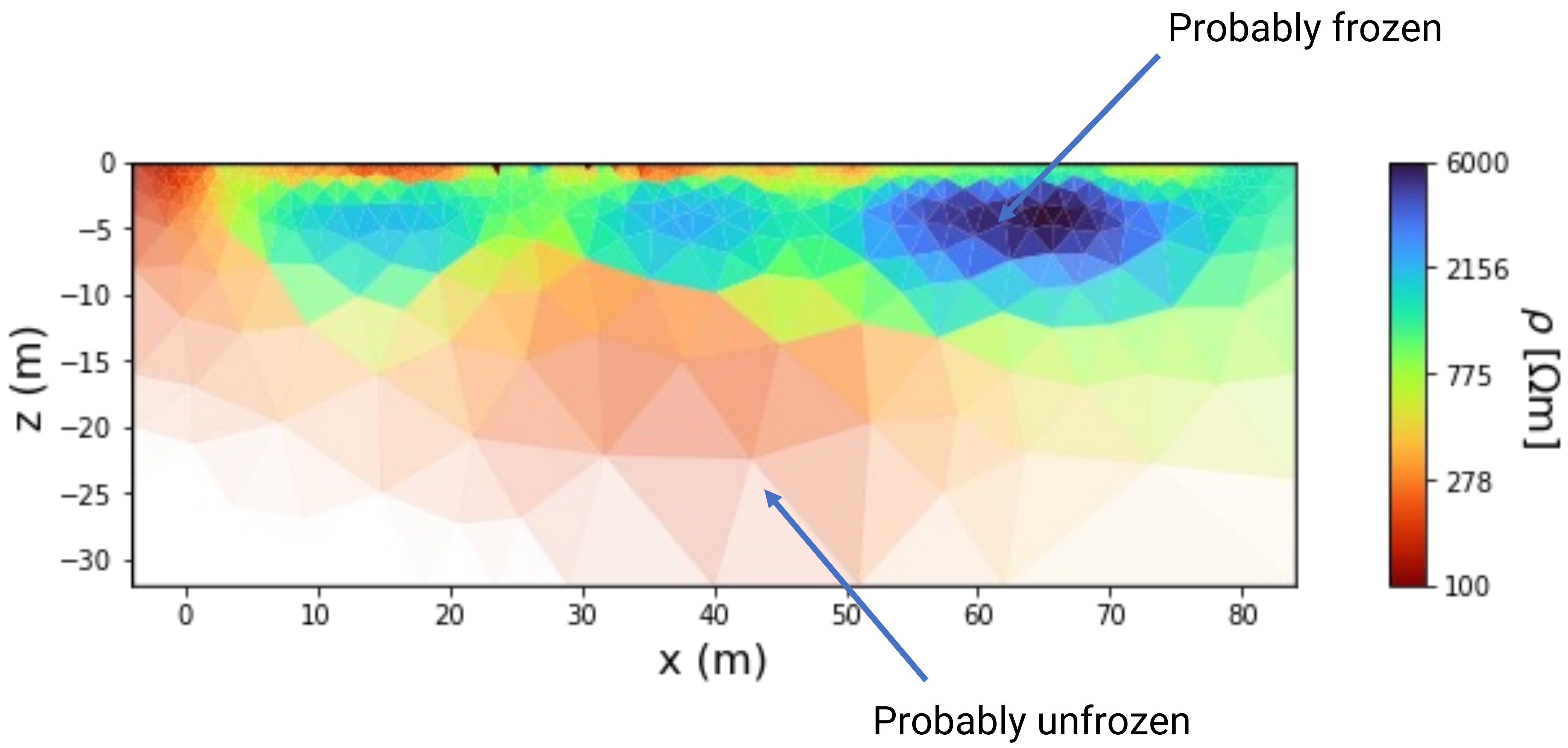
Key Outcomes of the Canadian Permafrost Electrical Resistivity Survey (CPERS) Database Project

Teddi Herring

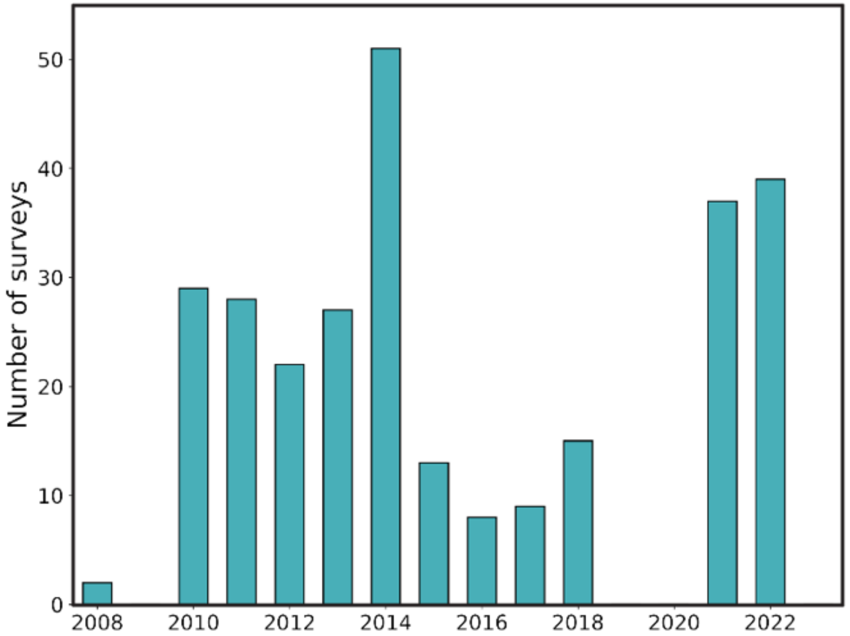
Antoni G. Lewkowicz

Electrical resistivity tomography (ERT)



Motivation for a database

Created and populated a database



Landform	Number of surveys
Active layer failure	2
Flat terrain (undifferentiated)	116
Flood plain	1
Ice wedge polygon	3
Lakeshore	2
Landslide (undifferentiated)	4
Lithalsa	3
Palsa	11
Peat plateau	56
Peatland (undifferentiated)	4
Retrogressive thaw slump	6
River channel	1
River terrace	4
Sloping terrain (undifferentiated)	49
Thermokarst mound	17
Undulating	1

209 profiles

280 surveys

15 profiles with time-lapse data

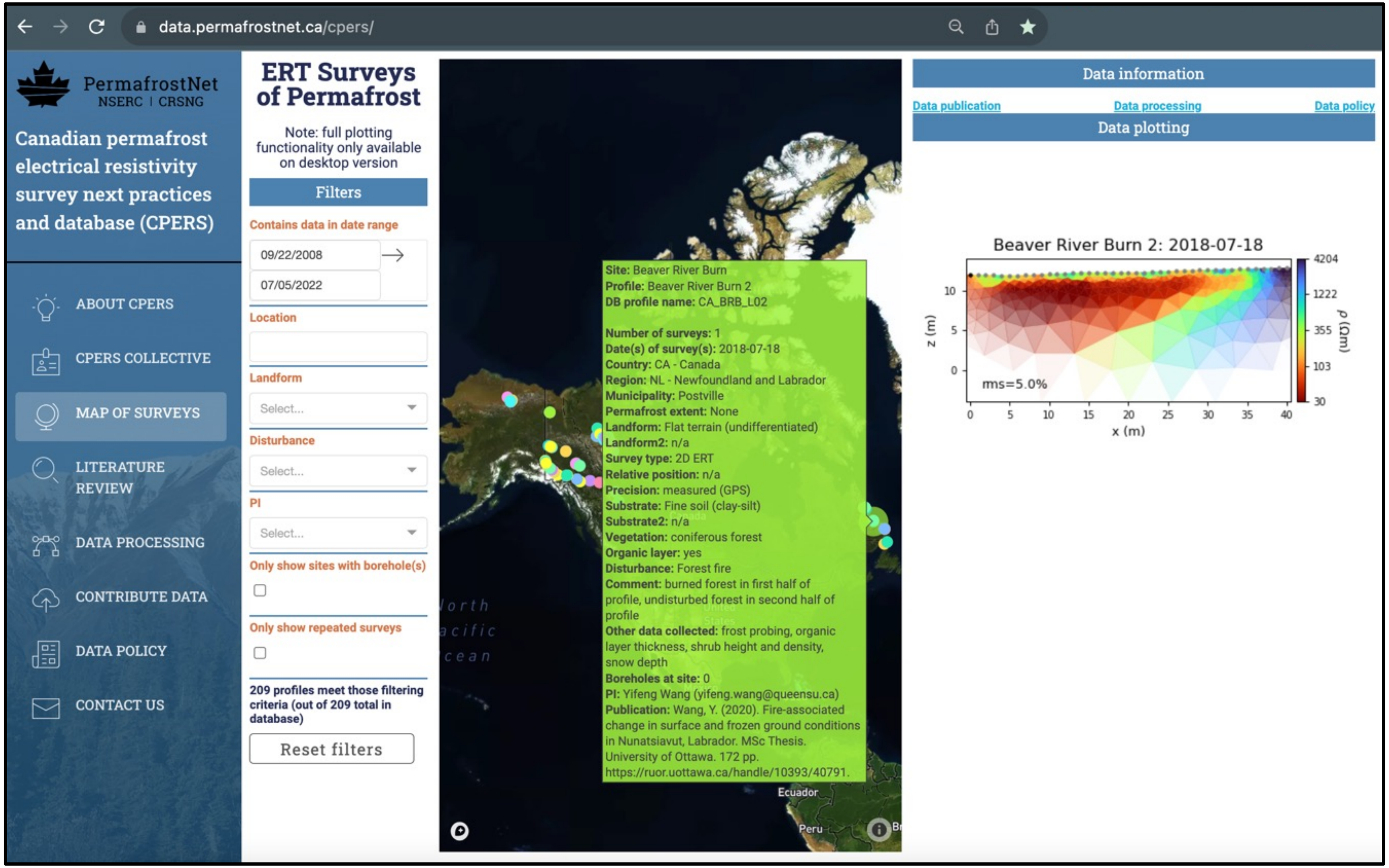
Data collected between

2008 - 2022

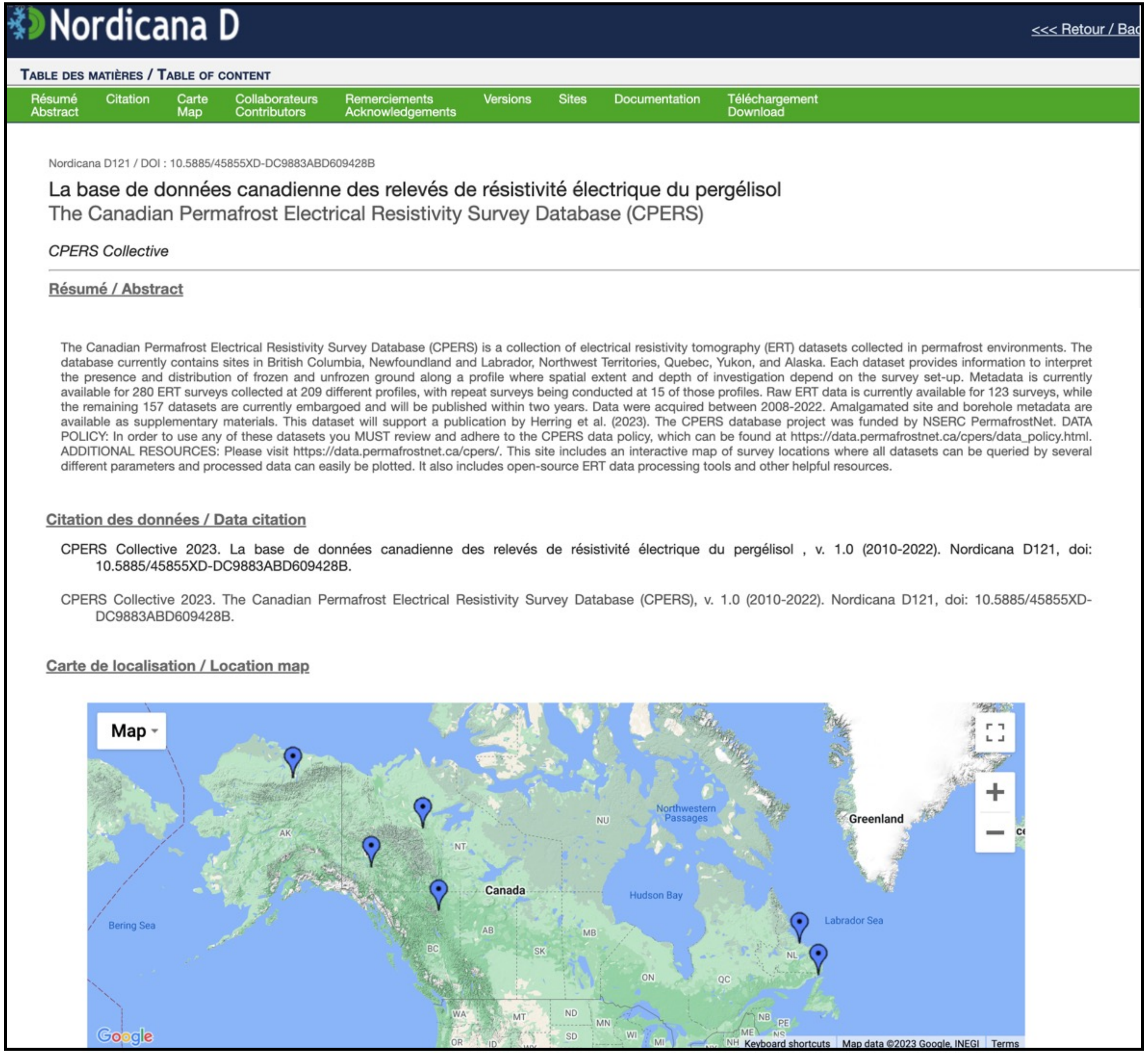
16 landform types

Standardized metadata describing the landform, substrate, vegetation, organic layer, disturbace, etc. for each profile

Built an interactive web map



Archived the data



Nordicana D

<<< Retour / Bac

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Nordicana D121 / DOI : 10.5885/45855XD-DC9883ABD609428B

La base de données canadienne des relevés de résistivité électrique du pergélisol

The Canadian Permafrost Electrical Resistivity Survey Database (CPERS)

CPERS Collective

Résumé / Abstract

The Canadian Permafrost Electrical Resistivity Survey Database (CPERS) is a collection of electrical resistivity tomography (ERT) datasets collected in permafrost environments. The database currently contains sites in British Columbia, Newfoundland and Labrador, Northwest Territories, Quebec, Yukon, and Alaska. Each dataset provides information to interpret the presence and distribution of frozen and unfrozen ground along a profile where spatial extent and depth of investigation depend on the survey set-up. Metadata is currently available for 280 ERT surveys collected at 209 different profiles, with repeat surveys being conducted at 15 of those profiles. Raw ERT data is currently available for 123 surveys, while the remaining 157 datasets are currently embargoed and will be published within two years. Data were acquired between 2008-2022. Amalgamated site and borehole metadata are available as supplementary materials. This dataset will support a publication by Herring et al. (2023). The CPERS database project was funded by NSERC PermafrostNet. DATA POLICY: In order to use any of these datasets you MUST review and adhere to the CPERS data policy, which can be found at https://data.permafrostnet.ca/cpers/data_policy.html. ADDITIONAL RESOURCES: Please visit https://data.permafrostnet.ca/cpers/. This site includes an interactive map of survey locations where all datasets can be queried by several different parameters and processed data can easily be plotted. It also includes open-source ERT data processing tools and other helpful resources.

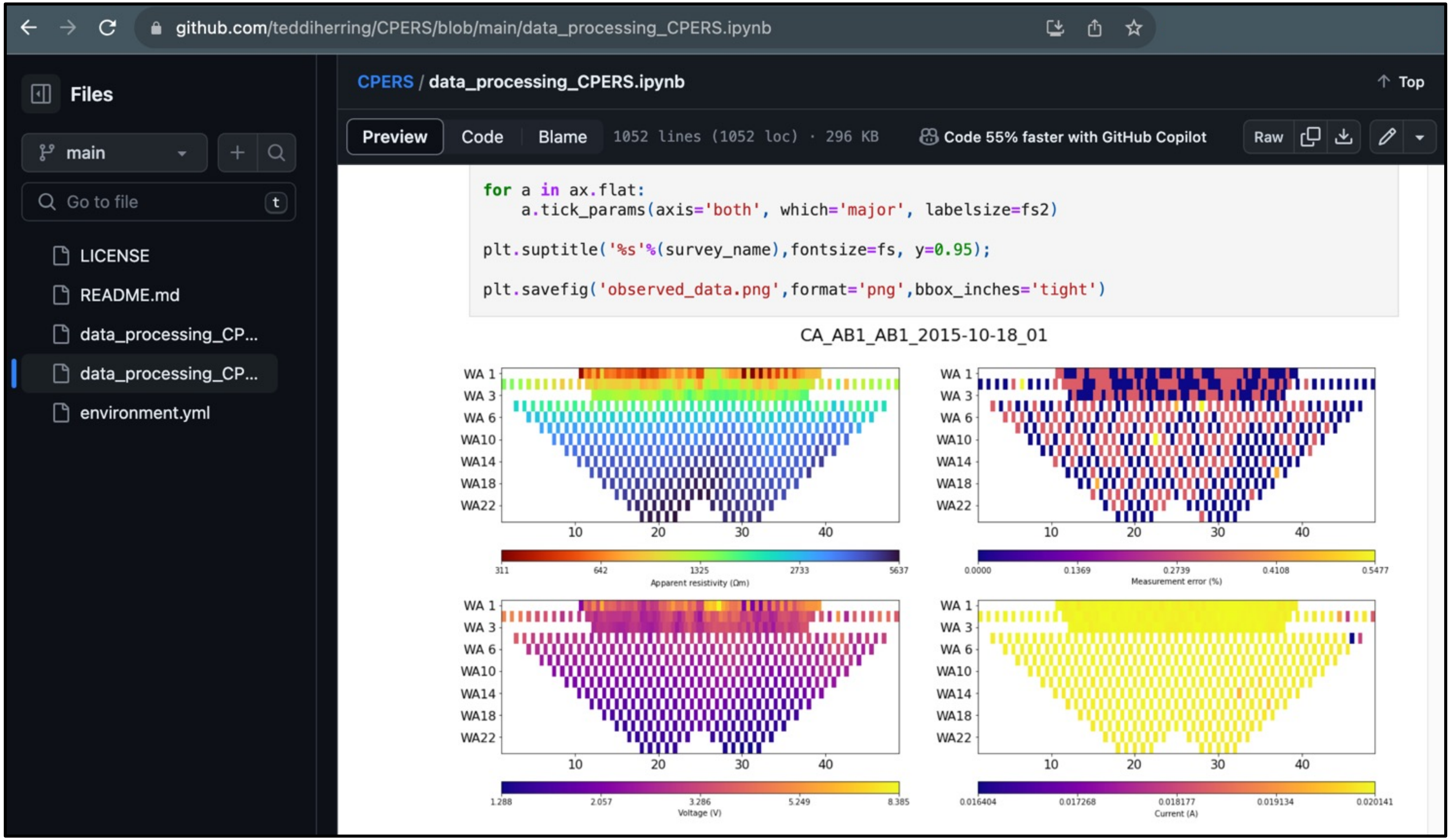
Citation des données / Data citation

CPERS Collective 2023. La base de données canadienne des relevés de résistivité électrique du pergélisol , v. 1.0 (2010-2022). Nordicana D121, doi: 10.5885/45855XD-DC9883ABD609428B.

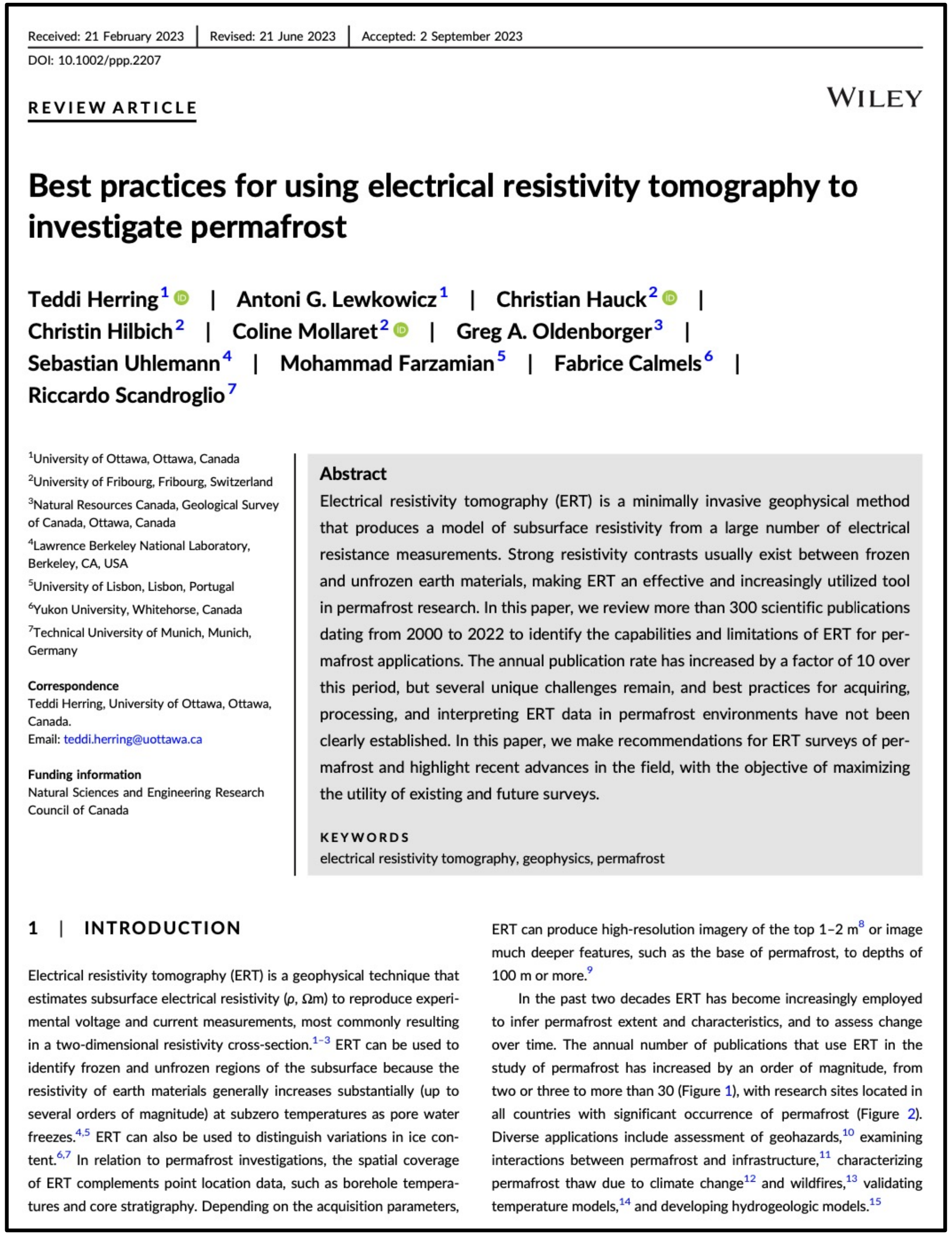
CPERS Collective 2023. The Canadian Permafrost Electrical Resistivity Survey Database (CPERS), v. 1.0 (2010-2022). Nordicana D121, doi: 10.5885/45855XD-DC9883ABD609428B.

Carte de localisation / Location map

Developed open-source data processing tools



Established best practices for using ERT to study permafrost



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REVIEW ARTICLE

WILEY

Best practices for using electrical resistivity tomography to investigate permafrost

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Abstract

Electrical resistivity tomography (ERT) is a minimally invasive geophysical method that produces a model of subsurface resistivity from a large number of electrical resistance measurements. Strong resistivity contrasts usually exist between frozen and unfrozen earth materials, making ERT an effective and increasingly utilized tool in permafrost research. In this paper, we review more than 300 scientific publications dating from 2000 to 2022 to identify the capabilities and limitations of ERT for permafrost applications. The annual publication rate has increased by a factor of 10 over this period, but several unique challenges remain, and best practices for acquiring, processing, and interpreting ERT data in permafrost environments have not been clearly established. In this paper, we make recommendations for ERT surveys of permafrost and highlight recent advances in the field, with the objective of maximizing the utility of existing and future surveys.

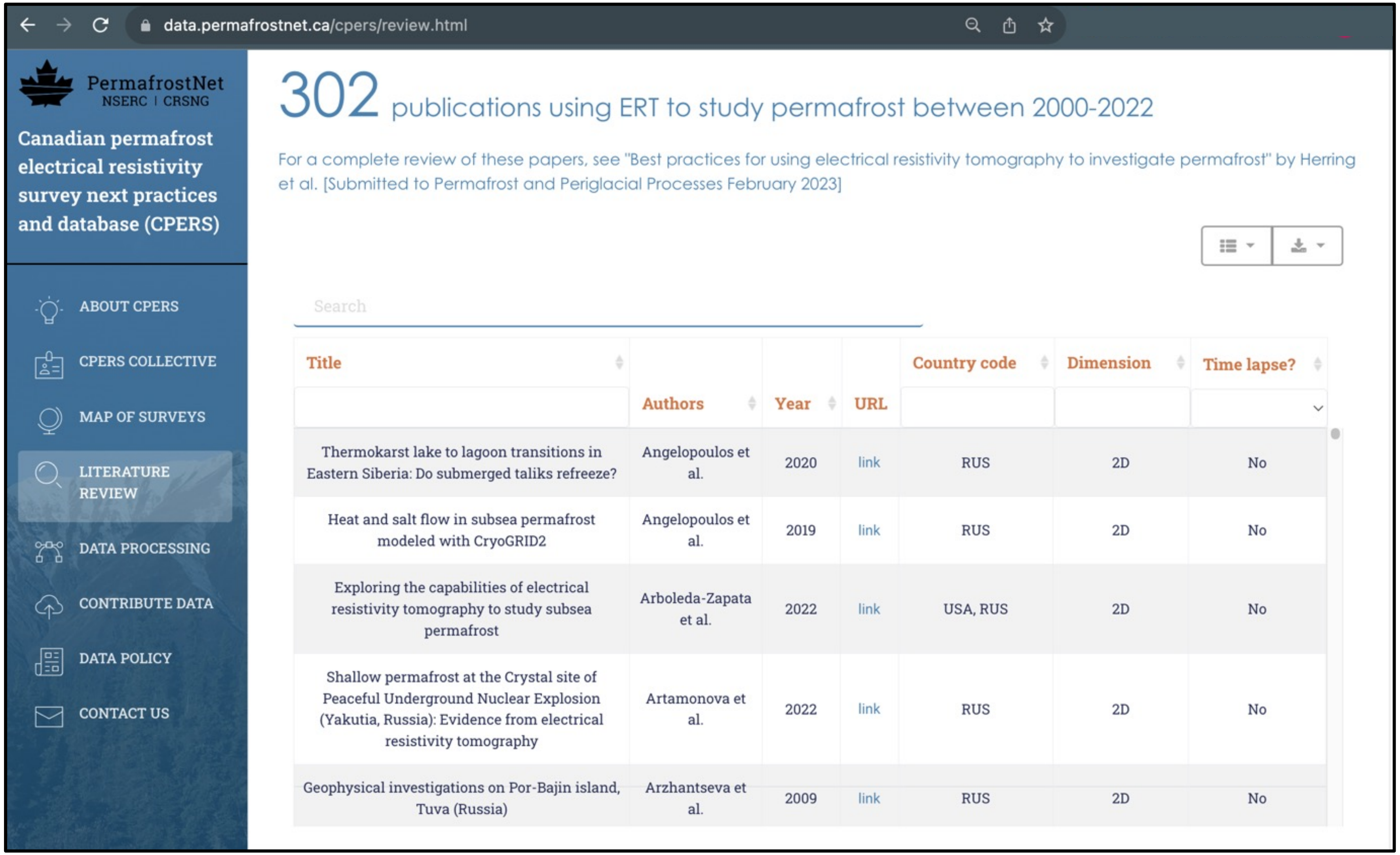
KEYWORDS
electrical resistivity tomography, geophysics, permafrost

1 | INTRODUCTION

Electrical resistivity tomography (ERT) is a geophysical technique that estimates subsurface electrical resistivity (ρ, Ωm) to reproduce experimental voltage and current measurements, most commonly resulting in a two-dimensional resistivity cross-section.[1–3] ERT can be used to identify frozen and unfrozen regions of the subsurface because the resistivity of earth materials generally increases substantially (up to several orders of magnitude) at subzero temperatures as pore water freezes.[4,5] ERT can also be used to distinguish variations in ice content.[6,7] In relation to permafrost investigations, the spatial coverage of ERT complements point location data, such as borehole temperatures and core stratigraphy. Depending on the acquisition parameters, ERT can produce high-resolution imagery of the top 1–2 m[8] or image much deeper features, such as the base of permafrost, to depths of 100 m or more.[9]

In the past two decades ERT has become increasingly employed to infer permafrost extent and characteristics, and to assess change over time. The annual number of publications that use ERT in the study of permafrost has increased by an order of magnitude, from two or three to more than 30 (Figure 1), with research sites located in all countries with significant occurrence of permafrost (Figure 2). Diverse applications include assessment of geohazards,[10] examining interactions between permafrost and infrastructure,[11] characterizing permafrost thaw due to climate change[12] and wildfires,[13] validating temperature models,[14] and developing hydrogeologic models.[15]

Compiled literature sources



data.permafrostnet.ca/cpers/review.html

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Canadian permafrost electrical resistivity survey next practices and database (CPERS)

- ABOUT CPERS
- CPERS COLLECTIVE
- MAP OF SURVEYS
- LITERATURE REVIEW
- DATA PROCESSING
- CONTRIBUTE DATA
- DATA POLICY
- CONTACT US

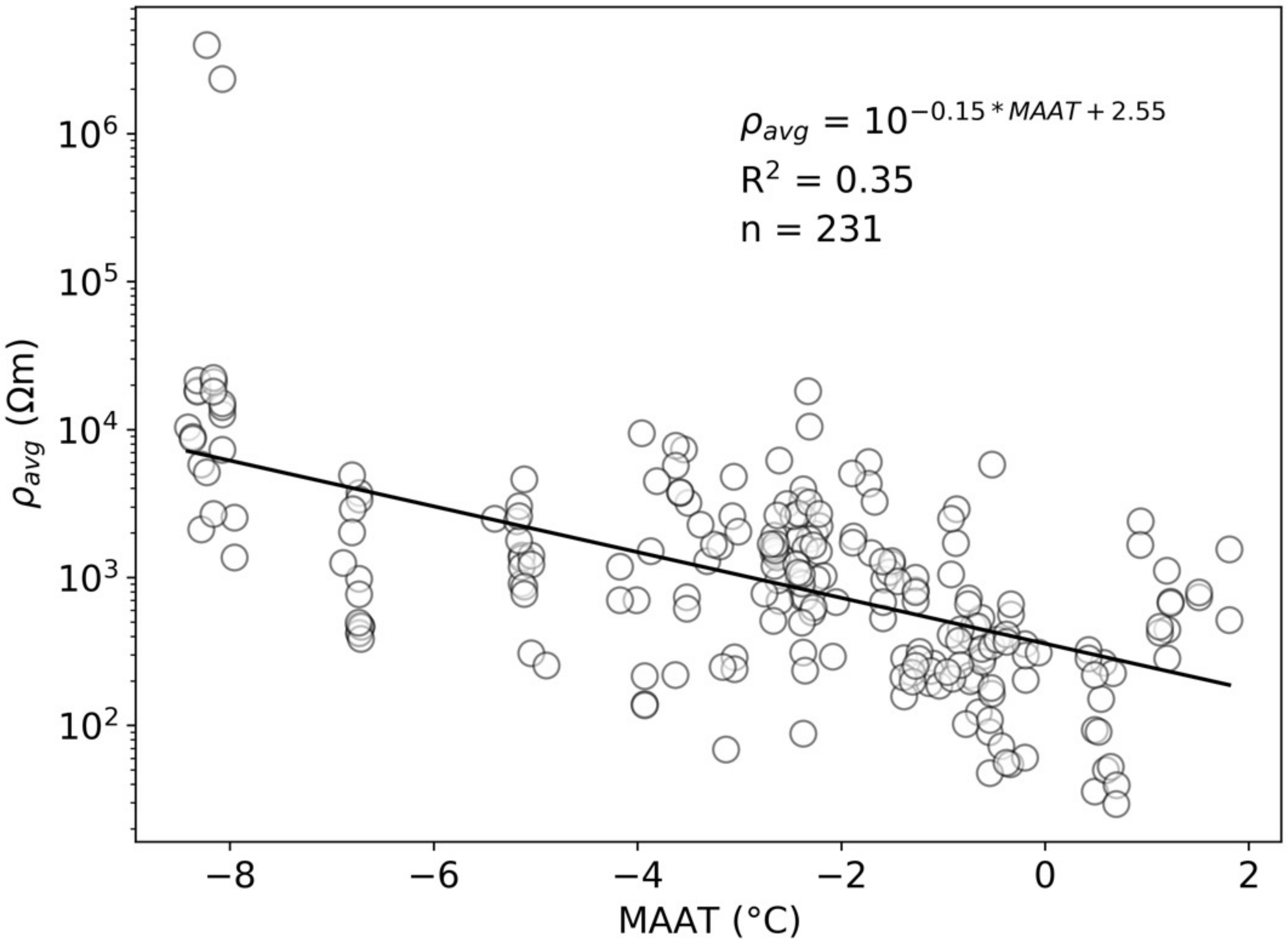
302 publications using ERT to study permafrost between 2000-2022

For a complete review of these papers, see "Best practices for using electrical resistivity tomography to investigate permafrost" by Herring et al. [Submitted to Permafrost and Periglacial Processes February 2023]

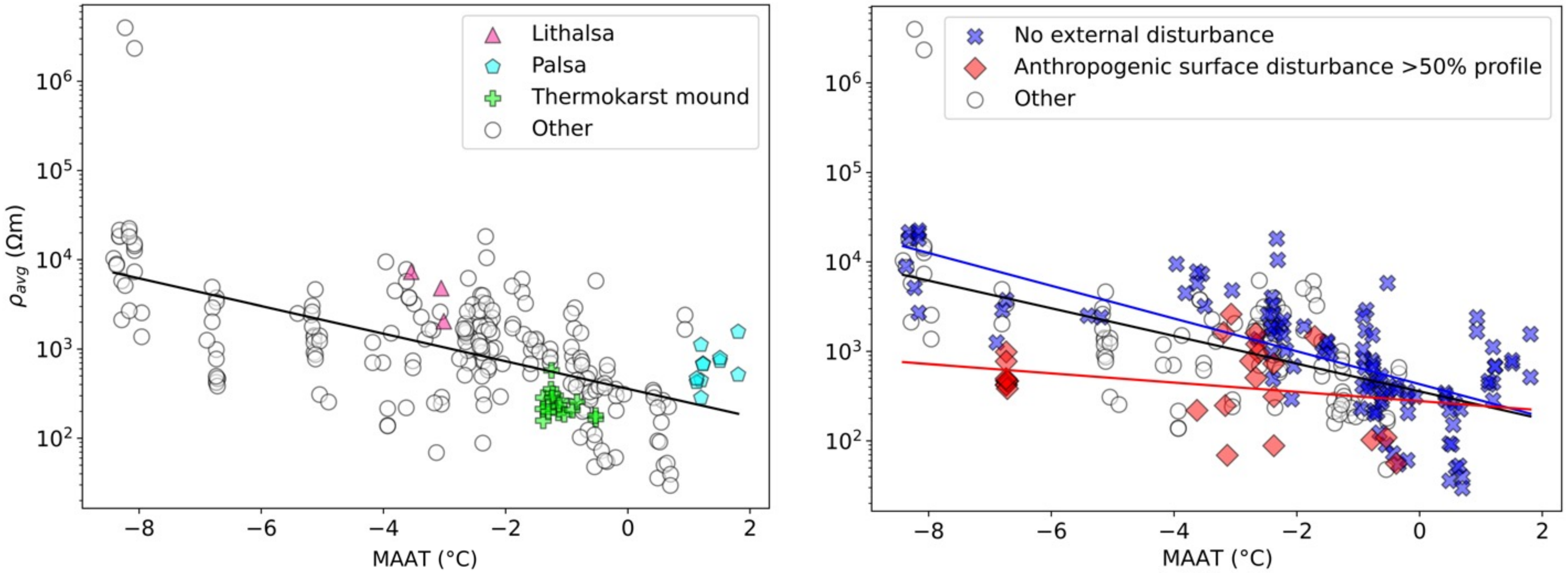
Search

Title	Authors	Year	URL	Country code	Dimension	Time lapse?
Thermokarst lake to lagoon transitions in Eastern Siberia: Do submerged taliks refreeze?	Angelopoulos et al.	2020	link	RUS	2D	No
Heat and salt flow in subsea permafrost modeled with CryoGRID2	Angelopoulos et al.	2019	link	RUS	2D	No
Exploring the capabilities of electrical resistivity tomography to study subsea permafrost	Arboleda-Zapata et al.	2022	link	USA, RUS	2D	No
Shallow permafrost at the Crystal site of Peaceful Underground Nuclear Explosion (Yakutia, Russia): Evidence from electrical resistivity tomography	Artamonova et al.	2022	link	RUS	2D	No
Geophysical investigations on Por-Bajin island, Tuva (Russia)	Arzhantseva et al.	2009	link	RUS	2D	No

Started making large-scale interpretations



Started making large-scale interpretations



Modified from Herring et al. [Submitted to ICOP 2024]

Aspirations

- Add new data
- Better large-scale interpretations (machine learning?)
- Improve how data is shared and used in the permafrost community

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Dr. Duane Froese

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