MULTI-PROXY GEOCHEMICAL APPROACH TO RECONSTRUCT LATE HOLOCENE CLIMATE AND ENVIRONMENTAL CHANGES IN WESTERN SRI LANKA

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Introduction

Multi-proxy palaeoclimate investigations are extremely useful in reconstructing climate variabilities and tracking past or ongoing environmental changes in the landscape. Despite its excellent geographical location in the Inter Tropical Convergence Zone, palaeoclimate investigations in Sri Lanka have been rarely attempted. Organic geochemical proxies together with sediment texture and elemental ratios can be successfully used to trace information about past climatic conditions, vegetation, primary productivity and digenetic alterations of organic matter in lake sediments. Therefore, in this study, a 4.1-m undisturbed sediment core was retrieved from Bolgoda Lake situated in the western coast of Sri Lanka, and influenced by the southwest monsoon (SWM). Mollusc shells in the core were dated, and the age-depth model indicated a depositional history from ca. 3000 cal yr BP to present. Grain size, geogenic elements, total organic carbon (TOC) and nitrogen (TN), stable C and N isotopes, and biomarkers were investigated to reconstruct the palaeoenvironmental changes in the lake.

Results

Based on the changes in the different proxies the core was divided into four sections (zone 1: 2941-2390 cal yr BP, 385-252 cm; zone 2: 2390-1782 cal yr BP, 252-140 cm; zone 3: 1782-1299 cal yr BP, 140-60 cm; and zone 4: 1299 cal yr BP-present, 60-0 cm). High level of sand together with elevated minerogenic elements (K/Al, Mg/Al and Ti/Al) overlapped with the low content of redox sensitive elements (Fe/Al and Mn/Al) and increased Average Chain Length (ACL) for biomarkers. This suggests a warm climate and strong SWM (Sun et al., 2010) resulting in high lake level in zones 1 and 3. This is supported by increase in C_{15} fatty acids and elevated saturated: unsaturated fatty acids suggesting intense microbial activity (Baker et al., 2014) in the lake coupled to warm climatic conditions.

C/N >20, $\delta^{13}C$ values around –28 ‰, high Carbon Preference Index (CPI), high P_{wax} and dominance of long-chain lipid biomarkers suggest that the major organic matter source into the lake are C_3 terrestrial vascular plants transported from the catchment. The dominance of C_{31} alkanes in these sediments suggests presence of grasses, herbs and marsh vegetation that are abundant in the catchment. Exception to this general trend, occurs during the period extending from 2390-2153 cal yr BP (252-202 cm) that is characterized by significant input of algae and elevated productivity in the lake. This inference is drawn from intermediate C/N values (between 12-18), increased $\delta^{13}C$ and elevated TN mass accumulation rate (MAR). Enhanced aquatic plant index (P_{aq}) values fluctuate between 0.1 and 0.4 suggesting contribution from emergent macrophytes (Ficken et al., 2000) to be high during 2390-1782 cal yr BP (zone 2). The high levels of TOC and TN MARs corresponding with high CPI values of alkanes, fatty acids and higher plant alkane (HPA) index suggest enhanced organic matter accumulation and preservation (Baker et al., 2014; Meyers, 2003) coupled with increased rainfall and high lake level during the periods 2941-2390 cal yr BP (zone 1) and 1782-1299 cal yr BP (zone 3).

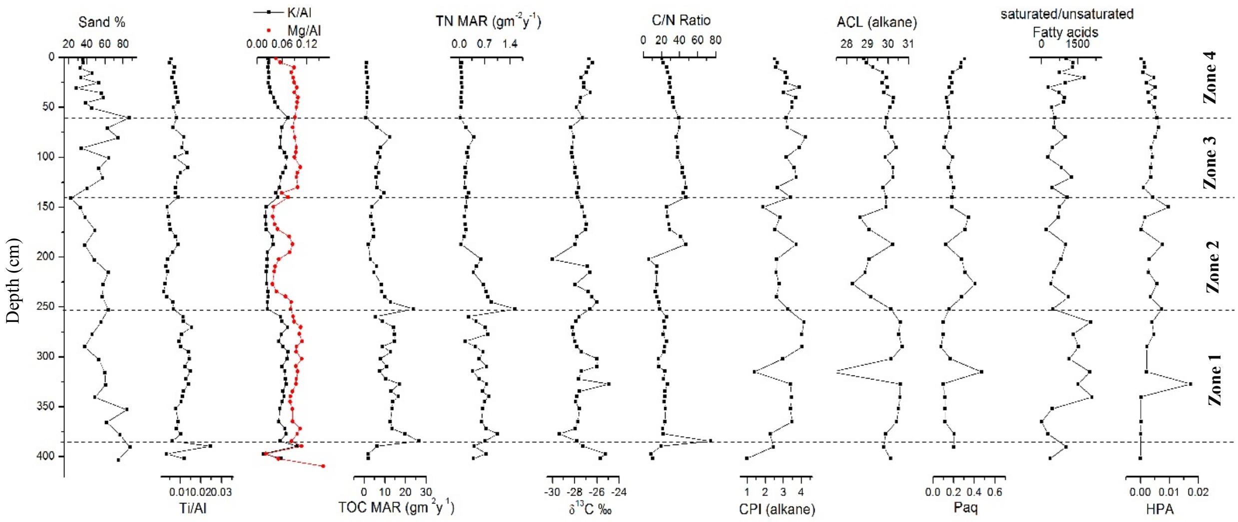

Figure 1 *Trends of selected geochemical proxies in Bolgoda Lake used to infer climatic changes: Sand (wt%), geogenic element ratios, Mn/Al, TOC and TN mass accumulation rates, $\delta^{13}C$, C/N, CPI and ACL indices of alkanes, Aquatic plant index (P_{aq}), saturated: unsaturated fatty acids, Higher plant alkane index (HPA).*

Conclusion

The different proxies in the Bolgoda core suggest that climate was wet/humid with intense SW monsoon precipitation that extends from ~3000 to 1300 cal yr BP. This resulted in enhanced chemical weathering and erosion in the catchment. The lake level was high during this period and degradation of sedimentary organic matter was less. The period extending from ~1300 cal yr BP to present represents a dry period with less intense SWM, and an overall weakening trend in precipitation during the late Holocene. However, no clear evidence on change in vegetation pattern was observed and terrestrial plants remain the dominant source of organic matter into the lake. Our records correlate with other regional palaeoclimate records in Sri Lanka and India suggesting that change in SWM was a regional phenomenon that affected the landscape.

References

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