

# Meteorite Košice



. Tóth, L. Kornoš, P. Zigo et al. - Comenius University in Bratislava  
. Borovička, P. Spurný - AsÚ AV ČR Ondřejov  
. Igaz - Hungarian Astronomical Association (MCSE)

# Meteorites in Slovakia

1814 – Lenartov, iron - find

1835 – Oravská Magura, iron - find

1837 – Divina, stone – fall

1895 – Vel'ké Borové, stone- fall

1994 – Rumanová, H5 – find

2010 – Košice, H5 - fall

| Meteorite name        | country         | year |
|-----------------------|-----------------|------|
| Příbram               | Czechoslovakia  | 1959 |
| Lost City             | USA             | 1970 |
| Innisfree             | Canada          | 1977 |
| Peekskill             | USA             | 1992 |
| Tagish Lake           | Canada          | 2000 |
| Morávka               | Czech Republic  | 2000 |
| Neuschwanstein        | Germany/Austria | 2002 |
| Park Forest           | USA             | 2003 |
| Villalbeto de la Peña | Spain           | 2004 |
| Bunburra Rockhole     | Australia       | 2007 |
| Buzzard Coulee        | Canada          | 2008 |
| Almahata Sitta        | Sudan           | 2008 |
| Grimsby               | Canada          | 2009 |
| Jesenice              | Slovenia        | 2009 |
| Košice                | Slovakia        | 2010 |

# AsÚ AV ČR Ondřejov



# Meteorites searched events:

**Morávka 2000**

**Turji-Remety 2001**

**Šášov 2006**

**Martin 2007**

**Košice 2010**

**Komjatná 2010**

**Zlatnô 2010**

**Kajárpéc, HU, 2011**







# **Meteorite Košice – description of the event**

- **Feb. 28, 2010 at 22:24:46 UT  
superbolide over Slovakia**
- **very bright flash, low freq. sound, many witnesses**
- **radiometric sensors of automatic fireball  
stations (dr. P. Spurný, AVČR)**
- **March 1 and 3, 2010, video records from Hungary**

**Astronomical and Geophysical Observatory at Modra  
Comenius University in Bratislava**





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## Info about the observatory

## Address:

Astronomical observatory  
P.O.Box 4  
900 01 Modra  
Slovakia

tel.: +421 336475261

## Longitude:

17°,27402056 E

## Latitude:

## Meteorite "Kosice", the fall in Slovakia

On February 28th at 22:24:46 UT a bright bolide enlightened the night sky over the Central Europe. Despite the late hour bunch of people were watching Olympics ice hockey finals on TV and eye witnessed astonishing celestial spectacle. The glare of the bolide illuminated streets and interior of apartments, at some places in Eastern Slovakia cannon-like burst or series of low frequency blasts were heard. Due to the bad weather, cloudy skies and scatter showers the Central European Fireball Network (operated by dr. Pavel Spurny of the Czech Academy of Sciences) did not take direct optical records of the bolide and Slovak Video Network (operated by dr. Juraj Toth of Comenius University in Bratislava) did not operate that night so that at first moment it seemed that there are no scientific records of this event. Fortunately fast photoelectric sensors on 7 automated fireball stations in the Czech Republic (6) and Austria (1) detected the illumination of the sky caused by the bolide which enabled to determine exact time and duration of the bolide and estimate its brightness. The bolide reached the maximum brightness at least -18 magnitude in one huge flare. In the morning few photographers took a picture of a possible scatter dust trail. Later on several surveillance camera data were published showing the moment when the night became a day for a second but only two videos from Hungary (Orkeny village, Fazzi Daniella and Vass Gabor; Telki village, contact persons Szarneczky Krisztian, Kiss Laszlo) actually captured the fireball itself. Thanks to calibration of videos by several members of the Hungarian Astronomical Association (MCSE - [www.mcse.hu](http://www.mcse.hu)) contributed (namely Igaz Antal) and trajectory analysis done by dr. Jiri Borovicka of the Czech Academy of Sciences gave the hope that significant number of meteorite fragments reached the surface. He also calculated the impact area near town Kosice in Eastern Slovakia. The data from Local Seismic Network Eastern Slovakia (project led by prof. Moczo of Comenius University) confirmed the fall location as well. The expedition consisting of scientists and graduate students of the Astronomical Institute of the Slovak Academy of Sciences (under the

# Meteorite Košice – video no. 1

- Örkény, Hungary  
Fazzi Daniella a Vass Gábor



# Meteorite Košice – video no. 2 Telki, Hungary

Contact persons Szarneczky Krisztian, Kiss Laszlo



14 (2010.02.26. 23:29:43.440)



14 (2010.02.26. 23:29:43.640)



14 (2010.02.26. 23:29:44.640)



14 (2010.02.26. 23:29:44.940)



14 (2010.02.26. 23:29:45.040)



14 (2010.02.26. 23:29:45.240)



14 (2010.02.26. 23:29:45.440)



14 (2010.02.26. 23:29:45.640)



14 (2010.02.26. 23:29:46.040)

# Meteorite Košice – video no. 3 Budapest, Hungary

Contact persons Vizi Pál, Igaz Antal



# **Meteorite Košice – expedition**

- **March 12**  
**interviewing people by me and L. Kornoš**
- **March 20**  
**fallowing first searching expedition**  
**by two institutions**  
**Comenius Univ. & Astr. Inst. SAS**

**interviewing people**  
**March, 12, Košice - Šaca**



**fireball, sounds direction ~ North**

**First expedition – close to the village Vyšný Klátov**

**March 20, 2010**





**First expedition – close to the village Vyšný Klátov**  
**March 20, 2010**  
**1. fragment of the meteorite Košice, Juraj Tóth**







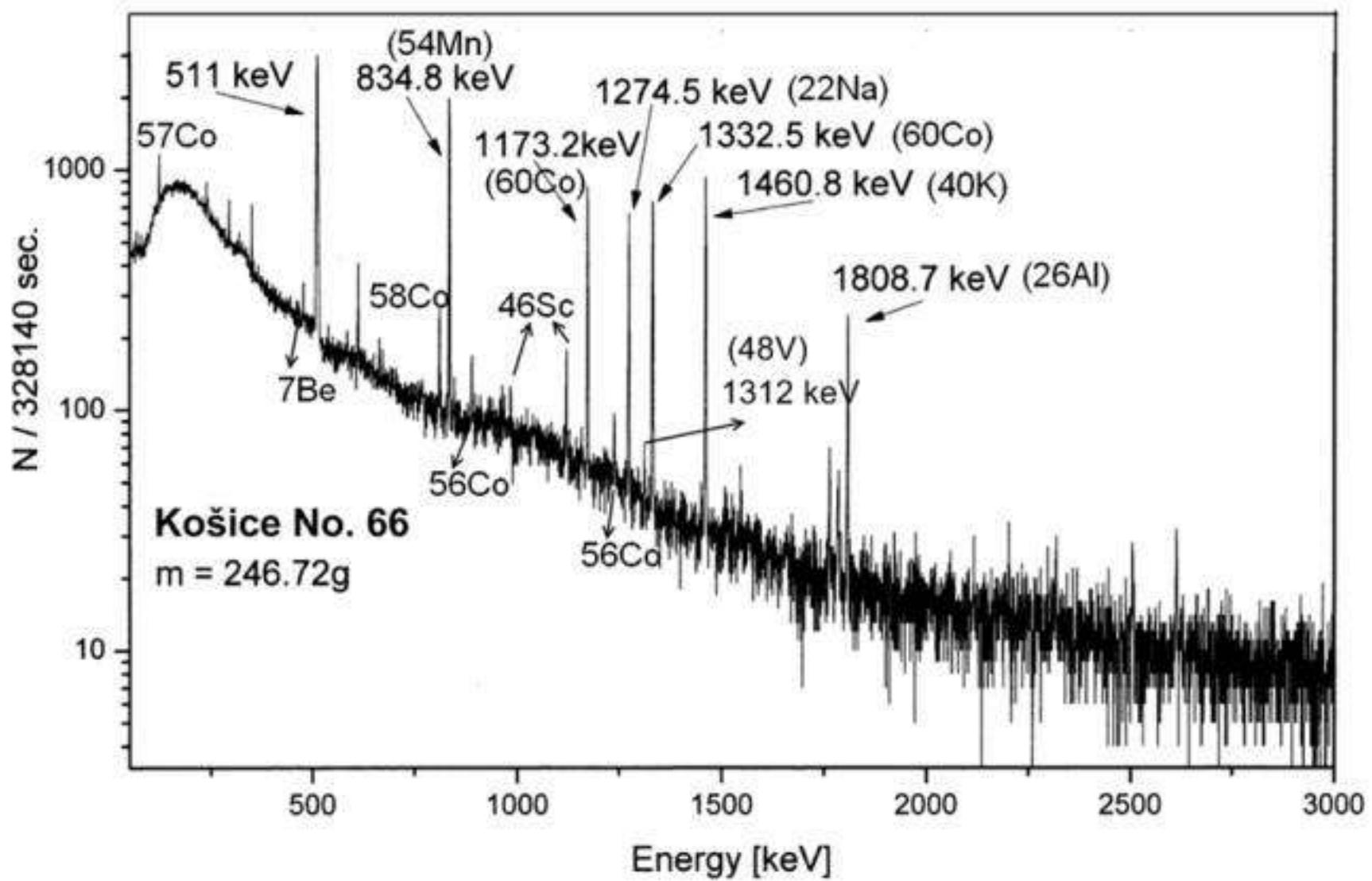
**First expedition – close to the village Vyšný Klátov**  
**March 20, 2010**  
**2. fragment of the meteorite Košice, Diana Búzová**

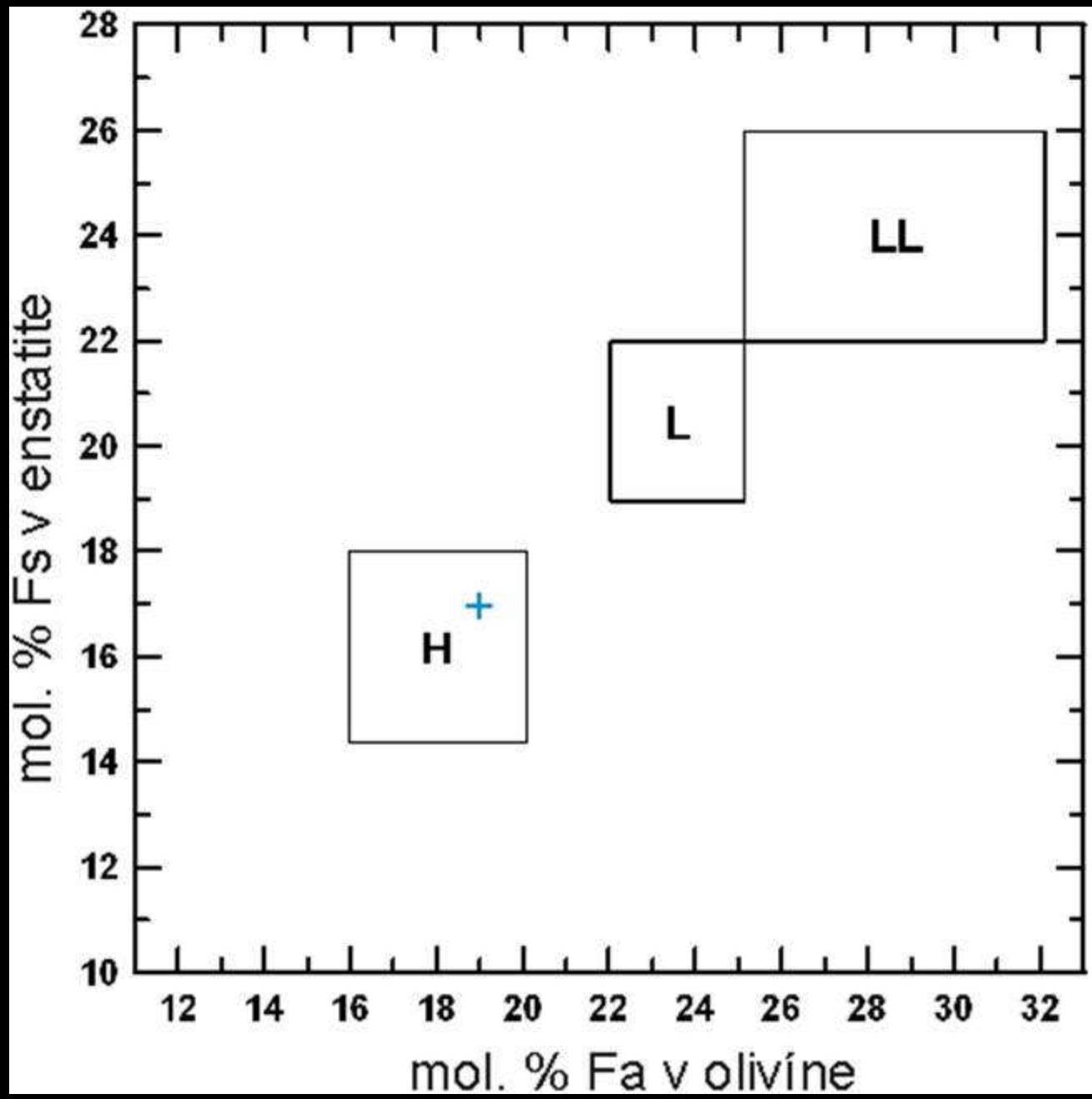




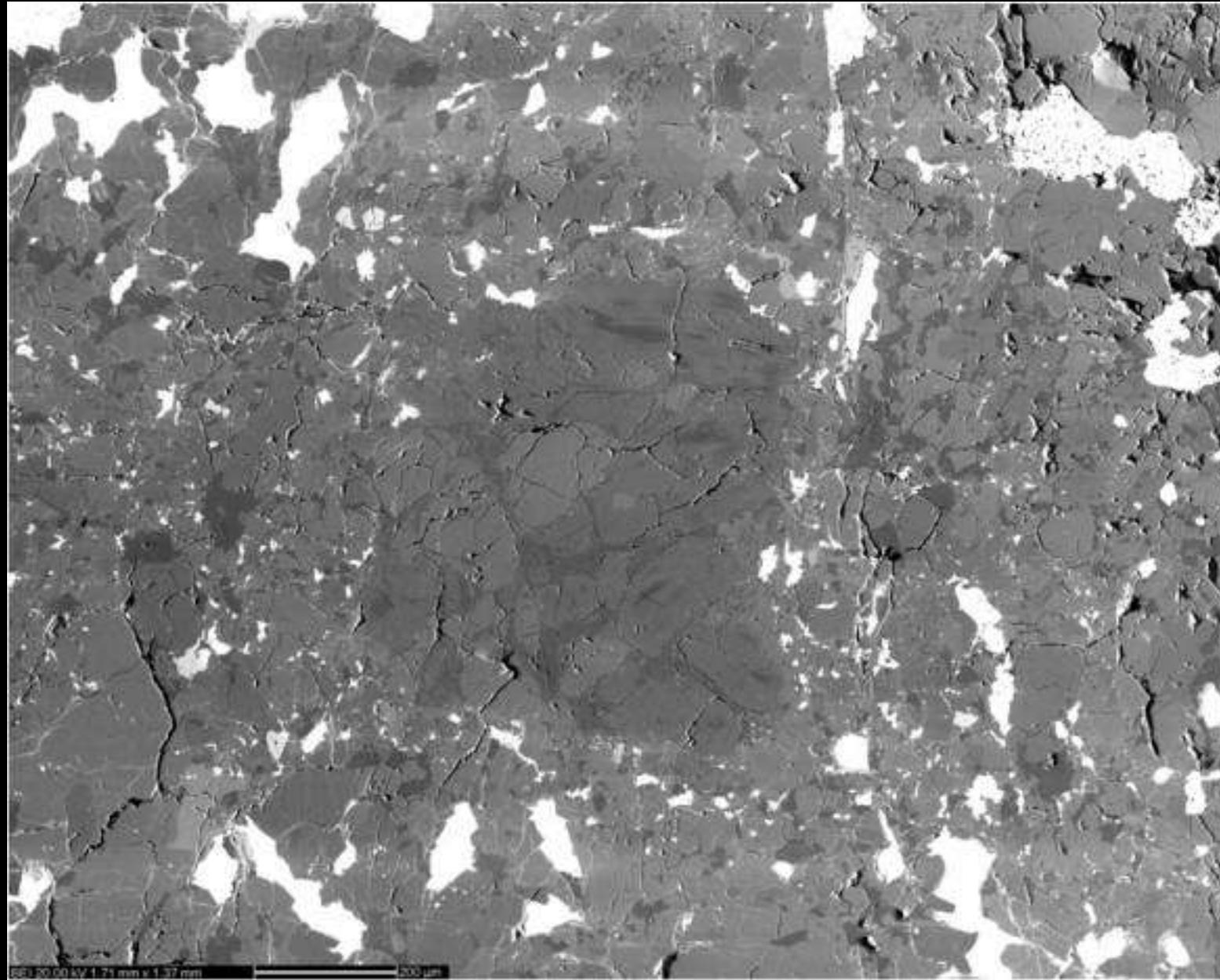
# Meteorite Košice – first analyses

- The first meteorite analyzed by nuclear physicist (prof. P. Povinec) => extraterrestrial origin
- Mineralogical analyzes of the fragment no. 15 by dr. J. Haloda Czech Geological Survey => ordinary chondrite H5
- dr. D. Ozdín, ass.prof. P. Uher Comenius University, detail mineralogical analyses

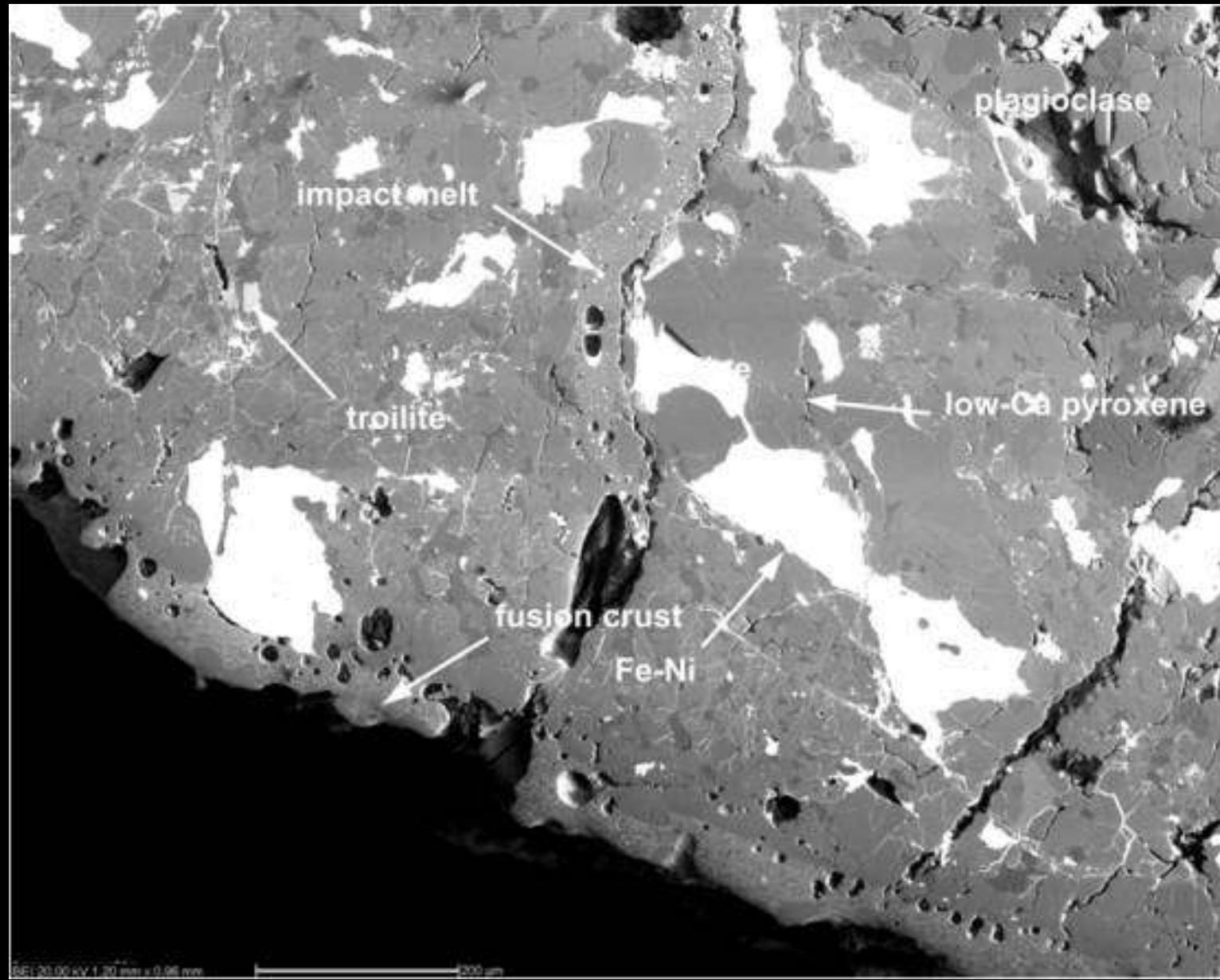




# Meteorite Košice – chodrule (dr. J. Haloda Czech Geological Survey)

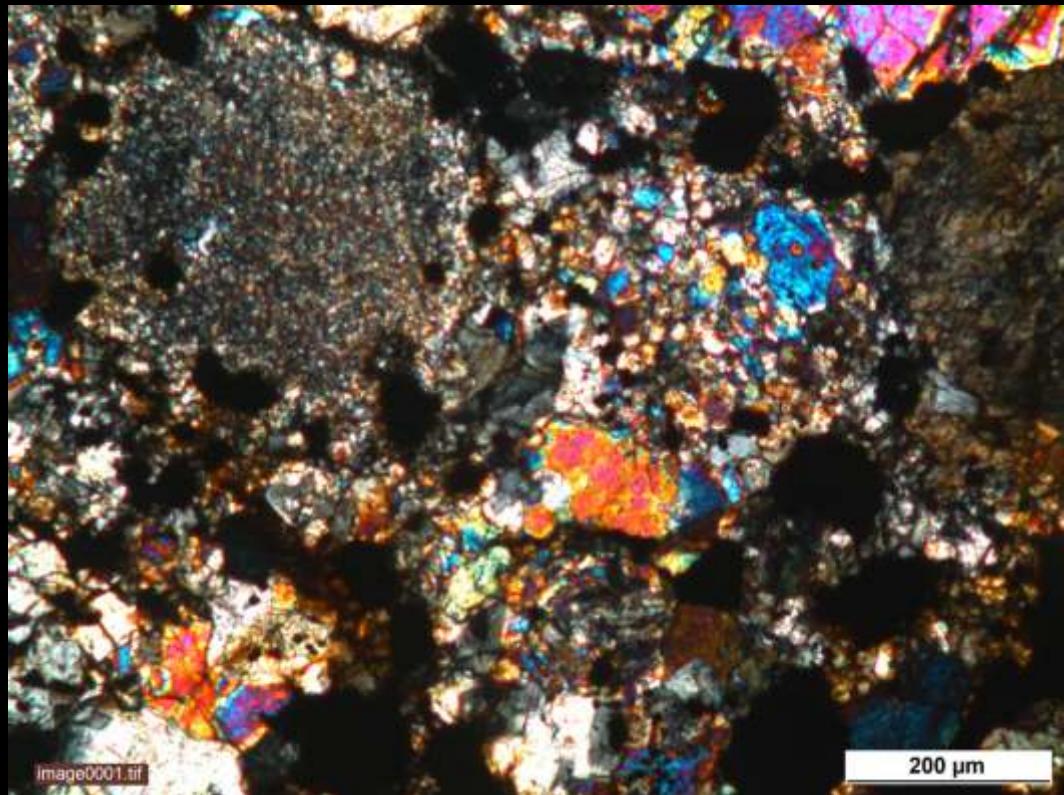


# Meteorite Košice –(dr. J. Haloda Czech Geological Survey)

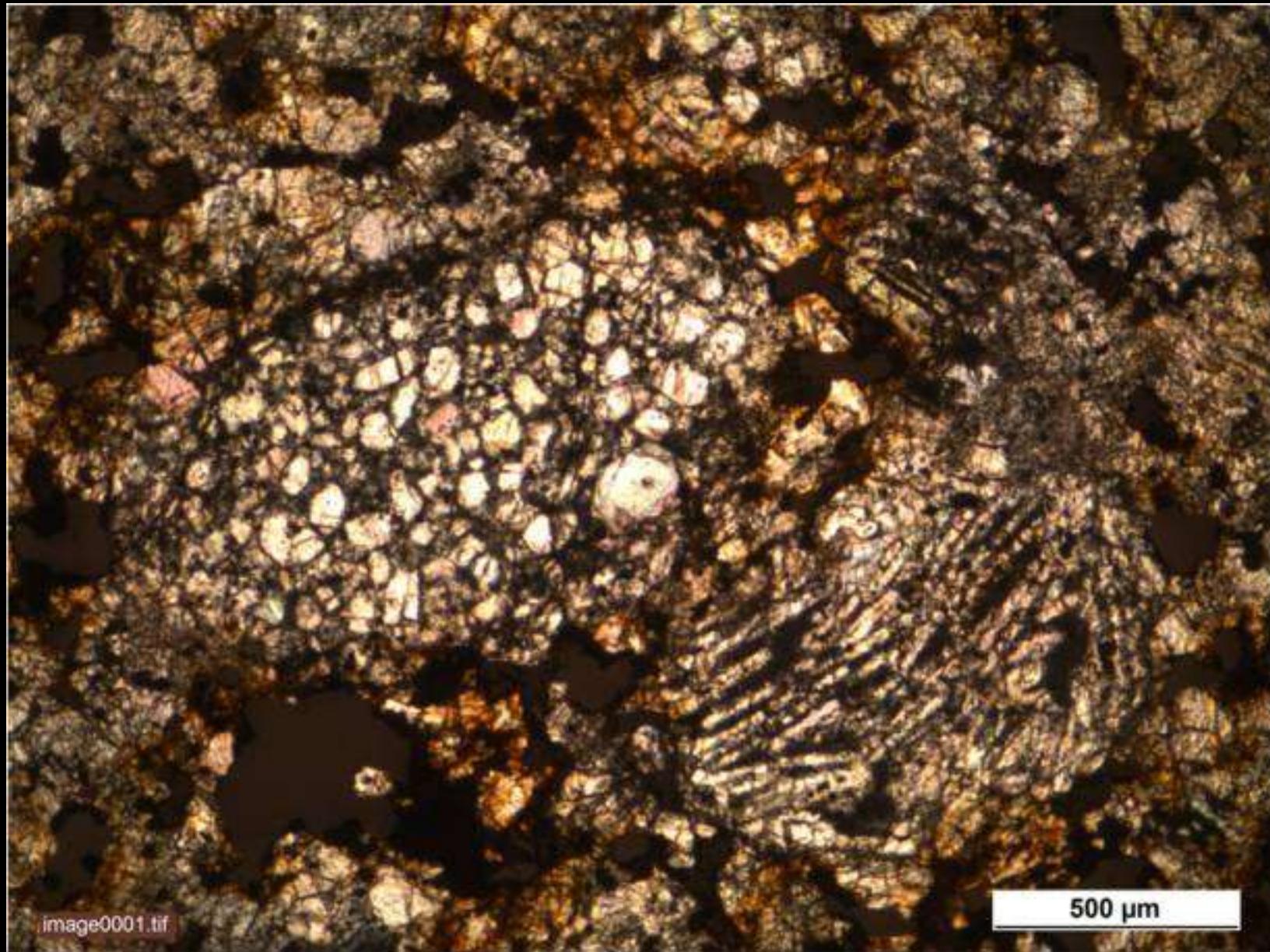


# Meteorite Košice (dr. D. Ozdín, doc. P. Uher PRiF UK)

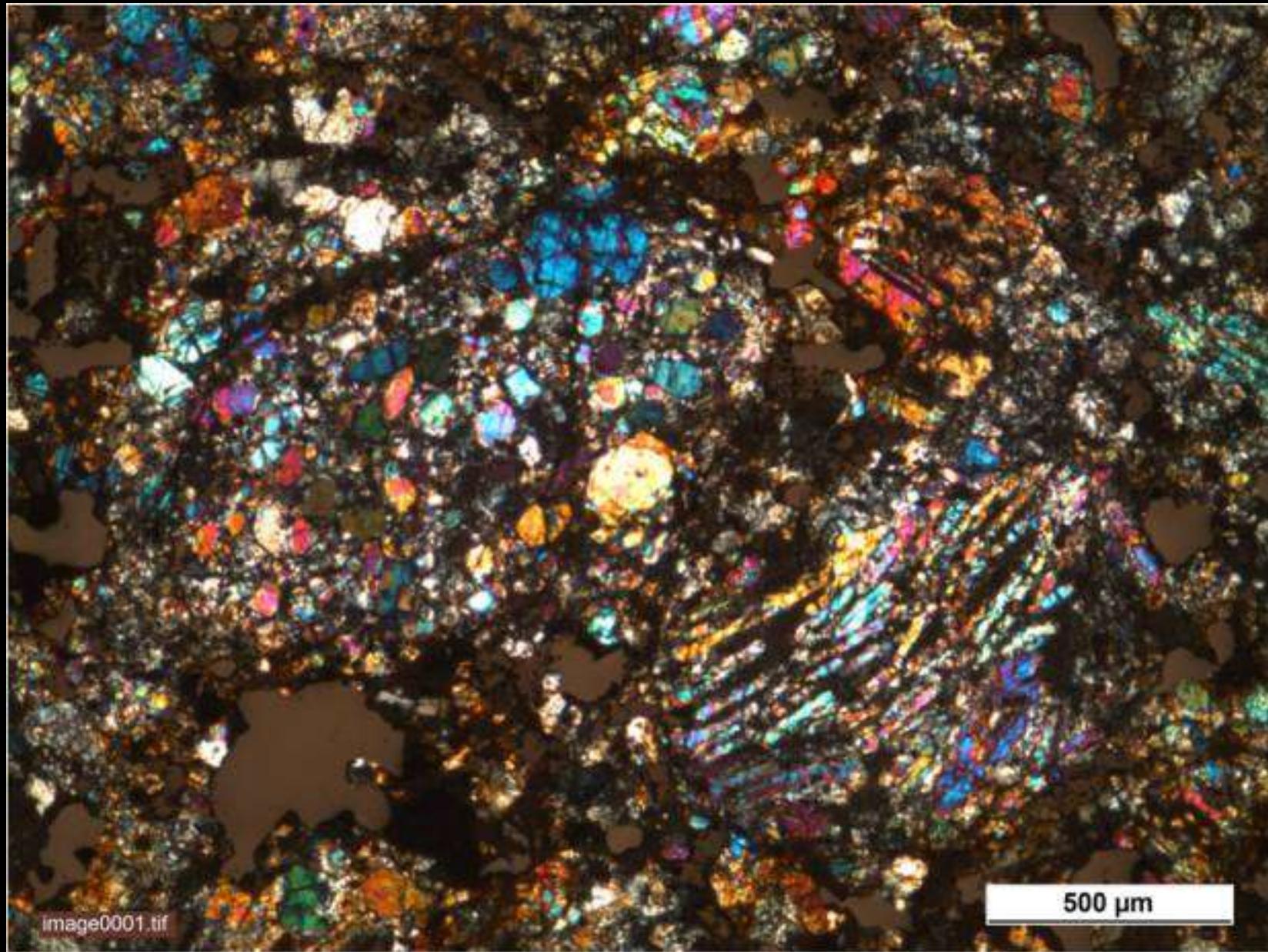
- matrix + chondrules
- more silicates than Fe-Ni
- olivine (forsterit)
- pyroxens (enstatite, augite, diopside)
- feldspars (albit)
- silicate glass
- chromite
- chloraparite
- merrillite
- troilite
- Fe-Ni (kamacit, taenite and tetrataenite)



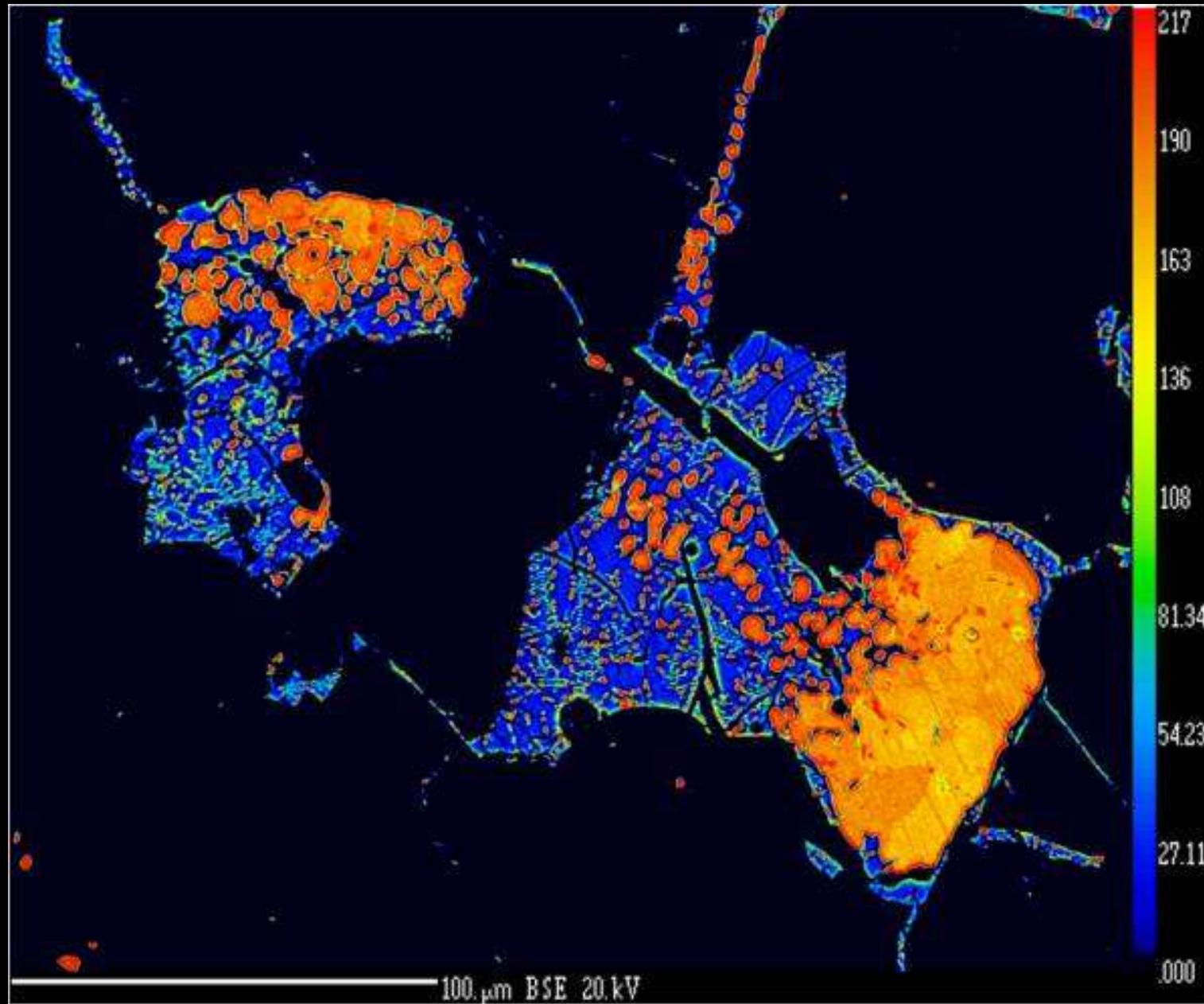
Meteorite Košice (dr. D. Ozdín, doc. P. Uher PRiF UK)



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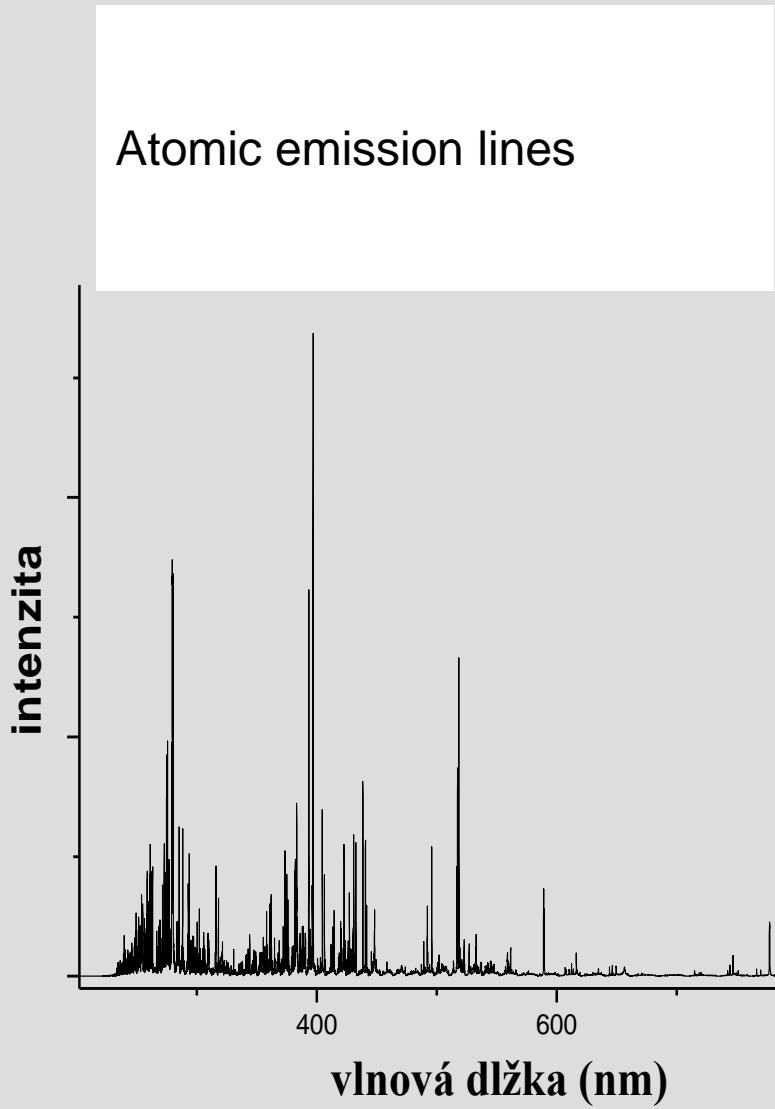
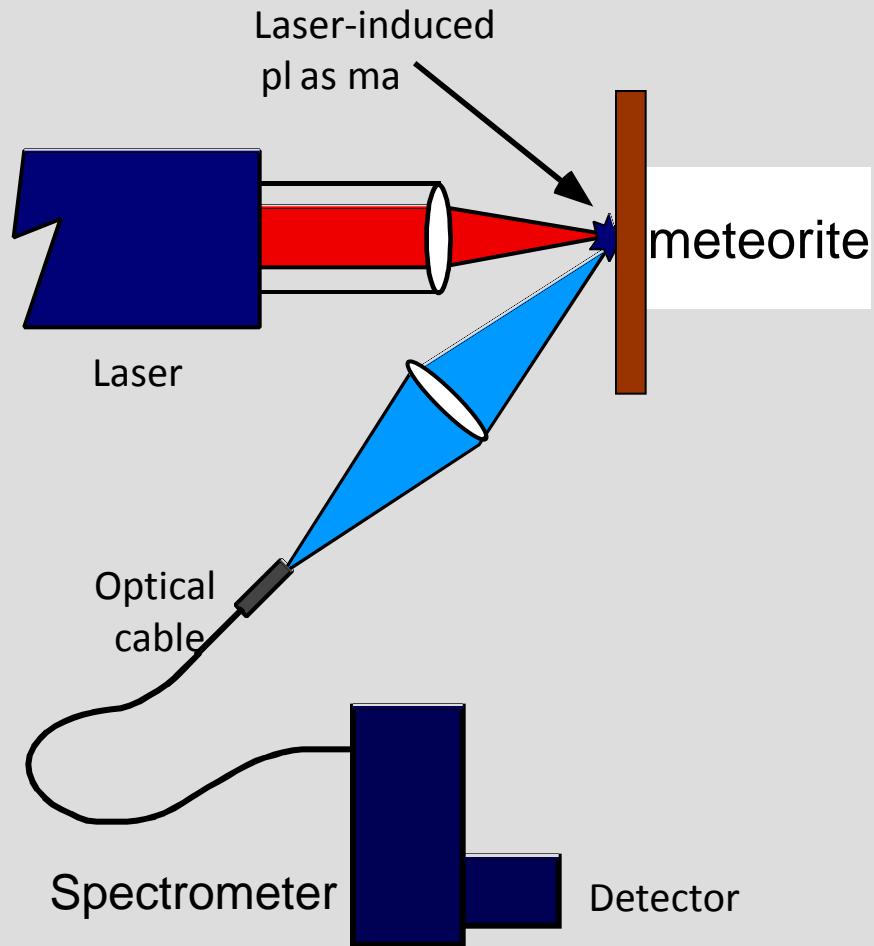


# **Laser induced breakdown spectroscopy of meteorite Košice**

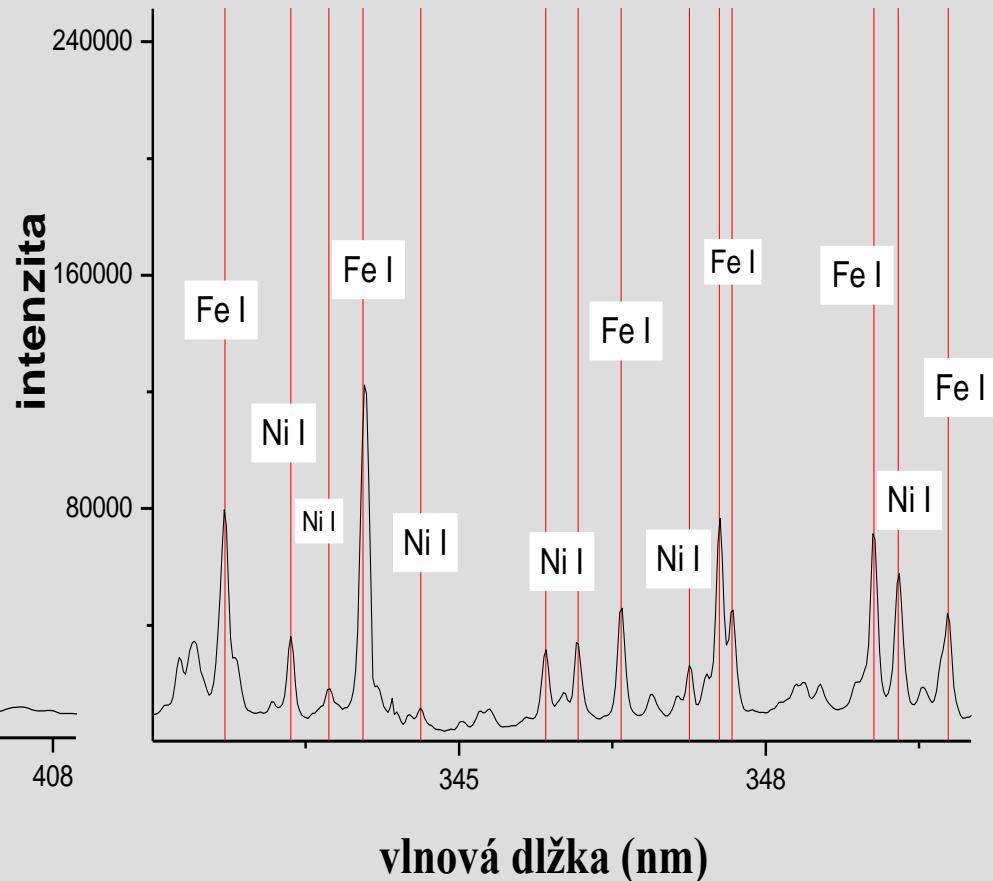
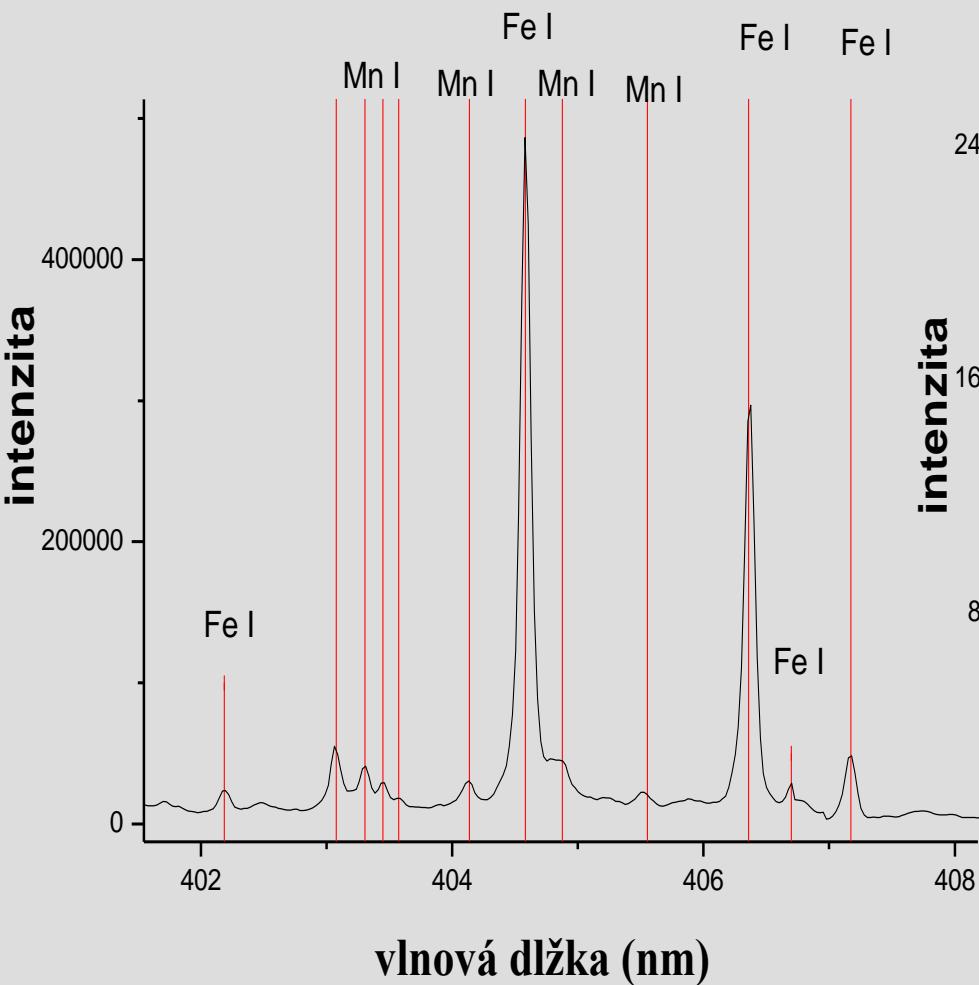
**Z. Grolmusova, J. Plavčan, P. Čermák,  
J. Rakovsky and P. Veis**

<sup>1</sup> Dept. of Experimental Physics, FMFI UK, Bratislava, Slovakia,

# Laser-Induced Breakdown Spectroscopy (LIBS)



# Some part of the emission spectra



## Identified major elements

Fe, Ca, Al, Si, Mg, Na, Ni, K, Mn, N, O, H

These elements were identified just from the fusion crust of the meteorite, possible contamination during the recovery.

Trace elements like (**S, Co, Sc ...**) and their quantity analyses are ongoing.

# *Chemical composition of H5 chondrites (in wt%)*

(*Příbram* – Clarke et al., 1971, Košice - dr. D. Ozdín, doc. P. Uher PRiF UK  
Acme Analytical Laboratories (Vancouver) Ltd., Canada)

|                                | <i>Rumanová</i> | <i>Příbram</i> | <i>Košice</i> |
|--------------------------------|-----------------|----------------|---------------|
| SiO <sub>2</sub>               | 38.85           | 37.22          | 35.31         |
| Al <sub>2</sub> O <sub>3</sub> | 1.94            | 2.10           | 2.02          |
| FeO                            | 9.52            | 9.34           | -             |
| MnO                            | 0.29            | 0.30           | 0.30          |
| MgO                            | 21.94           | 23.72          | 22.98         |
| CaO                            | 1.19            | 1.79           | 1.59          |
| Na <sub>2</sub> O              | 0.59            | 0.87           | 0.81          |
| K <sub>2</sub> O               | 0.07            | 0.09           | 0.11          |
| P <sub>2</sub> O <sub>5</sub>  | 0.32            | 0.29           | 0.27          |
| Ni                             | 1.27            | 1.68           | >1            |

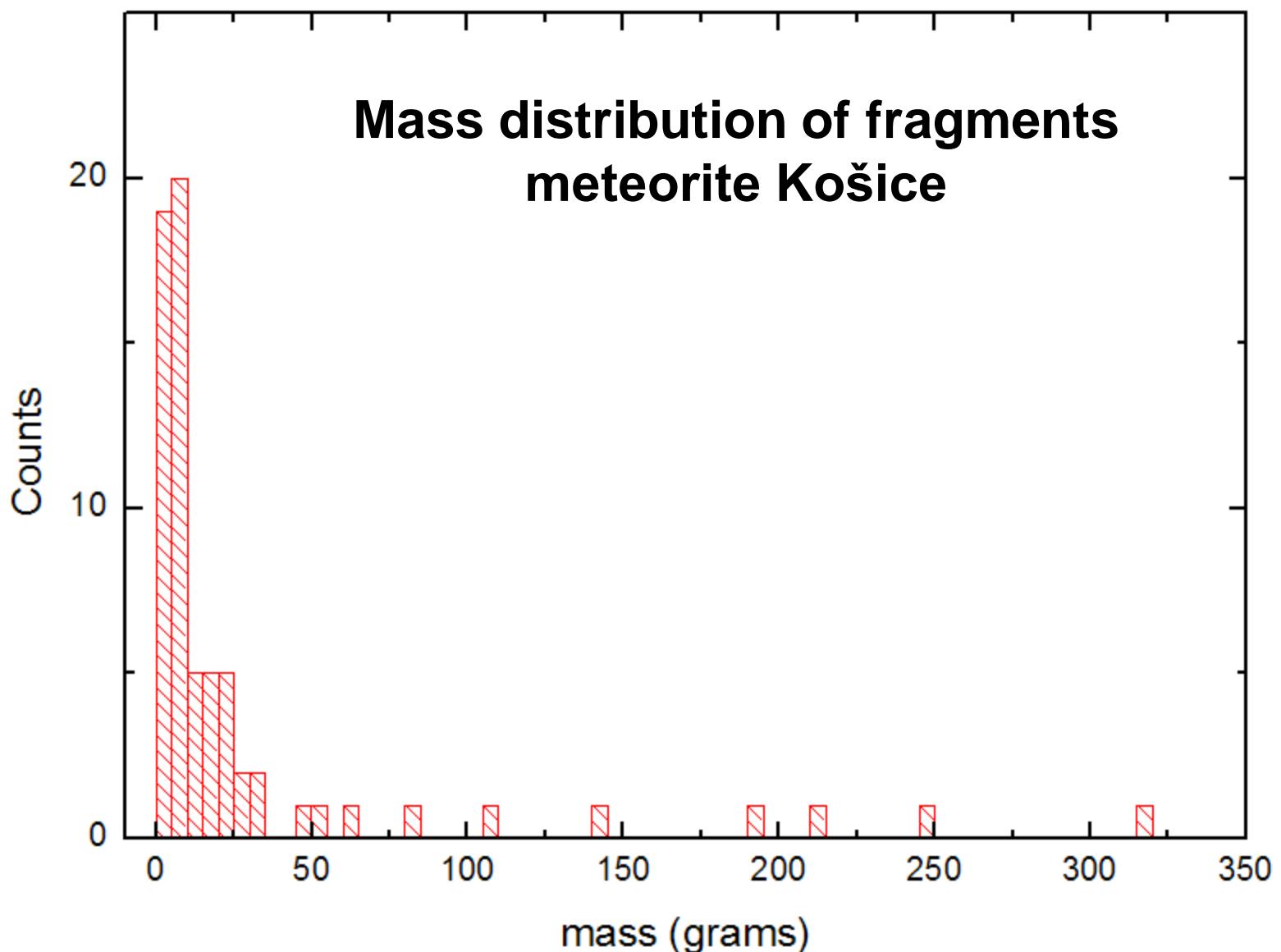
## Meteorite Košice

- officially found 77 fragments
- total weight 4,3 kg
- the largest one 2,16 kg (Tereza Krejčová)

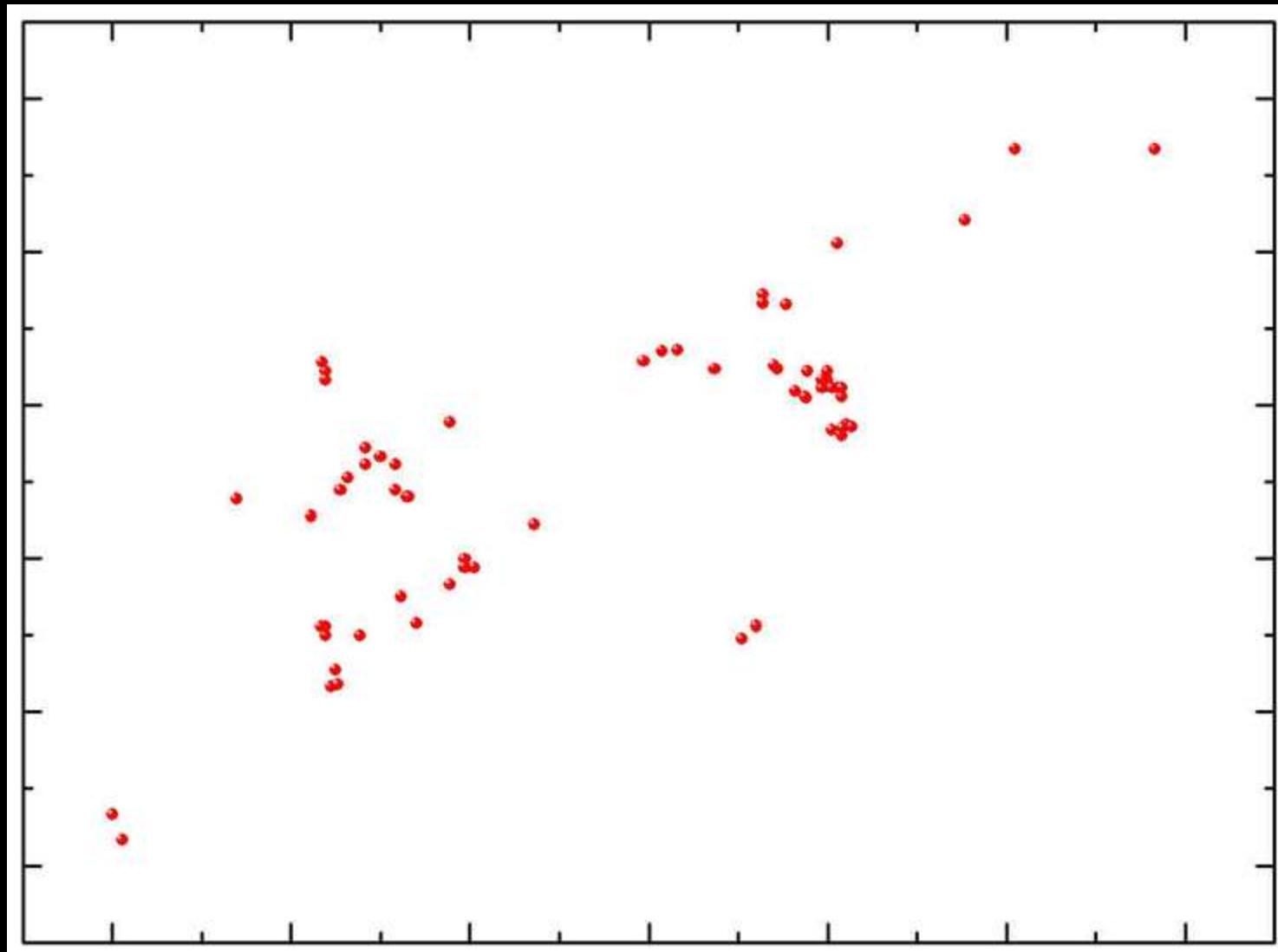
# Meteorite Košice

- 28 finders

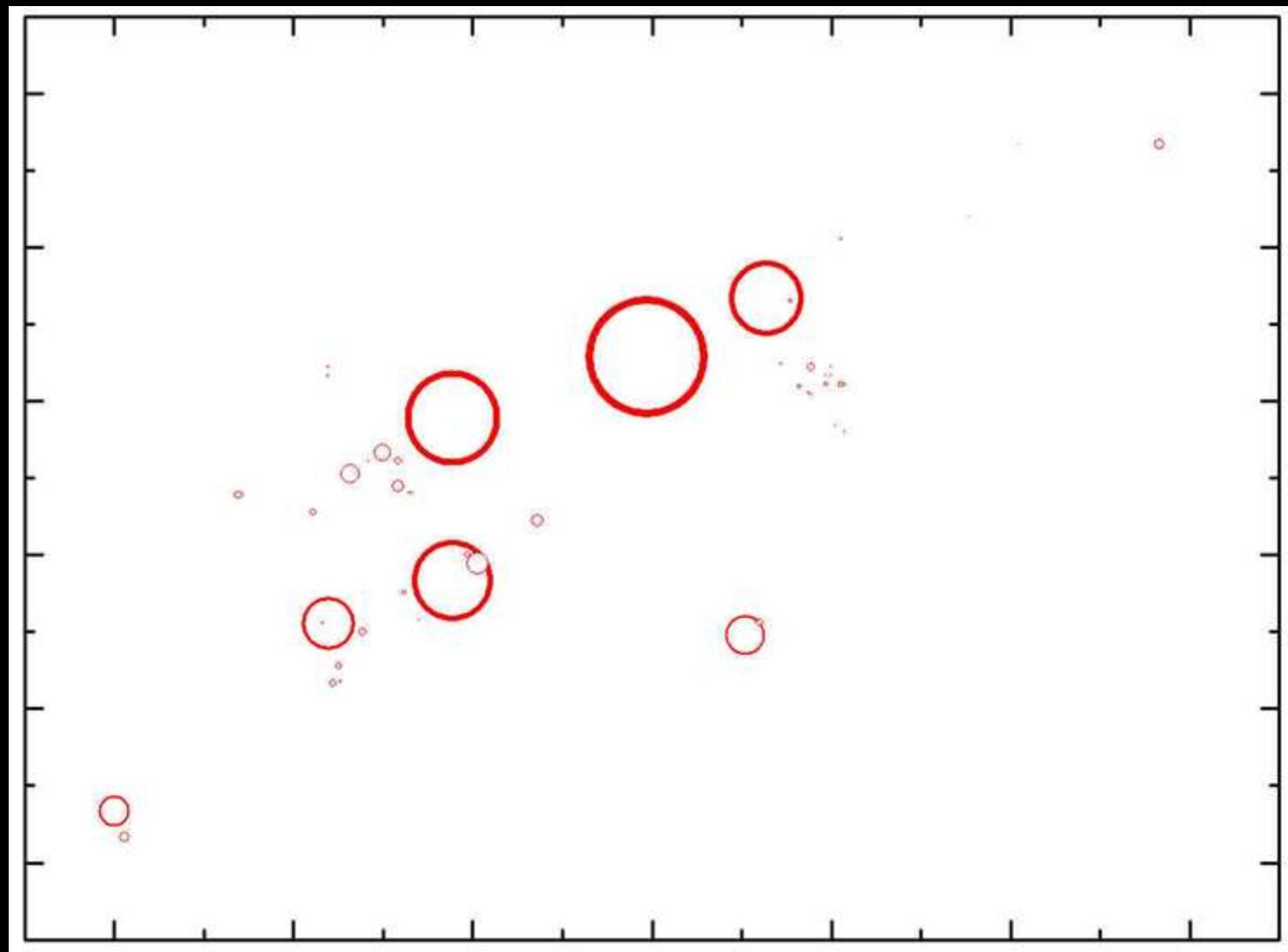
Juraj Tóth, Diana Buzová, Marek Husárik, Tereza Krejčová,  
Ján Svoreň, Julius Koza, David Čapek, Pavel Spurný,  
Stanislav Kanianský, Eva Schunová, Marcel Škreka, Dušan  
Tomko, Pavol Zigo, Miroslav Šebeň, Jiří Šilha, Leonard  
Kornoš, Marcela Bodnárová, Peter Vereš, Jozef  
Nedoroščík, Zuzana Mimovičová, Zuzana Krišandová,  
Jaromír Petržala, Štefan Gajdoš, Tomáš Dobrovodský,  
Peter Delinčák, Zdenko Bartoš, Aleš Kučera, Jozef Világi.



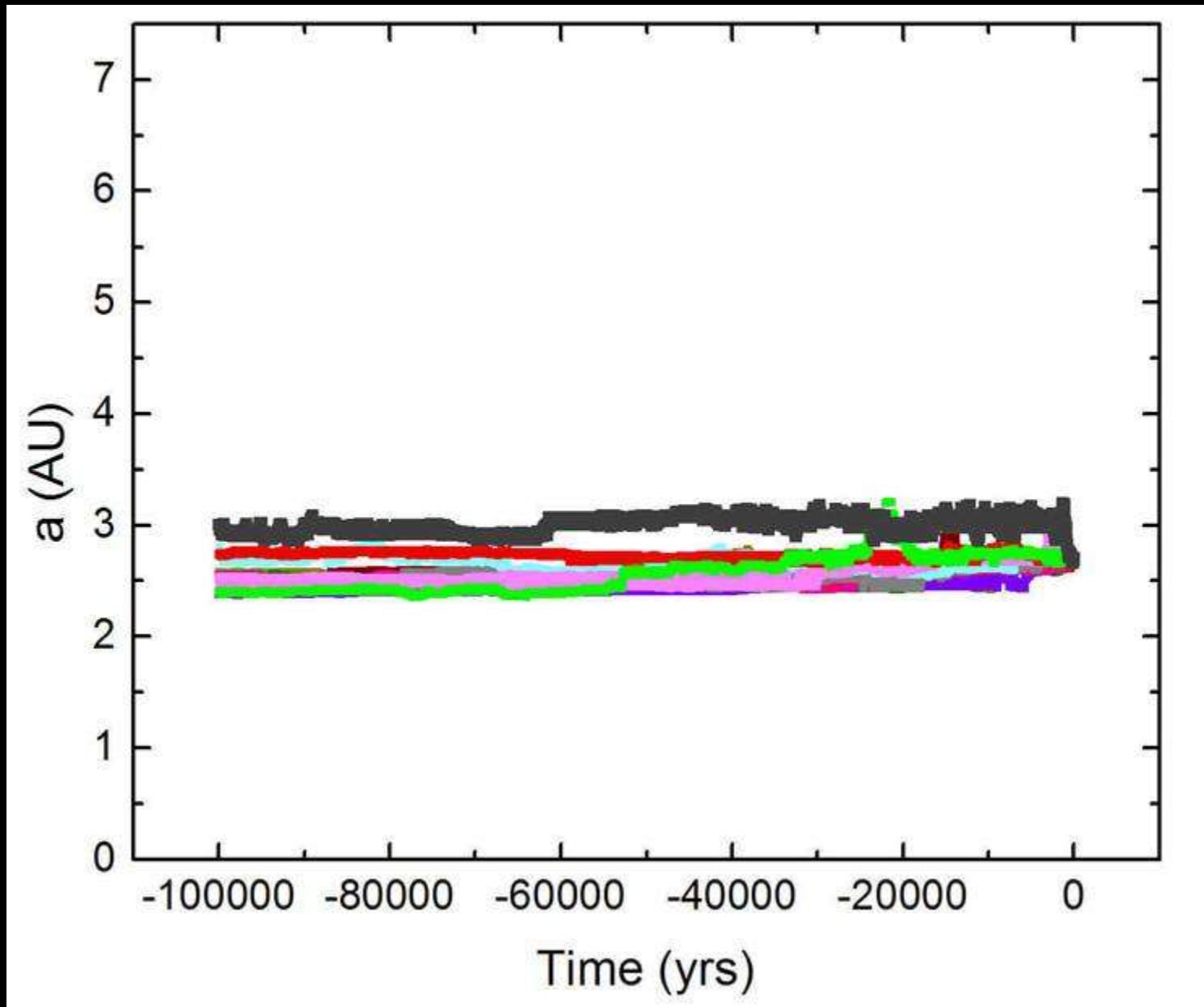
# Spatial distribution of fragments meteorite Košice



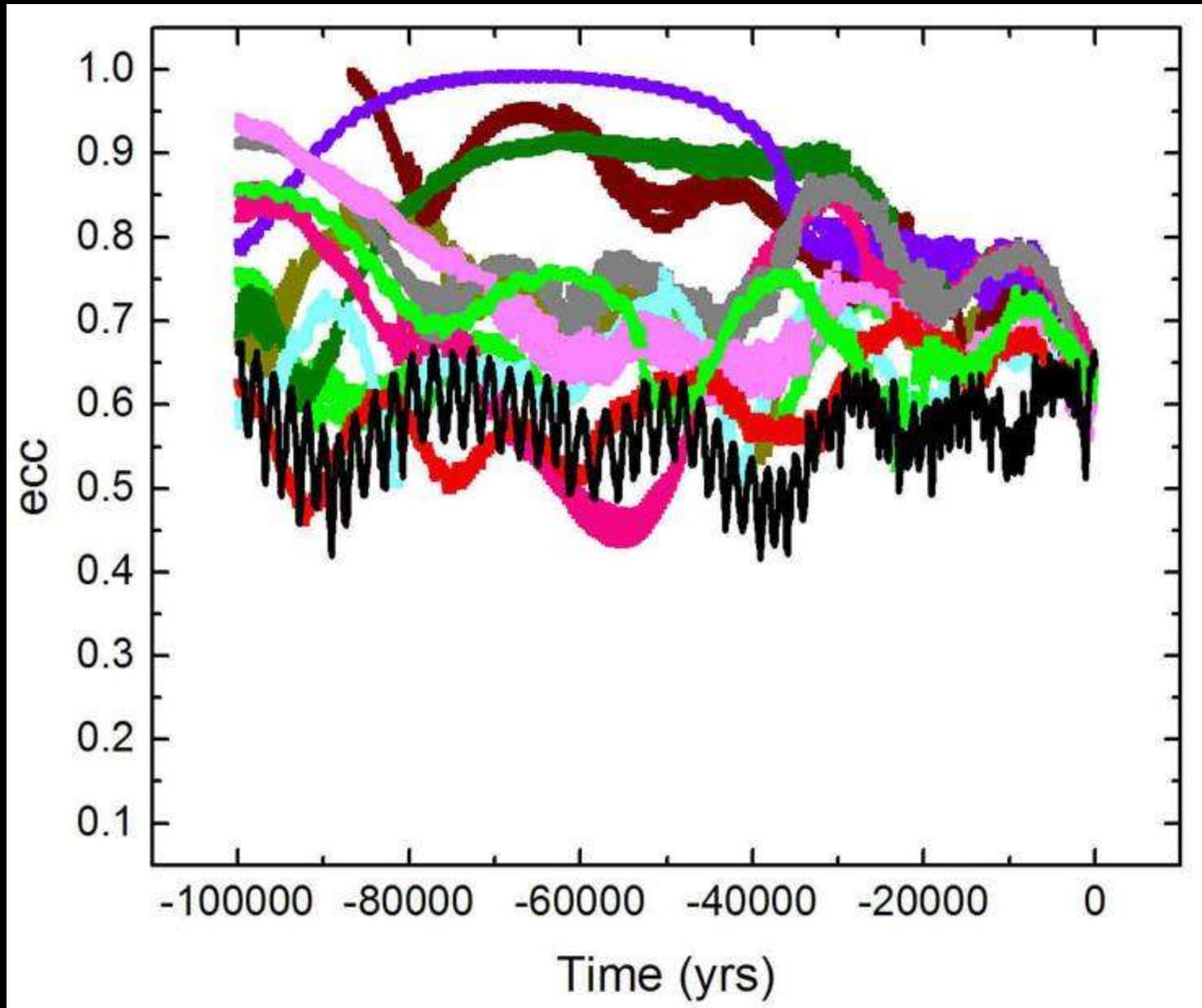
# Spatial distribution of fragments meteorite Košice



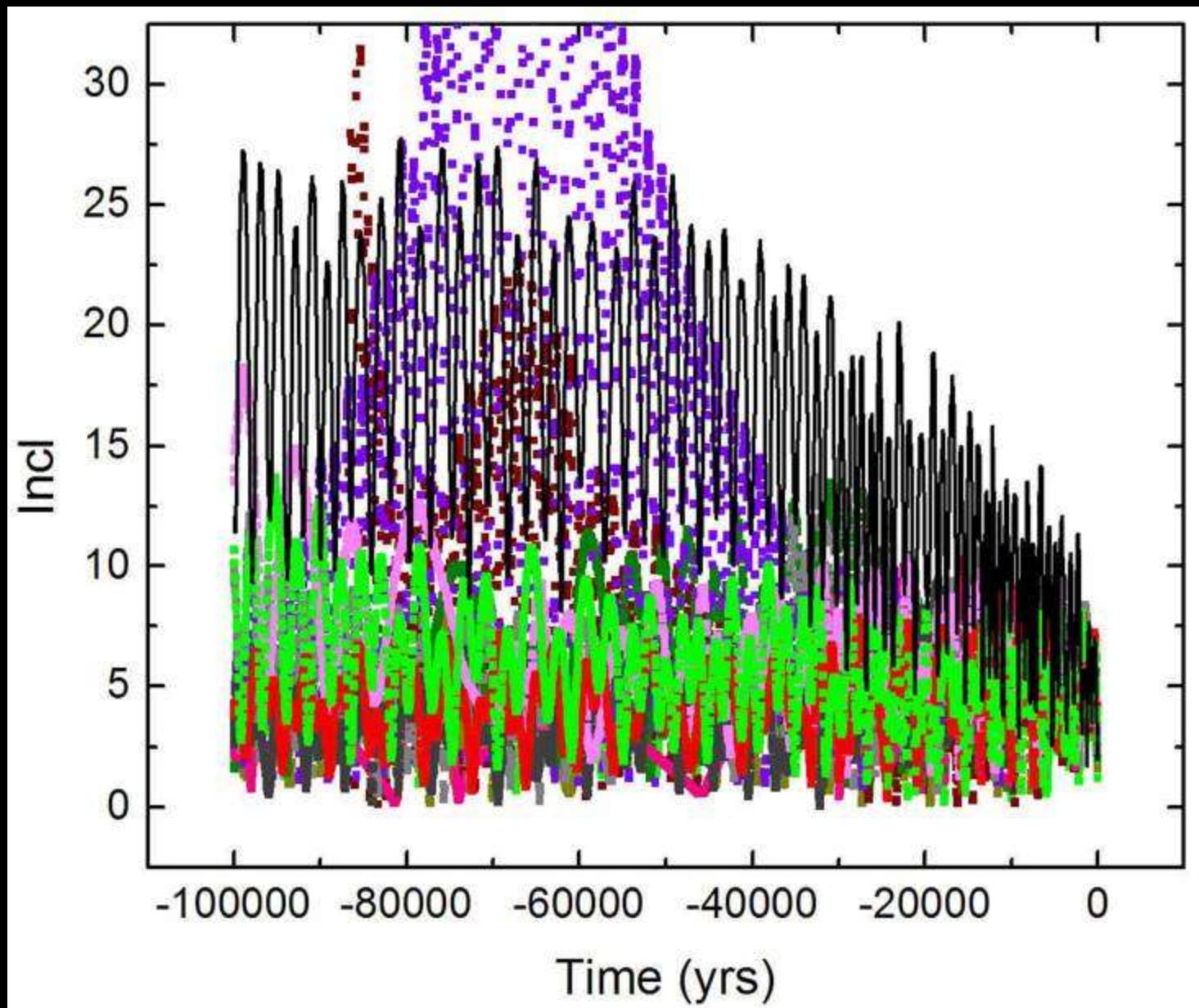
# Orbital evolution of 25 clones of Košice meteorite



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# **Legislation about meteorites findings and maintenance in Slovakia**

- **The law No. 287/1994 about natural minerals and fossils  
and particular regulation of the Ministry of the Environment  
No 213/2000 where are explicitly mentioned meteorites.  
The recovering and maintenance/care is reserved only to state  
and academic institutions of Slovak Republic.**