NEW STUDY OF THE ELEMENTAL COMPOSITION OF KABA METEORITE. Á. Csámer[1] and D. Nagy[2] J. Posta[3] and Á. Soós[4] and E. Nyeste[5] and B. Kovács[6], A. Gucsik[7], [1]Cosmochemistry Research Group, University of Debrecen, 1 Egyetem, Debrecen, Hungary 4032, csamera@unideb.hu, [2]University of Debrecen, 1 Egyetem, Debrecen, Hungary 4032, nagy.david@science.unideb.hu, [3]University of Debrecen, 1 Egyetem, Debrecen, Hungary 4032, posta.jozsef@science.unideb.hu, [4]University of Debrecen, 1 Egyetem, Debrecen, Hungary 4032, soos.aron@agr.unideb.hu, [5]University of Debrecen, 1 Egyetem, Debrecen, Hungary 4032, nyeste@agr.unideb.hu, [6]University of Debrecen, 1 Egyetem, Debrecen, Hungary 4032, kovacsb@agr.unideb.hu., [7]Eszterhazy Karoly University, 1 Eszterházy, Eger, Hungary, 3300, Cosmochemistry Research Group, University of Debrecen, 1 Egyetem, Debrecen, Hungary 4032, sopronianglicus@gmail.com

Introduction: The Kaba fell on 15th of April 1857, at the vicinity of Kaba village, in Bihar county, Hungary. Kaba, which is the least metamorphosed meteorite, belongs to the oxidized subgroup of the CV3 carbonaceous chondrite class ([1, 2]).

The first chemical analysis of the meteorite was performed by a German chemist Friedrich Wöhler, in 1858. That was the first case when organic material has been detected in a geological sample with extraterrestrial origin ([3, 4]).

The first modern geological study has been performed by Sztrókay et al. in 1961 [5]. He and his coauthors obtained the mineral composition and the major and minor element concentrations of the bulk. Using by optical microscopy and XRD methods they identified the following minerals: olivine, spinel, enstatite, diopside, magnetite, pentlandite and troilite.

Textural analysis showed that the Kaba contains altered chondrules consisting of olivine and pyroxene in various size and types, olivine-rich inclusions, Ca-Al-rich inclusions (CAIs), small (below 20 μm) mineral fragments (olivine, enstatite, hedenbergite, diopside) in a carbon-rich, phyllosilicate-bearing fine-grained opaque matrix ([6, 7].

During the last fifty years more than hundred scientific papers dealt with the mineralogical, physical and chemical properties of the meteorite, including the compositional analysis of the bulk or certain components (chondrules, CAIs, matrix), and if we consider the number of scientific papers published in the last ten years in this topic, we can conclude that the scientific interest has not decreased yet.

The main body of Kaba has been kept in the Debrecen Reformed College. It is particularly difficult to obtain a sample from the bulk for further investigation, not just for the foreign, but the for the domestic researchers too. Here we present new compositional data for the bulk meteorite. The aim of this work was to confirm the results of previous chemical analysis based on the analysis of a new sample obtained from Kaba, furthermore to perform trace elemental analysis of the studied sample using highly sensitive analytical techniques.

Sample preparation: A black, irregular piece of the meteorite showing no visible internal structure was used for the digestion. The digested mass was 0.1197 g. The sample was gradually dissolved in different acid mixtures for subsequent atomic spectrometric studies.

During the digestion, the sample was dissolved in 2 mL concentrated analytical grade nitric acid (M1 solution). The solid residue was further dissolved in the mixture of 1 mL concentrated nitric acid - 2 mL concentrated hydrochloric acid (*aqua regia*) and 0.5 mL concentrated hydrogen fluoride (M2 solution).

The residue was further digested in a closed Teflon vessel with the aid of microwave digestion, in the presence of 2 mL concentrated hydrochloric acid, 1 mL concentrated nitric acid and 0.5 mL 40 percent hydrogen fluoride. For the digestion Milestone Ethos Up microwave digestion system equipped with SK15 rotor was used. Under these conditions the remaining sample had been almost completely dissolved, except the 2 mass percent reside that is supposed to be carbon powder (M3 solution).

During the analysis analyte-free blank samples (reagent blank) also have been prepared and measured. The result values obtained during analyses of the samples were corrected by the average values of the reagent blanks.

Instrumental analysis: The major components of the meteorite were measured using Thermo Scientific iCAP 6300 Dual view inductively coupled plasma optical emission spectrometer (ICP-OES). Trace element analysis was carried out using a high sensitivity Thermo Scientific X-Series II inductively coupled plasma mass spectrometer (ICP-MS).

External calibration was used to determine the concentration of the following isotopes: ^{23}Na, ^{39}K, ^{40}Ca, ^{49}Ti, ^{51}V, ^{52}Cr, ^{55}Mn, ^{59}Co, ^{65}Cu, ^{75}As, ^{78}Se, ^{88}Sr, ^{89}Y, ^{95}Mo, ^{107}Ag, ^{111}Cd, ^{118}Sn, ^{121}Sb, ^{133}Cs, ^{137}Ba, ^{139}La, ^{140}Ce, ^{141}Pr, ^{146}Nd, ^{147}Sm, ^{153}Eu, ^{157}Gd, ^{159}Tb, ^{163}Dy, ^{165}Ho, ^{166}Er, ^{169}Tm, ^{172}Yb, ^{175}Lu, ^{197}Au, ^{202}Hg, ^{206}Pb, ^{232}Th and ^{238}U. The concentrations of 10 elements (Au, Hg, Pt, Ir, Re, W, Hf, In, Pd, Nb) were under the limit of detection in the samples.

Results and Discussion: After the treatment with concentrated nitric acid, 42 mass percent of the sample had been dissolved (fraction M1). Other 45 mass percent were dissolved after the subsequent treatment with the mixture of nitric acid, hydrochloric acid and hydrogen fluoride under atmospheric pressure (fraction M2), the remaining part was digested in the same mixture of nitric acid, hydrochloric acid and hydrogen fluoride by microwave assisted digestion in a closed vessel (M3 fraction).

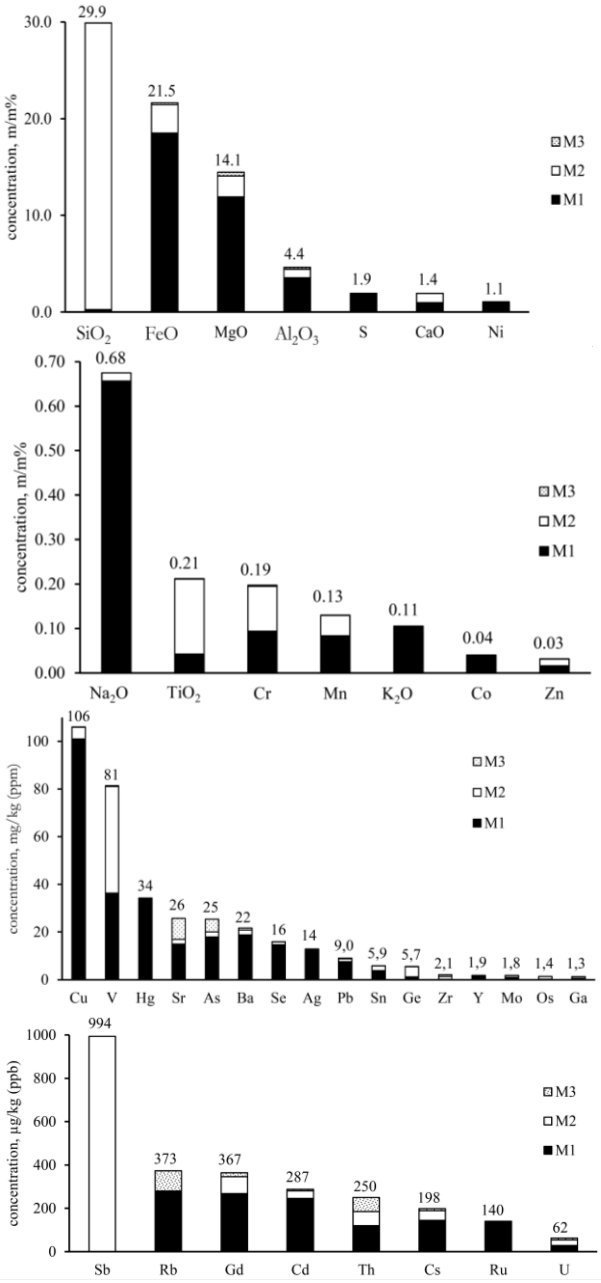

Figure 1 Concentrations of major and trace elements in various sample fractions of Kaba meteorite

At the end of these processes 2 mass percent of the sample remained undissolved as final residue, which is presumably carbon dust.

Following the concentrated nitric acid treatment all sulfides, some oxide minerals and probably a part of the glass had been dissolved (Figure 1). Larger part of REEs also were connected to these mineral phases.

Silicon was leached into M2 samples only, when the silicates and the remnant glass were in soluble fluoro-silicate complex form. The elements determined in the sample M2, probably were connected to the silicate minerals and/or glass.

The presence of major elements (e.g. Al, Mg, Fe) in the M3 fraction supports the occurrence of Mg-Al and Fe-Al mixed oxides (spinel group) (sample M3).

The major elements of the meteorite sample are in the concentration range between 1 and 30 mass percent (Figure 1). Some other elements, such as Na, Cr, Mn, K, Ti, Co and Zn are presented in the concentration range of tenth or hundredth mass percent. Further 37 elements can be found in ppm (mg/kg) or ppb (µg/kg) range, and 10 of the studied elements are below the limit of detection of the applied instrumental techniques. The concentrations of the major elements show good agreement with the elemental constituents of main mineral phases determined by Sztrókay et al. [5].

The abundance pattern of REEs may be caused by volatility differences between REEs, or preferential concentration of REEs in certain minerals compared to the matrix also could play important role, however it seems more likely that the smaller chips may not be representative of the bulk composition.

The explanation of this phenomenon is under debate, and it requires further investigation. Analysis of a new larger sample derived from the bulk is planned.

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