

CHC-NSC 2018

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Victoria, B.C.
March 26-29, 2018

Victoria, C.B.
26 au 29 mars 2018



Land and Sea Shaping the World
Terre et Mer Façonnant le Monde

Shoreline Verification with Unmanned Aerial Systems

Andrew Orthmann



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Andy Orthmann, TerraSond Limited

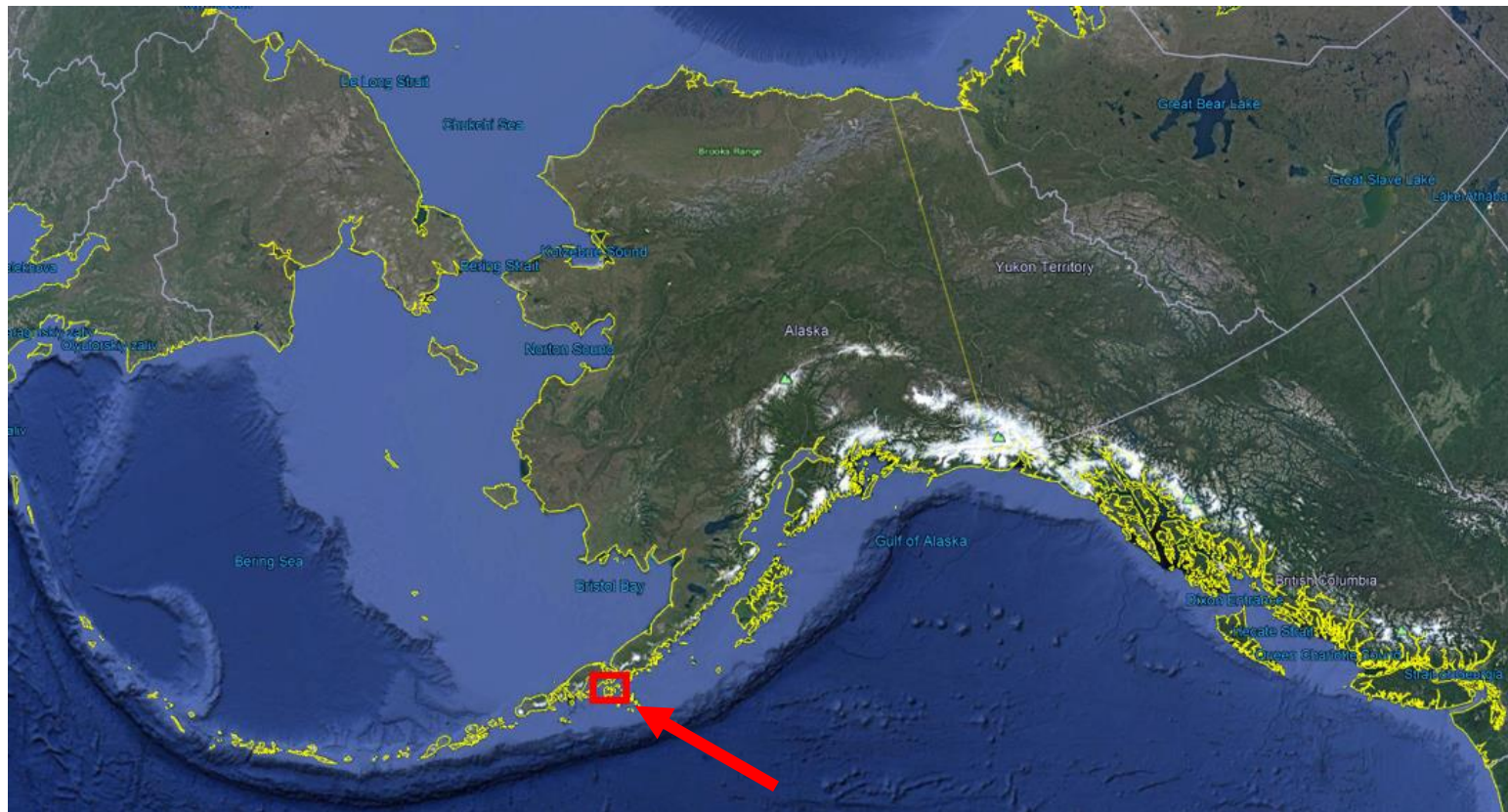
First presented at NOAA Field Procedures Workshop

February, 2018 – Portland, OR

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Pavlof Islands and Vicinity Project Area

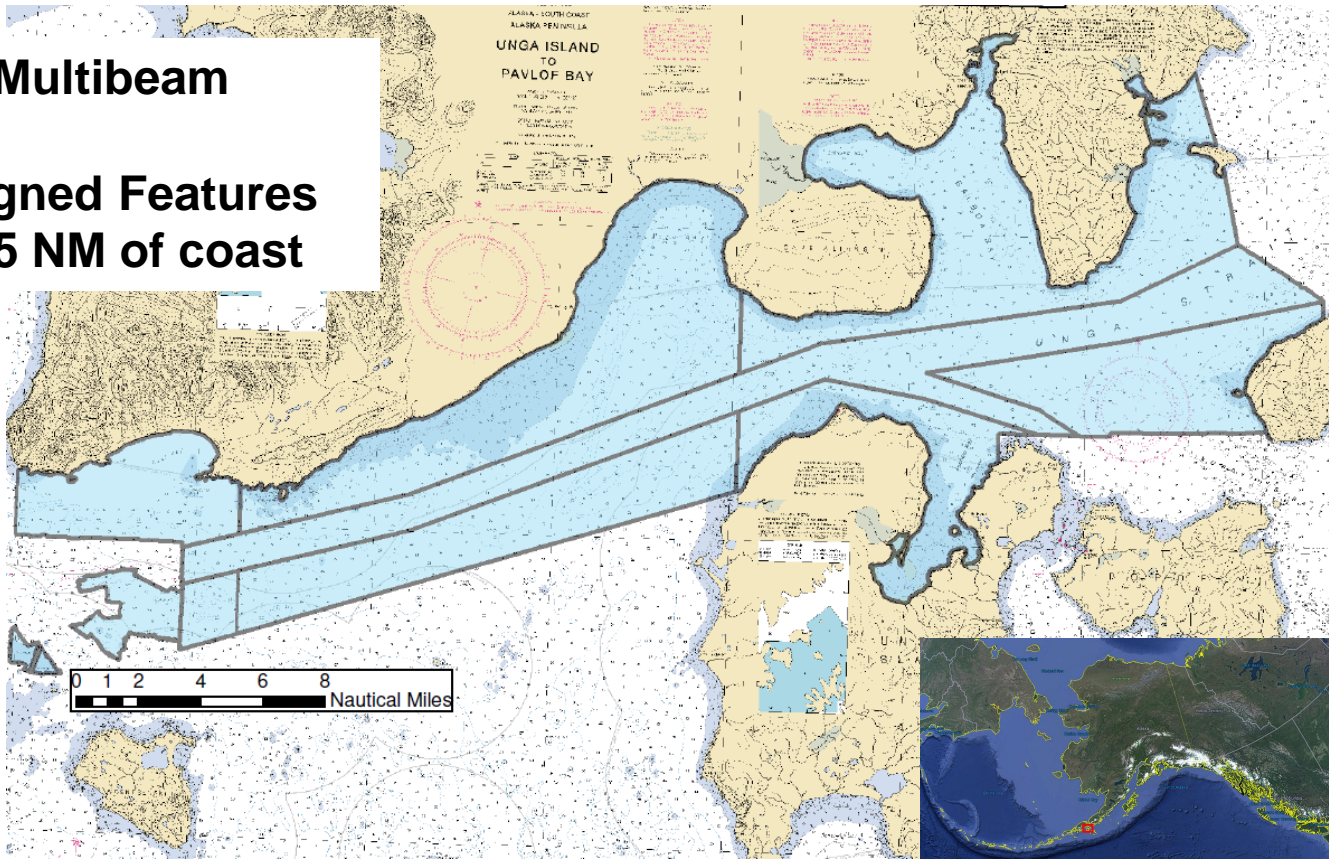
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- 271 NM² Multibeam
- 519 Assigned Features along 105 NM of coast



Pavlof Islands and Vicinity Project Area

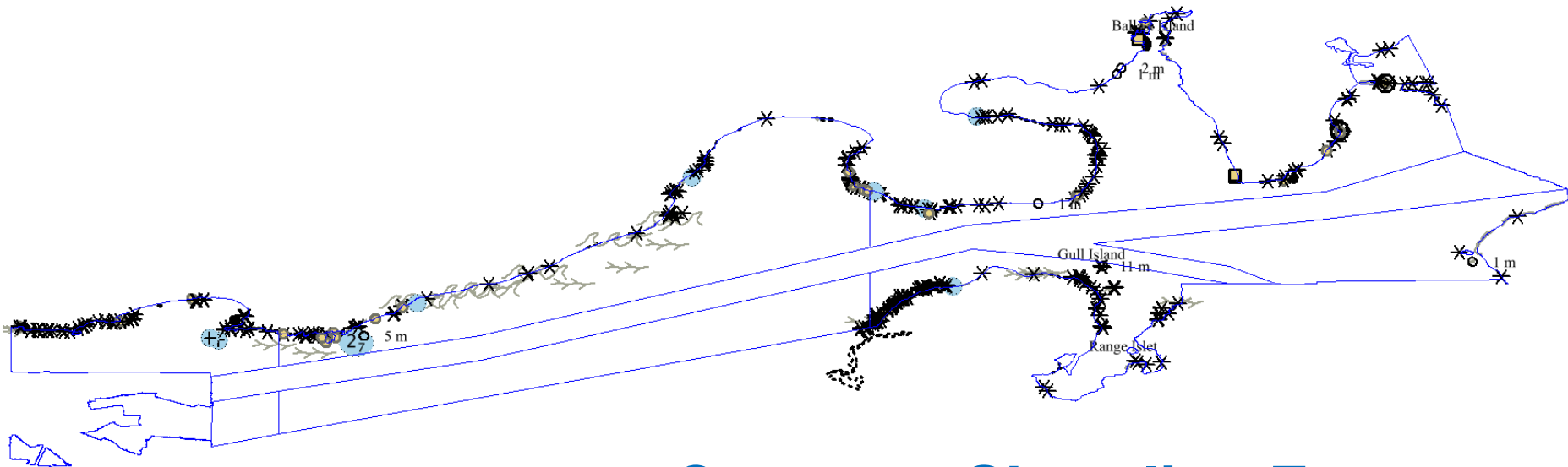
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- Rocks & Islets
- Ledges & Reefs
- Foul Areas & Kelp



Common Shoreline Features

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- Rocks & Islets
- Ledges & Reefs
- Foul Areas & Kelp

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Investigation via Skiff:

- Navigate to assigned features
- Verify feature
- Visually estimate heights



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Some problems with skiff-based approach:

- Can't approach features
- Low-confidence measurements
- What is NOT seen?
- Low efficiency
- Safety concerns



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Some problems with skiff-based approach:

- Can't approach features
- Low-confidence measurements
- What is NOT seen?
- Low efficiency
- Safety concerns

**These seem like
obvious areas that
UAS could improve
on...**

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DJI Phantom 4 Professional (P4P):

Off the Shelf!

- 3 lbs
- GNSS positioning
- ~ 20 minute flight time (real-world)
- Camera – 20 megapixel, gimbal stabilized
- Affordable, simple



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Flight Parameters

- ✓ Low tide (< 0.5 m)
- ✓ Good visibility
- ✓ No precipitation
- ✓ Wind 20 knots or less



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Mission Planning

- Missions defined in Google Earth
- Path, speed, altitude, turn radius
- Transmitted to the P4P via app

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus

Google Earth

Tour Guide 1984 55°21'26.59\"

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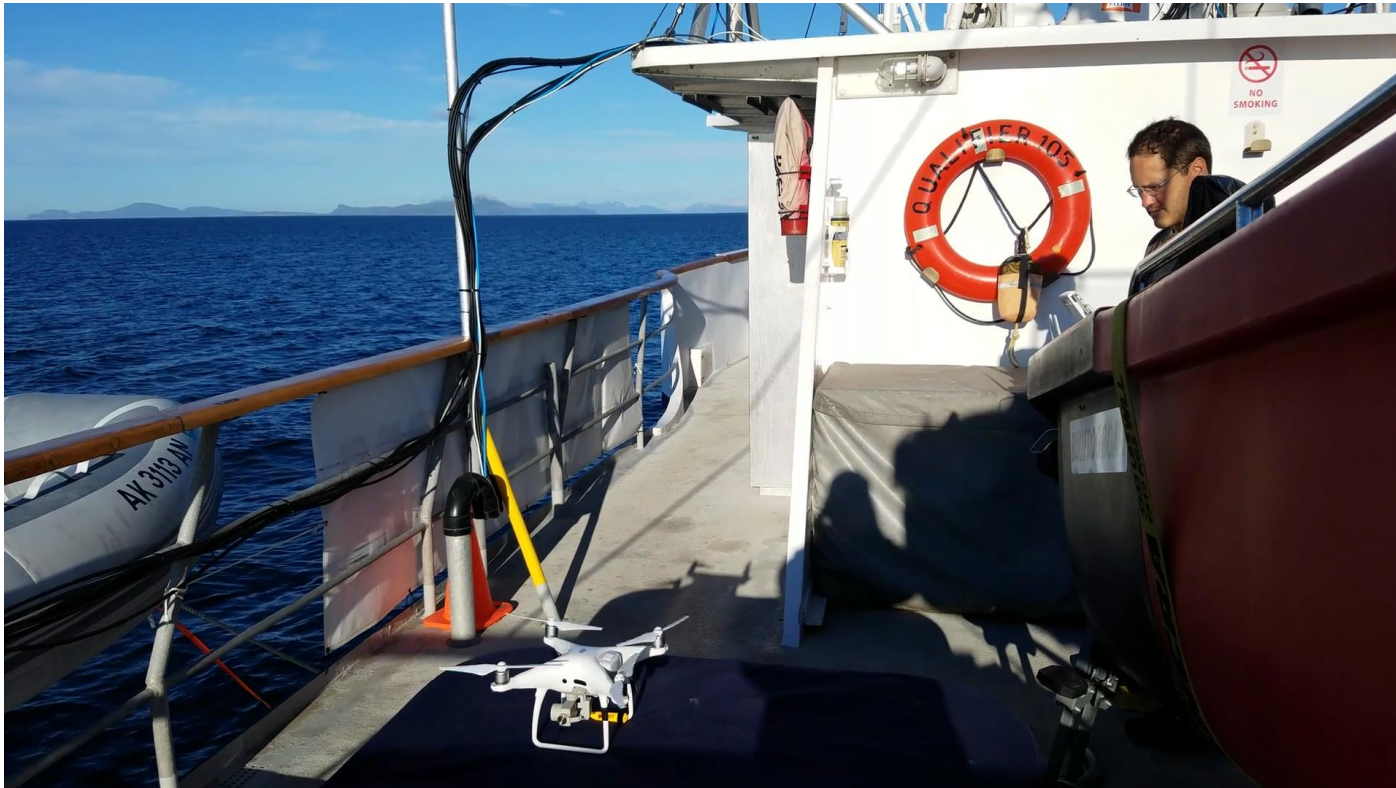
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- Manually-controlled launch
- After clear of vessel, initiate pre-planned mission

Launch



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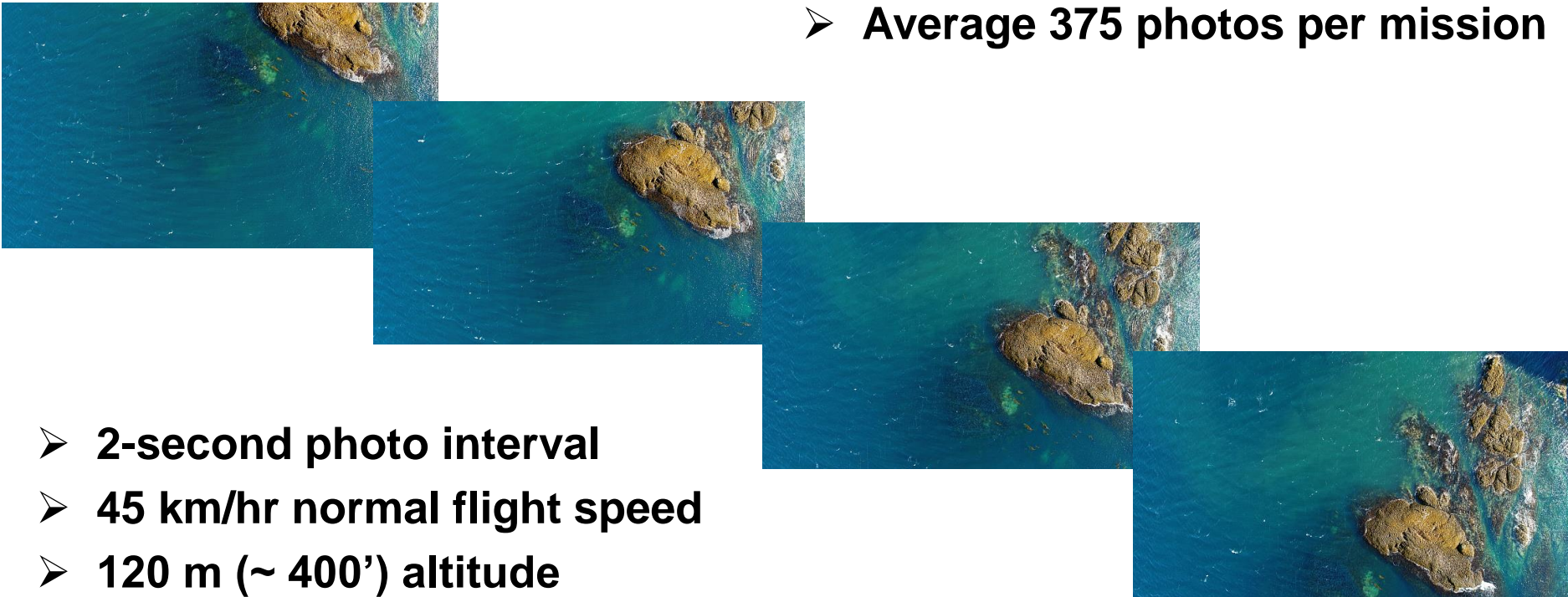
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Automatic Photo-taking

- At least 3 photos per object
- Average 375 photos per mission



- 2-second photo interval
- 45 km/hr normal flight speed
- 120 m (~ 400') altitude

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➤ Manually-controlled recovery

Recovery



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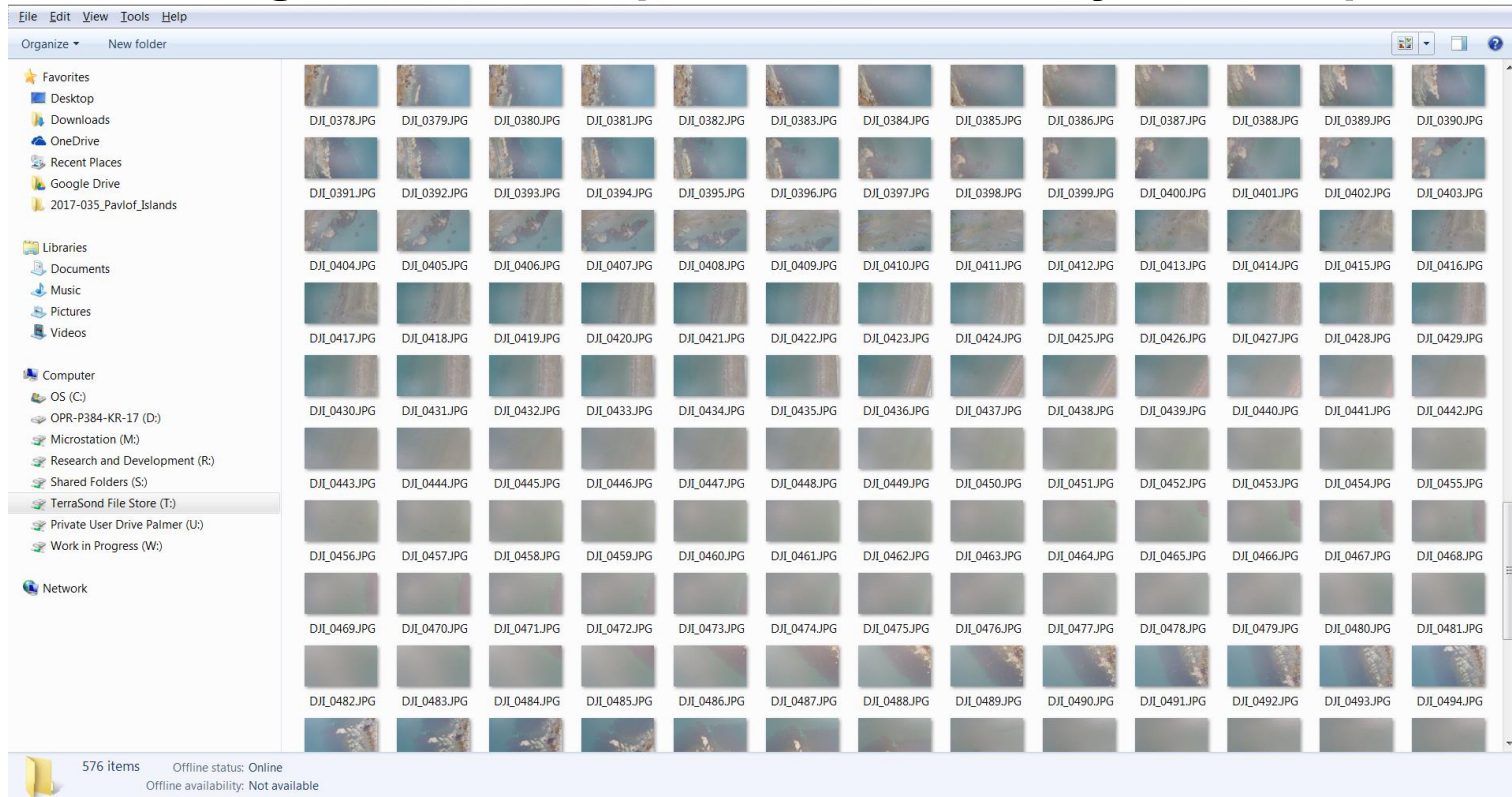
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Processing

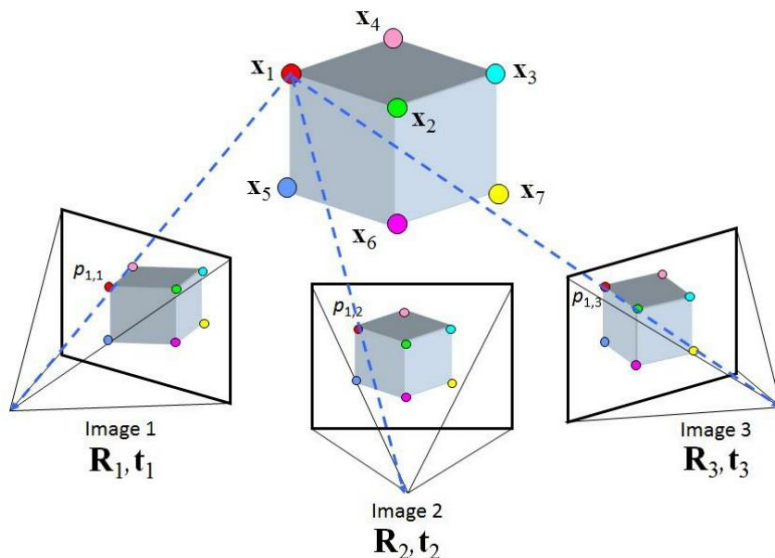
Examining hundreds of photos individually not an option...



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- Used Agisoft PhotoScan Professional
- Ortho-rectified photomosaics AND 3D-point clouds via SfM

“**Structure from motion (SfM)** is a photogrammetric range imaging technique for estimating three-dimensional structures from two-dimensional image sequences” - Wikipedia



Important elements:

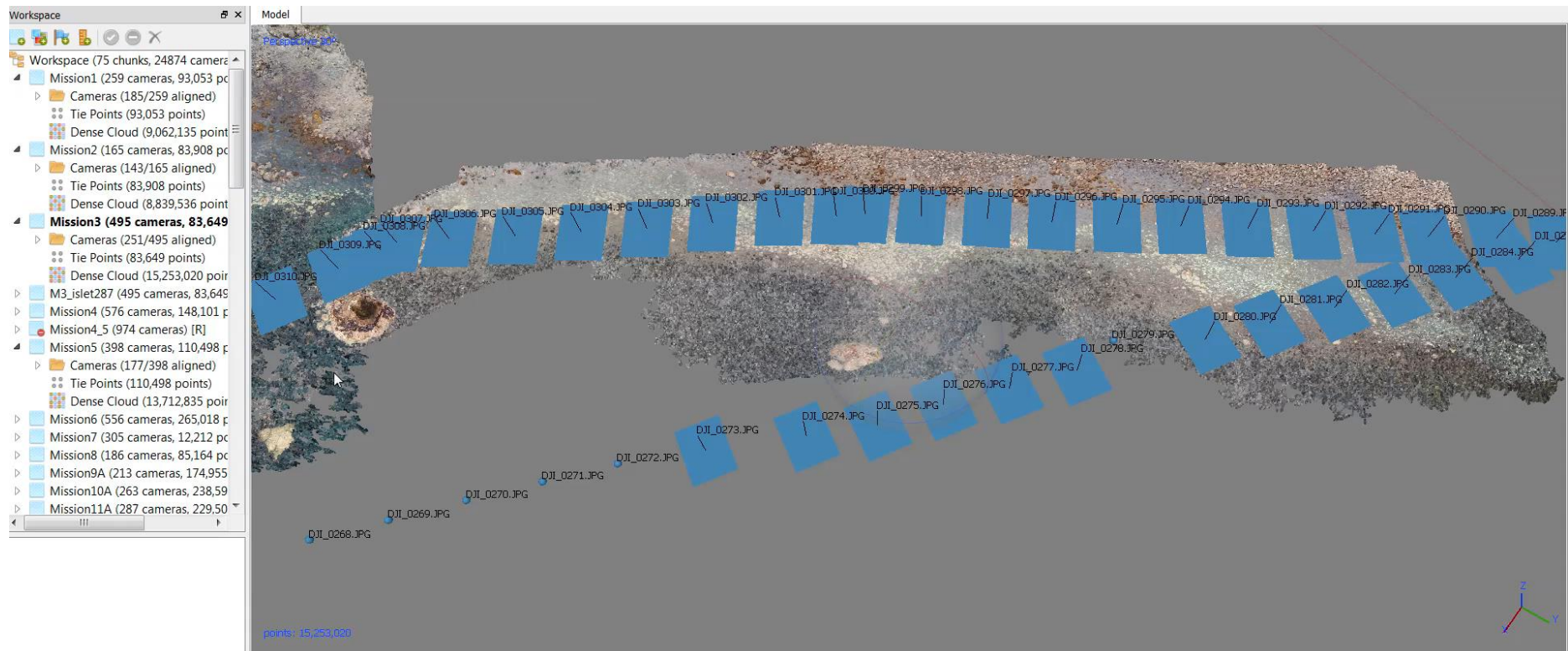
- Minimum 3 photos per object
- Common tie points
- Photo position (geotag) for absolute positioning
- Perspective (nadir to oblique)

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SfM Derived DEMs



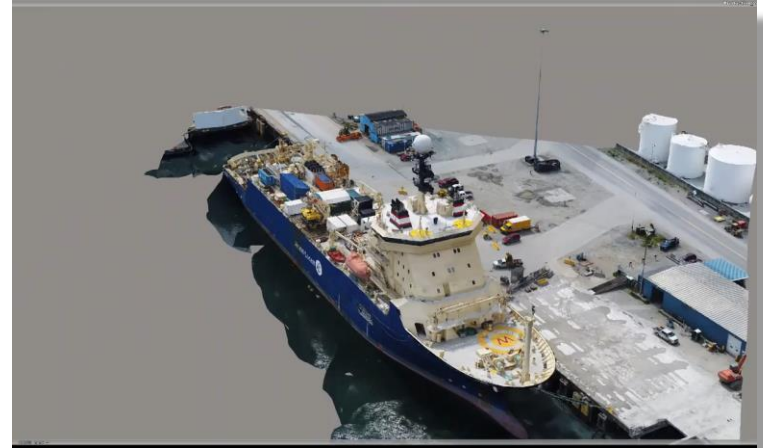
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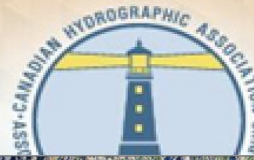
- **Prior Experience on projects with UAS & SfM**



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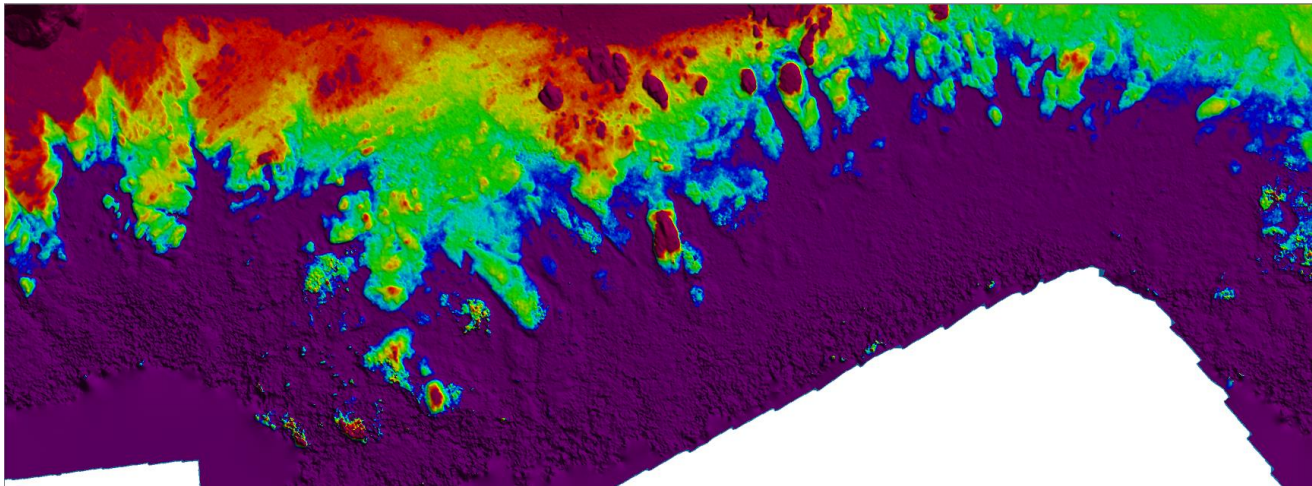
www.chc-ns



Ortho
3 cm



DEM
10 cm



Purple = 0 m MLLW and deeper

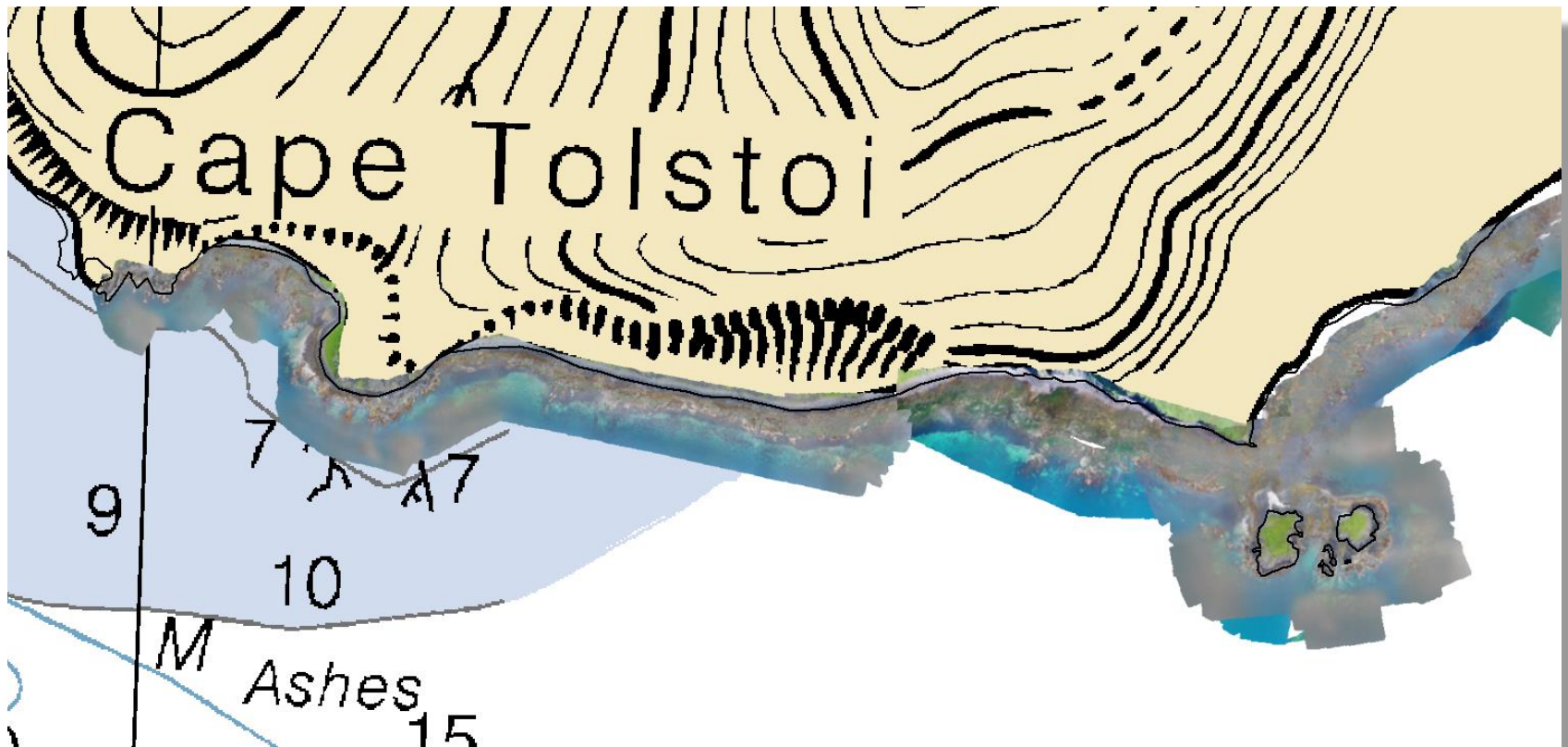
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Ortho-photomosaics



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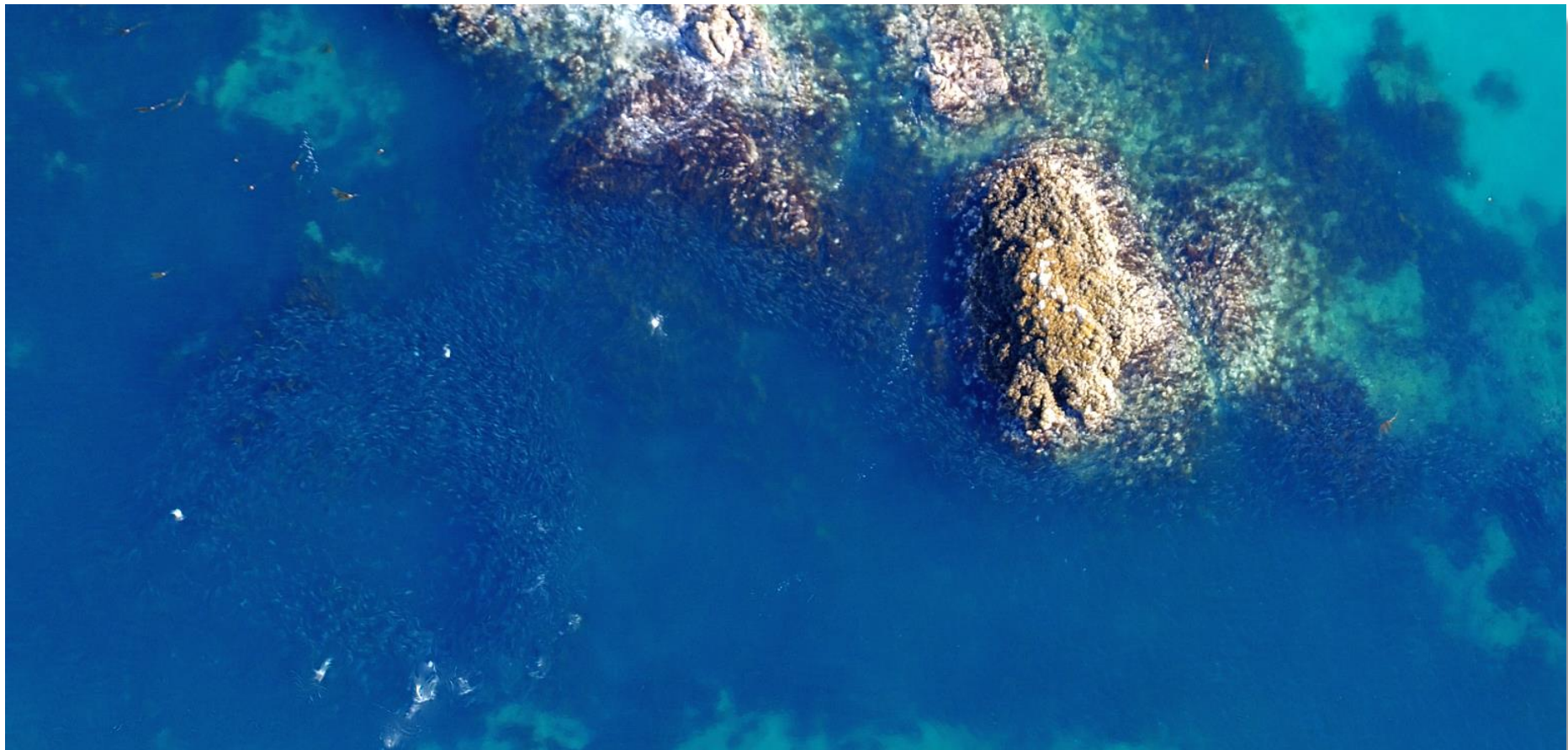
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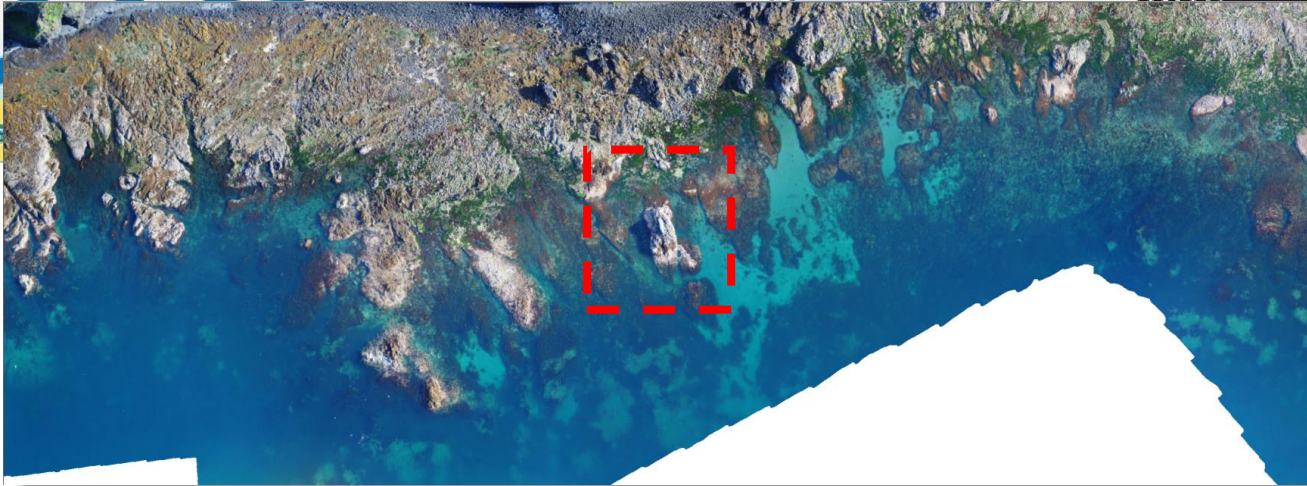
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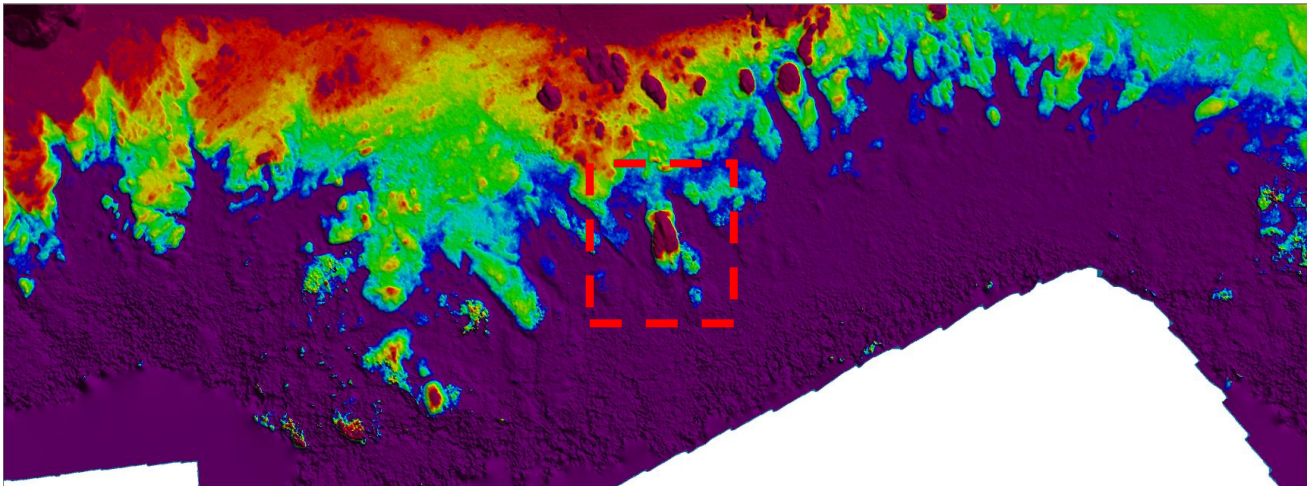


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Ortho



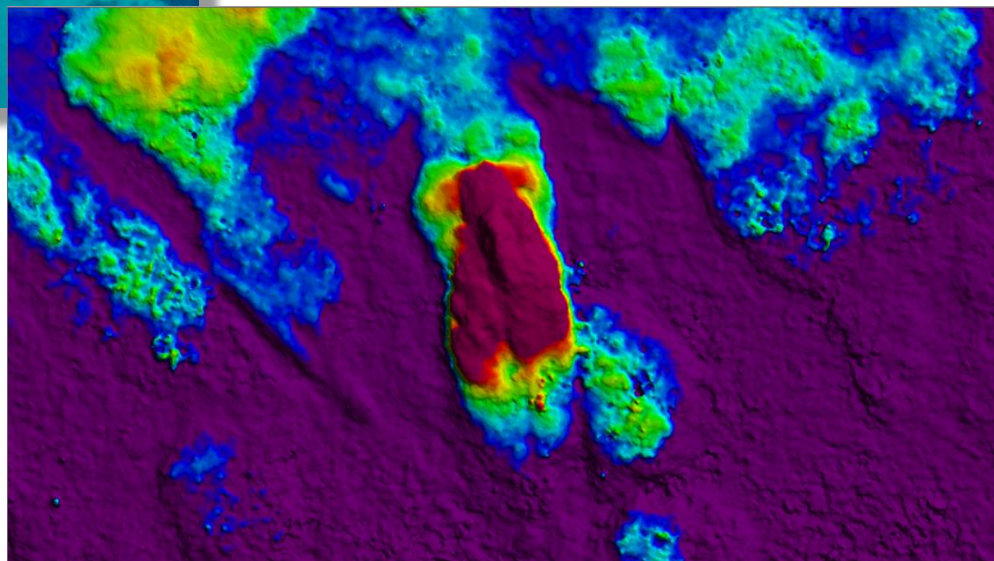
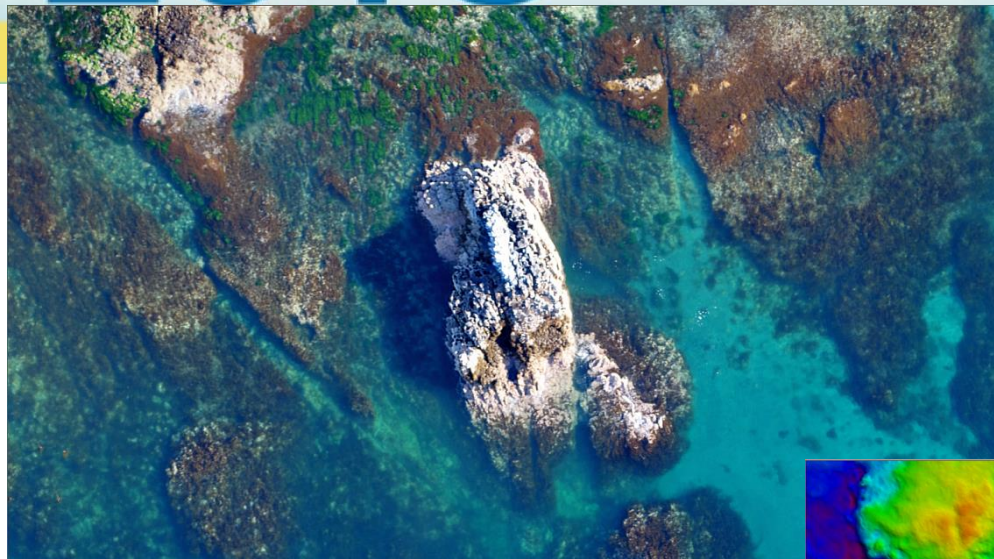
DEM



Purple = 0 m MLLW and deeper

SfM Derived DEMs

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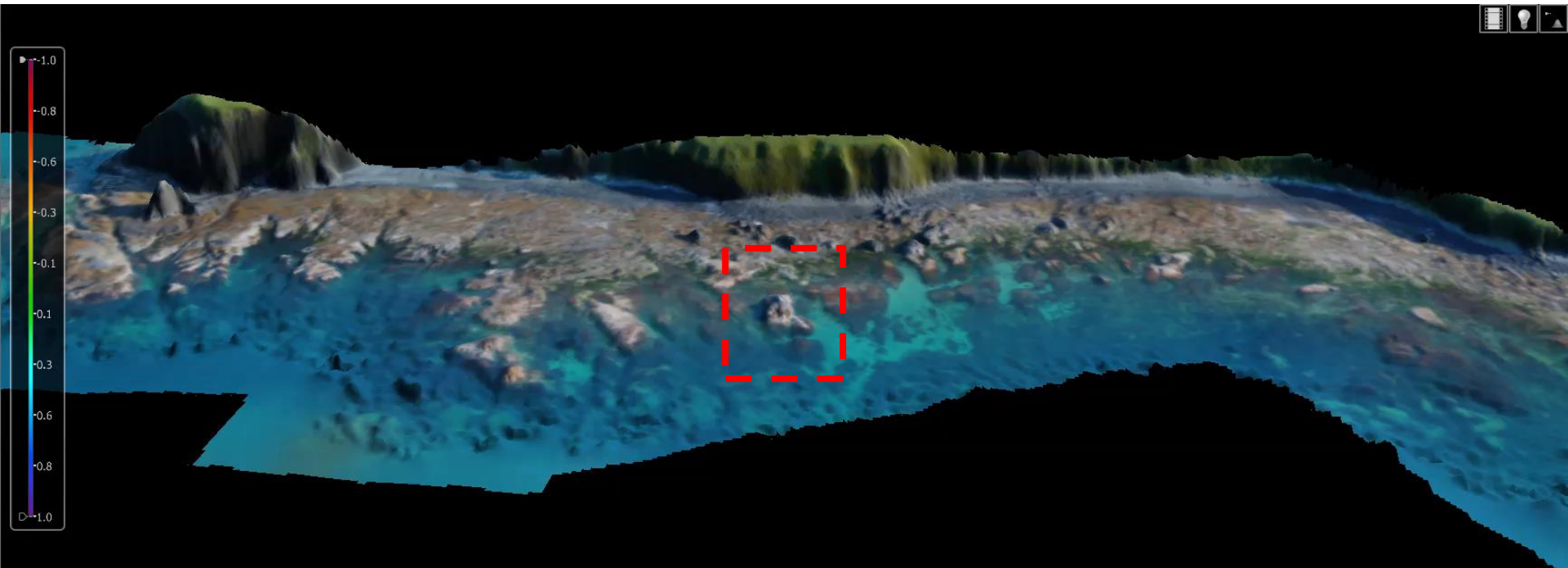
Purple = 0 m MLLW and deeper

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Ortho DEM Drape (in CARIS HIPS)

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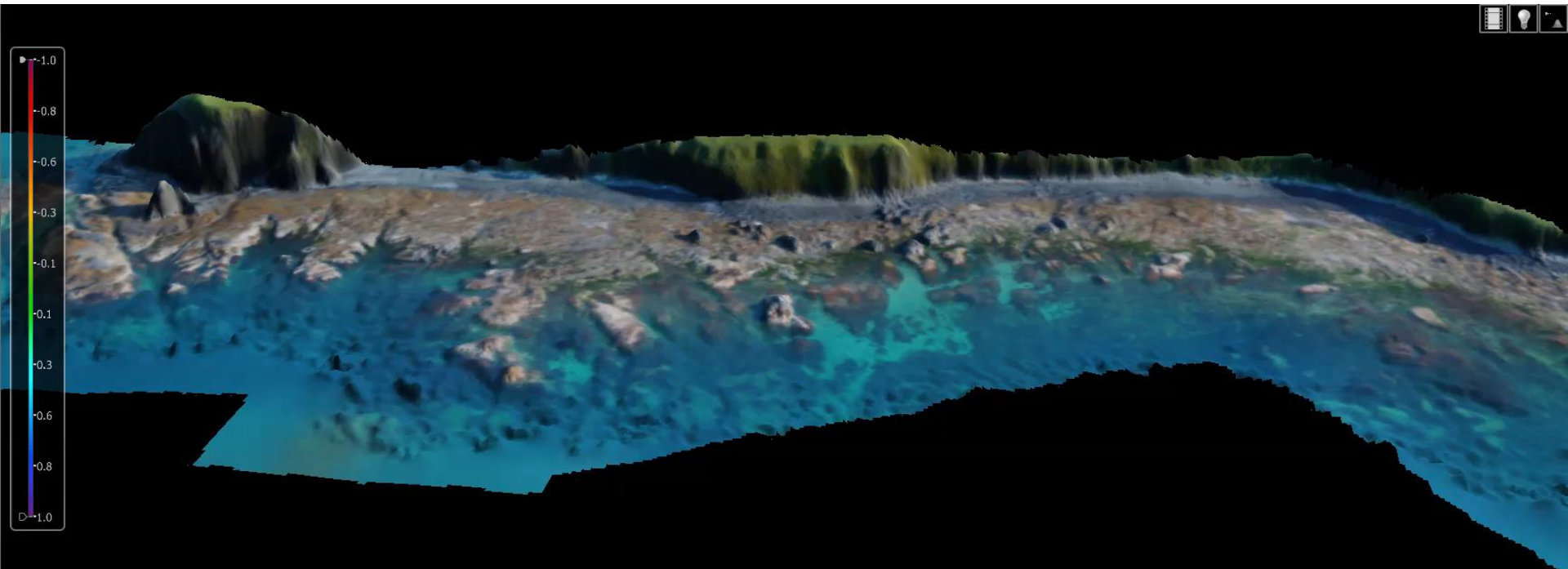


#chcnsc2018

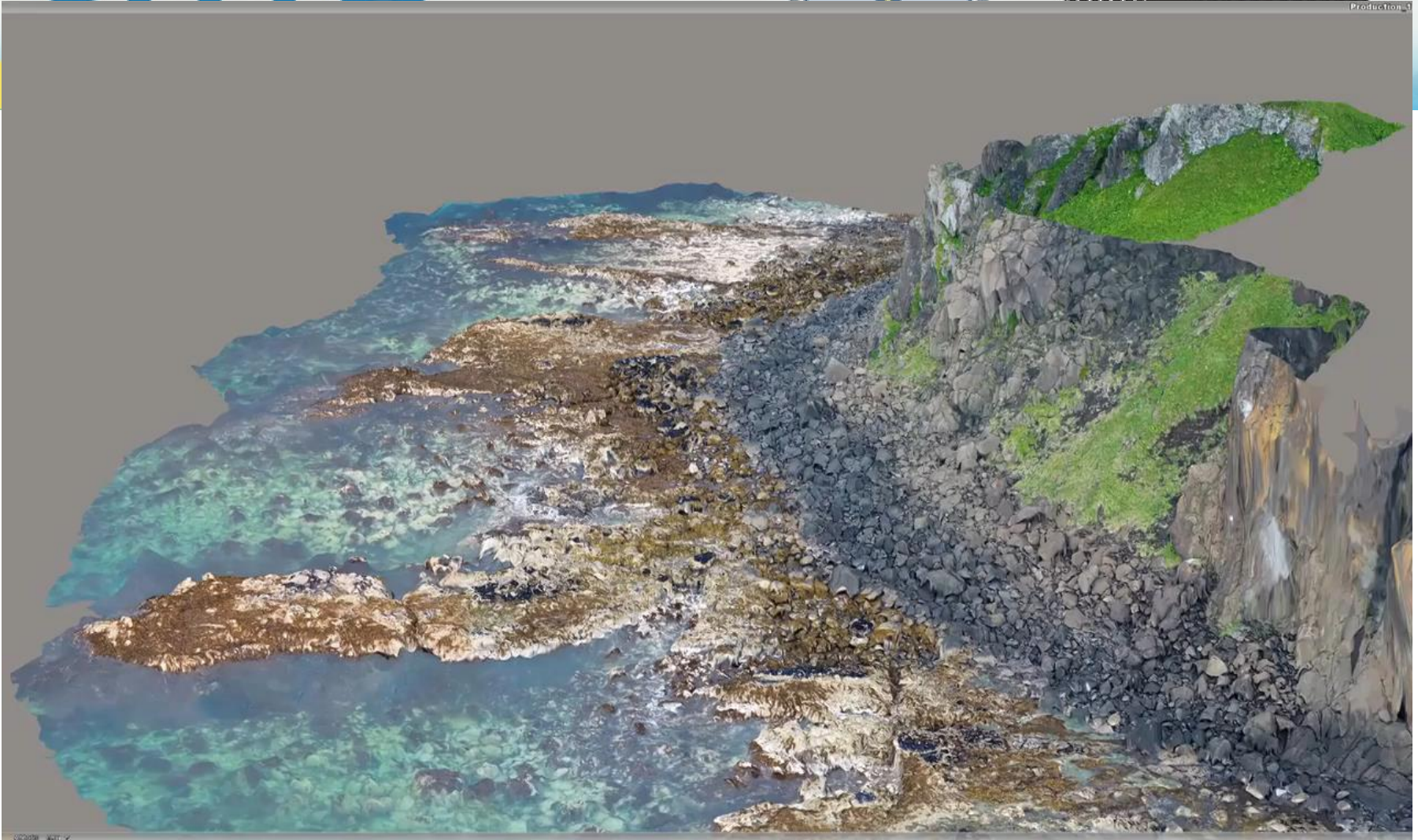
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Ortho DEM Drape (in CARIS HIPS)

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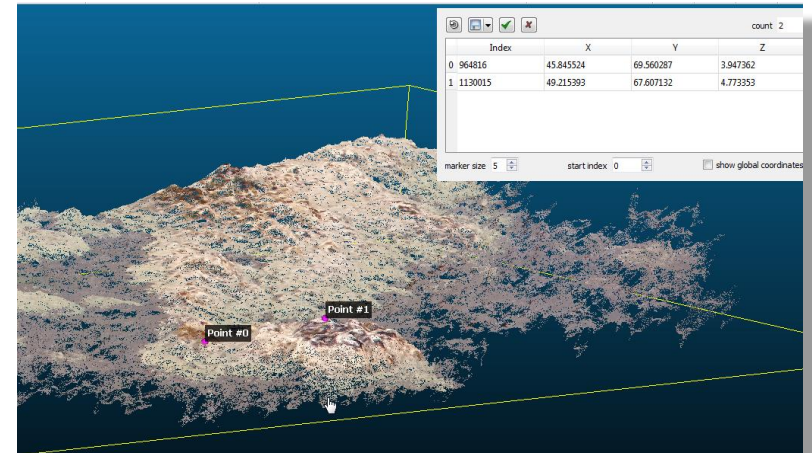
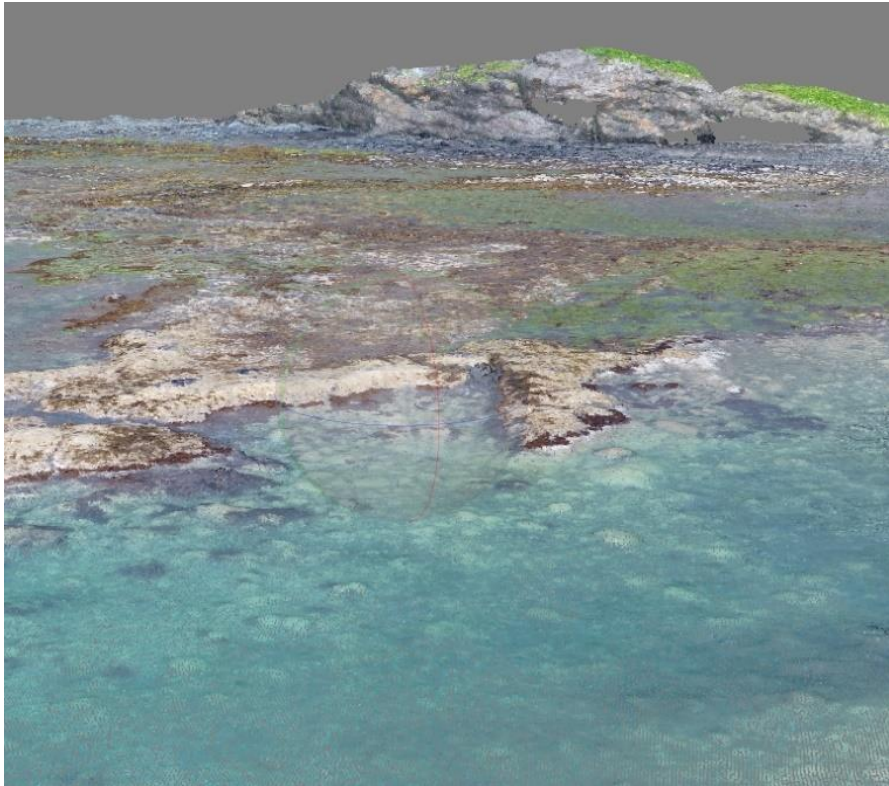


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Point Cloud Adjustment to MLLW

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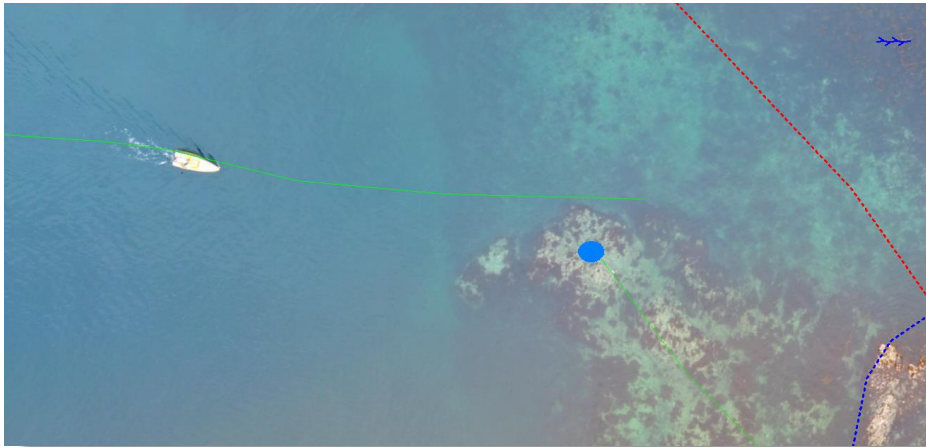
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Quality Control

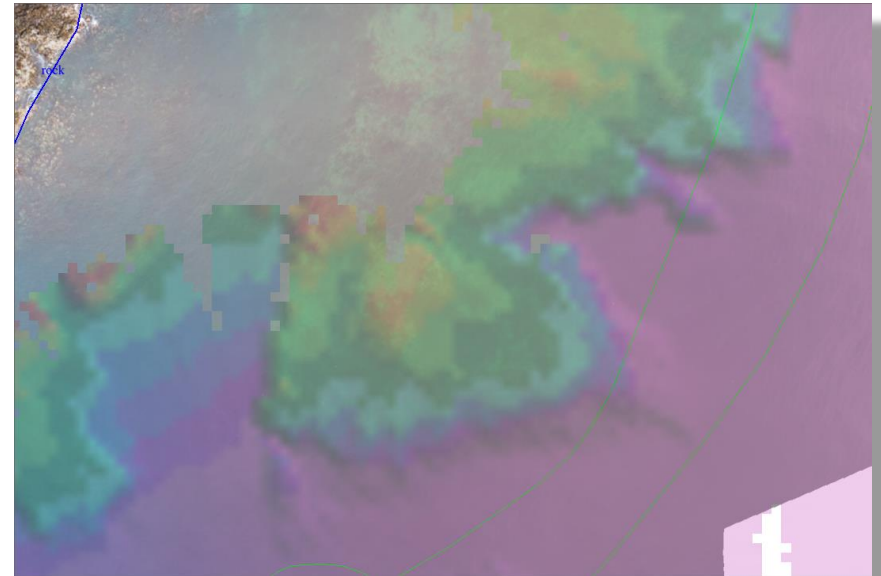
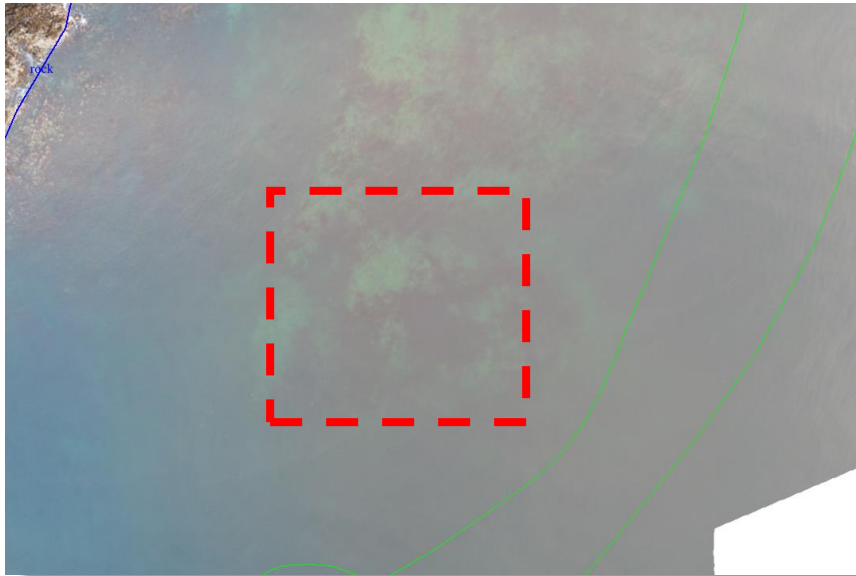


Ortho-photomosaic Horizontal Checks

- Vessel positions

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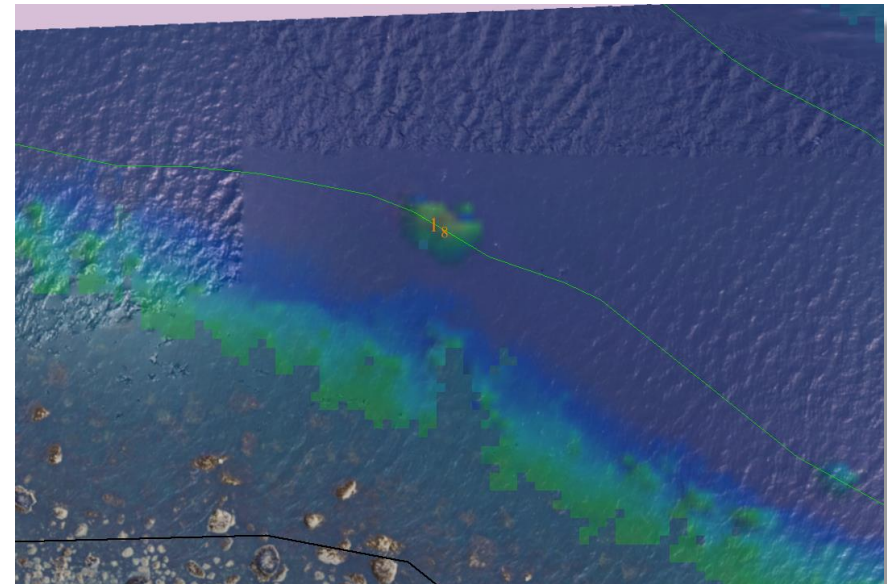
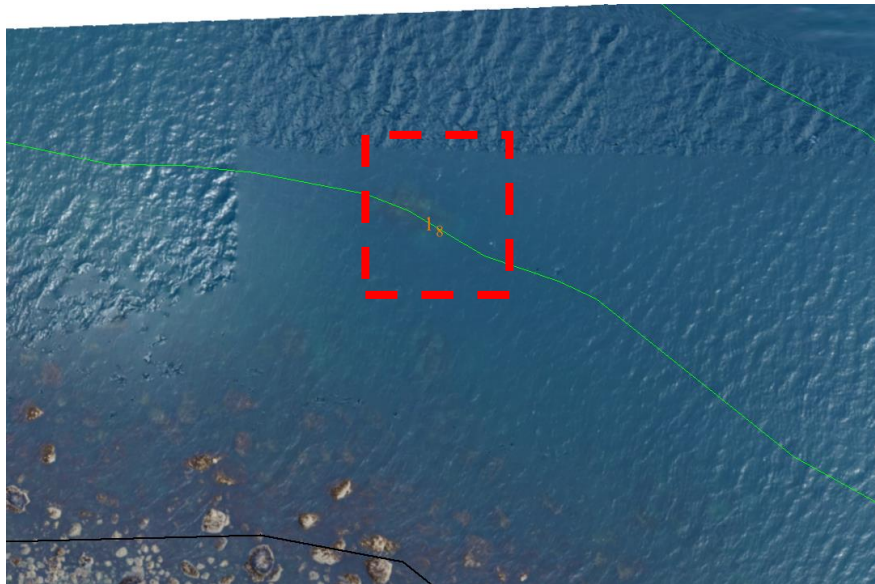
Ortho-photomosaic Horizontal Checks

- Vessel positions
- **Multibeam Positions**

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Ortho-photomosaic Horizontal Checks

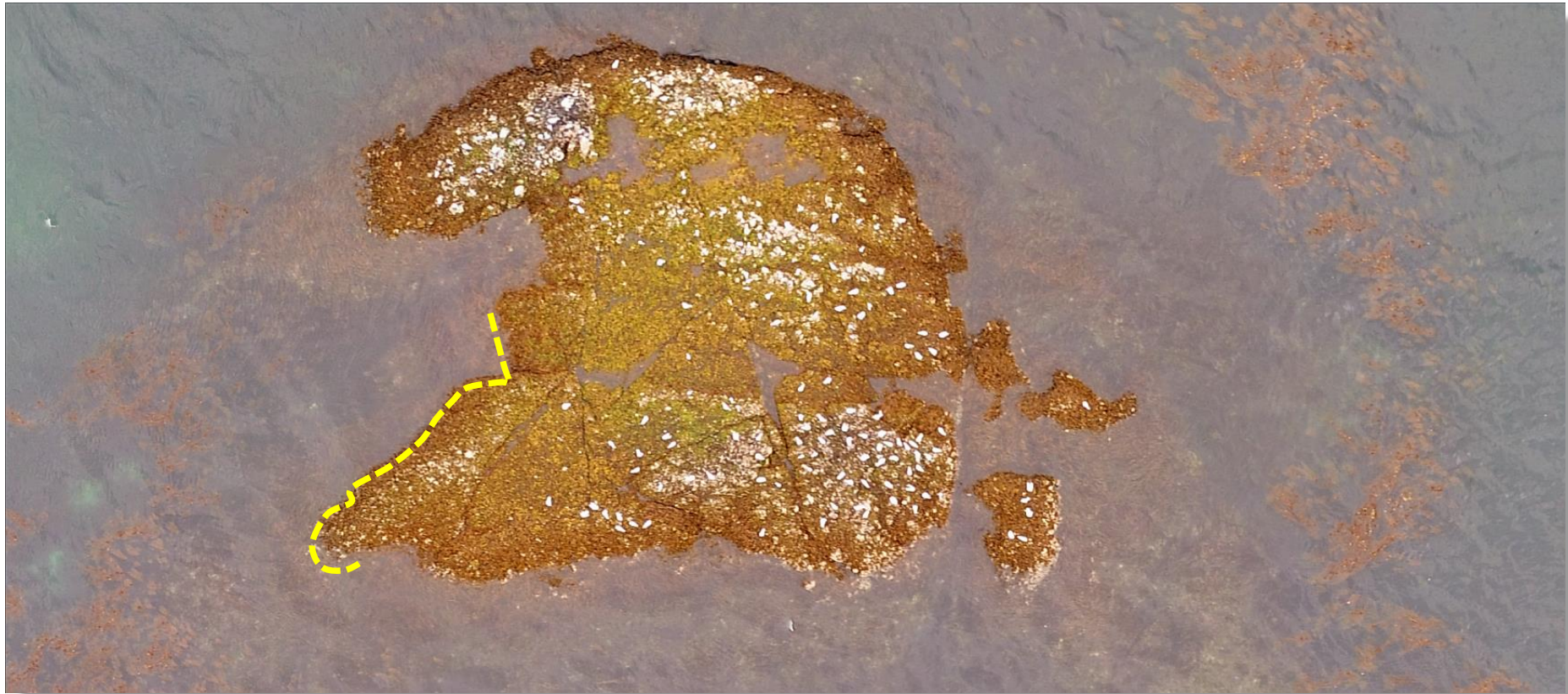
- Vessel positions
- **Multibeam Positions**

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Quality Control



DEM – Vertical Checks

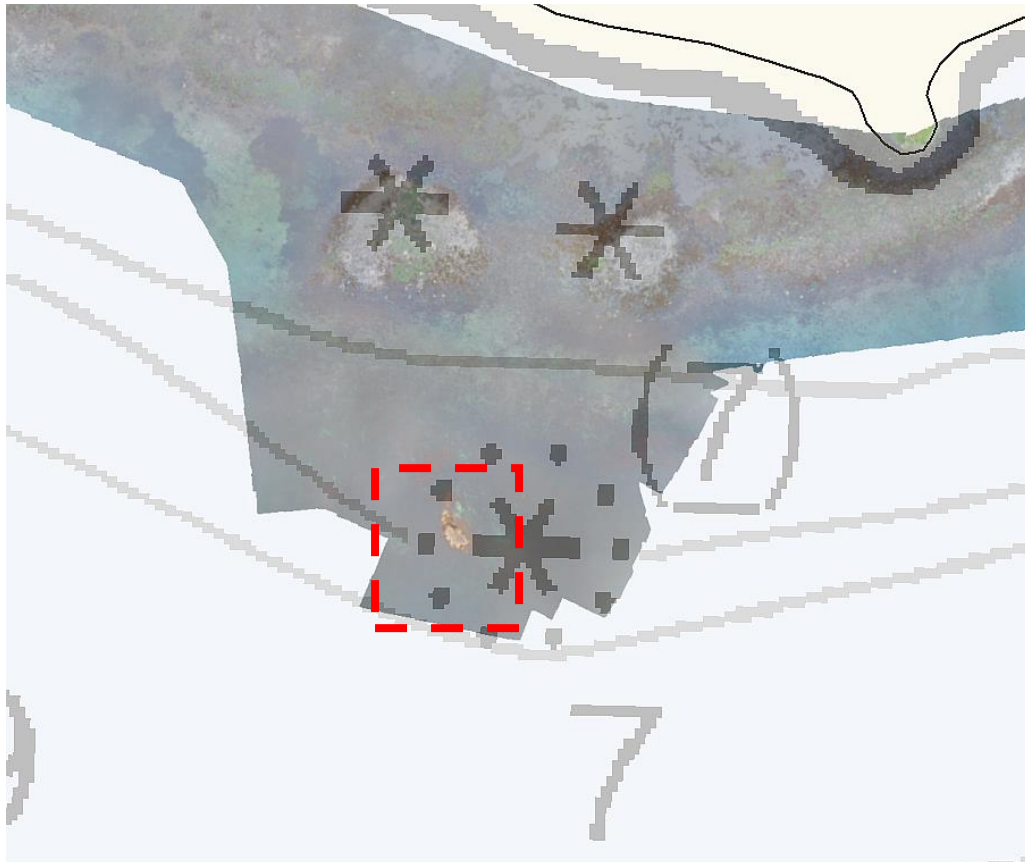
- Waterline (known tide at mission time)

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Quality Control



DEM height = 5', difference 2'

DEM – Vertical Checks

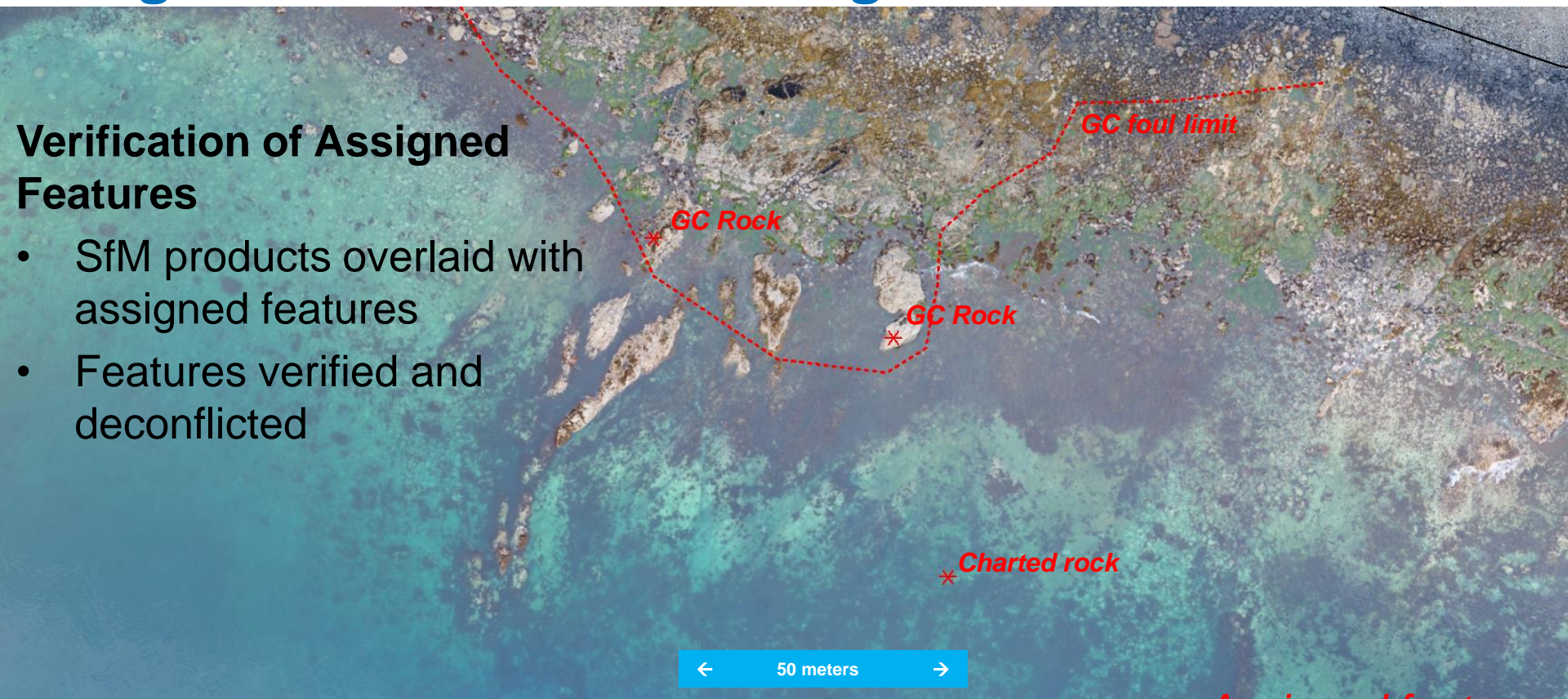
- Waterline (known tide at mission time)
- **Comparison to charted features**

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Using the Data / S57 Encoding

Verification of Assigned Features

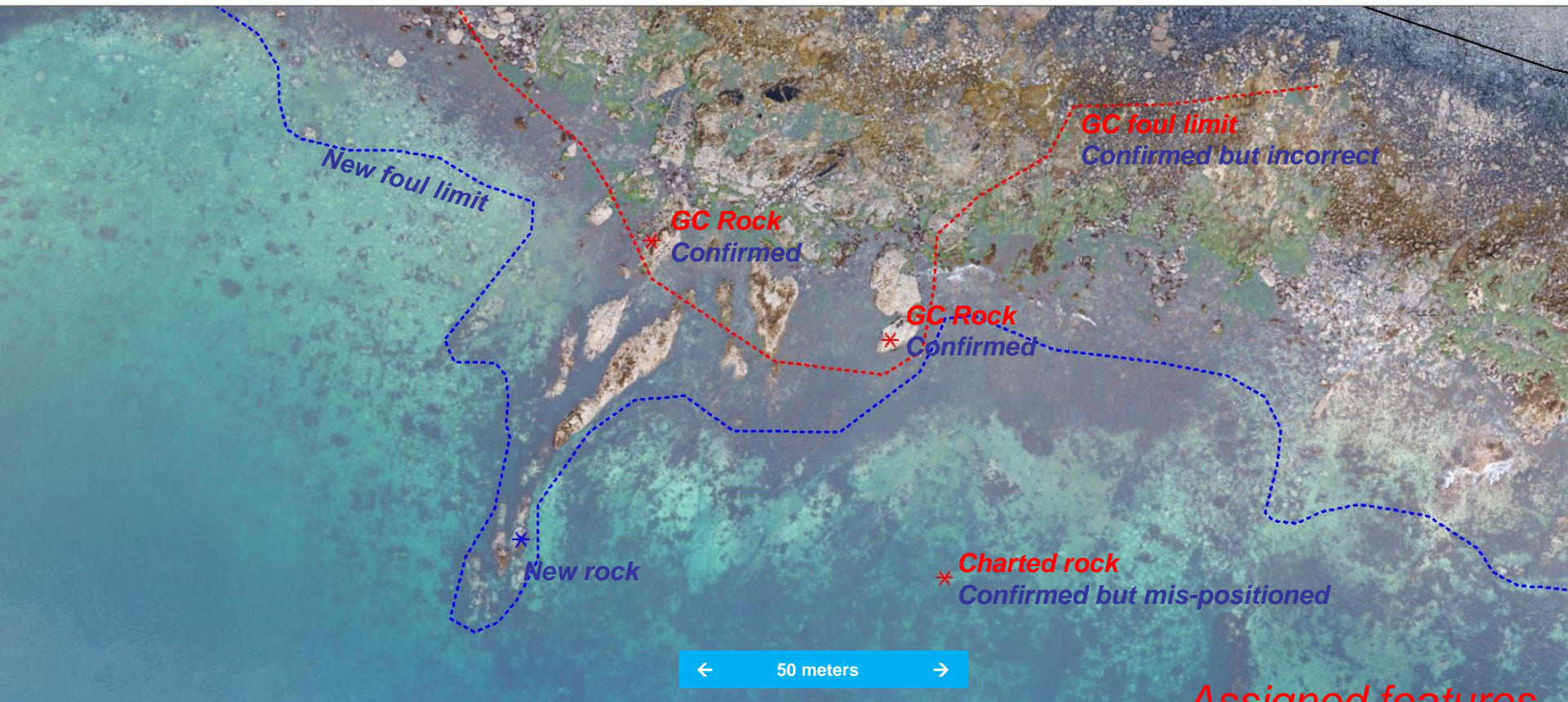
- SfM products overlaid with assigned features
- Features verified and deconflicted



Assigned features

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Assigned features
Verification results

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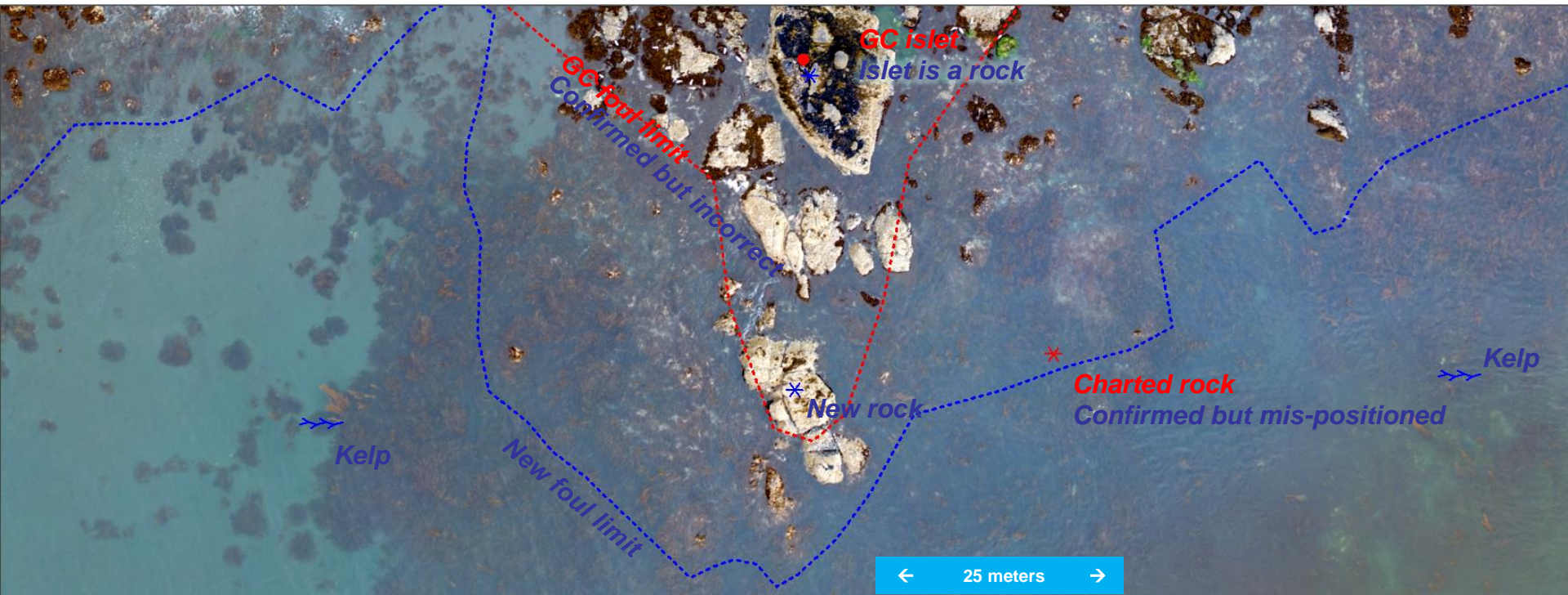


Assigned features

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Assigned features
Verification results

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Other Uses



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ATON Investigations

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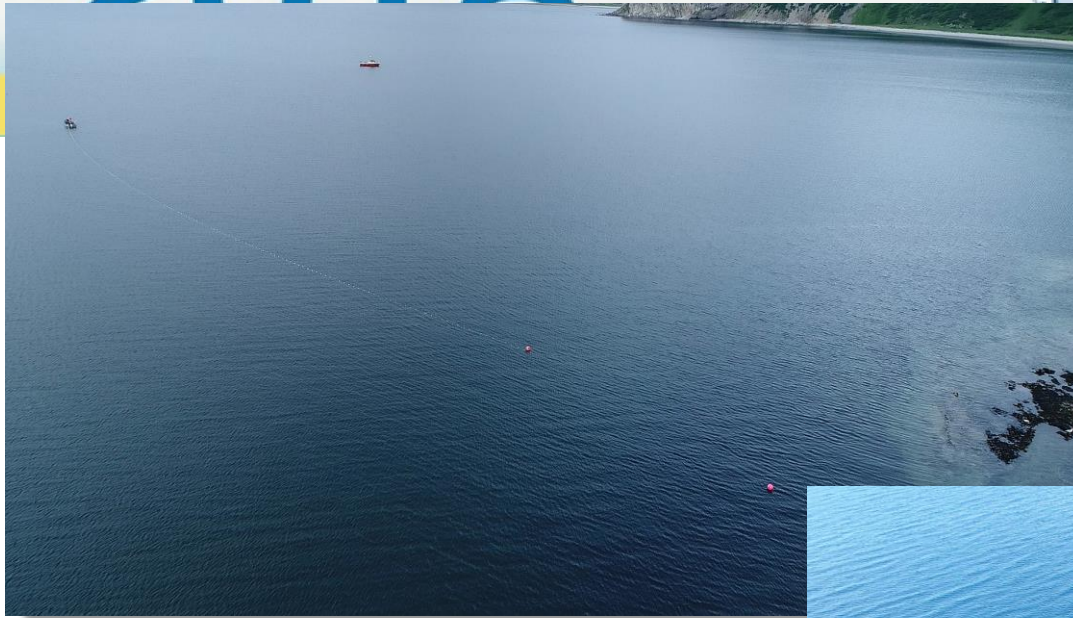


Sand Point, Alaska harbor entrance, July 2017

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Coast Pilot

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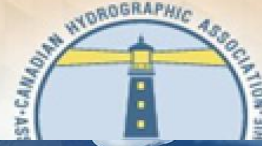
Scouting – Fishing Nets/Pots



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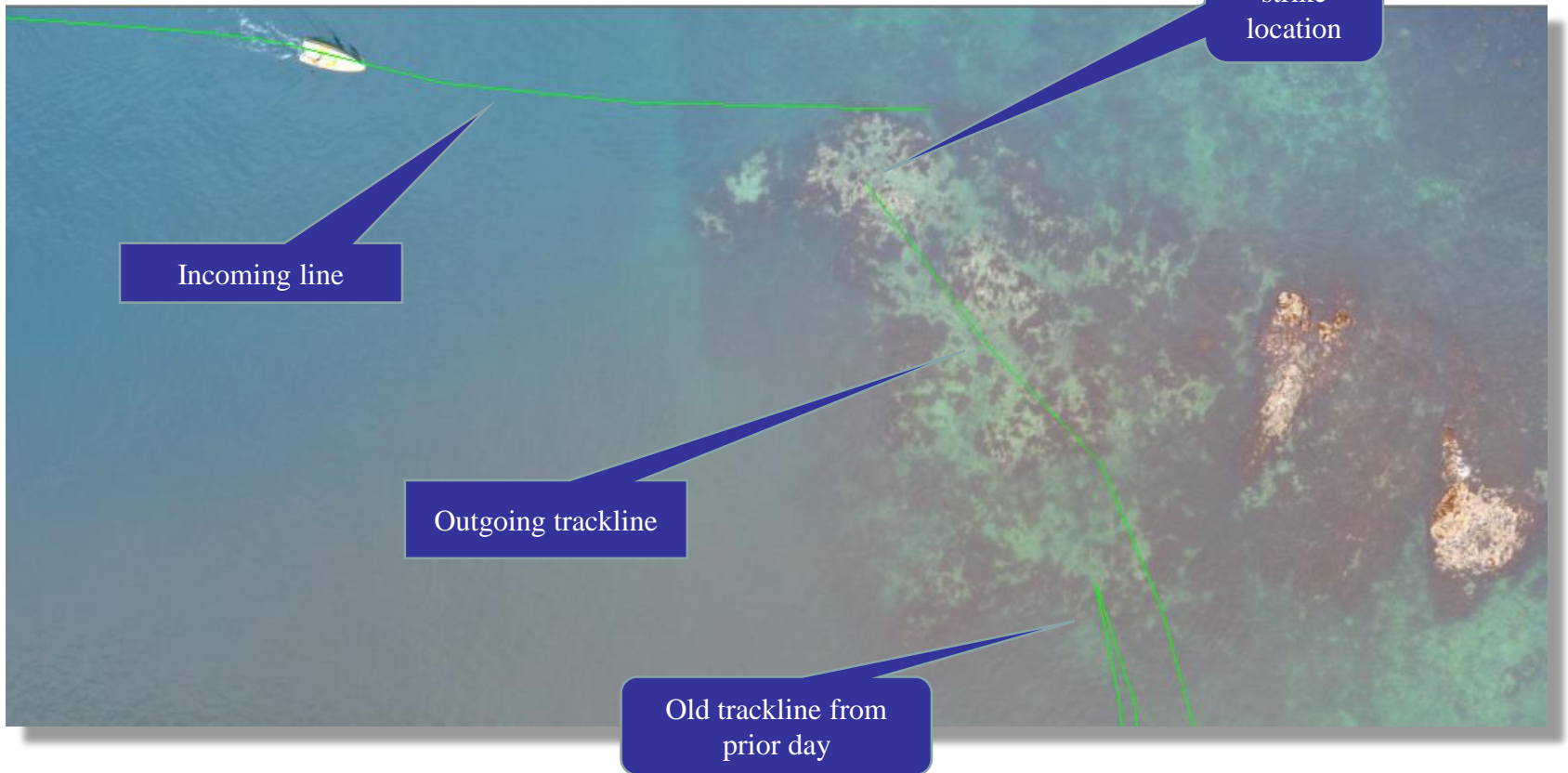
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Scouting – Shoreline

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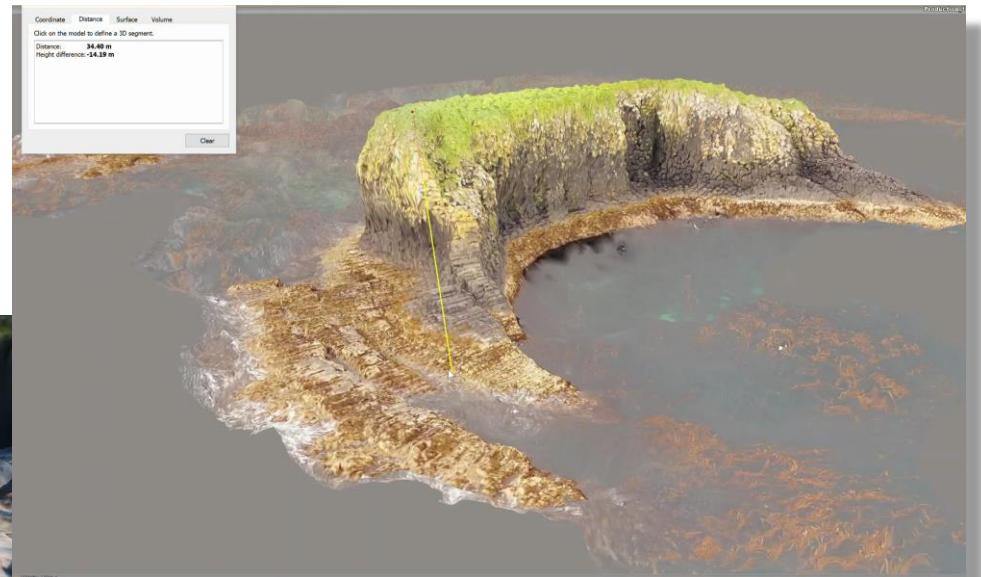
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PROS:

✓ Quality

Quantitative – not estimated / interpolated



**Results – compared to traditional,
vessel-based investigation**

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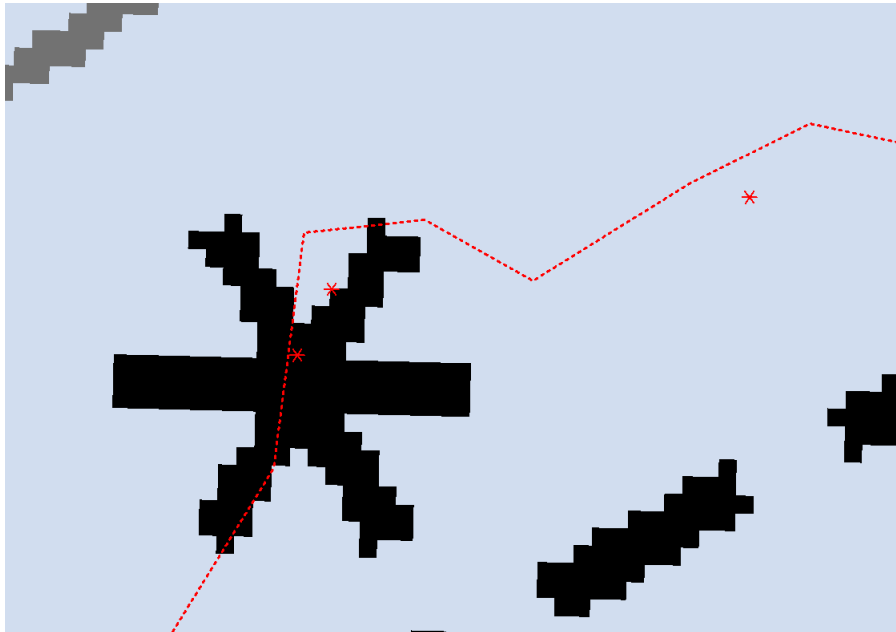
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PROS:

Comprehensive – wholistic view of the shoreline area



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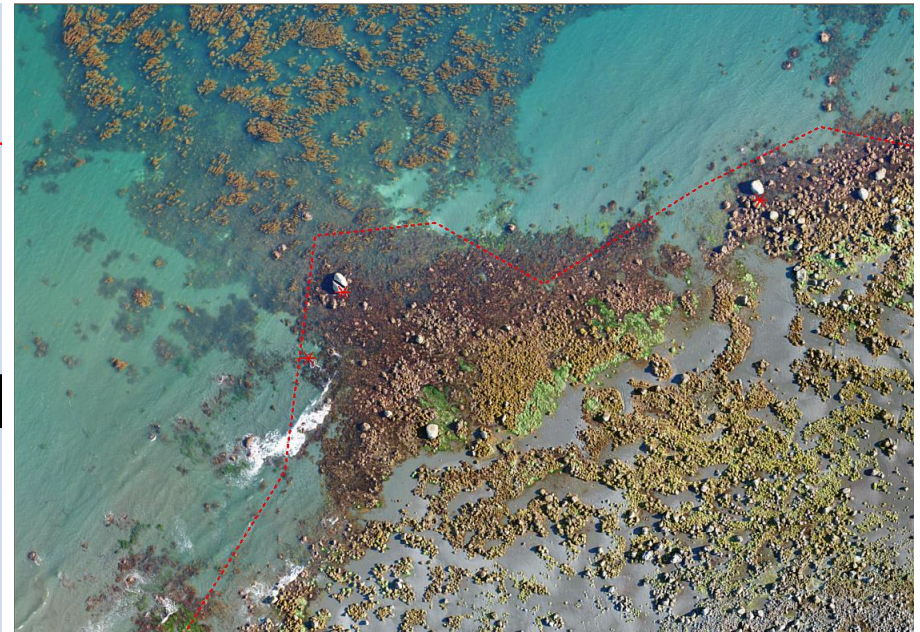
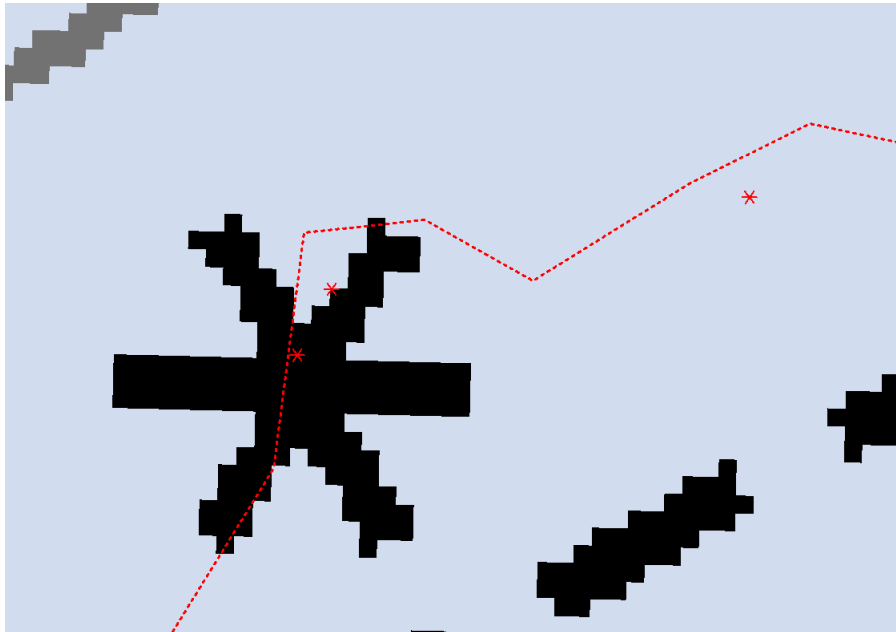
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PROS:

Comprehensive – wholistic view of the shoreline area



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PROS:

- ✓ Quality
- ✓ Efficiency

- About 2 NM per 15-20 minute flight
- No skiff deployment
- Reposition larger vessel between flights
- Two drones airborne at once



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PROS:

- ✓ Quality
- ✓ Efficiency
- ✓ **Simplicity**

- Simple, off-the-shelf
- Fits in a small case
- Easy to learn
- Inexpensive



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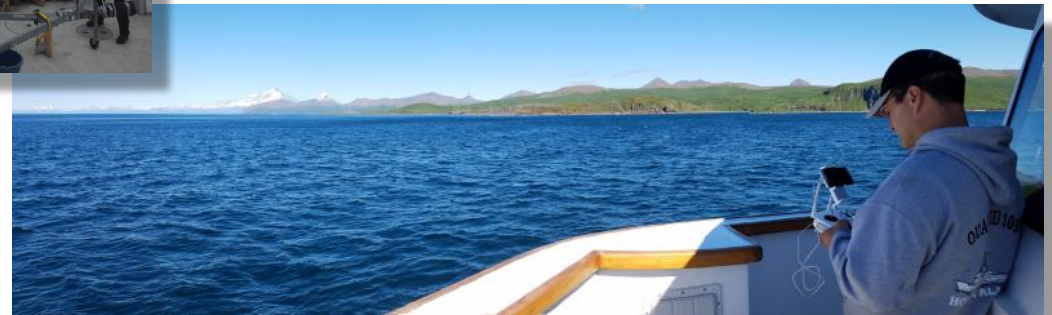


PROS:

- ✓ Quality
- ✓ Efficiency
- ✓ Simplicity
- ✓ **SAFETY**



**STAY ON THE BIG BOAT,
DRINK COFFEE,
INVESTIGATE SHORELINE!**



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PROS:

- ✓ Quality
- ✓ Efficiency
- ✓ Simplicity
- ✓ SAFETY



CONS:

- ✓ FAA Licensure



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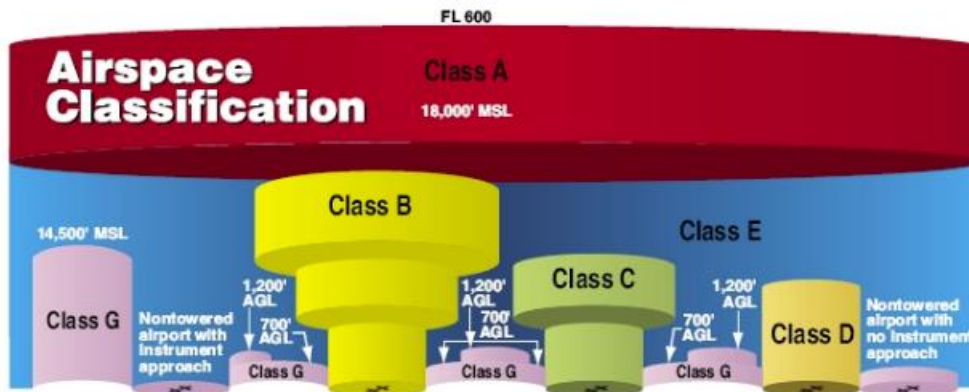
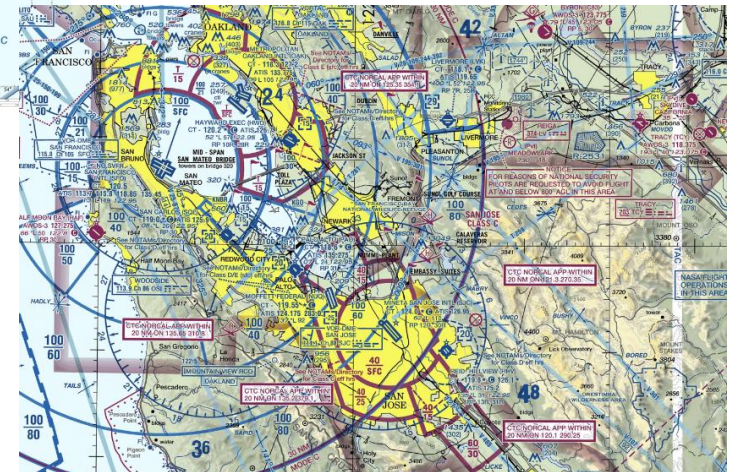
PROS:

- ✓ Quality
- ✓ Efficiency
- ✓ Simplicity
- ✓ SAFETY



CONS:

- ✓ FAA Licensure
- ✓ FAA Regulations



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PROS:

- ✓ Quality
- ✓ Efficiency
- ✓ Simplicity
- ✓ SAFETY

- Probably MORE wind-capable
- But, precipitation & visibility are concerns

CONS:

- ✓ FAA Licensure
- ✓ FAA Regulations
- ✓ **Different Wx Windows**



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PROS:

- ✓ Quality
- ✓ Efficiency
- ✓ Simplicity
- ✓ SAFETY

CONS:

- ✓ FAA Licensure
- ✓ FAA Regulations
- ✓ Different Wx Windows
- ✓ **Training & Procedures**

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PROS:

- ✓ Quality
- ✓ Efficiency
- ✓ Simplicity
- ✓ SAFETY

- ~ 200 GB raw
- ~ 1 TB processed (larger than the CARIS dataset)

CONS:

- ✓ FAA Licensure
- ✓ FAA Regulations
- ✓ Different Wx Windows
- ✓ Training & Procedures
- ✓ **More Data**

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- Took over 25,000 photos
- 200 km of coastline
- 700 features
- Will continue to use!
- Shoreline, scouting, documentation
- New technology



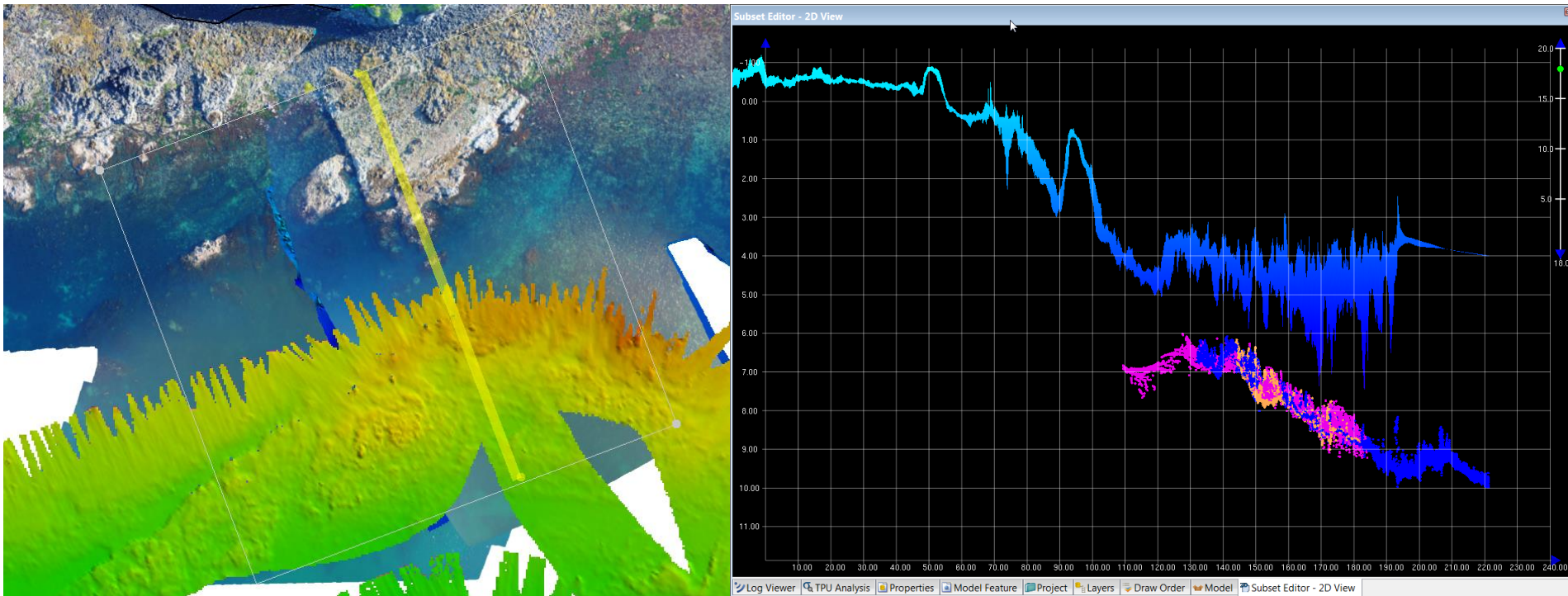
Other Possibilities:

- Full shoreline verification (with ground control)
- Bathymetry from SfM...

Summary / Looking Forward

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- **SfM Generates Bathymetry**
- Minimal overlap with MBES on this project to compare – results not great, **but what if...**



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3D rendering from SfM of Unga Point ATON

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Questions?