# FRAGMENTS OF LATE EOCENE EARTH-IMPACTING ASTEROIDS LINKED TO DISTURBANCE OF ASTEROID BELT

B. Schmitz[1,2,3], S. Boschi[1], A. Cronholm[1], P.R. Heck[2,4], S. Monechi[5], A. Montanari[6], F. Terfelt[1]. [1]Astrogeobiology Laboratory, Dept. of Physics, Lund Univ., Sweden. E-mail: birger.schmitz@nuclear.lu.se, [2]The Field Museum of Natural History, Chicago, USA. [3]Hawai'i Inst. of Geophysics and Planetology, Univ. of Hawai'i at Manoa, USA. [4]Chicago Center for Cosmochemistry, Univ. of Chicago, USA. [5]Dept. of Earth Sciences, Florence Univ., Italy. [6]Geological Observatory of Coldigioco, Frontale di Apiro, Macerata, Italy

The onset of Earth's present icehouse climate in the Late Eocene coincides with astronomical events of enigmatic causation. At ~36 Ma ago the 90-100 km large Popigai and Chesapeake Bay impact structures formed within ~10-20 ka [1]. Enrichments of $^{3}He$ in coeval sediments also indicate high fluxes of inter-planetary dust to Earth for ~2 Ma [2]. Additionally, several medium-sized impact structures are known from the Late Eocene. Here we report from sediments in Italy the presence of abundant ordinary chondritic chromite grains (63-250 μm) associated with the ejecta from the Popigai impactor. The grains occur in the ~40 cm interval immediately above the ejecta layer. Element analyses show that grains in the lower half of this interval have an apparent H-chondritic composition, whereas grains in the upper half are of L-chondritic origin. The grains most likely originate from the regoliths of the Popigai and the Chesapeake Bay impactors, respectively. These asteroids may have approached Earth at comparatively low speeds, and regolith was shed off from their surfaces after they passed the Roche limit. The regolith grains then settled on Earth some 100 to 1000 years after the respective impacts. Further neon and oxygen isotopic analyses of the grains can be used to test this hypothesis [3].

If the Popigai and Chesapeake Bay impactors represent two different types of asteroids one can rule out previous explanations of the Late Eocene extraterrestrial signatures invoking an asteroid shower from a single parent-body breakup [4,5]. Instead a multi-type asteroid shower may have been triggered by changes of planetary orbital elements. This could have happened due to transitions in motions of the inner planets or through the interplay of chaos between the outer and inner planets. Asteroids in a region of the asteroid belt where many ordinary chondritic bodies reside, were rapidly perturbed into orbital resonances. This led to an increase in small to medium-sized collisional breakup events over a 2-5 Ma period. Independent evidence for our scenario are the common cosmic-ray exposure ages in the range of ca. 33-40 Ma for recently fallen H and L chondrites.

The temporal coincidence of gravity disturbances in the asteroid belt with the termination of ice-free conditions on Earth after 250 Ma is compelling. We speculate that this coincidence and a general correlation during the past 2 Ga between K-Ar breakup ages of parent bodies of the ordinary chondrites and ice ages on Earth suggest that there may exist an astronomical process that disturbs both regions of the inner asteroid belt and Earth's orbit with a potential impact on Earth's climate [3].

**References:** [1] Koeberl C. 2009. *Geological Society of America Special Paper* 452:17-26. [2] Farley K. A. et al. 1998. *Science* 280:1250-1253. [3] Schmitz B. 2013. *Chemie der Erde* 73:117-145. [4] Tagle R. and Claeys, P., 2004. *Science* 305:492. [5] Kyte F.T. et al. 2011. *Earth and Planetary Science Letters* 302:279-286.