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MINERALOGY OF POLICE METEORITE

INTRODUCTION

Single meteorite-stone fell 16th of September 1969 at 7.15 GMT in the village Suchý Důl, near Police nad Metují, Czechoslovakia, (16° 14′ 40″ E long and 50° 32′ 17″ N lat.). K. TUČEK (1970) described in detail the fall, surface features as well as results of optical mineralogical studies and presented major element analysis of this meteorite made by M. Veselý, M. Mikšovský and J. Weiss (Geological Survey Prague) (Tab. 1). K. TUČEK (1970) classified this meteorite as L type.

Major element data are presented here for major mineral phases of the Police meteorite. The analyses were obtained using the electron microprobe. Thin section used for the studies is deposited in the files of National Museum in Prague.

METHOD

Analyses were carried out using the ARL-EMX electron microprobe in the Geochemistry Branch Laboratories at the Manned Spacecraft Center, NASA, Houston, Texas. Matrix corrections follow the method of Bence and Albee and analyzed natural minerals were used as standards. The conditions of analyses are those as reported in ASS (1971), with the exception of plagioclase analysis in which short (10 sec.) counting times and sample motion was employed because of extremely low stability of plagioclases under the electron beam.

RESULTS

The analytical results are presented in the Tables 1—5 together with mineral's structural formulae. Minerals analyzed from different chondrules as well as those from white part of meteorite — probably large chondrule, show extreme homogenity and thus range given by presented values could well be of analytical nature.

Table Nr. 1. Chemical composition of olivines in Police chondrite

Weight %	A1	A2	A3	B1	B2	C1	C2	C3	D1	D2	D3	ARC
SiO_2	38.58	37.61	38.14	38.58	38.69	38.57	38.87	37.68	38.09	38.15	38.82	38.25
FeO	22.95	23.47	22.52	23.05	22.95	22.69	22.91	22.72	22.47	22.37	22.91	22.11
MgO	38.87	38.53	38.44	38.80	38.93	39.18	39.15	38.56	38.48	38.84	39.61	38.98
Total	100.40	99.61	99.10	100.43	100.57	100.44	100.93	98.96	99.04	99.36	101.34	99.34

Structural formulae based on O = 4

Si	1.000	0.988	1.001	1.000	1.001	0.999	1.001	0.993	1.000	0.998	0.996	0.999
Fe	0.498	0.516	0.494	0.500	0.497	0.491	0.494	0.501	0.493	0.489	0.492	0.483
Mg	1.502	1.509	1.504	1.500	1.501	1.512	1.503	1.514	1.506	1.514	1.515	1.518

O l i v i n e (Tab. 1)

About 60 volume per cent of the meteorite is built by olivine of homogeneous composition with 25 mol. per cent of fayalite component. The difference has not been found among composition of olivines of different chondrules, nor among composition of "matrix and chondrule" olivines.

P y r o x e n e (Tab. 2)

More than 10 volume per cent of chondrite is made of low-calcium pyroxene. Similarily to olivine, pyroxene composition shows little, if any, variation without the relation to the position of analysed grain in the meteorite. The composition of pyroxene correspond to the $En_{77.8}Fs_{20.8}Wo_{1.4}$.

Table Nr. 2. Chemical composition of pyroxenes in Police chondrite

Weight %	A1	A2	A3	B1	B2	B3	B4	D1	D2
SiO_2	56.00	56.11	55.79	55.87	55.59	56.17	55.77	55.43	55.67
TiO_2	0.17	0.09	0.17	0.13	0.16	0.11	0.14	0.15	0.20
Al_2O_3	0.12	0.05	0.09	0.08	0.07	0.02	0.06	0.10	0.12
Cr_2O_3	0.10	0.06	0.07	0.09	0.07	0.07	0.09	0.06	0.10
FeO	13.72	13.75	13.58	13.61	13.56	13.92	13.72	13.82	13.64
MnO	0.44	0.45	0.43	0.44	0.45	0.44	0.44	0.44	0.47
MgO	29.25	29.33	29.24	29.30	29.73	29.73	29.74	29.64	29.94
CaO	0.97	1.00	0.90	0.86	0.85	0.67	0.62	0.60	0.66
Na_2O	0.01	0.02	0.00	0.00	0.01	0.00	0.01	0.07	0.00
Total	100.78	100.86	100.27	100.38	100.49	101.13	100.59	100.31	100.80

Table Nr. 2. — continuing. Structural formula based on O=6

Weight %	A1	A2	A3	B1	B2	B3	B4	D1	D2
Si	1.987	1.989	1.988	1.989	1.978	1.986	1.982	1.977	1.975
Ti	0.005	0.003	0.005	0.004	0.004	0.003	0.004	0.004	0.006
Al	0.005	0.002	0.004	0.003	0.003	0.001	0.003	0.004	0.005
Cr	0.003	0.002	0.002	0.003	0.002	0.002	0.003	0.002	0.003
Fe	0.407	0.408	0.405	0.405	0.404	0.412	0.408	0.412	0.405
Mn	0.014	0.014	0.013	0.013	0.014	0.013	0.014	0.014	0.014
Mg	1.547	1.550	1.553	1.555	1.577	1.567	1.575	1.576	1.583
Ca	0.037	0.038	0.034	0.033	0.033	0.025	0.024	0.023	0.025
Na	0.001	0.001	0.000	0.000	0.001	0.000	0.001	0.005	0.000
Total	4.005	4.007	4.004	4.005	4.015	4.010	4.012	4.018	4.016

Plagioclase feldspars (Tab. 3)

It is a characteristic feature of this meteorite that relatively large grains of plagioclase occur and form about 10 vol. per cent of meteorite matrix. Plagioclases show almost uniform composition with $Ab_{83}An_{11}Or_6$.

Chromite and ilmenite analyses are shown in Table 4. and do not show compositional difference from other L 6 chondrites (e. g. Kiel).

Table Nr. 3. Composition of feldspars in Police chondrite

Weight %	A1	A2	A3	B1	B2	D1	D2
SiO_2	65.93	65.27	67.13	65.85	64.79	64.18	65.80
Al_2O_3	22.47	22.75	21.82	21.94	21.09	21.77	21.71
FeO	0.47	0.19	0.21	0.49	0.18	0.23	0.13
CaO	2.24	2.22	2.21	2.23	2.19	2.68	2.18
Na_2O	9.34	9.43	9.53	9.72	9.53	9.58	9.81
K_2O	1.05	1.07	0.97	1.16	1.07	1.03	0.76
Total	101.50	100.93	101.87	101.39	98.85	99.47	100.39

Table Nr. 3. — continuing. Structural formulae based on O = 8

Weight %	A1	A2	A3	B1	B2	D1	D2
Si	2.864	2.852	2.899	2.873	2.893	2.856	2.885
Al	1.148	1.171	1.111	1.127	1.105	1.113	1.096
Fe	0.015	0.007	0.007	0.015	0.008	0.010	0.005
Ca	0.104	0.102	0.101	0.104	0.104	0.126	0.102
Na	0.788	0.798	0.799	0.823	0.826	0.829	0.832
K	0.058	0.058	0.051	0.062	0.059	0.058	0.042

Table Nr. 4. Chemical composition of chromites and ilmenite in Police chondrite

Weight %	1	2	3	4	ilm
TiO_2	2.80	3.13	3.26	2.93	55.49
Al_2O_3	6.85	6.51	5.85	6.55	0.00
Cr_2O_3	56.43	57.37	57.78	56.74	0.08
FeO	29.33	29.10	30.18	31.07	40.20
MnO	0.66	0.66	0.69	0.70	1.30
MgO	2.25	2.28	2.38	2.00	3.11
Total	98.32	99.05	100.14	99.99	100.18

Table Nr. 4. — continuing
Structural formulae based on O = 4 for chromites and O = 3 for ilmenite

Weight %	1	2	3	4	ilm
Ti	0.075	0.084	0.087	0.078	1.018
Al	0.289	0.273	0.244	0.274	0.000
Cr	1.598	1.612	1.615	1.590	0.001
Fe	0.878	0.865	0.892	0.921	0.820
Mn	0.020	0.020	0.021	0.021	0.028
Mg	0.120	0.121	0.126	0.106	0.114

Table Nr. 5. Chemical composition of metal phase in Police chondrite

Weight %	08—1	02—6	08—2	02—5	02—4	04—3	09—1	04—1	04—2	02—2
Fe	57.8	63.4	64.7	65.3	67.3	69.5	68.8	70.4	70.8	71.1
Ni	44.6	38.4	37.3	35.1	34.5	33.2	32.5	32.2	31.7	30.8
Cr	0.1	0.0	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1
Total	102.5	101.8	102.1	100.5	101.8	102.7	101.4	102.7	102.6	102.0

Table Nr. 5. — continuing

Weight %	04—4	02—3	02—7	06—1	03—1	05—1	07—1
Fe	70.8	73.9	73.6	93.1	93.1	92.3	92.1
Ni	30.4	27.2	26.6	6.8	6.7	6.6	5.7
Cr	0.1	0.0	0.1	0.1	0.1	0.0	0.1
Total	101.3	101.1	100.3	100.0	99.9	98.9	97.9

Metal phase (Tab. 5) shows distinct variations. Kamacite contains 5.5—7.0 per cent of nickel, whereas zonal and inhomogenous taenite grains contain from 30 to 44 per cent of nickel.

CHEMICAL COMPOSITION AND CLASSIFICATION

Chemical composition of Police was discussed by K. TUČEK (1970). Compositional criteria e. g. SiO_2/MgO, Fe/Ni, FeO place Police chondrite well within the L group of chondrites (Fe°/Fe is 0.31, SiO_2/MgO is 1.6, Fe/SiO_2 is 0.56).

Table Nr. 6. Chemical composition of Police chondrite
(analysis by Veselý et al., in TUČEK 1970)

SiO_2	39.49	K_2O	0.18
TiO_2	0.11	P_2O_5	0.24
Al_2O_3	2.61	Cr_2O_3	0.43
FeO	14.97		
MnO	0.27	Fe	7.04
MgO	24.55	Ni	1.06
CaO	1.96	Co	0.07
Na_2O	1.04	FeS	5.77

If mineralogical criteria are used e. g. Fa content of olivine Tuček's conclusion on classification of this meteorite is substantiated. K. TUČEK advocated (1971) however close similarity of Police and Kňahyňa chondrite though Fe values are slightly different. Kňahyňa however appears somewhat unusual in its low Fe°/Fe ratio on one hand, on the other it has normal Fa content in olivine or Fe/SiO_2 ratio of bulk stone. K. KEIL and K. FREDERIKSSON (1964) have pointed out that Kňahyňa's Fe determination by B. MASON and H. B. WIIK, 1963 could have been in error. Thus it appears that Police is in all aspect of major element composition as well as in its mineral composition similar to the other L group chondrites (Fig. 1).

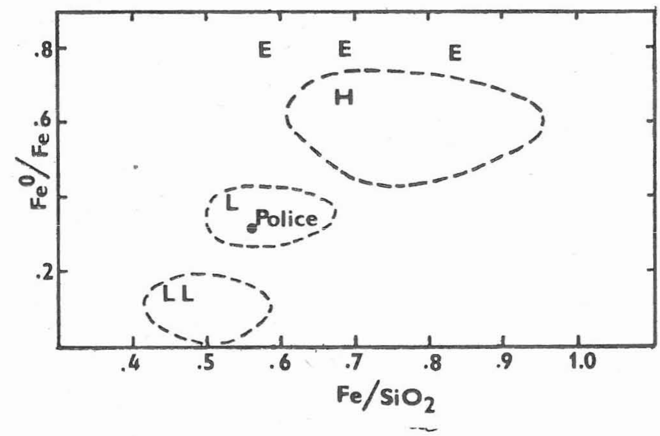

Fig. 1. Plot of metallic iron vs. total iron ratios (Fe°/Fe) versus Fe/SiO_2 ratios for all the chemical groups of chondrites; fields drawn according to W. R. van SCHMUS and J. WOOD'S (1967) data; circle — meteorite Police.

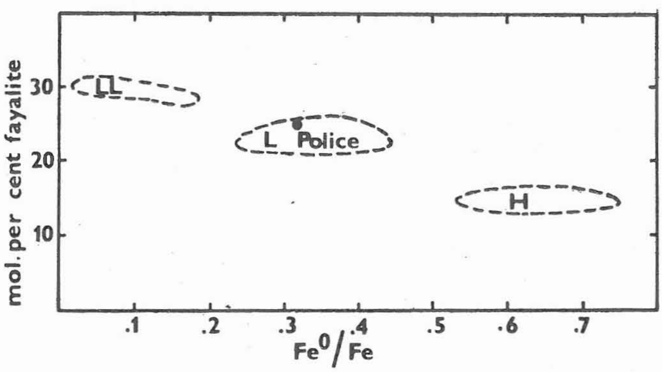

Fig. 2. Plot of mole per cent fayalite in olivine vs. Fe°/Fe in ordinary chondrites; fields drawn according to W. R. van SCHMUS and J. WOOD'S (1967) data.

Accordnig to petrologic classification of W. R. van SCHMUS and J. WOOD (1967) the Police could be classified as type 6. The homogenity of olivine and pyroxene compositions, lack of clinopyroxene as well as presence of well defined and crystallized plagioclase place this meteorite into L 6 type. The similarity with Kiel (D. ACKERMAND and P. RAASE, 1973) and other L 6 chondrites suggests that Police represents most abundant Earth reaching cosmic material.

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MINERALOGIE POLICKÉHO METEORITU

Úvod

Polický meteorit, který spadl 16. 9. 1969 v obci Suchý Důl u Police nad Metují (16°14'40" vých. délky a 50°32'17" sev. šířky) byl popsán K. TUČKEM (1970). K. Tuček popsal pád, povrchové rysy, optické vlastnosti minerálů a presentoval chemickou analýzu meteoritu, jejímiž autory jsou M. Veselý, M. Mikšovský a J. Weiss z Ústředního ústavu geologického (Tab. 1). Meteorit byl K. Tučkem na základě této analýzy klasifikován jako olivinicko-hyperstenický chondrit typu L.

V této práci jsou podány analýzy minerálních součástek polického meteoritu (pyroxeny, olivíny, chromit. ilmenit, živce a kov). Dokladový materiál je uložen ve sbírkách Národního muzea v Praze.

Metoda

Analýzy byly získány elektronovým mikroanalyzátorem a výsledky byly korigovány na matriční efekt. Analytické podmínky byly popsány jinde (např. ASS 1971).

Výsledky

Analýzy jednotlivých minerálů jsou uvedeny v tabulkách 1—5. Byly analyzovány: olivín (Fa 25), pyroxen ($En_{77.8}$ $Fs_{20.8}$ Wo_{14}), živec (Ab_{83} An_{11} Or_6), chromit, ilmenit, tenit a kamacit. Charakteristickým rysem je homogenita a konstantní složení minerálních součástek bez ohledu na pozici zrn (chonder) v meteoritu, svědčící o podstatné rekrystalizaci a ekvilibraci meteoritu.

Složení a klasifikace meteoritu

Na základě chemických kritérií (viz Tab. 6) byl polický meteorit zařazen K. TUČKEM (1970) do L skupiny. Minerální data toto zařazení potvrzují a navíc dovolují určení petrologického typu ve W. R. van SCHMUSOVĚ a J. WOODOVĚ klasifikaci (1967). Polický meteorit má chemické rysy shodné s ostatními L 6 chondrity ($Fe°/Fe$ = 0,31; SiO_2/MgO = 1,6; Fe/SiO_2 = 0,56), homogenitu minerálů, jejich složení, přítomnost živců; zatímco K. Tuček srovnával tento meteorit s meteoritem Kňahyňa, ukazují publikovaná data na chybné určení Fe v tomto meteoritu. Příbuznost s meteoritem Kiel (D. ACKERMAND and P. RAASE, 1973) i s ostatními L 6 chondrity (obr. 1, 2) ukazuje, že se jedná o nejběžnější kosmický materiál, který na Zemi dopadá (L 6).

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