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Ph.D candidate

Education

KANAZAWA UNIVERSITY
2022-present **Ph.D candidate**

KANAZAWA UNIVERSITY
2020-2022 **Master**

Dissertation title: “Analyses of Tsagaan Lake Sediment, Valley of The Gobi Lakes, Mongolia, to Understand the Past Environmental Changes and the Effect of Ongoing Global Warming”

Supervisor: Noriko Hasebe, Professor, Institute of Nature and Environmental Technology, KU

NUM, Mongolia
2015-2019 **Bachelor**

Dissertation title: “Sediment characteristics of Olgoi lake, Khangain Mountain, Mongolia”

Supervisor: Davaadorj Davaasuren, Associated professor, School of Art and Sciences, NUM

Research interest

- Lake sediment
- Paleoclimate
- Sediment chronology
- Remote sensing

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Analysis of tsagaan lake sediment, valley of the gobi lakes, Mongolia, to determine past environmental changes and the effect of ongoing global warming

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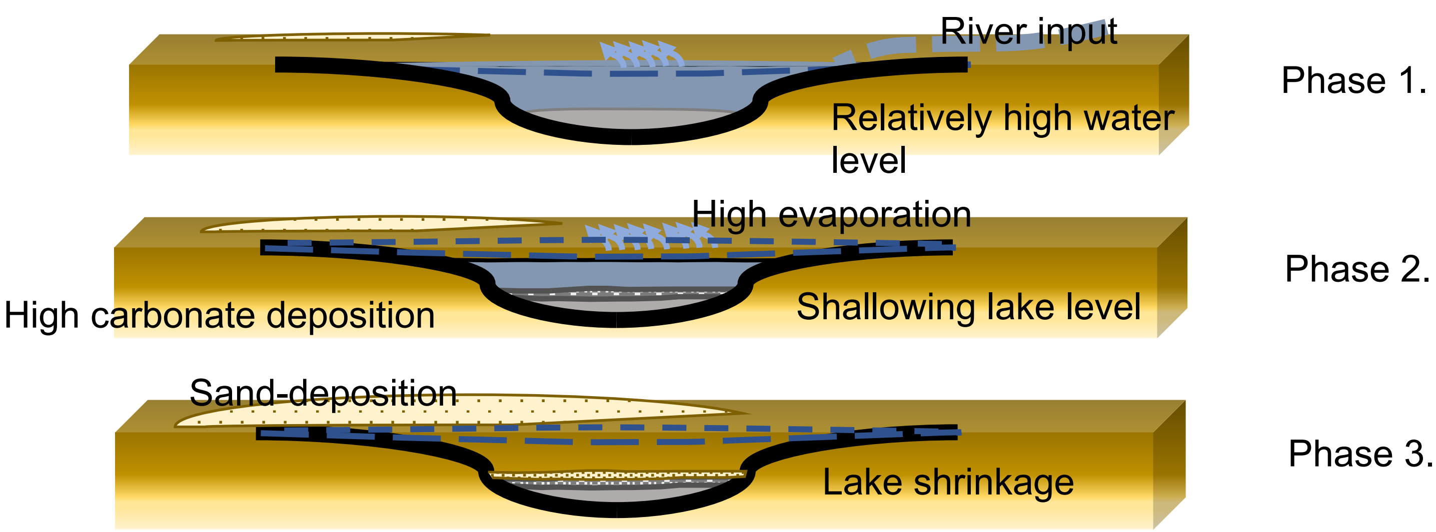

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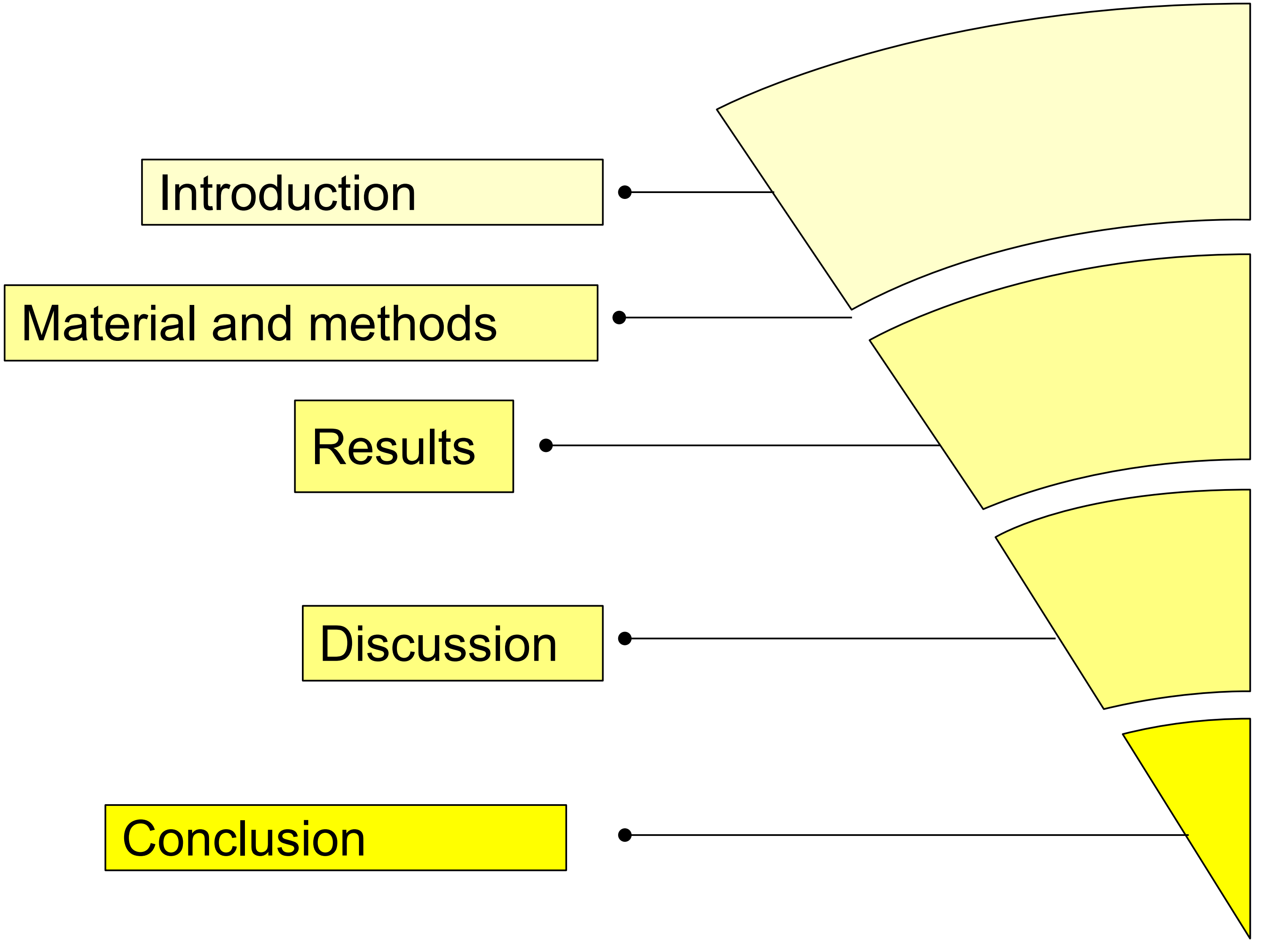
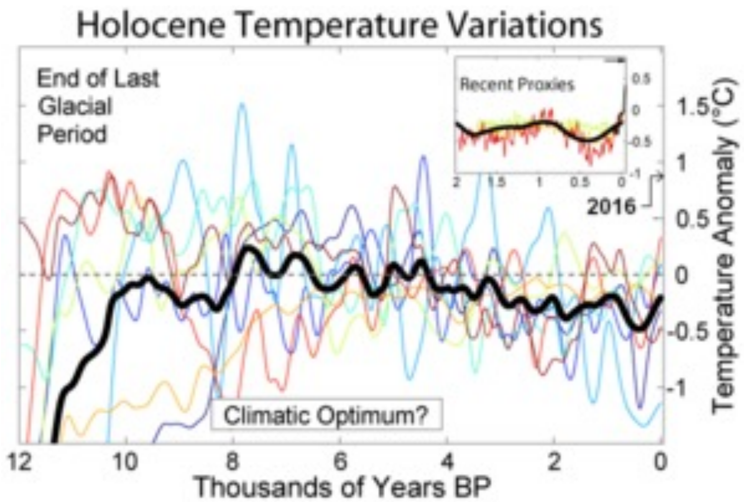

Introduction
Material and methods
Results
Discussion
Conclusion

Introduction:

Period	Marine Isotope Stage	Stage		Age (ka)
QUATERNARY	1	HOLOCENE		
				11.5
	2	DEVENSIAN = Weichselian	LATE	
		LGM		
				31
	3		MID	
				58
	4		EARLY	
				71
	5a			
				85
	5b			
				92
	5c			
				105
	5d			
				116
	5e	IPSWICHIAN = Eemian		

Late Quaternary chronostratigraphic stages and their correlation with Marine Isotope Stages (after Bradwell et al., 2008)



Temperature variations during the Holocene from a collection of different reconstructions

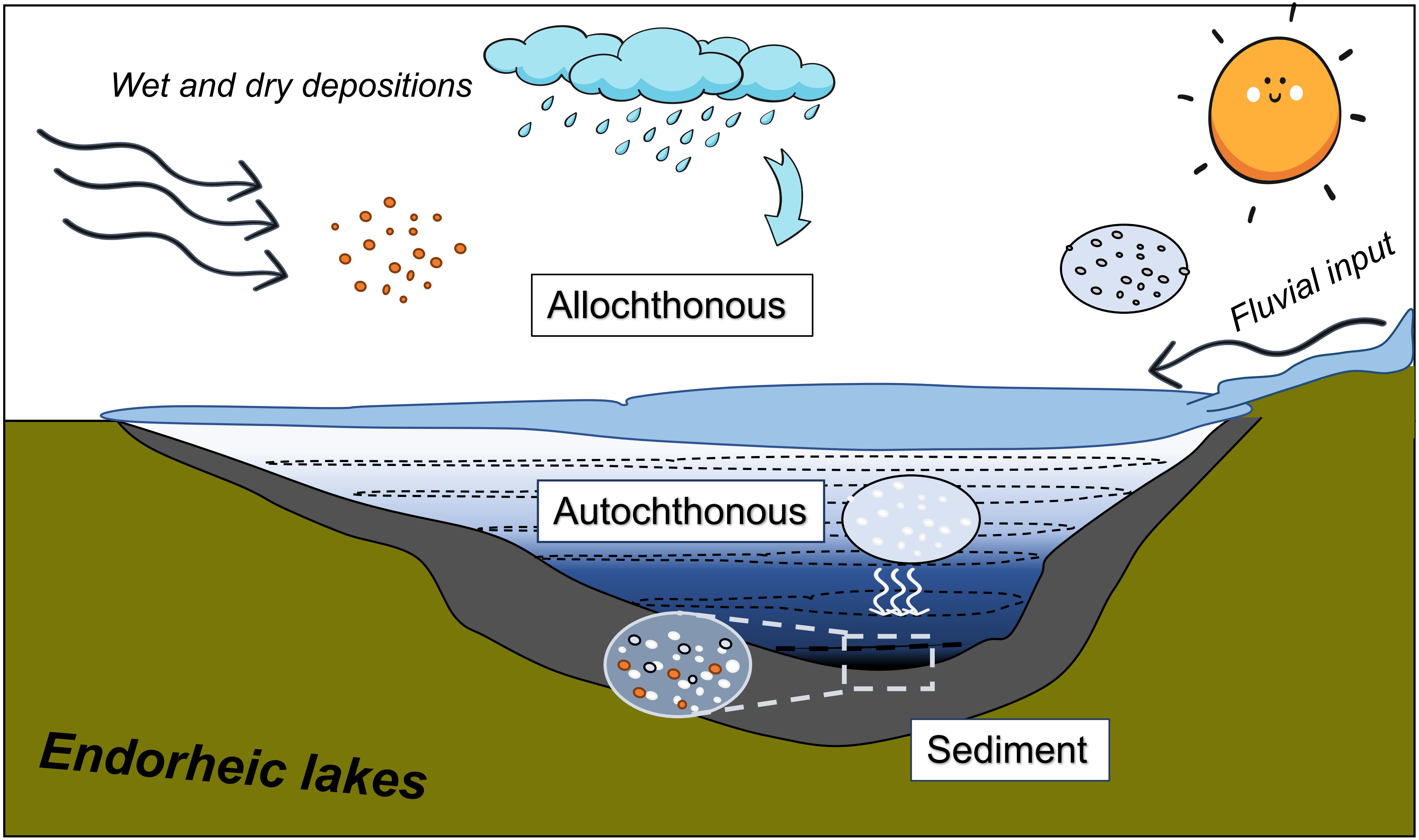
- Understanding of climate oscillations in the past plays an important role in the predicting further climate changes.

Introduction:

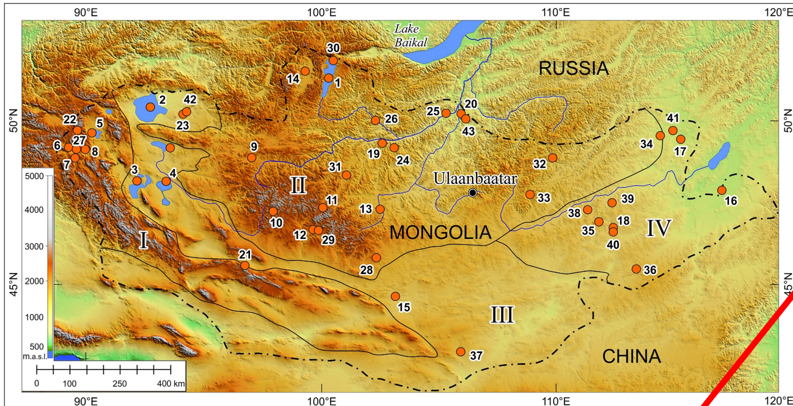
Natural archives

➢ Lake sediments can provide a great record of changes in hydrology and environmental conditions.

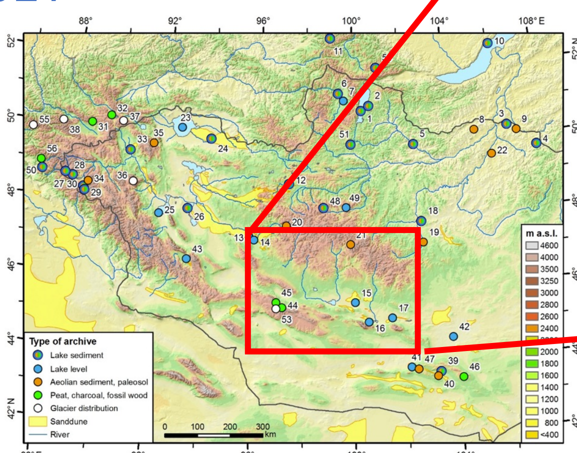
Introduction:



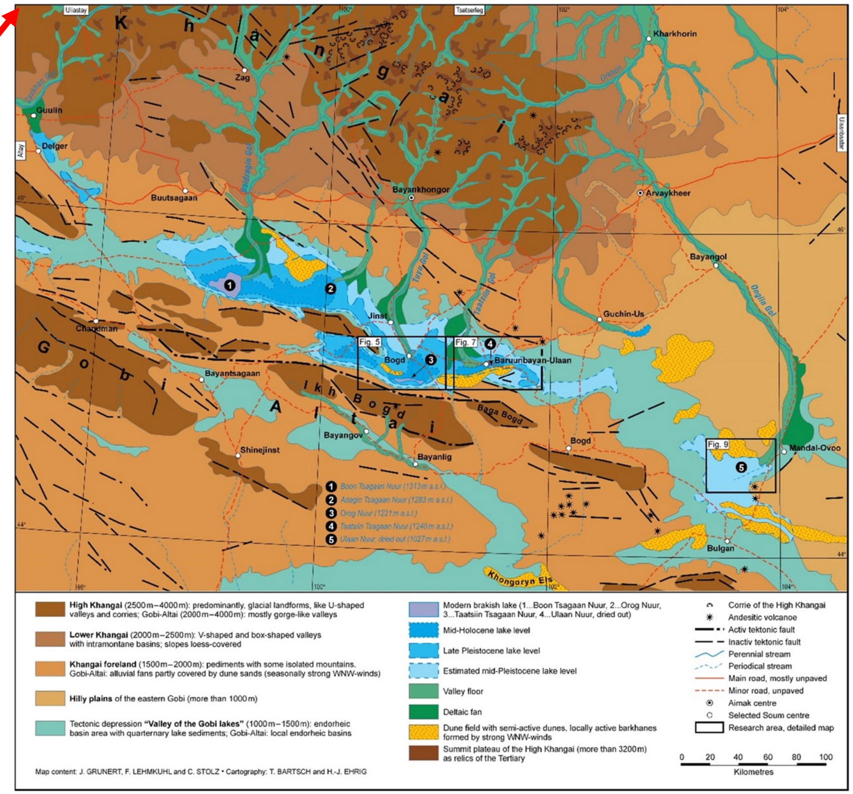
Introduction:



The location of key sections and archaeological sites, F. Khenzykhenova et al.,2021

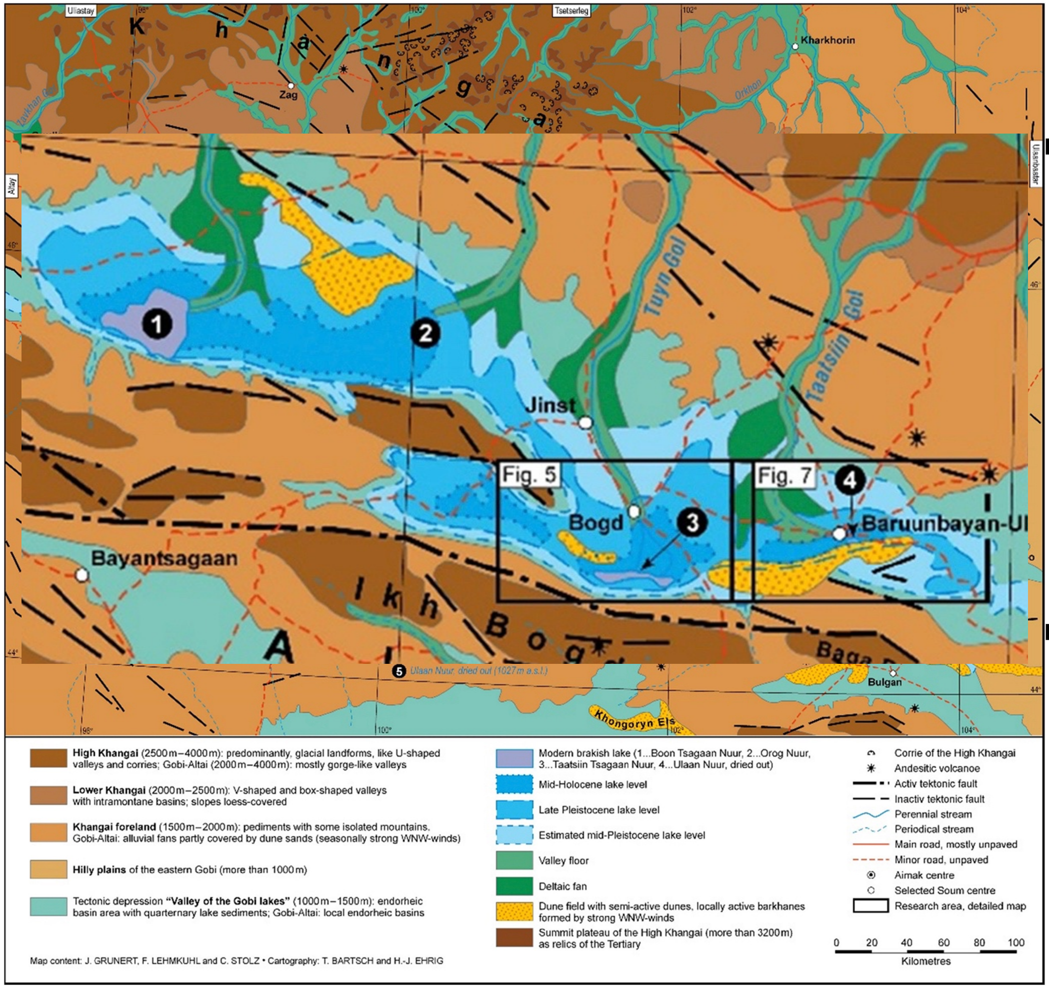


The location and types of the archives, M. Klinge et al., 2019



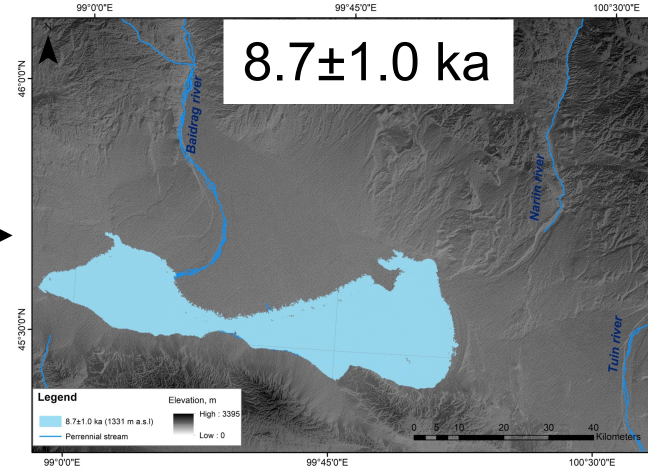
Geomorphological map of the "Valley of the Gobi Lakes", Lehmkuhl et al., 2017

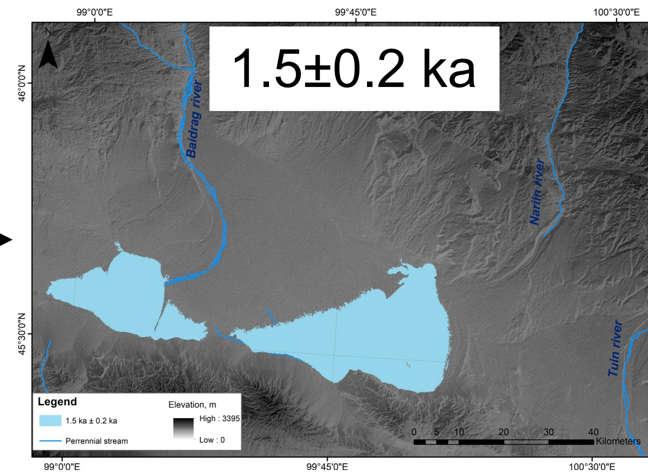
PALEOLAKE:

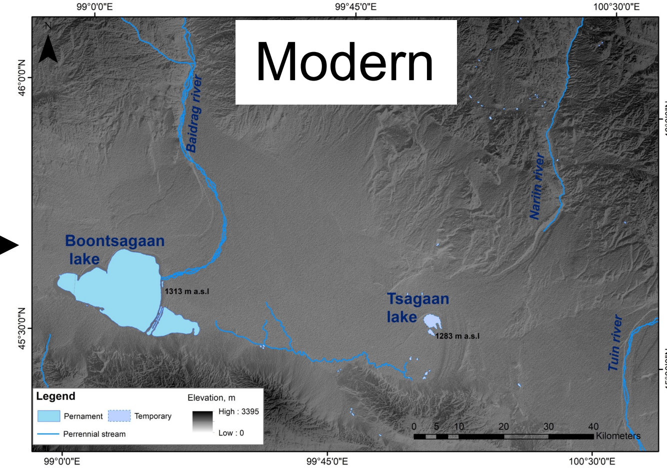


Lehmkuhl et al, 2017

The goal of this study is to conduct a reliable climate prediction based on the lacustrine sediment analysis



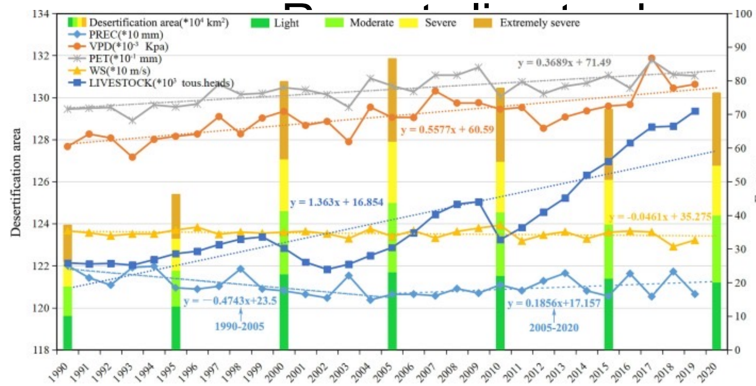




Introduction:

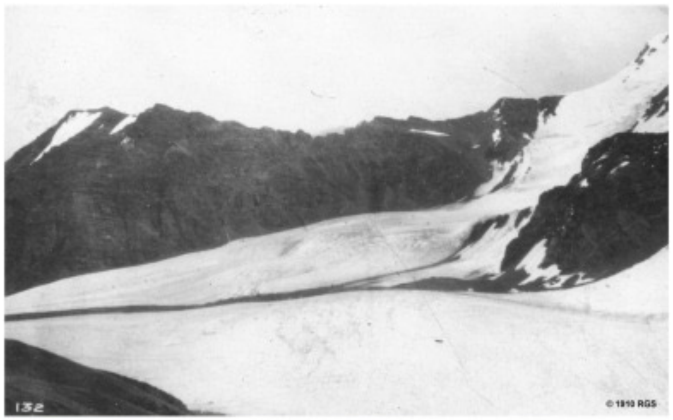
The arid regions of Mongolia

- **Desertification**



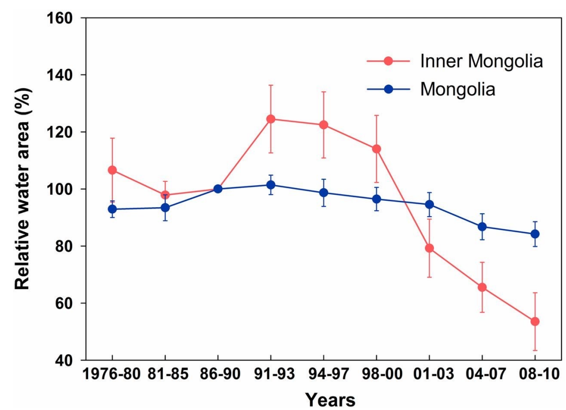
Variations in desertification area between 1990 and 2020, Meng et al., 2021

- **Degradation of permafrost**



The glaciers downwasted by 70 m, McManigal.,2011

- **Rapid loss of lake surface area**



Changes in relative water area in Mongolian plateau, Tao et al., 2015

Study area:

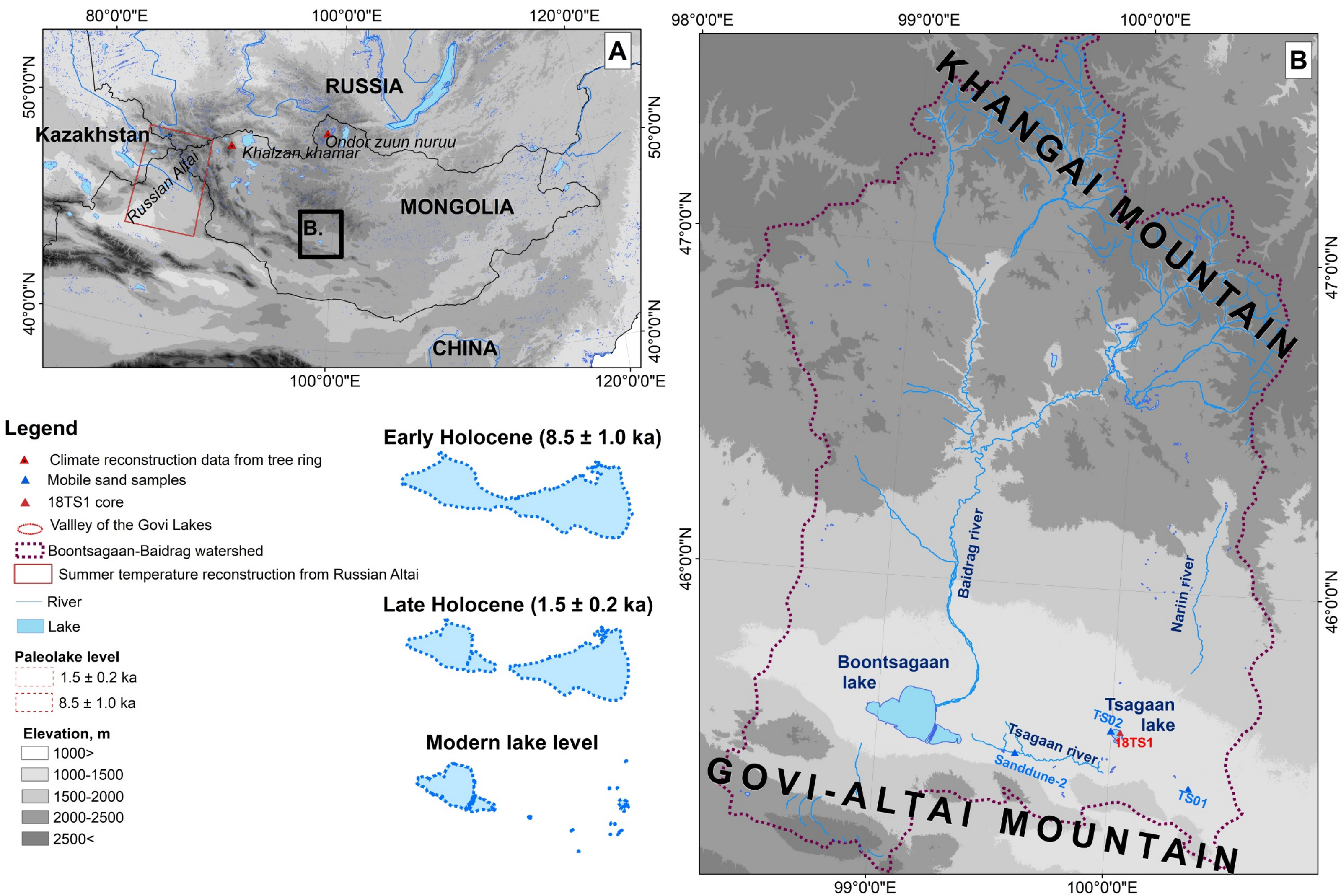
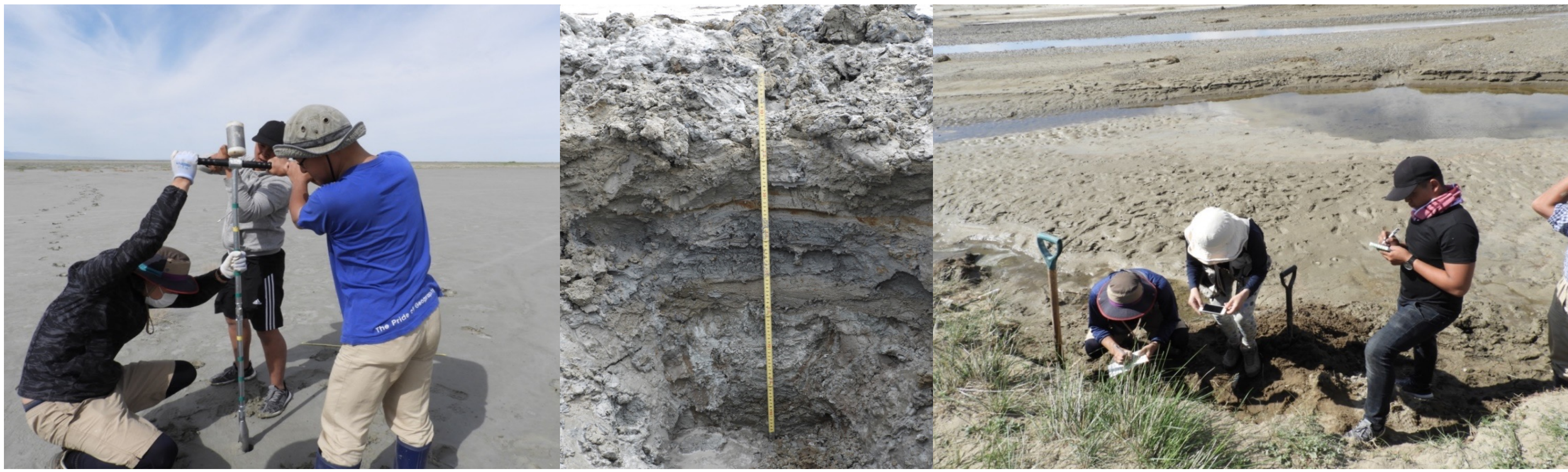


Fig. 1. Location of the Tsagaan lake in Valley of the Govi Lakes, Mongolia, A core (18TS-1) locality is indicated by red letters.

Material and method: Fieldwork

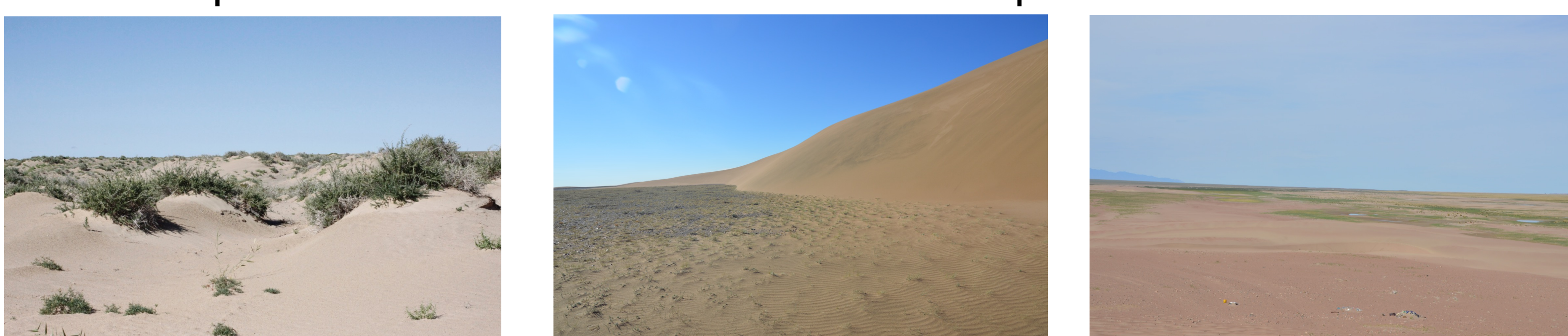
➢ **Russian peat corer (18TS1 – 137 cm depth)**



Fieldwork, 2018

➢ **Sand dune and sheet's elemental composition**

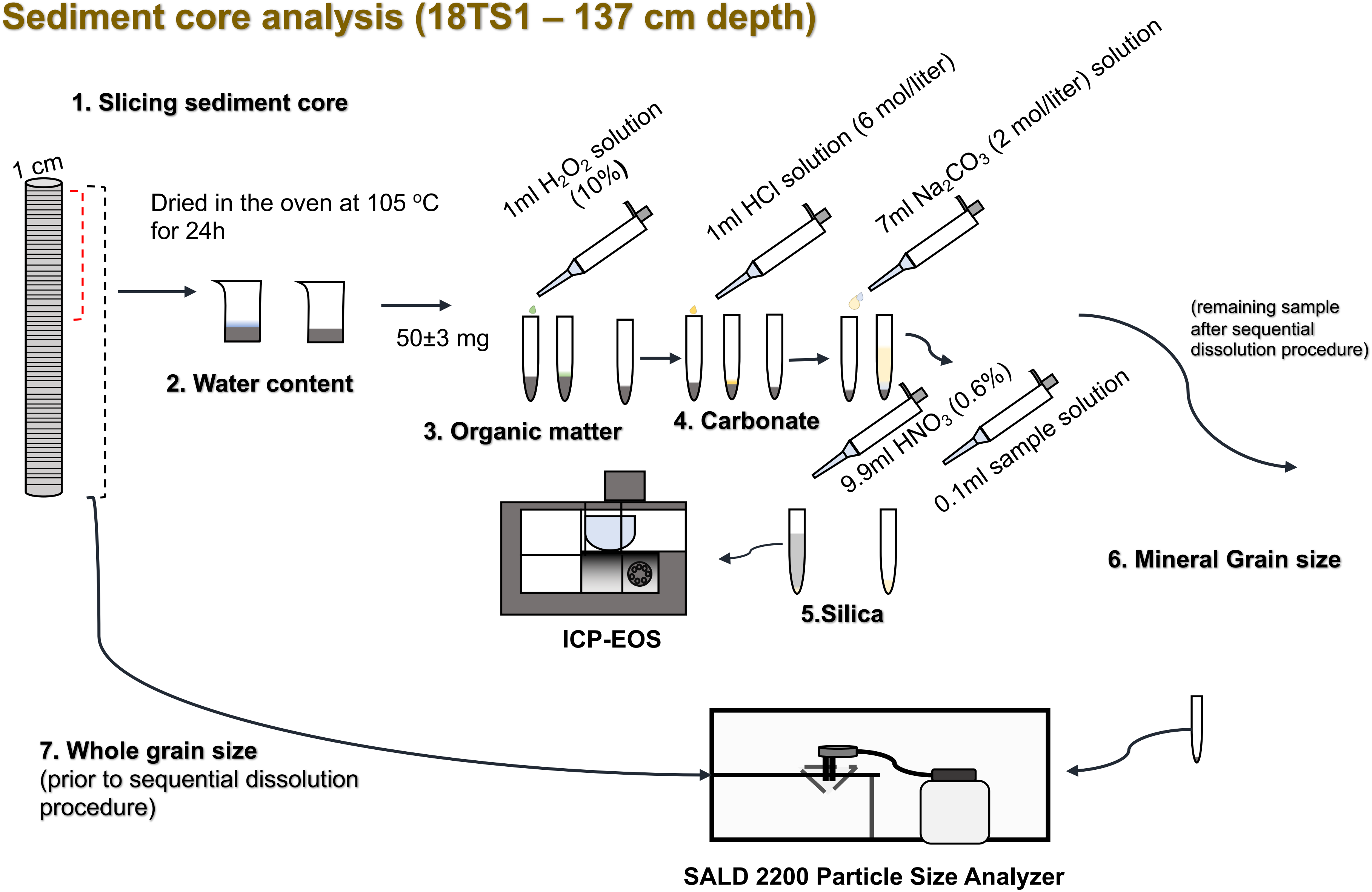
We collected samples of sand from three different sand profiles near the 18TS1 coring site



Fieldwork, 2021

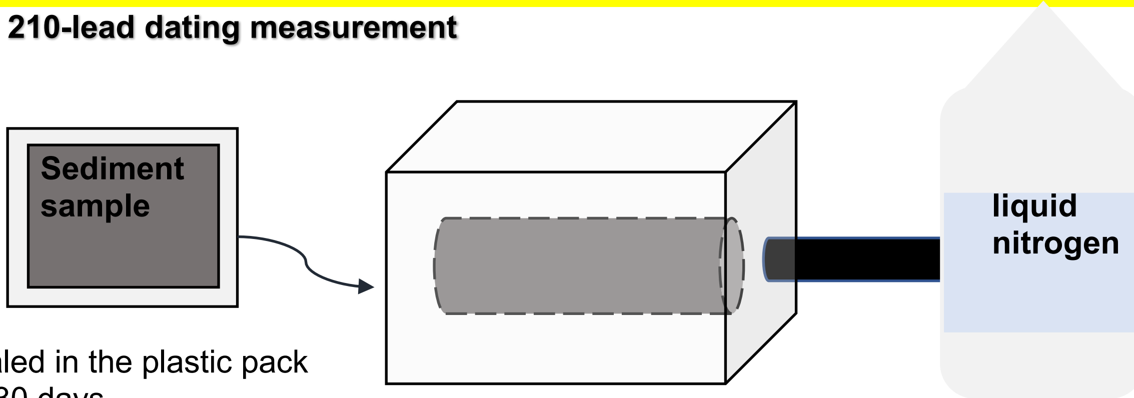
Material and method: Laboratory analysis

➢ Sediment core analysis (18TS1 – 137 cm depth)



Material and method: Laboratory analysis

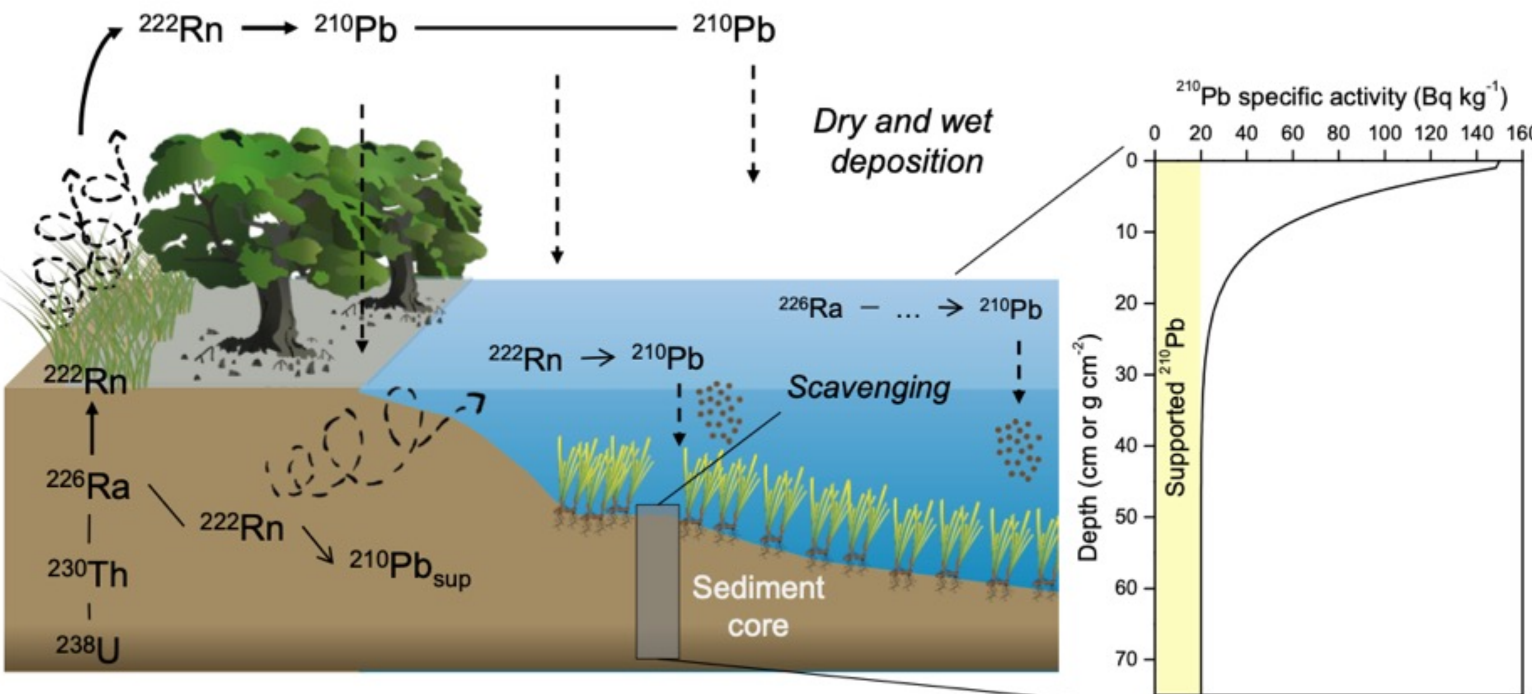
8. 210-lead dating measurement



Sealed in the plastic pack for 30 days.

High purity Ge-detector (ORTEC, GLP-16195)

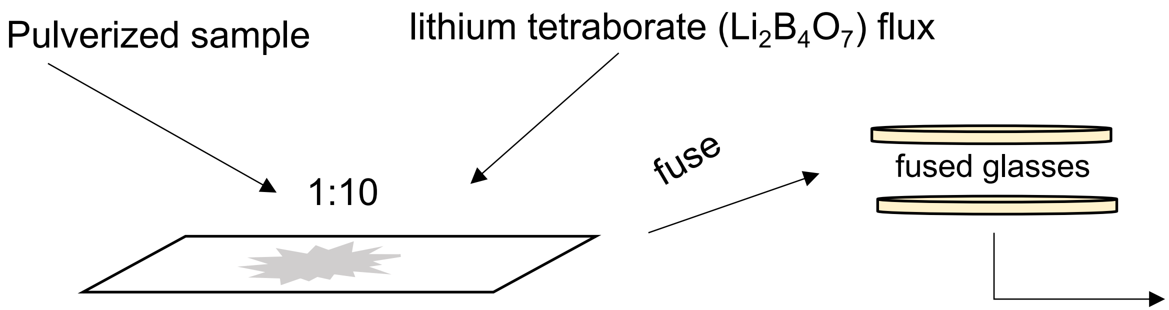
^{210}Pb was measured by its emission at 46.5 keV, and ^{226}Ra by the 351 keV emission



^{210}Pb cycle and idealized ^{210}Pb specific activity profile in sediment, Arias-Ortiz et al., 2018

Material and method: Laboratory analysis

9. X-ray Fluorescence Spectrometer (ZSX Primus IV, Rigaku)



XRF spectrometer (ZSX Primus IV, Rigaku) at the Kanazawa University, Japan

10. X-ray Diffraction Spectrometer (Ultima IV, Rigaku)

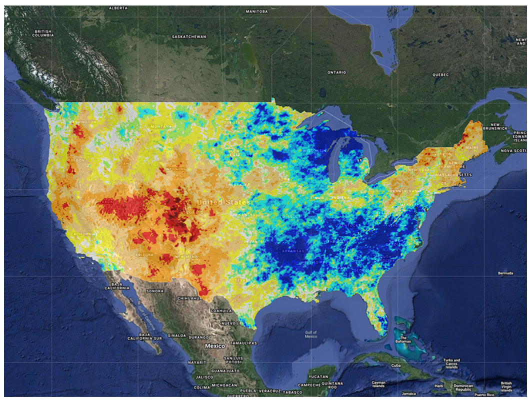
2-theta positions at 2 – 65°

XRD spectrometer Ultima IV Rigaku at Kanazawa University

Material and method:

- **Self-calibrating Palmer Drought Index (scPDSI)**

We utilized the **Climatic Research Unit (CRU) 4.05** precipitation and temperature data between 1930 and 2018 at 45.75 N and 100.25° E `



[U.S. Gridded Palmer Drought Severity Index (PDSI) from gridMET | Drought.gov]

- **Aerial imagery of Landsat 8 OLI**

(1990,2000,2005,2010,2015, and 2018)

https://earthexplorer.usgs.gov/

Sediment core profile

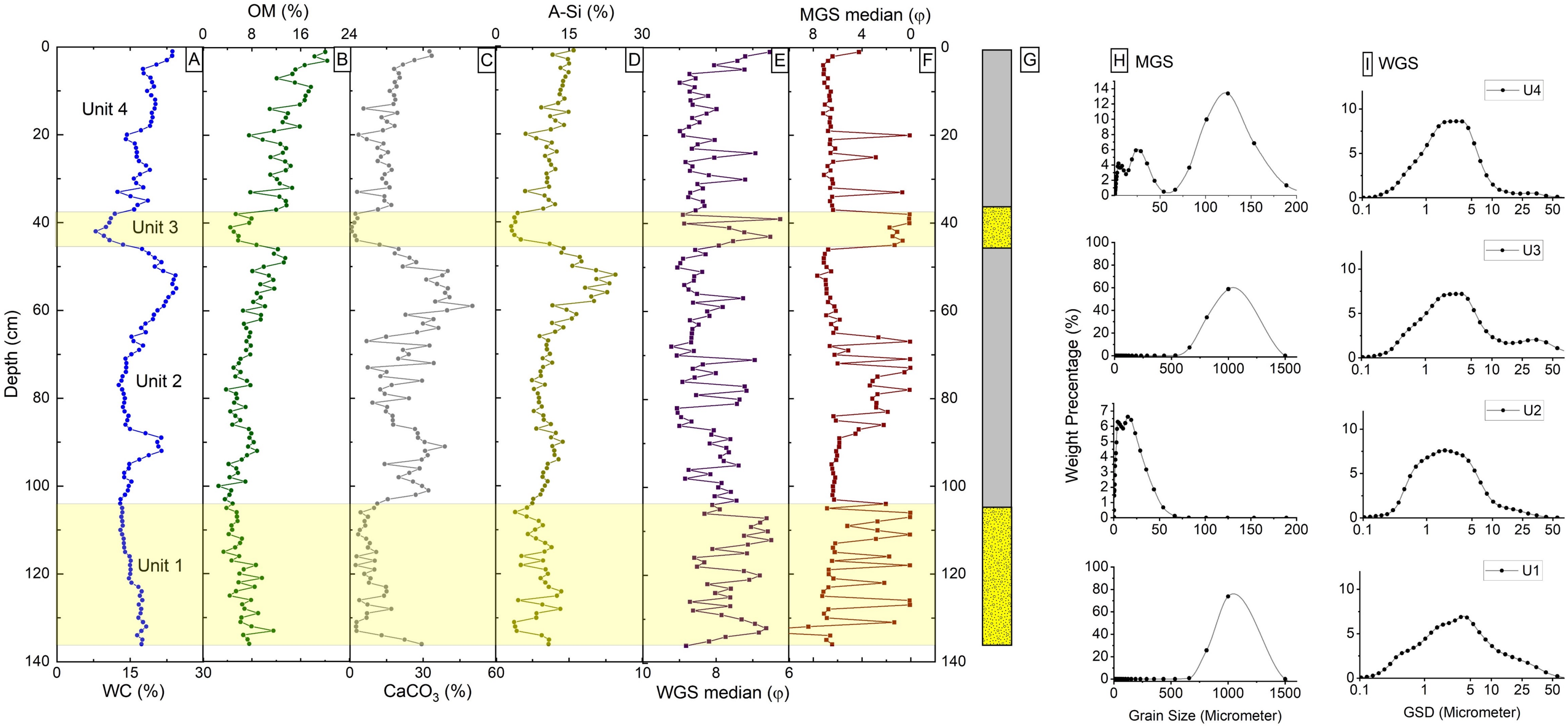


Fig. 2. 18TS1 core profile

- The core is divided into four units.
- Unit 1 and unit 3 are dominated by brownish sand. Unit 2 and Unit 4 consists of mainly clay and silt sediments.

Mineral assemblage

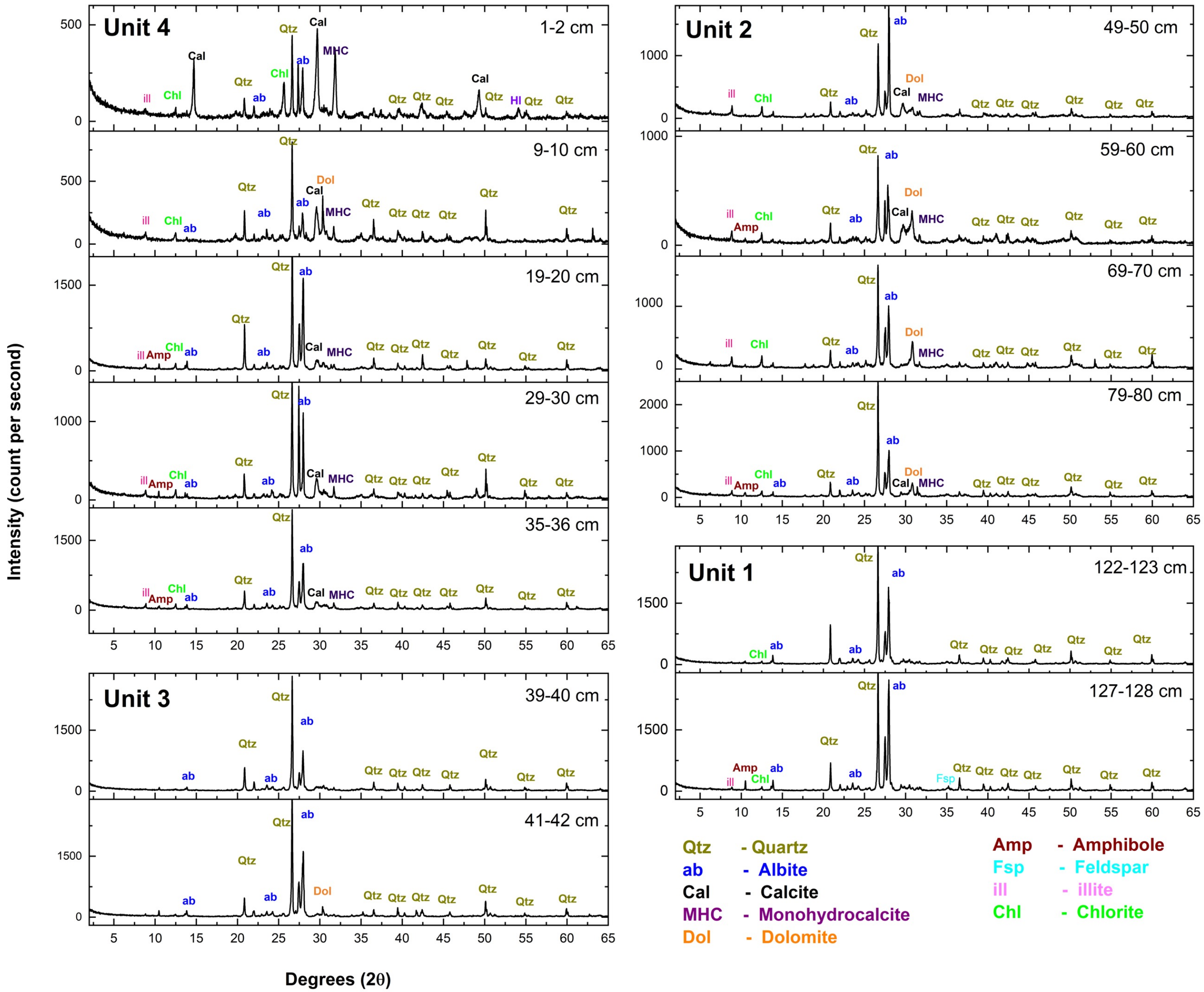


Fig. 3. Mineral assemblages

- XRD results suggest that Unit 1 and Unit 3 are predominantly composed of silicate minerals (quartz, albite, and amphibole).
- Carbonate minerals (monohydrocalcite, dolomite, and calcite) are presented for the Unit 2 and Unit 4.

Major element composition

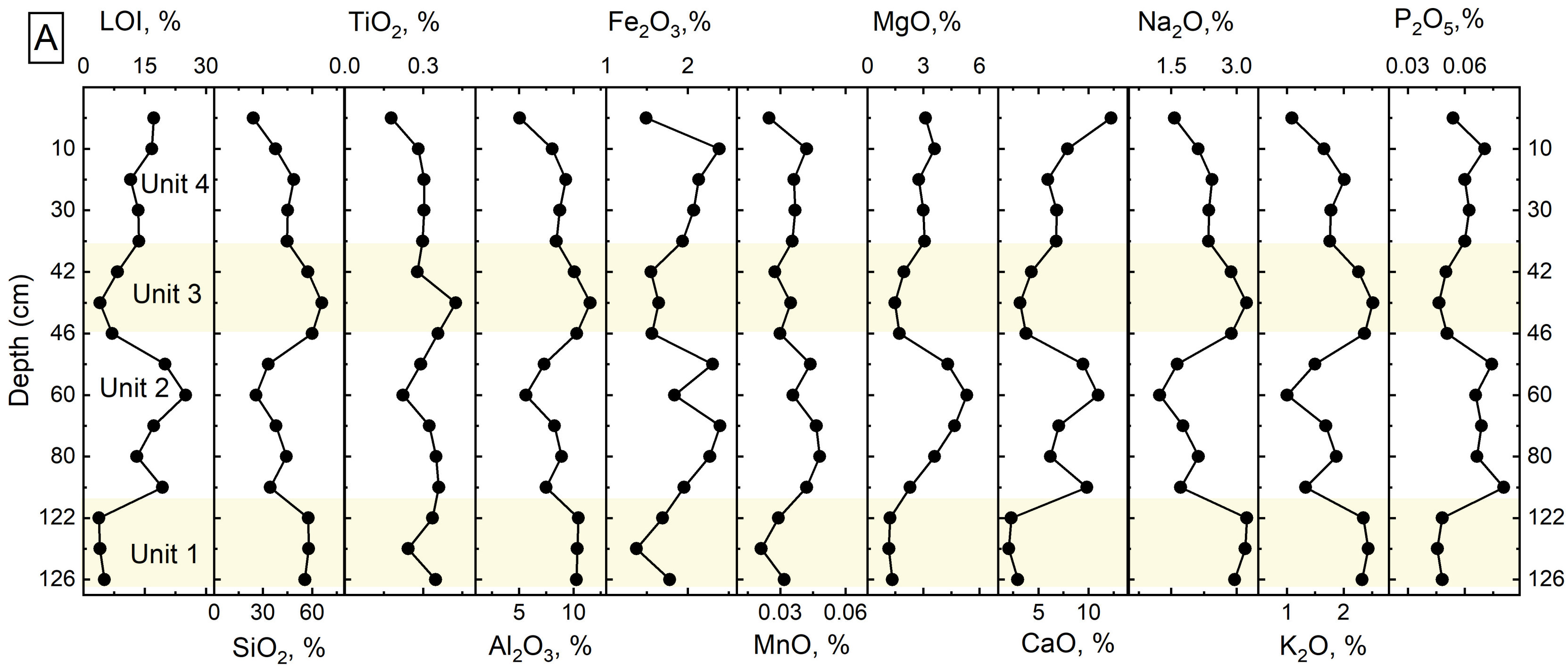


Fig. 4. Geochemical characteristics throughout core profile,

- Si/Ca and Si/Al indicate the weathering process together with K/Ti. These normalized values are high in unit 1 and unit 3.
- Ca/Mg ratios indicate enrichment of authigenic carbonate formation at 2 and 90 cm depth.
- The chemical composition of sand-dominated units in the sediment core well agrees with that of sand sheets and sand dunes.

Sediment chronology: ^{210}Pb dating

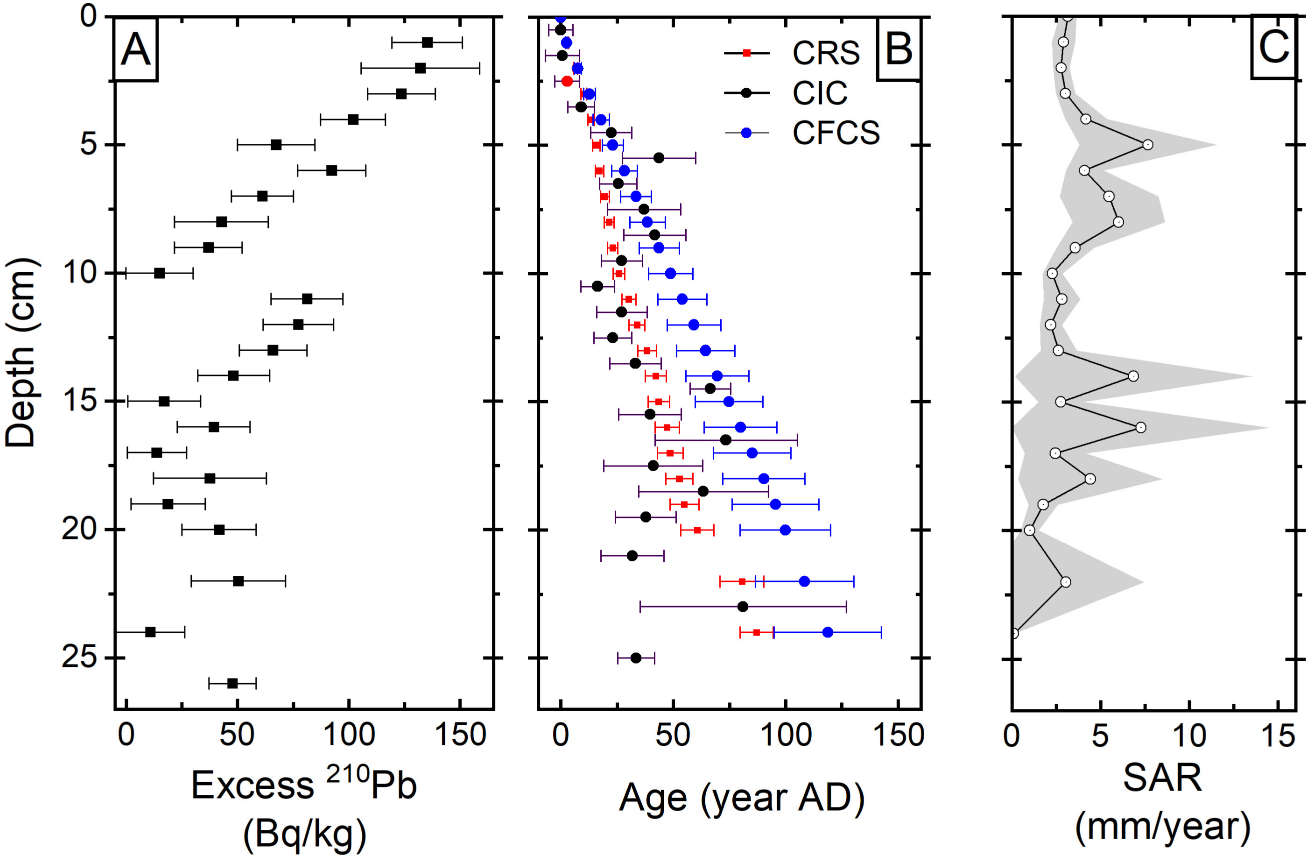
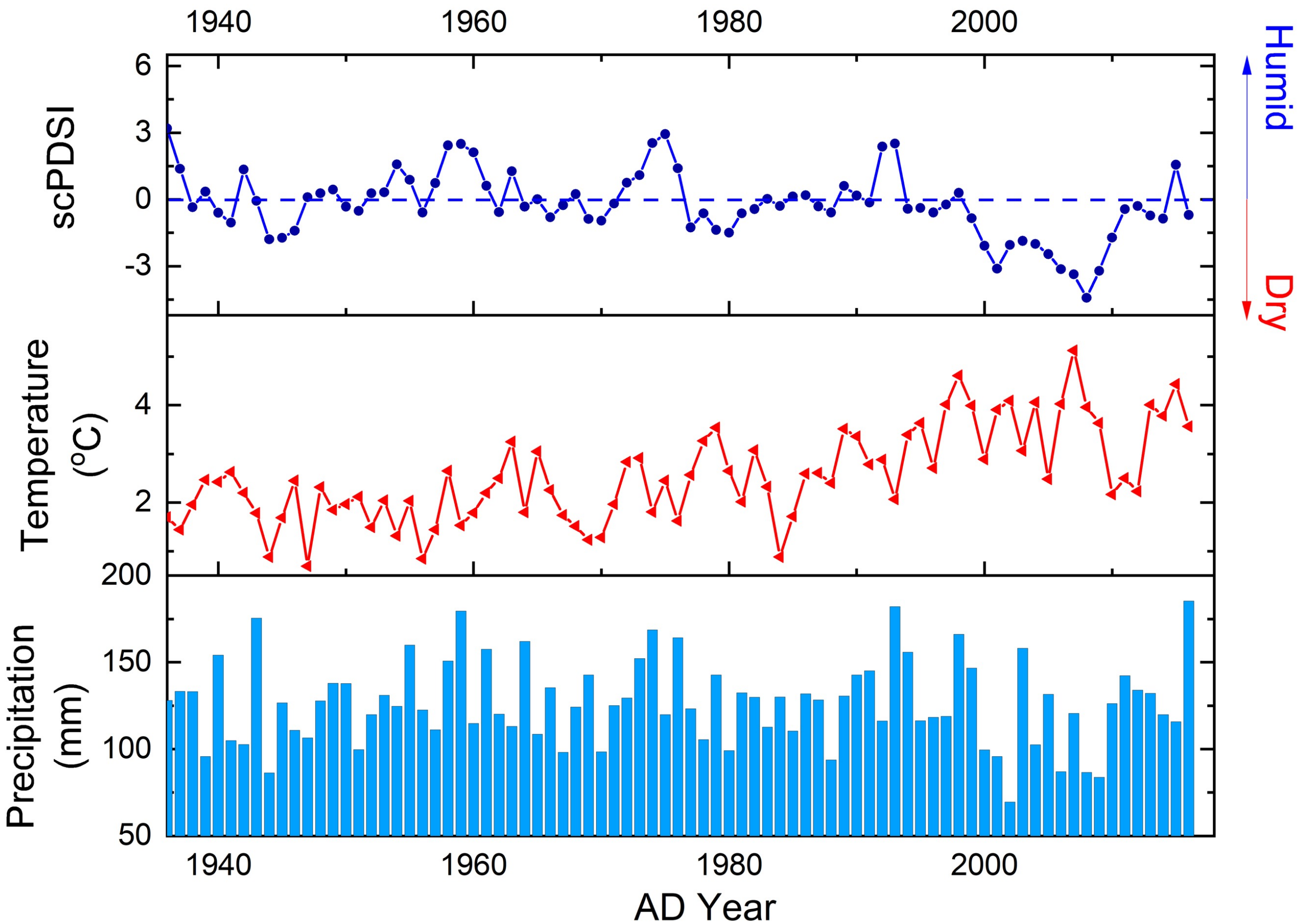


Fig. 5. ^{210}Pb dating results, A –Activity concentration of $^{210}Pb_{xs}$ down to the core profile, B–Age estimation of distinct models, CRS model (Red square), CIC model (black dot), CFCS model (blue dot), C–Sediment Accumulation Rate based on CRS model.

- Excess ^{210}Pb was detected only in the upper 24 cm.
- Constant Rate of Supply (CRS) model could estimate 87 years old age at 24 cm depth.
- Constant Initial Concentration(CIC) model ages are not in stratigraphic order with depth.
- Constant Flux and Constant Supply (CFCS) could provide relatively older ages, but, with higher age uncertainty.

Comparison of sediment characteristics and climate factor



- In the CRU data, the temperature trend has been increasing and the precipitation trend has been decreasing.
- Self-calibrated Palmer Drought Severity Index (scPDSI) indicates regional drought.

Fig. 6. Climatic data in study area between 1936 and 2018, A –scPDSI calculation based on the Climatic Research Unit (CRU) 4.05 precipitation and temperature data (Harris et al., 2020), B – Temperature, C –Precipitation. Low values of precipitation with highest temperature are coincided with the negative values of scPDSI, and last three decades were the driest period in the last century.

Comparison of sediment characteristics and climate factor

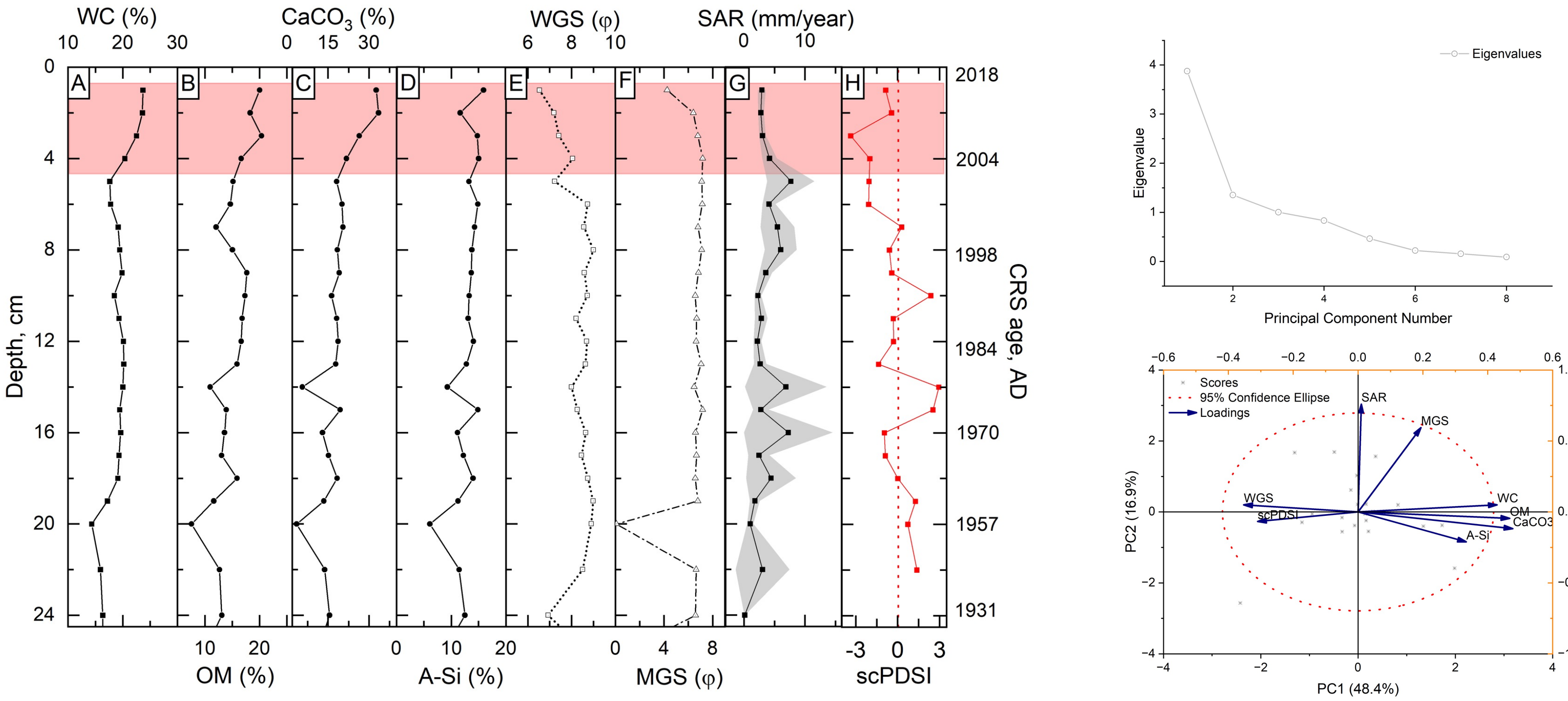
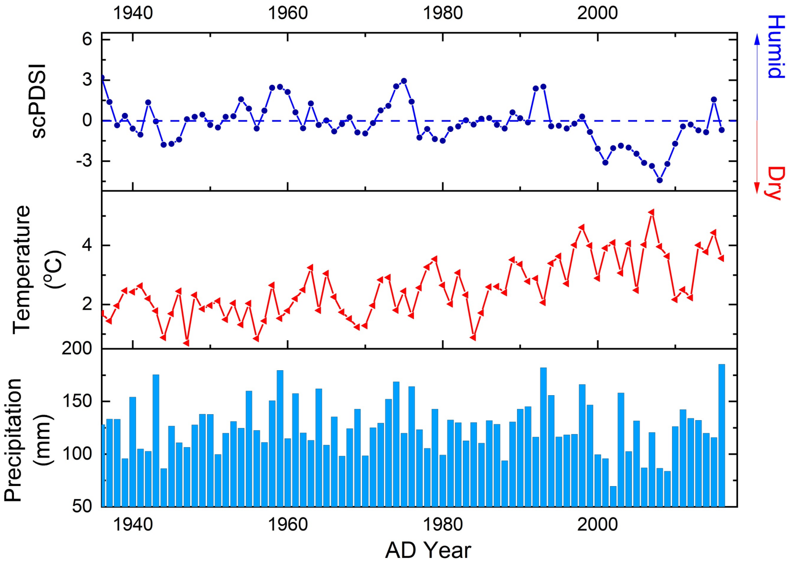
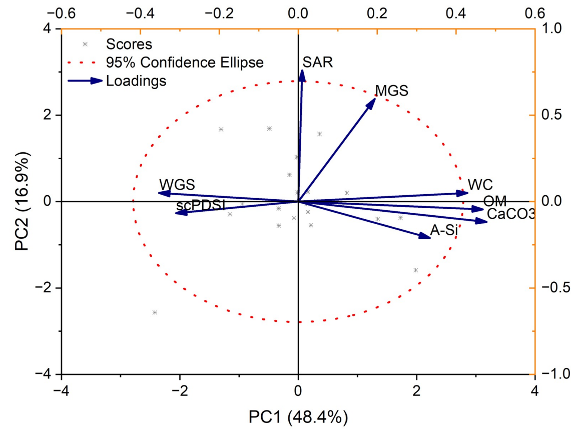


Fig. 7. Comparison between climatic factors and sediment characteristics and PCA results

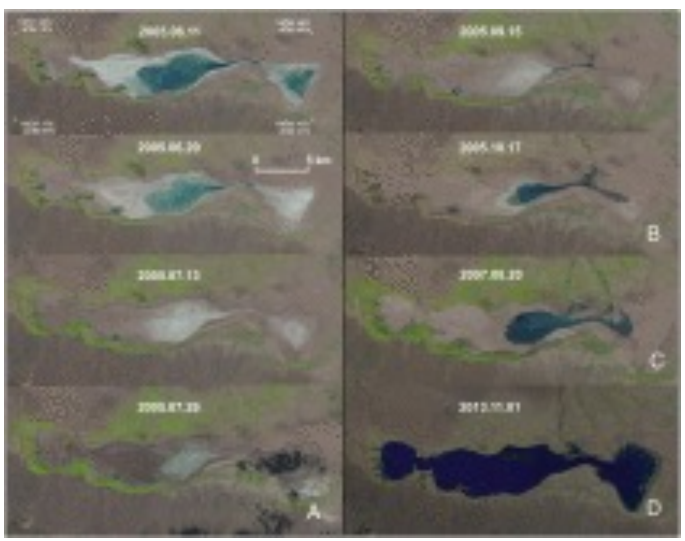
- Based on CRS model age, Sediment proxies were compared with scPDSI.
- PC1 is positively correlated with $CaCO_3$, Organic matter, and Amorphous silica, negatively correlated with Whole grain size and scPDSI value.
- Abundances of $CaCO_3$, Amorphous Silica, and Organic matter may indicate a dry climate inducing period.

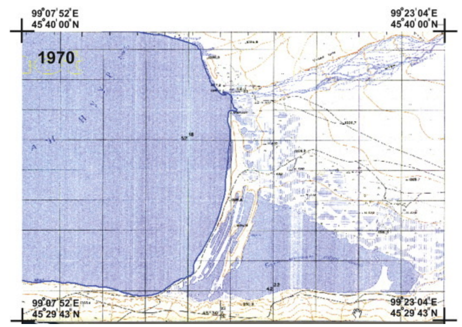
Lake sediment dynamics in response to climate change in the last 87 years (short term)

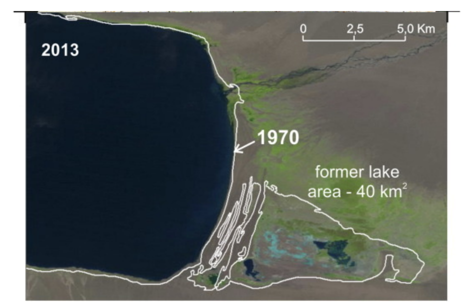




PCA results revealed that carbonate, organic matter, amorphous silica, and sediment grain sizes are great indicators of enhanced drought

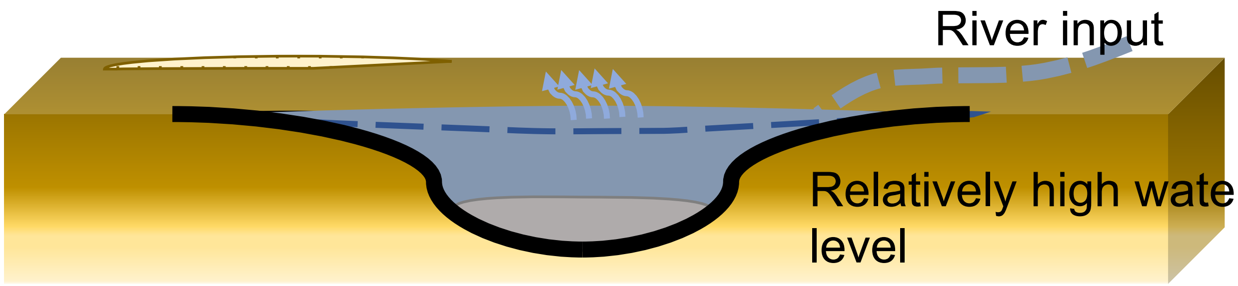




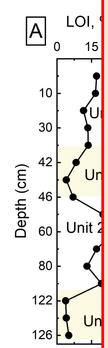


A significant decreasing trend between 1995 and 2013 (Szumin´ska, 2016)

Environmental changes in the past



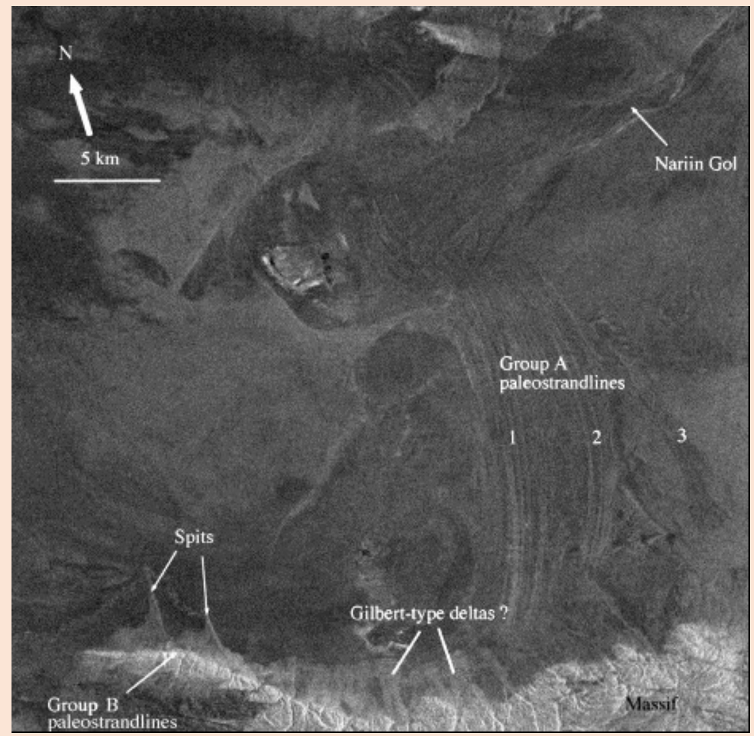
Phase 1.



The low XRD peak in carbonate minerals with low Ca/Mg values could be associated with the relatively high water level during the deposition of the lower parts of Unit 4 and Unit 2.

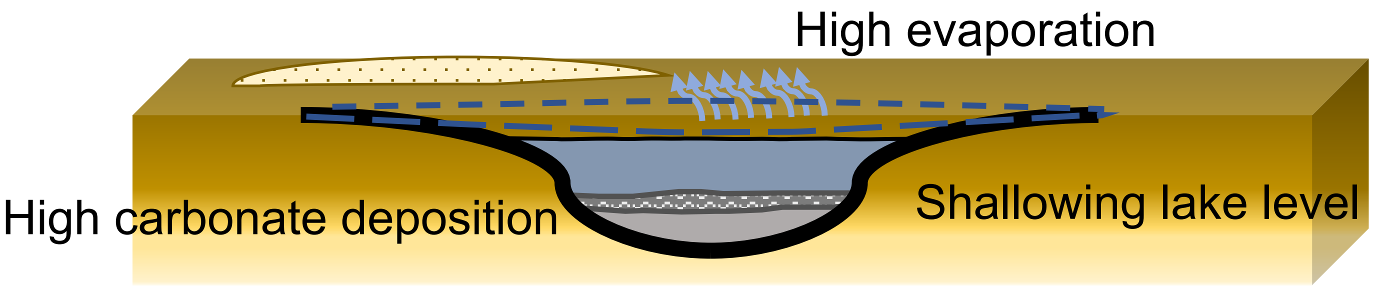
Low Ca/Mg (Lauterbach et al., 2011)

The deposition of fine-grained sedimentary sequences in the middle of a lake due to associated high lake level.



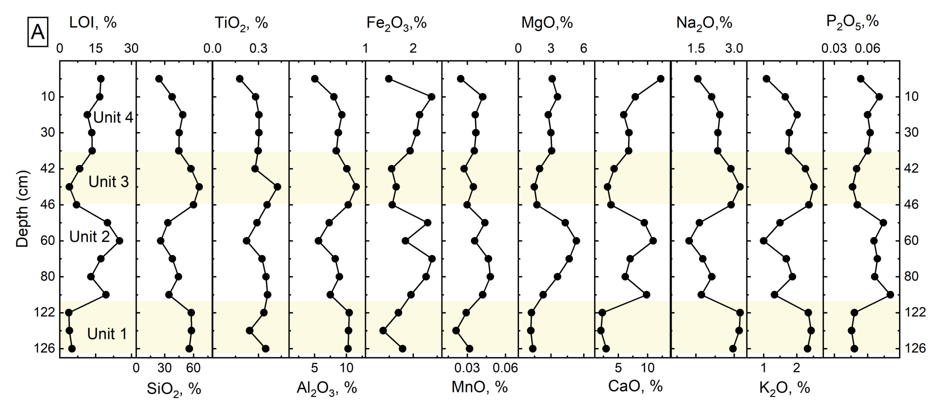
Paleoshoreline features in the Tsagaan Nuur topographic, Komatsu et al., 2001

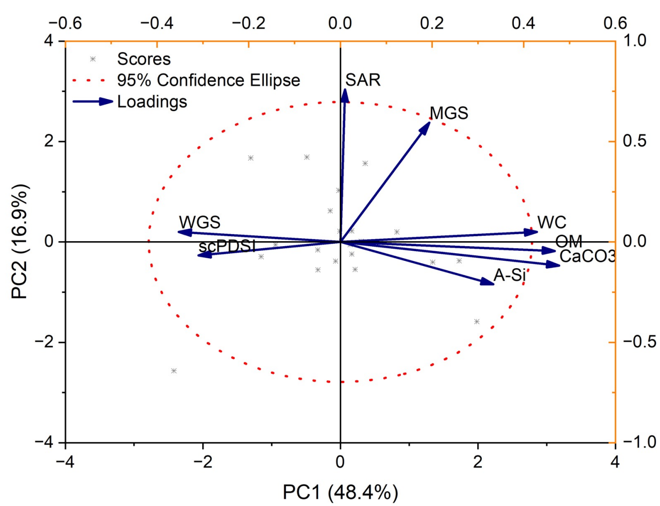
Environmental changes in the past



Phase 2.

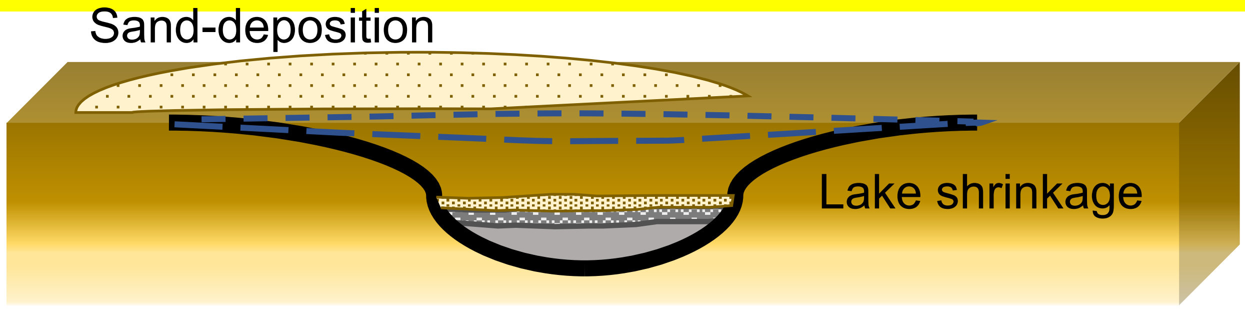
The high Ca/Mg values along with the high XRD peaks of calcite and MHC in the upper part of Unit 4 and Unit 2 could be indicative of precipitated minerals in the lake during the shallow lake conditions





Carbonate abundances are associated with the regional dry climate and might be considered a valuable indicator of shallow lakes prior to its drying up

Environmental changes in the past



Phase 3.

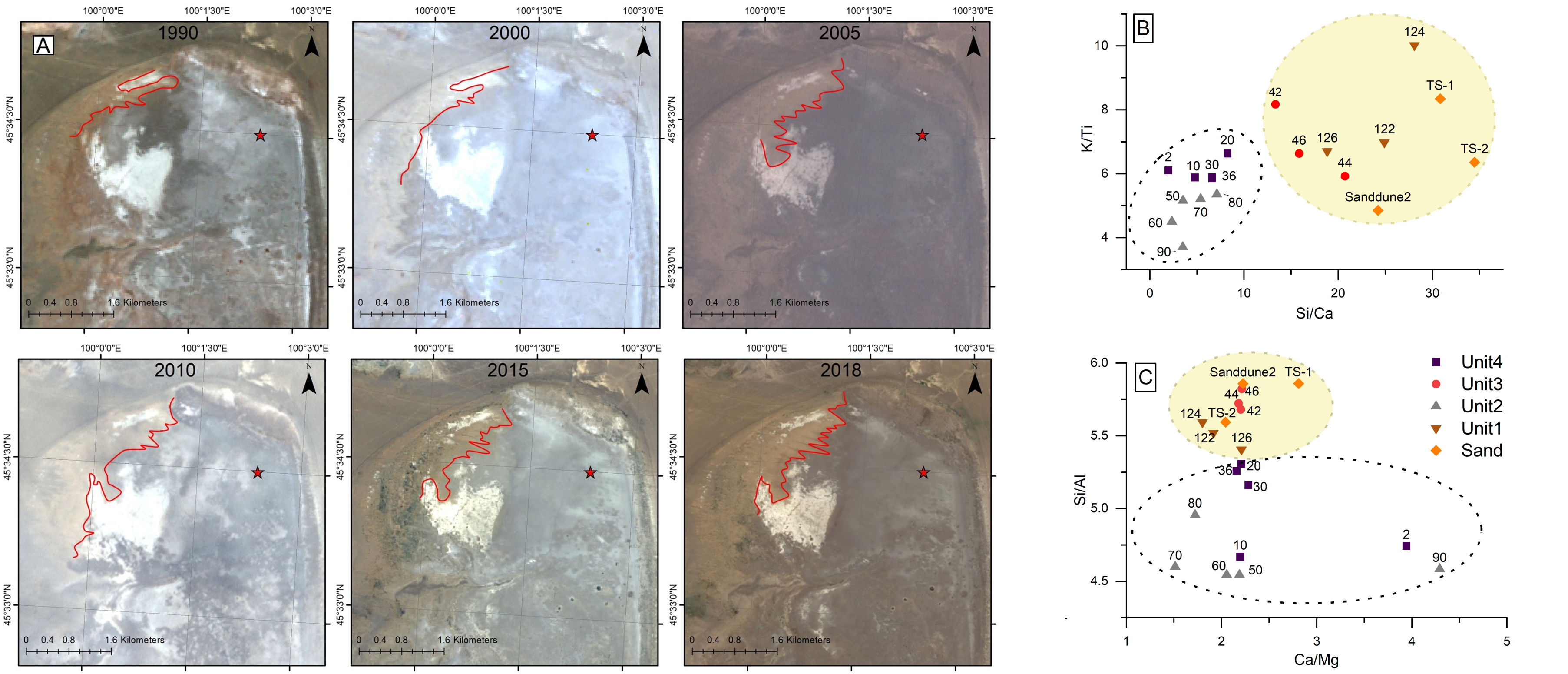
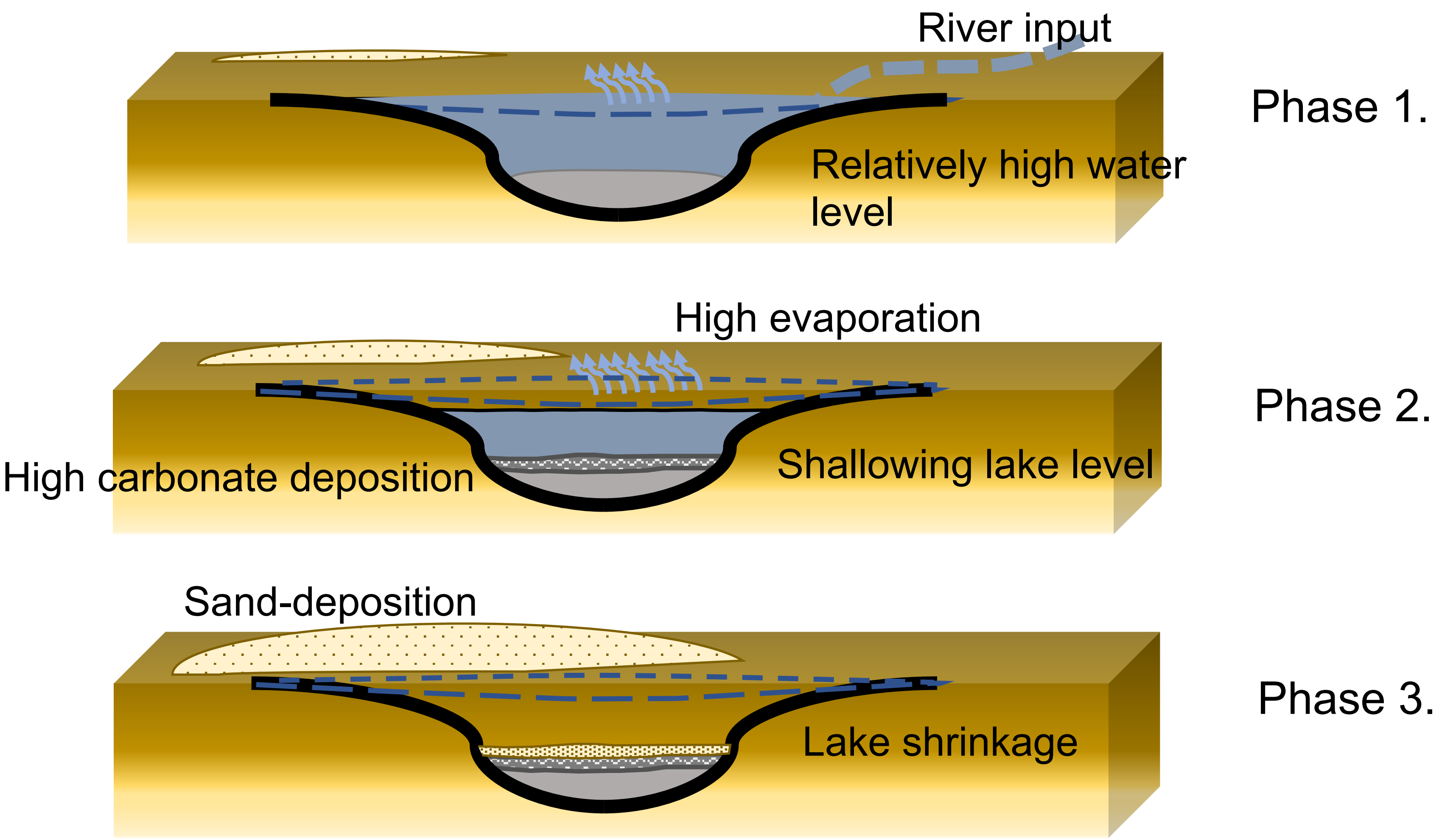
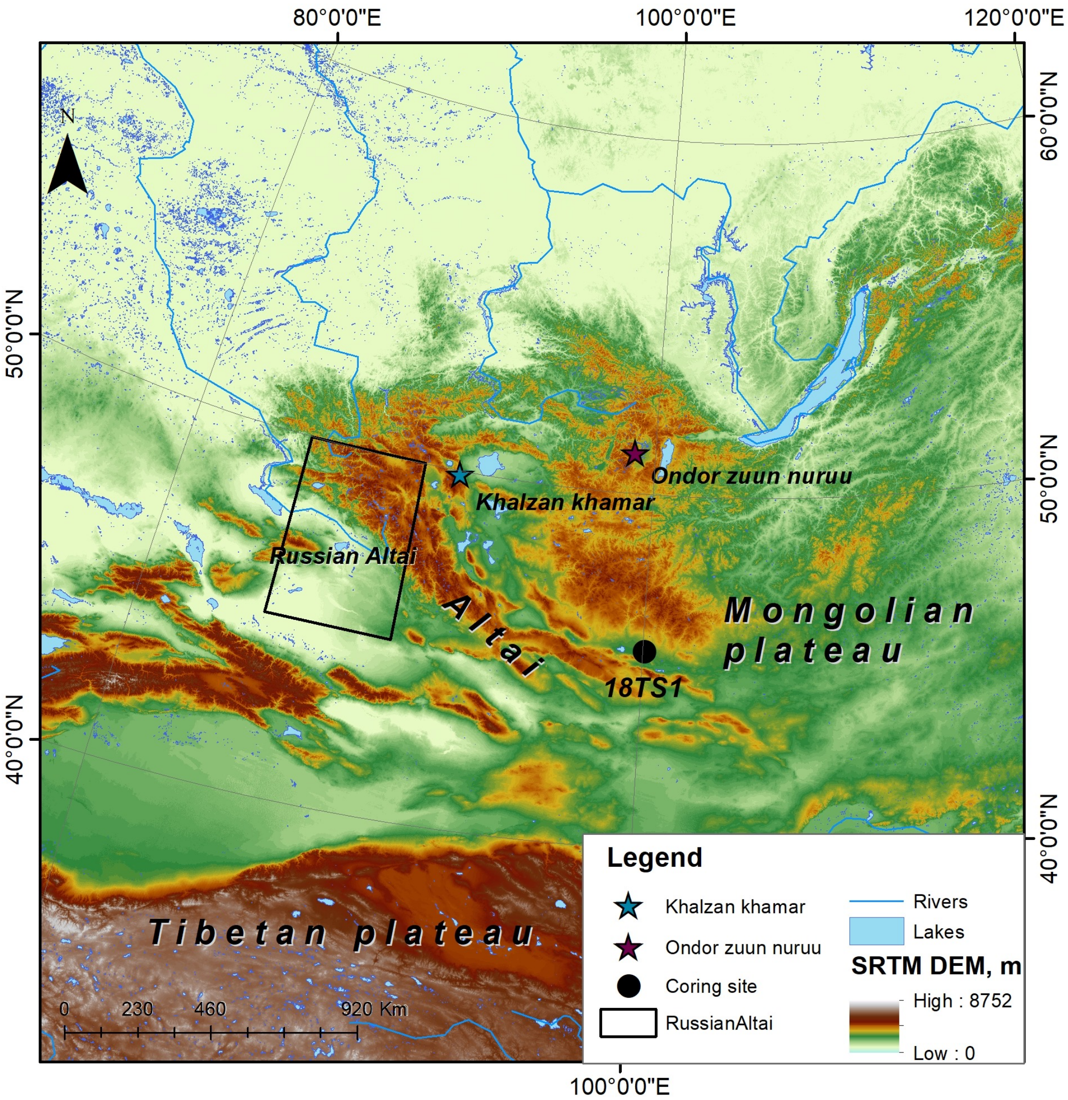


Figure 8. A – Sand sheet migration in the catchment, B–Biplot of K/Ti and Si/Ca, C –Biplot of Mg/Ca and Si/Al with the mobile sand sheet samples from the catchment

Environmental changes in the last millenium:



Environmental changes in the last millenium:



- Tree-ring proxy records in the Arid Central Asia (ACA)
- Temperature reconstruction from tree-ring data at 3 different sites
- Temperature trends were similar in each sites

Büntgen., 2016 and Davi.,2015., 2021

Environmental changes in the last millenium:

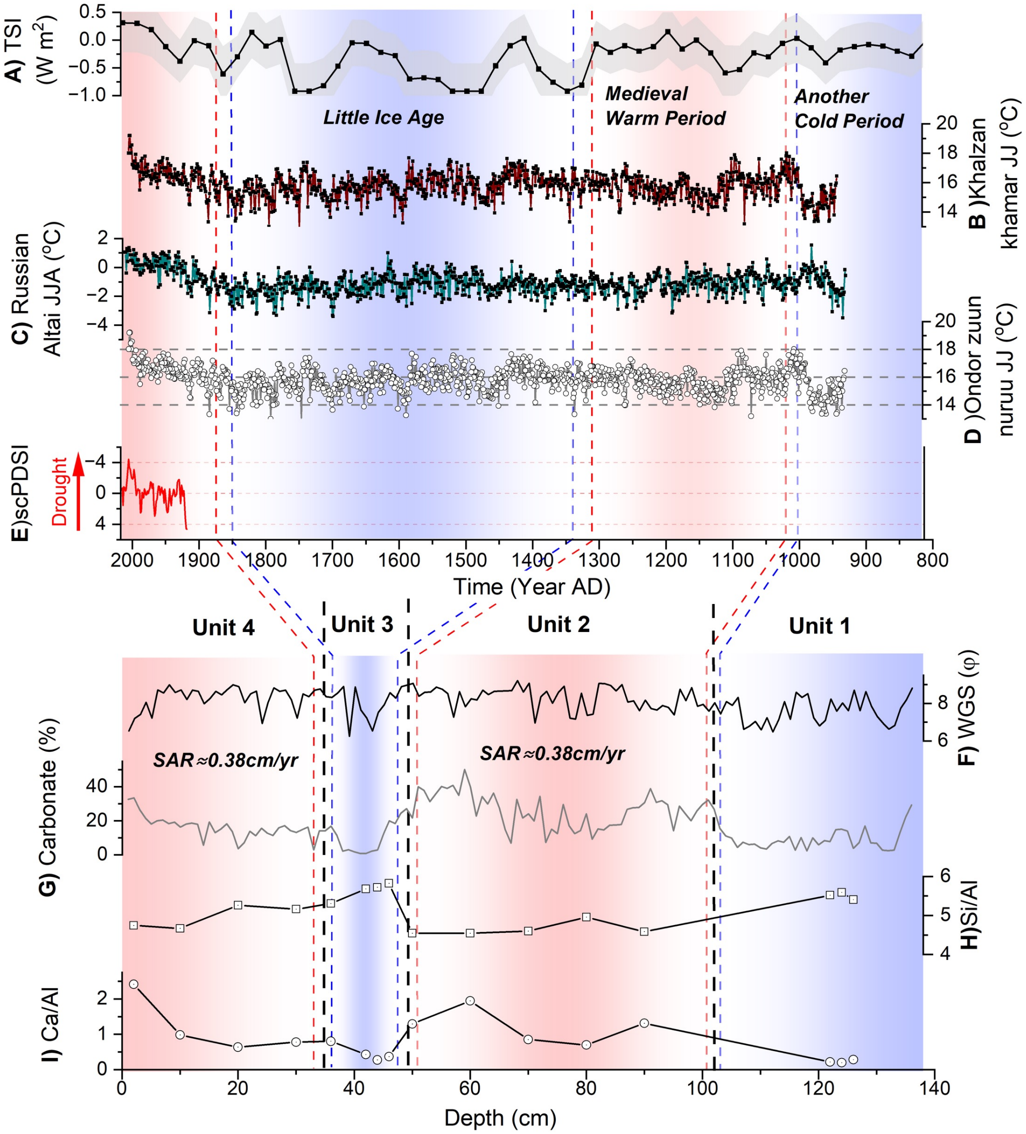


Figure 7. Reconstructed climatic data from other records and 18TS-1 core.

Cold period

- Little ice age (AD 1300-1850)
- Dark Age cold period (AD 500-800 centuries)

Warm period

- Recent warming (20-21st century)
- Medieval warm period (AD 1100-1300)

Conclusion:

- We investigated the lake sediment from the Tsagaan lake in the arid region of Mongolia.
- The precipitation of autogenic sediment increases during the lake shrinkage prior to the aeolian sedimentation.
- Distinct features of Unit 3 and Unit 1 revealed the two eolian sedimentation phases that were associated with cold periods. Furthermore, the sand sheets have expanded over the past three decades.

Thank you for your attention