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Biomarker Record of Lake Van: Signals for Holocene Climate and Ecosystem Changes in Eastern Anatolia

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The ecosystem of Lake Van deserves special attention as the largest soda lake on Earth (area: 3522 km^2; maximum water depth: 451 m; water volume: 576 km^3; and alkalinity of 152 meq L^{-1}; Kempe et al., 1991; Thiel et al., 1997). We present new organic geochemical data on four Lake Van cores recovered from different parts, extending back to 10500 (uncalibrated) years before present. A total of 65 samples were analyzed using basic organic geochemical (LECO and Rock-Eval) and the 27 samples by detailed molecular organic geochemical methods (GC-MS and GC-IRMS).

Bulk/molecular organic geochemical properties of the sediments from cores P01, P04 and P05 (eastern part of the lake) indicate that the uppermost 2.5 m intervals of the cores exhibit different characteristics than the lower parts. TOC content varies between 0.7% and 6% and HI values between 175 and 535 mgHC/gTOC, with an average value of 325 mgHC/gTOC. The results indicate that the organic matter is of mixed to algal origin. This conclusion is supported by the n-alkane distribution, having its maximum at nC_{17}, and strongly suggesting predominantly aquatic producers. Lower intervals are lithologically characterized by relatively thicker varves, laminae and bands. TOC content varies in a narrow range between 0.9% and 1.5%. Low HI values (105-282 mgHC/gTOC) indicate organic matter input of terrestrial plant origin, which is supported by the n-alkane composition having the predominance of the C_{29} and C_{31} n-alkanes. However, core P07 (southwestern part of the lake) exhibits some differences in terms of sedimentary and bulk/organic geochemical properties. The whole core is characterized by a very distinct varved structure showing strong seasonality and the lack of bioturbation. Sediments contain relatively low TOC (0,9 to 2.8%) with the organic matter consisting predominantly of terrestrial to mixed type, as indicated by HI values of 78-330 mgHC/gTOC and C/N values of 8-10. The upper 2.3 m interval shows a dominance of long chain n-alkanes, whereas the lower parts contain a higher contribution of C_{17}, C_{21} and C_{33} n-alkanes, indicating higher organic matter contribution from algal sources.

δD values of n-alkanes vary over a wide range between -121‰ and -254‰ for the nC_{17}, nC_{27}, nC_{29} and nC_{31} alkanes in the sediments collected from the eastern part of the lake. The lightest and heaviest values were measured for nC_{27}. Relatively heavier values were observed for the sediments of the southwestern core, where δD values ranged from -110‰ to -202‰ for the nC_{17}, nC_{27}, nC_{29} and nC_{31} alkanes. In general, nC_{17} exhibits the lightest δD values in Lake Van sediments. Such light isotopic values of this compound probably reflect isotopically light δD values of the lake water. Relatively heavy δD values of long-chain odd carbon numbered n-alkanes may be enriched in relation to evaporation processes (Sachse et al., 2006).

We propose that significant ecological changes have occurred in the lake ecosystem since the early Holocene in terms of terrestrial organic matter flux and/or primary production processes which is related to climate shifts. Volcanic events appear to be also an important factor for the lake Van ecosystem. Probably, after the accumulation of the T-3 tephra layer (dated 2.8 cal ka BP by Landman et al., 1996, and Litt et al., 2009) the ecosystem has significantly changed and primary organic matter productivity has obviously increased.

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