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27 September 2011

I enclose a hard copy of the addendum (with attachment) to my submission of 13 September 2011 "A scientific understanding of the Canterbury crustal earthquakes from 4 September 2010 to their closure on 21 June 2011".

Regards,

James Quinwallace

ADDENDUM

TO

A SCIENTIFIC UNDERSTANDING OF THE CANTERBURY CRUSTAL EARTHQUAKES FROM 4 SEPTEMBER 2010 TO THEIR CLOSURE ON 21 JUNE 2011.

Submitted by James Quinwallace 13 September 2011

This addendum submitted 27 September 2011

ADDENDUM TO

A SCIENTIFIC UNDERSTANDING OF THE CANTERBURY CRUSTAL EARTHQUAKES FROM 4 SEPTEMBER 2010 TO THEIR CLOSURE ON 21 JUNE 2011.

HYSTERESIS LOOP IN PORT HILLS SEISMIC SHOCKWAVE

Rock does not break when compressed, only when stretched. Elastic hysteresis occurs when the elastic response of the rock to the compression of applied stress is greater than the compression: then the rock stretches and breaks.

> **Hysteresis** refers to systems that may exhibit path dependence, or "rate-independent memory". There is no way to predict the system's output without looking at **the history of the input** (to determine the path that the input followed before it reached its current value) or inspecting the internal state of the system. *Wikipedia*

The *path dependence* of input and output must derive an absolute unit measure of distance, while a *rate independent memory* needs to reveal the physical nature of 'time'.

The internal spaces of matter, from the nucleus of the atom to the galaxy, are thermodynamic equilibrium spaces: they do not expand. Only the outer space between galaxies expands. Expansion of the universe increases disorder. Increasing disorder is the physical nature of 'time'.

Einstein realised that, whatever the nature of 'time', its reversibility within the internal spaces of matter meant each of these spaces is bounded by an isotropic inversion plane. He constructed his general theory of relativity around this postulate of the world's $1 = -1$ absolute unit measure, working out just what we would see around us in the heavens if his postulate was correct. Einstein's mathematical framework correctly predicts the orbit of Mercury that Newton's unit measure, egocentric like ours, breaks down on.

Mass is bound energy, and when energy is bound it is unavailable to do the world's work. We call that "entropy", which is just a measure of disorder. Energy is 'free' when it has the potential to do work, for then the energy carries order. In an equilibrium space, time is reversible: if mass increases, then time must slow. So time is measured in the displacement of mass. When matter is accelerated its mass increases: this increase is reversible, so its proper time slows (dilates) in proportion to the temporary increase in mass.

RATE INDEPENDENT MEMORY

The Earth's crust measures its breaking strain thermodynamically. It is not the quantity of shear stresses that ruptures the ground, but the speed with which this stress is applied. There is a standard rate of strain, common to all earthquakes, at which the ground will break and this rate is self-referencing.

Elasticity varies widely in different types of ground. In equilibrium, if physical time slows when disorder increases, then ground that is twice as stiff and takes up twice the shear stresses will tick off its seconds half as fast, so its rate of strain will equal that of its less accommodating neighbour and they will break together at the standard rate; that is, the standard rate as told by the kitchen clock.

There is only a standard rate of breaking strain because time is a function of the elastic response that reverses the disorder of deformation. When the ground is stressed to the standard breaking strain it measures the limit of **reversible** time and hence of thermodynamic equilibrium. The opening of the fault reduces the work value in the energy and so expresses the disorder that is **not reversible.**

The kitchen clock merely confirms the clock in the ground that is measuring the inversion plane of the Earth's crust: the Earth is a sub-system of the solar system, and the kitchen clock is set by the planet's daily rotation in the solar year's wider equilibrium space.

PATH DEPENDENCE IN THE PORT HILLS

The Port Hills above Christchurch run east-to-west and are now the top of the extinct Lyttelton shield volcano that, along with the Akaroa volcano now form Banks Peninsula.

The two volcanoes were laid down in spreading sheets of fluid lava flows, each often no more than a metre deep, that hardened into strata of fine-grained dense basalt with the capacity to maximally absorb the stresses of the shock fronts carried east in the thousands of aftershocks from the Greendale fault that opened in the 7·1 magnitude quake of 4 September 2010

Irreversible disorder is discontinuous: a fault opens as a series of discrete ruptures of the rock, each a yield surface that propagates as a shock front. The so-called "catches" of the walls that subsequently slip to cause aftershocks, are simply an expression of this essential discontinuity in the opening of a fault. In the Greendale, there were more than 6,000 such aftershocks: a bit much to be 'explained' as "catches".

In the laboratory, the yield surface is a mirror plane of symmetry between the compression of the rock under stress and the elastic response that measures the rock's tensile strength. When he makes his instrumental measure of this response, the structural engineer provides the continuity that overcomes the −1 of the 180° reversal inherent in every act of measurement. For this reason, his yield surface can only be a theoretical construct.

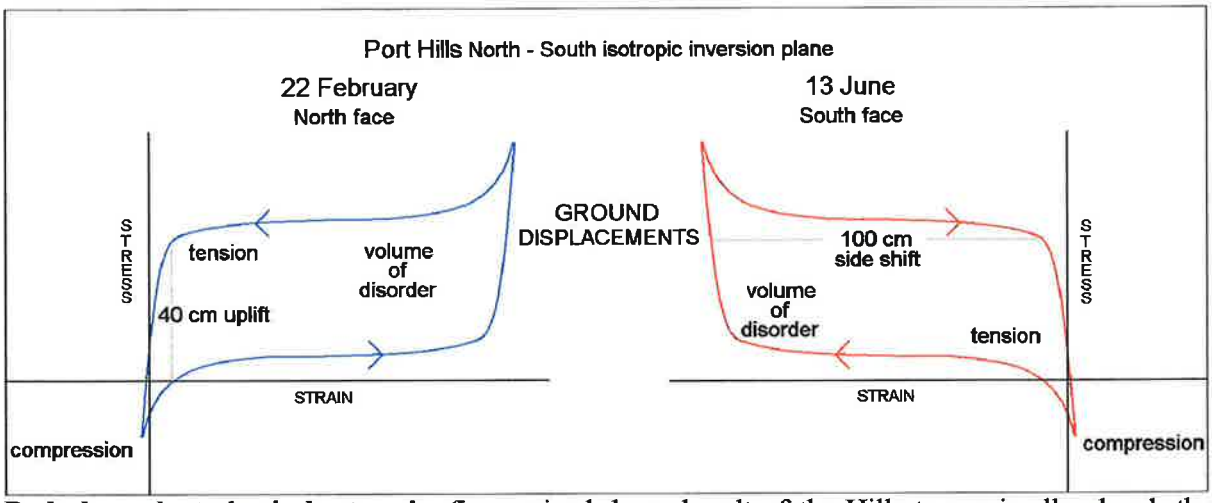
But in the wild, this yield surface is a surface of non-reversible increase in disorder. And disorder cannot spontaneously reduce, so the instrument that measures it must be perfect, a 1= −1 absolute.

Basalt always contains magnetic elements. Adjacent strata have opposite magnetic polarity: just like the pole reversals north and south in the alternate stripes of crust laid down by seafloor spread. Banks Peninsula is an upright example of the seafloor crust's isotropic inversion plane that bounds the stability of the Earth's internal space.

Each Greendale aftershock absorbed in the Port Hills was directed, hence a polarised surface, like all body waves through the ground. The North–South interface between adjacent strata turned these Greendale shock fronts of shear stress onto the horizontal plane, so allowing the polarity of the stratum surface to align their disparate moments of area.

The increasing compression, deformation, and elastic response, as each shock front was absorbed and its moment of area given the common alignment; tested the tensile yield strength of the basalt of the Hills. In so normalising all of the aftershock shear flow planes into the largest principal stress, the uniaxial tensile yield strength was exceeded.

Uniaxial, because the absolute geometry of the North–South interface in adjacent strata preserves the polarity of the principal stress when the relaxation of the rock measures the limit of reversible disorder. This allowed the disorder that was not reversible to create the yield surface – at 12.51 p.m. on the 22 February 2011.



Path-dependent elastic hysteresis: fine-grained dense basalt of the Hills to maximally absorb the disordered energy from the Greendale aftershocks. The stress loading is expressed in ground displacement: 40cm uplift of 22 February and 100cm side shift of 13 June that relieves the strain on the Port Hills. Note that the *direction of path dependence* in the 22 Feb quake is reversed in the 13 June event.

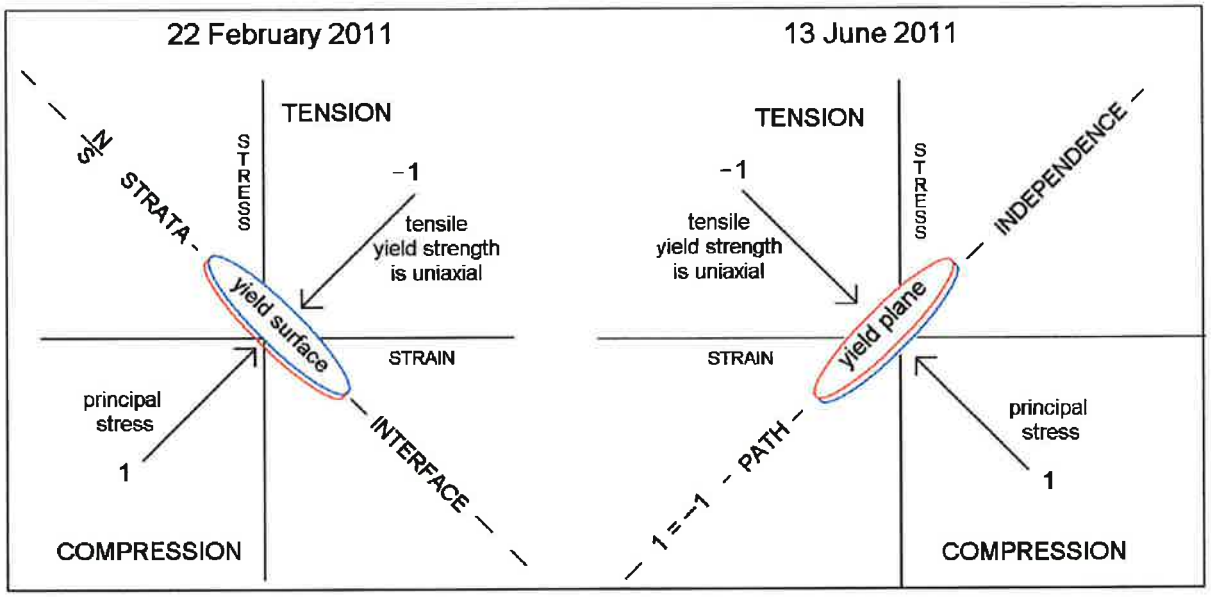
The displacement of these complementary volumes of disorder in 6·338 mag. and 6·434 mag. earthquakes was the path direction and reversal of an absolute 1 = −1 path independence that maintains the isotropic inversion plane of the Earth's crust, and hence the stability of the planet. As the Earth ages, its increase in non-reversible disorder is laid down in a growing volume of continental crust.

Exceeding the yield strength opened the North-South interface and lifted the Port Hills 40cm, with the work value of this lifting being the volume of non-reversible disorder sent out in the accelerated shockwave toward Christchurch.

When the shockwave was abruptly stopped by the high water-content of the ground there, this volume of disorder brought about its plastic deformation: the ground liquefied. The collapse of the CBD was a direct measure of the yield surface in the strata interface of the Port Hills.

But this was only one direction of path dependence. The reverse direction awaited the closure of the Greendale 'tips' still buried under Rolleston.

The reversibility in this closed hysteresis loop was demonstrated when the absorption of the Love wave on 6 June triggered the June 13 release of the opposite polarity's yield surface; that is, the integral moment of area of shock fronts accumulated since 22 February's quake and normalised by the North-South isotropic inversion plane in the Port Hills adjacent strata.



Measurement of absolute 1 = −1 yield plane by the interface in N–S strata of the Port Hills.

The yield surface of the 22 February became a yield plane on 13 June. The self-measure of path dependence gives the path **independence** that is the 1= −1 absolute measure of unit length. This restores the equilibrium to the Port Hills by the absolute removal of the stress field. And the equilibrium space allows the rate independent memory to once more set the standard rate of breaking strain within which 'time' is reversible.

> Monday afternoon's biggest earthquake came close to outstripping the magnitude of the deadly February 22 quake. GNS Science seismologists yesterday reclassified the 2.20pm aftershock as magnitude 6·338, just 0·005 of a magnitude smaller than February's 6·343 quake. Their new analysis found it was significantly shallower than first thought – at a depth of 6·1 kilometres. The February quake was about 5·9km deep. GNS Science seismologist Bill Fry said "The revised magnitudes **incorporate data from about 250 seismographs throughout New Zealand."**
>
> Paul Gorman *The Press, Christchurch 15 June 2011*

CONCLUSION

The standard breaking rate of strain is the limit of reversible disorder where the rock's elastic response can no longer recover its form: the tensile yield strength is exceeded. The fault opens as the integral of the moments of area of the discrete shock fronts, i.e. a yield surface.

Breaking the ground requires work. When the work value remaining in the energy of stress loading is no longer enough to break open the ground, the inverse yield surface forms as the 'tips' of this pent-up strain. The Greendale tips lie under Rolleston.

This inverse yield surface was turned to the horizontal on June 6 and carried to the Port Hills as a Love wave, a single surface relating stress and strain that triggered the 13 June quake and 100cm lateral displacement of the ground in the Port Hills.

This disorder in the Greendale 'tips' stopped the clock there on the morning of September 4 2010. Until this disorder was released and expressed in the displacement of the ground in

the Port Hills, the Christchurch CBD was in real danger of a 22 February 2011 event. The 4% risk assessment of such an event issued by GNS science was inappropriate.

I have quoted above from the Press report of 15 June 2011. (A highlighted copy of this report is included in the hard copy of this submission).These passages should be compared to the passage below from pages v and vi of the Executive Summary of the GNS technical report commissioned for this judicial inquiry.

> The most destructive earthquake of the Canterbury sequence occurred at 12.51 NZST on 22 February 2011, five and a half months after the Darfield main shock. This magnitude 6·2 aftershock (termed the Christchurch earthquake) occurred toward the eastern end of the aftershock zone and with an epicentre just 6km southeast of the Christchurch city centre.
> On 13 June 2011 a magnitude 6·0 earthquake occurred near the suburb of Sumner.

GNS here change the 6·343 magnitude of 22 February to 6·2 and the 6·338 magnitude of 13 June to 6·0. Bearing in mind that 6·2 is exactly double the energy of 6·0 one has to question why the original data "from about 250 seismographs throughout New Zealand" has been so arbitrarily overturned: especially given that the two quakes were at the same depth and same location.

When technical description fails to mature into scientific understanding, it soon degenerates into priest-craft where authority replaces reason. A Royal Commission of Inquiry deserves to be better served than this.

I trust this addendum to my original submission of 13 September 2011 will be of some such service.

James Quinwallace.

stuff.co.nz

NATIONAL

Monday's earthquakes 'lift risk to 30pc'

PAUL GORMAN Last updated 11:53 15/06/2011

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Geovert engineering firm engineers at the top of a cliff overlooking Shag Rock at Sumner.

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LATEST: Christchurch mayor Bob Parker says there are no reports of damage from this morning's 5.0 tremor which rattled the quake-hit city.

The tremor, which struck at around 6.27am, was centred 20km southeast of the city at a depth of 6km.

It was followed by a 4.2 magnitude shake at 6.32am.

At a media briefing outside the Christchurch Art Gallery this morning, Parker said Christchurch quakes remained a "live event" and residents should be prepared in case of any future emergency.

People should have supplies of food and water ready, though he hoped they would not be needed again.

Police earlier said there were no reports of damage.

GNS duty scientist Gill Jolly said the 5.0 aftershock was likely from the same fault line that produced Monday's big shakes.

"On it or very very close to it - there's been a number of aftershocks in that same area."

The 6.3 and 5.7 quakes would have generated their own series of aftershocks, Jolly said.

"Every time there is a bigger quake it resets the clock," she said.

Those would now follow the general pattern of decreasing in rate and frequency over the coming days and months.

Three other aftershocks rocked the city since midnight.

CHANCE OF NEW BIG QUAKE RISES

Monday's quakes have increased the probability of another earthquake of similar size or stronger hitting Canterbury in the next year.

New calculations by GNS Science yesterday show that from today until June 15 next year there is now a 30 per cent chance of a quake of between magnitude 6.0 and 6.9 striking the Canterbury aftershock zone.

That compares with a nearly one-in-four, or 23 per cent, probability expressed last month.

The calculations show if that quake does not occur in the next month, the chance of it happening will drop back to about the 23 per cent level.

GNS Science hazards modeller Matt Gerstenberger called it a "slightly increased" risk.

"Before, we were talking about a one-in-four chance. It's now three in 10. It's an increase but it isn't a large increase," he said.

"If we do the same [yearly] calculations for a month from now, assuming there haven't been any aftershocks of over 6.0 between now and then, it's back to where it was before."

Scientists analysing Monday's quakes – yesterday upgraded to magnitude 5.6 and 6.3 – now believe they occurred on another fault 2km to 3km south of the Port Hills Fault, which generated the February 22 shake.

Seismologist Bill Fry said there had been six aftershocks of magnitude 4.0 or greater on or near this fault since February.

Like most of the quakes since September 4, they had been high in energy. However, most of the energy released on Monday was horizontal, compared with vertical on February 22.

"This contributed to the anomalously high shaking intensity of the earthquakes, as the amount of shaking is proportional to the energy released," Fry said.

"The spatial size of the underground rupture area for the magnitude-6.3 quake was relatively small for the amount of energy released. This implies that the fault was very strong."

Visiting United States seismologist Kevin Furlong said Monday's major aftershocks had probably reduced the stress buildup around the eastern end of the Port Hills from the February 22 quake.

It was likely stress had now transferred further east and offshore, he said.

"So there will be aftershocks from this and they will likely mostly be on or near the fault that ruptured [on Monday], and also possibly further to the east, and also some to the north-northeast, as was the case after February."

He said the first quake had been a trigger for the second, with both showing almost identical movements.

"Although their locations relative to the February event are slightly different – more to the east – I think they reflect the same tectonics," he said.

"Whether we want to say they are the same fault or simply adjacent faults is really semantics to me. They are fault segments that are interacting with each other."

After such an incredible sequence of quakes, the problem now was knowing what "normal" was.

Earthquake scientists had "cut their teeth" on the behaviour of quakes from plate boundary faults such as the San Andreas in California and New Zealand's Alpine Fault but knew far less about small crustal quake sequences like this one.

"We know the plate boundary faults' history and behaviour that, say, every 300 years they do this or that. But with this type of event, we don't know what is normal for the Canterbury region," Furlong said.

"We assumed what we had up to September 4 was normal, but it appears it wasn't normal. We don't know what is the background condition that the Earth is now moving towards.

"Each earthquake sequence is unusual, this one both because of its character and observation.

"It's as well-recorded as any of this size has ever been. We are seeing things about it – things that we don't see in any other place.

"It's aspects of this that makes this [sequence] very important to science and why it's hard to be definite about how it's going to behave."

Geotech Consulting engineering geologist Mark Yetton said he had not seen any obvious surface rupture on the Port Hills from Monday's quakes.

QUAKES UPGRADE

Monday afternoon's biggest earthquake came close to outstripping the magnitude of the deadly February 22 quake.

GNS Science seismologists yesterday reclassified the 2.20pm aftershock as magnitude 6.338, just 0.005 of a magnitude smaller than February's 6.343 quake.

Their new analysis found it was significantly shallower than first thought – at a depth of 6.1 kilometres, not the originally reported 9km.

The February quake was about 5.9km deep.

The earlier shake on Monday was upgraded from 5.5 to 5.646 in magnitude and occurred at 1.01pm, about a second later than initially recorded. It was 9.2km deep rather than 11km.

GNS Science seismologist Bill Fry said the upgraded magnitudes reflected further analysis of local, regional and more distant New Zealand data. "It's quite a quick determination, but it includes a lot more data than we had for the solution yesterday," he said.

"The initial estimates of size and location were based on data received within minutes of Monday's earthquakes occurring. The revised magnitudes incorporate data from about 250 seismographs throughout New Zealand."

- The Press