



## **NIRB Uuktuutinga Ihivriughikhamut #125738**

### **Evaluation of multidrug-resistant bacteria in the tundra soil, active layer, and permafrost regions of the Canadian High Arctic**

**Uuktuutinga Qanurittuq:** New

**Havaap Qanurittunia:** Scientific Research

**Uuktuutinga Ublua:** 8/11/2022 1:13:10 AM

**Period of operation:** from 0001-01-01 to 0001-01-01

**Piumayaat Angirutinga:** from 0001-01-01 to 0001-01-01

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# QANURITTUT

## Tukihiannaqtunik havaariyaumayumik uqauhiuyun

**Qablunaatitut:** Project Name: Evaluation of multidrug-resistant bacteria in the Active soil layer, and Permafrost regions of the Canadian High Arctic  
Principal Investigator: Dr. K.P Krishnan, Science F and Group Director  
National Centre for Polar and Ocean Research  
Goa, India – 403804  
One of the most noticeable impacts of Arctic warming is the thawing of permafrost –which could potentially reactivate many of the dormant microorganisms that are preserved in the permafrost soils for centuries. Some of these microorganisms may be pathogenic and/or antibiotic-resistant bacteria (ARB) that can lead to the resurgence of zoonotic diseases. Besides, antibiotic resistance genes (ARG) can be transported to the Arctic environment through the migration and movement of humans and birds. Since ARGs are now widespread among microbial communities, whether the extensive diversity of ARGs and ARB in environmental reservoirs is the result of anthropogenic influence is controversial. Thus, in this proposal, we intend to perform a comprehensive survey of the tundra soil, active layer, and permafrost not only to evaluate the presence of potential ARG and ARB using a culture-dependent and independent approach but also to delineate potential sources-anthropogenic and/or ancient origins of ARGs and ARB in the Canadian high Arctic region. Thus, our proposed project will provide baseline data on the ARGs and ARB which could be utilized to demarcate the high-risk permafrost regions for the local population. In this context, we delineated the following objectives for the proposed project:- •Evaluation of Antibiotic-resistant genes (ARGs), virulence-related genes, and antibiotic-resistant bacteria (ARB) in the Canadian high Arctic Soil, and Permafrost regions •To evaluate the presence of resistance genes and at analyzing antibiotic resistance patterns, thereby allowing to determine the role of anthropogenic pressure in the apparition of antibiotic resistance We are planning for long-term monitoring (2022 to 2026) seasonally. Field methodology includes the collection of samples from the active layer and Permafrost soils using a field core sampler near the CHARS campus. The core samples will be cut aseptically into different layers and stored at -80 °C. These samples will be transported back to India (NCPOR-lab) using a cold shipment. In the NCPOR lab these layers will be used for the isolation, culturing, and screening of various health-significant bacteria (culture-dependent) and for the extraction of DNA and metagenomics studies (culture-independent). There are no expected waste or impacts associated with this study. In the unlikely case waste is generated, the proponent shall keep all garbage and debris in bags placed in a covered metal container or equivalent until disposed of at an approved facility. All such wastes shall be kept inaccessible to wildlife at all times. This study will provide baseline information on the possible reactivation of ARB in the permafrost, the risks associated with the release of potentially drug-resistant pathogens and antibiotic-resistant genes from permafrost, and the implications for policy and international cooperation in light of the Covid-19 pandemic. Nunavut residents can be involved in the field sampling. The data generated in the project will be stored at the data facility centre of NCPOR, India and the significant results of the projects will be shared with Nunavut Research Institute. The data will be shared by the lead Principal Investigator of the Project and coordinator of the Indian Arctic Programme – Dr. K.P. Krishnan.

**Uiviititut:** Nom du projet: Évaluation des bactéries multirésistantes dans la couche de sol active et les régions de pergélisol de l'Extrême-Arctique canadien  
Description du projet: L'un des impacts les plus notables du réchauffement de l'Arctique est le dégel du pergélisol, qui pourrait potentiellement réactiver de nombreux micro-organismes dormants qui sont conservés dans les sols du pergélisol pendant des siècles. Certains de ces micro-organismes peuvent être des bactéries pathogènes et/ou résistantes aux antibiotiques (ARA) pouvant entraîner la résurgence de maladies zoonotiques. En outre, les gènes de résistance aux antibiotiques (ARG) peuvent être transportés dans l'environnement arctique par la migration et le mouvement des humains et des oiseaux. Étant donné que les ARG sont maintenant répandus parmi les communautés microbiennes, la question de savoir si la grande diversité des ARG et des ARB dans les réservoirs environnementaux est le résultat d'une influence anthropique est controversée. Ainsi, dans cette proposition, nous avons l'intention d'effectuer une étude complète du sol de la toundra, de la couche active et du pergélisol non seulement pour évaluer la présence d'ARG et d'ARB potentiels en utilisant une approche dépendante de la culture et indépendante, mais aussi pour délimiter les sources potentielles anthropiques. et/ou les origines anciennes des ARG et des ARB dans la région canadienne de l'Extrême-Arctique. Ainsi, notre projet proposé fournira des données de base sur les ARG et ARB qui pourraient être utilisées pour délimiter les régions de pergélisol à haut risque pour la population locale.

**Inuktitut:** Technical Project Proposal Description Rationale: Climate change is predicted to increase the rate and spread of antibiotic resistance among bacterial pathogens (Cavicchioli et al., 2019; Rodríguez-Verdugo et al., 2020). The evolution and spread of antibiotic resistance among pathogenic bacteria are one of the most important challenges in public health today. Permafrost, the most ancient and extreme environmental ecosystem in which microbial life has been reported, is the potential site to study

bacteria dated back to the pre-antibiotic era. Antibiotic resistance genes (ARGs) were functionally diverse before the anthropogenic use of antibiotics began, contributing to the evolution of natural reservoirs of resistance genes. Under the ongoing climatic warming scenario, there is a possibility of horizontal transfer of these natural ARGs among other microbes via mobile genetic elements (MGEs) giving rise to the drug-resistance pathogens. Similar to ARGs, virulence factor genes (VFGs) of pathogenic bacteria can also be transferred to other bacteria by phages and plasmids (Wagner and Waldor, 2002). These transmitted genes can disrupt the host immune system, allowing bacterial pathogens to invade and cause infectious diseases (Wang et al., 2021). These drug-resistance pathogens may cause infections that are untreatable with currently available antibiotics (Zhang et al., 2022). ARB was identified in permafrost dated 15–290 ka, with species even more abundant in active layers in older and deeper permafrost (Perron et al., 2015). Subsequently, concerns have been raised about the potential for the exchange of genetic material between antibiotic-resistant permafrost microorganisms and contemporary bacteria to create new antibiotic-resistant strains. The local human settlement (the northerners) near the active permafrost region is at risk of being a potential host of these ancient types of ARGs and ARBs. Besides, these indigenous populations could potentially become a vector for the spread of such ARGs and ARBs. Thus, our proposed project will provide baseline data on the ARGs and ARB which could be utilized to demarcate the high-risk permafrost regions for the local population. In this context, we delineated the following objectives for the proposed project:-

**Objectives:**

- Evaluation of Antibiotic-resistant genes (ARGs), virulence-related genes, and antibiotic-resistant bacteria (ARB) in the Canadian high Arctic Soil, and Permafrost regions
- Genomics of cryopreserved bacteria from permafrost and comparison with their modern counterparts
- To evaluate the presence of resistance genes and analyse antibiotic resistance patterns, thereby allowing to determine the role of anthropogenic pressure in the apparition of antibiotic resistance.

This study will provide baseline information on the possible reactivation of ARB in the permafrost, the risks associated with the release of potentially drug-resistant pathogens and antibiotic-resistant genes from permafrost, and the implications for policy and international cooperation in light of the Covid-19 pandemic.

**Progress to Date:** Our works on antibiotic resistance in the Svalbard Arctic on migratory birds; Indicate that migratory birds are one of the potential carriers of Antibiotic resistance in the Svalbard Arctic (Prakash et al., 2022). Our studies on Antibiotic-resistant genes and bacteria from the Tundra, Marine and permafrost samples from the Svalbard Arctic are going on.

**Methodology:** Field methodology includes the collection of samples from the active layer and Permafrost soils using a field core sampler near the CHARS campus. The core samples will be cut aseptically into different layers and stored at -80°C. These samples will be transported back to India (NCPOR-lab) using a cold shipment. In the NCPOR lab, these layers will be used for the isolation, culturing, and screening of various health-significant bacteria (culture-dependent) and for the extraction of DNA and metagenomics studies (culture-independent).

**Data management:** Describe your data management plan, including where and when the data and metadata records will be stored. All data will be made available by the wider community, but with an embargo period ( date of collection) to allow publication of the results beforehand. On publication, the data is publically available. Data will be stored at NCPOR, India data center and will be shared on request before publication also.

**Research outputs:** Describe the major research outputs to be generated through the project (academic theses, publications, presentations, reports, etc.).

**Major Research output expected from the projects were publications and reports. Publications include**

- Diversity of multidrug-resistant bacteria and antibiotic-resistant genes from Canadian High Arctic.
- Reports on antibiotic-resistant genes and antibiotic-resistant bacteria from Canadian High Arctic.

Qutiqtumi UkiuqtaqtumiAtauhiq naunaitqiaq akturninga Ukiuqtaqtup uunaqpalianinga auktuqpalianinga nunap qiqumaninganik – atuqtaulaaqtut amihunik microorganism-nik ilipqamayauyut nunap qiqumaninganit. Ilangit hapkua microorganism-guyut aaniarutaulaqtut ukualu/uvaluniit halumailrut (ARB) pijutaulaqtut zoonotic-nik aaniarutininik. Talvalilu, havautinit huuyungnaiqtirutit genes (ARG) agyaqtaunginnariaaqtut Ukiuqtaqtumut avatianut nuutirnikkut auladjutainnutlu inuit tingmianiklu.Talvanga ARGngit aulaliqtun avatingnun tapkuninga microbial nunalaani, taima anginirmik allatqiinguyut ARGngit ARBngitlu avatiliqinikkut atuqtauffaaqtukharnik taima naunairutiqahimayug talvuuna auladjutikharnik ayungnautigivakhimayainik. Talvuuna, uumani tukhiutimi, piniaqhimaqjugut naunaijattiaqpiakhimajumik naunaijautikhanik nunap nuna, aullaranginnaqtumik qaliriiktunik, imaalu nunap qiqumaninganik naunaijailimaittut taja PINIARUngnaqhijut ARG unalu ARB aturlutit pitquhikkut-inmikkut imaalu inmikkut atuqtakhainnik kihimi ikiglijuumirlugit piniarungnaqhijut-qanurinningit imaalu/imaaluuniit qaujimattiaqhimaqjugut aullaningit ARGs ukualu ARB Ukiuqtaqtumi avikturviingit. Talvuuna, tukhiqtavut havaaqhangit tuniniaqtun tunngavikharnik naunairutikharnik talvani ARGs-nik ARB-niklu taima atuqtaugiaqtaqtun naunaiyaiyaangat anginirmik ayungnautiqtaqtunik nunap qiqumaninga avikturviingit talvani nunalaani inugaingit.\* Inuinnaqtun language translation through Automated programme; Not have checked by local language expert

#### **Personnel**

Personnel on site: 2

Days on site: 20

Total Person days: 40

Operations Phase: from 2022-11-01 to 2026-10-31

## Hulilukaarutit

Inigiya	Hulilukaarut Qanurittuq	Nunannga Qanurittaakhaanik	Initurlinga qanuritpa	Initurlinga utuqqarnitat unaluuniit Ingilraaqnitat Uyarannguqtut akhuurninnga	Qanitqiyauyuq qanitqiamut nunallaat kitulluuniit ahiruqtaliyainnit nuna
Six locations inside the polyline with out disturbing activities and envirnment	Drilling	Commissioners	No	The project is planning to take the sample from the 6 locations from the polygon and not have any archeologically and paleontologically important site	No activity in near community area

## Nunaliin Ilauyun, Aviktuqhimayuniitunullu Ikayuuhiarunguyun

Nunauyuq	Atia	Timiuyuq	Upluani Uqaqatigiyaungmata
Ikaluktutiak	Beverly Maksagak	Ekaluktutiak Hunters and Trappers Organization	2022-07-28

# Angiuttauvaktunik

Naunaiqlugu nunanga talvani havauhikhaq ittuq:

Kitikmeot

## Angiuttauvaktunik

Munariniqmut Ayuittiaqtuq	Angirutinga Qanurittuq	Tadja Qanurittaakhaanik	Ublua Tuniyauyuq/Uuktuqtuq	Umikvikhaa Ublua
Nunavunmi Ihivriuqniqmut Timiqutigiyanga	Application submitted for permit	Applied, Decision Pending	2022-07-28	

## Project transportation types

Transportation Type	Qanuq Atuqtauniarmangaa	Length of Use
Land	Land through Walking	

## Project accomodation types

Permanent Camp

Alaanut,

# Ihuaqutivaluin Atuqtauyukhan

Hanalrutit atuqtaunahuat (ukuallu ikuutat, pampiutainnik, tingmitinik, akhaluutinik, hunaluuniit)

Hanalrutit Qanurittuq	Qaffiuyut	Aktikkulaanga – Qanurittullu	Qanuq Atuqtauniarmangaa
Drill	1	3*1 m	For collecting permafrost samples

## Qanurittuq Urhuqyuaq unalu Qayangnaqtut Hunavaluit Aturninnga

Qanurittuq urhuqyuaq hunavaluit aturninnga:	Urhuqyuaq Qanurittuq	Qaffiuyut qattaryut	Qattaryuk Aktikkulaanga	Atauttimut Qaffiuyut	Ilanga	Qanuq Atuqtauniarmangaa
Information is not available						

## Imaqmik Aturninnga

Ubluq qanuraaluk (m3)	Aturumayain imavaluin utiqtittagaani qanuq	Atulirumayain imavaluin utiqtittagani humi
0		

# Iqqakuq

## Ikkakunik Munakgiyauyunik

Havauhikhaq Hulilukaarut	Qanurittuq Iqqakut	Ihumagiyauyuq Qanuraaluktut Atuqtait	Qanuq Iqqakuurniarmangaa	Halummaqtirarnirutikhan piyutin
Information is not available				

### Avatiliriniqmut Ayurhautingit:

There is no expected waste or impact associated with this study. If any unlikely case, waster is generated the proponent will keep in metal containers in approved facility and inaccessible to wild life. Samples will be collected from the field sampling locations with the help of the local community. DNA isolation and bacterial culture isolation were conducted in NCPOR lab India after the transportation of samples.



# **Additional Information**

**SECTION A1: Project Info**

**SECTION A2: Allweather Road**

**SECTION A3: Winter Road**

**SECTION B1: Project Info**

**SECTION B2: Exploration Activity**

**SECTION B3: Geosciences**

**SECTION B4: Drilling**

**SECTION B5: Stripping**

**SECTION B6: Underground Activity**

**SECTION B7: Waste Rock**

**SECTION B8: Stockpiles**

**SECTION B9: Mine Development**

**SECTION B10: Geology**

**SECTION B11: Mine**

**SECTION B12: Mill**

**SECTION C1: Pits**

**SECTION D1: Facility**

**SECTION D2: Facility Construction**

**SECTION D3: Facility Operation**

**SECTION D4: Vessel Use**

**SECTION E1: Offshore Survey**

**SECTION E2: Nearshore Survey**

**SECTION E3: Vessel Use**

**SECTION F1: Site Cleanup**

**SECTION G1: Well Authorization**

**SECTION G2: Onland Exploration**

**SECTION G3: Offshore Exploration**

**SECTION G4: Rig**

**SECTION H1: Vessel Use**

**SECTION H2: Disposal At Sea**

**SECTION I1: Municipal Development**

**Qanurittuq Ittunik Avatinga: Avatingalluanga**

**Qanurittuq Ittunik Avatinga: Inuuhimayunut Avatinga**

**Qanurittuq Ittunik Avatinga: Inungit-maniliurutingit Avatinga**

**Miscellaneous Project Information**

**Naunaiyainiq ukuninnga Ayurhautingit unalu Piumayaat Ikikliyuumiutinahuarutit**

**Tamatkiumayunik Ihuikgutivaktunik**

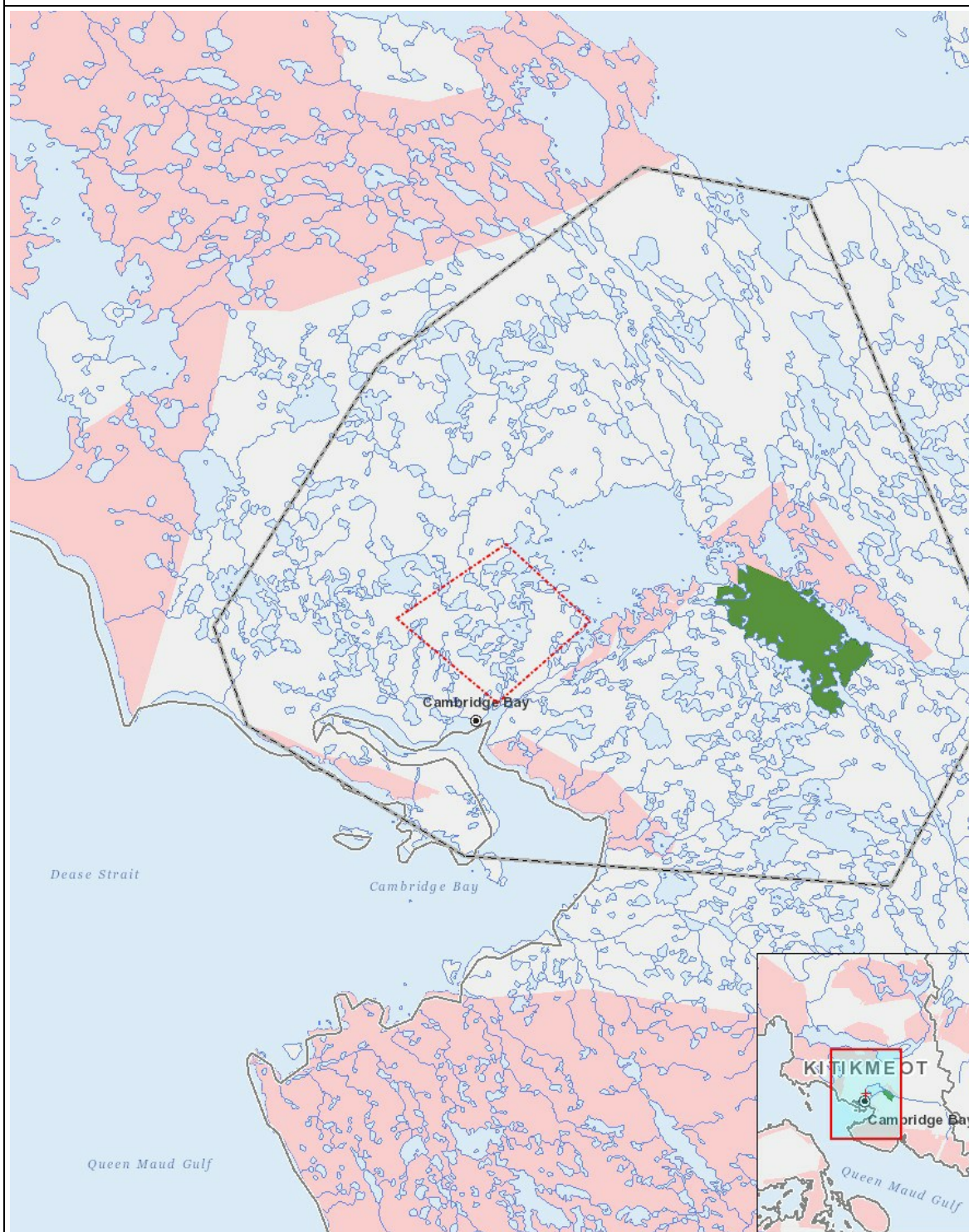
Impacts

Ilitariyauniq Avatiliriniqmut Ayurhautingit

		PHYSICAL	Designated environmental areas	Ground stability	Permafrost	Hydrology / Limnology	Water quality	Climate conditions	Eskers and other unique or fragile landscapes	Surface and bedrock geology	Sediment and soil quality	Tidal processes and bathymetry	Air quality	Noise levels	BIOLOGICAL	Vegetation	Wildlife, including habitat and migration patterns	Birds, including habitat and migration patterns	Aquatic species, incl. habitat and migration/spawning	Wildlife protected areas	SOCIO - ECONOMIC	Archaeological and cultural historic sites	Employment	Community wellness	Community infrastructure	Human health
Havakvinga																										
-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aulapkaininnga																										
Drilling		-	-	P	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	U	P	P	-	P	P
Piiqtauniq																										
-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(P = Nakuuyuq, N = Nakuungittut unalu mikhilimaittuq, M = Nakuungittut unalu mikhittaaqtuq, U = Naluyauyuq)

# Havaariyauyukhamut Nayugaa



## List of Project Geometries

- 1 polyline Six locations inside the polyline with out disturbing activities and envirnment