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Elements and Magnetic Susceptibility Dataset from the Lake Yamzhog Yumco Core in Southern Tibetan Plateau over the Past 2000 Years

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Abstract: The chronology presented herein is based on ^{210}Pb and AMS ^{14}C dates from a series of 50-cm sediment cores recovered from the northwestern basin of Yamzhog Yumco lake on the southern Tibetan Plateau using a Russian drill corer. Data for elemental geochemistry and magnetic susceptibility were acquired using an X-ray fluorescence core scanner for *in situ*, high-resolution, continuous, multi-element analyses. Multivariate numerical analyses (correlation analysis and principal component analysis) were used to reconstruct how the environment of the southern Tibetan Plateau has changed over the past 2000 years. Temperature and precipitation reconstructions indicate that the Medieval Warm Period was associated with low precipitation and high temperatures whereas the Little Ice Age was associated with high precipitation and low temperatures. The climate records from Yamzhog Yumco lake confirm a cold–moist/warm–dry climate pattern on the southern Tibetan Plateau over the past 2000 years. The lake levels in the second millennium were generally higher than those in the first, this being affected by both temperature and precipitation. The dataset is archived in .xlsx format with a data size of 23 KB.

Keywords: Tibetan Plateau; Elemental chemistry; Lake Yamzhog Yumco; Climate change

Dataset Availability Statement:

The dataset supporting this paper was published and is accessible through the *Digital Journal of Global Change Data Repository* at: https://doi.org/doi:10.3974/geodb.2019.05.19.V1.

1 Introduction

The climatic history of the past 2000 years is of great scientific interest for (i) understanding future climate conditions and (ii) assessing present and future human-induced climatic changes superimposed on natural trends[1]. For the southern Tibetan Plateau (TP), the cli-

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[2] Guo, C., Ma, Y. Z., Li, J. F. Elements and magnetic susceptibility dataset from the Lake Yamzhog Yumco core in Southern Tibetan Plateau over the past 2000 years [J/DB/OL]. *Digital Journal of Global Change Data Repository*, 2019. https://doi.org/10.3974/geodb.2019.05.19.V1.

mate changes in the region over the past 2000 years are represented quantitatively in a dataset of the intensity of major elements and magnetic susceptibility in cores from Yamzhog Yumco (YY) lake[2]. Located at mid-to-low latitudes in the northern hemisphere, the TP is among the areas most sensitive to climate change, and its climate is controlled by interactions with large-scale atmospheric circulations, including East Asian monsoons, Indian monsoons, and mid-latitude westerlies[3]. Unfortunately, most investigations to date have been restricted to the northern sections of the TP[4–6], and thus the climatic variations in the southern region over the past 2000 years remain poorly known. The climate changes there have contrasting features, with the precipitation or moisture records for different climatic regions occasionally exhibiting opposing trends, which may indicate regional atmospheric circulation from the associated topography. Therefore, a better understanding of how the temperature-precipitation combination varies on different timescales would help decipher the climatic processes and force mechanisms of natural climatic variability. Variations in chemical elements and magnetic susceptibility in lake sediment are controlled by various factors, such as physical and chemical weathering processes, relative contributions to biogenic and regional climate changes, and human activity[7]. The present dataset is helpful for reconstructing the patterns of climate change in the southern TP over the past 2000 years, and it is important for a better understanding of the mechanisms of climate change in monsoon areas at high elevation.

2 Metadata of the dataset

The metadata for the "Elements and magnetic susceptibility dataset from the Lake Yamzhog Yumco core in Southern Tibetan Plateau over the past 2000 years"[2] is summarized at Table 1, including the dataset full name, short name, authors, year, data format, data size, data files, data publisher, and data sharing policy, etc.

3 Methods

3.1 Data Sources

The raw data were sourced from drilling the lake core and analyzing them in the laboratory. Four 50-cm sediment cores were recovered from the lake basin using a Russian drill corer (5-cm internal diameter), as shown in Figure 1. The lithologies in these four sediment cores are well correlated. The sediment cores in PVC pipes were transported to the laboratory, where they were described and subsampled shortly thereafter. The chemical elements and magnetic susceptibility were determined at 0.5-cm resolution using X-ray fluorescence core-scanning measurements. The observations and grain-size analysis indicate that each core could be divided stratigraphically into four major units from bottom to top, namely Sediment Unit 1 (50–40 cm; a gray-brown clay-silt layer), Sediment Unit 2 (40–34 cm; a gray-white silt layer), Sediment Unit 3 (34–13 cm; a gray-brown clay-silt layer), and Sediment Unit 4 (13–0 cm; characterized by abundant plant roots and comprising Subunit 1 (13–7 cm; a gray silt layer), Subunit 2 (7–5 cm; a gray-white fine sand layer) and Subunit 3 (5–0 cm; a gray-white medium sand layer) (Figure 2).

Table 1 Metadata summary of the "Elements and magnetic susceptibility dataset from the Lake Yamzhog Yumco core in Southern Tibetan Plateau over the past 2000 years"

Items	Description
Dataset full name	Elements and magnetic susceptibility dataset from the Lake Yamzhog Yumco core in Southern Tibetan Plateau over the past 2000 years
Dataset short name	Elem&MS_YamzhogYumco_p2000
Authors	Guo, C. AAF-6180-2019, College of Resource Environment and Tourism, Hubei University of Arts and Science, gc@mail.bnu.edu.cn Ma, Y. Z. AAF-6498-2019, Faculty of Geographical Science, Beijing Normal University, mayzh@bnu.edu.cn Li, J. F., College of Resource Environment and Tourism, Hubei University of Arts and Science, 11650@hbuas.edu.cn
Geographical region	Southern Tibetan Plateau
Year	0–2000AD
Data format	.xlsx
Data size	23 KB
Data files	The chronology, elements and magnetic susceptibility sequence during the past 2000 years
Foundations	Ministry of Science and Technology of P. R. China (2013CB956001); National Natural Science Foundation of China (41571186, 41330748)
Data publisher	Global Change Research Data Publishing & Repository, http://www.geodoi.ac.cn
Address	No. 11A, Datun Road, Chaoyang District, Beijing 100101, China
Data sharing policy	***Data*** from the Global Change Research Data Publishing &Repository includes metadata, datasets (in the *Digital Journal of Global Change Data Repository*), and publications (in the *Journal of Global Change Data & Discovery*). ***Data*** sharing policy includes: (1) ***Data*** are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use ***Data*** subject to cita-tion; (3) Users, who are by definition also value-added service providers, are welcome to redistribute ***Data*** subject to written permission from the GCdataPR Editorial Office and the issuance of a ***Data*** redistribution license; and (4) If ***Data*** are used to compile new datasets, the 'ten per cent principal' should be followed such that ***Data*** records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset[8]
Communication and searchable system	DOI，DCI，CSCD，WDS/ISC，GEOSS，China GEOSS，Crossref

3.2 Algorithm Principle

Based on previous environmental interpretations for different element indices, we used correlation analysis (CA) and principal component analysis (PCA) to summarize and classify the chemical elements and determine their environmental meanings.

3.2.1 Correlation Analysis

CA was performed to discern similarities throughout the entire set of proxies. The correlation of elements is controlled by the geochemical behavior in the epigenetic environment, and the CA of different elements can reveal the associated relationships among them and identify their possible sources[11]. A higher correlation among chemical elements produces a larger correlation coefficient.

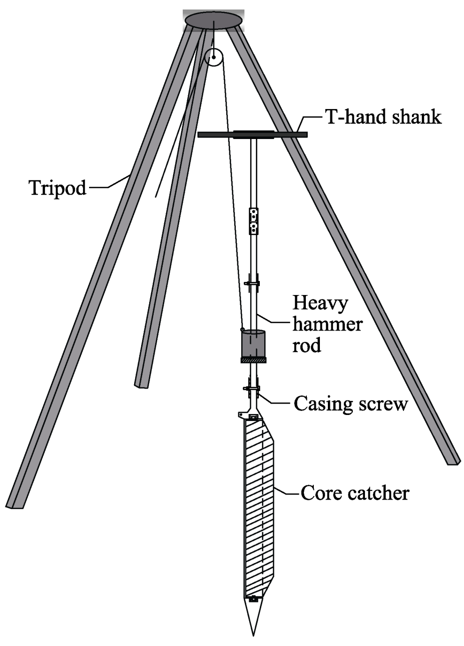

Figure 1 The diagram of Russian drill corer[9]

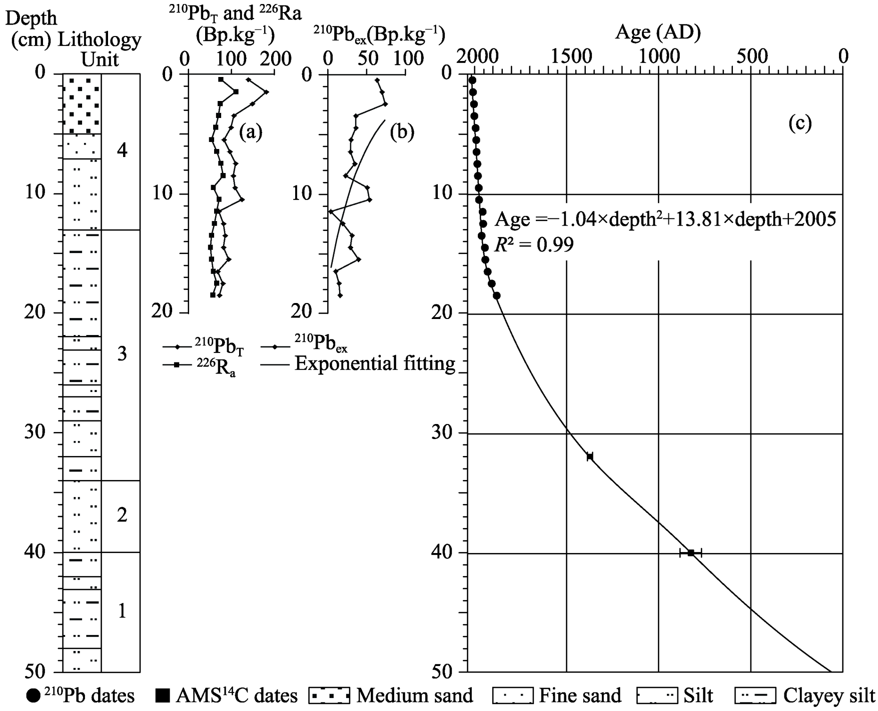

Figure 2 Stratigraphy and chronology of Lake Yamzhog Yumco core[10]

3.2.2 Principal Component Analysis

PCA can describe objectively the main factors that control the elemental composition of sediments. This approach was chosen to provide a two-dimensional representation of high-dimensional geometric distances between each element as defined in transect. PCA has been used frequently for elemental analysis because it is easily implemented on large datasets and the results can be displayed graphically[12].

4 Data Results and Validation

4.1 Data Composition

The dataset includes (i) ^{210}Pb activities at 1-cm intervals from the top 19 cm, (ii) two AMS ^{14}C dates obtained from 32–40 cm, and (iii) chemical elements and magnetic susceptibility data at 0.5-cm resolution from the lake cores.

4.2 Data Results

4.2.1 Chronology

The final age-depth model was generated based on the ^{210}Pb and AMS ^{14}C dates using a second-order polynomial regression model with 95% significance as determined using the *p* value. The results from the model were then used to extrapolate the age of the bottom samples as being approximately 100 AD, and the chronology of the YY lake core was established over the past 2000 years (Figure 2).

4.2.2 Correlation Analysis

Although the elements demonstrate several correlations, three particular groups are observed, namely (i) Si, K, and Ti; (ii) Fe, Cu, Zn, and Pb; and (iii) Ca and Sr. Note that the correlation characteristics of Al, Y, Rb, and Zn are not significant and have obvious transitional characteristics, thus they are not included in the following discussion.

4.2.3 Principal Component Analysis

The PCA results show that the first three eigenvectors account for 82.9% of the total variance. The first eigenvector represents 47.3% of the total variance and displays high positive scores for Si, K, and Ti. The second eigenvector accounts for 23.8% of the total variance and is characterized by high positive scores for Br and Pb, and to lesser extents Fe and Cu. The third eigenvector accounts for 11.9% of the total variance and shows high positive scores for Ca and Sr at the positive end (Figure 3).

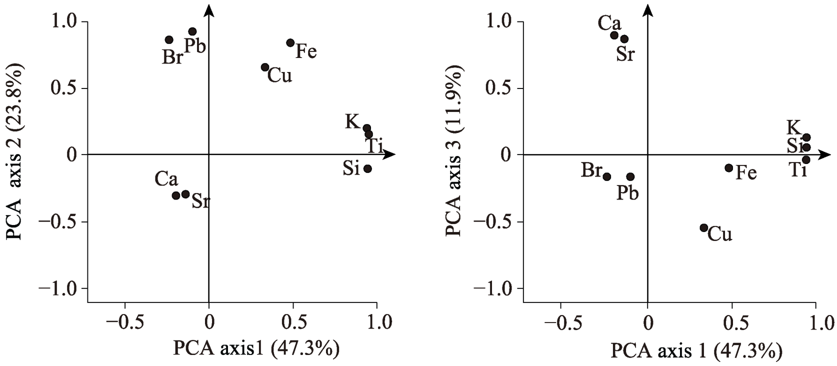

Figure 3 Major elements from Lake Yamzhog Yumco core[10]

The PCA confirms the inferences observed previously using CA. First, Si, K, and Ti contribute to the first eigenvector, thereby suggesting that they have a common origin. This is likely related to their occurrence in terrigenous detrital minerals and can represent precipitation in the catchment[11]. Second, Fe, Pb, Cu and Br contribute to the second eigenvector, which is likely due to the influence of redox conditions in the deposition[13]. Note that the high correlation of Br may be because it is controlled by temperature[14]. Third, the strong correlation between Ca and Sr in the third group suggests that the record contains carbonate deposition. Ca and Sr in lake sediments are related to carbonate weathering in the catchment and in-lake deposition of $CaCO_3$ with the co-deposition of $SrCO_3$, which increases with heightening water level of lake.

4.2.4 Environmental Variations over Past 2000 Years

The robust chronology and high-resolution chemical elements and magnetic susceptibility sequences[10] allow us to reconstruct the history of climate variations over the past 2000 years in the study area. In addition, the magnetic susceptibility has been discussed widely as an effective indicator of precipitation changes in the basin[16]. Finally, we select Ti, Si, K, and magnetic susceptibility from which to reconstruct the precipitation changes in the YY lake basin. The strengths of Br, Fe, Cu, and Pb indicate changes in temperature, and the strengths of Ca, Sr and Ca/Fe indicate changes in the lake level. The records from YY lake confirm a cold-moist/warm-dry climate pattern in the southern TP over the past 2000 years. During the Medieval Warm Period (800–1200 AD), the strengths of Si, K, and Ti and the magnetic susceptibility were relatively high whereas the strengths of Br, Fe, Cu, and Pb were relatively low, thereby suggesting a dryer climate associated with low precipitation and high temperatures. In contrast, during the Little Ice Age (1200–1900 AD), the simultaneous increases in Si, K, Ti, and magnetic susceptibility and the dramatic decreases of Br, Fe, Cu, and Pb reveal humid climate conditions with high precipitation and low temperatures. Moreover, given the effects of temperature and precipitation, the lake levels in the second millennium were generally higher than those in the first (Figure 4).

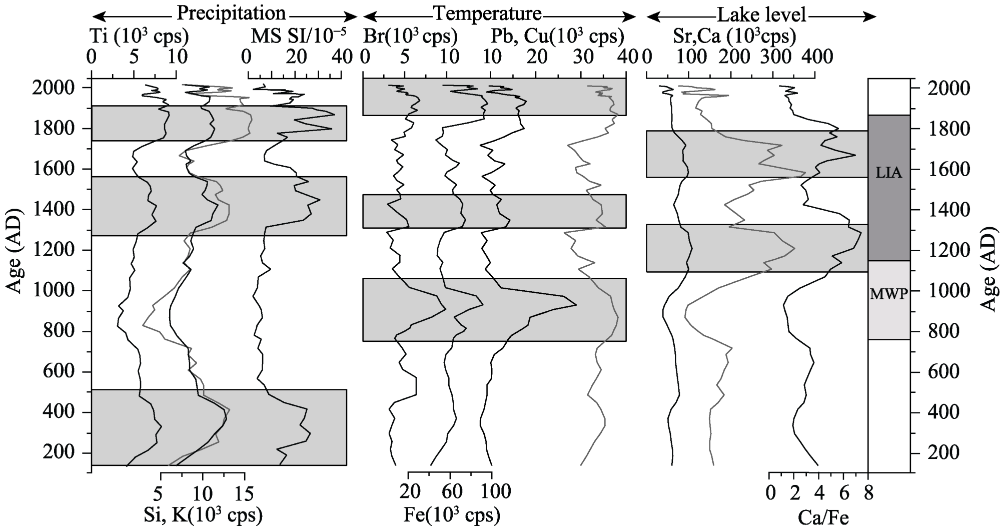

Figure 4 Reconstruction of the environmental conditions (precipitation, temperature, water level) of Lake Yamzhog Yumco catchment during the past 2000 years[10] (MWP: Medieval Warm Period; LIA: Little Ice Age)

4.3 Data validation

We assessed the validity of the chemical-element indices of temperature, precipitation, and lake-level proxies based on a Pearson correlation test between the strength of elements on top of the lake cores and modern instrumental records from nearby hydrological stations[17], as given in Table 2. The intensities of Ti and K have higher correlations with the mean annual precipitation (MAP), with *R* values reaching 0.69 and 0.79, respectively, and passing the double-sided test at a 0.01 confidence interval. Analogously, the intensities of Br and Fe have higher correlations with the mean annual temperature (MAT), with *R* values reaching 0.79 and 0.73, respectively, and passing the double-sided test at a 0.01 confidence interval. In addition, the strength of Ca is correlated well with the lake level ($R = 0.75$ and at 0.01 level double side). Therefore, it is considered that changes in the chemical elements in the YY lake cores are effective for reflecting past environmental changes in the southern TP.

Table 2 Pearson-correlation test between major elements and modern instrument records

Element	MAP	MAT	Lake level
Ti	0.69**		
K	0.68**		
Br		0.79**	
Fe		0.73**	
Ca			0.75**

** At 0.01 level (double side)

5 Discussion and Conclusion

The southern TP is located at the southwest end of mainland China and is influenced more strongly by the Indian summer monsoon than are the northern parts of the TP. Thus, the volatility and differences in climate change are more pronounced. Based on lake records from the southern TP, a robust chronology was used as the framework, and various mathematical and statistical methods were used to reconstruct a high-resolution environmental-change model of the southern TP over the past 2000 years based on records of major elements and magnetic susceptibility. The data validations suggest that variations in the major elements in jor elements in YY lake cores are effective for reflecting past environmental changes. These results provide a reference for exploring the response of global climate change in the southern TP over the past 2000 years.

Author Contributions

Ma, Y. Z., designed the algorithms of dataset. Guo, C., contributed to the data processing and analysis. Li, J. F., wrote the data paper.

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