

Mid-late Holocene hydroclimate variation in the source region of the Yangtze River revealed by lake sediment records

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Introduction

The headwater region of the Yangtze River serves as major constituent of Asian Water Tower and is critical in providing fresh water for hundreds of millions of people living downstream (IPCC, 2014). Hydrological variation is mainly influenced by environmental changes. However, there are few records focus on the palaeohydrological change in the source region of Yangtze river (SRYR), also great complexity of the records nearby this area mentioned a lot in previous studies which belongs to the transitional zone in Tibetan Plateau, deserving prompt attention. Therefore, a good understanding of climate changes in SRYR is of great significance.

Here, we (1) present sediment records from Saiyong Co, a closed-basin lake, with reliable chronologies and robust proxies to reconstruct the paleoclimate variations and determine the main factors influenced it since 5.8 cal ka BP, (2) compare the new reconstructions from SRYR with other records across the Third Pole with a comprehensive assessment.

Materials and methods

- A 130 cm long gravity core was collected at depocenter with depth of 3.80 m.
- A small alpine lake on the eastern Tibetan plateau at 4545 m asl (33° 20'49"N, 96° 04'47"E).
- Radiocarbon ages of the sediment core were dated by AMS ¹⁴C (Beta Analytic Inc.) on 5 samples at 25 cm intervals of bulk organic matter.
- Analysis method includes XRF, grain size, loss on ignition (LOI), magnetic susceptibility.

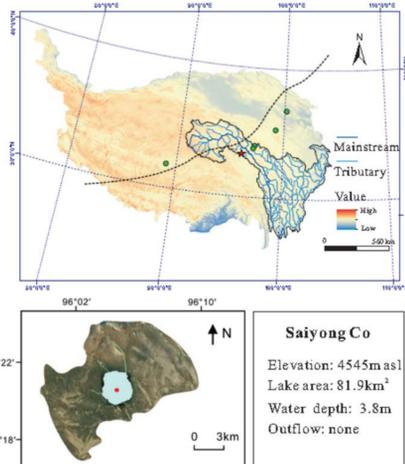


Fig.1 Location and setting

Results

- **Sediment description:** Scattered organic fragments were found throughout whole core, almost all of it was aquatic plants, which belong to submerged plants without stoma apparatus (Fig. 3A, B). Dimensions of the largest fragment: 0.3cm*1.0cm.

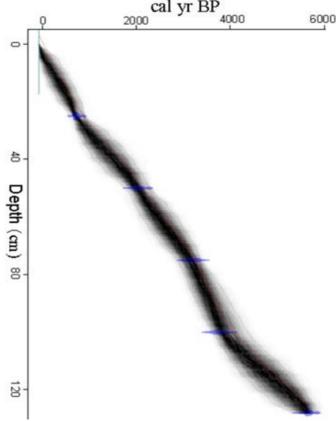


Fig.2 Bacon age-depth model

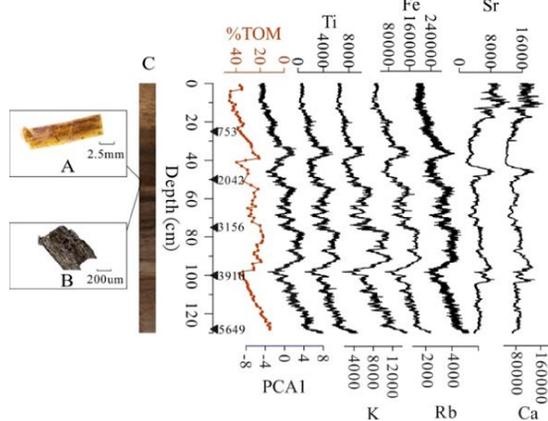


Fig. 3 Variations of selected element concentrations

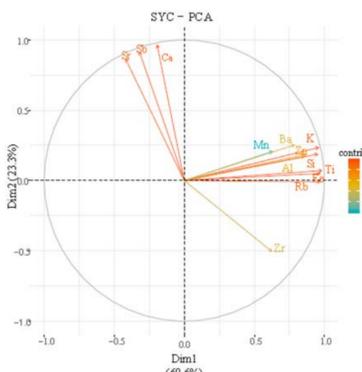


Fig. 4 PCA results

■ XRF:

PCA1 accounts for 60.6% of the XRF variance (Ti, Fe, Rb, Si, Al, Zn, K, Ba, Mn). PCA2 explains 23.3% of the XRF (Ca, Sr and Sb) (Fig. 3, 4).

Consistent pattern of Ti, Fe, Al, K and Mn suggest all these lithogenic elements are mainly of allogenic detrital. Therefore, variations of PCA1 can be interpreted as a proxy for runoff intensity in Saiyong Co catchment. Relatively high (low) PCA1 values might indicate intensified (diminished) runoff or humid (dry) condition.

■ Grain Size:

we interpret the relationship between grain size and runoff or precipitation is such that increased fine-grained sediment reflect high lake levels as a result of wetter conditions with enhanced runoff intensity and greater abundance of coarse particles as shallower lake levels during periods of lake contracted in dried conditions with reduced allochthonous input.

References

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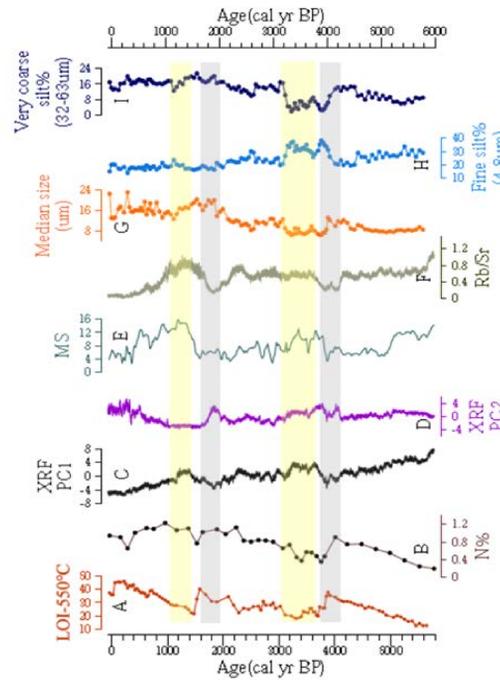


Fig.5 Physical sedimentology results of Saiyong Co

Discussions

- The decreasing trend of ISM of SRYR was interrupted abruptly at 4.1 ka, corresponding to 4.2 ka cold event within the uncertainties in chronology. Then ISM intensity increased rapidly after the cold event, mainly attributed to the elevated temperature accompanied with more precipitation or snowmelt water. Saiyong Co show increasing runoff intensity, high lake stand between 3.8-2.3 ka. An interval of relatively strengthen ISM occurred from 1.6 ka. Over the last 1.2 ka, proxies exhibit gradually weakening ISM behavior.

- Saiyong Co results suggest the changes in SRYR track the position of ITCZ with weakened ISM spanning past 5.8 ka. The dry condition emerged between 2.3 ka and 1.4 ka also suggest an aridity phase distributed over considerable regions, This widespread arid condition may be related to reduced Indo-Pacific SST and colder temperature on Tibetan Plateau, while strengthen El Niño conditions might add contribution to it (Fig. 6F, J). On the contrary, the relatively high moisture between 3.6 ka and 2.4 ka maybe due to enhanced Indo-Pacific SST and elevated temperature on the TP.

■ LOI-550°C:

LOI-550°C show considerable anti-phased throughout the whole core ($r=-0.91$), indicating the organic matter mainly contributed by autogenetic hydrophyte. (Fig. 3), so aquatic productivity was the source of sedimentary organic matter. Changes of lake water level indicated by grain size show generally consistency with LOI-550°C.

■ Rb/Sr, MS

In summary, the record of Saiyong Co is used to get insight into hydrological variations with in SRYR, showing a gradually weakening of runoff and precipitation after the mid-Holocene. All the proxies indicate a gradual decline of the ISM, with several significant fluctuations (Fig. 5).

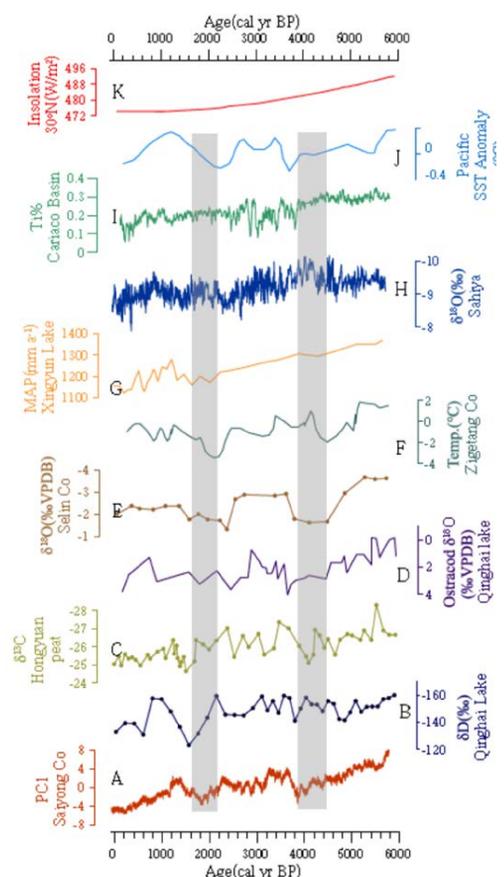


Fig.6 Comparison of results from (a) PC1 of Saiyong Co, (b) δD from Lake Qinghai, (c) δ¹³C at Hongyuan bog, (d) δ¹⁸O from Lake Qinghai, (e) Selin Co δ¹⁸O, (f, g) pollen-based temperature and precipitation from Zigetang Co and Xingyun lake, (h) Sahiya Cave δ¹⁸O, (i) Cariaco basin Ti%, (j) western Pacific SST anomaly, (k) 30° N insolation

Summary

Our study show an enhanced aridity during this period, where such knowledge is scarce in SRYR. Comparison with other regional records on central and eastern Tibetan Plateau, India, Arabian Sea suggest a large coherent ISM variability related to summer insolation and ITCZ and Indo-Pacific SSTs. However, due to the practical significance of SRYR and its climate system complexity and spatial heterogeneity, spatiotemporal expression focus on centennial and decadal ISM evolutions worthy further investigations. (Unpublished)

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