

Using High-Res. Orthoimagery for Environmental Change Detection & Analysis in Northern Alaska

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Talk Outline

ARCN Coastal Orthoimagery

Evaluating Imagery for Use

Create Your Own Imagery

Opportunities & Challenges for ARCN

Introduction

Orthorectified imagery was completed as part of a study on coastal erosion by the University of Colorado in collaboration with the Arctic Network Inventory and Monitoring Program.

Beyond analysis of coastal change, the imagery will be of interest to land managers, scientists, and others for observation and study of natural features and ecosystems.

Goals

The three, co-registered timeslices of imagery will be helpful to assess the status of environmental features, and to detect change in:

- cultural resources and archeological sites
- ecosystem components such as coastal zones, wetlands, geology, soils, permafrost, lake and stream hydrology, and vegetation assemblages
- marine, terrestrial, and freshwater habitats for a variety of animals

The imagery assists the goals of the NPS Arctic Network Inventory and Monitoring Program, which has a mission to "collect, compile, and synthesize scientific information about the arctic network of parks to facilitate their preservation, unimpaired, for future generations."

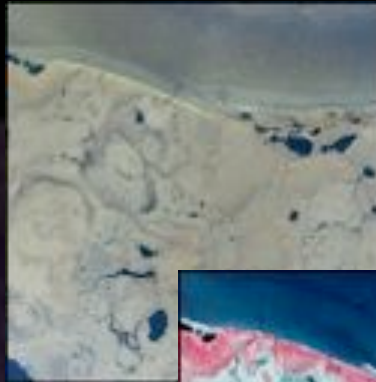
Study Area



Imagery

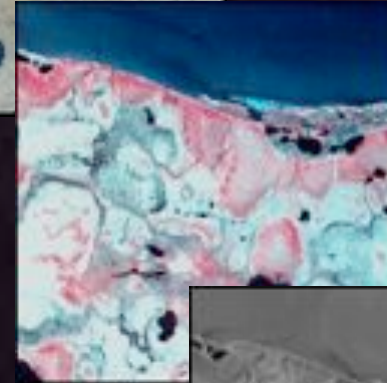
2003 orthophoto mosaic (94 GB)

2003



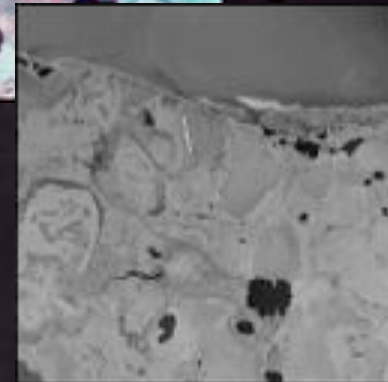
ca. 1980

orthorectified photography for
approx. 1980 (53 GB)



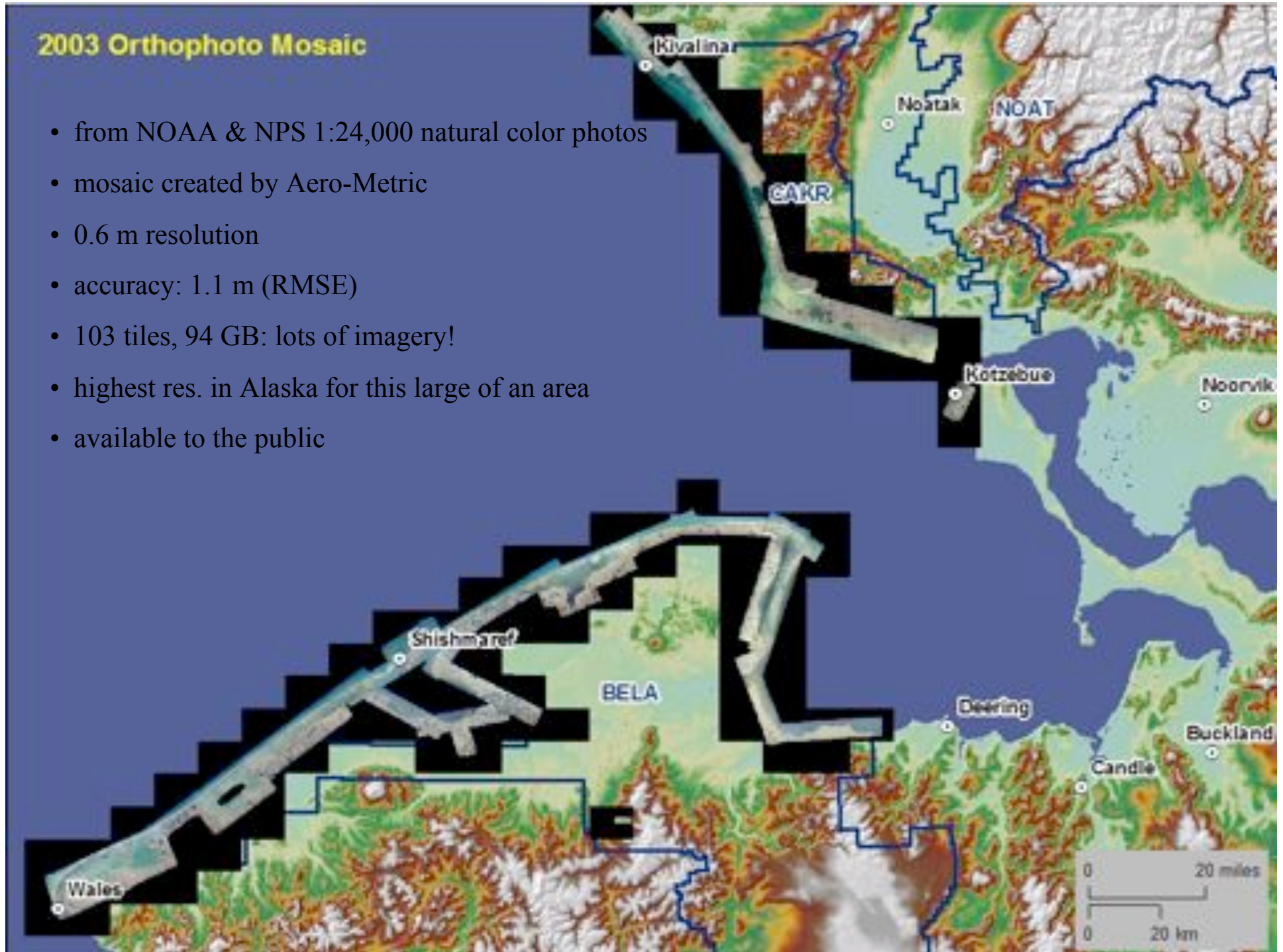
ca. 1950

orthorectified photography for
approx. 1950 (15 GB)



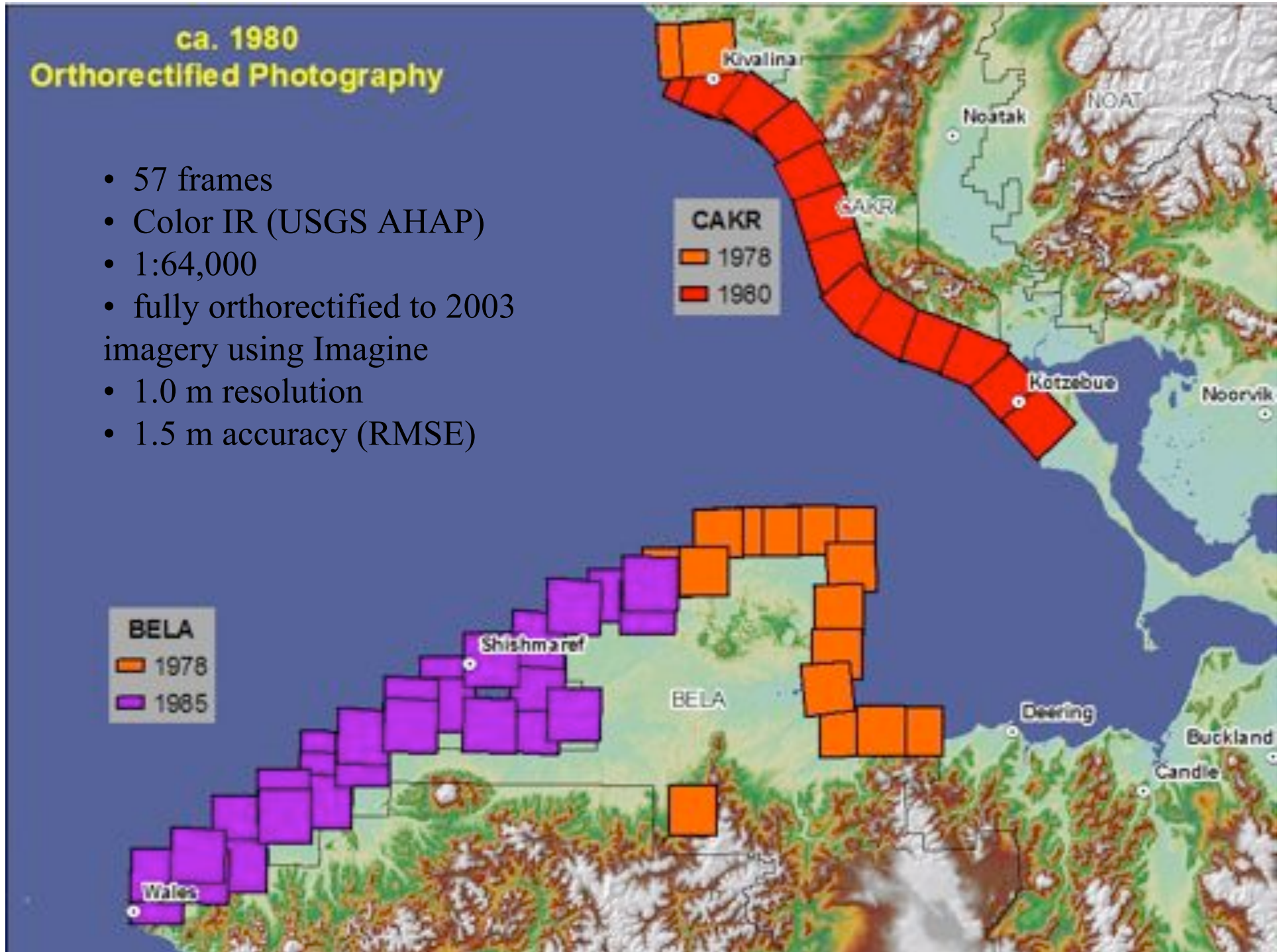
2003 Orthophoto Mosaic

- from NOAA & NPS 1:24,000 natural color photos
- mosaic created by Aero-Metric
- 0.6 m resolution
- accuracy: 1.1 m (RMSE)
- 103 tiles, 94 GB: lots of imagery!
- highest res. in Alaska for this large of an area
- available to the public



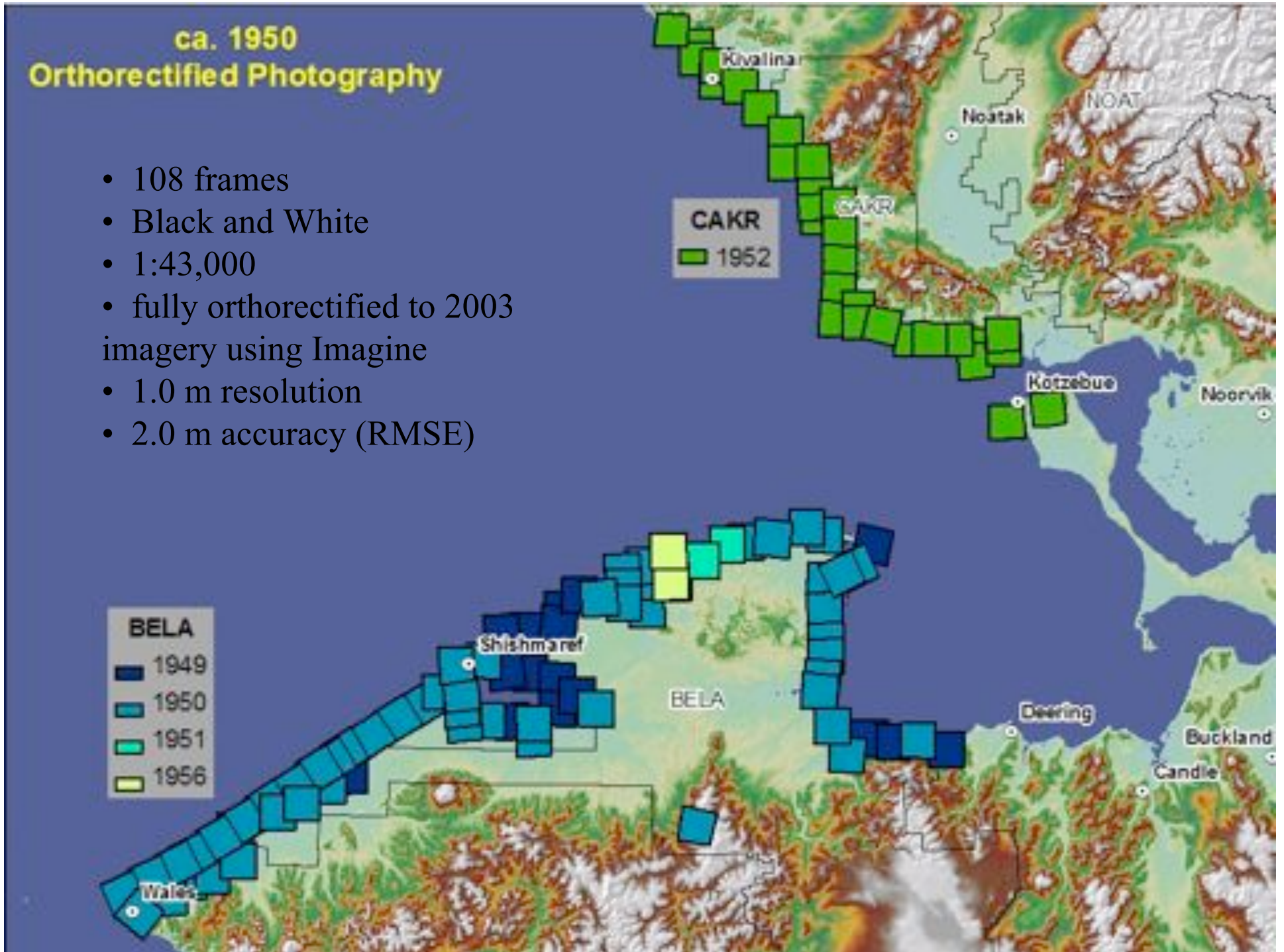
ca. 1980
Orthorectified Photography

- 57 frames
- Color IR (USGS AHAP)
- 1:64,000
- fully orthorectified to 2003 imagery using Imagine
- 1.0 m resolution
- 1.5 m accuracy (RMSE)



ca. 1950
Orthorectified Photography

- 108 frames
- Black and White
- 1:43,000
- fully orthorectified to 2003 imagery using Imagine
- 1.0 m resolution
- 2.0 m accuracy (RMSE)



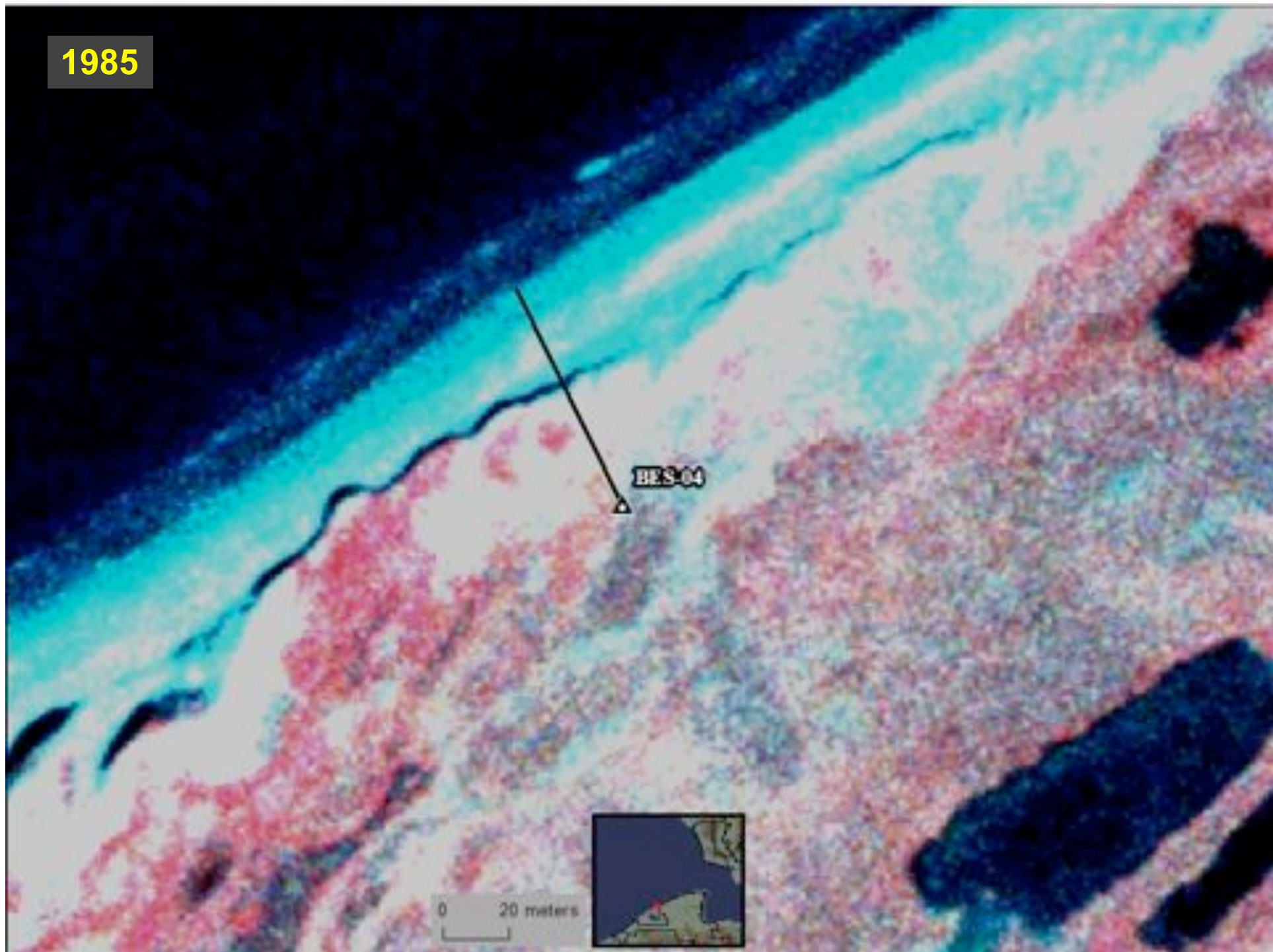
1949

BES-04

0 20 meters



1985



Bluff erosion, as an example of environmental change:

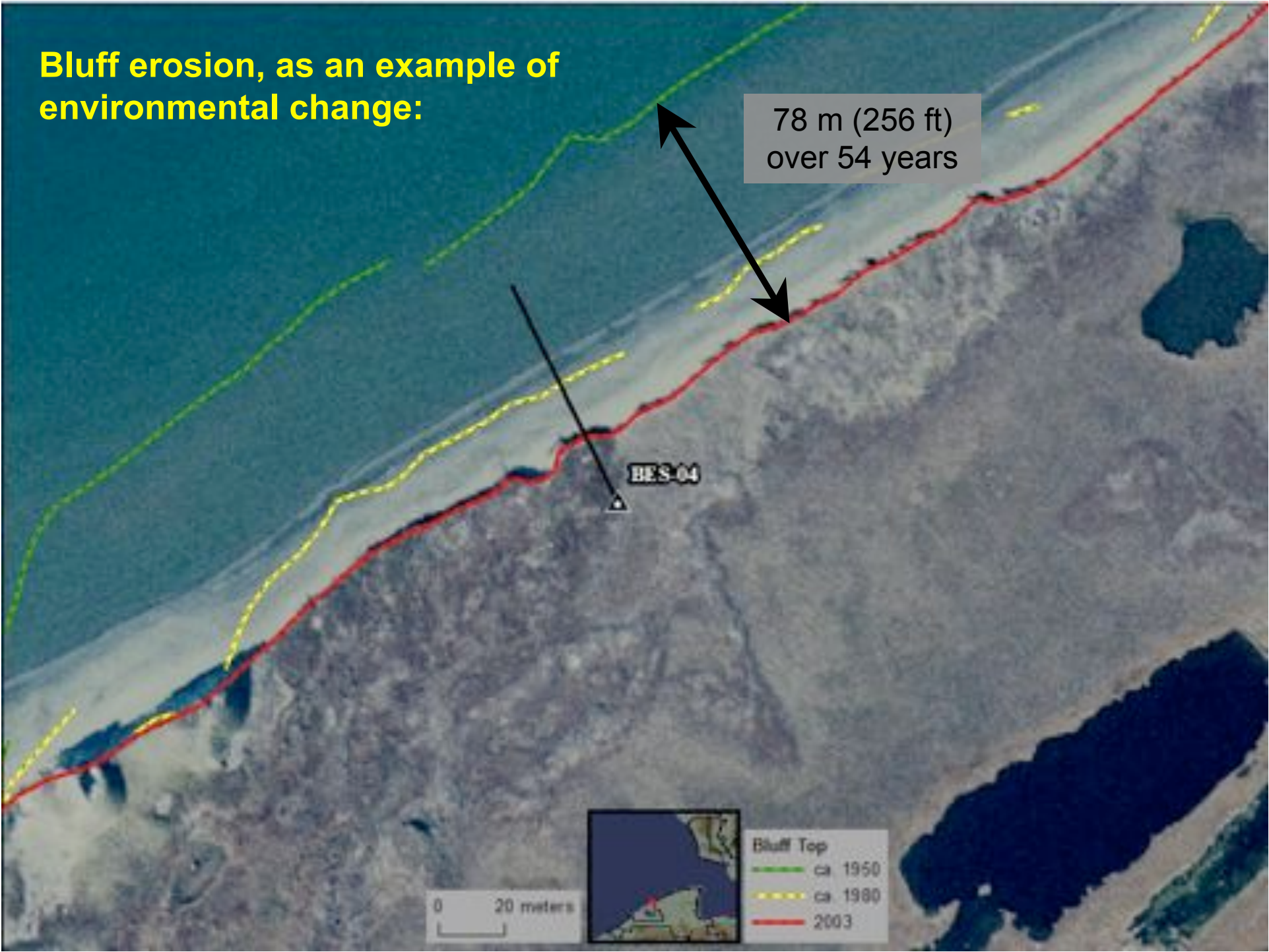
78 m (256 ft)
over 54 years

BES-04

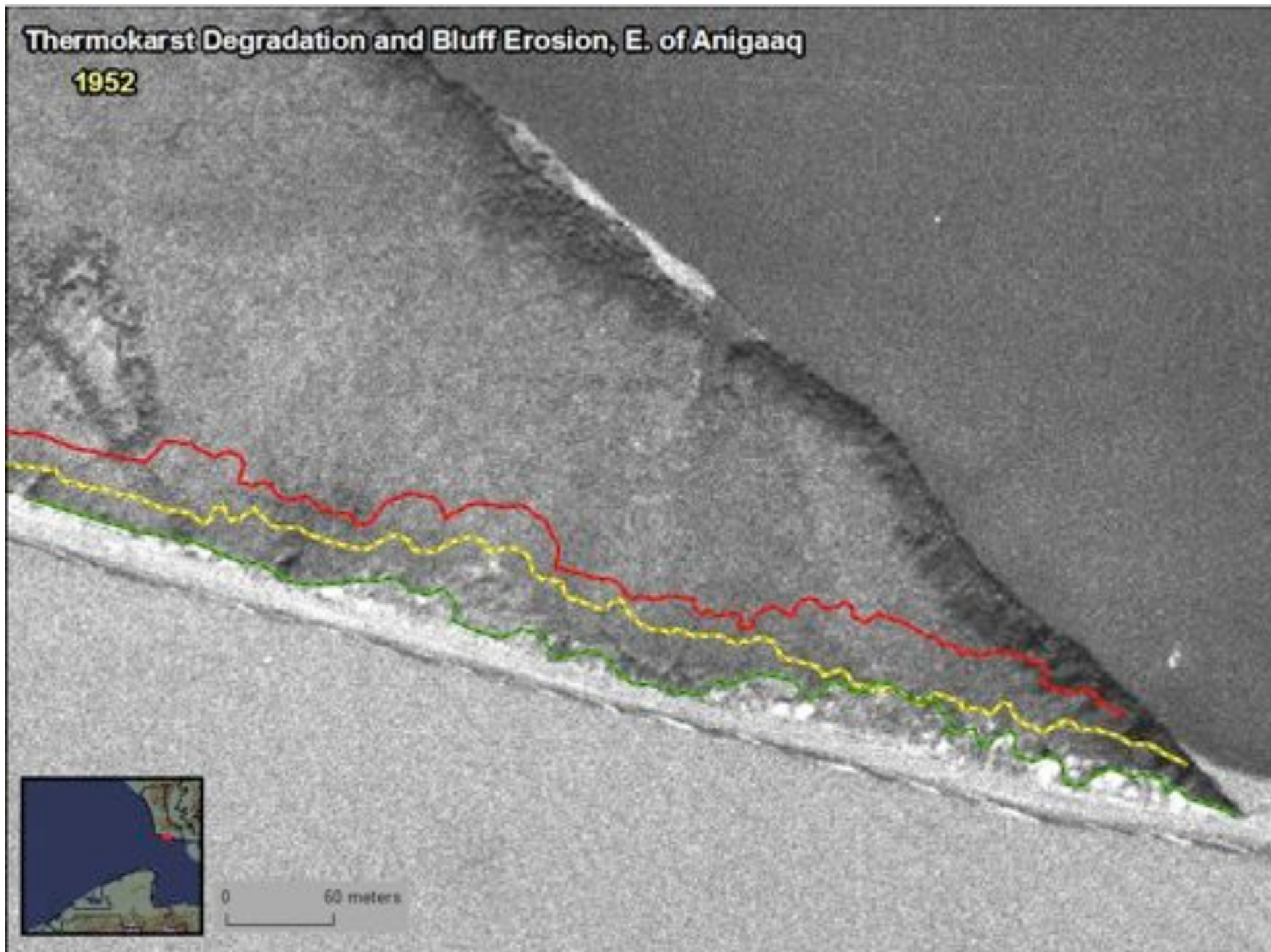
0 20 meters



Bluff Top
— ca 1950
— ca 1980
— 2003



Thermokarst Degradation and Bluff Erosion, E. of Anigaaq
1952



Thermokarst Degradation and Bluff Erosion, E. of Anigaaq
1980



Thermokarst Degradation and Bluff Erosion, E. of Anigaaq
2003



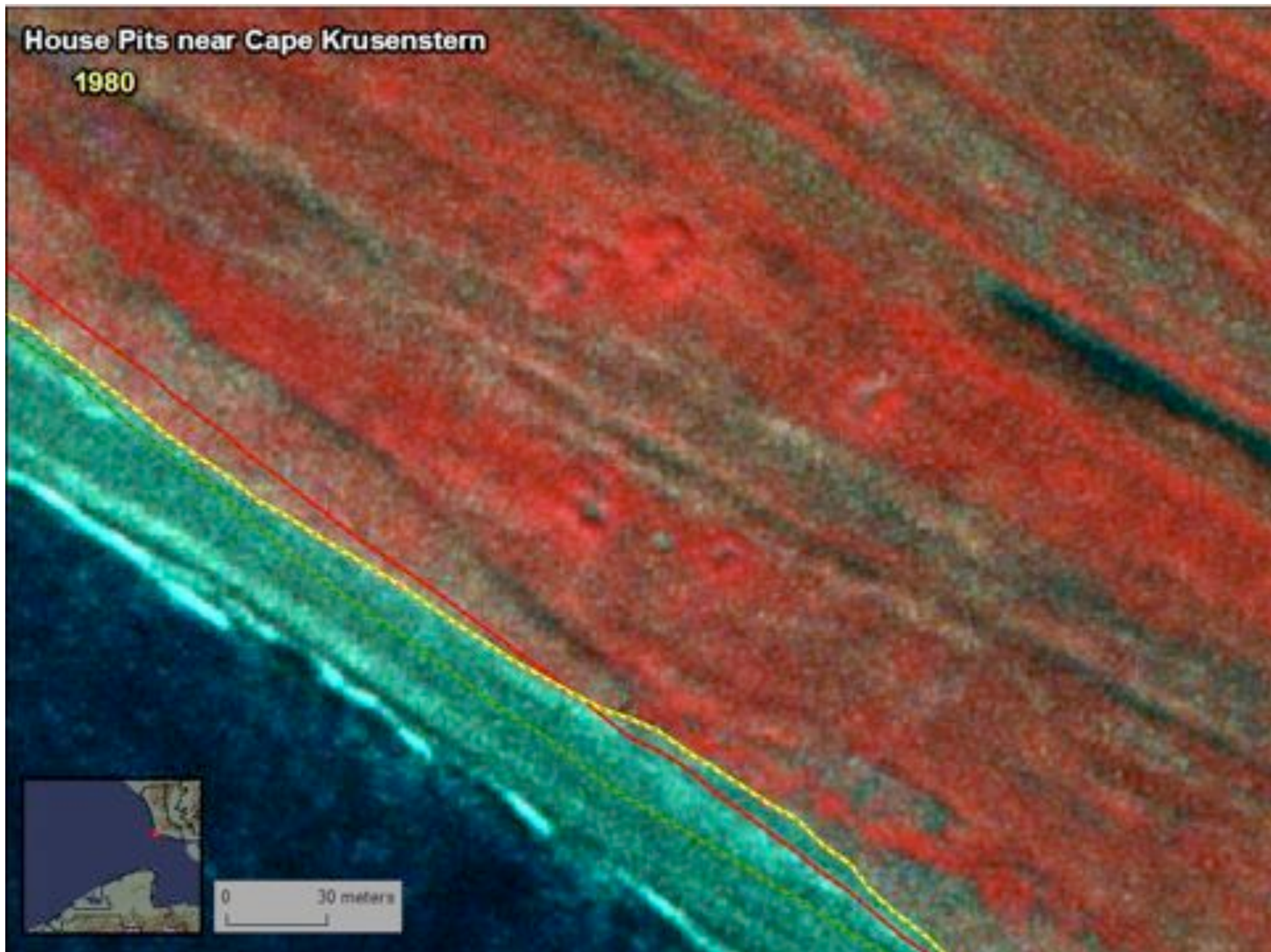
House Pits near Cape Krusenstern

1952

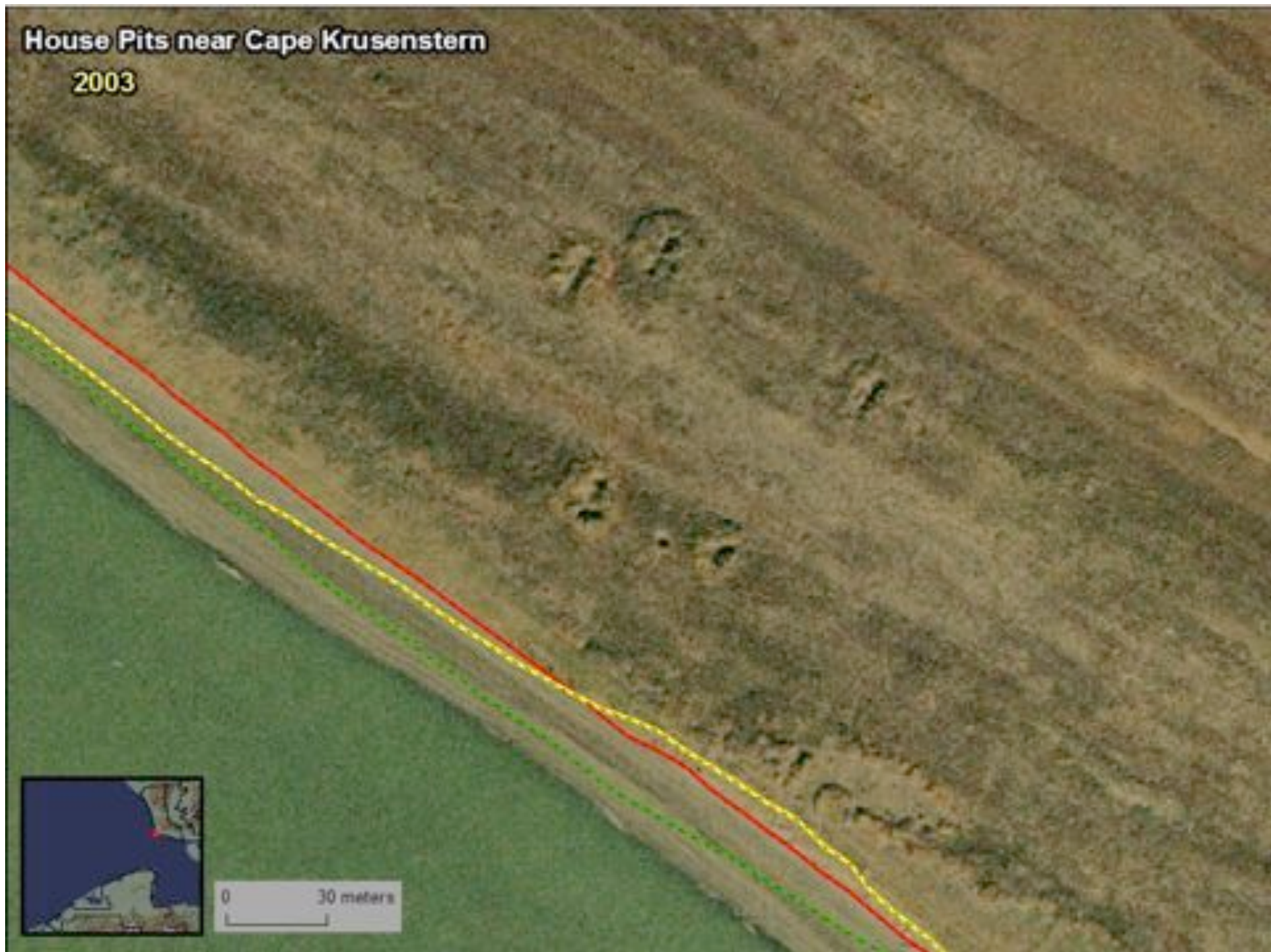


House Pits near Cape Krusenstern

1980



House Pits near Cape Krusenstern
2003



Flooding of Kiligmak Inlet

1952



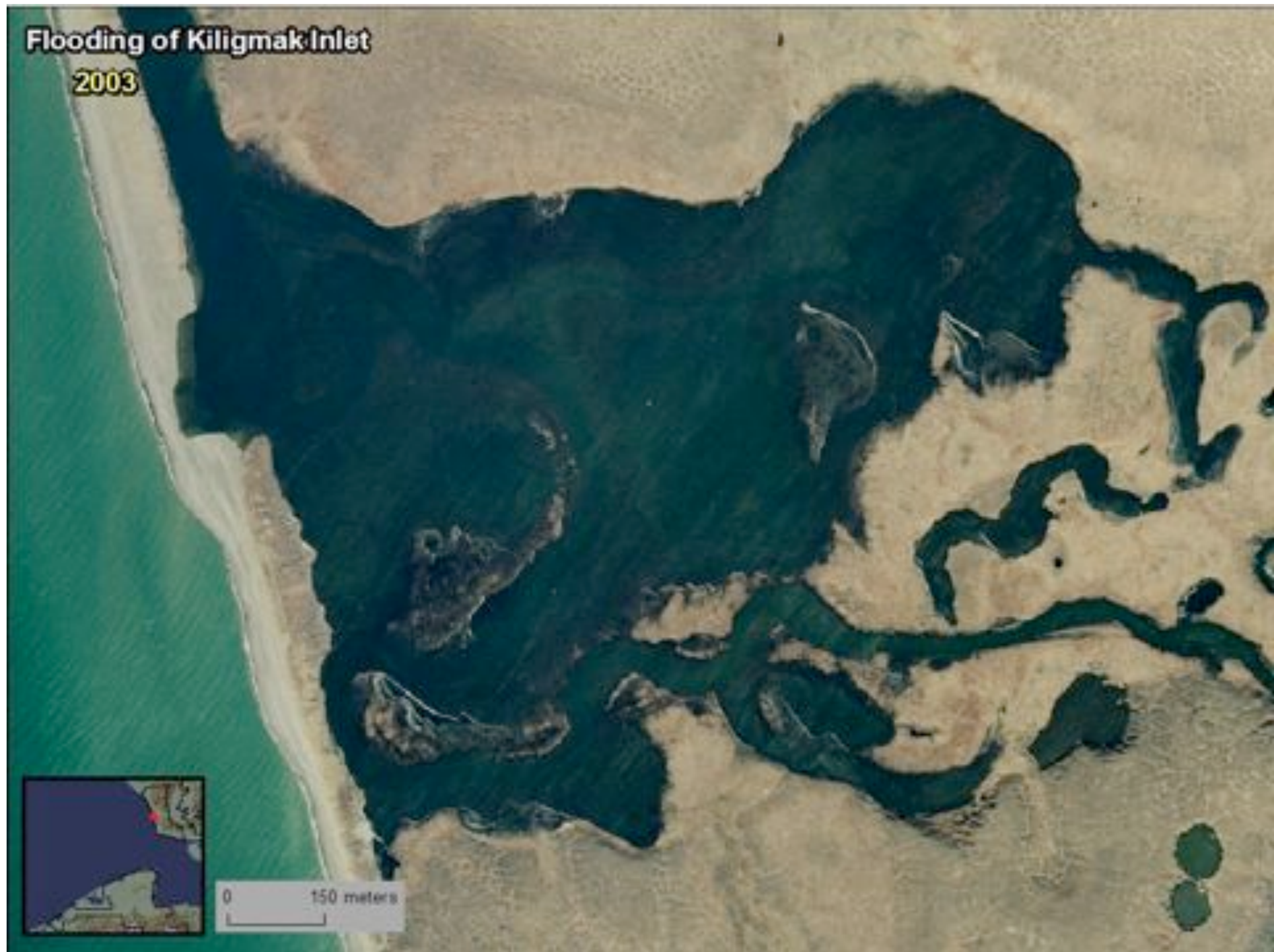
Flooding of Kiligmak Inlet

1980



Flooding of Kiligmak Inlet

2003



Shrub Expansion, E. of Anigaaq
1980



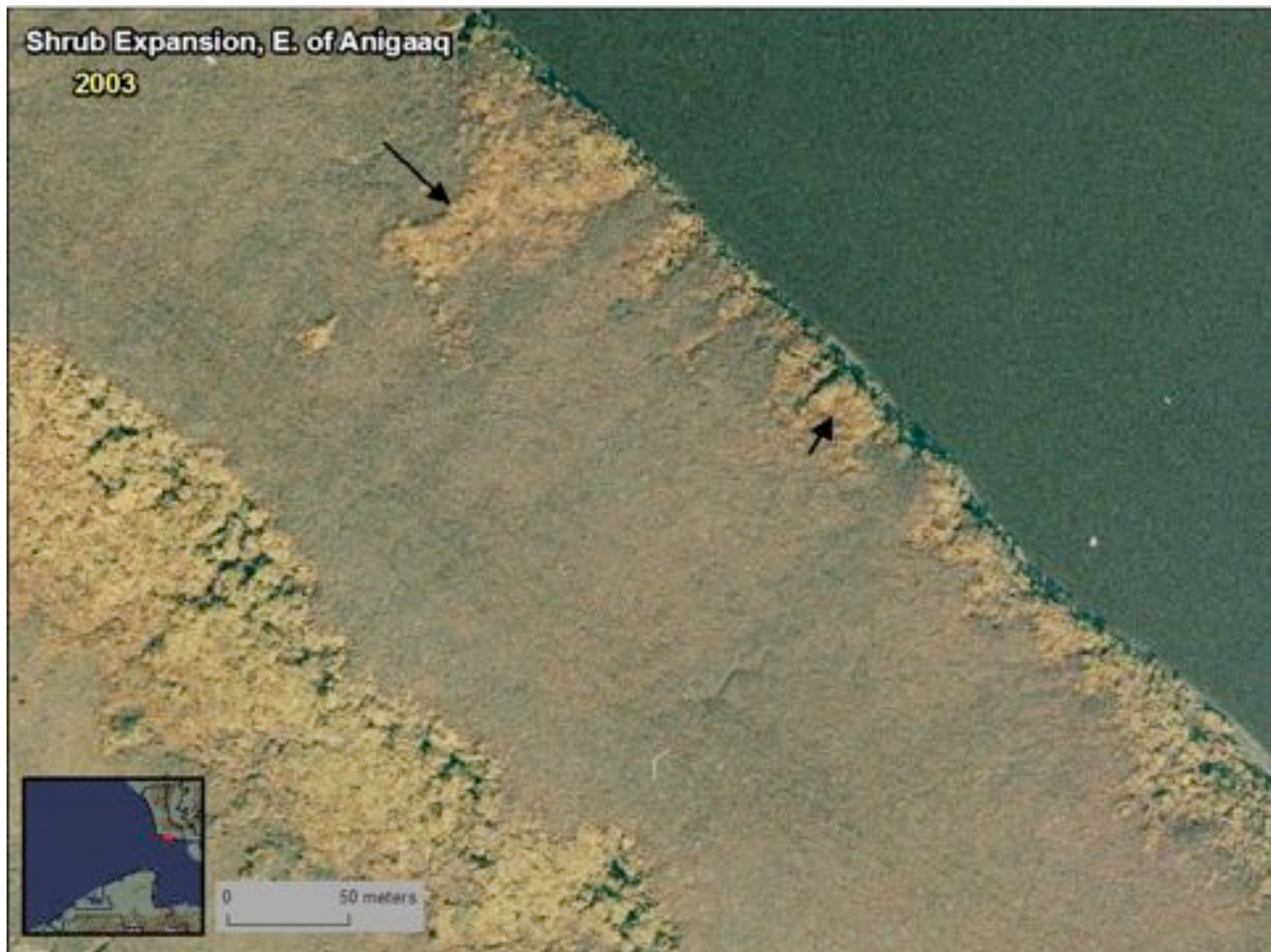
Shrub Expansion, E. of Anigaaq
1980



0 50 meters



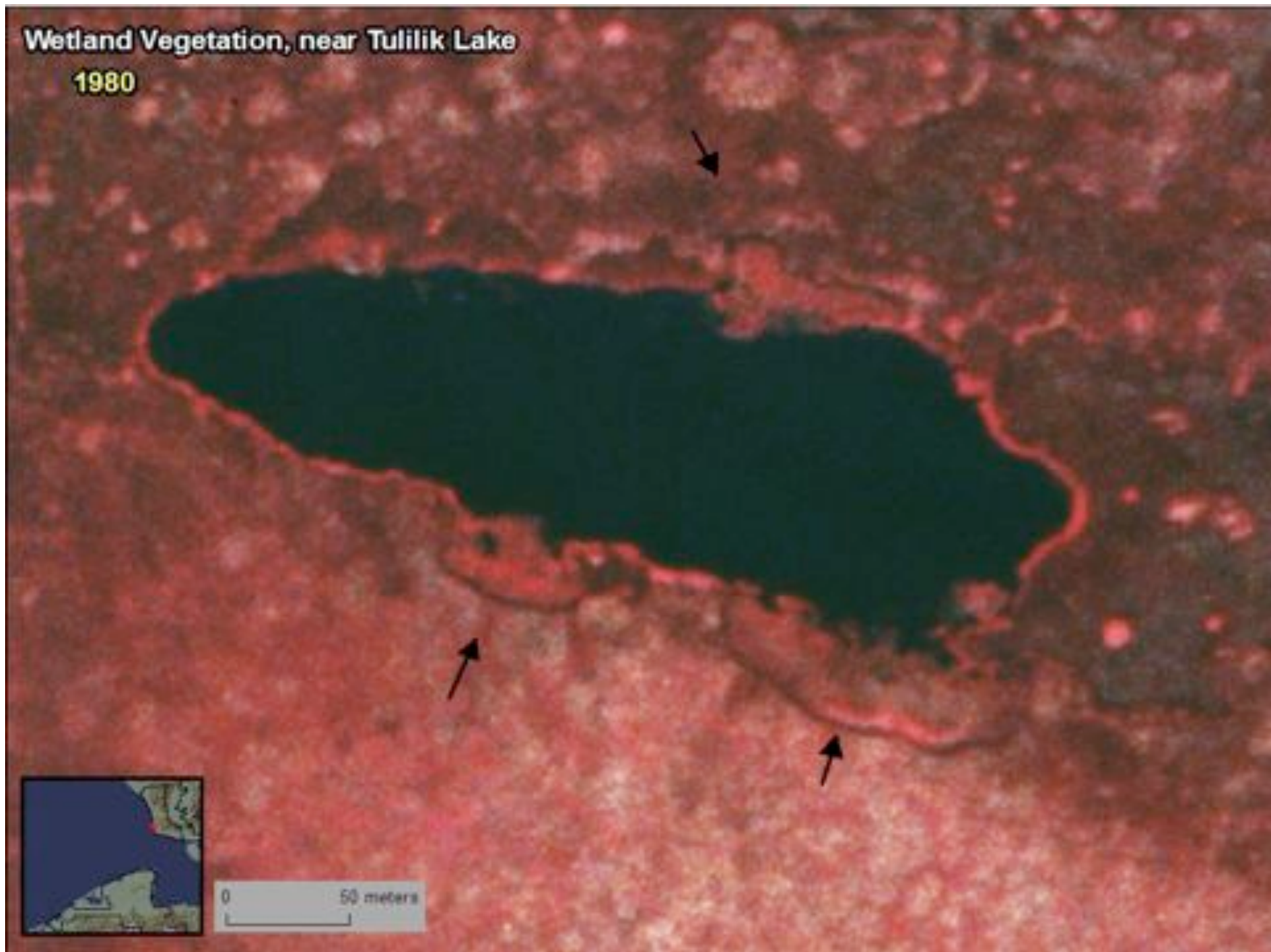
Shrub Expansion, E. of Anigaaq
2003



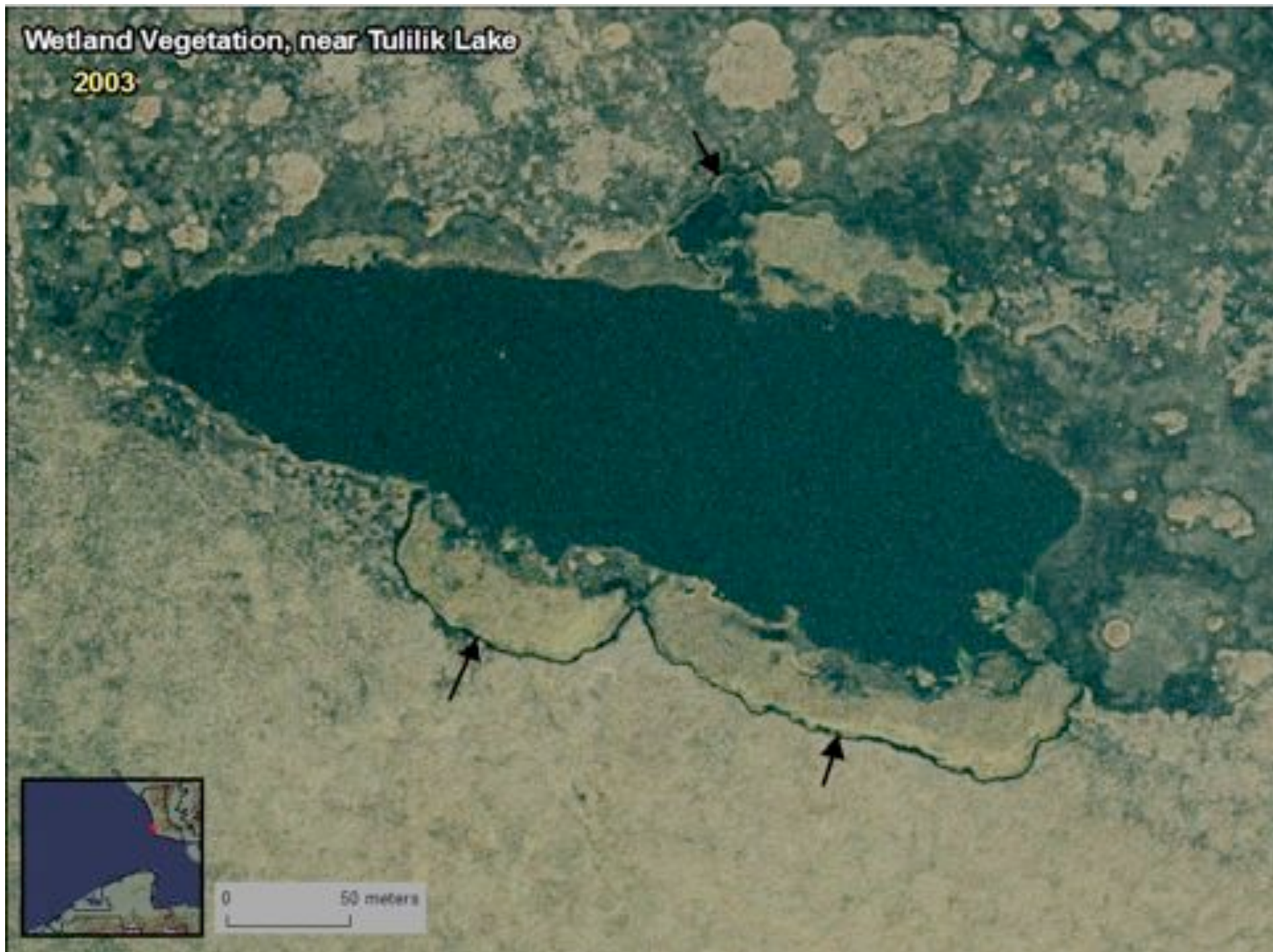
Wetland Vegetation, near Tulilik Lake
1952

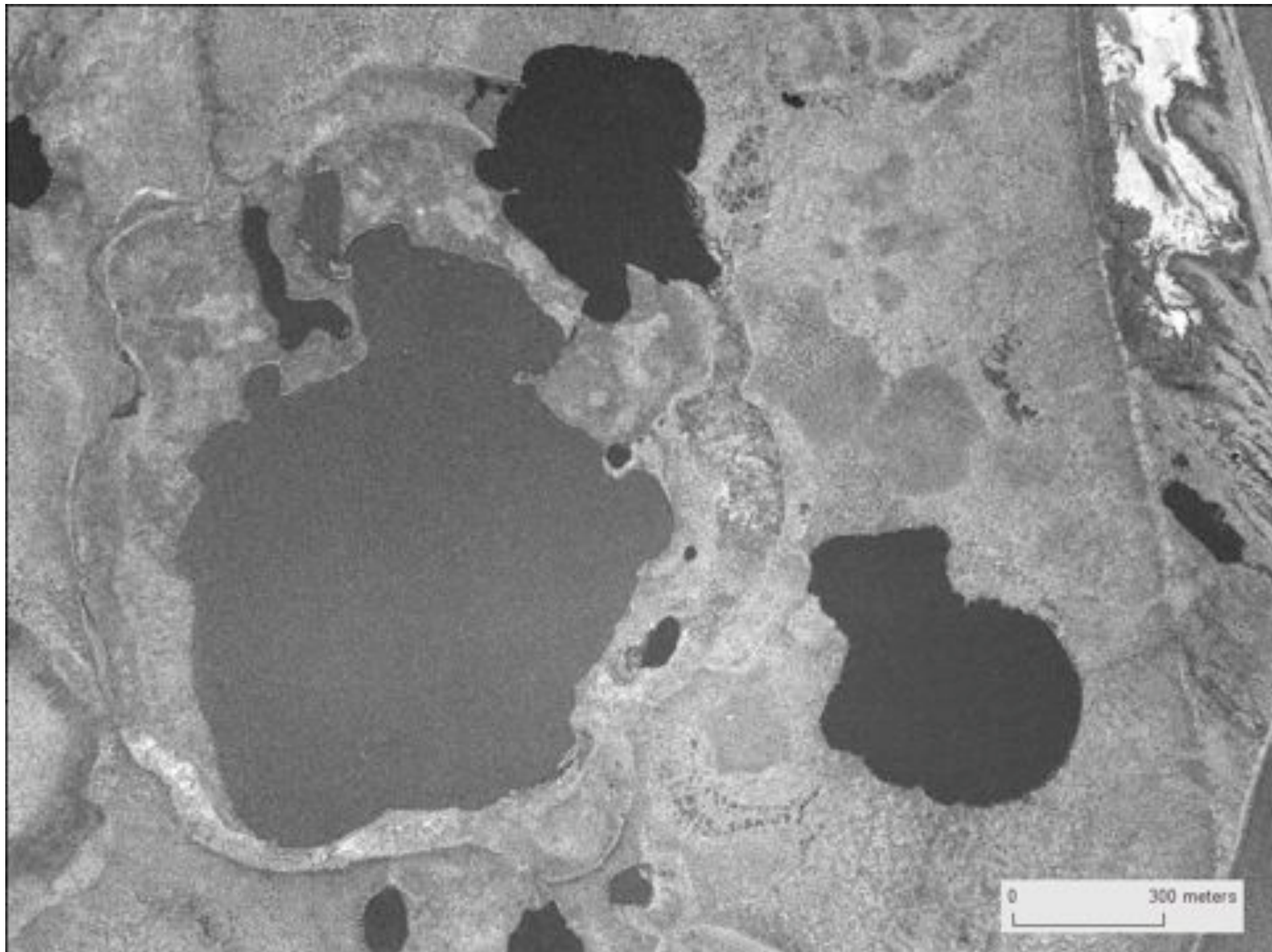


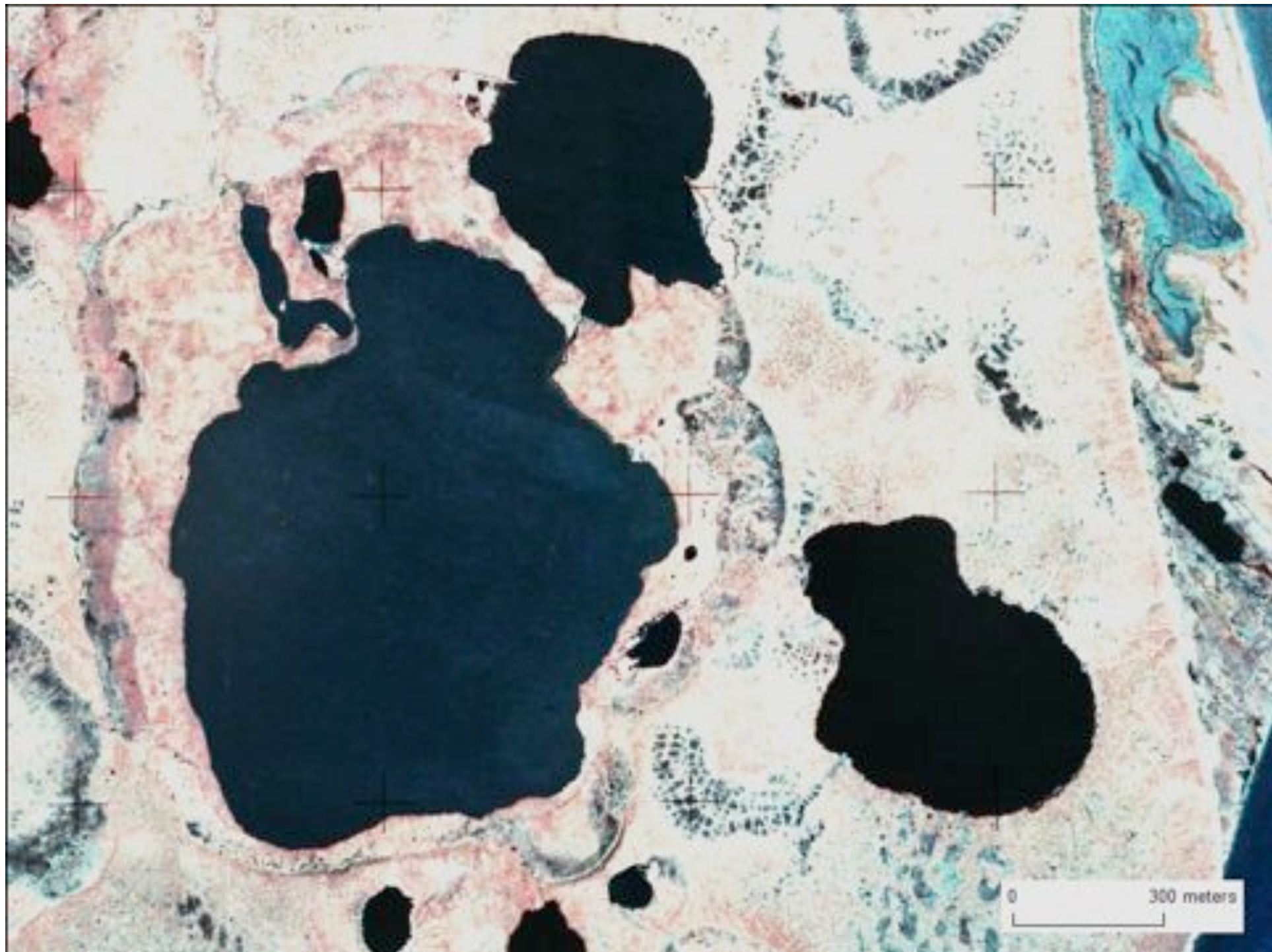
Wetland Vegetation, near Tulilik Lake
1980



Wetland Vegetation, near Tulilik Lake
2003









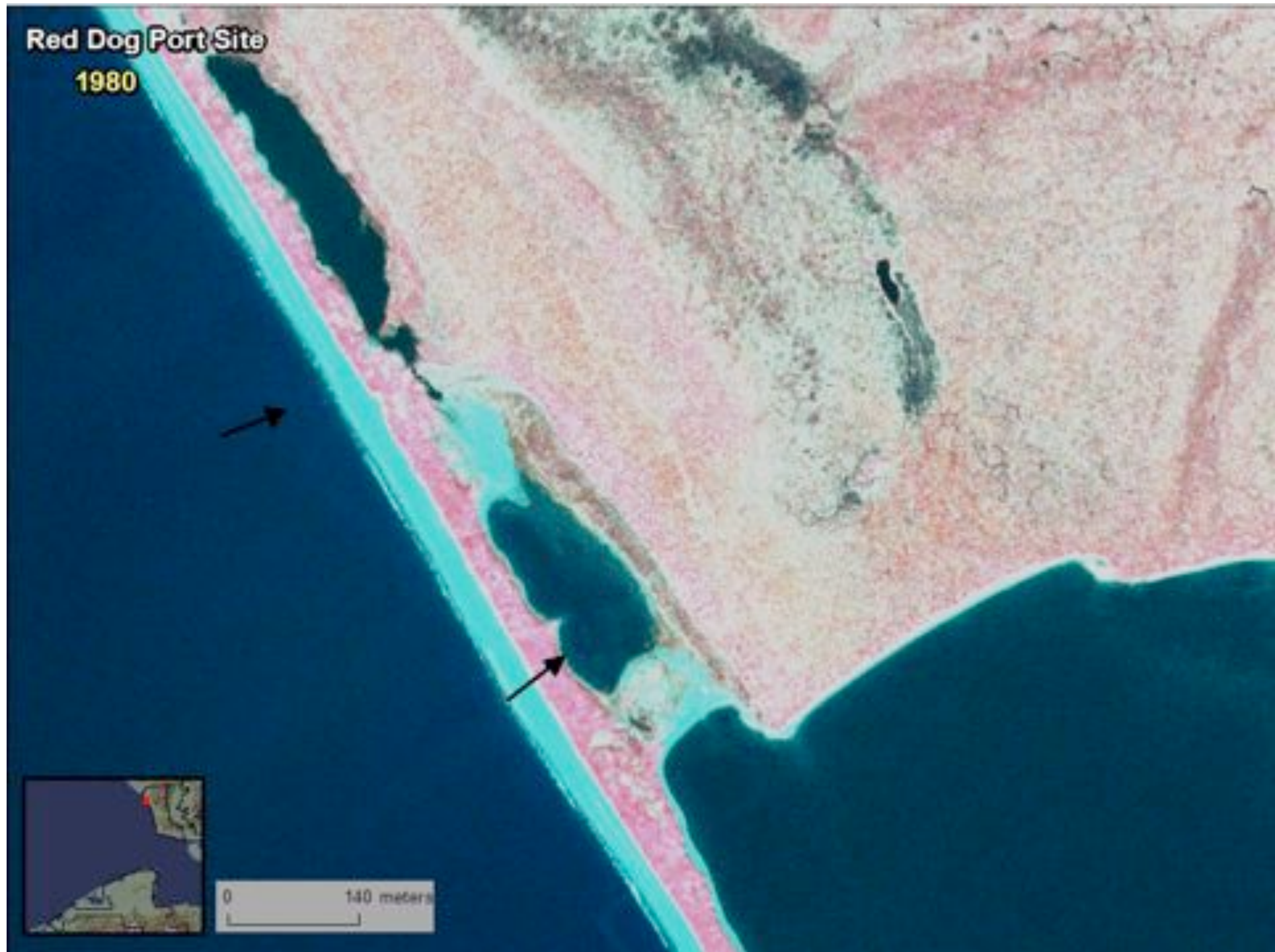
Red Dog Port Site

1952



Red Dog Port Site

1980



Red Dog Port Site
2003



0 140 meters

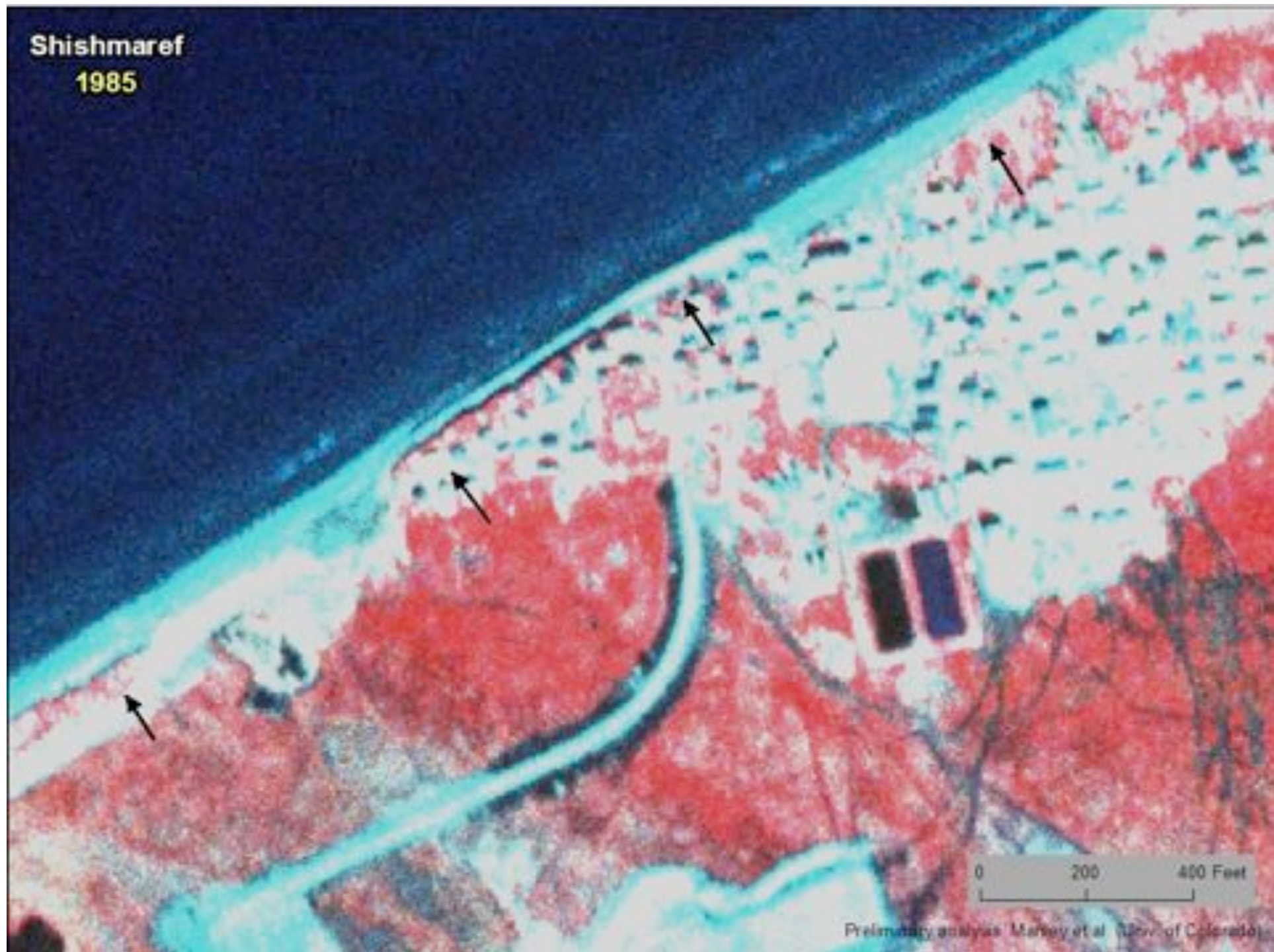
Shishmaref
1950



0 200 400 Feet

Preliminary analysis, Marley et al. (Univ. of Colorado)

Shishmaref
1985



Preliminary analysis: Marney et al. (Univ. of Colorado)

Shishmaref
2003



Available to the Public:

- readme file
- 2003 orthophoto mosaic (103 tiles)
 - image files (.tif, .tfw, .rrd)
 - sid files (.sid, .sdw)
 - metadata files (.html, .txt, .xml)
- ca. 1980 orthorectified photos (57 frames)
 - image files (.tif, .rrd) *Note: georeferencing info. embedded in .tif*
 - metadata files (.html, .txt, .xml)
- ca. 1950 orthorectified photos (108 frames)
 - image files (.tif, .rrd) *Note: georeferencing info. embedded in .tif*
 - metadata files (.html, .txt, .xml)
- accessory layers
 - 2003 image extent showing NPS vs. NOAA source areas
 - index shapefiles *Note: attributed with details*
 - 2003 tiles
 - ca. 1980 frames
 - ca. 1950 frames

See the README file and metadata files for more information.

Available to the Public, cont'd:

The three datasets are being made available on external hard drive.

Contact:

Arctic Network Data Manager
National Park Service
Arctic Network Inventory and Monitoring Program
4175 Geist Road
Fairbanks, AK 99709-3420
907-455-0600
Scott_Miller@nps.gov

Now available also at <http://www.AlaskaMapped.org>!

Questions:

Arctic Network Data Manager
National Park Service
Arctic Network Inventory and Monitoring Program
4175 Geist Road
Fairbanks, AK 99709-3420
907-455-0600
Scott_Miller@nps.gov

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Opportunities & Challenges for ARCN

All Imagery

Extent – Imagery should cover entire Area of Interest (AOI) or selected target areas.

Acquisition Date – Recent for base imagery; at approx. 5-10 yr intervals and as far back in time as possible for photography. Typically acquired in summer; avoid sea ice and snow cover; consider phenology for ecological applications.

Image Type – Black & white is acceptable; true color or color infrared (CIR) is preferable; multispectral is best.

Image Quality – Avoid cloud cover or low-contrast imagery.

Image Documentation & Metadata – To the extent possible for assessment of suitability.

File Format – Typically as georeferenced .tif (GeoTIFF) for base imagery and .tif for scanned photography; avoid .jpg, .sid, or other lossy formats.

Ownership, Licensing, & Availability for Use – Preferably through unrestricted public license, and readily available on DVD or hard drive at minimal cost.

Base (Reference) Imagery

Product Level Georeferencing – Fully orthorectified, using best available DEM and ground control (GCP's).

Horizontal Resolution – 1.0 m or better?.

Absolute Horizontal Accuracy – Best possible; RMSE preferably less than approx. 10 m? for acceptable co-registration with independently acquired datasets.

Projection & Datum – As appropriate for present and future needs of project, and for use with other map layers; avoid resampling to other coordinate systems.

Historic Photography (digital scans)

Scale – 1:65,000 is acceptable; 1:24,000 or larger is preferable.

Camera Calibration Information – Calibrated focal length is most important; principle point coordinates can be assumed to be 0,0; film fiducial coordinates can be measured from prints, negatives, or scans; by far the best approach is to obtain full camera calibration reports. Calibration information can be difficult or time-consuming to compile from scans, negatives, film cans, metadata, online databases, or by communication with other organizations or agencies.

Scan Resolution – At, or better than, planned output resolution. Recommended: 1800 dpi (14 micron) for 1:65,000 scale (ca. 0.9 m); 1800 dpi (14 micron) for 1:45,000 scale (ca 0.6 m), or better; 1800 dpi (14 micron) for 1:24,000 scale (ca. 0.3 m), or better; 1200 dpi (21 micron) or better for larger scales. Scans should include full photo frame, including side or corner fiducial marks.

Horizontal Resolution – Recommended resolutions for orthorectified output: 1.0 m for 1:65,000 scale; 0.6 m for 1:45,000 scale; 0.5 m or better for larger scales, up to reasonable file size per image of approx. 0.5-2.0 GB

Relative Horizontal Accuracy – RMSE for orthorectified output, relative to base imagery, should be less than approx. 20 m, and preferably 5 m or better to minimize errors for detailed analysis.

Projection & Datum – Same as base imagery.

Number of frames – For a given Area of Interest, larger scales entail a significant increase in number of frames and processing.

Bottom Line:

Extent, Date, Resolution and
Accuracy needed for intended
analysis.

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What is a GCP?

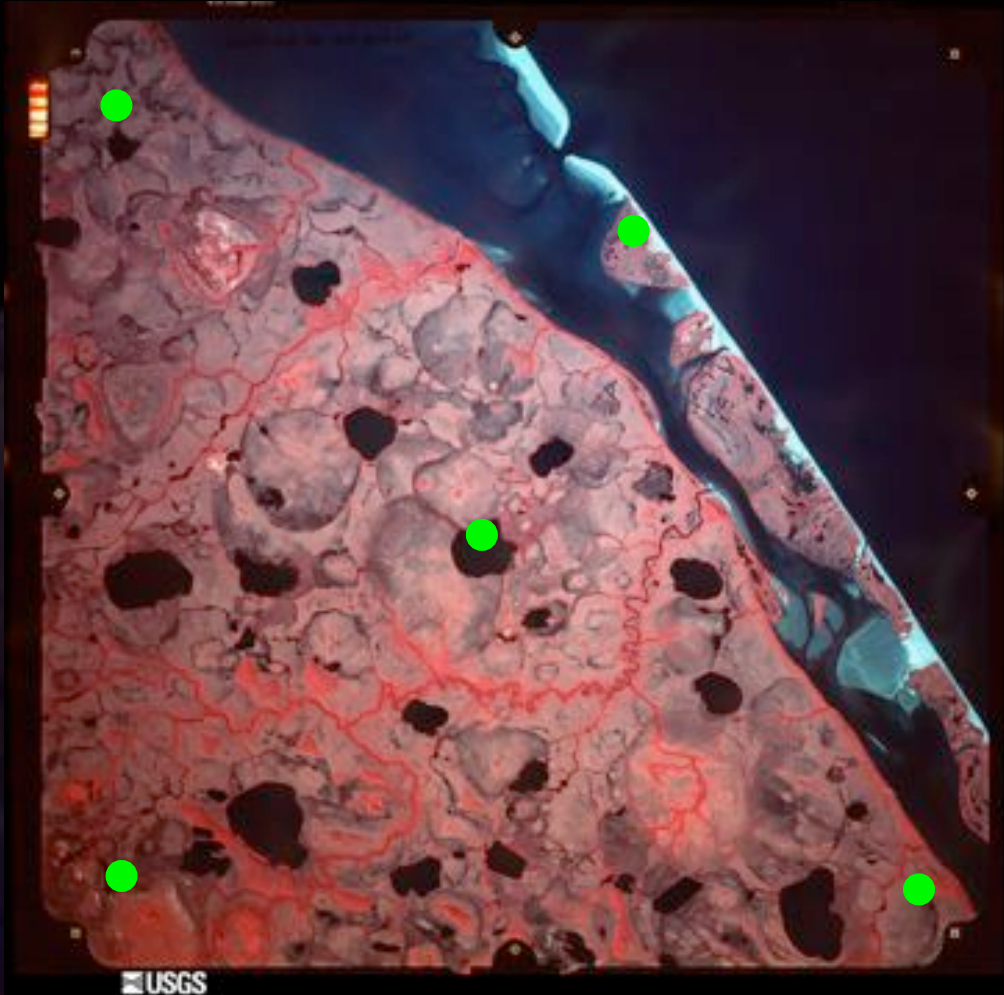
Ground control point surveyed in the field on a photo-identifiable feature ...

GCP_ID: **C059**
Feature Type: utility pole
Description: Utility pole on island at corner of Stevens and Cakeater Roads



Latitude (DD): 71.31985737
Longitude (DD): -156.70513720
UTM Northing (z4, m): 7,914,627.25
UTM Easting (z4, m): 582,017.50
Elevation (m): 2.77

Start From Scratch:



at least 5 GCP's
per frame

Start with well-orthorectified base imagery and use image-to-image control points

basic georeferencing

- scan + 1 control point = “georeferenced”
- doesn’t remove distortions from camera or terrain
- errors > 300 m

basic georectification -- polynomial transformation (ie., ArcMap)

- scan + control points = “georectified”
- doesn’t remove distortions from camera or terrain
- errors approx. 3-300 m

full orthorectification -- with aerial triangulation (ie., ERDAS Imagine)

- scan + camera calibration information + control points + good DEM = “orthorectified”
- removes distortions from camera and terrain
- errors approx. 2-30 m

Bottom Line:

Measure errors

- with independent check points
- ArcGIS NEAR command

Create FGDC metadata

Share the data

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Availability of High-Res. Orthoimagery for N. Alaska

- ARCN coastal imagery
- IKONOS for the ARCN parks
- USGS DOQQ's (NPRA; might cover part of Noatak)
- Intermap IFSAR ORRI (NPRA; might cover part of Gates)
- Commercial imagery (\$\$)
- others??

Up and coming: the Statewide Digital Mapping Initiative!

For ARCN I&M Goals:

Base imagery = “inventory”

- mapping, visualization, analysis

Other years of imagery = “monitoring”

- “repeat orthoimagery” for time-series detection and analysis of environmental change