

Climatic variability in arid central Asia over the last 2000 years documented by Bosten Lake, China

Xiao-zhong Huang¹ Fa-Hu Chen¹ Jonathan A. Holmes²

1. CAEP, MOE Key Laboratory of West China's Environmental System, Lanzhou University, Lanzhou 730000, China.
2. ECRC, Geography Department, University College London, London, UK; contact person: Xiaozhong Huang, email: xzhuang@lzu.edu.cn

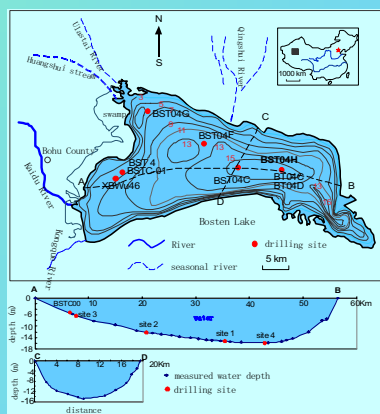
Introduction

The Northern Hemisphere has experienced three distinct climate phases during the past two millennia - the Medieval Warm Period (MWP), the Little Ice Age (LIA) and the recent rise in global temperatures. The past studies suggested that the MWP was a 'Little Climate Optimum' period in Europe and North America experienced **periodical droughts**. How did past climate evolve and how did it influence the environment and culture (such as 'the Silk Road') in arid central Asia remain poorly understood, especially with the **humidity variations** at centennial to multi-centennial timescale.

Geographical Settings

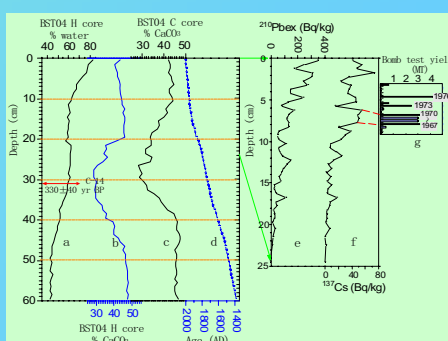


Bosten Lake (41°56'N ~ 42°14'N, 86°40'E ~ 87°26'E) is located on the southern slope of Tianshan Mountains and lies in the southeastern part of Yanqi Basin between Tianshan and Taklimakan Desert in the Tarim Basin. Bosten Lake (1048 m a.s.l.) is the largest inland freshwater lake in China with a surface lake area of c. 1000 km², maximum water depth of 16.2 m and an average depth of 8 m. Because of its arid climate, Bosten Lake is surrounded by large area of desert vegetation and lack of forest in the Tianshan mountains.

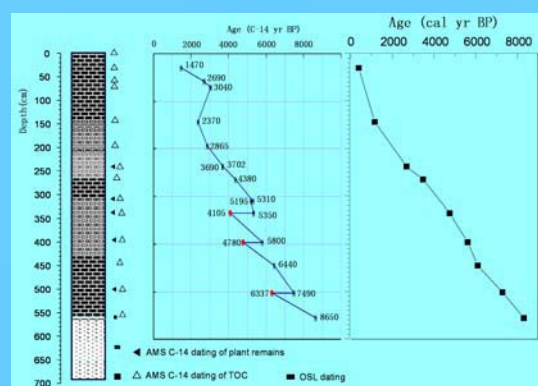


A series of cores were retrieved from Bosten Lake in June, 2000 and Feb., 2004. The photo shows that we were drilling the cores by using Kullenberg type piston corer at the platform of lake ice in the winter.

Lithology and Chronology



The ²¹⁰Pbex and ¹³⁷Cs (see curve e, f) were measured at 0.5 cm intervals on a Glew core retrieved from BST04H core site. BST04 C core was drilled at a site 7 km west of the BST04H core site, and its



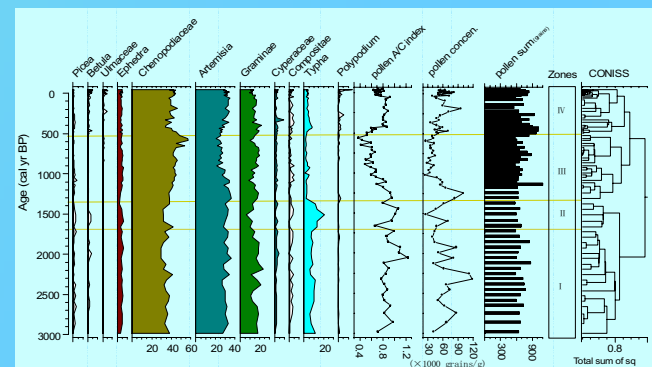
carbonate content (curve c) varies with a same trend as that of H core. Curve d is the age model of BST04H core.

The chronology of the BST04 H core is based on ²¹⁰Pb and ¹³⁷Cs, 19 AMS ¹⁴C dating results and other 3 OSL datings. Comparisons of radiocarbon dates based on total organic carbon (TOC) and terrestrial plant remains from the same depth intervals indicate a difference of 1140 years. As a result, an 1140-year age correction was applied to the remaining TOC dates. Then, the ages were calibrated to calendar ages.

Results

Pollen Assemblages

Standard procedures were employed for pollen extraction with little modification. Averagely 703 pollen grains were counted per sample, and the main compositions of the pollen assemblage are Chenopodiaceae, *Artemisia*, Gramineae, *Ephedra* and *Typha*. The pollen assemblage is shown in the following Figure plotted with Tilia.

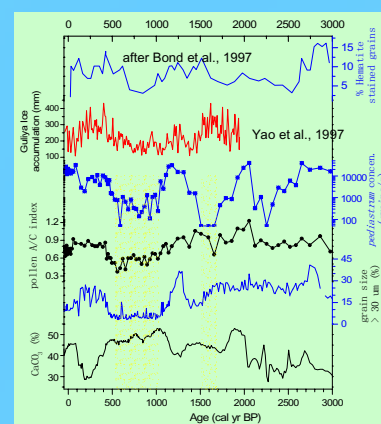


Pollen assemblage diagram of BST04H core since 3000 cal yr BP

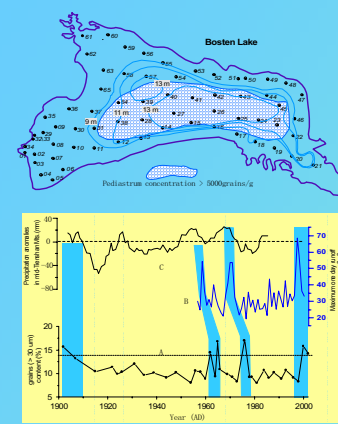
The pollen assemblage of the BST04 H core was divided with 4 zones with *Tilia* coniss.

The pollen A/C index was proved as a good humidity indicator in arid, semi-arid area, and the driest stage between 1100 and 500 cal yr BP (ca. 850 ~ 1450 AD) can be inferred with it.

Other proxies



Multi-proxy analysis of BST04H core



Analysis on the surface sediments suggests that the *Pediastrum* concentration strongly correlates with water depth; As a freshwater algae, it is also strongly influenced by the water salinity.

The coarse sand content of the sediments is comparable with Kaidu River runoff, which indicates that the grains size is mainly controlled by the river runoff and regional precipitation.

Therefore, it can be inferred that the regional climate was extremely **DRY** during the **MWP** suggested by low *pediastrum* concentration, higher carbonate content, finest grain size and lowest A/C index. A similar drought event also can be identified at around 1650~1500 cal yr BP (ca. 300~450 AD). On the other hand, some humid periods, for example the LIA, can be concluded. Bosten Lake recorded humidity variations generally agree with the snow accumulation in Guliya ice core, and regional humid climate is also correlated with North Atlantic cooling events. In the recent hundred years, proxies indicated that regional climate was warm and dry but with a humidification trend.

Discussion and conclusions



The Silk Road is an important channels joining the ancient cultures in central Asia, India and China. Loulan once was an important station on the way, but it totally disappeared from historical documents from 330 AD, and it is a secret in the history.

The regional humidity variations during the past two millennia documented in Bosten Lake could be used as natural climatic background to explain the history evolution/dynasty succession in western China and the rise and fall of the Silk Road. The humid climate during Han Dynasty (ca. 0-300 AD) and Tang Dynasty (600-800 AD) corresponded to the culture expansion and busy Silk Road recovered by archeological discoveries, while the dry climate during 300-450 AD and 800-1500 AD was responsible to the collapse of Loulan culture and some other ancient cities (boomed in Tang Dynasty) covered by fluvial aeolian sands presently.

>Summary: The dry MWP stands in vivid contrast against humid LIA climate in central Asia, and the regional climatic regime is generally cold-humid and warm-dry. In the past two millennia, regional climate strongly influenced the culture development.

Chen F.H., Huang X.Z., Zhang J.W., Holmes J.A., Chen J.H. 2006. Humid Little Ice Age in arid central Asia documented by Bosten Lake, Xinjiang, China. Science in China (Ser D).

✓ This study is supported by NSFC grants