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Geomorphology and Archaeology: Landscape reconstruction in South-East Kazakhstan

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Fig.1: Field work in Kazakhstan 2009

Project and Objectives

Our purpose is a landscape reconstruction outgoing from the late Bronze Age up to early Iron Age (2nd-1st millennium B.C.). The linking of the results from the method group should flow in a scenery model of historical "land of seven rivers", named Zhetisu.

Besides, the result of the investigation can deliver a new understanding of the concept "Space" at the moment of the Sakes culture. Moreover the collaboration with archaeologists is narrowly interlocked in a tandem project with archaeological scientist Anton Gass.

Our questions are how the Sakes culture use their landscape and are they agropastoralists besides their nomadic life?

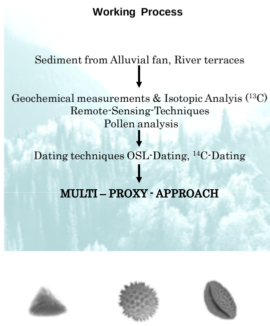
Geomorphology

The site is located in the vicinity of Turghen, between the northern Tien-Shan fault and the Ili Valley with River Ili.

„Land of seven rivers" contains 4 climatic zones after climatic system of Köppen. From northwest to southeast a desert climate, steppe climate, dry summer climate and humic cool winter climate are present.

For palaeoenvironmental studies we interested in archives like river terraces, alluvial fans, loess sediments and organic remains.

Landscape can be divided in 4 geomorphological areas.
I.) Floodplain-Area III.) Aeolian loess deposition
II.) Alluvial-fan deposits IV.) Tien-Shan Mountains



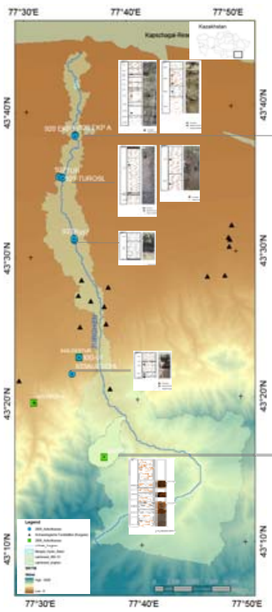


Fig.2: Catchment area of Turghen and subcatchment of profile 868-19

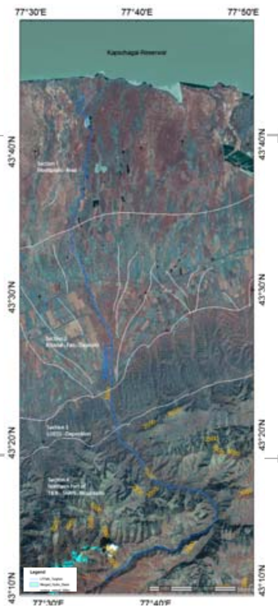


Fig.3: ETM pansharped p148r029, RGB 3/2/1 imprinted with geomorphological units

Fig.4: Situation at profile MB920-01 in May 2009

River Turghen (MB920):

CATCHMENT AREA:

491,09km²

DRAINAGE LENGTH:
45,7km (48%),
above Turghen-City:
50,1km (52%),
above Turghen-City:

LENGTH RIVER TURGHEN:
95,8km

DEPOSITIONAL ENVIRONMENT:
Aeolian and alluvial deposits are changed through the 190cm profile. Compact clayey layer at 79-87cm can be indicated through slowlier river flow velocity which result in accumulation of suspension load (Fig.6).

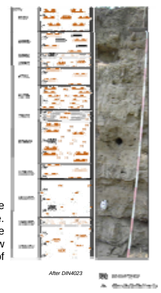


Fig.6: Profile MB920-01

Fig.5: Situation of profile 868-19 during Field Work September 2008

Sink (868-19)

CATCHMENT AREA:
3,59km²

LENGTH (RIVERSYSTEM):
6,3km

DEPOSITIONAL ENVIRONMENT:
Nival and alluvial deposits are alternatly found which contains silty and clayey material (Fig.7). First ^{14}C-dates from organic remains in 80 & 170cm show landslide activity, locked through inverse $^{14}C_{calc}$-ages.

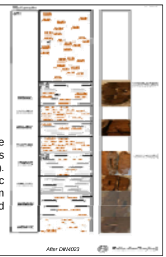


Fig.7: Profile 868-19

Processes

Geomorphological aspects in the land of seven rivers are glacial impacts: cirques, trough valleys and sharp mountain ridges. Deposits from mudflows are widespread located.

Through Saijliskij-Alatau with altitudes of more than 4500m a borderline from west to east retains humidity of westerlies and arrange a pluvial system. Physical and chemical wheatering are intensive, so the material were bulked for erosion.

Reliefspan from Peak Talgar (4.953m a.s.l.) through Ili-Valley (475m a.s.l.) achieved 4.478m a.s.l., with distance near 70km.

Connection between reliefspan, bulked material and seismicity results in denudation processes.

Fig.8: Kurgan–Field of Issyk, Kazakhstan 2008

Parallel Steps

To answer the interesting time period of 2nd to 1st millenium BC it is important to date material; organic and non-organic (^{14}C and OSL-dating).

Discussion

Results of remote sensing, pollen and sediment analysis combined with Datings are followed by Interpretion can give knowledge of past processes and understand the landscape development by imprinting archaeological research (Fig.8)
-> reconstruct the landscape.

Acknowledgements

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EXCELLENCE CLUSTER TOPOI The Formation and Transformation of Space and Knowledge in Ancient Civilisations

Research Area A
Spatial Environment and Conceptual Design

Freie Universität Berlin

Institute of Geographical Sciences
Physical Geography

The Sakian culture and its environment - Geoarchaeological investigations in Kazakhstan

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Introduction

Since summer 2008 the land of Seven Rivers, southeast Kazakhstan is in the focus of geo-archaeological investigations. Target are the graves - so-called kurgans - which can be found nearly all over the area. For the investigations a study site along the rivers Issyk and Turghen, covering an area of c. 60 km² is selected.

These kurgans are remains of the Sakian culture which inhabited the region in the early Iron Age (Fig. 1.). The Sakes are described as mounted warrior nomads and are a part of the “Scythian people” in the Eurasian steppe.

We detected Kurgan-fields of the Sakian culture near the cities Issyk and Turghen. Their geomorphological setting and spatial distribution are investigated. This is supplemented by an intensive characterisation of present and past landscape, focussing characteristics of grave sites.

Objectives

The aim of this project is to answer questions such as
- How did the Sakes inhabited and settled in this landscape?
- Did they cultivate plants?
- Were they agropastoralists beside their nomadic life?
- Is it possible to detect any evidences for an increase of morphodynamic activity for the time slice of the Sakes?

Fig. 1.: Sakes Kurgan-field on alluvial fan near Issyk, Kazakhstan

Methods

Following methods were applied:
(1) large scale geomorphological mapping,
(2) **description, sampling and dating** of sediment sections of valley-fills, alluvial plains and fluvial terraces within the loess-like sediment in the northern foreland of the Tien-Shan. Samples for dating are based on IRSL and radiocarbon (AMS) datings. AMS-datings were calibrate with CalPal (2007).
(3) **grain-size distribution** (laser-particle-analyser), mineralogy (XRD) and elemental composition (ICP-OES),
(4) **Zonation of geomorphological units** data from AsterDEM (Fig. 2) and ETM+ satellite images (Fig. 6),
(5) Pollen analysis are conducted to investigate possible vegetation changes.

1 Section in the foreland (1.030 m a.s.l.) of the northern Tien-Shan mountains (Loess hills)

Fig. 3 shows a section of valley fills of a tributary to the Issyk river. These sediments consist of silty clay and clayey silt. The AMS-dates date the sedimentation into the late Bronze Age. The fine-layered deposits are overlain by a 45cm thick layer of clayey silt with an increased sand content, which represents a change in the sedimentation regime and may point to an extreme run-off event. The IRSL dates at depths of 120 cm, 225 cm and 325 cm are presented and show an inverse structure.

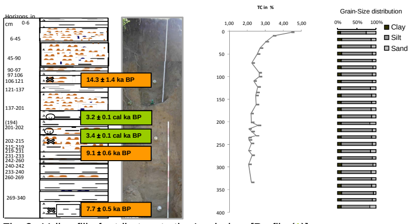

Fig. 3.: Valley fill of a tributary to the Issyk river [Profile (1)]

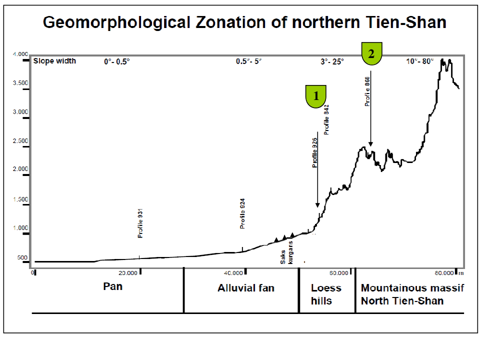

Fig. 2.: Geomorphological Zonation of northern Tien-Shan

Two profiles are presented in detail which originate from the mountainous massif of the North Tien-Shan (Fig.4) and its northern foreland with loess hills (Fig.3).

First results of the AMS-dates bracket the investigated sections from nearly 3500 to 1900 cal a BP and match the time slice of the Sakian culture.

2 Sediments from a cirque floor position (2.200 m a.s.l.) within the North Tien-Shan massif

Profile (2) represents a core (270 cm) in a cirque floor position. The sediments consist of silt and clay and show a similar layering as profile (1) in the loess hills. The investigated sediments are located within a natural sink. Grain-size distribution shows higher clay content than profile (1). Coarser silty sediments show slide activity which have been dated to approximate 2000 cal a BP (AMS dates of organic material).

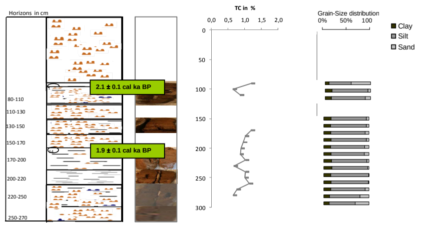

Fig. 4.: Core in a cirque of northern Tien-Shan [Profile (2)]

Preliminary results

Preliminary analysis of mapping results shows the kurgans of the Sakes are nearly all situated on alluvial fans.

Sediment analysis of profile 1 indicates in gully erosion (Fig. 5.) in the geomorphological unit of “loess hills” and corresponds to a colluvial outcrop with most recent regressive erosion. Brown (2001) shows that landscape activities during wetter conditions result in gully erosion (Fig. 5.).

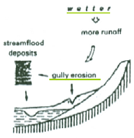

Fig. 5.: Impact on landscape during wetter conditions (Brown 2001)

IRSL-datings of the colluvial deposits give evidence for phases of Holocene slide activities. Datings are maximum ages and measured from polymineral fine grain (grain-size 4-11µm) of sample. IRSL-ages are fading corrected. Stability of IRSL-measurements were encouraged by dose recovery & preheat plateau tests.

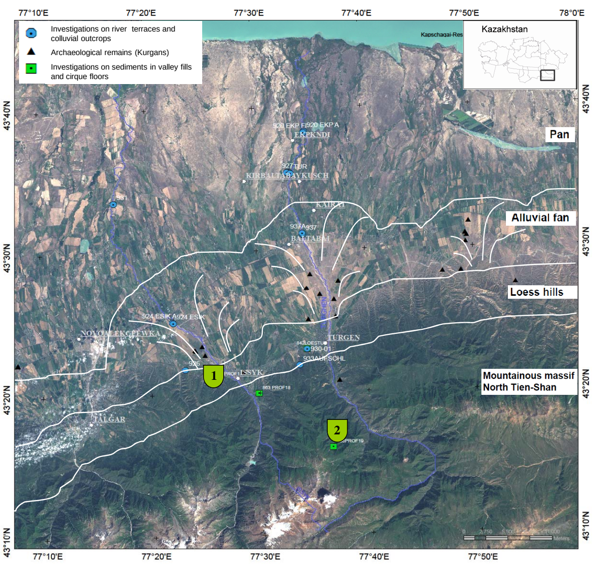

Fig. 6.: Landsat ETM Scene (RGB/321) with geomorphological units

Discussion

Through IRSL-dating for profile (1) inverse age structure for inorganic substance are highlighted. Because of incomplete bleaching during transport and sedimentation processes fading-corrected IRSL-dates are older as the AMS-dates. Extreme run-off events have slower bleaching time on sediments (layer thickness).

Landscape stability phases shown by rooted layers alternating with landslide activities interpret from sediment change.

For information about vegetation history and landscape use, pollen analysis is presently being investigated.

Conclusion

Together with archaeologists we observe Kurgans of Sakian culture and geomorphological environment surrounding the Kurgan-fields of Issyk and Turghen.

By combining results of sediment analysis, pollen analysis and past precipitation regimes from climate models we may describe and understand past landscape processes close to the Sakian culture in the Land of Seven Rivers.

References
Brown, A.G. (2001): Alluvial Geoarchaeology. Floodplain archaeology and environmental change. *Cambridge Press. University of Exeter*
Danzeglocke, U., Jöris, O., Weninger, B.(2007): CalPal-2007online. http://www.calpal-online.de/
David-Kimball, J., Bashilov, V. A. & Yablonsky, L. T. (1995): Nomads of eurasian steppe in the Early Iron Age. Zinat Press, Berkeley, California

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EXCELLENCE CLUSTER TOPOI

IRSL - Dating of loessic sediments in the Land of Seven Rivers, Kazakhstan

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Introduction

Since summer 2008 the land of Seven Rivers (Kazakhstan) is in the focus of geoarchaeological investigations and has been studied in order to understand the relationship between the activity of the Sakes (warrior nomads who are a part of the "Scythian people" in the Eurasian steppe) and the change in the landscape.

Targets of our investigations are the Sakian graves – so-called kurgans -which are found nearly all over the area along the rivers Issyk and Turghen (Fig. 1). These kurgans are remains of the Sakian culture inhabited in the region during the early Iron Age. Two outcrops on the Loess hills (MB842 and 926), which are close to the concentrated distribution of kurgans, and a profile MB924 located on an alluvial fan of river Issyk (Fig. 2), were investigated.

Nine samples for infrared stimulated luminescence (IRSL) dating were collected to estimate the ages of the loess and colluvial sediments.

Objectives

The aim of this project is to answer questions such as

- Did landscape changed during activity of Sakian culture?
- Is it possible to detect any evidences for an increase of morphodynamic activity around the 1st mill. BC?

Fig. 1: Sakes Kurgan-field on alluvial fan near city Issyk

Protocol for IRSL measurements

Laboratory IRSL experiments with single aliquot regenerative-dose protocol (SAR) were carried out from extracted polymineral fine-grains (4-11 µm) of aeolian and colluvial sediments.

For D_e measurements we used a modified elevated temperature post-IR IRSL protocol after BUYLAERT et al. (2009):

1. Dose
2. Preheat (250 °C for 60 s)
3. IRSL, 100 s at 50 °C
4. post-IR, 100 s at 225 °C
5. Test dose
6. Preheat (250 °C for 60 s)
7. IRSL, 100 s at 50 °C
8. post-IR, 100 s at 225 °C
9. Return to step 1

(Steps 1–4:) $[L_x]$ = the main signal
(Steps 5–8:) $[T_x]$ = the response to the related test dose.

The ages were calculated from the IRSL signal measured at 50°C (IR50) and the post-IR IRSL at 225 °C (IR225).

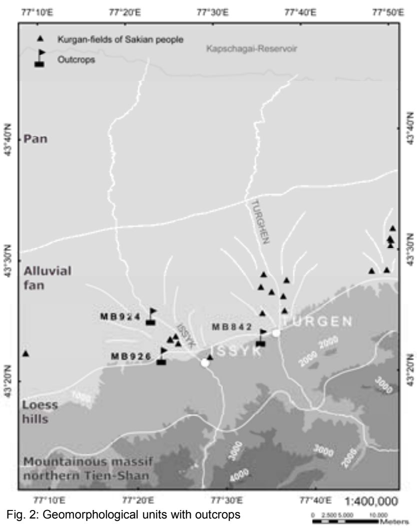


Fig. 2: Geomorphological units with outcrops

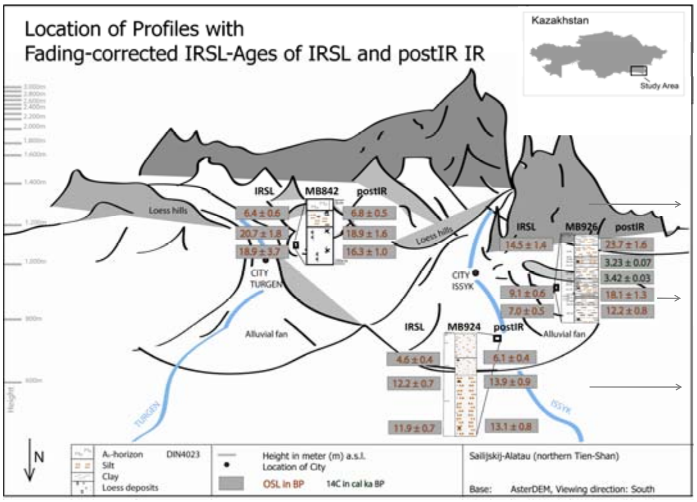


Fig. 3: Location of profiles with fading-corrected IRSL- and postIR IR ages

Results

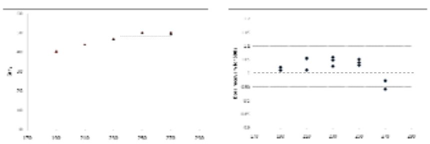
The fading-corrected IRSL and post-IR IRSL ages agreed for 6 samples but the post-IR IRSL ages overestimated the IRSL ages for the 3 samples (MB926) :

	Difference in ka	Depositional environment	Bleach character
MB842	0,4 1,8 2,6	Loess hill (aeolian)	well bleached
MB926	9,1 9,0 5,2	Loess hills (colluvial)	insufficient bleached
MB924	1,5 1,6 1,2	Alluvial fan (aeolian & fluvial)	well bleached

Both IRSL and post-IR IRSL ages from MB926 showed inverse relationship with the depth, suggesting the sediments were not sufficiently bleached before deposition.

Suitability: Sample LUM2128 (MB926)

(a) Preheat plateau test (Plateau at 250°C; 15 Aliquots) / Dose Recovery test (Mean 1.02; 15 Aliquots)



(b) Recuperation rate and Recycling ratio (8 Aliquots)

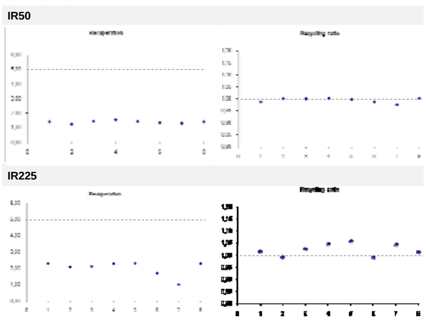


Fig. 4: (a) Preheat plateau test and Dose recovery test, (b) Recuperation rate and Reycling ratio of LUM2128 (sample of MB926)

Discussion

The preheat and the post-IR IRSL measurement temperatures were selected according to the results of the preheat plateau test and the dose recovery test (Fig. 4a). Small recuperation (< 5%) and recycling ratio (≈ 1.0) support the suitability of the protocol for D_e measurements (Fig. 4b).

Spatial analysis of the profile MB926 indicates that the site is located on the loess hills (Fig. 5). The sediments are interpreted as a colluvium due to the most recent regressive erosion. We interpret the age reversal and the difference between the IRSL and post-IR IRSL ages due to insufficient bleaching during transport and sedimentation. The overestimation of the post-IR IRSL age suggests this signal is less sensitive to light exposure than the IRSL signal.

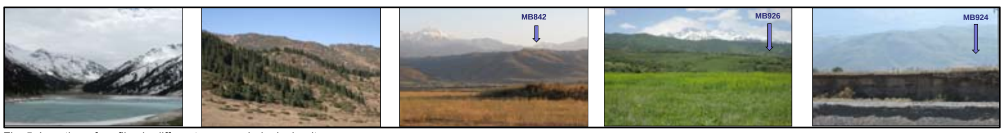


Fig. 5: Location of profiles in different geomorphological units

On the other hand, the IRSL and post-IR IRSL ages from the aeolian outcrops (MB842 and MB924) in loess hills show comparable ages, which suggest the grains were sufficient bleached. The youngest IRSL age (4.6 ka, IR50) was obtained from 0.4 m from the top from MB924, which is slightly older than the age of Kurgan (Early Iron age, ~2.6 ka).

Thus the difference between IRSL and post-IR IRSL ages can be used as an indicator of the degree of bleaching prior the deposition.

Reference

BUYLAERT ET AL. (2009): Testing the potential of an elevated temperature IRSL signal from K-feldspar. Radiation measurements 44 (5-6). 560.

Conclusion

As a result of IRSL and post-IR IRSL dating, the ages are in agreement for the 6 samples from the loess profile and in disagreement for the 3 samples from the colluvial profile.

We interpret the difference between the IRSL and post-IR IRSL ages is due to different residual doses before deposition. This age difference will be a useful indicator to judge if the sediments are well bleached or not for polymineral fine grains, i.e. if the ages are reliable.

At present it is difficult to say if the morphodynamic activity was increased or not by Sakian culture. Further chronological data close to the top of the sections are necessary combined with a geomorphological mapping and the reconstruction of palaeoprecipitations from climate model.

Acknowledgements

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Sediment based proxies and downscaled paleoprecipitation model – a qualitative approach to reconstruct late Holocene landscapes

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Introduction

A landscape reconstruction of the late Holocene [< 4 ka] is the major objective in the Land of Seven Rivers, southeast of Kazakhstan. Information on late Holocene landscape conditions and potential changes is scarce and needs to be clarified.

Therefore, a qualitative approach with sediment based proxies [weathering index, Luminescence (IRSL) and AMS dating, carbon contents (TIC)] and a downscaled ECHO-G paleo-precipitation model [time series for 6.0 ka to 0.1 ka] was applied to investigate the paleoenvironmental conditions.

Nomadic Scyths (Sakian) people inhabited the Land of Seven Rivers during the first Mill. BC [PARZINGER, 2006] - remains are the kurgan fields [Fig.1]. The multi-proxy study shows how paleoenvironmental conditions for the late Holocene landscape may be approximated.

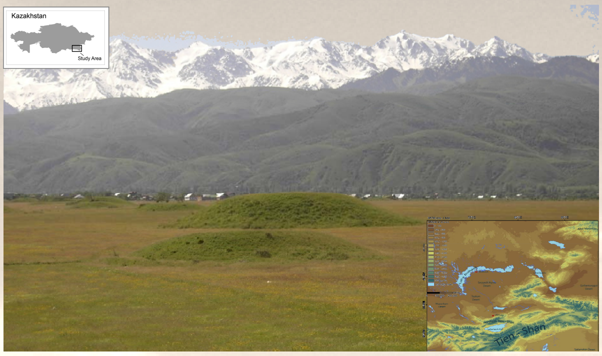


Fig. 1: Sakian Kurgan-field (Issyk) on alluvial fan near Almaty

Objectives

1. Reconstructing the regional late Holocene landscape!
2. Are there changes in paleoprecipitation during the late Holocene [< 4 ka]? Is there evidence for more humid conditions in the steppe region?
3. Are there any evidences for late Holocene morpho-dynamic activity?

Methods

Sediment based proxies:

- · Depositional environment
- · Weathering index [ICP-OES]
- · Grain sizes [Laser method]
- · TIC [WOESTHOFF],
- · Luminescence dating
- · ^{14}C - AMS dating

Paleoprecipitation model:

Statistically downscaled precipitation time series for the climate station Almaty (mountains) und Balhash (steppe) from 6 ka until present day derived from a general circulation model simulation with ECHO-G (WAGNER et al., 2007).

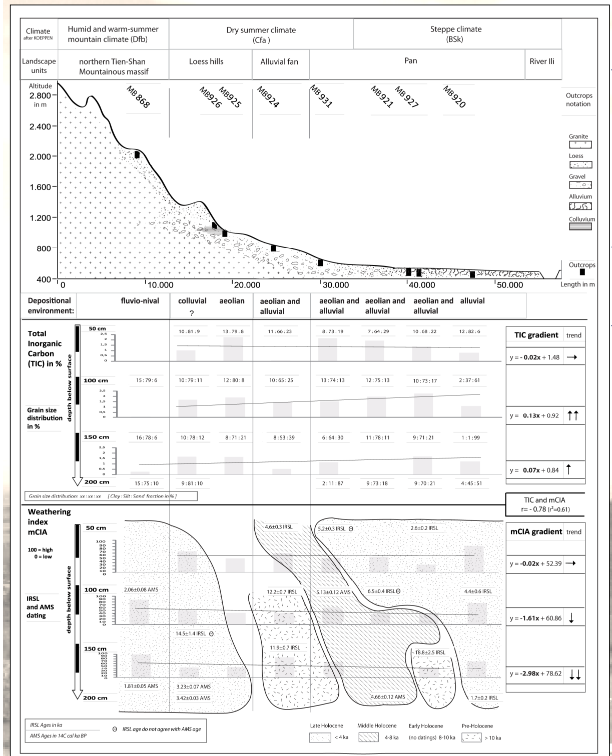


Fig. 3: Sediment based proxies of all outcrops

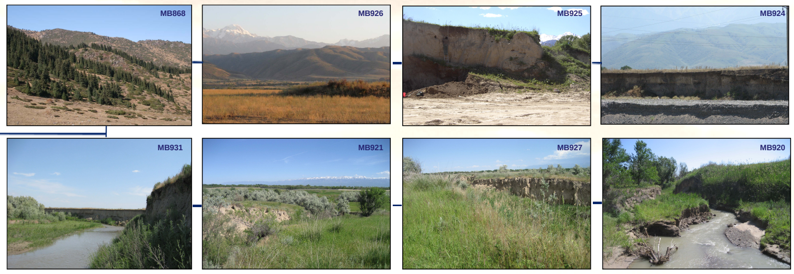


Fig. 2: Locations of studied outcrops

Results and Discussion

Aeolian, alluvial and colluvial outcrops were studied near cities Issyk and Turghen, 55 km east of Almaty. The **depositional environments** for studied outcrops [Fig.2] differ between the landscape units and passing three climatic zones after KOEPPEN [1936].

Sediment proxy of **TIC** ranges between 0.04% and 2.27%. In varied depths of 50 cm, 100 cm and 150 cm the catenarian TIC of all outcrops increases in 100 cm [0.13·x] and 150 cm [0.07·x] from mountains to pan. **Grain sizes** [Fig.3] show silt and sand fraction dominated sediments.

The modified **weathering index** [mCIA after NESBITT and YOUNG, 1982] with molar elements of

- $$mCIA = \frac{Cr}{(Cr + Na + K + Ca + Mg)} * 10^5$$

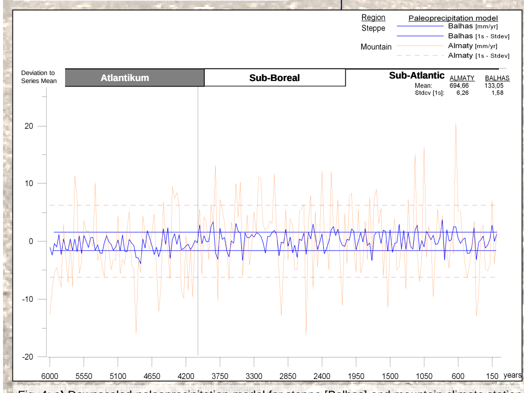
ranges from 37 to 99. In summary, a negative gradient in 100 cm [-1.61·x] and in 150 cm depth [-2.98·x] explains a decreasing weathering index from northern Tien Shan Mountains to the pan. In comparison with TIC a correlation of r = -0.78 was identified, suggesting calcium dominated carbonates explain primarily the weathering processes.

The geochronological frame of **IRSL** [1.7±0.2 ka to 18.8±2.5 ka] and **AMS** ages [1.81±0.05 cal ka BP to 5.13±0.12 cal ka BP] indicate pre- to late Holocene sediment deposits.

Through the geochronological frame differences between the landscape units points out.

1. Erosive processes of parent loess (loess hills) took place –» **dynamic** in late Holocene.
2. A alluvial mega fan represents relatively stable conditions after formation of the alluvial fan. IRSL ages in MB924 show late Pleistocene to late Holocene alluvial fan deposits –» **adynamic** in late Holocene.
3. Conducted Pan explains middle to late Holocene sediment deposits, which were partly inverse to the AMS ages, suggesting erosion processes. Transport and accumulation processes from the sediment of the adjacent hinterland occurred –» **dynamic** in late Holocene.

Paleoprecipitation for Almaty station ranges from 678.5_{min} to 715.2_{max} mm*yr^{-1} [std.= ±6.3 mm]. Late Holocene paleoprecipitation varies slightly [Fig.4a]. For steppe region at Balhash paleoprecipitation from 129.1_{min} to 136.7_{max} [std.= ±1.6 mm] results. With a 500yr average of two time series an increasing trend can be determined from 6.0 ka to 0.1 ka – from middle to the late Holocene [Fig.4b]. A potential change to more humid conditions in late Holocene is not confirmable. Investigations on monthly data are needed to test intra-annual variabilities.



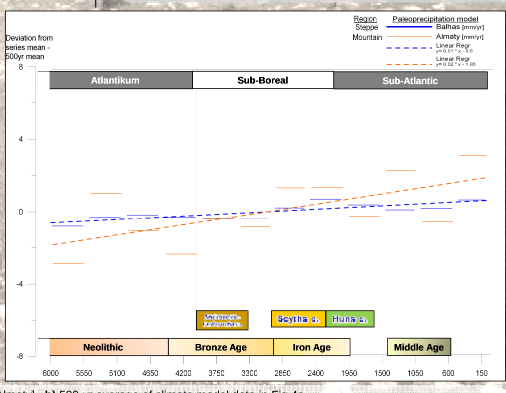


Fig. 4: **a)** Downscaled paleoprecipitation model for steppe [Balhas] and mountain climate station [Almaty] **b)** 500-yr average of climate model data in Fig.4a

Conclusions

To reconstruct late Holocene landscapes sediment based proxies and modeled paleoprecipitation are presented.

Reconstruction of paleoenvironmental conditions due to weathering changes and depositional environment [SCHÜTT et al., 2010] was applied. Based on a modified weathering index [mCIA] and a statistically downscaled paleoprecipitation model the late Holocene landscape has been approximated.

Evidences for paleoprecipitation changes to more humid conditions during the late Holocene [< 4 ka] cannot be determined (Fig. 4a+b).

Further, the landscape units show different late Holocene sediment dynamics from the Tien Shan Mountains to the northwarded Pan. Dynamic areas are Loess hills and the Pan. The alluvial mega fan show adynamic sediment deposits in late Holocene, suggesting a stabile landscape unit during the last 4 ka.

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References

NESBITT, H.W. and YOUNG, G.M. (1982): Early proterozoic climates and plate motions inferred from major element chemistry of lutites. Nature, Vol 299, pages 715-718

PARZINGER, H. (2006): Die frühen Völker Eurasiens: Vom Neolithikum bis zum Mittelalter. Beck. München.

SCHÜTT, B. et al. (2010): Late Quaternary transition from lacustrine to a fluvio-lacustrine environment in the north-western Nam Co, China. Quaternary International

WAGNER, S. et al. (2007): Transient simulations, empirical reconstructions and forc-ing mechanisms for the Mid-Holocene hydrological climate in Southern Patagonia. Clim. Dyn., 29:333–355

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