A chondrite find in Slovakia

V. Porubčan[1] and I. Rojkovič[2]

[1] *Astronomical Institute of the Slovak Academy of Sciences, Interplanetary Matter Division, Dúbravská cesta 9, 842 28 Bratislava, The Slovak Republic*

[2] *Geological Institute, Slovak Academy of Sciences, 842 26 Bratislava, The Slovak Republic*

Received: April 29, 1996

Abstract. A stony meteorite, chondrite was found about 15 km west of the city of Nitra in Western Slovakia near the village of Rumanová. The Rumanová meteorite was one piece 4.3 kg stone with an evident degree of weathering. The meteorite is classified as a H5 chondrite with distinct chondrules consisting mostly of olivine and pyroxene, kamacite, taenite and troilite. Kamacite shows Neumann bands and in some parts is replaced by the secondary mineral goethite.

Key words: meteorites – chondrites

1. Introduction

A meteorite was found in August 1994 during the harvest in the local farm field near the village of Rumanová, which is about 15 km west of the city of Nitra (Slovakia). The site of the find (17.87°E, 48.35°N) is 1.2 km northwest of the village. The meteorite was found by J. Tehlár as a single stone without a characteristic crust. Before being sent to scientific research, the stone was broken into three large and four small pieces. The fragments compound together form the original shape of the stone. The meteorite was donated to the Slovak National Museum, where the two largest fragments are deposited and the third fragment is at the Astronomical Institute of the Slovak Academy of Sciences (SAS). All the analyses were performed on this fragment. The stone was analysed at the Geological Institute SAS and the first results have been published in Mineralia Slovaca (Rojkovič et al. 1995).

Rumanová is the first meteorite find in Slovakia in this century. Four meteorites from this region are registered so far, and all the four are from the 19th century. One of the best known of them is the Oravská Magura iron (Magura - in official catalogue), with many pieces from a total mass over 300 kg deposited in various institutions all over the world. Since the early nineteen-sixties, in Slovakia, there operates an all-sky photographic camera network coordinated by the Astronomical Institute SAS as a part of the European fireball network

Contrib. Astron. Obs. Skalnaté Pleso **26**, (1996), 31– 36.

(Ceplecha, Rajchl 1965). The purpose of the network (similar to those which operated in nineteen-seventies in the U.S.A. and Canada) is the recording of very bright fireballs from which meteorites may drop and subsequently be recovered. As a result of the operation of all the three networks only three meteorites were photographed, recovered and their orbits in space determined: Přibram in 1959 (Ceplecha 1961), Lost City in 1970 (McCrosky et al. 1971) and Innisfree in 1977 (Halliday et al. 1978). A fourth meteorite - Peekskill in 1992 - was recorded by video cameras and its orbit could also be determined (Beech et al. 1995). All four are ordinary chondrites with aphelia in the asteroidal belt. The statistics of the fireball networks operation shows that on an area of one million square kilometres falls one meteorite per year on the average, e.i. for Slovakia it is one meteorite in about 30 years. The most promising case so far was a bolide photographed on May 27, 1979 (recorded by five stations) from which one kilogram chondrite was expected to drop in the area of the city Zvolen (Ceplecha et al. 1980). Unfortunately, despite several expeditions the meteorite was not recovered and Rumanová remains so far the only one meteorite found in Slovakia in this century.

2. Texture, mineralogical and chemical composition of Rumanová

The total weight of the stone was 4.3 kg, with the density of 3.53 g/cm^3 and size $18.5 \times 14.0 \times 12.5$ cm (Fig.1a). The fragment studied had the size $16 \times 12 \times 9$ cm. The stone is significantly marked by terrestrial weathering, documenting that it has been on the ground for a longer time. It might also be covered and uncovered by the soil several times at ploughing of the field. Its surface is relatively smooth, covered by iron hydroxides and composed mostly of grains of pyroxene and olivine. In its central part are disseminated ore minerals.

The dominant feature of the stone are chondrules of different types (Fig.1b-1f), what is characteristic for all chondrites. The chondrules were studied on thin polished sections in both transparent and reflecting light of the polarized microscope. The chondrules are mostly from a half to one millimetre in diameter, with the largest ones up to 2.5 mm. In the basic matrix of the meteorite various types of chondrules can be observed: porphyritic, radial pyroxene, barred olivine, granular olivine-pyroxene and microcrystalline. The main constituents of the chondrules are aggregates of pyroxene, olivine and also small grains of nickel-iron and troilite. The largest chondrules are microcrystalline consisting of fine grained pyroxene ($< 10\,\mu$m), olivine, plagioclase and are often covered by goethite. There appear also compound chondrules, which are interpreted as products of collisions between chondrules which were plastic at the time of mutual encounter (Van Schmus 1969).

Recrystallized matrix of the meteorite is mostly hypidiomorphic and prevailing minerals are olivine and orthorombic pyroxene followed by augite and

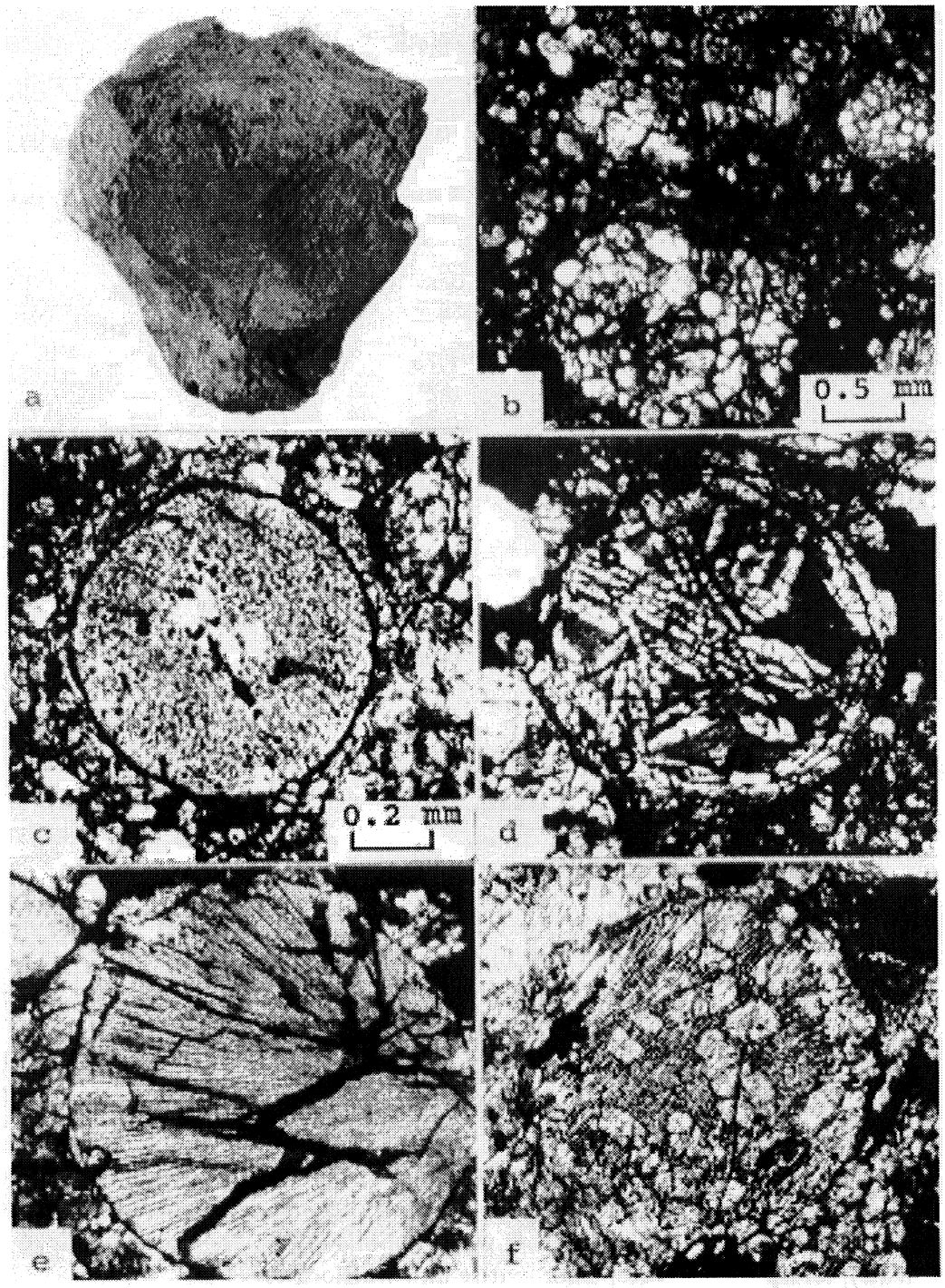

Figure 1. (a) Meteorite Rumanová. Chondrules in the Rumanová chondrite: (b) granular olivine-pyroxene; (c) microcrystalline consisting of fine granular olivine, pyroxene and oligoclase; (d) barred olivine; (e) radial pyroxene; (f) porphyric. (Scale for frames (c) - (f) is the same).

Table 1. Chemical composition (a)

	Rumanová (H5)	Příbram[1] (H5)	Příbram[2] (H5)	Lost City (H5)	Chondrites (H)
SiO_2	38.85	35.87	37.22	36.49	36.60
Al_2O_3	1.94	3.36	2.10	2.08	2.14
FeO	9.52	8.10	9.34	9.42	10.30
Fe_2O_3	19.71	1.70			
MnO	0.29	0.21	0.30	0.29	0.31
MgO	21.94	22.74	23.72	23.67	23.26
CaO	1.19	1.45	1.79	1.72	1.74
Na_2O	0.59	0.37	0.87	0.89	0.86
K_2O	0.07	0.09	0.09	0.10	0.09
TiO_2	0.23	0.14	0.11	0.12	0.12
P_2O_5	0.32	0.10	0.29	0.33	0.27
Ni	1.27	1.67	1.68	1.65	1.74
S	1.80				
LOI	0.29				
H_2O-	0.61	0.02	0.03		
Cr_2O_3	0.20	0.30	0.50	0.53	0.52
Fe		17.35	14.78	16.75	15.98
FeS		5.85	6.47	5.62	5.43
Co	0.07	0.11	0.08	0.09	0.08
C	0.31		0.07	0.01	0.11
Total	99.20	99.40	99.71	99.76	99.55
density	3.53	3.62	3.69	3.73	

Příbram[1] (Rost 1965), Příbram[2], Lost City (Clarke et al. 1971), H Chondrites (Wolf and Lipschutz 1995)

pigeonite. Opaque minerals are mostly in interstices of silicate minerals. The chondrite contains also metallic nickel-iron in irregularly shaped grains of 0.3–0.6 × 0.1–0.3 mm in size, with some up to 1 mm. The metallic nickel-iron is represented by kamacite (6–7 at.% Ni) and taenite (17–38 at.% Ni) and frequently is replaced by goethite as a result of weathering. Kamacite after etching by nital shows Neumann bands of various orientation. Additional constituents are iron sulfide mineral troilite (which together with iron fills interstices between silicate minerals), feldspar, chromite, chlorapatite and whitlockite.

Geochemical characteristics of the Rumanová meteorite were established by four standard analytic methods and chemical composition of the meteorite is close to H chondrites (Table 1 and 2). However, Rumanová exhibits a higher amount of Fe_2O_3 which is due to its terrestrial supergene alteration. Metallic nickel-iron is partially replaced by goethite and limonite. While ordinary

Table 2. Chemical composition (b)

	Rumanová (H5)	Příbram (H5)	Richardton (H5)	Earth's crust
Si	18.16	16.77	16.3	30.5
Al	1.03	1.78	1.05	7.83
FeΣ	21.19	28.41	29.0	3.54
Fe^{+2}	7.40	9.87		
Fe^{+3}	13.79	1.19		
Mn	0.22	0.16	0.23	0.07
Mg	13.23	13.71	13.8	1.39
Ca	0.85	1.04	1.15	2.87
Na	0.44	0.27	0.71	2.45
K	0.06	0.07	0.07	2.82
P	0.14	0.04	0.10	0.08
Ti	0.14	0.08	0.06	0.47
S	1.80	2.28	1.42	0.03
Ni	1.27	1.67	0.72	0.004
Cr	0.14	0.21	0.32	0.007
Co	0.07	0.11		
C	0.31		0.08	0.03

Příbram (Rost 1965), Richardton and Earth's crust (Heide and Wlotzka 1995)

chondrites (H, L, LL) are also referred to as chemical groups, there are further divided into petrographic types, which are chemically similar, but differ petrographically (designated by arabic numbers 1–6, Van Schmus and Wood 1967). The meteorite can be assigned to equilibrated chondrites. A progressive crystallization, homogeneity of the dominant minerals olivine and pyroxene, absence of chondrule glass allow to classify the chondrite as a petrologic type 5. Concluding the analysis, the Rumanova meteorite is classified as an ordinary H5 chondrite.

Acknowledgements. The authors greatly appreciate J. Tehlár for providing the meteorite to research and thank P. Siman, M. Letková, P. Andráš and L. Turanová for help with the analyses. The work was partly supported by the Slovak Grant Agency for Science, Grant No. 2002/95.

References

Beech, M., Brown, P., Hawkes, R.L., Ceplecha, Z., Mossman, K., Wetherill, G.: 1995, *Earth, Moon, and Planets* **68**, 189

Ceplecha, Z.: 1961, *Bull. Astron. Inst. Czechosl.* **12**, 21

Ceplecha, Z., Rajchl, J.: 1965, *Bull. Astron. Inst. Czechosl.* **16**, 15

Ceplecha, Z., Boček, J., Ježková, M., Porubčan, V., Polnitzky, G.: 1980, *Bull. Astron. Inst. Czechosl.* **31**, 176
Clarke, R.S., Jarosewich, E., Nelen, J.: 1971, *J. Geophys. Res.* **76**, No. 17, 4135
Halliday, I., Blackwell, A.T., Griffin, A.A.: 1978, *J. Roy. Astron. Soc. Canada* **72**, No. 1, 15
Heide, F., Wlotzka, F.: 1995, *Meteorites*, Springer-Verlag, Berlin, 158
McCrosky, R.E., Posen, A., Schwartz, G., Shao, C.-Y.: 1971, *J. Geophys. Res.* **76**, 4090
Rojkovič, I., Porubčan, V., Siman, P.: 1995, *Mineralia Slovaca* **27**, 331
Rost, R.: 1965, *Bull. Astron. Inst. Czechosl.* **16**, 102
Van Schmus, W.R.: 1969, *Earth-Sci. Rev.* **5**, 145
Van Schmus, W.R., Wood, J.A.: 1967, *Geochim. Cosmochim. Acta* **31**, 747
Wolf, S.F., Lipschutz, M.E.: 1995, *Earth, Moon, and Planets* **68**, 605