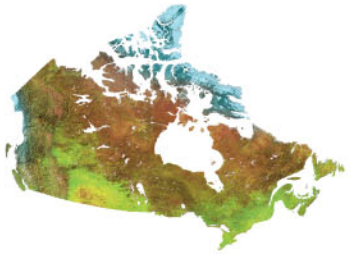
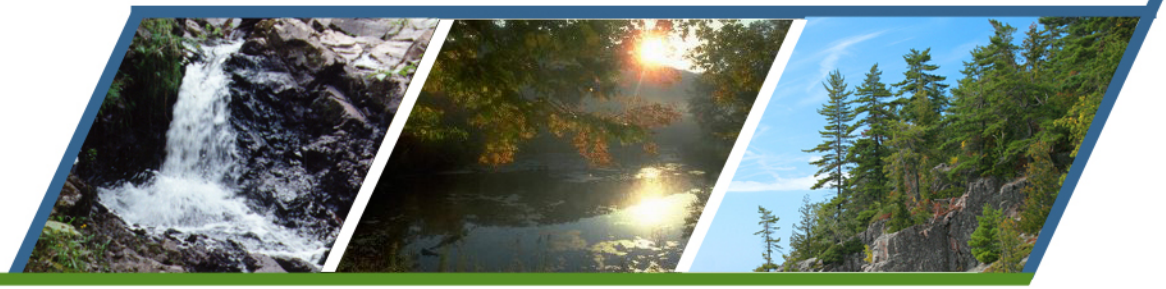
FERC Meeting, Washington, 1 March 2016





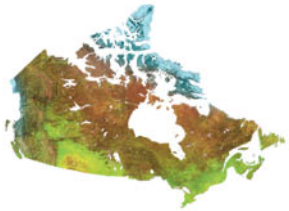
Geomagnetic Hazard Assessment: The Canadian Perspective

D. H. Boteler
Canadian Space Weather Forecast Centre

Natural Resources Canada | Ressources naturelles Canada

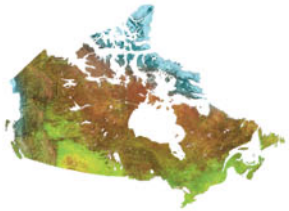
Canada

Geomagnetic Data Availability



Name	Years of Operation	Digital Data (1 min)	Digital Data (5 sec)
Alert	1961 -	1978 -	
Eureka	2007 -	2007 -	2007 -
Resolute	1948 -	1974 -	1992 -
Mould Bay	1961 - 1997	1975 -	
Cambridge Bay	1972 -	1972 -	1992 -
Iqaluit	1995 -	1996 -	1995 -
Baker Lake	1947 -	1974 -	1991 -
Yellowknife	1974 -	1975 -	1991 -
Fort Churchill	1957 -	1973 -	1991 -
Sanikiluaq	2007 -	2008 -	
Poste-de-la-Baleine (closed)	1984 - 2007	1984 - 2007	1991 - 2007
Great Whale River (closed)	1965 - 1984	1972 - 1984	
Meanook	1916 -	1972 -	1991 -
Brandon	2007 -	2007 -	2007 -
Glenlea (closed)	1980 - 2006	1982 - 2006	1991 -
Whiteshell (closed)	1975 - 1982	1975 - 1982	
St John's	1968 -	1972 -	1991 -
Ottawa	1968 -	1973 -	1991 -
Agincourt (closed)	1898 - 1969		
Toronto (closed)	1840 - 1895		
Victoria	1957 -	1973 -	1992 -

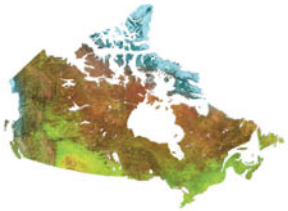
Extreme Value Analysis

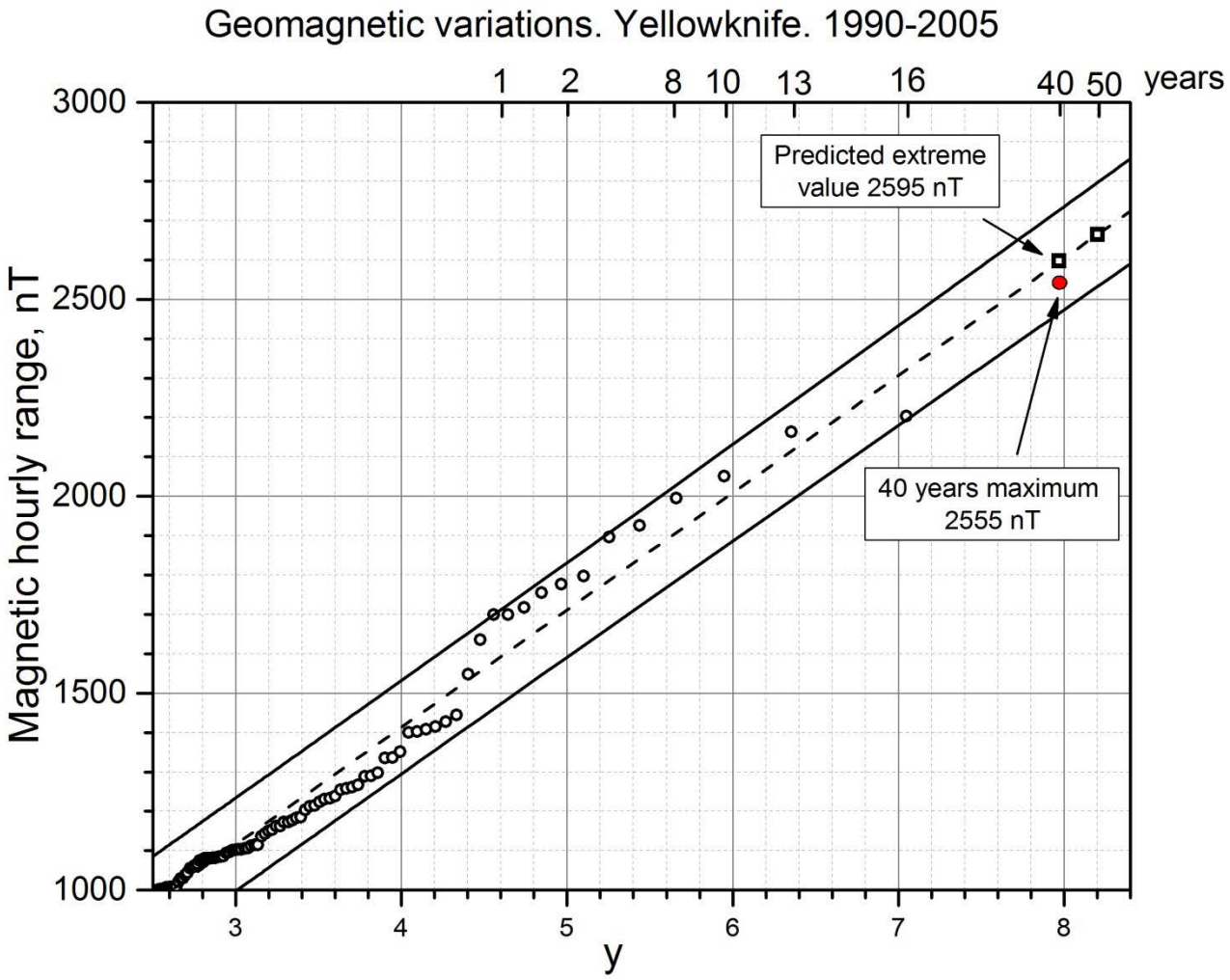


- Initial data is Geomagnetic Hourly Range values based on 1-minute observatory data
- Determine maximum value for each 5-day block
- Source data for analysis = block extremes
  - Ensure that block extremes are independent
- Fit to generalised extreme value distribution
- Test the process using 16-year subset of data
- Determine the return period as function of event size

From Nikitina et al, 2016

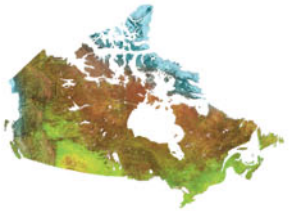
Testing the Extreme Predictions

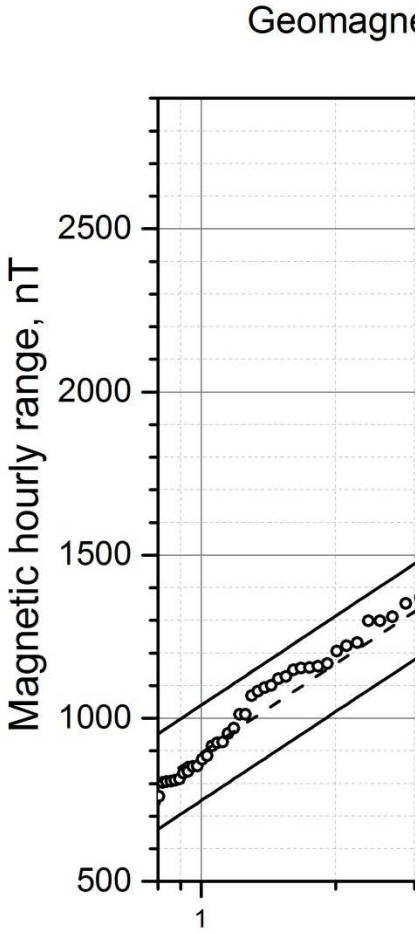


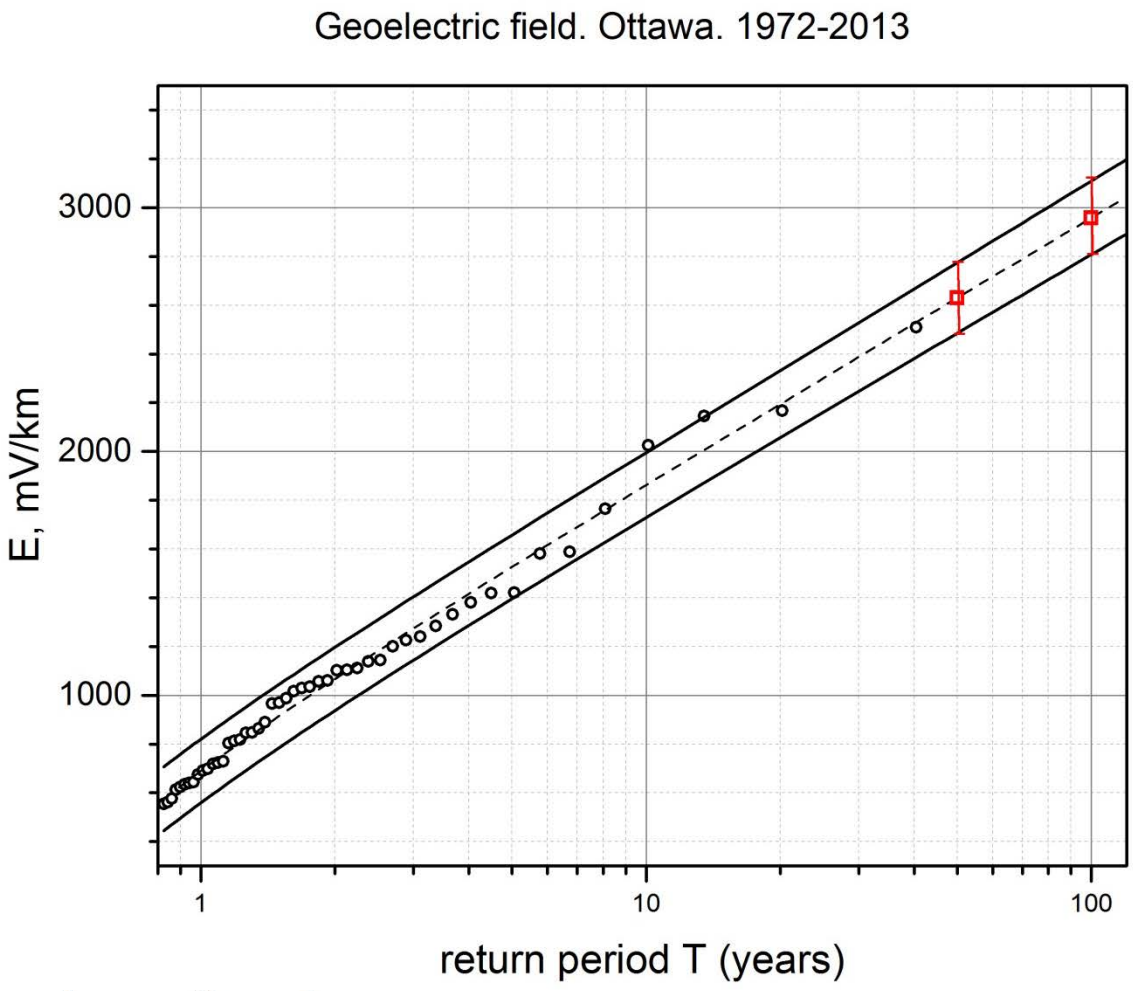


From Nikitina et al, 2016

Extreme Occurrences: Ottawa

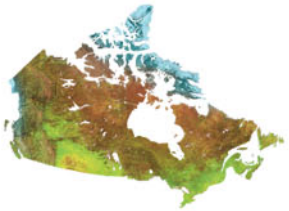


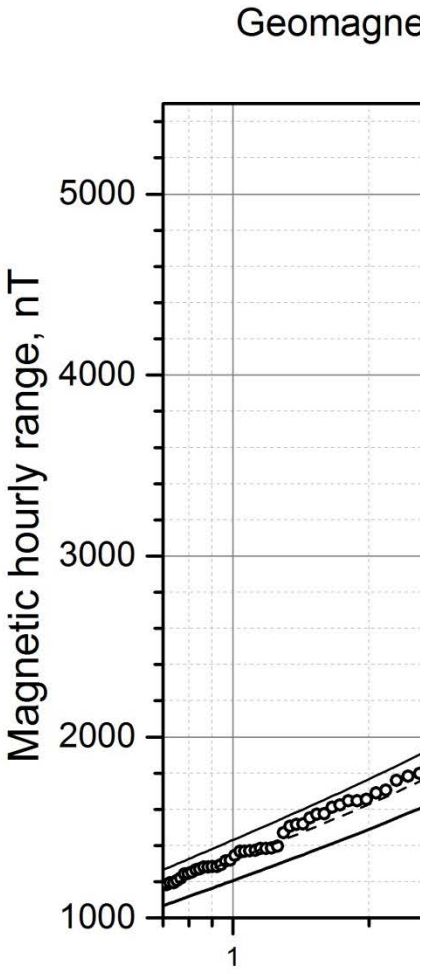


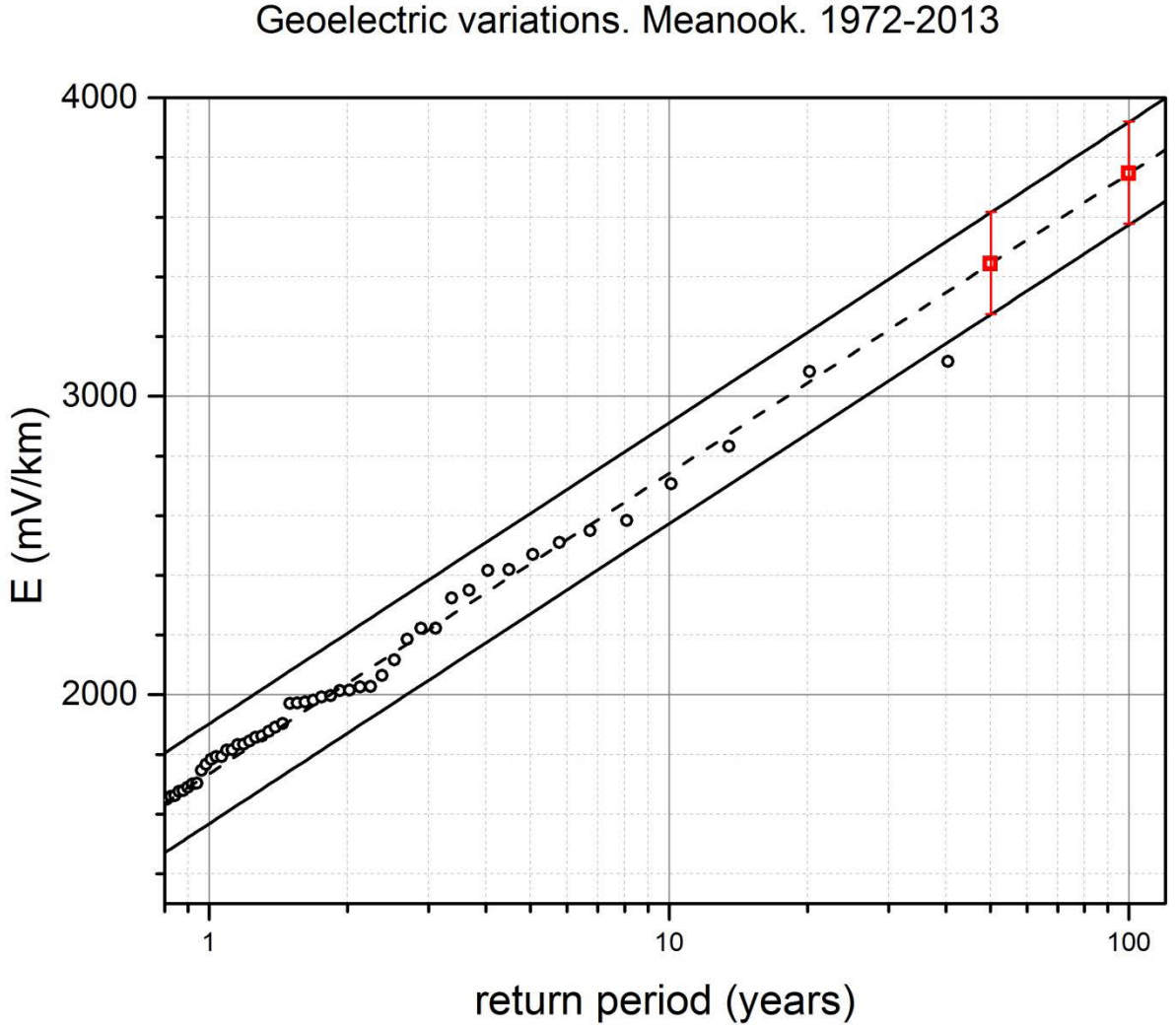


From Nikitina et al, 2016

Extreme Occurrences: Meanook

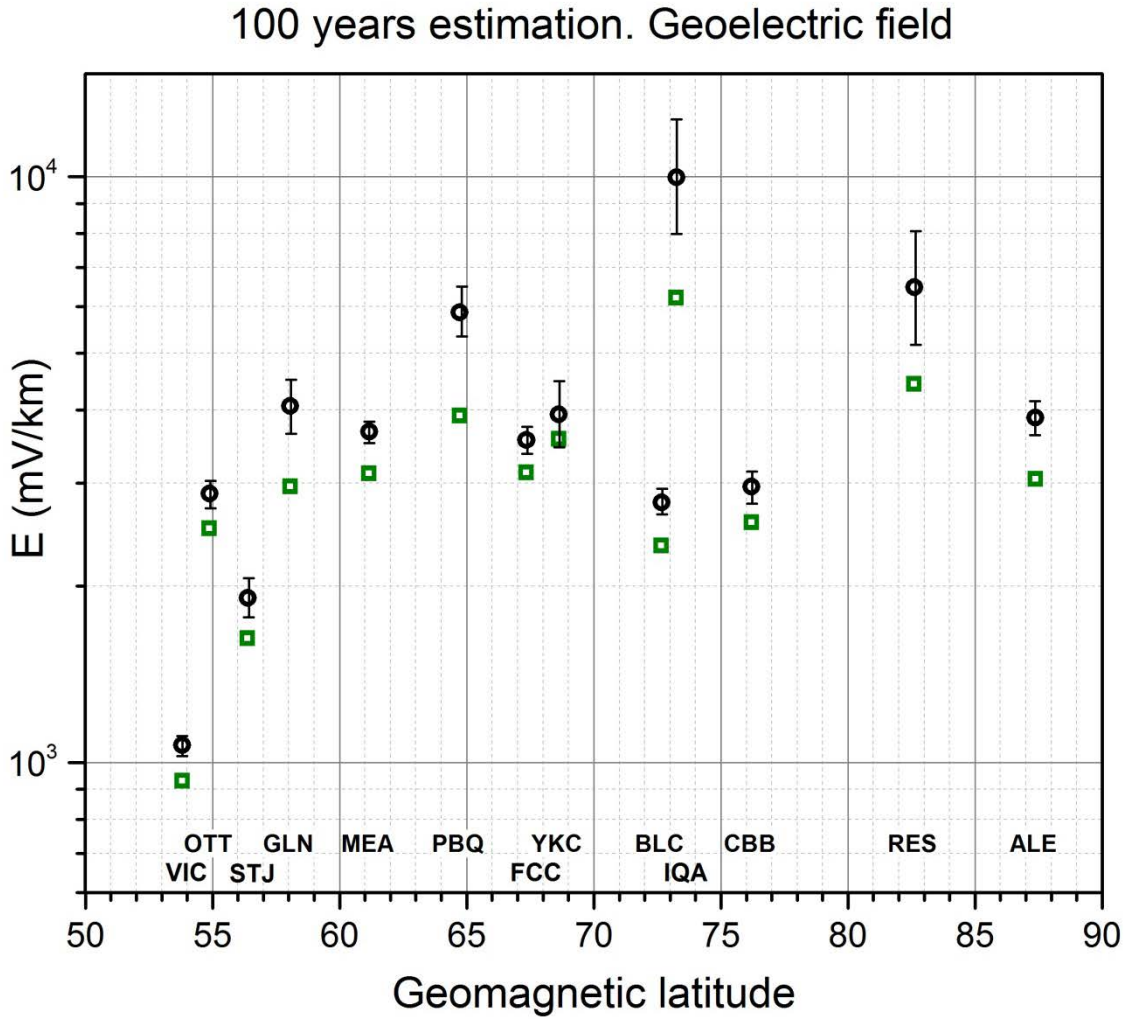




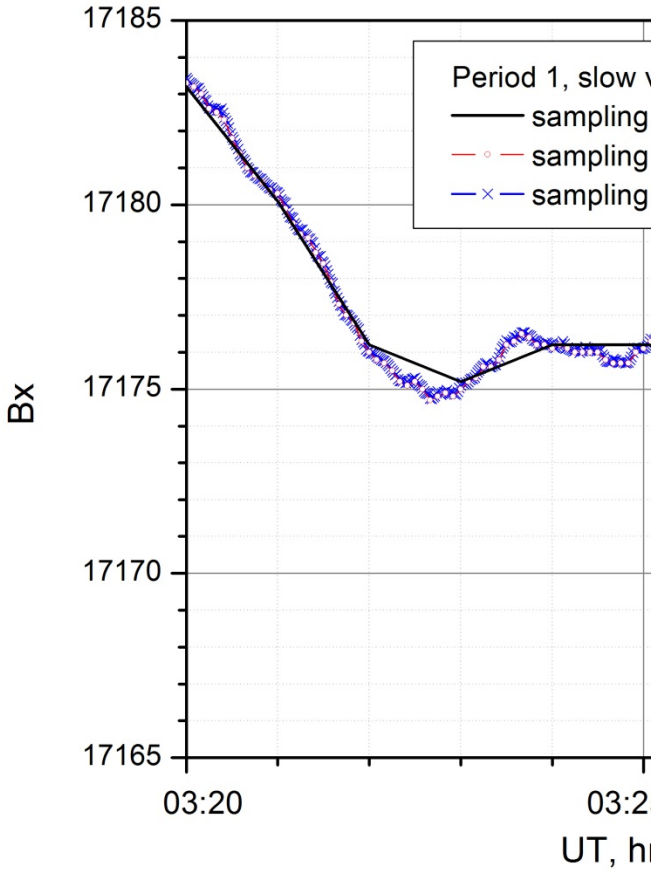


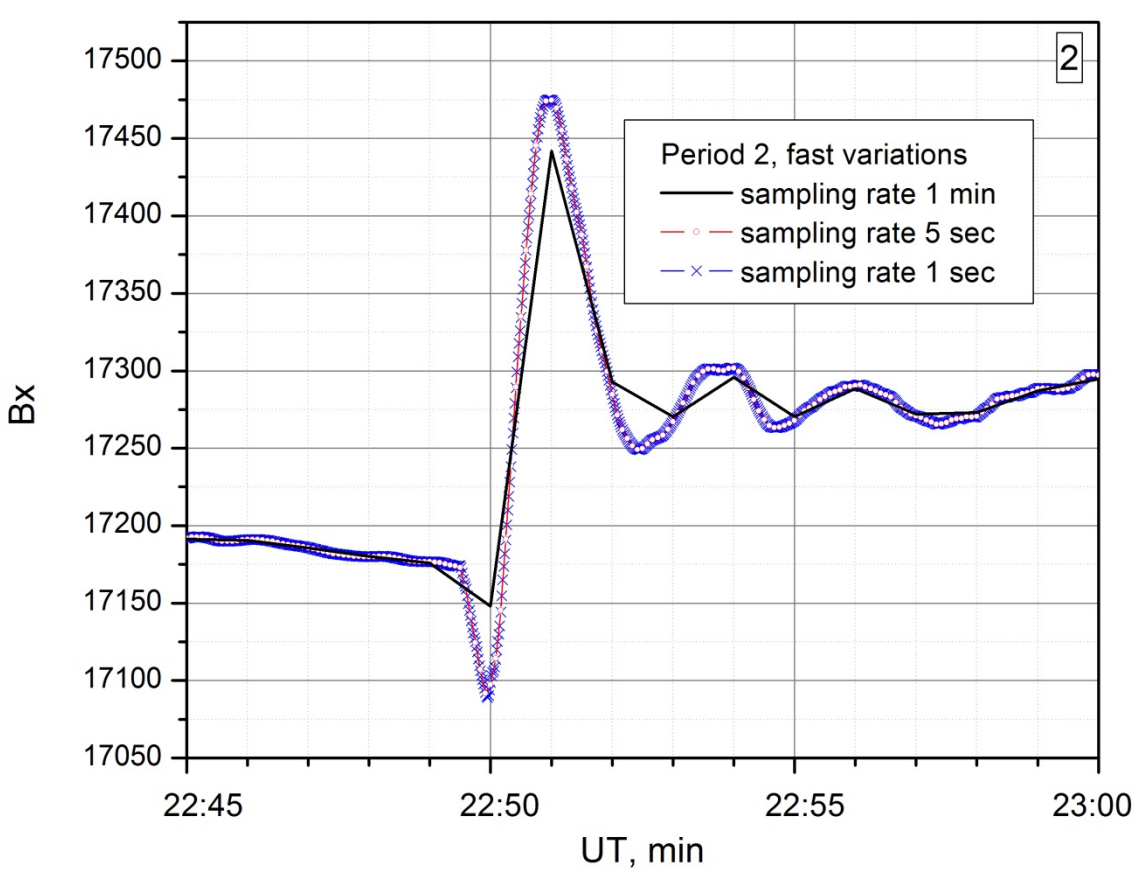
From Nikitina et al, 2016

Extreme Occurrence v Latitude



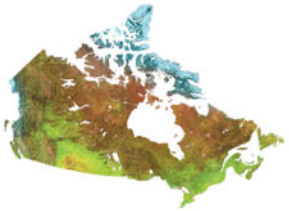
Effect of Sampling Rate

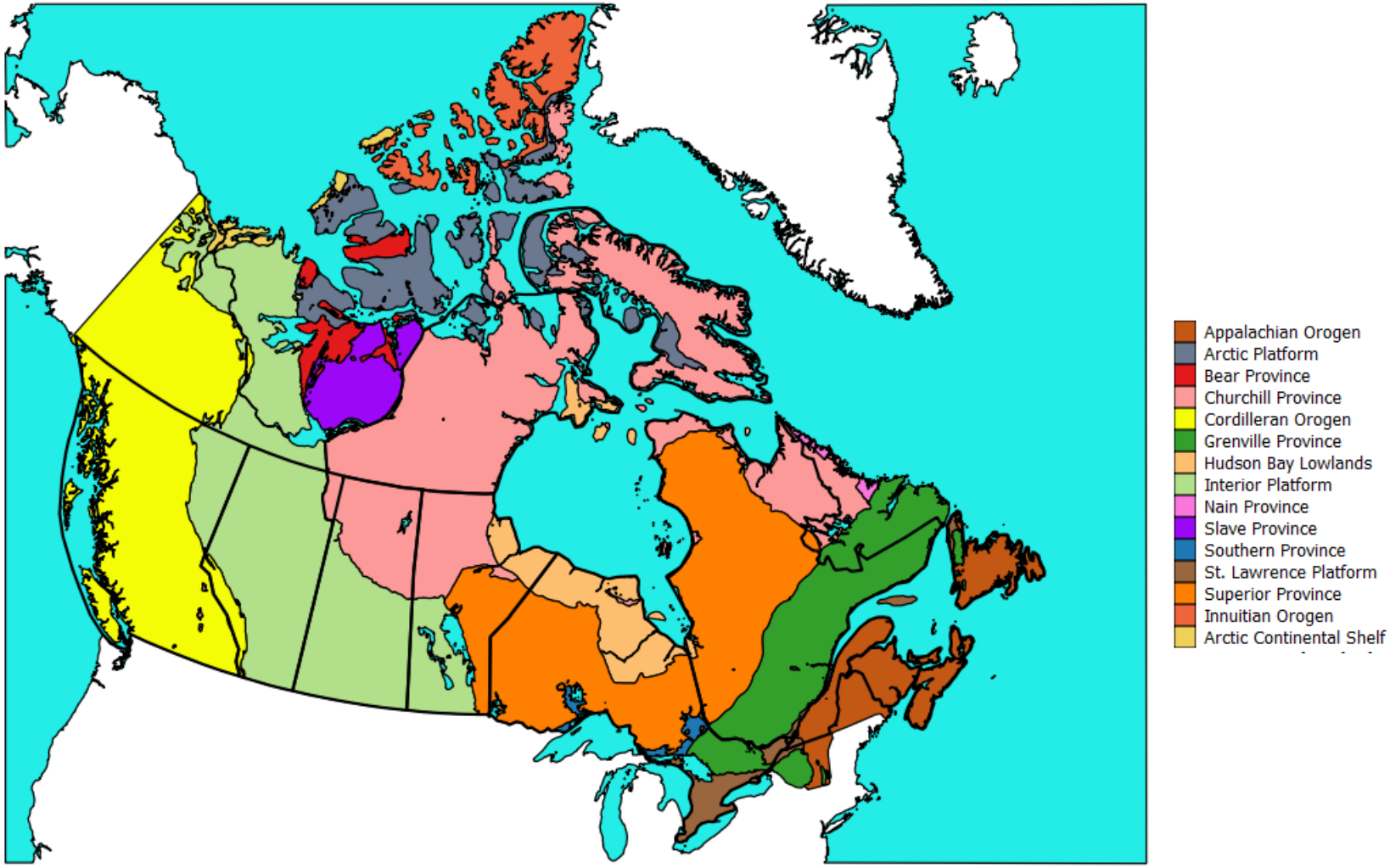




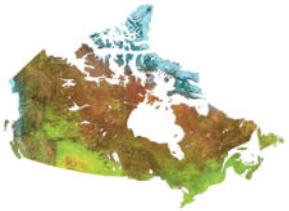
From Trichtchenko, 2016

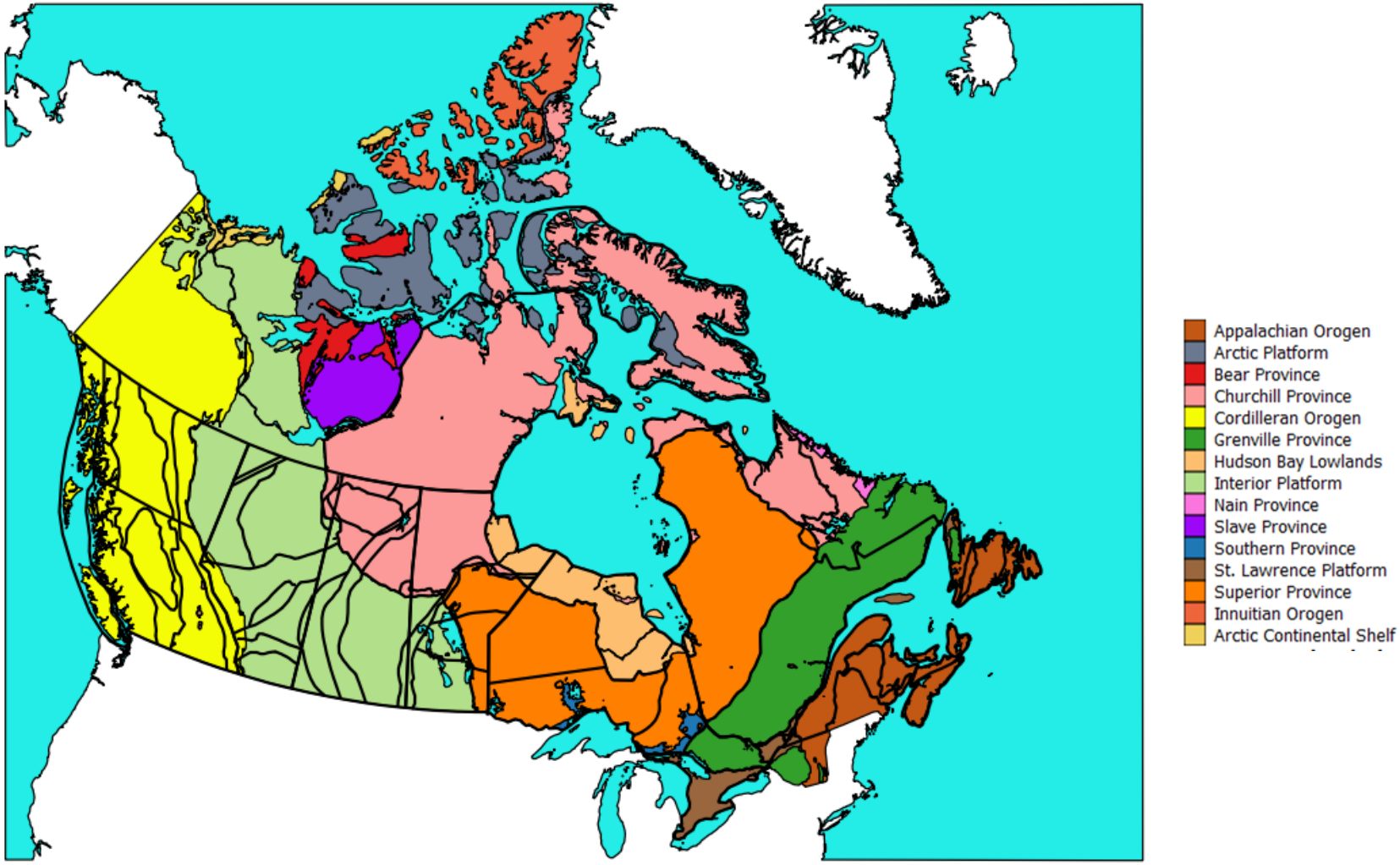
Geological Zones in Canada



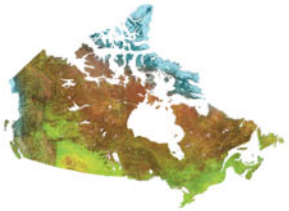


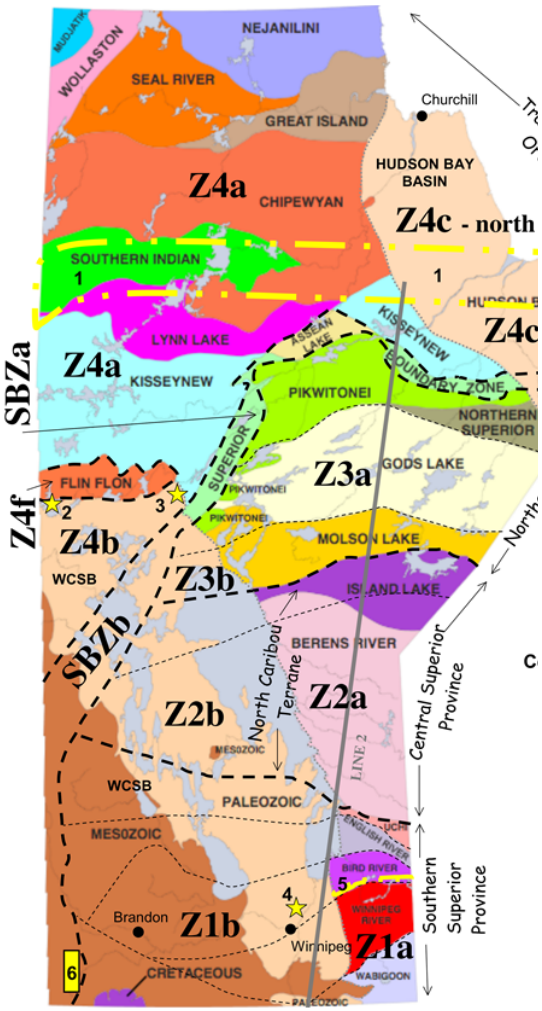
New Earth Models





Manitoba earth model zones





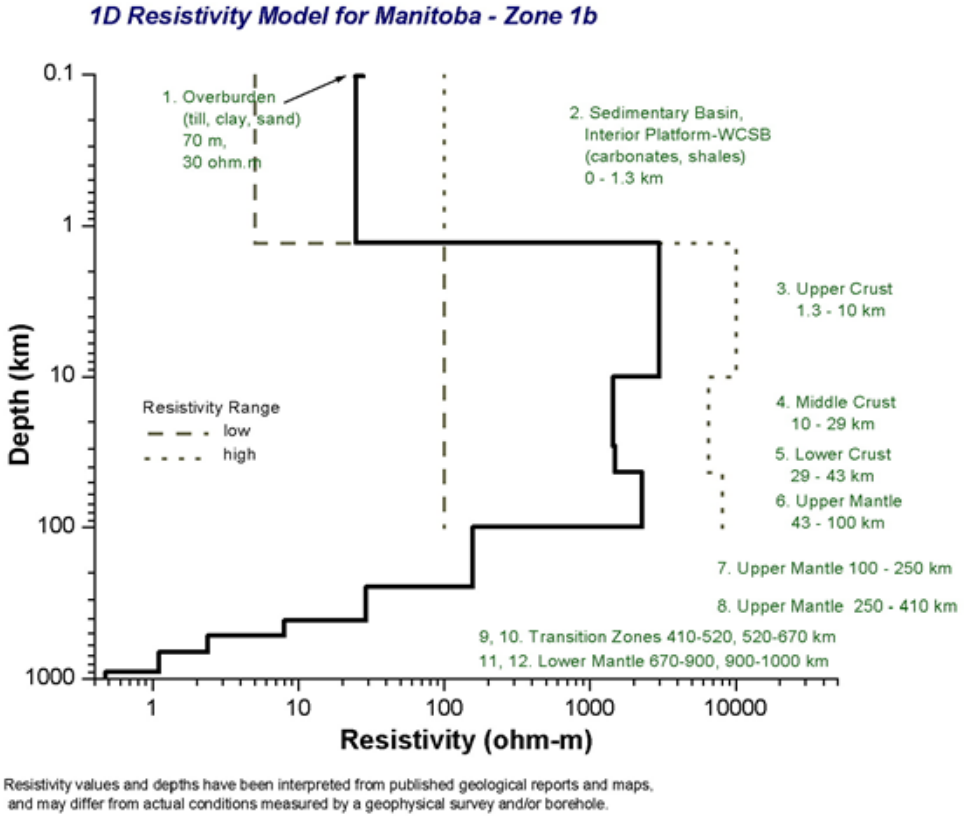
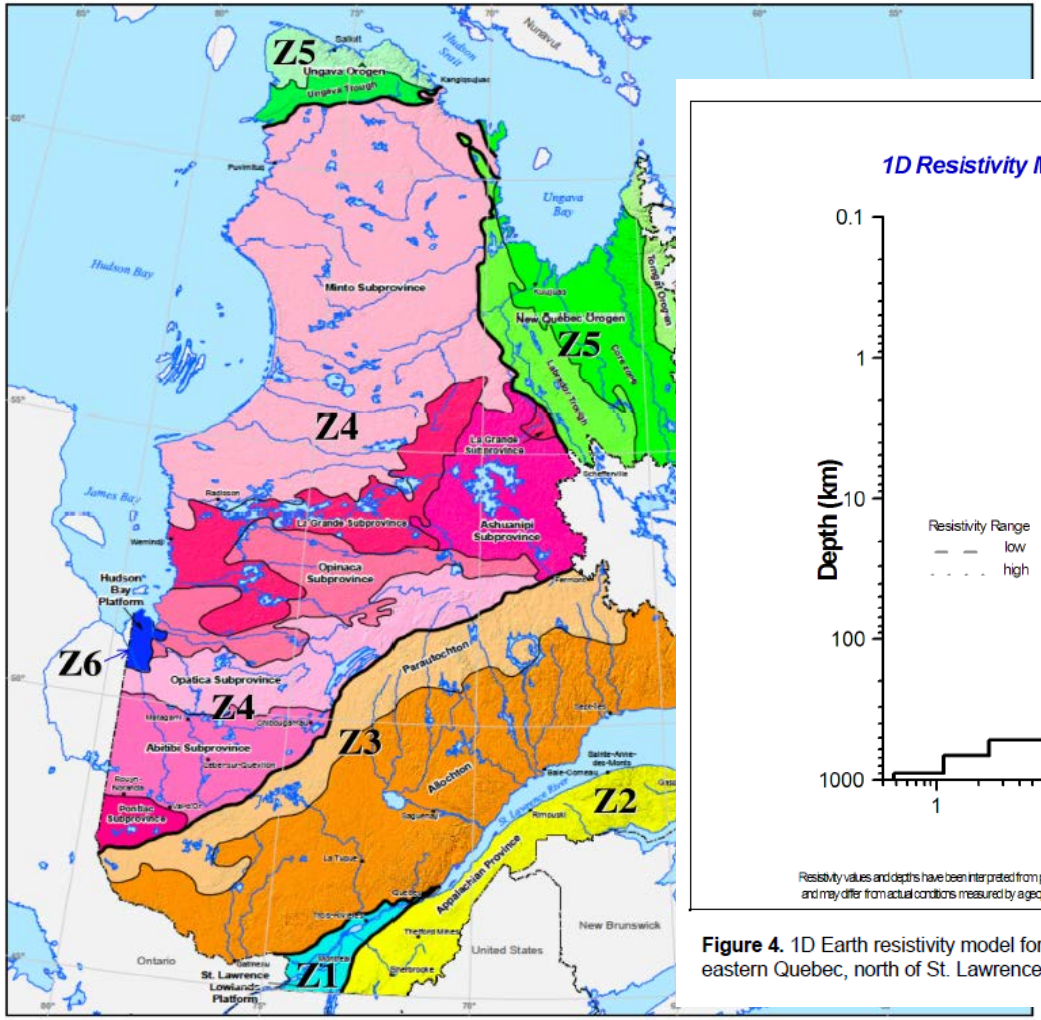


Figure 4. 1D Earth resistivity model for Zone 1b, covering part of southwestern Manitoba. Zone 1b includes the Western Canada Sedimentary Basin overlying the crystalline basement rock of the Superior geological province. Refer to Table 2 for additional details.

Quebec earth model zones



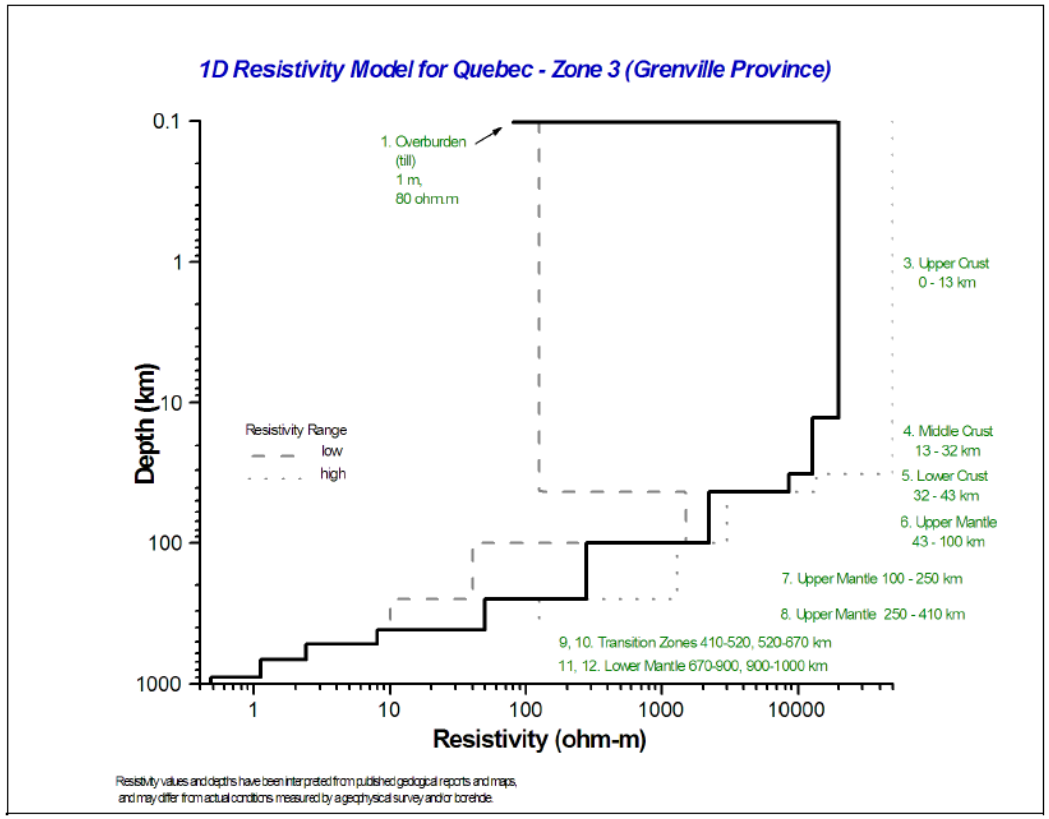
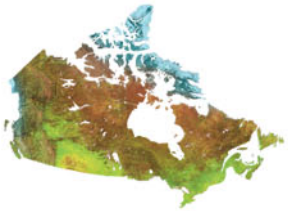


Figure 4. 1D Earth resistivity model for Zone 3 – Grenville geological province – located in south-central and eastern Quebec, north of St. Lawrence River. Refer to Table 3 for additional details.

From Fernberg, 2016

Conclusions



- Use of multiple 1-D earth models provide a first approximation to including 3-D earth structure in GIC modelling
  - ignores boundary effects
  - ignores 3-D effects in Earth response

    (off-diagonal elements in magnetotelluric impedance tensor)
- More work needed on the Coast Effect
  - Frequency and spatial dependence
- GIC modelling techniques can handle electric fields produced