Natural Resources Canada | Ressources naturelles Canada

GEOLOGICAL SURVEY OF CANADA
OPEN FILE 8944

Investigation into the feasibility of increasing geoscience accessibility through existing web platforms and mobile applications, Nunavut

M. Sanborn-Barrie, N.M. Rayner, and A. Ford

2023

Canada

ISSN 2816-7155
ISBN 978-0-660-47366-6
Catalogue No. M183-2/8944E-PDF

GEOLOGICAL SURVEY OF CANADA
OPEN FILE 8944

Investigation into the feasibility of increasing geoscience accessibility through existing web platforms and mobile applications, Nunavut

M. Sanborn-Barrie, N.M. Rayner, and A. Ford

2023

Permanent link: https://doi.org/10.4095/331384

This publication is available for free download through GEOSCAN (https://geoscan.nrcan.gc.ca/).

Recommended citation
Sanborn-Barrie, M., Rayner, N.M., and Ford, A., 2023. Investigation into the feasibility of increasing geoscience accessibility through existing web platforms and mobile applications, Nunavut; Geological Survey of Canada, Open File 8944, 1 .zip file. https://doi.org/10.4095/331384

Publications in this series have not been edited; they are released as submitted by the author.

Abstract

Accessibility and uptake of geoscience knowledge by First Nations and Inuit community members has traditionally been limited. This is, at least in part, due to the technical nature of geological maps and the expensive licensing requirements of the geographic information system software that is used to view and analyse geoscience data. During the Foundational Year of GEM GeoNorth, we investigated the potential of available apps and platforms, including NRCan Observer, Rockd and SIKU to broaden access and knowledge sharing of geoscience with non-specialists. Most prospective was SIKU - a mobile app developed by northerners for northerners that currently supports knowledge-gathering related to the natural world (currently mammals, birds, fish and sea-ice conditions). This report provides an overview of our investigation and presents detailed aspects of the feasibility and related costs of incorporating a geoscience component(s) into SIKU that could allow northerners the opportunity to calibrate geoscience through georeferenced photographs and structural trends for consideration and use on their terms.

Introduction

Historically, fieldwork to address gaps in the framework geoscience knowledge of Canada has been carried out largely by southern scientists who have typically employed university students as field assistants for on-the-job training. Mapping is accomplished using specialized tools that require relatively advanced training. Northern data collected in the field is generally brought south for further analysis and processing. While valued insights are gained and new geoscience maps produced that help to drive economic development opportunities in the north, uptake and capacity building in northern communities has remained limited using this approach.

Reconciliation requires a new vision for conducting natural science (cf. Wong et al., 2021) and, accordingly, NRCan's GeoNorth program (2020-2027) aims to build upon its Geo-Mapping for Energy and Minerals (GEM) program (2009-2019) by providing geoscience support in underexplored regions of Canada's North in co-development with Indigenous organizations and communities wherever possible. During it's Foundational Year, a desktop study was initiated to investigate ways to facilitate geoscientific observations in the North by northerners. A variety of innovative, user-friendly platforms and mobile applications (apps), as well as non-specialist mapping aids (e.g., photo glossary) were considered with a view to develop a 'tool-kit' that northerners could more easily access and use to record geoscience observations.

Background

Traditionally, government-led geoscience fieldwork has involved equipping apprentice geologists (typically undergraduate ± graduate students) with a digital camera, expensive (Brunton) compass, and hand-held computer with GPS capability to measure and record field observations of rocks and minerals (bedrock mapping), glacial landforms and ice-movement indicators (surficial mapping), permafrost and sea-level features (Fig. 1). More specifically, over the ~6 week duration of a bedrock mapping field season, pairs of researchers walk the land observing and recording changes in the character of exposed bedrock underfoot, with systematic collection of representative hand-size rock samples. Each field season, large (e.g., 10,000-16,000 km^2) areas are mapped in this way with the support of a helicopter to ferry traverse teams daily to pre-determined starting locations and retrieve them each evening. Extensive frontier regions typically deploy six 2-person traverse teams who map while walking 10-15km to their pickup locations. Geospatial data is collected for the duration of each traverse using hand-held computers that have evolved in capability throughout the past several decades. Geo-referenced data and digital photographs are downloaded each evening by the project's GIS support scientist and compiled in a field database that uses costly licensed GIS software (e.g., ESRI ArcMap) for visualization and analysis.

Figure 1: Group training of university students on key aspects of bedrock mapping at the start of the fieldseason on Boothia Peninsula 2017 (left). Photograph by A. Ford. NRCan photo 2022-461, and at Creswell Bay, Somerset Island 2018 (right). Photograph by M. Sanborn-Barrie. NRCan photo 2022-462.

Participation in northern fieldwork by northerners has long been an integral part of such framework geoscience projects (Fig. 2). Whereas involvement traditionally encompassed wildlife monitoring, it has evolved over time to include camp management and maintenance, camp cook and/or cook's assistant, and support in ground geophysical surveys (e.g., electro-magnetic (EM) imaging). Participation in bedrock mapping by students from Arctic College (Rayner et al., 2015) and, in some cases, high school students (Williamson et al., 2013) has further enriched Northern research programs.

Figure 2: Taloyoak residents employed and engaged at the GEM-2 Boothia Peninsula camp, 2017. **Left**: Randy Alookee, Louisa Alookee and Peter Qayutinuak, Jr. Photograph by M. Sanborn-Barrie. NRCan photo 2022-463. **Right**: Henry Totalik. Photograph by M. Sanborn-Barrie. NRCan photo 2022-464.

New Tools for a new approach

Northerners traditionally spend an extensive amount of time on the land travelling by foot, ATV, shoreline boating and/or snowmachine. With two decades of advances in the mobile device field, the Foundational Year of GEM-GeoNorth supported investigation into whether there exist mobile applications and non-specialist mapping aids that could be incorporated into a user-friendly 'tool-kit' that northerners could more easily access and use. With an over-arching goal to engage community members with an interest in geoscience (Fig. 3), this approach could target high-school teachers and their students, stake-holders such as those who completed the Government of Nunavut (GN)'s Prospecting course, students enrolled in Arctic College's Environmental Tech Program (ETP), Government of Nunavut (GN) Resident Geologists, northern First Nations communities, and community recreational programs/staff.

Figure 3: GEM GeoNorth Foundational Year activity P56 investigated approaches to facilitate "geo" observations in the north by northerners, such as user-friendly apps, so that northerners can conceptualize and solve northern geoscience problems on their own terms. Photographs by M. Sanborn-Barrie. NRCan photo 2022-465 (background), 2022-466 (top right), 2022-468 (lower right), and 2022-469 (lower middle). Photograph by Tommy Tremblay. NRCan photo 2022-467 (middle right).

Web platform / mobile applications investigated

1. **NRCan Observer**

NRCan Observer is a mobile crowdsourcing application developed by NRCan's Emergency Geomatics Service (EGS) that uses Survey123 to collect volunteered geographic information. Currently, the NRCan Observer app is being used to power surveys that collect Earth Observation data related to several environmental aspects:

River Ice Jams Reporter (River Ice Jams Reporter) was created to explore and promote citizen science for the enhancement of flood risk management in Canada. Users can anonymously submit observations of river ice features, such as the location and time of observed ice jams, to provide ground-truth information that help that EGS staff provide stakeholders with accurate river ice monitoring classification maps and assist with Spring flood response.

CCRS Lichen Survey (CCRS Lichen Survey) was created by NRCan's Canada Centre for Remote Sensing (CCRS) to facilitate field data collection to enhance regional mapping of reindeer lichens. Reindeer lichens are an essential food source for caribou, especially during winter, and can be a valuable indicator for ecosystem health and climate change. As such, an inventory of lichen abundance allows assessment of availability within caribou ranges and the effects of natural and anthropogenic disturbances. The CCRS Lichen Survey app allows users to anonymously complete a survey (Fig. 4) which can be submitted to an online ESRI database

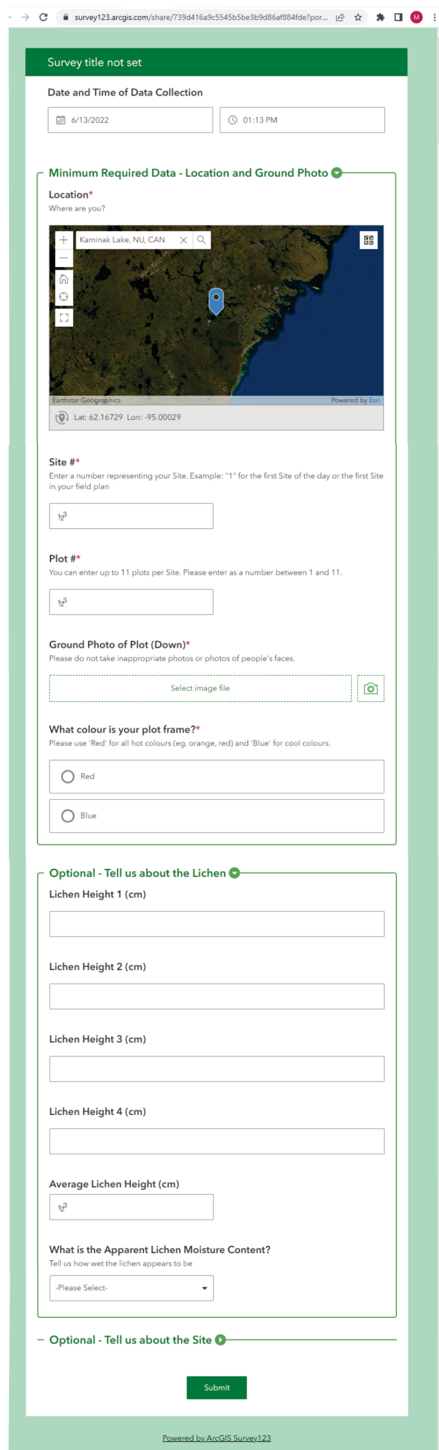

Figure 4: CCRS Lichen Survey utilizes NRCan Observer app to allow georeferenced observations and photos of lichen cover to be submitted to a database.

thereby providing ground-truth information needed for calibration and validation of machine learning models to map fractional reindeer lichen cover.

The NRCan Observer application was investigated to determine whether it could be tailored to support geoscience observation reporting. An attempt to download and utilize the app was initially unsuccessful. After direct contact with CCMEO staff, they were able to resolve a licensing problem with the application and it was possible to download the survey. Test interactions with the Lichen Survey indicate that users input their observations (Fig. 4) and this data then goes into an online ESRI database that NRCan researchers, the main beneficiaries of the data, are able to access, download and process.

2) Rockd

Rockd https://rockd.org/ is a web platform and mobile application, available free from Apple's App Store and/or Google Play, that allows users to learn, explore and document the geological world. Rockd has 3 main functions:

1) provides access to geological maps at a variety of scales;
2) enables users to learn key geological facts (Fig. 5);
3) allows users to easily record geological observations (i.e., tag stratigraphic names, record strike and dip measurements using the built-in compass/clinometer; search for and tag Paleobiology Database taxa) and download photos, using location to provide spatially informed suggestions for nearby geologic units, time intervals, and fossils.

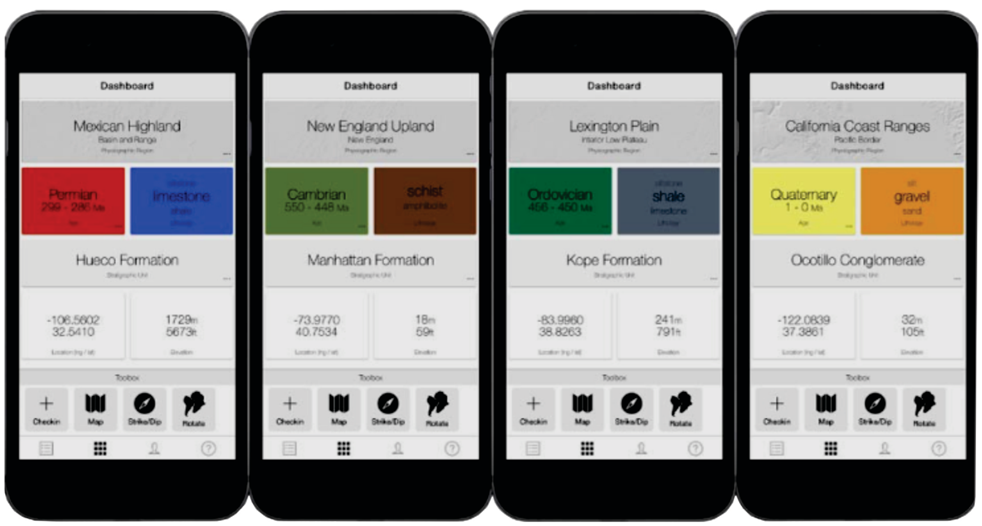

Figure 5: Examples of Rockd's dashboard that distills key geological facts about users' location, including geologic domain, rock age, rock type and formational name, into a single, easy-to-read interface, thereby enabling users' to become familiar with key geological facts at various locations. Screen capture from rockd.org

Rockd was developed by the University of Wisconsin-Madison, funded partly by the National Science Foundation. It currently allows access to more than 155 geological maps (scalable according to magnification/zoom factor) worldwide. Users' entries documenting geological elements (Fig. 6), referred to as "checkins", are geographically widespread (Fig. 7) with most posted across the US, and significant checkins also from southern Spain, the UK and Germany. The distribution of checkins highlights regions that are well documented in terms of "citizen geoscience", and those that lack uptake of the Rockd platform including Canada, with only 43 checkins in western Canada and no entries for all of Nunavut or the NWT.

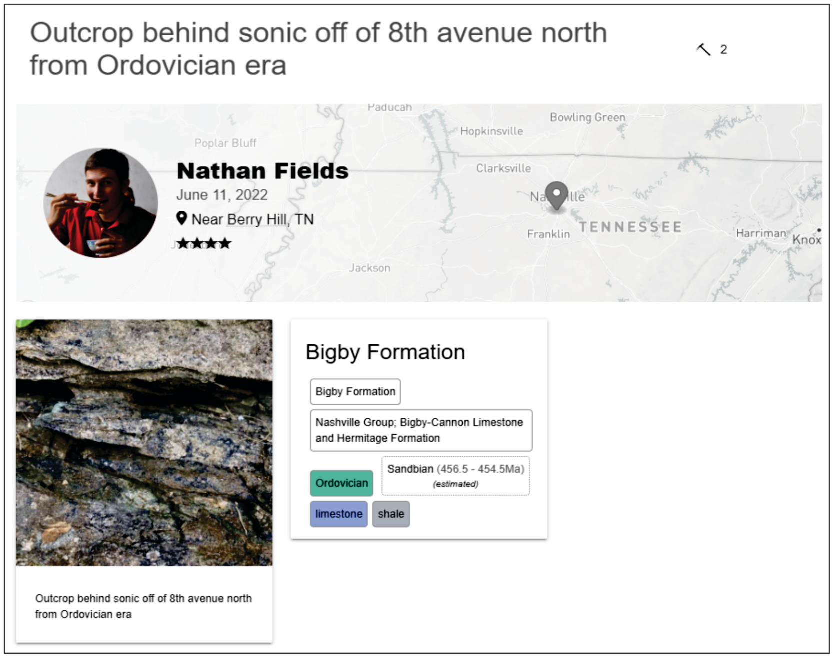

Figure 6: Example of Rockd checkin, submitted on June 11, 2022 posting the character of 2m-high outcrop ridge exposed behind the Sonic Drive-In Restaurant off 8th Avenue, Berry Hill, Tennessee.

Figure 7: Screen capture of Rockd.org's scalable geological map of the world showing number of geological entries (checkins) for various regions, with ~9,636 entries documenting geological elements across the USA, and none for Canada's North.

Our investigation into the Rockd app indicated that a unique opportunity exists for Northerners to document and calibrate geological elements across Nunavut. With an introduction to the app and on-site mentoring and coaching in northern communities, it is feasible that Northerners could document geo features such as rocks and minerals, landforms and permafrost features encountered on the land. For some regions where multiple maps of various scales have been downloaded, the interactivity of the basemaps within Rockd can be quite advanced, with greater detail appearing at higher magnification levels. Clicking/touching a polygon brings up the source map details in a pop-up. Currently, only one basemap resides in Rockd for Nunavut and NWT: the 1:5 million scale Geological Map of the Arctic (Fig. 8 upper; Harrison et al., 2011) limiting the degree of detail available. Furthermore, the colour scheme chosen for the Canadian Shield (shades of pink/red) unfortunately makes it difficult to make out the various units (Fig. 8 lower). An important feature of Rockd is that maps can be downloaded (cached) such that the app can be used on-line or offline, an important consideration when out on the land beyond WIFI range.

As part of our investigation we attempted to contact Rockd 's Wisconsin-Madison maintenance team to determine if higher resolution geological maps for Nunavut, such as the 1:550,000-scale compilations for the Hearne (Tella et al., 2007), south Rae (Pehrsson et al., 2014) and north Rae (Skulski et al., 2018), could be imported into Rockd's map database to improve content and clarity. We also wished to inquire whether it might be feasible to import a **plain-language legend** (to be devised at GSC) to be linked to the maps, so that non-specialists selecting a map unit would access a pop-up containing a plain-language descriptor of the nature and significance of the rock unit could be displayed. Currently, the pop-up information (Fig. 8) requires knowledge of specialized terminology. In this way, it might be possible for non-specialist Northerners to gain greater access to available geological map information.

Attempts to contact the Rockd maintenance team (contact information Appendix 1) by email in October 2021 and January 2022 were unsuccessful. The Rockd application was last updated 3 years ago, and remains active for checkins (e.g., Fig. 6). As restrictions due to the Covid-19 pandemic ease, it may be feasible to establish contact and implement an upgrade that could improve representation of Northern geoscience and allow greater accessibility by Northerners. However, the lack of response thus far suggests that Rockd is not the ideal choice to proceed on a search to collaborate on additional functionality. It does, however, remain an option for Northerners to calibrate the geoscience of Nunavut through photographs and structural trends, with on-site coaching and mentoring support.

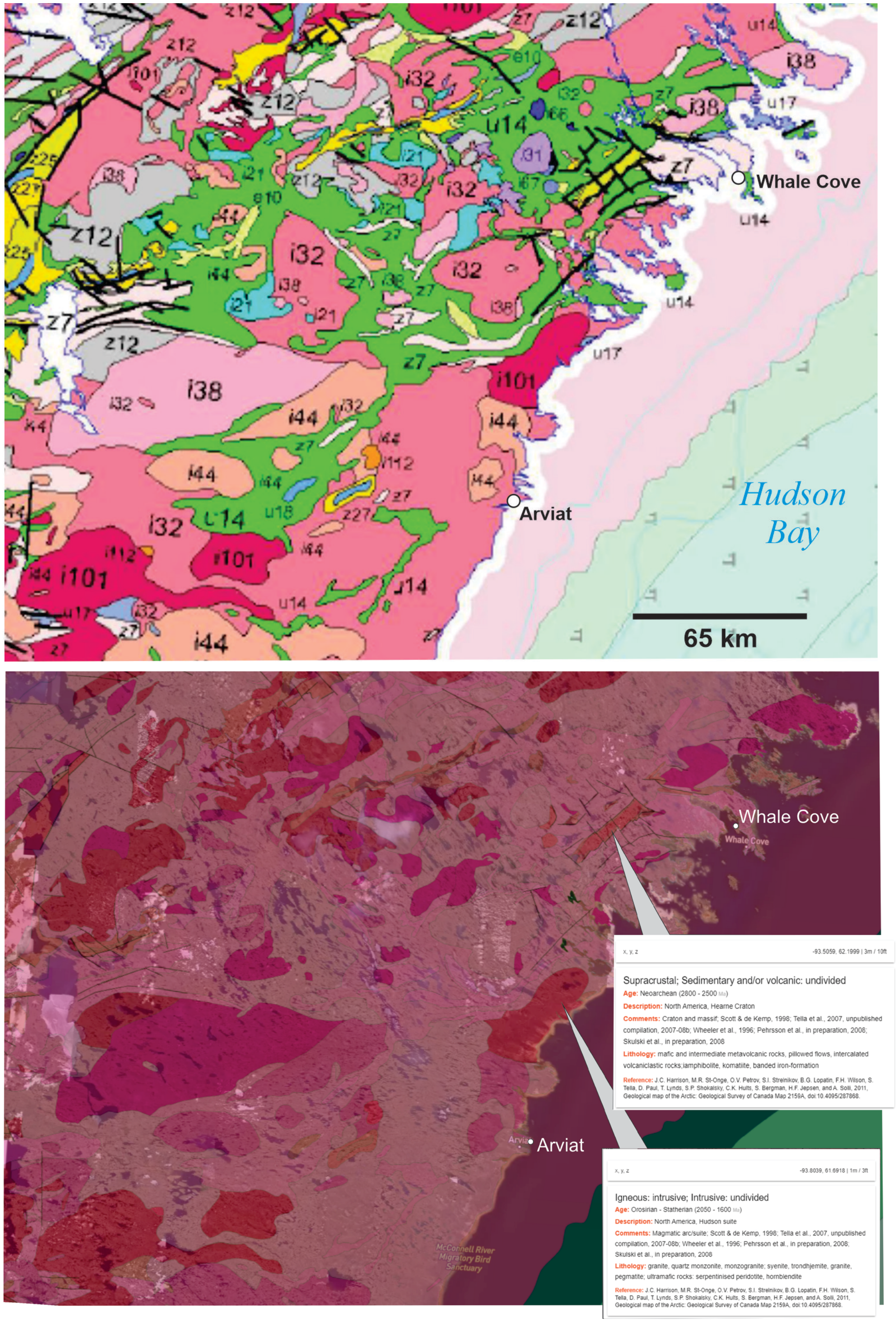

Figure 8: Geological bedrock map of the Kivalliq region of lower Nunavut, proposed site of the Churchill-Kivalliq Hydro-fibre link infrastructure coridor. **Upper**: Geological Map of the Arctic (Harrison et al., 2011) showing 1:5 M-scale compilation on which basemap residing in Rockd (lower) is based; **Lower**: screen capture of Rockd's basemap (colours reassigned) pop-up dialogue boxes showing current content for two units: Archean supracrustal rocks west of Whale Cove, and an 1820 Ma Hudson granite pluton.

3) SIKU

SIKU is a web platform and mobile application (Fig. 9) developed by the Arctic Eider Society (Appendix 1) in close collaboration with Inuit, that is serving as an Indigenous Knowledge social network by, and for, Inuit. Users of SIKU can digitally document and share their observations on the land to "mobilize" their knowledge systems and approaches to environmental observations and monitoring to advance Indigenous priorities. As with Rockd, this app can be used online or off.

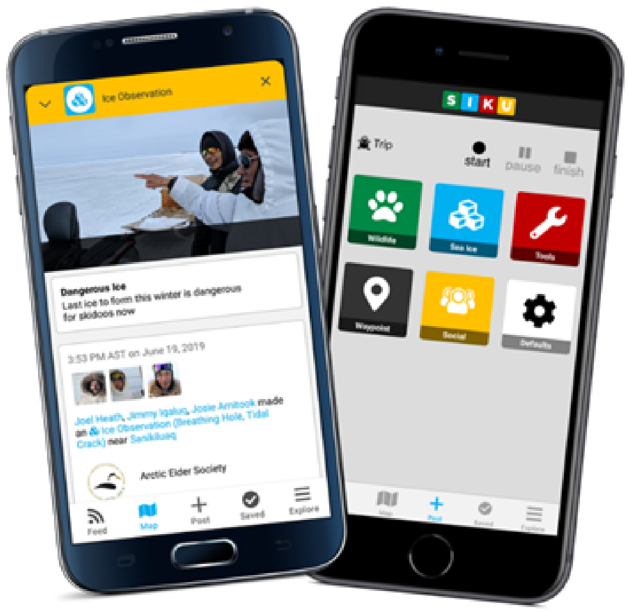

Figure 9: Smart phone display of mobile application of SIKU

Three aspects of SIKU stand out as viable reasons to pursue adaptation of this platform for the geosciences:

- SIKU already has >10,000 users from more than 50 northern communities in Canada;
- SIKU is free and is available on both Android and Apple devices, with features that allow georeferenced observational data to be captured on the land and uploaded once WIFI connections in communities are re-established;
- SIKU's users retain ownership of their data when they enter it into the app. They choose if they wish to make it public or not, and it is not used by the app without their permission. SIKU is unique in that it uses a stewardship framework with the express aim of "respecting Indigenous knowledge, protecting it from misuse while encouraging its mobilization for the benefit of Indigenous self determination". More details on SIKU's Stewardship framework is provided at https://siku.org/support/knowledge-base/post-stewardship/

Currently SIKU is designed and built to record natural observations related to Ice & Weather and Wildlife & Hunting (Fig. 10), amongst other functions. We have identified several approaches that could be taken to modify the functionality of SIKU to permit geoscience observations to be part of SIKU's platform. The feasibility and costs related to these approaches, as determined by SIKU's development team are provided in **Appendix 2**.

Incorporation of geoscience map layer(s) into SIKU would permit visualization of rock units underlying the terrain (bedrock maps), or of glacial deposits overlying bedrock (surficial maps). Bedrock maps are available for much of Nunavut, some regions at quite detailed scales, with comprehensive coverage provided by three 1: 550 000 scale regional bedrock compilations for the Hearne (Tella et al., 2007), south Rae (Pehrsson et al., 2014) and north Rae (Skulski et al., 2018). To increase access by non-specialists to the knowledge incorporated into, and represented by, geological maps, it would be desirable to display plain-language information when clicked/selected and, ideally, a representative photograph of the relevant geoscience feature (by links with educational/information module).

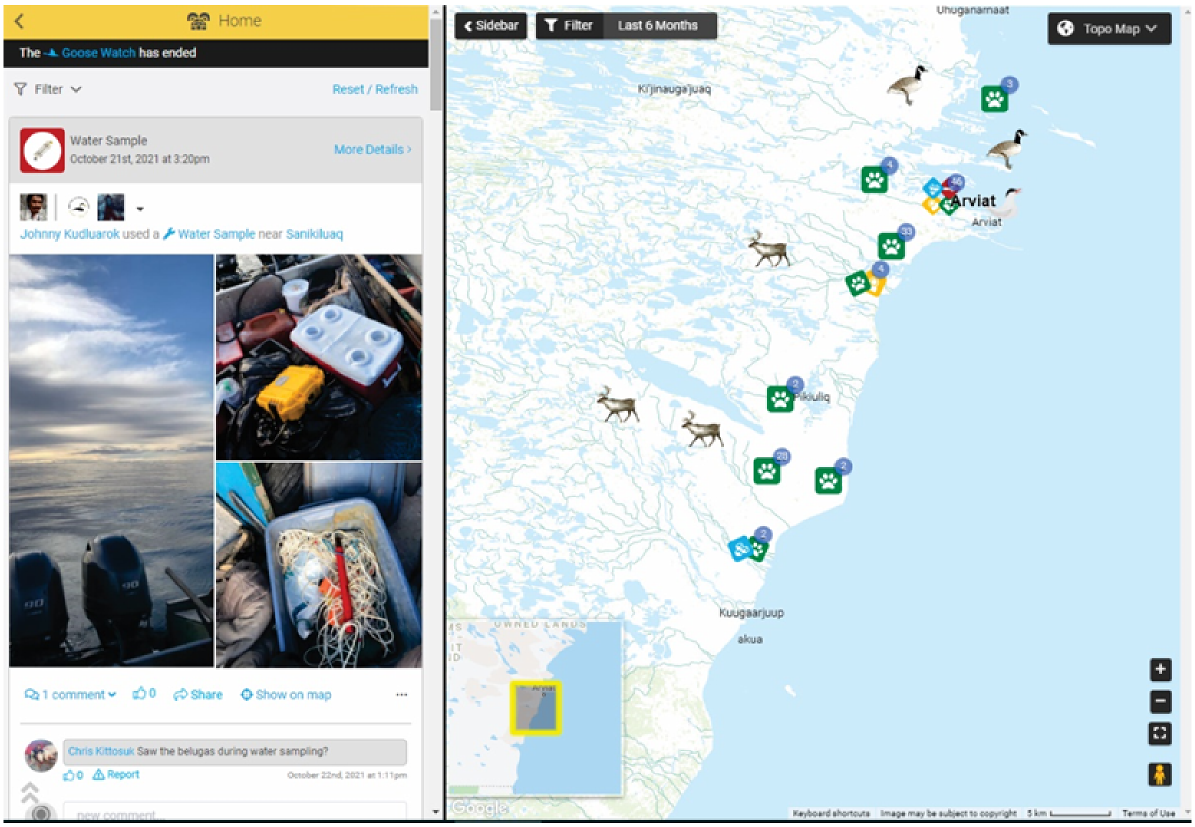

Figure 10: SIKU's observation module allows users to create a Post. Screen captures reproduced with permission of Arctic Eider Society.

Another approach is through **creation of a geoscience observation module**, whereby SIKU users could input their own geoscience observations, similar to the existing Goose Watch and Sea Ice modules. The observation input module could permit inclusion of multiple types of geoscience information for the observation site: including, but not necessarily limited to, notes, photographs, structural measurements (azimuth and dip angle) taken directly from the mobile device's on-board compass. Related to this could be the creation of a layer of publicly-visible "sites of geoscienceinterest" that could include more detailed geological maps and routes (or "trips" in SIKU nomenclature) with observation sites of particular geological interest (e.g., geology, surficial features, fossils, geo-walking tours of communities, etc.).

A third approach relates to **creation of a geoscience education/information module** with links to the other two modules, akin to the existing "Food Web" (Fig. 11) and "Ice Scape" modules.

Such a module could consist of text and diagrams (e.g., the rock cycle with types of rocks and minerals (Fig. 12), carving stone, landforms and/or permafrost features) essentially providing a visual "101 course" on geoscience with photo glossary of geological terms/rock types/mineral identification where the photos are linked to text in the educational module and to the rock types identified in the map legend.

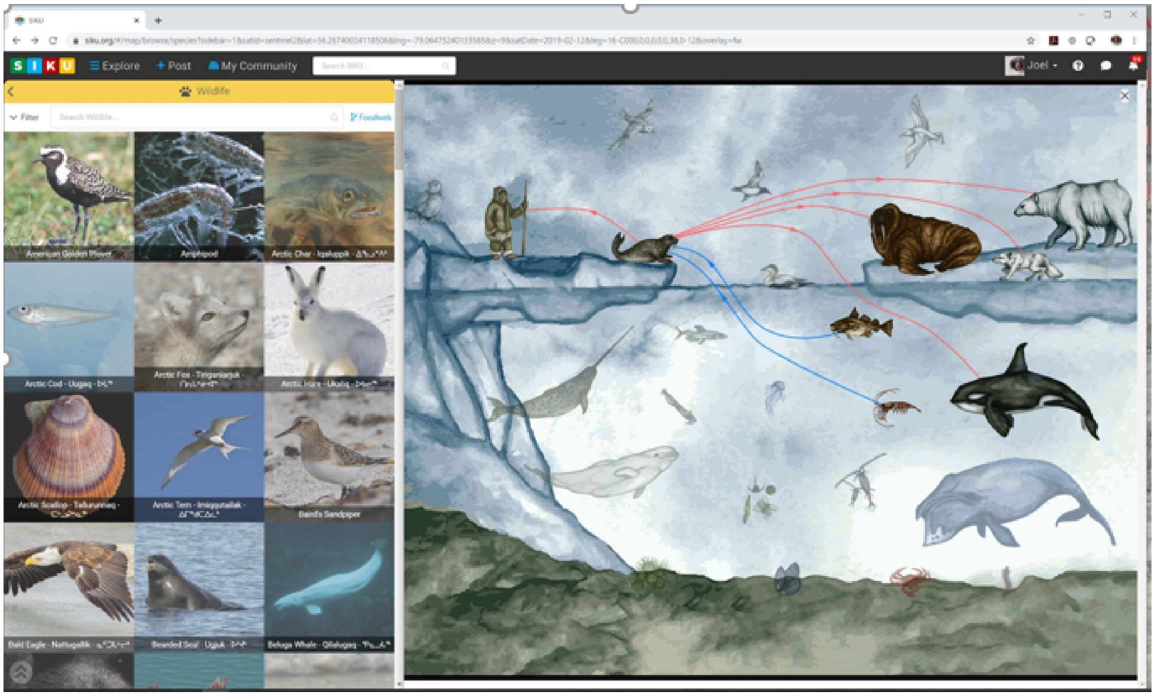

Figure 11: SIKU's interactive Arctic foodweb module, currently available on the web platform, in which energy flows between the selected seal and other creatures are highlighted. Reproduced with permission of Arctic Eider Society.

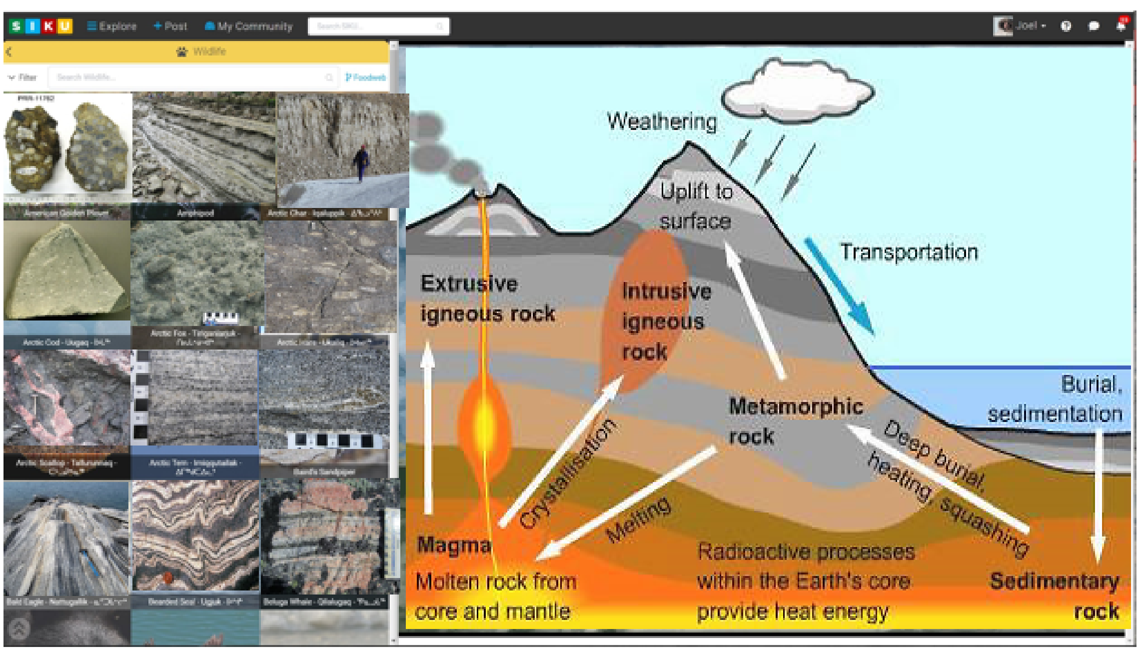

Figure 12: Rough mock-up of an example of an educational module pertaining to the rock cycle that could be linked to various profiles for various rocks observed in Nunavut

Conclusions

This investigation is focused on approach(s) that could increase access to geoscience by Northerners, engage non-specialists, and enhance the impact and usefulness of geoscience materials to further benefit those whose lands and geological history are studied. There exist several available mobile applications that could be tailored to allow non-specialists to conceptualize and solve northern geoscience questions on their own terms.

The NRCan Observer app supports submission of data by Northerners via several surveys (Ice Jam, Lichen), such that observational (ground-truthed) data can be accessed by NRCan researchers (key beneficiaries) from an ESRI database for incorporation into high-level academic studies (e.g., He et al., 2021). Currently the observations are not re-integrated back into products/maps accessible to Northerners. Rockd is an app specifically designed with geological observations in mind. As such, it has the potential, with on-site mentoring and coaching, for Northerners to document aspects of geoscience encountered on the land, such as bedrock outcroppings, carvingstone localities and/or quarry conditions, permafrost features, and/or glacial deposits (sands, gravels). The current lack of uptake of Rockd checkins across northern Canada provides the opportunity for Northerners to determine what type of observations are documented for which areas. At present, Rockd may be of limited use, however, given the technical language (undergraduate geology level) in use, and the single basemap option available for all of northern Canada. The Indigenous Knowledge Network, SIKU, is a web platform and mobile app that could be tailored to optimize not only the collection of geoscience observations, but also the incorporation of an education module that would allow for knowledge mobilization and transfer. With plain-language glossaries and geoscience terms translated into local dialects, as is currently done for wildlife and snow & ice, users could acquire insights that would strengthen capacity in communities for the geosciences.

In conclusion, one of the key pillars of self-determination in research (Inuit Tapiriit Kanatami, 2018) is Inuit access, ownership and control over data and information gathered. Our analysis suggests that both coaching and mentoring in regard to Rockd and supporting advancements to SIKU would promote self-determination in geoscience research and contribute to greater sharing of geoscience data and knowledge. These, in turn, could support the next generation of Northerners in the collection of data and knowledge required to adapt to a changing climate and realize resource-based economic benefits.

References

Harrison, J C., St-Onge, M. R., Petrov, O. V., Strelnikov, S. I., Lopatin, B. G., Wilson, F. H., Tella, S., Paul, D., Lynds, T., Shokalsky, S. P., Hults, C. K., Bergman, S., Jepsen, H. F. and Solli, A. 2011. Geological map of the Arctic. Geological Survey of Canada, "A" Series Map 2159A, 2011, 9 sheets; 1 DVD, https://doi.org/10.4095/287868

He, L., Chen, W., Leblanc, S.G., Lovitt, J., Arsenault, A., Schmelzer, I., Fraser, R.H., Latifovic, R., Sun, L., Prévost, C., White, H.P. and Pouliot, D., 2021. Integration of multi-scale remote sensing data for reindeer lichen fractional cover mapping in Eastern Canada. Remote Sensing of Environment 267, https://doi.org/10.1016/j.rse.2021.112731

Inuit Tapiriit Kanatami, 2018. National Inuit strategy on research 48p. (online): Available from https://www.itk.ca/wp-content/uploads/2020/10/ITK-National-Inuit-Strategy-on-

Research.pdf

Pehrsson, S. J., Currie, M., Ashton, K. E., Harper, C. T., Paul, D., Pana, D., Berman, R. G., Bostock, H., Corkery, T., Jefferson, C. W. and Tella, S. 2014. Bedrock geology compilation and regional synthesis of south Rae and parts of Hearne domains, Churchill Province, Northwest Territories, Saskatchewan, Nunavut, Manitoba and Alberta; Geological Survey of Canada, Open File 5744, 2014, 2 sheets, https://doi.org/10.4095/292232

Rayner, N.M., St-Onge, M.R., Weller, O.M., and Tschirhart, V., 2015. 2015 Report of Activities for Completing the Regional Bedrock Mapping of the southern half of Baffi n Island: GEM 2 Baffi n Project; Geological Survey of Canada, Open File 7953, 1 .zip file, https://doi:10.4095/297297

Skulski, T., Paul, D., Sandeman, H., Berman, R. G., Chorlton, L., Pehrsson, S. J., Rainbird, R., Davis, W.J., and Sanborn-Barrie, M., 2018. Bedrock geology, central Rae Craton and eastern Queen Maud Block, western Churchill Province, Nunavut. Geological Survey of Canada, Canadian Geoscience Map 307, 2018, 1 sheet, https://doi.org/10.4095/308348

Tella, S., Paul, D., Berman, R. G., Davis, W. J., Peterson, T. D., Pehrsson, S. J. and Kerswill, J. A. 2007. Bedrock geology compilation and regional synthesis of parts of Hearne and Rae domains, western Churchill Province, Nunavut - Manitoba; Geological Survey of Canada, Open File 5441, 2007, 3 sheets; 1 CD-ROM, https://doi.org/10.4095/224573

Williamson, M.-C., Rainbird, R.H., Froome, J. and Brown, O. 2013. A virtual geological field trip across Victoria Island, Northwest Territories; Geological Survey of Canada, Open File 7361, 6 p. + poster. https://doi.org/10.4095/292435

Wong, C., Ballegooyen, K., Ignace, L., Johnson, M.J. and Swanson, H., 2020. Towards reconciliation: 10 Calls to Action to natural scientists working in Canada. Facets 5: 769-783 https://doi.org/10.1139/facets-2020-2005

Acknowledgements

We thank NRCan analysts Julie Lovitt, Simon Tolszczuk-Leclerc and H. Peter White, all with the Canada Centre for Mapping and Earth Observation (CCMEO) for their assistance and insights with aspects of the NRCan Observer application and associated survey data. Screen captured images of SIKU are reproduced with permission from the Arctic Eider Society. This report was improved by reviews by Mike Ellerbeck and H. Peter White.

Appendices

Appendix 1 Contact Information

Appendix 2 Feasibility Study for incorporating geoscience into SIKU

Appendix 1. Contact Information

NRCan Observer Application

H. Peter White, Research Scientists

Canada Centre for Remote Sensing – Canada Centre for Mapping and Earth Observation

580 Booth St., Ottawa, ON

Phone: 343-543-7301

Email: hpeter.white@NRCan-RNCan.gc.ca

Rockd
Department of Geoscience
Lewis G. Weeks Hall
1215 West Dayton Street
Madison, WI 53706-1692
Phone: 608-262-8960
Email: web@geoscience.wisc.edu

SIKU
Arctic Eider Society
House 408B, no 174
Saniqiluaq, NU
X0A 0W0
Phone: 613-416-9607
www.arcticeider.com

Appendix 2 Feasibility Study for Geology on SIKU