

**Construction of the
2014 Alberta Composite Catalog:
AlbertaCompCat2014-x**

By

Azadeh Fereidoni

November 2014

Introduction:

The Alberta Composite Catalog is a compilation of catalog information in the Alberta region from the TransAlta/Nanometrics Network (NMX catalog), the Geological Survey of Canada (GSC) and U.S. sources (ANSS catalog). The aim is to provide a comprehensive list of seismic events reported by different agencies, identifying duplicates and retaining all available information on each event. It is patterned after the ideas in the Canadian Composite Seismicity Catalog (CCSC; Fereidoni et al., 2012, in Seism. Res. L.). Estimated moment magnitudes are provided for all events (the work on the magnitude conversions is still in progress as of Dec. 1, 2014). The compilation is done semi-automatically using a matlab script, so that the catalog can be updated a few days after the end of each month (AlbertaCompCat2014-10, AlbertaCompCat2014-11, etc). The catalog is in the same format as a similar composite catalog that provides seismicity information from 1900 to the end of 2013 (Cui, 2014), allowing users to merge pre-2014 information with the more recent information.

Coordinates of the study region

- North: 59° N
- South: 48° S
- East: -110° W
- West: -121° W

Input catalogs:

Nanometrics catalog (NMX)

- Source: Nanometrics

GSC catalog

- Source: Earthquakes Canada <http://www.earthquakescanada.nrcan.gc.ca/stndon/NEDB-BNDS/bull-eng.php>
- Types of events included:
 - Quakes
 - Mining events
 - Blast
 - Induced

ANSS Comprehensive Earthquake Catalog

- Source: USGS <http://earthquake.usgs.gov/earthquakes/search/>
- Types of events included:
 - Earthquakes
 - Non-Earthquakes (Explosion, Mining Explosion, Quarry, Quarry Blast)
- Initially, the PNSN (Pacific Northwest Seismic Network) which is operated by the University of Washington was considered as the US source of data. As magnitude type is not being reported in the PNSN catalog, it was removed from the process. However, the PNSN, as a regional

catalog, is routinely loaded into the ANSS catalog with all the magnitude type information. Therefore, the ANSS comprehensive catalog is added to the process as the US source.

- Moreover, the ANSS specifies the type of the events (Earthquake vs Quarry) in the catalog. This type of data might be very useful in future.

Time period of the composite catalog

The start and end of the composite catalog can be set interactively. The default of start time is 2014-01-01. The NMX, GSC and ANSS events need to be downloaded for the same time period, as these downloaded catalogs are the source information.

Priority of Input Catalogs

When combining the information from different catalogs together, the following priority of input catalogs is considered:

1. NMX catalog
2. GSC catalog
3. ANSS catalog

For duplicate events (i.e. the same event reported by multiple agencies), the solution of the highest-priority catalog is kept in the composite catalog. However, the set of available magnitudes and locations for each duplicate is enhanced with the information in alternative sources.

Criteria for Identifying Duplicates in time, space and magnitude

The intervals for the designation of an event as a duplicate are defined by the user. For the Alberta catalog, I have set the following intervals:

- Time (in second) = 2 sec
- Space (in km) = 30 km
- Magnitude (in magnitude unit, regardless of mag type) = 1 magnitude unit

These intervals were determined based on evaluation of the histograms shown in the Appendix. The events with time difference of 2 sec or less are considered as potential duplicates. When the differences in locations and magnitudes of potential duplicates are both smaller than the designated legitimate intervals listed above, the events are automatically considered as duplicates. In the case of a duplicate, the time, location and magnitude are assigned from the highest-priority source, and the alternative sources are used to provide additional information on alternative magnitudes and locations. If there is some ambiguity (event close in time, but the space or magnitude criteria are not met) , the magnitude difference and distance and other information are printed on the screen. The user subjectively decides whether they should be considered as duplicates or separate events.

When multiple events pass the duplicate criteria, the user subjectively decides which one should be kept in the composite catalog. Supplementary information from secondary sources (i.e. alternative location and magnitude information) is retained in the composite catalog.

The process

The matlab script “alberta_comp_cat_exe.m” performs the following process to combine the input catalogs and creates the Alberta composite catalog:

First, the computer program asks for the time period and region of the composite catalog. Note that the default region in the dialog box is the same as the study region defined above. Additionally, in the dialog box, the user has the option for automatic or manual download of input catalogs. If the automatic option (1) is selected, the computer program builds a custom URL with the user’s search parameters and sends requests to the agencies’ servers (GSC and ANSS websites), and it automatically downloads the catalog information in csv format. If the manual option (0) is selected, the user should manually download the catalogs from the corresponding websites in csv format. Then he/she locates the downloaded files on the drive.

For the GSC input catalog, the user should download and generate two separate files for earthquake and non-earthquake events. This is because GSC does not list the event types in the catalog. However, its database can be searched for variety of event types. The user should search the GSC database and download the data with only Quakes and Induced types of event included. One more time, he/she should submit the search with Mining events and Blasts selected in the event type. The user should be very careful to first locate the earthquake events file, and second the non-earthquake events file. It is important to locate the file in proper order as the computer program flags the events based on this order. If the automatic download option for GSC is selected, the computer program will do all these steps automatically. Therefore, the automatic download is recommended for the GSC catalog to avoid the possible mistakes in downloading and locating the proper files.

In the next step, the computer program imports the events information from the input catalogs (NMX, GSC, ANSS) into matlab, using the embedded “readAthena.m”, “readGSC.m”, and “readANSS.m” functions. Next, it uses the “Comb_Cat_f.m” function to combine the NMX and GSC catalogs. The NMX catalog is the preferred source, in case of duplicates.

Finally, it adds the US data source (ANSS) to the composite catalog, removes duplicates and generates the final catalog file in .txt format (AlbertaCompCat-x.txt, where x is the date in year-mo format), retaining supplementary information for duplicates. The process is summarized in the flow chart.

Note:

- The input catalogs must be downloaded in *.csv format from the agencies’ websites.
- In the case of manual download, all input catalogs and the matlab files must be in the same folder.

- The automatic download option is not available for Nanometrics (NMX) catalog, as the earthquake data is password protected. The user should download the catalog manually and leave the download option in the dialog box as 0.

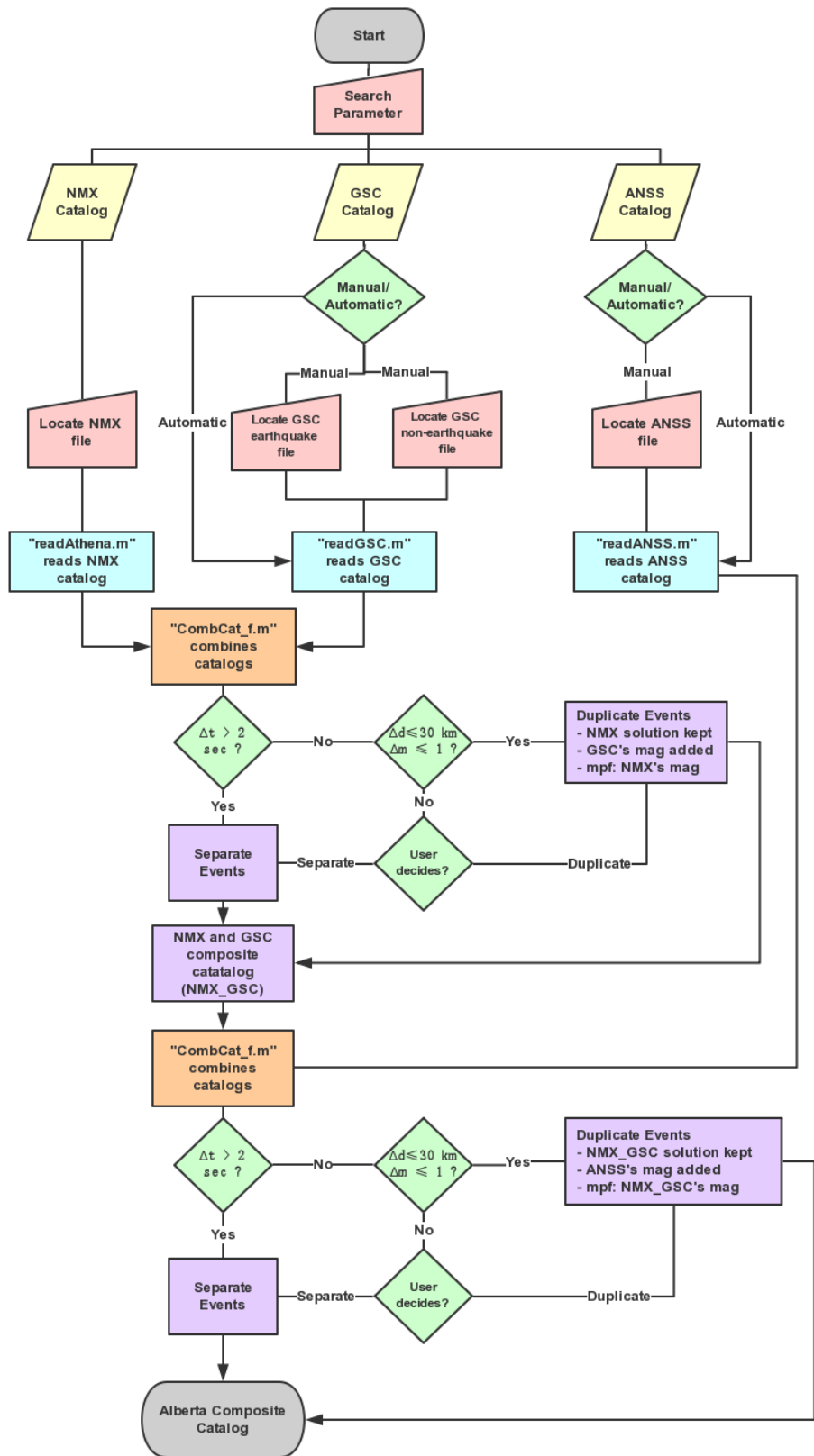


Figure 1- Schematic representation of development process

Final composite catalog format

- The final Alberta composite catalog has 34 columns.

1	year	Occurrence date in preferred catalog (column 21)
2	month	
3	day	
4	hour	
5	minute	
6	second	
7	Latitude	Location in preferred source catalog
8	Longitude	
9	ML	Local magnitude, -9.99 if not available
10	MN	Nuttli magnitude, -9.99 if not available
11	MB	Body wave magnitude, -9.99 if not available
12	MW	Catalog moment magnitude, -9.99 if not available
13	MS	Surface wave magnitude, -9.99 if not available
14	MC	Coda wave magnitude, -9.99 if not available
15	MD	Duration magnitude, -9.99 if not available
16	MZ	Unknown magnitude type, -9.99 if not available
17	Mpf	Preferred magnitude For now, the preferred magnitude is the one in highest-priority source catalog. In future, it will be decided based on magnitude type.
18	Mpf Type	Preferred magnitude type
19	Depth	Event depth in km. A value of 0 denotes very shallow. In NMX catalog a 0 depth is a suspected blast.
20	Depth Error	Not available in GSC catalog(for consistency in composite catalog, reported as -9.99 for GSC events)
21	Depth Designation	Indication on how the depth is determined or assigned *: Calculated hypocenter , G:Value assigned by a geophysicist, Z: No information for depth designation
22	Data Source	1: NMX(Nanometrics) 2: GSC 5: ANSS (preferred catalog information source)
23	zf	Seismic source zone , Not specified at this time
24	mf	MW conversion factor, Not specified in current version. It will be revised in future.
25	Mw Rev	Revised Mw, after calibration. Not available in current version. It will be revised in future.
26	Event Type	1= earthquake 2= Suspected Blast 3=No information available, 4= suspected induced. Available in ANSS and GSC. It can be revised in future to add the event type for NMX
27, 28	alternative location (GSC)	lat, lon of alternative location (GSC), if available.
29, 30		Alternative Magnitude and Magnitude type (GSC), if available.
31,32	alternative location (ANSS)	lat, lon of alternative location (ANSS), if available.
33,34		Alternative Magnitude and Magnitude type (ANSS), if available.

35,36	Alternative location (AGS)	lat, lon of alternative location (AGS-Alberta Geological Survey catalog), if available.
37,38		Alternative Magnitude and Magnitude type (AGS), if available.
39	Comment	Any comments provided by original source.

Alberta Composite Catalog (2014/01/01-2014/11/30)

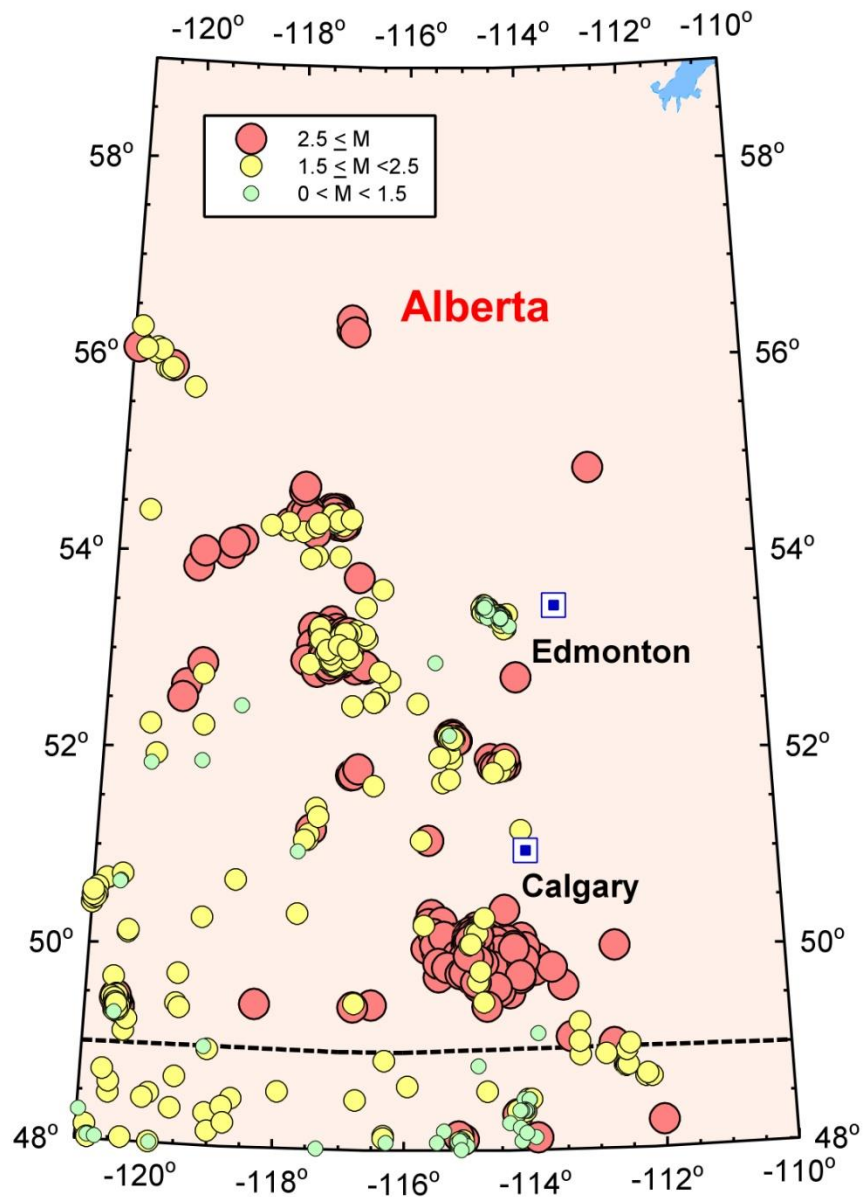


Figure 2-Events in the Alberta Composite Catalog from 2014/01/01 to 2014/11/31.

Appendix

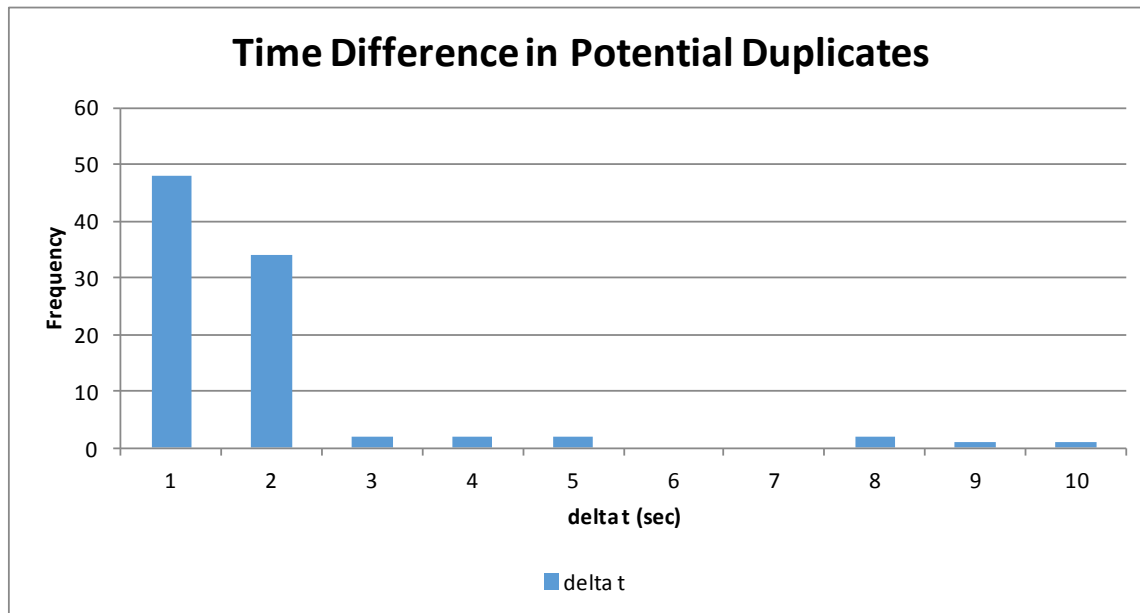


Figure 3-Time difference between potential duplicate pairs (data from 2013 Alberta Composite Catalog)

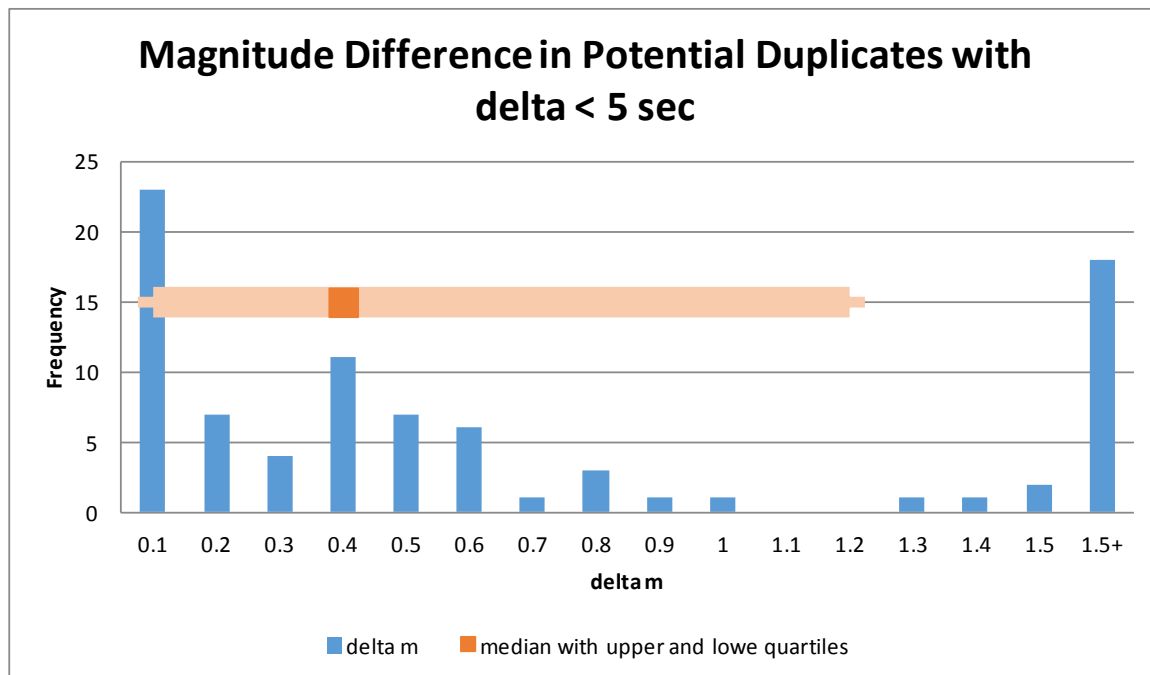


Figure 4- Magnitude difference between potential duplicate pairs, with time separation less than 5 seconds (data from 2013 Alberta Composite Catalog).

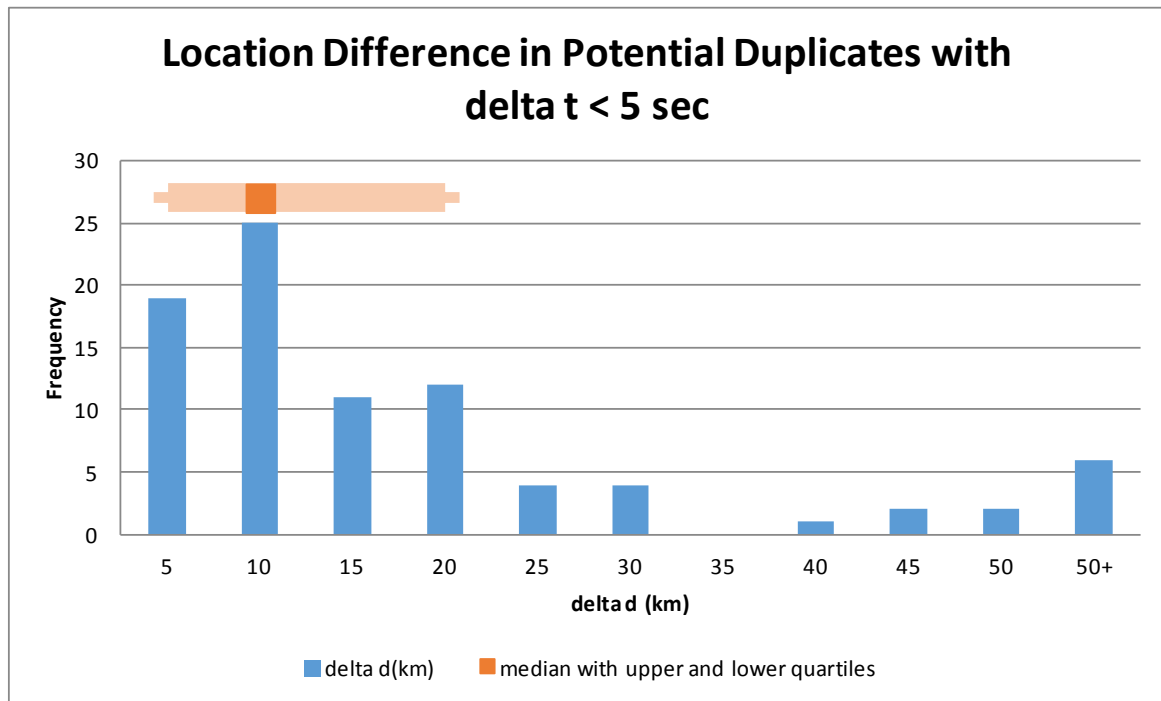


Figure 5- Spatial difference between potential duplicate pairs, with time separation less than 5 seconds (data from 2013 Alberta Composite Catalog).