Depth of Kalahari cover in Botswana

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Where and what’s in Botswana?
Outline

• The Kalahari cover
• Passive seismic sounding examples (H/V)
  - clean and easy to model
• Passive seismic vs drilled depth of Kalahari
  - good correlation
• Passive seismic vs AEM-modelled depths
  - poorer AEM correlation with drilling
• Conclusions
  - passive seismic appears to do better than AEM ... but ... how good is a drill hole?
Kalahari cover

- Geologically not a simple, homogeneous sand layer
- Variably lithified sand, calcrete/silcrete layers
- Bedrock transition is sharp, < 50 cm weathering
Kalahari cover

- First issue is explorability - used AEM
  - Looking for < 100 m, preferably < 60 m (plus shales)
Typical (Tromino) sounding

Max. H/V at 3.75 ± 0.03 Hz. (In the range 0.0 - 64.0 Hz).
Typical (Tromino) sounding

\[ \rho \text{ Kal, } V_s \text{ bedrock from logging} \]
More soundings

Max. H/V at 2.59 ± 0.56 Hz. (In the range 0.0 - 64.0 Hz).
More soundings

Max. H/V at 4.91 ± 1.11 Hz. (In the range 0.0 - 64.0 Hz).
More soundings
Passive seismic vs drilled depth

Rough bedrock topography? Calcrete/silcrete layer?
Good news statistics over 75 holes:

- Mean Vs for the Kalahari = 578 m/s ± 101 m/s (one SD)
- Mean Kalahari thickness (drilled) = 51.8 m
- Mean Kalahari thickness (Tromino) = 51.8 m
  (remarkable/coincidental? identical result to drilling)
- Mean Tromino depth deviation from actual = ± 6.5 m
Comparison between two units

Outliers share good soundings

- Centred_On

- Centred_On
H/V peak centre vs peak apex

**Peak centre**

**Peak apex**

Max. H/V at 2.59 ± 0.56 Hz. (In the range 0.0 - 64.0 Hz).
Drilling vs passive seismic depths

Drilling (20-90 m)

H/V peak centre (2 – 5.5 Hz)
Detailed profiles

13 calibration holes,
11 repeated = 24 measurements

mean \( \text{Vs} \) of 540 m/s ± 73 m/s
average 12.5% error in depth estimation
= 6m error in the depth range 28-68 m
Detailed profiles

• Unlikely to be modelling anything other than bedrock interface
• Brings new information to geochemical dispersion modelling
Passive seismic vs AEM

H/V peak centre (2 – 5.5 Hz)

AEM-derived depth (25-130 m)
AEM vs drilling depths

- Scatter is worse than with passive seismic vs drilling
AEM vs passive seismic

Why is the EM scatter worse vs drilling?

- Seismic and EM footprints are different
  - EM vs drill holes is almost always a poor correlation
  - What is the H/V footprint at depth?
- Seismic and EM are measuring different interfaces
  - Petrophysical logs
Petrophysics

- Inductive EM logging shows Kalahari - Katangan transition is not so sharp (with 50 & 80 cm Tx-Rx)

EOH = bedrock + 1 m
Conclusions

- Best FQM passive seismic survey results
  - c.f. Atacama gravels, Amadeus basin, Yilgarn regolith (OK)
- In spite of intra-Kalahari stratigraphy, dominating impedance interface is Kalahari-Katangan
- Passive seismic (H/V) appears to pick up the Kalahari-Katangan interface with greater accuracy than EM
  - caveat: drill hole sample area
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