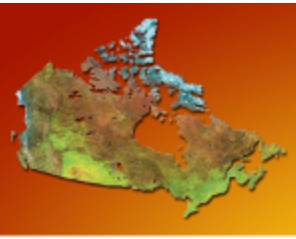
Canadian Hazards Information Service (CHIS)

and

Seismic Networks in Canada

Tim Côté
Canadian Hazards Information Service
Natural Resources Canada (NRCan)

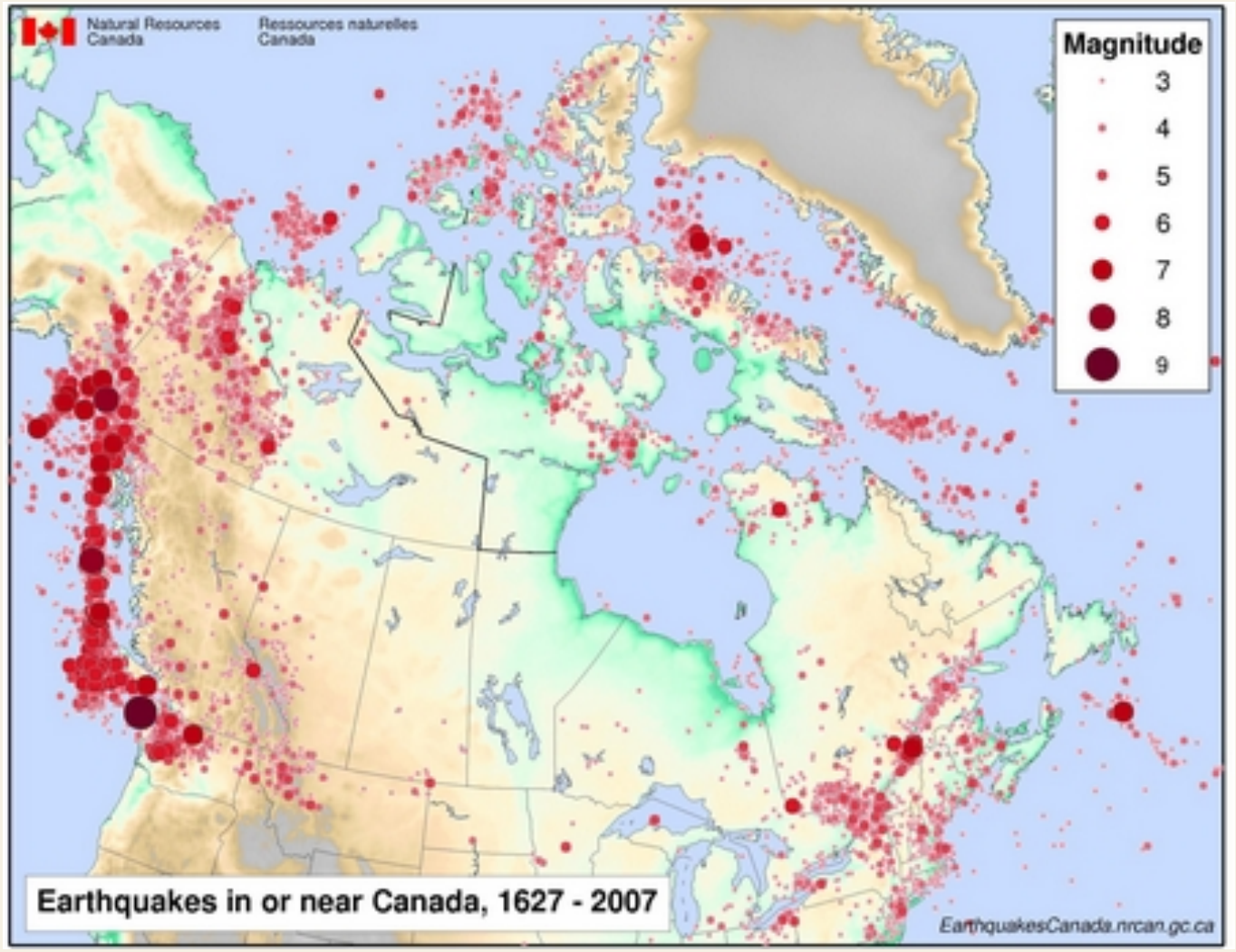
Antelope Users Group meeting
Reno, Nevada
October 23-25, 2012

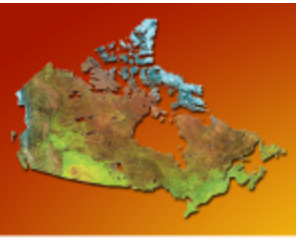


What We Are Part Of

- Natural Resources Canada (NRCan) – federal government
  - Earth Sciences Sector
    - Geological Survey of Canada (GSC-AWCB)
      - Canadian Hazards Information Service (CHIS)
        - Earthquakes Canada
- What is CHIS involved in? – Natural Hazards
  - Earthquake Monitoring – Earthquakes Canada
  - Geomagnetic Monitoring
  - Space Weather Forecasting
  - Nuclear Emergency Response
    - Providing real-time mapping of radiation release
  - Tsunamis and Landslides
  - Nuclear Explosion Monitoring
- Other groups in NRCan but outside CHIS that do more research
  - CHIS focus: operating the seismic network, locating eq's, eq catalog

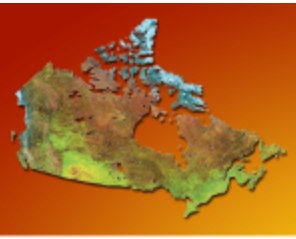
Earthquakes in or near Canada





Mandate

- **Canadian Hazards Information Service Mandate**
  - "the provision of information on the actual or probable occurrence and intensity of earthquakes".
- From the Emergency Management Act
- Clients:
  - Federal, provincial, and territorial Emergency Management Organizations (EMOs)
  - Critical Infrastructure (CI) operators
  - Media
  - Canadian public



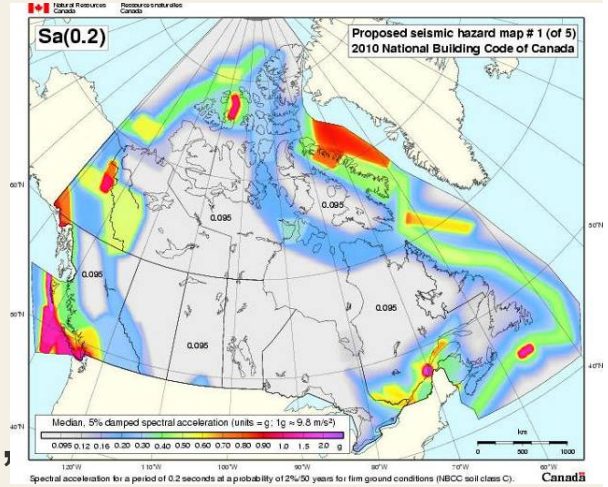
CHIS Seismology Staff and Budgets

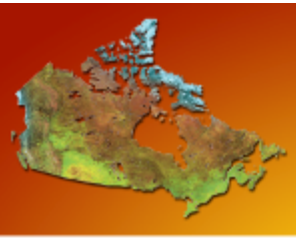
- 4 offices (Ottawa, East Ottawa, Sidney, Yellowknife)
- 3 seismologists + 1 contractor
  - Recently lost 1 seismologist and 1 contractor
- 5 Scientists (plus other researchers for on-call work)
- 6 IT specialists plus Acting IT manager
- 11 Field technicians plus Acting Field Operations manager

- ~$500k per year plus one time “capital” requests
  - Lost $750k per year plus 2 IT staff to Shared Services Canada (consolidate IT data centres & communications)
  - Salary costs not included

CHIS Earthquake Responsibilities

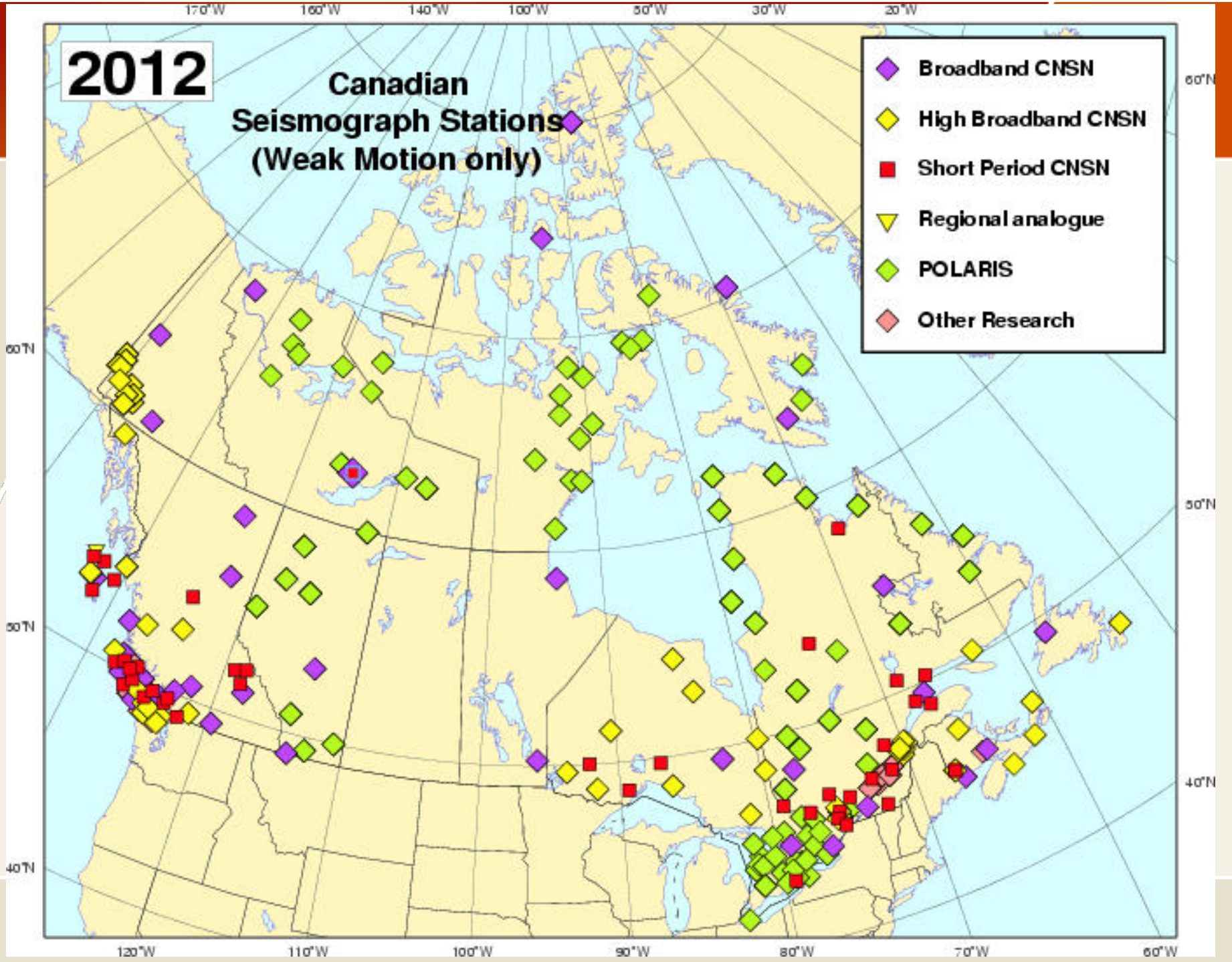
- Seismic Monitoring
- Collaboration with other agencies – data exchange
- Rapid Response for Earthquake Info
- Public Information
- Earthquake Hazard Assessment
  - Seismic hazard zoning maps
    - National Building Code
  - Advice for Critical Infrastructure
    - Hydro dams, Nuclear power plants
    - Pipelines, power transmission lines,

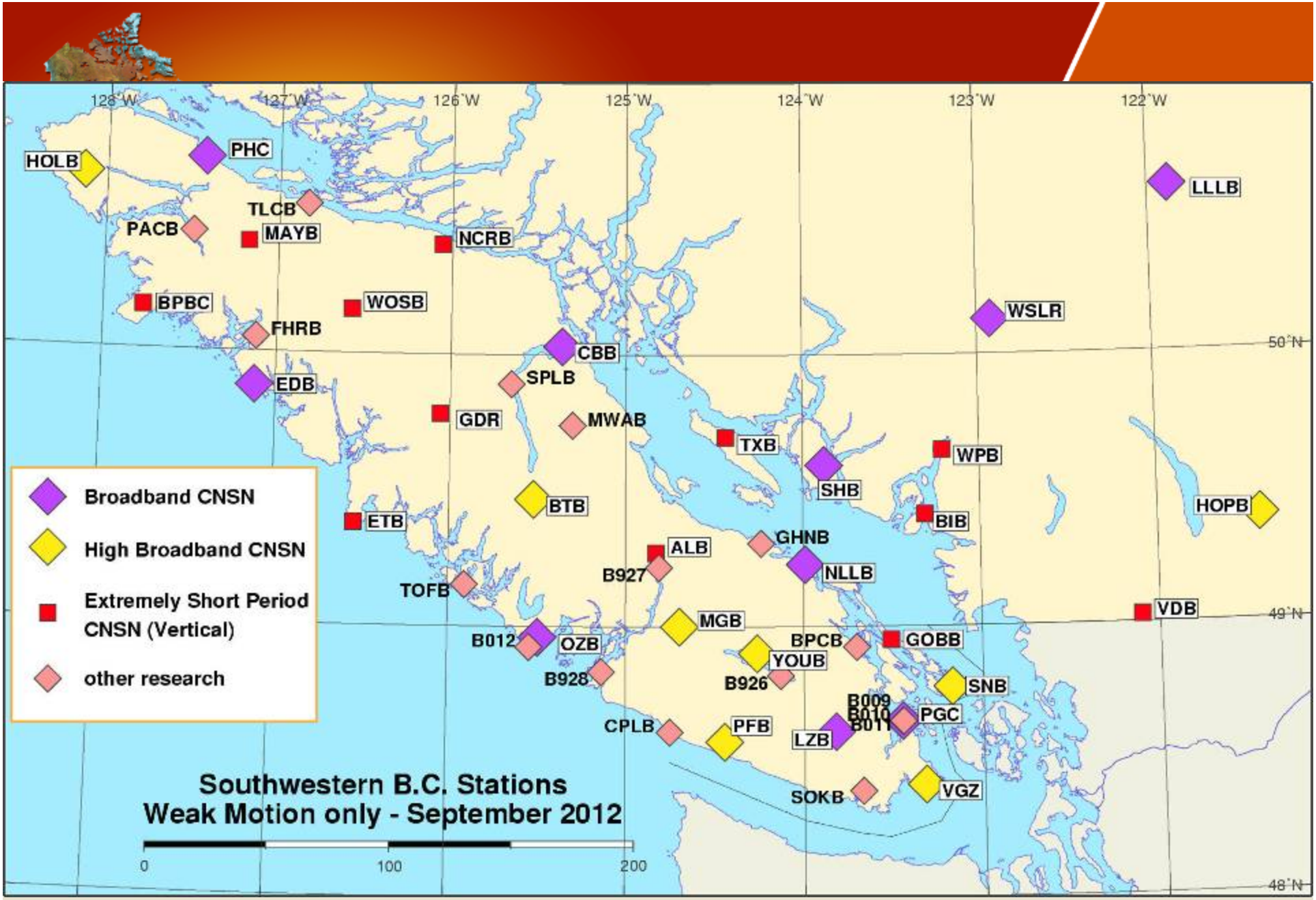




Seismic Monitoring - Inputs

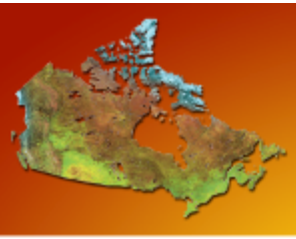
- Continuous, real-time, weak-motion data from:
  - Canadian National Seismograph Network (CNSN)
    - ~160 Observatory-grade, permanent stations
    - Refresh network in coming years
  - Other special deployments within NRCan
    - ~60 temporary stations, e.g. ETS, PISA, SL
  - University stations from POLARIS Network
    - ~55 Portable, temporary stations for research
- Strong motion monitoring
  - ~120+ stations in Canada


2012
Canadian
Seismograph Stations
(Weak Motion only)
Broadband CNSN
High Broadband CNSN
Short Period CNSN
Regional analogue
POLARIS
Other Research
170°W
160°W
140°W
100°W
50°W
30°W
20°W
60°N
50°N
40°N
120°W
110°W
100°W
90°W
80°W
70°W
60°W



Natural Resources Canada | Ressources naturelles Canada

Canada



Seismograph Equipment

- Yellowknife array – 18 SP & 4 BB sites, upgrade to Guralp in progress
- Three main types of equipment used in CNSN
  - Digitizers designed in house and use CNSN protocol – cnsn2orb
  - ~40 SPD Vertical-only Short Period sampled at 100 s/s
    - S13 seismometers
  - ~10 GD1 3 Component Broadband sampled at 40 s/s
    - Guralp CMG 3ESP & 3T seismometers; STS1 seismometers
      - Various bandwidths 50Hz - 30s, 60s & NSN; 360s for STS1
  - ~60 GD2 3 Component Broadband sampled at 40 or 100 s/s
    - Guralp CMG 3ESP, 3T, 40T seismometers
      - Various bandwidths 50Hz - 30s, 60s, 120s, 360s & NSN; 360s for STS1
    - MB2000 microbarometers for infrasound
- 3C BB Libra/Trident & Taurus digitizers (40 or 100 s/s) – convert to CNSN
  - Guralp CMG 3ESP and Nanometrics Trillium seismometers
    - Various bandwidths 50Hz - 60s, 100s (POLARIS standard), 120s

NCRB & WOSB in British Columbia

elles

ULM Seismic Station in Manitoba

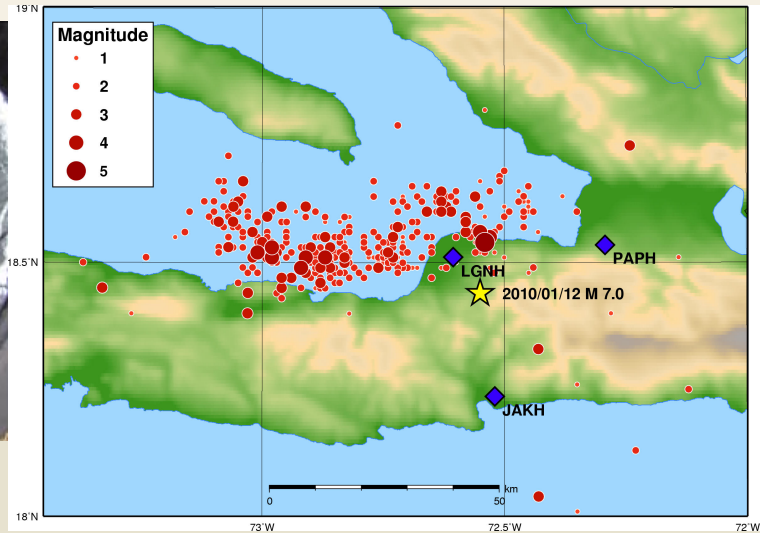
Polaris KSVO Station

Other Deployments

June 23, 2010 Val-des-Bois Aftershock deployment

Val-des-Bois real-time station, installed July 24, 2010

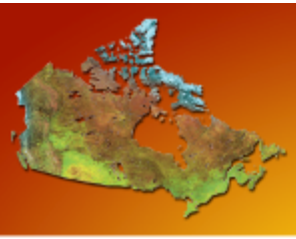
Feb 2010 Haiti Deployment



Natural Resources Canada | Ressources naturelles Canada

Strong Motion Monitoring

- ~100 Internet Accelerometers
  - ia2orb for data access
- Some Nanometrics Titan
  - At Libra or Taurus weak-motion sites
- ~20 Kinemetrics Altus Etna
  - Non-realtime
- Future – increase in strong motion stations
  - collocated with weak motion stations



Seismic Monitoring - Telecommunications Network

- Acquisition of continuous, real-time CNSN data requires operation of a national telecommunications network (SeisWAN) involving 30+ VSAT satellite links, UHF/VHF radio, spread-spectrum radio, dedicated telephone/ modem links, cell modems, T1 links, Frame Relay links, and the Internet.
- Heterogeneous on purpose!
- ~60 Nanometrics Libra stations in CNSN and POLARIS use Carina Hub for master earth station and NAQS software which is then converted to CNSN protocol. Will replace NAQS with ApolloServer & SeedLink feed.

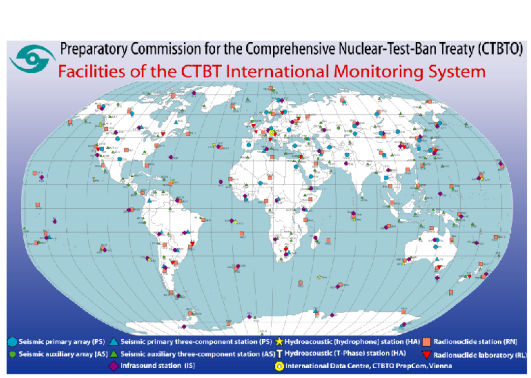
Seismic Monitoring - CHIS Data Centres

Two data centres: Ottawa, Sidney

- Parallel Operation
- Redundant Systems & Communications
- Change control procedures
  - 2 man rule, in-house ticket tracking system
- Operate on a 24x7 basis with on-call IT systems staff
- Legacy systems – Sparc/Solaris with in-house software
- New systems – Intel/Linux CentOS with Antelope & Nanometrics software

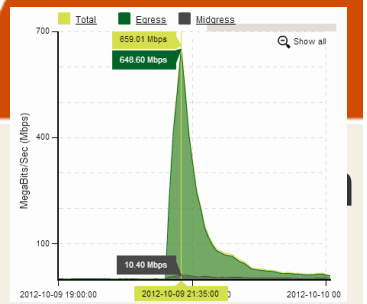
- Acquire, process and archive over 4 GB/day of waveform data
- Waveform Archive (~20 TB and growing) – sync'd between data centres
  - Channel or station day files, internal or mini-seed format
- National Earthquake DataBase (catalogue), Ingres RDBMS moving to Postgres
- Automatic and analyst reviewed processes to locate earthquakes

Collaboration with Other Agencies – Data Exchange



- Forward real-time data from 10 IMS stations to CTBTO in Vienna (under contract with SLA's)
- Disseminate Wave Form and Earthquake data to other agencies and researchers including:
  - Tsunami Warning Centres
  - USGS
  - IRIS
  - US Regional Networks
- Import and export via various formats
  - CD1.x, orb2orb, earthworm, seedlink, NMXP/NP, etc
- Earthquake Catalogue
  - Sent to ISC when complete
  - Bulletins from US networks imported via Antelope
  - Working towards better real-time integration with USGS

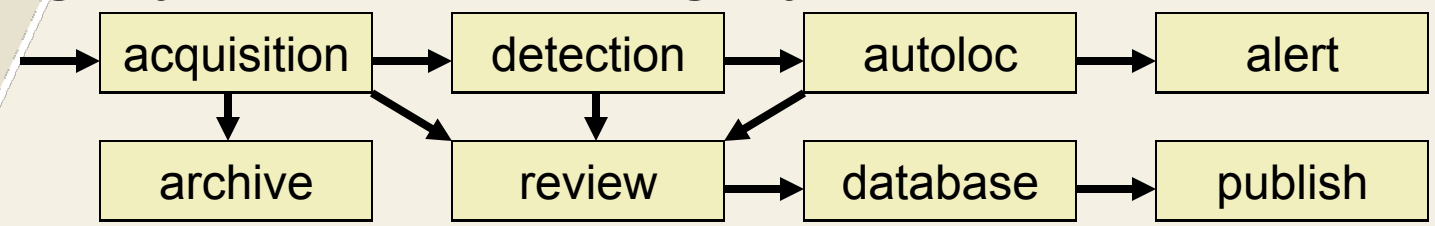
Rapid Response for Earthquake Info and Public Information



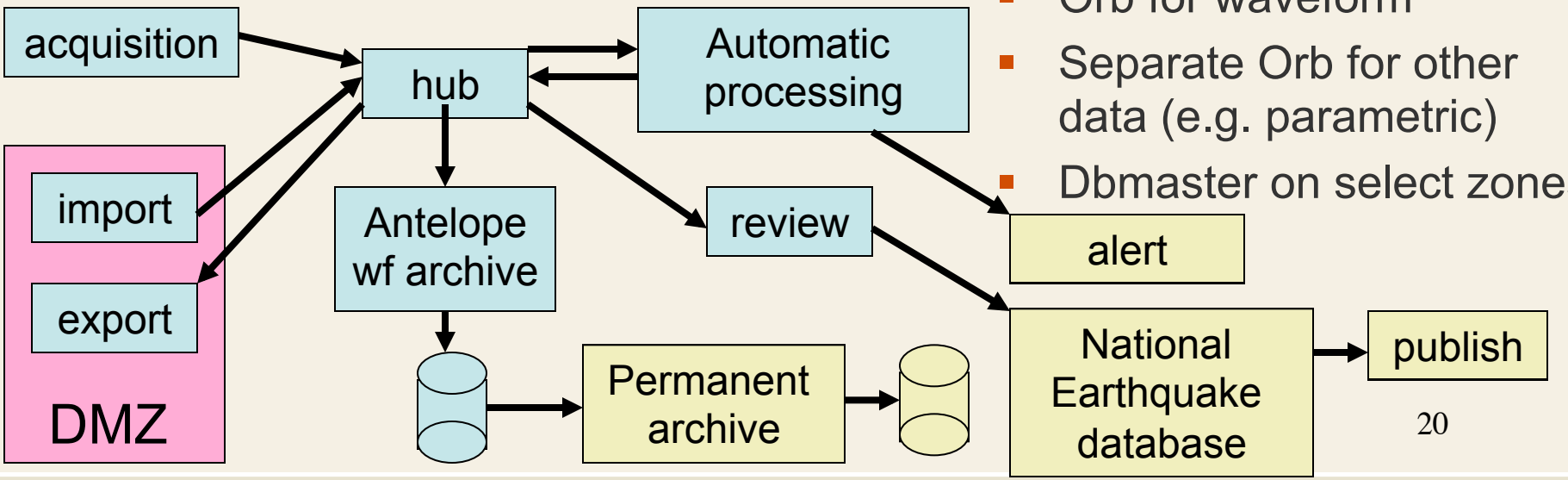
- 24x7 on-call seismologists provide rapid information on earthquake location, magnitude, aftershocks
- Earthquake reports, maps & lists @ www.earthquakescanda.ca, DYFI
- Tweet automatic and reviewed earthquake notifications on Twitter
  - English: @CANADAquakes, Français: @CANADAseisme
- AENEAS (Automated Event Notification and Eq Alert Service)
  - Alerts Customized for client's facilities and thresholds
    - sent via email, scp, SMS, ftp, fax
  - e.g. "STOP/SLOW TRAIN" alerts sent to railways within minutes
- Earthquake alerts to Multi-Agency Situational Awareness System (MASAS) using open standards, e.g. Common Alerting Protocol (CAP)
  - sharing of location-based situational awareness information and alerts between issuers, first responders & emergency management agencies

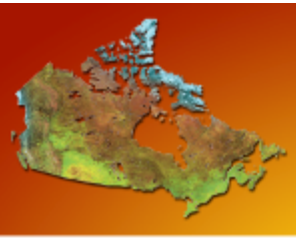
Processing System

- Legacy Data Processing System – developed in-house



- Current Sidney Antelope 4.x System – all on one computer
- New Antelope 5.2 System – partially implemented
  - Orb for waveform
  - Separate Orb for other data (e.g. parametric)
  - Dbmaster on select zones





Challenges & Future Issues

- Validating station response that is created with dbbuild.
  - Currently create dbmaster from Ingres reference database
- Configure dbloc2, dbpick and location programs to work for Ottawa office.
- Configure all desired magnitudes (e.g. Mn) with dbevproc
  - save amplitude and period info.
  - view and manipulate automatic amplitude and period “picks” for magnitude.
- Handle felt flag, blast flag and event comments.
- Transfer of events (or entire catalogue) to and from existing Ingres reference database
- Configure orbassoc for automatic locations of events in Canada
- Move non-Antelope tasks (e.g. alerting) into Antelope
- Add shakemap product
- Handle future seismograph network upgrades