Evaluation of Geophysical Techniques to Investigate River Embankments

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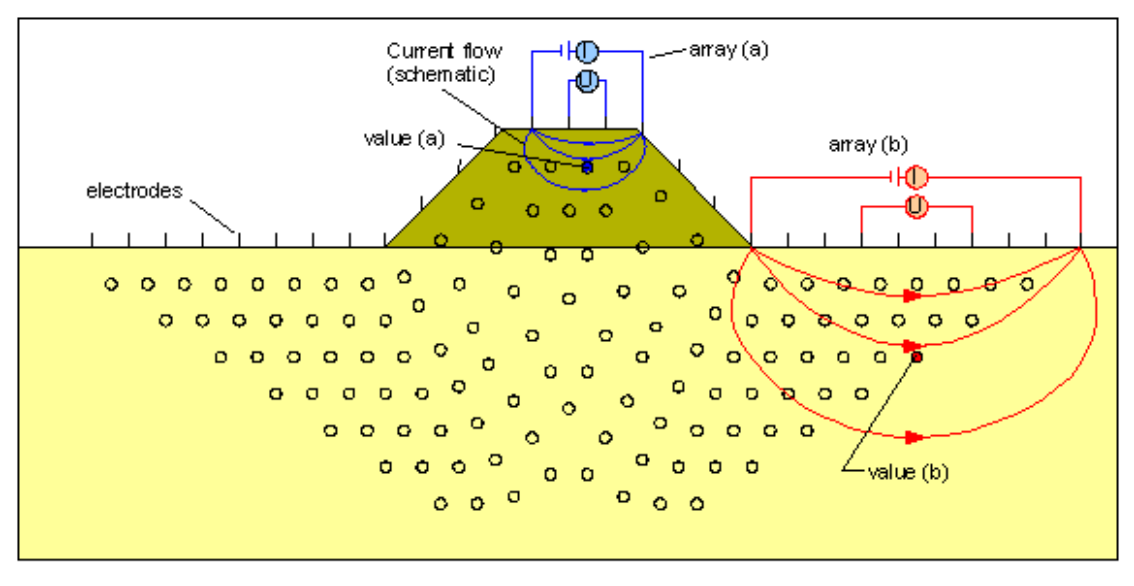
Elbe Flood 2002

Problems

- Recent floods (2002, 2005) caused embankment failures
- Many embankments more than 100 years old
- No maps or drawings, structure of levees and the soil below unknown
- Flood protection state affair: different measures in different states
- Geophysics not part of standards and regulations (until now)

What is geophysics?

- **Measurement of physical fields from the surface to detect subsurface features and parameters**



- **Non-destructive**
- **Fast**
- **Cost-effective**
- **Avoid data gaps**
- **Indirect properties**
- **Sometimes difficult to interpret**
- **Need some time and budget**

The project

Partners:

Standard methods

- **DC-Geoelectrics / resistivity**
- **Induction EM**
- **Refraction seismics**
- **GPR**

Innovative methods

- **IP/SIP**
- **RMT**
- **MASW**
- **GPR arrays**

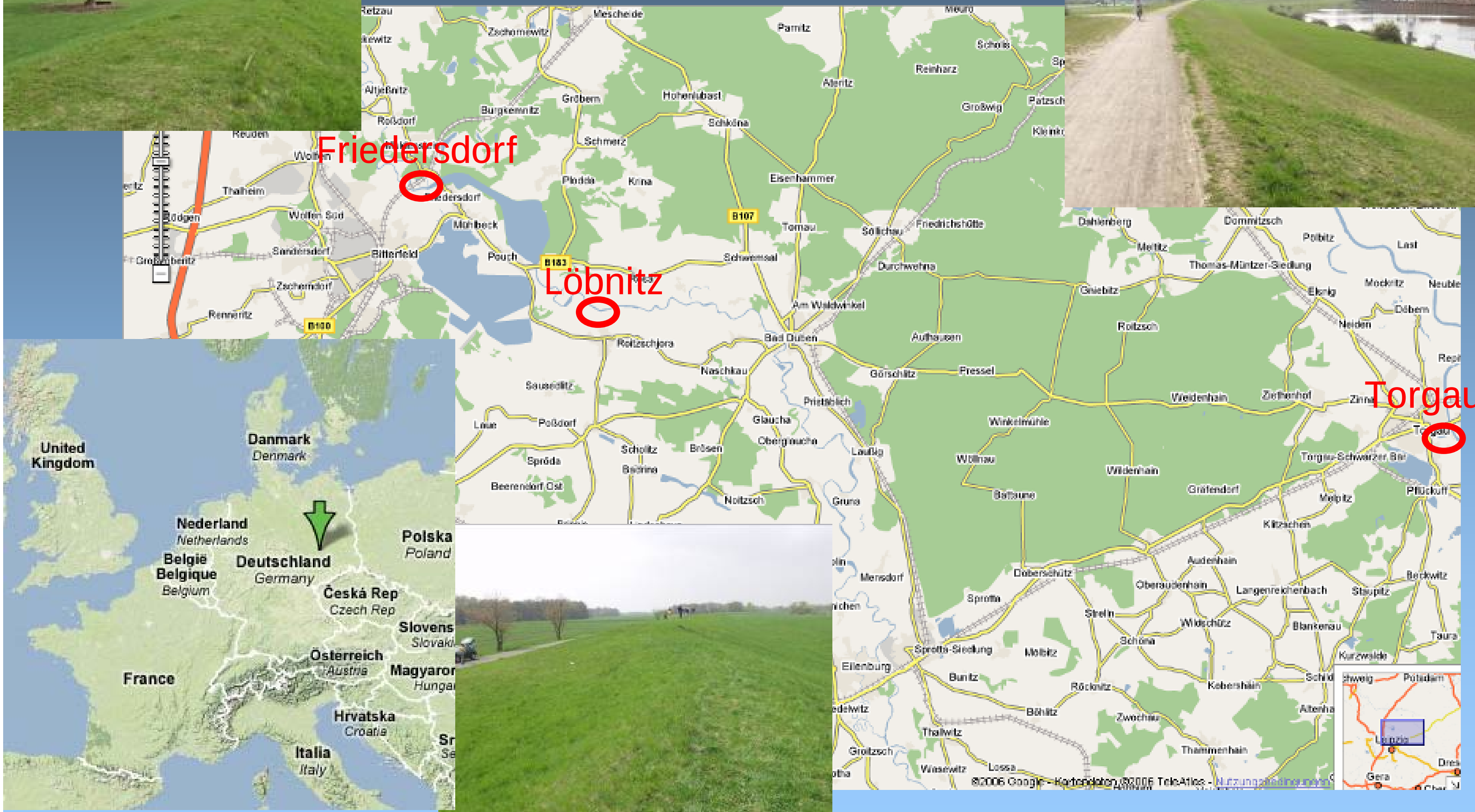
Test sites

- **Old homogeneous levee (clay)**
- **Old inhomogeneous levee (clay/sand)**
- **New levee (according to standards)**

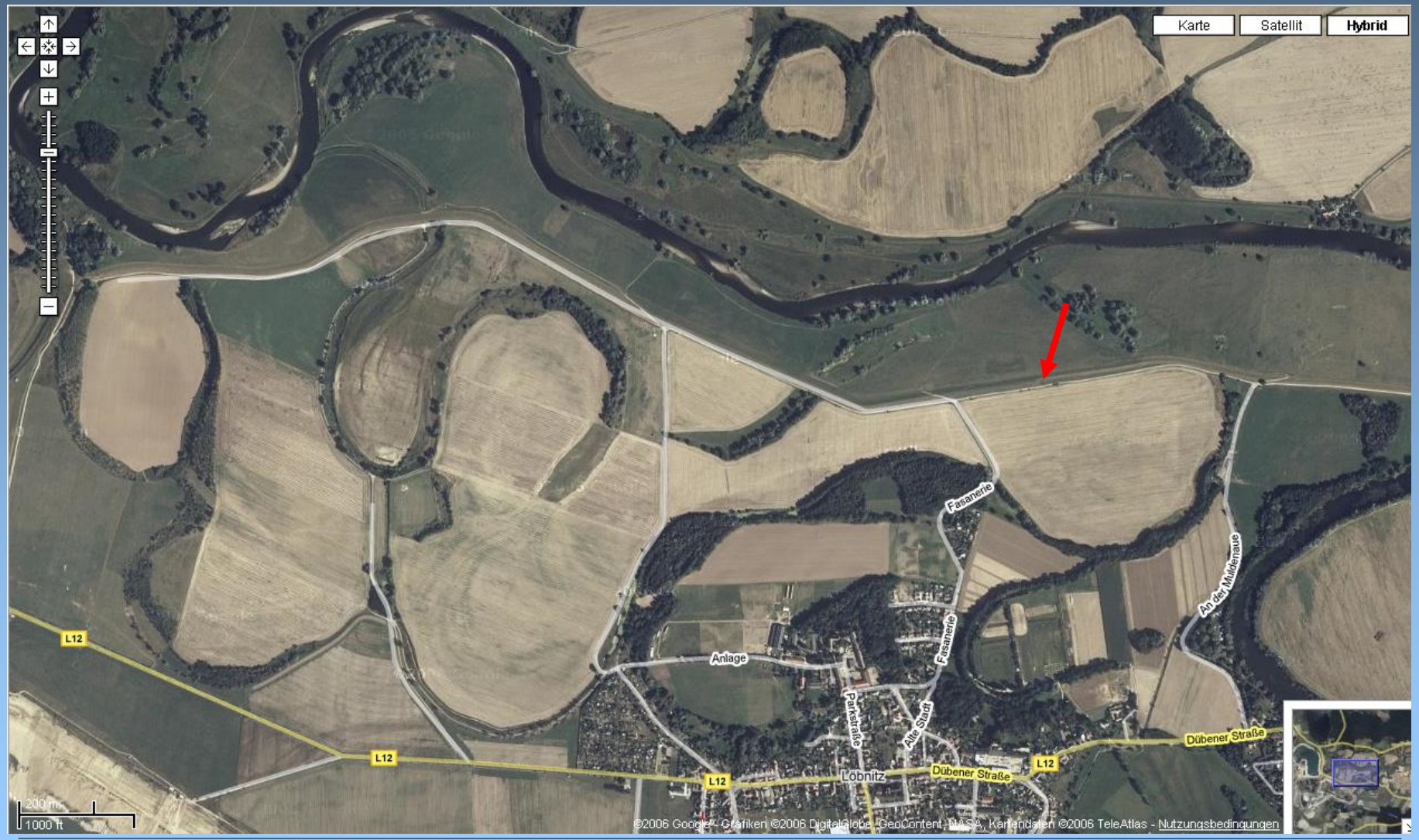
Calibration

- **Boreholes, CPT, lab…..**

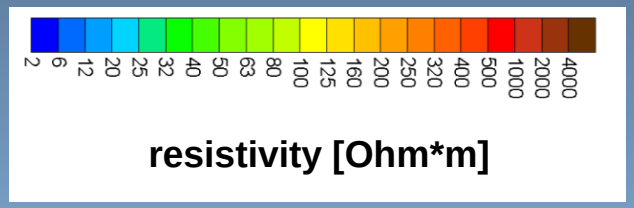
Test Sites

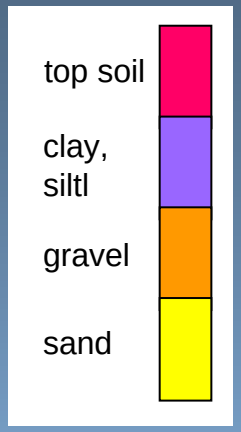

Friedersdorf
Löbnitz
Torgau
©2006 Google - Kartendaten ©2006 TeleAtlas
United Kingdom
Danmark
Denmark
Nederland
Netherlands
België
Belgique
Belgium
Deutschland
Germany
Polska
Poland
Česká Rep
Czech Rep
Österreich
Austria
France
Hrvatska
Croatia
Italia
Italy

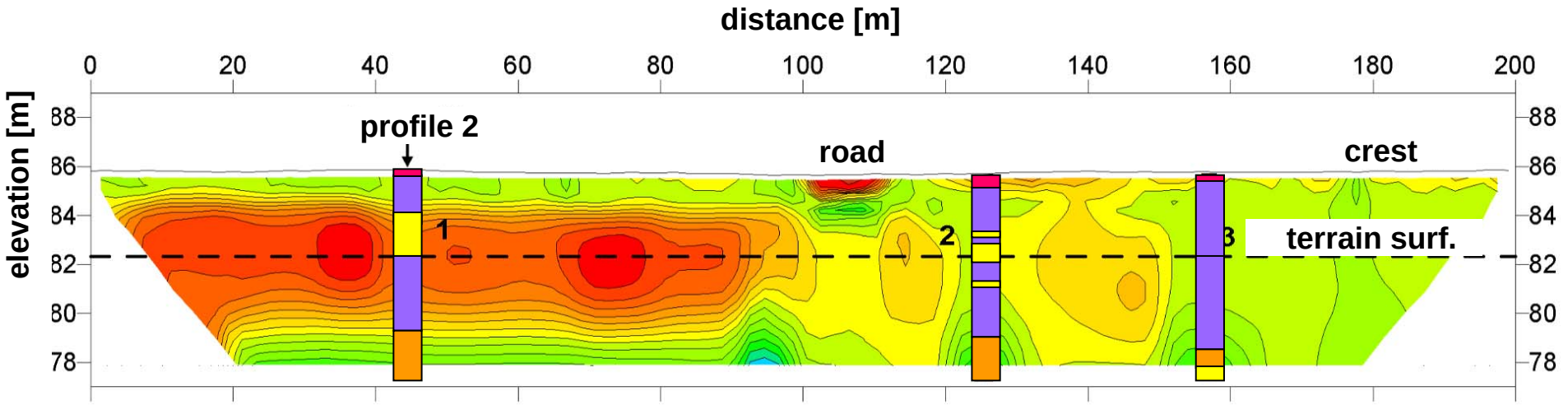
Test Site Löbnitz



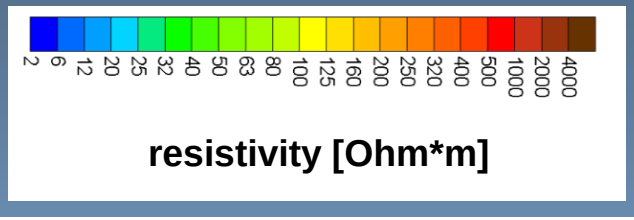
Standard methods: resistivity (1)

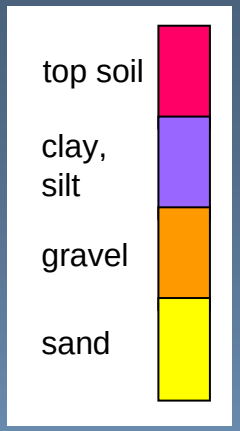


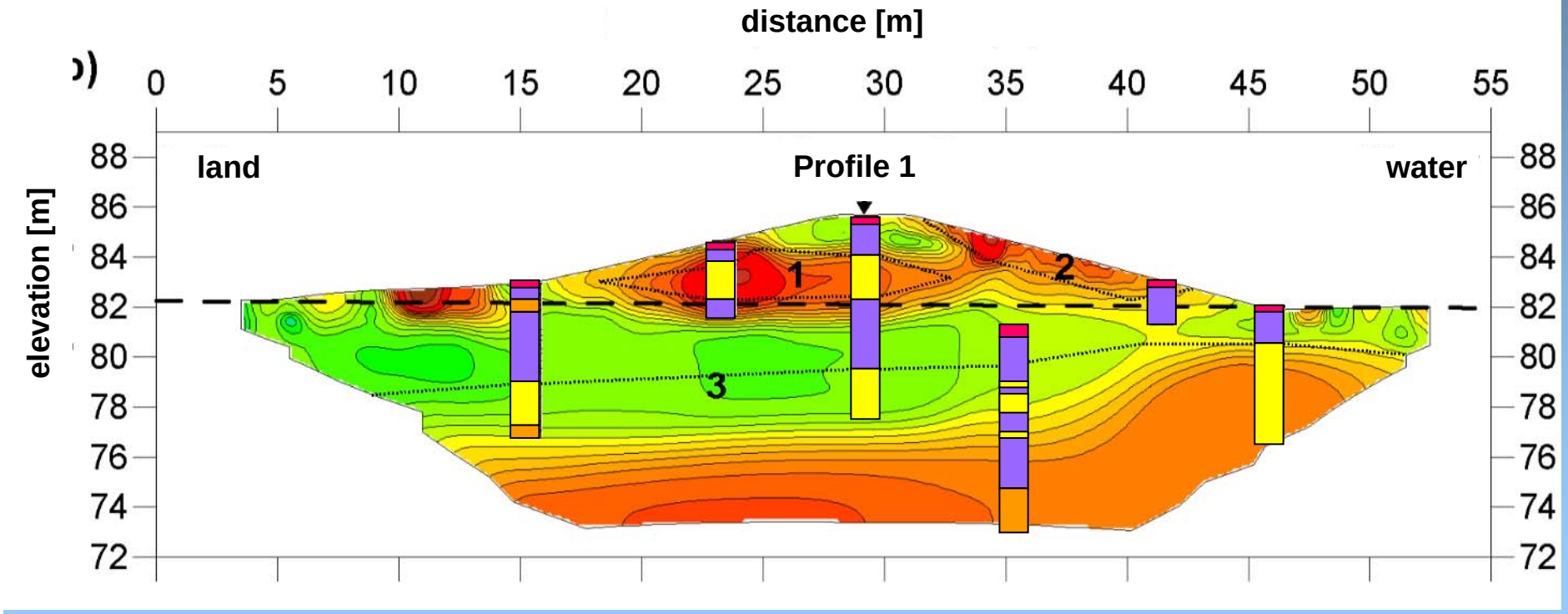




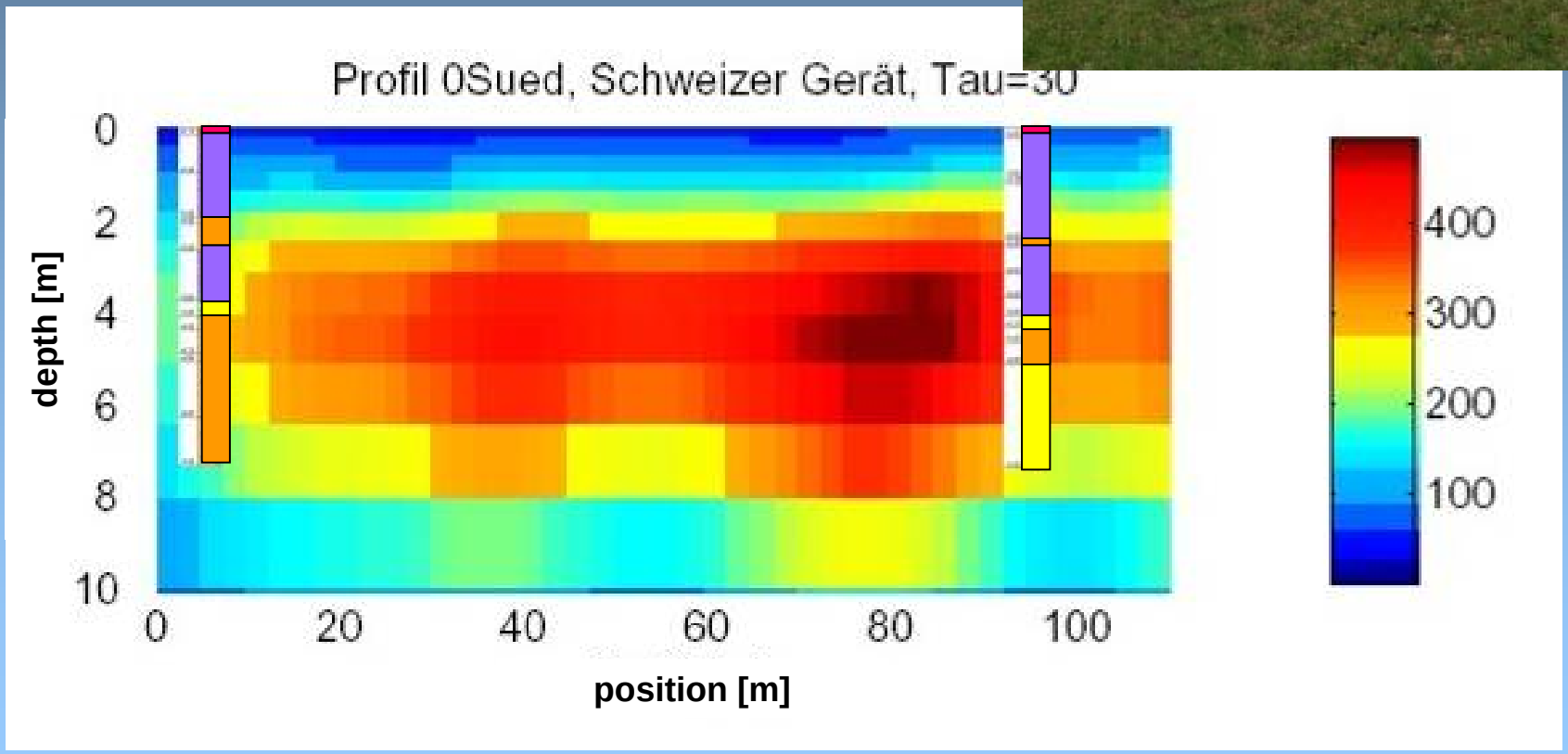
Standard methods: resistivity (2)



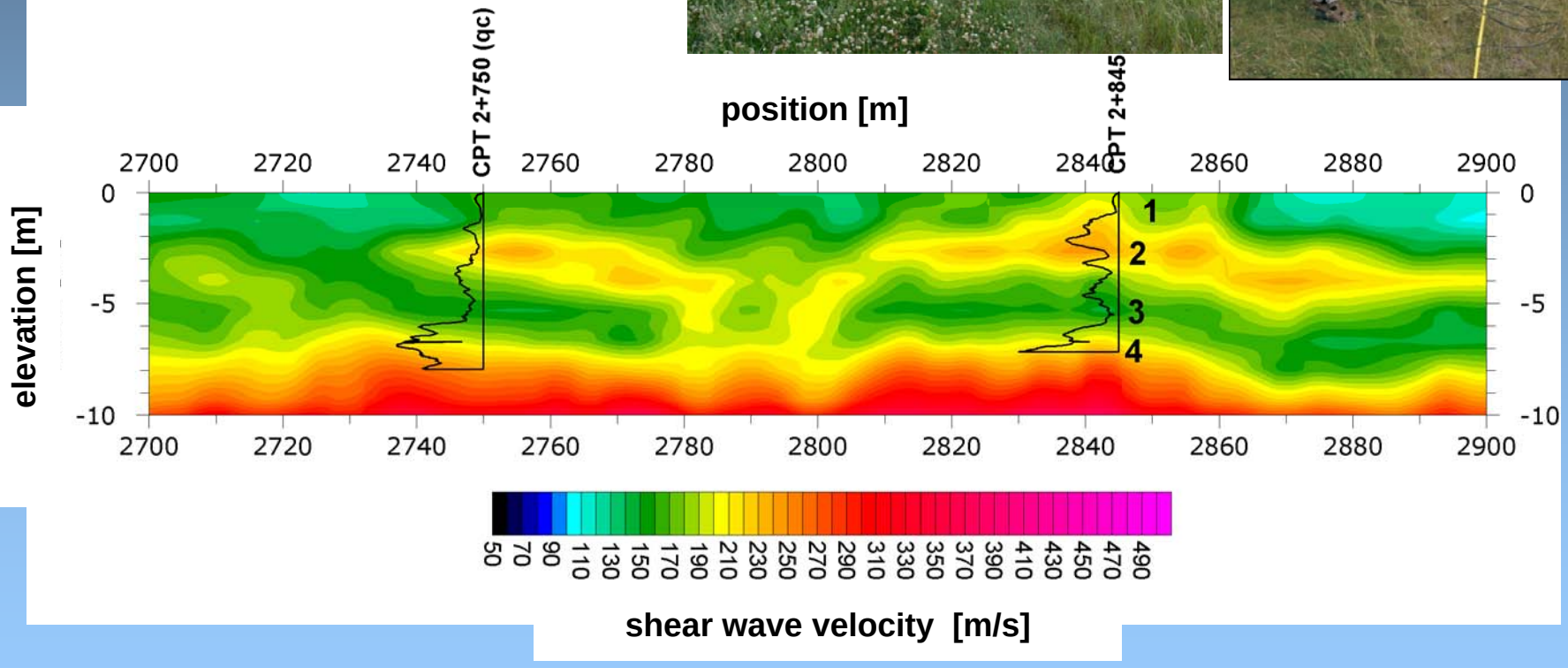




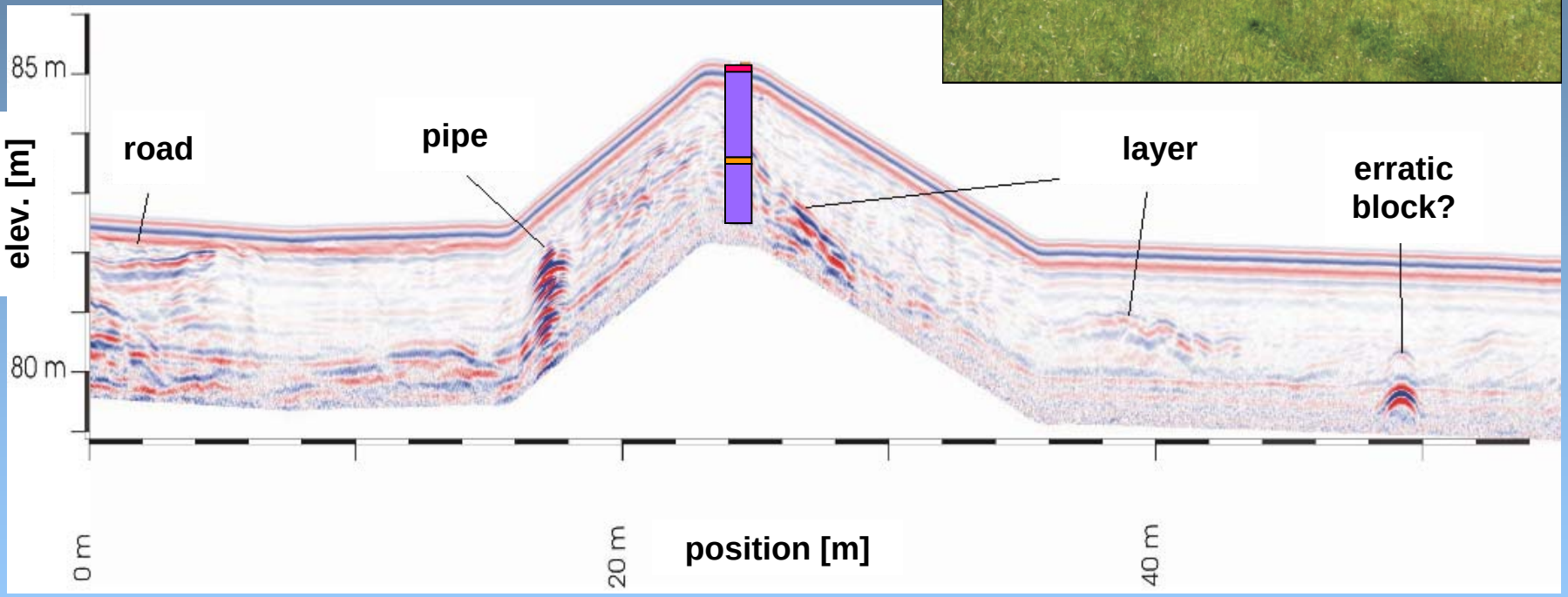
Innovative methods: RMT



Innovative methods: MASW



(Innovative) methods: GPR (array)



BAM
Zerstörungsfreie Schadensdiagnose und Umweltmessverfahren
VIII.2

Comparison with reality

Calibration (by boreholes, sampling, CPT) absolutely required!

Test Site Löbnitz

Rapid reconaissance methods

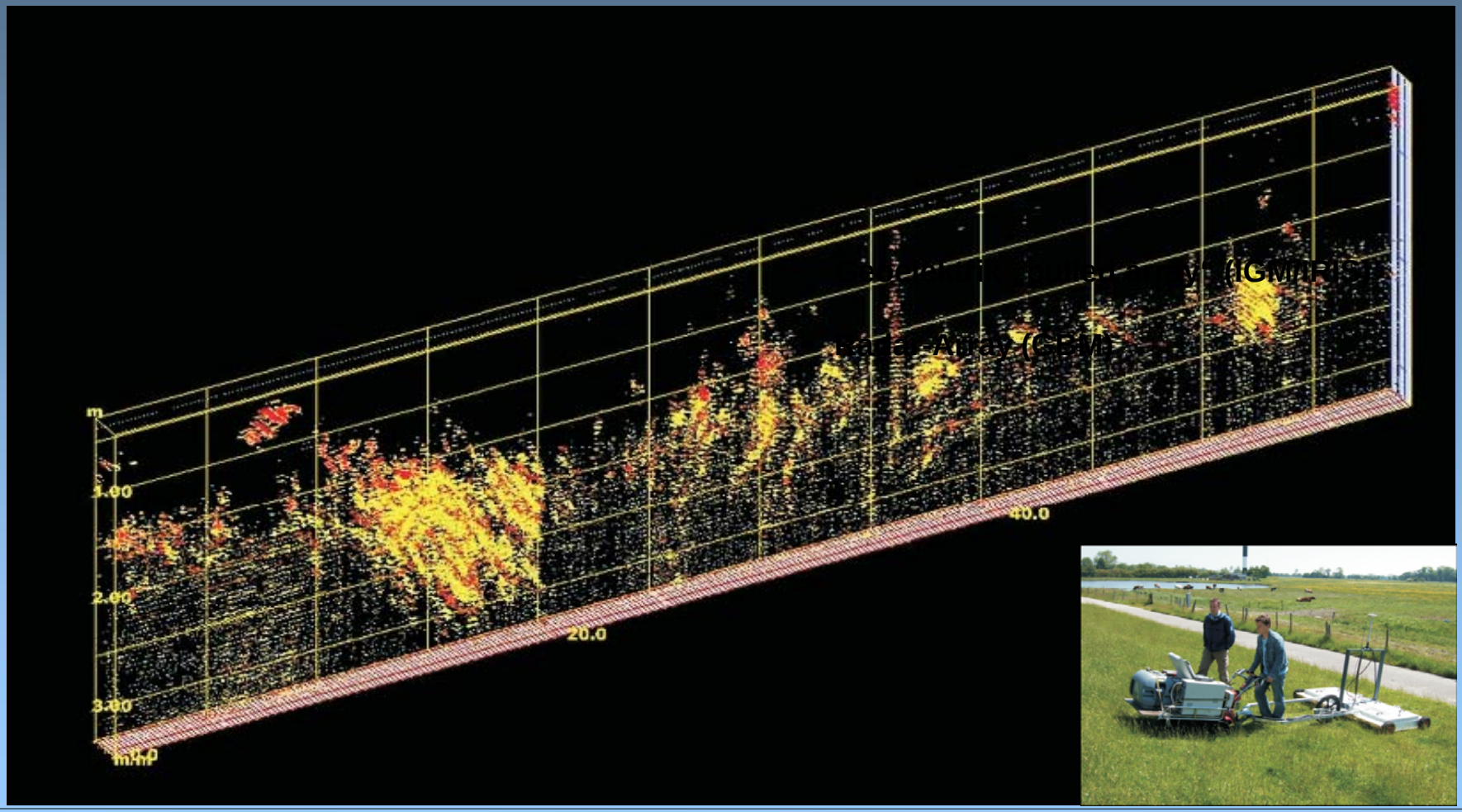
Geoelektrics „pulled array“ (IGM/IRIS)

Induction EM (BfG Lorenz, U Köln)

GPR-Array (GBM)

Test Site Löbnitz

3D-GPR

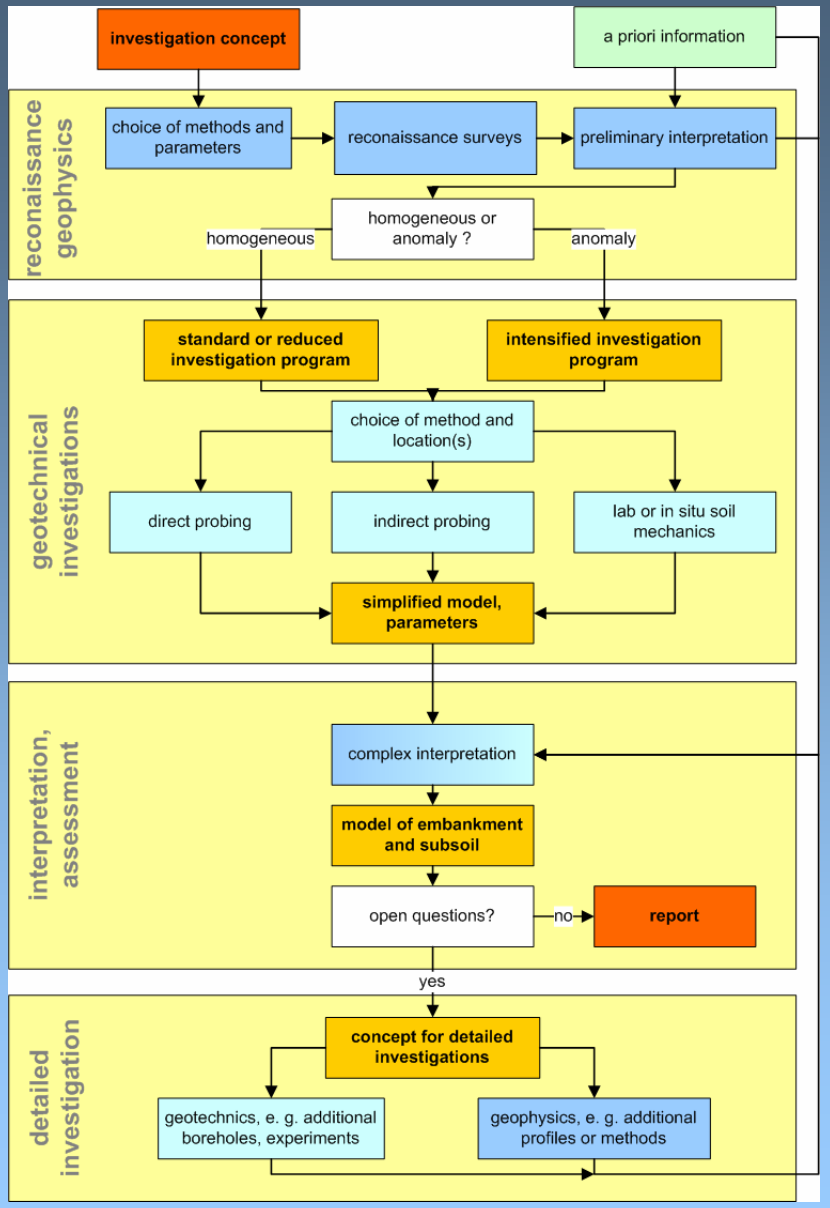


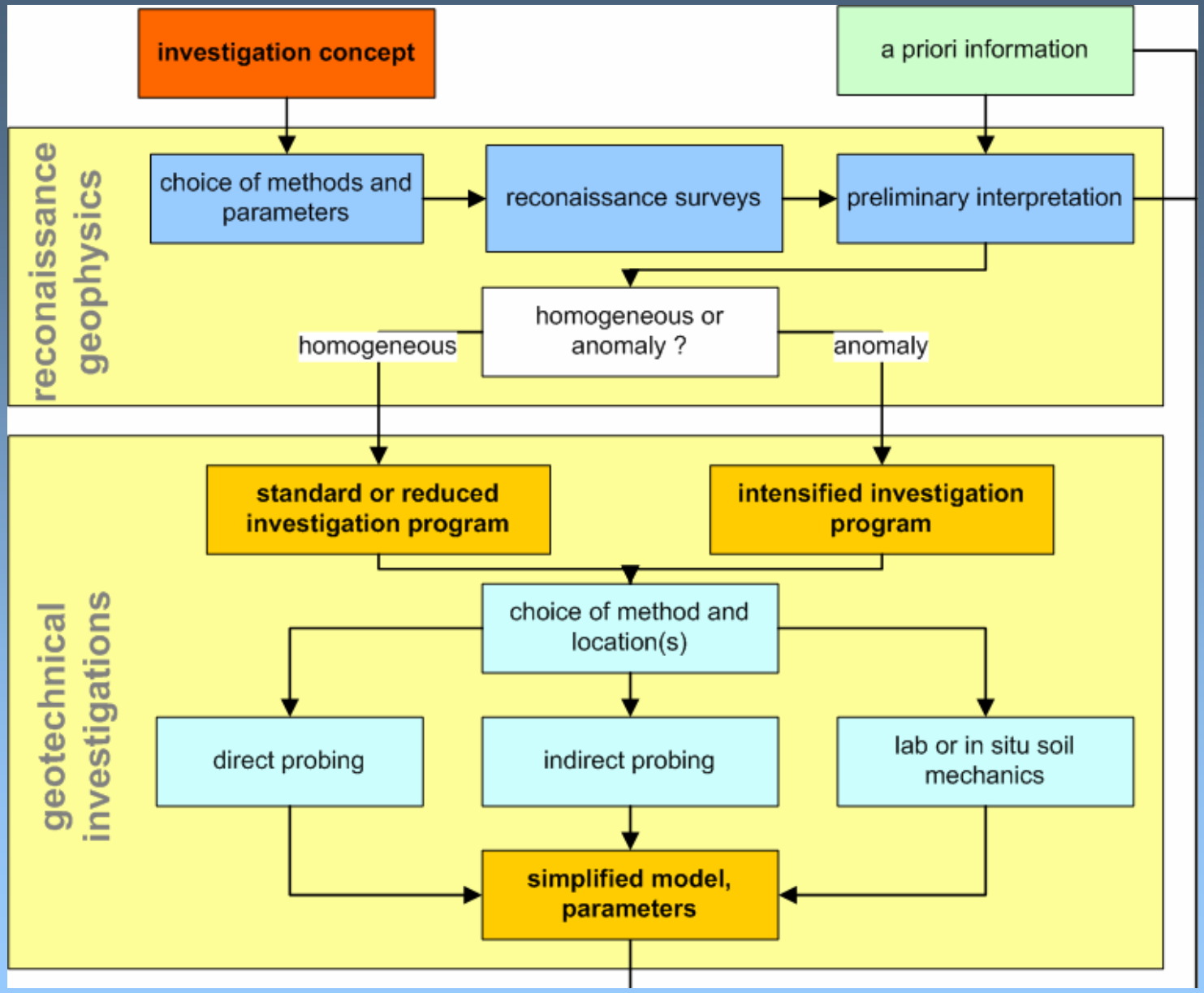
Recommendations

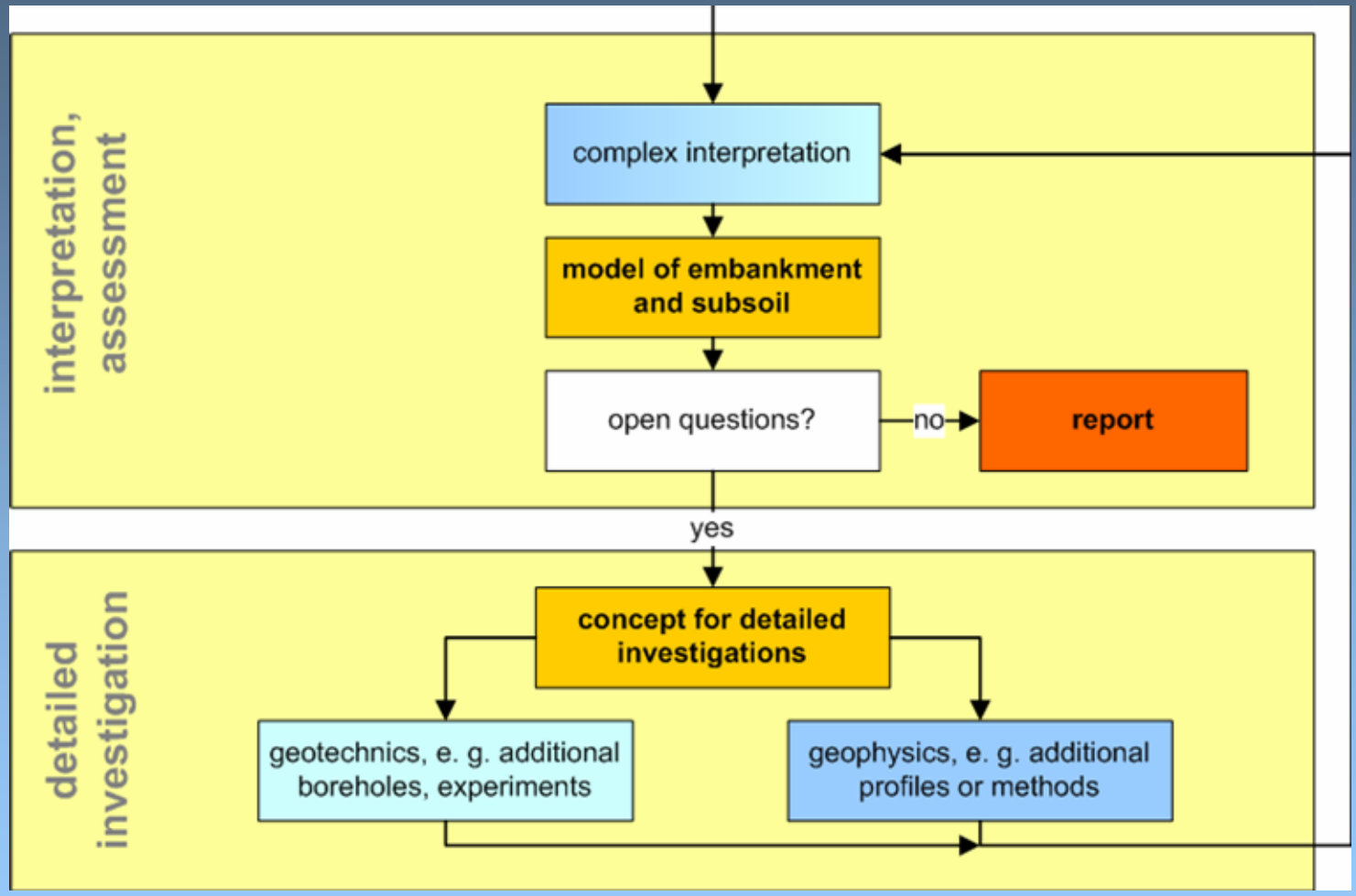
Task/problem	resistivity	electro-magnetics	GPR	seismics	radiometric sounding
Global delineation of homogeneous areas (levee and subsoil)	+	O	-	-	-
detection of structural anomalies (e.g. repaired areas)	O	O	O	O	-
localisation of manmade objects	O	O	+	-	-
identification of levee structure	+	O	O	-	+
characteristic layer boundaries	O	O	O	O	+
impermeable layers (subsoil, existence and thickness)	+	O	O	-	+
water level	-	-	O	O	+
petrophysical/geotechnical properties	-	-	-	O	+

+ : application recommended
O : application recommended with restrictions
- : application not recommended

Recommendations
Integration of geophysics into investigation procedures




investigation concept
a priori information
reconaissance geophysics
choice of methods and parameters
reconaissance surveys
preliminary interpretation
homogeneous or anomaly ?
homogeneous
anomaly
geotechnical investigations
standard or reduced investigation program
intensified investigation program
choice of method and location(s)
direct probing
indirect probing
lab or in situ soil mechanics
simplified model, parameters


interpretation, assessment
complex interpretation
model of embankment and subsoil
open questions?
no
report
yes
detailed investigation
concept for detailed investigations
geotechnics, e. g. additional boreholes, experiments
geophysics, e. g. additional profiles or methods

Conclusions and Outlook

Handbook

- In German
- www.deistrukt.bam.de
- Out this month
- Translations planned

Regulations

- New national standard and recommendations on river embankments out this year
- Geophysics recommended/required
- Deistrukt handbook as reference

Outlook

- automatisation, multichannel
- Fast „non-contact“ methods
- International network?

Thank you!

www.deistrukt.bam.de

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