Mapping Undersea Feature Names in S-100

UFNPT at SCUFN 31

Wellington, New Zealand

October, 2018

Content

- Update about UFNPT
- Discovery of Undersea Features - excercise

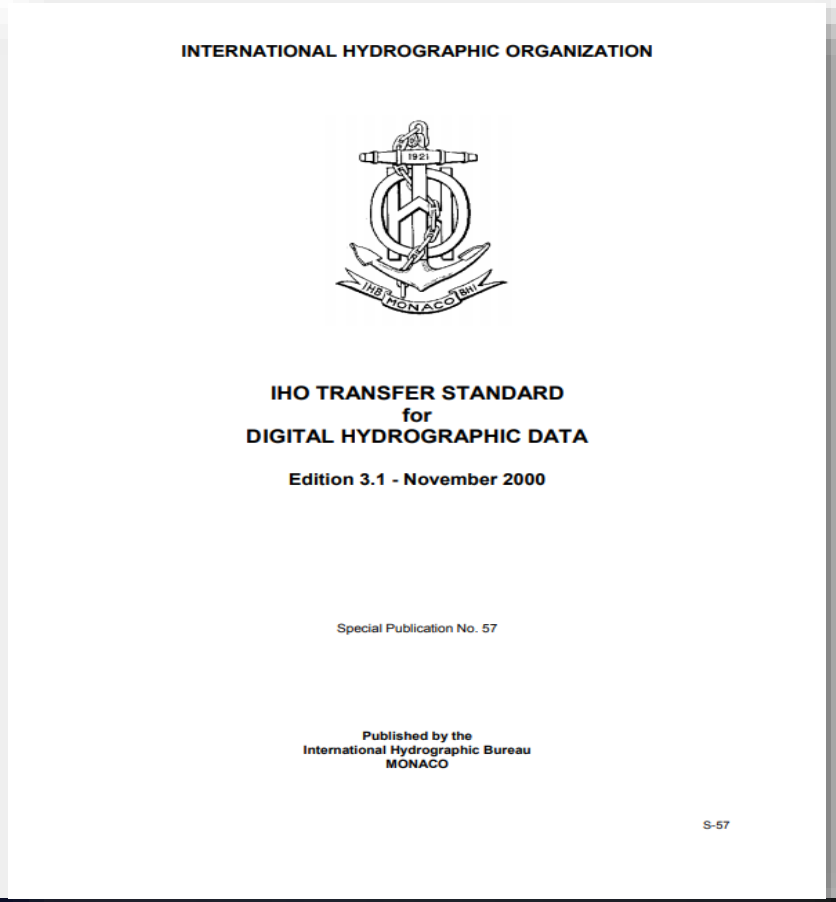
Work Plan of the UFNPT

Action Items (SCUFN30)	Tasking (Lead)	Target Completion Date
Convene the UFNPT via email correspondence to provide summary of UFNPT kick-off meeting and discuss project team task list and next steps	UFNPT (Canada)	October 20, 2018
Prepare an information paper for HSSC-9 outlining the results of UFNPT kick-off meeting at SCUFN-30	Canada	October 27, 2018
Conduct preliminary test case of the current IHO Geo-spatial Information Registry using the current UFN Data Motel (S-57) considering the current concept definitions in B6	UFNPT (Canada), Generic Terms WG	February 2018
Present results of the test case to UFNPT, obtain their feedback and comments; finalize summary report on results, for submission to SCUFN	Canada, UFNPT	March 31, 2018
Conduct preliminary testing of Beta Gazetteer in the context of potential S-100 requirements	Canada, Korea, Argentina (SCUFN lead tester)	November 2017
Evaluate the current list of UFN terms and definitions in relevant IHO publications (B6, S-32) and comparisons/analysis to date	UFNPT, Generic Terms WG	

Background

S-57 & S-100

- The cartographic standard for Electronic Navigation Charts (ENC's)
- S-57 first came out in 1992
- S-100 will replace S-57 once becomes operational



INTERNATIONAL HYDROGRAPHIC ORGANIZATION

IHO TRANSFER STANDARD
for
DIGITAL HYDROGRAPHIC DATA

Edition 3.1 - November 2000

Special Publication No. 57

Published by the
International Hydrographic Bureau
MONACO

S-57

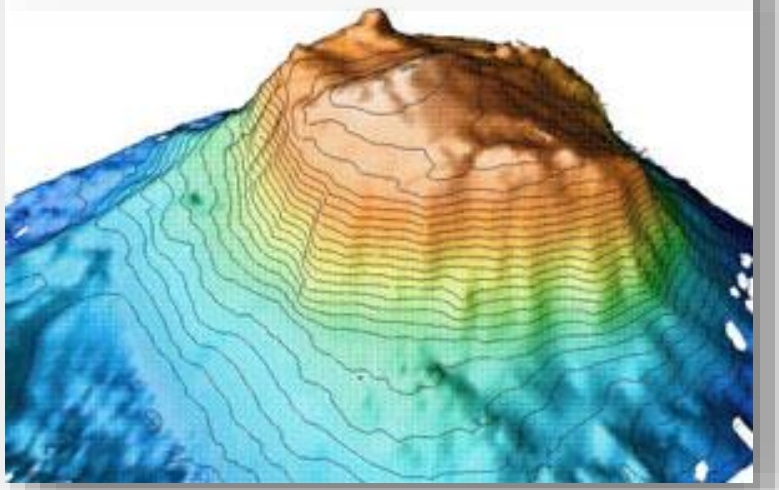
Preliminary test case of an UFN S-100 compatible

Step 1. What do we need to describe? Review the definitions in B-6

- Some of the definitions for undersea features are descriptive and qualitative
- But there are quantifiable descriptions:
  - Depth
  - Height difference compare to surroundings
  - Dimension
  - Elevation

KNOLL

A distinct elevation with a rounded profile less than 1000 m above the surrounding relief as measured from the deepest isobath that surrounds most of the feature.



Step 2. What do we want to show? Decide on requirements

We came up with a list of required attributes base on:

- Definitions in B-6
- Attributes in the existing S-57
- Fields in the SCUFN proposal form
- General Bathymetric Chart of the Ocean's (GEBCO) database

Require attribute	Description
B-6 Generic Term	single choice from the list of generic terms in B-6
Feature Name	basic information
Display Name	basic information
Language	basic information
Name	basic information
Scale Minimum	basic information
Depth range minimum value	vertical distance from highest point of the feature to the sea level, in meters.
Depth range maximum value	vertical distance from lowest point of the feature to the sea level, in meters.
Vertical length	vertical distance between the highest point and the lowest point of the object.
Horizontal length	measurement of the longer horizontal linear axis
Horizontal width	measurement of the shorter horizontal linear axis.
Textual description	additional information such as country of discovery, origin of name, etc.

Step 3. Has it been developed? Review documentation about S-100

The table shows that the elements and documentation of S-57 are comparable to the elements and documentation of S-100

Organization of S-57	Organization of S-100
Object – can be found in the Object Catalogue	Feature – can be found in the Feature Catalogue
Object catalogue – Appendix A, Chapter 1 of S-57*	Feature Catalogue – **(in development)**
Object acronym – can be found in the Object Catalogue	Feature acronym – n/a in S-100
Object attribute – can be found in the Attribute Catalogue	Feature attribute – can be found in the Feature Concept Dictionary.
Attribute catalogue – Appendix A, Chapter 2 of S-57*	Feature concept dictionary – **(in development)**
Encoding – can be found in Use of Object Catalogue for ENC	Encoding – can be found in the Data Classification and Encoding Guide
Use of Object Catalogue for ENC – Appendix B.1, Annex A of S-57*	Data Classification and Encoding Guide – **(in development)**
Symbol – can be found in the Symbol library for the use of ECDIS	Symbol – can be found in the Portrayal Register and Portrayal Catalogue
Symbol library for the use of ECDIS – Annex A of S-52**	Portrayal Register – **(in development)** Portrayal Catalogue – **(in development)**
Product specification – the only one that exists is the ENC Product specification	Product specification – various exist or are **(in development)**, depending on the type of product (S-101 ENC, S-102 Bathymetry, S-103 Nautical Publications, etc.)
ENC Product specification – Appendix B.1 of S-57*	S-101 ENC – **(in development)** S-102 – Bathymetric Surface Product Specification S-103 – **(in development)** ...
Domain – n/a	Domain – various exist or are **(in development)**: Hydrography, Sea Ice, Aids to Navigation, etc.

Step 4. Test of Proposed S-101

(the word Feature in S-100 means Data Object)

Brothers Seamount encoded in S-101 standard		
Feature	Sea Area / Named Water Area	
Feature acronym	n/a	
Feature attributes	Category of Sea Area	Seamount
	Feature Name	Brothers Seamount
	Display Name	Brothers Seamount
	Language	English
Symbol	n/a	
Product Specification	S-101 ENC	
Domain	Hydrography	
Additional attribute that should be added to Sea Area/Named Water Area (in development)		
Text		This feature forms a volcano with a central caldera. It lies 15 km north of James Healy Seamount in the Kermadec volcanic arc

Comments received from the Generic Term Working Group and the UFN PT

- Create a new feature (object) for Undersea Features with the necessary attributes.

- Consider if we wanted to keep the new feature (object) for Undersea Features under S-101.

Second Test Case
New Geo object
in S-101

Testing a new proposed S-101 Object using the same Seamount

(The word Feature in S-100 means Data Object)

(See **Annex 2** for more information about Brothers Seamount)		
Feature	Undersea Feature	
Feature acronym	N/A	
Feature attributes	B6 Generic Term	Seamount
	Feature Name	Brothers Seamount
	Display Name	Brothers Seamount
	Language	English
	Scale Minimum	
	Depth range minimum value	1197
	Depth range maximum value	2250
	Vertical length	1053
	Horizontal length	1500
	Horizontal width	1500
	Textual description	This feature forms a volcano with a central caldera. It lies 15 km north of James Healy Seamount in the Kermadec volcanic arc. It is named after Professor RN Brothers (1924-1988), Volcanologist, University of Auckland, 1952-1988, who described the first submarine volcanic rocks from the southern Kermadec arc. Discovered by New Zealand research vessel "Rapuhia", in 1991
Symbol	n/a	
Product Specification	S-101 ENC	

Result obtained

- Most feature attributes that will meet the requirements for storing descriptive information about UFNs, already exist in the IHO Feature (object) Dictionaries in development.
- Feature (object) attribute B6 Generic term, provides a direct cross-reference to B-6

Round 2 of comments received from the Generic Term Working Group and the UFN PT

Textual description - classification is necessary in textual description

- Associated Features
- Reason for choice of name
- Discovery facts
- Survey Data information

Conclusion

The UFNPT has fulfilled the action items assigned to it at SCUFN 30.

- Neither of the two test case provide all the attributes that the UFN PT desires.
- The UFN PT desires a longer list of attributes than are currently developed for the purpose of safe navigation that is associated with S-101 for ENC.
- However, the S-100 data structure provides flexibility to add more attributes and modify the list of generic terms, as proven.

Next Steps

- Consider further expansion of the UFN standard S101.
  - S101 Not owned by SCUFN
- Or consider the creation of a new S-100 Product Specification for Undersea Feature Names, customized to all data sharing and interoperability requirements of SCUFN and GEBCO.
  - S10? Owned by SCUFN
- Select new Chair of UFNPT
- Confirm membership

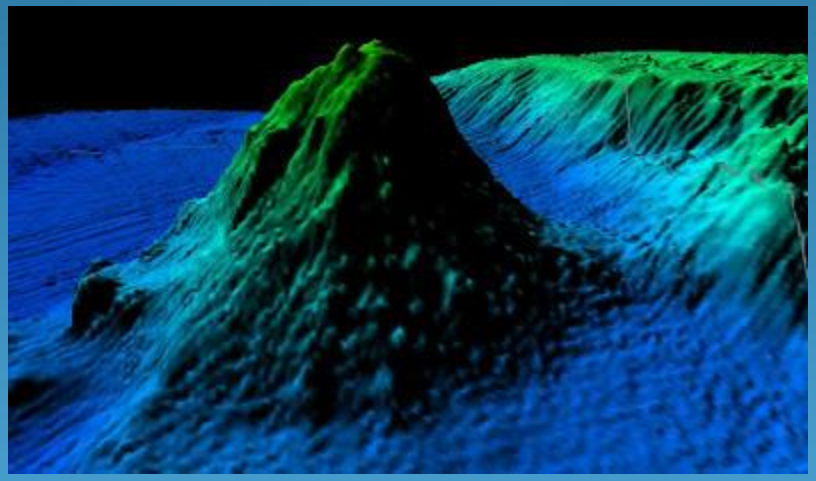
Confirmation of Membership

UFNPT 2018-2019			
Member State	**Name of Delegate**	**Email**	**Organization**
Argentina	Rocio del Valle Borjas	borjas@hidro.gov.ar	SIHN
Belgium	Paula Oset Garcia	paula.oset.garcia@vliz.be	Marine Regions
Canada	Anna Hendi	anna.hendi@dfo-mpo.gc.ca	CHS
China	Xing Zhe	Xz_nmdis@163.com	NMDIS
Korea	Boram Jang	jangbbo89@korea.kr	KHOA
SCUFN experts	Generic Term Sub Group		IHO and OIC

Proposed Work Plan 2018-2019

Action Items (SCUFN 31)	Tasking Lead	Target Completion Date
Explore within existing product specifications in S-100, the expansion of textual description to include - Associated Features - Reason for choince of name - Discovery facts - Survey Data information	Canada and UFNPT	January 2018
Explore the steps necessary to develop a product specification for UFN	Canada	January 2019
Prepare and information paper for HSSC 11, with the status of work of the UFNPT and the work plan for the year 2019.	Canada	February 2017
Hold a video conference call for UFNPT, to discuss if the creation of a product specification is necessary for UFN	Canada and UFNPT	March 2019
If necessary, hold a Face to Face meeting of the UFNPT or Online workshop, to discuss initial steps to develop the product specification	Canada, UFNPT and Generic Terms WG	June 2019
Re-evaluate work plan	Canada, UFNPT	August 2019
Prepare documentation to report progress to SCUFN	Canada, UFNPT	September 2019

Discovery of Undersea Features Using Bathymetric Data



By: Oliver Farwell

Aug 1st 2018

Purpose

- Automate the identification of undersea features
- Using a workflow or script in available GIS software
- Using International Hydrographic Organization [IHO] B-6 definitions of undersea features

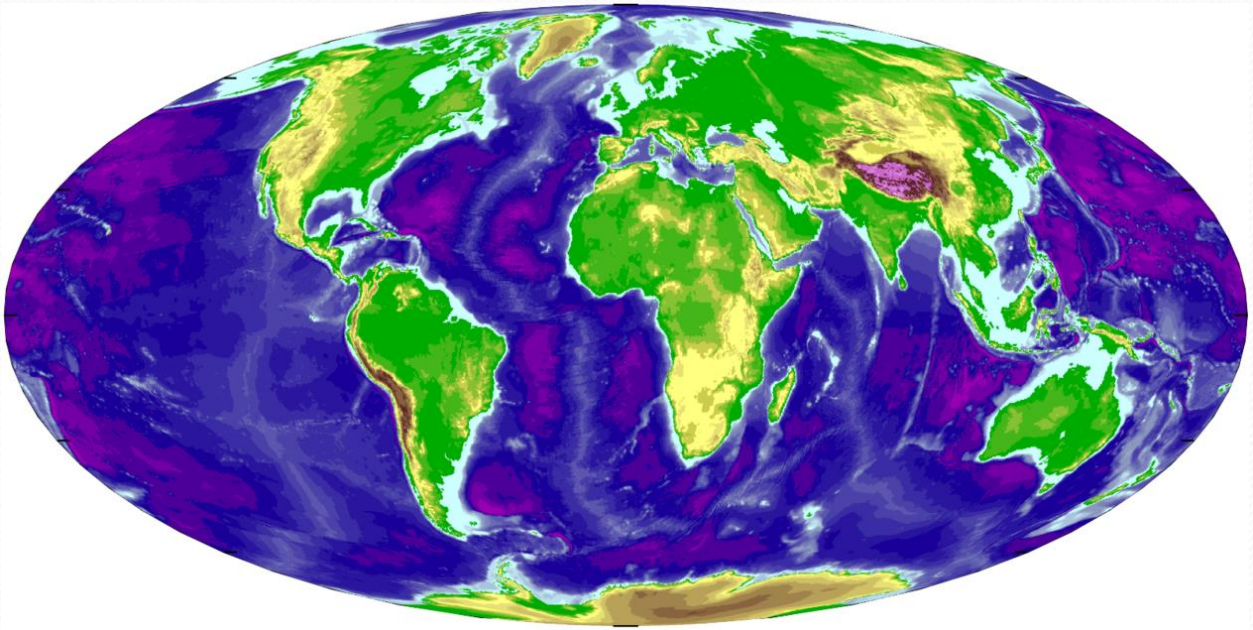


Image: https://www.google.ca/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=2ahUKEwjm8LGhpu_bAhUFPKoKHc21D_8QjRx6BAgBEAU&url=https%3A%2F%2Fen.wikipedia.org%2Fwiki%2FBathymetry&psig=AOvVaw2T_cSRqpPGtxwDye7Ppit8&ust=1530032722111328

Difficulties

- IHO definitions are broad/qualitative
- Definitions are open to interpretation
- Automated identification needs yes/no decisions

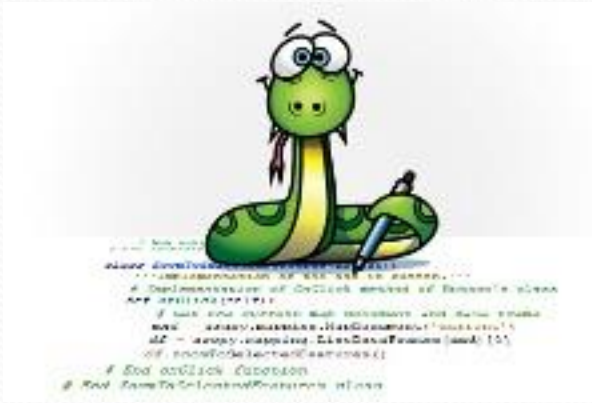
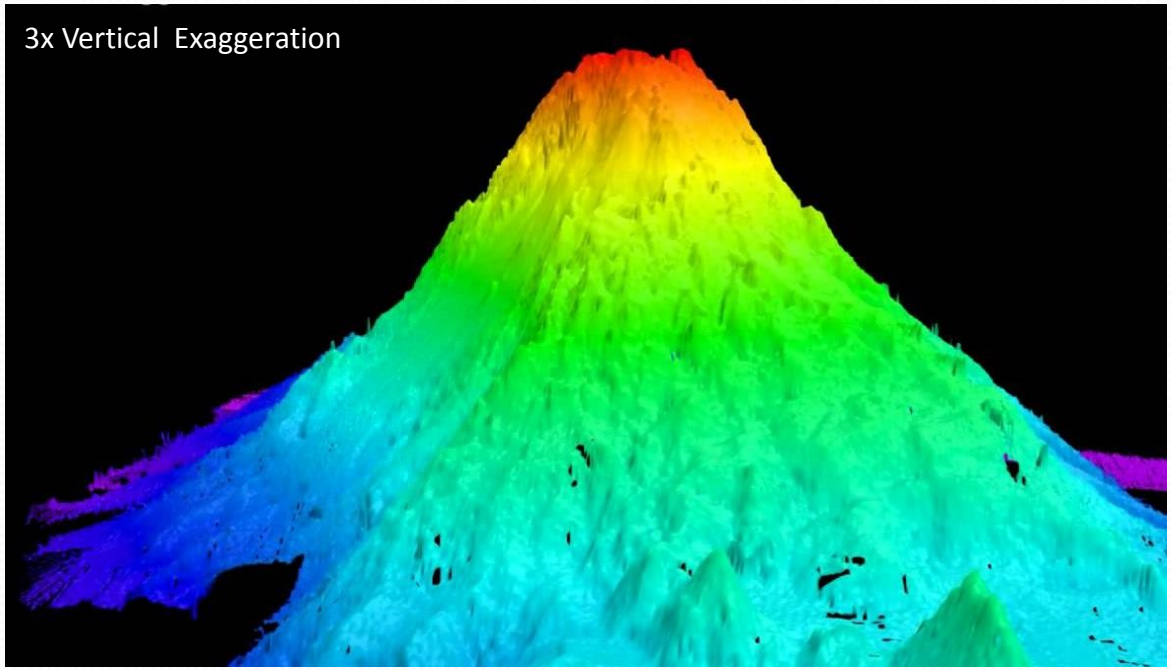


Image (right): iho.int
Image (left): https://www.arcgis.com/home/item.html?id=5f3aefe77f6b4f61ad3e4c62f30bff3b

Seamounts

- Undersea mountain

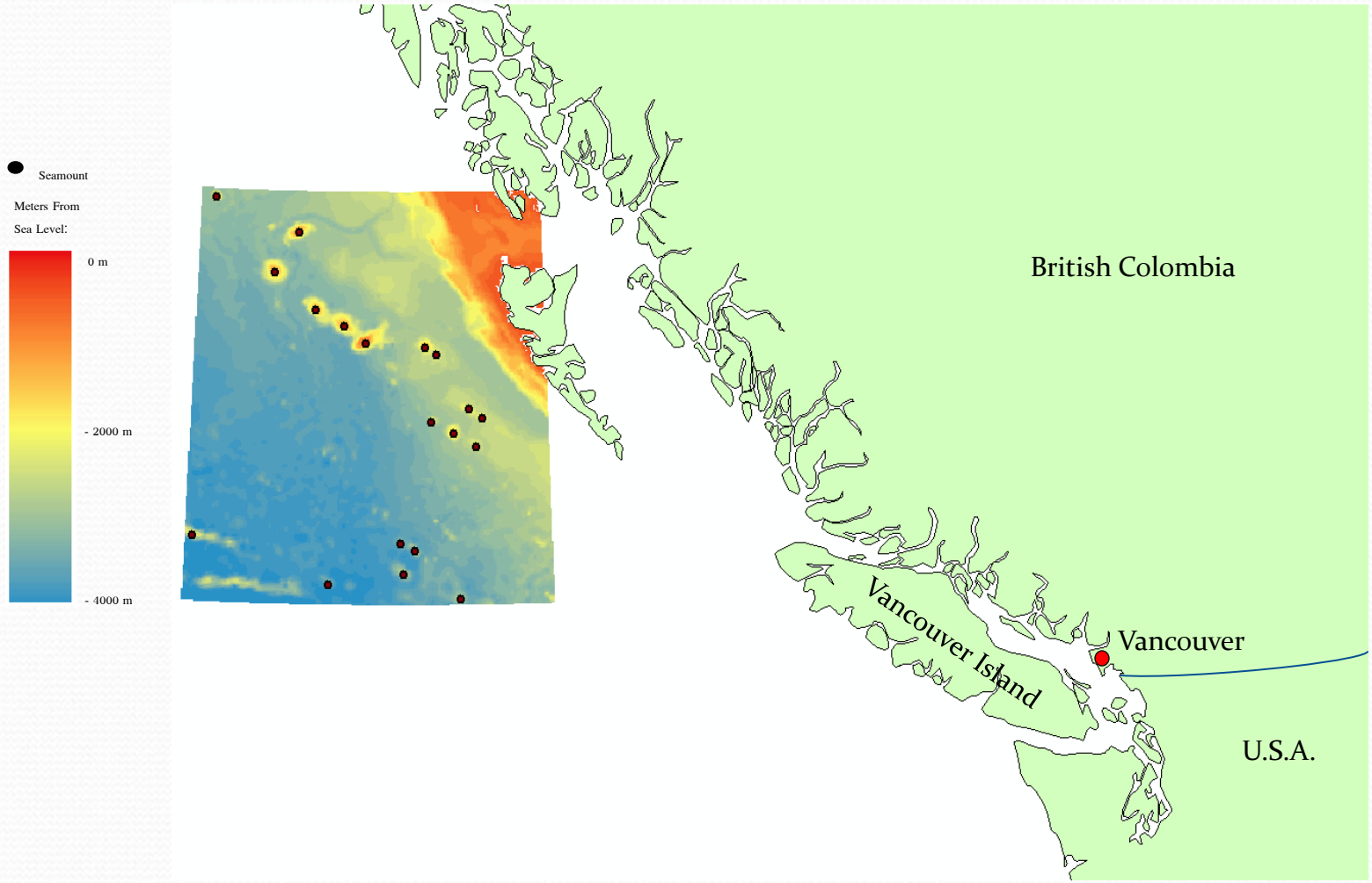


Definition:

- Equidimensional in shape
- Rises 1000 m from deepest isobath surrounding most of the feature

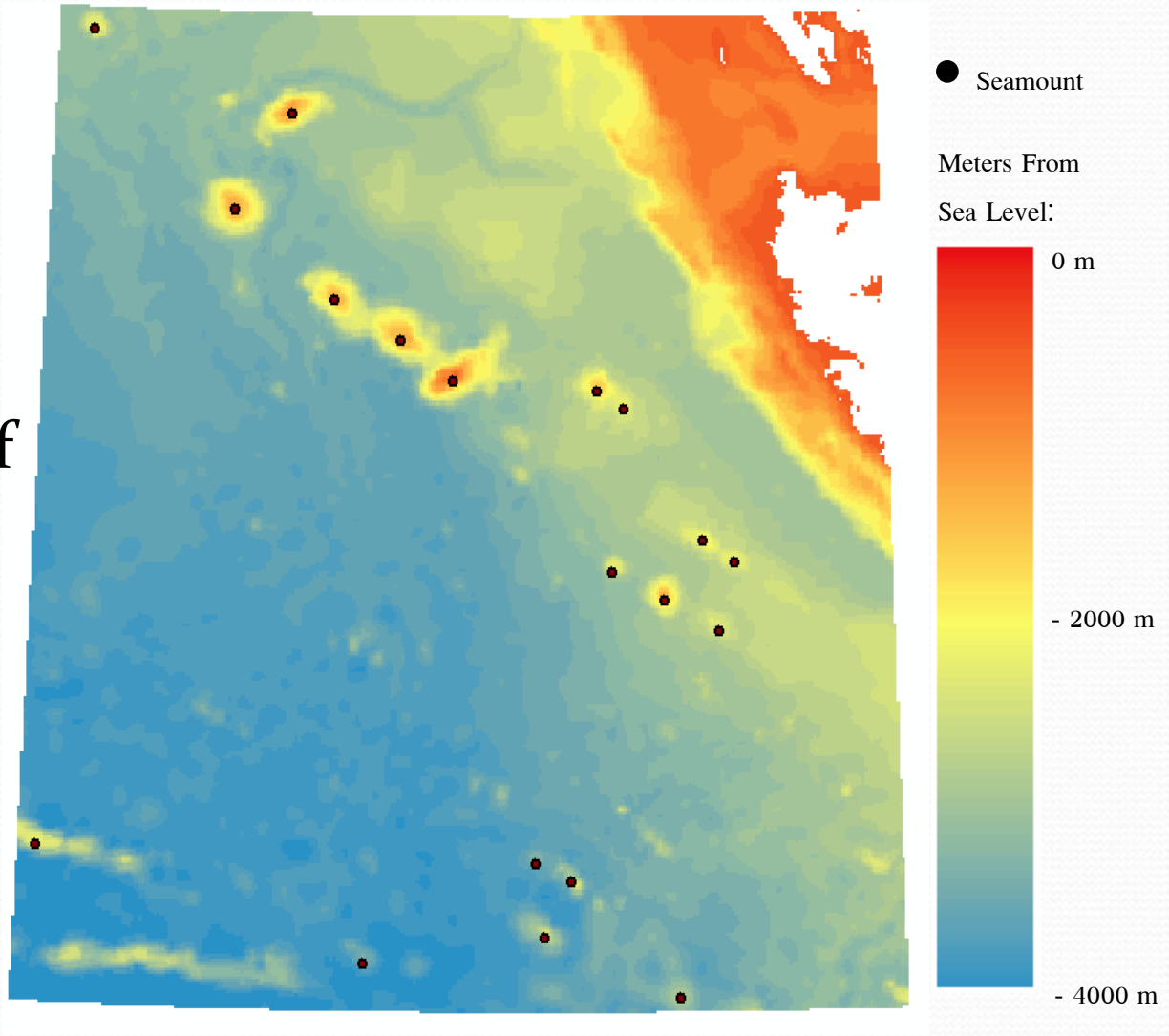
Image: deepreef.org

Area of Interest

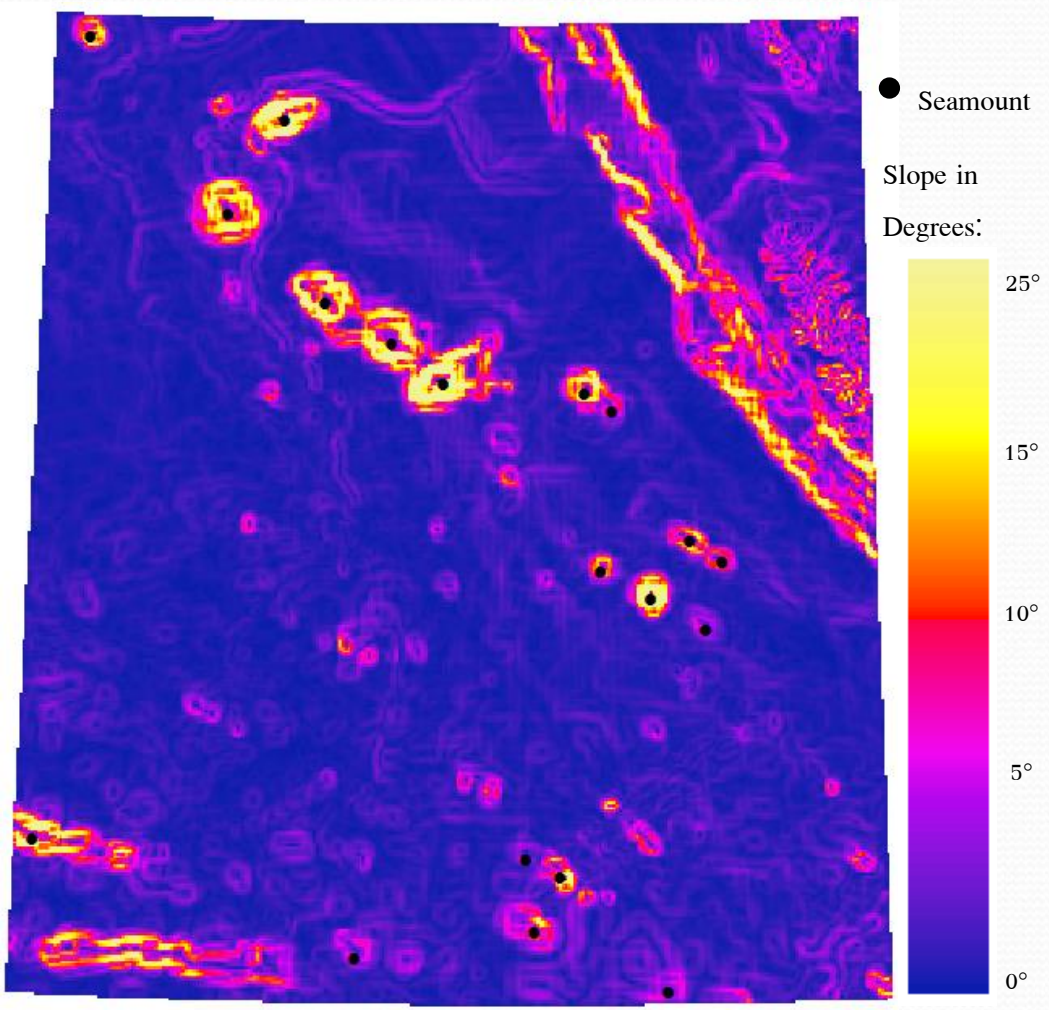


Test Area

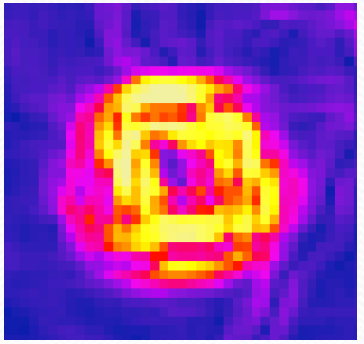
- 19 confirmed seamounts off the coast of B.C.



Slope



- Slope tool in ArcGIS
- Gives an image of slope in degrees
- General ocean floor is very flat (>4°)
- Anomalies like seamounts range from 5° to 25°
- Produce doughnut shaped rings, outlining seamounts
- Good for visual check



Hydrology Tools

- Hydrology tools within ArcMap for Raster datasets
- Model the flow of water on impermeable surface
- Basins tool (right) divides the elevation model into separate basins that collect water
- Each colour represents a separate basin on a topographical model of a river system

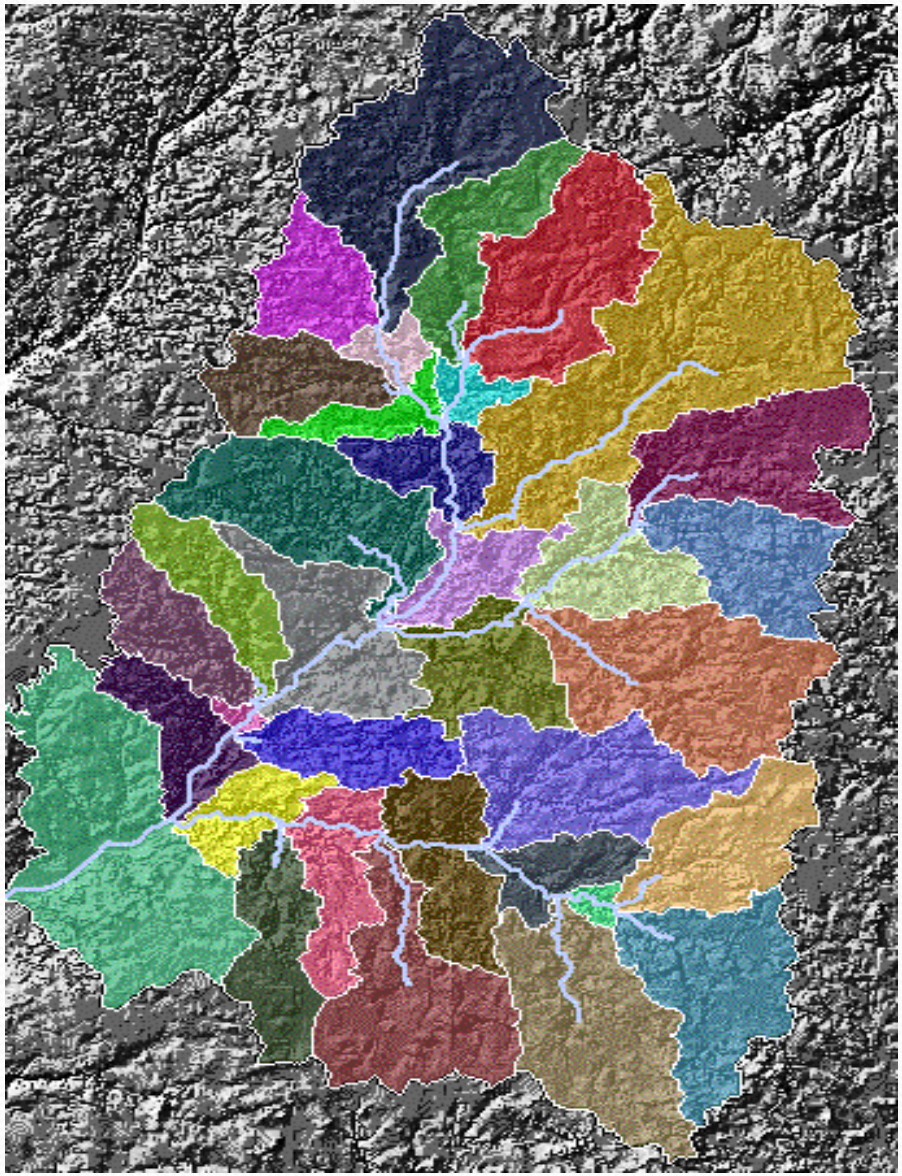
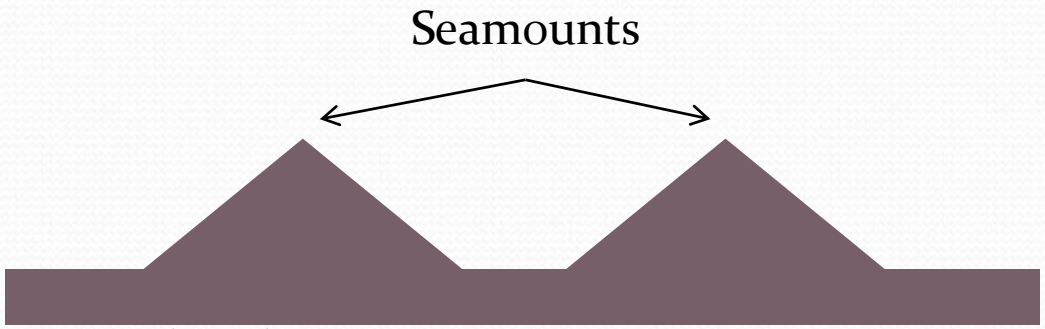


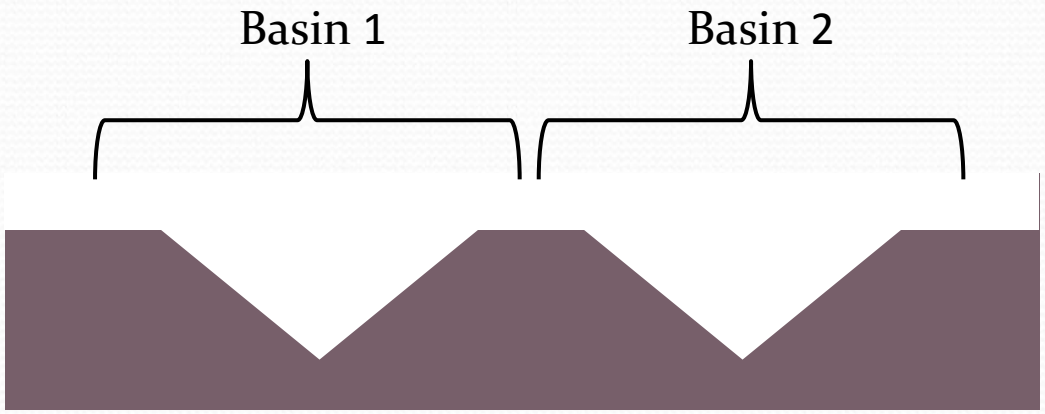
Image (left):
https://www.google.ca/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=2ahUKEwi7gcz4uODbAhXsx4MKHZdVA4cQjRx6BAgBEAU&url=http%3A%2F%2Fwww1.udel.edu%2Fjohnmack%2Ffrec480%2Farc_watershed%2F&psig=AOvVaw30OfoVKCwL-26B9vDGzZ1N&ust=1529522355829306

Inverting Bathymetry

- If the bathymetry is inverted it resembles a DEM
- Peaks become troughs to collect water
- Large basins delineate seam amount locations



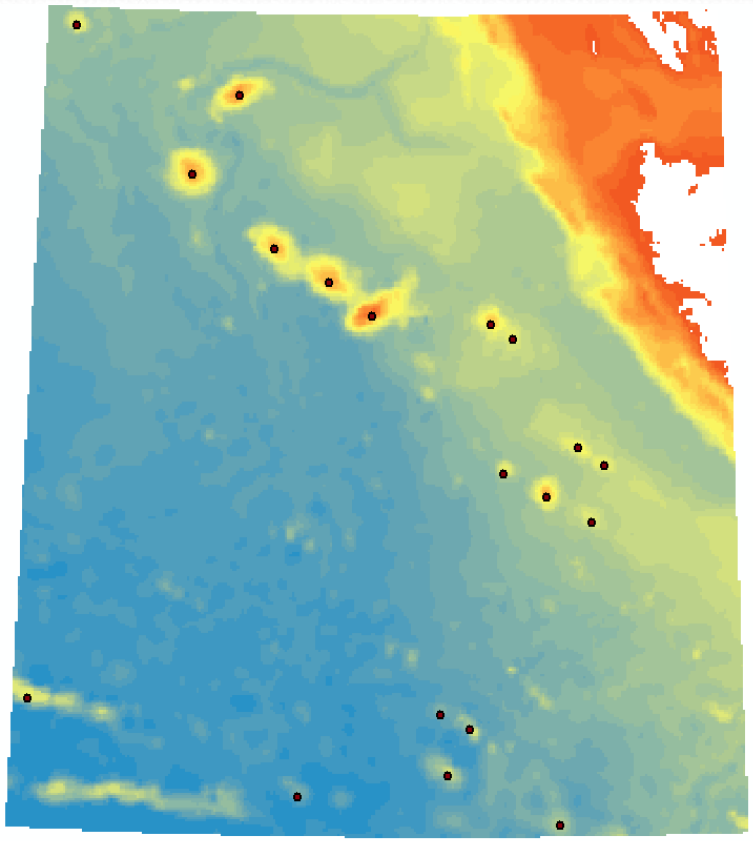
Original Bathymetry

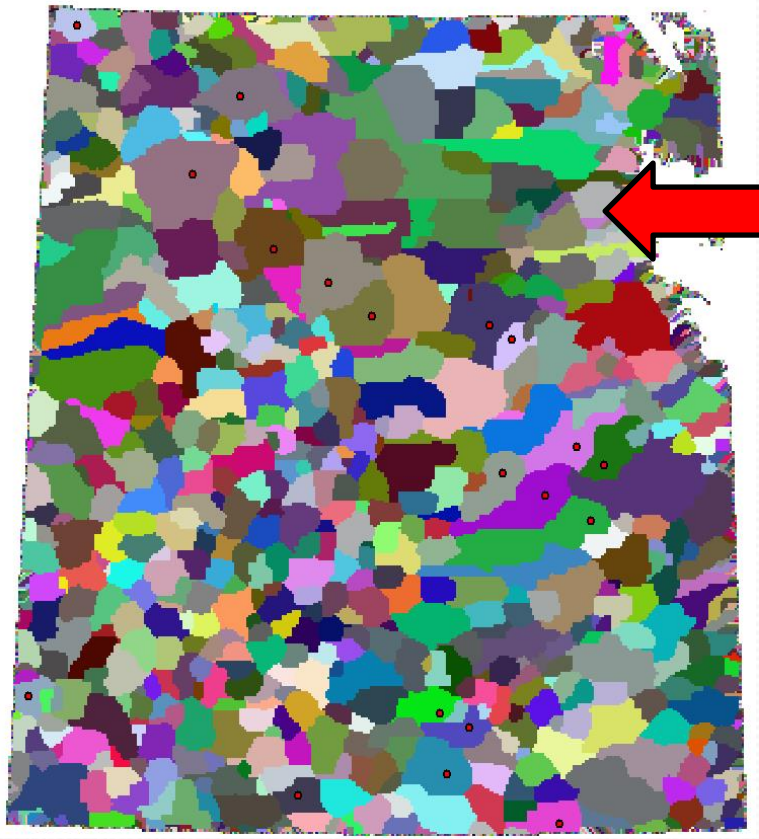


Inverted Bathymetry

Basins

- Invert the bathymetry (multiplied by -1)
- Seamount peaks became troughs (deep points)
- Use basins tool to derive basins of seafloor

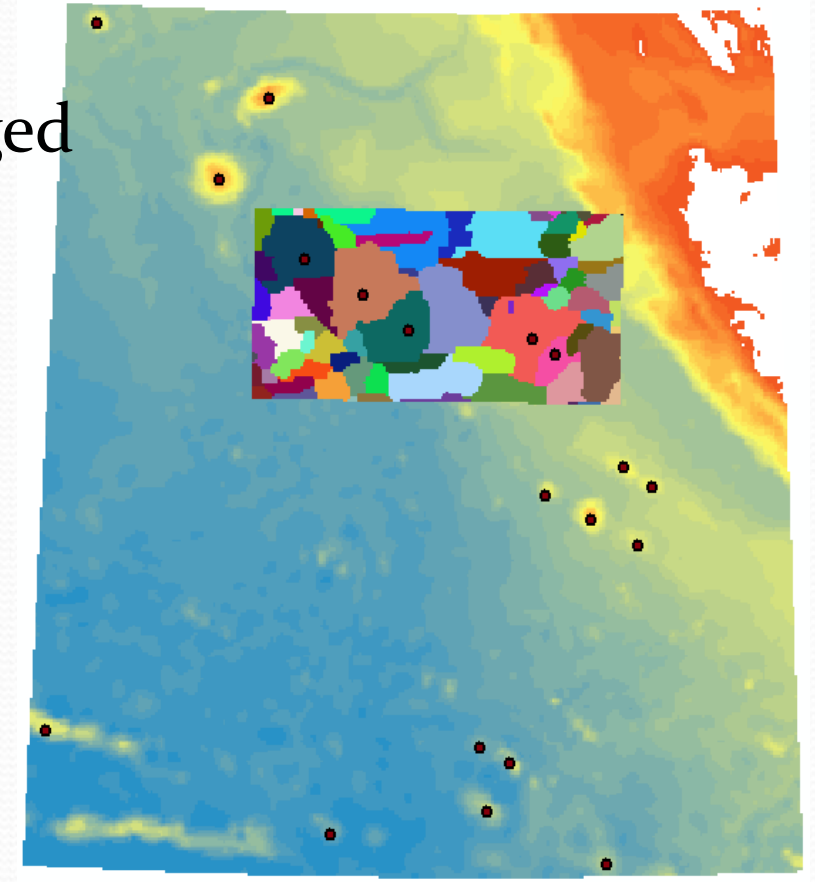




Each unique colour is a different basin

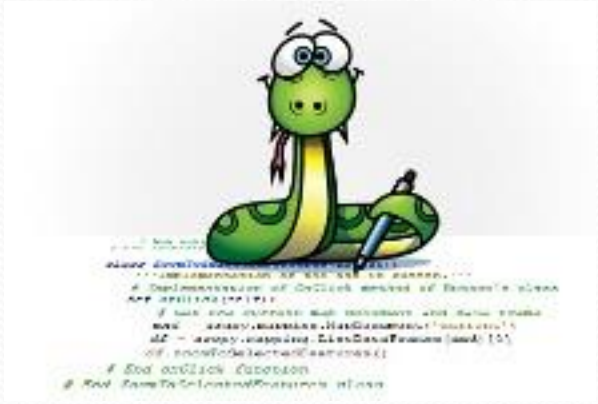
Testing Basins

- Basins encase the footprint of the seamounts
- Extract max/mini depth from original un-inverted bathymetry
- Difference >1000 m depth flagged



Python Script

- Python script used to automate process of extracting basin and checking min/max



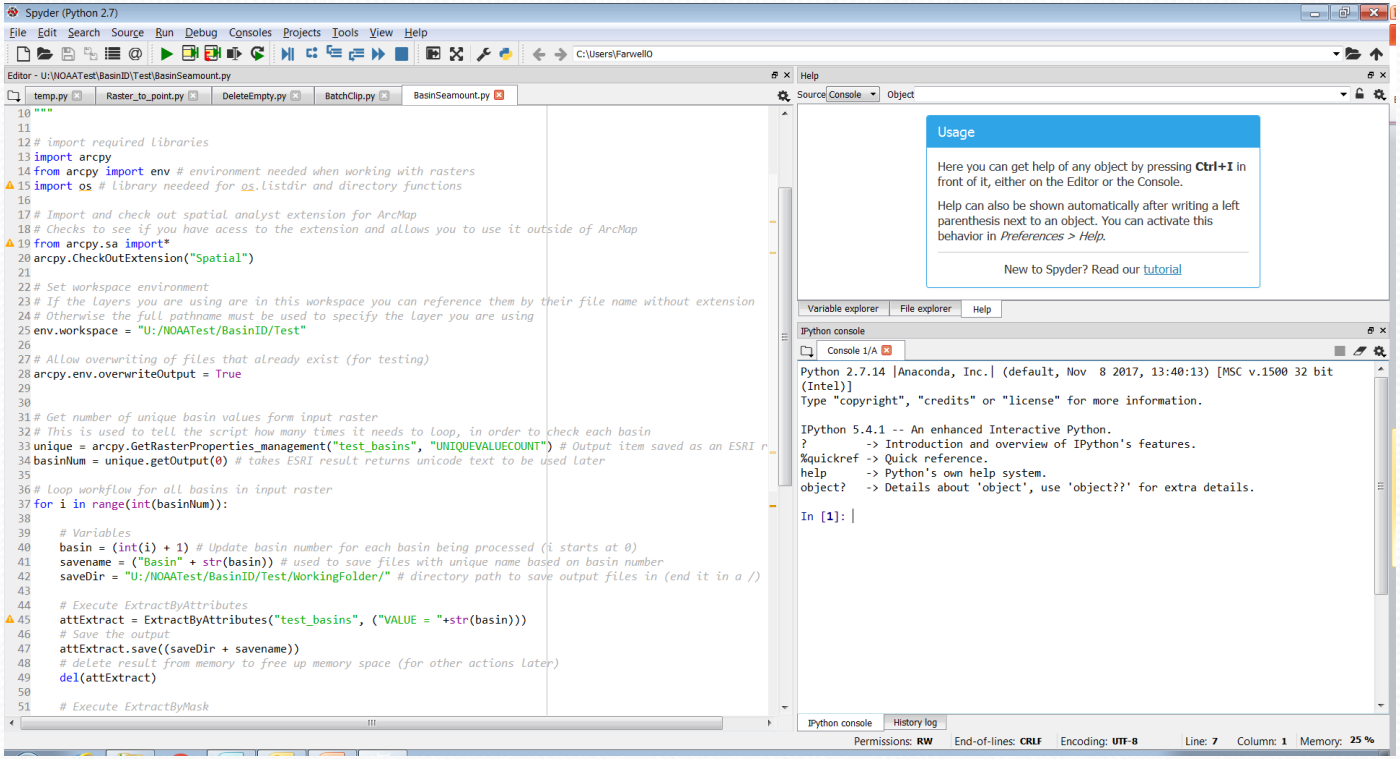
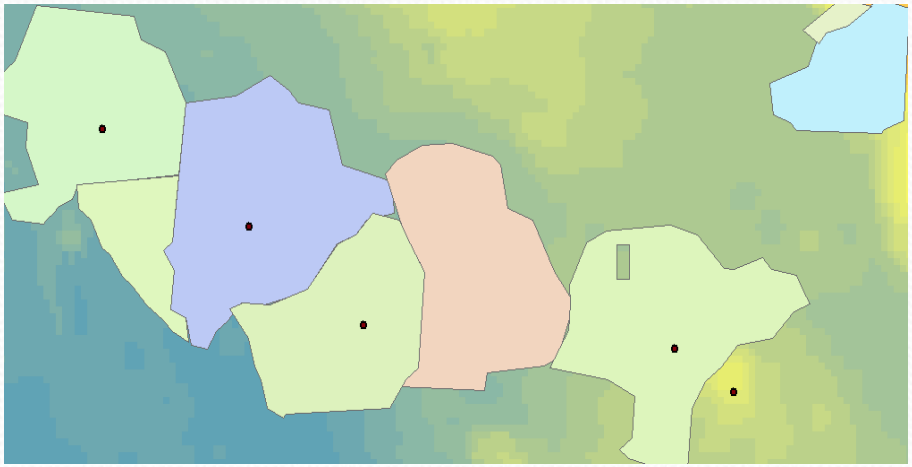
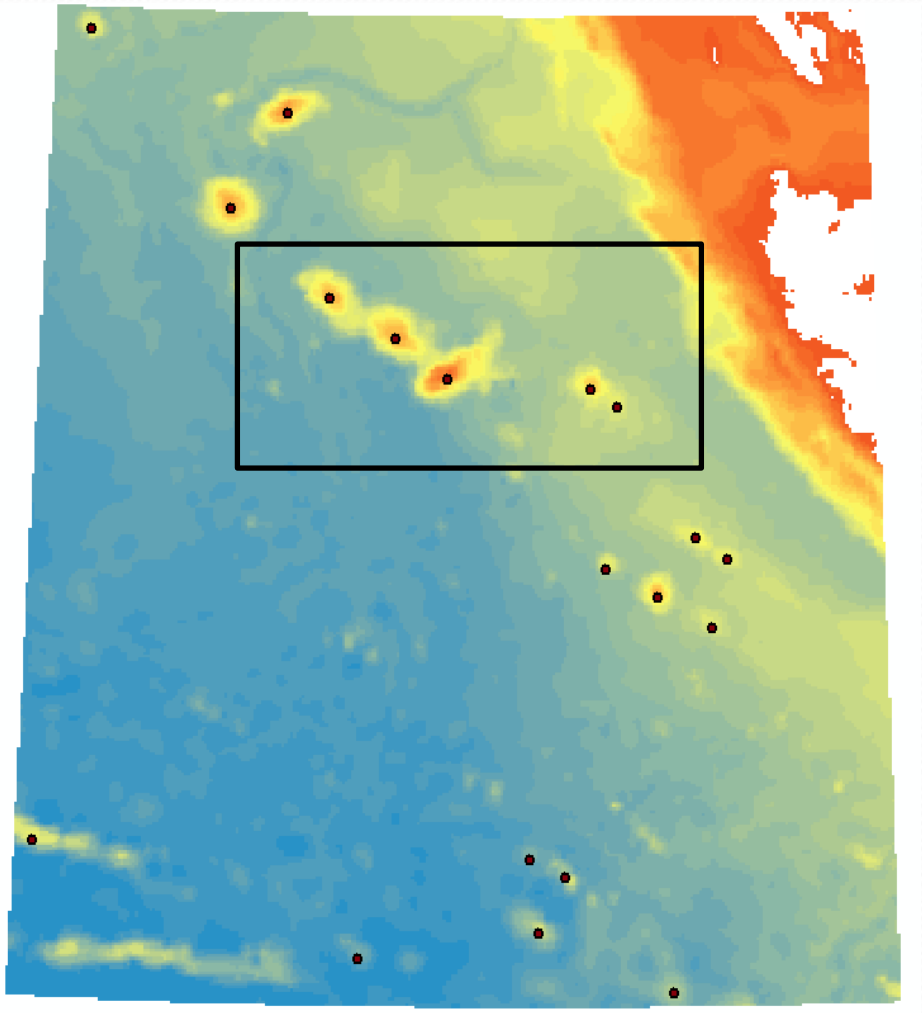


Image :
https://www.arcgis.com/home/item.html?id=5f3aefe77f6b4f61ad3e4c62f30bff3b

Results

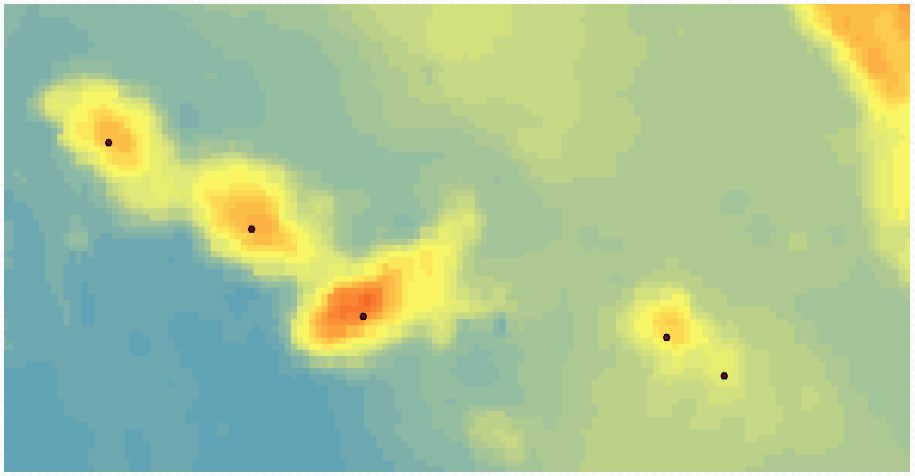
- Tested method on subset of 75 basins, encasing 5 seamounts

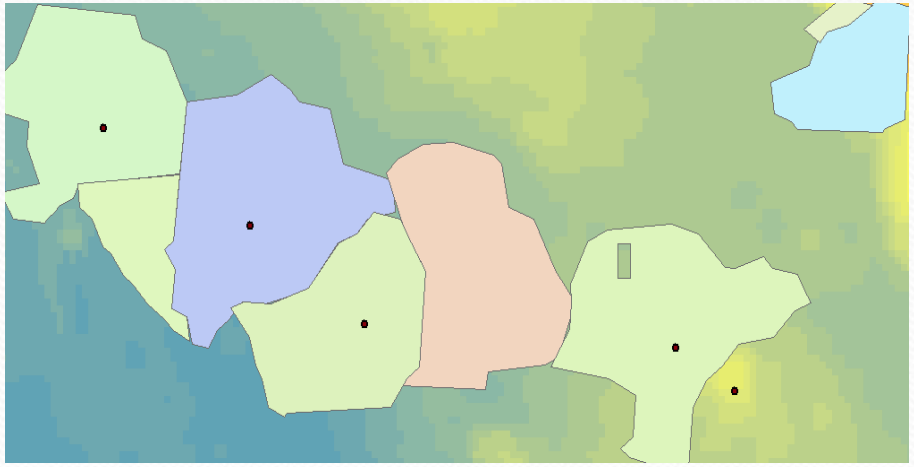




Results

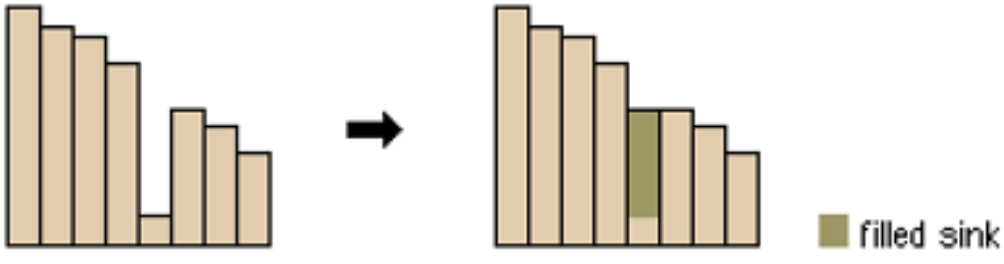
- Successfully ID 4/5 seamounts
- 5th seamount was actually below 1000m threshold
- Method also flagged continental shelf
- Also split seamounts into sections





Fill Tool

- Used to fill troughs in raster before using hydrology toolset
- Can specify maximum depth to fill
- Can be used to extend footprint of basins outward
- Also can fix splitting of a seamount into multiple basins

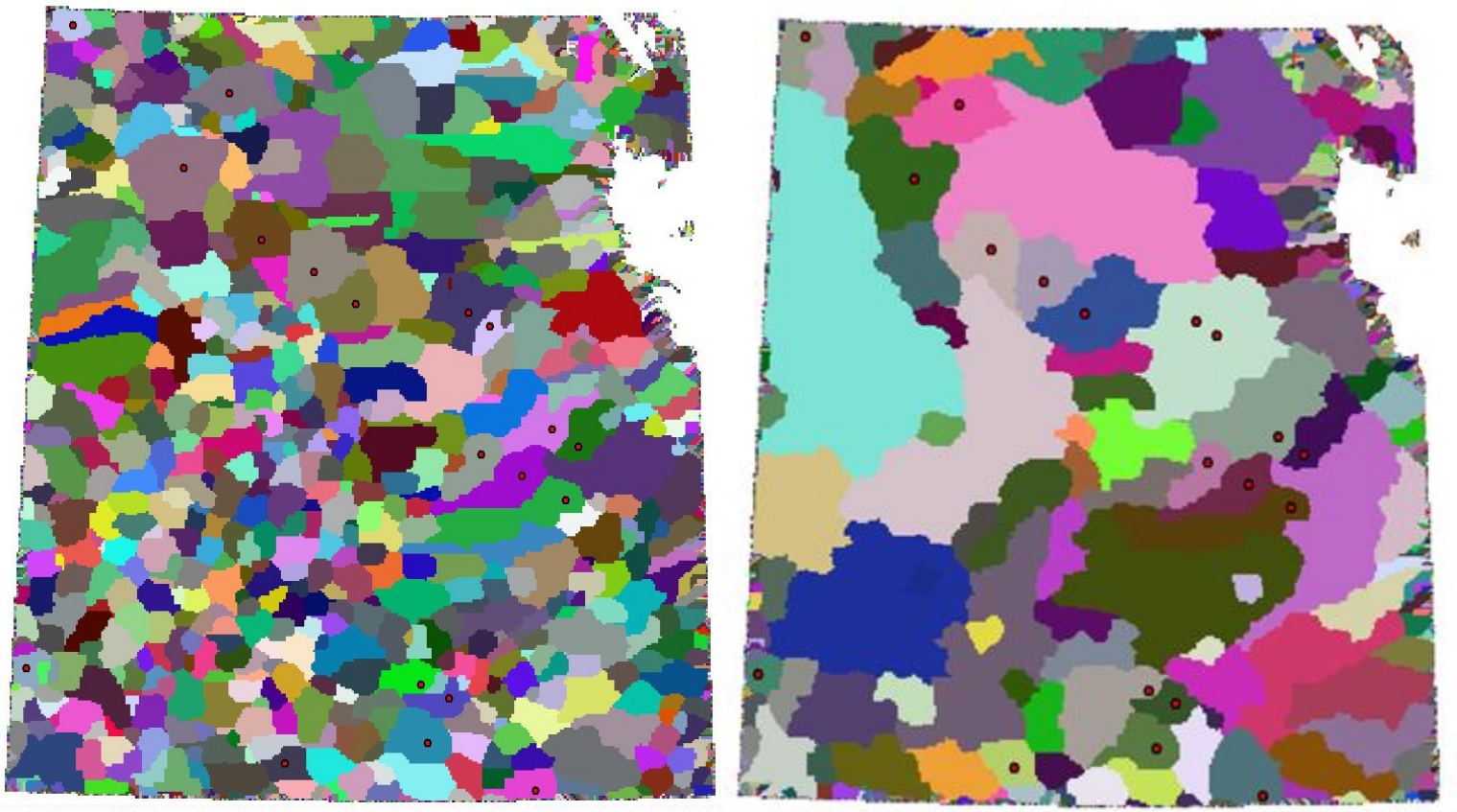


Profile view of a sink before and after running Fill

Image:
http://pro.arcgis.com/en/pro-app/tool-reference/spatial-analyst/how-fill-works.htm

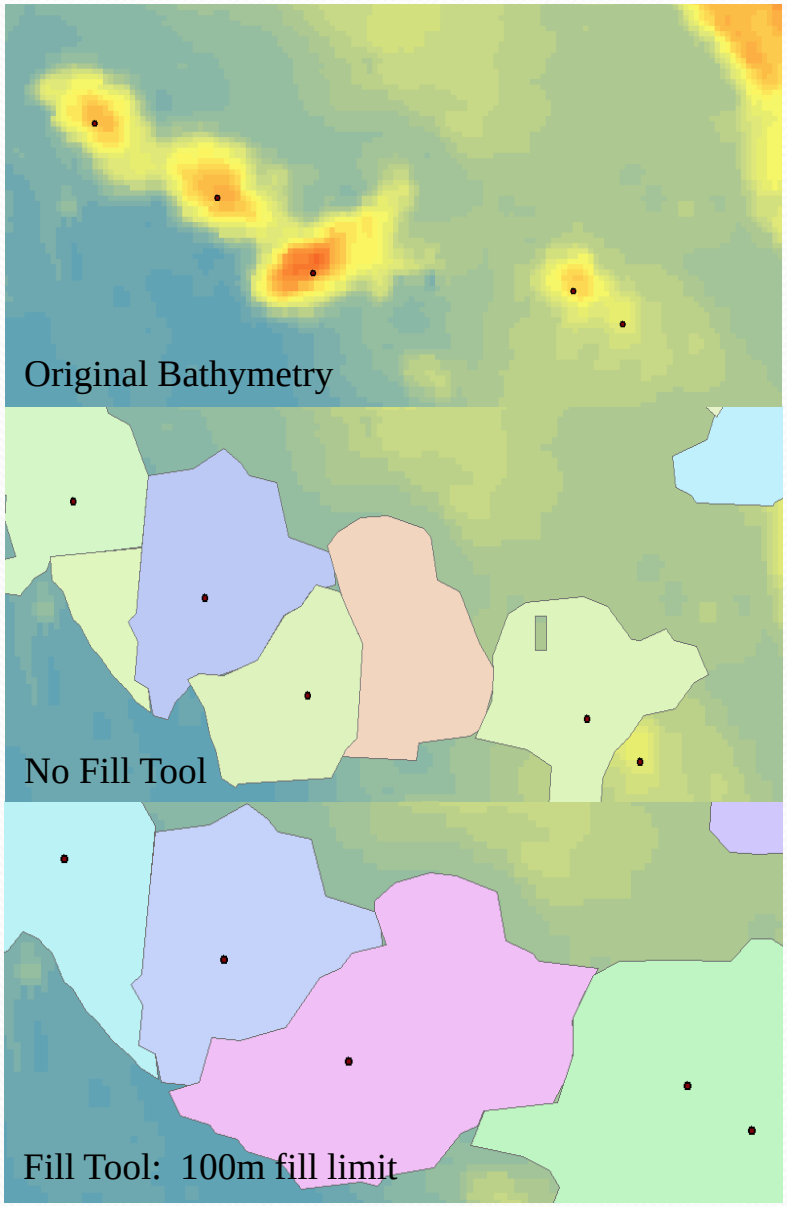
Fill Tool on Basins

- Fill tool removes small basins
- Previously 2,250 now 1700 basins
- Extends seamount basins outward



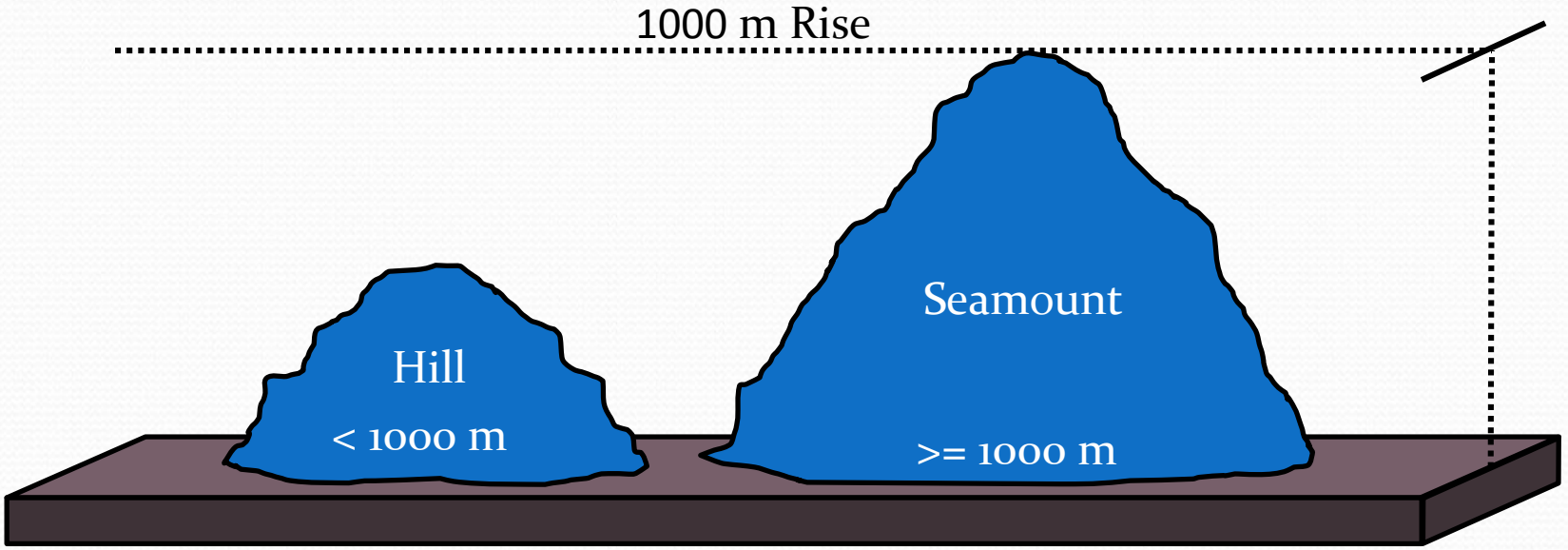
Fill Tool Results

- Similar results with same area flagged
- Combine basins of two seamounts into one
- Continues to flag continental shelf



Hills

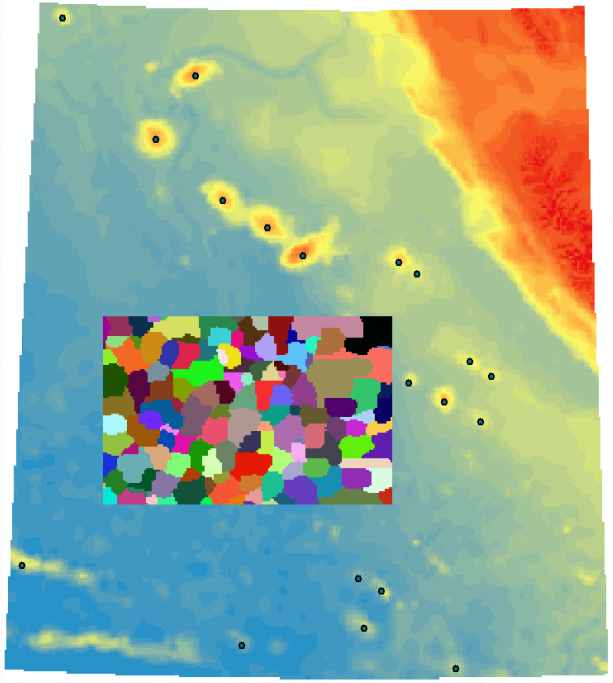
- A distinct elevation generally of irregular shape, less than 1000m above the surrounding relief as measured from the deepest isobath that surrounds most of the feature.

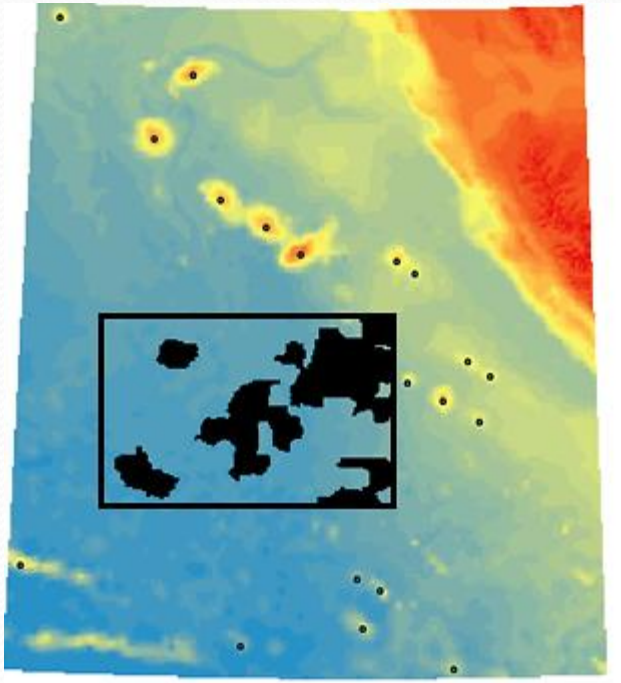


- Script was adapted to work with a second undersea feature, Hills

Hill Results

- Redefined the threshold needed for the script to flag the basin being tested
- Tested for a height difference between 500 m and 999 m
- 25 out of 134 basins flagged as possible hills





Next Steps

- Applications of slope to identify other types of undersea features
- Using slope to automate the identification of a seamount
- Application of fuzzy logic on different seamount thresholds
- Refining workflow to prevent ID errors (flagging the continental shelf)

Next Steps

- Process could be used in Canadian Arctic
- Help identify seamounts as more complete high resolution data is collected

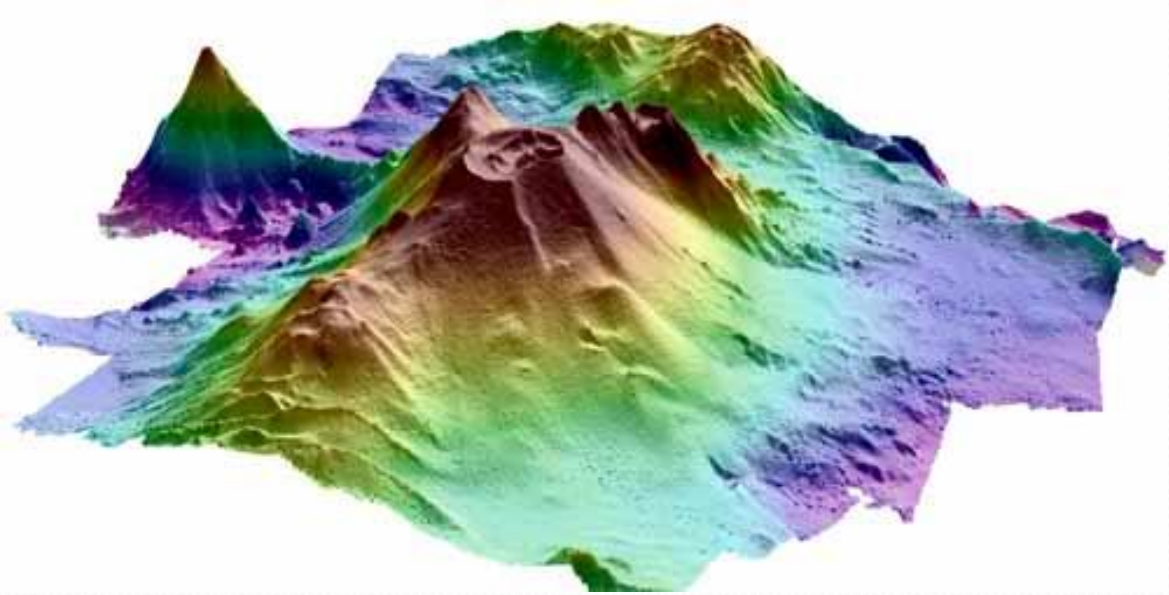


Image: http://4.bp.blogspot.com/_CDTtntnI_tU/TARrAorLj_I/AAAAAAAACH8/oLkFVQUYFuA/s1600/seamount.jpg

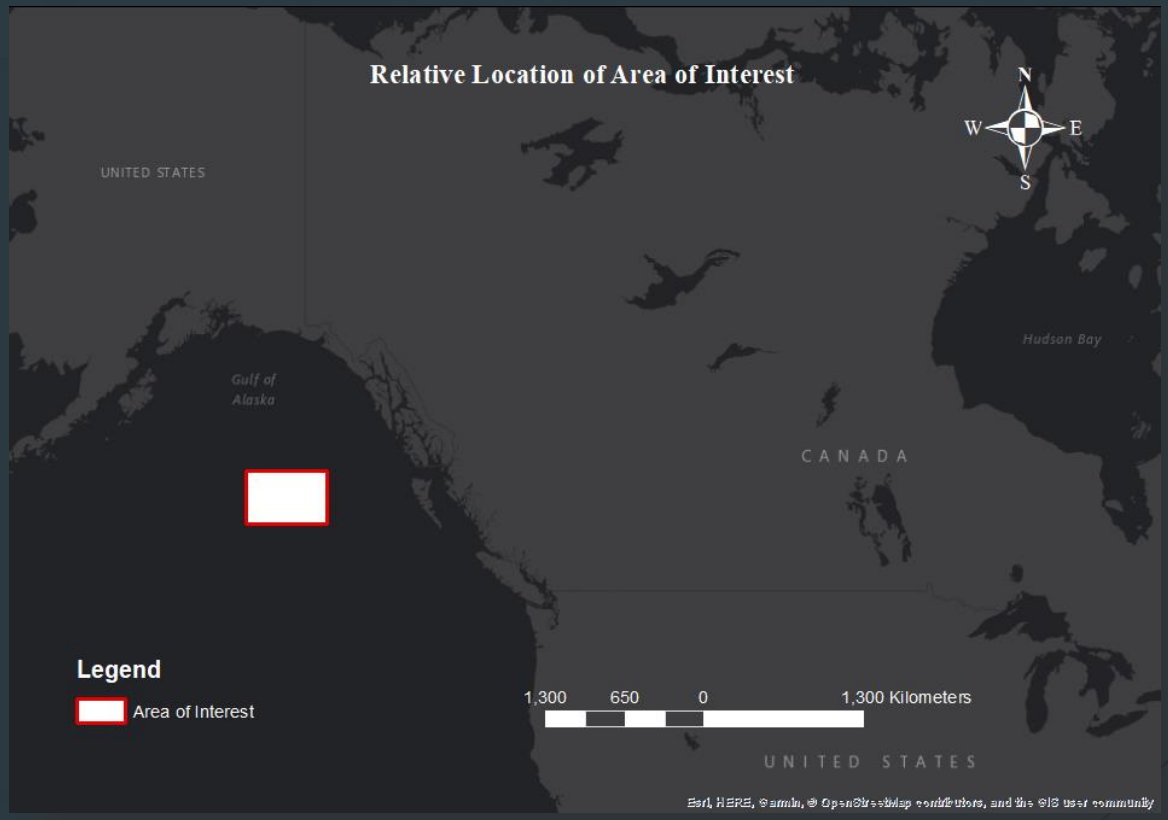
Automation of Undersea Feature Detection – Basin

Using Spatial Analysis with ArcMap 10.6

By Shenghao Shi

(Project in progress)

Area of Interest



B-6 Definition of Basin

- **BASIN:**
- A depression more or less equidimensional in plan and of variable extent

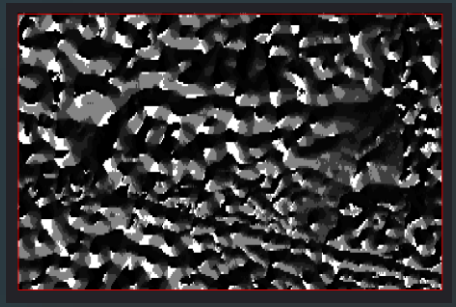
- Key points:
- Depression: center lower than edge (depth)
- Depression: center flatter than edge (slope)
- Equidimensional: overall shape

General method Summary

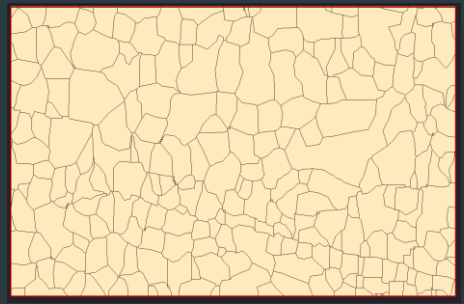
1. Use hydrology-basin tool to **identify basins** base on flow direction analysis
2. Check each basin with three factors:
    1. **Slope** value difference between **edge and center**
    2. **Depth** value difference between **edge and center**
    3. Overall **shape**
3. Using fuzzy logic to combine the result of step 2 (in progress)

Step 1. Hydrology Analysis

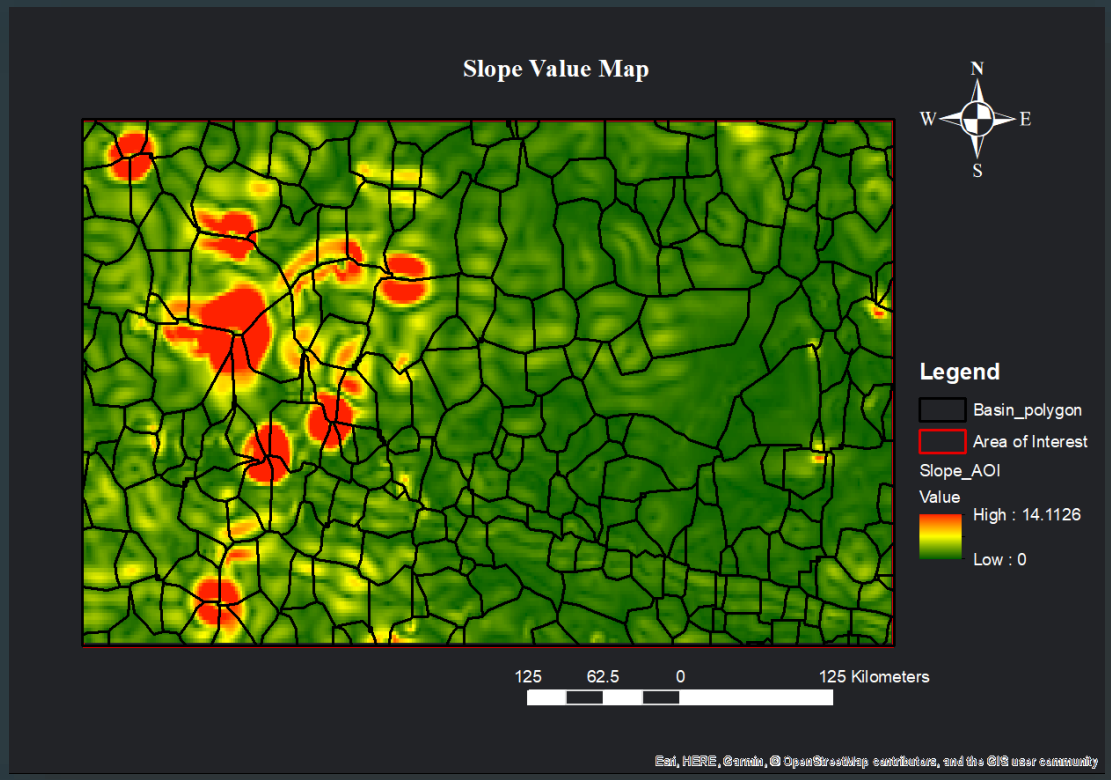
- Flow direction:
- Creates a raster of flow direction from each cell to its downslope neighbor, or neighbors.



- Basin:
- Creates a raster delineating all drainage basins.

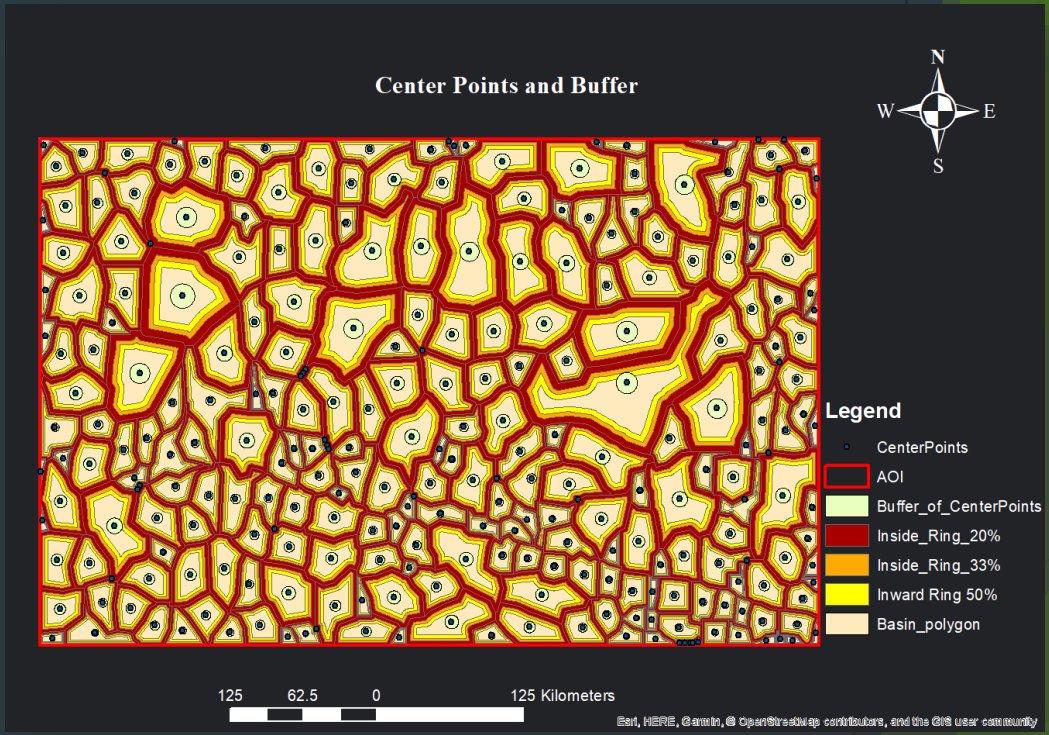


Step 3. Bathymetry and Slope Data



Step 4. Identify the center of each basin

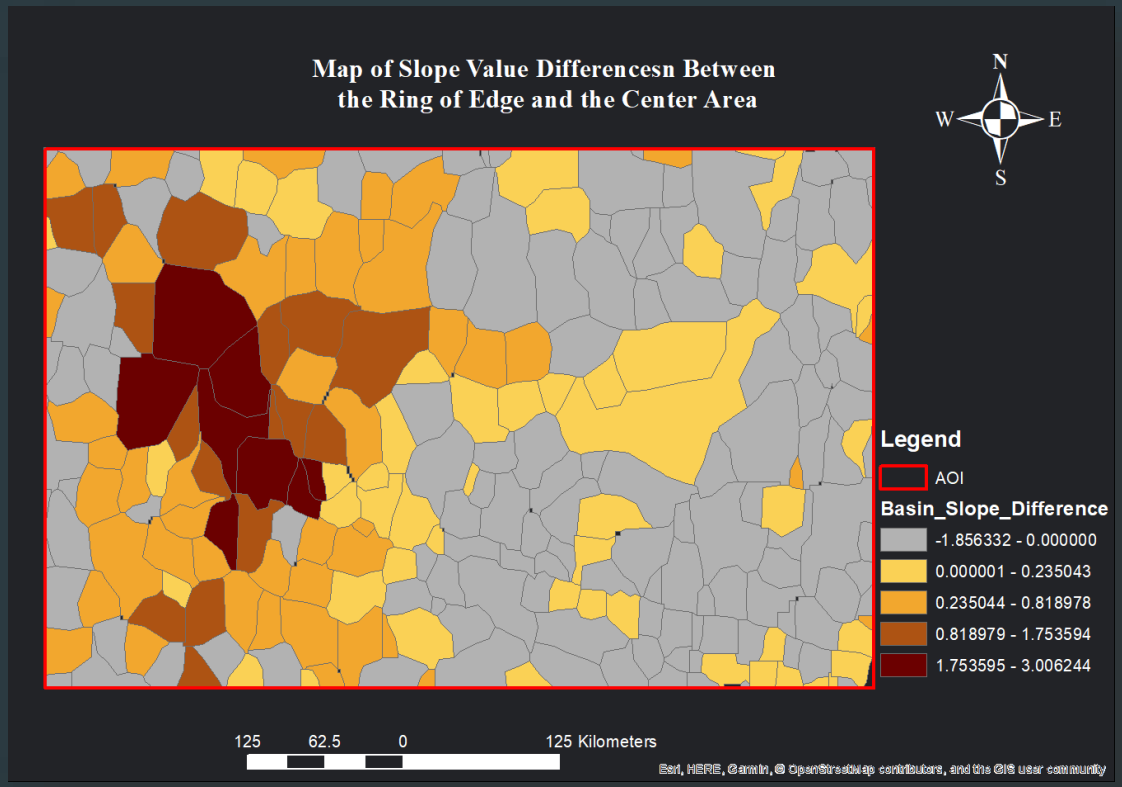
- Use calculate geometry- X coordinate of centroid & Y coordinate of centroid to get the center coordinate for each basin
- Export value as table
- Use Table-Display XY data to generate the central points
- Use buffer tool to create central area for each basin



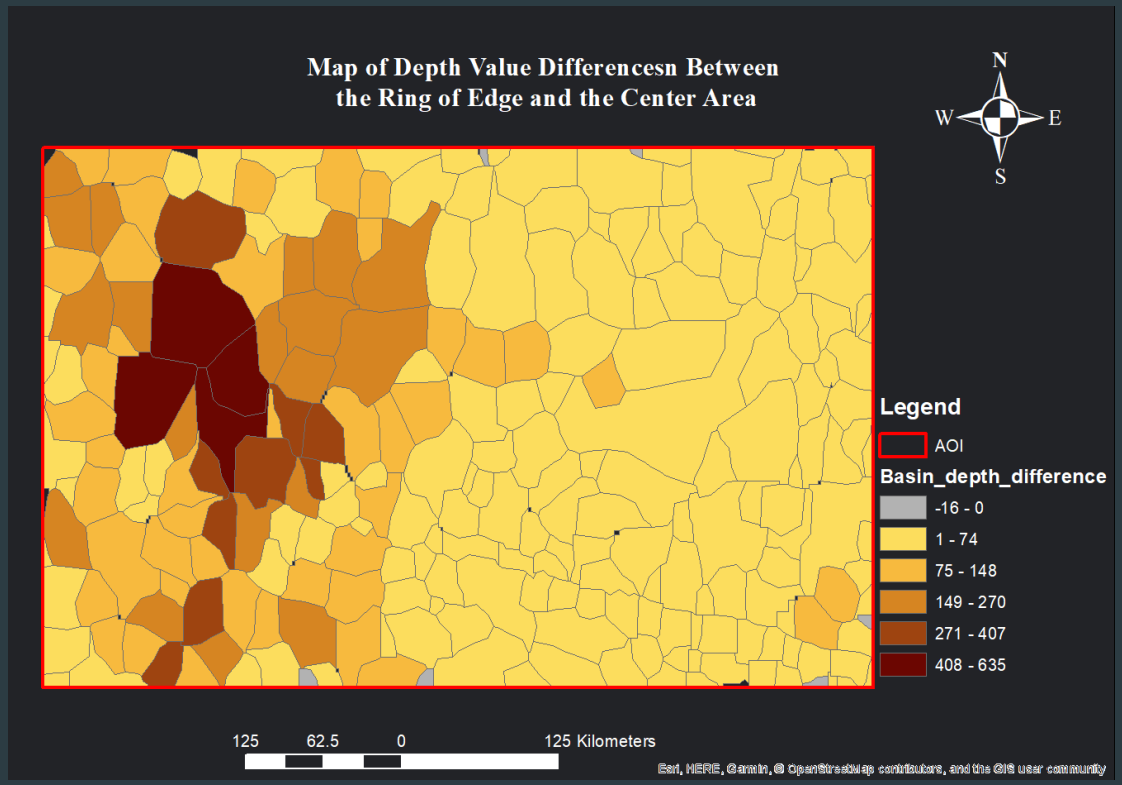
Step 5. Import Bathymetry and Slope Data into Center Area and Edge Area

- Use raster to point function to convert Bathymetry and Slope Data into point layers
- Use Analysis Tools -> Overlay - Spatial Join tool to import value into the center area and rings of edge respectively
- Joining the attribute tables

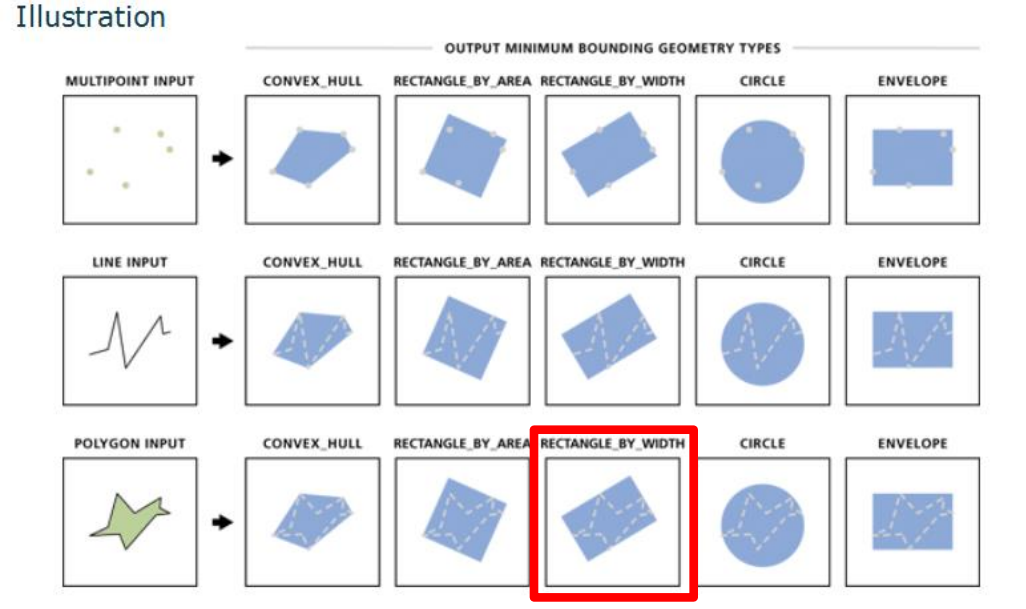
Step 6. Compare the Differences



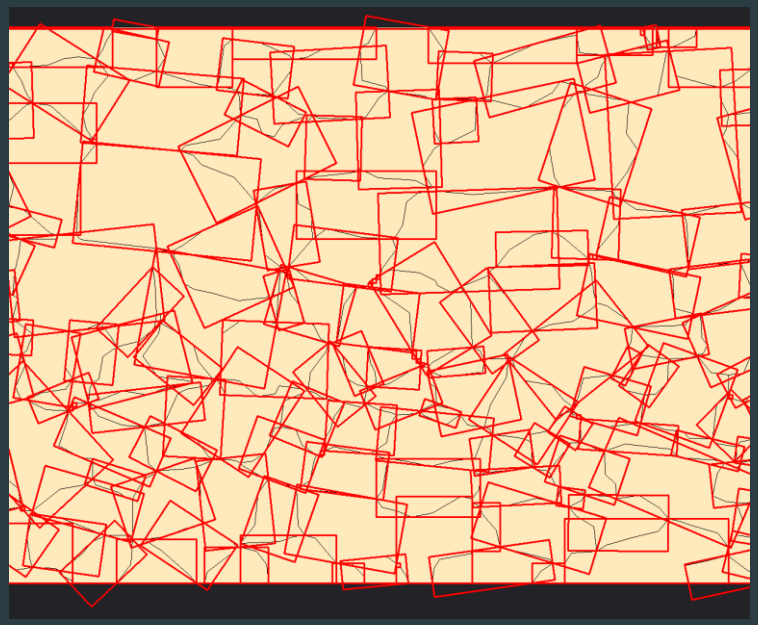
Step 6. Compare the Differences



Step 7. Shape Check using Minimum Bounding Geometry Tool (in progress)



Step 7. Shape Check using Minimum Bounding Geometry Tool (in progress)



This project is still in progress and we look forward to sending the result of the analysis when it is completed.

Next Step

- Continue to work on the shape check using minimum bounding geometry tool
- Experiment with different setting, such as difference basin size, use difference constant for calculations, etc.
- Use fuzzy logic to combine the result of three results.
- Check coordinates in real life to evaluate the effectiveness of the tool
- Automatic the procedure using module builder or script.

Thank You / Merci

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Questions

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