Geophysical Research Abstracts
Vol. 14, EGU2012-503-1, 2012
EGU General Assembly 2012

Structural and stratigraphic analysis of the Lake Van, Eastern Turkey: An integration of high resolution seismic and drilling data

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Lake Van in Eastern Anatolia (Turkey) is the fourth largest terminal lake in the world with a surface area of 3,574 km^2, a volume of 607 km^3, a maximum depth of 450 m, and a maximal length of 130 km WSW-ENE. In summer 2010, Lake Van was chosen for scientific drilling in the framework of the International Continental Drilling Program (ICDP) aiming to recover long paleoclimate and paleoseismic archives. Two sites (Ahlat ridge and Northern basin) were successfully drilled based on seismic data collected during a pre-site survey in 2004. Here we present a joint interpretation of the seismic and drilling data.

Seismic data reveals the main structural features inside the lake, including the Northern basin, Tatvan basin, Ahlat sub-basin, and Deveboynu basin. These basins are separated by basement ridges such as Northern and Ahlat ridges. Seventeen seismic sequence boundaries including the top of the acoustic basement were interpreted and mapped in the Tatvan basin. The time-structure maps were converted into depth using the time-depth relationship constructed from seismic-to-well tie at the Ahlat ridge well. The structure maps of the sequence boundaries exhibit tilting to west, suggesting that the sequences were deposited with greater subsidence in the west. NE-trending normal faults are dominant; E-W oriented thrust faults are seen locally.

The seismic sequences in basins are dominated by an alternation of well-stratified and chaotic reflecting layers. The chaotic seismic facies are interpreted as mass-flow deposits (up to $\sim$50 m thick), most probably triggered by earthquakes and/or rapid lake level fluctuations. The absence of mass flows in Ahlat sub-basin indicate that most mass flows originate close to the southern shore of Lake Van and that Ahlat ridge is likely to have acted as a structural barrier for these mass flows. The moderate-to-high-amplitude, well-stratified facies seen in the deeper parts of the basins are interpreted as lacustrine deposits and tephra layers. Core-to-seismic correlation supports this interpretation; strong high-amplitude reflections on seismic data correlate well with thick ($\sim$2 m) tephra layers.

Seismic data suggest a minimum age of 500 ka for Lake Van, consistent with the preliminary results of core dating. Since then, lake level fluctuations reaches an amplitude of more than 500 m (up to 450 m deeper and 80 m higher than the present lake level) but the deep basins were permanently filled with water.