

## Introduction

Scientific concepts in Planetary Science are in large part based on theories and models. These theories are changing with new observations or models that describe reality better than previous ones. System of major theories – called paradigms [1] – are changing when new observations and better models made majority of scientists abandon an earlier system of theories. This event is called a paradigm shift.

Such systems of theory also exist in the minds of everyone. Concepts of a phenomenon – meteorites, for example – are different in the mind of a 5-year old child and a grown-up. During someone's education, "paradigm shifts" occur concerning these concepts, but these systems are not as coherent as scientific paradigms and not always fit the current scientific frames. Such change of cognitive schemes were first described by Piaget [2].

Mapping these mental concepts from kindergarten to university level reveal (1) the change in personal (more or less coherent) explanations of things (mostly in childhood), the effect of education: (2) in one part, the material the student memorized and the extent of distortion of the memorized curriculum; and (3) the impact of popular media: press, movies, books etc. From these three sources sometimes conflicting theories can be found in the concepts of students, one often not being able to erase or overwrite the other. Materials learned through formal education often results in passive knowledge that can not be used for solving real, practical problems or linking the memorized material to scenes seen at the cinema.

In formal education and also in scientific outreach – including press releases – it is essential to know the prior knowledge, concepts and misconceptions of the potential reader (in schools: student). Without having a picture of these, educational and outreach materials may be not effective.

The research of the conceptual framework (including preinstructional and informal knowledge) and misconceptions has a rich literature. Several research was made about the mental concepts and naive models of the Earth, Sun, Moon and the Day/Night cycle [3, 4, 5, 6].

## Mapping concepts and misconceptions about meteorites

Large part of previous research concentrated on the ages of 3 to 12 years. The research presented here has the goal to map concepts and misconceptions from 3 to 23 years, from kindergarten to university level. The research was conducted in Budapest and Piliscsaba (the capital of Hungary and a small town 30 km North of Budapest).

In the research knowledge about meteorites was mapped. Since meteorites are part of the popular culture, children from very early age has a concept

about them. This concept is well grounded from an early age and is refined with new elements during the years of education (a good example to this refinement is the knowledge of the building material of meteorites). However, in a later stage new misconceptions may come in.

## Questions

In the research we used informal discussion in kindergarten (audio recorded and typed later) and questionnaires for older students. For the older students, new questions were added.

The basic questions were the followings:

- What is a meteorite?
- What are meteorites made of?
- What is the size of meteorites?
- Where can you find meteorites?
- What happens when a meteorite reaches the surface of the Earth?
- What is the difference between meteorites and meteors?
- What is the relation of falling stars and meteorites?
- Which are the best known meteorites?
- What is the goal of the scientific research on meteorites?
- Draw the timeline of the life a meteorite.

## Results

Some results from the research:

- children from a very early age have a general concept of what a meteorite is
  - at high school level even the difference of meteorites and meteors are clear to some of the students
  - there are clear age categories when a new information is built into the knowledge of meteorites
  - in several cases the answers reveal basic contradictions
  - the word "meteorite" can refer to asteroids, comets, meteoroids, meteors, meteorites or "transient" planetary bodies (Fig.1.) or even craters to many students
  - There is a confusion about where one can find a meteorite: in space or on Earth
  - At kindergarten level, falling stars and meteorites are clearly two separate phenomena. For some 15-16 years old, these two are "similar", to other 15-16 years old they have "no connection".
  - The extinction of dinosaurs are usually not linked to meteorites or and impact event at kindergarten; but they have other explanations.
  - Several students related the goal of meteorite research to avoiding large impact to Earth.
- The last result is not surprising, since the goal of real scientists of a particular field of study is often

poorly known by students, even at university level.

This and other results show the topics that should be explained or clarified and stressed in educational and outreach materials for the various ages. Visualization of such problems (like “the life of a meteorite”) is essential in this (Fig.1.).

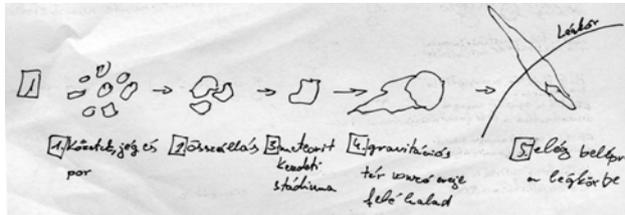


Fig 1. Life of a meteorite, drawn by a 16-year old student: explanations: “1: stone, ice and dust. 2: aggregation 3: early phase of a meteorite 4: it is moving towards the force of the gravitational field 5: it burns in the atmosphere”

### Conclusion

The mental concept of meteorites is being mapped from kindergarten to university level. Several misconceptions and conflicting concepts have been found. The research reveals topics that should be clarified or that should have more emphasis in educational or outreach materials from elementary to university level. One of the most interesting result is about the goal of meteorite research in general: students have a poor understanding about what meteorite researchers are doing.

### References:

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