Extinction of larger benthic foraminifera in the late middle Eocene and across the Eocene-Oligocene transition, Kilwa district, Tanzania.

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It has long been known that a number of widespread and long-ranging genera of larger benthic foraminifera undergo extinction events in the late middle Eocene and across the Eocene-Oligocene transition. Larger benthic foraminifera peak in size within the middle Eocene, but large sized species of *Nummulites*, along with *Assilina* and *Alveolina* become extinct during the late middle Eocene, closely linked with muricate planktonic foraminiferal extinctions. Larger benthic foraminifera then suffer a second dramatic, rapid, extinction during the Eocene-Oligocene transition, with the last global occurrences of families such as Asterocyclinidae, Discocyclinidae, Pellatispiridae and a number of species belonging to the genus *Nummulites*.

However, questions remain about the exact timing of events and correlation with global stratigraphy, largely due to the mutually exclusive environments of larger benthic and planktonic foraminifera, and species endemism preventing exact correlation between provinces. Additionally the global regression associated with the transition means many shallow water carbonate successions are incomplete across the boundary itself. Adams *et al.* (1986) suggested the extinction of larger benthic foraminfera was a mass extinction caused by the drop in sea level, however data from new and recently discovered sections from Tanzania suggest this is not the case.

We have studied these larger benthic foraminiferal events in detail, using recently drilled cores from the Pande formation of southern coastal, (Kilwa District) of Tanzania. Within the Pande formation limestones rich in larger benthic foraminifera occur as secondary gravity flow deposits and as isolated specimens within the clays, allowing for a detailed study of larger benthic foraminifera events. These secondary limestone beds, along with clay specimens and numerous field samples (collected in 2009) have been used to construct an overview of the larger benthic foraminiferal ranges through the Eocene to Early Oligocene with particular emphasis on the two extinction events. This larger foraminferal stratigraphy is calibrated by stable isotope, planktonic foraminiferal and nanno-fossil studies of the clays bounding the limestones, allowing for accurate integration with global stratigraphy.

Three of the TDP cores (drilled 2004-5) continuously span the Eocene/Oligocene boundary and have been used in a high resolution study of the larger benthic foraminiferal extinction. Extensive previous work on the planktonic foraminifera, nanno-fossils and stable isotopes ($\delta^{18}O$, $\delta^{13}C$) of the Tanzanian record has enabled detailed correlation with plankton stratigraphy and the global isotope curve and therefore precise extinction levels to be determined.

The results of this correlation have proved surprising.

The extinction of the majority of larger benthic foraminifera in the Tanzanian sections occurs at the Eocene-Oligocene boundary, as recognized by the extinction of the planktonic foraminiferal Family Hantkeninidae, rather than as Adams predicted at the oxygen isotope excursion associated with the main phase of Antarctic ice growth and eustatic regression. This correlates both the top of letter stage Tb and shallow benthic foraminiferal zone 20 with the Eocene-Oligocene boundary (top of planktonic foraminifer Zone E16) in the stratotype section at Massignano, Italy. It also raises the question of what process could have caused the simultaneous extinction of planktonic foraminifera in the open ocean and larger benthic foraminifera on the carbonate platforms.