1 Introduction

Lake Qinghai, famous as the largest inland saline lake in China, located on the high-altitude northeastern Tibetan Plateau, and four junctional zones of the East Asian summer monsoon (EASM), Indian summer monsoon (ISM), East Asian winter monsoon and the westerly jet stream prevail, making it sensitive to global climate change (e.g. Lister et al. 1991; Yu and Kelts 2002; Henderson et al., 2010). Due to its unique geographical location, Lake Qinghai has been attracted extensive attentions during the past two decades. For instance, Lister et al. (1991) have discussed effective humidity (E/P ratio) at Lake Qinghai in terms of $\delta^{18}O$ values of biogenic and bulk carbonates.

Generally, ostracod shells have been increasingly used as the geochemical approaches in paleoclimate research. Relative to inorganic carbonate, ostracod shells have its own advantages. Firstly, it can avoid contamination by detrital carbonates. Secondly, the composition of ostracod shells is very sensitive to environmental changes because their calcification occurs very quickly, from hours to several days. Previous studies have revealed that abundant ostracod shells were well preserved in Lake Qinghai sediments, also enabling it an ideal place to investigate paleoenvironmental changes. There are two species of ostracod identified in Lake Qinghai, including Limnocythere inopinata and Eucypris inflate (Henderson et al., 2003; Li et al., 2007). To the best of our knowledge, present paleoclimate studies on Lake Qinghai focused on monsoon and precipitation reconstruction. Until to now, few independent temperature indicators have been reported in Lake Qinghai. In this study, on the basis of the establishment of age model according to the radionuclide $^{137}$Cs dating, we have analyzed Mg/Li and Li/Ca ratios of ostracod shells at Lake Qinghai with the aim to deduce paleoclimate changes during the past 1000 years.

In the previous publications, both field and laboratory studies have shown that Li/Ca ratios of carbonate are chiefly controlled by temperature variations (Marriott et al., 2004a, 2004b). A series of laboratory-grown carbonate studies by Marriott et al. (2004a) have indicated that Li/Ca ratios of carbonate are inversely correlated with temperature.

There are two reasons to explain the negative correlation between Li/Ca ratios of ostracod shells and temperature. On the one hand, Lithium (Li) is incorporated into calcite crystals when carbonate is precipitated. Previous experiment has demonstrated that Li is preferentially incorporated into the 0001 face in calcite (Tiloloye et al., 1993). The 0001 face in calcite is exothermic when compared with other faces, and is likely in favor of the lower temperature (Parker et al., 1993). The 0001 face in calcite is exothermic when compared with other faces, and is likely in favor of the lower temperature (Parker et al., 1993). Therefore, the higher Li concentrations of carbonates may be associated with the lower temperature.

On the other hand, numerous works have revealed that the residence time of Li and Ca in the ocean are 2.5Ma and 1Ma, respectively (Hall et al., 2004). Researchers have calculated the residence time of Li in Lake Mono, with a surface area of 200km$^2$ and a volume of 27×10$^6$m$^3$, and we have obtained the residence time of Li in Lake Mono is 28ka (Tomascak et al., 2003). Compared with Lake Mono, Lake Qinghai has a larger surface area (4340 km$^2$) and volume (778×10$^8$m$^3$) (Wang et al., 1998), implying that Li and Ca in Lake Qinghai have the longer residence times than those in Lake Mono, which will keep the Li/Ca ratios of water constant on centennial to millennial scales. Therefore, we can conclude that Li/Ca ratios of ostracod shells may be a potential temperature indicator.

To testify this hypothesis, we compare temperature...
variations reconstructed from Li/Ca ratios of ostracod shells of *Eucypris inflate* with the temperature variations derived from meteorological records, and the good correlation between them is found. Due to the lack of temperature record in Lake Qinghai, the tree ring in adjacent regions has been applied for comparative research. Tree ring growth in Dulan and Qinlian were both interpreted to reflect temperature variations. In this study, they share some similarities between Li/Ca ratios of ostracod shells and the trends of temperature inferred from tree ring width in adjacent regions. Especially, the occurrences of Sporer and Mauder cold periods have further proved that Li/Ca ratios of ostracod shells may be an indicator for temperature reconstruction. Otherwise, the good relationship between Li/Ca and Mg/Li ratios in Lake Qinghai ($r=-0.68$, $n=58$, $p<0.01$) also reveal Mg/Li ratios can also been used as temperature proxy.

**Key words:** Lake Qinghai; Li/Ca ratios; Mg/Li ratios; temperature variations.

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**References**


