Hydroclimatic fluctuation in Lake Yakhi, eastern Mongolia

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1. Introduction

This study aims to infer landscape evolution in the Lake Yakhi basin in eastern Mongolia (Fig. 1) based on geomorphological and geochemical estimations of changes in lake area, provenance, tectonic setting, source rock compositions and chemical weathering.

Late Pleistocene and Holocene lacustrine sedimentations in Mongolia have rarely been focused to date. For instance, except for paleofossils of plants in Lake Yakhi studied by Binderya (Khosbayar, 2005), lacustrine sedimentations in eastern Mongolia (Fig. 1) have never been studied in comparison with northern Mongolia (e.g., Prokopenko et al., 2007; Orkhonselenge et al., 2013), western Mongolia (e.g., Grunert et al., 2000; Sun et al., 2013), central Mongolia (e.g., Schwanhart et al., 2009; Davaagatan et al., 2014) and southern Mongolia (e.g., Komatsu et al., 2001; Lehmkuhl et al., 2018).

In eastern Mongolia, Lake Yakhi (Fig. 2) is one of challenging water resources influenced by global warming today. To date, the continuous temperature increase has rapidly reduced water resource of Lake Yakhi and forced to shrink over the past decades (Fig. 3).

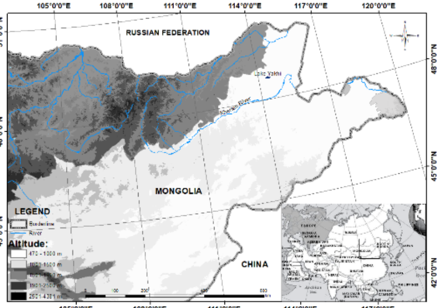

Fig 1. Geographical location of Lake Yakhi in eastern Mongolia.

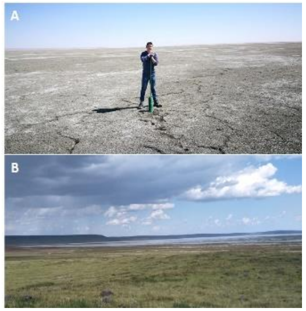

Fig 2. Exposed (A) and inundated (B) Lake Yakhi in 2018 and 2019. Photos by O. Bulgan on April 15th, 2018 (A) and August 25th, 2019 (B).

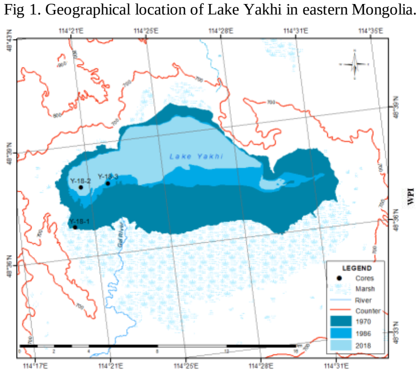

Fig 3. Changes in lake area of Lake Yakhi in 1970, 1986 and 2018.

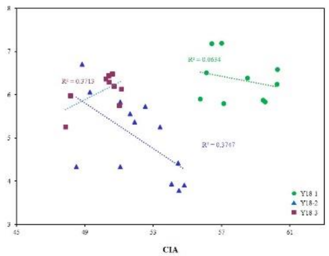

Fig 4. Chemical index of alteration (CIA) and Weathering potential index (WPI) of Lake Yakhi sediments.

2. Methods

During a fieldwork in Apr, 2018 core samples were collected from three sites (Fig. 2) at the exposed bottom of Lake Yakhi using reinforced sand augur (Fig. 3).

Major element compositions of the lacustrine sediments were analysed at the Division of Radionuclide Analysis, the Central Geological Laboratory in Mongolia using the Axios Max X-ray fluorescence (XRF) spectrophotometer. The major element oxides are presented in figures.

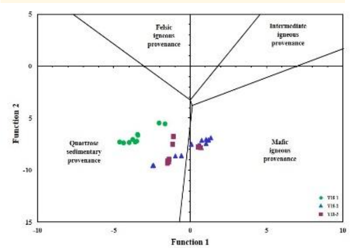

Fig 5. Discrimination plot of discriminant function 1 (F1) and 2 (F2) showing four main provenance groups: P1-mafic igneous, P2-intermediate igneous, P3-felsic igneous and P4-quartzose sedimentary.

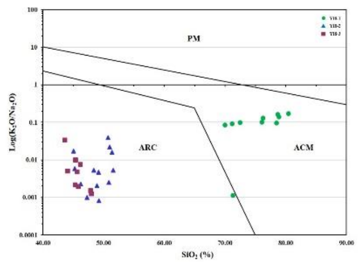

Fig 6. A plot of log [K_2O/Na_2O] *vs.* SiO_2 relations for Lake Yakhi sediments on the tectonic setting discrimination diagrams: Passive margin (PM), Active continental margin (ACM), Oceanic Island Arc (ARC).

3. Results and Discussion

For Lake Yakhi, the lake area reduced by 25.9 km^2 and 44.68 km^2 from 79.72 km^2 in 1970 to 53.76 km^2 in 1986 and 35.03 km^2 in 2018 (Fig. 2). The result from hydraulic dynamics and field observation show that Lake Yakhi is shifting into a playa lake (Fig. 3). CIA and WPI indicate more intensive weathering for the core Y18-1 in the marginal part than those cores Y18-2 and Y18-3 in the central part of Lake Yakhi (Fig. 4).

Discriminant function plots indicate the mafic igneous, and felsic igneous and quartzose sedimentary provenances derived from weathered granite and gneiss terrain and the pre-existing sedimentary terrain (Fig. 5). Tectonic setting diagram log [K_2O/Na_2O] *vs.* SiO_2 indicates oceanic island arc and active continental margin basins (Fig. 6). The A-CN-K (Al_2O_3-$CaO+Na_2O$-K_2O) ternary plot shows that the sediments were generated from the source rocks enriched in plagioclase and feldspar (Fig. 7). CIA values indicate a low degree of weathering (Fig. 7) suggesting that arid climatic conditions are reflected in the source area (Fig. 8).

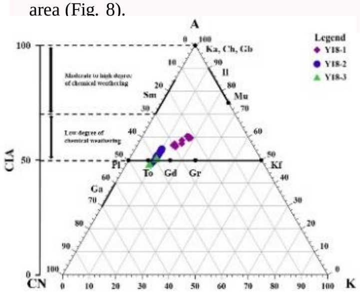

Fig 7. A-CN-K ternary diagram showing the weathering trend of the Lake Yakhi sediments

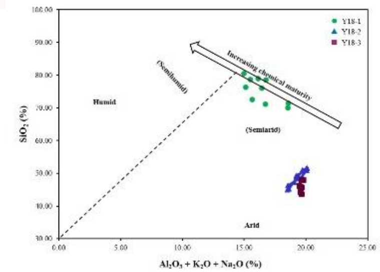

Fig 8. A chemical maturity plot of of SiO_2 *vs.* $Al_2O_3+K_2O+Na_2O$ for the Lake Yakhi sediments.

4. Conclusions

Playa lake development is strongly contributed by local climate change with the rising temperature since 1987 and the dropping precipitation since 1992. Further detail geomorphological and geochronological records from Lake Yakhi would review the paleoclimate changes in eastern Mongolia. Leading the dates would precisely determine the paleohydroclimatic fluctuations in eastern Mongolia.

Reference

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Orkhonselenge, A., Komatsu, G., Uuganzaya, M. 2018. Climate-driven changes in lake areas for the last half century in the Valley of Lakes, Govi region, southern Mongolia. Natural Science 10 (7), 263–277.

Acknowledgements

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