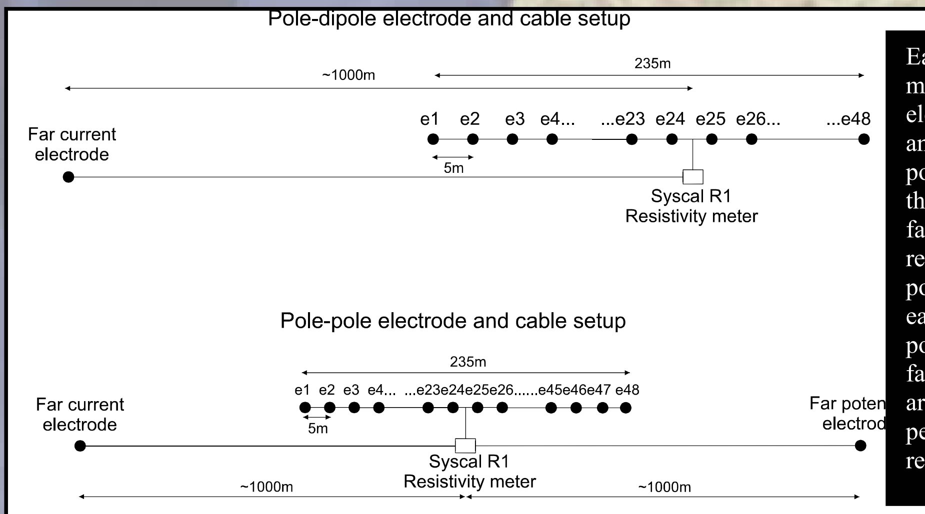
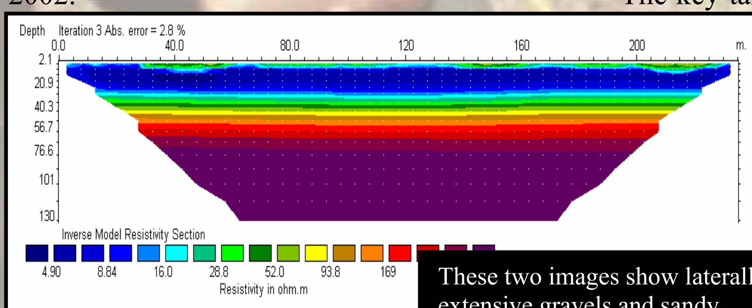
Groundwater Case Study: Finding Drinking Water

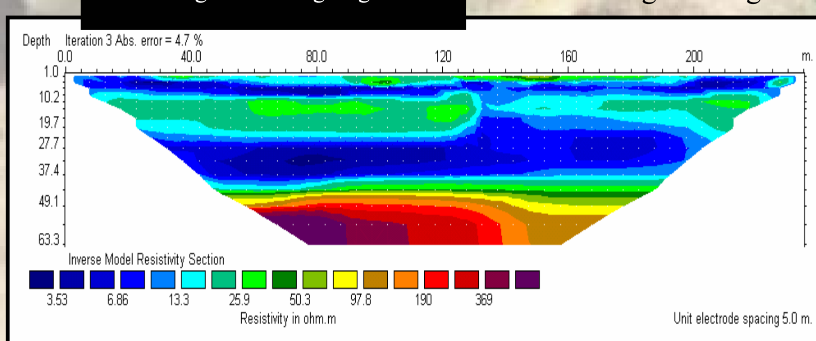
Subsurface Imaging NZ carried out 2D resistivity surveys that formed part of a project to locate groundwater supplies in rural areas of Cambodia. The aim of the project was to establish positions for production bores using resistivity surveying methods. The field work was carried out between 24 April and 15 June 2002.



Each resistivity measurement uses four electrodes, two current and two potential. In the pole-dipole array, one of the current electrodes is far removed from the rest of the array. In the pole-pole array, one of each current and potential electrode are far removed. These arrays improve depth penetration and lateral resolution.



These two images show laterally extensive gravels and sandy gravels below 50 m. These data are typical for the region and illustrate good drilling targets.



Drilling targets were located by detection of the most suitable rock units, rather than direct detection of the water in the rock itself. The geological units were characterised based on resistivity values from previously collected soundings. These values varied from 1-1000 ohm-m, with clays and silts being 1 – 50 ohm-m, sands and sandy gravels 50 – 120 ohm-m, gravels 120 – 800 ohm-m, basalts and basement rocks 250 – 1000 ohm-m. Where the rocks were sedimentary, the method works very well; an increase in resistivity indicates coarser material and hence an increase in porosity and permeability.

The key targets are bands of clean gravels and sandy gravels. In some cases a zone of fractured rock above competent bedrock makes a viable alternative acquifer.

The resistivity imaging method was substituted for single soundings. This effectively replaces one sounding with up to 48 soundings along a

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240m long line. The depth penetration from the two layouts used was 65m for the pole-dipole array and 150m for the pole-pole array. The layout design was facilitated by software supplied by Iris Instruments. The resistivity meter used was an Iris Syscal Switch R1. This is a standard resistivity imaging system with the capability to quickly conduct surveys of this type.

Resistivity imaging produces depth sections that represent blurred versions of the actual electrical structure of the subsurface. The blurring effect is more severe with depth.

Typically for the pole-pole array the number of quadrapoles (electrode sets) was 1060, and for the pole-dipole 860 quadrapoles, with each quadrapole equivalent to one data point in the final resistivity image.

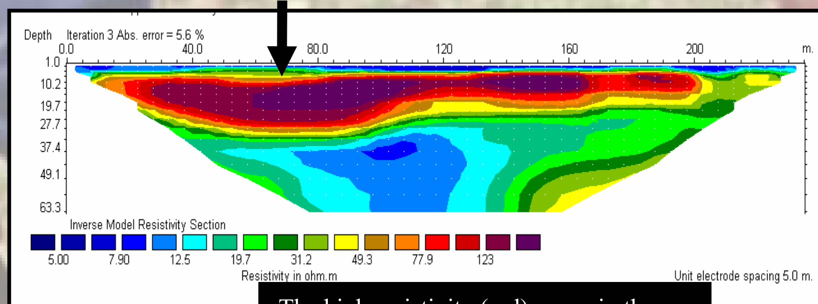
The maximum electrode spacing used was between 750 and 1000m, this met the project requirement in electrode spacing but also well exceeded the project requirement for the effective number soundings of 50 to 150 per town. 28 Cambodian towns were surveyed, with 65 resistivity data lines in total collected.

In summary, the results showed that:

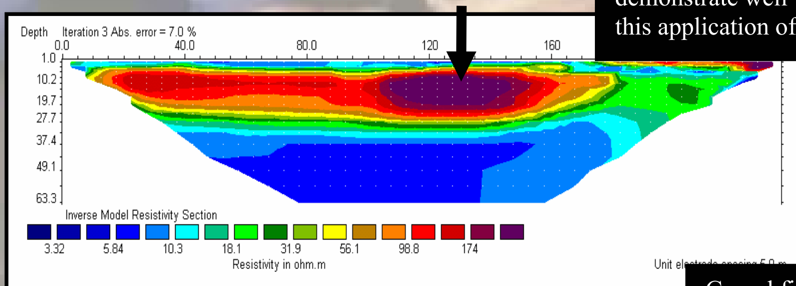
1) Depth changes and structure with offsets of a few metres are detectable.

2) The lateral and vertical geometry of structures should be defined with a precision of better than 10 meters, although this accuracy is dependent on depth. Consequently, very thin layers may not be detected with this method.

3) It is not possible to distinguish between closely spaced layers of clean gravels, and these will usually be seen as one geological unit.

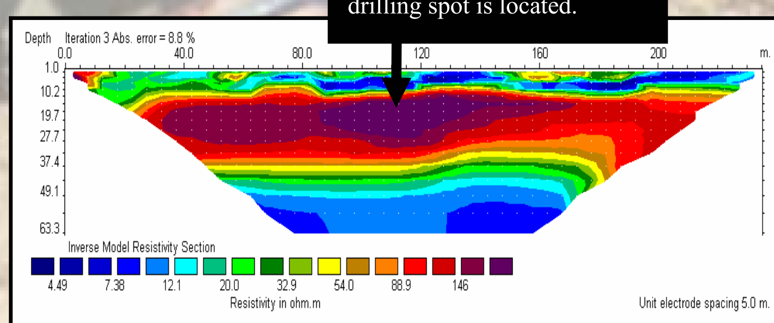


The high resistivity (red) zones in these images clearly delineate zones of river gravels. The higher the resistivity, the better the target is. The images demonstrate well the effectiveness of this application of resistivity imaging.



These points agree with theoretical considerations and computer simulations.

Gravel filled river channels are identified as high yield targets. These images show not only the location of the river channels, but also where the gravels are thickest and hence most permeable, and hence where the most suitable drilling spot is located.



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