Troilite occurs in association with metal and also as irregular masses up to 0.12 mm across. Grains near the fusion crust and within the heat affected zone have decomposed to fine-grained eutectic-like intergrowths.

Chromite occurs in various textural associations: coarse-grained chromite (0.10–0.15 mm) associated with metal and troilite; discrete grains (0.03–0.06 mm) in the matrix; and aggregates of small ($\sim$6 μm) rounded grains also in the matrix. Analyses of coarse-grained and matrix chromite are given in Table 2. The compositions are consistent with that for H-group chondrites (BUNCH, et al., 1967; BUNCH and OLSEN, 1975). Some chromite grains enclose phosphates but were too small to analyse by electron microprobe.

Native copper is rare and occurs as aggregates of irregular grains ($\sim$5 μm) in nickel-iron surrounded by troilite.

BULK CHEMISTRY

The chemical analysis reported in Table 1 was obtained from a 3.4 gram sample of Utzenstorf (B.M. 1975, M. 14). The chemical composition and calculated total Fe/SiO_2 and Fe°/total Fe ratios of 0.80 and 0.63, respectively, are consistent with an H-group classification of the meteorite (VAN SCHMUS and WOOD, 1967). Calculated Ni contents of both kamacite and taenite are in excellent agreement with those determined by electron microprobe and the normative silicate $(Fe+Mn)\times 100:(Fe+Mn+Mg)$ molecular ratio, 17.5, is close to that derived from the electron microprobe analyses of olivine and pyroxene.

The method of analysis (MOSS, et al., 1967), uses a magnetic separation followed by selective attack of dry Cl_2 on kamacite and sulphide, leaving silicates and taenite essentially unaffected. This enables the major and some trace elements to be determined in a number of fractions of chondritic meteorites. Gallium and germanium concentrations in different fractions of Utzenstorf are given in Table 1. The ratio of Ga in metal to Ga in silicate, 6.1, is slightly high but within experimental error for the range of values for H 4–6 chondrites (2.8–6.0) (CHOU, et al., 1973). The high Ni concentration, 470 ppm, of the non-magnetic, unattacked fraction is probably the result of terrestrial oxidation. Schreibersite was not detected.

CONCLUSIONS

The composition of the olivine ($Fa_{18.3}$), abundance of free metal, and total Fe content of 28.75 wt% confirm HUTTENLOCHER and HÜGI's (1952) classification of Utzenstorf as an olivine-bronzite or H-group chondrite. The absence of polysynthetically twinned clinopyroxene and well developed plagioclase grains indicates that the meteorite belongs to petrologic grade 5 of the VAN SCHMUS and WOOD (1967) classification.

Acknowledgements

The authors thank Professor H. A. Stalder for making a sample of the meteorite available for study; and Drs R. Hutchison and A. L. Graham for advice and critically reading the manuscript.

References

BUNCH, T. E., K. KEIL and K. G. SNETSINGER (1967): Chromite composition in relation to chemistry and texture of ordinary chondrites. Geochim. Cosmochim. Acta, *31*, 1569–1582.

BUNCH, T. E. and E. OLSEN (1975): Distribution and significance of chromium in meteorites. Geochim. Cosmochim. Acta, *39*, 911–927.

CHOU, C.-L., P. A. BAEDECKER and J. T. WASSON (1973): Distribution of Ni, Ga, Ge and Ir between metal and silicate portions of H-group chondrites. Geochim. Cosmochim. Acta, *37*, 2159–2171.

GERBER, E. (1929): Vorläufige Mitteilungen über den Meteorstein von Utzenstorf (Unteremmental), Kanton Bern. Mitt. naturf. Ges. Bern, 1928, 25–31.

HEY, M. H. (1966): Catalogue of Meteorites, 3rd edition, British Museum (Nat. Hist.), London.

HUTTENLOCHER, H. and T. HÜGI (1952): Der Meteorit von Utzenstorf. Mitt. naturf. Ges. Bern, ser. 2, *9*, 67–128.

MASON, B. (1963): Olivine composition in chondrites. Geochim. Gosmochim. Acta, *27*, 1011–1023.

MASON, P. K., M. J. FROST and S. J. B. REED (1969): BM-IC-NPL computer program for calculating corrections in quantitative X-ray microanalysis. National Physical Laboratory, I.M.S. Report 1.

MOSS, A. A., M. H. HEY, C. J. ELLIOTT and A. J. EASTON (1967): Methods for the chemical analysis of meteorites: II. The major and some minor constituents of chondrites. Mineralog. Mag., *36*, 101–119.

SWEATMAN, T. R. and J. V. P. LONG (1969): Quantitative electron-probe analysis of rock forming minerals. J. Petrol., *10*, 332–379.

VAN SCHMUS, W. R. and J. A. WOOD (1967): A chemical-petrologic classification for the chondritic meteorites. Geochim. Cosmochim. Acta, *31*, 747–765.

Manuscript received July 11, 1977.