Depositional history of Lake Chala (Mt. Kilimanjaro, equatorial East Africa) from high-resolution seismic stratigraphy

Aihemaiti Maitituerdi¹, Maarten Van Daele², Dirk Verschuren³, Marc De Batist², and Nicolas Waldmann¹

¹Dr. Moses Strauss Department of Marine Geosciences, Leon H. Charney School of Marine Sciences, University of Haifa, Mount Carmel 3498838, Israel
²Renard Centre of Marine Geology (RCMG), Department of Geology, Ghent University, Krijgslaan 281/S8, B-9000 Ghent, Belgium
³Limnology Unit, Department of Biology, Ghent University, K. L. Ledeganckstraat 35, B-9000 Ghent, Belgium

Sediments deposited in Lake Chala constitute a high-resolution archive of past climate and environmental change in equatorial East Africa spanning two glacial-interglacial cycles. To correctly interpret the proxy records it contains, it is crucial to understand the evolution of lacustrine sedimentation in this volcanic crater basin since its formation on the lower south-eastern slope of Mt. Kilimanjaro. A dense grid of 37 km high-resolution seismic-reflection profiles allowed the reconstruction of the depositional history of Lake Chala. The seismic-stratigraphic sequence comprises sixteen distinct and finely-stratified units (U1-U16, youngest to oldest), grouped into five major depositional stages. Depositional stage I (U16, ~243-198 ka) marks the initiation of sedimentation in the originally ring-shaped depositional area surrounding two central tuff cones emerging from the basin floor and is characterized by a high rate of sediment accumulation and frequent occurrence of mass-wasting events (MWEs) under conditions of a relatively low lake-surface level compared to today. Depositional stage II (U15-U12, ~198-114 ka) represents the onset of basin-wide sedimentation above the central tuff cones, implying a higher position of the lake surface, less sediment focusing, and a shift to more strictly hemipelagic sedimentation. Multiple large-scale slope failures occurred around the basin periphery accompanying the progressive rise in lake level. Depositional stage III (U11-U8, ~114-97 ka) represents the development of a relatively flat lake floor under a significantly lower lake level, with evidence for strong sediment focusing implying accelerated sediment accumulation in central bottom areas. Depositional stage IV (U7-U4, ~97-20 ka) is again characterized by largely undisturbed hemipelagic sedimentation under mostly high lake-level conditions. However, frequent occurrence of mass-wasting events (MWEs) after ~48 ka resulted in the development of a longer, more gentle bottom slope towards the basin center. Depositional Stage V (U3-U1, ~20 ka BP to Present) represents the most recent period of basin evolution, during which the frequent occurrence of basin-focused sedimentation under a fluctuating lake surface level contributed to the establishment of the present-day very broad and flat basin floor of Lake Chala. Extrapolation of sedimentation rates established for the uppermost part of the sediment sequence, supplemented with basin-morphometric inferences derived from the successive depositional stages, yields an estimated age
of ~243 ka for the oldest sediments in Lake Chala.