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The Investigation of Genetic Relationship Between the Baszkówka and Mt. Tazerzait Chondrites by NAA and Other Methods

by Rajmund Dybczyński[1*], Jerzy Borucki[4], Bożena Danko[1], Krzysztof Kulisa[1], Halina Polkowska-Motrenko[1], Zbigniew Samczyński[1], Marian Stępniewski[2], Zygmunt Szopa[1] and Koji Tanida[3]

[1]*Department of Analytical Chemistry, Institute of Nuclear Chemistry & Technology, 16 Dorodna Str., 03-195 Warszawa, Poland*
[2]*Polish Geological Institute, 00-975 Warszawa, 4 Rakowiecka Str., Poland*
[3]*Nippon Instruments Corporation, 12-8 Akaoji, Takatsuki-shi, Osaka, Japan*
[4]*3/24 Peszteńska Str. 03-925 Warszawa, Poland*

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The similarity of two meteorites, Baszkówka (Poland, 1994) and Mt. Tazerzait (Niger, 1991), was studied by instrumental and radiochemical neutron activation analysis supplemented by mercury determination with the aid of an automatic mercury analyzer yielding data for 23 elements. The bulk composition of both meteorites is nearly identical within the experimental error. Their composition is also similar to the mean composition of L chondrites but there are marked deviations in the cases of Pd, Os, Pt, Cu and Hg. It seems also that both meteorities are slightly enriched in light rare earth elements (REE) and slightly depleted in heavy REE in comparison with L chondrites. This study supports earlier suggestions based on petrological properties, abundance of noble gases and their isotopic composition, gas retention ages and cosmic ray exposure ages, that these two chondrites have the same origin and the common parent body. It cannot be excluded that this parent body is different from that typical for all other known L chondrites.

* Corresponding author.

Stosując instrumentalną i radiochemiczną neutronową analizę aktywacyjną oraz automatyczny analizator rtęci badano podobieństwo dwóch meteorytów o nazwach: Baszkówka (Polska, 1994) oraz Mt. Tazerzait (Niger, 1991). Na podstawie oznaczenia 23 pierwiastków stwierdzono, że całościowy skład obu meteorytów jest niemal identyczny w granicach błędu doświadczalnego. Ich skład jest też podobny do średniego składu chondrytów typu L, jednakże z istotnymi odchyleniami w przypadku Pd, Os, Pt, Cu i Hg. Wydaje się także, że oba meteoryty są nieznacznie wzbogacone w lekkie i nieznacznie zubożone w ciężkie ziemie rzadkie w stosunku do chondrytów L. Badania te potwierdzają wcześniejsze sugestie, oparte na własnościach petrologicznych, obecności gazów szlachetnych i ich składu izotopowego, wieku zatrzymania gazu oraz wieku kosmicznego napromieniowania że oba chondryty mają takie samo pochodzenie i wspólne ciało macierzyste. Nie jest wykluczone, że to ciało macierzyste różni się od ciała macierzystego wszystkich innych chondrytów typu L.

A hypothesis about the cosmic affinity of two meteorites: Baszkówka and Mt. Tazerzait that fell in different parts of our globe within a period of 3 years was originally based on a general similarity of their exteriors [1]. The Baszkówka meteorite fell on August 25, 1994 in a small village (Baszkówka near Warszawa, Poland), as a single oriented stone weighing 15.5 kg. The fall was observed by a woman and the meteorite was collected soon afterwards [2,3]. The other meteorite which weighed 110 kg fell three years earlier on August 21, 1991 in Niger (Africa) and was later renamed as Mt. Tazerzait. The news about this meteorite reached the scientific community *ca* 5 years after the fall *via* the Swiss Meteorite Laboratory [4]. The fall was observed and the stone was broken by local Tuaregs into numerous fragments. Fortunately the fall occurred on the birthday of the son of one of the Tuaregs, so the date of the event could be easily established. Both meteorites were classified as L5 ordinary chondrites [4,5]. Abundances of noble gases and their isotopic composition, gas retention ages and cosmic ray exposure ages were determined at the Max Planck Institut für Chemie, Mainz, Germany. Unexpectedly long exposure ages determined for Baszkówka and Mt. Tazerzait (76 ± 10 Ma and 61 ± 9 Ma respectively) indicate that both meteorites were exposed to cosmic rays in space longer than most of known L5 chondrites [6].

Taking into consideration the above mentioned results as well as dates of the fall (August 25, and August 21, respectively) it could be presumed that both meteorites were members of a meteoroid stream and were ejected from the same source region of their parent body.
Similarities were also observed in some petrological properties [6].

Most credible arguments for the similarity or dissimilarity of both meteorites can be expected from studies of their chemical composition. Initial results on the chemical composition of the Baszkówka meteorite were previously published [7]. In this paper the striking similarity of the Baszkówka and Mt. Tazerzait meteorites is pointed out and discussed using our work on the determination of several trace and majer constituents in both meteorites by neutron activation analysis, supplemented by mercury determination with the aid of automatic mercury analyzer which employs heat vaporization – gold amalgamation method followed by cold vapor atomic absorption spectrometry.

EXPERIMENTAL

Sample preparation

In the case of Baszkówka, after cutting a flat fragment from the bottom of the meteorite with a diamond saw, a cylindrical sample from the interior of the stone (*ca* 5 cm depth) was taken using the milling cutter. Part of the sample (not adjacent to the cut edge) was comminuted using an agate mortar and pestle which were previously thoroughly washed and cleaned with quartz.

The cut fragment of Mt.Tazerzait used in this study was received from R.W.Bühler, Swiss Meteorite Lab., Glarus, Switzerland. One part was used on thin section and the other was comminuted in the same way as Baszkówka.

Investigations using both optical and scanning electron microscopes revealed that both analyzed samples, prepared as described above, contained a considerable number of fine particles (0.5–23 μm), but at the same time there were numerous larger particles with diameters up to 400–500 μm.

Two small chips and a single chondrule from Baszkówka and single chips from Mt. Tazerzait and other meteorites respectively were used for the determination of mercury.

Instrumental neutron activation analysis (INAA)

100–250 mg samples of the meteorites as well as suitable certified reference materials (CRM) were accurately weighed into high purity polyethylene snap-cap capsules (0.22 cm^3) and irradiated together with a set of mixed elemental standards for 3 min. in the MARIA reactor at a thermal neutron flux density of 1.6×10^{13} n cm^{-2} s^{-1}, and cooled for 4–6 h. γ-ray spectrometric measurements were performed with the aid of a 213 cm^3 coaxial HPGe detector (ORTEC), resolution 1.9 keV for 1332.5 keV ^{60}Co line coupled *via* an ORTEC analog line to a TUKAN multichannel analyzer consisting of an ISA card inserted into a typical PC. To determine as many elements as possible and to assure maximum reliability of the determinations, the same samples, standards and CRM were also measured using a 180 cm^3 well-type HPGe detector (CANBERRA) (resolution 2.3 keV for 1332.5 keV ^{60}Co line). Several measurements were performed on each sample after cooling times varying from 0.06 to 60 days and employing measurement times from 0.01 to 1.2 days.

Experimental details, nuclides employed for quantitative determinations, methods of accounting for spectral interferences etc. were as described earlier [7].

Radiochemical neutron activation analysis (RNAA)

Palladium, platinum and gold were determined by a newly developed procedure in which the sample (*ca* 0.5 g) is digested in a microwave oven with *aqua regia* and HF. Silica is next removed by evaporation and the solution evaporated with concentrated HCl. The residue is dissolved in 0.5 mol l^{-1} HCl and the solution introduced onto the Chelex 100[H^+] column. Most of the cations are eluted with 0.5 mol l^{-1} HCl while Au, Pd and Pt are retained on the resin. Palladium and platinum are eluted jointly with 8 mol l^{-1} HCl, and evaporated to dryness in a quartz ampoule. Gold was eluted with 1 mol l^{-1} NH_3 + 0.1 mol l^{-1} NH_4Cl, and afterwards retained on a small Chelex 100 column from 0.5 mol l^{-1} HCl solution. The resin is dried and transferred quantitatively to a polyethylene capsule. The chemical yields assigned on the basis of many experiments with radioactive tracers (with and without real samples) were found to be very reproducible and amounted to: 99.0 ± 1.0% (Pd), 95.3 ± 2.2% (Pt), and 94.5 ± 3.1% (Au). The results were corrected for chemical yield accordingly.

Samples, blank and standards were irradiated for 3 h at a thermal neutron flux density of 1.6×10^{13} n cm^{-2} s^{-1} and cooled for 12–18 h.

^{198}Au was measured directly on the resin by γ-ray spectrometry. Pd and Pt after adding of 20 μg carriers were washed out of the quartz ampoule with *aqua regia,* evaporated with concentrated HCl, and retained on Chelex 100 column from 0.5 mol l^{-1} HCl. Washing the column with 0.5 mol l^{-1} HCl removes some trace impurities (*e.g.* ^{24}Na). ^{197}Pt is eluted by means of an acetate buffer solution (pH = 5) and then ^{109}Pd is stripped with the aid of 8 mol l^{-1} HCl. Finally ^{199}Au (originating from the decay of ^{199}Pt), and the residual amounts of Pd and Pt that remained on the resin were stripped with 0.2 mol l^{-1} thiourea in 2 mol l^{-1} HCl. Count rates of the three fractions were measured by γ-ray spectrometry and compared with those of the standards measured in the same geometrical conditions. The total amount of each analyte can be determined, so in this case no correction for chemical yield is needed. Blank for the whole procedure was checked and was below the detection limit for all three elements.

Determination of mercury with an automatic mercury analyzer

The automatic mercury analyzer [8,9] adopts the method of a two step gold amalgamation, heating decomposition with ceramic tube and sample boat and cold vapor atomic absorption. After initially feeding the sample, all operations starting from the process of sample decomposition to the determination of mercury, are carried out automatically. Mercury from the combustion gas is collected selectively on a mercury collector as a gold amalgam; the gold collector is then heated to release mercury to the atomic absorption cell.

In this way from 0.01 ng to 1000 ng of mercury can be determined with good accuracy, high precision and in a short time.

Typical sample masses taken for analysis were in the range of 20–50 mg.

RESULTS AND DISCUSSION

Data on elemental contents and their reliability

Concentrations of 22 elements in the bulk meteorites Baszkówka and Mt. Tazerzait as determined by INAA and RNAA are shown in Table 1. The results are presented as: mean ± standard deviation and are based on the analyses of 3–6 samples for each element.

Considering the obvious intrinsic inhomogeneity of the analyzed materials, rather broad ranges of particle size and relatively small masses of the samples being analyzed, the precision of the determination for most elements can be considered as more than satisfactory.

Analogous data for CRMs are presented in Table 2 demonstrating the high reliability of the methods used in this study.

Results of mercury determination in Baszkówka and Mt. Tazerzait as well as in some other meteorites as obtained in this work are presented in Table 3. Data for Baszkówka and Mt. Tazerzait are based on six independent determinations and those for other meteorites on three determinations respectively.

Table 1. Element content as determined by INAA and RNAA in the Baszkówka and Mt. Tazerzait meteorites $\bar{x}$ – arithmetic mean, s – standard deviation

Element	Concentration units	Baszkówka $\bar{x} \pm s$	Mt. Tazerzait $\bar{x} \pm s$
As	$\mu g\ g^{-1}$ (ppm)	1.79 ± 0.48	1.56 ± 0.28
Au	$ng\ g^{-1}$ (ppb)	171 ± 31	132 ± 16
Au *)	$ng\ g^{-1}$ (ppb)	146 ± 30	134 ± 15
Co	$\mu g\ g^{-1}$ (ppm)	601 ± 201	569 ± 75
Cr	$\mu g\ g^{-1}$ (ppm)	3531 ± 54	3535 ± 192
Cu	$\mu g\ g^{-1}$ (ppm)	130 ± 8	121 ± 15
Eu	$ng\ g^{-1}$ (ppb)	96 ± 71	63 ± 39
Fe	% m/m	21.91 ± 1.71	21.11 ± 1.48
Ga	$\mu g\ g^{-1}$ (ppm)	5.79 ± 0.44	5.98 ± 1.13
Ir	$ng\ g^{-1}$ (ppb)	514 ± 37	506 ± 43
K	$\mu g\ g^{-1}$ (ppm)	680 ± 71	732 ± 115
La	$ng\ g^{-1}$ (ppb)	520 ± 119	407 ± 40
Mn	$\mu g\ g^{-1}$ (ppm)	2392 ± 402	2590 ± 305
Na	% m/m	0.635 ± 0.163	0.678 ± 0.166
Ni	% m/m	1.14 ± 0.14	1.07 ± 0.08
Pd *)	$\mu g\ g^{-1}$ (ppm)	4.02 ± 1.78	0.763 ± 0.223
Pt *)	$\mu g\ g^{-1}$ (ppm)	–	1.95 ± 0.53
Pt *), **)	$\mu g\ g^{-1}$ (ppm)	1.43 ± 0.88	1.80 ± 0.59
Os	$\mu g\ g^{-1}$ (ppm)	1.67 ± 0.15	1.34 ± 0.43
Sc	$\mu g\ g^{-1}$ (ppm)	8.67 ± 0.61	9.07 ± 0.65
Se	$\mu g\ g^{-1}$ (ppm)	10.7 ± 1.1	10.4 ± 1.4
Sm	$ng\ g^{-1}$ (ppb)	235 ± 54	234 ± 64
Yb	$ng\ g^{-1}$ (ppb)	179 ± 22	184 ± 39
Zn	$\mu g\ g^{-1}$ (ppm)	67.7 ± 22.9	59.1 ± 13.7

*) Results obtained by RNAA.
**) *Via* ^{199}Au.

Table 2. NAA results for certified reference materials as obtained in this study. Our results for all elements are presented as: mean ± standard deviation in $\mu g\ g^{-1}$ (ppm), except of these marked: *) which are in % m/m. Certified values are given with their confidence intervals

Element	Fine Fly Ash CTA-FFA-1		IAEA Soil–5	
	Our results	Certified value or (*information value*)	Our results	Certified value or (*information value*)
As	47.9 ± 7.5	53.6 ± 2.7	96.4 ± 18.3	93.9 ± 7.5
Co	37.9 ± 2.2	39.8 ± 1.7	14.0 ± 1.2	14.8 ± 0.8
Cr	160 ± 11	156 ± 8	30.6 ± 6.1	28.9 ± 2.8
Cu	178 ± 34	158 ± 9	–	–

Table 2 (continuation)

Eu	2.32 ± 0.14	2.39 ± 0.08	1.28 ± 0.07	1.18 ± 0.08
Fe	4.64 ± 0.22*)	4.89 ± 0.14*)	4.45 ± 0.19*)	4.45 ± 0.19*)
Ga	43.5 ± 8.4	(*49*)	–	–
Hf	5.2 ± 0.1	6.09 ± 0.45	5.41 ± 1.32	6.30 ± 0.30
K	2.10 ± 0.23*)	(*2.2*)*)	1.81 ± 0.37*)	1.86 ± 0.15*)
La	62.9 ± 9.3	60.7 ± 4	28.5 ± 5.1	28.1 ± 1.5
Mn	1009 ± 184	1066 ± 41	829 ± 197	852 ± 37
Na	1.84 ± 0.34*)	2.19 ± 0.08*)	1.61 ± 0.30*)	1.92 ± 0.11*)
Sc	24.0 ± 1.3	24.2 ± 1.1	14.8 ± 0.8	14.8 ± 0.7
Sm	9.3 ± 2.2	10.9 ± 0.6	4.51 ± 0.72	5.42 ± 0.39
Yb	4.10 ± 0.90	4.24 ± 0.19	2.07 ± 0.21	2.24 ± 0.20
Zn	633 ± 122	569 ± 58	–	
	PRECIOUS-METAL ORE SARM-7		NOBLE-METALS-BEARING SULFIDE CONCENTRATE PTC-1	
Au	0.300 ± 0.058	0.310 ± 0.015	0.649 ± 0.188	0.65 ± 0.10
Ir	0.069 ± 0.013	0.074 ± 0.012	–	–
Pd	1.50 ± 0.06	1.530 ± 0.032	12.0 ± 0.39	12.7 ± 0.7
Pt	3.74 ± 0.33	3.740 ± 0.045	2.87 ± 0.24	3.0 ± 0.2
Pt**)	3.74 ± 0.33	3.740 ± 0.045	2.96 ± 0.19	3.0 ± 0.2

* % m/m.
** *via* ^{199}Au.

Table 3. Results of mercury determination in chondrites by heat vaporization gold amalgamation method (this work)

Chondrite		Hg content $\bar{x} \pm s$, ng g^{-1}
Baszkówka	L5	4.5 ± 0.5
Baszkówka	L5 (single chondrule)	4.6
Mt.Tazerzait	L5	5.1 ± 0.4
Bjurbole	L6	965 ± 31
Barwell	L6	3257 ± 97
Tuxtuac	LL5	22.4 ± 3.4
Estacado	H6	34.3 ± 3.1
Pułtusk	H5	237.7 ± 13.3

Mercury in L chondrites

Mercury seemed to be of special interest for the purpose of classification of the two meteorites studied in this work. As can be seen from Table 3, mercury contents in Baszkówka and Mt. Tazerzait determined with the aid of Mercury/SP–3D analyzer are very similar considering intrinsic inhomogeneity of the materials and at the same time they are very low in comparison with those observed in other chondrites. Incidentally, the literature data for mercury in chondrites are very scarce and *e.g.* the only mean value reported for different chondrite groups in the compilation by Wasson and Kallemeyn [10], is that for CI chondrites (390 ng g^{-1}). Lower value for these chondrites (258 ng g^{-1}) is given in another paper [11] and it is mentioned that the estimated value for mercury changed in recent years more than those for all other elements.

Therefore an attempt was made in this work to evaluate the distribution and the central value for Hg content in L chondrites on the basis of literature data [12–15].

One should note that the results for Hg are largely dispersed and this concerns all the L chondrites as a group but also data for individual meteorites. The case of Sevrukovo L5 chondrite for which enough data were available to make some meaningful conclusions may serve as an example. Seven results for Hg content (ng/g) quoted by Saukov *et al.*, [14] are as follows: 28; 41; 50; 500; 890; 2500; and 3500. The distribution of these values is highly skewed (arithmetic mean : 1073; standard deviation: 1384). If however the logarithms of these values are taken and used as an abscissa of the histogram, the distribution is close to normal with the lognormal mean $X_{\log}$ = 2.478 and its antilogarithm *i.e.* geometric mean, *GM* equal to 301. The lognormal distribution of data was quite often observed when determining trace elements in rocks and other geochemical materials. The reasons for that are numerous: the use of inadequate analytical methods or too small samples, contamination due to inappropriate handling and storing the samples, sample heterogeneity *etc.*

The fact that geometric mean, *GM* is often a better representation of the true value in geochemical samples has been pointed out some time ago [16–18].

So, whenever more than one literature Hg result for a given meteorite was available we have calculated corresponding *GM* and combined these values with data for Hg contents in other L chondrites. Final population consisted of data for 30 L chondrites (range of Hg concentrations from 20 ng g^{-1} (Krymka) to 3257 ng g^{-1} (Barwell) [12–15].

The population of these values is skewed (arithmetic mean = 540; standard deviation: 755). The histogram showing the frequency distribution of logarithms of Hg concentrations in L chondrites is shown in Figure 1.

The distribution is very well represented by normal distribution as confirmed by chi-square test ($\chi^2 = 2.834 < \chi^2_{0.05} = 7.815$). Calculated from these data lognormal mean $X_{\log} = 2.336$, ($s_{\log} = 0.637$) *i.e.* $GM = 217$ ng g^{-1}. *GM* is in a fairly good agreement with the median equal to 251 ng g^{-1}. If we compare *GM* and its limits ($X_{\log} \pm 2\ s_{\log}$) equal to 11.5–4076 ng g^{-1}, and comprising at least 95% of the population, with corresponding results and their confidence limits (at a significance level of 0.05) for Baszkówka: 4.5 ± 0.51 ng/g and Mt.Tazerzait: 5.1 ± 0.47 ng/g, it appears that the two latter meteorites exhibit Hg content much lower than all other known L chondrites.

Formal statistical comparison of data for Hg content in the population of L chondrites with analogous data for Baszkówka ($X_{\log} = 0.6478$; $s_{\log} = 0.04718$, *i.e.* *GM* =

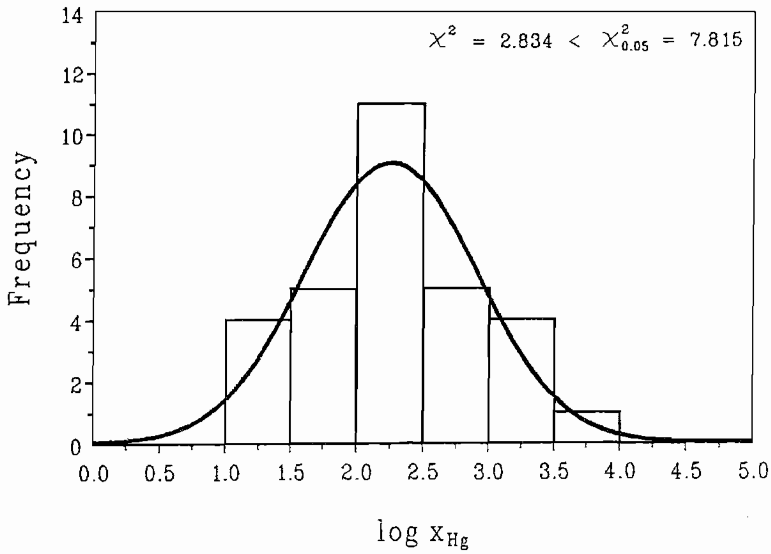


Figure 1. Frequency distribution of the population of logarithms of literature Hg abundances in individual L chondrites

4.44 ng g^{-1}) and Mt. Tazerzait (X_{log} = 0.70711; s_{log} = 0.03647, *i.e.* GM = 5.09 ng g^{-1}) by Student's *t*-test revealed that t = 5.86 (Baszkówka) and t = 5.66 (Mt. Tazerzait) respectively, exceeding in each case $t_{0.0000001}$ = 5.326. So, it may be concluded that both meteorites differ significantly from the population of all other L chondrites. Such low values of Hg content are unusual not only for L chondrites but also for all kinds of meteorites. The only similarly low result (4 ng g^{-1}) appeared in the literature for Abee enstatite chondrite [19], but it was reported that it cannot be excluded that this result may be doubtful. Other literature values for Hg content in Abee : 200, 1400, and 1520 ng g^{-1} are higher by orders of magnitude [12–13].

Classification and similarity

The preliminary classification of Baszkówka and Mt. Tazerzait as L chondrites was based on electron microprobe analysis of olivine and orthopyroxene grains and comparison of their Fa and Fs contents with literature values [6, 20]. The classification of Baszkówka as an L chondrite was later confirmed by its oxygen isotopic composition: $\delta^{17}O$ = 3.66 and $\delta^{18}O$ = 4.88 (Stępniewski *et. al.* [20], quoted after I. Franchi, The Open University).

Abundances of elements in both meteorites as determined in this work, normalized with respect to the mean composition of L chondrites [10] are plotted in Figure 2 and 3. In the case of mercury the value of 217 ng g^{-1} as evaluated in this work as the mean concentration of Hg in L chondrites was used for normalization. One can easily note that for most of the elements studied, their concentrations are very close to those

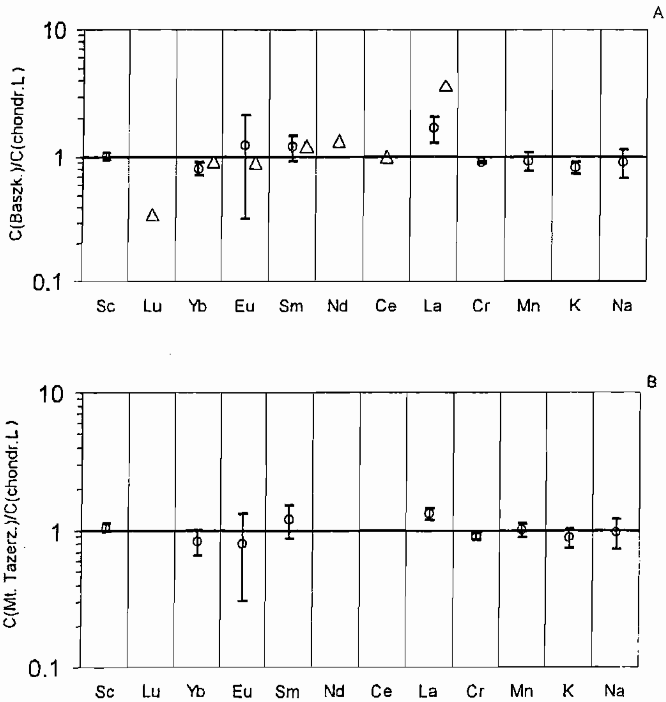
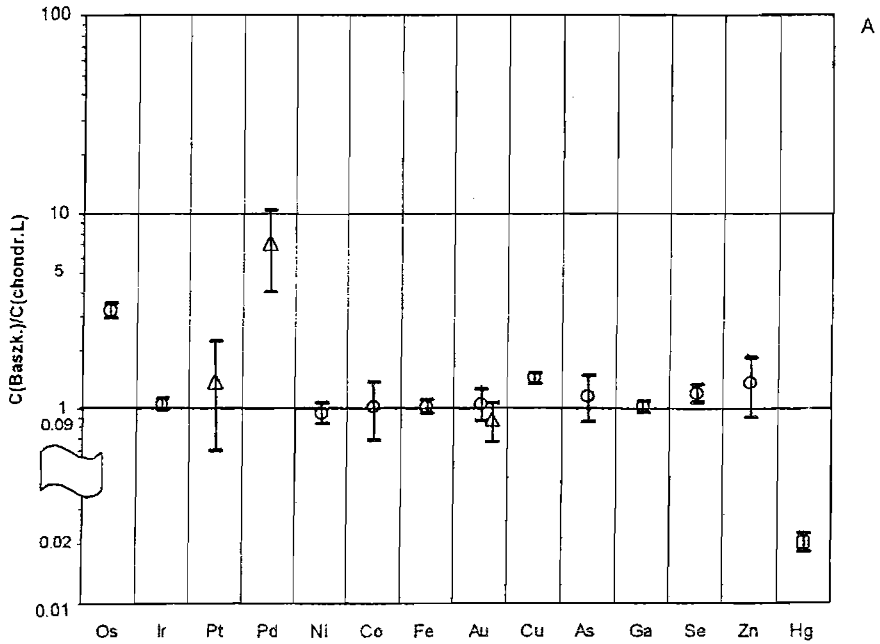


Figure 2. Concentrations of litophile elements in Baszkówka and Mt. Tazerzait chondrites normalized with respect to mean composition of L chondrites. Elements are ordered from left to right in approximate order of decreasing condensation temperatures . INAA results (arithmetic mean ± standard deviation) – open circles. Earlier single results for REE in Baszkówka by NAA with preirradiation preconcentration (R. Dybczyński *et al.*, [7]) – open triangles

typical for L chondrites. There are however, marked deviations in the case of several elements. Osmium , palladium , copper and to a lesser extent platinum show elevated, and mercury distinctly lower concentrations with respect to mean composition of L chondrites. It seems also that Baszkówka and Mt. Tazerzait are slightly enriched in light rare earths and depleted in heavy rare earths. It is worth stressing that in those cases where the concentrations of individual elements differ from the mean values for L chondrites , the values for Baszkówka and Mt.Tazerzait are very similar to each other and their deviations from the mean composition of L chondrites show a similar trend. The only exception is palladium which shows an elevated content in the two meteorites studied, but seems to be more abundant in Baszkówka than in Mt. Tazerzait. However, as one can infer from the individual results of the Pd determinations in Baszkówka (6.33; 4.35; 2.18; and 3.23 $\mu g\ g^{-1}$, respectively) and RSD = 44.3% as compared to RSD = 5–6% in SARM–7 and PTC–1 (Table 2), this element seems to be very inhomogeneously distributed in Baszkówka chondrite.

There is no doubt that Baszkówka and Mt. Tazerzait show striking similarity in their bulk elemental content. If the best estimates of concentrations of elements in Mt. Tazerzait *(y)* are plotted *vs.* analogous data for Baszkówka (*x*) on a log-log scale (Fig.



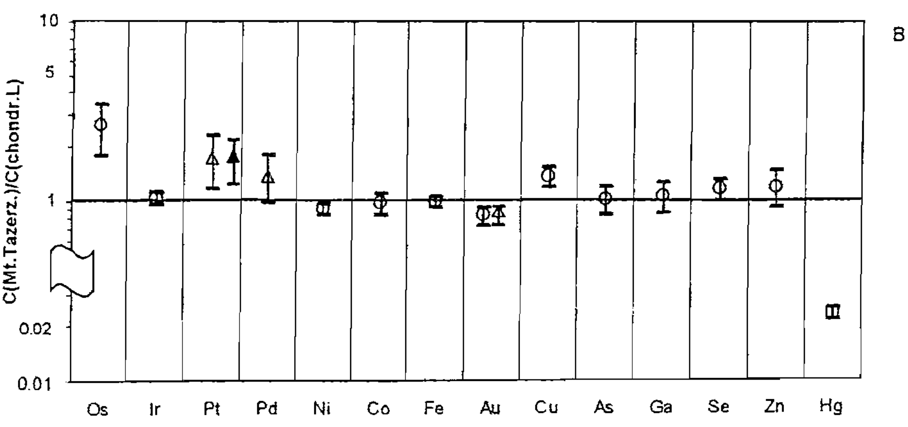


Figure 3. Concentrations of siderophile and other elements in Baszkówka and Mt. Tazerzait chondrites normalized with respect to mean composition of L chondrites. Elements are ordered from left to right in approximate order of decreasing condensation temperatures.

4) one gets the straight line with the parameters: $y = 1.012\,x - 0.065$, and coefficient of correlation R = 0.9969. Without taking into consideration the data for Pd the equation would be: $y = 1.007\,x - 0.029$ with R =0.9995, *i.e.* nearly the perfect match ($y = x$).

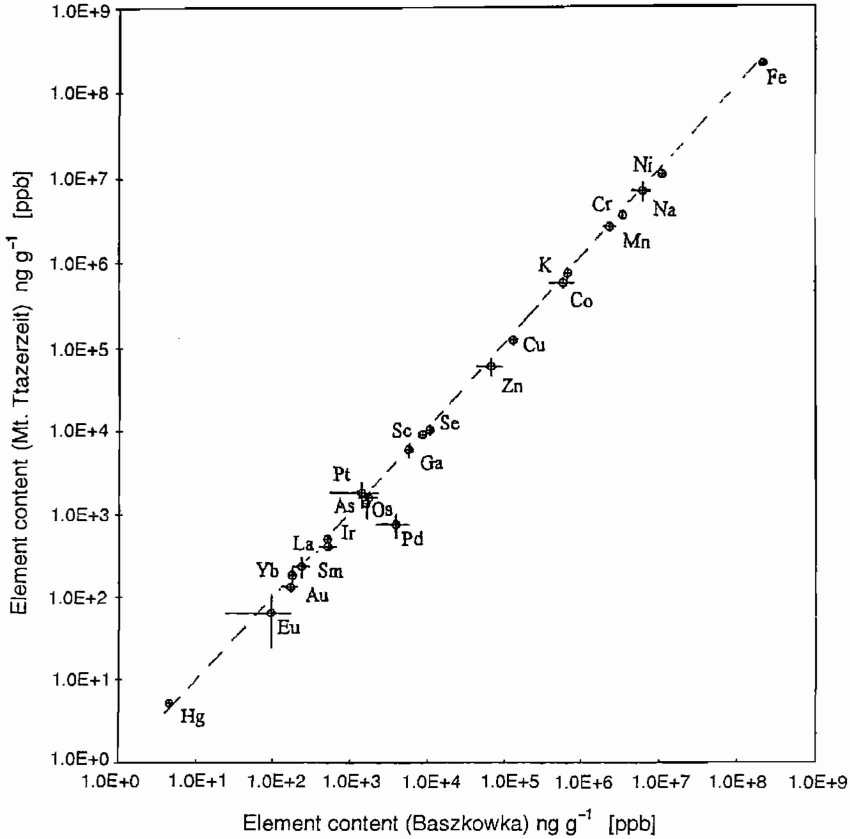


Figure 4. Linear correlation between concentrations of elements in Mt. Tazerzait and Baszkówka chondrites , respectively. Vertical and horizontal bars associated with points correspond to one standard deviation

Except of nearly identical bulk content of several elements, the similarity of Baszkówka and Mt.Tazerzait is reflected also in several petrographic and other properties. Both meteorites show high porosity and reveal the presence of euhedral stubby crystals of olivine, pyroxene, troilite and FeNi, which apparently grew in the pores during equilibration. Very long exposure ages are characteristic for both meteorites (Baszkówka: 61 ± 9 Ma; Mt. Tazerzait: 76 ± 10), the latter being the longest exposure time ever found for L5 chondrites [6].

Both meteorites are of shock grade 1 and retained their radiogenic gases. Calculated gas retention ages amounted to 4.0 Ga (U–Th–He) and 4.3 Ga (K–Ar) for Baszkówka and > 4.6 Ga for Mt.Tazerzait respectively [6].

The ratio of cosmogenic isotopes: $^{22}Ne/^{21}Ne$ of 1.09 for Mt.Tazerzait "indicates a rather shielded position of the sample within the meteoroid in contrast to the 1.19 ratio for Baszkówka " [6].

Concentrations of trapped krypton and xenon are also similar and correspond to chemical-petrologic type 4–5, with $^{129}Xe/^{132}Xe$ ratios of 1.37 (Baszkówka), and 1.11 (Mt. Tazerzait) respectively [6].

Similar is also sulfur isotopic composition of both meteorites namely: $\delta^{14}S$ = –1.25 and 1.18 for Baszkówka and Mt. Tazerzait respectively (Stępniewski *et al.* [20], quoted after St.Hałas, Lublin University).

CONCLUSIONS

The results of this investigation together with the available literature data confirm striking similarities of Baszkówka and Mt. Tazerzait meteorites. It is very probable that both meteorites have the common origin and a different cosmic history than other L5 chondrites. It cannot be excluded that Baszkówka and Mt. Tazerzait may be coming from different parent body than all other L5 chondrites known so far.

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REFERENCES

1. Pilski A.S. and Walton W., *Meteorite*, 4, 12 (1998).
2. Stępniewski M., Radlicz K., Siemiątkowski J. and Borucki J., *Meteorit. Planet. Sci.*, 31, Suppl., A134 (1996).
3. Stępniewski M., Siemiątkowski J., Borucki J. and Radlicz K., *Arch. Min.*, **51**, 131 (1988).
4. Grossman J.N., *Meteorit. Planet. Sci.*, 32, *The Meteoritical Bulletin No. 81.*, 159 (1997).
5. Wlotzka F., *Meteoritics*, 30, *The Meteoritical Bulletin No. 78*, 792 (1995).
6. Wlotzka F., Scherer P., Schultz L., Otto J. and Stępniewski M., *Meteorit. Planet. Sci.*, **32**, Suppl., A140 (1997).
7. Dybczyński R., Danko B., Kulisa K., Polkowska-Motrenko H., Samczyński Z., Stępniewski M. and Szopa Z., *Chem. Anal. (Warsaw)* **44**, 471 (1999).
8. MERCURY/SP-3D, Automatic mercury analyzer, NIC Technical Report N9202, Nippon Instruments Corporation, Osaka, 1992, Japan.
9. Tanida K. and Hoshino M., *The Rigaku Journal*, **7(No.2)**, 35 (1990).
10. Wasson J.T. and Kallemeyn G.W., *Phil. Trans. R. Soc. Lond. A*, **325**, 535–544 (1988).
11. Anders E. and Grevesse N., *Geochim. Cosmochim. Acta*, **53**, 197 (1989).
12. Reed Jr. G.W. and Jovanovic S., *J. Geophys. Res.*, **72**, 2219 (1967).
13. Ehmann W.D. and Lovering J.F., *Geochim. Cosmochim. Acta*, **31**, 357 (1967).
14. Saukov A.A., Aidin'yan N.Kh. and Ozerova N.A., *Ocherki geokhimii rtuti.*, (in Russian) Izdat. Nauka, Moskva (1972).
15. Jovanovic S. and Reed Jr. G.W., *Geochim. Cosmochim. Acta*, **49**, 1743 (1985).
16. Ahrens L.H., *Geochim. Cosmochim. Acta*, **5**, 49 (1954).
17. Shaw D.M., *Geochim. Cosmochim. Acta*, **23**, 116 (1961).
18. Sankar Das M., *Geostand. Newsl.*, **3**, 199 (1979).
19. Reed Jr. G.W., Kigoshi K. and Turkevich A., *Geochim. Cosmochim. Acta*, **20**, 122 (1960).
20. Stępniewski M., Borucki J. and Siemiątkowski J., *Meteorit. Planet. Sci.*, **33**, Suppl., A150 (1998).

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