

Presenting the rejected hypothesis – its contribution to science success

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Alternative titles for talk

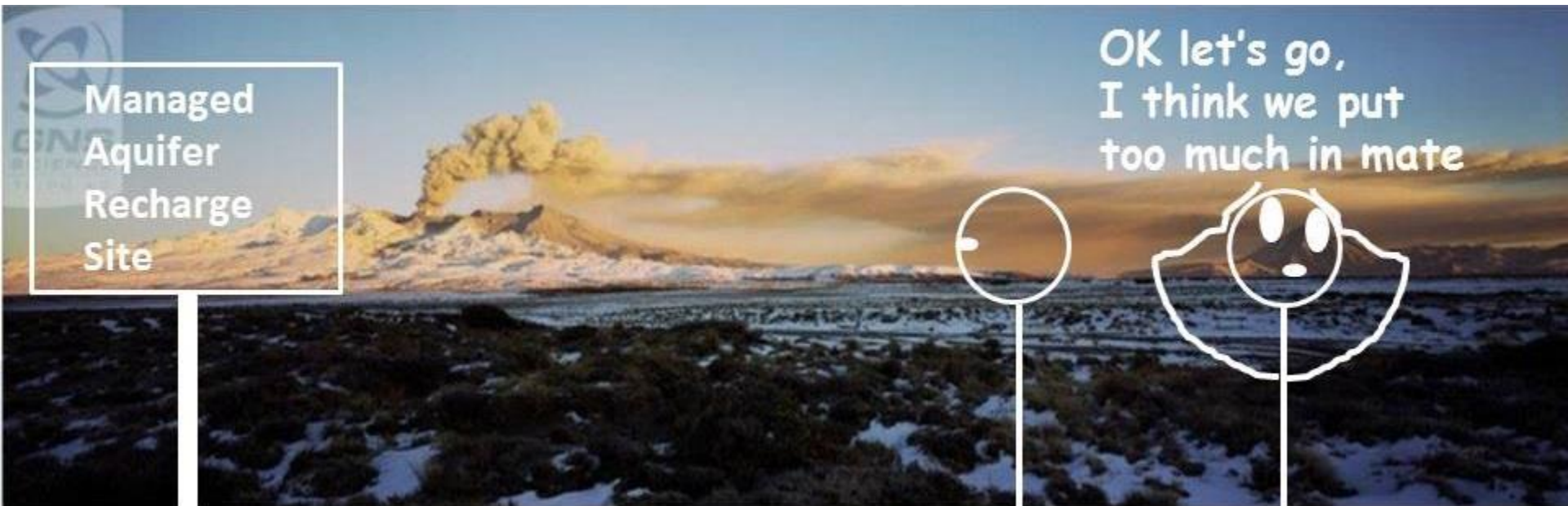
Presenting the rejected hypothesis – its contribution to science success

How can failure stories contribute to science success

The importance of negative results

The importance of anomalies

Flawed theories



List of contributors

Maybe in the audience?	Not in the Audience
Kirchner (2006) Klemes, 1986, 1988; Grayson et al., 1992; Beven, 2002 Vazken Andréassian , Charles Perrin , Eric Parent & Andras Bárdossy (Browman 1999) Cox (2013) Lovett (2015) Rawlinson Allchin (2001)	

The null hypothesis

- **Definition** - usually refers to a general statement or default position that there is no relationship between two measured phenomena, or no association among groups.
- **Errors**
 - **Errors while testing hypothesis H**
 - Type I error reject H when it is actually true
 - Type II error accept H when it is actually false.
 - material (e.g. violated experimental protocol),
 - observational (e.g. sampling error),
 - conceptual (inappropriate model or theory) and
 - discursive (i.e. in communicating results)

Allchin (2001)

The importance of publishing negative results in science

- ‘In my opinion, this is perhaps the most important effectively undiscussed subject in the entire methodology of science’ - Stephen J Gould
- Cordelia’s Dilemma (Gould, 1993)

“Cordelia’s Dilemma arises in science when an important (and often predominant) signal from nature isn’t seen or reported at all because scientists read the pattern as ‘no data’, literally as nothing at all.” (Gould, 2002:



theory of **punctuated equilibrium**

- Cordelia's Dilemma (Gould, 1993): palaeontology literature neglect of the widely observed phenomenon of stasis within the fossil record. The lack of documented commentary on stasis was interpreted by the community as an indication of the idea's lack of significance, ie **'hidden in plain sight'**

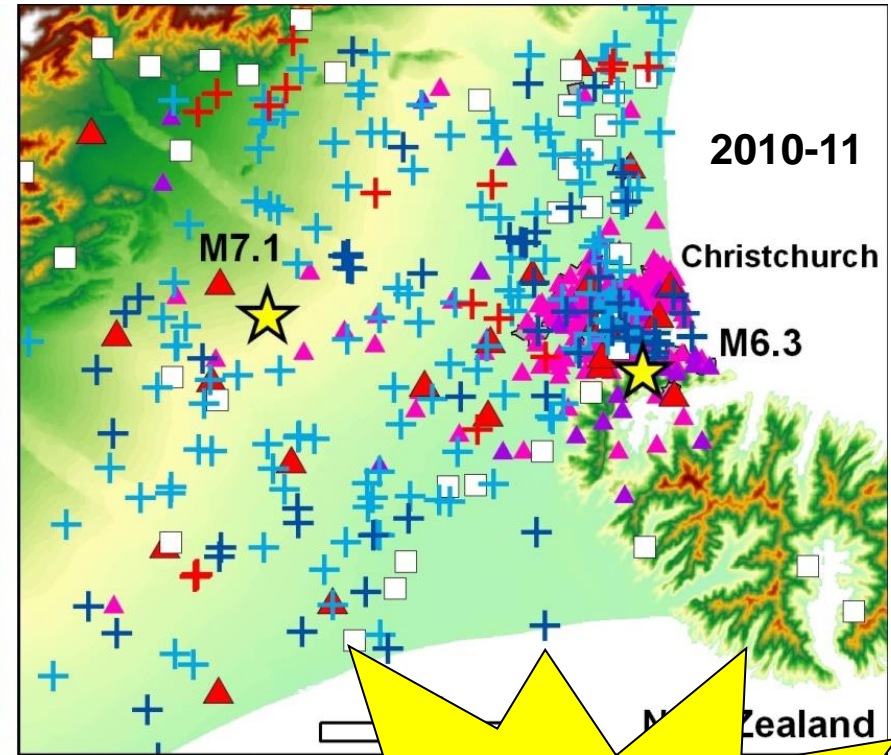
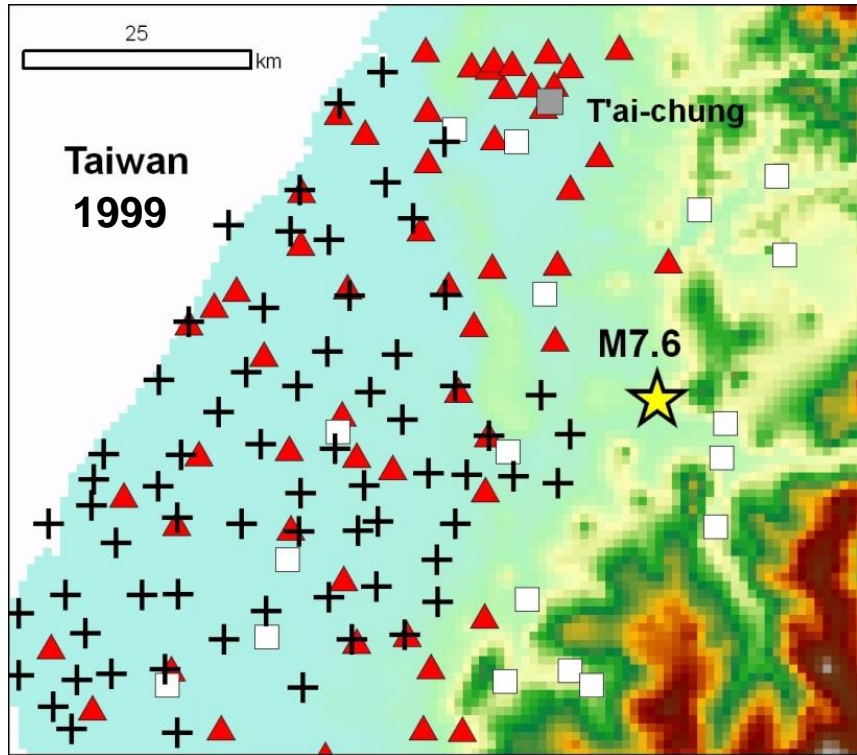
The Court of Miracles of Hydrology: can failure stories contribute to hydrological science?

- Vazken Andréassian , Charles Perrin , Eric Parent & Andras Bárdossy (2010)
- Hydrological Science Journal
- Main themes (from Andréassian et al 2010):
 - implement **severe tests** with the aim to improve models and assess models as hypothesis
 - **Repeating experiments** and avoid the one case study approach in modelling
 - **Publish** failure stories eg. Close but no cigar,
 - Marine Ecology Progress Series – Theme Section Negative Results. (Browman 1999)
 - **Post audit** and evaluation (of models) to help identify which directions produced advances and dead ends

Negative result (flawed theory?)

Estimating aquifer hydraulic properties from active seismicity

Near-field monitoring network Chi Chi (Taiwan) vs Canterbury (NZ) EQs



Hydrologic station

- + 15 min with Temp
- + 15 min recorded
- + Monthly manual
- + Unclassified
- River Gauge

Seismometers

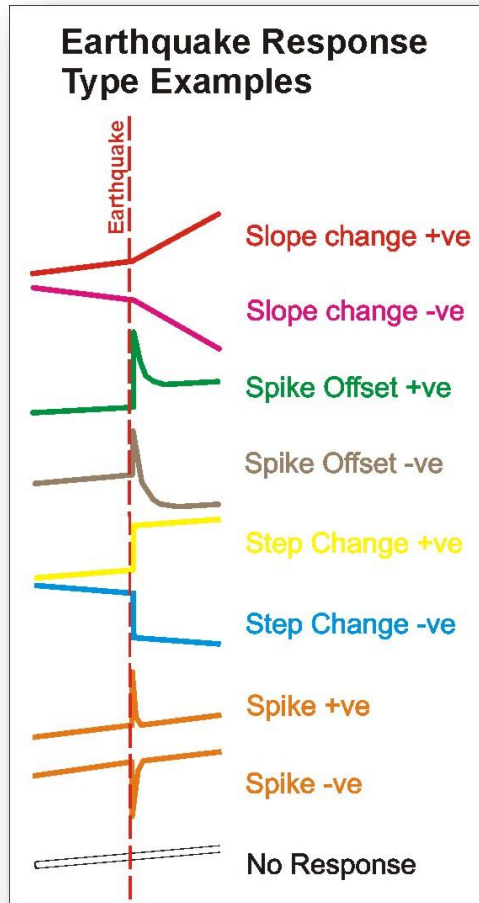
- ▲ GeoNet temporary network
- ▲ Quakecatcher network
- ▲ Strong motion seismograph

Arguably THE most instrumented earthquake on the planet wrt hydrological monitoring (esp in context of strong motion network and geodetic surveying)

Negative result (flawed theory?)

Estimating aquifer hydraulic properties from active seismicity

Classification Cox et al. (2012) NZJGG



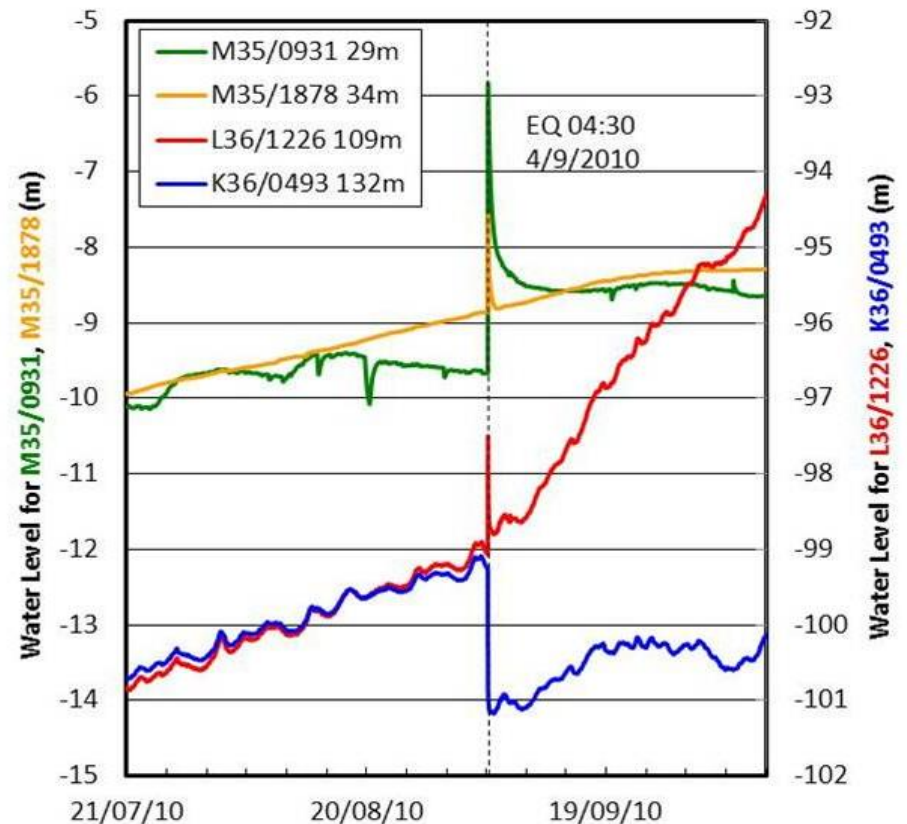
Potentially
Permanent



Transient

No Effect

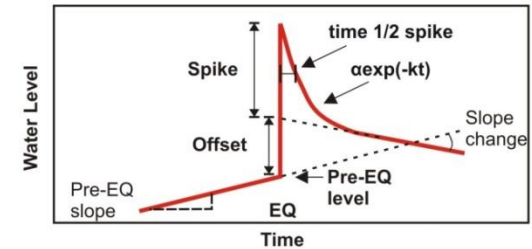
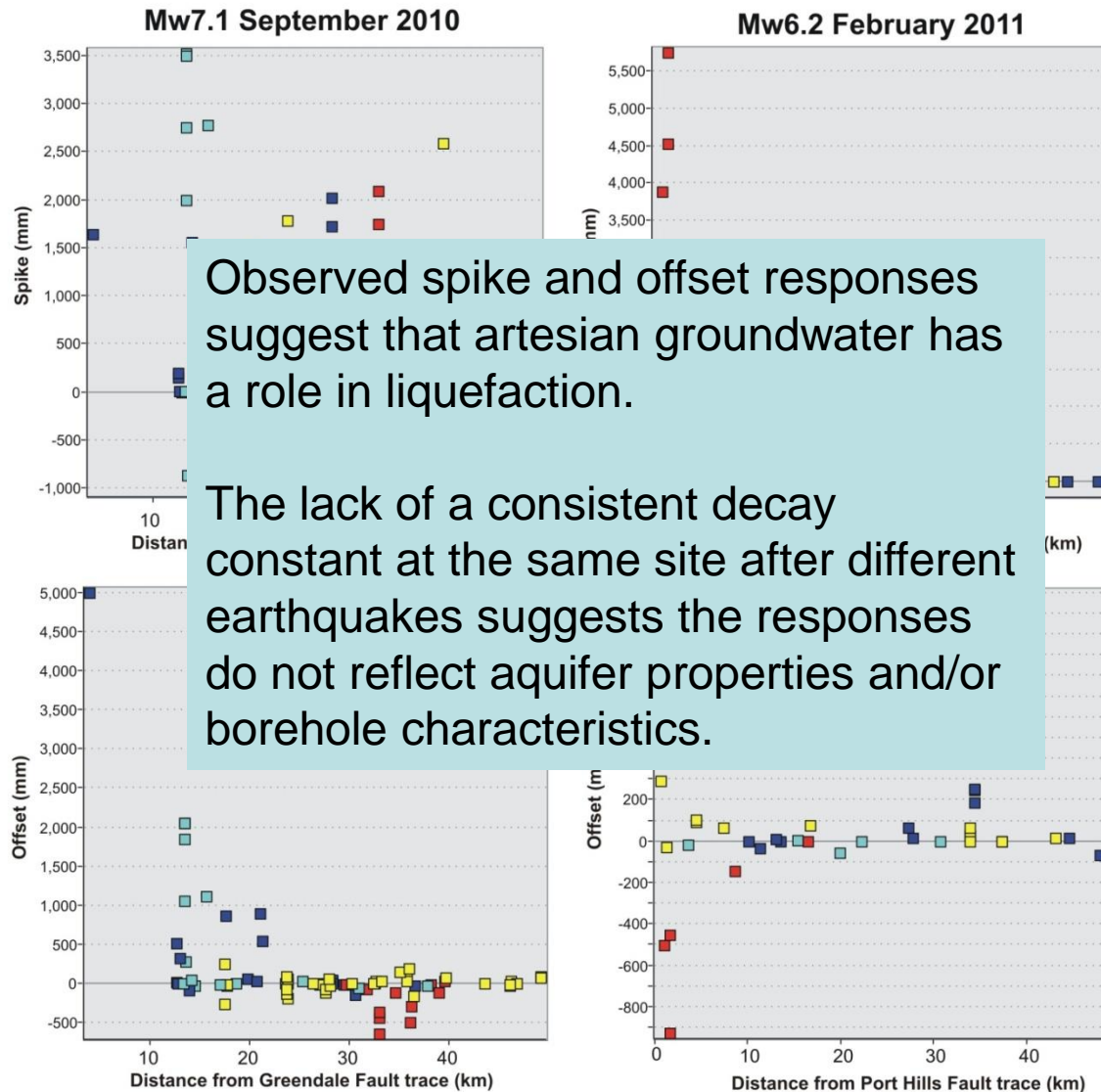
Hydrographs Bore-water level



Negative result (flawed theory?)

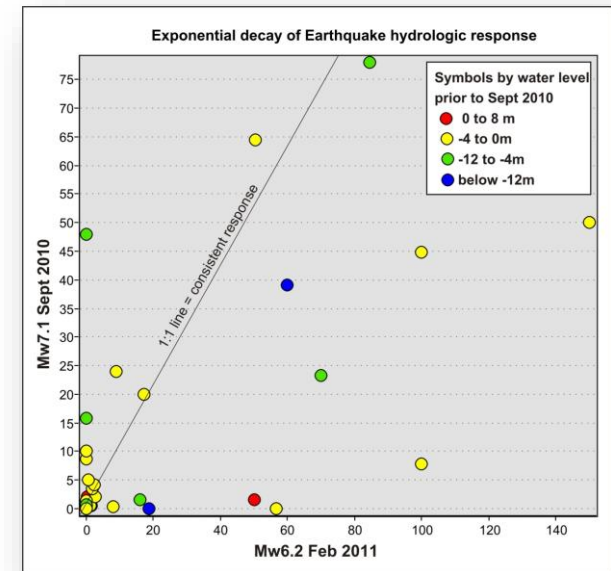
Estimating aquifer hydraulic properties from active seismicity

Cox et al. (2012) NZJGG



Well symbols coloured according to pre-earthquake water level

- 0 to 6.3 m (positive artesian)
- 4 to 0 m
- 12 to -4 m
- 100 to -12 m (deep)



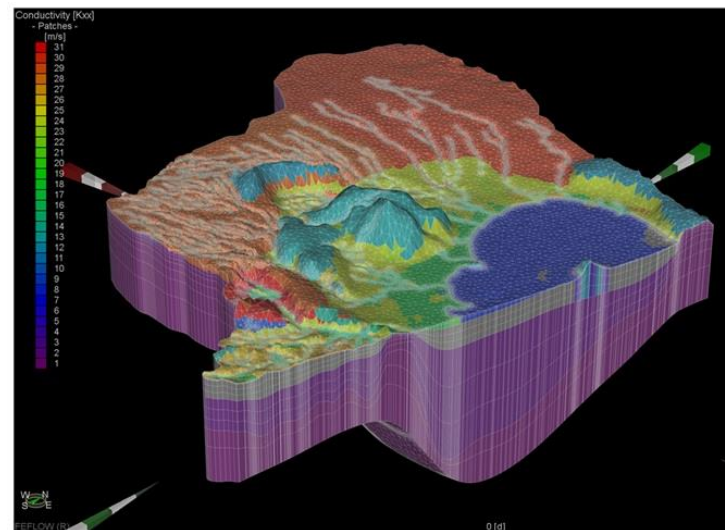
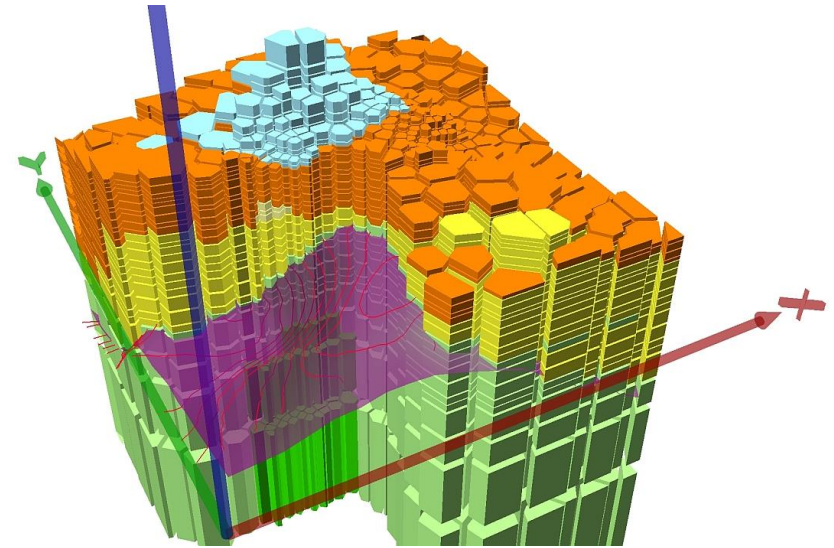
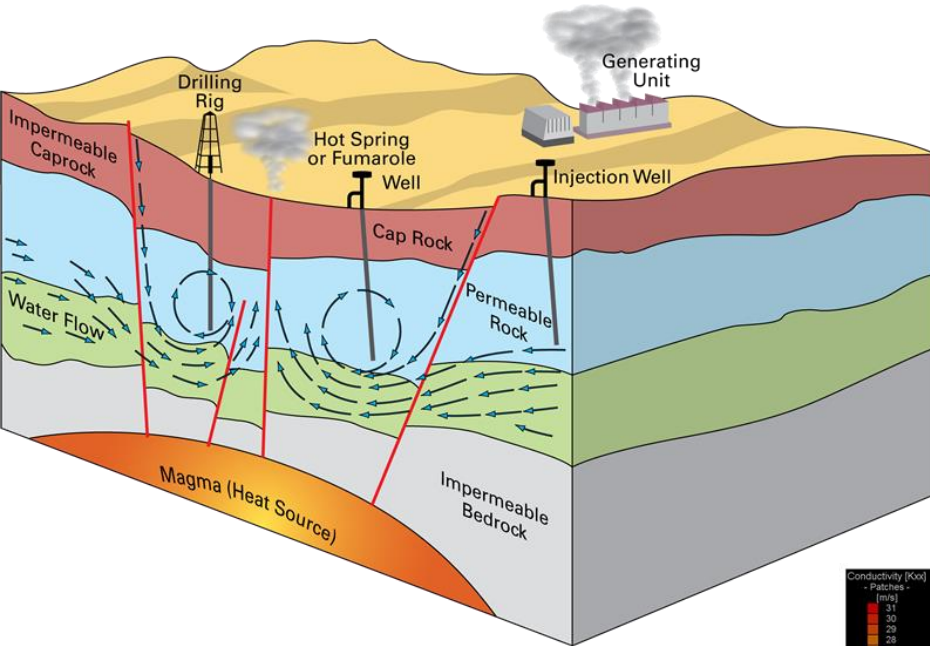
‘negative’ results - important for several reasons: Browman 1999

- they may provide more **balance** for a subject area thus far supported only (or primarily) by positive results (e.g. the impacts of solar ultraviolet B radiation).

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- They may indicate that a subject area is **not as mature** or clearly defined as previously suspected (e.g. GW-geothermal interface, HG mapping in NZ)

Groundwater – geothermal system interface and co-management



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- they may provide more **balance** for a subject area thus far supported only (or primarily) by positive results (e.g. the impacts of solar ultraviolet B radiation).
- They may indicate that a subject area is **not as mature** or clearly defined as previously suspected (e.g. GW-geothermal interface, HG mapping in NZ)
- They may show that a particular line of research is **not worth further efforts** (e.g. active seismic), or that our current methodologies are inadequate for producing a definitive result (e.g. passive seismic).

ESTIMATING WATER TABLE DEPTH AND AQUIFER THICKNESS WITH QUANTIFIED UNCERTAINTIES USING PASSIVE SEISMOLOGY

Zara Rawlinson, Timo Lähivaara, Nick Dudley Ward, Tomi
Huttunen, Janne Koponen, and Jari Kaipio.



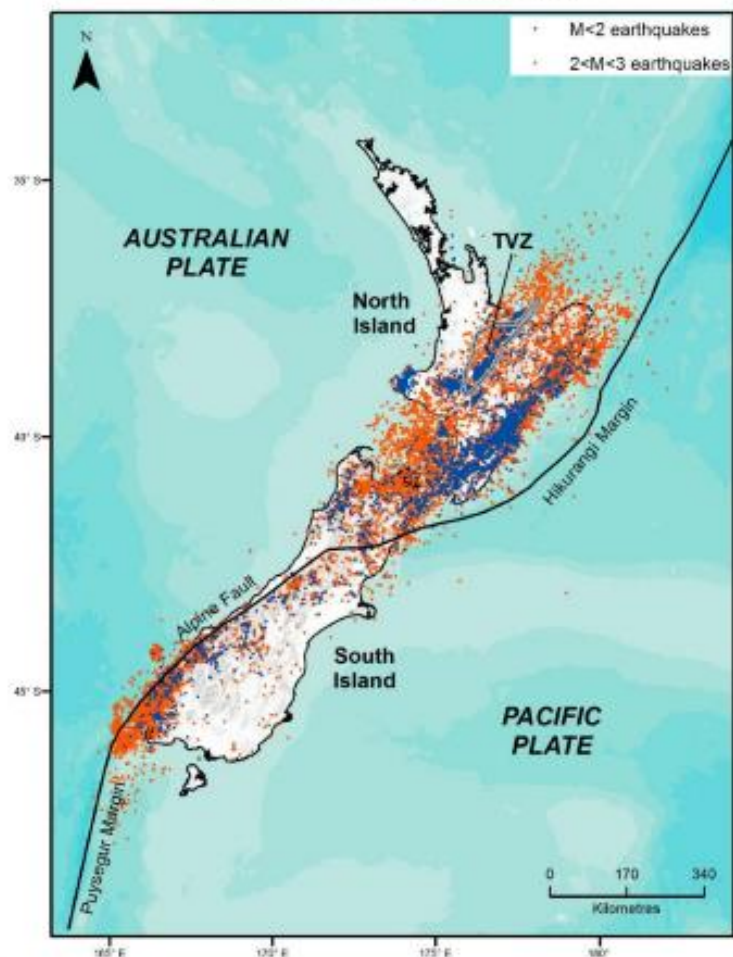
Finnish Centre of Excellence
in Inverse Problems Research



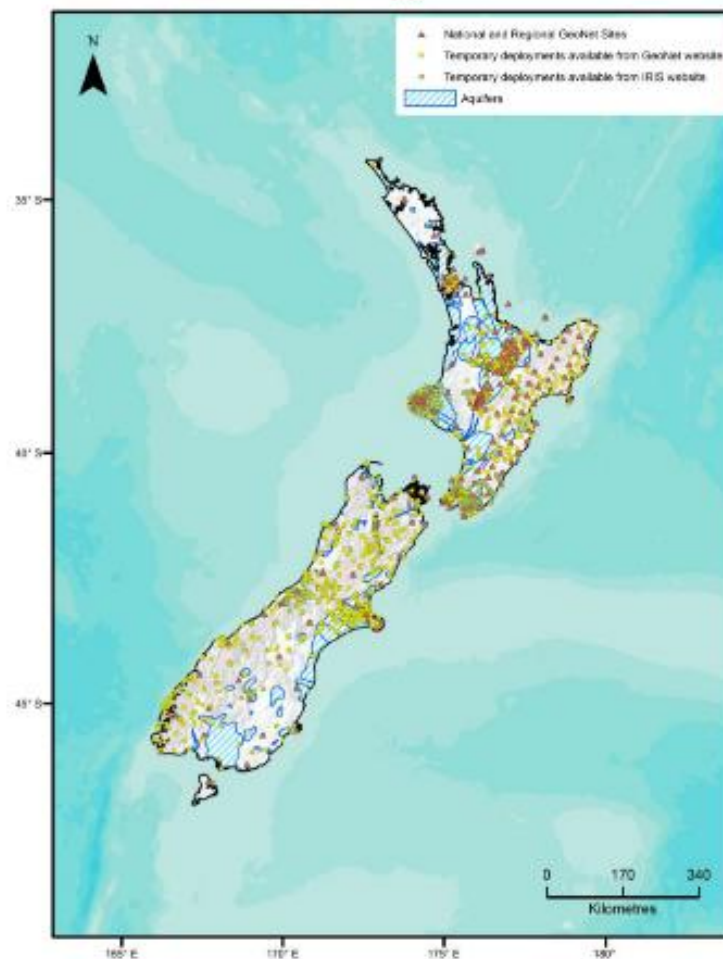
UNIVERSITY OF
EASTERN FINLAND



Lots of earthquakes



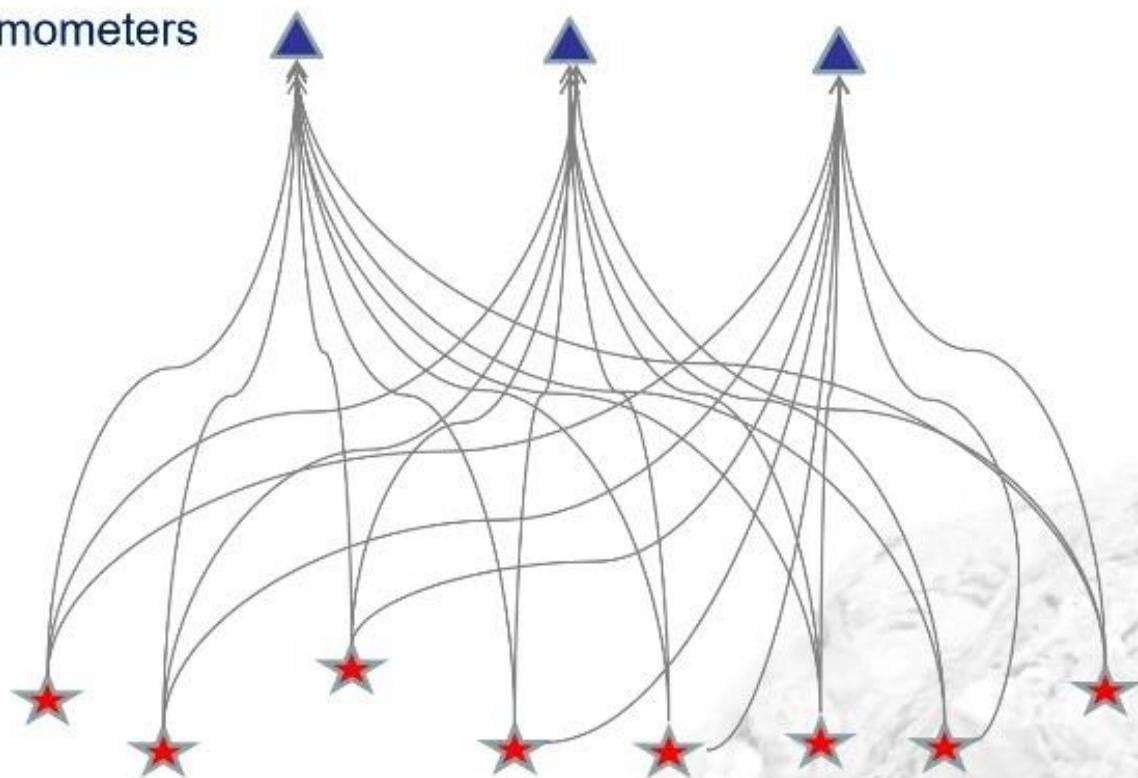
Monitoring network



- **Image locations of changes in fluid saturation**
- **Utilise the response of a seismic wavefield to these changes**
- **Construct an inverse problem that solves the wave equation using the Bayesian framework**
- **Make the problem computationally tractable**

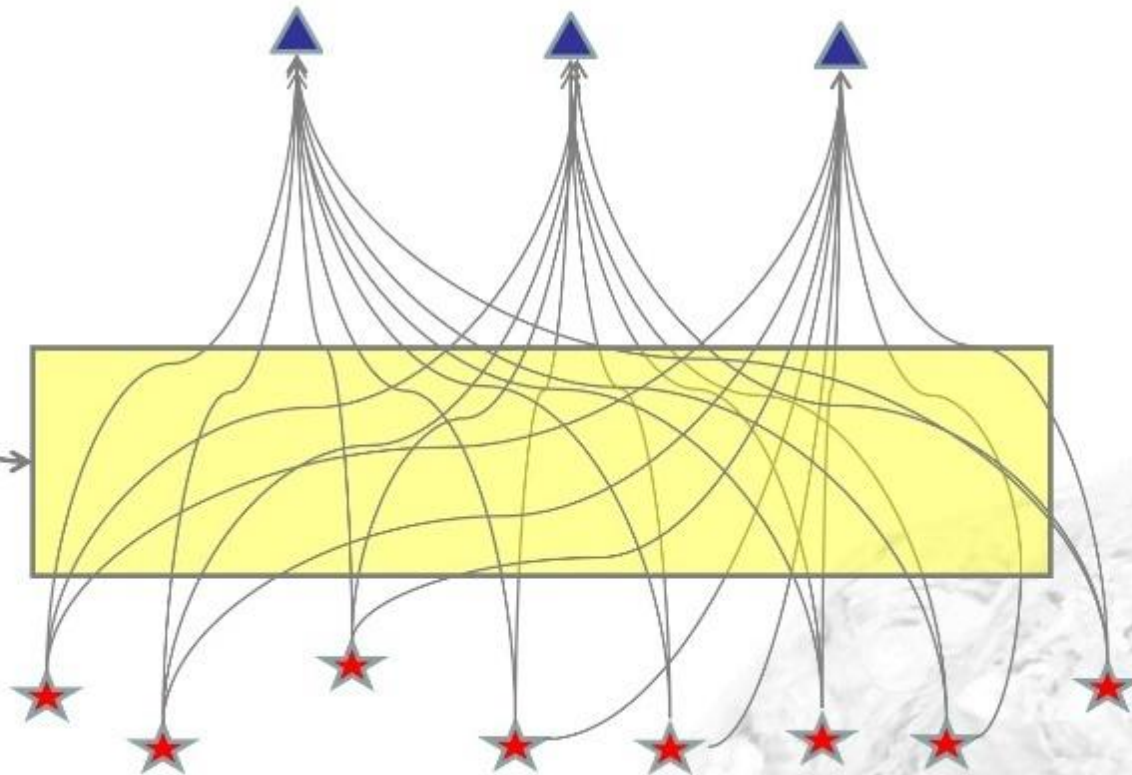
Seismometers

Earthquakes

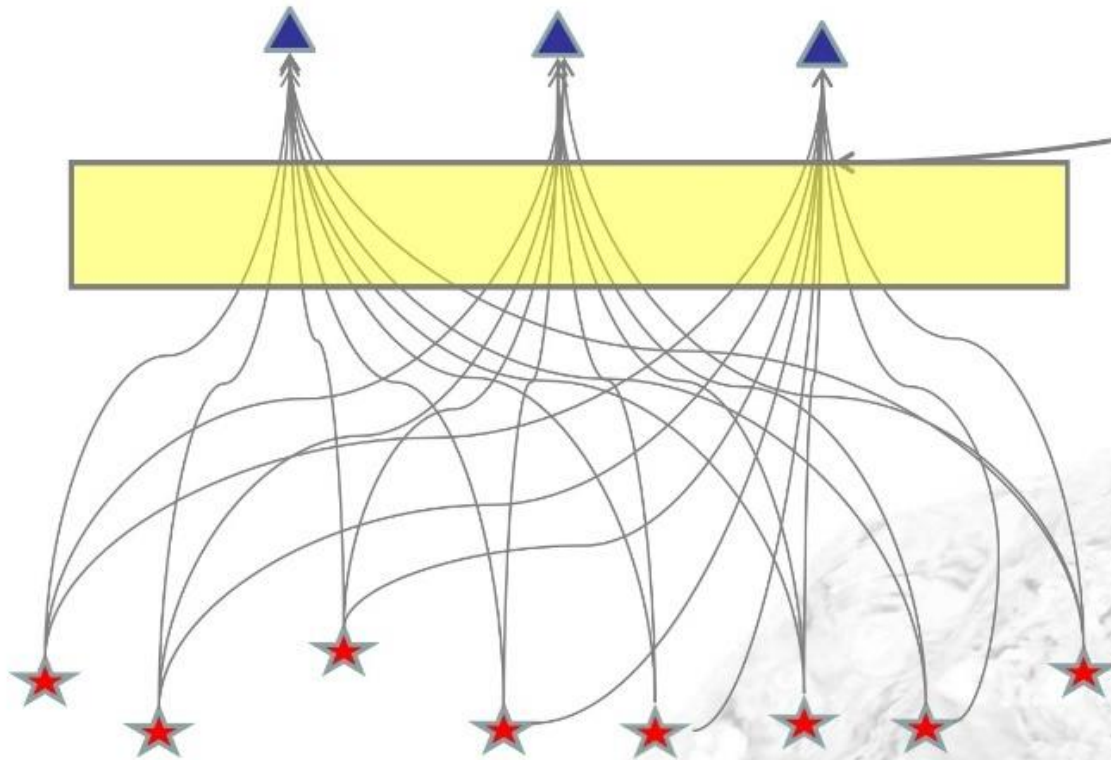


What you want:

- Lots of crossing ray paths



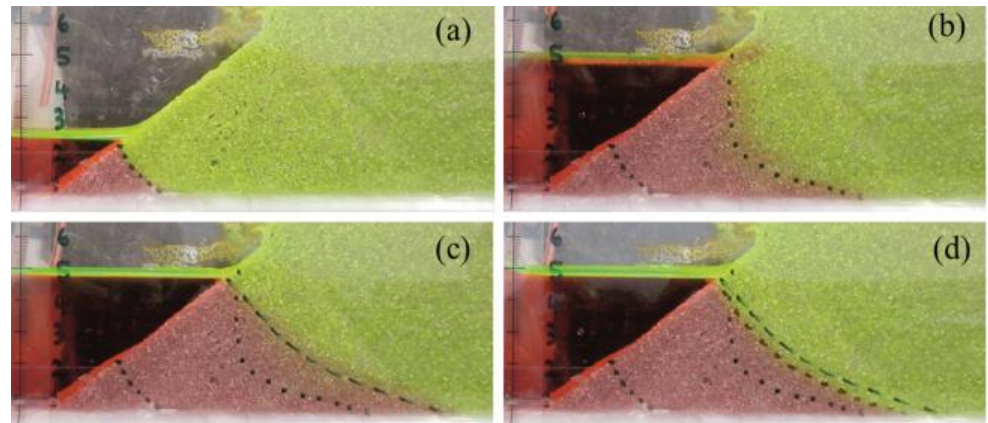
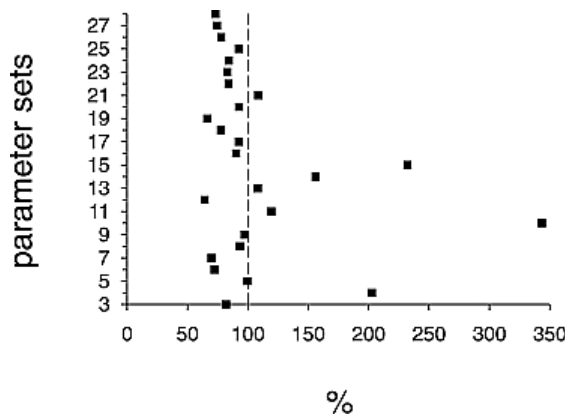
Near surface, what you've got:
- near-vertical ray paths



The importance of anomalies

Philip Sharp - Nobel Prize winning molecular biologist, MIT.

- “I would never dream of doing an experiment where I don’t know the results before I set out. It would be a criminal waste of expensive equipment and chemicals, and an unwarranted waste of the time of my grad students and post-docs.’ ‘Of course, there have been a couple of times when the experiments didn’t work out. That’s when it gets really exciting.’
- Seawater intrusion overshoot – Flinders University & NCGRT

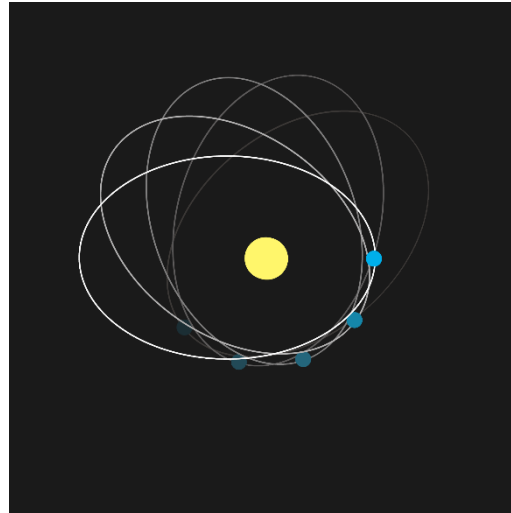


- (Watson et al. 2010)

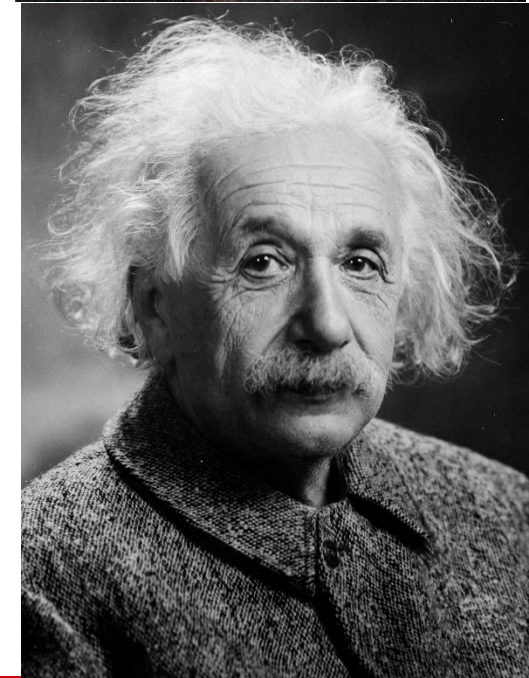
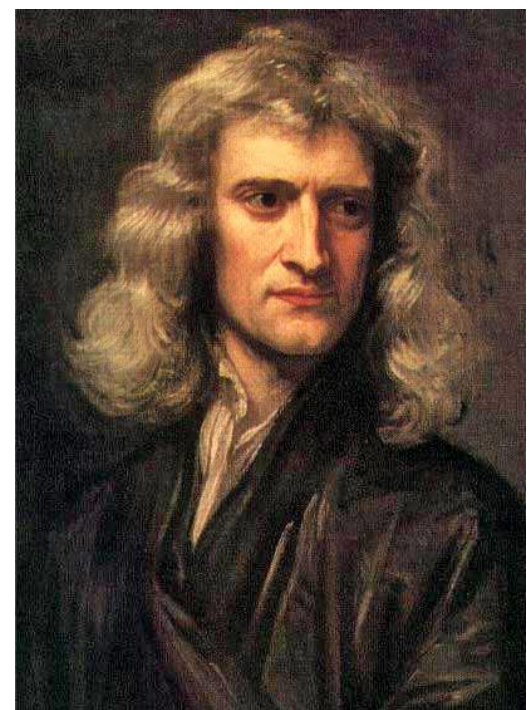
Images from the SLR physical experiment:
(a) 0 min, (b) 9 min, (c) 21 min, and (d) 2 h.
Morgen et al 2013

The role of negative evidence

perihelion of Mercury

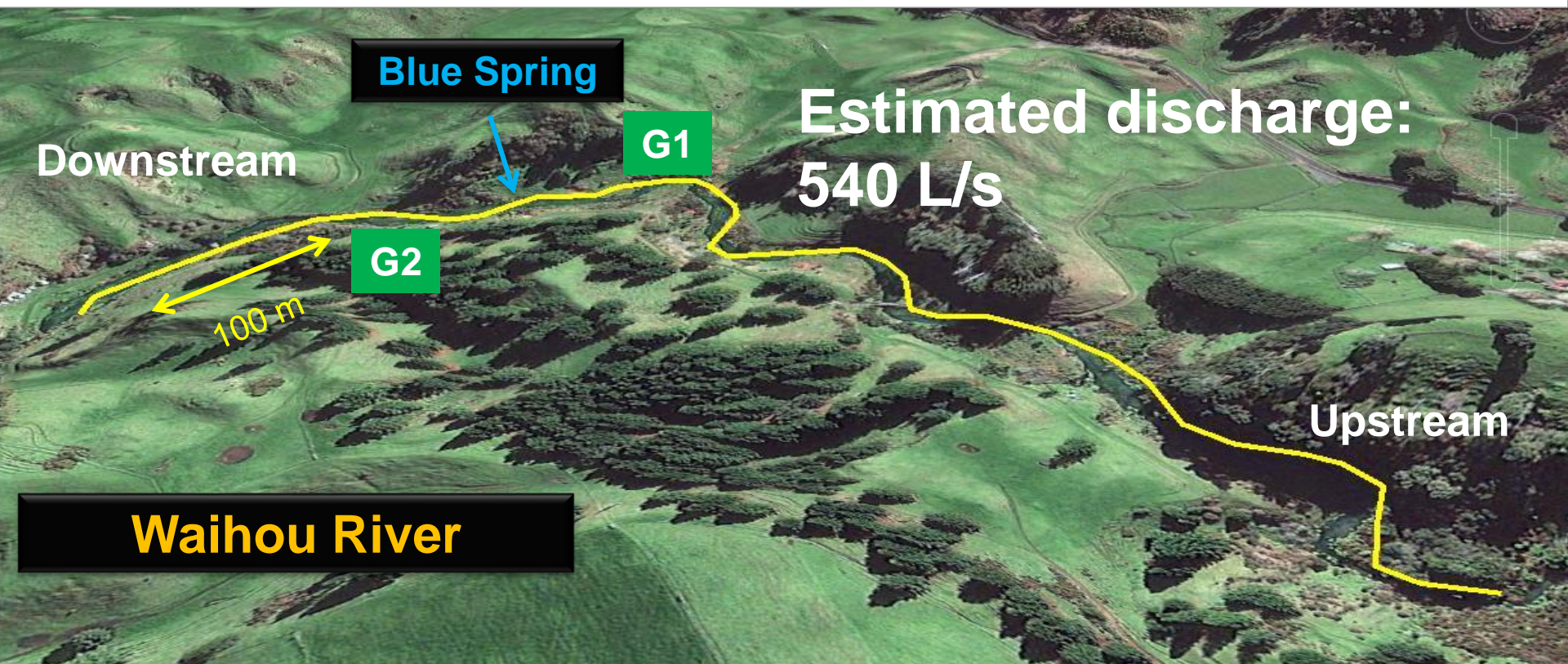
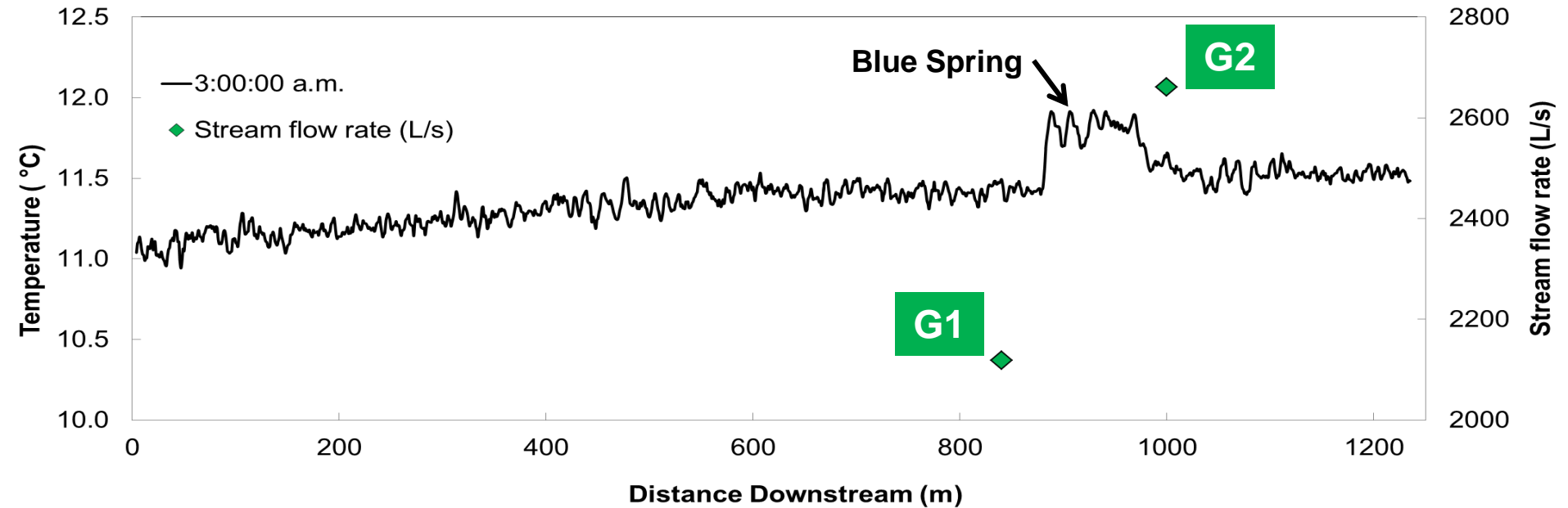


- Mercury was frequently not where it was supposed to be according to Newton's Law
- Alternative theories couldn't explain it
- It took Einstein's general relativity theory of gravitation being mediated by the curvature of spacetime



Rigorous testing

DTS survey in the Waihou River, NZ



Rigorous testing

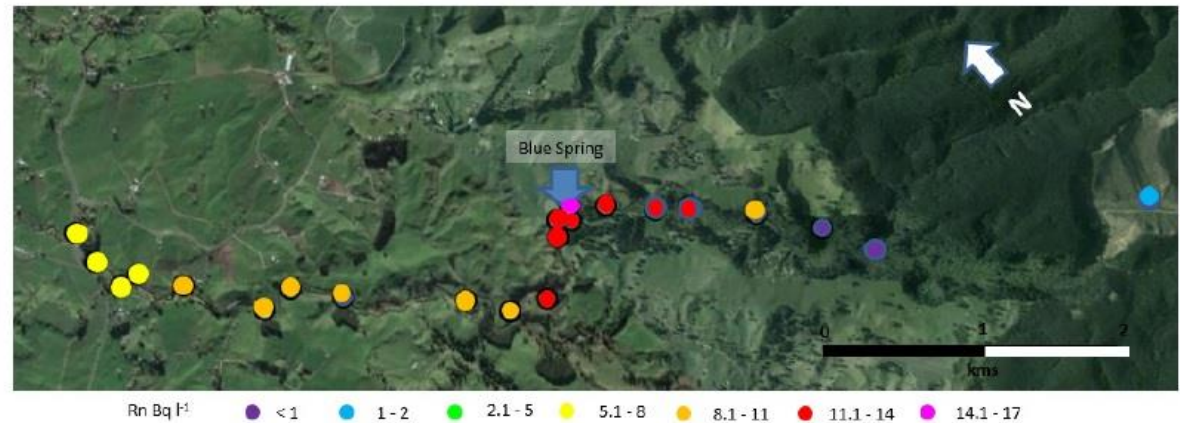


Figure 1 Radon concentration variation in the vicinity of Blue Spring (downstream to the left)

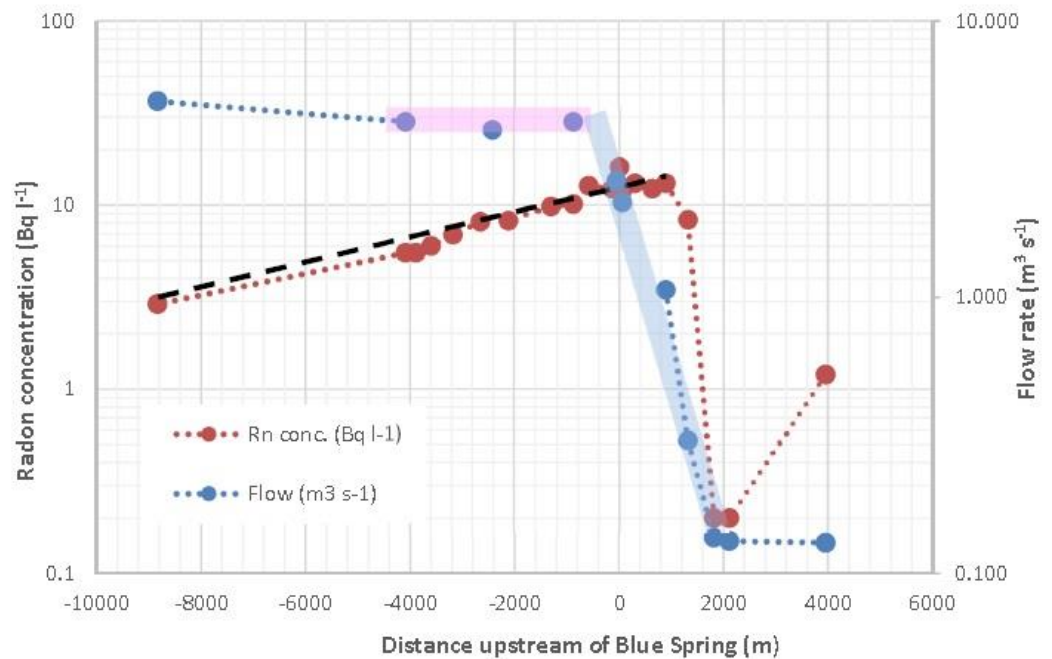


Figure 2 Radon concentration and flow variation in the vicinity of Blue Spring

The quality of water in the Waihou River at Whites Rd (4100 m downstream of the Blue Spring) has

Take home message ?

1. Why don't negative results get published?

- Positive results polish the paradigm**
- Negative results are not deemed worthwhile - except when they are anomalies that show there is something wrong with paradigm**

2. But how do you distinguish anomalies from negative results?

- hindsight and history**

3. But how is one to tell beforehand if a result is an anomaly and thus worth publishing or simply negative and to be ignored and go unreported?

- At one level, it takes genius to recognise it.**

Thank you