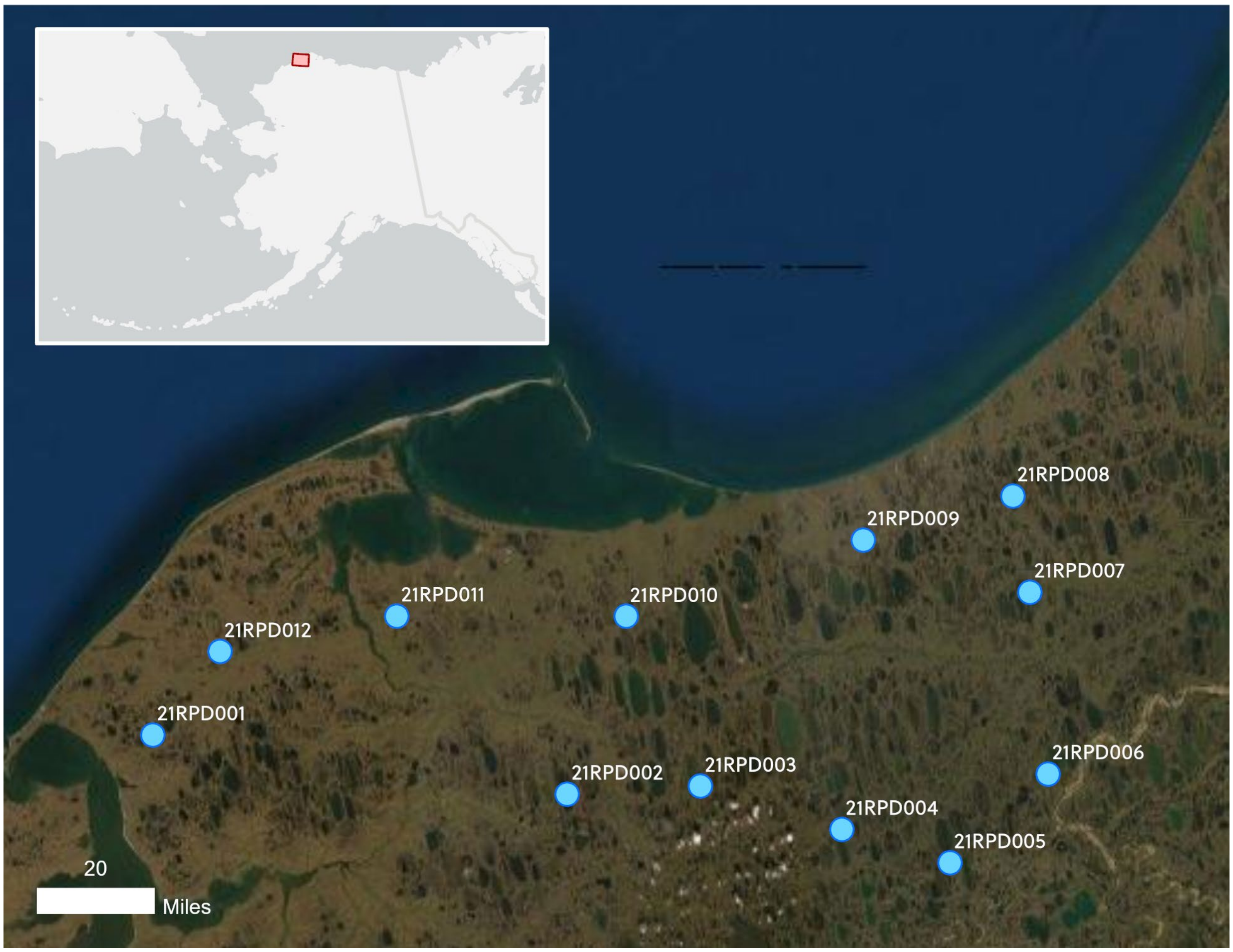
SONAR AND SEISMIC LAKE SURVEYS ALONG THE PROPOSED TRIANGLE ROAD CORRIDOR, NORTHWESTERN ALASKA, COLLECTED JULY 6–13, 2021

Ronald P. Daanen and Tyler B. Stokes

Raw Data File 2023-1



Location map of surveyed lakes with orthometric image.

This report has not been reviewed for technical content or for conformity to the editorial standards of DGGS.

2023
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

STATE OF ALASKA
Mike Dunleavy, Governor

DEPARTMENT OF NATURAL RESOURCES
John Boyle, Commissioner

DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
David L. LePain, State Geologist & Director

Publications produced by the Division of Geological & Geophysical Surveys are available to download from the DGGS website (dggs.alaska.gov). Publications on hard-copy or digital media can be examined or purchased in the Fairbanks office:

Alaska Division of Geological & Geophysical Surveys (DGGS)
3354 College Road | Fairbanks, Alaska 99709-3707
Phone: 907.451.5010 | Fax 907.451.5050
dggspubs@alaska.gov | dggs.alaska.gov

DGGS publications are also available at:

Alaska State Library, Historical
Collections & Talking Book Center
395 Whittier Street
Juneau, Alaska 99801

Alaska Resource Library and
Information Services (ARLIS)
3150 C Street, Suite 100
Anchorage, Alaska 99503

Suggested citation:
Daanen, R.P., and Stokes, T.B., 2023, Sonar and seismic lake surveys along the proposed triangle road corridor, northwestern Alaska, collected July 6-13, 2021: Alaska Division of Geological & Geophysical Surveys Raw Data File 2023-1, 19 p. https://doi.org/10.14509/30954

SONAR AND SEISMIC LAKE SURVEYS ALONG THE PROPOSED TRIANGLE ROAD CORRIDOR, NORTHWESTERN ALASKA, COLLECTED JULY 6–13, 2021

Ronald P. Daanen[1] and Tyler B. Stokes[1]

INTRODUCTION

During the 2021 field season, the Alaska Division of Geological & Geophysical Surveys (DGGS) collected bathymetric sonar and seismic data for 12 lakes in a proposed road corridor between Atqasuk and Wainwright, Alaska, on July 6–13, 2021 (fig. 1). These surveys aimed to assess gravel resources in northwestern Alaska as part of the Arctic Strategic Transportation and Resources (ASTAR) program. We measured lake depths with an Edgetech 2205 sonar system and imaged near-surface sediment profiles with an Edgetech sub-bottom profiler, or chirp sensor, installed in a catamaran-style Sea Robotics SR-Surveyor M1.8 autonomous hydrographic survey system. Very little is known about lake-bottom conditions in the region. In addition to acquiring new information about North Slope lake bathymetry, this work serves as a pilot study to identify optimal equipment configuration and project design for challenging, helicopter-supported remote data collection.

Figure 1. Orthometric image with locations of surveyed lakes.

[1] Alaska Division of Geological & Geophysical Surveys, 3354 College Road, Fairbanks, Alaska 99709

This data is being released as a Raw Data File with an open end-user license. All files can be downloaded from the DGGS website at https://doi.org/10.14509/30954.

Table 1. Lakes and station ID with their locations (NAD83).

Name	Station ID	Latitude	Longitude
Lake 1	21RPD001	70.620196	-159.750136
Lake 2	21RPD002	70.571861	-158.733155
Lake 3	21RPD003	70.578411	-158.405762
Lake 4	21RPD004	70.5431149	-158.059906
Lake 5	21RPD005	70.515847	-157.793972
Lake 6	21RPD006	70.588378	-157.553533
Lake 7	21RPD007	70.736183	-157.596971
Lake 8	21RPD008	70.813858	-157.638646
Lake 9	21RPD009	70.778368	-158.007477
Lake 10	21RPD0010	70.716376	-158.589293
Lake 11	21RPD0011	70.716842	-159.151409
Lake 12	21RPD0012	70.687931	-159.585581

LIST OF DELIVERABLES

- Bathymetric digital terrain models (DTMs)
- Bathymetric control points
- Sontek density and salinity profiles
- Sonar images
- Seismic profiles
- Metadata

AVAILABLE DATA

Observation	Data Type	Description
Bathymetry	.las	Point cloud data format data of the lake bottom surface elevations
Bathymetry	.tif	Georeferenced raster format data of the lake bottom surface elevations
Bathymetry	.kmz	KML format georeferenced, color ramped raster (.kmz) depicting the lake bottom surface elevations in Google Earth
Bathymetry	.png	Color ramped raster (.png) of the relative lake bottom surface elevations
Hypack	.HS2,.hs2x, and .LOG	Hypack proprietary data format navigation data
Sesimic	.png file	Image of the seismic chart
Seismic	.seg segtracks	Seismic data format
Seismic	.FFT .header .0	Hypack file containing seismic profile
Sonar Image	.tif files per line tiled	Raster files showing the sonar reflection image

MISSION PLAN

We used the Robotics SR-Surveyor M1.8 with a double frequency Edgetech 2205 sonar system with 540kHz bathy/1600 kHz sidescan transducers built into the hull. In addition, we installed an Edgetech sub-bottom profiler, or chirp sensor, on the surveyor with dual frequencies of 2 and 4 kHz. The surveyor has an SBG 1.1 m separation dual antenna Global Navigation Satellite System (GNSS) system operating in Real-Time Kinematic (RTK) mode for navigation. Rotational motion is resolved by an Inertial Measurement Unit (IMU). The surveyor has dual 1 kW pocket thrusters used for propulsion and steering and an AML micro-SV sound velocity sensor. The surveyor has an onboard computer that runs Hypack Max software for navigation and data collection and a remote-control system for manual interface during survey start and finish. A single 1500 Whr Li-ion Battery powers all electronics.

Although this equipment configuration allowed us to collect useful data successfully, the remote location and weather conditions required several modifications to our acquisition plan. Battery size and windy conditions limited fieldwork to about two hours per battery charge. We lost propulsion of the surveyor during testing and the early part of the data collection and did not have sufficient spare parts to continue using the onboard thrusters. In addition, we found that the shallow nature of the lakes did not allow the sonar to map the entire lake bottom during the planned fieldwork time. However, because the focus of the fieldwork was to attempt to find any structures in the sediment layering that would indicate gravel layers, we decided to continue data collection by towing the surveyor by kayak across the lake to measure a single seismic line. Using this mode of operation, we surveyed 10 lakes on a single battery charge.

Sonar

Side-scan uses a sonar device that emits conical or fan-shaped pulses down toward the seafloor across a wide-angle perpendicular to the path of the sensor through the water. The side scan sonar built into the surveyor's hull provided bathymetry and an image of the lake bottom. We used the data to produce a DTM of the areas surveyed (fig. 2). These survey lines are provided for each lake in the appendix.

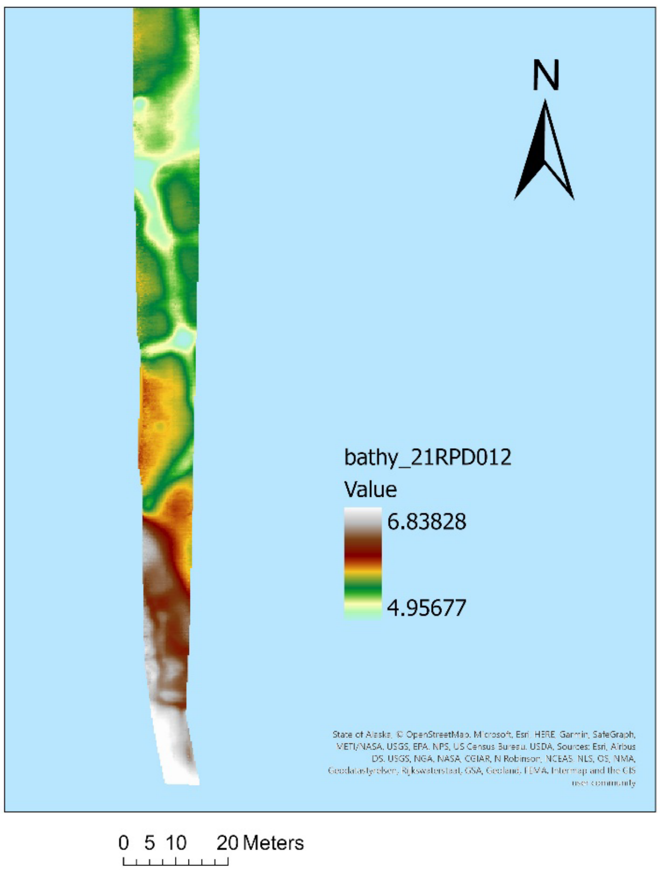


Figure 2. The bathymetry survey of Lake 12 (21RPD012) shows degrading ice-wedge polygons in the sub-bottom lake sediment.

Seismic Chirp

Seismic chirp, or sub-bottom profiling, is a technique used to detect sediment layers by measuring the timing and strength of reflections from a single energy wave. The seismic chirp can be heard during surveying as a clicking sound. During our survey, we did not detect reflectors in the seismic data that would indicate sediment layering. The layering displayed in the figures is an echo of the lake bottom.

PROCESSING REPORT

Sonar and Seismic Dataset Processing

Raw data from the sonar and seismic chirp devices were processed in Hypack Max. This software package integrates the location and movement information from the RTK GNSS antennas and IMU data to show sonar reflection and seismic profiles in the correct location relative to known datums. Sonar data provides a reflection image of the lake bottom and can be used to investigate sediment conditions. The image can be enhanced using a variety of gain functions. The sonar also provides the depth soundings needed to create the DTM. The seismic imagery was processed with standard cleaning steps of a frequency filter, dynamic range filter, time-varying gain filter, bottom tracking (automated or manual), and a sound velocity correction.

Bathymetric Digital Terrain Model

The DTM represents lake bottom surface elevations. The DTM is a single-band, 32-bit float GeoTIFF file, with a ground sample distance of 0.25 meters. No Data value is set to -3.40282306074e+038.

Bathymetric Control Points

Due to circumstances, no control points could be collected in the elevation dataset. The elevation datasets in this report are strictly based on the onboard RTK and IMU systems processed through Hypack Max software. No verification data was available.

Sontek Density and Salinity Profiles

Salinity profiles were collected during our fieldwork for select lakes investigated. The shallow nature of the lakes does not require correction of the sound velocity with depth to add more accuracy to our datasets.

Sonar Image

The sonar image describes the relative amplitude of reflected signals contributing to the point cloud. Sonar intensity is largely a function of scanned object reflectance in relation to the signal frequency, is dependent on ambient conditions, and is not necessarily consistent between separate scans. The intensity image is a single-band, 32-bit float GeoTIFF file with a ground sample distance of 0.25 meters. No Data value is set to -3.40282306074e+038 (32-bit, floating-point minimum).

Coordinate System and Datum

All data are processed and delivered in NAD83 (2011) UTM Zone 4N and vertical datum NAVD88 (GEOID12B).

DATA CONSISTENCY

Due to the nature of the surveys, we could not verify the elevation data sets with independent measurements of an RTK GPS, which would be the standard procedure. The lake sizes prevented us from surveying entire lakes due to a lack of time. A malfunction in the onboard propulsion system prevented its use throughout the entire area of each lake. We opted to survey a single line across a lake for the remainder of the selected lakes in the survey area.

ACKNOWLEDGMENTS

These data were paid for by the State of Alaska's Arctic Strategic Transportation and Resources (ASTAR) project and collected and processed by DGGS. We thank the Bureau of Land Management and the City and Native Village of Wainwright for permission to access their land and lakes.

APPENDIX

See figure 1 for locations of the lakes surveyed.

Lake1, Station ID 21RPD001

Figure A1a. Google Earth image of lake 1, the first lake surveyed, with survey lines.

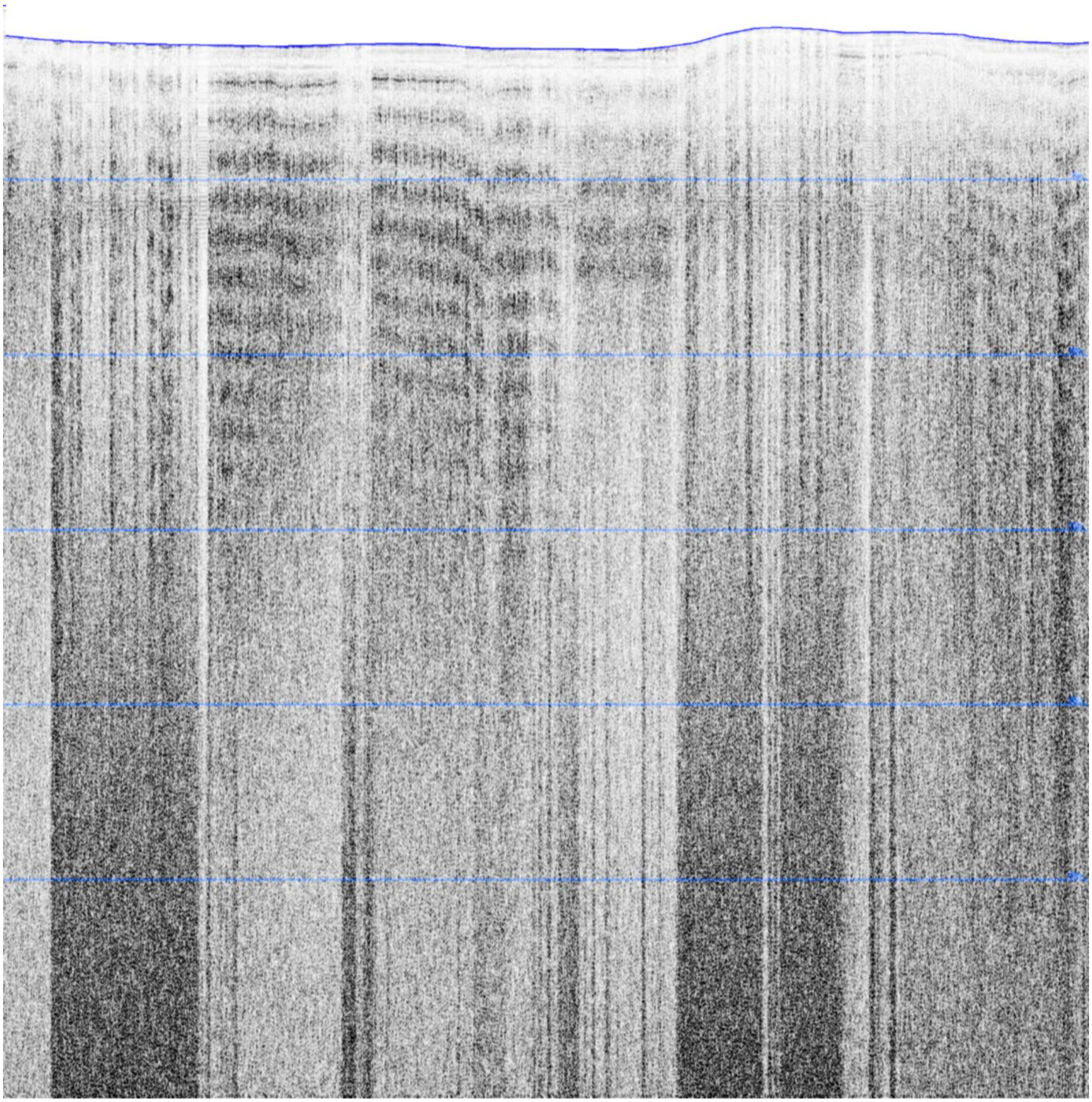


Figure A1b. Thirty-meters-deep seismic cross section of lake 1 with 5-meter depth marks.

At Lakes 2–12 we collected a single elevation line across each lake. The elevation line is shown on a Google Earth image for each lake location. Seismic lines associated with the transects are also provided (figs. A2–A12). The seismic lines show a variety of frozen and thawed lake bed conditions.

Lake 2, Station ID 21RPD002

Figure A2a. Google Earth image of lake 2 with single crossing elevation line.

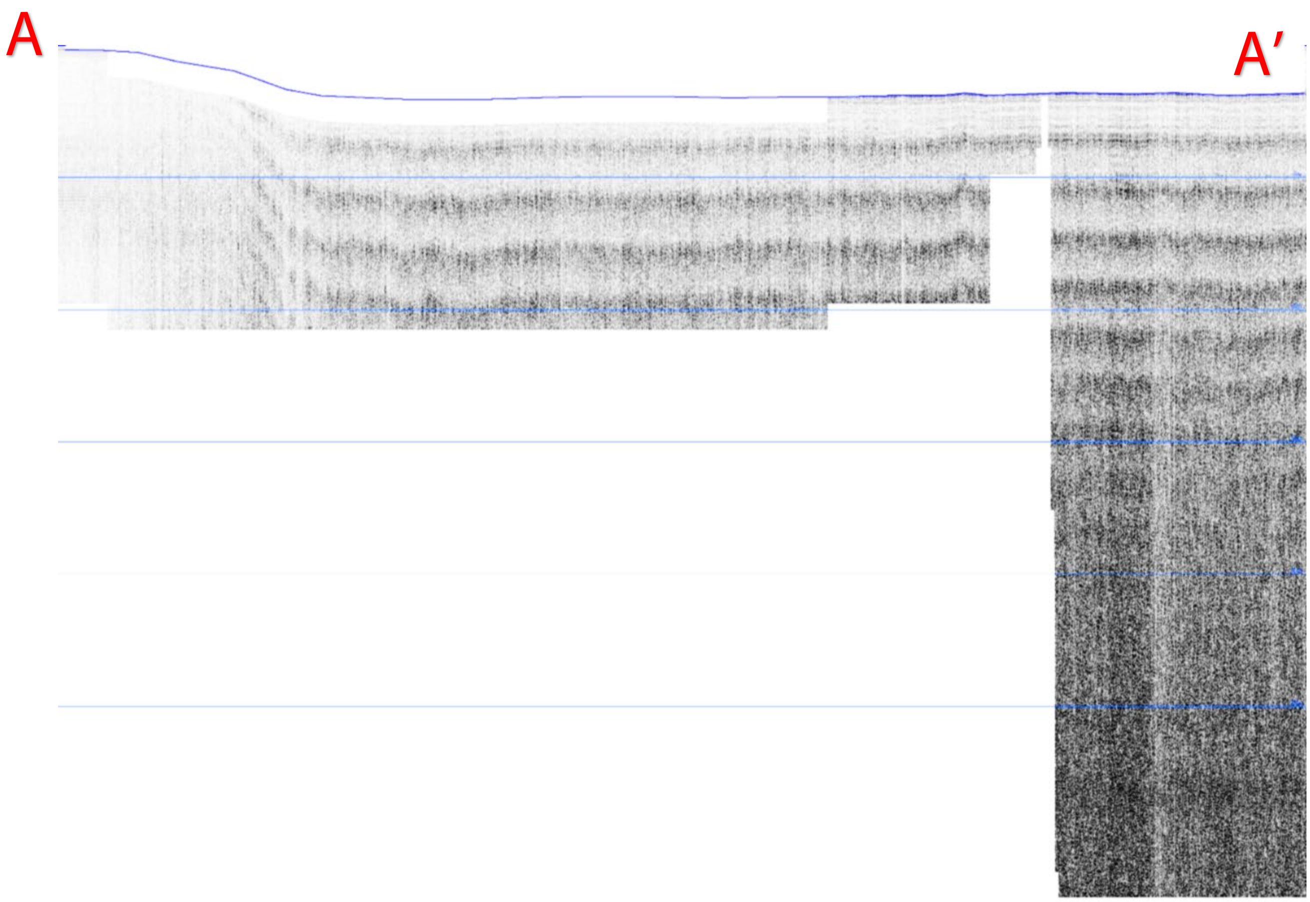


Figure A2b. Seismic cross section of lake 2. Maximum depth is 35 meters with 5-meter depth marks.

Lake 3, Station ID 21RPD003

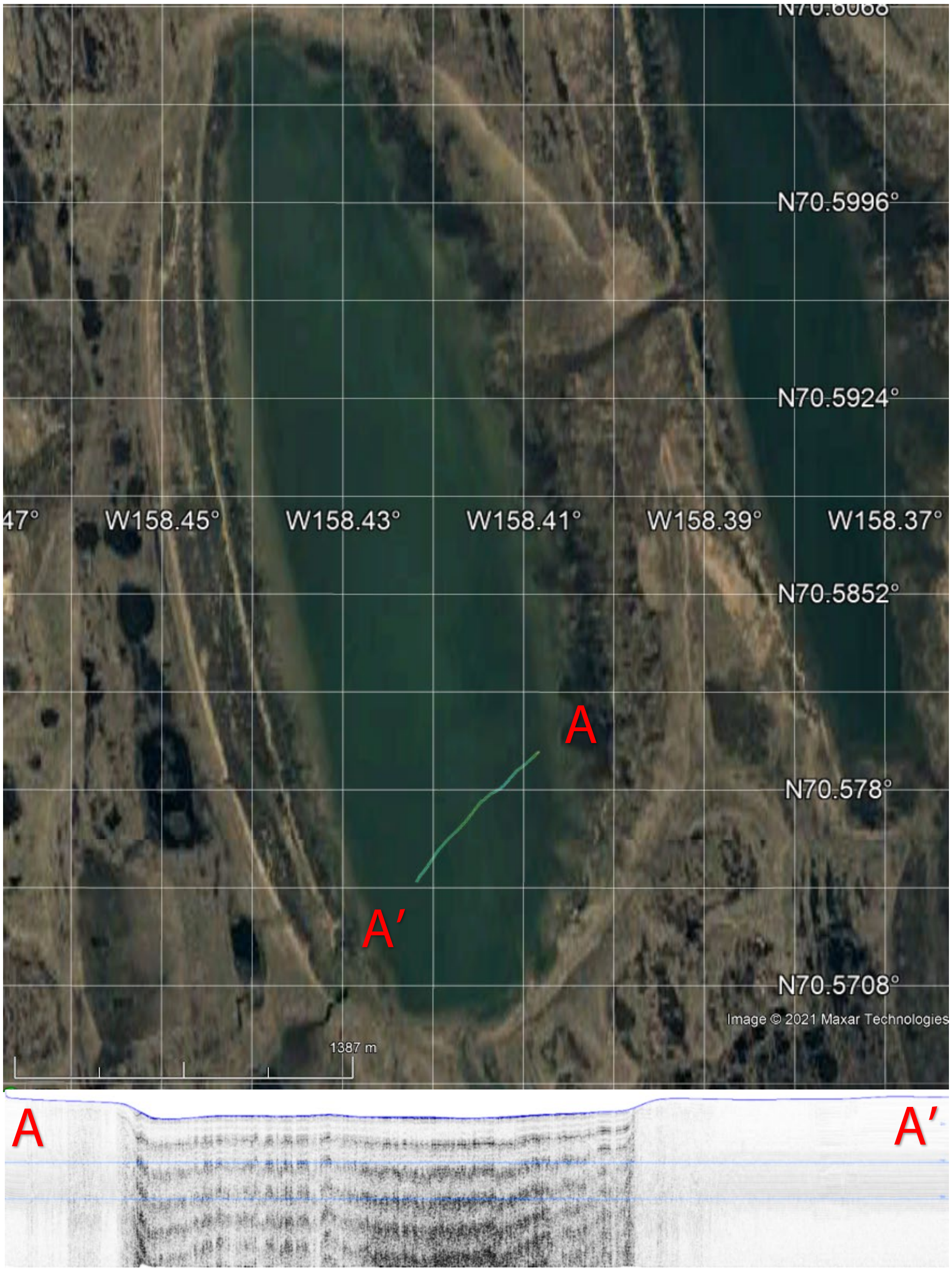


Figure A3. Google Earth image of lake 3 with single crossing elevation line (top). Seismic cross section of lake 3. Depth is 10 meters with 2-meter depth marks (bottom).

Lake 4, Station ID 21RPD004

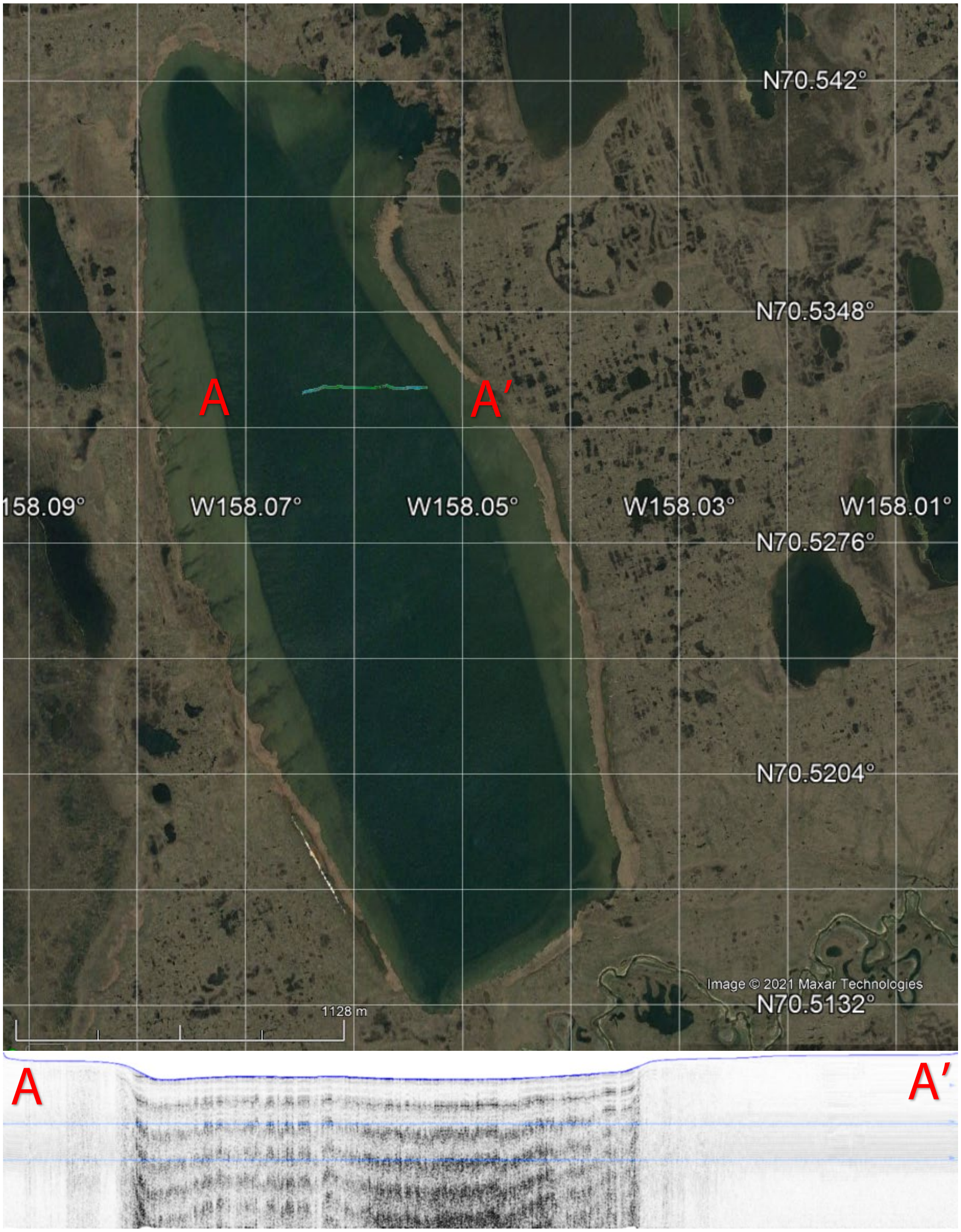


Figure A4. Google Earth image of lake 4 with single crossing elevation line (top). Seismic cross section of lake 4. Depth is 10 meters with 2-meter depth marks (bottom).

Lake 5, Station ID 21RPD005

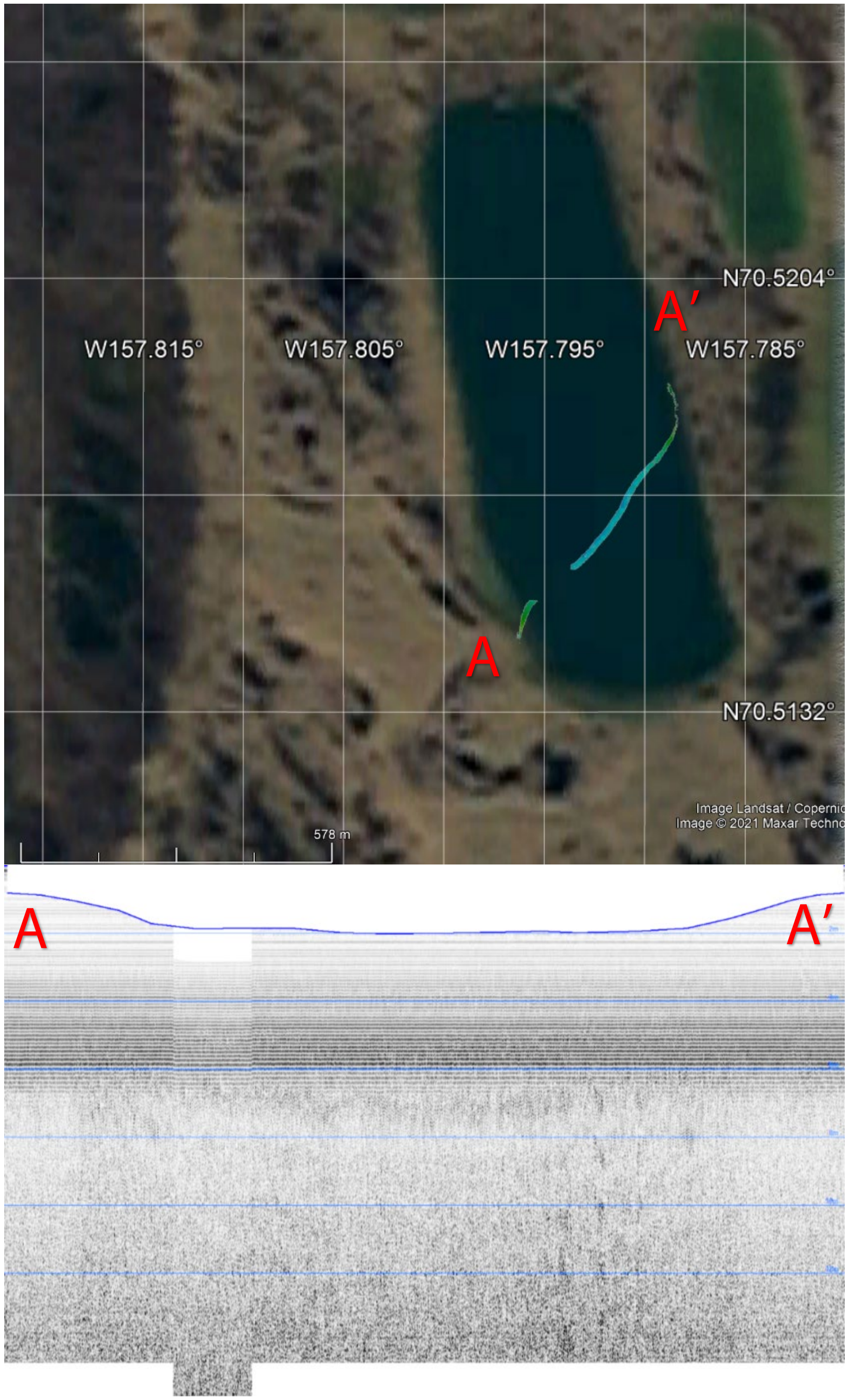


Figure A5. Google Earth image of lake 5 with single crossing elevation line (top). Seismic cross section of lake 5. Maximum depth is 14 meters with 2-meter depth marks (bottom).

Lake 6, Station ID 21RPD006

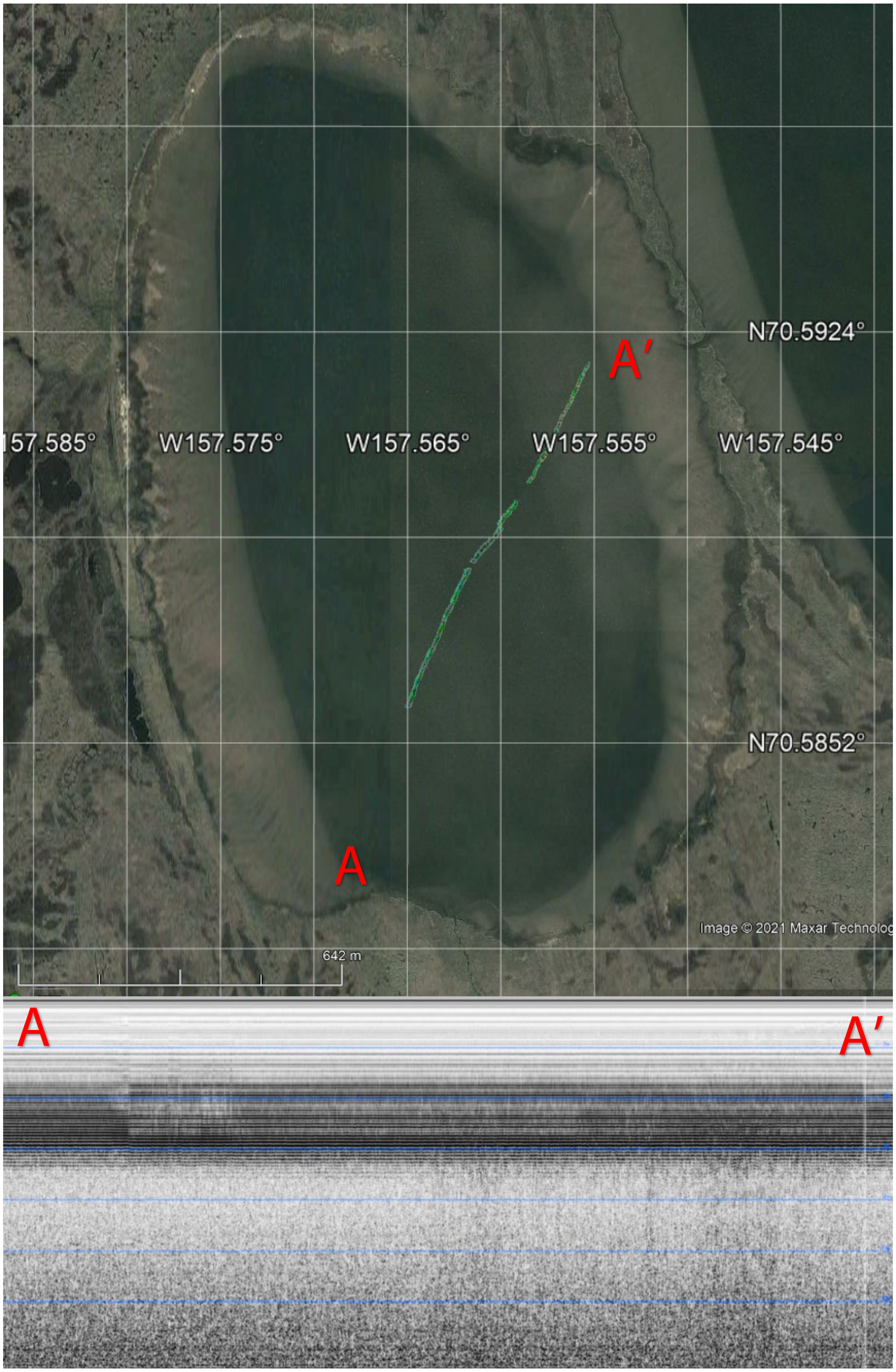


Figure A6. Google Earth image of lake 6 with single crossing elevation line (top). Seismic cross section of lake 6. Depth is 14 meters with 2-meter depth marks (bottom).

Lake 7, Station ID 21RPD007

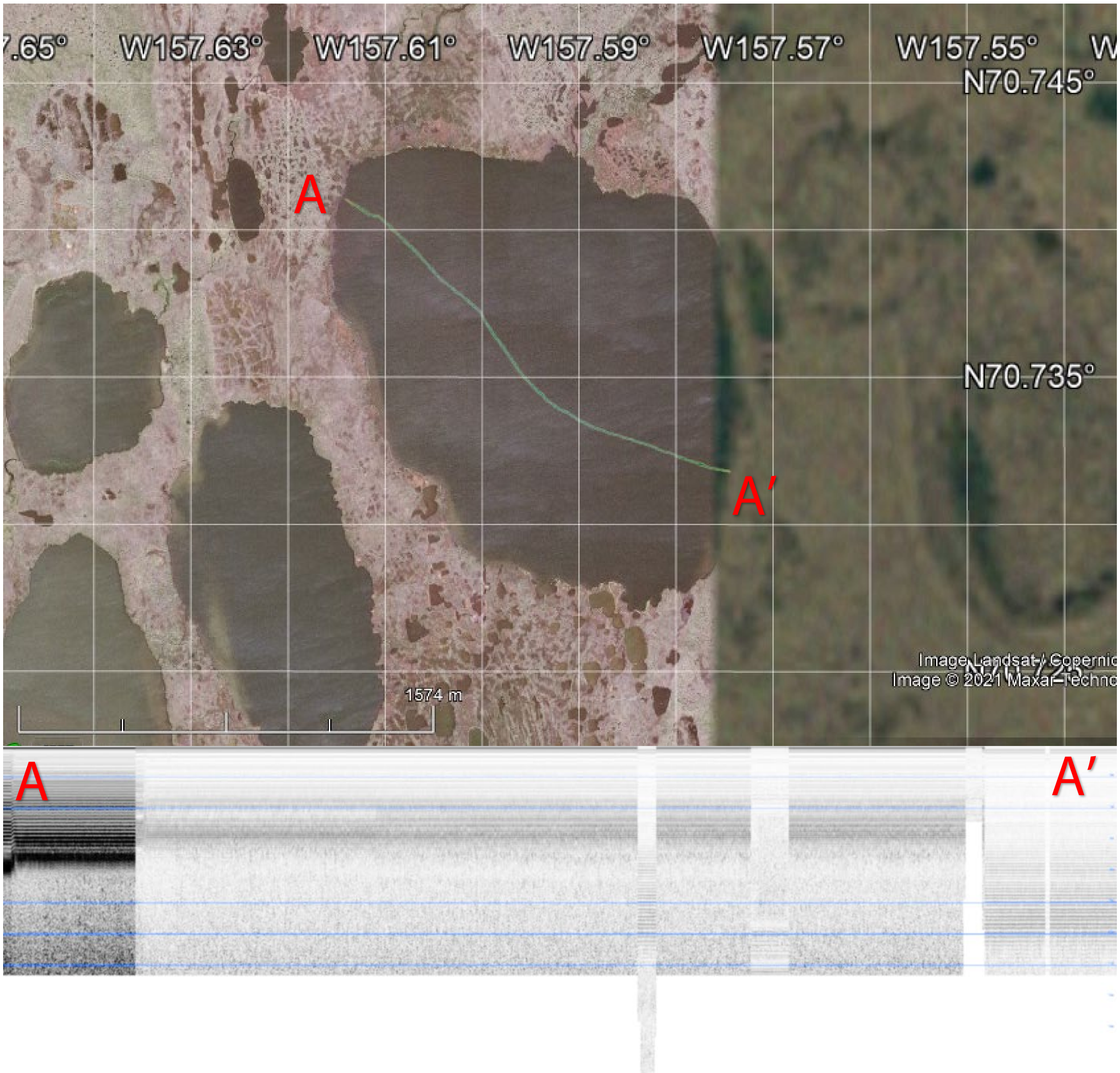


Figure A7. Google Earth image of lake 7 with single crossing elevation line (top). Seismic cross section of lake 7. Maximum depth is 21 meters with 2-meter depth marks (bottom).

Lake 8, Station ID 21RPD008

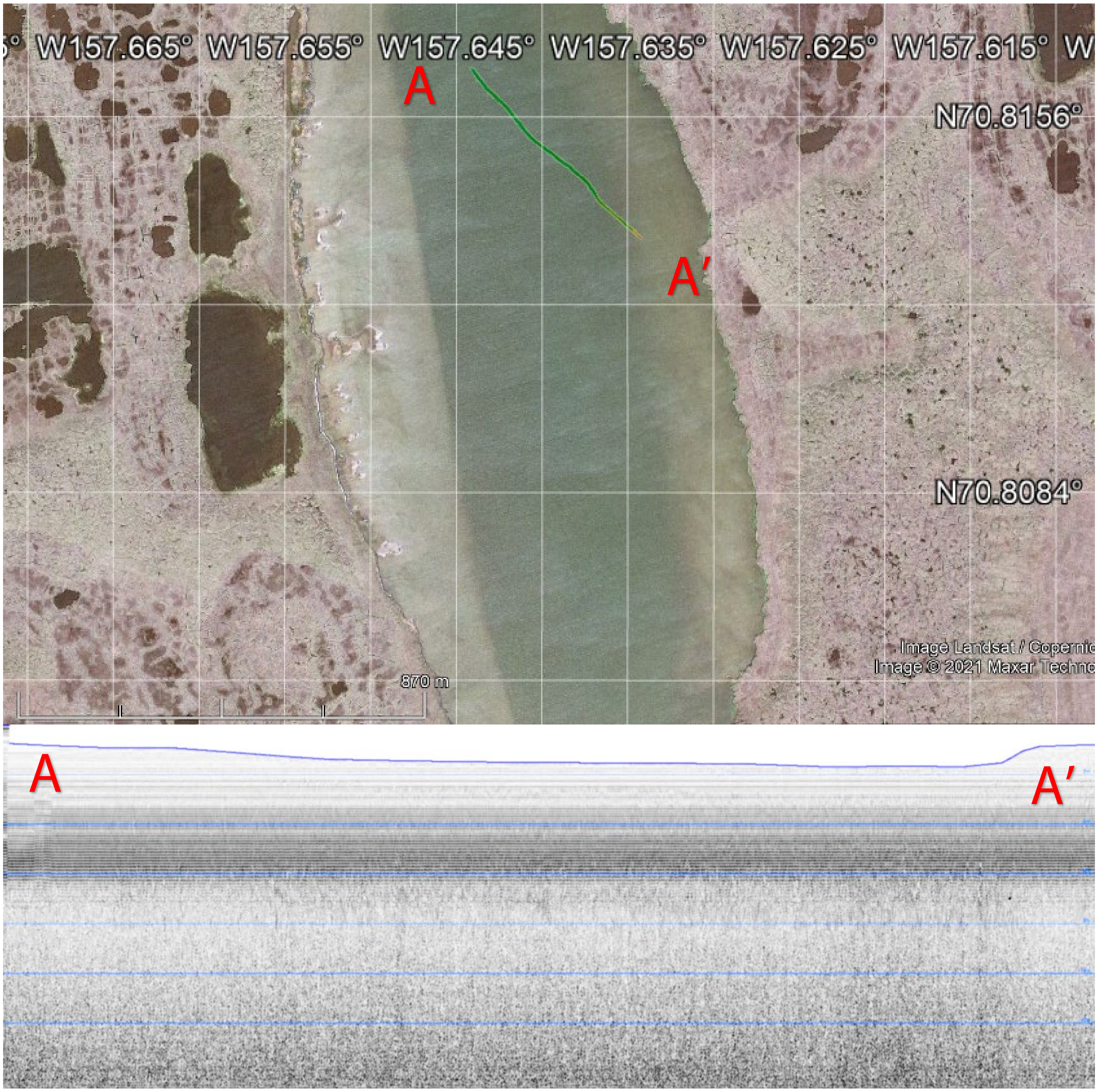


Figure A8. Google Earth image of lake 8 with single crossing elevation line (top). Seismic cross section of lake 8. Depth is 15 meters with 2-meter depth marks (bottom).

Lake 9, Station ID 21RPD009

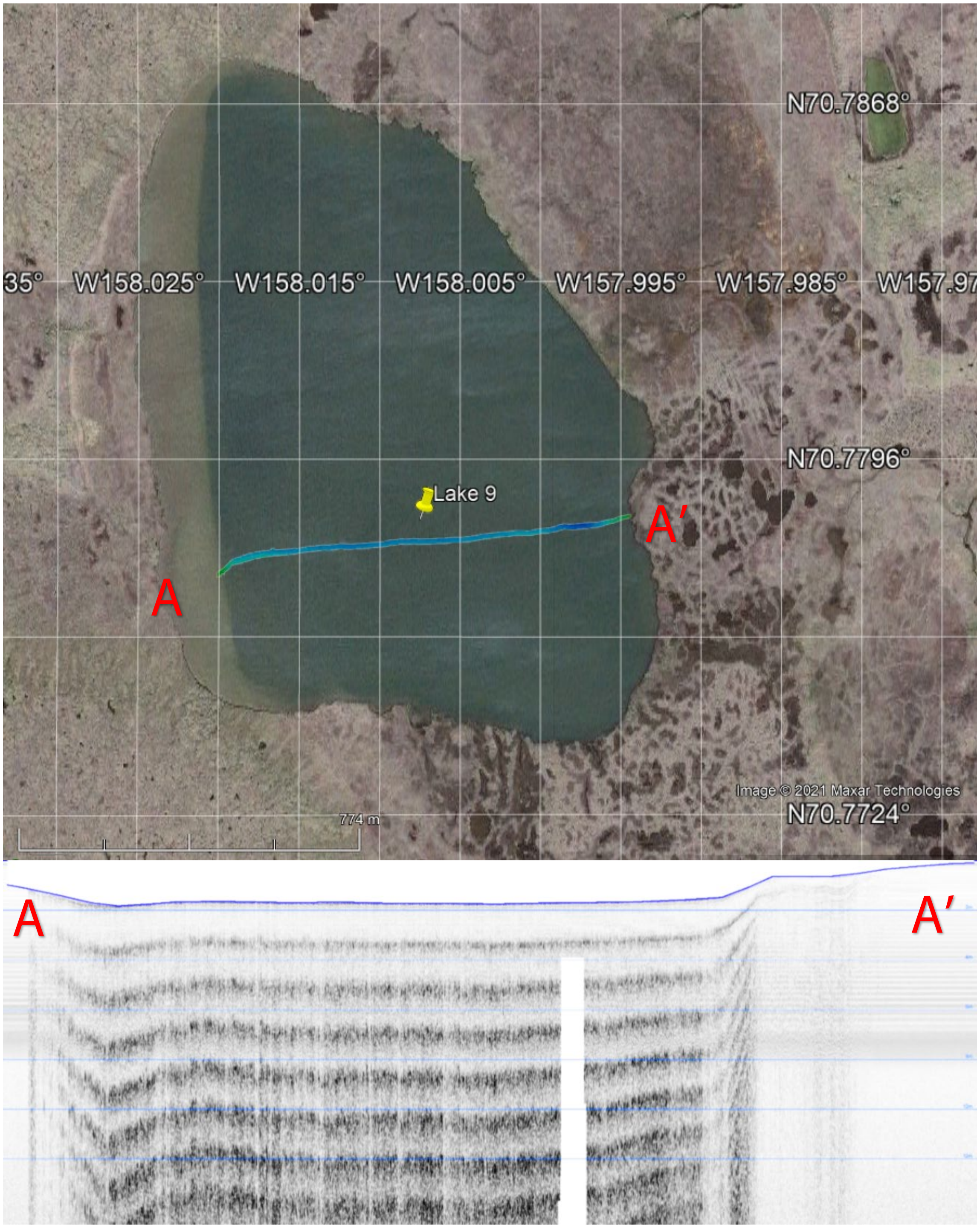


Figure A9. Google Earth image of lake 9 with single crossing elevation line (top). Seismic cross section of lake 9. Depth is 15 meters with 2-meter depth marks (bottom).

Lake 10, Station ID 21RPD010

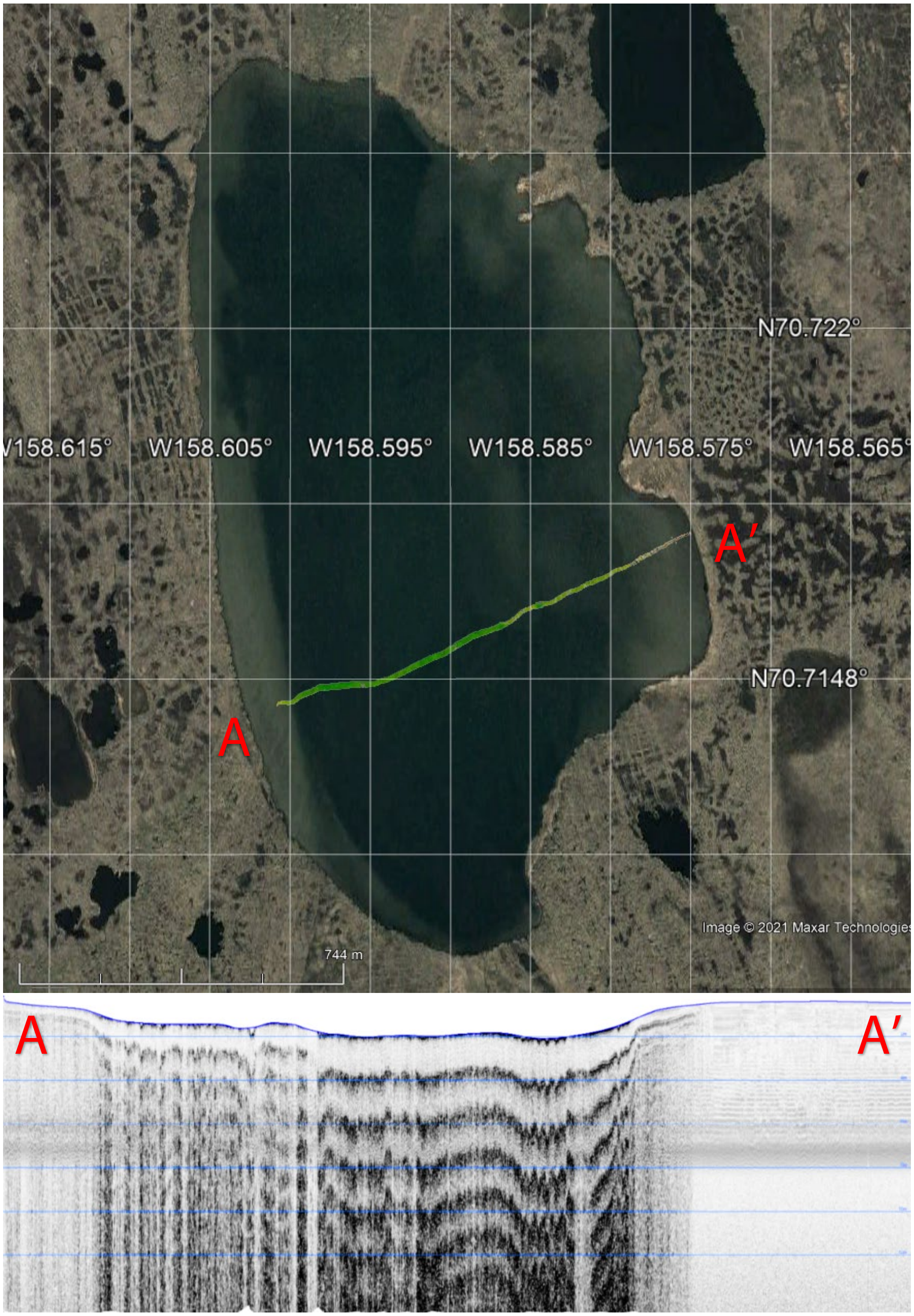


Figure A10. Google Earth image of lake 10 with single crossing elevation line. (top). Seismic cross section of lake 10. Depth is 14 meters with 2-meter depth marks (bottom).

Lake 11, Station ID 21RPD011

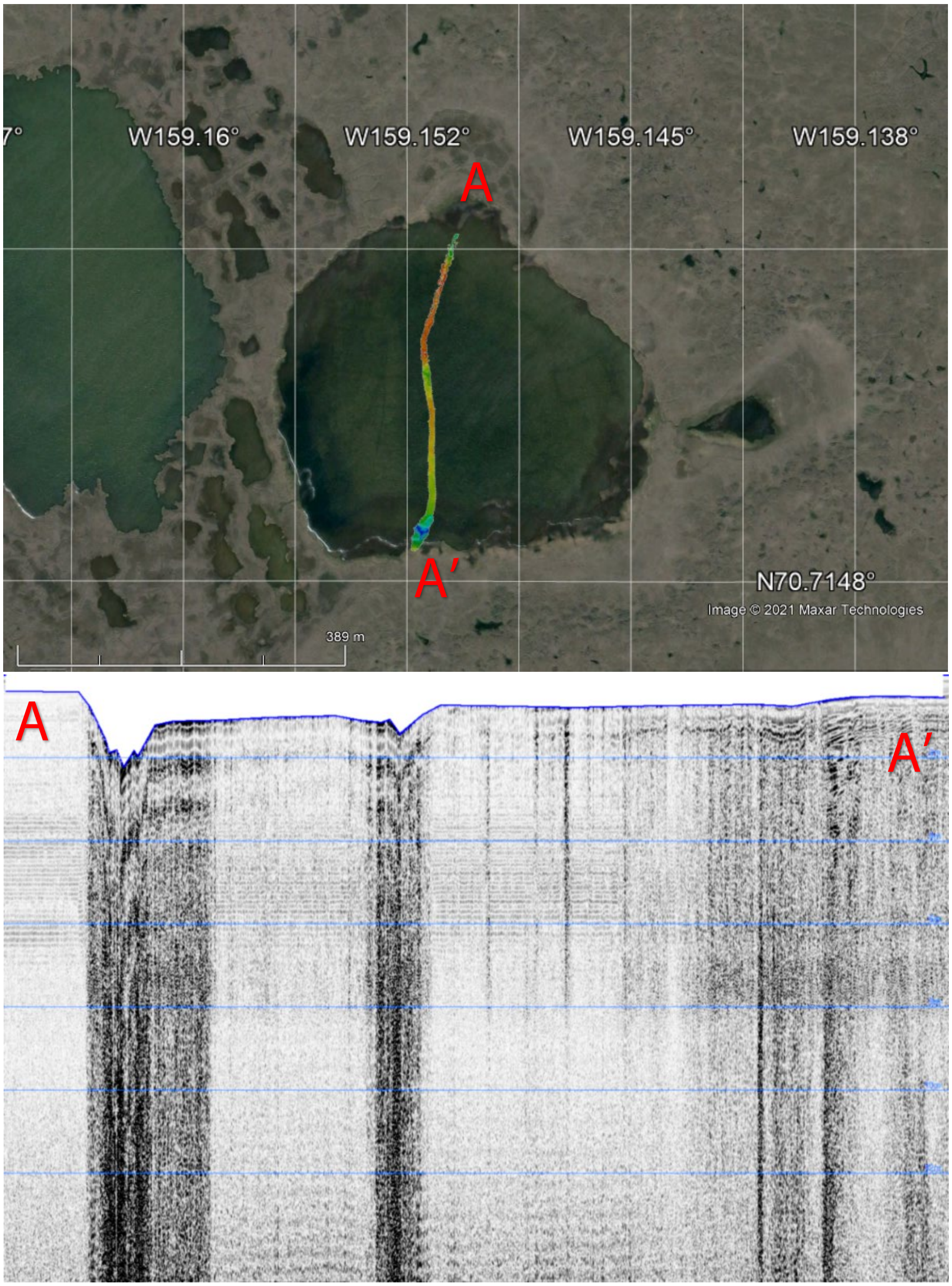


Figure A11. Google Earth image of lake 11 with single crossing elevation line (top). Seismic cross section of lake 11. Depth is 15 meters with 2-meter depth marks (bottom).

Lake 12, Station ID 21RPD012

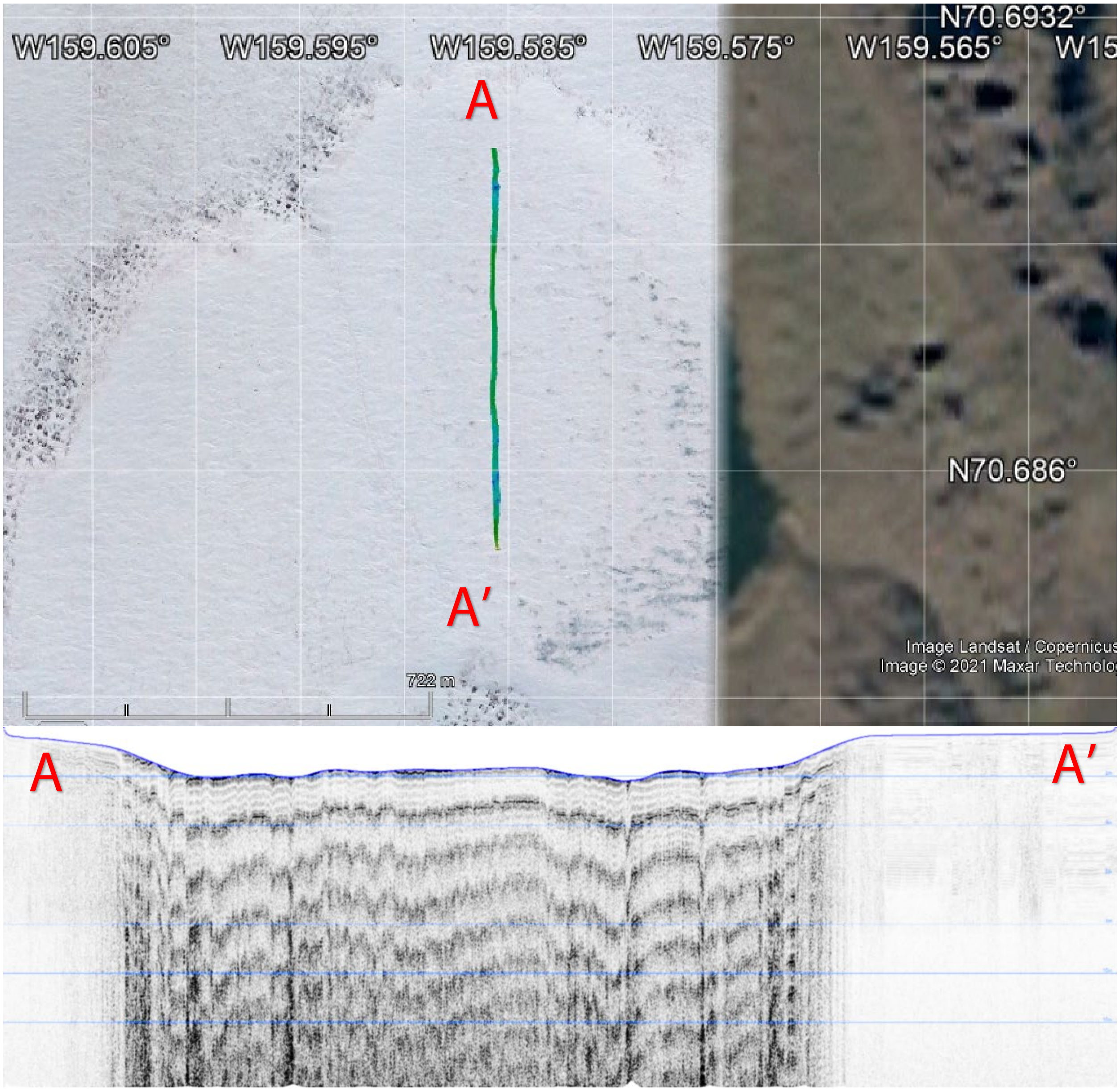


Figure A12a. Google Earth image of lake 12 with single crossing elevation line (top). Seismic cross section of lake 12. Depth is 15 meters with 2-meter depth marks (bottom).