SCEK 2013-2014 Final Report for Year 2 of the Induced Seismicity Monitoring Project (ISMP)

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Contents

Background

A research consortium was created in 2012 between Geoscience BC, the Canadian Association of Petroleum Producers (CAPP), the BCOGC and NRCan to help improve the accuracy of the Canadian National Seismograph Network (CNSN). The consortium's mandate is to collect, interpret and make public the data collected from the installation of six new seismograph stations and to complement the pre-existing CNSN network (Figure 1). The *Induced Seismicity Monitoring Project* (ISMP) has $1 million in funding from 50/50 equity partners Geoscience BC and the SCEK Fund with in-kind support from CAPP, BCOGC and NRCan. The project has a mandate to monitor induced seismic activity for a total of five years (until June 2017) with an interim review scheduled for June 2014 to assess the project's performance.

This project helps address two recommendations from the BC Oil & Gas Commission's (BCOGC) report, titled *Investigation of Observed Seismicity in the Horn River Basin (2012),* firstly to help improve the accuracy of the CNSN; and secondly to study the relationship between the hydraulic fracturing and seismicity.

The project is managed by joint Steering and Technical committees largely comprised of representatives from each of the partners. There are four members from each of the partners in the Steering Committee, and its role is to oversee general project direction and execution with respect to the MOU and to provide financial guidance to the Technical Committee. A Communication Plan has been drafted by the Steering Committee to aid in regular stakeholder communication along with missives which may be necessary in response to an anomalous induced seismic event. At present, all events registered by the network are published on the NRCan website: http://www.earthquakescanada.nrcan.gc.ca/index-eng.php.

The Technical Committee's mandate is to oversee operation and maintenance of the seismographs and review and advise on all technical aspects relating to the project. The Technical Committee comprises seven individuals: three from industry, one academic and three from various government agencies (NRCan, BCOGC and the Alberta Geological Survey). During the initial installation and testing stages both committees are meeting on a quarterly basis.

Summary of Activities

Six seismographs were installed in late March 2013 by Nanometrics. The first four months were technically dedicated to ensure the instruments were properly set up to optimize the signal-to-noise ratio and gain levels and optimizing accuracy. The network was fully integrated into the Canadian

National Seismic Network (CNSN) by mid-August 2013 and now provides real-time data to the Geological Survey of Canada's earthquake location operation. The results from analysis are posted on the Earthquakes Canada website: http://www.earthquakescanada.nrcan.gc.ca/index-eng.php.

The network is currently attaining 1 to 5 km epicentre accuracy, with posting of the analyses on the Earthquakes Canada website usually within one day of the seismic event(s). The network's accuracy should be further improved with the placement of two new stations by NRCan in 2014-2015, one of which will be located within the Montney gas fairway.

In late 2013, the Technical Committee made two recommendations to improve the network:

1. Hire a dedicated seismologist to reside at NRCan's Sidney, British Columbia office and report directly to the consortium. The seismologist's responsibilities would include real-time analysis of events within the project area, recommend improvements to the enhanced network and perform project-specific research.

2. Acquire a rapidly deployable portable dense array to complement the existing enhanced network. The purchase of this portable array would allow accurate depth-to-event (hypocentre) resolution and quick deployment to new event (or high risk) areas which would help in causal determination of the event (induced vs. naturally occurring).

On February 26, 2014, the Steering Committee approved the budget for a dedicated project seismologist for the upcoming year of the ISMP. Budgetary approval of this position beyond one year will necessitate further discussion. The recommendation for a portable dense array, although technically viable, will require further discussion with respect to whether it fits the original project scope and dialogue on funding options.

Results and Discussion

Since installation of the six additional seismographs into the CNSN, a total of 149 low-level events (most <2.5 M_L) have been recorded throughout northeast B.C. The data captured from Year 2 has been displayed as a suite of deliverables which can be seen in Figures 1-3 and in Appendices A-J.

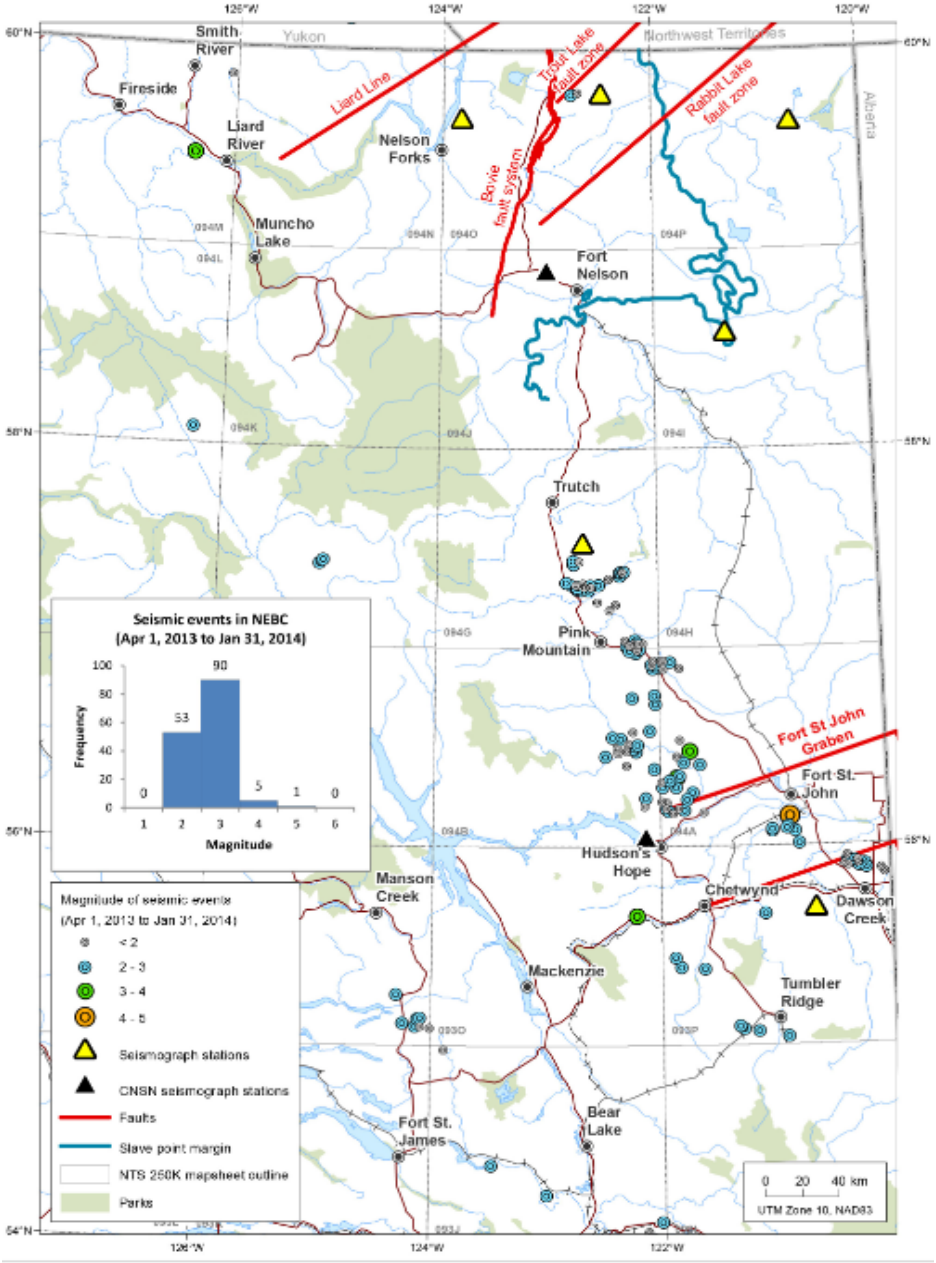

Figure 1. All seismic events captured by the enhanced seismic network from April 1, 2013 to January 31, 2014.

The majority of the events lie within the 2.0-3.0 M_L range with a mean of 2.25 M_L and a standard deviation of 0.46 M_L – meaning that 68.2% of the events lie between 2.72 M_L and 1.78 M_L magnitude (Figure 2). Seismic events within that range (1.78-2.72 M_L) are generally not felt on surface. The largest event (4.2 M_L) was recorded on May 27, 2013 and was felt on surface in the city of Fort St. John.

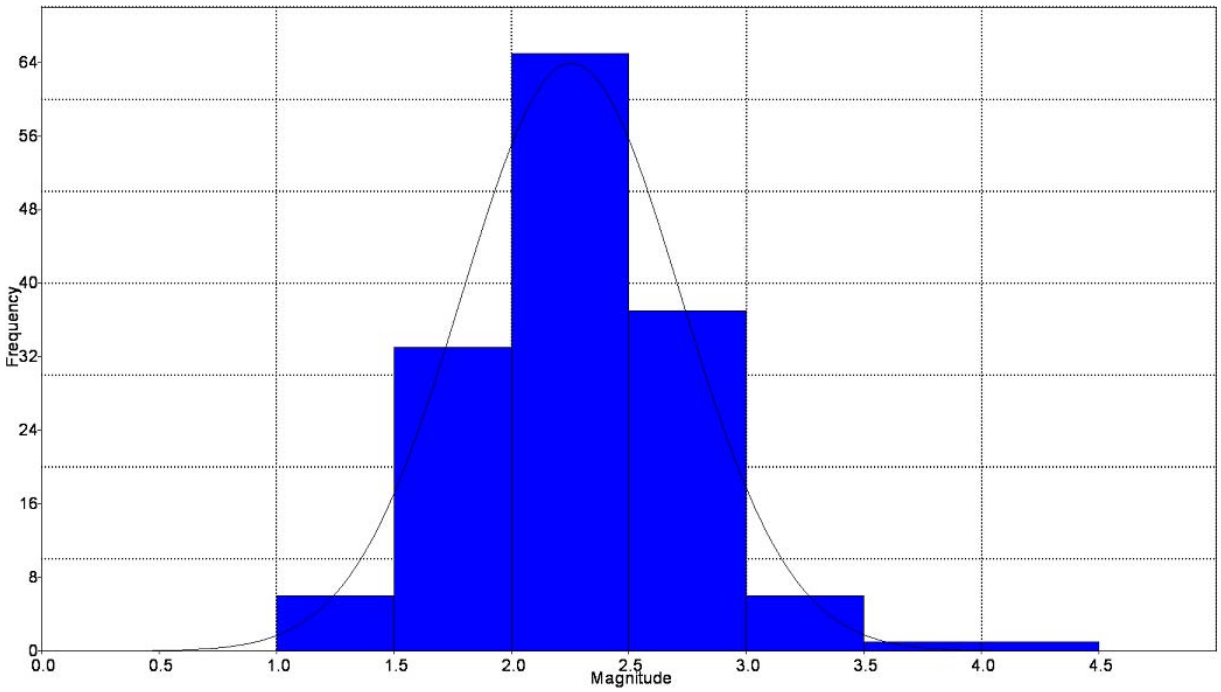

Figure 2: Frequency vs. Magnitude histogram for all seismic events captured by the enhanced network from April 1, 2013 to January 31, 2014

It is estimated that the current detection limits of the enhanced network could be as low as 1.5 M_L, but with the collection of almost a year's worth of data, it is becoming apparent that the data is likely artificially skewed towards the higher magnitudes. The improvement in the lower threshold detectability is possibly not reflected due to (Dr. Honn Kao, pers. comm.):

1. the initial CNSN detection is automatically generated and utilizes a conventional short-time-window vs. long-time-window amplitude ratios methodology. This methodology works well for relatively larger events that may have seismic hazard implications, which is the primary mandate of the CNSN. However, for smaller events whose amplitudes approach background noise level, its performance is much poorer – hence detection of smaller events is compromised; and/or,

2. all events listed in NRCan's earthquake catalog must be reviewed by a seismologist whose prime focus is the analysis of events which have seismic hazard implications; as such, verification of smaller events (especially those not picked up by the automatic detection system) is severely backlogged and ultimately may never get reviewed. The net result is that smaller events (those smaller than 2.5 M_L) are most likely under represented.

Events captured by the network have been also tabulated on a monthly basis along with its corresponding frequency histogram (Appendices A-J).

The OGC is currently using the network to aid them with regulatory decisions with respect to potential induced seismicity. Generally speaking, induced seismicity is usually characterized by clustered events of low magnitude, while naturally occurring events tend to be larger and not clustered (other than those aftershocks from a large event). At present, the OGC has noted seven areas with a high incidence of low-level seismicity (Caribou, Beg, Town, Graham Altares, Doe-Dawson and Septimus; Figure 3).

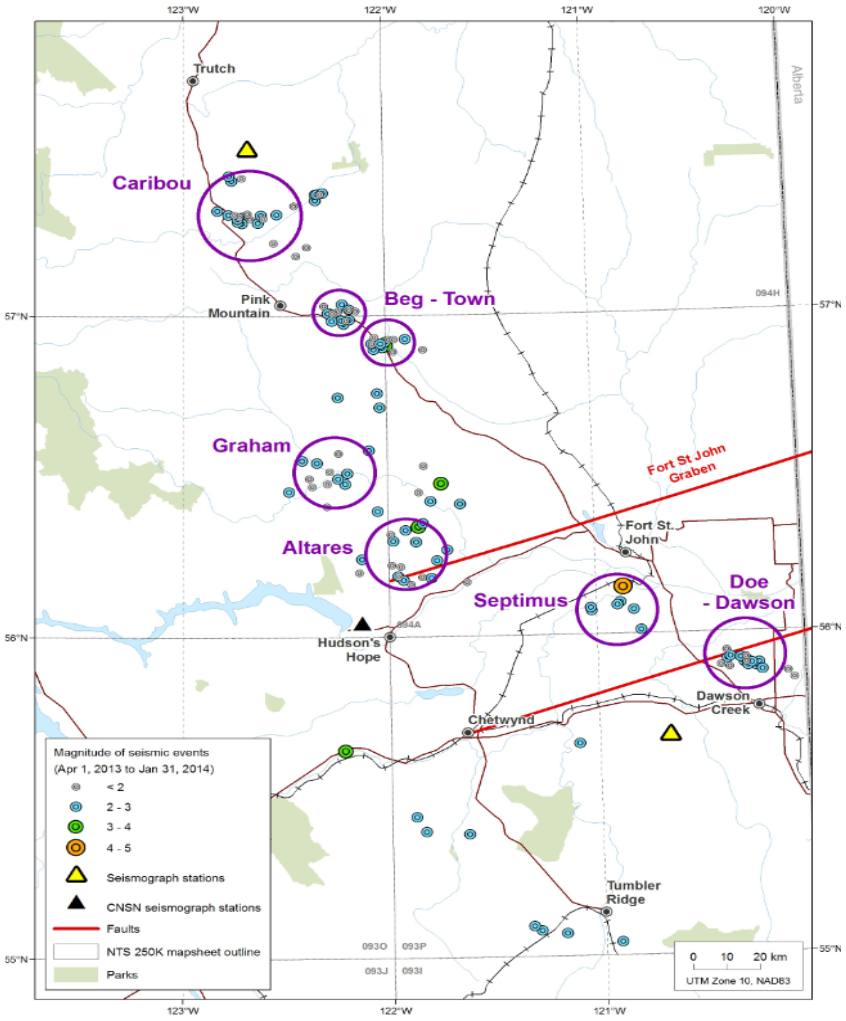

Figure 3. BCOGC-defined areas with a high incidence of low-level seismic activity

Communications

Project communication is guided by an internal Communication Plan for the consortium members (Appendix K).

Throughout the past year, members of the consortium have presented the following presentations and papers:

Carlos Salas

- Salas, C.J., Walker, Dan; Johnson, Jeff; Kao, Honn (2013). *Creating a regional seismograph network in NEBC to study the effect of induced seismicity from unconventional gas completions*. Unconventional Gas Technical Forum, Victoria
- Salas, C.J., Walker Dan; Johnson; Jeff; Kao, Honn (2013). *Developing a regional seismograph network in NEBC to study the effect of induced seismicity from oil & gas operations*. CSEG-CGF-MUG Induced Seismicity Forum, Calgary
- Salas, C.J. and Walker, D. (2014): Update on regional seismograph network in northeastern British Columbia (NTS 094C, G, I, O, P); *in* Geoscience BC Summary of Activities 2013, Geoscience BC, Report 2014-1, p. 123–126.

Dan Walker (BCOGC)

- Sept 12-14, 2012, SPE/SEG meeting, Broomfield Colorado, short talk
- Sept 21, 2012, MUG (Microseismic User Group), Calgary, lunchtime talk
- February 7, 2013, Spectraseis Open House, Calgary, 30 min talk
- March 1, 2013, U of C Microseismic Industry Consortium, Calgary, 30 min talk and panel discussion
- Spring, 2013, OGC internal talks, FSJ and Prince George (McLeod Lake Indian Band)
- November 2, 2013, US National Research Council meeting, Washington DC, 20 min talk
- Nov 22, 2013, CSEG-MUG, Calgary, 20 min talk and panel discussion

Media

- Lamars, Matt. *Did you feel that? Probably Not.* Dec.5, 2013, Dawson Creek Daily News

GBC Communications

- “Northeast BC Regional Seismographic Network” brochure; available at CSUR Conference, October 9-10, 2013.
- 2-page non-technical article in Geoscience BC’s 2013 Annual Report (formerly called “Explorer Magazine”)
- Mention of ISMP in one-page brochure: “Oil & Gas Projects” and tri-fold brochure: “From the Ground Up”

Contact

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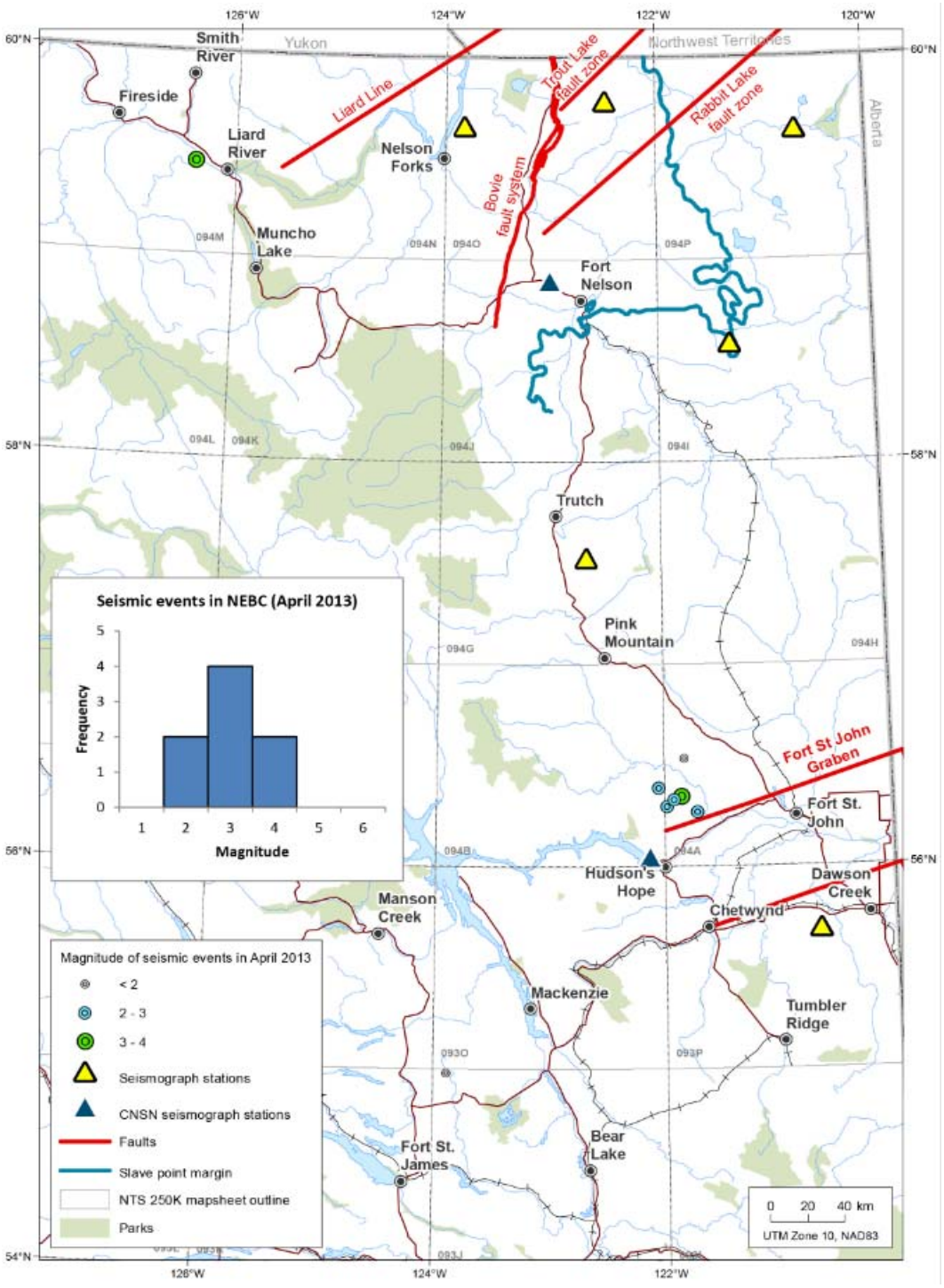
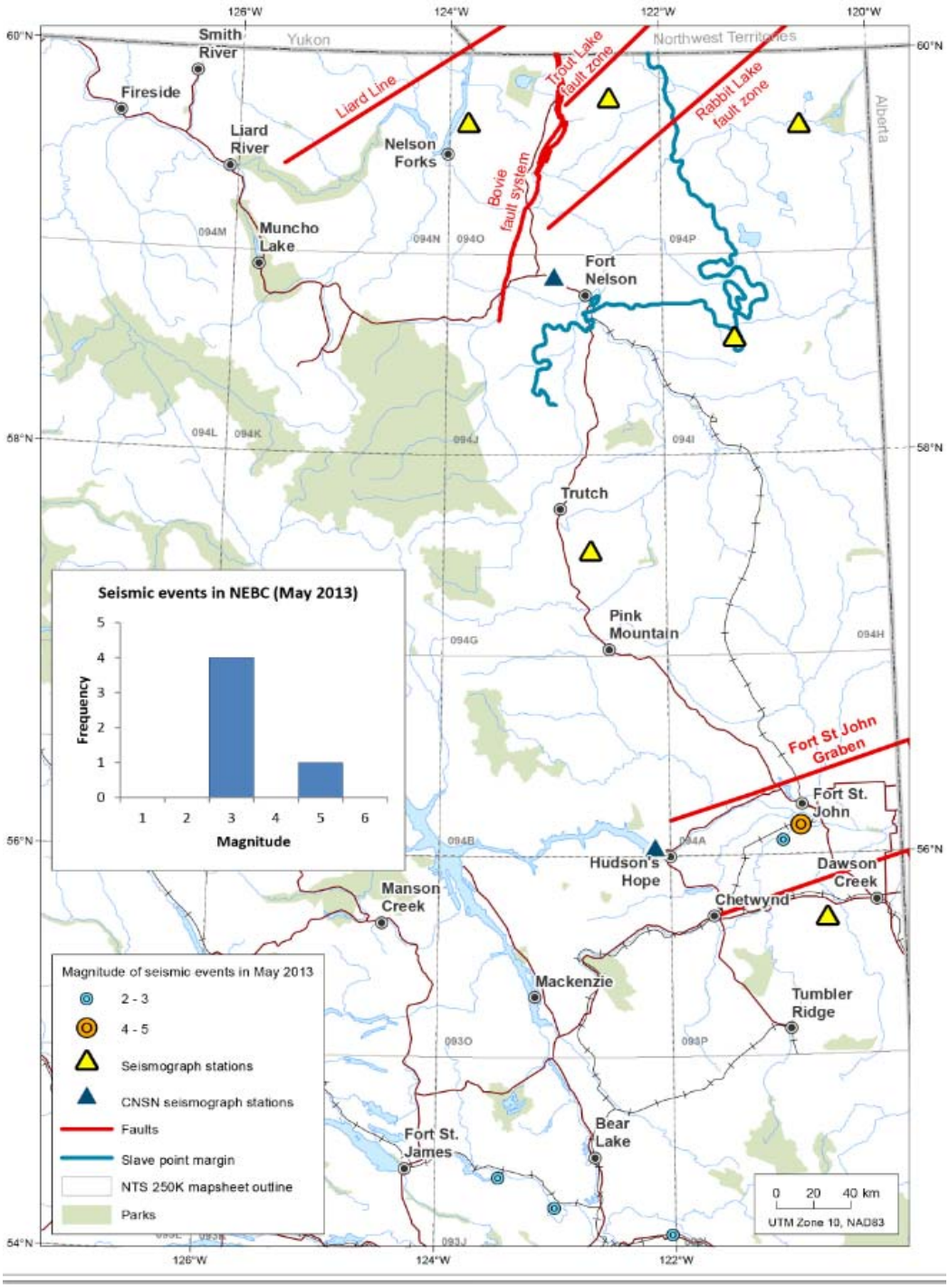
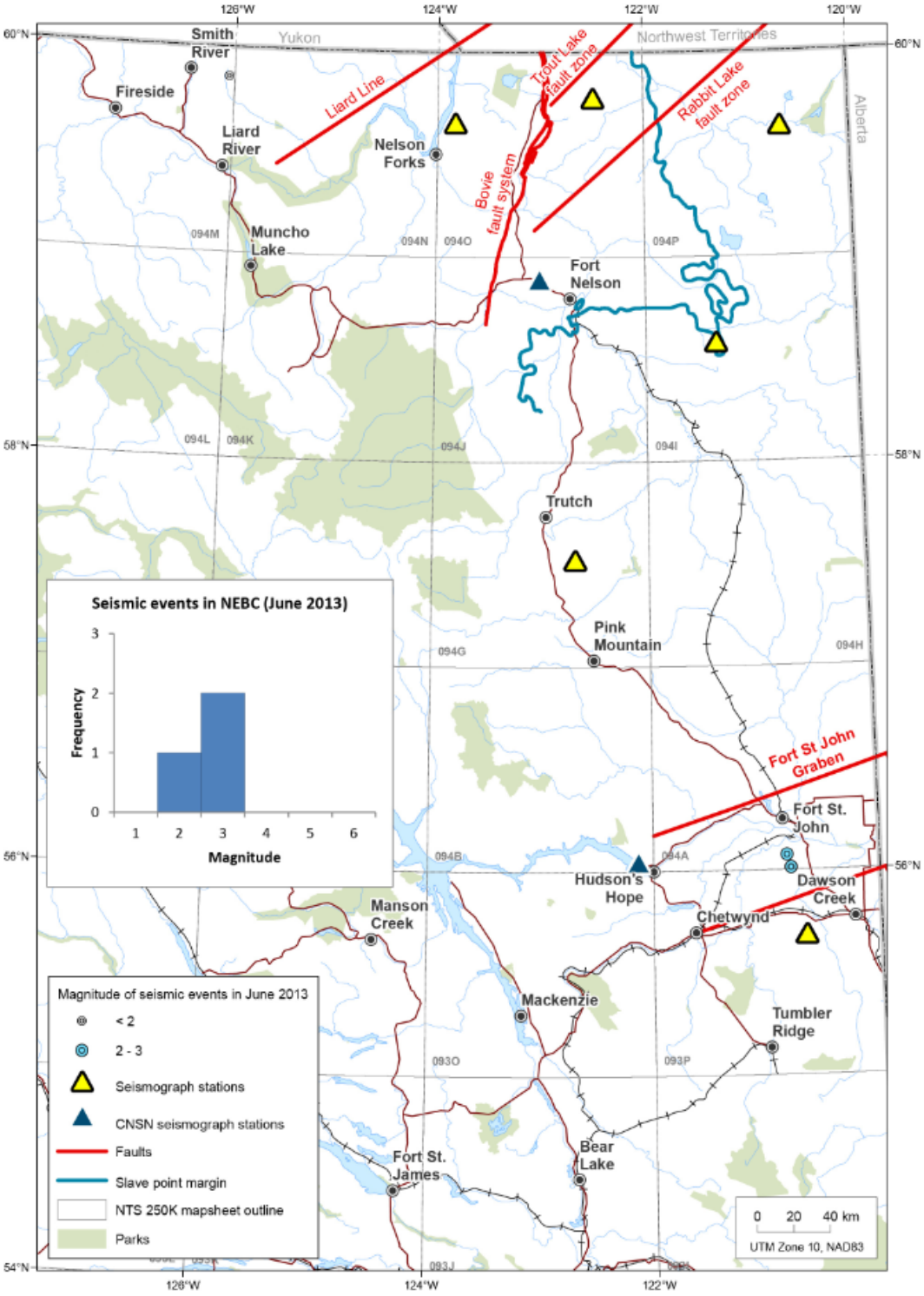
Appendix



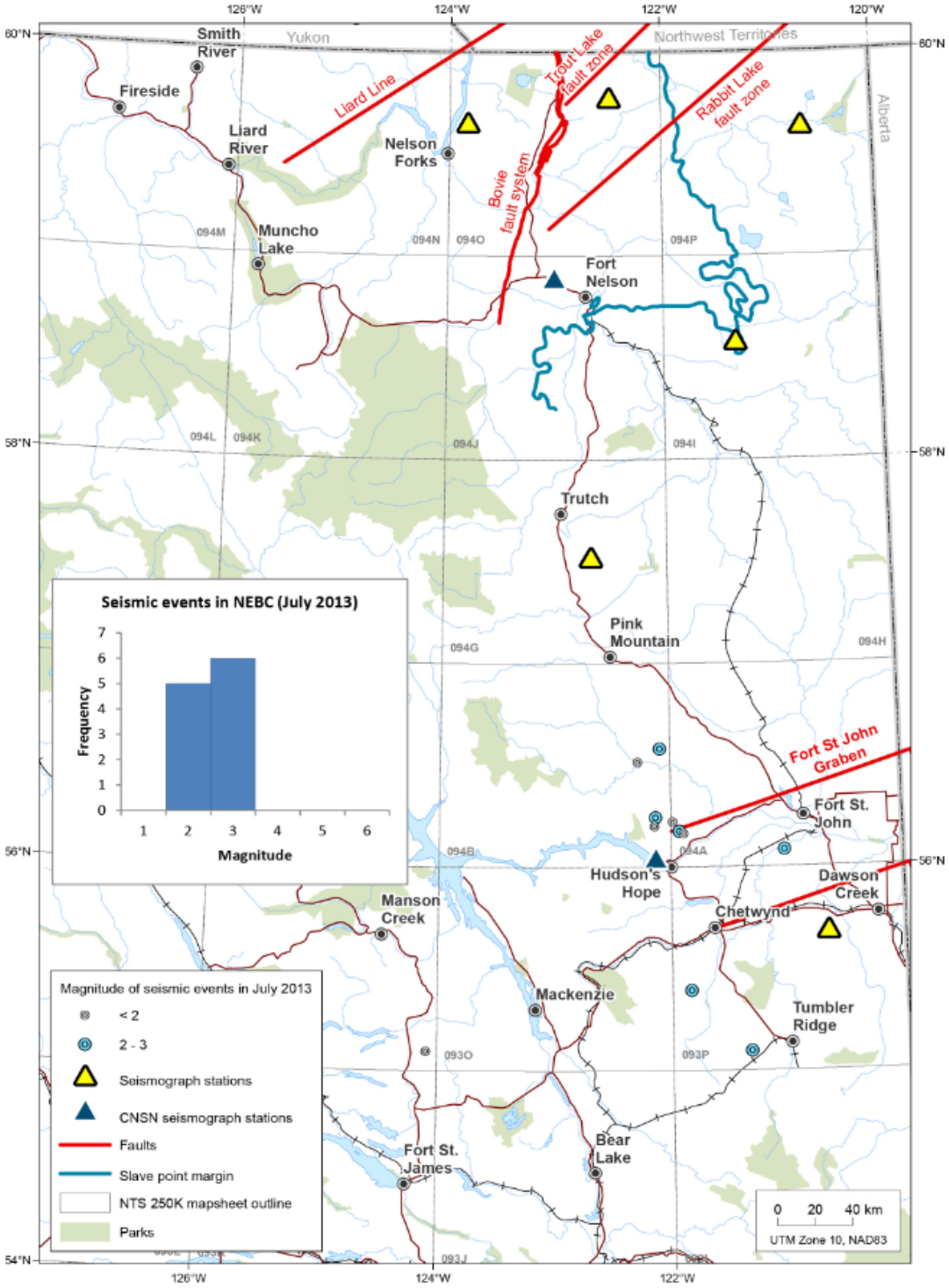
Appendix A. *Seismic activity monitored in April 2013*



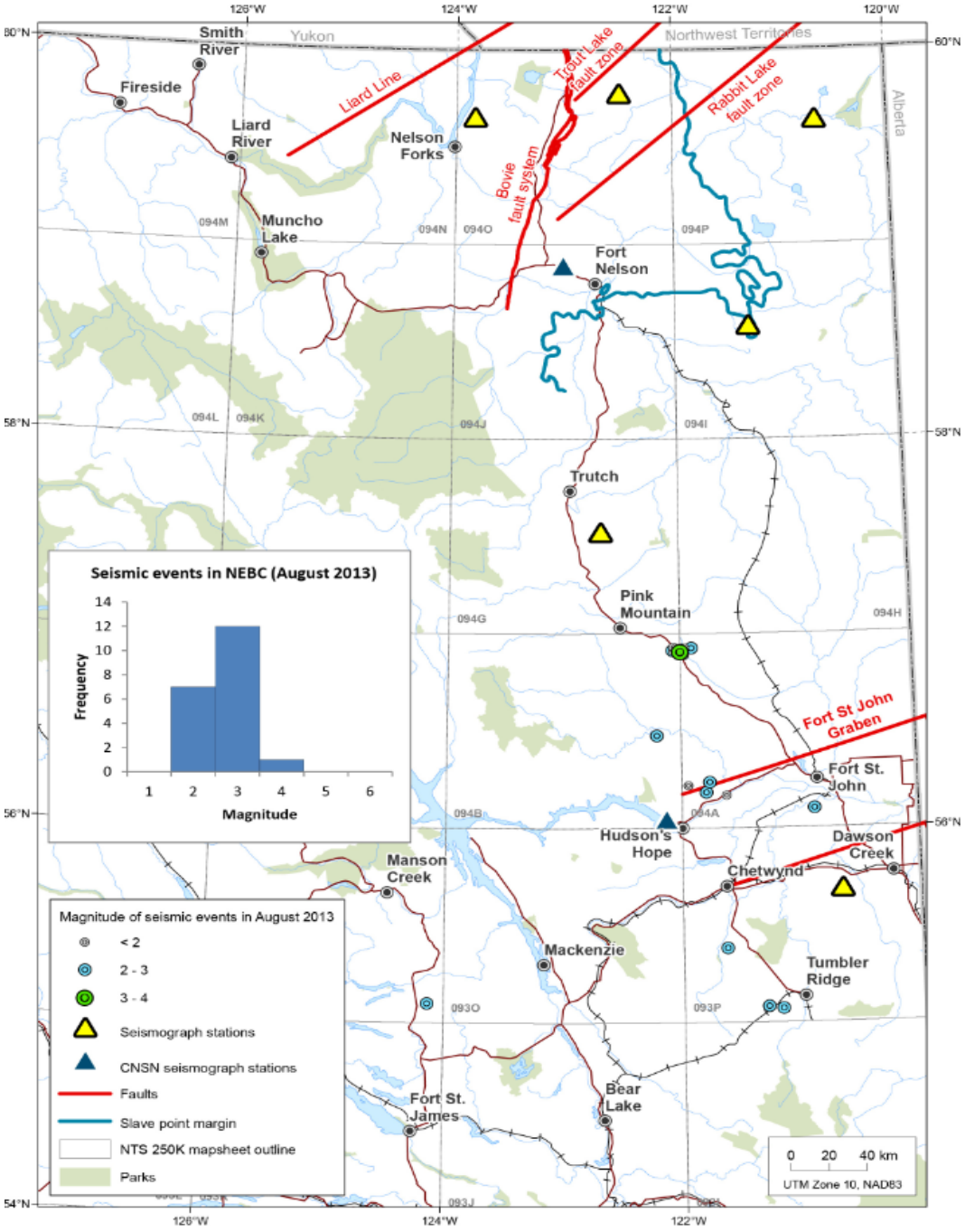
Appendix B. *Seismic activity monitored in May 2013*



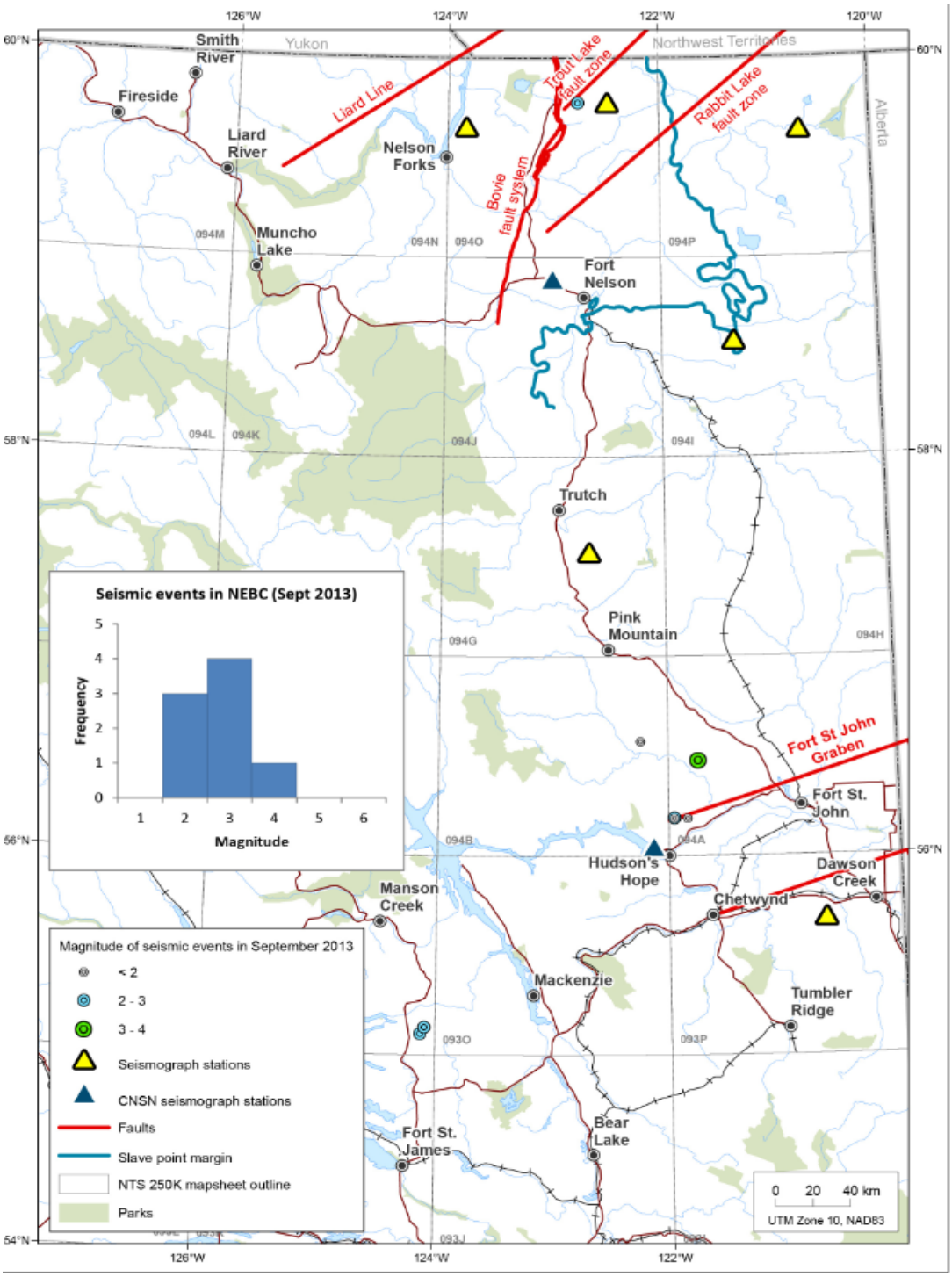
Appendix C. *Seismic activity monitored in June 2013*



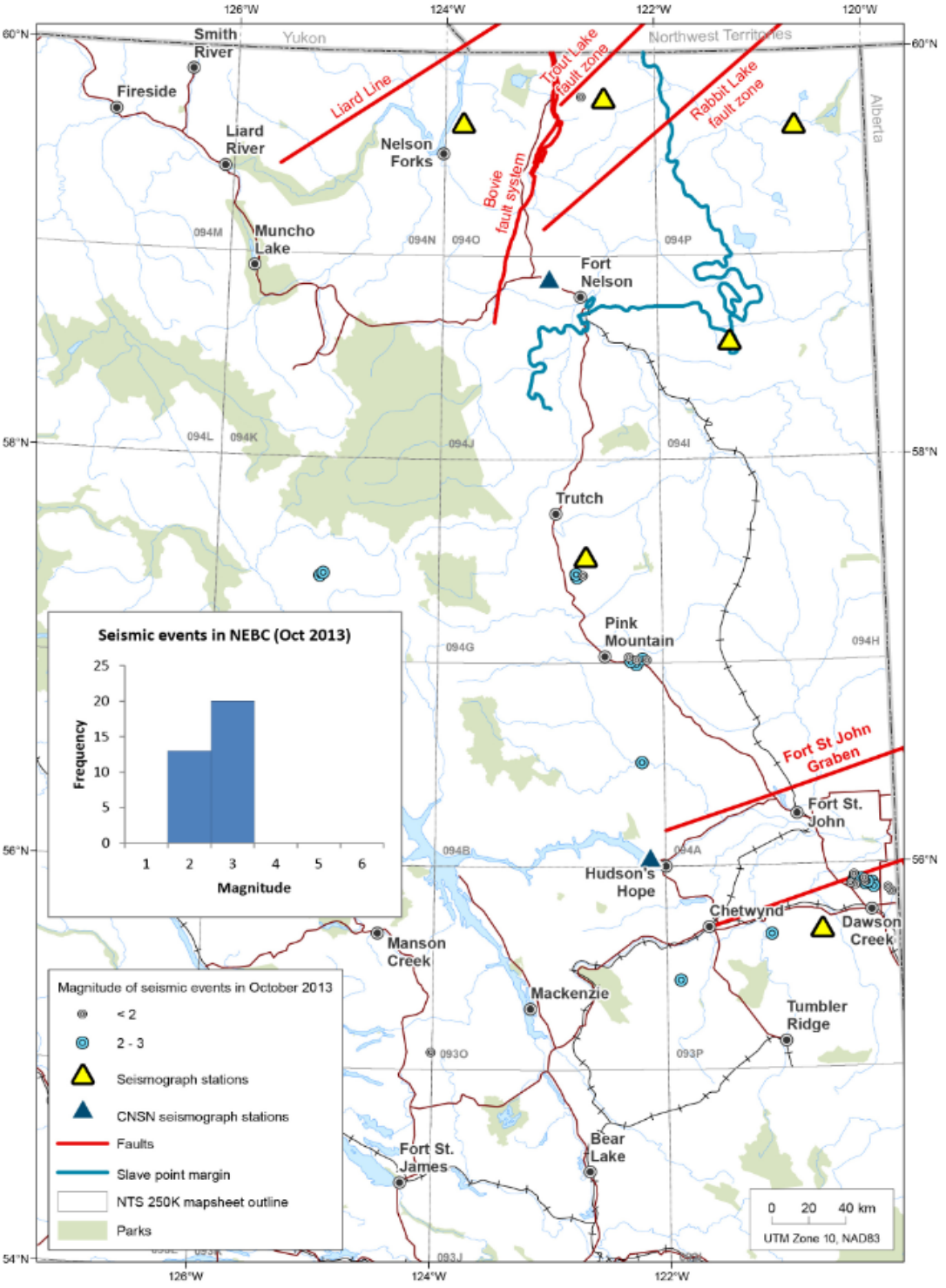
Appendix D. *Seismic activity monitored in July 2013*



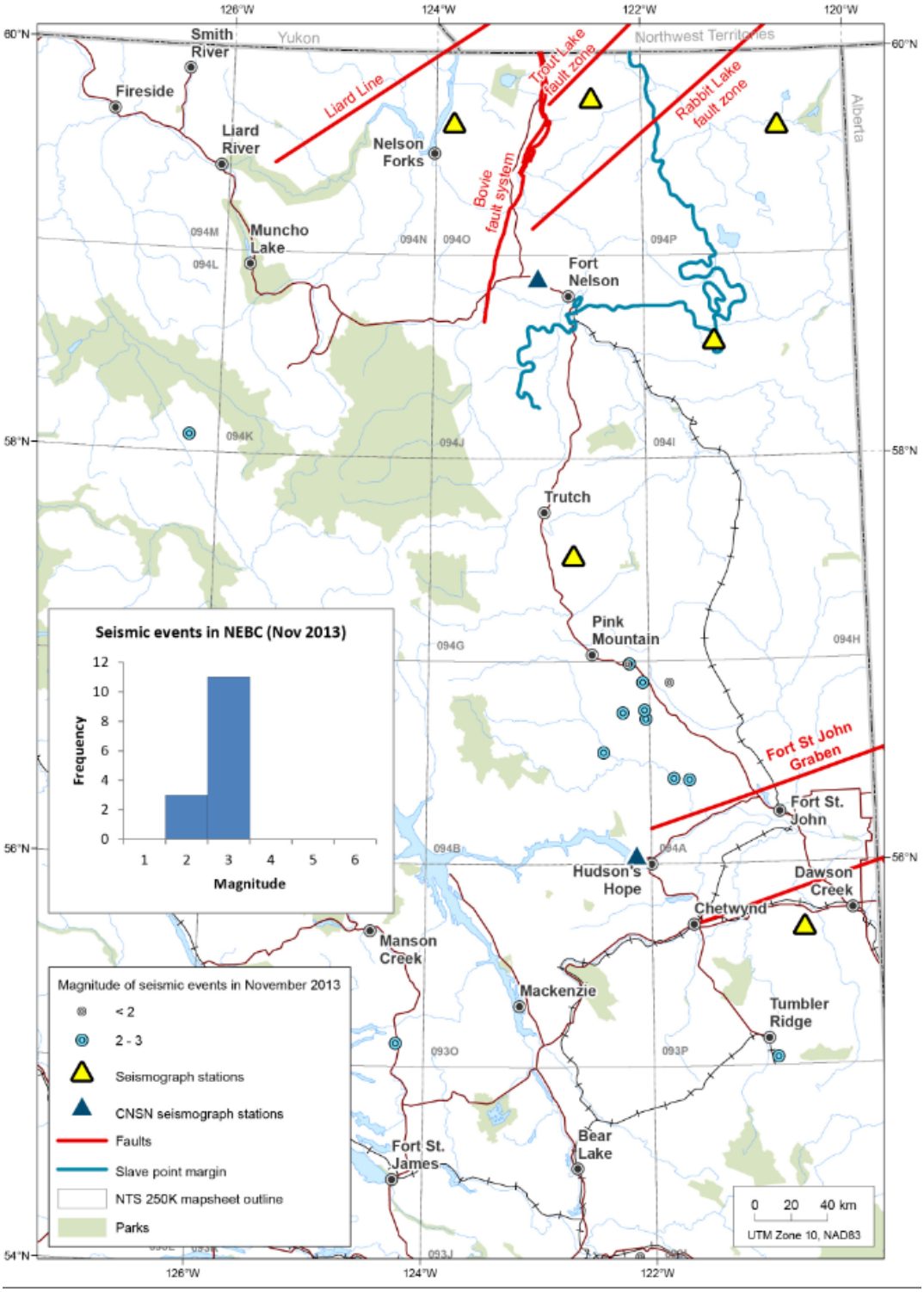
Appendix E. *Seismic activity monitored in August 2013*



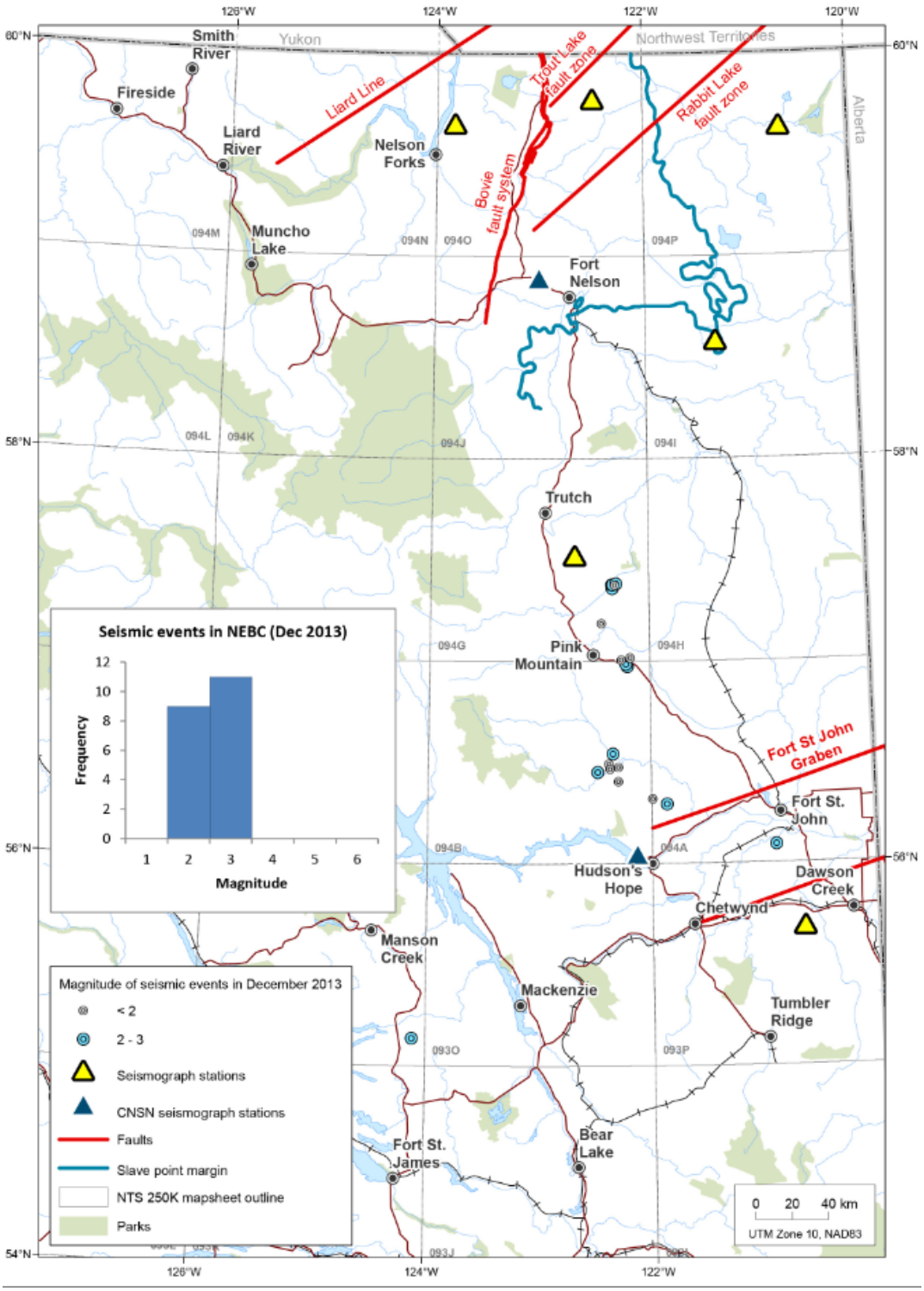
Appendix F. *Seismic activity monitored in September2013*



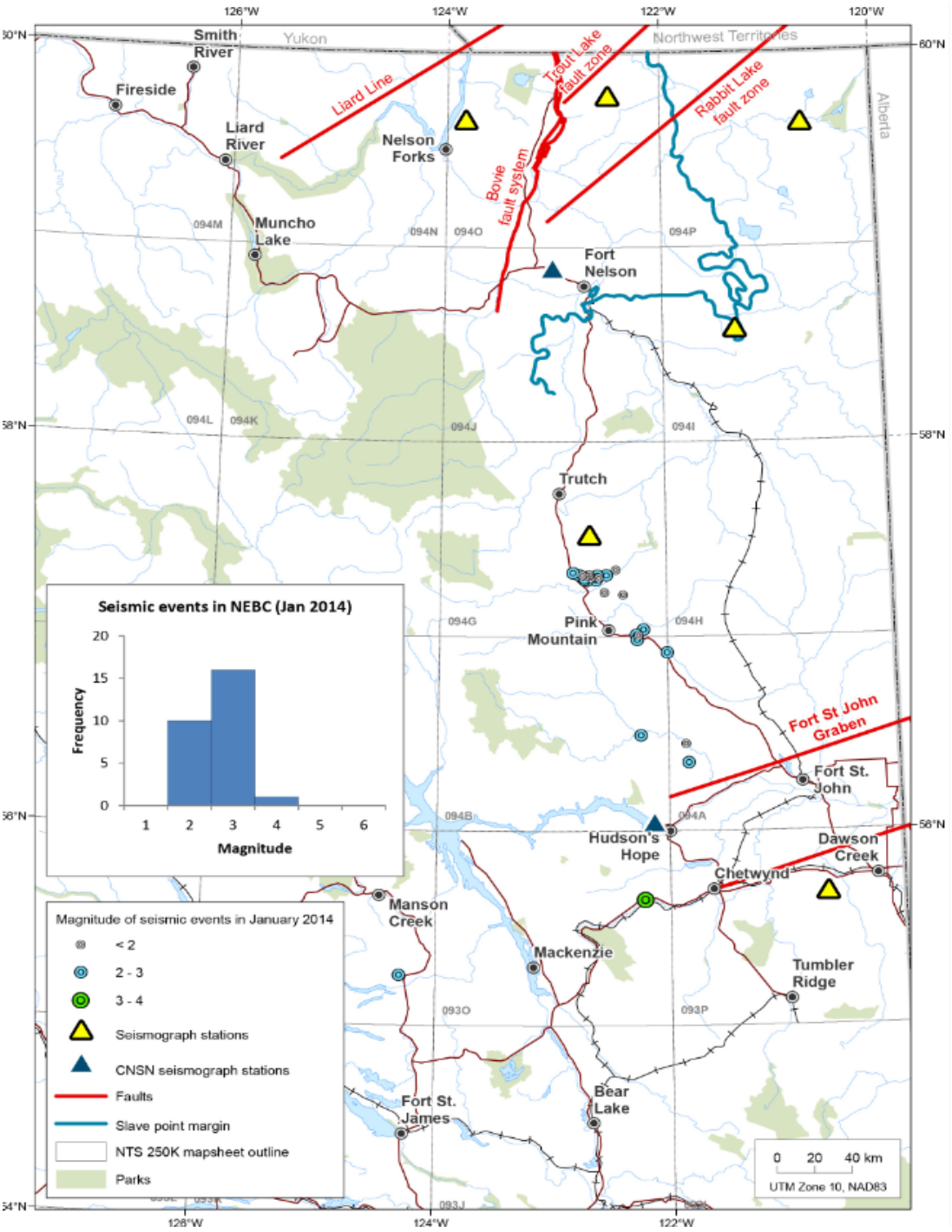
Appendix G. *Seismic activity monitored in October2013*



Appendix H. *Seismic activity monitored in November 2013*



Appendix I. *Seismic activity monitored in December 2013*



Appendix J. *Seismic activity monitored in January 2014*

Appendix K. *Communication Plan for Induced Seismicity Monitoring Project (ISMP)*

Purpose

To create a Communication Plan between partners of the *Induced Seismicity Monitoring Project,* namely Geoscience BC, the Canadian Association of Petroleum Producers (CAPP), the British Columbia Oil and Gas Commission, and Natural Resources Canada (NRCan). This Communication Plan will be an addendum to the Terms of Reference for *ISMP*.

Background

In response to public, provincial and industry concern over recently monitored low-level induced seismicity, attributed to hydrofracturing, a consortium made up of Geoscience BC, CAPP, the BC Oil and Gas Commission and NRCan was formed. The ***ISMP*** was created to collect, interpret, manage and make publicly available information gathered from a regional state-of-the-art seismograph array which will complement the pre-existing Canadian National Seismic Network seismographs.

Communication Objectives

- To provide the Target Audience with background information on the ISMP by June 30, 2013.
- To provide the Target Audience with ongoing updates of the data collected from the ISMP on a quarterly, or in an as-needed basis, starting Sep. 30, 2013.

Target Audience

Primary (including, but not limited to):

- First Nations
  - Treaty 8 First Nations (Dene Tha; Doig River; Prophet River; Saulteau; West Moberly; McLeod Lake; Fort Nelson; and, Halfway River).
- Oil and Gas industry
  - Canadian Association of Petroleum Producers (CAPP)
  - Canadian Society for Unconventional Resources (CSUR)
- Communities
  - Fort St. John Council
  - Dawson Creek Council
  - Northern Rockies Regional Municipality (councillors)

Secondary (including, but not limited to):

- Academia
  - University of BC
  - University of Northern BC

- Government
  - Provincial Ministries of Forests, Lands and Natural Resource Operations; Energy, Mines and Natural Gas; and, Environment
  - Peace River North and Peace River South MLAs
- Industry

Communication Tools

- News wire (news release(s))
- Websites (e.g. BCOGC, CAPP, NRCan, GBC)
- Social media feeds (Twitter; Facebook)
- Email blasts
- Oral presentations at professional conferences
- Brochures
- Radio (if invited)
- Television (if invited)

Timing and Frequency

- Quarterly operational (*ISMP* updates)
- *ISMP* communication at significant project milestones (e.g. Background awareness pre-launch, initial data report, etc.)
- *ISMP* communication in response to anomalous seismic activity (as needed)
- *ISMP* communication in response to target audience queries (as needed)

Responsibilities

- BCOGC is responsible for communication related to induced seismicity regulation issues
- NRCan has legislated and mandated responsibilities for the timely provision of information related to natural and anthropogenic earthquakes occurring in Canada or potential to impact Canada
- CAPP is responsible for industry-related communication associated with induced seismicity issues and industry best practices
- GBC as lead manager and co-owners of the seismograph stations is responsible for communication related to organizational (i.e. project management), operational, financial, data distribution and general *ISMP* inquiries

- ISMP Technical Committee will recommend and/or implement a web-based delivery mechanism for the data collected
- While respecting the above-noted responsibilities, all parties agree to proactively sharing project-related information and other information relevant to induced seismicity and oil and gas development with each other in a timely manner

Protocols/Strategic Considerations

- All members of the Steering Committee will be responsible for identifying opportunities to communicate ISMP achievements and results to the Target Groups. The committee shall evaluate each opportunity (e.g. merits, best tools to use, appropriate timeframes for communication, implications respecting the responsibilities of committee member organizations, etc.) prior to taking action
- The lead for internally-generated *ISMP* communication is defined in the *Responsibilities* subsection, unless consensually agreed to by the Steering Committee
- The lead for responses to information requests from media (e.g. television, radio, newspaper etc.) will be determined from the aforementioned *Responsibilitie*s
- Whomever receives the media request will make a decision as to whose responsibility it is to respond, utilizing the aforementioned *Responsibilities* definitions, then immediately notify the other Steering Committee Members that this request will be acted on, or, pass the media request to another member in the consortium which is better suited to answer the media request. The ensuing media response from the responding consortium member will be circulated to the Steering Committee
- Response to an ISMP-detected anomalous (or perceived anomalous) induced seismicity event (>4 ?)– In the event of such an occurrence, each consortium member may deem a media response is necessary, as defined in the *Responsibilities* subsection. Each responding consortium member will circulate a copy of their media response to the other members and attempt to get commentary from the other members in a timely manner. Whenever possible, the responses by members should have consensus from the other members, but ultimately, the given response is solely the responsibility of member issuing the response to the detected anomalous event.
- In the event of an election, federal or provincial, individual consortium members belonging to government agencies (NRCan and BCOGC) will be bound by all their respective government policies with respect to communication during this period. These government agencies may choose to pass on inquiries with respect to ISMP to other consortium members. Other parties in the consortium (CAPP, GBC) may continue with communication of ISMP following the existing protocols.

- All communication (e.g. reports, scientific papers, posters, oral presentations) dealing with ISMP, where possible, will mention all the partners, and include their corporate logos, if appropriate
- Communication costs directly attributable to ISMP will be borne by the project
- Key Contacts for Media requests:

NRCan- Carmel Lowe work: 250-262-6763
Cell: 250-812-8220
Home: 250-655-1455

BCOGC- Hardy Friedrich: work: 250-794-5219
Cell: 250-261-6136

CAPP- Geoff Morrison: work: 403-776-1409
Cell: 250-634-4010
Home:

GBC- Carlos Salas: work: 604-662-4107
Cell: 778-870-8644
Home (weekdays): 604-687-1644
Home (weekends): 604-885-5709

- The Key Contacts may designate internal personnel in their organization to respond to the media requests