



Planning for a future magnitude 8 Alpine Fault earthquake



Dr. Caroline Orchiston // UNIVERSITY OF OTAGO
Science Lead, AF8 // Deputy Director, Centre for Sustainability

RESILIENCE
TO NATURE'S
CHALLENGES

Kia manawaroa
– Ngā Ākina o
Te Ao Tūroa

National
Science
Challenges

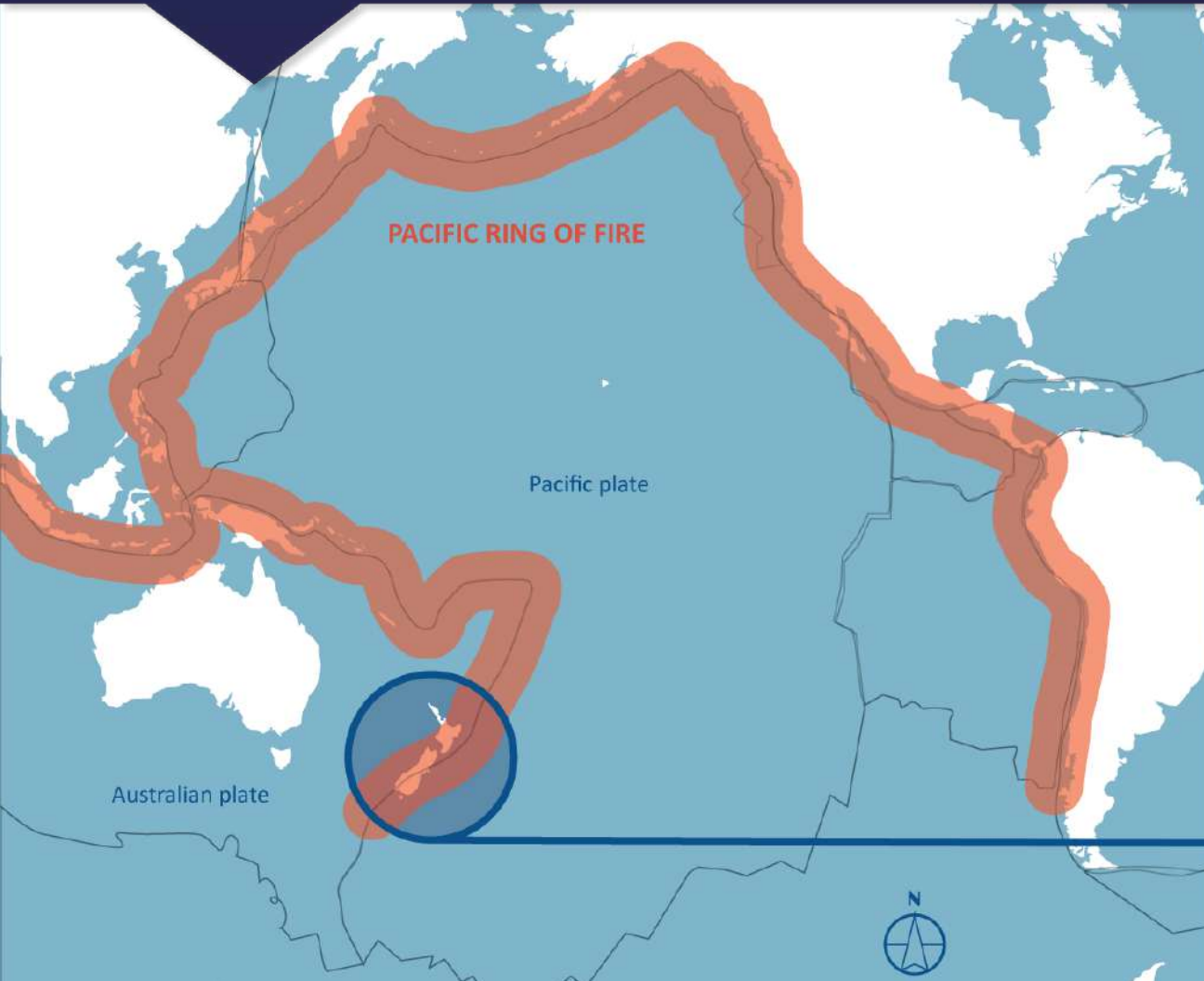


University Club, February 21st 2020

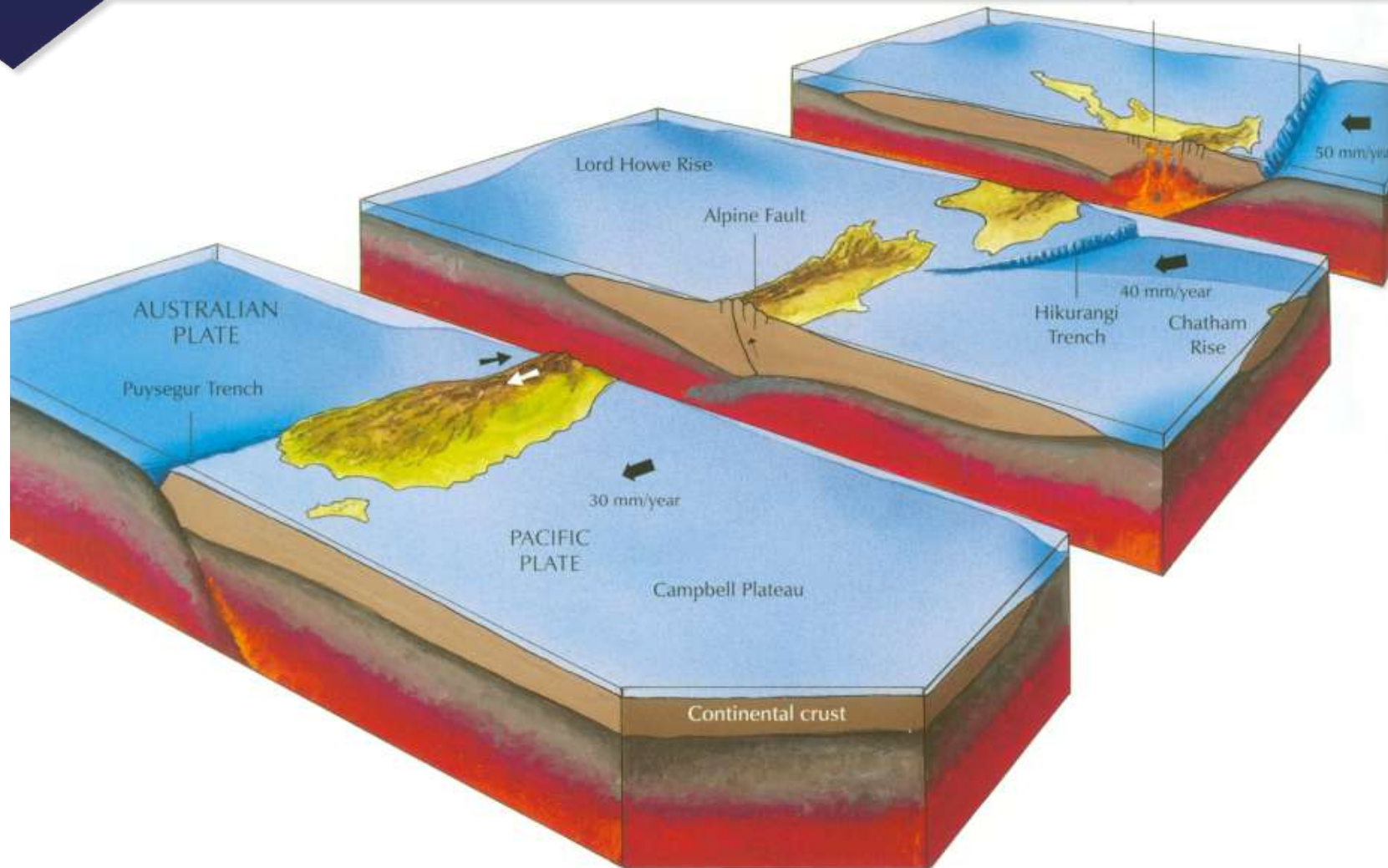
Why has NZ got high seismic risk?



Tectonic setting of NZ



Tectonic setting of NZ



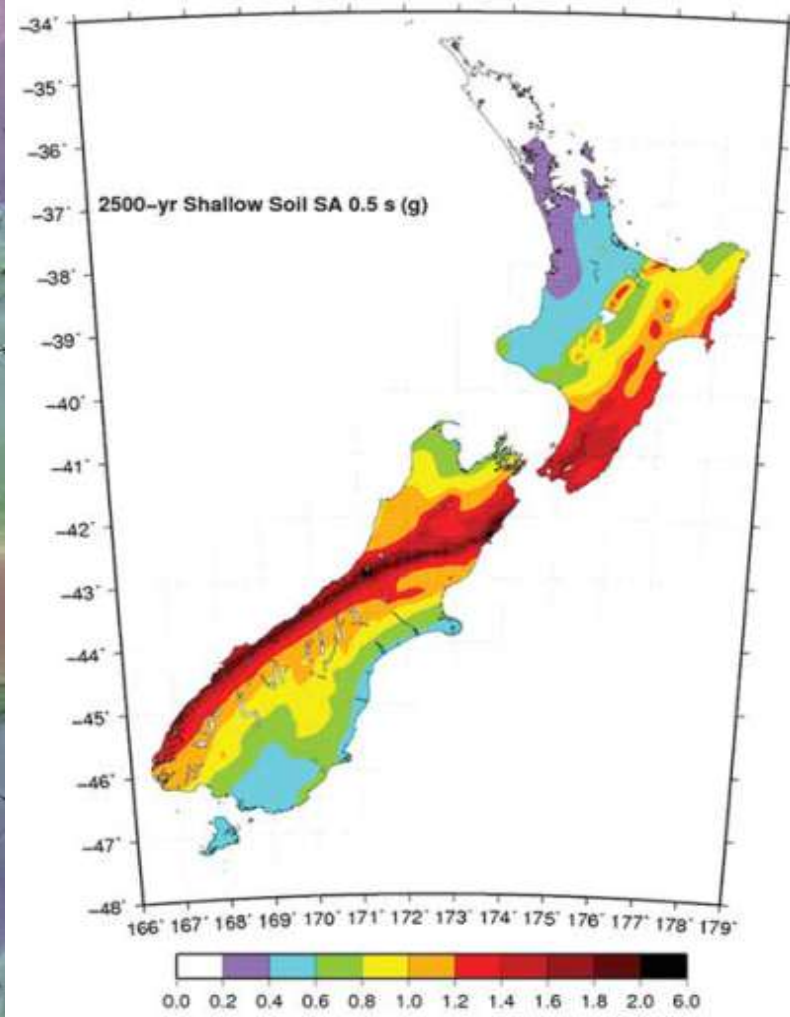
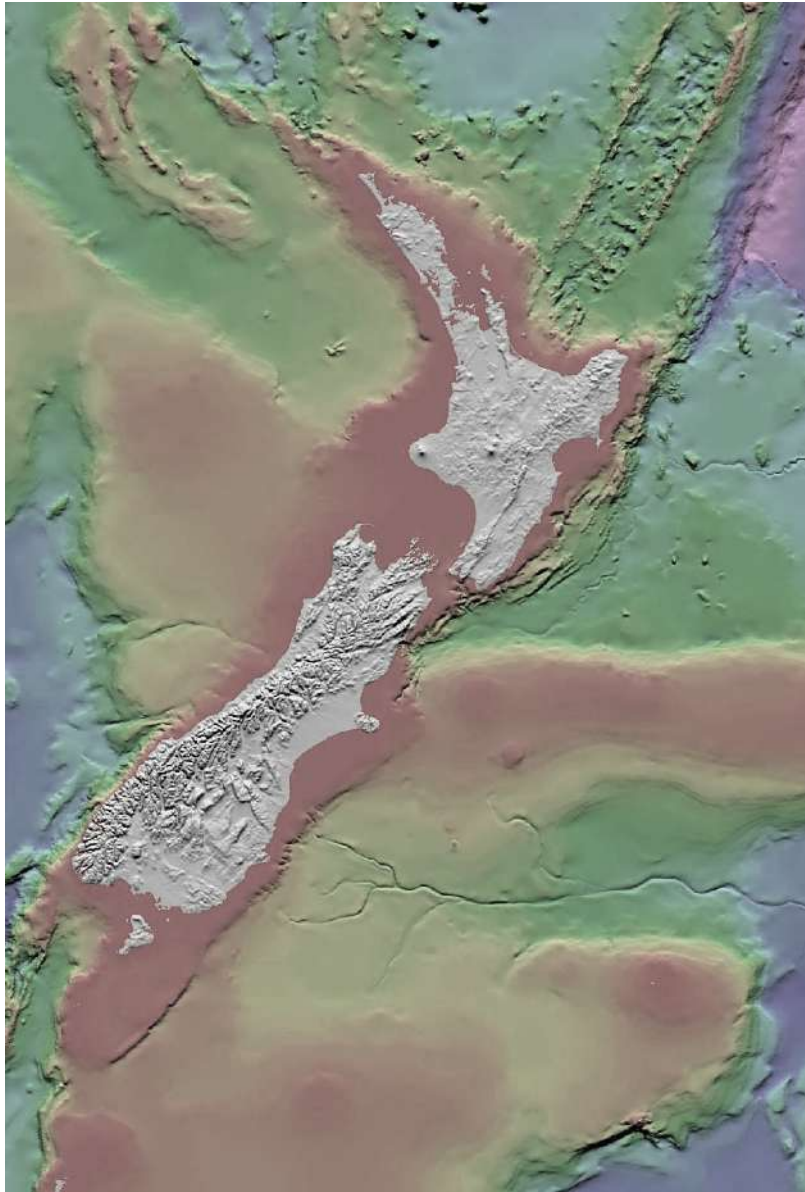
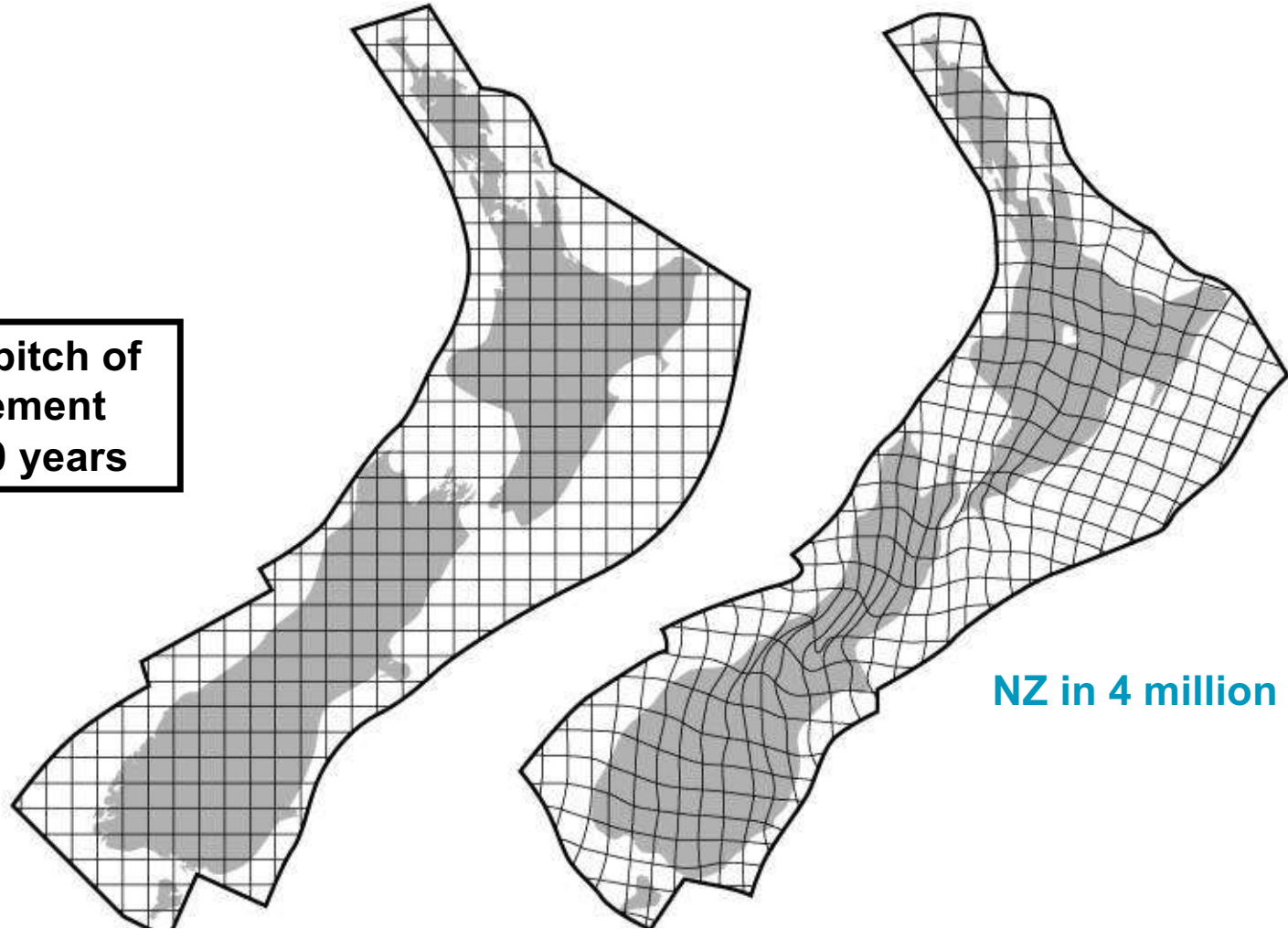


PLATE MOTION & DEFORMATION

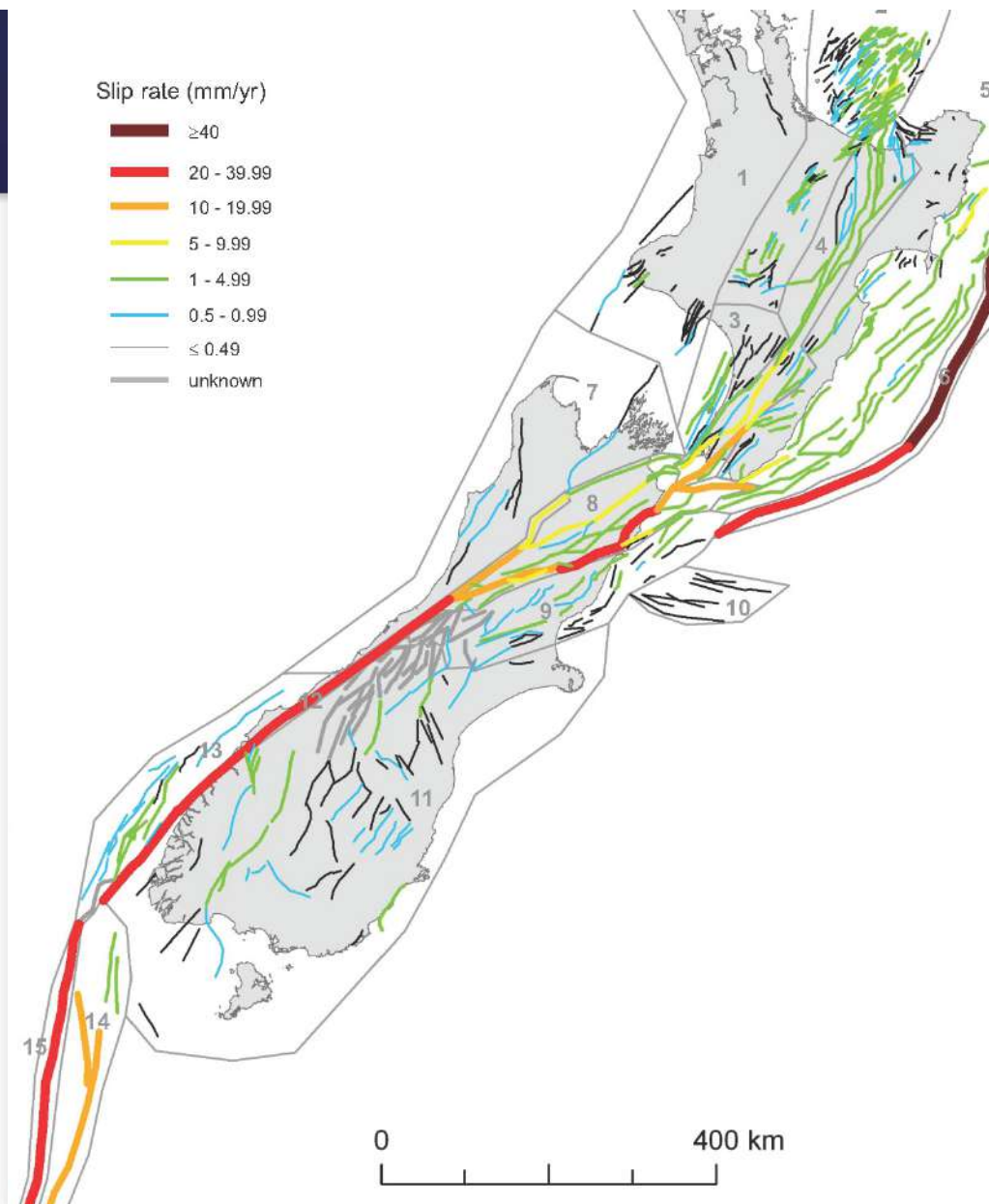


**A cricket pitch of
displacement
every 500 years**



NZ in 4 million years.

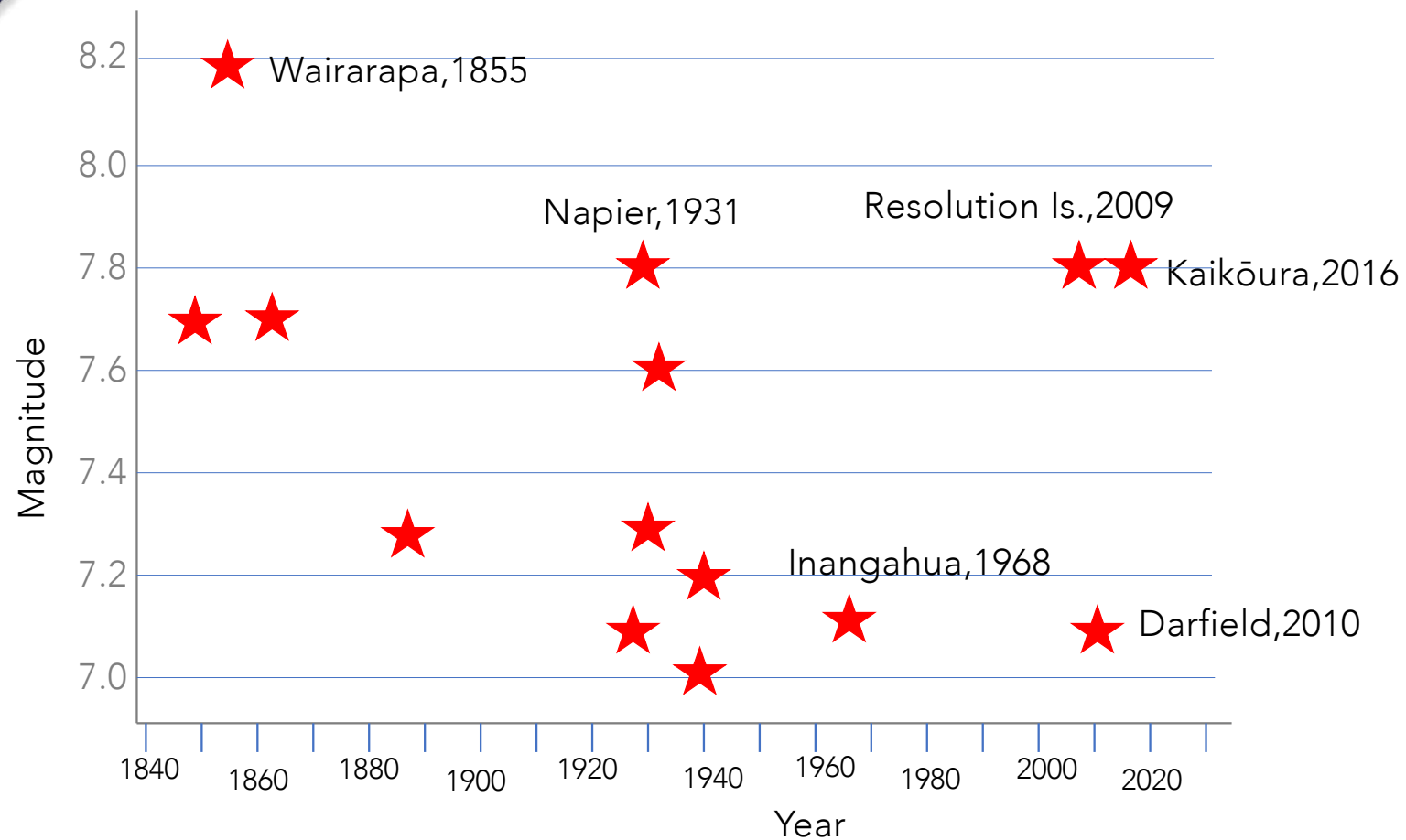
Active Faults

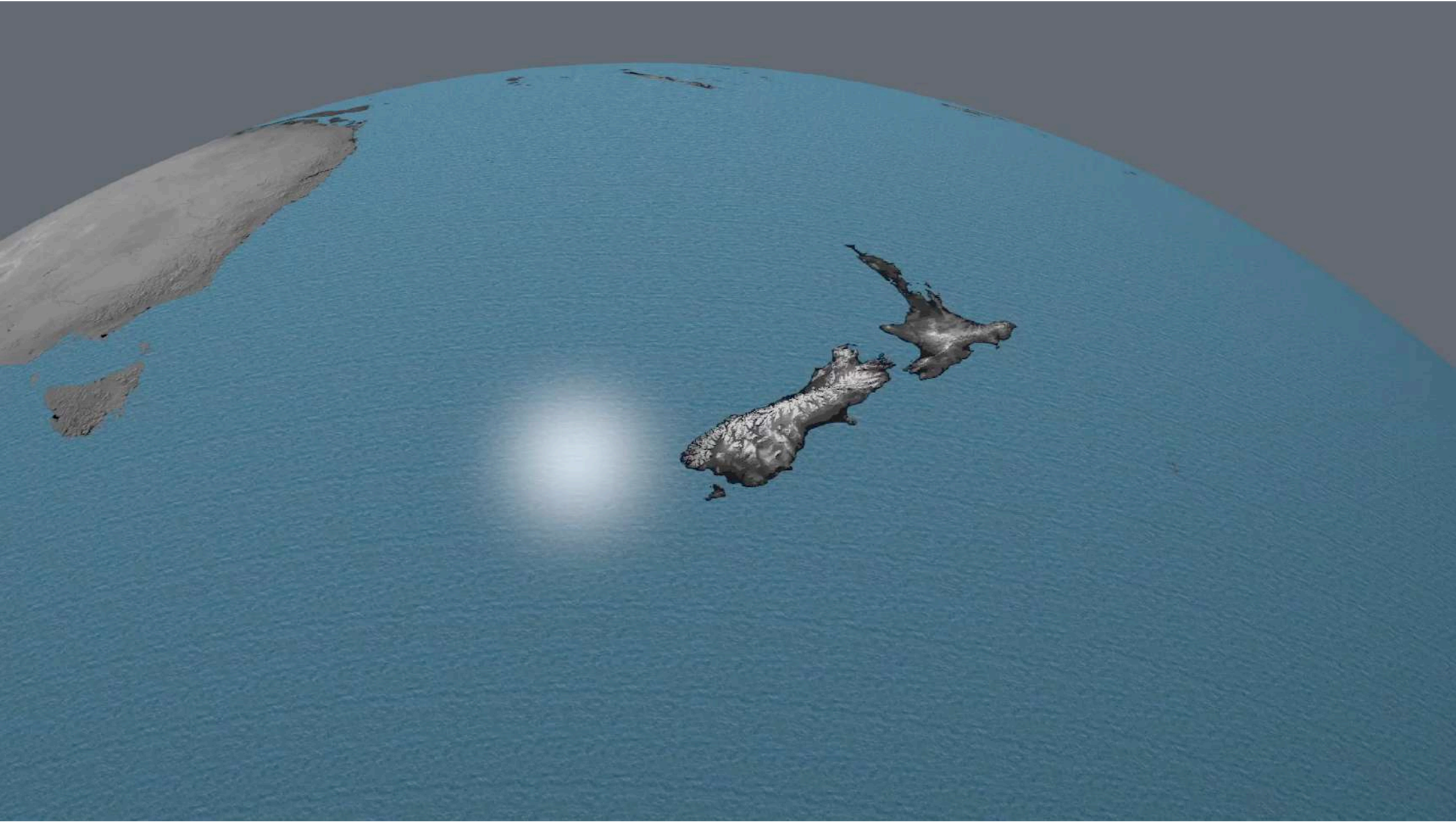


AF8
ALPINE FAULT MAGNITUDE 8

Slide courtesy of
Simon Cox, GNS Science

NZ earthquake history









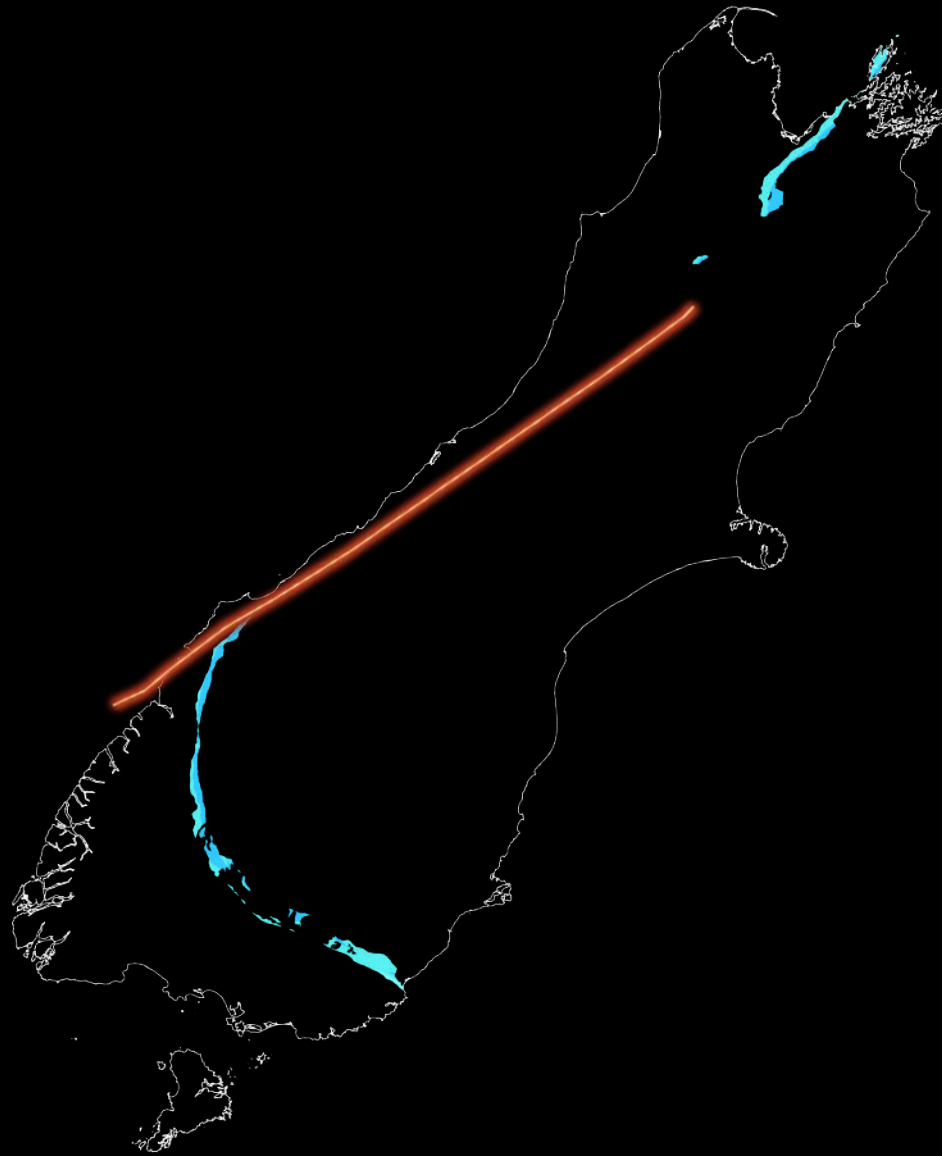


Harold Wellman



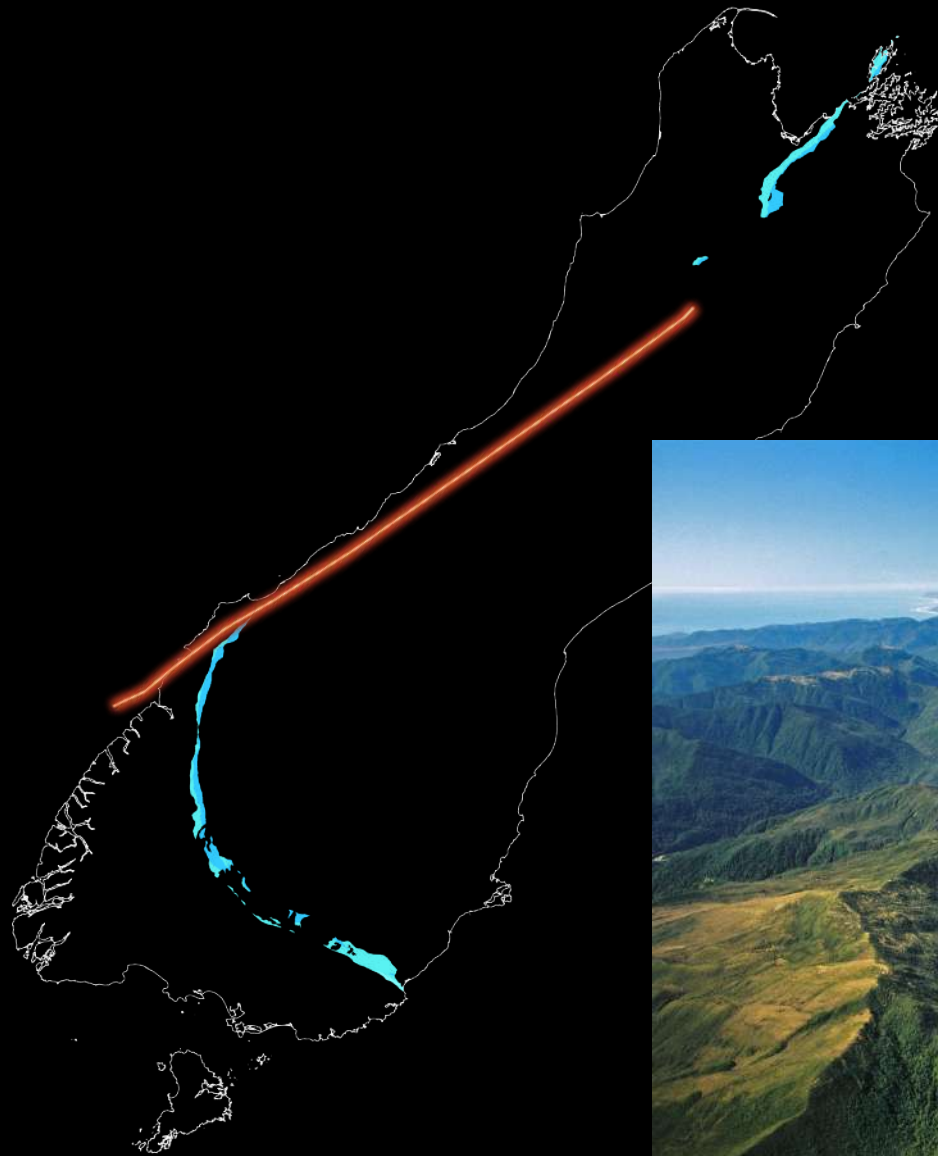


Harold Wellman

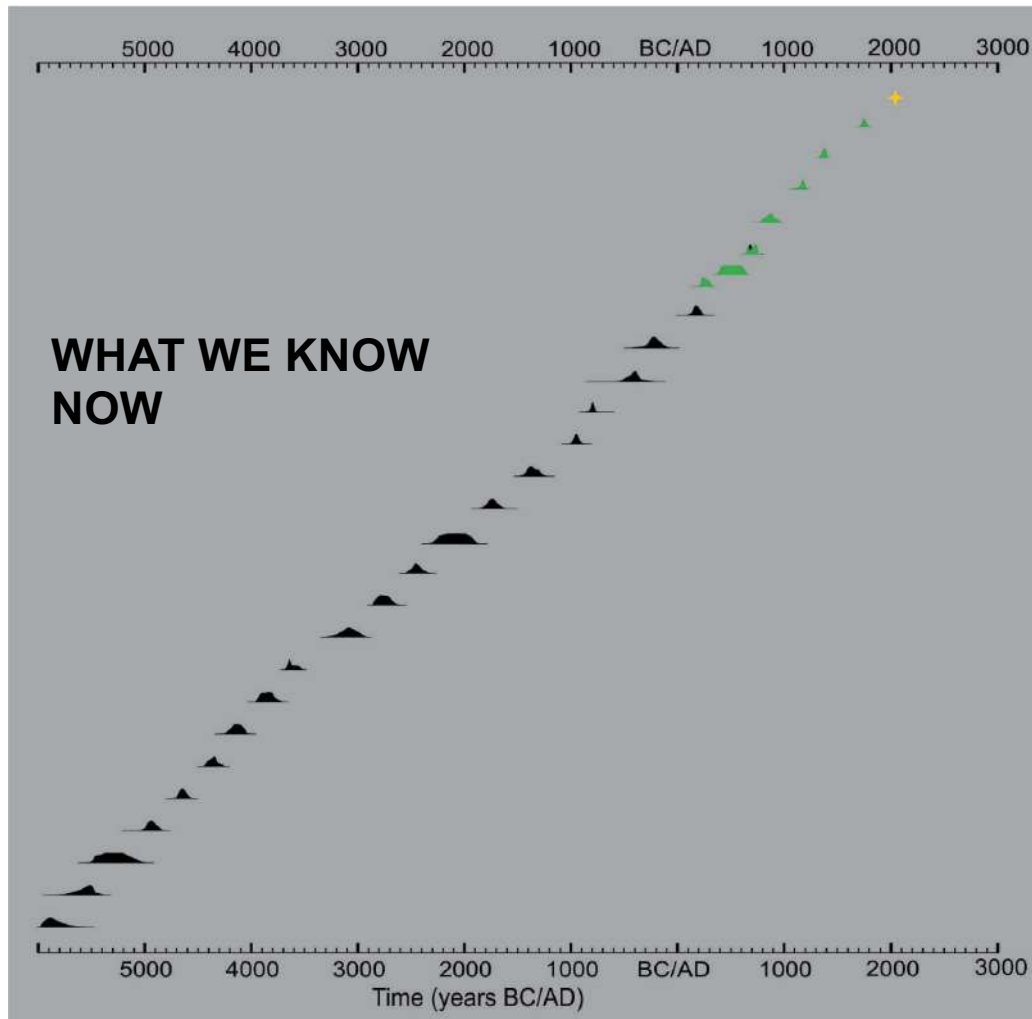




Harold Wellman



Past large Alpine Fault earthquakes



27 events over the
past 8,000 years

Long history of large
earthquakes

Remarkable regularity

Over 8,000 years on record
– no reason for that to stop
happening...

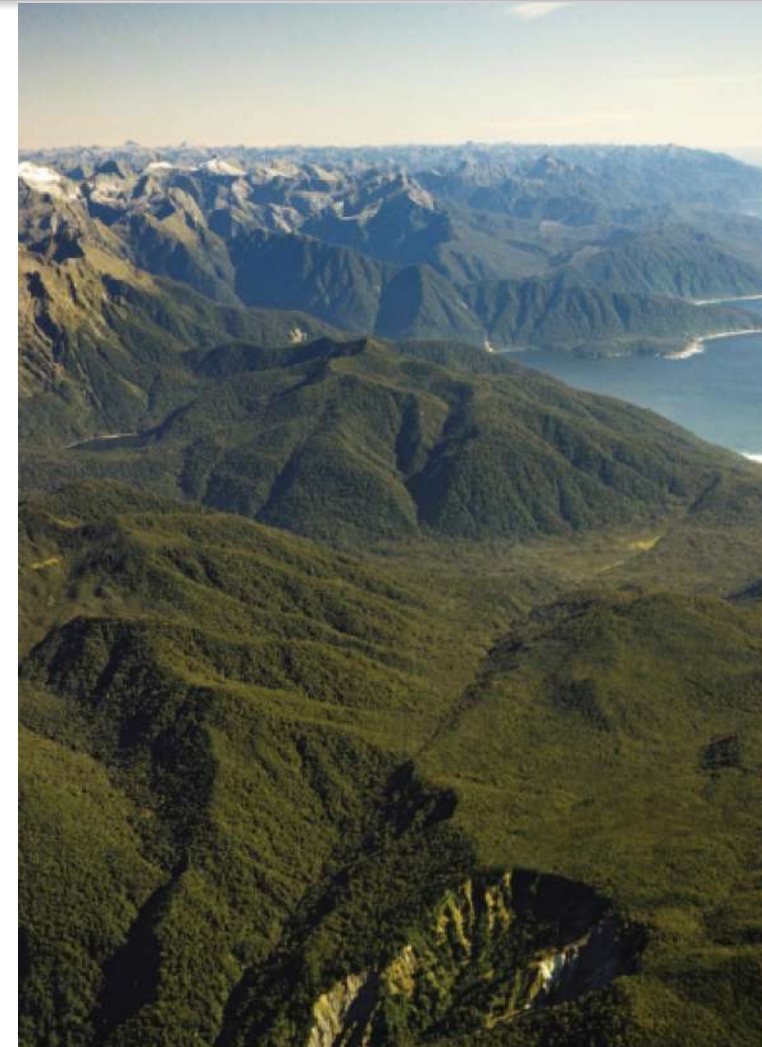
Next event is inevitable

Slide courtesy of Dr. Ursula Cochran, GNS Science

Alpine Fault behaviour



- Alpine Fault rupture approx. every 300 years
- Last rupture 1717 AD
- Estimated to produce M7.8-8.2 earthquakes
- Rupture length 400 km
- 8-10 m horizontal / 2-3 m vertical surface displacement
- Major coseismic + cascading consequences
- Significant human, environment, infrastructure + economic impact



Building our collective resilience



What is AF8?



- ▶ 2015-onward
- ▶ A programme of scientific modelling, response planning and community engagement.
- ▶ Scope of work - the South Island
- ▶ Building our collective resilience to future events



What is AF8?



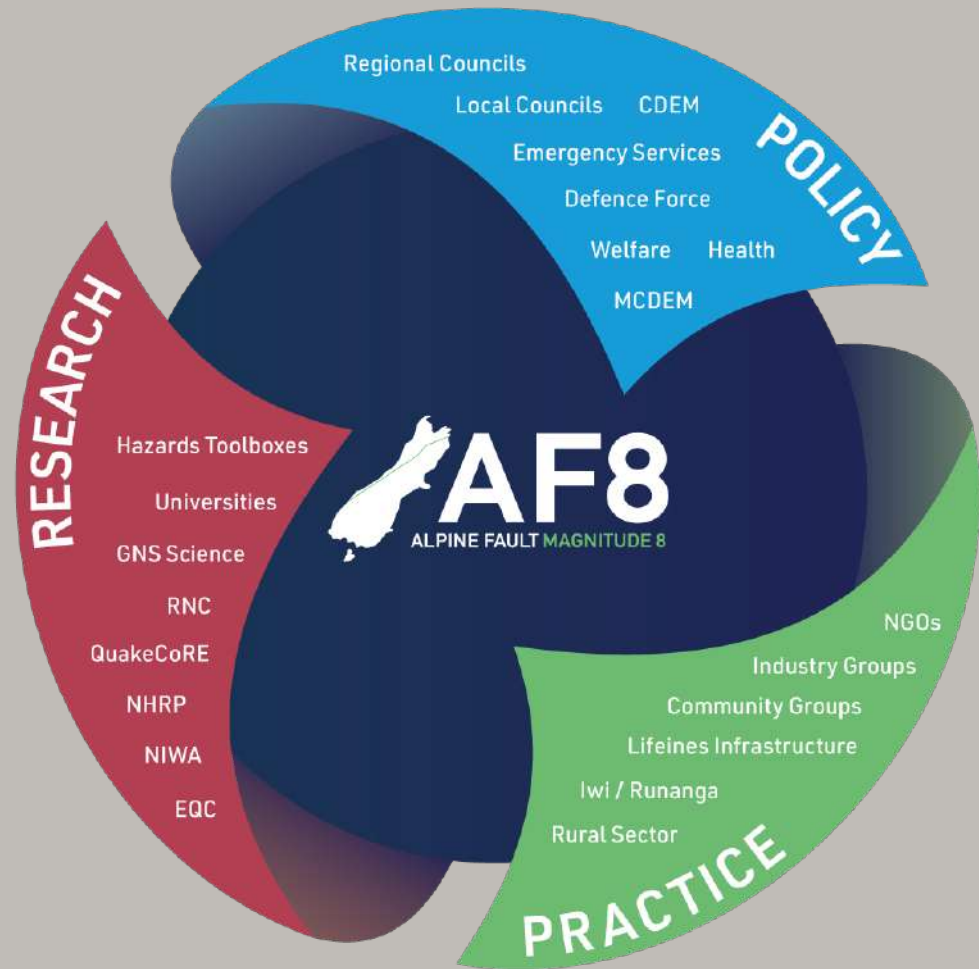
RESEARCH



POLICY



PRACTICE



What we have achieved so far



- ▶ Produced a credible science scenario
- ▶ Brought stakeholders together to produce a response plan
- ▶ Raising awareness with workshops, AF8 website and social media



Response – SAFER Framework

South Island Alpine Fault Earthquake Response Framework

Available for download
from the AF8 website:

www.af8.org.nz



SAFER

SOUTH ISLAND/TE WAIPOUNAMU
ALPINE FAULT EARTHQUAKE RESPONSE

FRAMEWORK



MANA TANGATA: POWER OF LEADERSHIP THROUGH THE PEOPLE



This document has been published by:
Emergency Management Southland
August 2018
www.projectaf8.co.nz

SHARED
SITUATIONAL
AWARENESS AND
OPERATIONAL
COORDINATION
IN THE EVENT
OF A MAJOR
ALPINE FAULT
EARTHQUAKE.

Cover image:
NASA Earth Observatory via Wikimedia Commons, the free media repository.
Internal images:
GNS Science Visual Media Library; Dr. Caroline Orchiston, Unsplash; Tyler Lestovich, Jeff Finley and Adam Edgerton; and, Wikimedia Commons, the free media repository.

What will an Alpine Fault earthquake be like?

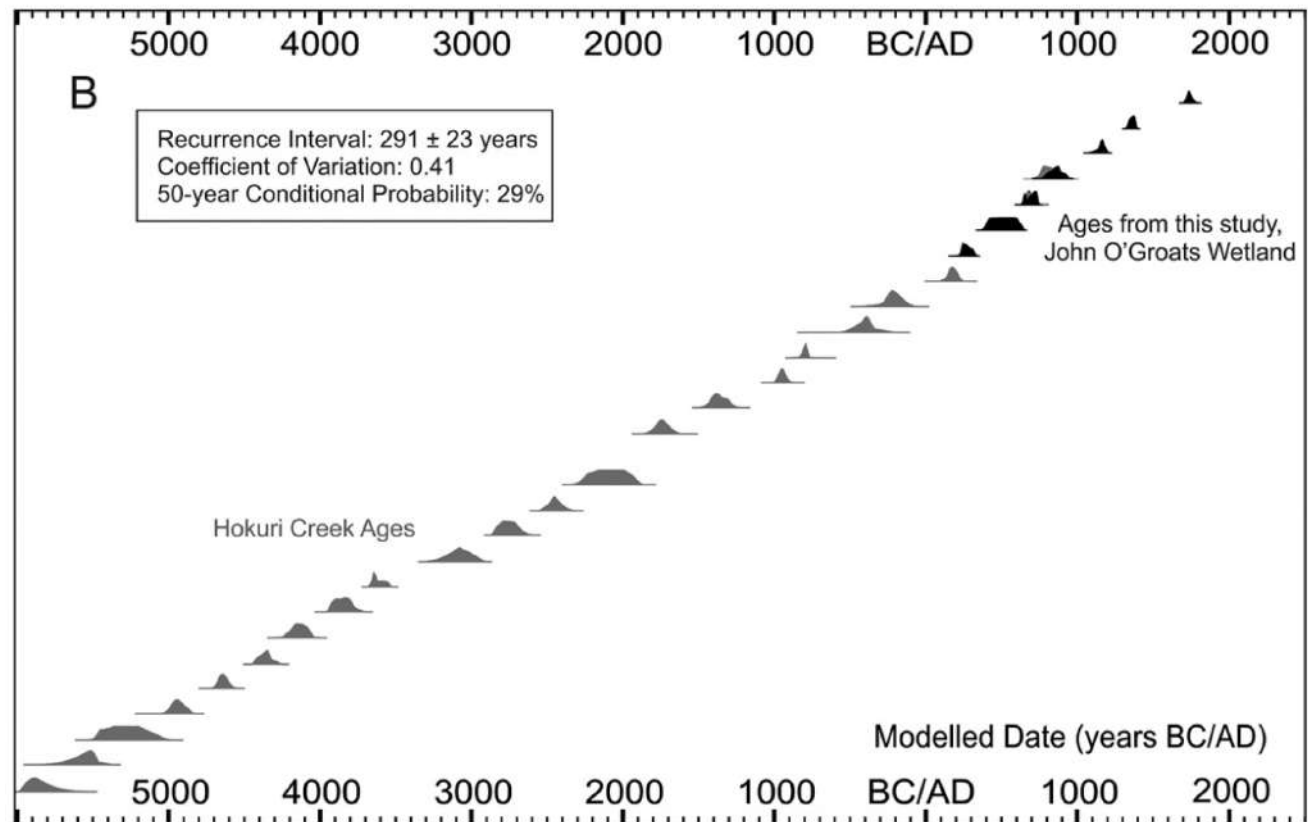


Frequency



Frequency – when is the next event(s) going to occur?

- ▶ Longest interval ~510 yrs
- ▶ Shortest interval ~140 yrs



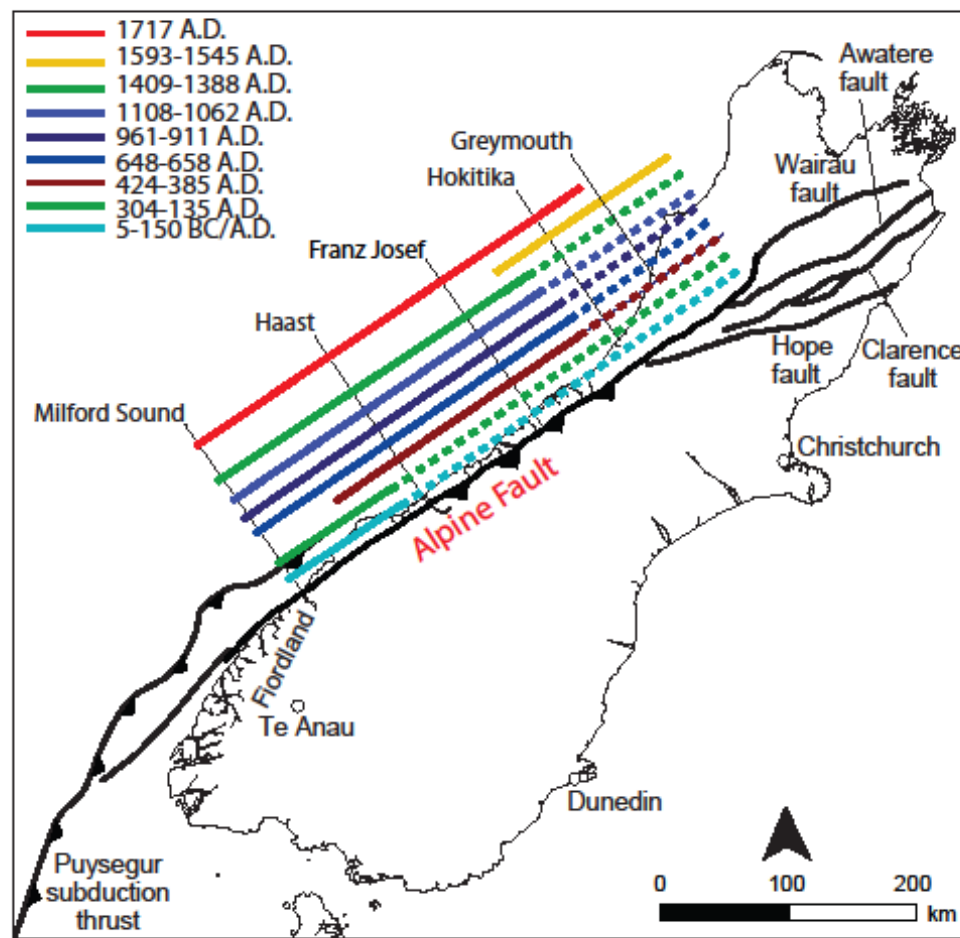
Magnitude



- Of the last 9 earthquakes, 8 appear to have been >400 km M8 events

- Fault has stored enough energy to move ...

~8-10 m horizontally,
and
~2 m vertically



(Cochran et al.; Howarth et al.)

Intensity- Hazard Footprint



**4 September 2010
Darfield Earthquake**

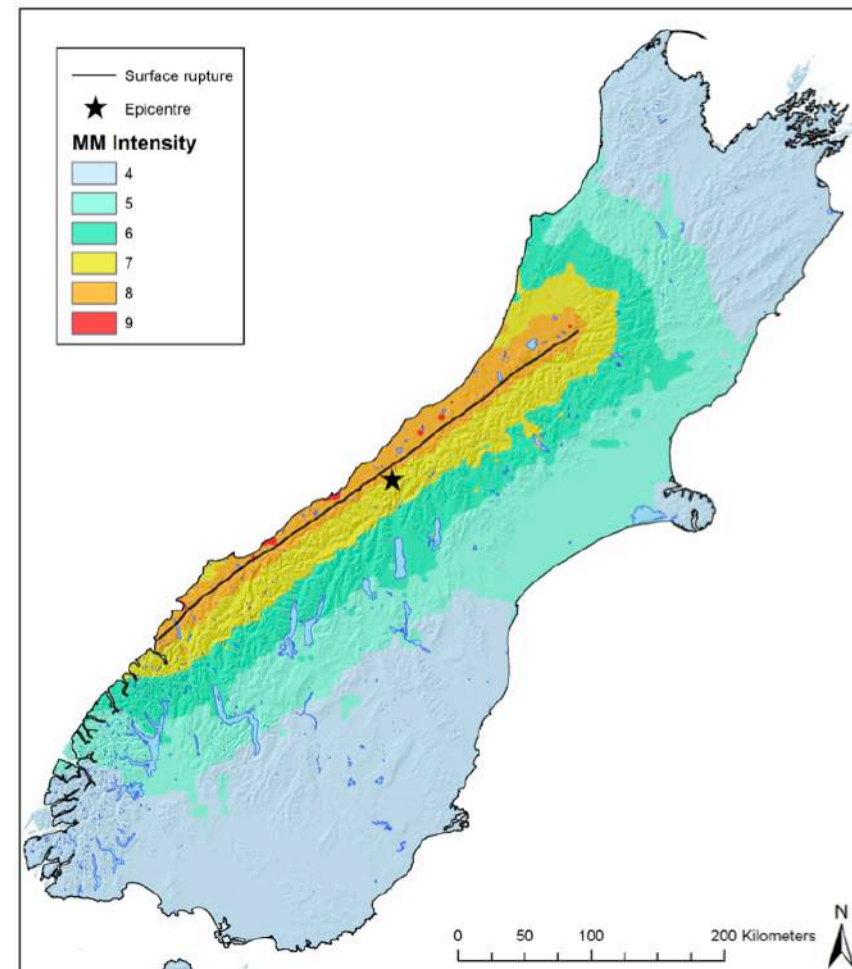
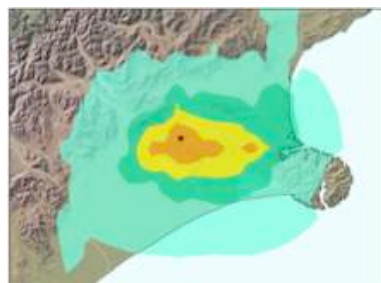
(to scale)

**= 32x more seismic energy
compared to an AF8**

**22 February 2011
Christchurch Earthquake**

(to scale)

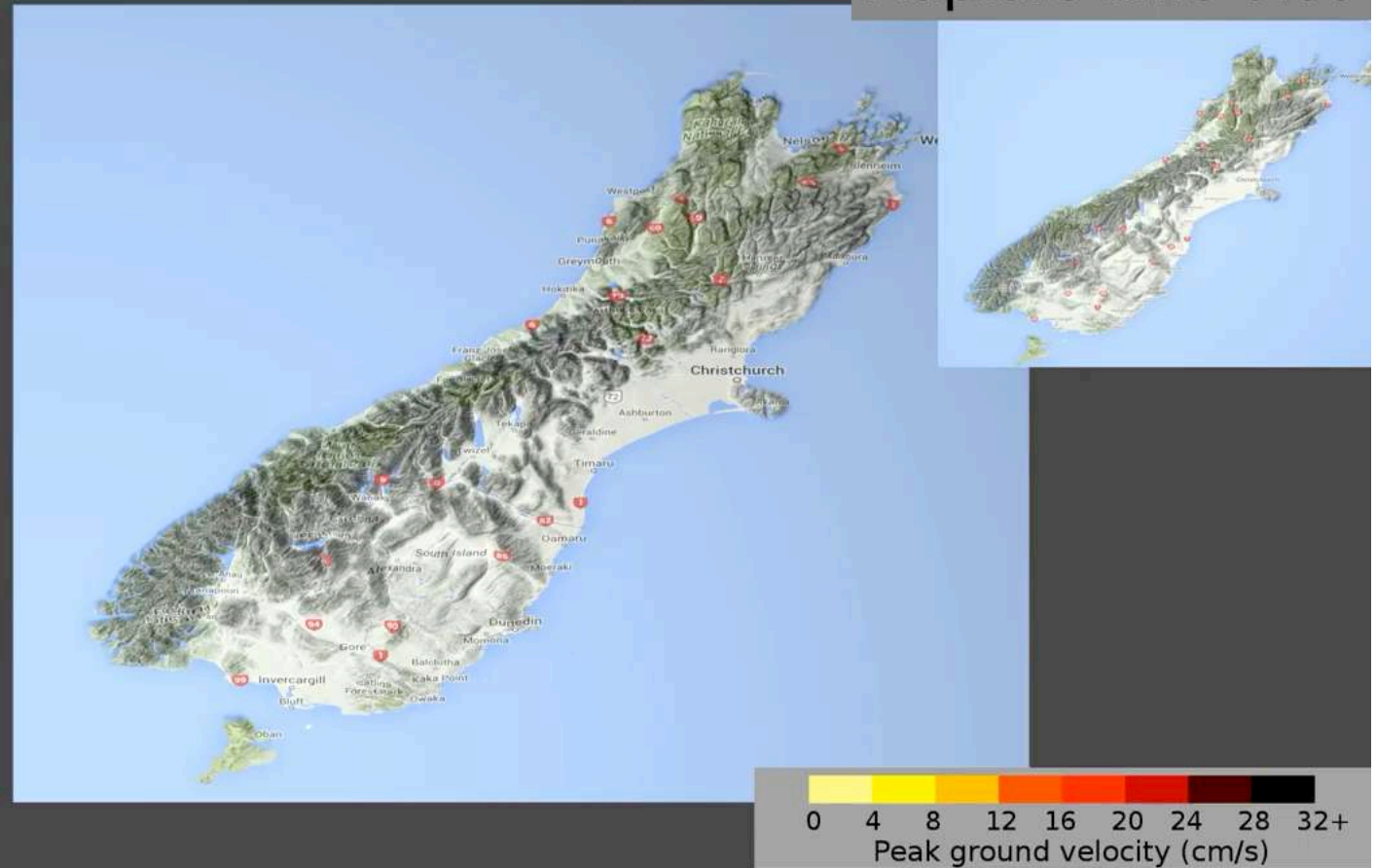
**= 1000x more seismic energy
compared to an AF8**



Hazard Footprint: shaking intensity



Rupture time 0:00



Professor Brendon
Bradley

University of
Canterbury

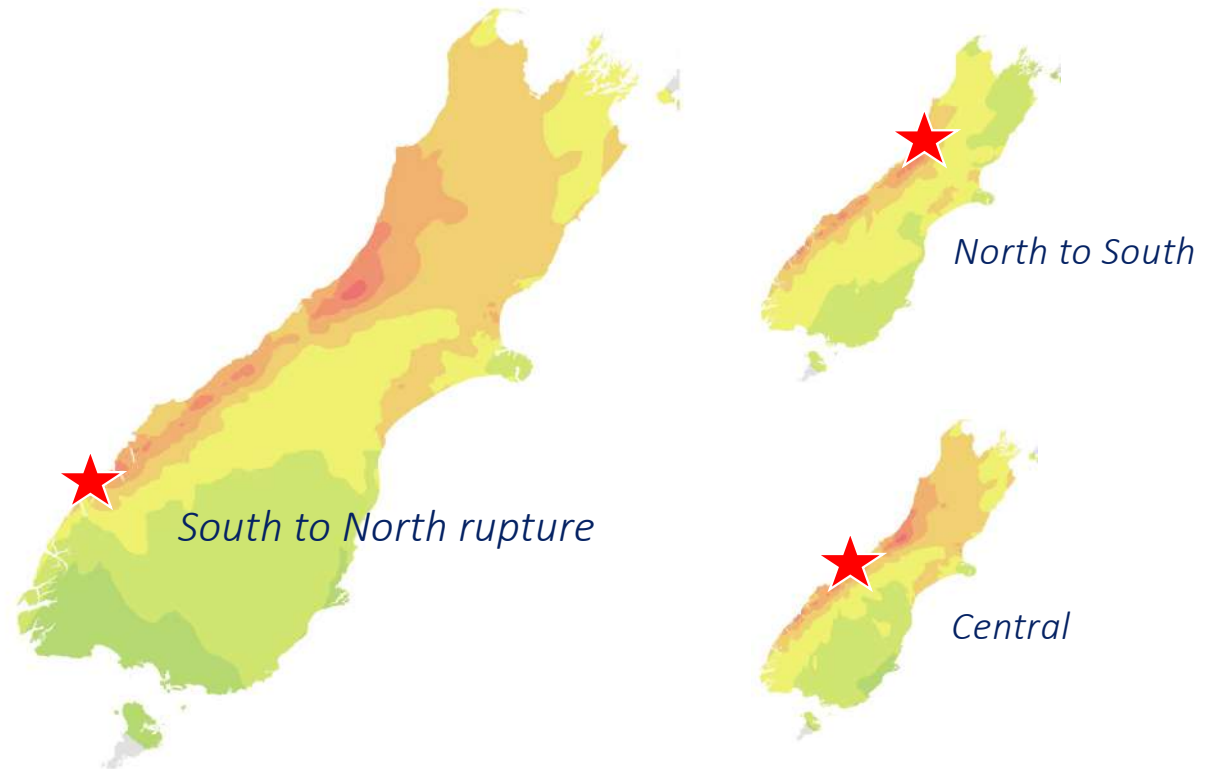
<https://www.youtube.com/watch?v=uGWbYy3to00&feature=youtu.be>

Science-based Scenarios



Science-based scenario :

- ▶ Magnitude 8
- ▶ MM Intensity 4-10

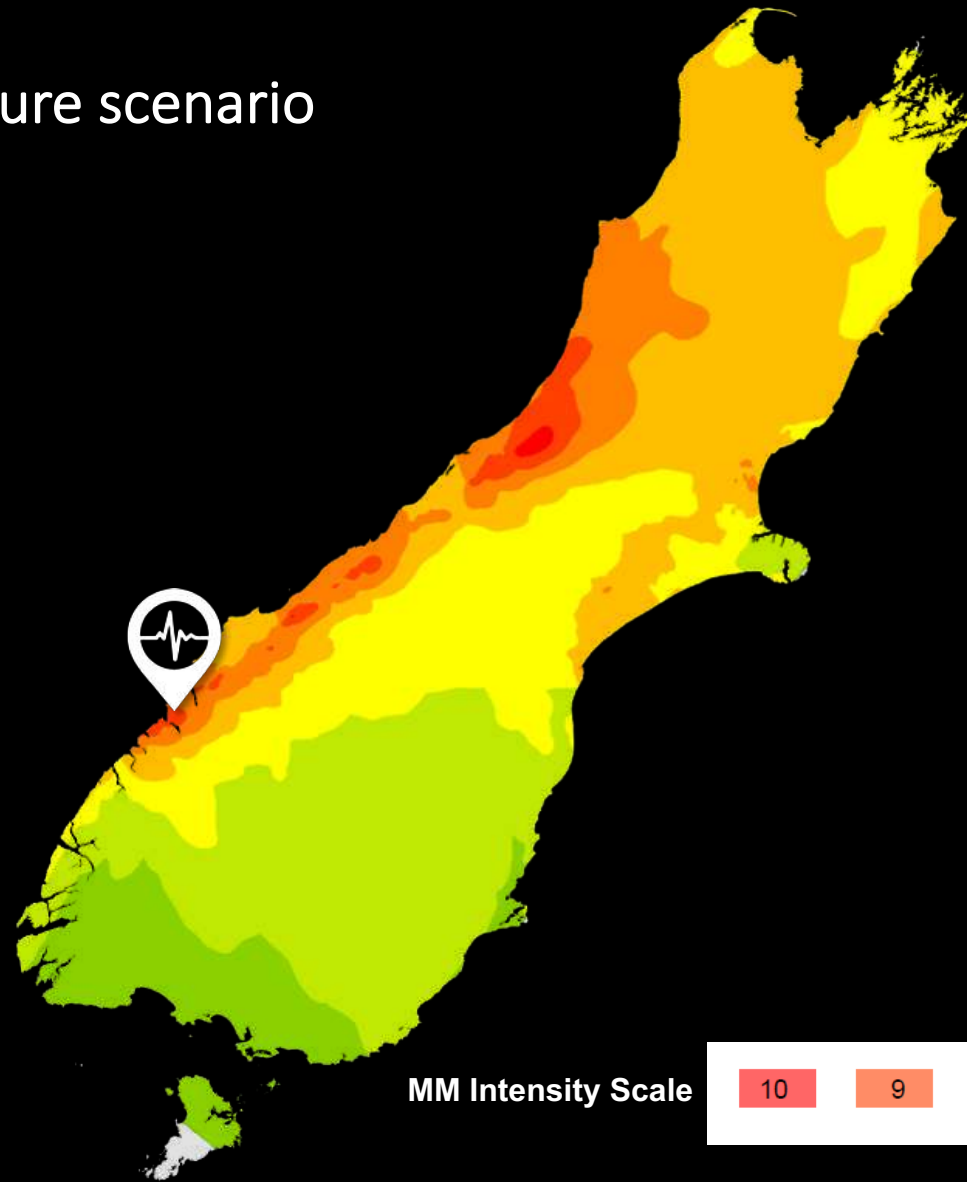


MM Intensity Scale



Images: Conrad Zorn. Based on Brendon Bradley et al. (2016)

South to North rupture scenario



MM Intensity Scale



Earthquake Hazards



Secondary Hazards

Earthquakes are not just the initial strong ground shaking

They cause a series of secondary hazards which cascade on from each other

- + Aftershocks
- + Weather Events
- + Fire

EARTHQUAKE



LANDSLIDE



QUAKE LAKE



DAMBREAK FLOOD

Secondary Hazards



Often these secondary hazards can be worse than the initial shaking:

- ▶ **2004 Indonesia – Tsunami**
- ▶ **2011 Japan – Tsunami**
- ▶ **2010-11 Christchurch – Liquefaction & Landslides**
- ▶ **2016 Kaikōura – Landslides**



Liquefaction in Christchurch: CEISMIC Digital Archive (Mark Lincoln)

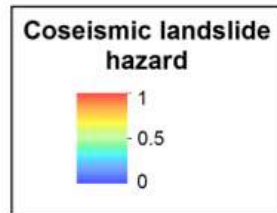


Landslides on SH1 following the Kaikōura earthquake (GeoNet)

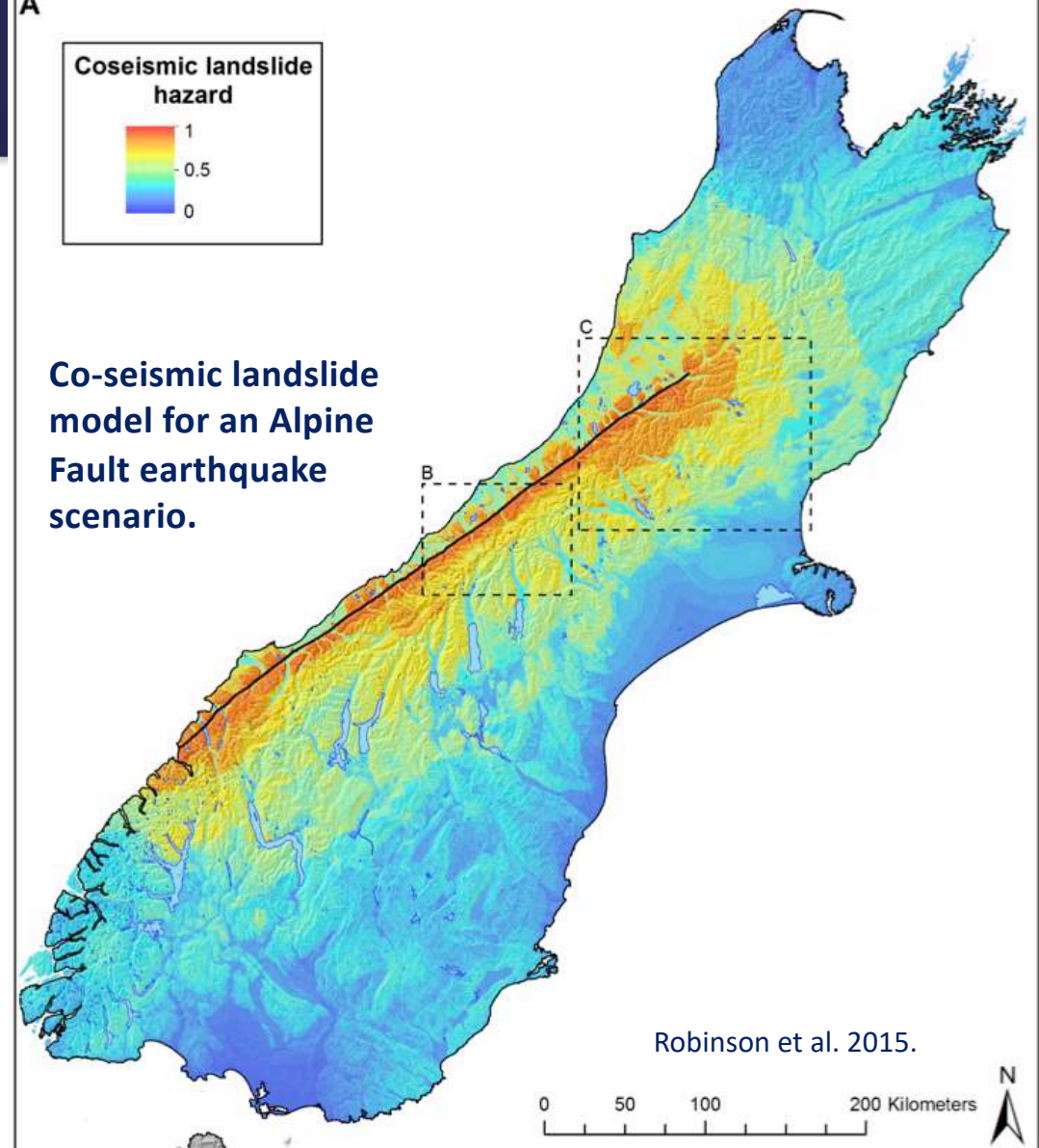
Secondary Hazards

Landslide dam
following the 2016
Kaikōura
earthquake

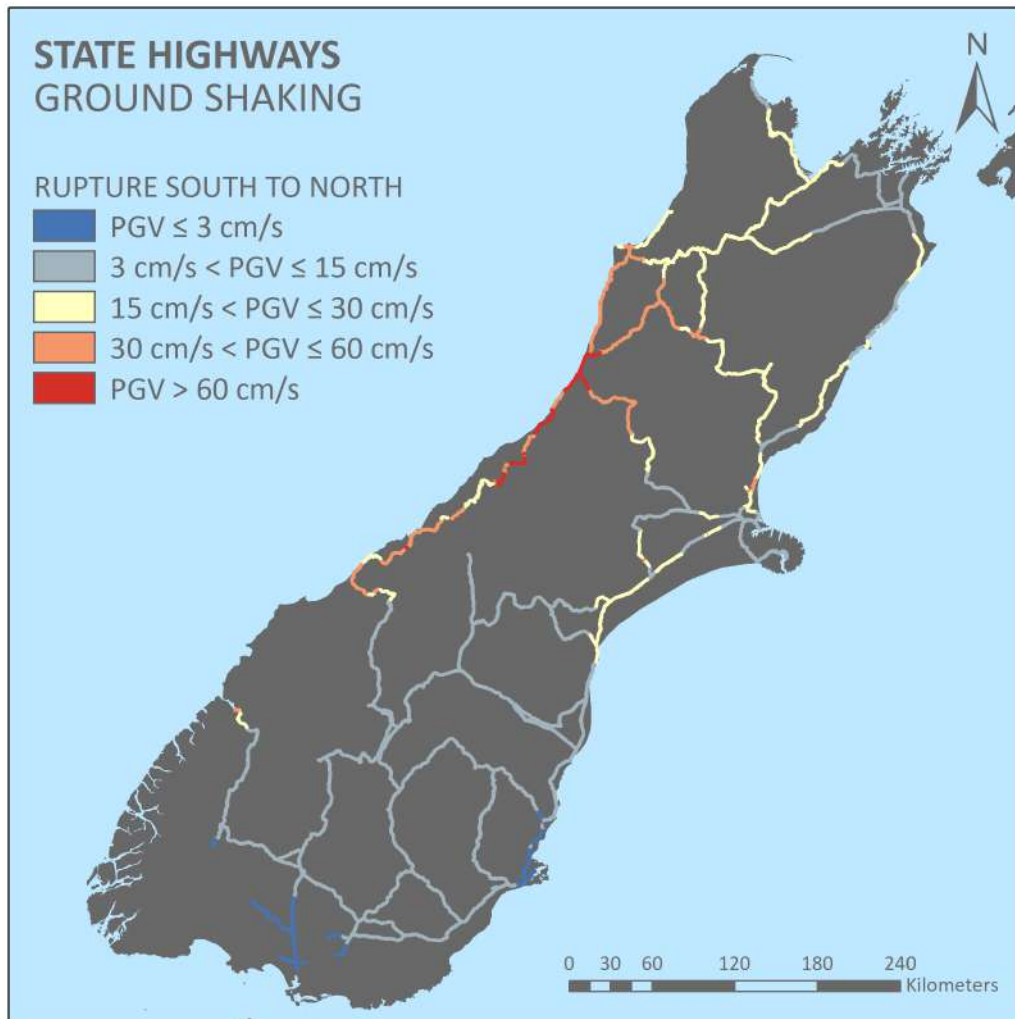
A



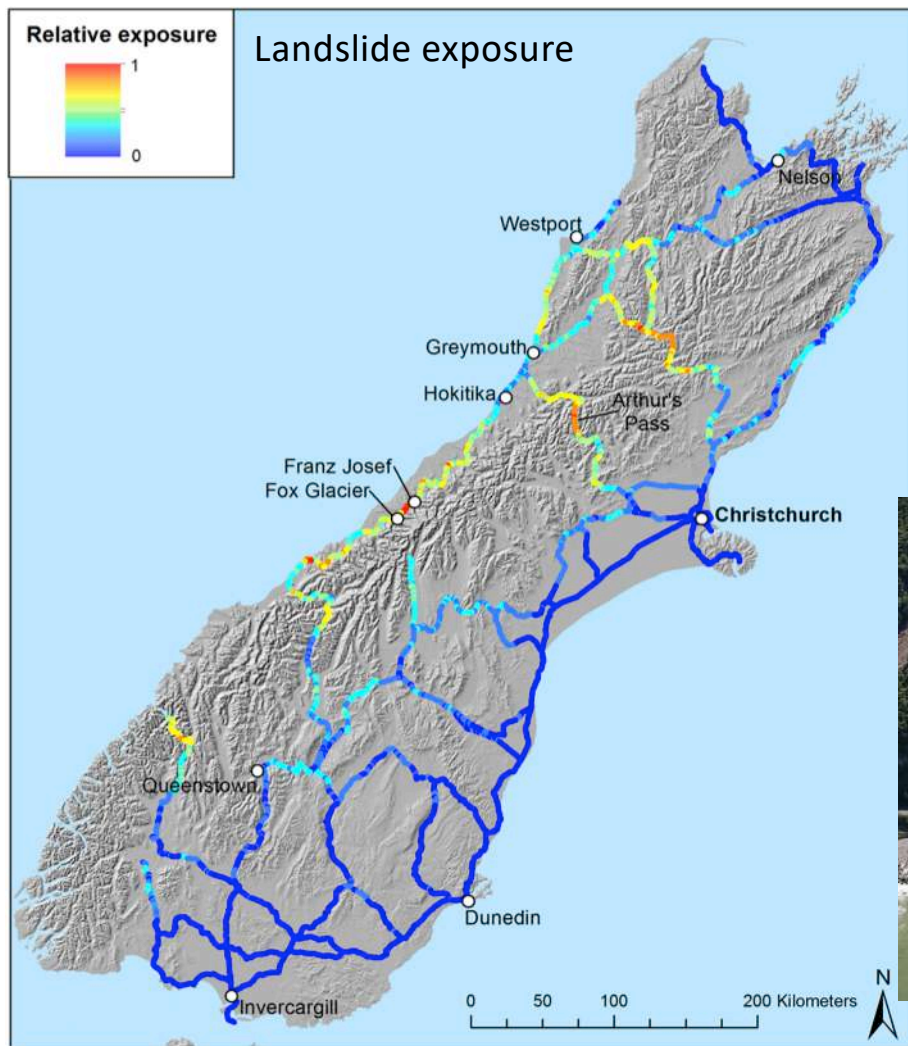
Co-seismic landslide
model for an Alpine
Fault earthquake
scenario.



State Highway Network – Shaking



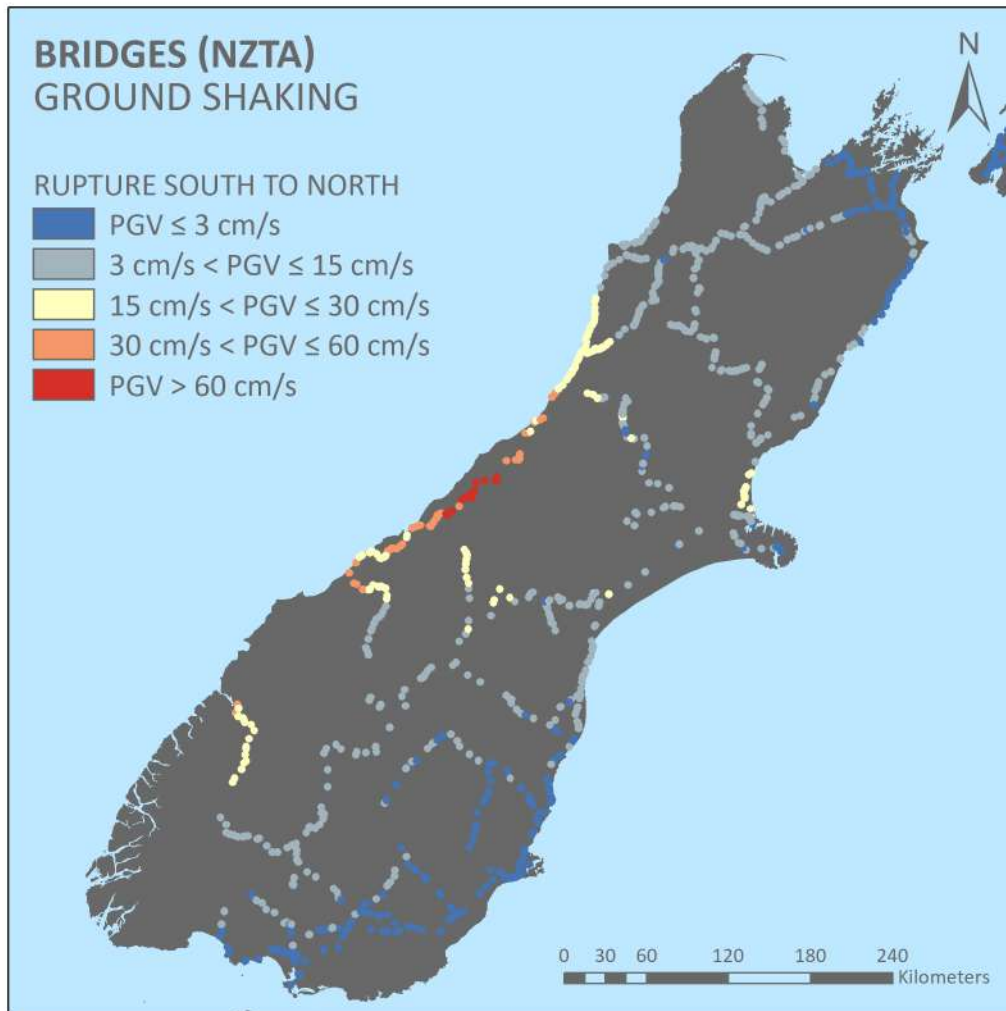
State Highway Network- Landslides



- 5 sections are particularly exposed:
 - Arthur's Pass
 - Lewis Pass
 - Fox Hills (Franz-Fox)
 - Haast Pass
 - Milford Road (Homer Tunnel)



State Highway Network- Bridges



Lessons from Kaikōura



© GNS Science, Lloyd Homer

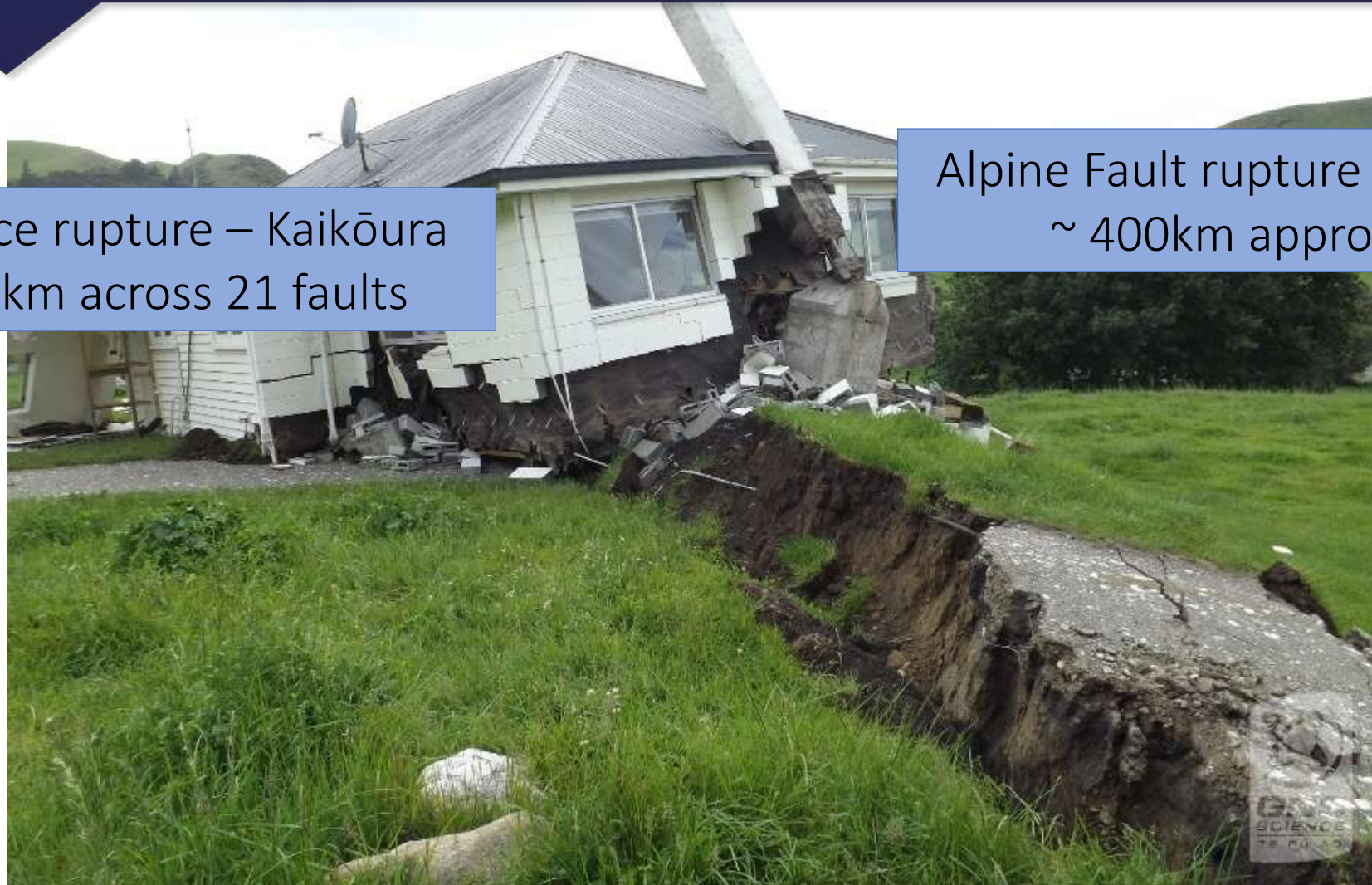
© GNS Science / EQC, Julian Thomson

Lessons from Kaikōura



Surface rupture – Kaikōura
~ 180km across 21 faults

Alpine Fault rupture length
~ 400km approx

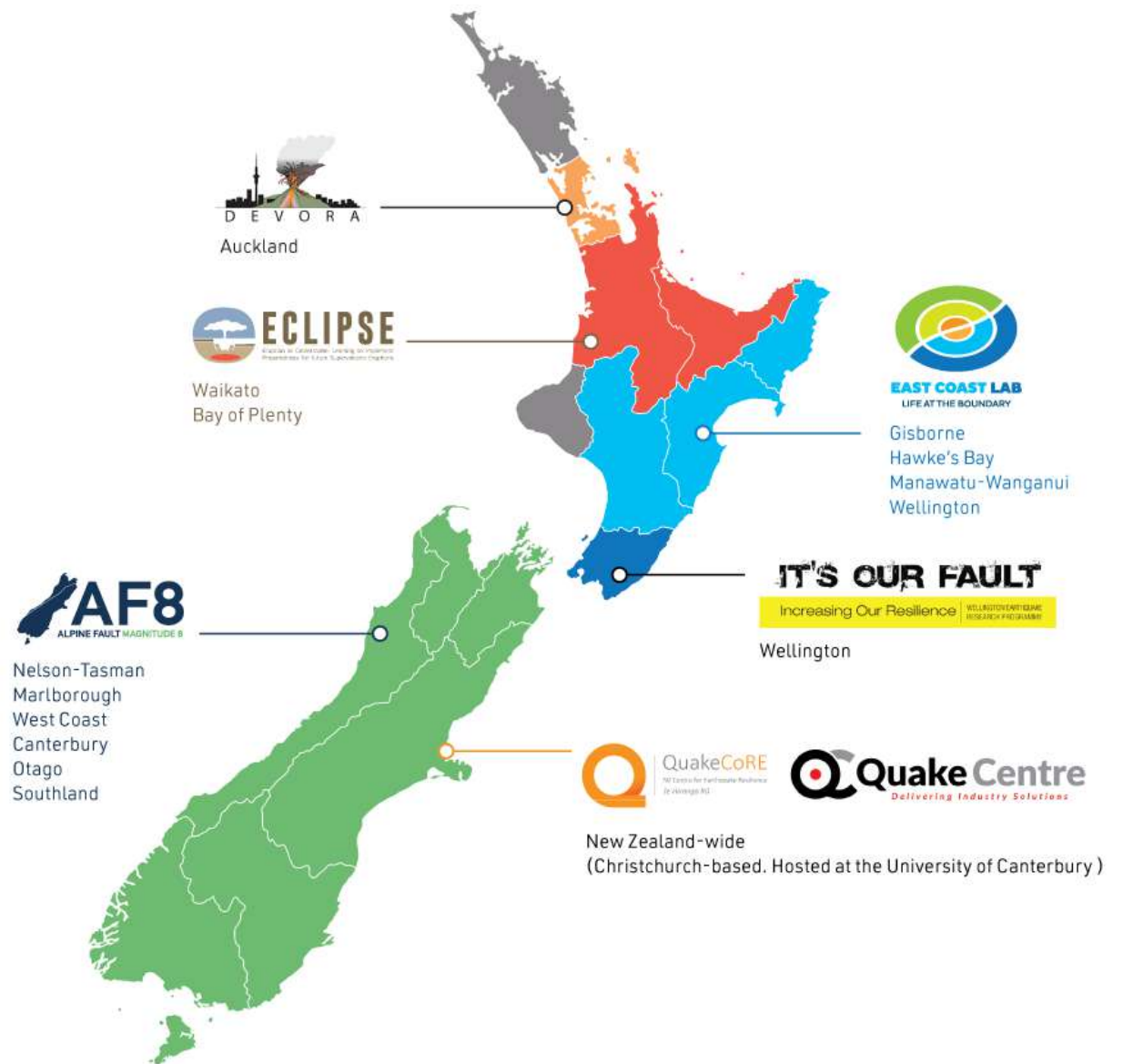


Lessons from Kaikōura



Regional Natural Hazard Programme Alliance

Public Education + Engagement



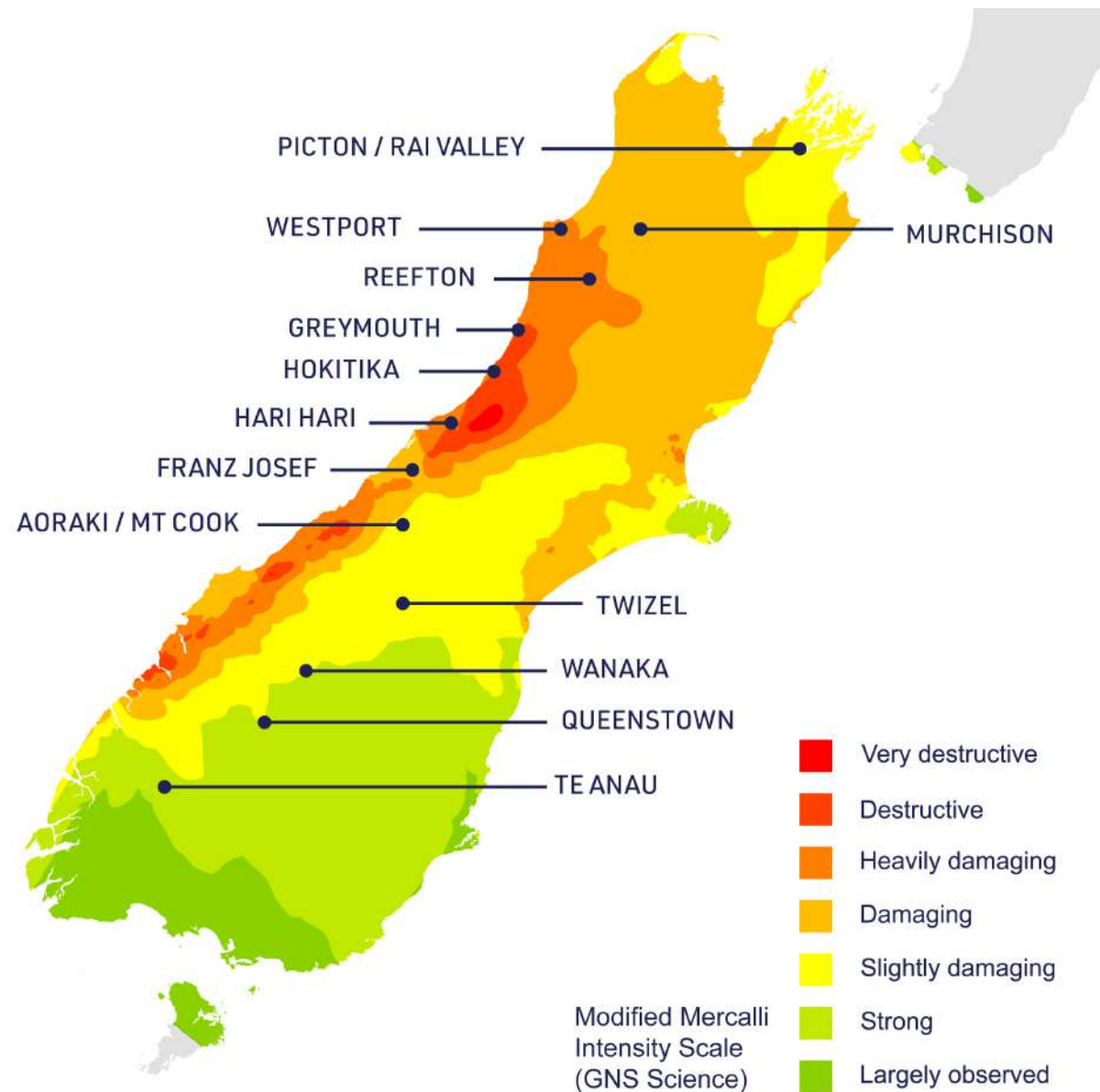
The Science Beneath Our Feet

AF8 Roadshow | March-June 2019



Bringing Alpine Fault science and hazard impact information to South Island communities, in areas most likely to be affected by an AF8 earthquake.

- What is the Alpine Fault?
- What would an AF8 event be like?
- How to prepare?





TOURISM FORUM

26 September 2019

Distinction Hotel | Te Anau



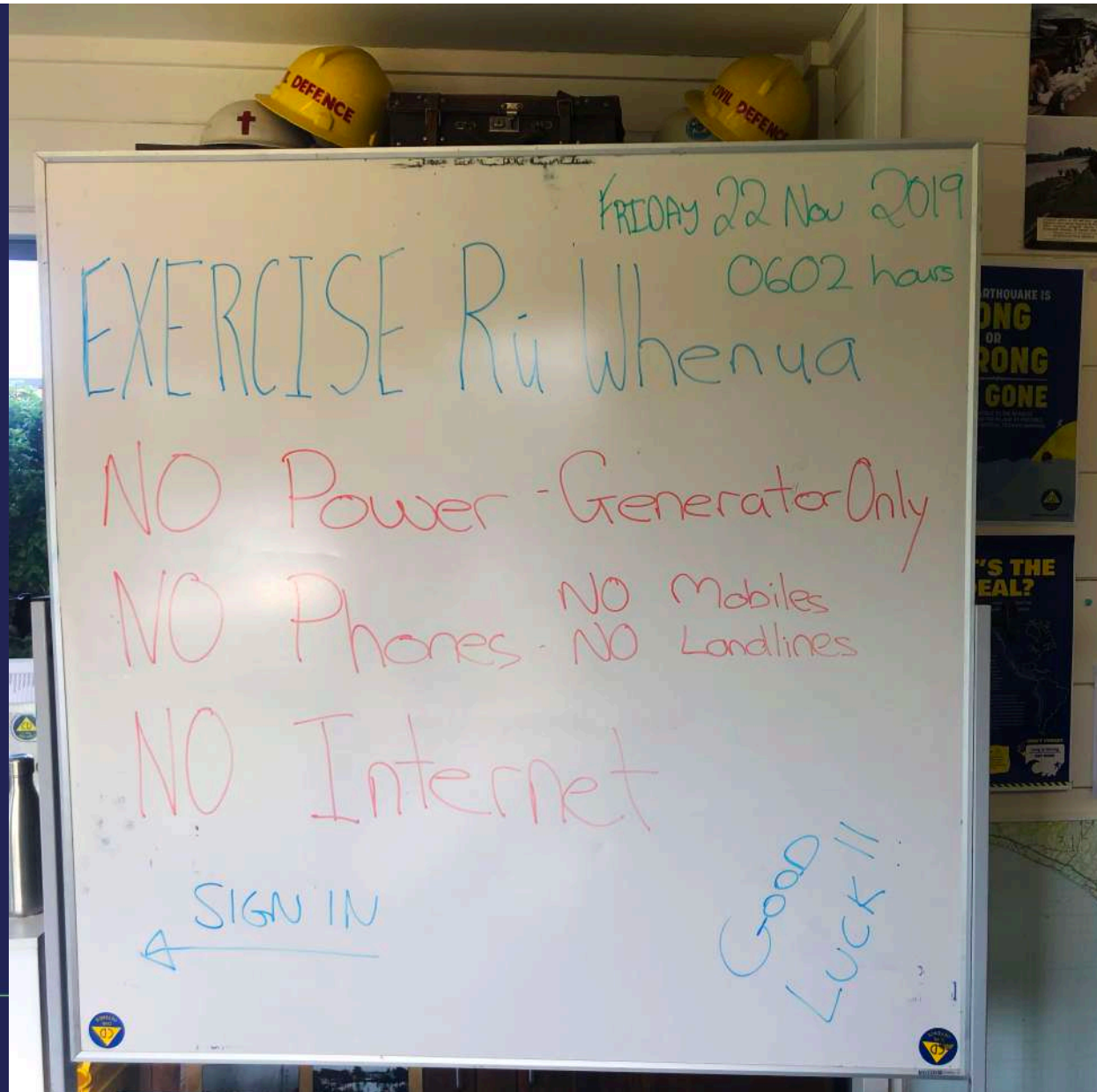


South Island CDEM Tier 3 Alpine Fault Exercise

Rū Whenua Whakariterite

Prepare for Earthquake

22 November 2019





Thank you!

www.af8.org.nz



Ministry of Civil Defence
& Emergency Management
Te Rākau Whakamarumarū

RESILIENCE
TO NATURE'S
CHALLENGES

Kia manawaroa
– Ngā Ākina o
Te Ao Tūroa

National
SCIENCE
Challenges



QuakeCoRE
NZ Centre for Earthquake Resilience
Te Hiranga Rū



UNIVERSITY
of
OTAGO
Te Whare Wānanga o Ōtago
NEW ZEALAND