Canadian Cordillera Array is Coming Soon

Presented by: Stan Dosso (Uvic)

Representing: Boggs, K. (MRU), Eaton, D. (UofC), Hyndman, R. (PGC/UVic), Audet, P. (UofO), Elliot, J. (Purdue), Freymueller, J. (UAF; EarthScope), Aster, R. (CSU), Schutt, D. (CSU), Rowe, C. (McGill), Morell, K. (UVic), Leonard, L. (UVic), and many others

The Blue Marble

(Apollo 17 – Dec 7, 1972; ~45,000km)

Goals:

1. Unify the Canadian Earth Sciences community
2. Create new research networks to improve holistic understanding of entire Earth Systems
3. Put geosciences on a national standing equivalent to the other natural sciences
4. Public benefits – hazard mitigation, strategic significance for transportation corridors; outreach/education

Godfrey Nowlan: "We have only one planet and it is important to us"

“EarthsCAN” – Motivation:

Maintain North American Large Geoscience Research Program Momentum

Consortium for Continental Reflection Profiling
11,000km - 30 US states

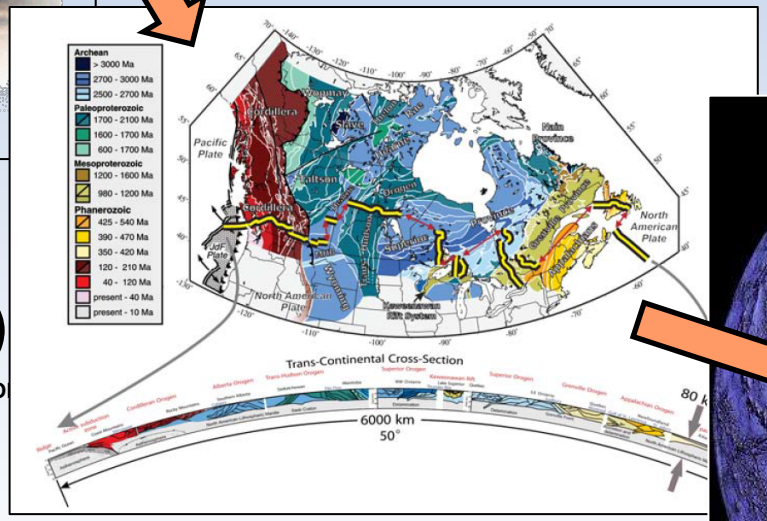
(~1980 to 1997)

http://www.geo.cornell.edu/geology/cocorp/COCO

LITHOPROBE
1000 geoscientists
& 1500 scientific pubs

(1984 to 2004)

(Hammer et al 2011; GSA Today)

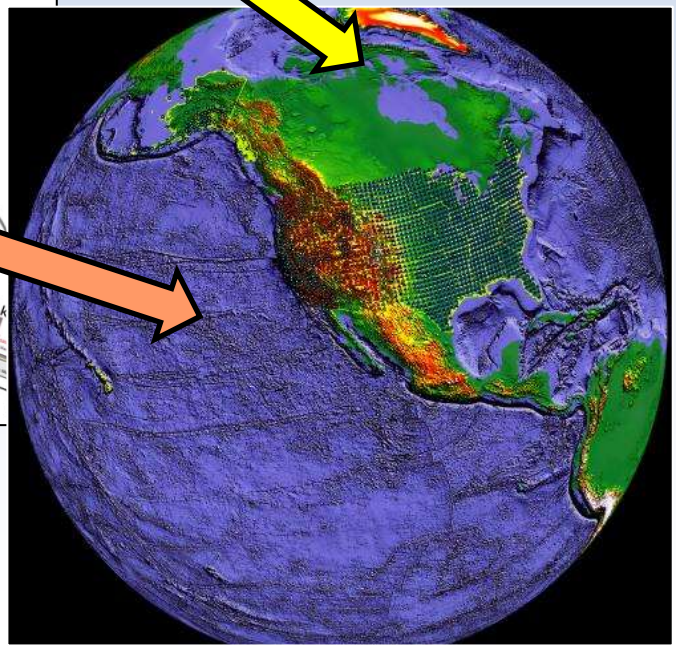


Earthscope (IRIS)
TA – 2226 sites
>290 scientific pubs 2009 to 2013

(2004 to ~2018)

http://www.earthscope.org

“EarthsCAN?”
~2017 to ???



NOTE: Timeline = EarthScope funding ends in 2018!!
Strong support from US Collaborators, IRIS (& UNAVCO)
Now have 2 assigned US NSF Program Officers

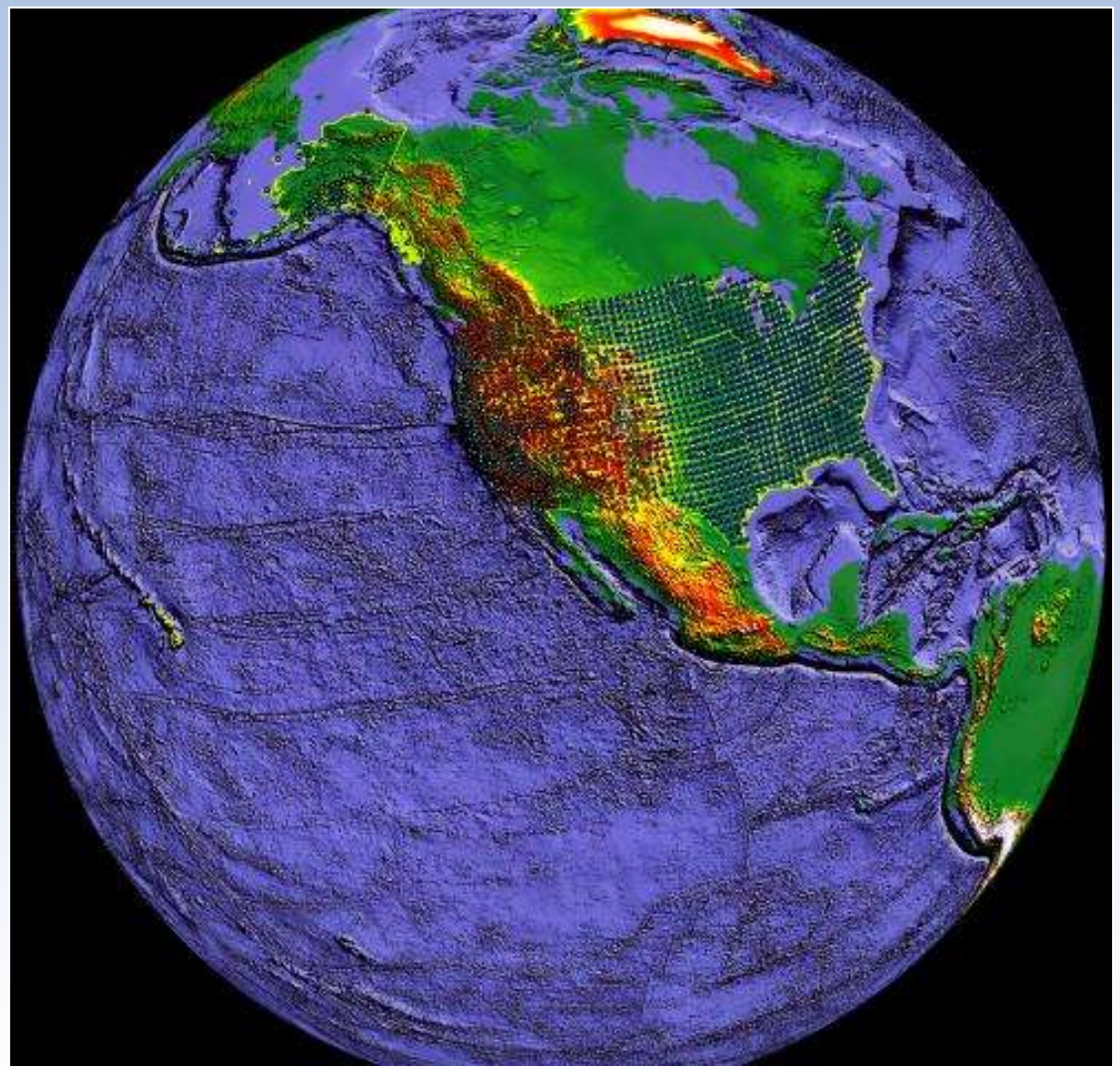
EarthScope

#1 Epic Science Experiment of Decade
(Popular Science January 2011)

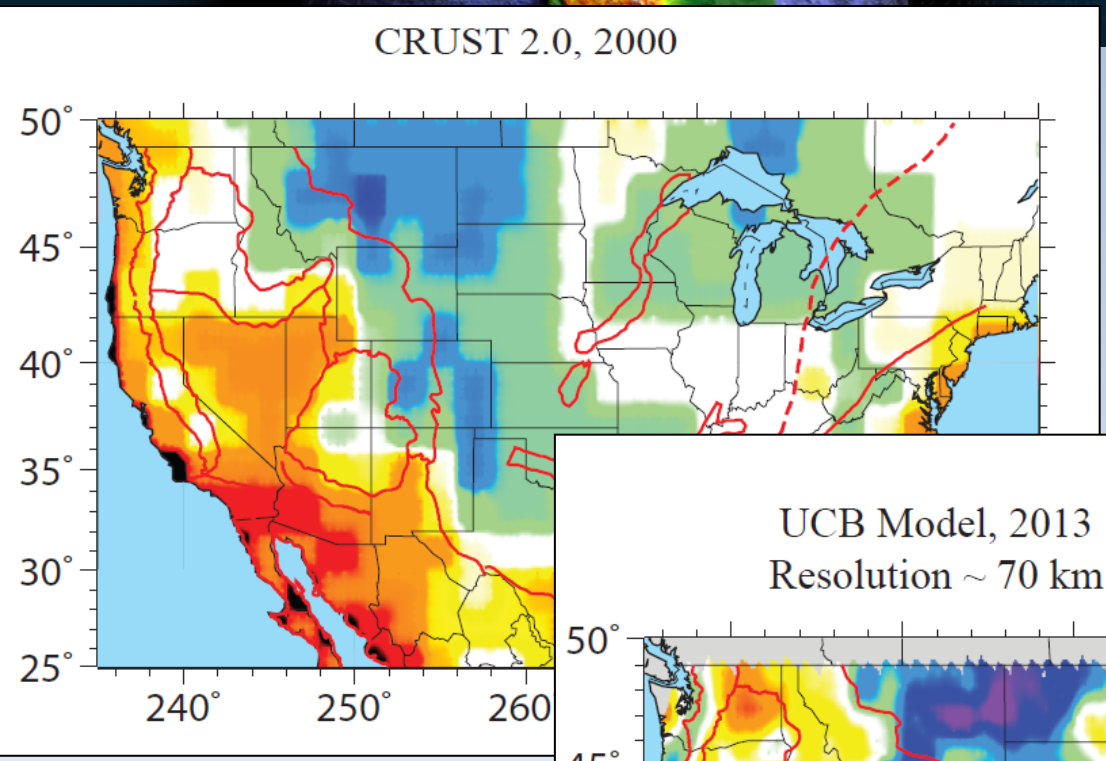
3 Main Components:

IRIS – handles seismic component
UNAVCO – handles Plate Boundary Observatory
Drilled into San Andreas Fault

National Office now at UAF
in Fairbanks, Alaska



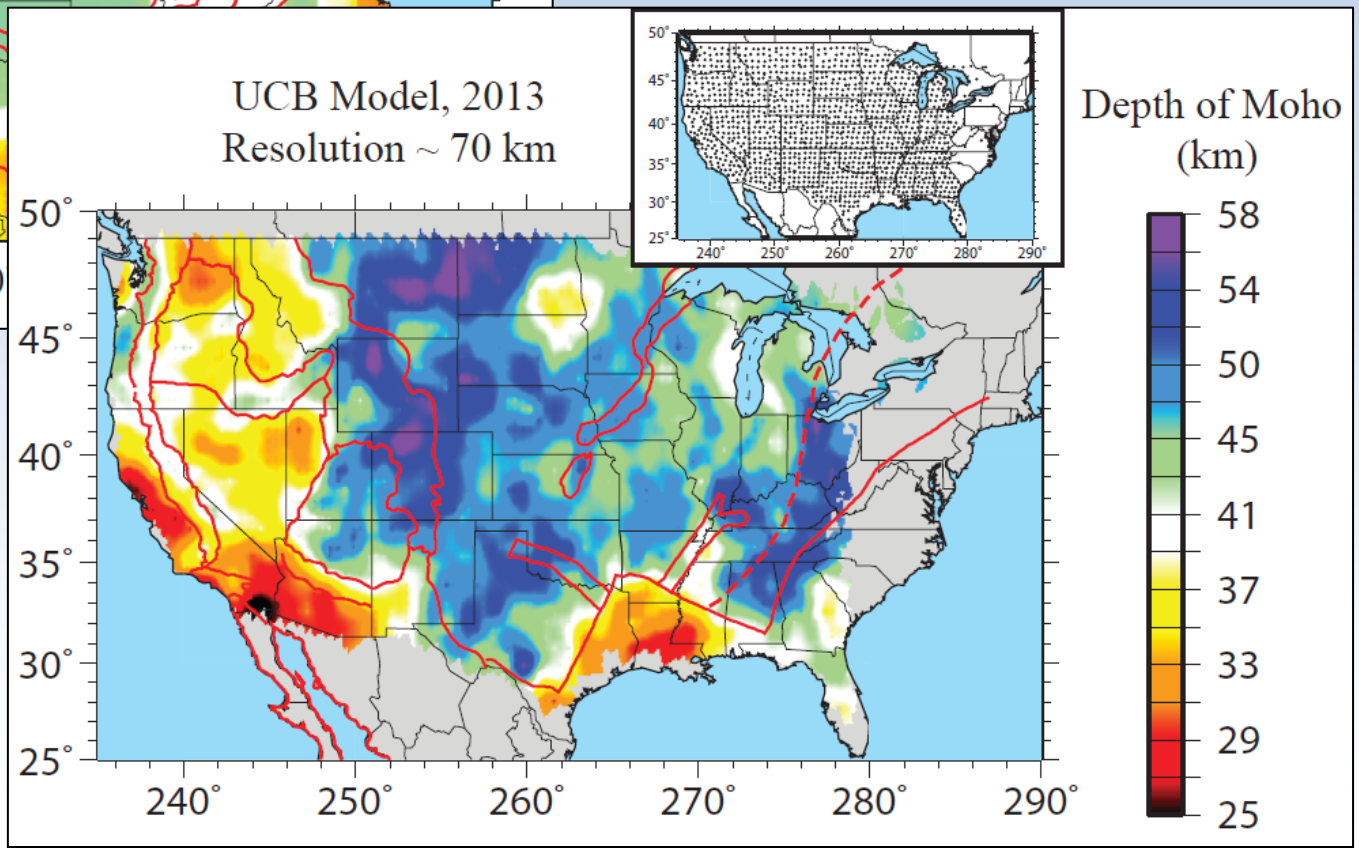
Resolution Before



Bassin et al., 2000
AGU Fall Meeting

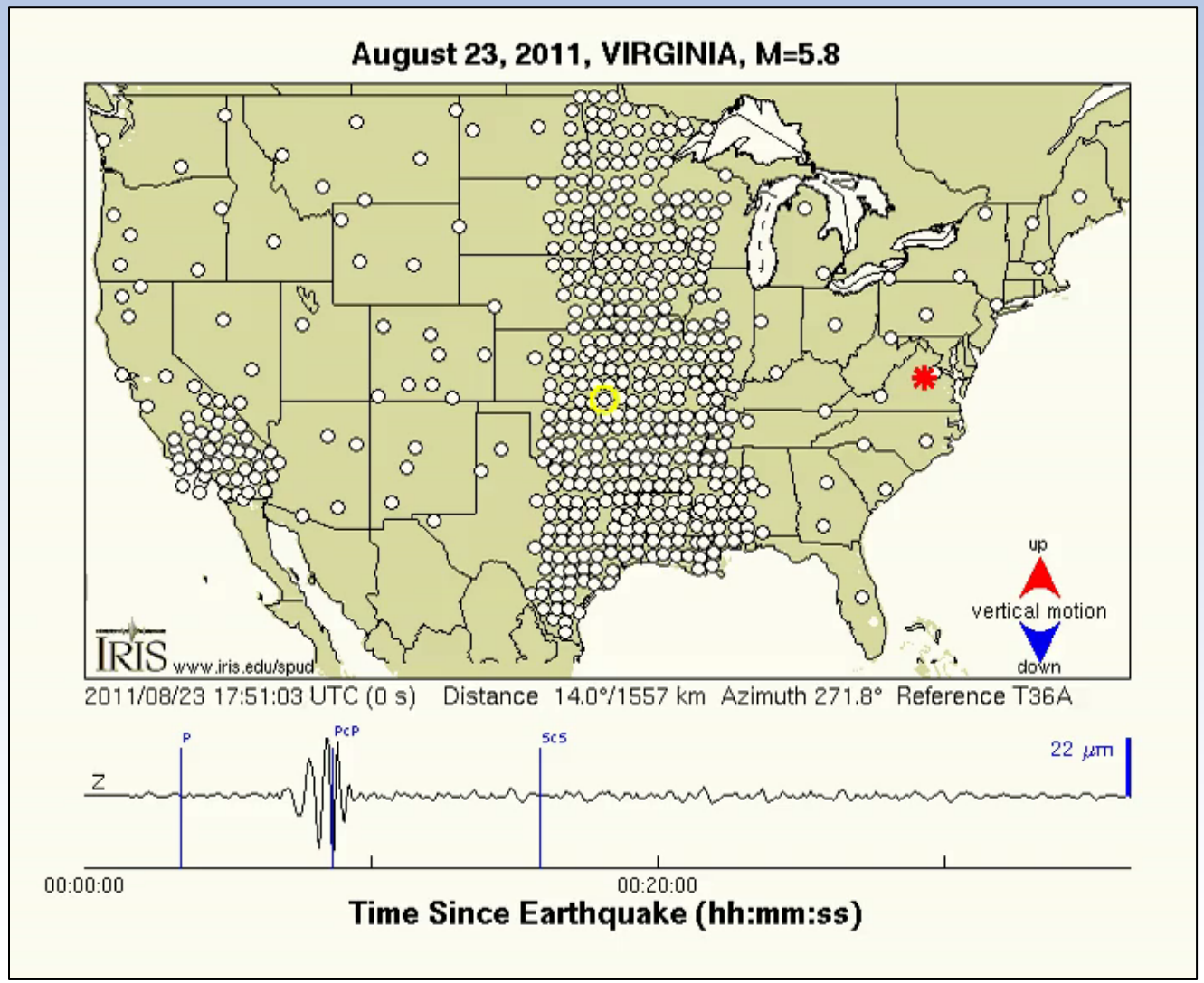
Resolution After

Shen and Ritzwoller,
CU-Boulder, 2013
AGU Fall Meeting

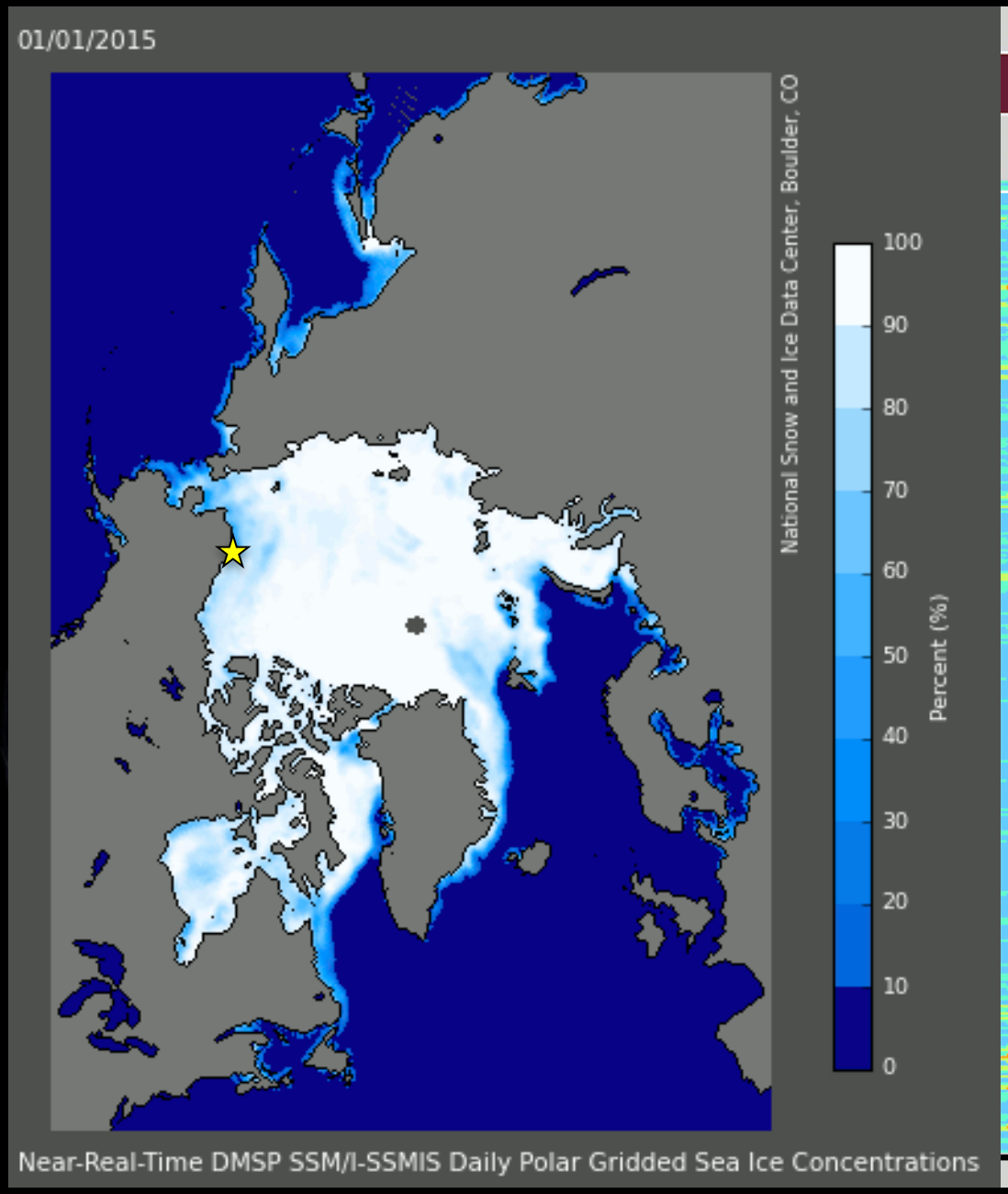


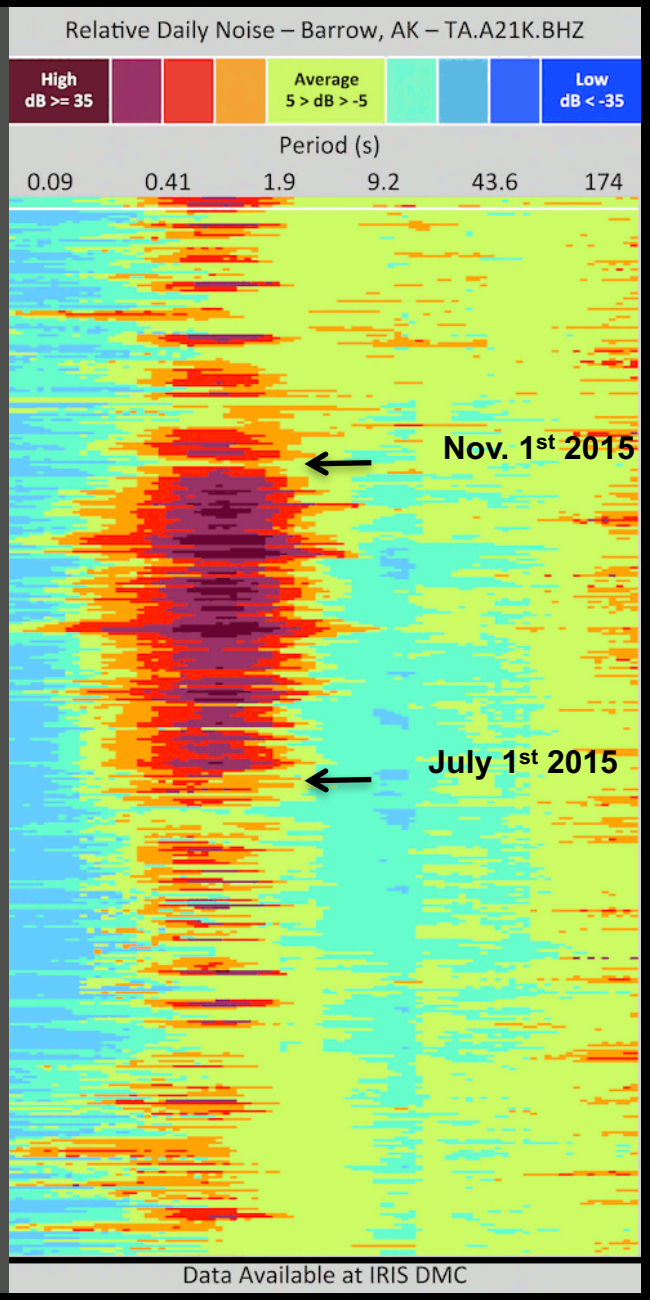
Typical Earthquake

Like ripples on a pond…

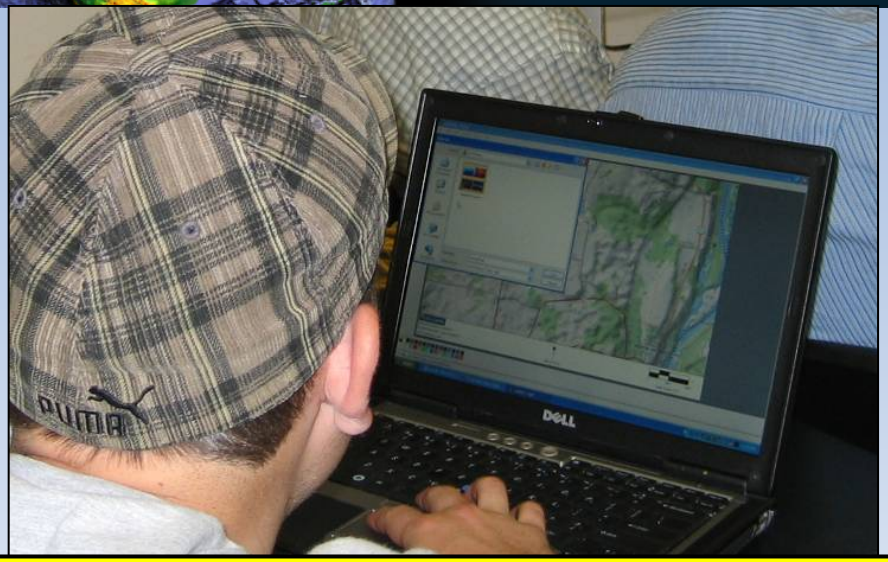


Seismometers can track the status of sea ice extent in northern Alaska
High noise (red) corresponds to open water after the peak of summer





Students Key to TA Site Reconnaissance



- Direct student participation in national science project
- Altered students' studies and careers

Student Siting

- 31 schools (51 total) and 67 students (131 total) participated in the summer siting program during the award

Student Comments

"I especially enjoyed the traveling aspect of reconnaissance in an endeavor to become a 'salesman for science.' We brought …EarthScope's mission to …**people who otherwise would never have even considered earthquakes in their state** or the impressive earth sciences beneath their own feet…I would consider my summer task an absolute success and would do it again in a heartbeat."

"**Seeing my state in this way was a life altering experience** and to know that I helped a scientific community in learning more about earth structure gives a sense of pride."

"My experience this summer was absolutely a positive one. It gave me the opportunity to travel, improve my communication skills…and start to focus on the upcoming school year. **I could not recommend this program enough to other future students in the Earth Sciences**."

“EarthsCAN” – Goal:

New Research Network – Holistically examine entire Earth Systems from Magnetosphere through Lithosphere Deep into Mantle

Magnetosphere & Auroras (SWARM (ESA) logo)

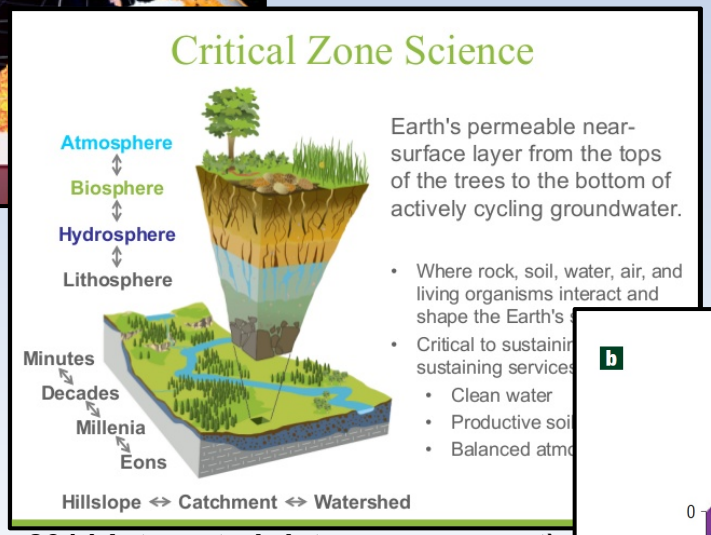
Auroras

To

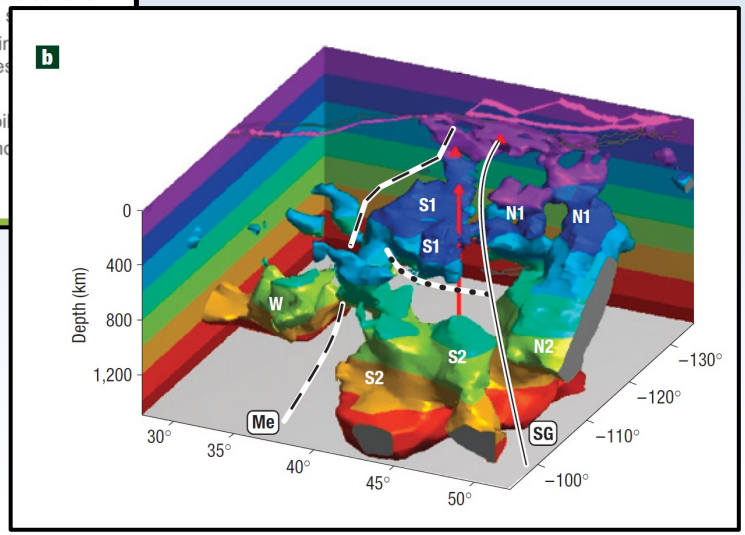
Critical Zone

To

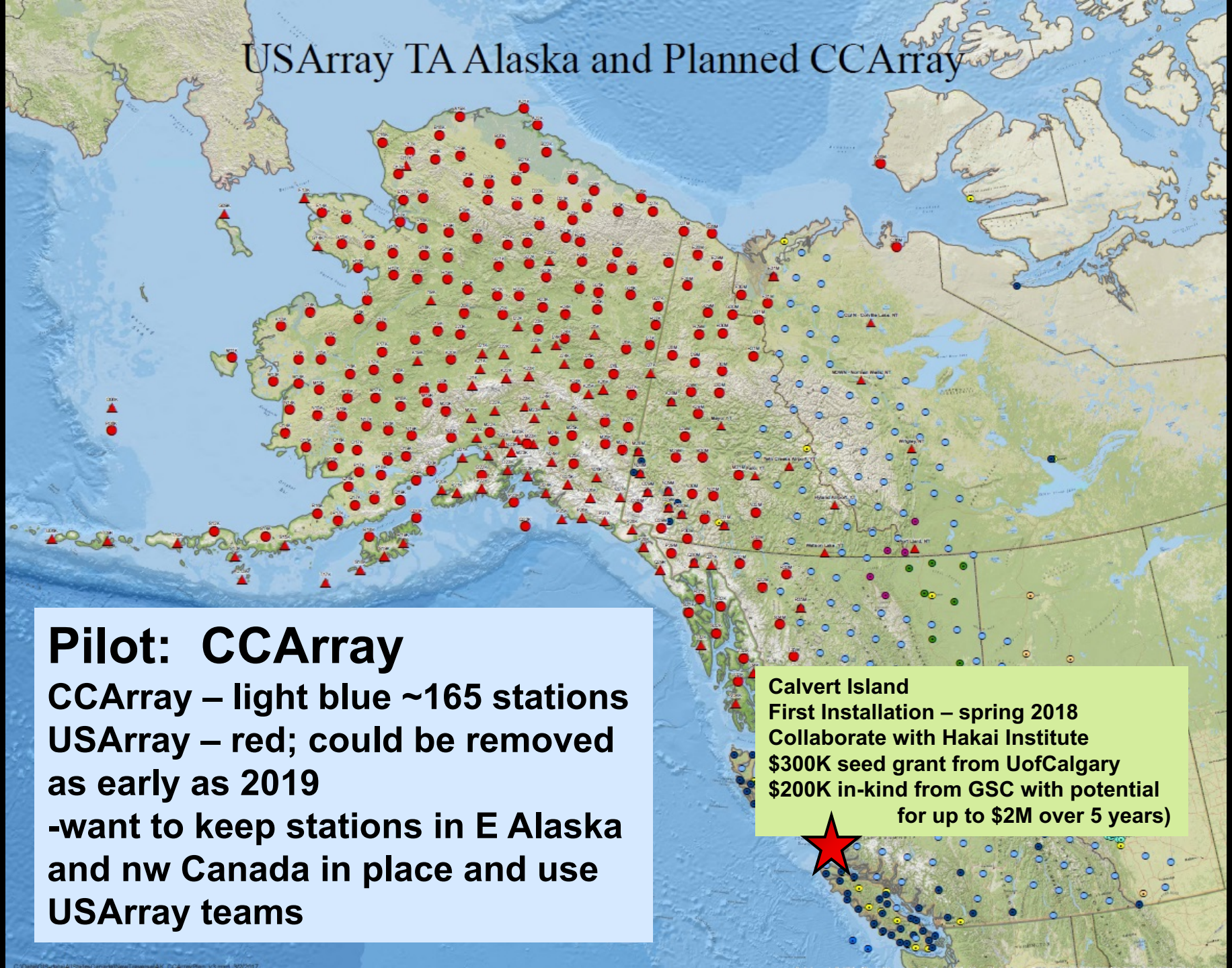
Tomography



(ahm-2014-Integrated-data-management)



(Sigloch et al, 2008; Nature Geoscience)

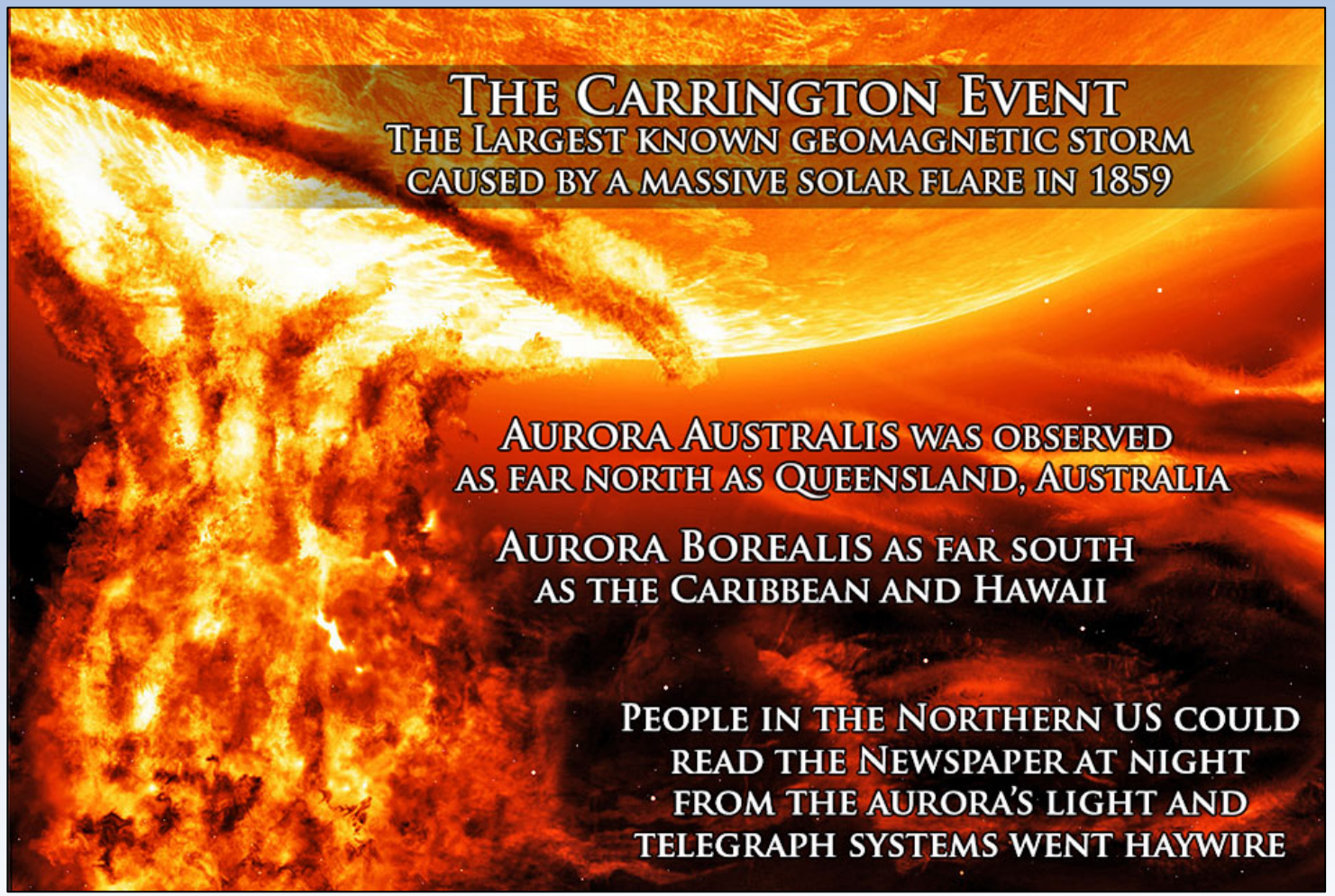


Pilot: CCArray

CCArray – light blue ~165 stations
USArray – red; could be removed as early as 2019
-want to keep stations in E Alaska and nw Canada in place and use USArray teams

Calvert Island
First Installation – spring 2018
Collaborate with Hakai Institute
$300K seed grant from UofCalgary
$200K in-kind from GSC with potential for up to $2M over 5 years)

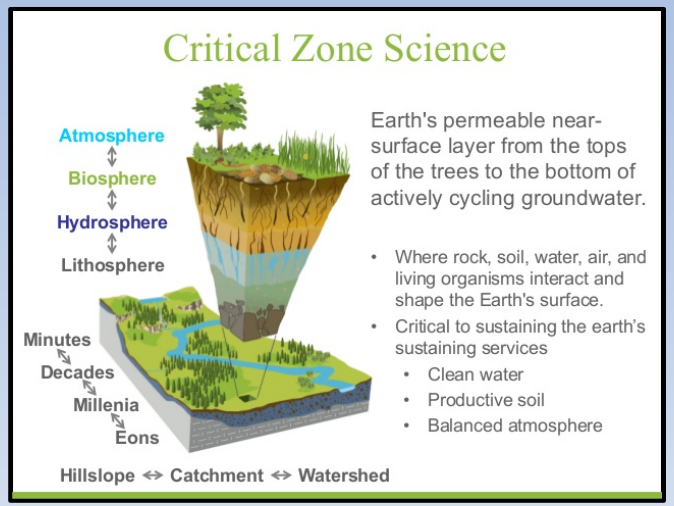
Why care about magnetosphere?



One "Carrington" event today would cause >1T$ of damage
-destroy all satellites and severely damage most power grids

Why care about critical zone science?

-zone that supports life!!



(ahm-2014-Integrated-data-management)

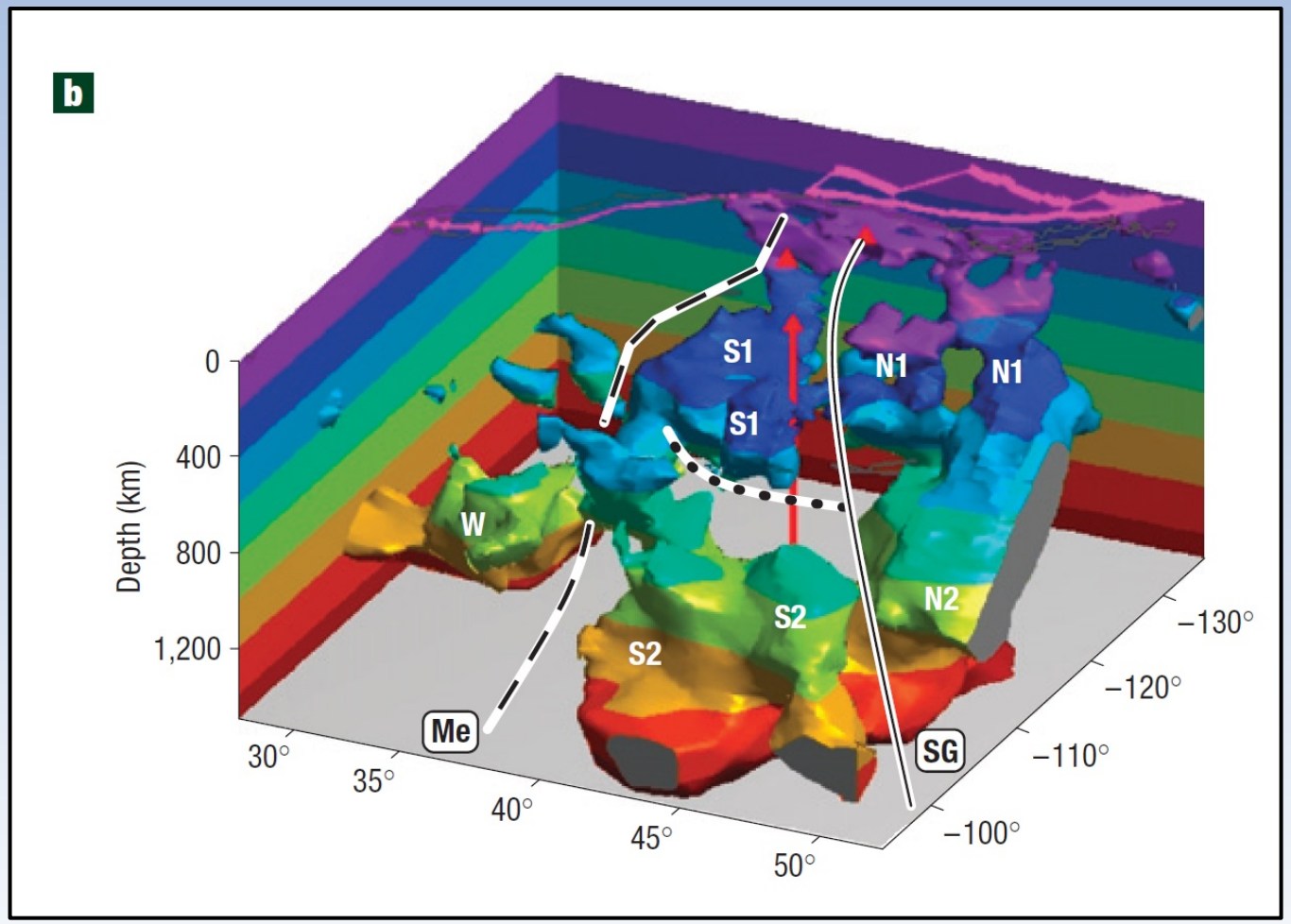
(Stats Canada)

Proposed permanent "legacy" stations -monitor impact of climate change on Canadian ecosystems

Partial CZO in place

Proposed new CZO

Why care about tomography?



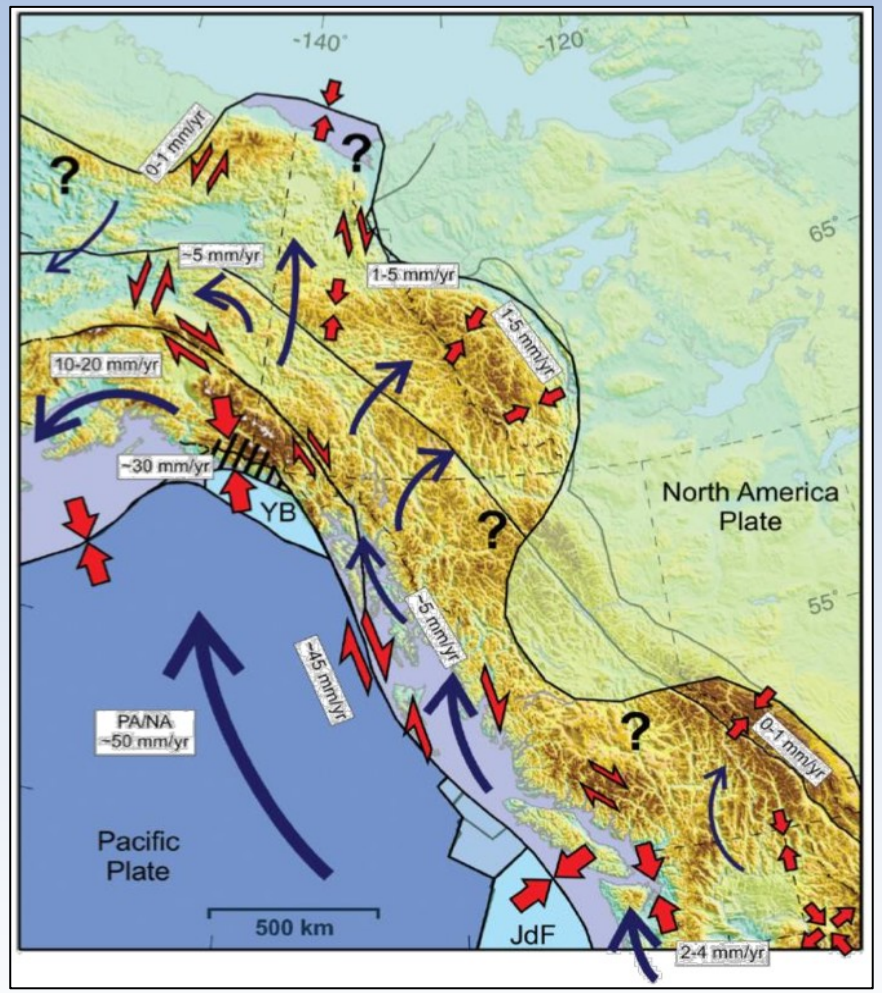
(Sigloch et al, 2008; Nature Geoscience)

Improve understanding of subduction slab mechanics

Greatly improved resolution possible due to array

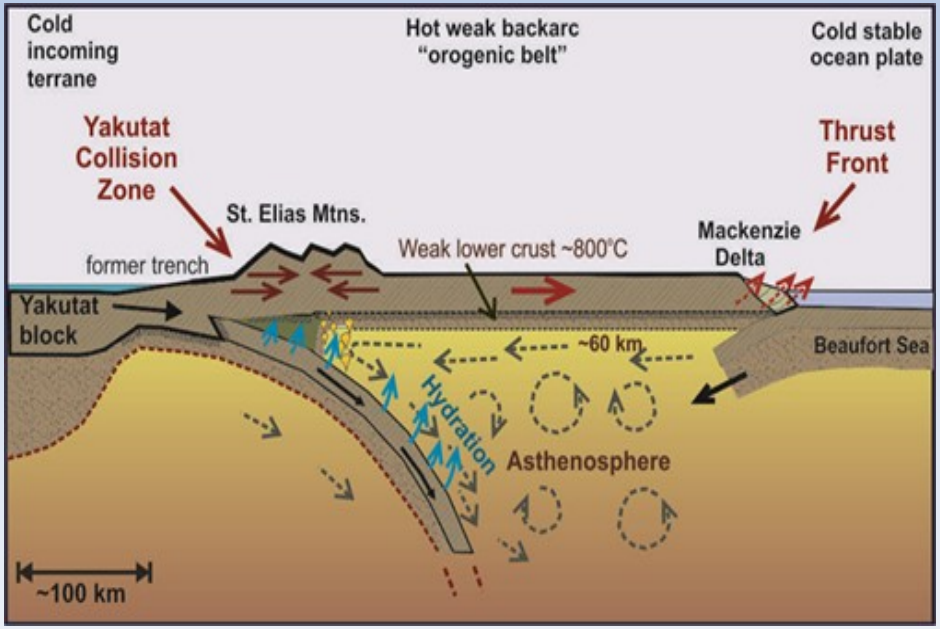
Bird's eye view from ne of Cascadia subduction system. Me (dashed) – continuation of Mendocino fracture zone underground. SG (solid) – slab gap; 2500km long tear in the current subducting slab. The dotted line represents the lateral tear between upper and lower mantle.

“Mini Himalayas” Yakutat Block



(Mazzotti et al 2008)

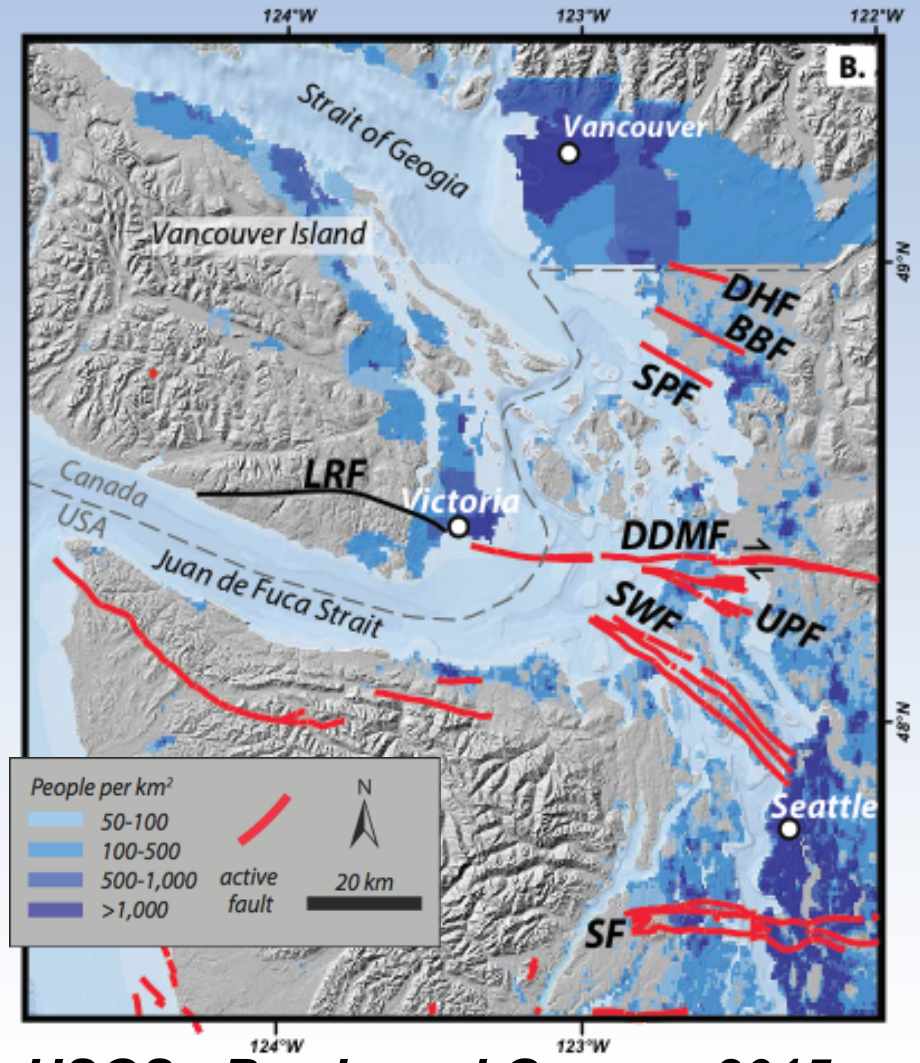
Orogenic Float Model



(Hyndman & Mazzotti 2002)

First White Paper – Cascadia Forearc active fault

(Amos (WWU), Harrington (McGill), Kirkpatrick (McGill), Leonard (UVic), Levson (UVic), Liu (McGill), Morrell (UVic), Regalla (Boston U) , Rowe (McGill); Morrell et al GSA Today 2016)



USGS - Barrie and Greene, 2015

Red – active crustal faults

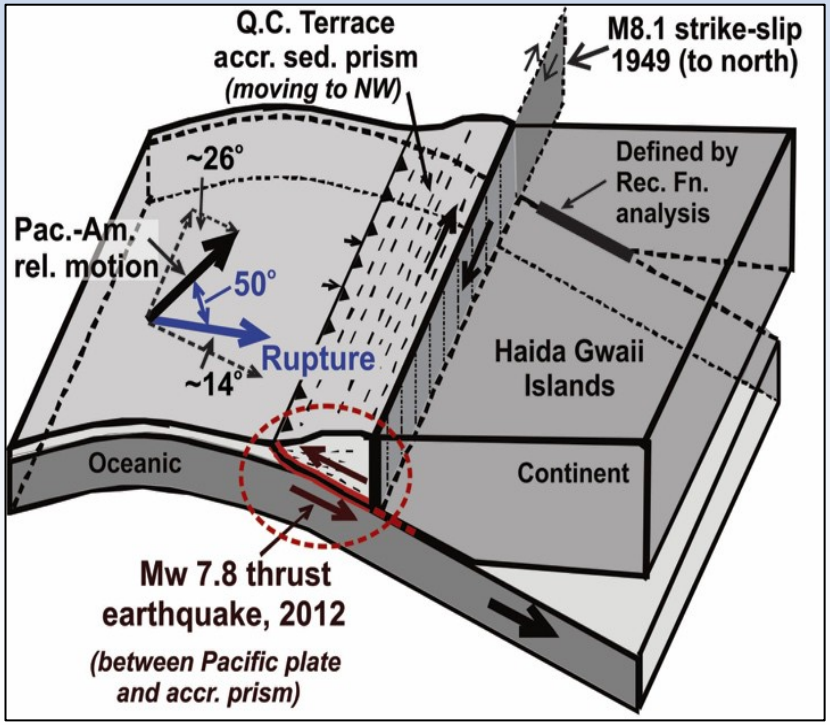
No previous active faults ID in Canada

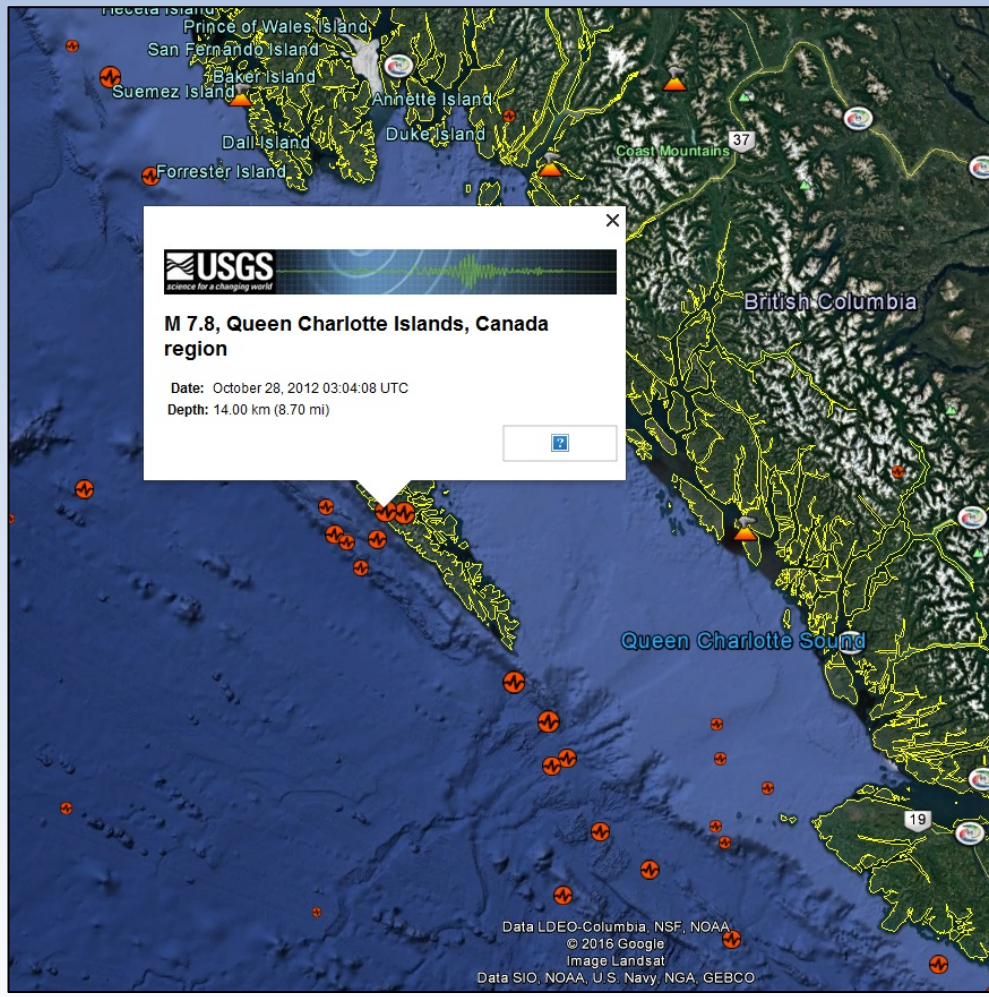
Recent lidar, field work, & paleoseismic trenching
→ large (M6-7) late Quaternary Eq on Leech River Fault

Proposed:
Expand lidar, seismic, GPS
→ fieldwork, trenching
→ ID other active crustal faults in western (and NW) Canada

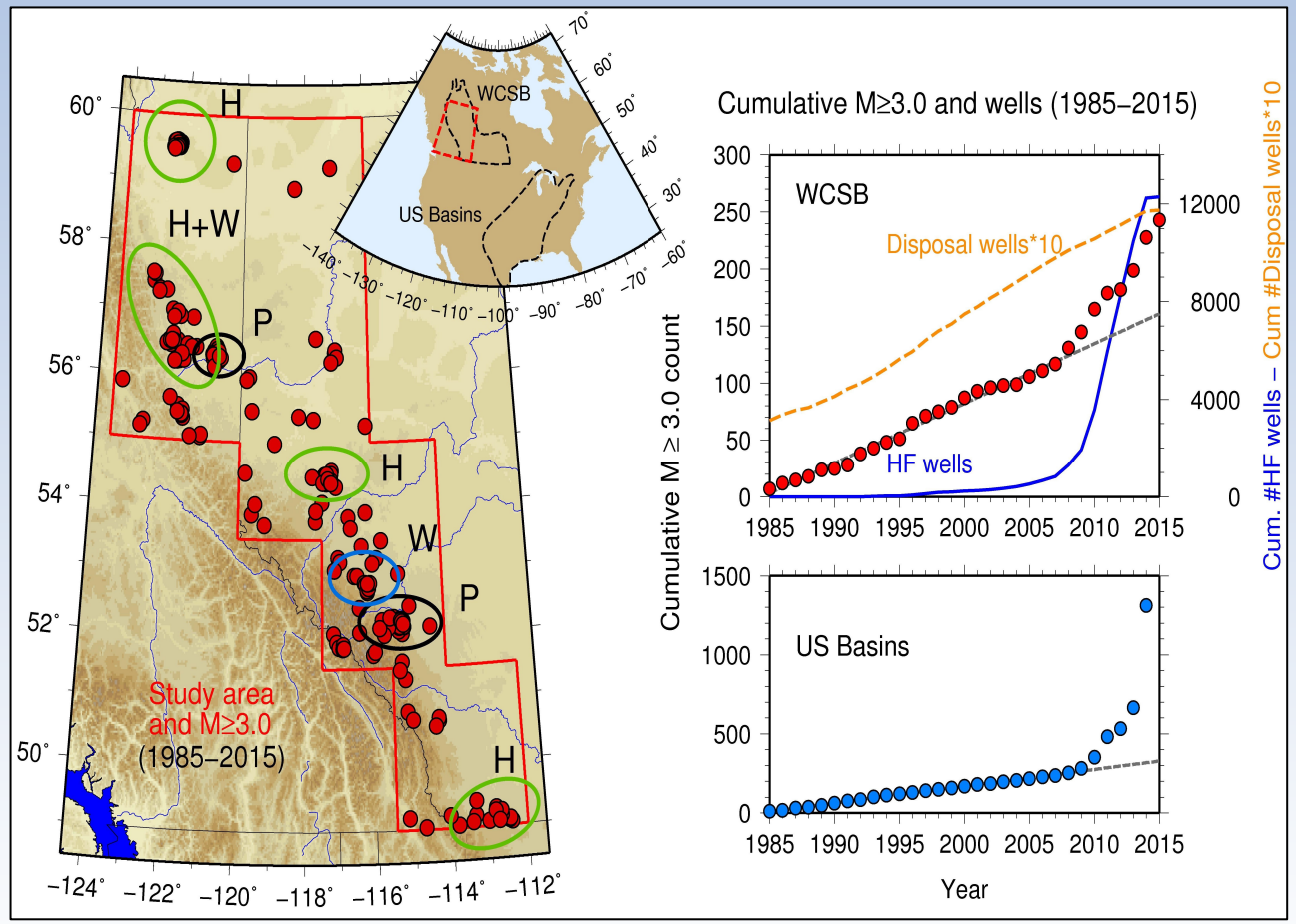
Subduction initiation

Haida Gwaii Margin
-partition of oblique convergence into strike slip
-2012 thrust Eq
(Hyndman et al 2014)





Induced seismicity; eastern margin Canadian Cordillera

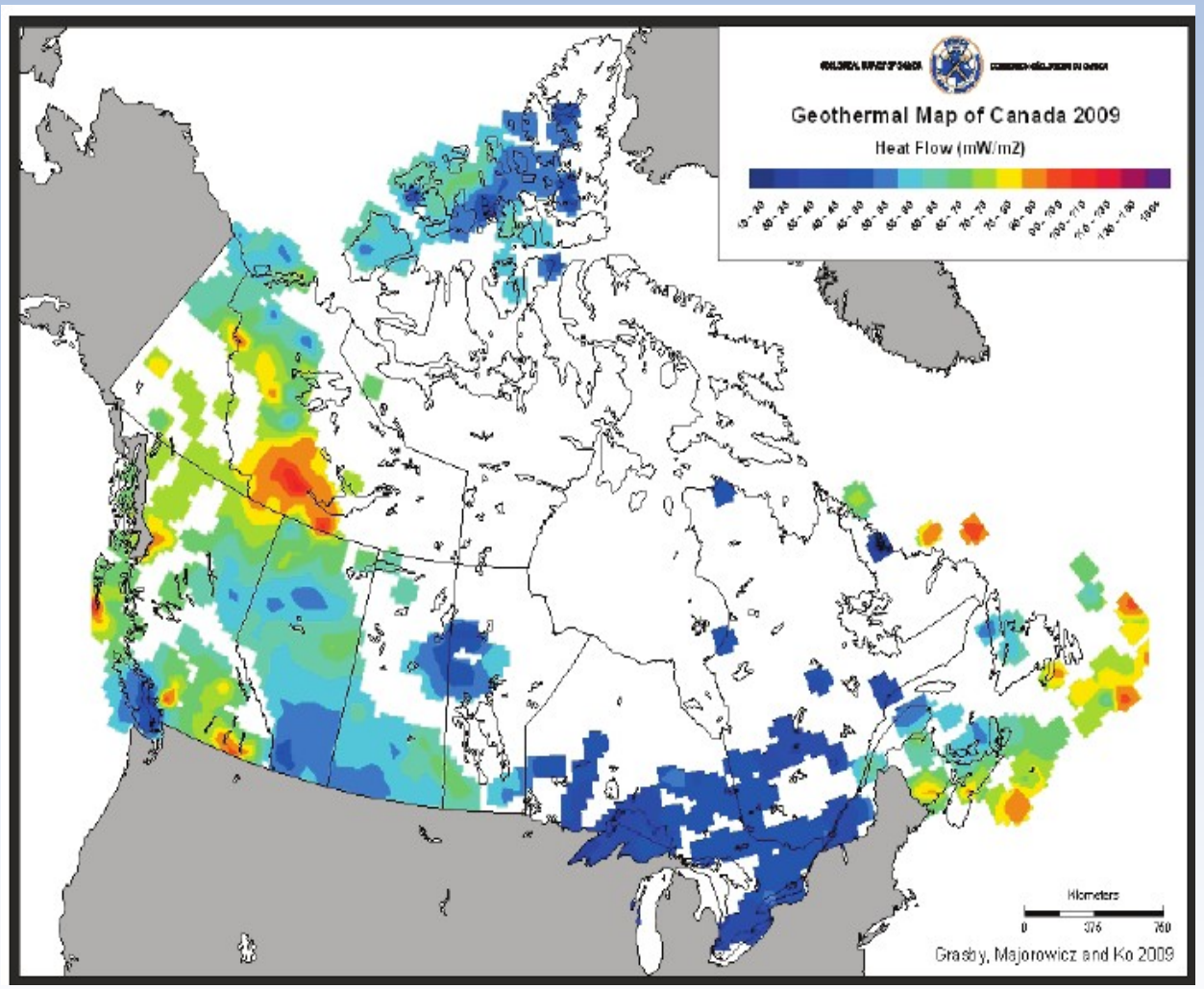


(Atkinson et al 2016)

Ovals – seismicity attributed to:
Hydraulic fracturing (H)
Wastewater injection (W)
Production (P)

Grey line – expected rates for stationary process

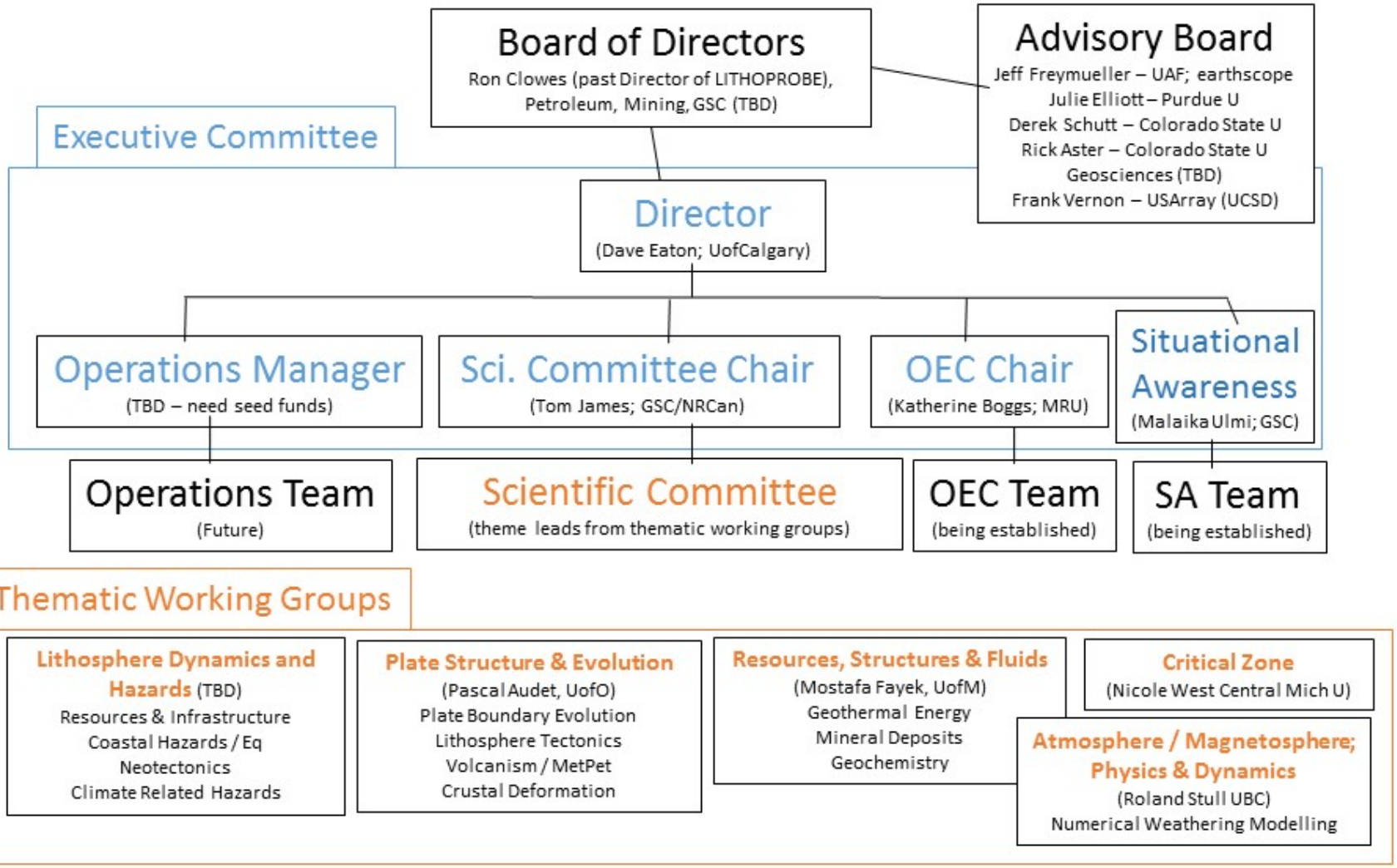
Heat Flow Map: Geothermal Energy Potential



NOTE:
Gaps &
Bright spots:
S Cordillera
W Coast BC

(Grasby et al 2009)

CCArray Proposed Organizational Structure

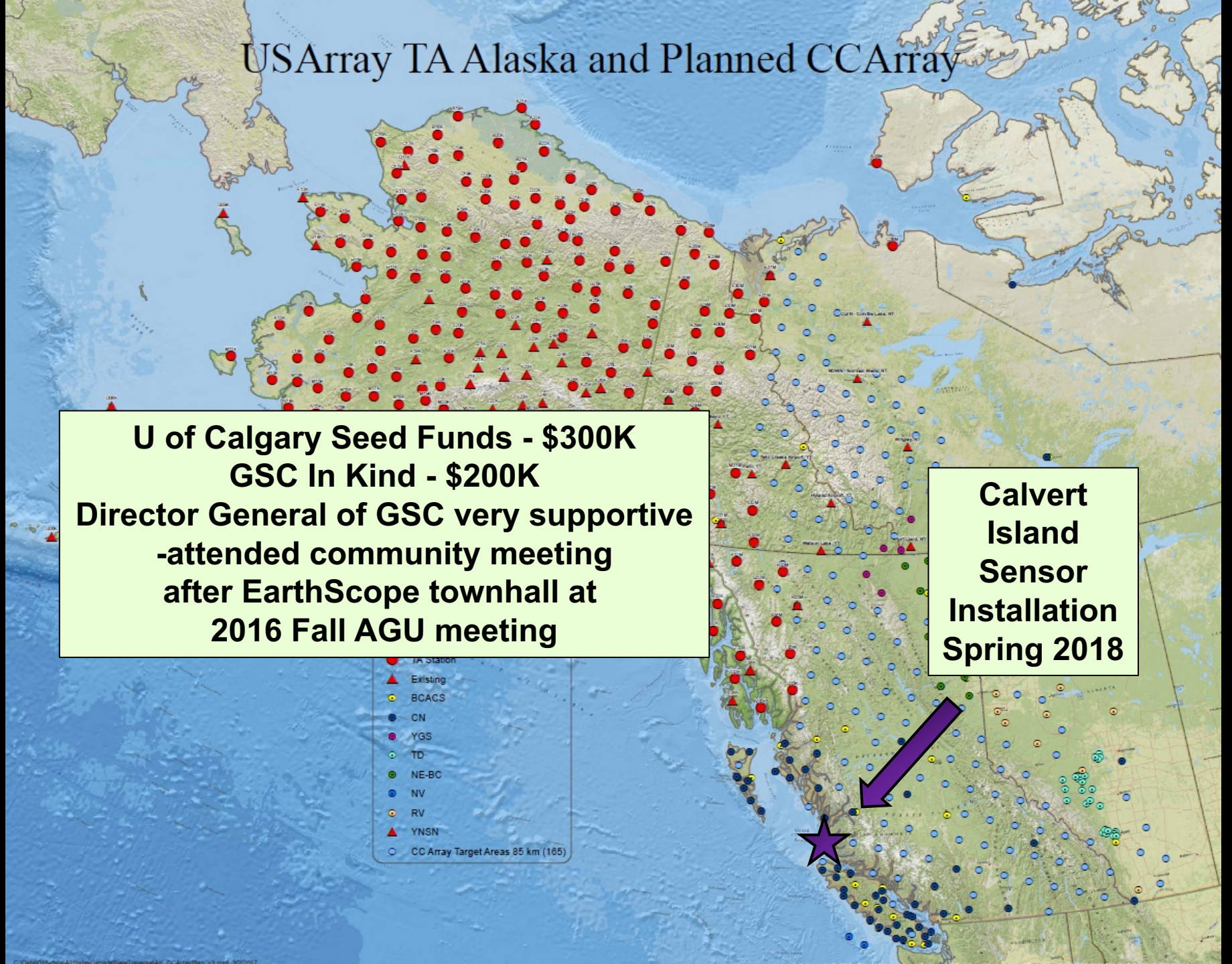


ccarray.org

Home

Updated: CCArray scientific workshop

August 16-18, 2017
Pacific Geoscience Centre, Sidney, British Columbia, Canada


USArray TA Alaska and Planned CCArray
U of Calgary Seed Funds - $300K
GSC In Kind - $200K
Director General of GSC very supportive
-attended community meeting
after EarthScope townhall at
2016 Fall AGU meeting
Calvert
Island
Sensor
Installation
Spring 2018
TA Station
Existing
BCACS
CN
YGS
TD
NE-BC
NV
RV
YNSN
CC Array Target Areas 85 km (165)

Next Steps?

- AGU – CCArray breakfast – Wed Dec 13
- Presentation during AGU EarthScope townhall (Dec 13) and AGU CZO townhall
- Scientific planning workshop, funding application writing and executive meeting – Ottawa, Feb 2018
- Pursuing funding from NSERC, CFI, NSF and provincial/territorial funding agencies

FUTURE? Roll east? Across north?? St Lawrence Seaway and the Charlevoix Structure??

Takeaways

1. **Community building** – intrigued?

   Want to be involved?

   Is there someone else who we should talk to?

2. **Ideas for "grand" research questions?**

3. **Are there other applications to these proposed stations that would benefit your research?**

4. **Comments, suggestions?**

5. **Please spread the word**

Please contact one of the authors (or Katherine Boggs at kboggs@mtroyal.ca)