Stratigraphic assignment of eolian sediments in the Central Gobi Desert, Mongolia using an indicator of defect centers in quartz composed of sand particles

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The Upper Cretaceous eolian sediments in the Mongolia's Gobi Desert yield a large number of dinosaur fossils with good preservation, well known as one of most-important dinosaur localities in the world. Furthermore, vertebrate fossils have been extensively found from the Djadokhta Formation in these areas, where any of tephra and micro-fossils for a key of geochronological examination has not been confirmed so far. Therefore, a stratigraphic assignment of the eolian sediments should be indispensable in advancing paleontological investigations on the evolution of the dinosaurs by comparison with those reported elsewhere in the world as well as geological study in these areas. The present study focuses on the variation in cathodoluminescence (CL) features obtained from quartz grains. CL can precisely specify various kinds of defect centers in quartz undetectable by other methods, whereas mineralogical properties of quartz are characterized by an absence of variation. In the study, we have conducted to clarify the CL prosperities of quartz grains collected from the formation including four dinosaur-bearing localities (Figure 1 and Figure 2) and the sand specimen attached with the fossils, which were confiscated articles due to illegally digging (Figure 3).

Quartz grains with 180-250 μm after a sieving preparation were used for CL measurements. CL spectra of the quartz grains were obtained by a SEM-CL system, which is comprised of an SEM combined with a grating monochromator. CL spectral

data were corrected for total instrumental response using a calibrated standard lamp. All samples exhibit two broad bands at 400 nm in a blue region and at 600-650 nm in a red region. The deconvoluted components by a Gaussian curve fitting can be assigned to the emission centers derived from structural defects related to trivalent Fe at 1.65 eV, NBOHC at 1.89 eV, tetravalent Ti at 2.75 eV and trivalent Al at 3.19 eV, which are concordant with the values reported by Steven-Kalceff (2009). Therefore, an integral intensity of each emission component was employed for as an indicator to characterize the eolian sediments in this area. A statistical examination using these indicators that most of quartz grains in eolian sediments are relocated in a same group of the layers, suggesting the formation with lithologically cognate rocks in similar processes of supply and sedimentation during a geological age (Figure 4).

Further application of CL spectral analysis employed here has been made to specify the provenance of illegally-collected fossils in the Gobi Desert using the quartz grains attached to the fossils. Babies nest of *Protoceratops* stored in the Institution of Paleontology and Geology, Academy of Mongolia can be possibly judged to occur in the area corresponding to the Djadokhta Formation from the result obtained by a discrimination function analysis. It demonstrates that this method is expected for the provenance study of the fossils as well as stratigraphic investigations. CL spectral analysis of quartz grains in the study will be promoted for the different dinosaur specimens and the eolian sediments assigned to the Upper Cretaceous in the Gobi Desert. Furthermore, an electron spin resonance (ESR) method will be applied for a cross comparison with a CL method, for which reason is a high sensitivity for unpaired electrons derived from Ti and Al defect centers in an ESR analysis.

References

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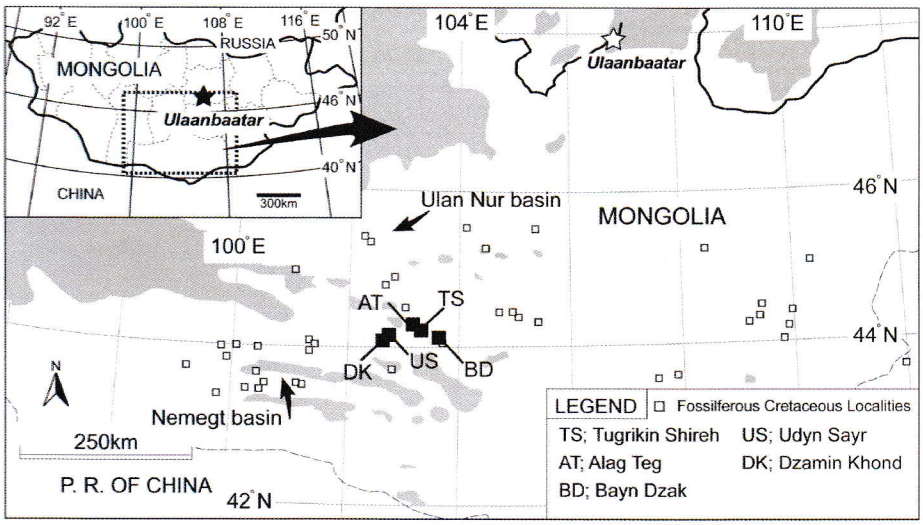

Figure 1. Locations of the dinosaur specimens in Central Gobi Desert (modified from Jerzykiewicz, 2000).

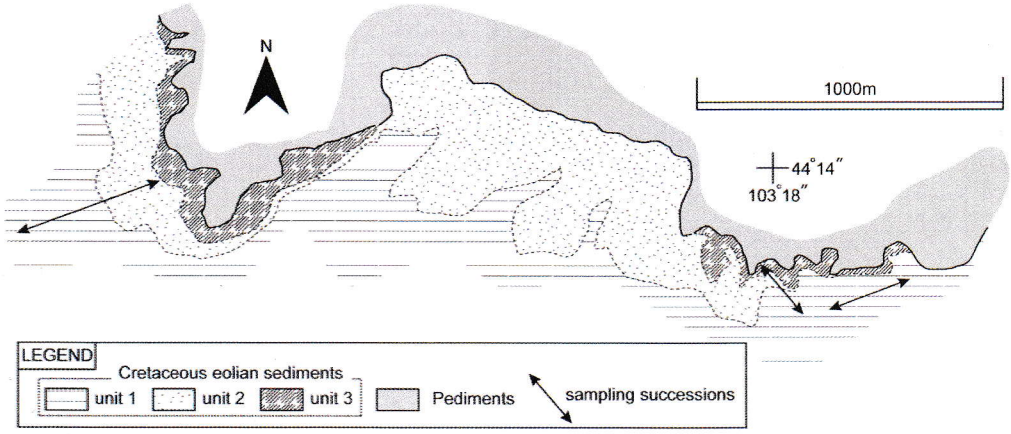

Figure 2. Sampling localities in the survey region at Tugrikin Shireh.

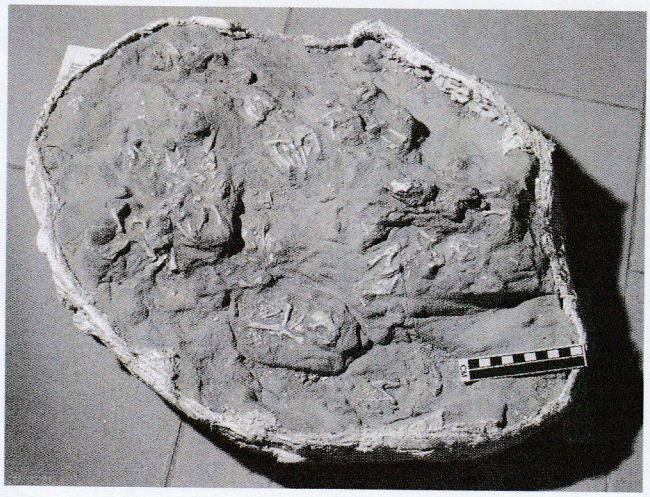

Figure 3. Illegally-collected dinosaur fossils stored by Institution of Paleontology and Geology, Mongolia.

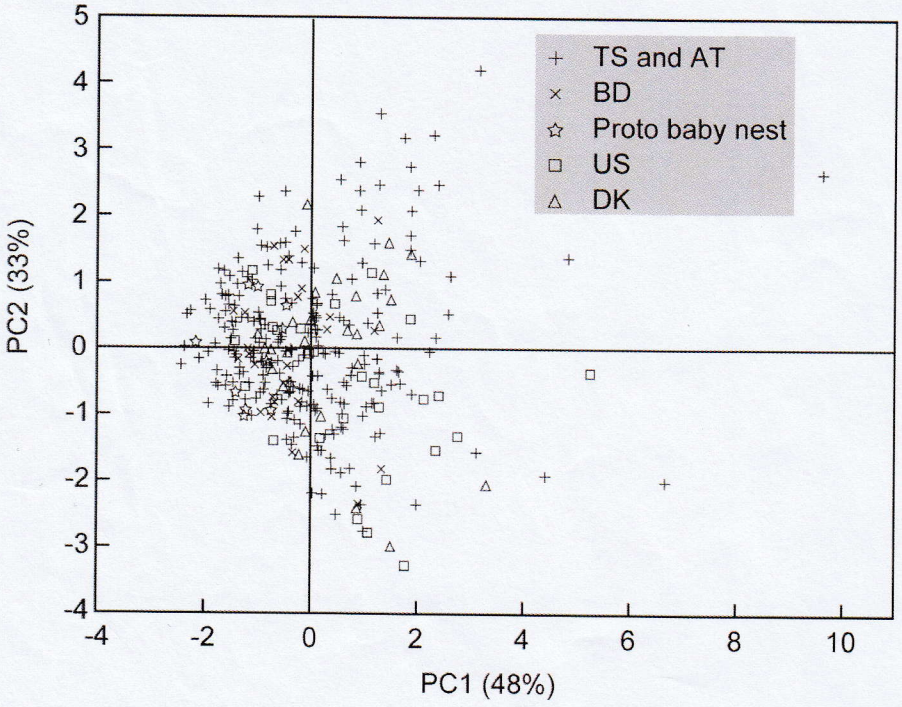

Figure 4. Result of principal component analysis for quartz from dinosaur-fossil localities (TS; Tugrikin Shireh, BD; Bayn Dzak, US; Udyn Sayr and DK; Dzamin Khond) and the sand attached with the dinosaur fossils in Figure 3.