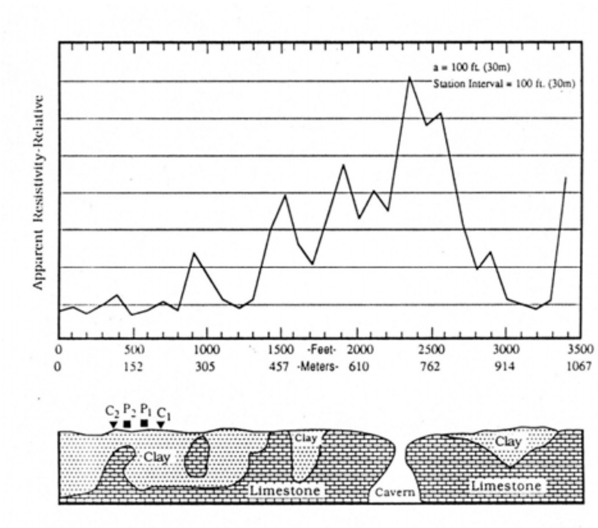
C7 Application of DC resistivity exploration

C7.1 Mapping resistivity structures in 2-D and 3-D

Most modern studies using DC resistivity collect data for generating a 2-D or 3-D resistivity model of the Earth. A simple 1-D analysis does not often yield results that are satisfactory.

C7.1.1 Cavity detection



Studies in karst terrain. Caves show up as very high resistivity zones in a Wenner array profile.

Do you think this provide a better way of detecting tunnels than using gravity exploration? Why?

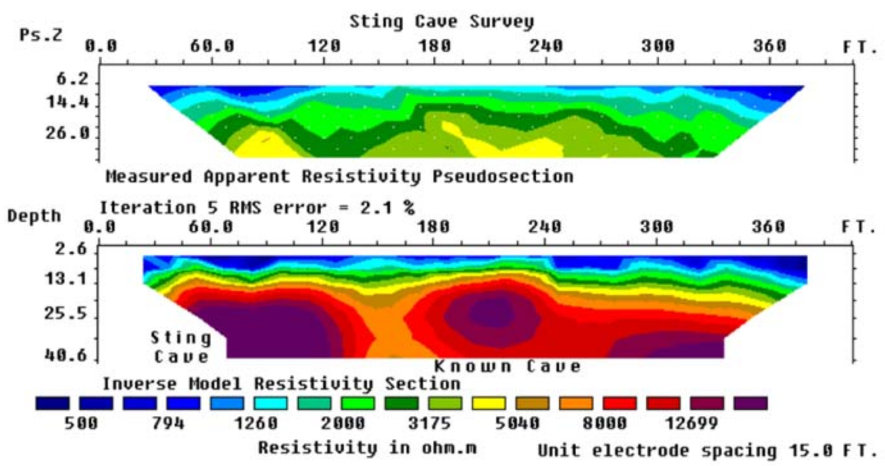
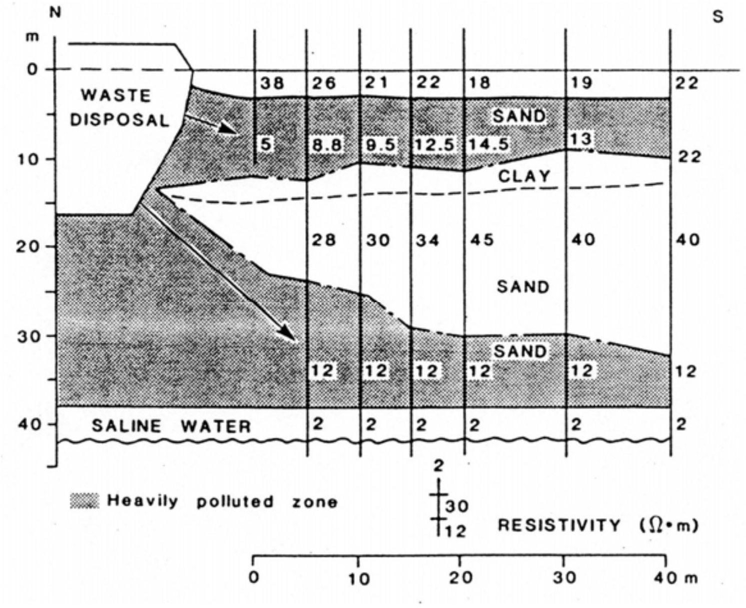


Figure 18. The observed apparent resistivity pseudosection for the Sting Cave survey together with an inversion model. The time taken to invert this data set on a 90 Mhz Pentium computer was 98 seconds (1.6 minutes), while on a 266 Mhz Pentium II it took 23 seconds.

In the second example, the DC resistivity survey detected both a known cave and discovered a new (larger) cave that was called the Sting Cave. Figure courtesy of M.H. Loke

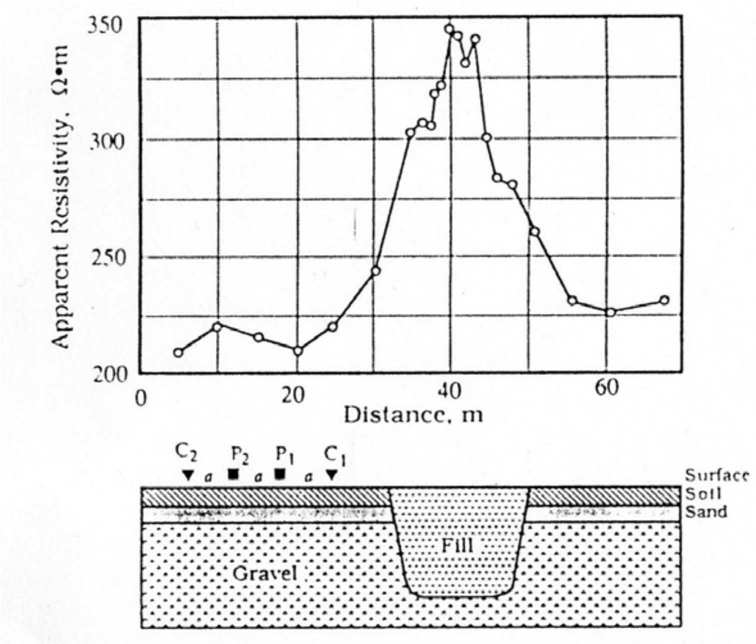
C7.1.2 Environmental geophysics

Conductive plume: (low resistivity) often due to saline water, heavy metals
Resistive plume: hydrocarbons, CCl_4 and DNAPLS (dense non-aqueous phase liquids)



Example from a landfill near Utrecht in the Netherlands.

Contaminated fluids leak into two layers that are characterized by a low resistivity.



Locating and mapping landfills. In this example the landfill is higher resistivity than the surroundings. In other cases the landfill will be a low resistivity zone. Why?

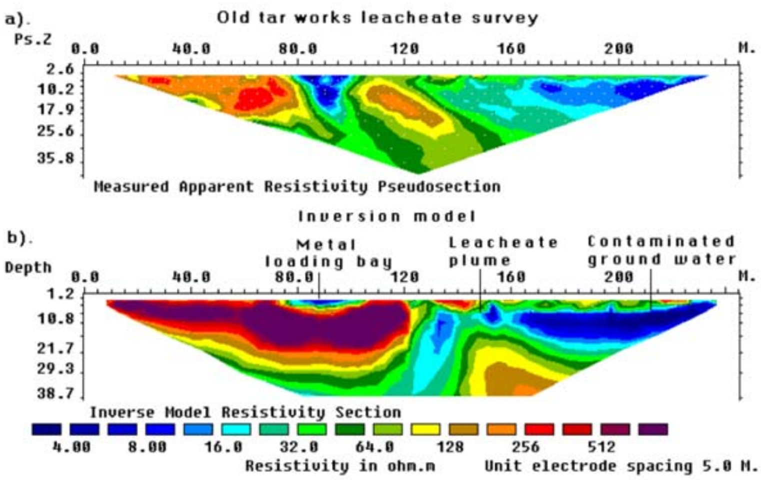


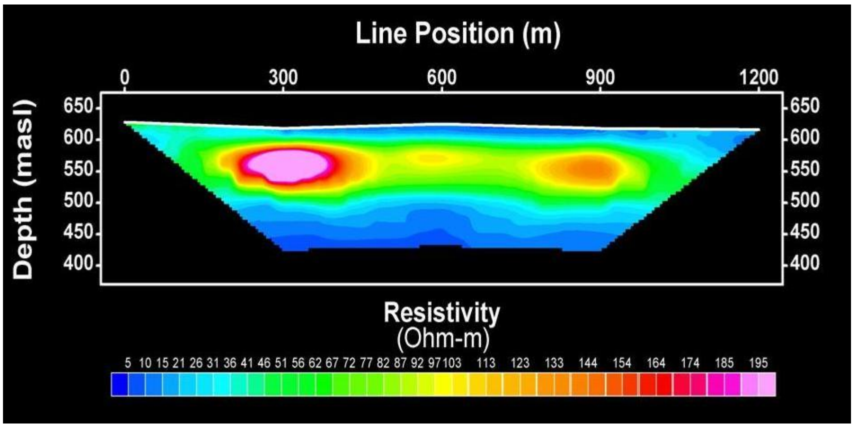
Figure 20. (a) The apparent resistivity pseudosection from a survey over a derelict industrial site, and the (b) computer model for the subsurface.

Note that contaminants leak from surface at the edge of a metal loading dock (shows up as a low resistivity zone). Figure courtesy of M.H. Loke

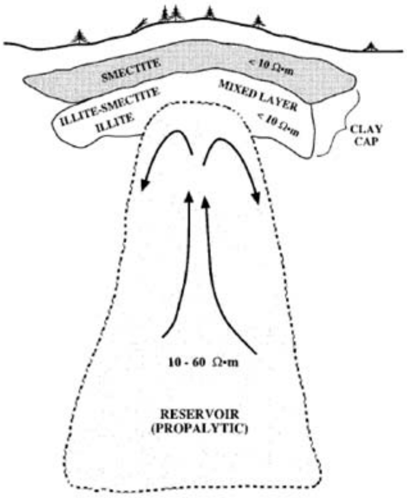
C7.1.3 Hydrocarbon exploration

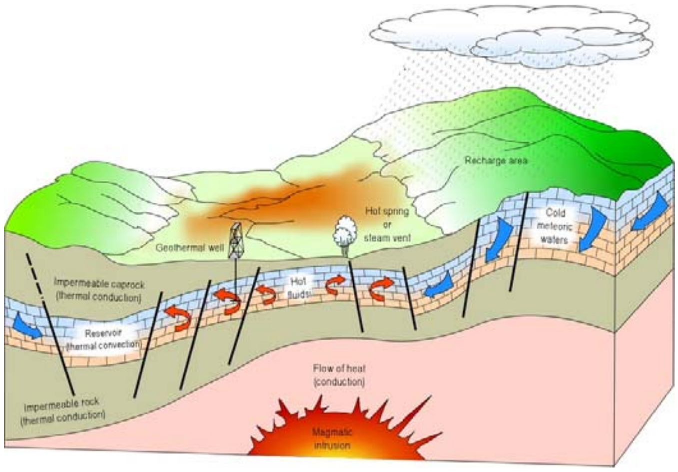
- Shallow gas exploration

Example from Alberta. Data courtesy of Komex International



C7.1.4 Geothermal exploration





A geothermal reservoir is generally a low resistivity zone, owing to the presence of saline fluids. The hydrothermal circulation and high temperatures often form a low resistivity clay cap above the reservoir. DC resistivity exploration can be used to locate the clay cap, but DC resistivity is not always effective at locating the underlying reservoirs. Also note that when a geothermal reservoir is depleted, the clay cap will remain. Electromagnetic exploration can be used to map geothermal reservoirs, as discussed in Geophysics 424.

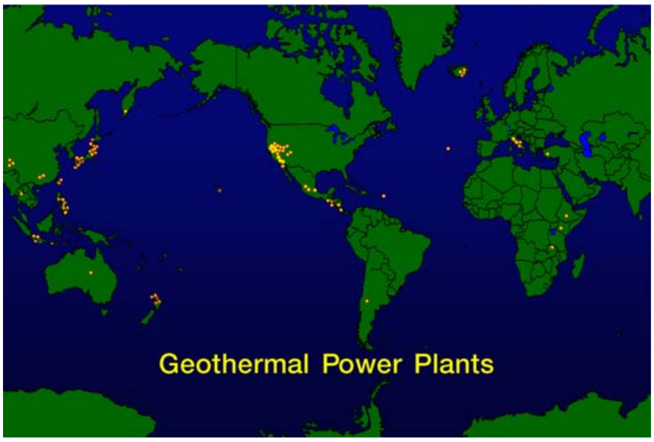
Bacman geothermal field

Tongonan geothermal field

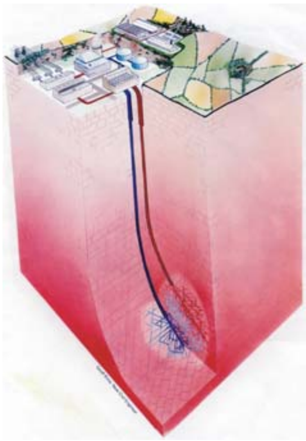
Mayon volcano, Philippines

Country	**1990**	**1995**	**2000**
Argentina	0.67	0.67	0
Australia	0	0.17	0.17
China	19.2	28.78	29.17
Costa Rica	0	55	142.5
El Salvador	95	105	161
Ethiopia	0	0	8.52
France	4.2	4.2	4.2
Guatemala	0	33.4	33.4
Iceland	45	50	170
Indonesia	145	310	590
Italy	545	632	785
Japan	215	413	547
Kenya	45	45	45
Mexico	700	753	755
New Zealand	283	286	437
Nicaragua	35	70	70
Philippines	891	1227	1909
Russia (Kamchatka)	11	11	23
Thailand	0.3	0.3	0.3
Turkey	20.6	20.4	20.4
USA	2775	2817	2228
Total	**5832**	**6833**	**7974**

http://iga.igg.cnr.it/geo/geoenergy.php

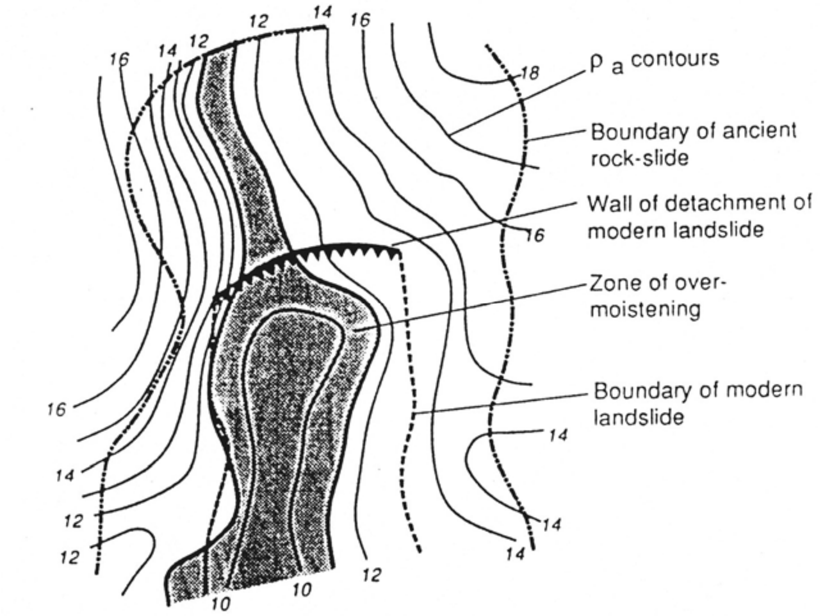


More details http://geothermal.marin.org/GEOpresentation/



Hot dry rock projects

C7.1.5 Geotechnical applications



● Evaluating the hazards posed by landslides.

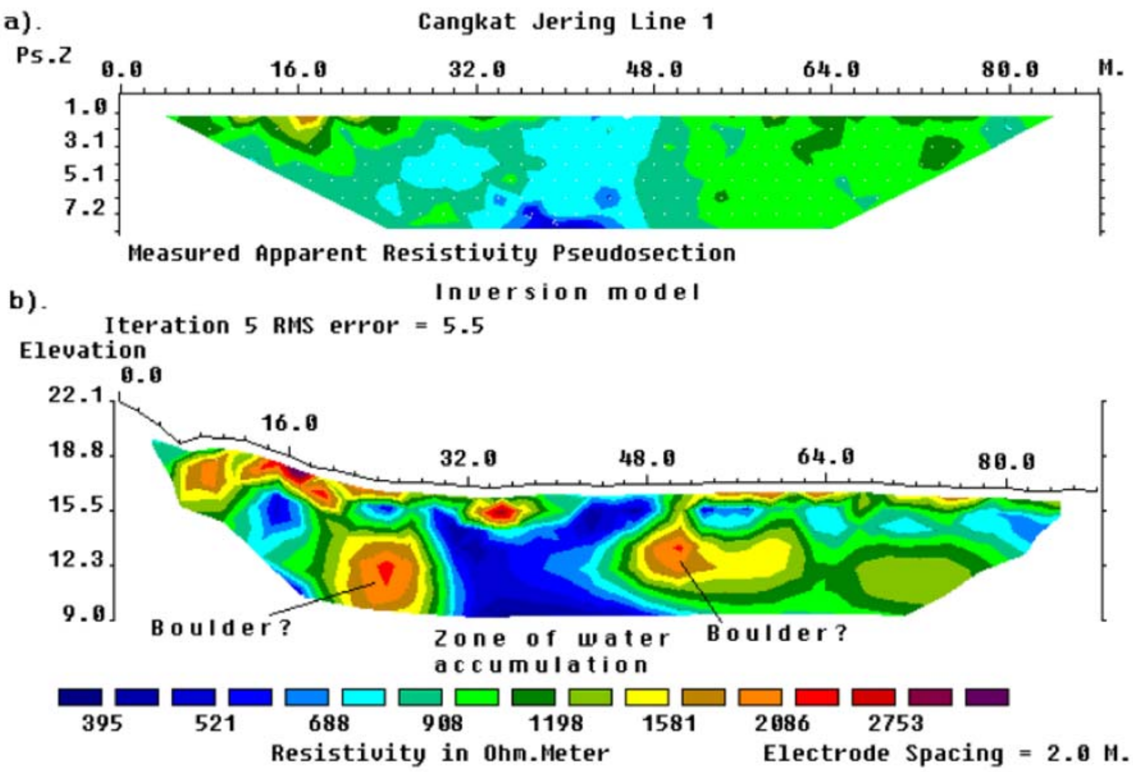


Figure 19. (a) The apparent resistivity pseudosection for a survey across a landslide in Cangkat Jering and (b) the interpretation model for the subsurface.

Figure courtesy of M.H. Loke

C7.2 Studying the time variation of subsurface resistivity structures.

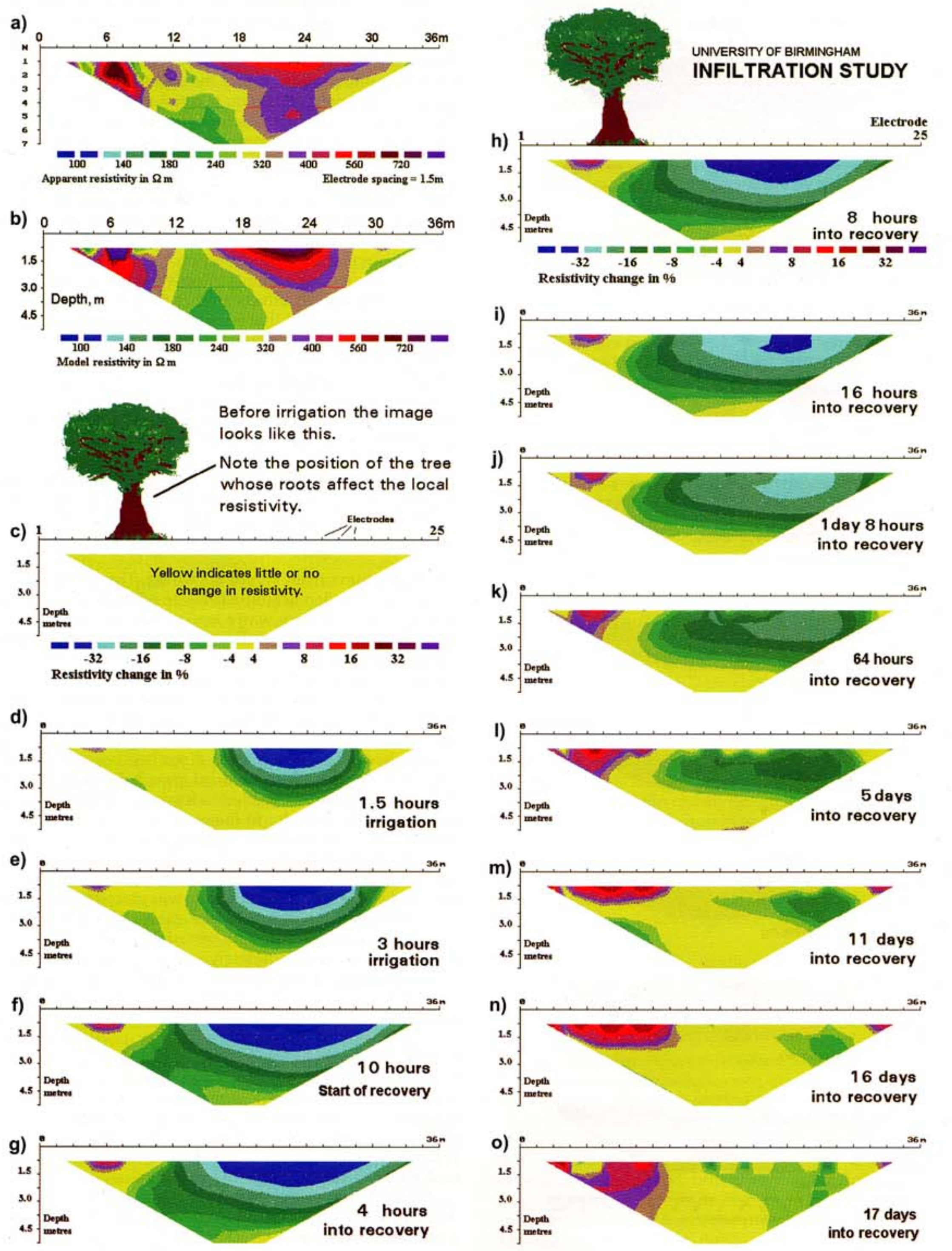


Figure 2. (a) Apparent resistivity pseudosection measured over sand and gravel with electrode spacing of 1.5 m; (b) resistivity produced from the inversion of (a); (c)-(o) difference images measured during infiltration and recovery phases of the study.

OCTOBER 1998 THE LEADING EDGE 1455

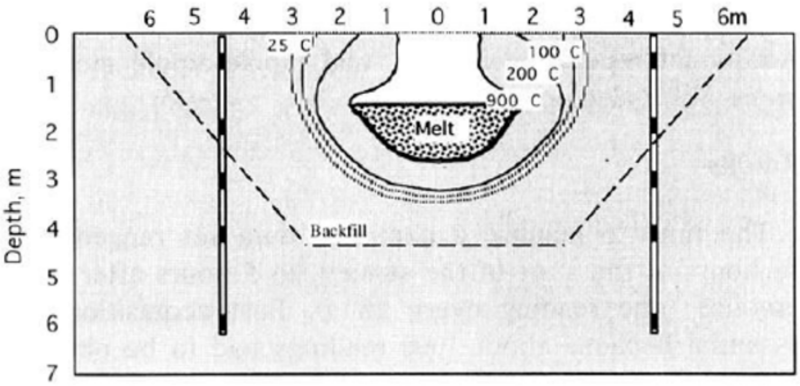
- Monitoring the flow of water in the ground and hydrogeology (*TLE*, October 1998)

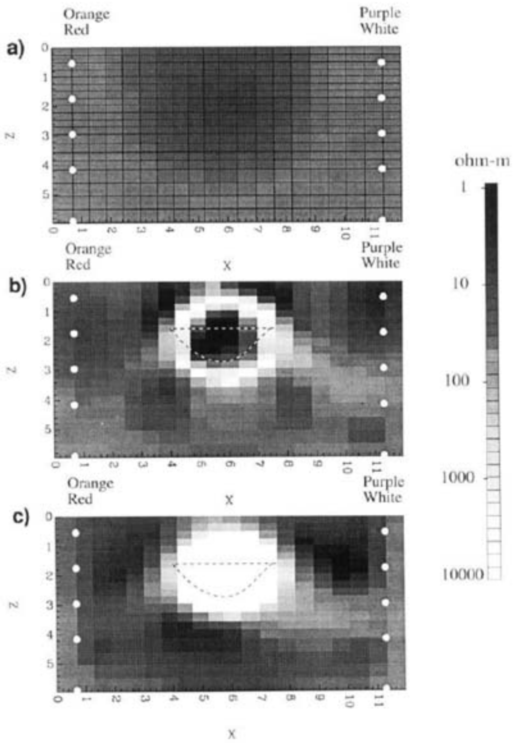
● Monitoring in-situ vitrification of radio active waste

Spies and Ellis, Cross-borehole resistivity tomography of a pilot scale, in-situ vitrification test, *Geophysics*, **60**, 886-898, 1995)

Cross-borehole resistivity tomography of a pilot-scale, in-situ vitrification test

B. R. Spies* and Robert G. Ellis‡





(a) Pre-melt (b) maximum amount of melting. The melt body has a low resistivity but is surrounded by a high resistivity halo. Why? (c) post-melt. The melt has frozen to glass and has a high resistivity.

MJU November 2005