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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

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

Submitted by James Quinwallace, scientist, in regard to subsection

(a) (iv) the nature of the land associated with the buildings inquired into under this paragraph and how it was affected by the Canterbury earthquakes.

in the Royal Commission's terms of reference.

I present my analysis of shallow crustal earthquakes as it purports to the physical connection between the Greendale and Port Hills faults whose opening was generated by the respective shock fronts that hit the Christchurch CBD on 4 September 2010 and 22 February 2011.

I understand the Commission is charged with discovering why the 4 specified buildings failed, why they failed with such loss of life; and why only certain buildings in the CBD so failed. While technical reports can describe these events, only their physical explanation will allow an informed opinion as to their cause.

The following excerpts are taken from my small book, *Love from Rolleston,* a free download pdf file from my website **www.justiceforgoodnz.org**

(i) how the Greendale fault was opened on 4 September 2010.

(ii) how the aftershocks of the opening were absorbed by the Port Hills

(iii) how this disordered energy was further accelerated and relayed into Christchurch and why it caused such excessive damage to the CBD

(iv) how we can be sure that both the Greendale and Port Hills faults are now physically closed and the Canterbury ground made safe.

(i) Greendale 4 Sept 2010. Shear stresses, transversely applied, compress the rock: its elastic response restores its form, so propagating a compression wave through the rock. There is a standard rate of breaking strain common to all earthquakes. When the shear stresses are applied fast enough the strain ruptures the rock. The opening in the rock relieves the strain at that point, so the rate of strain falls below breaking strain. If the compression is not now accelerated, the rock, rather than rupturing, will recover its form and the deformation will again be transmitted onwards as a compression wave. It doesn't happen because there is now an interface, a shear flow plane with rock ahead and air behind. Sound travels fifteen times faster in granite than in air, and even faster in basalt.

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. Disorder is the physical nature of time.

Time is thus a function of the elastic response that reverses the disorder of deformation. If absorbing disorder slows the passage of time, then releasing disorder speeds time up. The elastic response in air is 15 times slower than in granite which effectively dilates time across the rock-to-air interface: thereby accelerating the compression wave so its shear flow plane of disorder becomes a shock front that propagates the rupture of the ground to generate a fault. The disorder is now **irreversible.** The equilibrium space of the crust is broken and the ground is no longer stable.

As the shock front rips open the ground, so the flow plane is one of increasing disorder. The reduction in useful energy reduces the area of the shear flow plane, with not enough work left in it to break the ground all the way to the surface. Soon the rate of strain falls below the breaking point, leaving unreleased stresses buried in these 'tips'. The Greendale tips lie under Rolleston.

Aftershock energy accumulates in the tips as discrete shear flow planes. In structural engineering the shear flow plane is a mathematical construct, whereas in an earthquake it is a mirror plane of disorder. This mirror plane of symmetry cannot be spontaneously removed: it is conserved, just like the spent energy it carries.

(ii) Port Hills fault 8 September. On this date, just four days after the 7·1 earthquake generated by the opening Greendale fault, a 5·1 aftershock was recorded under the southern boundary of the Mary Duncan Park in the Port Hills of Banks Peninsula.

The aftershock (Geonet Ref. No.3368445) was at the same depth and exact location 43.58°S, 172.69°E as the fault that opened there months later in the 22 Feb quake. This location is the very limit of aftershock activity; that is, at a distance from Rolleston equal to the length of the Greendale open trace that generated it.

The Port Hills run east-to-west and are now the top of the extinct Lyttelton shield volcano that, along with the Akaroa volcano on the south side, formed an offshore island 50km from the mainland.

The two volcanoes were laid down in spreading sheets of fluid lava flows; each sheet often no more than a metre deep that hardened into strata of dense basalt with the capacity to maximally absorb the stresses of the disordered energy carried east in the shear flow planes of the aftershocks from the 7·1 magnitude quake.

Basalt always contains magnetic elements. Alternating 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 absolute inversion plane.

The world's internal spaces of matter are all bounded by such a $1 = -1$ absolute inversion plane: the absolute inversion through the plane gives an absolute reversal within each surface of the plane. Such an isotropic exchange of light between masses is the central postulate of Einstein's general theory of relativity that gives the only accurate description of gravity.

By contrast, we have no absolute unit measure. Hold your left hand before a mirror: it reflects as a right hand. There is a mirror plane of symmetry between the two hands, a 180 degree -1 discontinuity that limits all of our measurements of the world: it is the distinction between technology and science. Science studies the world's self-measurement.

The shear flow planes of disorder were directed from Greendale toward Banks Peninsula where the interface of opposite polarities in alternating strata gives an isotropic inversion plane at nearly every metre of depth. The tangential shears that rupture the ground were efficiently isolated and stored by the stiffness of the rock's elastic capacity. Absorbed from the thousands of aftershocks, from 4 September onwards, their accumulated disorder reached breaking strain on 22 February 2011.

The break opened the interface of the inversion plane, with the under stratum now serving as the footwall of a reverse fault whose oblique angle lifted the Port Hills by 40cm. to express the shear stresses and relieve the strain on the ground.

(iii) Christchurch 22 Feb 2011. The shear waves in an earthquake are like waves on a rope, the ground is displaced at right angles across the direction of propagation. Shear stresses compress the rock, side-to-side and also up-and-down. The elastic response from the rock generates the shear waves.

Seen head on, the opposing cycles of particle motion of these two polarised waves rotate through one another, generating in turn a compression wave along their axis of propagation, which is the axis of strain.

The opening of a fault depends on the continual stressing of the ground to breaking point. This measure is carried as the shock front of its shear flow plane. The flow plane relates stress and strain, and so carries the accumulating disorder of the breaking ground.

In an earthquake the compression wave leads the way. It is driven by the shock front of the shear waves. The time taken for the following shear waves to reach the seismic monitors gives the depth of disorder of the shock front for the hypocentre, the focal depth of the quake energy, to be ascertained by cross-referencing from the several seismic monitors.

A shear flow plane has two inverse faces, but only one depth. This point of maximum depth is the moment of area of the shear flow plane described about the axis of strain by the opposing cycles of polarised shear waves. It is the single point of continuity between the inverse surfaces of the flow plane.

But a single point can neither invert nor reverse through 180°: the moment of area can only rotate the shear flow plane through 90°. And this it does when the vertical flow plane of a Greendale aftershock is absorbed, rotated, and measured by the isotropic inversion plane that is the interface between the opposite North and South polarities of alternate strata in the Port Hills. These eastward directed vertical planes were now turned on the horizontal toward Christchurch.

The old volcanoes of Bank's Peninsula are basalt, a fine-grained dense basalt not easily compressed. The harder the rock is to compress, the more energy goes into its deformation and the more work is required to push it to breaking point. When it does finally break, the potential for disorder is expressed all the faster.

Each increase in the store of shear stress slows the passage of time. The shear stresses from the Greendale aftershocks accumulated in the Ports Hills, until their stored disorder reached the threshold rate of strain to break the ground. The irreversible disorder of the break realised the potential stored as dilated time.

The rupture of the basalt of the Hills released this pent up strain in an accelerated shockwave. Many experts attributed the widespread death and destruction of the 22 Feb quake to the unusually high rate of acceleration. But acceleration doesn't kill you: it's the sudden deceleration that does it.

A compression wave transmits well through water: it was the rapid rumble that people felt. But shear waves, like the ripples on a pond when you throw a stone into the water, are quickly damped out: rather than being transmitted through the water, the energy is absorbed.

The high water content in the ground under Christchurch absorbed this shear flow from the Port Hills to realise the potential disorder it carried. This was the jolt that followed the rumble. So abrupt was the deceleration of the shock front that it liquefied the soil and collapsed the buildings erected on it.

(iv) Rolleston 6 June 2011. For the pent up strain on the ground of the Greendale buried 'tips' to be relieved the vertical flow plane of its stresses must turn horizontal and lie in the surface layer. But the discontinuity in its inverse faces prevents such a release of the strain: a mirror plane of symmetry can only be displaced by continuity.

The continuity comes from an unlikely source: from the aftershocks generated by slippage back along the fault where the facing walls have caught on one another. The change from rock to air, when the fault was opening, is so abrupt as to be almost discontinuous. Even a minor difference in the rock can cause the shockwave to jump past and leave that point unbroken.

Such 'catches' prevent the full exploitation of the work value in the free energy. When they break under pressure they generate a pulse of disorder; and there were thousands of them in the aftermath of the first quake on 4 September.

They were directed eastwards along the open fault trace. With so many aftershocks constantly coming, this disordered energy significantly built up in the tips: and it loaded the inverse surface of the Greendale flow plane, the westward face; because this disordered energy was coming to it from the west.

The shear stress from the aftershocks accumulated for months: until Queen's birthday weekend, the morning of 6th June at 9:09am. It was the instant the two faces of the shear flow plane in the Greendale tips became equally loaded with disordered energy: equal and opposite, their opposition defined the −1 mirror plane of symmetry, the discontinuity in the two faces.

They also defined the point of maximum disorder, the single point of continuity between the two faces, which is the moment of area of the shear flow plane. Rotating the depth of disorder through 90° brings it to the top of the ground as a Love wave, a polarised, single-surface of shear stresses.

But this horizontal flow plane must bring along as its undercurrent the opposite polarisation of the vertical shears. These discrete flow planes are still (13 Sept 2011) being individually, hence harmlessly, dissipated as aftershocks.

The body wave through the ground distributes its disorder over three dimensions in two mirror planes of symmetry, both vertical and horizontal: the flow plane of the surface wave is just one plane of symmetry. In so limiting the spread of disorder to two dimensions, the degree of order increases.

The 5·5 magnitude of shear stress the Love wave carried to the Port Hills on June 6 was enough to "trigger" the 13th June 6·3 quake that completed the absolute removal of the stress field by displacing the ground in a longitudinal shift of one metre, with a mere 2cms uplift given by a small dip angle of thrust.

The 22 Feb quake measured 6·343 at a focal depth of about 5·9km: the 13 June quake was 6·338 at a depth of about 6·1km, which is a remarkable coincidence; but one that local geologists did not remark on.

The disorder of shear stresses carried to the Ports Hills from the Greendale fault in the inverse faces of the shear flow plane of disorder have now been fully expressed in the displacement of the ground on the Hills: the vertical lift and horizontal shift.

The inversion plane of the Hills' crust encloses these crossed planes of mirror symmetry: and this physical displacement of their discontinuity testifies to that absolute.

This $1 = -1$ absolute removal of the stress field was the necessary precondition to the absolute release of the strain, not only from Christchurch but from the entire surrounds.

On June 21 the strain released in the Greendale closure and absorbed by the Port Hills in the Love wave, was alternated with the strain in the tips of the Port Hills fault and jointly released from under Halswell in a rapid trilling roll of short wavelength.

This 5·4 magnitude release went out as a Rayleigh wave, a longitudinal wave of both polarisations, in an isotropic inversion across the top of the ground. It was a drum roll from the Hills on the skin of the Earth's crust. A drum roll seems an appropriate way to signal the settling of the ground and the return of stability.

And further, in regard to your terms of reference subsection

(b) (ii) whether, on or before 4 September 2010, those buildings had been identified as "earthquake-prone"

I submit that the structural integrity of a building cannot be divorced from that of the ground in which it is founded.

The Civil Defence Emergency Management report published by Christchurch City Council in November 2004 identified the high potential for liquefaction of the ground under the CBD in the event of an earthquake. In the Darfield quake of 4 September this potential was realised.

The GEER NZ Darfield report of 14 November 2010 noted:

> the most significant engineering aspects of the 2010 Darfield Earthquake were geotechnical in nature, with liquefaction and lateral spreading being the principal culprits for the inflicted damage.

While Tonkin & Taylor's stage 1 report of October 2010 commissioned by CERA warned:

> That some of these areas did not liquefy in the recent earthquake does not mean that they are not at risk under future earthquake events.

How likely was such a "future earthquake event"?

Local seismologists knew, of course, that the buried 'tips' of the Greendale fault harboured unreleased stresses, with frequent aftershocks adding to the pent-up strain on the ground.

Visiting U.S. seismologist, Kevin Furlong, acknowledges that earthquake scientists know far less about small crustal quake sequences than about the behaviour of quakes from plate boundary faults such as the San Andreas and New Zealand's Alpine Fault.

New Zealand sits on the boundary between the Pacific and Australian plates .At this plate boundary the subduction of continental crust is in dynamic equilibrium with the laying down of new crust in seafloor spread on the other side of the Pacific Ocean. Such crustal renewal maintains the absolute monocoque shell formed by the Earth's seven crustal plates.

But this stability derives from the isotropic inversion plane within each of these plates. Shallow crustal faults cannot harbour disordered energy in their 'tips' indefinitely. The strain on the crust must be relieved in timely fashion if the Earth is not to blow itself apart.

The self-measuring that removed the stress field by a 40cm vertical uplift of the Port Hills on 22 February had to happen: it is how the Earth evolves. Seafloor crust is only 10km thick, but continental crust is as much as 70km thick.

Unlike oceanic crust, which is in constant renewal, continental crust is permanent. It only accounted for 10 per cent of the total crust when the Earth first formed, but now 40 per cent of the Earth's surface is underlain by continental crust, and it makes up 70% of the total crust by volume.

The increasing depth of continental crust through mountain building is the measure of increase in irreversible disorder without which the reversibility in time of the Earth's equilibrium space would not be real.

For the Port Hills not to uplift 40cm on 22 February 2011 time would have to stand still and the Earth cease to evolve. That's how certain was the 22 Feb event. Yet Geonet put the risk of such an event at only 4%. Perhaps Geonet is unreal, rather than the Earth.

No-one can tell exactly when an earthquake will occur but, as of 4:35 a.m. on 4 September 2010, it was certainly possible to know that the ground under Christchurch was in a highly dangerous state. With the ground being thus confirmed as "earthquake prone", the buildings could not be otherwise.

The surface waves of 6 June from Rolleston and 21 June from Halswell were clear signals from the Greendale and Port Hills faults that the danger was over. They should have been anticipated by our academic geologists; and waited for by those with a statutory duty-of-care to the people of Christchurch.

Identifying human error as a contributing cause of 22 February's tragic loss of life does not entail the laying of blame. And if it educates all those concerned, it must surely prevent a repeat of the error.