



## K/Ar dating and stable isotope analysis of the Baszkówka and Mt. Tazerzait L5 chondrites

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We have determined the content of  $^{40}\text{Ar}^*$  (1.49 nmol/g) and  $^4\text{He}$  (1.75 nmol/g) in the Baszkówka meteorite by static vacuum mass spectrometry. The radiogenic argon content was calculated from the measured argon spectrum using the equation:  $^{40}\text{Ar}^* = ^{40}\text{Ar} - 295.5^{36}\text{Ar}$  assuming a potassium content of 680 ppm wt. We have obtained K/Ar ages of 3.78 Ga for the chondrules and 3.47 Ga for a bulk sample of Baszkówka. A similar  $^4\text{He}$  content (1.47 nmol/g) but larger  $^{40}\text{Ar}^*$  (2.32 nmol/g) content was found for the Mt. Tazerzait bulk sample. The K/Ar age of this meteorite on the basis of the K content (732 ppm) is 4.34 Ga. Sulphur isotope analysis of troilite specimens from both meteorites reveals essentially negative  $^{34}\text{S}$  values:  $-1.25 \pm 0.06\text{‰}$  for Baszkówka and  $-1.18 \pm 0.06\text{‰}$  for Mt. Tazerzait expressed on the V-CDT scale. This indicates that both chondrites may have a common origin. The oxygen isotope data ( $^{18}\text{O} = 4.88 \pm 0.03\text{‰}$  and  $^{17}\text{O} = 3.66 \pm 0.10\text{‰}$ ) suggests that Baszkówka belongs to the L chondrites.

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### INTRODUCTION

As part of the 6PO4D 031 13 project we have analysed  $^{40}\text{Ar}$ ,  $^{38}\text{Ar}$ ,  $^{36}\text{Ar}$  and  $^4\text{He}$  isotopes in three specimens of the Baszkówka meteorite and one specimen of the Mt. Tazerzait meteorite. The main goals of this study were K/Ar dating of these L5 chondrites and determination of their stable isotope ratios of sulphur and oxygen.

The previous study of noble gases by Wlotzka *et al.* (1997) indicate that both meteorites are characterised by long exposure ages, about 70 Ma, and estimated K/Ar ages, calculated assuming that the K content is 800 ppm, are 4.3 and  $> 4.6$  Ga for Baszkówka and Mt. Tazerzait respectively. Recalculated using known K contents (given below) the ages are 4.57 and  $> 4.75$  Ga respectively. The two meteorites share a number of unusual features concerning their petrography and noble gas

composition. In this study we update the age determinations and discuss the new values of the stable isotope ratios of sulphur and oxygen.

### ANALYSIS OF ARGON ISOTOPES AND OTHER NOBLE GASES

The static vacuum spectrometer *MS-10* with an original magnet of 0.12 T (for  $^4\text{He}$  measurement) and with a stronger Nd-Fe-B magnet of 0.437 T (for the remaining noble gases) was employed. The analytical procedures were described by Hałas (1995).

Aliquots of meteorite fragments of about 60–80 mg each were wrapped in Al-foil and loaded into the extraction-purification line, where gases were released at a temperature of about 1500°C. The noble gases were purified by

Table 1

## Analytic of data

Sample	K <sup>a</sup> [%]	<sup>40</sup> Ar [nmol/g]	<sup>38</sup> Ar [pmol/g]	<sup>36</sup> Ar [pmol/g]	<sup>40</sup> Ar* [nmol/g]	<sup>40</sup> Ar* [%]	Age [Ga]	<sup>4</sup> He [nmol/g]
Baszkówka chondrules	0.0680±0.0075	1.730	na	0.83	1.486	85.9	3.75±0.62	1.75
		1.736 <sup>b</sup>	4.54	0.63	1.550	89.3	3.81±0.52	
Baszkówka bulk		1.723	na	1.61	1.246	72.3	3.47±0.47	1.12
Baszkówka shell		1.568	na	3.94	0.403	25.7	1.92±0.38	na
Mt. Tazerzait bulk		0.0732±0.0110	2.747	na	1.33	2.354	85.7	4.37±0.72
	2.586 <sup>b</sup>		6.27	1.04	2.278	88.1	4.31±0.72	

<sup>40</sup>Ar\* — radiogenic argon; a — determined by R. Dybczyński; b — analysis repeated using an unspiked method; na — not analysed

adsorption of other gases. The peaks of the noble gases were measured by static-vacuum mass spectrometry.

In this study we were able to estimate the <sup>4</sup>He content and to analyse argon isotopes by means of an unspiked method and by using a pure <sup>38</sup>Ar spike. All samples were measured using the <sup>38</sup>Ar spike method except for bulk samples of Baszkówka and Mt. Tazerzait, which were repeated by the unspiked method. In these cases <sup>38</sup>Ar released from meteorites was recorded. The radiogenic argon content V<sup>40</sup>Ar\* was calculated from measured <sup>40</sup>Ar by correcting for atmospheric content (295.5<sup>36</sup>Ar content).

Because we did not have any the helium spike, we determined the helium content of the specimens using the sensitivity of the mass spectrometer given in the MS-10 manual. The argon and helium ion currents were measured and the He content was calculated from the sensitivity ratio and from the volume ratio of individual parts of the vacuum line determined by means of a portion of <sup>38</sup>Ar spike.

## NOBLE GAS ANALYSES

The results obtained are displayed in Table 1. The measured <sup>4</sup>He content is comparable to that of <sup>40</sup>Ar. We have also observed the Ne isotopes (only <sup>21</sup>Ne and <sup>22</sup>Ne were detected because <sup>20</sup>Ne was overlapped by the <sup>40</sup>Ar<sup>++</sup> peak) at the detection level of our mass spectrometer, which is about 0.03 pmol. Our determination of the <sup>4</sup>He content is consistent with the previous measurement made by Scherer (1996, pers. comm.) for a bulk specimen only. The remaining results were somewhat higher.

We have obtained an age for the meteorites close to the age of the solar system (4.60 Ga). The large errors on our dates arise mainly from the potassium determination. We plan to re-determine the % K by the isotope dilution method (Hałas and Maciocha, 2000).

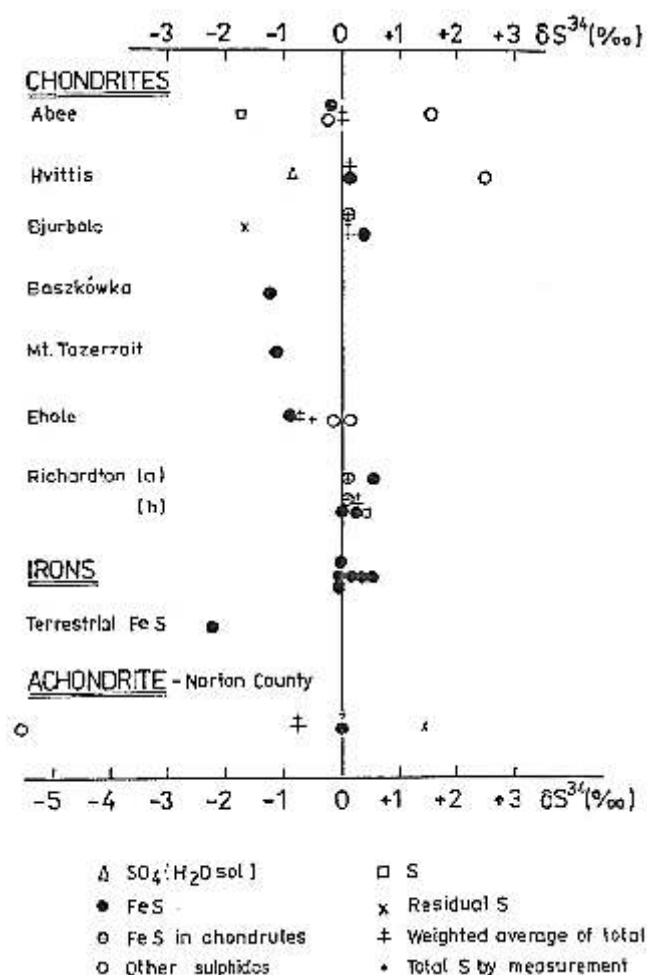


Fig. 1. Isotope composition of troilite sulphur from Baszkówka and Mt. Tazerzait against a background of data from Kaplan and Hulston (1966)

## SULPHUR ISOTOPES

Two particles of troilite (FeS) were separated from both meteorites by hand picking under a binocular microscope for mass spectrometric determination of  $^{34}\text{S}$ . Aliquots of ca. 10 mg FeS were oxidised by  $\text{Cu}_2\text{O}$  at  $850^\circ\text{C}$  in a vacuum line according to the procedure described by Robinson and Kusakabe (1975). The  $\text{SO}_2$  gas produced was analysed on a dual inlet, triple collector mass spectrometer which was calibrated to the V-CDT scale by means of  $\text{SO}_2$  gas produced from an IAEA-S1 reference  $\text{Ag}_2\text{S}$  specimen of known  $^{34}\text{S} = -0.30\%$ .

The results obtained are:

- Baszkówka —  $^{34}\text{S} = -1.25 \pm 0.06\%$ ;
- Mt. Tazerzait —  $^{34}\text{S} = -1.18 \pm 0.06\%$ .

The above results may be considered as identical within error. However, they significantly depart from most values obtained for troilite from meteorites. In Figure 1 the above results are compared with data obtained at McMaster University, where Kaplan and Hulston (1966) have investigated several dozen samples taken from various stony meteorites, siderites and one specimen of terrestrial FeS.

As is seen in Figure 1 both meteorites investigated here have the most negative  $^{34}\text{S}$  values for troilite sulphur yet obtained. Moreover, their identical sulphur isotopic composition indicates a common origin for these bodies.

## OXYGEN ISOTOPE COMPOSITION

A whole-rock specimen of the Baszkówka meteorite was analysed at the Open University in England by Dr. Ian A. Franchi. Respective delta values were expressed on the V-SMOW scale.

The results obtained are:

- $^{18}\text{O} = 4.88 \pm 0.03\%$ ;
- $^{17}\text{O} = 3.66 \pm 0.10\%$ .

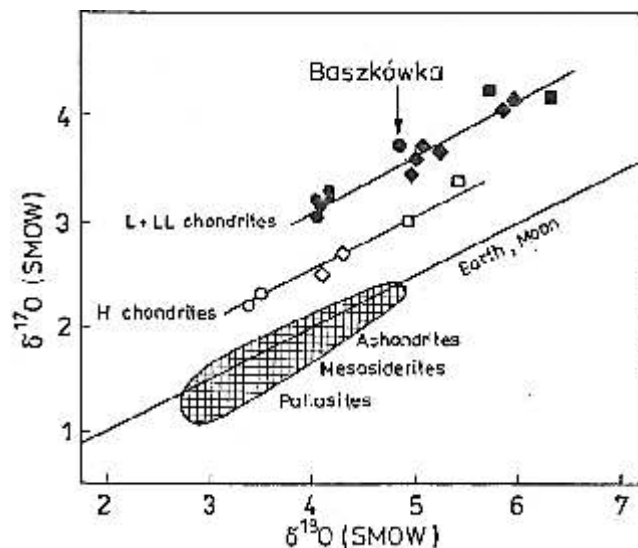


Fig. 2. Oxygen isotope composition of Baszkówka chondrules against a background of data obtained by Clayton *et al.* (1976)

These results are plotted on Figure 2 along with data obtained for various meteorites at the University of Chicago (Clayton *et al.*, 1976). It is clearly seen that Baszkówka falls into class L and LL. Hence this body represents negligibly altered original matter of the solar system. For the significance of the oxygen isotope variation the reader is referred to Clayton (1981) and the review by Shima (1986).

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