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Differentiating climatic- and tectonic-controlled lake margin in rift system: example of the Plio-Quaternary Nachukui Formation, Turkana depression, Kenya

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The Turkana Depression is part of the eastern branch of the East African Rift System. This area consists of several Oligo-Pliocene north-south oriented half-grabens that connect the Ethiopian and Kenyan rift valleys. Exposed on the west side of the Lake Turkana, the Nachukui Formation represents a Plio-Quaternary syn-rift succession mainly outcropping near the border fault of the North Lake basin. This Formation consists of a > 700 m thick fluvial-deltaic-lacustrine sediments deposited in this area between 4.2 and 0.5 Ma. In this contribution, we present preliminary results from the investigation of the complete succession based on field geology. Facies description and sequence analyses are provided focusing on lake margin evolution through time and deciphering their controlling factors.

Two main types of facies association can be distinguished in the Nachukui Fm and reveal two main types of lake margins that alternatively developed in the Turkana basin. Type-1 is characterized by thick conglomeratic proximal alluvial fan fining laterally from the border fault to the central portion of the lake to gravelly distal alluvial fan. Conglomerate and gravel beds display recurrent wave reworking (ripples, clasts sorting, open-work), as well as intercalated shells placer and stromatolites beds. Laterally, facies rapidly grade to offshore siliciclastic muds. These facies are interpreted as aggrading and prograding coarse fan deltas that entered directly in the lake. Their subaqueous parts were then affected by waves and allowed the development of shell placers and stromatolite reefs. This facies association is generally included in thick packages representing long-term prograding trends of several hundred thousand years duration (> 500 ka). Type-2 is characterized by poorly developed alluvial fan near the border fault, rapidly grading laterally to a fluvial plain and then to well-developed wave-dominated coast (beaches, washover fans, coastal wedges), finally connected to offshore facies basinward. Such successions present more complex and higher-frequency prograding-retrograding sequences displaying superimposed periodicities ranging from 400 ka to 20 ka (i.e. Milankovitch's cycles). Type-1 facies association is interpreted to reflect tectonic-controlled lake margin when rift shoulder was characterized by high relief that directly fed large alluvial fan deltas. Type-2 facies association is interpreted to illustrate climatic-controlled lake margin developed during tectonic quiescence. At that time, coastal sedimentation prevailed recording paleolake fluctuations mainly related to astronomical forcings. Finally, in this contribution, an example of each lake margin type is presented. Facies are detailed, transect and depositional models are provided. We propose that these two types of facies association are keys to decipher tectonic and climatic forcings from other syn-rift successions in the geological record.