Geophysics Case Studies: Pavements, Voids, Runways

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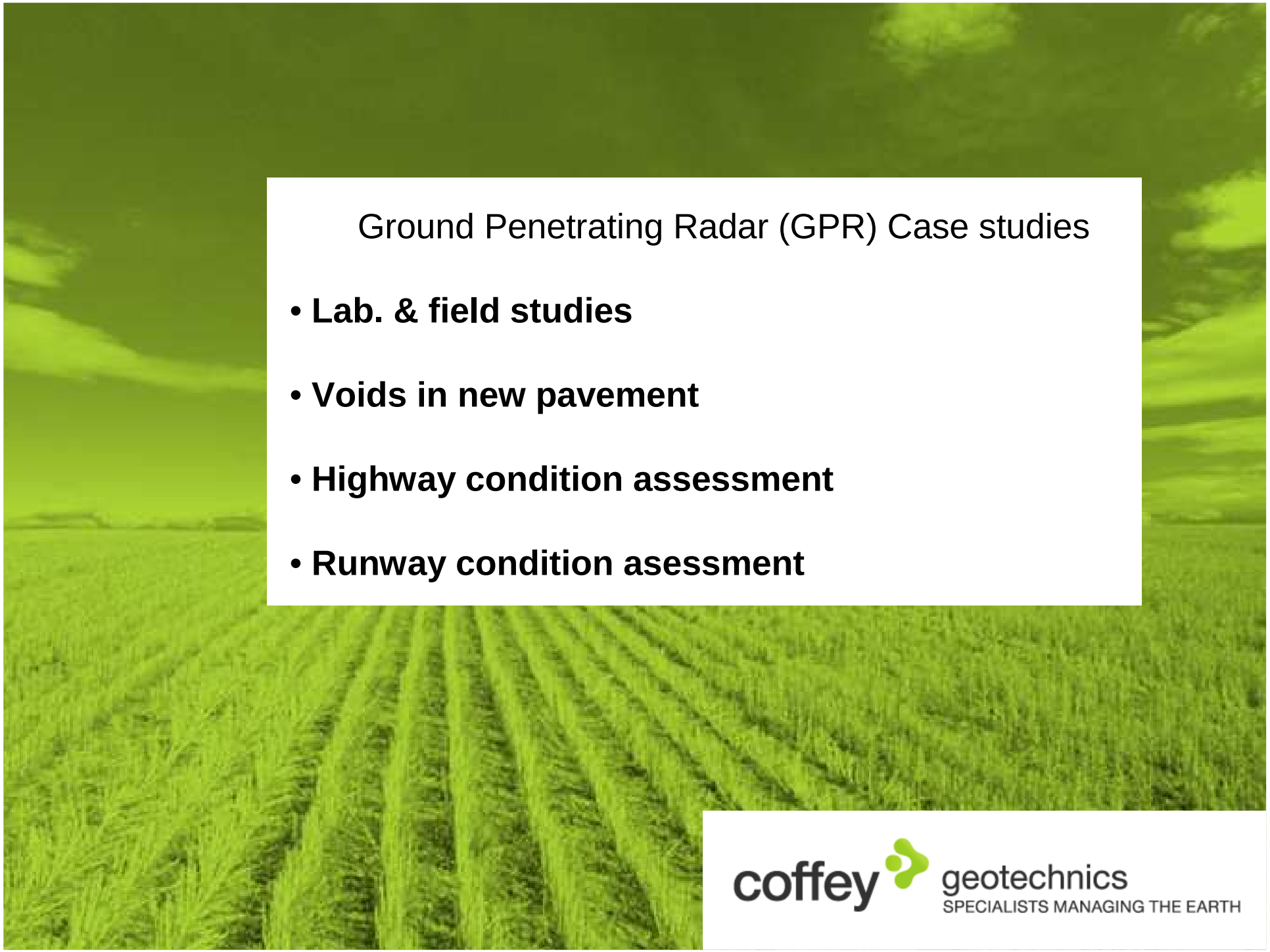
SPECIALISTS MANAGING THE EARTH

Prof. Bob Whiteley

Senior Principal



Ground Penetrating Radar (GPR) Case studies

- **Lab. & field studies**
- **Voids in new pavement**
- **Highway condition assessment**
- **Runway condition asessment**

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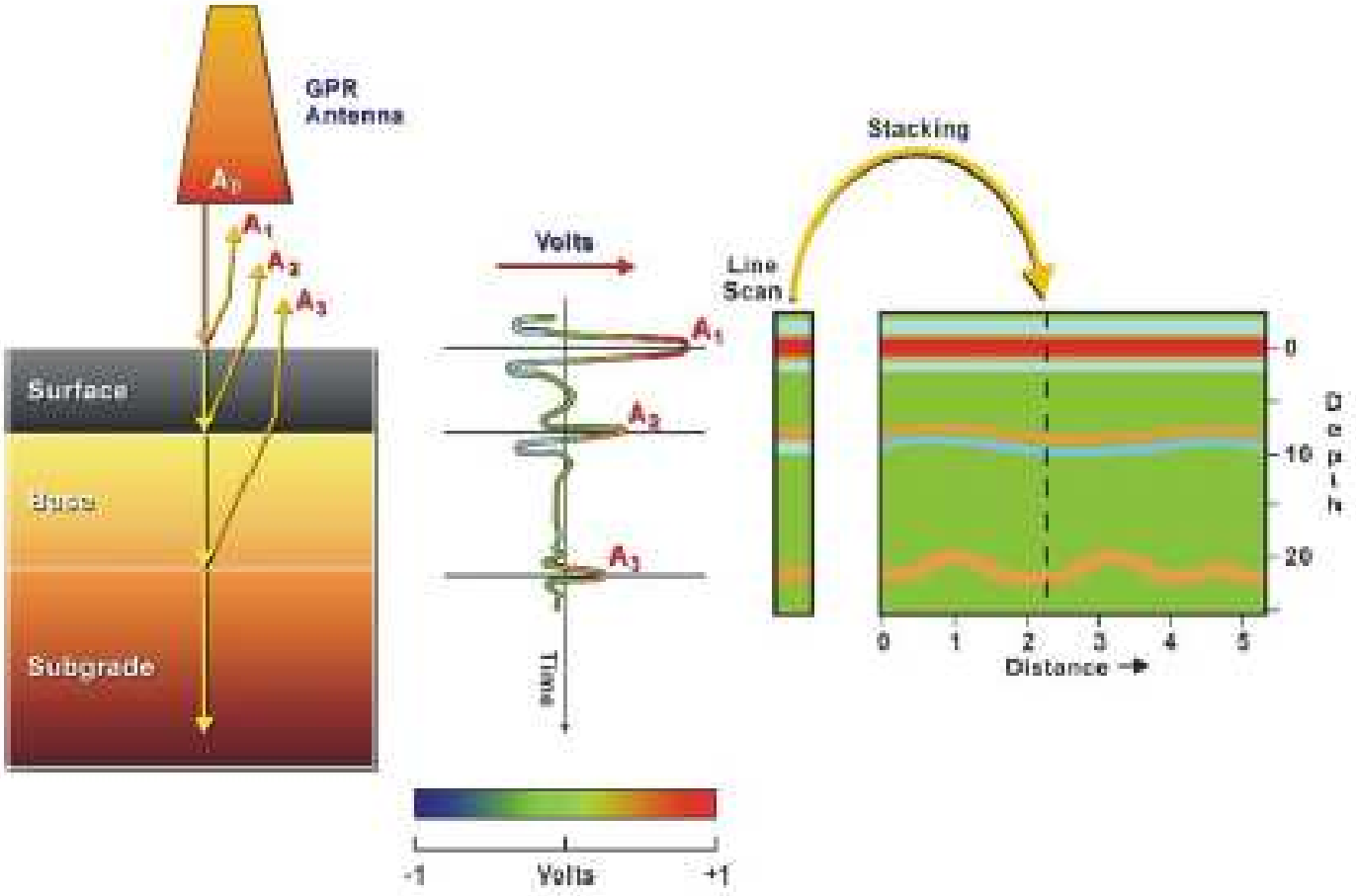
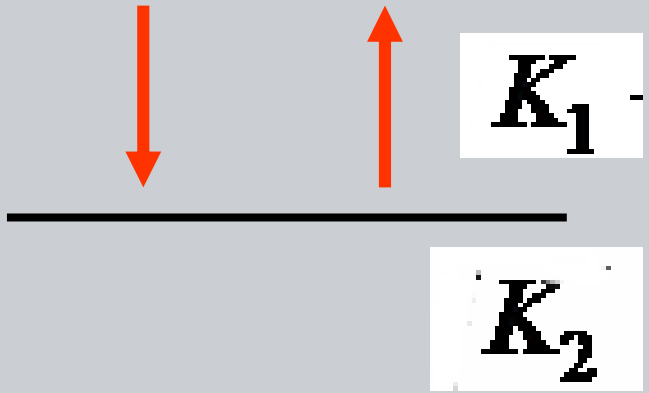
Principles of Ground Penetrating Radar



Radar reflection at interfaces

$$R = \frac{\sqrt{K_1} - \sqrt{K_2}}{\sqrt{K_1} + \sqrt{K_2}}$$



Reflected energy = R x Incident energy

Table 1: Typical Dielectric values

Material	Relative dielectric constant, K	Radar pulse velocity (metres/nanosecond)
Air	1	0.3
Water	80	0.03
concrete	4 – 10	0.09 to 0.12
Sand (dry)	4 – 10	0.13
Clay / silty soil	8 – 11	0.09

Reflection amplitude of a GPR pulse from an interface such as concrete /air is governed by the reflection coefficient, *R*, which is given by,

$$R = \frac{\sqrt{K_1} - \sqrt{K_2}}{\sqrt{K_1} + \sqrt{K_2}}$$

where K_1 and K_2 are the dielectric constants of two materials and the reflected signal amplitude = R x incident signal amplitude. Note that the sign of R may be positive or negative depending on the relative magnitudes of K_1 and K_2.

Portable GPR antenna & back-pack control unit

Acquisition system, voice communication & computer

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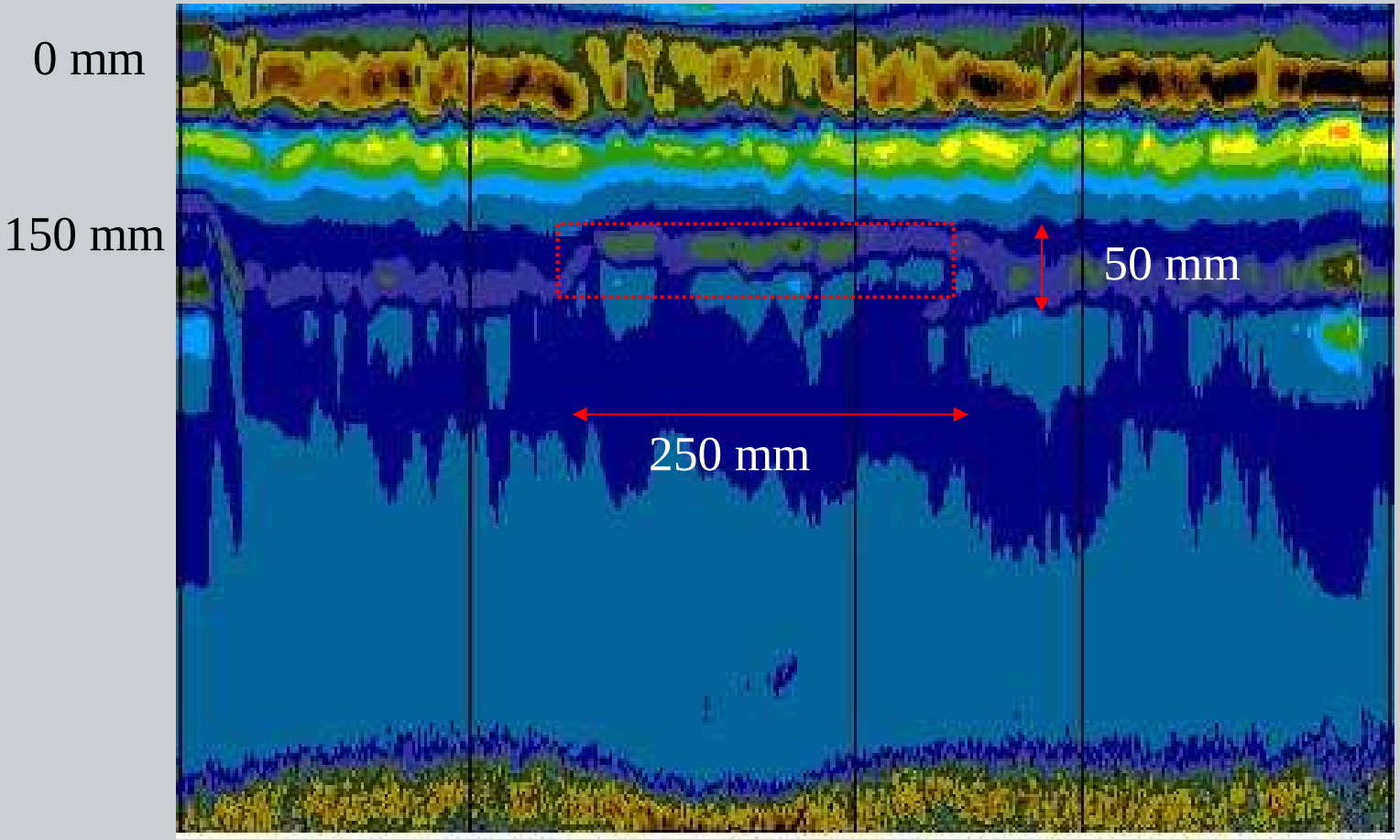
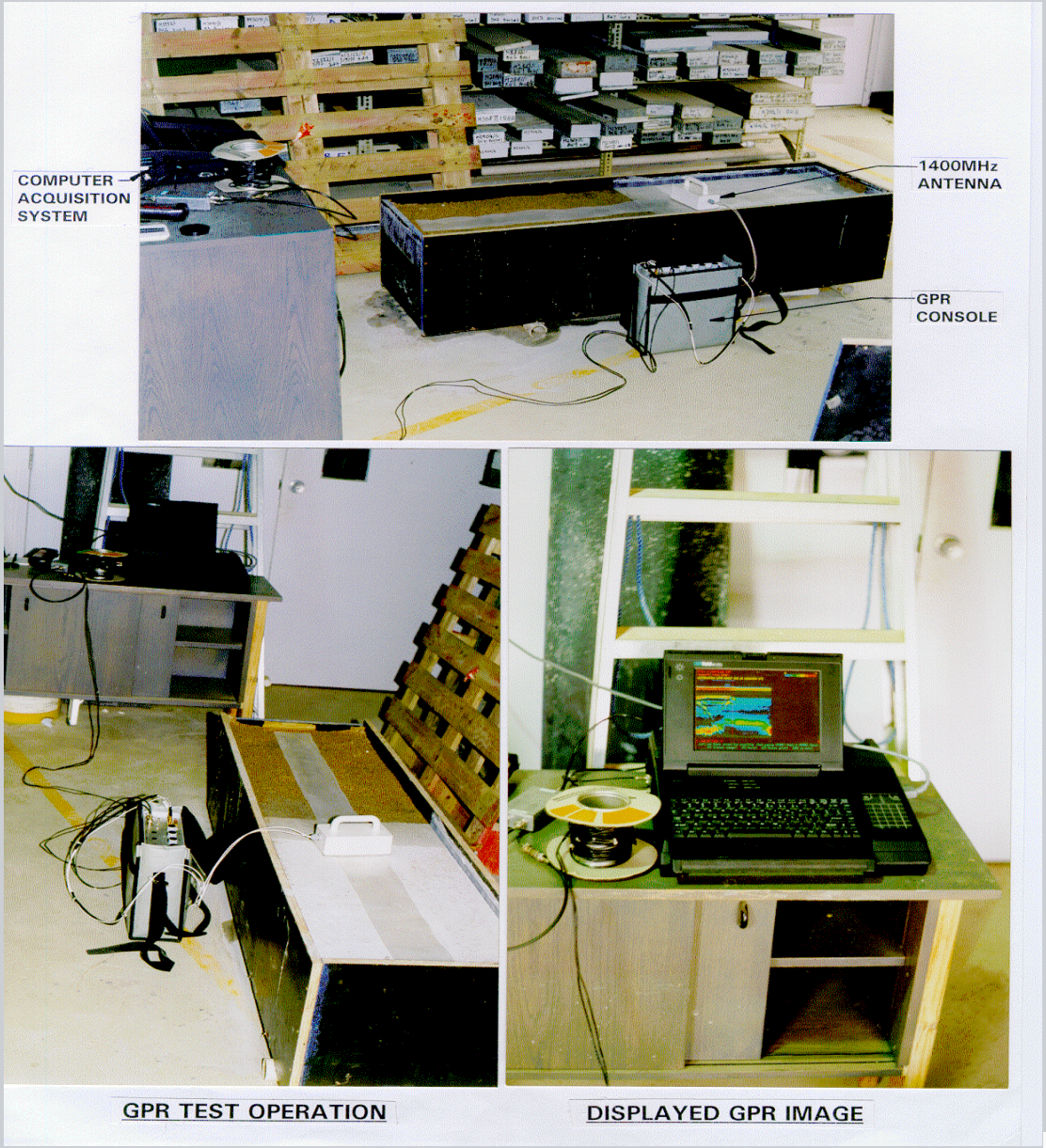
GPR image of airfilled void behind concrete liner



Radar Test Facility for Concrete



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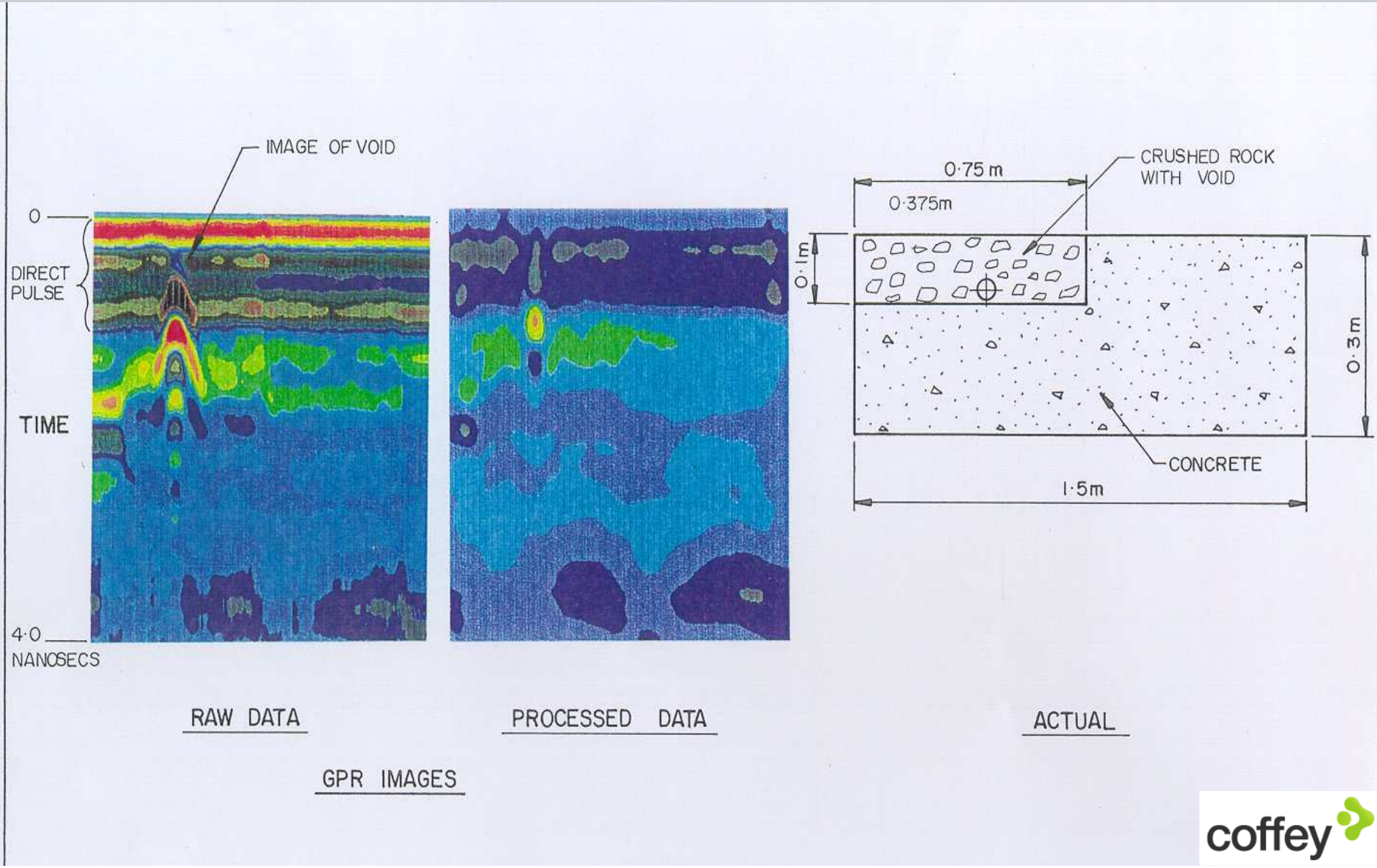
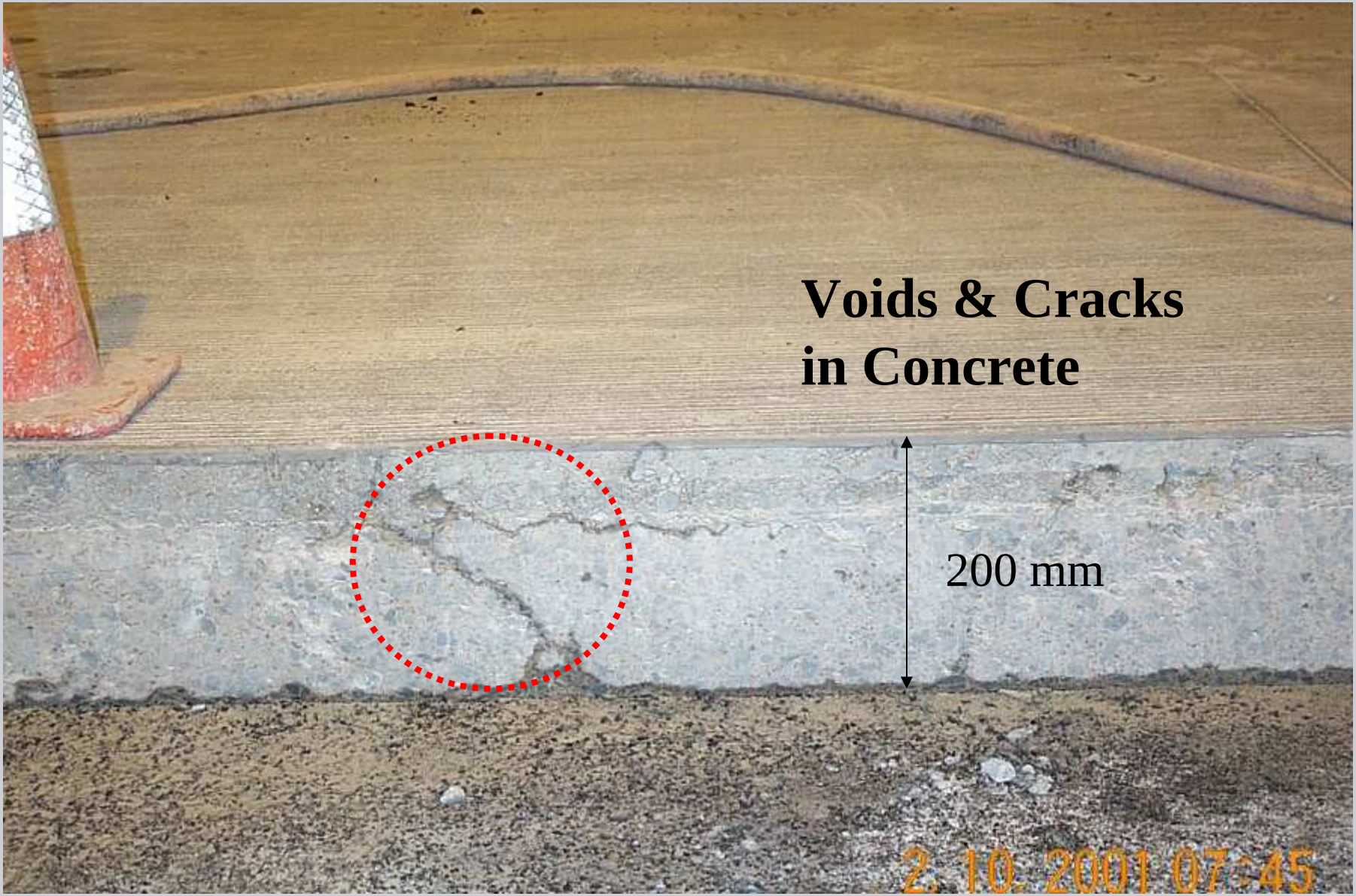
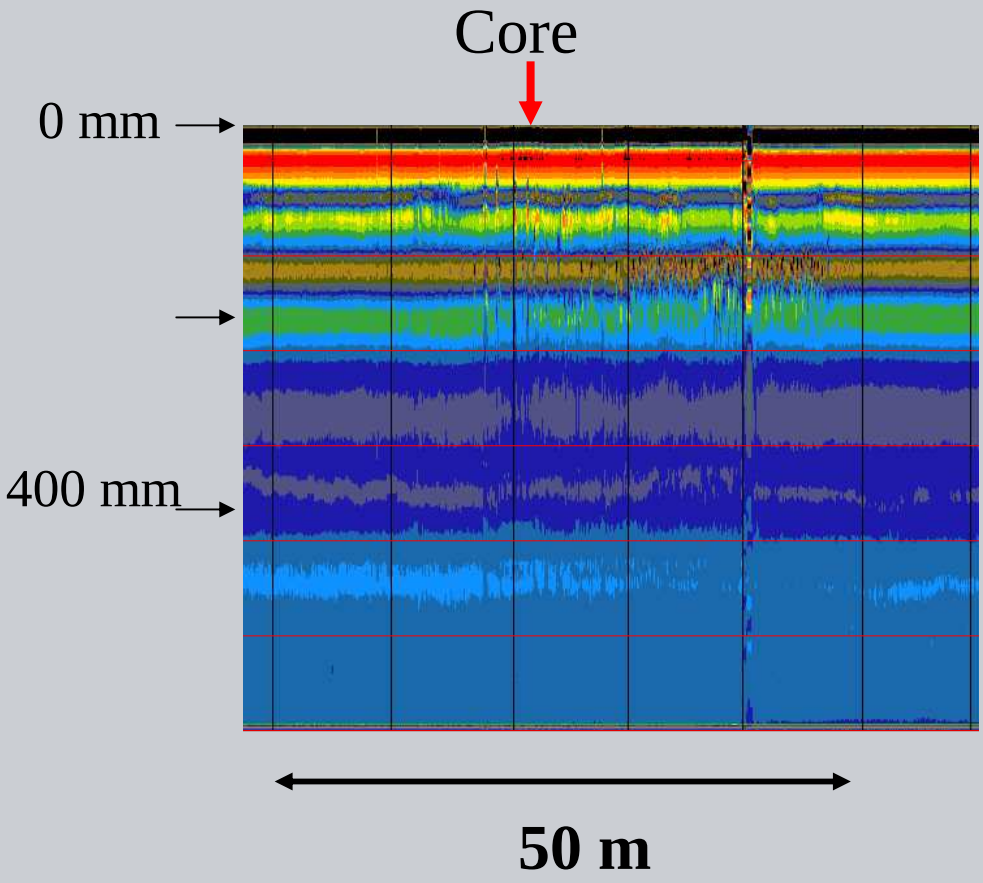
GPR Images of Deteriorated Concrete & Voids




Voids & Cracks
in Concrete
200 mm
2. 10. 2001 07:45



0 mm

200 mm

GPR Image of Voids in Concrete

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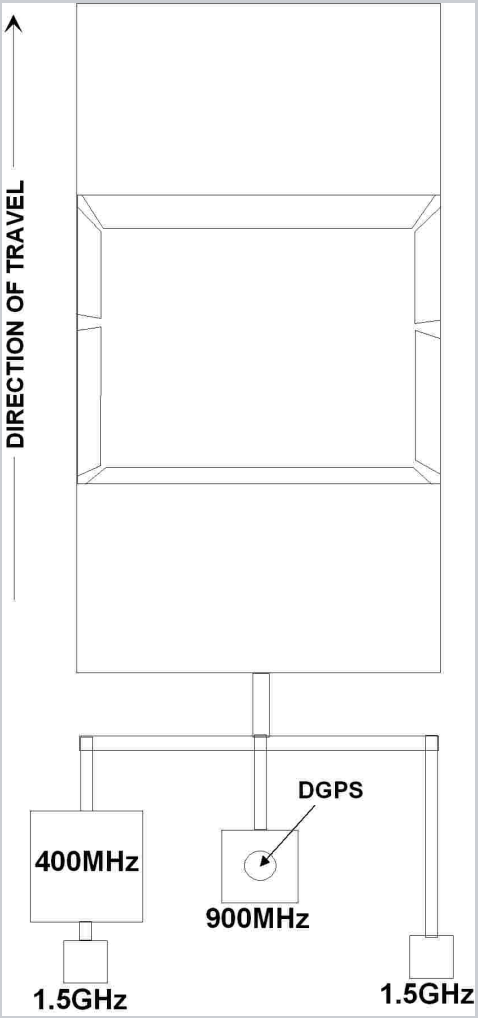
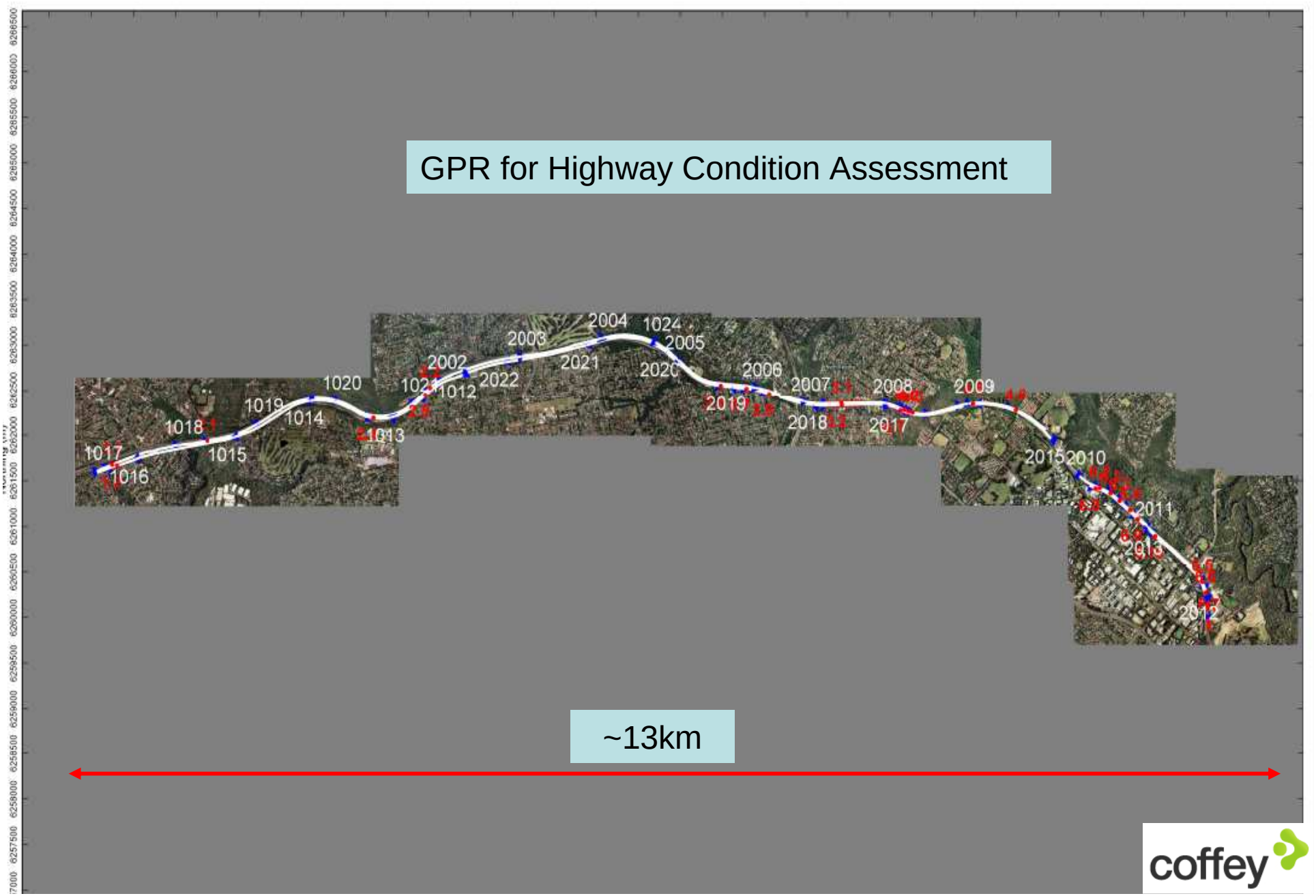
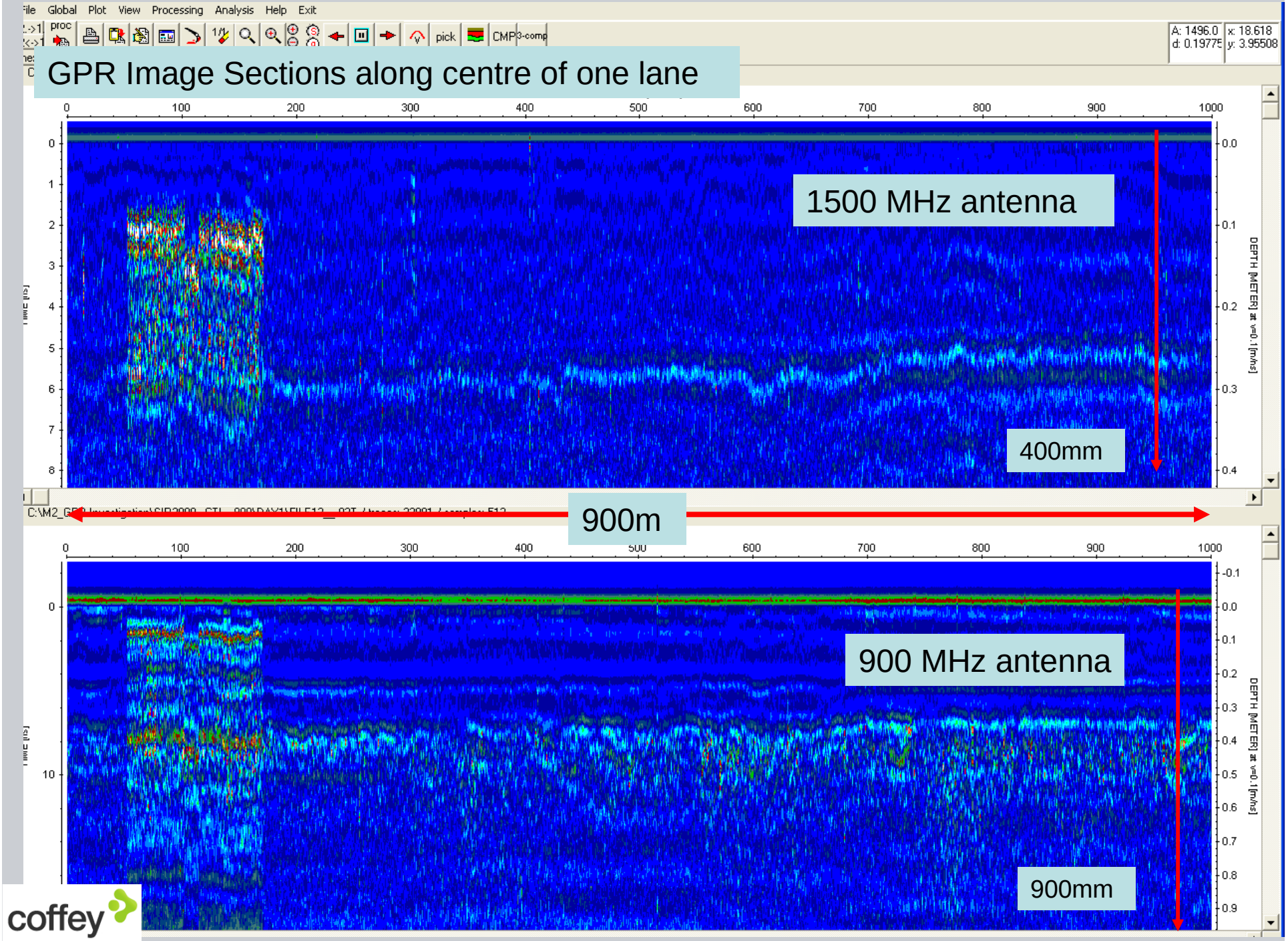
GPR Profiling of the Hard Shoulder




GPR for Highway Condition Assessment
1017
1016
1018
1015
1019
1014
1020
1013
1021
1012
2002
2022
2003
2021
2004
1024
2005
2020
2006
2019
2007
2018
2008
2017
2009
2015
2010
2011
2013
2012
~13km

GPR Image Sections along centre of one lane



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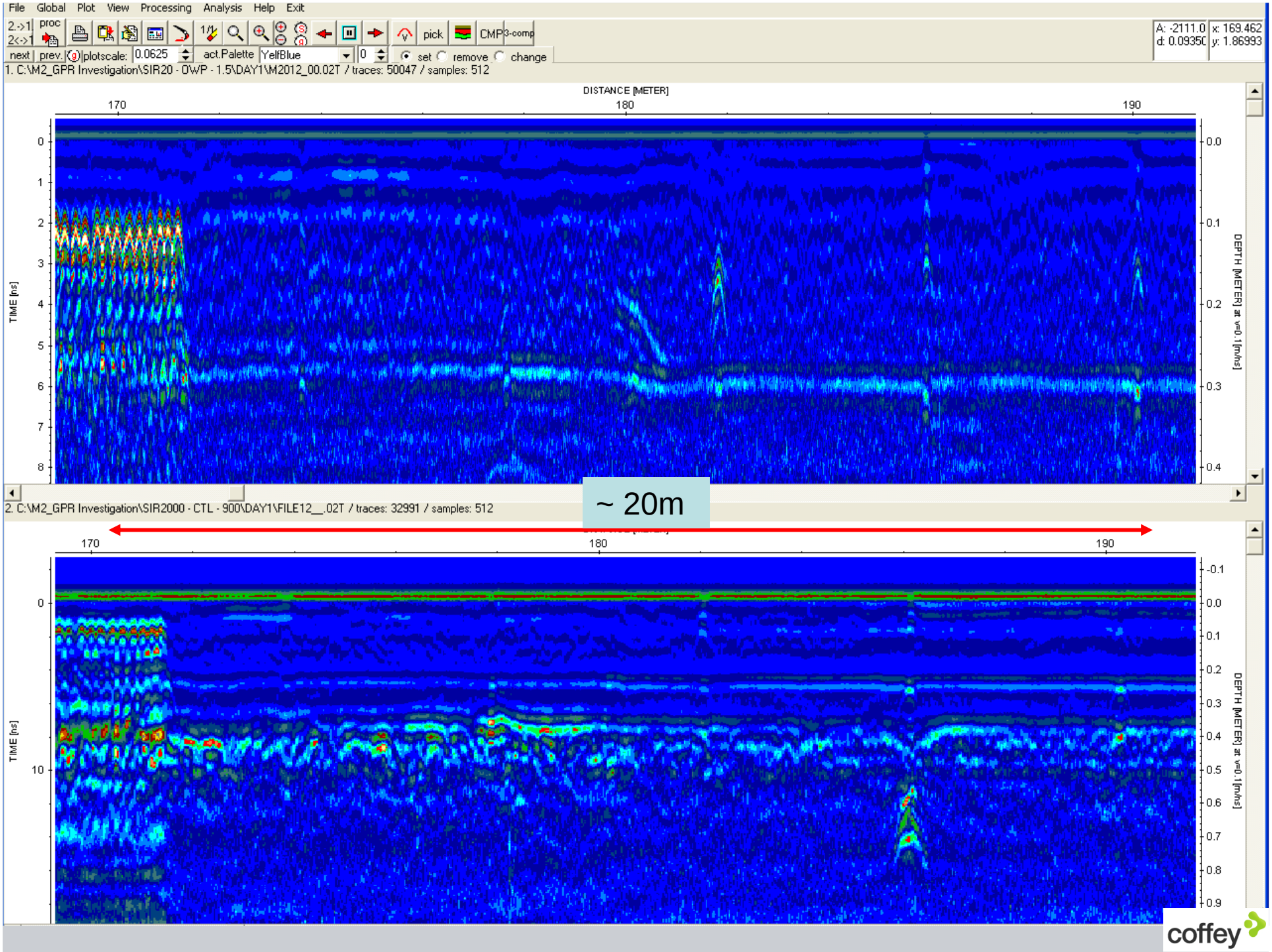
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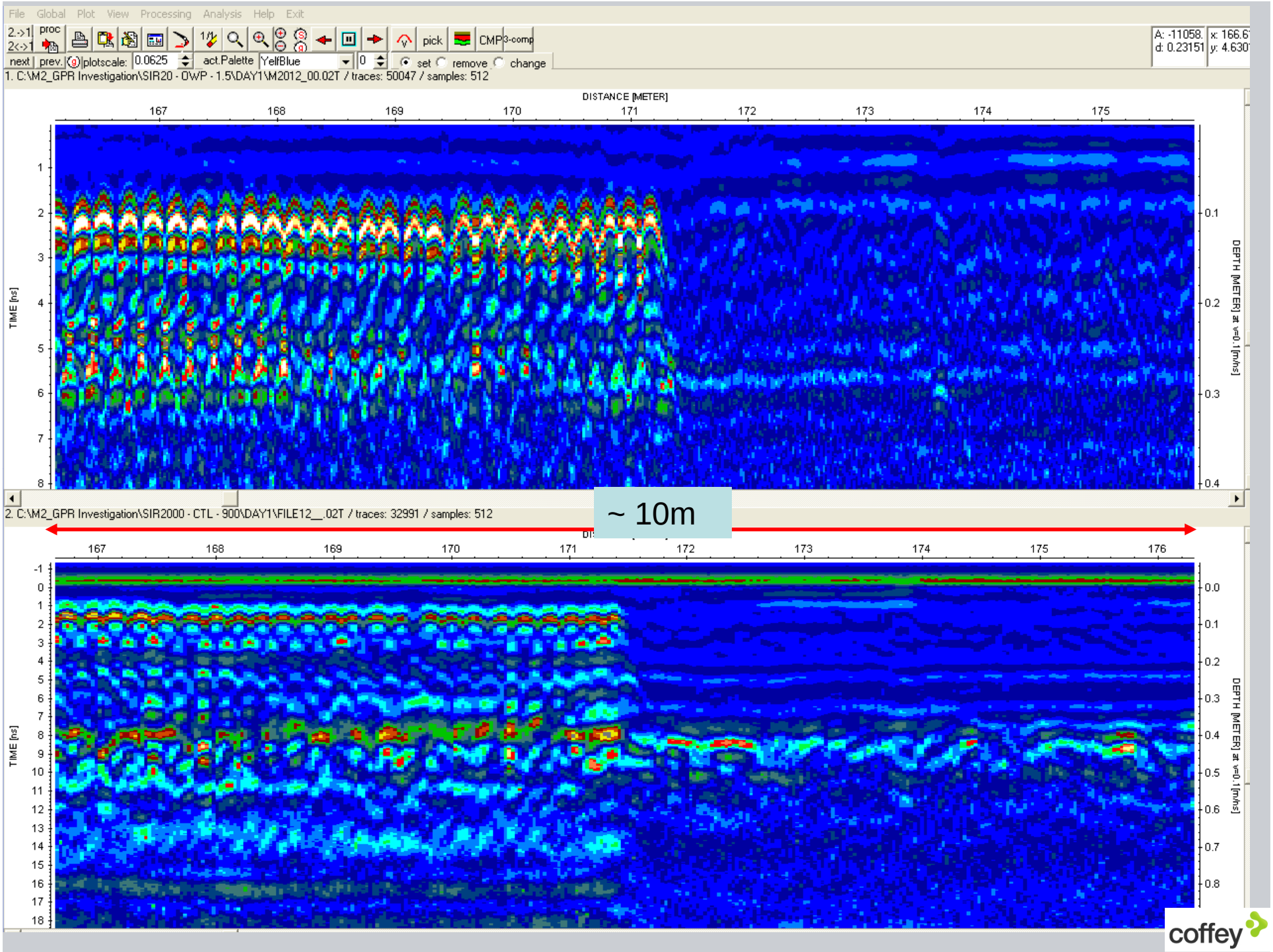
pick
CMP
3-comp
next
prev.
plotscale:
0.0625
act.Palette
YelfBlue
set
remove
change
1. C:\M2_GPR Investigation\SIR20 - OWP - 1.5\DAY1\M2012_00.02T / traces: 50047 / samples: 512
DISTANCE [METER]
170
180
190
TIME [ns]
DEPTH [METER] at v=0.1 [m/ns]
2. C:\M2_GPR Investigation\SIR2000 - CTL - 900\DAY1\FILE12__.02T / traces: 32991 / samples: 512
~ 20m
coffey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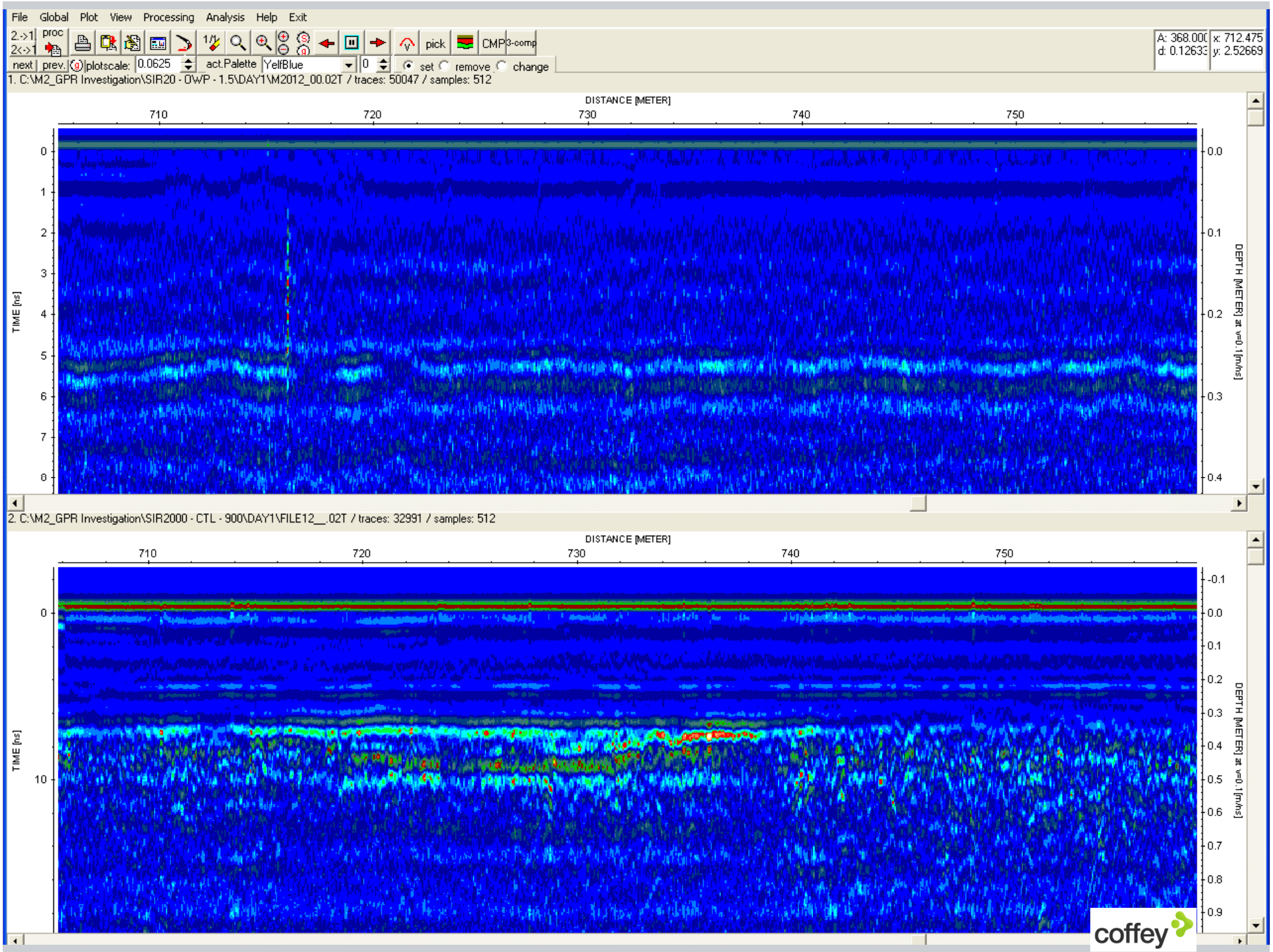
pick
CMP
3-comp
next
prev.
plotscale:
0.0625
act.Palette
YelfBlue
set
remove
change
A: -11058.
d: 0.23151
x: 166.6
y: 4.630
1. C:\M2_GPR Investigation\SIR20 - OWP - 1.5\DAY1\M2012_00.02T / traces: 50047 / samples: 512
DISTANCE [METER]
TIME [ns]
DEPTH [METER] at v=0.1 [m/ns]
2. C:\M2_GPR Investigation\SIR2000 - CTL - 900\DAY1\FILE12__.02T / traces: 32991 / samples: 512
~ 10m


File Global Plot View Processing Analysis Help Exit
2.->1
2<-1
proc
pick
CMP
3-comp
next
prev.
plotscale:
0.0625
act.Palette
YelfBlue
set
remove
change
A: 368.000
d: 0.12633
x: 712.475
y: 2.52669
1. C:\M2_GPR Investigation\SIR20 - OWP - 1.5\DAY1\M2012_00.02T / traces: 50047 / samples: 512
DISTANCE [METER]
710
720
730
740
750
TIME [ns]
DEPTH [METER] at v=0.1 [m/ns]
2. C:\M2_GPR Investigation\SIR2000 - CTL - 900\DAY1\FILE12__.02T / traces: 32991 / samples: 512
DISTANCE [METER]
TIME [ns]
DEPTH [METER] at v=0.1 [m/ns]
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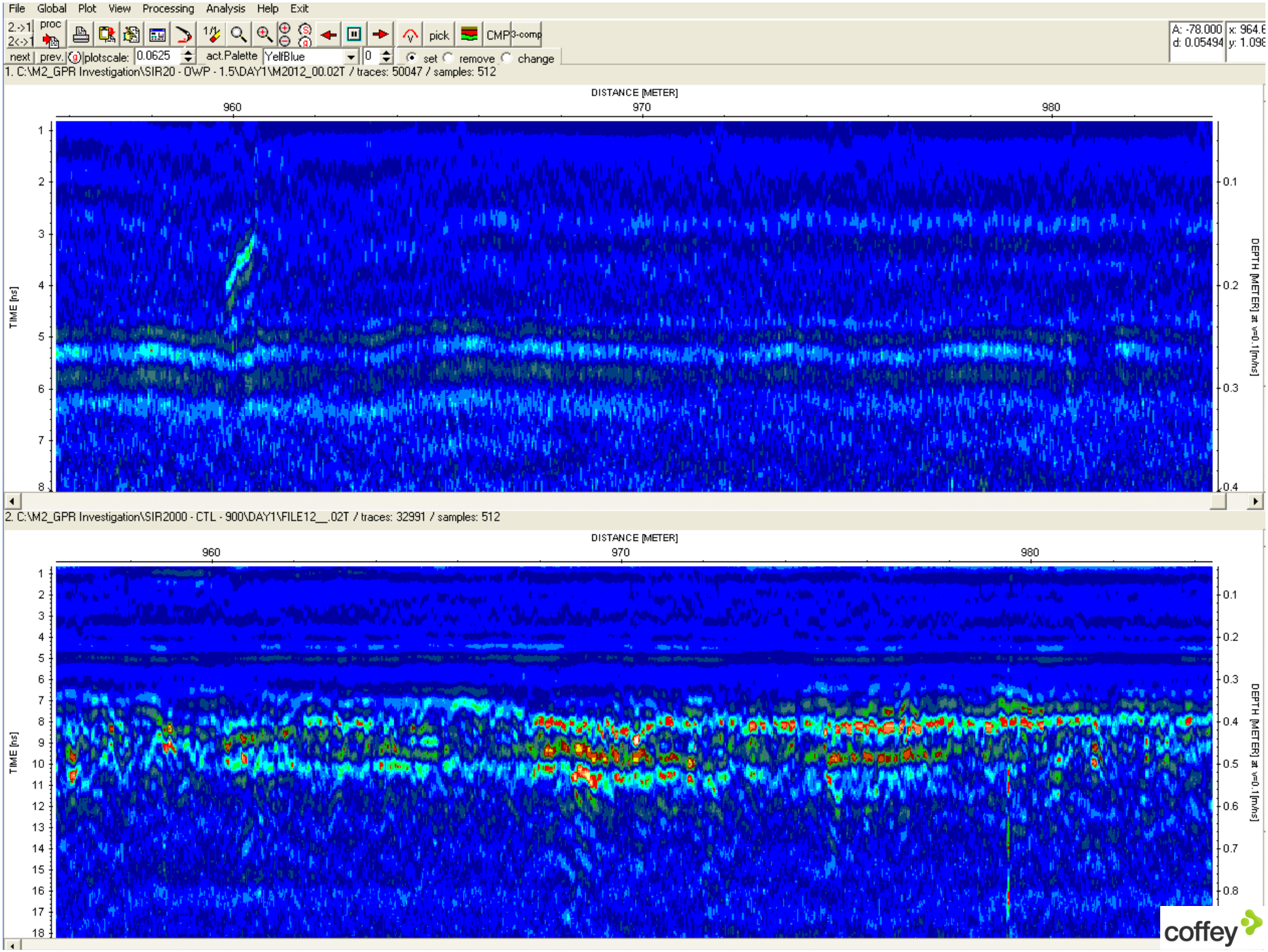
File Global Plot View Processing Analysis Help Exit
2->1 2<->1 proc
pick CMP 3-comp
next prev. plotscale: 0.0625 act.Palette YellBlue 0 set remove change
A: -78.000 d: 0.05494 x: 964.6 y: 1.098
1. C:\M2_GPR Investigation\SIR20 - OWP - 1.5\DAY1\M2012_00.02T / traces: 50047 / samples: 512
DISTANCE [METER]
960
970
980
TIME [ns]
DEPTH [METER] at v=0.1[m/ns]
2. C:\M2_GPR Investigation\SIR2000 - CTL - 900\DAY1\FILE12__.02T / traces: 32991 / samples: 512
DISTANCE [METER]
960
970
980
TIME [ns]
DEPTH [METER] at v=0.1[m/ns]

Geotechnical Case Study

AIRPORT RUNWAY CONDITION ASSESSMENT, Vanuatu


Vanuatu

GPR Field Operations

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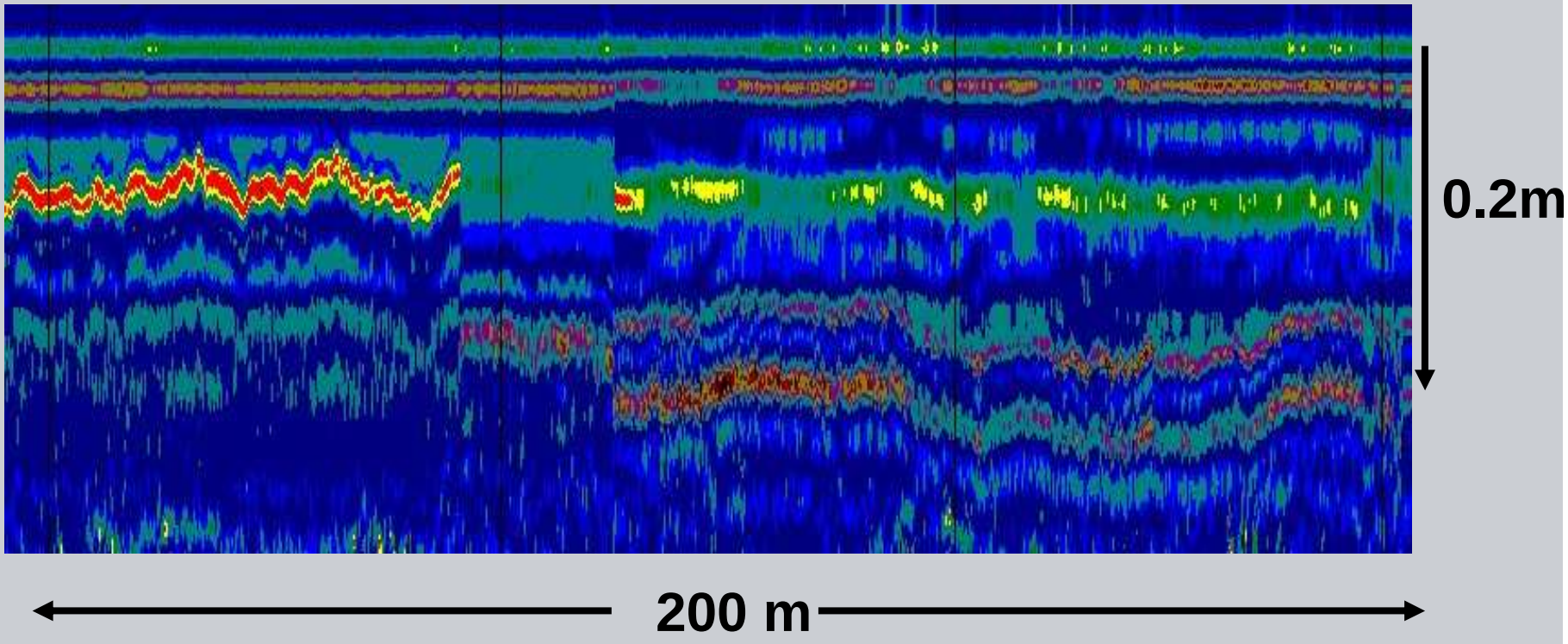
GPR for Airport Runway Testing

Old Pavement | New Pavement



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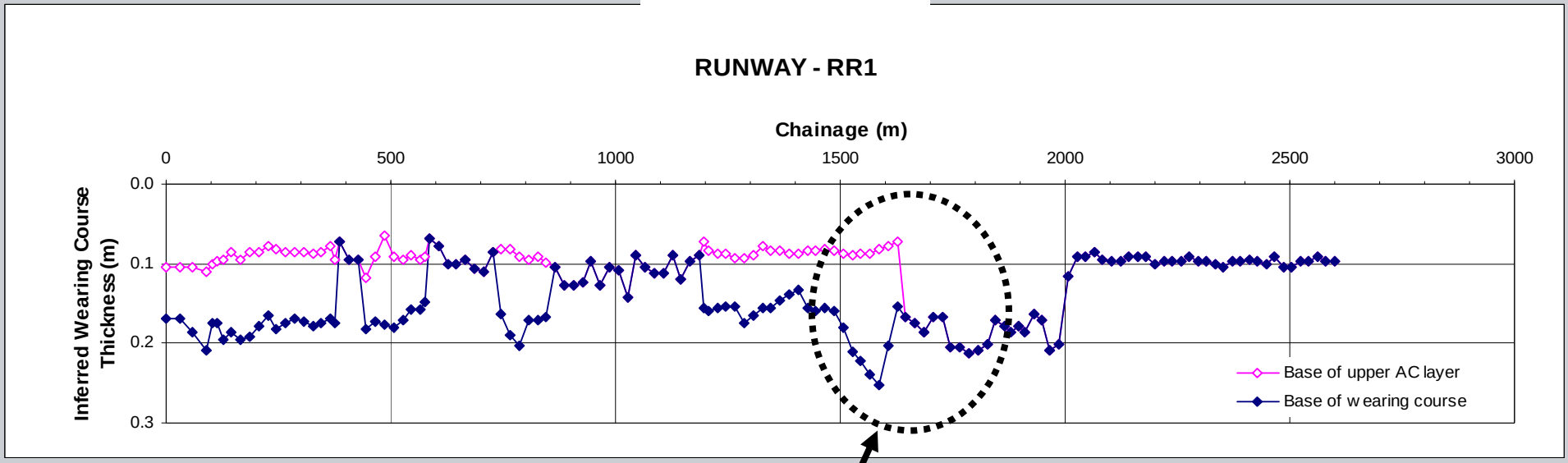
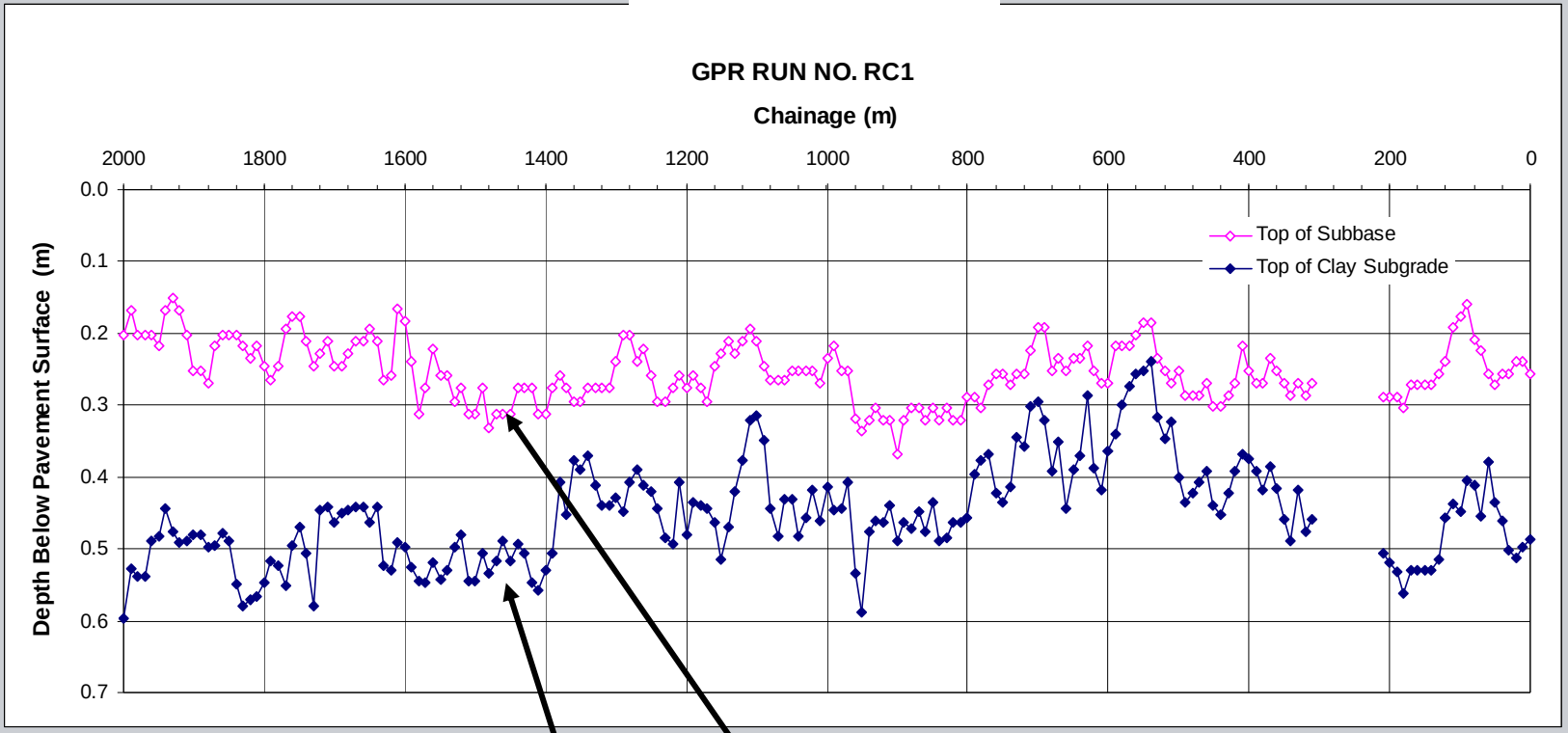
Interpretation of GPR: Airport Runway



GPR IMAGE



Calibration of GPR Interpretation

Sub-Base Layer

Clay Layer