湖泊体系中长链烯酮研究进展

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中文摘要:长链烯酮不饱和度(U37k?)作为定量反映古温度变化的重要替代指标，已在海洋中得到广泛应用，但在湖泊中长链烯酮不饱和度与温度的关系及其母源研究则很少。课题组研究了中国不同气候带、不同水化学环境湖泊表层沉积物中长链烯酮，发现多数湖泊中存在2~4个不饱和键的长链烯酮，首次报道硫酸盐型湖泊中存在长链烯酮，总结了湖泊中长链烯酮的分布模式，探讨了分布模式与环境、母源的关系。研究了湖泊长链烯酮不饱和度与温度的关系，发现湖泊长链烯酮不饱和度与年均气温和春秋季节温度高度相关，建立了中国湖泊表层沉积物中长链烯酮不饱和度与温度的经验函数关系，结合文献中发表的数据，建立了从热带的北缘湖光岩玛珥湖到北极的格陵兰的湖泊沉积物中长链烯酮不饱和度与温度的经验函数关系: U37k? = 0.031? T + 0.094 (n=76, r2 = 0.67)。首次发现并成功分离出湖泊中长链烯酮母源等鞭金藻Chrysotila lamellosa, 通过单藻种控温培养，建立长链烯酮不饱和度与水温关系方程，实验室培养公式与经验公式斜率一致，验证了长链烯酮不饱和度温标，表明长链烯酮是可靠的陆地温标。

中文关键词:湖泊 长链烯酮 不饱和度 分布特征 温度 母源

The Occurrence and Distribution of Long Chain Alkenones in Lakes

Abstract:The alkenone unsaturation paleothermometer has been successfully and widely applied to reconstructing SST in most oceanographic settings. The utility of the alkenone unsaturation index in the marine system has stirred the interest in the study of LCK in the limnic system, in the hope that it can also be used as a paleotemperature proxy in lacustrine sediments. A suite of long-chain di-, tri- and tetra-unsaturated ketones whose chain lengths range from C37 to C39 with variable patterns of LCK were detected in the lake sediment samples. The ratio of C37:4 methyl ketone to the sum of C37 alkenones observed in different lakes is highly variable, and higher than that seen in marine systems. Different distribution patterns of LCK were detected in the surface sediment samples. The very high ratio of C37 / C38 may imply that dominant LCK-producing algae are probably similar to the species C. lamellosa and I. galbana. The detection of C38:4-2 ethyl alkenones suggests that the precursor organism might be similar to E. huxleyi G. oceanica and some species of Isochrysis galbana. However, if only C38:4-2 ethyl alkenone was identified, the precursor organism may be or closely related species to Chrysotila lamellosa or some species of Isochrysis galbana. Empirical relationships between the alkenone unsaturation index U37k’ and different tempera-ture sets (mean annual air temperature, mean annual air temperature in different seasons, and lake surface water temperature of July) were tested. The better correlation between U37k’ and temperature was obtained using mean annual air temperature, mean air temperatures of spring and autumn. Based on the new data from the reference the authors fit a new global linear regression of U37k’ and MAAT can be expressed as U37k’ = 0.031? T + 0.094 (n=76, r2 = 0.67), it covers the lake system from the lakes in Greenland to the lakes in the northern part of tropical area in China. Although problems such as species-uncertainty and other unknown factors for U37k’ temperature dependence remain existent, the equation might be the representative of the average contribution of LCK to sediments for these data over a wide range of surface temperatures, water chemistry and different alkenones-producer algal popula-tions. A lacustrine source, the non-calcifying species Chrysotila lamellosa Anand (Haptophyceae), was collected and isolated from an inland saline water body, Lake Xiarinur (Inner Mongolia). Its alkenone distribution pattern is similar to that of coastal marine strains of C. lamellosa, but the relationship between U37k’ index and culture tem-perature for the lacustrine species is quite different from that of the coastal species. A significant feature of the alkenones in this strain of C. lamellosa is the lack of C38 methyl alkenones, which might be used to distinguish the species from the marine haptophyte species Emiliania huxleyi and Gephyrocapsa oceanica. The authors examined U37k’ and U37k values for C. lamellosa as a function of culture temperature in a batch culture experiment. The cali-bration for U37k’ versus culture temperature (T) was U37k’ = 0.0257? T -0.2608 (n = 9, r2 = 0.97), from 14?C to 22?C. The slope of the equation is similar to the empirical relationship between U37k’ and mean annual air tem-perature in saline lakes. The authors’ studies show that the alkenone unsaturation index U37k’ is strongly controlled by environmental temperature the

precursor organisms live in, and can be used for palaeoclimate reconstruction. This supports the suggestion that the biosynthetic pathway of alkenones and the mechanism of their temperature signal may be similar in both marine and limnic systems. LCK might be used as an important paleotemperature proxy in the limnic environment.

keywords: lake alkenone U37k' distribution pattern temperature precursor organism