# An Introduction to Bathymetry

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This resource was developed as a result of participation in CSIRO's teacher professional learning program, Educator on Board.



# An Introduction to Bathymetry

## Overview:

Students will learn about Bathymetry and apply their understanding of this process by completing a research task, modelling task and graphing. Students will conduct research to identify and describe a variety of underwater geological features, and observe and identify a number of actual bathymetry images taken from features in the Coral Sea. Students will then use clay to model one particular geological feature, using a bathymetric map of their choice. Finally, students will use bathymetric sound data to graph an image of an underwater geological feature.

## Duration:

This sequence of lessons should take approximately 5 to 6 x 60min lessons

## 1> Introduction – What is Bathymetry?:

The students must be familiar with the concepts of plate tectonic movement and hot spot activity. Students should also be confident with graphing skills.

Class discussion

Ask students – how do we know what is under the ocean? How do we know what the sea floor looks like? How do we know how deep the sea is?

Introduce the concept of Bathymetry

Watch the videos found at the links below

- "How to map the ocean floor" https://www.youtube.com/watch?v=bADFB199KIc
- "RV *Investigator* – mapping the sea floor" https://www.youtube.com/watch?v=VqzeWw35CXo

Comprehension task

Provide students with a copy of the worksheet "Mapping the unknown". Students use the information provided at the link below to answer the questions

> CSIRO Educator on Board Blog "Mapping the Unknown"
https://research.csiro.au/educator-on-board/day-16-mapping-the-unknown/

Extension /Homework:

Ask students to go online and research

- One job or industry that requires the use of bathymetry (give a brief outline of why they need it)
- One bathymetry map of the sea floor somewhere around Australia.

NB: The video below is also useful for this lesson and could be set for homework if students complete the extension task during the lesson

"Scientists see ocean floor via Sonar" https://www.youtube.com/watch?v=-fAAxEIFeLU

# An Introduction to Bathymetry

## 2> Underwater geological features:

Sharing time/Discussion:
Check homework/extension task from previous lesson by asking students to share descriptions of jobs/industries/organisations that use Bathymetry. Display some of the student found images of bathymetry on the projector and discuss what the images show and what the colours on the map mean.

Class discussion:
Ask students – why do we need to map the sea floor? What does the sea floor look like? What sort of geological features are on the sea floor.

Stimulus Video:
Watch the video at the link below to find out about some underwater geological features
https://www.youtube.com/watch?v=Z1b3yNgIfKw

Research task
In pairs, students conduct research to complete the summary table on the double-sided worksheet "Underwater Geological Features". Students will need access to a device for this task.
When completing the worksheet, students will need to find the following information

- Provide a description of the feature
- Include shape, key identification features, average measurements if possible
- A sketch of the feature or diagram

Extension /Homework:
Read the blog posts below to learn more about how Bathymetry maps are created on board the RV *Investigator*
> CSIRO Educator on Board Blog "Pictures of the Underworld"
https://research.csiro.au/educator-on-board/day-17-olivia-belshaw/

# An Introduction to Bathymetry

## 3 to 4 > Exploring Bathymetry

Sharing time/Discussion:

Check homework/extension task from previous lesson by encouraging students to discuss what they learnt from reading the Blog post. Some questions could be

- What is the name of computer software used by research?
- What is the name of one of the key researchers on board the RV *Investigator* helping map the sea floor?
- Describe the shape and features of the Lexington Seamount
- How many sound data points do you believe have been used to create the 10 by 10km image?

Class discussion:

Ask students to recap the last lesson – what did we learn yesterday? What do we now know about underwater geological features?

Analysis Task:

Provide students with a colour copy of the double-sided worksheet "Bathymetry Maps from the Coral Sea".

Prior to students beginning this task, teachers should explain the Colour-coding and key found at the side of each image – the key refers to metres below sea surface. The Image has been "falsely" coloured to assist scientists in distinguishing features and areas of depth.

Students work with a partner or independently to identify what geological feature the bathymetry maps may be showing. Students need to justify their decision by referring to key characteristics of underwater geological features.

NB: teacher can project larger versions of images onto the screen. These can be found in the "Bathymetry Images" PowerPoint.

Practical Activity:

Provide students with a copy of the worksheet "Building a Model". Students will follow the instructions to construct ONE underwater geological feature from the previous worksheet "Bathymetry Maps of the Coral Sea".

# An Introduction to Bathymetry

## 5 to 6 > Plotting Data

Class discussion:
As a class, encourage students to discuss the success of their 3D models from last lesson. Use the discussion questions from worksheet 4 “Building a Model” to guide students through an evaluation of the success of their model. Are the models or Bathymetry maps more useful for scientists? Why?

Plotting Data:
In this task, students will plot modified bathymetric data, taken from the RV *Investigator’s* 2019 voyage into the Coral Sea.

Students will use the data set provided and the colour code provided to plot each bathymetric data point onto a grid. Once students have plotted their data, they are to identify which underwater feature they have mapped – they will need to justify their choice.

NB: for teacher reference, the actual bathymetric map used to inspire this activity can be found on slide 6 of the “Bathymetry Images” PowerPoint.

Class Discussion:
At the completion of the mapping task, students should discuss their findings – do their maps look the same? Are there differences and if so, why? What are some benefits to plotting this type of data? What are the disadvantages or limitations to this data?

Formative Assessment:
If teachers wish to assess the understanding of students at the end of this sequence of lessons, students can complete the Bathymetry Quiz, which consists of 10 multiple choice questions.

Answers -
1. B
2. C
3. B
4. C
5. A
6. D
7. C
8. B
9. A
10. D

# Worksheet 1 – Mapping the Unknown

Read the information provided at the link below and use it to answer the questions on this worksheet.
https://research.csiro.au/educator-on-board/day-16-mapping-the-unknown/

1. How much of the sea floor is mapped?

2. What is “swathing”?

3. Describe the process of swathing that occurs on-board the RV *Investigator*.

4. When interpreting Swathing data, what other factors must computer software take into account?

5. Describe how *backscatter* assists with developing our understanding of the sea floor.

# Worksheet 2 – Underwater Geological Features

In pairs, you will conduct research using the internet to create a summary of some of the different types of underwater geological features that can be mapped using Bathymetry.

When you're writing your descriptions in the summary table below, make sure you consider the following points:

- Provide a description of the feature
- Include shape, key identification features, average measurements if possible
- Consider naming an example

| Feature Name | Description of feature | Sketch of shape / Diagram |
|---|---|---|
| **Continental shelf** | | |
| **Mid ocean ridge** | | |
| **Ocean trench** | | |

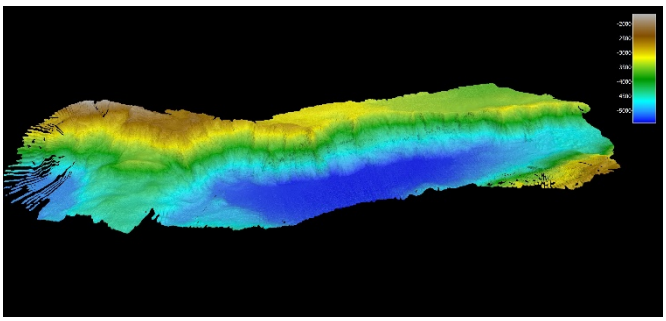
# Worksheet 2 – Underwater Geological Features

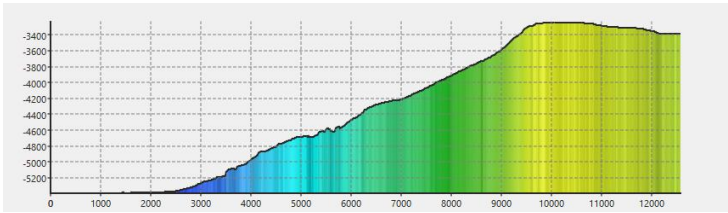
| Feature Name | Description of feature | Sketch of shape / Diagram |
|---|---|---|
| **Oceanic Trough** | | |
| **Seamount** | | |
| **Guyot** | | |
| **Abyssal plain** | | |

# Worksheet 3 – Bathymetry Maps from the Coral Sea (RV *Investigator*)

Observe each Bathymetry image below, including the supporting feature profile. For each bathymetry image

- Identify the geological feature being depicted
- Justify your decision by referring to key characteristics of the underwater feature






GEOLOGICAL FEATURE 1
What is it? _____

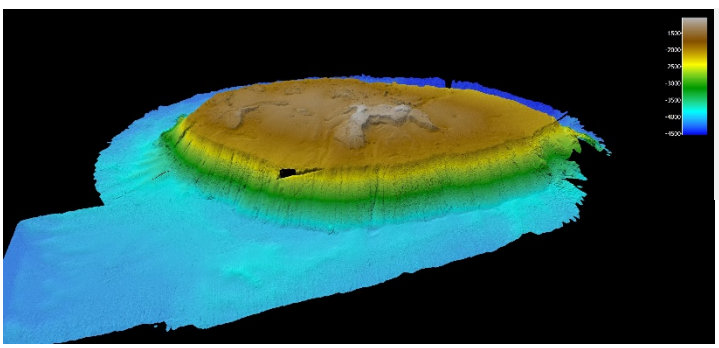
Justification:

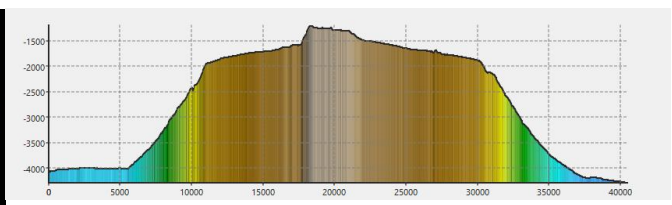
_____

_____

_____

_____






GEOLOGICAL FEATURE 2
What is it? _____

Justification:

_____

_____

_____

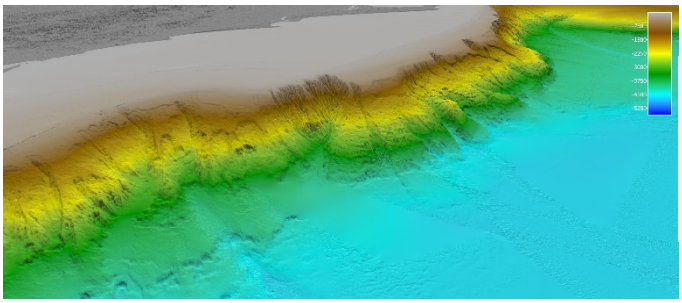
_____

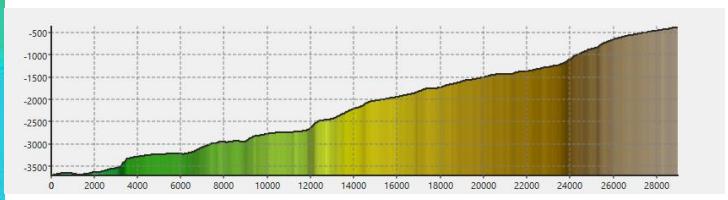
All images created by Amy Nau – Marine National Facility "RV_Investigator_2019_V04". Shared with her permission.

# Worksheet 3 – Bathymetry Maps from the Coral Sea (RV Investigator)

Observe each Bathymetry image below, including the supporting feature profile. For each bathymetry image

- Identify the geological feature being depicted
- Justify you decision by referring to key characteristic of the underwater feature






GEOLOGICAL FEATURE 3

What is it? _____

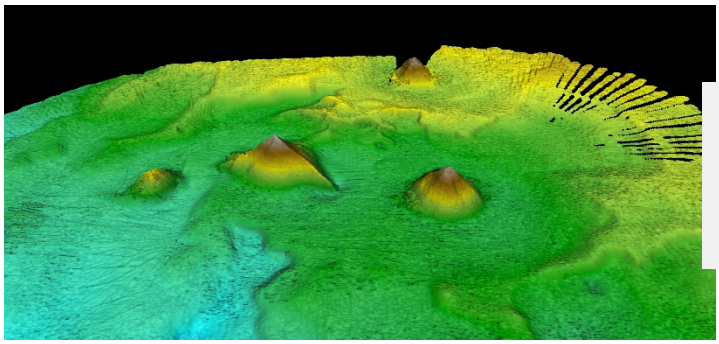
Justification:

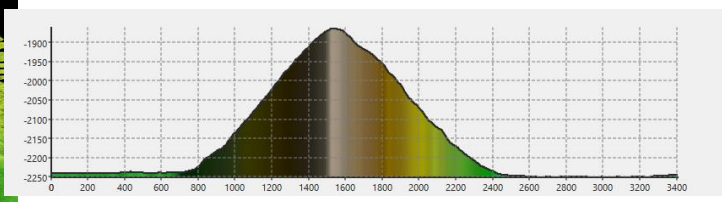
_____

_____

_____

_____






GEOLOGICAL FEATURE 4

What is it? _____

Justification:

_____

_____

_____

_____

All images created by Amy Nau – Marine National Facility "RV_Investigator_2019_V04". Shared with her permission.

# Worksheet 4 – Building a Model

This is a practical task. Work in groups of 4 to 5 to complete this task.

Select ONE bathymetry map from the previous activity (worksheet 3). Work with your team to create a 3D model representation of this map. You should use colours in your model that correspond with depth colours in your bathymetry image.

**Equipment required:**

- 8 squares of craft foam OR 8 blocks of plasticine (each square/block should match a depth colour form your selected bathymetry image)
- Plastic tub or plastic lid to sit your model on
- Scissors
- Plasticine clay modelling tools (or plastic knives, spoons, fishing line etc.)

**Method:**

1. Construct a 3D model of your chosen Bathymetry image.
2. Ensure the model is colour coded as closely as possible to your chosen image
3. Start with the deepest layer/contour first, then move on to the second deepest layer and so on
4. Where possible, carve out pieces of plasticine as required to ensure your model represents your image as closely as possible.

**Results:**

Include a photograph of your final model in the space below.

**Discussion Questions:**

Compare your 3D model to the Bathymetric image.

- Which do you prefer? Why?
- Which shows more detail?
- Which would provide scientists with the most useful information?
- List 2 advantages of the Bathymetric image over your 3D model.

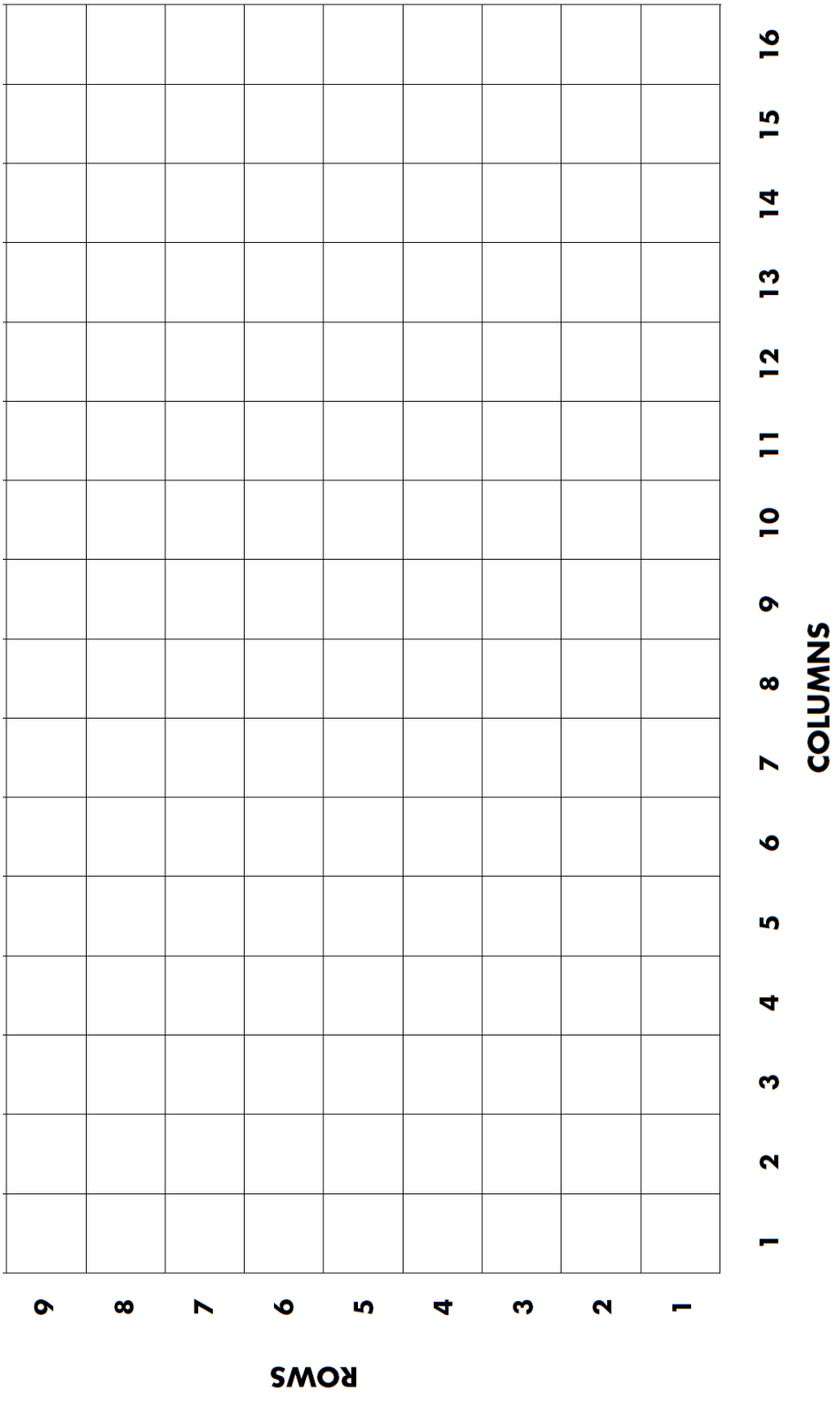
# Worksheet 5 – Bathymetric Data

Use the modified Bathymetry data on the next page to create a basic Bathymetry map of a feature identified by the RV *Investigator* on Voyage 4 2019 in the Coral Sea.

Use coloured pencils to fill in each section of the grid, based on the depth information and the key below.

Depth Colour coding
- 5000 to 4600m dark blue
- 4500 to 4100m light blue
- 4000 to 3600, green
- 3500 to 3100m yellow
- 3000 to 2600m orange

Based on your Bathymetry map, what type of underwater geological feature do you think you have mapped? Justify your answer.



# Worksheet 5 – Bathymetric Data

| Grid Cell (R, C) | Depth (m) | Grid Cell (R, C) | Depth (m) | Grid Cell (R, C) | Depth (m) | Grid Cell (R, C) | Depth (m) | Grid Cell (R, C) | Depth (m) | Grid Cell (R, C) | Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1, 1** | 3100 | 2, 12 | 5000 | 4, 6 | 4800 | 5, 16 | 4200 | 7, 10 | 4500 | 9, 4 | 4800 |
| **1, 2** | 3300 | 2, 13 | 5000 | 4, 7 | 4900 | 6, 1 | 4500 | 7, 11 | 4400 | 9, 5 | 4800 |
| **1, 3** | 3600 | 2, 14 | 4800 | 4, 8 | 5000 | 6, 2 | 4700 | 7, 12 | 3100 | 9, 6 | 4500 |
| **1, 4** | 3800 | 2, 15 | 4800 | 4. 9 | 4900 | 6, 3 | 4700 | 7, 13 | 3600 | 9, 7 | 4400 |
| **1, 5** | 3800 | 2, 16 | 4800 | 4, 10 | 4800 | 6, 4 | 5000 | 7, 14 | 3600 | 9, 8 | 4000 |
| **1,6** | 4600 | 3, 1 | 3500 | 4, 11 | 4700 | 6, 5 | 5000 | 7, 15 | 3500 | 9, 10 | 3900 |
| **1, 7** | 4900 | 3, 2 | 3700 | 4, 12 | 4700 | 6, 6 | 5000 | 7, 16 | 3400 | 9, 11 | 3900 |
| **1, 9** | 5000 | 3, 3 | 4000 | 4, 13 | 4700 | 6, 7 | 5000 | 8, 1 | 4600 | 9, 12 | 3800 |
| **1, 10** | 5000 | 3, 4 | 4300 | 4, 14 | 4600 | 6, 8 | 4900 | 8, 2 | 4700 | 9, 13 | 3500 |
| **1, 11** | 5000 | 3, 5 | 4600 | 4, 15 | 4500 | 6, 9 | 4700 | 8, 3 | 5000 | 9, 14 | 3100 |
| **1, 12** | 5000 | 3, 6 | 4700 | 4. 16 | 4400 | 6, 10 | 4600 | 8, 4 | 5000 | 9, 15 | 3000 |
| **1, 13** | 5000 | 3, 7 | 4800 | 5, 1 | 4000 | 6, 11 | 4400 | 8, 5 | 5000 | 9, 16 | 2900 |
| **1, 14** | 5000 | 3, 8 | 5000 | 5, 2 | 4000 | 6, 12 | 3800 | 8, 6 | 4800 | | |
| **1, 15** | 4900 | 3, 9 | 5000 | 5, 3 | 4600 | 6, 13 | 3700 | 8, 7 | 4800 | | |
| **1, 16** | 4900 | 3, 10 | 5000 | 5, 4 | 4800 | 6, 14 | 3700 | 8, 8 | 4800 | | |
| **2, 1** | 3300 | 3, 11 | 5000 | 5, 5 | 4900 | 6, 15 | 3600 | 8, 9 | 4000 | | |
| **2, 2** | 3500 | 3, 12 | 4900 | 5, 6 | 4900 | 6, 16 | 3600 | 8, 10 | 4000 | | |
| **2, 3** | 3700 | 3, 13 | 4900 | 5, 7 | 5000 | 7, 1 | 4700 | 8, 11 | 4200 | | |
| **2, 4** | 4200 | 3, 14 | 4700 | 5, 8 | 5000 | 7, 2 | 4800 | 8, 12 | 3799 | | |
| **2, 5** | 4000 | 3, 15 | 4600 | 5, 9 | 4800 | 7, 3 | 5000 | 8, 13 | 3500 | | |
| **2, 6** | 4700 | 3, 16 | 4600 | 5, 10 | 4800 | 7, 4 | 5000 | 8, 14 | 3600 | | |
| **2, 7** | 4900 | 4, 1 | 3800 | 5, 11 | 4500 | 7, 5 | 5000 | 8, 15 | 3500 | | |
| **2, 8** | 5000 | 4, 2 | 3800 | 5, 12 | 4600 | 7, 6 | 5000 | 8, 16 | 3300 | | |
| **2, 9** | 5000 | 4, 3 | 4300 | 5, 13 | 4600 | 7, 7 | 5000 | 9, 1 | 4700 | | |
| **2, 10** | 5000 | 4, 4 | 4500 | 5, 14 | 4600 | 7, 8 | 4900 | 9, 2 | 4800 | | |
| **2, 11** | 5000 | 4, 5 | 4700 | 5, 15 | 3800 | 7, 9 | 4700 | 9, 3 | 5000 | | |

Name: _____

# Bathymetry Quiz

1. Approximately how much of the sea floor has been mapped by scientists?
    a. 10%
    b. 4%
    c. 0.4%
    d. 40%

2. Which of the following describes an oceanic trench?
    a. It rises above the surface of the seawater
    b. A stretch of undersea mountains
    c. A flat, low lying area of the oceanic floor
    d. Deep cuts in the ocean floor, canyon-like

3. Mountains the form along the bottom of the seafloor, and do not extend above the sea surface are called:
    a. Guyots
    b. Seamounts
    c. Islands
    d. Coral Reefs

4. When you are wading in the sea, just beyond the shoreline, what are you standing on?
    a. Continental rise
    b. Abyssal plain
    c. Continental shelf
    d. Oceanic crust

5. What is Bathymetry?
    a. The measurement of the depth of the sea floor
    b. The measurement of the height of submarine mountains
    c. Photographing underwater geological features
    d. Biological surveying of deep-sea ecosystems

6. What technology is used to map the sea floor?
    a. LIDAR
    b. RADAR
    c. LASER
    d. SONAR

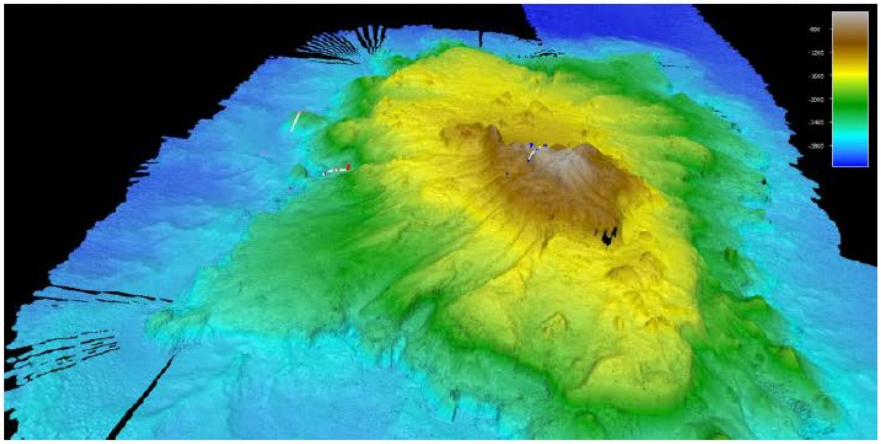
7. What is the name of the system attached to the base of the RV Investigator that is used to map the sea floor?
    a. Single Beam
    b. Dual Beam
    c. Multibeam
    d. Sidescan beam

Name: _____

# Bathymetry Quiz

8. A seamount has a flat top. This means that at one time the seamount was above sea level and the top eroded away. What is this geological feature called?
    a. Oceanic plateau
    b. Guyot
    c. Submarine seamount
    d. Submarine Reef

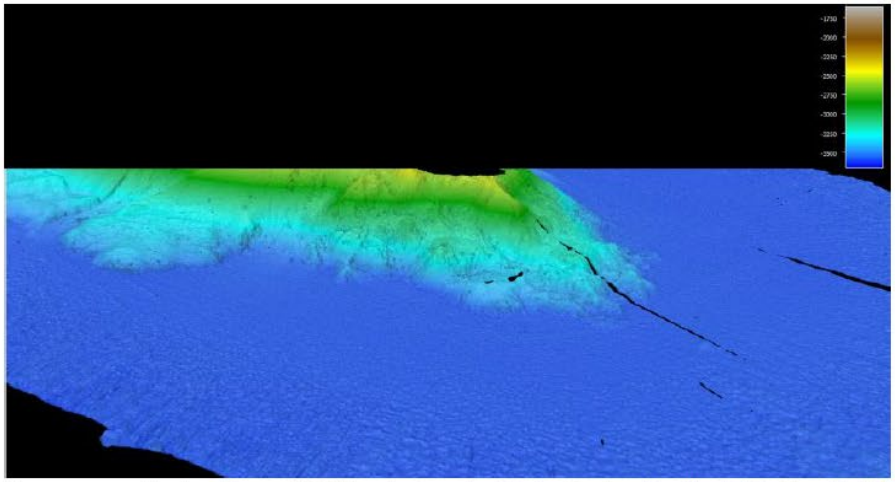
9. Look at the Bathymetric image below. What feature does it depict?



*(Image created by Amy Nau and Phil Vandenbossche, Marine National Facility 2019. Shared with permission).*

    a. Seamount
    b. Guyot
    c. Reef
    d. Abyssal Plain

10. What is the **main** geological feature depicted in the Bathymetric image below?



*(Image created by Amy Nau and Phil Vandenbossche, Marine National Facility 2019. Shared with permission).*

    a. Reef
    b. Continental Shelf
    c. Oceanic trough
    d. Abyssal Plain

| Total | /10 |
|---|---|

# References


In Close (2016) *How to Map the Ocean Floor | Mapping the Sound*. Available at: https://www.youtube.com/watch?v=bADFB199KIc (Accessed 28 November 2019)

CSIRO (2017) *RV Investigator – mapping the sea floor (science version).* Available at: https://www.youtube.com/watch?v=VqzeWw35CXo (Accessed 28 November 2019)

Olivia Belshaw 2019, *Day 16: Mapping the Unknown,* CSIRO, viewed 28 November 2019 <https://research.csiro.au/educator-on-board/day-16-mapping-the-unknown/>

National Geographic (2011) *Scientists "See" Ocean Floor via Sonar | National Geographic.* Available at: https://www.youtube.com/watch?v=-fAAxEIFeLU (Accessed 28 November 2019)

Lincoln Learning Solutions (2017) *Ocean Floor Features*. Available at: https://www.youtube.com/watch?v=Z1b3yNgIfKw (Accessed 28 November 2019)

Olivia Belshaw 2019, *Day 17: Pictures of the Underworld,* CSIRO, viewed 28 November 2019 < https://research.csiro.au/educator-on-board/day-17-olivia-belshaw/ >

**Images - Worksheet 3**
*Profile and Plan views of underwater geological features (obtained during RV_Investigator_2019_V04)*, Amy Nau, Marine National Facility, 2019

**Images - Bathymetry Quiz**
*Plan views of underwater geological features (obtained during RV_Investigator_2019_V04)*, Amy Nau and Phil Vandenbossche , Marine National Facility, 2019