Sequence Stratigraphy, Chronostratigraphy, and Spatio-Temporal Stratigraphic Thickness Variation of the Agbada Formation, Robertkiri and Delta Fields, Niger Delta, Nigeria

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ABSTRACT

The Miocene-aged deltaic Agbada Formation, Niger Delta, Nigeria, is composed of prograding sediments deposited on a series of basin-ward tilted normal faults, characterized by structural collapse. It consists of shallow marine and non-marine deposits overlying faulted collapsing sub-formation shale deposits. Sequence stratigraphic analysis of gamma ray wireline well logs shows that the Agbada Formation consists of at least four third order sequences. Thickness maps of the sequences and structural analysis of the sequence surfaces indicate rollover anticlinal structures reflecting the orientation of the underlying faults. Generally stratigraphic thinning of older sequences covers a wider areal extent than that of younger sequences and the sequences become thinner upward and landward. Chronostratigraphic analysis reveals the spatial variation in the location and zones of stratigraphic thinning. The stratigraphic thinning may be the result of erosion, non-deposition, or slower deposition. The spatial variation may be related to shift in fluvial deltaic deposition combined with a fall in the relative sea level.

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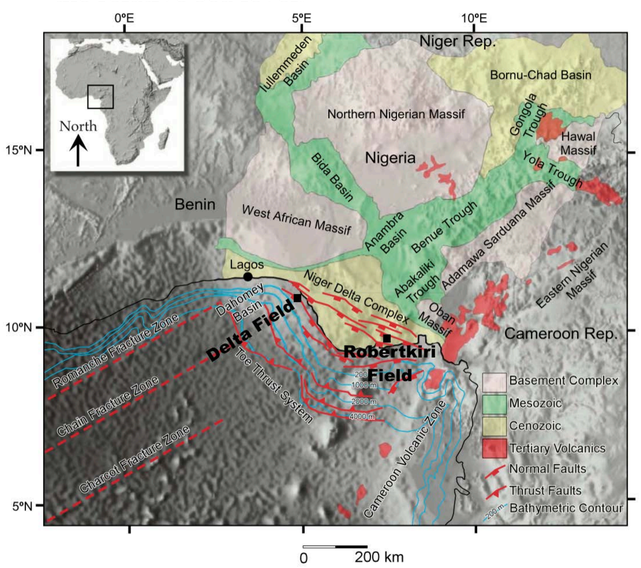
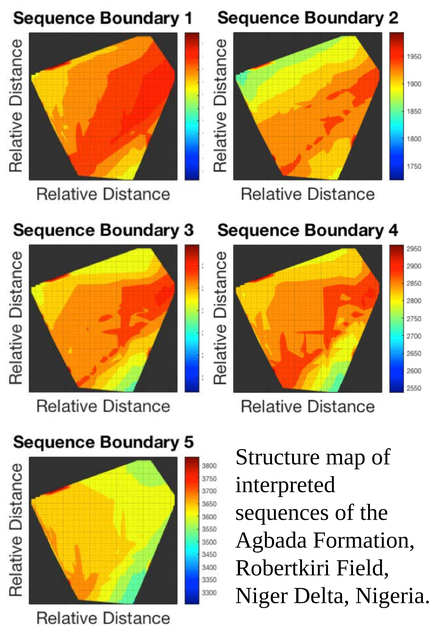
OBJECTIVE

- The Miocene-aged deltaic Agbada Formation, Niger Delta, Nigeria, is composed of prograding sediments deposited on a series of basin-ward tilted normal faults, characterized by structural collapse.
- Thickness maps of the sequences and structural analysis of the sequence surfaces indicate rollover anticlinal structures reflecting the orientation of the underlying faults.
- Generally stratigraphic thinning of older sequences covers a wider areal extent than that of younger sequences and the sequences become thinner upward and landward.
- Chronostratigraphy reveals the spatial variation in the location and zones of stratigraphic thinning. The stratigraphic thinning may be the result of erosion, non-deposition or slower deposition.
- The spatial variation may be related to shift in fluvial deltaic deposition combined with a fall in the relative sea level.

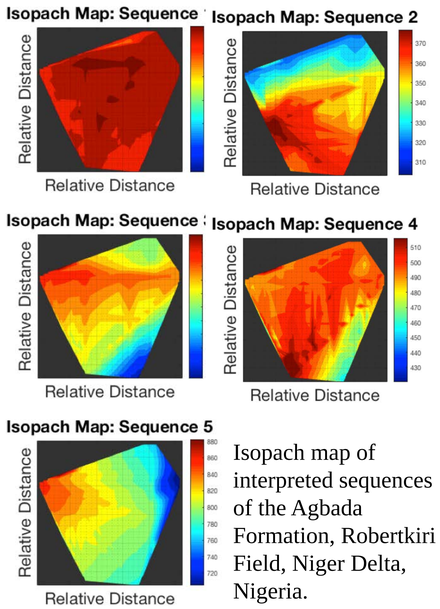


Geological map of Nigeria showing approximate locations of Robertkiri and Delta Fields. Tertiary Niger Delta regressive clastic sequences formed at the site of an aulacogen related to the breakup of the southern Atlantic starting in the Late Jurassic till the Middle Cretaceous. The failed arm of the aulacogen formed the Benue Trough under the Gulf of Guinea while the other two arms followed the southeastern coast of Nigeria and the northwestern coast of Cameroon. Modified from Corredor et al (2005).

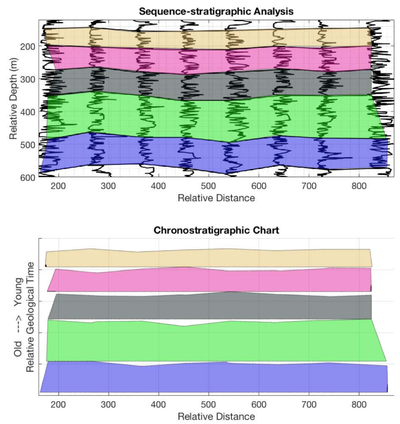
Robertkiri Field



Structure map of interpreted sequences of the Agbada Formation, Robertkiri Field, Niger Delta, Nigeria.



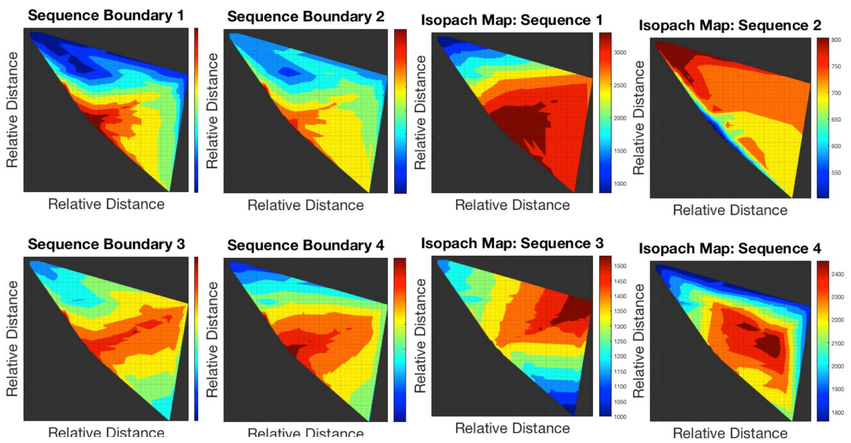
Isopach map of interpreted sequences of the Agbada Formation, Robertkiri Field, Niger Delta, Nigeria.



Chronostratigraphic analysis of the Agbada Formation, Robertkiri Field, Niger Delta, Nigeria. Analysis carried out using WheelerLab (Amosu and Sun, 2017). Modified from Magbagbeola and Willis (2007)

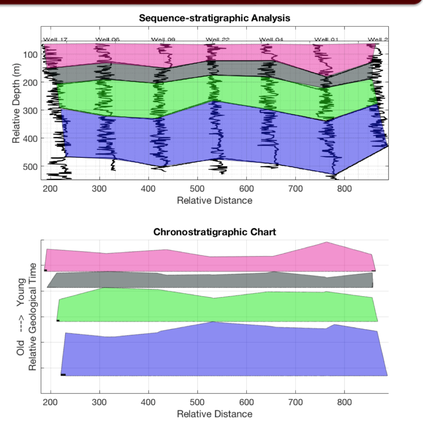
The chronostratigraphic analysis and thickness map of the Robertkiri field reveals areas of stratigraphic thinning shifting from the center towards the edges as time progresses. Sequence 3 contains an elongated structural high extending from east to west and thinning to the north and south. The thinning is mostly localized to the flanks of the formation within the field. The structural high gets bigger from the older sequences to the younger sequences. Thinning of older sequences covers a wider areal extent than that of younger sequences.

Delta Field



Structure map of interpreted sequences of the Agbada Formation, Delta Field, Niger Delta, Nigeria.

Isopach map of interpreted sequences of the Agbada Formation, Delta Field, Niger Delta, Nigeria.



Chronostratigraphic analysis of the Agbada Formation, Delta Field, Niger Delta, Nigeria. Analysis carried out using WheelerLab (Amosu and Sun, 2017). Modified from Owoyemi and Willis (2006) For other work and Software see: Amosu and Sun 2017 (a-f), Amosu and Wehner (2015), Amosu et al, (2016), Amosu (2013), Amosu and Smalley (2014), Amosu et al, (2011,2012, 2013), Attanayake et al (2010).

Generally the structure in the Delta field reflects a north-south basinward oriented structural high which is interpreted as a rollover anticline. Orientation of faults also strongly influence the structure of the Agbada Formation in Delta field. The structure map of the fourth sequence boundary reveals a localized structural high to the south. The chronostratigraphic analysis and thickness map reveals areas of stratigraphic thinning at the center of the structural high and towards the edges. The third sequence contains an elongated anticlinal shape extending north south that thickens basinward to the south. Stratigraphic thinning is mostly localized to the eastern and western flanks of the formation within the field. The second sequence is thinner than the lower sequences and contains a structural high to the south. Stratigraphic thinning is concentrated in the southern to southwestern part of the formation. The first sequence is thicker than the second sequence and retains a structural high south of the formation but thinning is shifted more towards the center of the formation.

DISCUSSION

- The chronostratigraphic analysis and thickness map of the Robertkiri field reveals areas of stratigraphic thinning shifting from the center towards the edges as time progresses.
- The thinning is mostly localized to the flanks of the formation within the field. The structural high gets bigger from the older sequences to the younger sequences. Thinning of older sequences covers a wider areal extent than that of younger sequences.
- Generally the structure in the Delta field reflects a north-south basinward oriented structural high which is interpreted as a rollover anticline.
- Orientation of faults also strongly influence the structure of the Agbada Formation in Delta field. The chronostratigraphic analysis and thickness reveals areas of stratigraphic thinning at the center of the structural high and towards the edges.
- In summary, stratigraphic thinning of older sequences covers a wider areal extent than that of younger sequences and sequences become thinner upward and landward. The stratigraphic thinning may be the result of erosion, non-deposition or slower deposition.

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