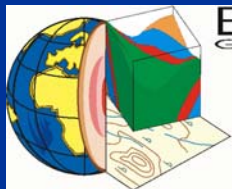


Ground Penetrating Radar (GPR)

In the search for uraniferous paleo-channels



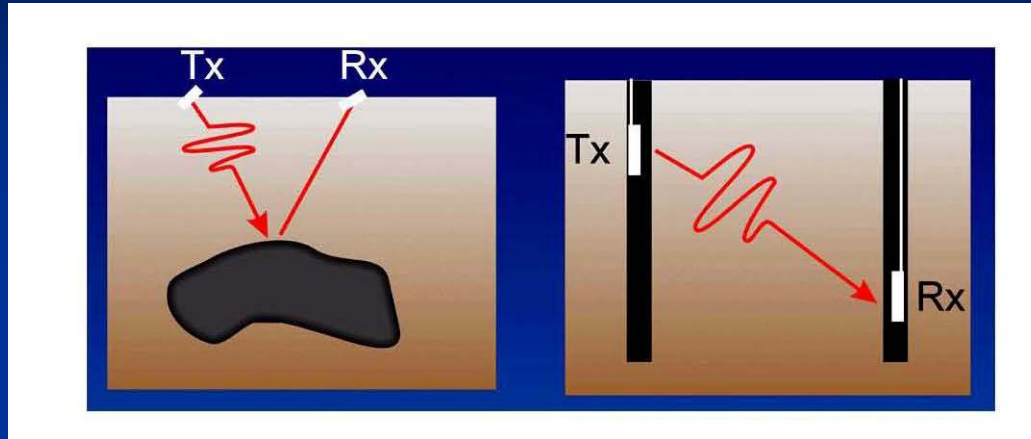
EARTHMAPS CONSULTING
GEOPHYSICAL CONSULTING

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Some GPR Principles

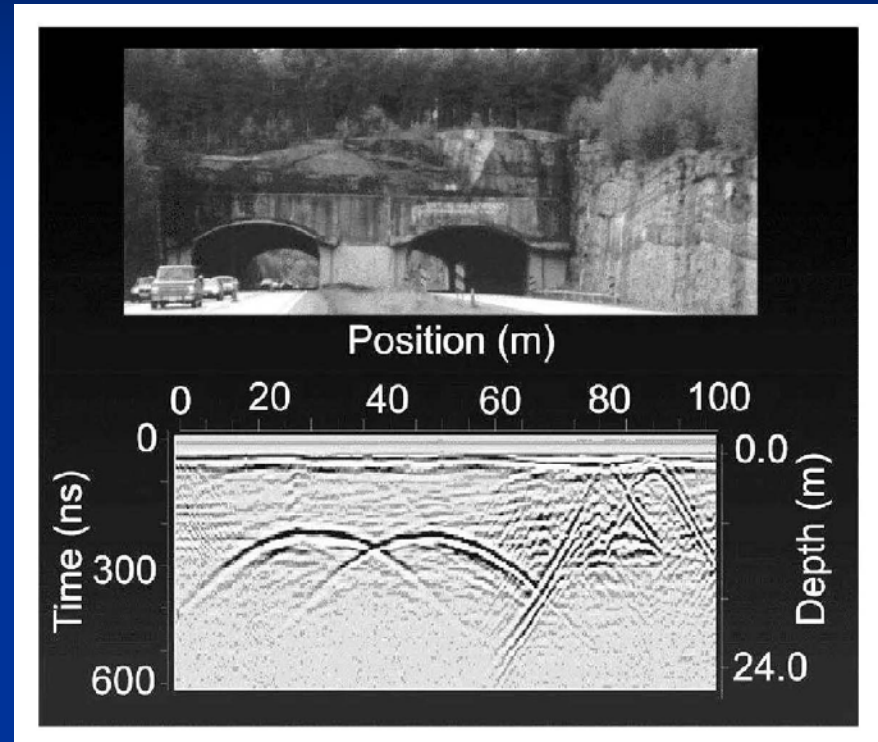
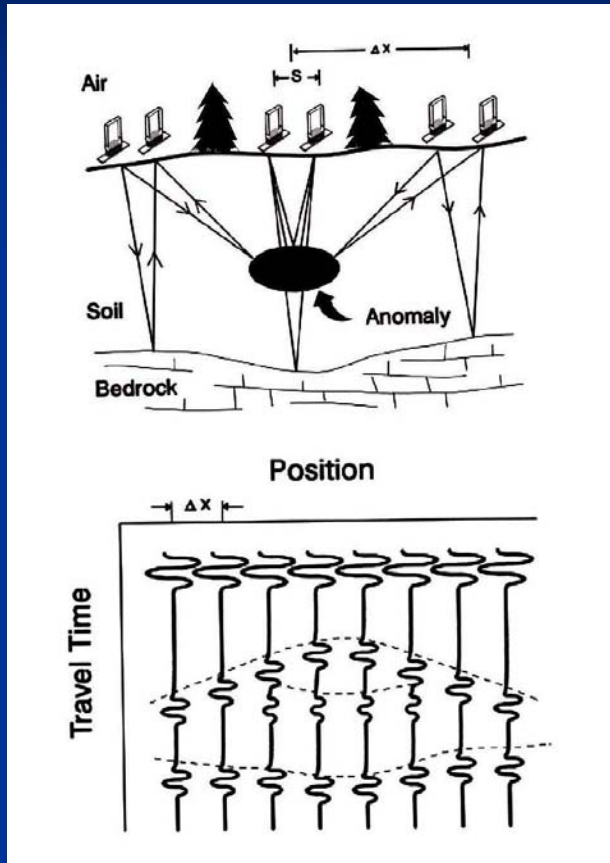


Source: Sensors & Software Inc.

GPR Signal is sensitive to changes in:

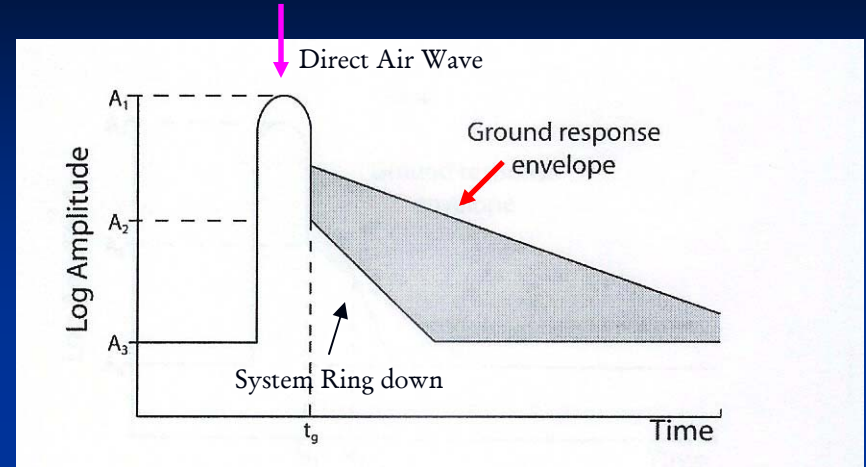
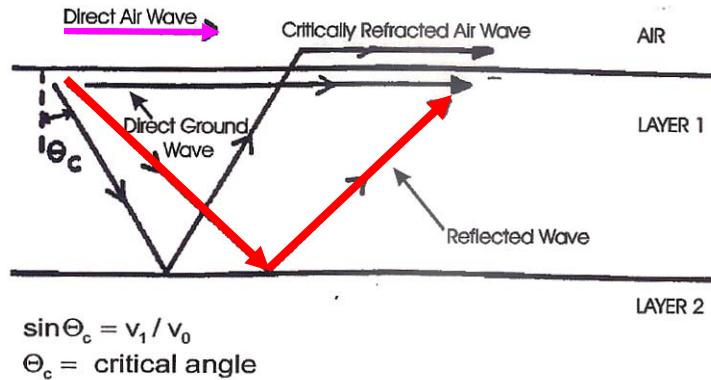
- electrical conductivity σ
- dielectric permittivity ϵ
- (magnetic permeability μ)

GPR Survey Principles



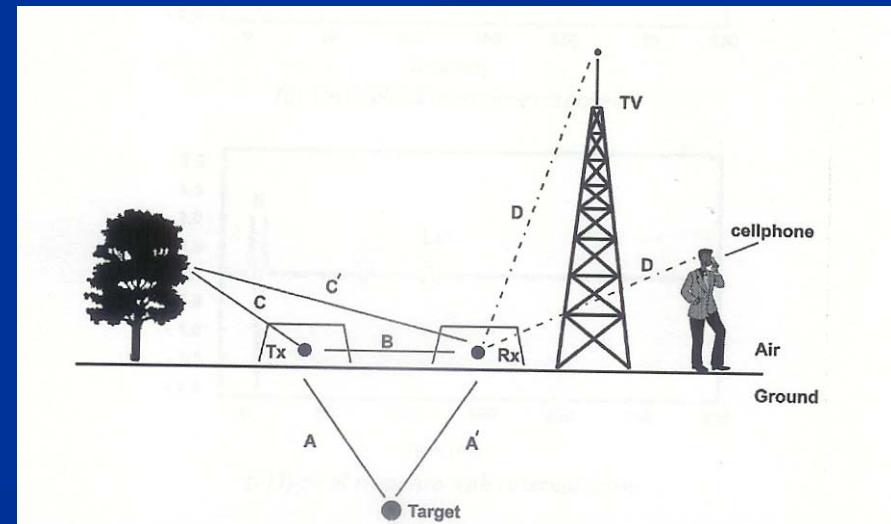
Source: Sensors & Software Inc.

GPR: Factors to consider



Direct Air Wave Response

Source: Sensors & Software Inc.



Sources of Noise

Radar Velocity

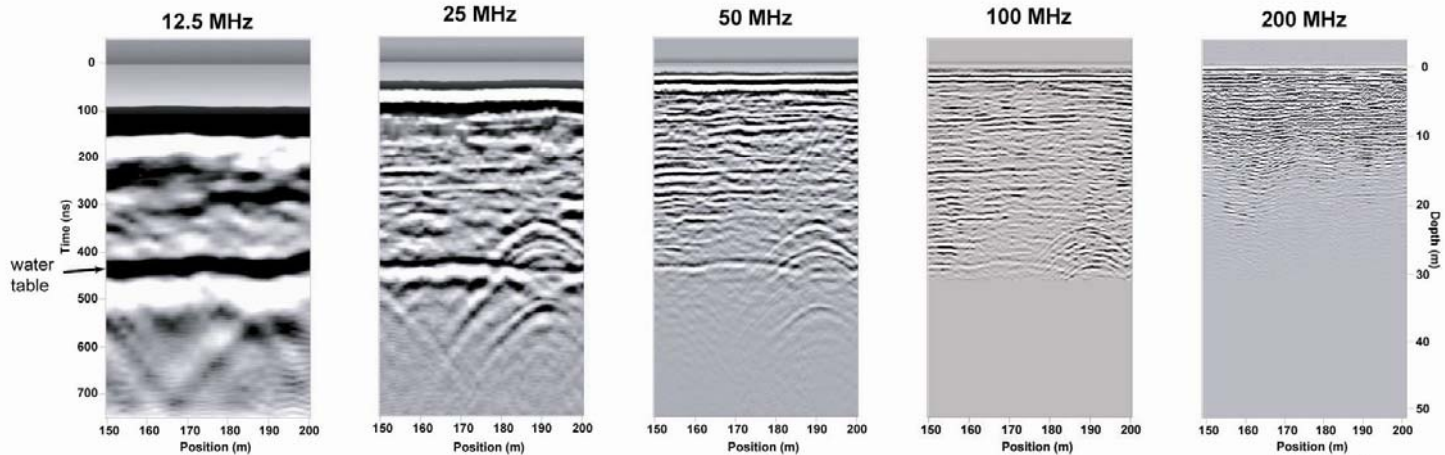
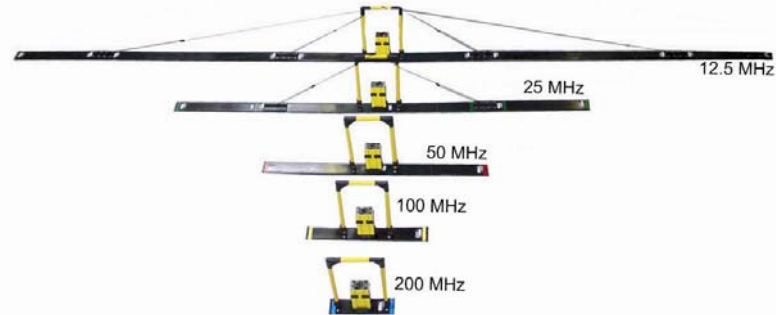
Material	Velocity (m/ns)	Velocity (ft/ns)
Air	0.30	0.98
Ice	0.16-0.17	0.52
Dry Soil	0.15	0.49
Dry Sand	0.15	0.49
Granite	0.13	0.43
Dry Salt	0.13	0.43
Dry Rock	0.12	0.39
Limestone	0.12	0.39
Wet Rock	0.10	0.33
Concrete	0.08-0.12	0.26-0.39
Pavement	0.10	0.33
Shales	0.09	0.30
Silts	0.07	0.23
Calcrete	0.06 - 0.065	
Wet Soil	0.06	0.20
Wet Sand	0.06	0.20
Clays	0.06	0.20
Fresh Water	0.033	0.11
Sea Water	0.033	0.11

GPR Survey: Antennas

pulseEKKO® PRO
subsurface imaging solutions

Multi-frequency Antenna Survey

Sensors & Software Inc.



Sensors & Software



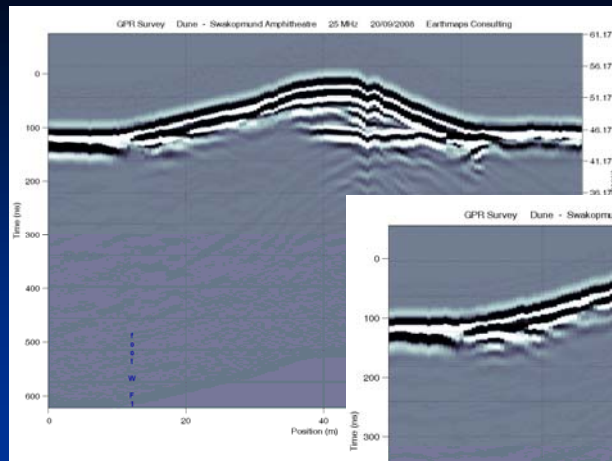
GPR Survey: Antennas



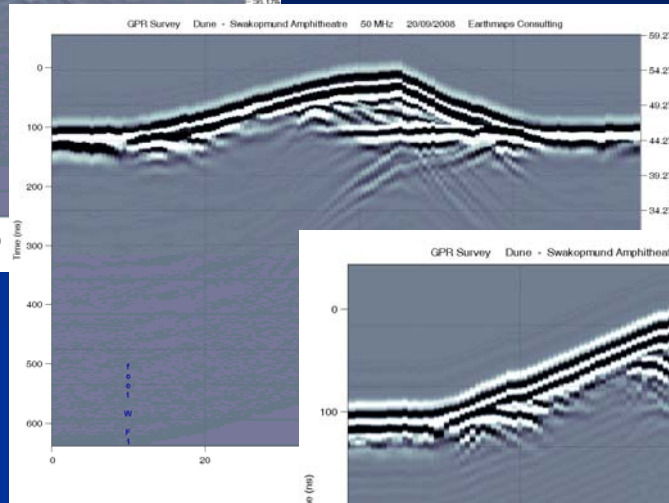
Dune Survey



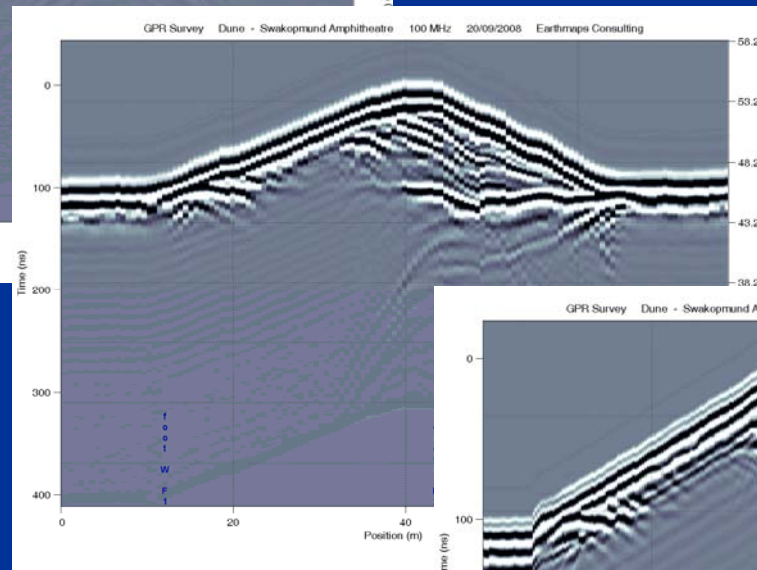
GPR Survey: Antennas



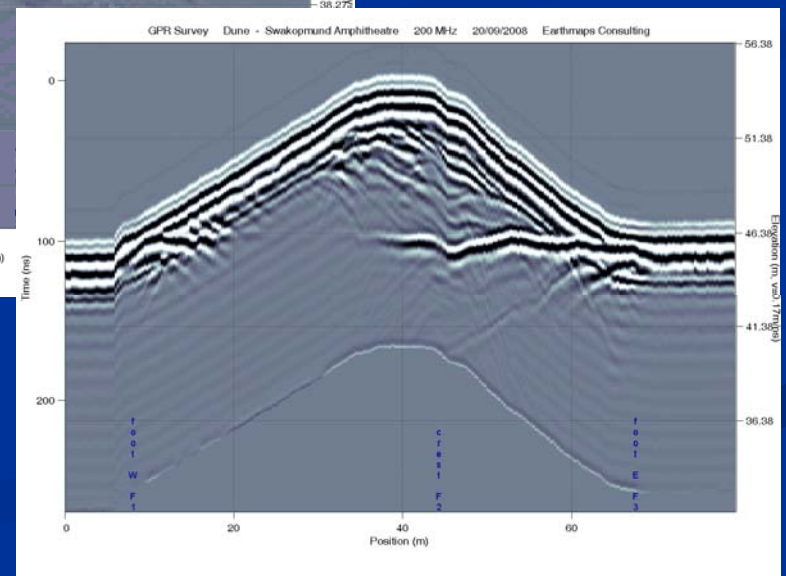
25 MHz



50 MHz



100 MHz



200 MHz

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GPR Survey: Antennas for Paleo-channel work



25 MHz

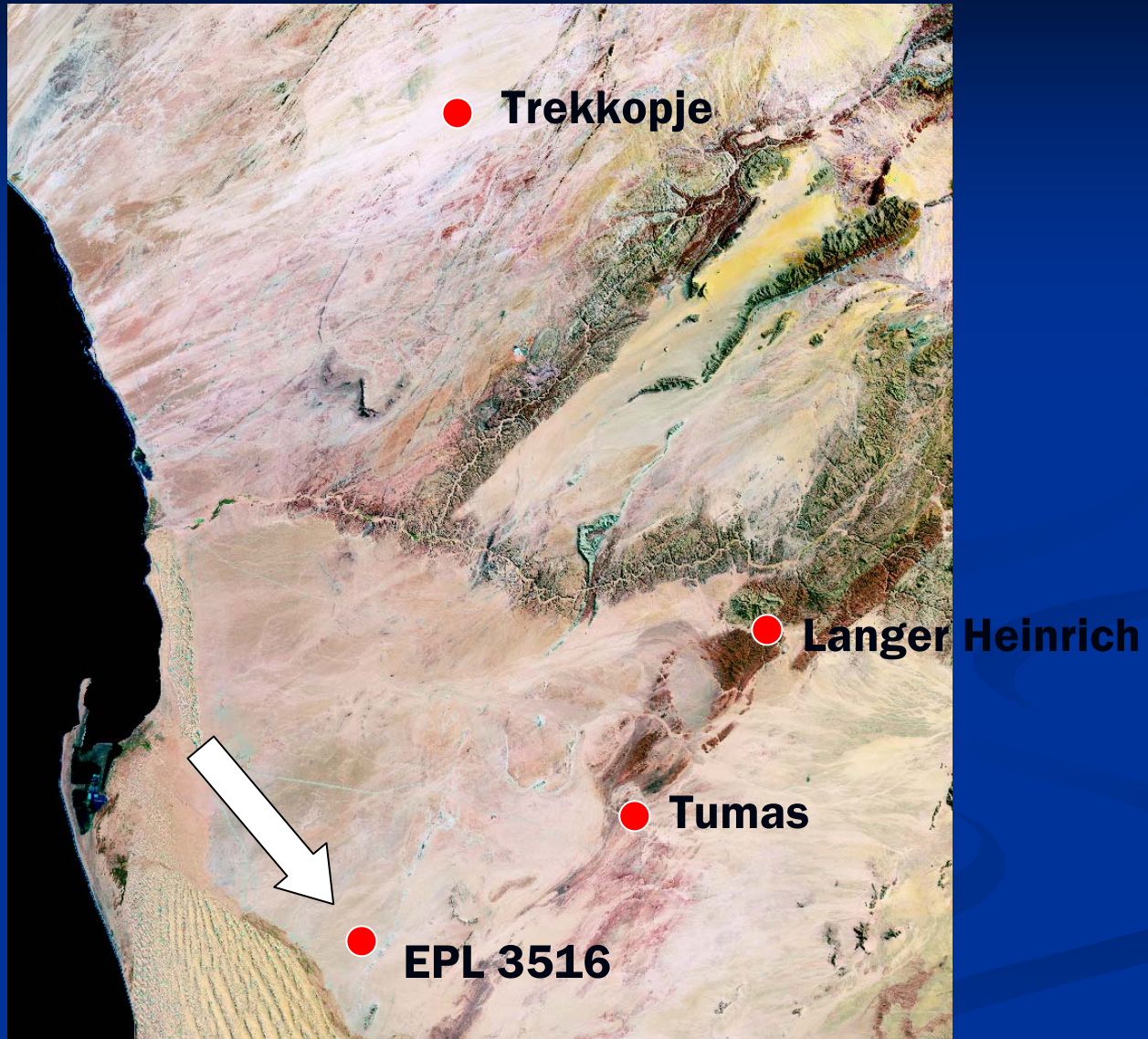
Production Rate:

3.5 km/day

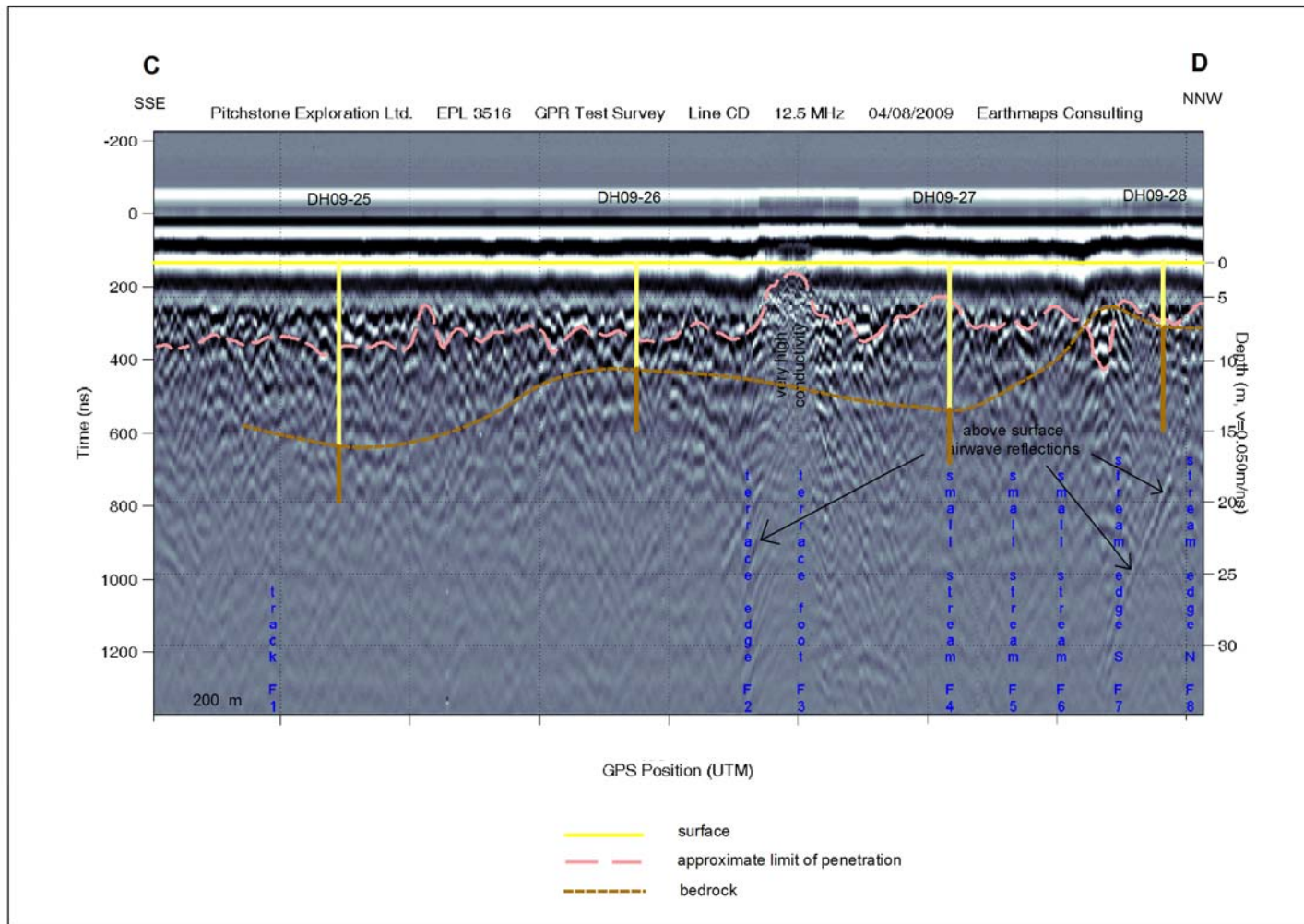
12.5 MHz



GPR Survey: Namibian Case Studies



EPL 3516 - Pitchstone Exploration Ltd.



Terrain:

**Gypcrete
& Calcrete**

GPR

Acknowledgements: Pitchstone Exploration Ltd.

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EPL 3516 - Pitchstone Exploration Ltd.

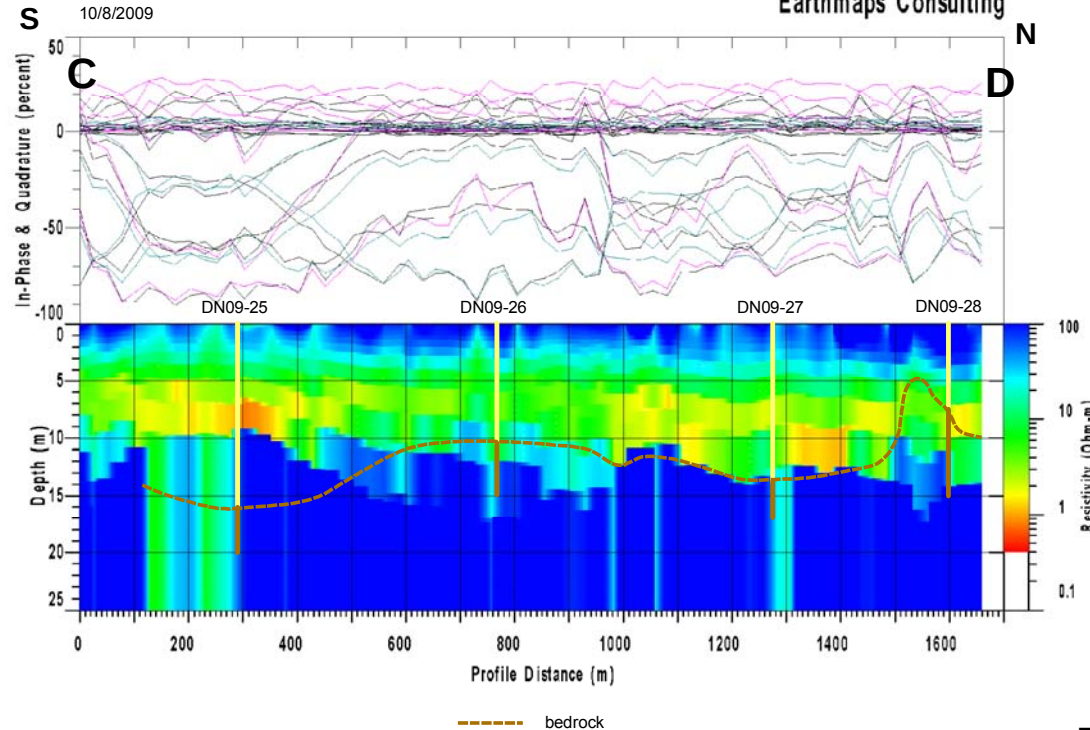
Pitchstone Exploration Ltd.

Horizontal Loop Electromagnetic (HLEM) Test Survey: 50 m coil spacing

Line CD - EPL 3516

10/8/2009

Earthmaps Consulting



Terrain:

Gypcrete
& Calcrete

HLEM

+

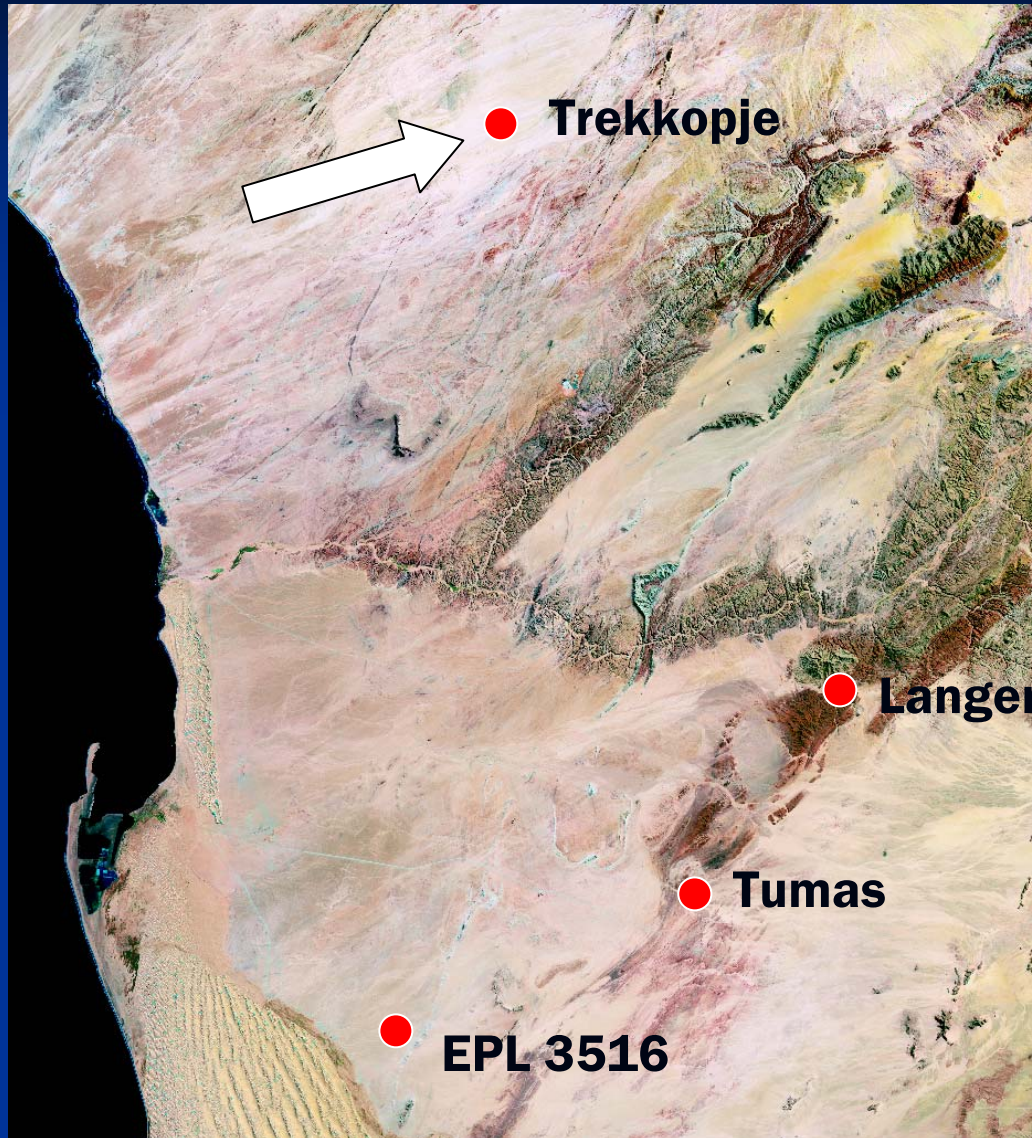
Acknowledgements: Pitchstone Exploration Ltd.

EARTHMAPS

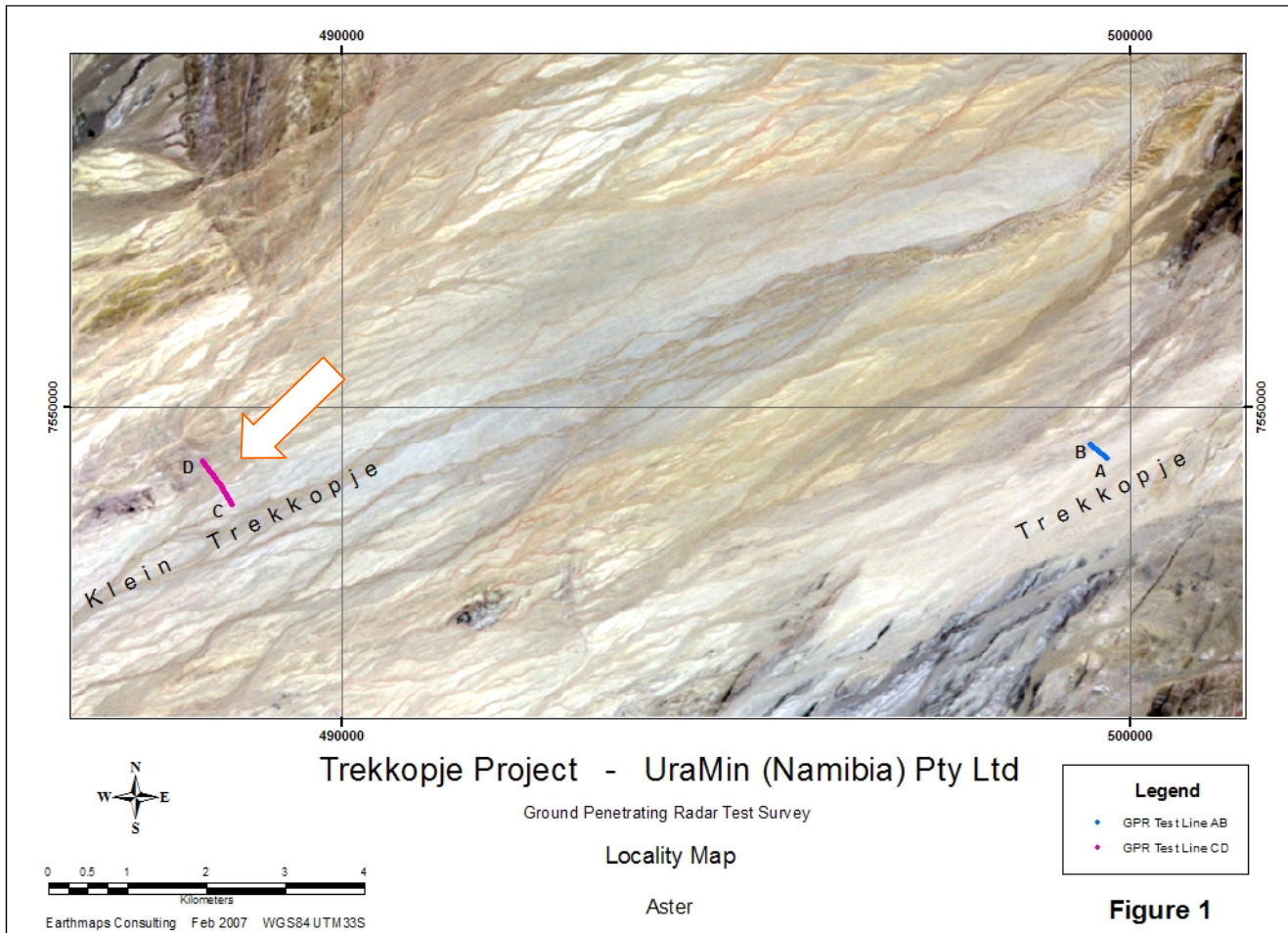


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GPR Survey: Namibian Case Studies



Trekkopje Mine



Terrain:

**Gypcrete
& Calcrete**

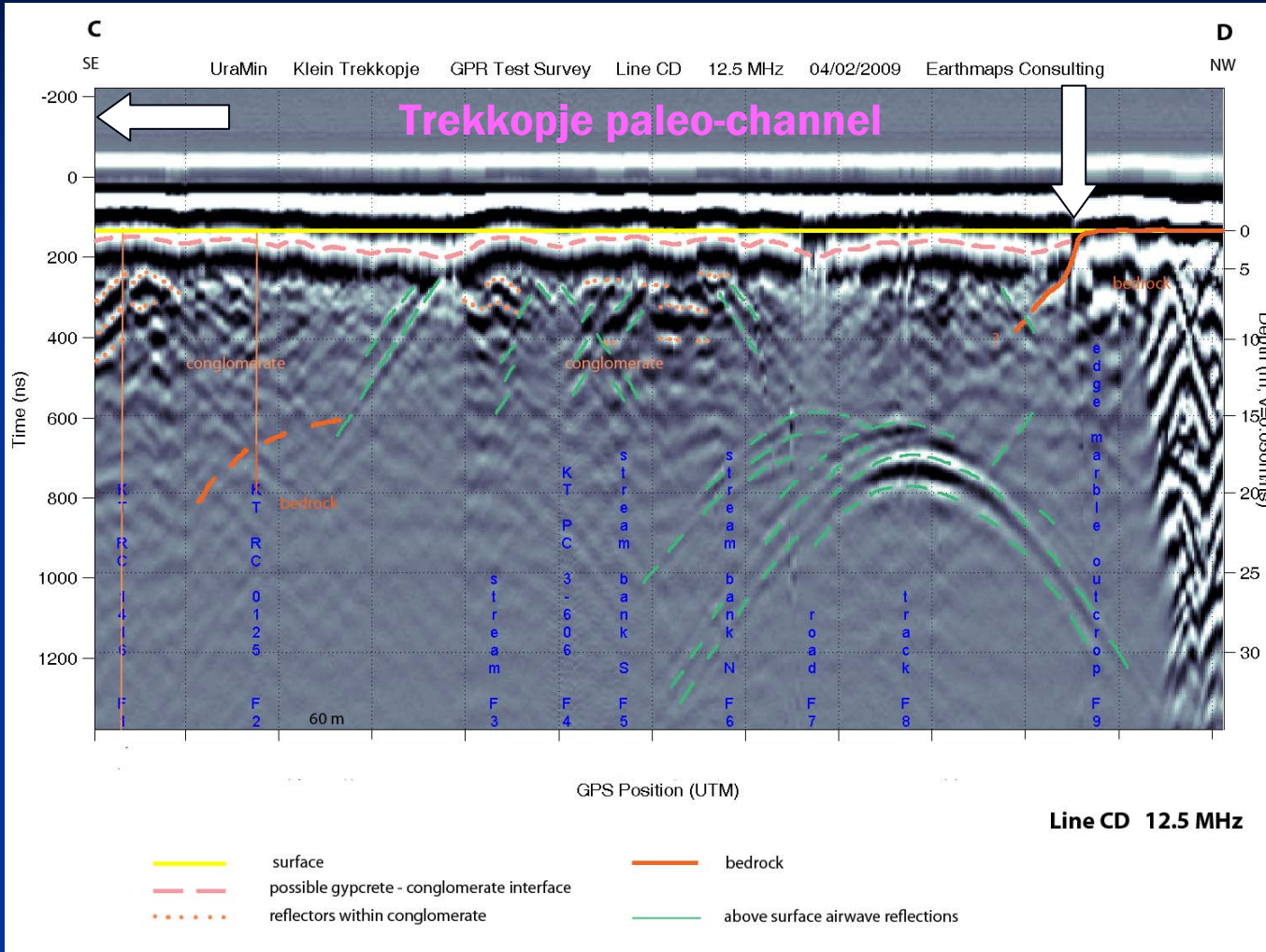
Acknowledgements: Areva Resources Namibia

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Trekkopje Mine



Terrain:

Gypcrete & Calcrete

GPR

Acknowledgements: Areva Resources Namibia



Trekkopje Mine

UranMin (Namibia) Pty Ltd

Horizontal Loop Electromagnetic (HLEM) Test Survey: 50m coil spacing

Line CD - Klein Trekkopje

Earthmaps Consulting

3/9/2009

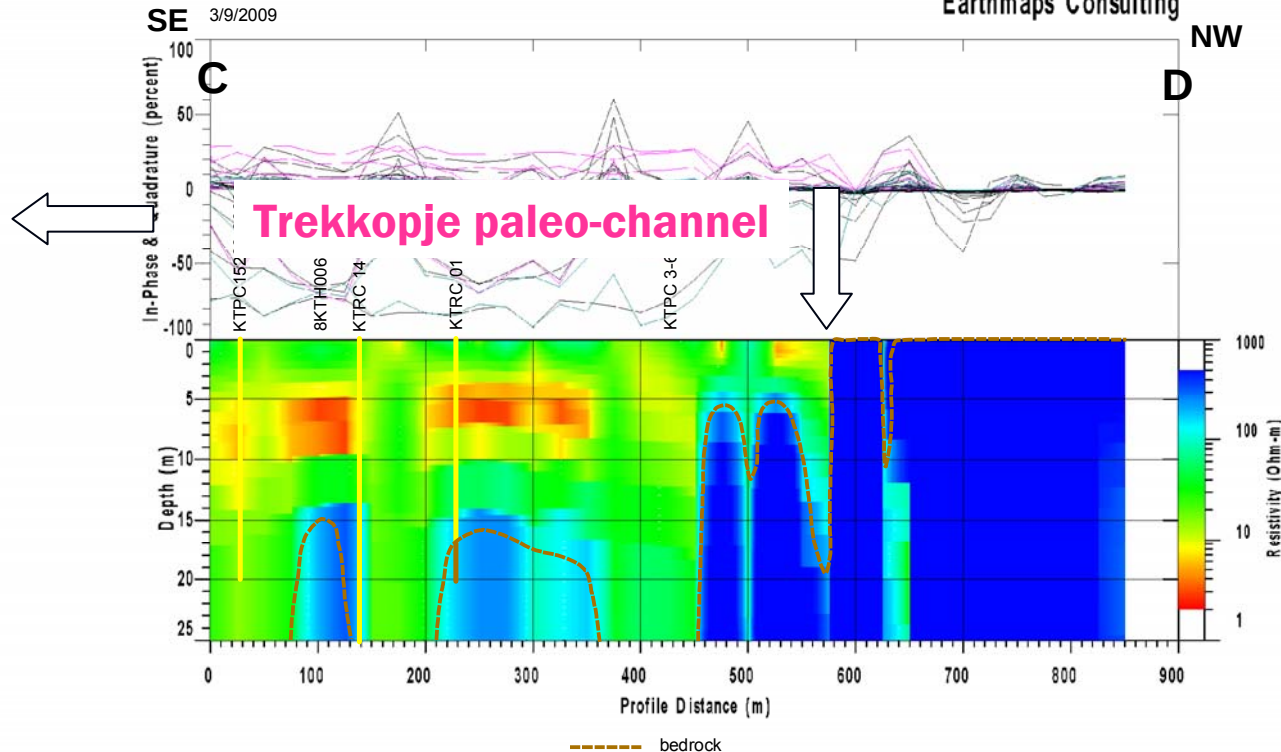


Figure 5

Terrain:

**Gypcrete
& Calcrete**

HLEM

+

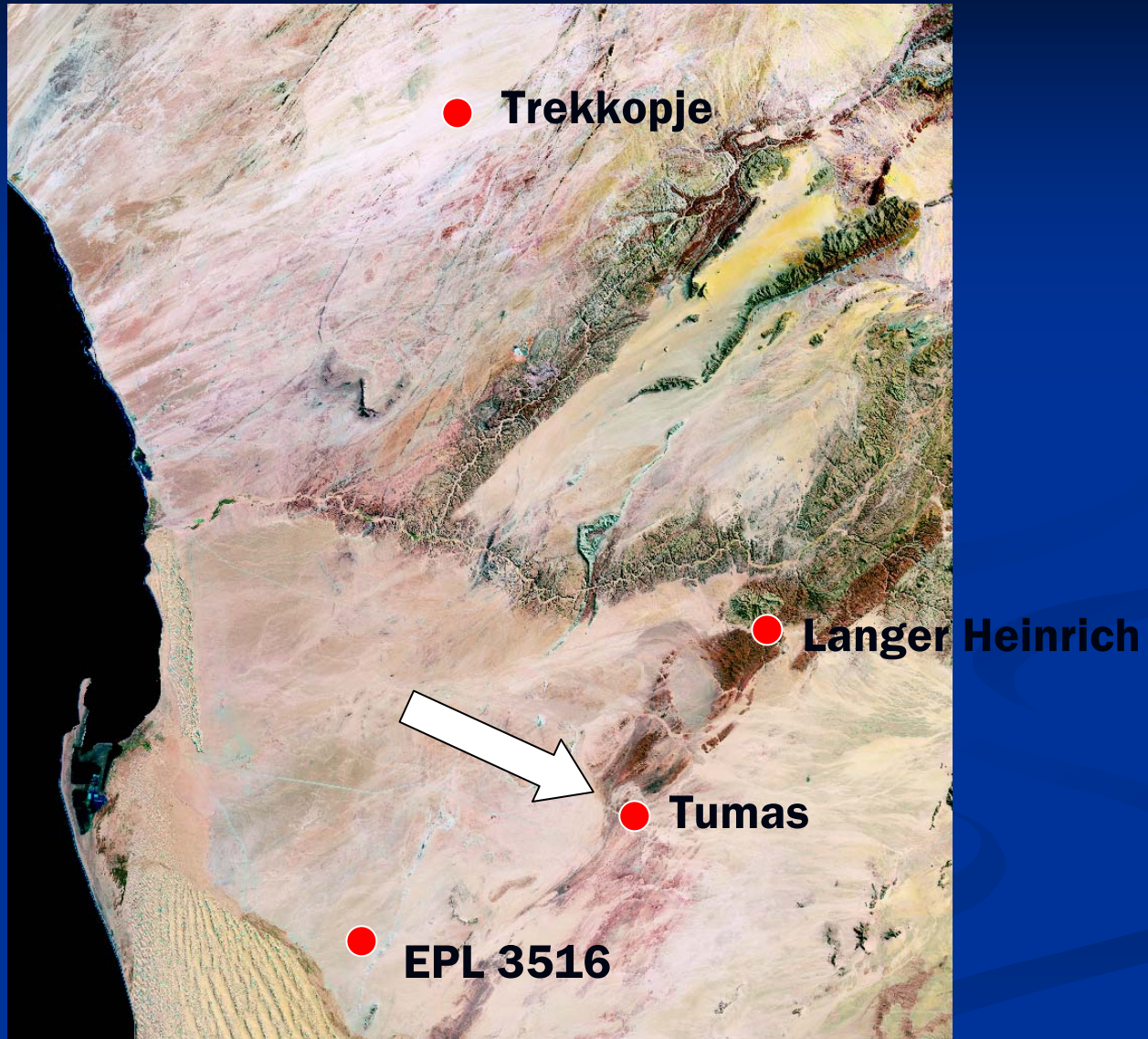
Acknowledgements: Areva Resources Namibia

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GPR Survey: Namibian Case Studies

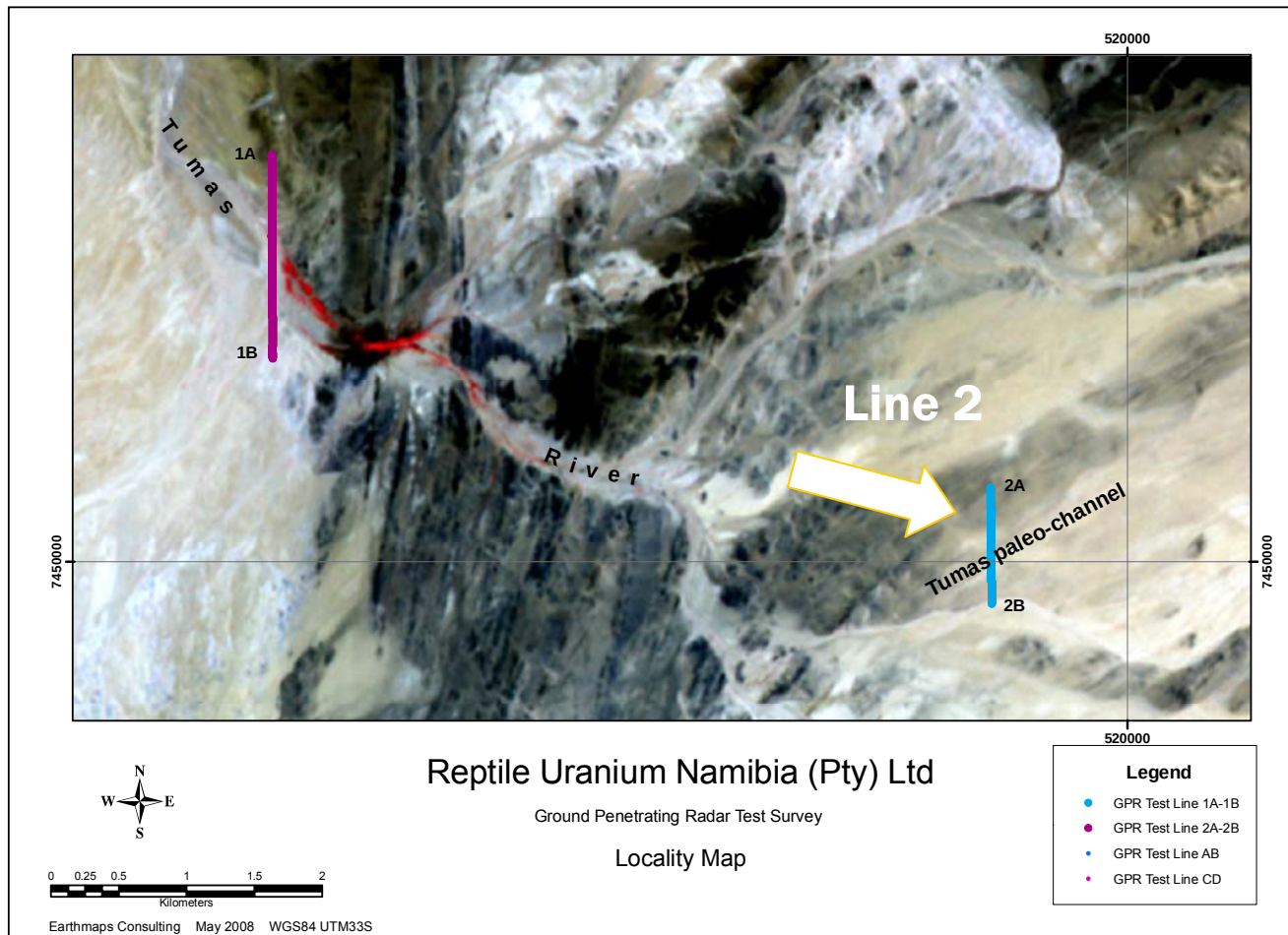


Tumas Project

Line 2

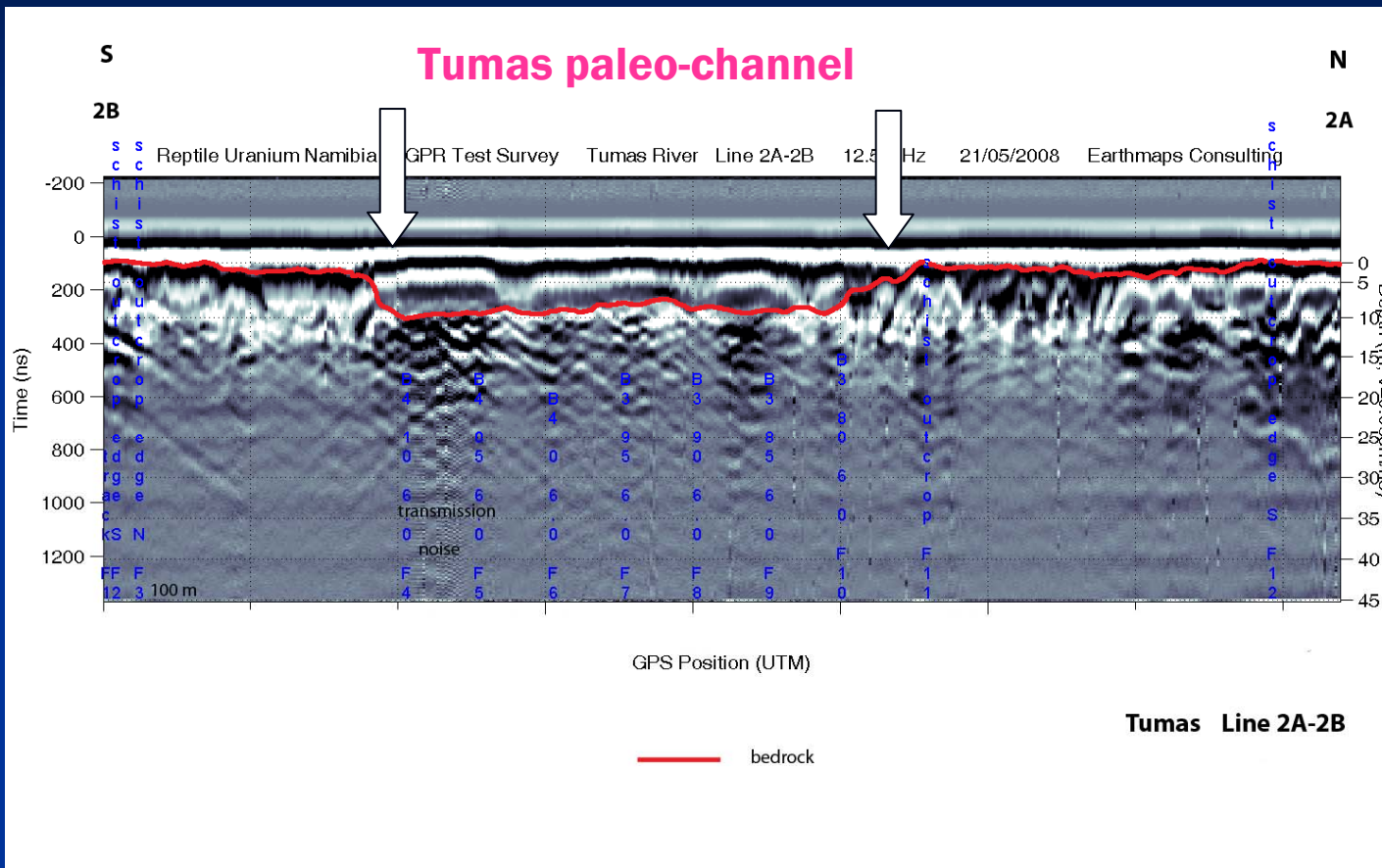
Terrain:

Calcrete
&
Alluvium



Acknowledgements: Reptile Uranium Namibia (Pty) Ltd

Tumas Project



Terrain:

Calcrete
Paleo-channel

GPR

+

Acknowledgements: Reptile Uranium Namibia (Pty) Ltd



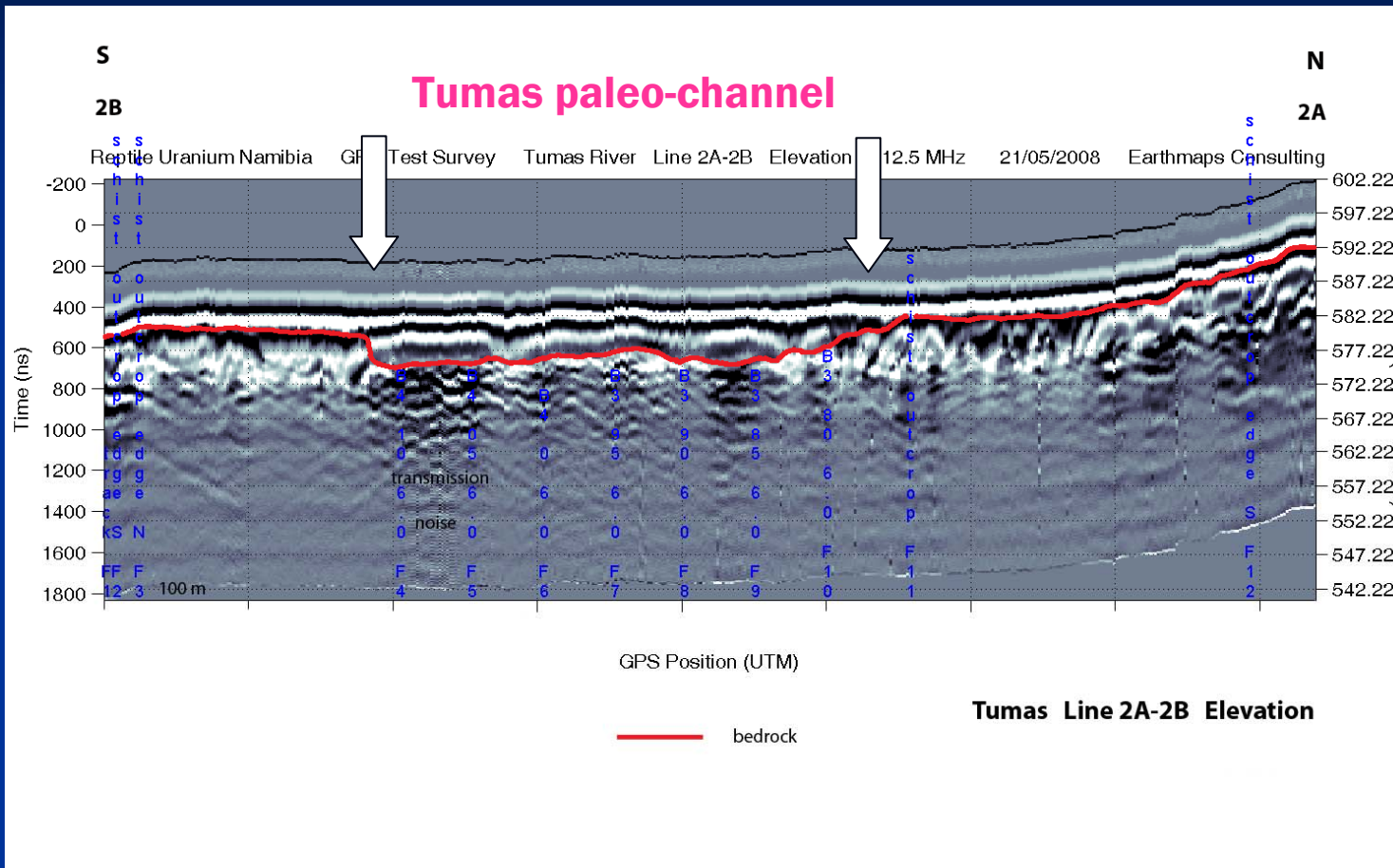
Tumas Project

Line 2

Terrain:

Calcrete Paleo-channel

GPR



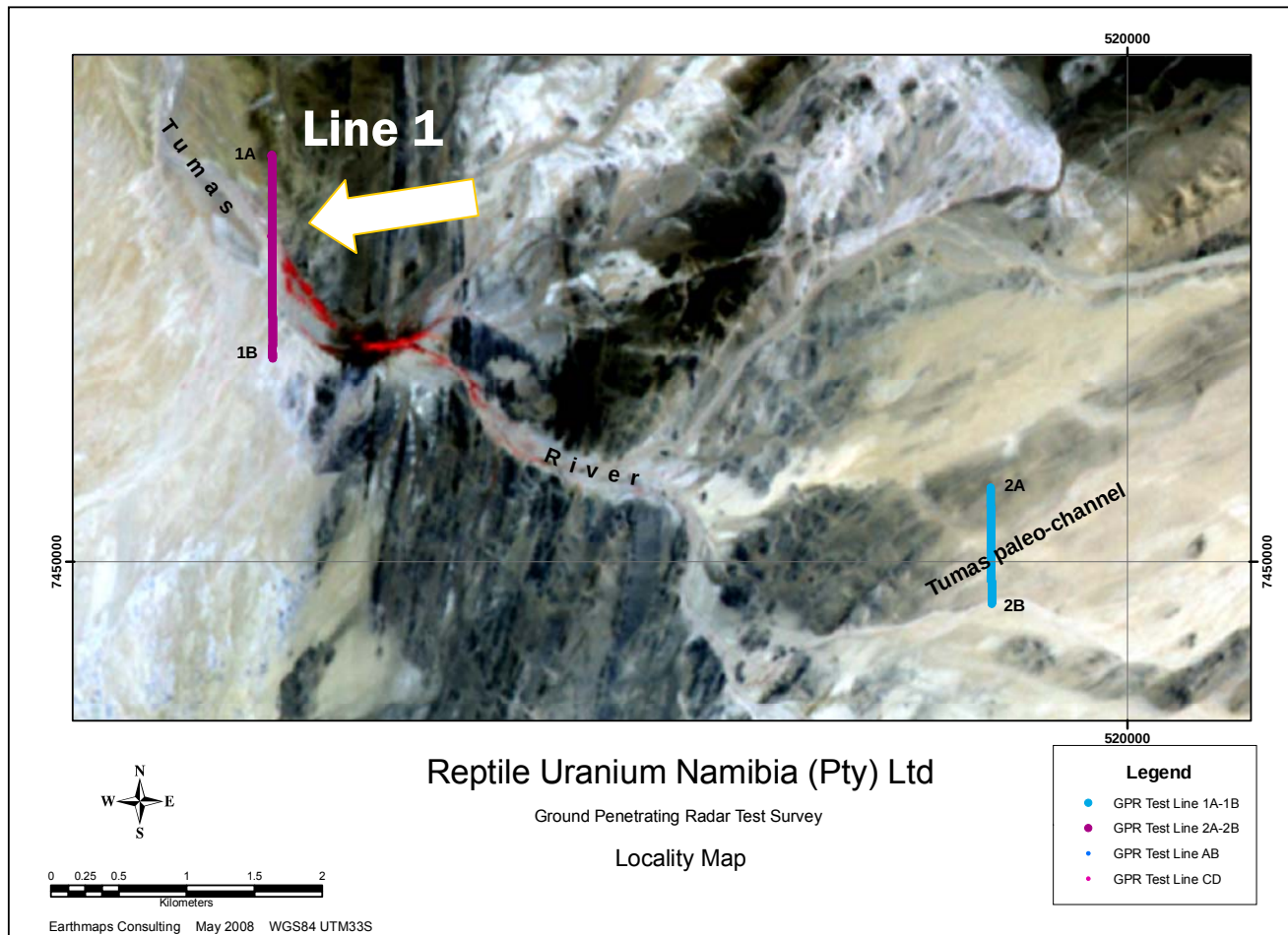
Acknowledgements: Reptile Uranium Namibia (Pty) Ltd

Tumas Project

Line 1

Terrain:

Active
River
Drainage

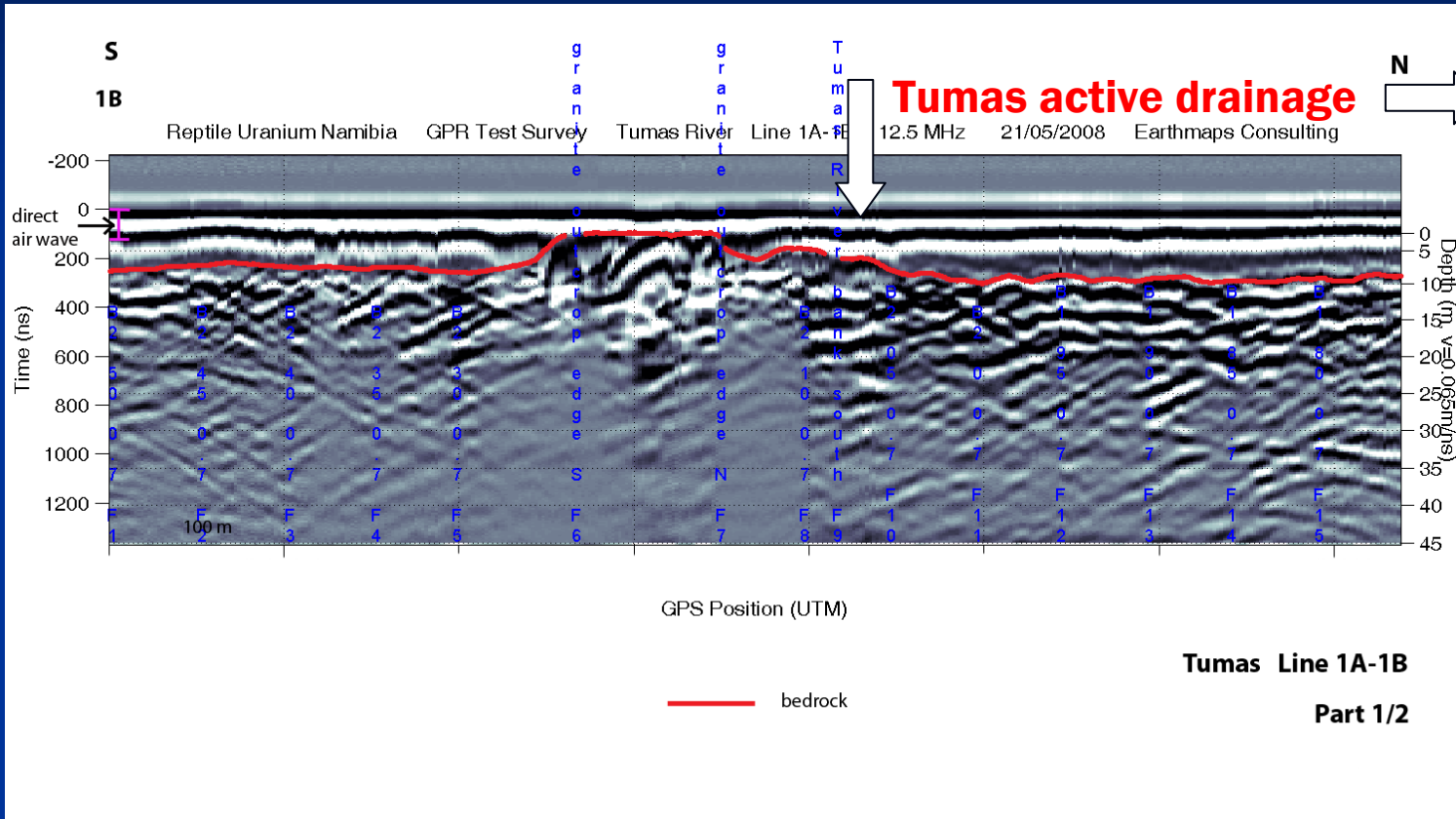


Acknowledgements: Reptile Uranium Namibia (Pty) Ltd



Tumas Project

Line 1 - S



Terrain:

Active River Drainage

GPR

+

Acknowledgements: Reptile Uranium Namibia (Pty) Ltd

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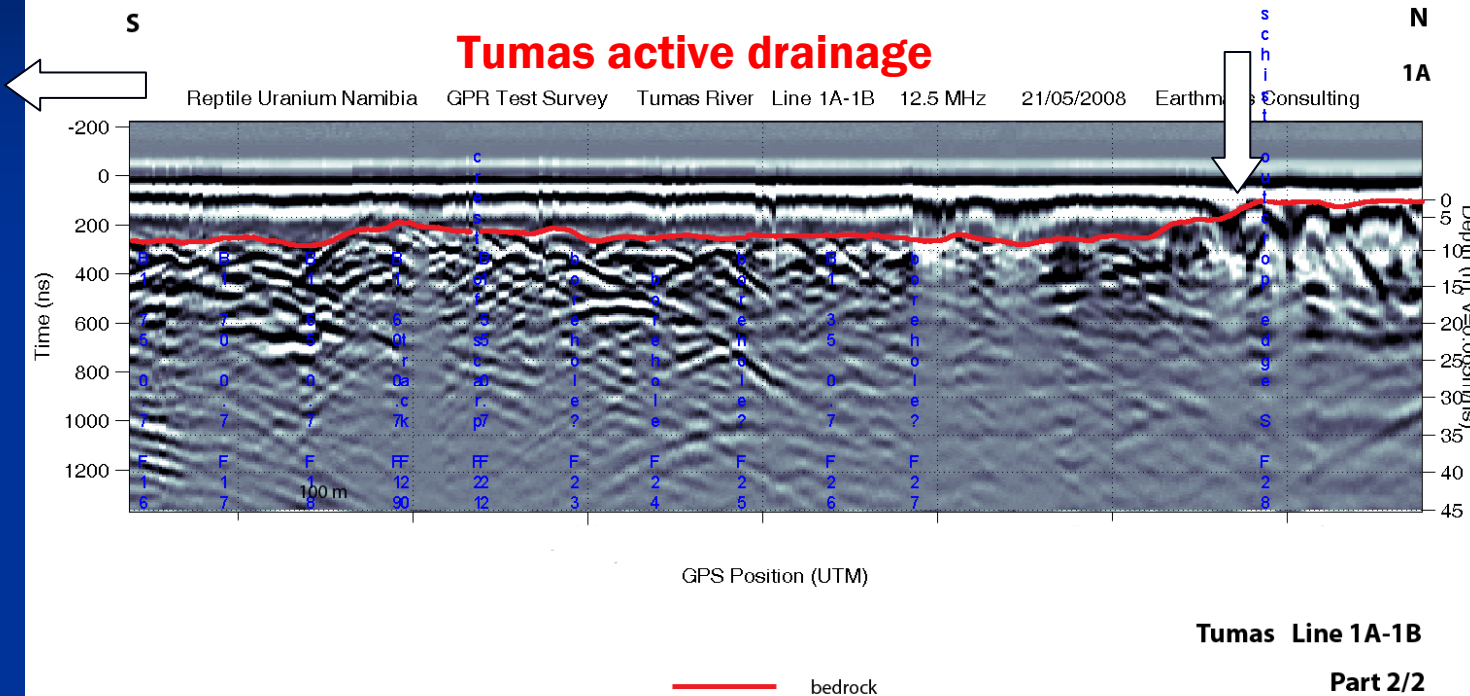


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Tumas Project

Line 1 - N

Tumas active drainage



Terrain:

Active
River
Drainage

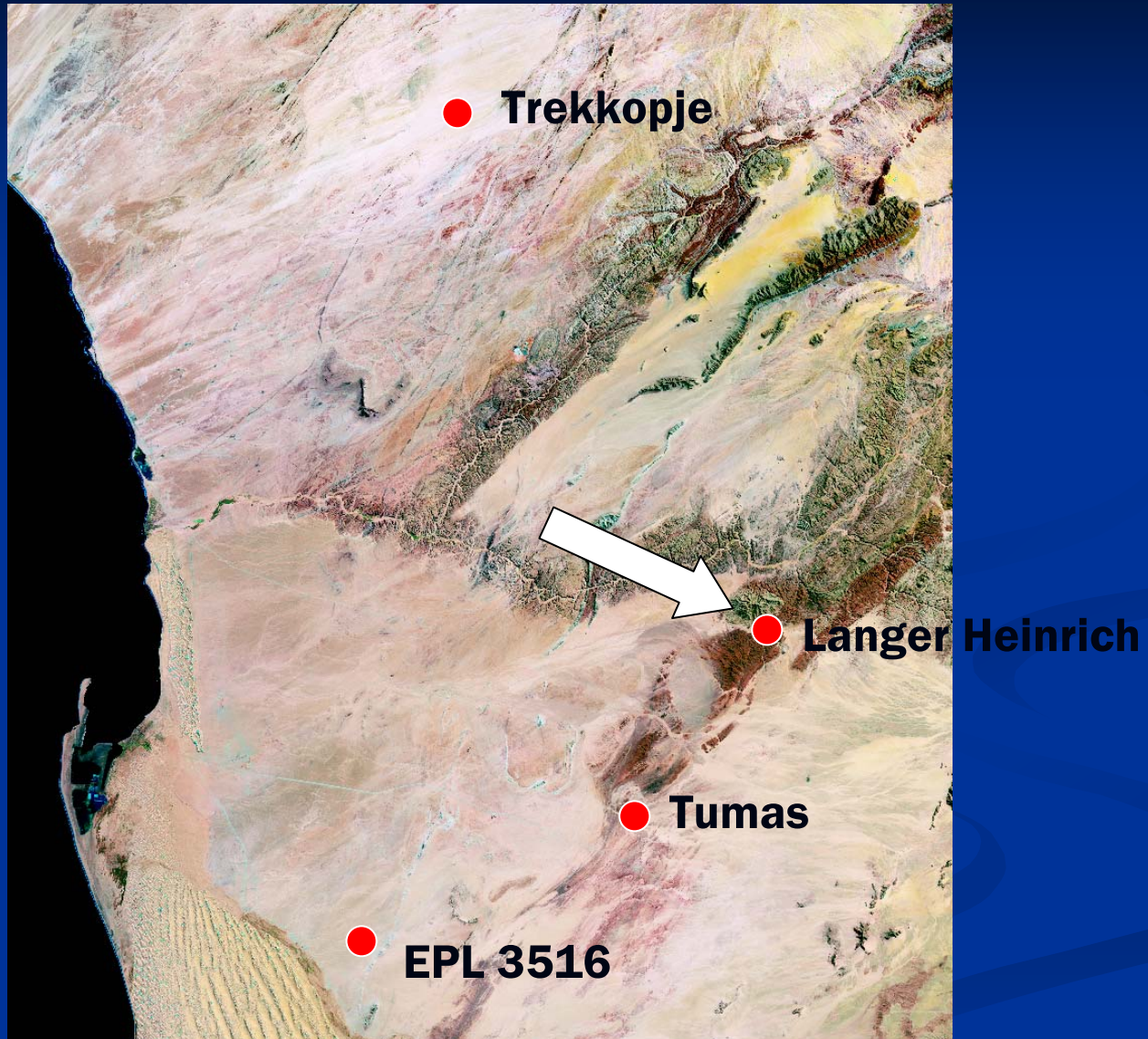
GPR

+

Acknowledgements: Reptile Uranium Namibia (Pty) Ltd



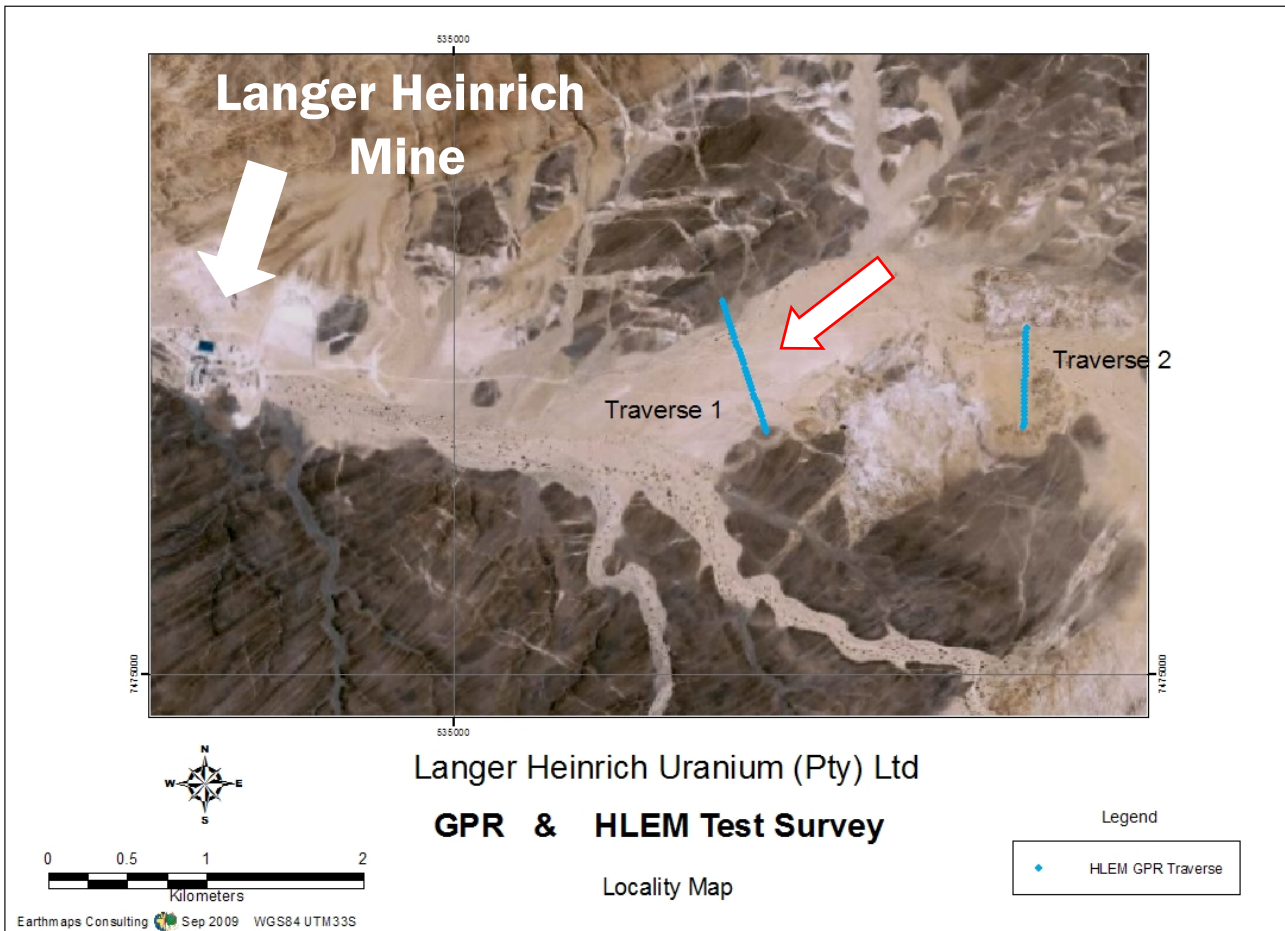
GPR Survey: Namibian Case Studies



Langer Heinrich Mine

Terrain:

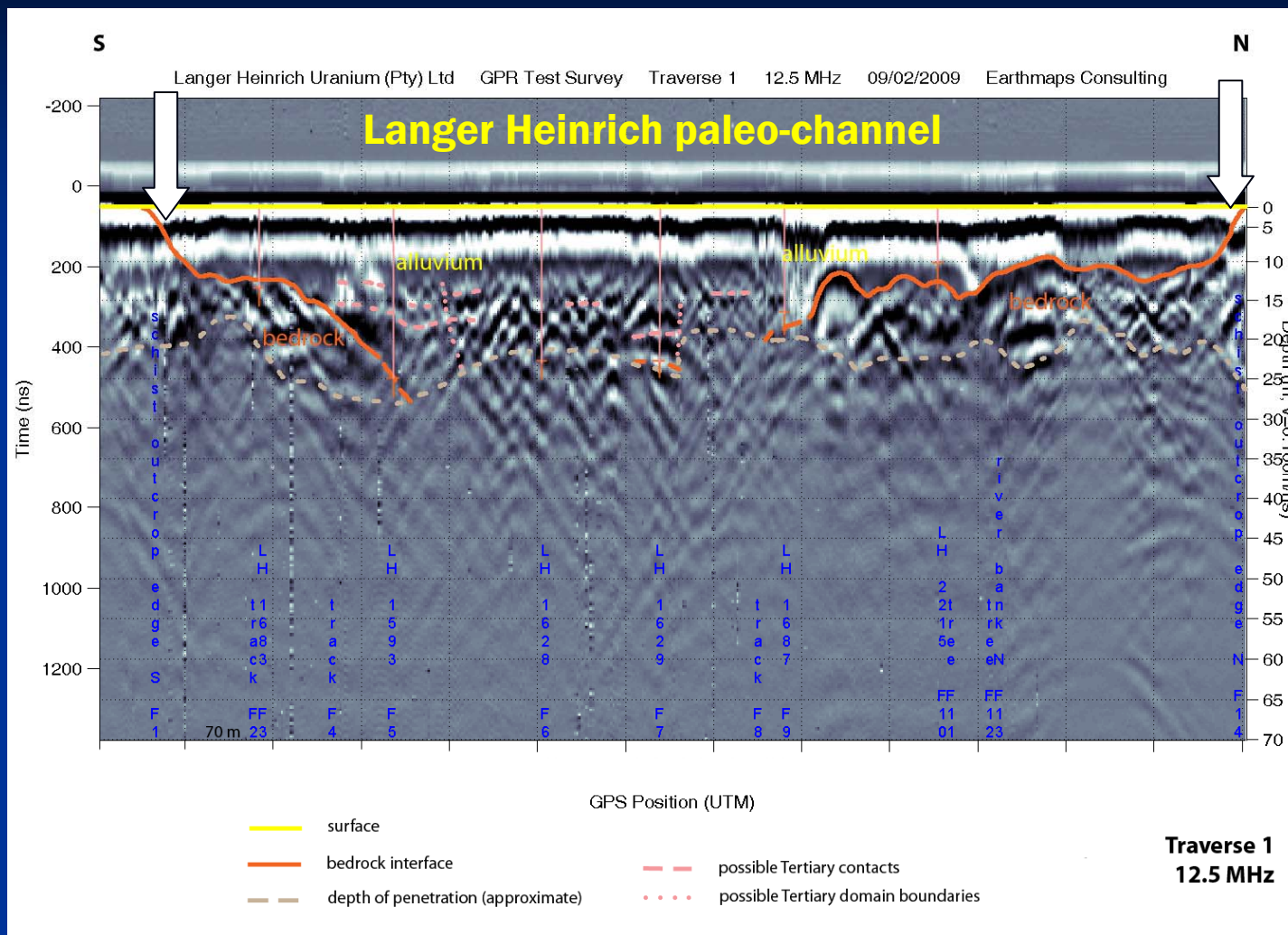
**Calcrete
&
Alluvium**



Acknowledgements: Langer Heinrich Uranium (Pty) Ltd

Langer Heinrich Mine

Traverse 1



Terrain:

Calcrete
&
Alluvium

GPR

+ -

Acknowledgements: Langer Heinrich Uranium (Pty) Ltd

Langer Heinrich Mine

Traverse 1

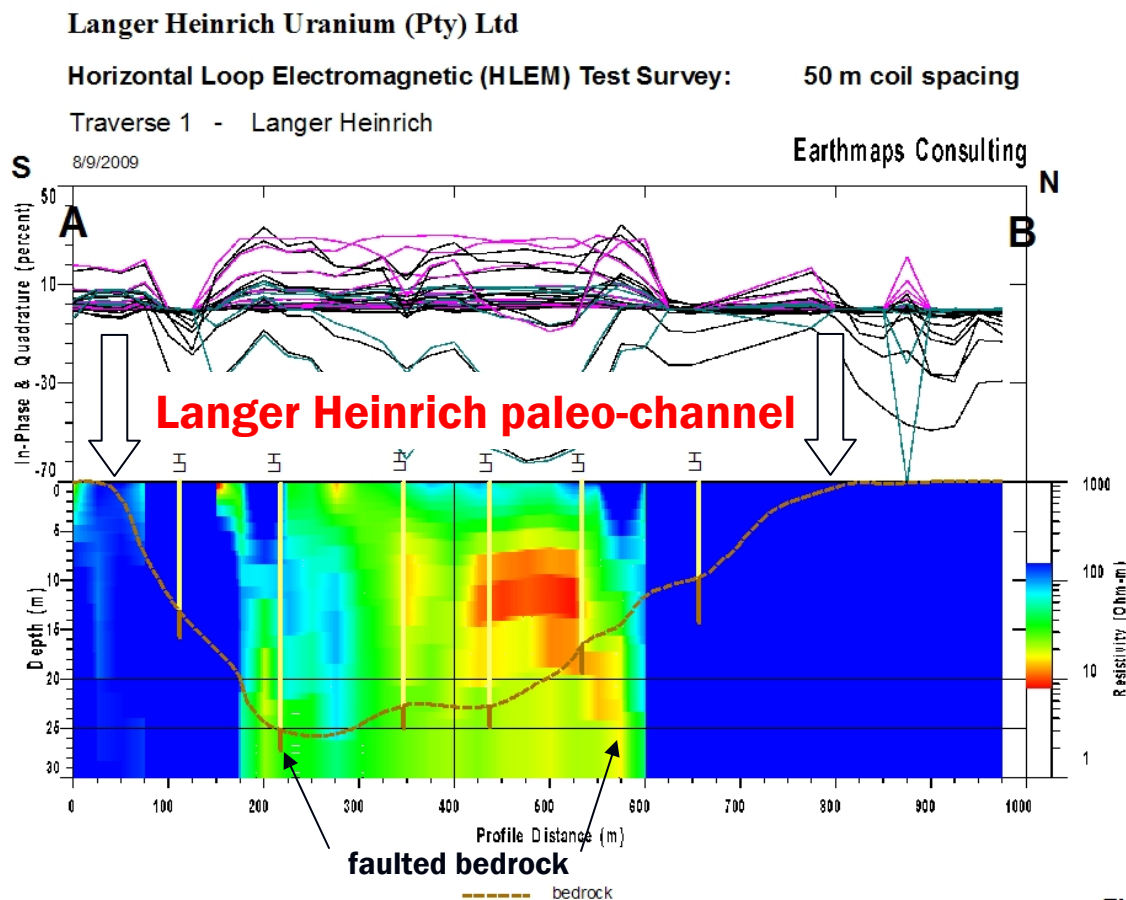


Figure 4

Terrain:

Calcrete
&
Alluvium

HLEM

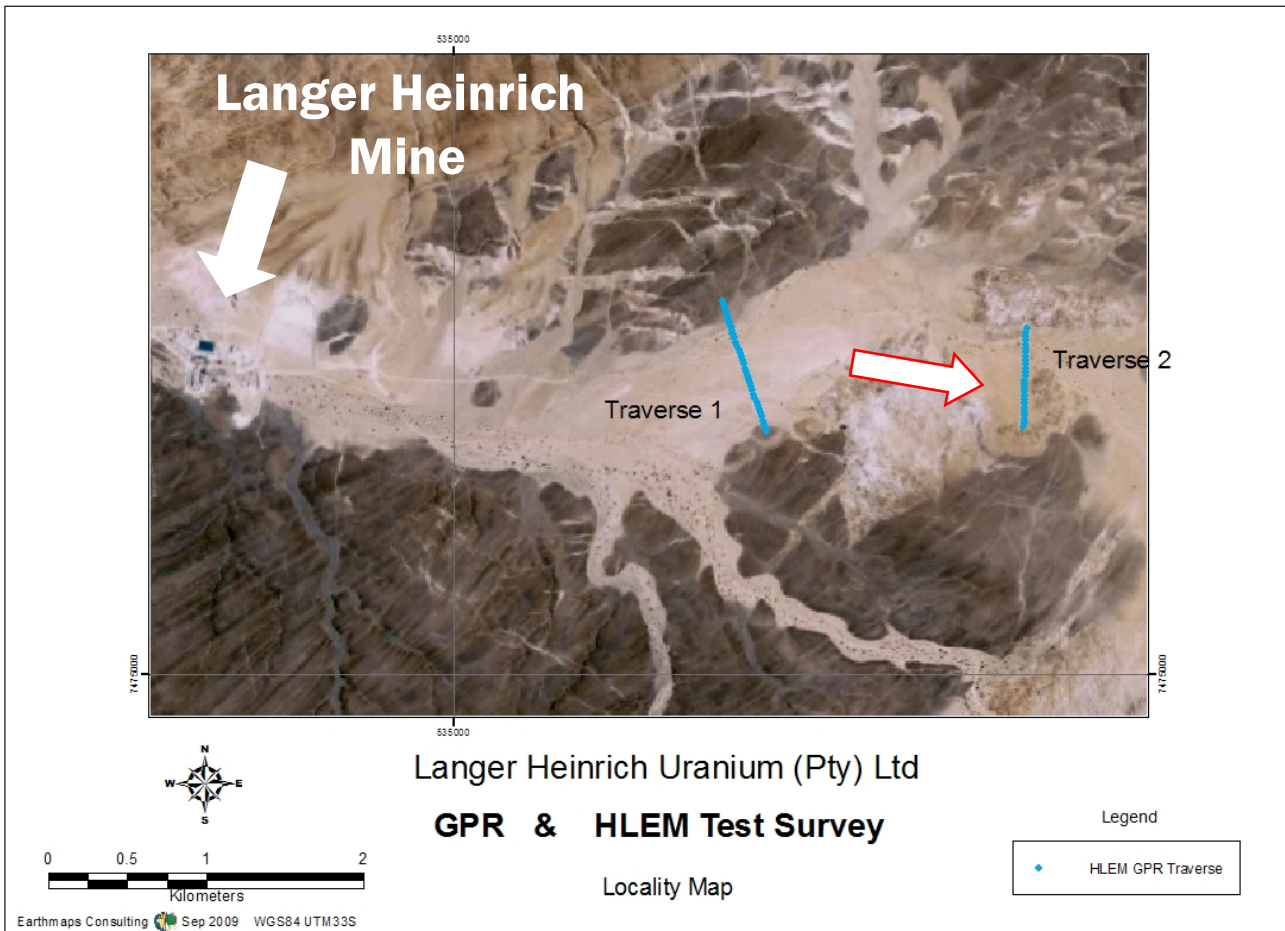
+ -

Acknowledgements: Langer Heinrich Uranium (Pty) Ltd

Langer Heinrich Mine

Terrain:

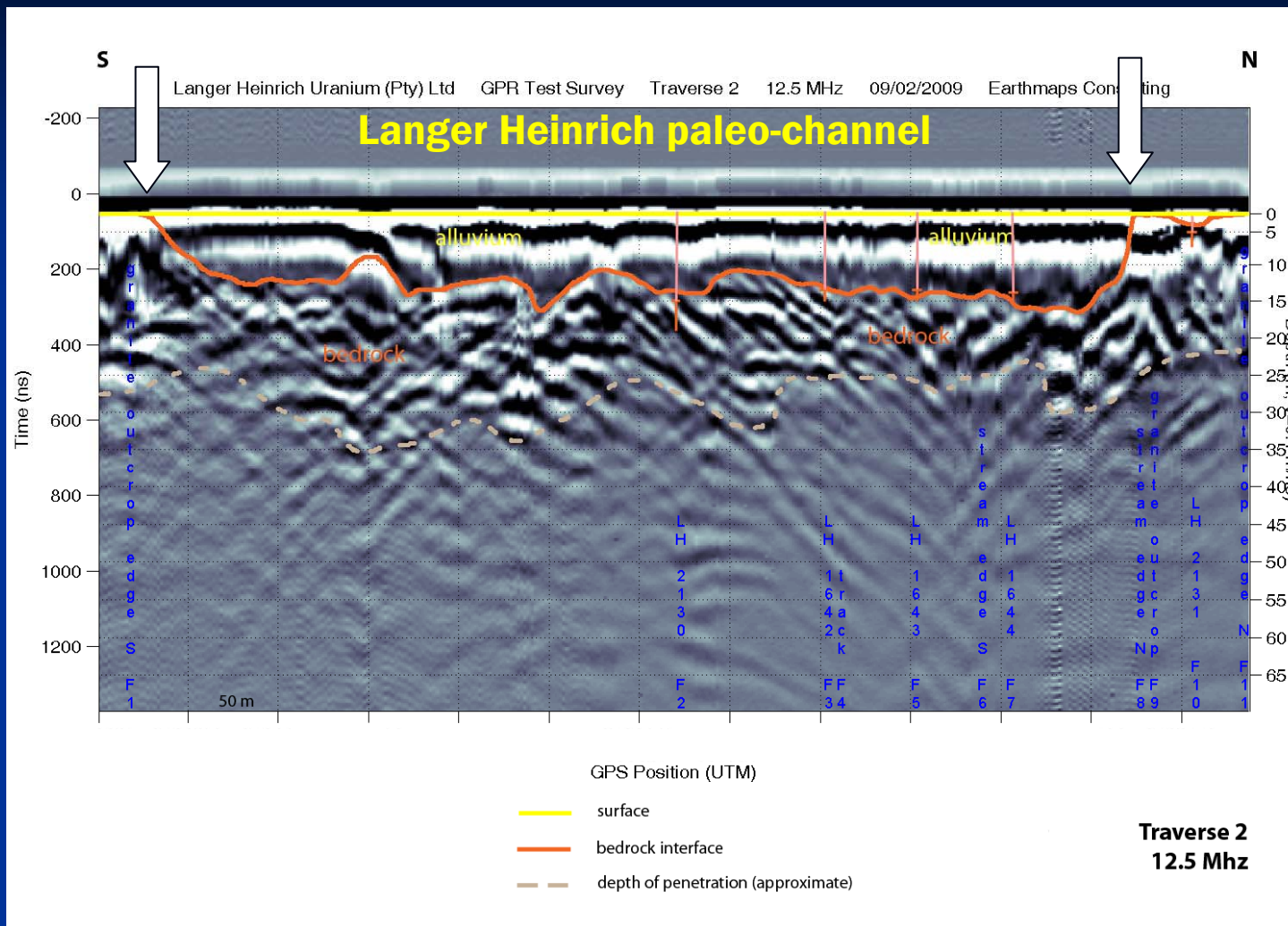
**Calcrete
&
Alluvium**



Acknowledgements: Langer Heinrich Uranium (Pty) Ltd

Langer Heinrich Mine

Traverse 2



Terrain:

**Calcrete
&
Alluvium**

GPR

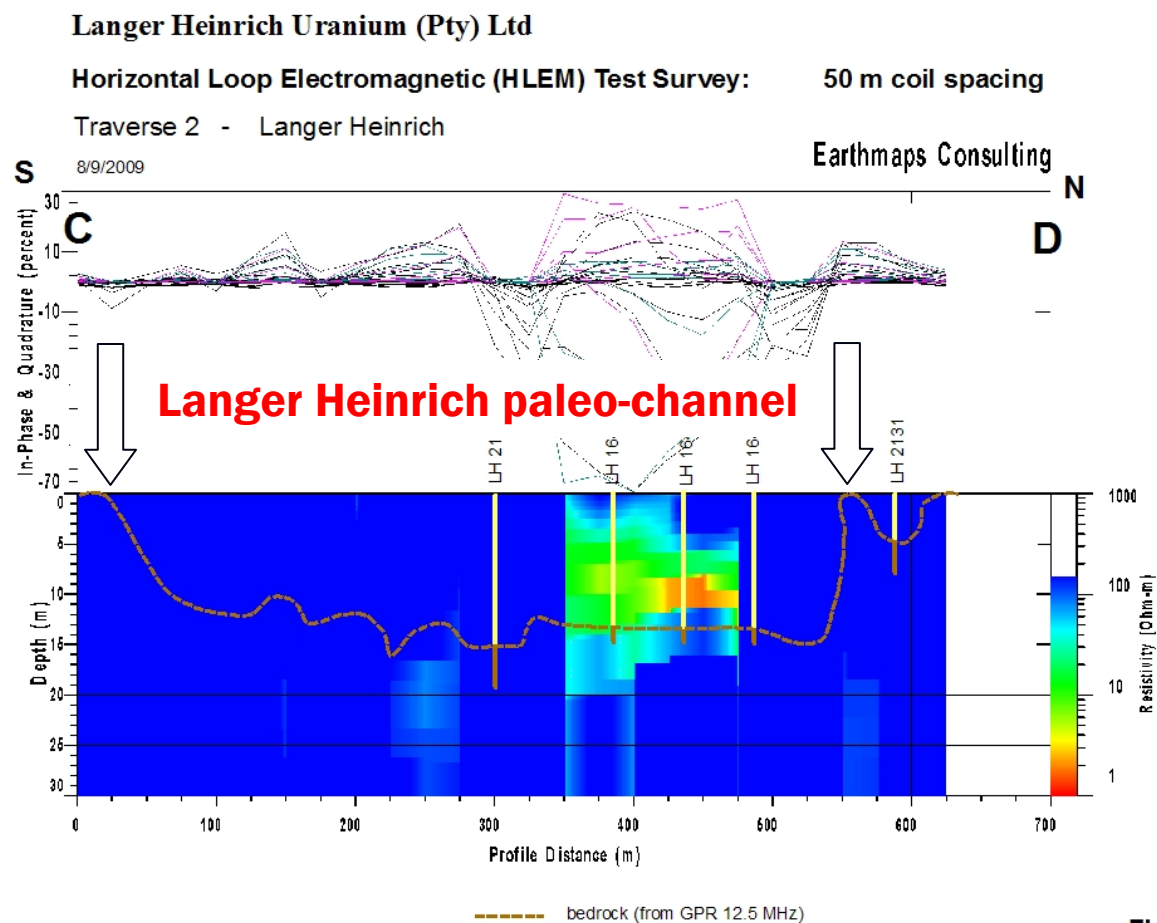
+

Acknowledgements: Langer Heinrich Uranium (Pty) Ltd



Langer Heinrich Mine

Traverse 2



Terrain:

Calcrete
&
Alluvium

HLEM

Acknowledgements: Langer Heinrich Uranium (Pty) Ltd

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GPR & HLEM: Comparison

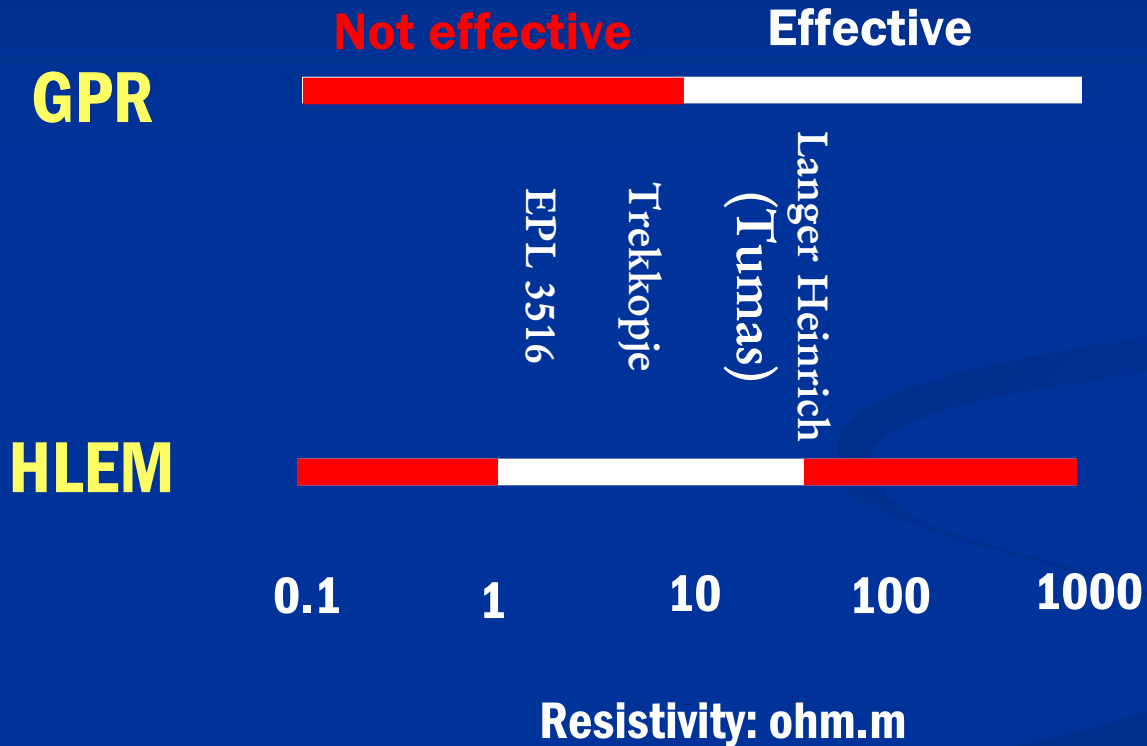
Colour Key:

Good resolution & penetration

Poor resolution & poor penetration

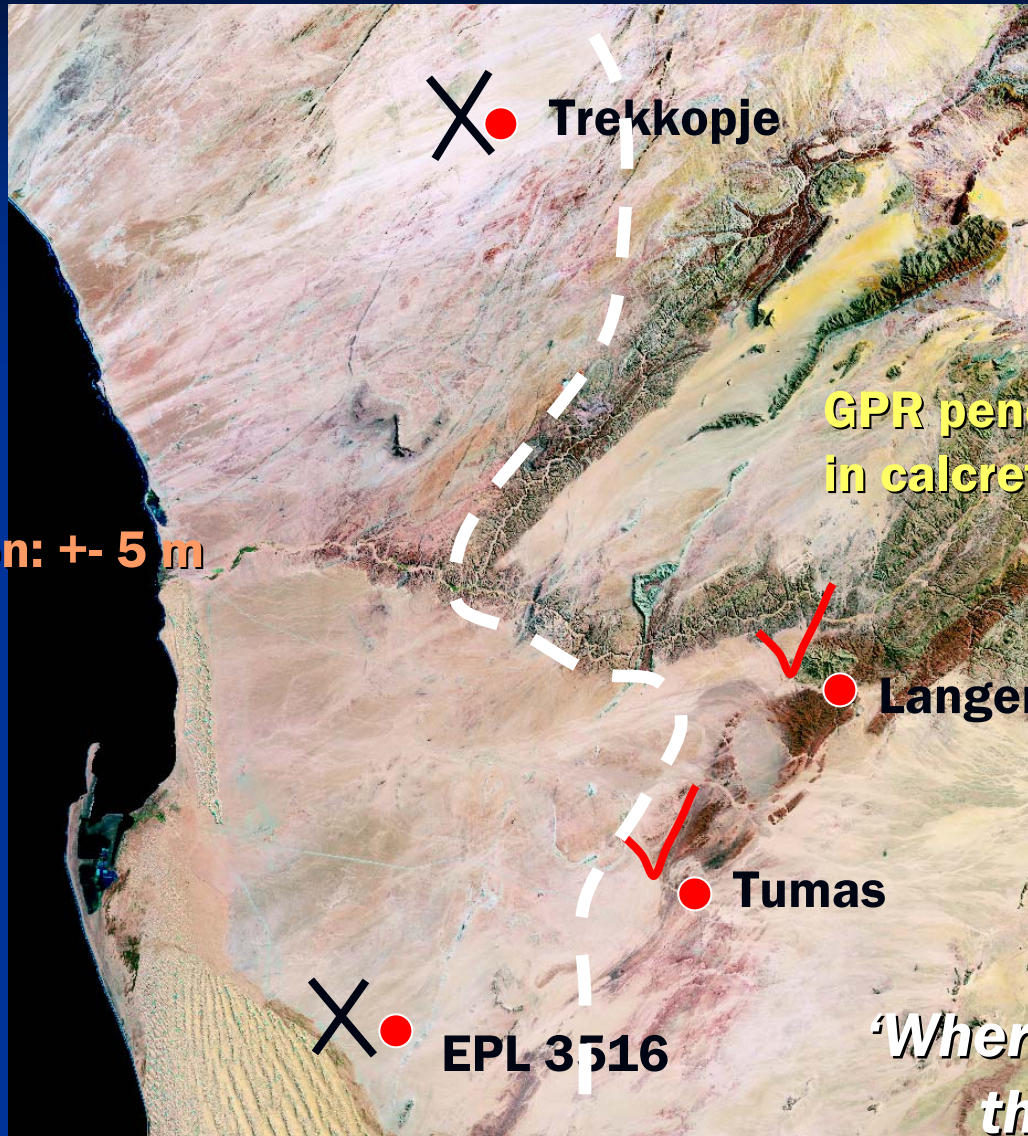
Environment	GPR (12.5 MHz)	HLEM (50m coil)
Calcrete, Alluvium >10 ohm.m	+ -2m depth resolution down to + - 25 m	+ - 4 m depth resolution to + - 35 m provided resistivity not > 30 ohm.m
Gypcrete, Calcrete < 10 ohm. m	+ - 2 m depth resolution down to + -5 m	+ - 4 m depth resolution to + - 25 m provided resistivity not < 1 ohm.m

GPR & HLEM: Comparison



GPR Survey: Namibian Case Study: Results

GPR penetration: +/- 5 m
in cypcretes



GPR penetration: +/- 25 m
in calcretised alluvium

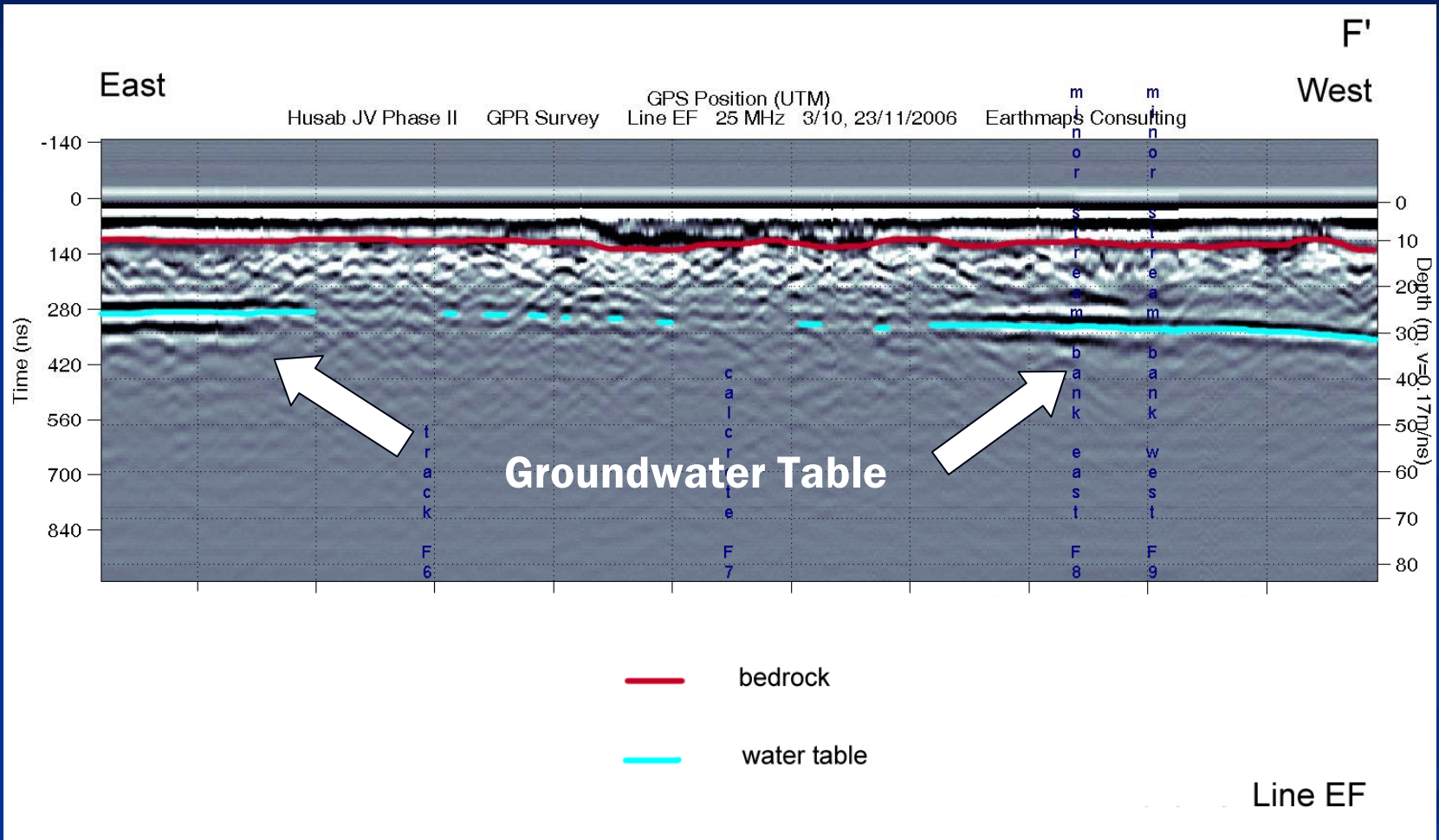
Langer Heinrich

Tumas

EPL 3516

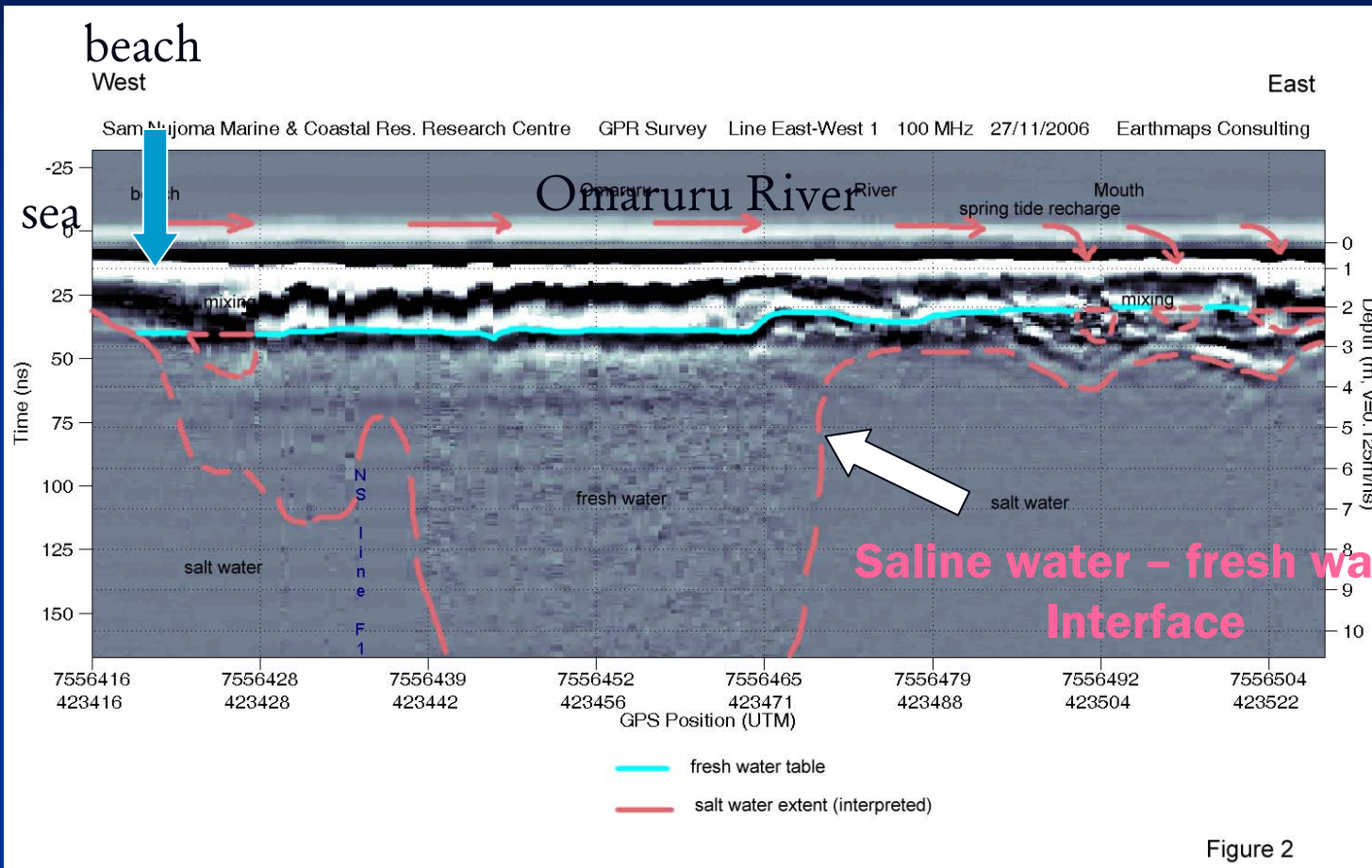
*'Where you penetrate
the resolution
is hard to beat.'*

GPR: Other Applications



Acknowledgements: Swakop Uranium (Pty) Ltd

GPR: Other Applications

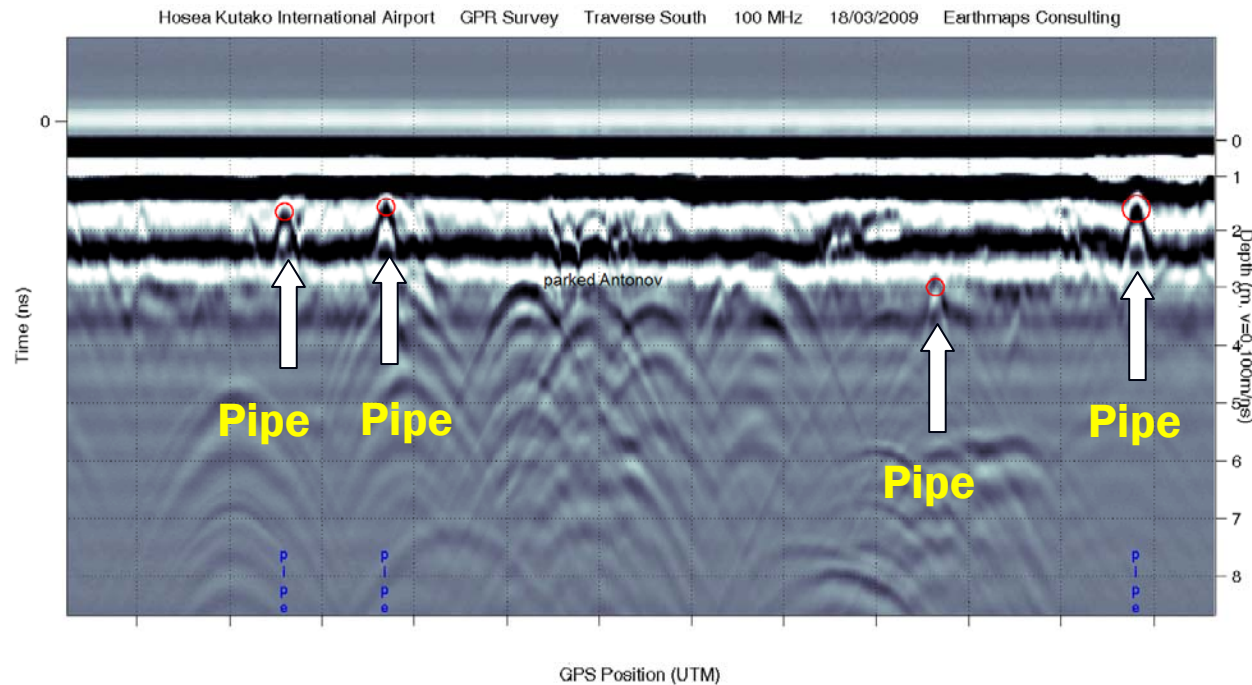


**Salt Water
Vs.
Fresh Water
(Omaruru
River
Mouth)**

Figure 2

Acknowledgements: Sam Nujoma Marine and Coastal Research Centre

GPR: Other Applications



Acknowledgements: Knight Piesold (Pty) Ltd

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GPR: Other Applications

**Diamondiferous
Gravels in
Kasai & Longatshimo
Rivers**

(DRC)



Acknowledgements: Gem Diamonds Mining Company of Africa

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GPR: Other Applications

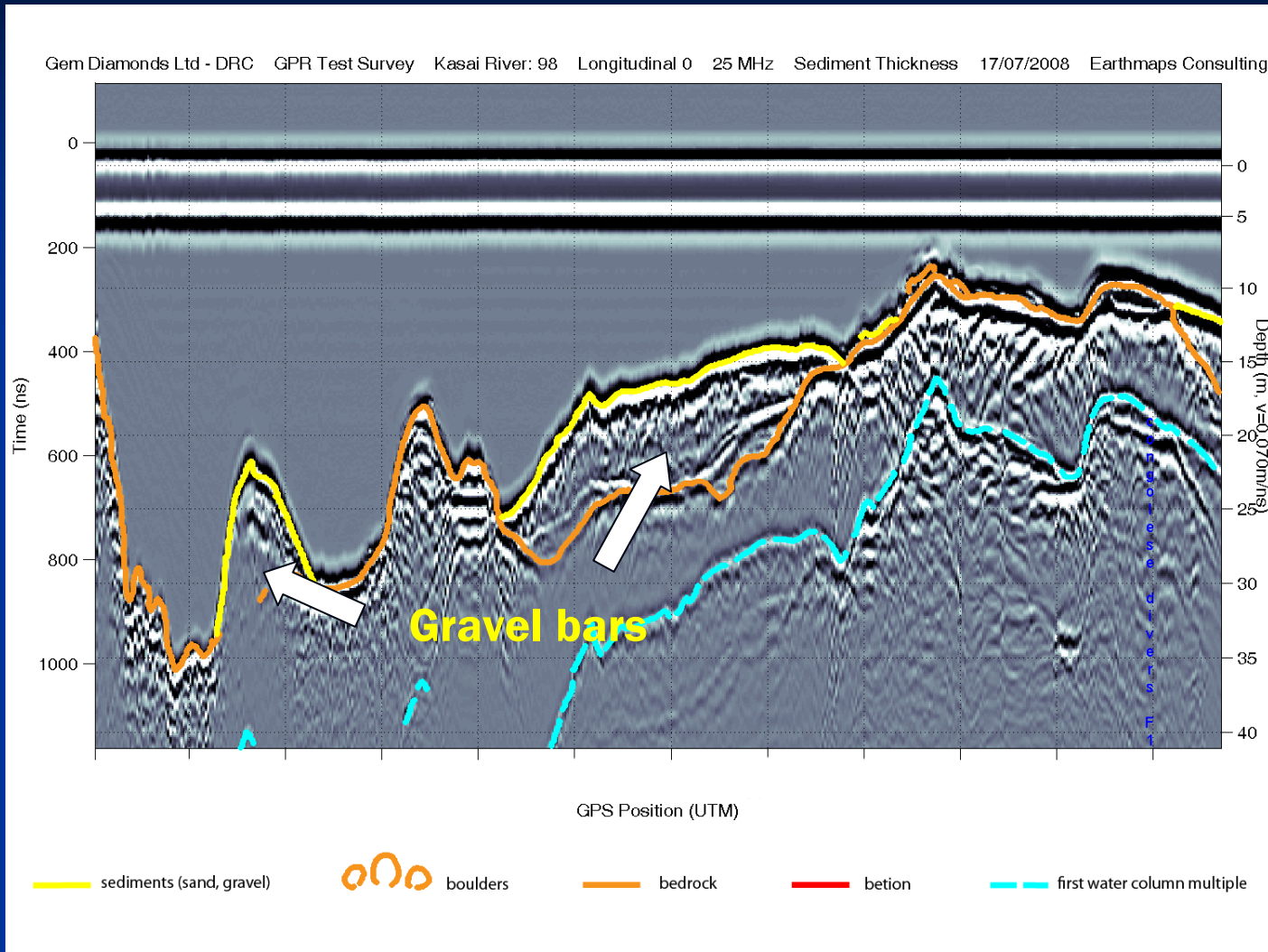
**Diamondiferous
Gravels in
Kasai & Longatshimo
Rivers**

(DRC)



Acknowledgements: Gem Diamonds Mining Company of Africa

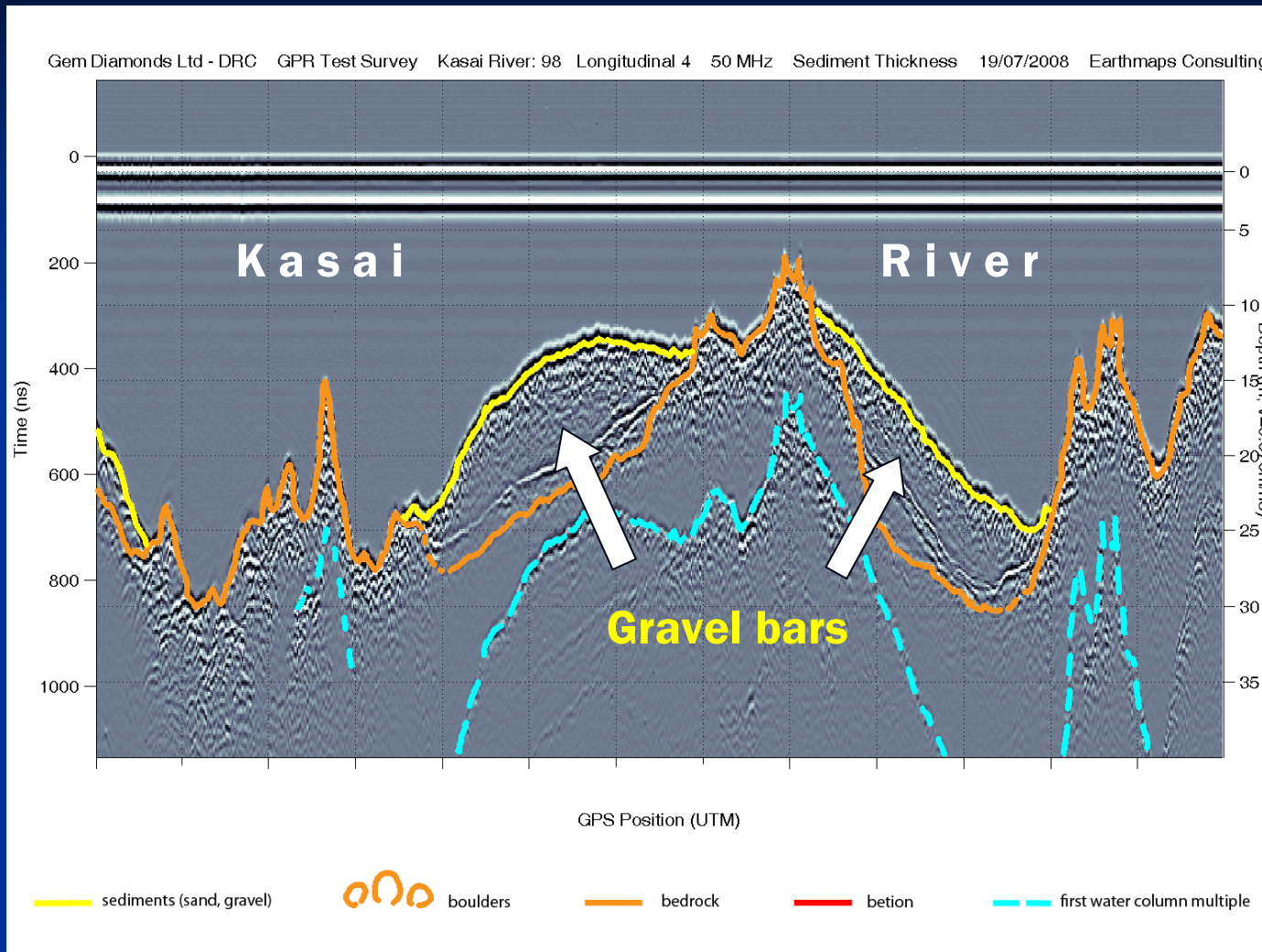
GPR: Other Applications



**Diamondiferous
Gravels in
Kasai &
Longatshimo
Rivers
(DRC)**

Acknowledgements: Gem Diamonds Mining Company of Africa

GPR: Other Applications



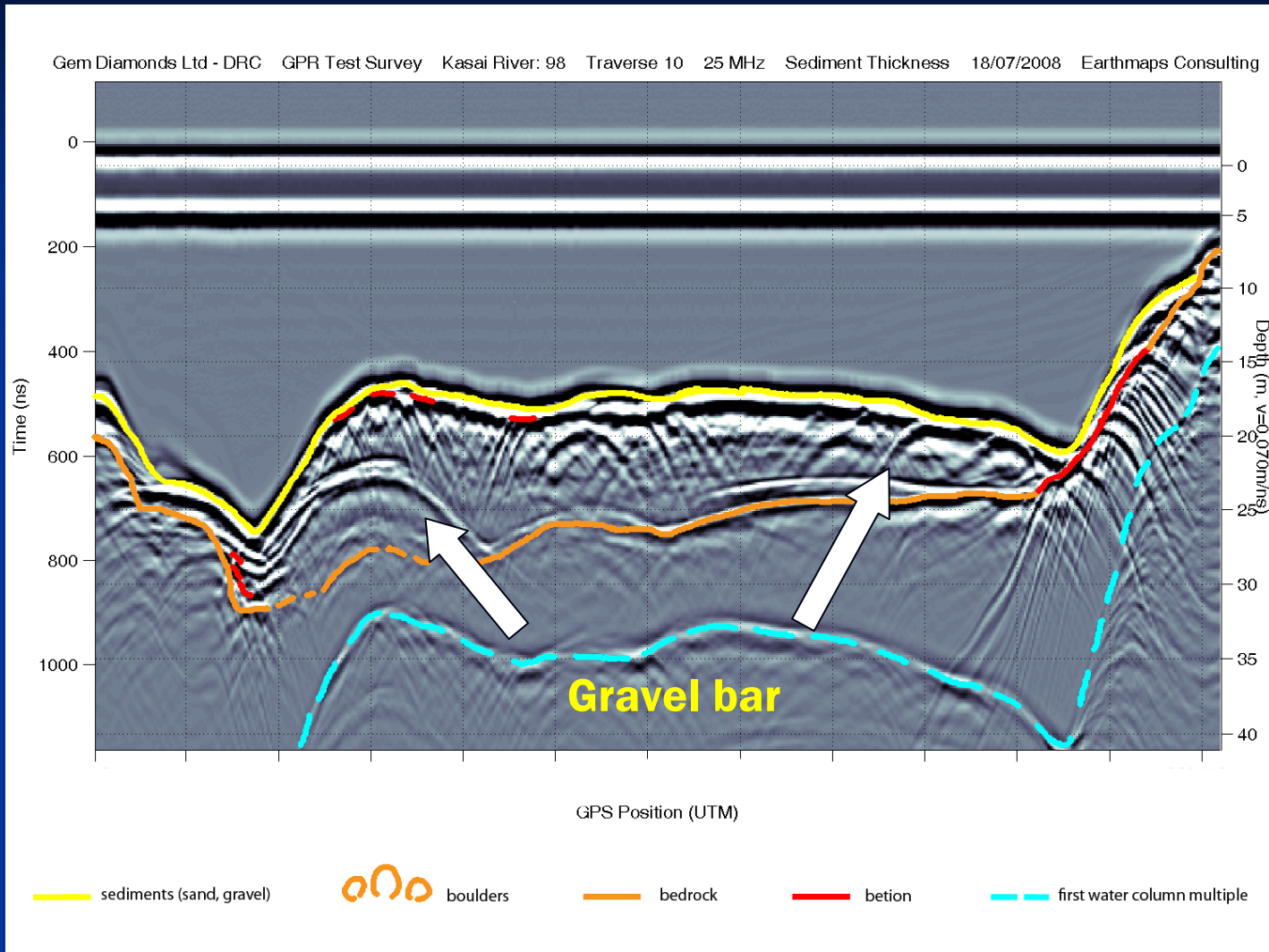
Acknowledgements: Gem Diamonds Mining Company of Africa

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GPR: Other Applications



**Diamondiferous
Gravels in
Kasai &
Longatshimo
Rivers
(DRC)**

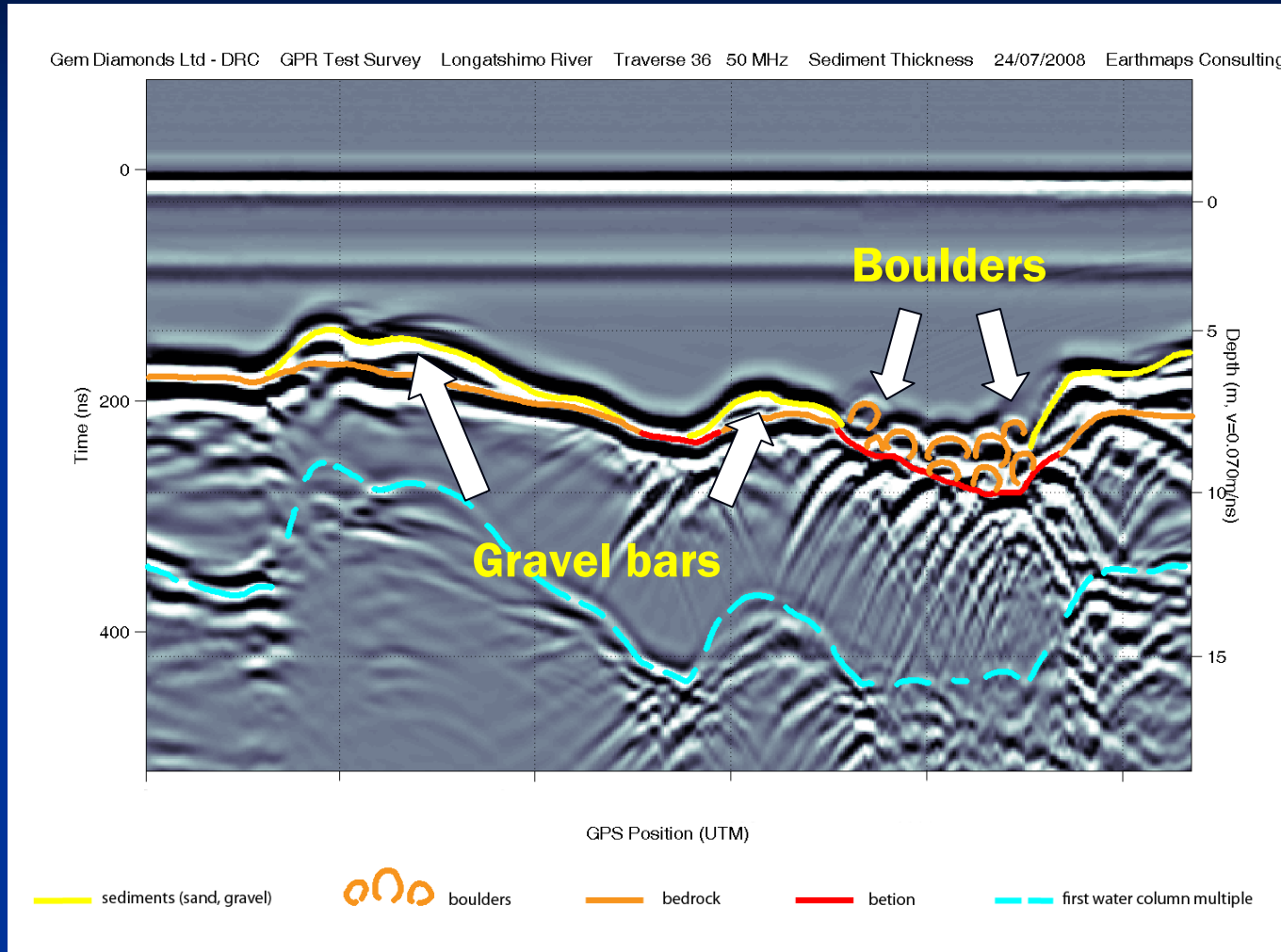
Acknowledgements: Gem Diamonds Mining Company of Africa

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GPR: Other Applications



**Diamondiferous
Gravels in
Kasai &
Longatshimo
Rivers
(DRC)**

Acknowledgements: Gem Diamonds Mining Company of Africa

Thank You

