Abnormal positive δ^{13}C values of carbonate in Lake Caohai, Southwest China and their possible paleoenvironmental significances

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Carbon source inputs, CO_2 exchanges between atmosphere and lake water, as well as lacustrine productivity are commonly considered as the main controls on the δ^{13}C values of lake authigenic carbonates. Generally, δ^{13}C values of carbonates in most lakes are lower than +5‰, few are up to +13‰ [1]. Here, stable carbon isotopes were measured on bulk carbonates from a short sedimentary core in Lake Caohai, Guizhou Province, southwest China. The results showed that δ^{13}C values vary between -14.25‰ and +23.10‰, which is the largest carbon isotope variations discovered so far in carbonates from lacusrine sediments, and some δ^{13}C values are the most positive values up to +23.10‰, more positive than previously reported values. On the basis of combination with oxygen isotope and carbonate contents proxies, we suggested that the carbon isotope composition of carbonate from Lake Caohai was controlled by photosynthesis/ respiration of aquatic plants, and the input of bacteria to carbon isotope fractionation of organic matter may be responsible for the abnormal positive δ^{13}C values in Lake Caohai [2,3]. Therefore, more attention should be paid on the carbon isotope composition of carbonates in Lake Caohai in future research.

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Al diffusion in olivine: An experimental study

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Al content in olivine is temperature dependent [1] and diffusion is thought to be very slow [e.g. 2].

We performed a series of experiments of Al diffusion in San Carlos olivine and synthetic forsterite at 1300ºC and log fO2 = -0.7; -5.7 and atmosphere pressure. In order to provide an inside into mechanism of alumina substitution into olivine, activities of SiO_2, MgO and Al_2O_3 were buffered in all runs. Four mineral associations were used: (a) forsterite – periclase – spinel; (b) forsterite – spinel – sapphirine; (c) forsterite – sapphirine – cordierite; (d) forsterite – cordierite – enstatite and the results analysed by LAICPMS. Each profile was fitted to a one – dimensional diffusion model in a semi-infinite medium with a source reservoir maintained at constant concentration.

The concentration of Al at the interface in equilibrium with the high silica activity buffer (d) is 5 times higher than in case of the low silica activity buffer (a), changing from 50 ± 12 ppm to 220 ± 30 ppm. The solubility of Al in S.C.O. is 2 - 4 times higher than in forsterite (430 ± 50 ppm). These concentrations are 2-4 times lower then those calculated from olivine-spinel geothermometer (940 ± 170 ppm) [1] and obtained by partitioning experiments (755 ± 25 ppm) [3] at temperature of interest.

High rate diffusion of Al in S.C.O. and forsterite was obtained: $\log D_{Al/Fo} = -15.6 \div -13.2$ (m^2/s) and $\log D_{Al/Ol} = -15.1 \div -14.4$ (m^2/s). No dependence of Al diffusion rate on oxygen fugacity has been observed. The rate of Al diffusion was strongly controlled by activity of major cations (Si, Mg): there are 2 order of magnitude difference between diffusion coefficients of Al in forsterite in low and high silica activity experiments: $\log D_{Al/Fo(a)} = -15.5 \pm 0.1$ (σ) (buffer *a* with activities of $a_{SiO2} = 0.01$ and $a_{MgO} = 1.00$) compare to $\log D_{Al/Fo(c)} = -13.3 \pm 0.1$ (σ) (buffer *d* with activities of $a_{SiO2} = 0.58$ and $a_{MgO} = 0.14$). This difference suggests that the mechanism of Al substitution into the olivine lattice requires an ochtohidral site vacansy.

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