

# INVESTIGATION OF RECENT MICRO-SEISMIC ACTIVITY IN THE SOUTHERN NECHAKO BASIN: IMPLICATIONS FOR MAPPING SUBSURFACE GEOLOGY UTILIZING SEISMIC TOMOGRAPHIC TECHNIQUES



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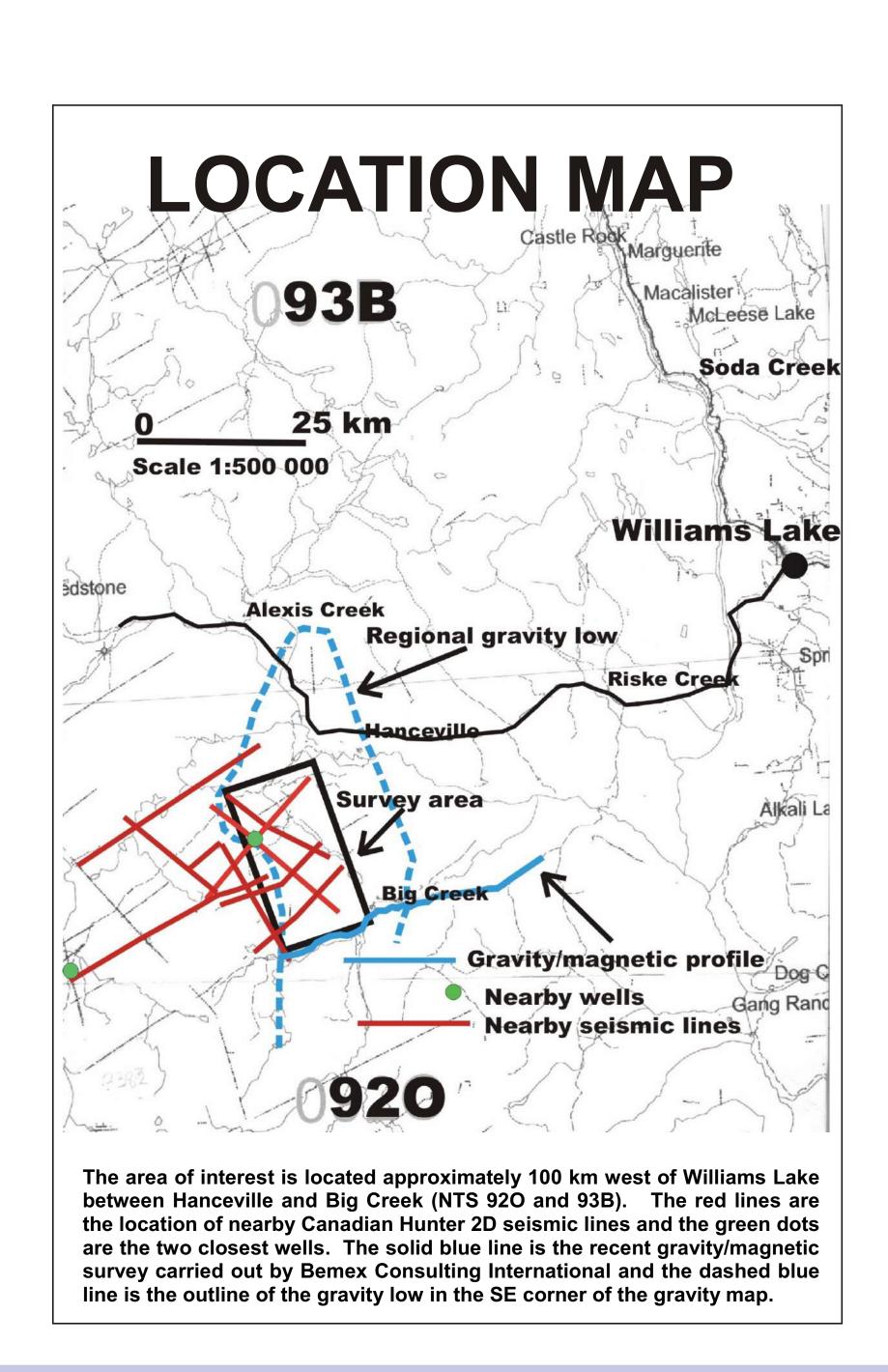
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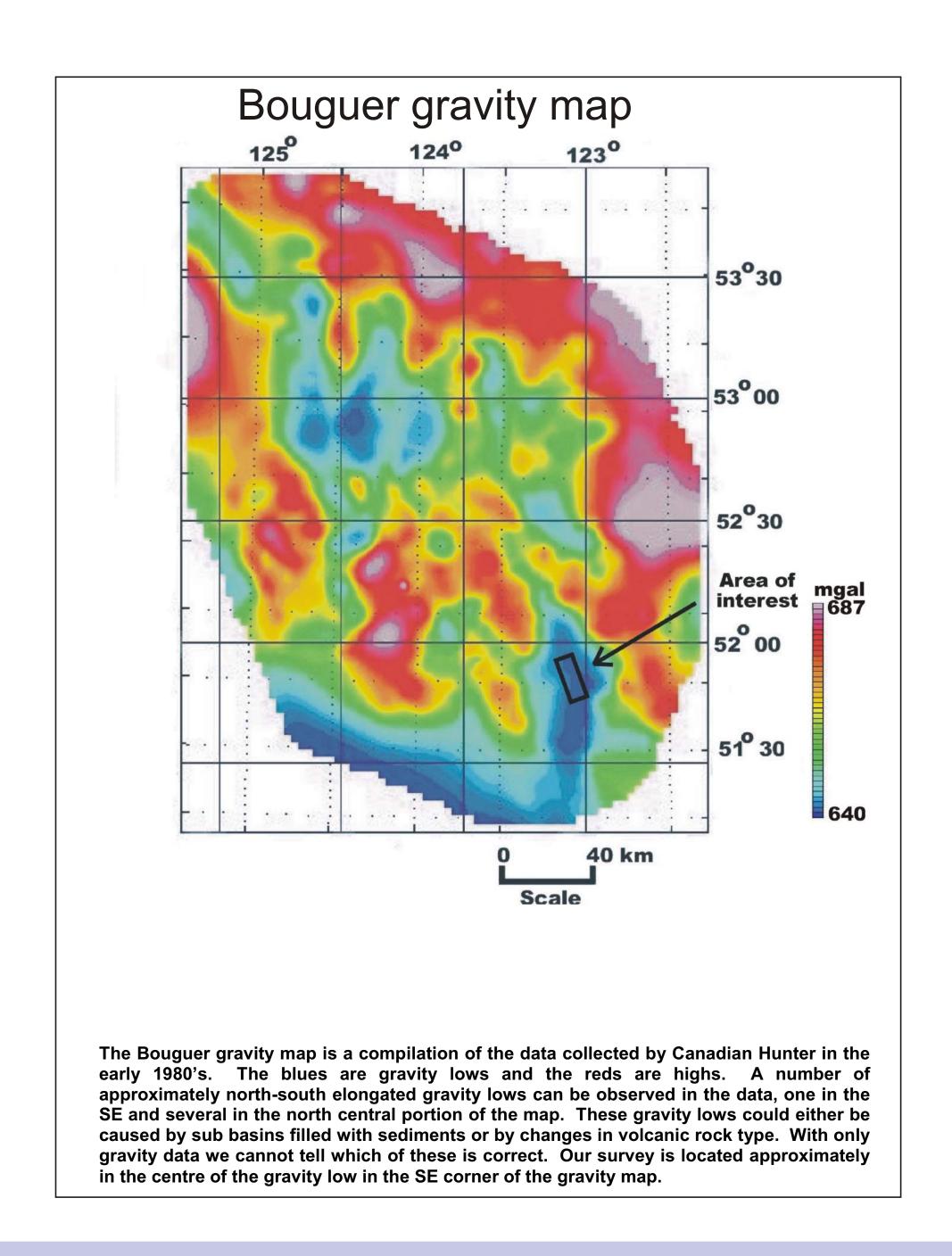
#### INTRODUCTION

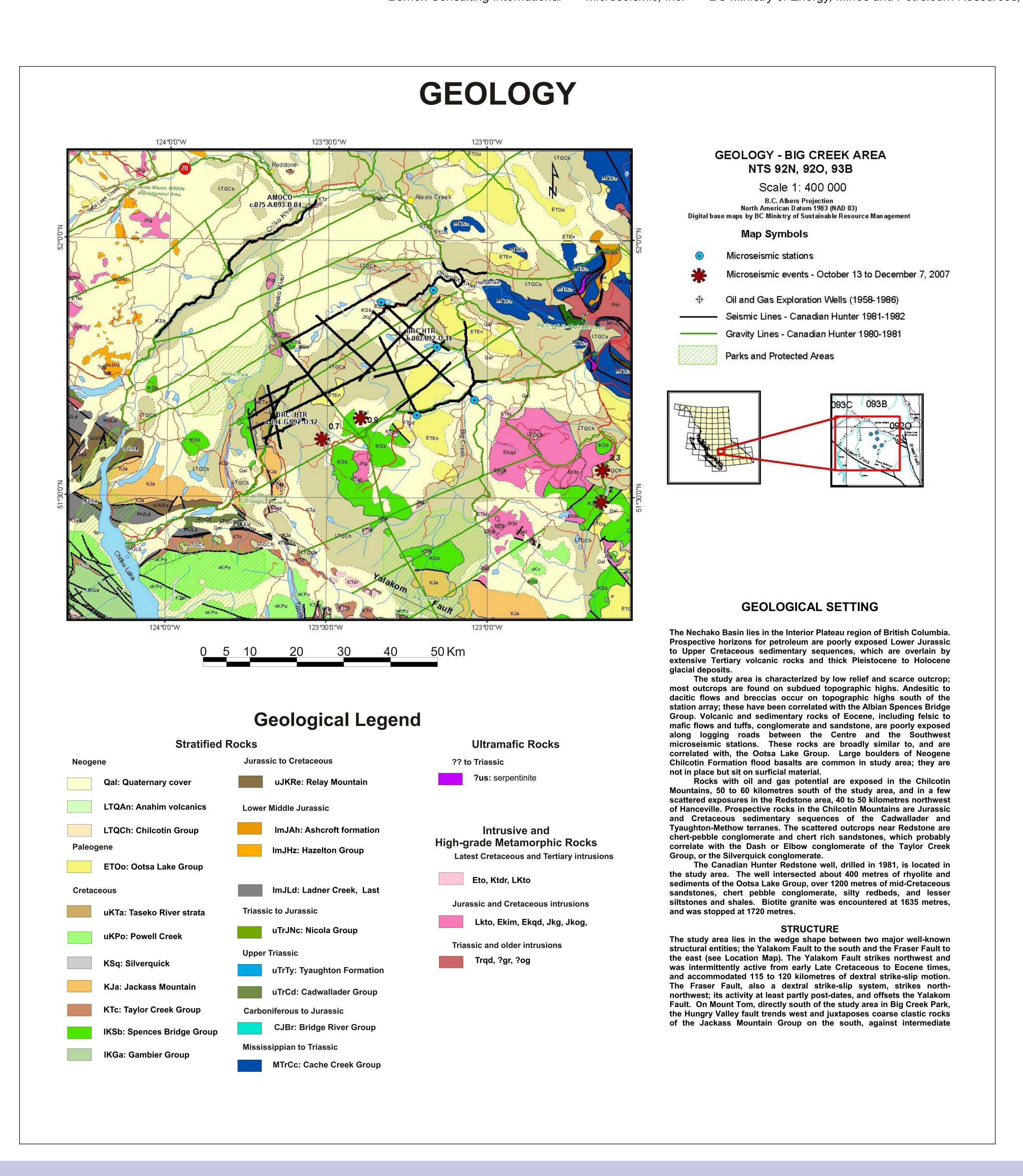
Reflection seismic surveying in the Nechako basin has been difficult in the past because of basalt flows at or near the surface. Canadian Hunter carried out a significant seismic, gravity and drilling program in the Nechako basin in the early 1980's. They abandoned the play after drilling several dry holes. Reprocessing this older 2D reflection data does help to improve data quality but there are still regions where data quality remains poor. Reflection seismic acquired with modern acquisition and processing techniques is anticipated to be significantly better than the earlier 2D seismic data however.

In addition to traditional reflection methods we are investigating the use of microseismic activity (small local earthquakes) to map geological structure beneath the basalt. The area selected for this study is shown on the location map. This area was selected within a gravity low that may be associated with a sedimentary sub basin (see gravity map). In addition there are several old seismic lines in and near the area, and a well (b-82-C) for calibration.

Passive seismic transmission tomography uses the ray paths associated with local microseismic earthquakes to generate a P and S-wave velocity volume of the earth. Before embarking on such a survey it is important to measure the level of activity to determine if there are enough events to generate the tomographic inversion with the desired resolution. This present study used five 3-component geophone arrays, one at each corner of the area shown in the location map and one near the middle. We measured local seismic activity over an 8 week period. This poster describes the geological setting of the study area and discusses the results of the survey.









### DATA ACQUISITION AND PROCCESSING

The area selected for the passive seismic survey is a within the Nechako Basin approximately 50 km east-northeast from the Southern Coastal Mountain Seismic Belt (SCMSB). A micro-earthquake network was laid out to cover a 26 x 17 km rectangular area roughly outlining the northern portion of the gravity low shown earlier. The 3-component geophones at each site were oriented by hand and buried to a depth of three feet. The seismic data were recorded in a continuous mode using five Reftek RT130 seismographs. The data were digitized using a sample rate of 2 ms with a +30 dB gain. The data were manually downloaded three times during the time of the survey. The recording configuration was deployed to measure the rate and strength of the local background seismicity close to this area. This information would be used to design an array for a larger, more extensive effort that would be appropriate for mapping shallow structures at scales useful for petroleum and/or mineral exploration.

The records from each station were processed using a trigger detection algorithm. A trigger was generated when the 1 second short-term average (STA) exceeded the 30 second long average (LTA) above a given threshold level on two of the three seismic channels for that particular station. The STA/LTA power ratio of 15 dB was used as the threshold level. This ratio was based on previous, successful micro-earthquake surveys in environments with similar cultural noise characteristics. A one minute SEG-y event file of all the active stations was output when three or more station triggers could be temporally associated within a five second time window.

# RESULTS

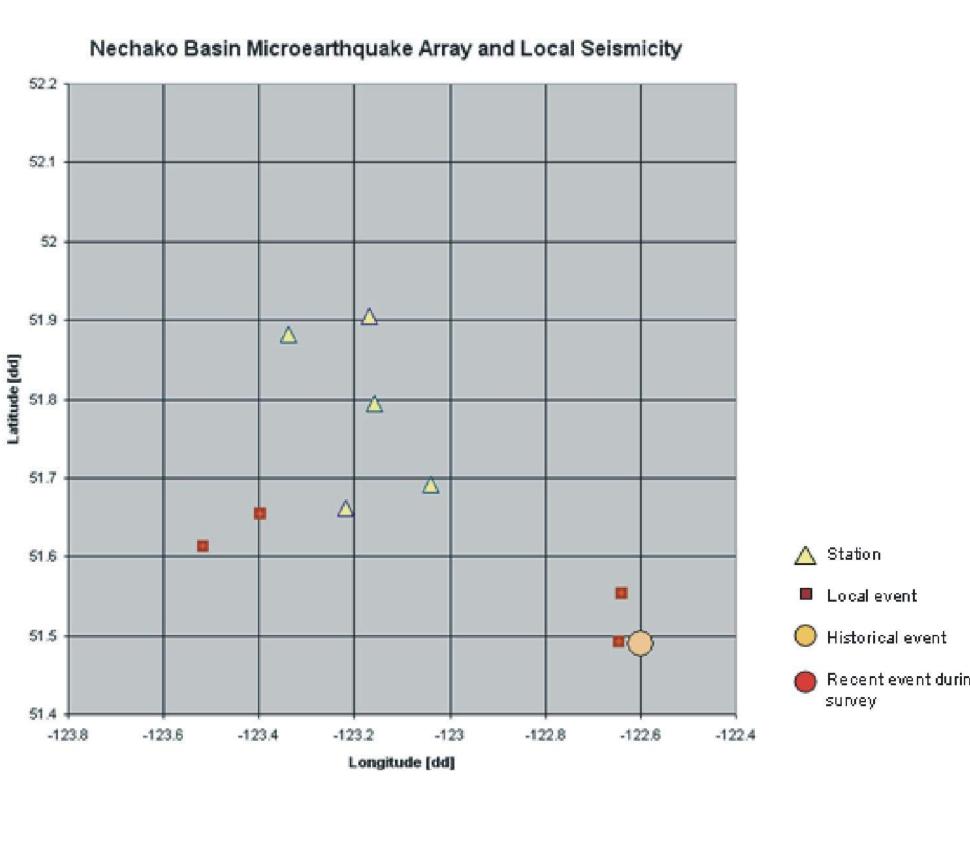
Over 1037 trigger files were generated between October 12 and December 17, 2006. A visual inspection of the trigger records was done in order to classify the events as local microearthquakes, regional earthquakes, teleseismic (deep focus) earthquakes or false triggers/air blasts. Local microearthquakes were selected based on the character and arrivals of their phases. High frequency events with arrival time differences between the P-wave and S-wave less than five seconds were classified as local microearthquakes. Additionally, these events also showed a strong partition of the amplitude of their phases on the seismometer components with the P-waves arriving primarily on the vertical component and S-waves arriving dominantly on the horizontal components. The majority of the events were false triggers created by air blasts associated with mining or other cultural activities that were coincidental within the area.

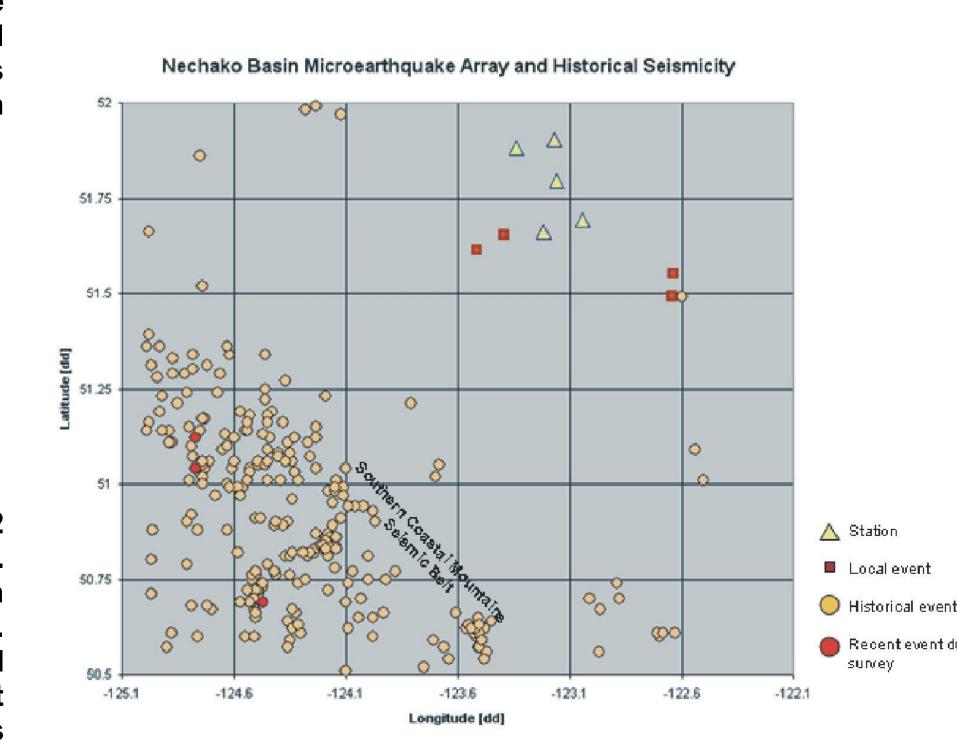
Of the 1037 triggers, only seven were found to be local microearthquakes. Hypocenter locations of four of these events were obtained (See Geological Map). The remaining three did not have sufficient S/N to properly locate. The epicenters of the events showed them to be located outside of the array. Two events plotted to the west towards the SCMSB, while the other two plotted to the SE. The events to the SE of the array occurred in close proximity to the location of a magnitude 3.0 event as reported in the NRCAN catalog. The magnitude 3.0 event is the only significant historical earthquake in this area. The low background level of seismicity seen here is consistent with a magnitude 3.0 event recurring every 10 years or so within this epicentral area.

#### Table 1: LOCAL EVENTS

ate	Latitude	Longitude	Magnitude	
006/10/13	51.6552	-123.3973	0.9	
006/12/02	51.6144	-123.5175	0.7	
006/12/07 AM	51.4923	-122.6452	2.0	
006/12/07 PM	51.5537	-122.6412	2.3	

During the two month time period, 117 regional events and 22 teleseisms located far from the local microseismic survey were also identified. Three of the regional triggers corresponded to earthquakes from the Southern Coastal Mountain Seismic Belt as listed on the NRCAN online catalog. Unfortunately these events are too far away to be of much use for local tomographic investigations. The S-wave is highly attenuated and the emergent P-wave is difficult to pick in the noise. Further, the errors in the locations would likely be significantly greater than the desired tomographic resolution.





## CONCLUSIONS

From the measured level of background seismicity it is possible to determine the number of stations needed to image a particular area for a mographic investigation of the crustal structure. The rate of seven microearthquakes over an eight week time period can be approximated occurrence along the well known Gutenberg-Richter magnitude-frequency relationship. For purposes of estimating an array design, a background rate of seismicity was generated by assuming that a magnitude 3.0 event occurs in the area every 10 years and the cumulative number of events is scaled by a crustal b-value of -1. After 1 year, around 146 local events greater than magnitude 0.0 could be expected. With the low number of events, and because not all of these events would be seen by every station in the network, this level of seismicity would require a substantial "listening" effort. It would require around 120 stations to be deployed over the area to image the crust at a scale of 500 meters resolution over a 500 square km area. After 5 years of listening, it would be possible to reduce the resolution to 250 meters.

With the advent of newer interferometric techniques it may be viable to use the more regional data to augment the sparse background seismicity seen over the area of interest. In seismic interferometry, each station can be transformed through correlation to act as a virtual source. Therefore it becomes possible to pick travel-times of phases between the station that is positioned as a virtual source and the surrounding receiver array. This technique could provide many additional travel-times based on the source-receiver pairs within the array and would greatly augment and possibly facilitate a tomographic investigation using microearthquakes in this area.