THE METEORITE FLUX TO EARTH THROUGH THE PHANEROZOIC EON - THE FIRST RESULTS

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Introduction: Relict spinel grains (~25–250 μm in diameter) from decomposed extraterrestrial material in ancient sediments can be used to reconstruct variations in the flux of different types of meteorites to Earth through the ages [1]. Meteorite falls are rare and meteorites weather and decay rapidly on the Earth surface, making it a challenge to reconstruct ancient fluxes. Almost all meteorite types, however, contain a small fraction of spinel minerals that survive weathering and can be recovered by acid-dissolution of large samples (100–1000 kg) of slowly deposited sediments of any age. The spinel grains can give detailed information on the types of extraterrestrial matter that fell on Earth at specific times in the past. Our Astrogeobiology Laboratory is constructed for the routine acid dissolution of up to five tons of sediment per year. Preliminary results on ancient meteorite fluxes are now available based on samples from the following periods: early and middle Ordovician, late Devonian, middle and late Jurassic, early Cretaceous, and the earliest Cenozoic.

Methods: Samples of 300 to 800 kg of pelagic limestone for each geological period studied have been collected in the field and brought to the laboratory. The samples are placed in large plastic barrels and HCl is added by an automatic process. For a 200 kg-sized sample 400 liters of HCl is added. The clay residue remaining after HCl-treatment is sieved and the fraction >32 μm is then dissolved in HF. The final residues are searched under the optical microscope for transparent and opaque spinel grains. Identification of the extraterrestrial spinels is made based on chemical composition, and by using a calibrated SEM-EDS instrument for the analyses.

Results and Implications: Because of the absence of any data with which our results can be compared interpretations will be preliminary until a better overview of changes in the spinel flux is acquired. Some generalizations, however, may already be made. For example, ordinary chondrites have been a common constituent of the meteorite flux to Earth throughout the past 500 Ma, but the ratios between the different groups appear to have changed much with time. Sometimes the flux is dominated by L chondrites, at other times LL or H chondrites. During periods without any major breakup events in the asteroid belt the flux of meteoritic matter is low and the ratios between spinel grains from the different ordinary chondrites appear to change at a high rate, about every 100 ka to 1000 ka. In the Ordovician period prior to the breakup of the L-chondrite parent body, LL and H chondrites appear to dominate, but we find also many spinels from other unidentified meteorite types. Oxygen and chromium isotopes will determine the origin of these spinels. A major enigma is that so far we have not found any MgAl-spinels from carbonaceous chondrites, despite such micrometeorites being very common today. The distribution of extraterrestrial spinels in sediments represents a global signal. Changes in the ratios between different types of spinels can be used in stratigraphy and for linking the histories of Earth's biosphere, tectonics and climate etc. to events in the asteroid belt.

Reference: [1] Schmitz B. 2013. *Chemie der Erde* 73:117-145.