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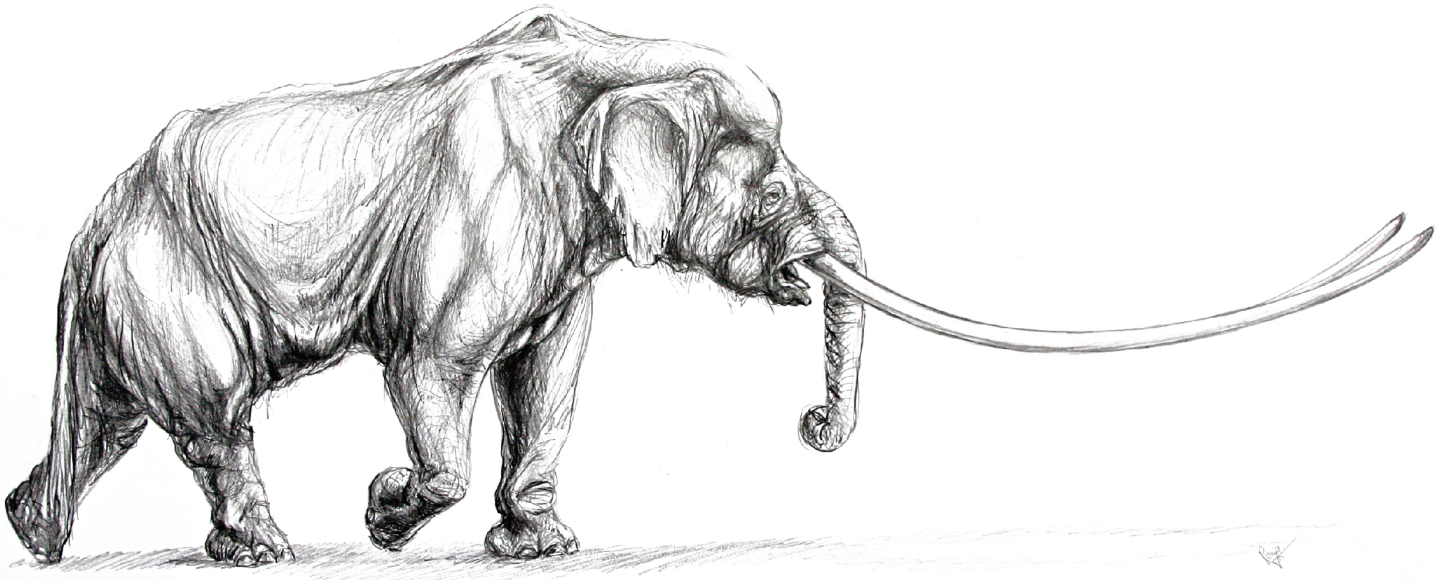

VI[th] International Conference on Mammoths and their Relatives

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# ABSTRACT BOOK

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# Stratigraphical interpretation of rare earth element signatures in fossil bones from the Pleistocene fauna site Kharabai, Central Yakutia

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Most palaeontological remains are found in disturbed sedimentary contexts where bones and teeth may be secondarily mixed from a number of primary burial sources. Post-depositional movement and reworking of bone increases the spatial and temporal averaging of any bone accumulation and causes significant problems for the interpretation of palaeontological sites. In most palaeontological situations no method exists to date bone remains directly, and no alternative methods to assess the relative age of bone remains. Many studies reported already the use of REE (Rare Earth Elements) in fossil biogenic apatite as taphonomic and palaeoenvironmental tracers and as the "fingerprints" for testing stratigraphic provenance and the stratigraphic integrity of a site (Trueman et al., 2006; Suarez et al., 2010 and references therein). Fossil bone REE concentrations and patterns, thus, reflect pore-water chemistries specific to different depositional and burial environments.

Results of our studies of bone remains from different paleontological sites of Eastern and Central Yakutia (Ivanova, Nikolskiy, 2005, 2007; Ivanova, Nikolskiy, Basilyan, 2011; Ivanova, 2012) allow to propose an additional feature in the distribution patterns of the REEs - the tetrad effect - as criteria of the stratigrafic provenance. This effect can cause a split of chondrite-normalized REE patterns into four rounded segments called tetrads (first tetrad, La-Ce-Pr-Nd; second tetrad, (Pm)-Sm-Eu-Gd; third tetrad, Gd-Tb-Dy-Ho; fourth tetrad, Er-Tm-Yb-Lu). The rounded segments are either convex or concave and form M-shaped and W-shaped lanthanide distribution patterns, respectively (Masuda et al., 1987).

This work presents the results of studying rare earth element (REE) fractionation trends in Quaternary mammal bones for testing stratigraphic provenance. The field works were carried out at the Pleistocene fauna site Kharabai

Fig. 1. Teeth of the Pleistocene elephants *Archidiskodon trogontherii trogontherii* (bottom two samples) and the tooth of a woolly mammoth with very thin enamel (*Mammuthus primigenius*, top), found at Kharabali site (Yakutia).

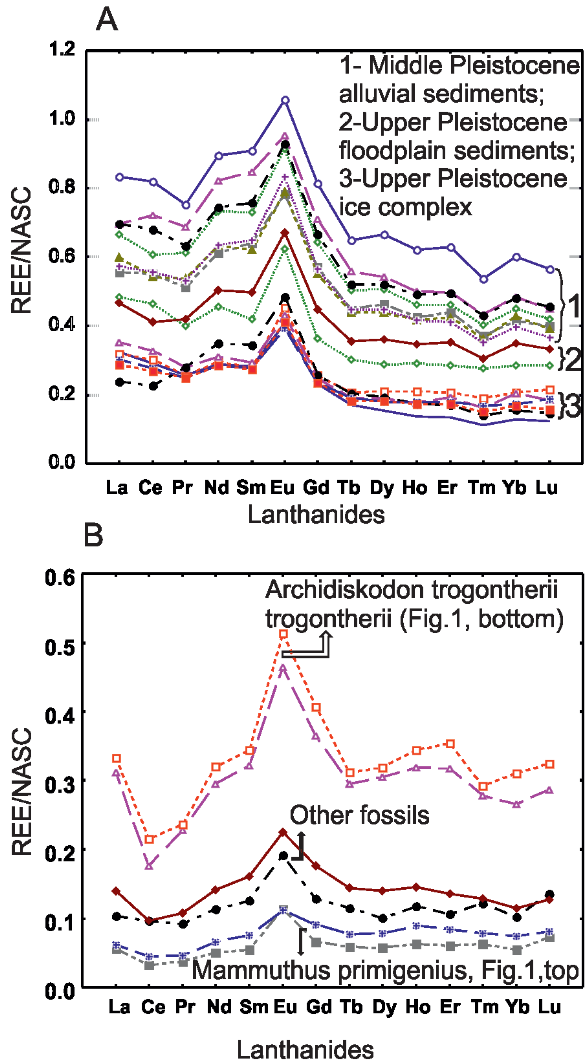


Fig. 2. NASC-normalized REE signatures in sediments from individual stratigraphic units (A) and fossil bones (B).

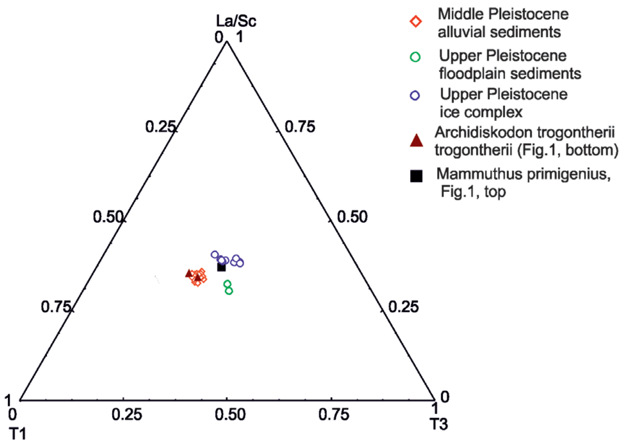


Fig. 3. Ternary diagram T1 (tetrad effect for La-Ce-Pr-Nd)-T3 (tetrad effect for Gd-Tb-Dy-Ho)- La/Sc (sediment composition) indicates the REE fractionation in bones and sediments.

(63.77 ° N, 121.10 ° E, lower reaches of the Vilyuy river, 20 km upstream Viljujsk, Central Yakutia , East Siberia) . The Kharabai outcrop is famous because there in the 1950s, a tooth of the Lower-Pleistocene mammoth-like elephant Archidiskodon trogontherii was found for the first time in East Siberia.

At this site in coastal cliffs Cretaceous and Quaternary sediments are exposed, which differ in lithology, the composition of fauna and flora and cryolithological features: (upward) Upper Cretaceous tephra, layer of the end of the Middle Pleistocene alluvial sediments, floodplain sediments of the beginning of the Upper Pleistocene age, upper Pleistocene ice complex in which alas complexes are embedded (Alekseev et al, 1978).

The Middle Pleistocene age of the basal alluvium is defined by the presence of *Archidiskodon trogontherii* and *Cervalces latifrons* remains (Alekseev 1978). Floodplain sediments and ice complex are dated by a mammoth fauna assemblage with Radiocarbone dates about 40 ka (Alekseev 1978).

To investigate REE composition the REE concentration was determined (ICP MS) in 42 bones of Pleistocene mammals (42 samples related to 7 species) and in sediments collected at Kharabai site. Some mammal remains are important for biostratigraphy, such as the mammoth-like form with thick enamel close to the standard form *Archidiskodon trogontherii trogontherii* (Fig. 1, 2 bottom pieces) and the woolly mammoths with very thin enamel *Mammuthus primigenius* (Fig. 1, top). These remains were found on the beach and it is important to assign it to the correct depositional unit.

-All investigated samples, such as rocks or bones-have a W-type tetrad effect.

-Bones and sediment layers can be correctly differentiated based on their trace element content.

-REE signatures are distinguished from each stratigraphic unit; therefore, fossils eroded from their stratigraphic context may be assigned to their proper depositional unit based on REE signature comparisons.

Results of REE analyses of fossil bones show that REE signatures of fossils and sediments are similar. Fig. 2 shows REE signatures (NASC normalized concentration vs. atomic number). These REE signatures are light rare earth (LREE) enriched with small negative cerium anomalies and strong negative europium anomalies. However, sediments from different stratigraphic unit yield different REE content. REE signatures in bones from the studied units vary from strong (LREE) and middle REE (MREE) enriched in the Middle Pleistocene alluvial sediments, to low (LREE) and middle REE (MREE) enriched in the Upper Pleistocene ice complex. REE signatures in fossils are generally similar in HREE content to surrounding sediments.

The ternary diagram (Fig.3) T1 (tetrad effect for La-Ce-Pr-Nd)-T3 (tetrad effect for Gd-Tb-Dy-Ho)- La/Sc (sediment composition) indicates that REE data shows accurate isolation of bone remains: assigned to the Middle Pleistocene alluvial sediments; assigned to upper Pleistocene ice complex. Stratigraphically, the REE spectrum becomes enriched by light REEs. Within the set of aleurite samples the tendency to enrichment with heavy REEs is observed. This trend can be caused by adsorption of light REEs by colloidal particles, or mixing of various types of soil and surface water.

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