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Seismic investigations of ancient Lake Ohrid (Macedonia/Albania): a pre-site survey for the SCOPSCO ICDP-drilling campaign

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Lake Ohrid (Macedonia/Albania) is probably the oldest lake in Europe (2-5 Ma), and has been found as an important archive to study the sedimentary evolution of a graben system over several million years. Lake Ohrid has a length of 30 km (N-S) and a width of 15 km (W-E) and covers an area of 360 sqkm. Two major mountain chains surround the lake, on the west side the Mocra Mountains (app. 1500 m) and on the east side the Galicica Mountain (app. 2250 m). With more than 210 endemic species described, the lake is a unique aquatic ecosystem that is of worldwide importance. An international group of scientists has recently submitted a full drilling proposal entitled SCOPSCO (Scientific Collaboration On Past Speciation Conditions in Lake Ohrid) to ICDP in order to (i) to obtain more precise information about the age and origin of the lake, (ii) to unravel the seismotectonic history of the lake area including effects of major earthquakes and associated mass wasting events, (iii) to obtain a continuous record containing information on volcanic activities and climate changes in the central northern Mediterranean region, and (iv) to better understand the impact of major geological/environmental events on general evolutionary patterns and shaping an extraordinary degree of endemic biodiversity as a matter of global significance.

The lake was the target of several geophysical pre-site surveys starting with a first shallow seismic campaign in spring 2004 using a high resolution parametric sediment echosounder (INNOMAR SES-96 light). Airgun multichannel seismic data were collected during two surveys in 2007 and 2008, resulting in a dense grid of seismic lines over the entire lake. In total 650 km of shallow seismic lines 400 km of airgun multichannel seismics demonstrates the potential of Lake Ohrid as target for ICDP.
Seismic profiles show that the lake can be divided into slope areas and a large central basin. The slope areas are characterized by a dense net of faults, clinoforms, and slide deposits. The major faults are the eastern and western graben fault but numerous additional faults, especially in the northern part of Lake Ohrid, seem to be active, as we can trace them from the basement up to the lake floor. Clinoforms that are mainly found in the southern part of the lake, the main water supply area, indicate major lake level fluctuations. Additionally, slides are widespread and were mainly mapped based on the high resolution sediment echosounder data. In contrast the central basin shows widespread areas with a thick undisturbed sedimentary succession. No indications for a dry lake are found in this part of the lake, hence offering the possibility to recover long, continuous archives for the entire lifetime of Lake Ohrid.

The dense net of seismic profiles allowed us to map the total sediment thickness (measured in two-way-travel time because a good velocity model has not been calculated yet) on top of the basement in high lateral resolution. Values vary in between 0 s and 0.84 s TWT at places where the basement strikes out of the lake floor and the central part of the lake, respectively. The maximum sediment thickness of up to 680 m can be calculated assuming an average velocity of 1600 m/s for lacustrine sediments.
Five primary drill sites have been chosen as promising ICDP sites. The most important one is located in the central part of Lake Ohrid basin at a water depth of 250 m and will provide substantial information to the age and origin of the lake, a complete record of the environmental history and of tephra deposition, and forms the basis to link evolutionary changes with geological events. Another four drill sites closer to the shore of the lake will provide information to major changes of the hydrological regime, the age of ancient foresets as well as lake level changes, the tectonic activity, and mass movements.