The Clay Research Group

RESEARCH AREAS

Climate Change ◆ Data Analysis ◆ Electrical Resistivity Tomography
Time Domain Reflectometry ◆ BioSciences ◆ Ground Movement
Soil Testing Techniques ◆ Telemetry ◆ Numerical Modelling
Ground Remediation Techniques ◆ Risk Analysis
Mapping ◆ Software Analysis Tools

The Clay Research Group
www.theclayresearchgroup.org

August/September 2008

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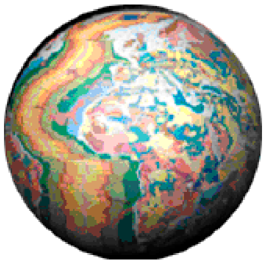
A World Geology

www.bgs.ac.uk.

The BGS has joined with geologists from 80 nations to map between 60 – 70% of the worlds geology.

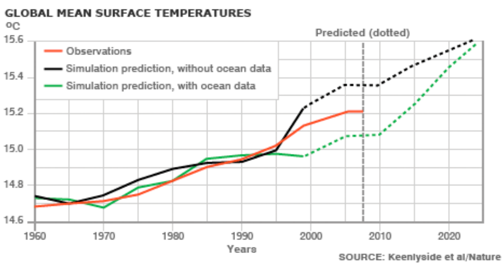


The project, called "OneGeology", is being led by Ian Jackson from the BGS.

Climate Change on Hold?

~ Nature, 453, 2008 ~

A team of German researchers report in Nature that "The Earth's temperature may stay roughly the same for a decade, as natural climate cycles enter a cooling phase".



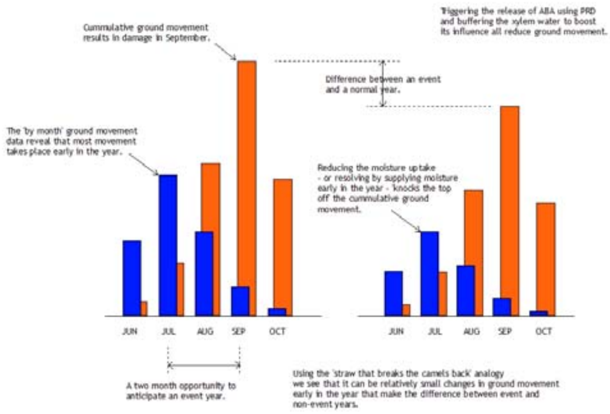
Noel Keenlyside's team from the German Institute of Marine Science has used 50 years data to model what they see as a 10 year pause before climate change trends continue. See graph above.

2007 and 2008 certainly provide anecdotal support to this theory, and Dr Wood from the UK Hadley Centre confirms that this comes as no surprise to his team. They expect variations from year to year, and between decades.

Intervention Technique

Our intervention project is underway and we have an Agrement Certified scheme to harvest water and introduce it to the root system at a targeted depth, at a specific time of the year using our 'movement by month' values.

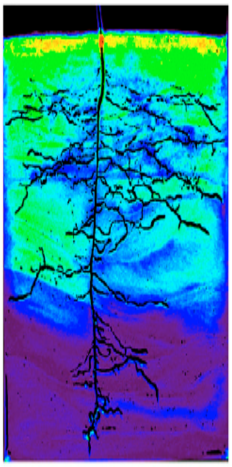
The system uses naturally occurring minerals to raise the pH of the soil, thus increasing the effectiveness of ABA whilst satisfying the Partial Root Drying requirement by treating a portion of the root zone.



The solution is being tested commercially by Innovation and Crawford on a selection of claims. Unfortunately the wet weather may delay our understanding of the benefit the treatment delivers.

ROOT IMAGING

Using Neutron Radiography Oswald et al, have demonstrated (using lupine and maize seedlings) how moisture moves through the soil (compressed sand) in their paper entitled "Qualitative Imaging of Infiltration, Root Growth and Root Water Uptake via Neutron Radiography" published in the Vadose Zone Journal.



InFront innovation – ADDRESSOLOGY – Crawford – Aldenham School – MAT-LAB – KEELE UNIVERSITY – University of Southampton

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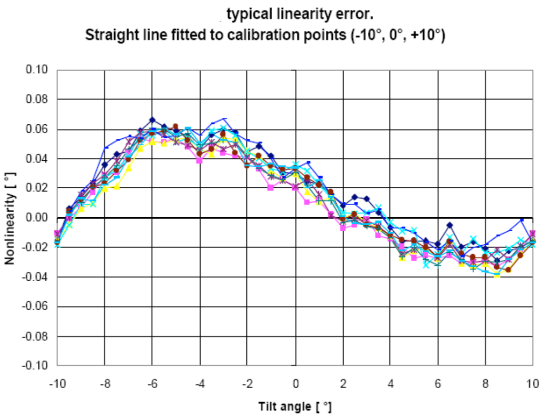
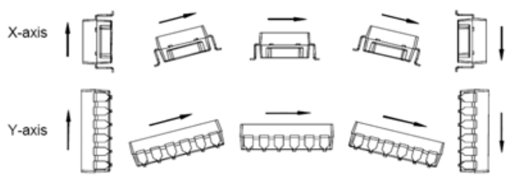
Inclinometers

In conjunction with Crawford we are testing a new range of inclinometers. The solid state circuitry and reduced cost offer significant benefits with no loss of accuracy if the manufacturers claims are proven.



Above we see the manufacturers linearity plot. The profiles appear regular and repeatable within a practical range for our purposes.

Jon Grey is setting up a test rig to replicate our earlier work, securing the sensor to a 1m long bar and raising it 1mm intervals over a 10mm range, and then lowering it, repeating this cycle several times. The work helps us to check (a) the resolution of the sensor and (b) hysteresis.



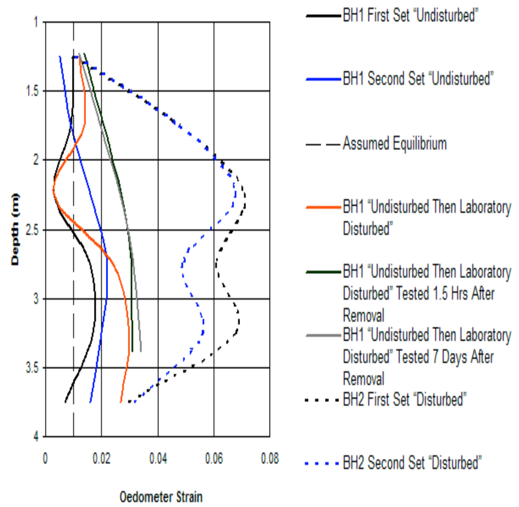
The sensor measures tilt in two directions (see above) and has a claimed resolution of 0.001 degrees. Hopefully the new and cheaper technology will raise industry interest.

Sample Disturbance

We wondered what effect storing samples for a period of time prior has on recorded stress. For example, does some form of 'relaxation' take place, and if so, does this influence disturbed samples more than undisturbed?

If there was a difference, could it be related to moisture dissipation or re-distribution within the sample, or possibly volume change?

MatLab retrieved undisturbed samples from the core taken near the Willow at Aldenham and tested them in several ways as we see below.



Some were tested in their undisturbed state, 1.5 hours following removal from the sample tube. Others were 'laboratory disturbed' and a third set were allowed to stand for several days prior to testing.

Although too small a sample to provide any conclusive findings, there is no evidence that leaving soil for a period of time prior to testing has any measurable effect.

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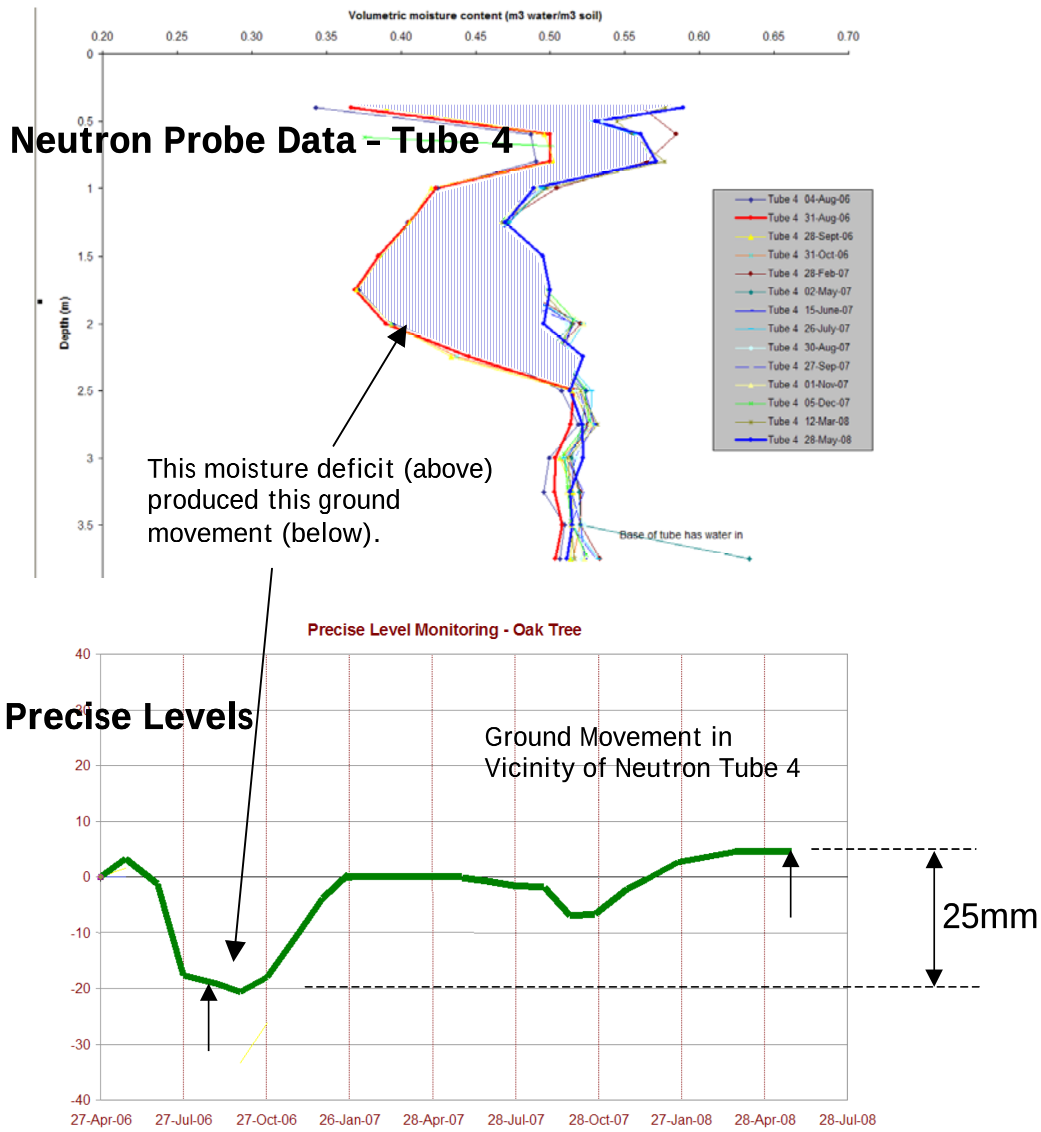
Neutron Probe Data -v- Ground Movement

Top is the volumetric moisture content measured by Southampton University over time using the neutron probe. The red line plots the results from August 2006 – a particularly dry spell – and the blue line plots the data from May 2008. The difference between them – the amount of rehydration that has taken place - is shaded with a blue grid.



The green line (bottom) plots the ground movement in the vicinity of the neutron probe over time. The difference between August 2006 and May 2008 amounts to around 25mm. The blue shaded area of the top graph (representing the loss of moisture between the two readings) has produced 25mm of ground movement.

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In-situ Detection of Tree Root Distribution and Biomass by Multi-Electrode Resistivity Imaging.

Mariana Amato et al

Tree Physiology 28:1441 - 1448

"Traditional methods for studying tree roots are destructive and labour intensive, but available non-destructive techniques are applicable only to small scale studies or are strongly limited by soil conditions and root size.

Soil electrical resistivity measured by geo-electrical methods has the potential to detect below-ground plant structures, but quantitative relationships of these measurements with root traits have not been assessed. We tested the ability of two-dimensional (2-D) DC resistivity tomography to detect the spatial variability of roots and to quantify their biomass in a tree stand. A high-resolution resistivity tomogram was generated along a 11.75 m transect under an Alnus glutinosa (L.) Gaertn. stand based on an alpha-Wenner configuration with 48 electrodes spaced 0.25 m apart.

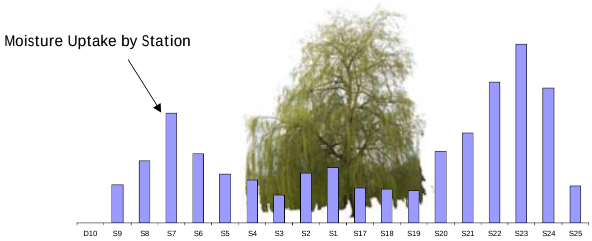
Data were processed by a 2-D finite-element inversion algorithm, and corrected for soil temperature. Data acquisition, inversion and imaging were completed in the field within 60 min. Root dry mass per unit soil volume (root mass density, RMD) was measured destructively on soil samples collected to a depth of 1.05 m. Soil sand, silt, clay and organic matter contents, electrical conductivity, water content and pH were measured on a subset of samples. The spatial pattern of soil resistivity closely matched the spatial distribution of RMD.

Multiple linear regression showed that only RMD and soil water content were related to soil resistivity along the transect. Regression analysis of RMD against soil resistivity revealed a highly significant logistic relationship (n = 97), which was confirmed on a separate dataset (n = 67), showing that soil resistivity was quantitatively related to below-ground tree root biomass. This relationship provides a basis for developing quick non-destructive methods for detecting root distribution and quantifying root biomass, as well as for optimising sampling strategies for studying root-driven phenomena."

Extract from Web page
http://heronpublishing.com/tphome.html

Dynamics of Ground Rehydration

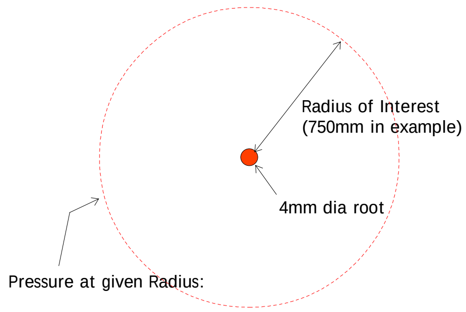
The 'water uptake by month' figures derived from differences in ground movement data are recorded in the bar chart below for every station across the root footprint of the Willow tree in July 2006.



The moisture uptake is greatest at the root periphery and this appears to be a characteristic of a mature tree in the presence of a persistent deficit – or perhaps a history of dry summer soil. See soils data elsewhere.

On leaf fall – when the canopy is open - we see significant rehydration taking place across the footprint – see following page.

METHOD OF ESTIMATING PRESSURE AT ANY POINT



Root Radius (r) = 2mm
Radius of Interest (R) = 750mm
Pressure at Root Surface (Pr) = 1,500kPa
Pressure as Radius of Interest (PR) = ?
Pi = 3.142
Force at Root (F) = Pr x Pi x 2r (pressure x area)
PR = F / (Pi x 2R) = (Pr x Pi x 2r) / (Pi x 2R) = Pr*r/R
PR = 1500 x 2 / 750 = 4kPa

Clive Bennett provides the above area method of estimating pressure at any distance from the root by entering the suction exerted by the root, its radius and the distance to the point of interest.

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Moisture Uptake by Month

Below is the plot of the 'moisture uptake by month' values as determined by differences in ground movement across the footprint of the Aldenham Willow where we have level stations. The red line plots the moisture uptake in July 2006 – an exceptionally dry summer – and reveals how trees absorb moisture from a dry soil where there is a persistent deficit.

The blue line represents the subsequent 'difference by month' recovery profile in November 2006 following rainfall. Rehydration of the soil immediately beneath the tree is slow initially but then increases quickly on leaf loss due to the open canopy. The grey shaded area reveals rehydration that took place between November and December.

The more 'normal' profile of ground movement beneath a tree is shown as an orange line below, and has been estimated by taking the difference between the maximum and minimum readings.