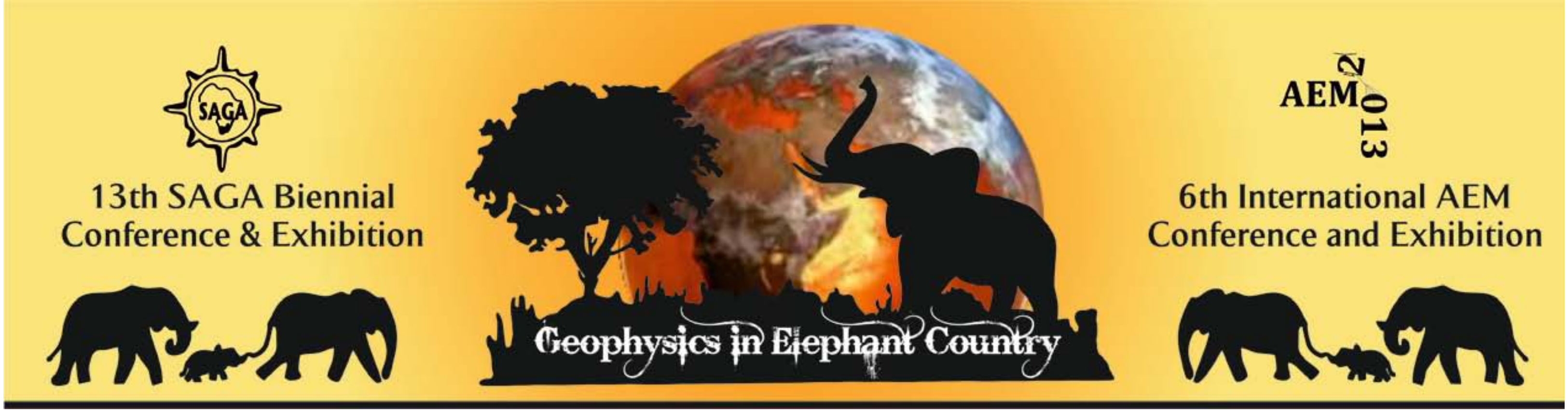

RESULTS OF RECENT GROUND-BASED GEOPHYSICAL SURVEYS IN THE OKAVANGO DELTA

A.G. GREEN[A], J.E. PODGORSKI[A], F. REISER[A], P. MEIER[A], C. SCHMELZBACH[A], T. KALSCHEUER[A], L. RABENSTEIN[A], H. HORSTMEYER[A], H.R. MAURER[A], S. GREENHALGH[A], W.K.H. KINZELBACH[B], E. AUKEN[C], G. TSHOSO[D]

[A]INSTITUTE OF GEOPHYSICS, ETH ZURICH, SWITZERLAND (JOEL@AUG.IG.ERDW.ETHZ.CH)

[B]INSTITUTE OF ENVIRONMENTAL ENGINEERING, ETH ZURICH, SWITZERLAND

[C]INSTITUTE FOR GEOSCIENCE, AARHUS UNIVERSITY, DENMARK

[D]DEPARTMENT OF GEOLOGICAL SURVEY, PRIVATE BAG 14, LOBATSE, BOTSWANA.

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Quasi-3D inversions of an extensive helicopter time-domain electromagnetic (HTEM) data set acquired across the Okavango Delta (OD; Figures 1 and 2) yield 3- to 4-layer electrical resistivity models that include (1) a shallow resistive layer of dry and fresh-water-saturated sands, (2) an intermediate-depth conductive layer of intercalated saline-water-saturated sands and clay, and (3) a relatively deep resistive layer of fresh-water-saturated sands/gravels and/or crystalline basement. The upper resistive layer clearly represents unconsolidated sediments in the current alluvial fan-like environment, whereas the intermediate conductive layer likely represents sediments deposited under earlier lacustrine conditions. The top part of the deeper resistive layer has an intriguing fan shape, centred about the entrance to the main part of the delta (Figures 2e and f). If the fan-shaped portion of the deeper resistive layer comprises fresh-water-saturated gravels/sands, it would be evidence for a paleo-alluvial fan, which we refer to as the Paleo-Okavango Delta in the following text.

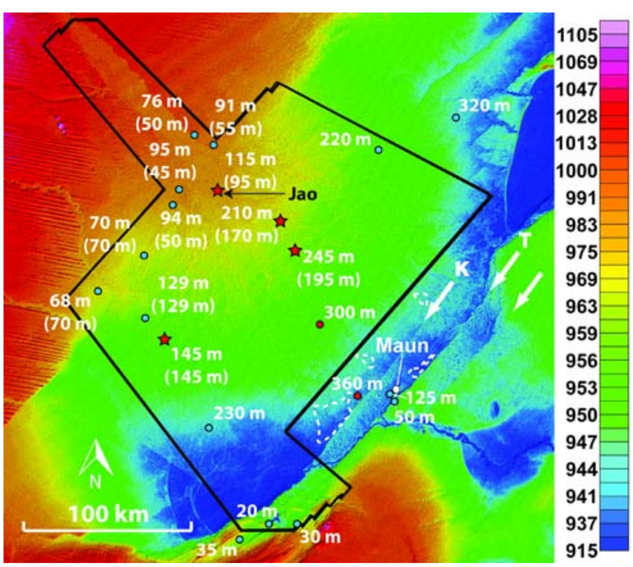

Figure 1: Topographic map (SRTM-3 data) showing (i) known faults (white arrows), (ii) Okavango Delta HTEM survey (outlined by the black polygon), (iii) basement depths defined by boreholes (blue dots), vintage seismic surveys (red dots) and our recent seismic surveys (red stars), (iv) depths to the top of the lower electrically resistive layer (white numbers in brackets), (v) clusters of boreholes that do not reach basement (outlined by white dashed lines). Ground-based electromagnetic and electrical resistivity tomographic data were also recorded at the positions marked by stars. K - Kunyere Fault; T - Thamalakane Fault.

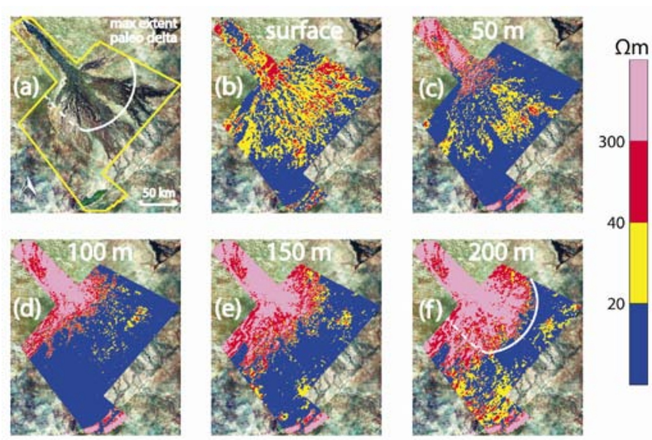

Figure 2: (a) Satellite image showing the Okavango Delta HTEM survey area. (b) - (f) Depth slices at 50m intervals extracted from the 3D resistivity model obtained by inverting the Okavango Delta HTEM data set using a quasi-3D spatially constrained scheme. The 28,000km^2 of HTEM data were acquired at an average height of 50 m almost exclusively along northeast-directed profiles separated by 2km.

In an attempt to verify the HTEM-based electrical resistivity model and test the Paleo-Okavango Delta hypothesis, we acquired multiple types of electromagnetic, electrical resistivity tomographic, and high-resolution seismic tomographic refraction and seismic reflection data at 4 sites within the delta (Figure 1). At each site, the various data sets were acquired along two lines that were approximately perpendicular to each other (e.g. Figure 3a). Models derived from single and joint inversions of our ground-based time-domain electromagnetic, natural and controlled-source audiomagnetotelluric, and electrical resistivity tomographic data confirm the important characteristics of the HTEM-based resistivity model, including the depth distribution and generally high resistivity of the lowermost layer (Figure 3b). Based on its resistivity alone, the approximately fan-shaped lower resistive feature could represent a fresh-water-saturated sand/gravel unit or a prominent basement dome.

Basement depths within the OD are available from a limited number of boreholes, simple dipping layered models derived from 1970's vintage seismic refraction data recorded at several locations, and our high-resolution seismic refraction tomograms and reflection images (see Figure 1 for locations). The unconsolidated sediment - basement boundary is well delineated in the modern seismic images and tomograms by an abrupt transition from horizontally layered reflections and 1750 - 1850 m/s P-wave velocities above to largely reflection-free and 4600 - 5500 m/s P-wave velocities below (Figures 3c - e). In the one region where our investigation site is close to that of a 1970's survey, the old and new basement depth estimates are essentially the same, giving us confidence in the quality of the older data and derived models. In the western part of the OD, the borehole- and seismic-determined basement depths practically coincide with the depths to the top of the lowermost resistive layer (Figure 1). In other parts, the borehole- and seismic-determined basement depths are deeper than the top of the resistive layer by 20-50m (see example in Figures 3b and 3c). Based on these comparisons, the lowermost resistive layer in the western part of the OD is unequivocally the basement and in other parts it likely comprises a fresh-water-saturated sand/gravel unit overlying basement.

In conclusion, the fan-shape of the proposed fresh-water-saturated sand/gravel unit suggests that it may be the remnant of a Paleo-Okavango Delta. If this interpretation is correct, then laterally continuous silt/clay units within the overlying low resistivity layer would act as an effective barrier to the mixing of saline water above with the underlying fresh-water aquifer.

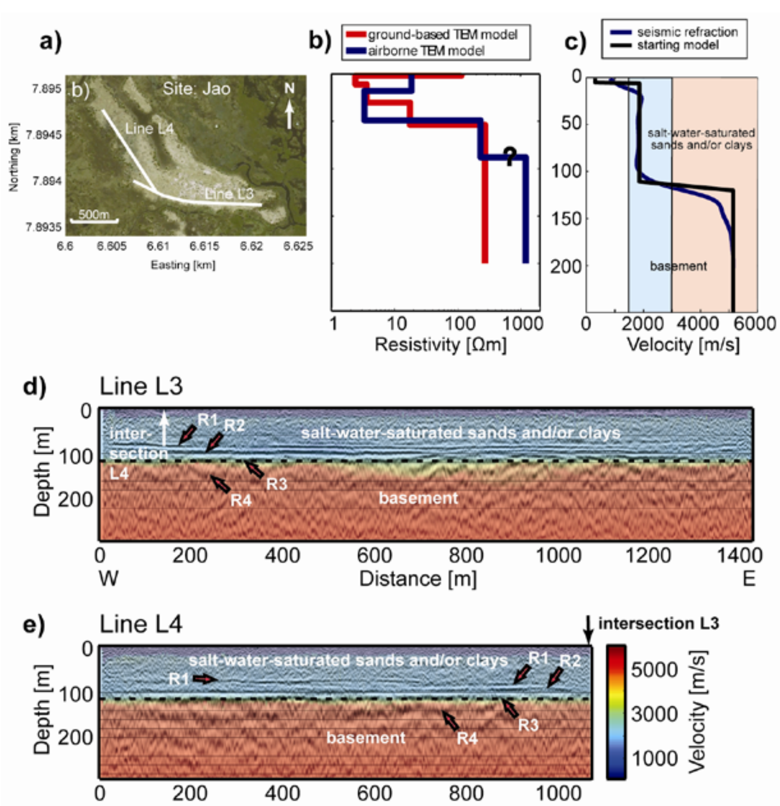

Figure 3: Summary of geophysical models for Jao. (a) Locations of seismic and ground-based time-domain electromagnetic measurements. Spatially averaged (b) resistivity and (c) seismic velocity tomographic inversion results. Velocity range of water-saturated sand and clay is marked by light blue and that of basement rock by pink. Basement depth according to the seismic model is 115 ± 10 m. (d) and (e) Seismic tomography velocity models (colours) superimposed on seismic-reflection images.