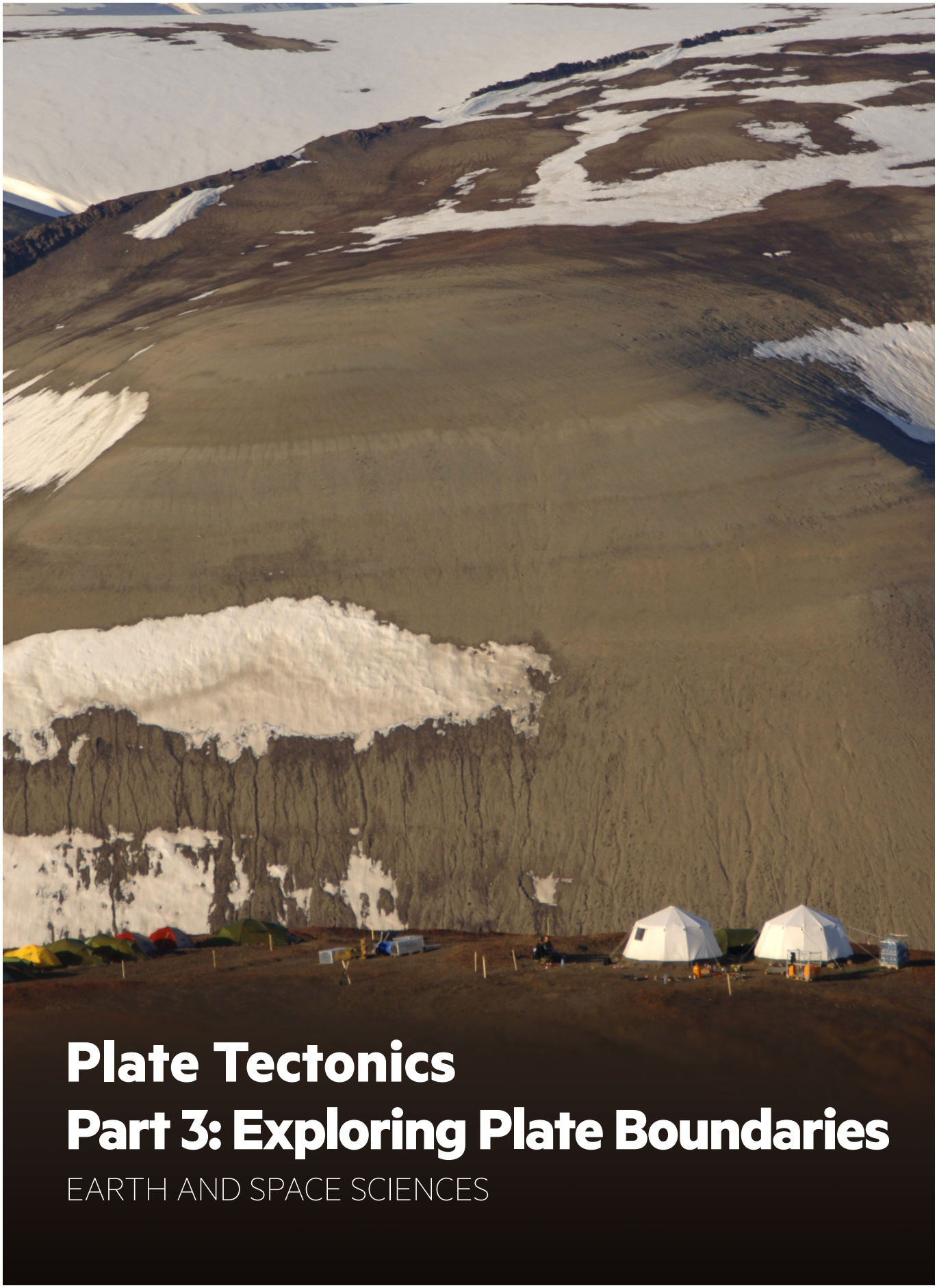

Plate Tectonics
Part 3: Exploring Plate Boundaries

EARTH AND SPACE SCIENCES

QGC | FUTUREMAKERS | QUEENSLAND MUSEUM NETWORK | Queensland Government

Introduction

The Queensland Museum Network has one of the largest and most significant Geosciences Collections in the southern hemisphere. The Geosciences Collection consists of 55,000 geological samples and 27,000 mineral samples, as well as over 7 million fossil specimens! This includes nearly 10,000 primary type specimens (reference specimens used to identify, name and classify fossil plant or animal species).

The Geosciences Collection contains pivotal resources that help scientists to:

- Discover and document past Australasian biodiversity as revealed from the fossil record.
- Interpret the evolutionary history of animals and plants over 3000 million years.
- Understand the geological history of Australia and how that impacted upon both terrestrial and marine ecosystems.
- Understand historical environmental changes in Australia as seen in the fossil record.
- Interpret past climates and understand how living things responded to these climatic and environmental changes.
- Use historical data to predict future trends, and infer how ecosystems may respond to the changing climate and environment.

Fossils such as the ichthyosaur (page 9) can be seen in the *Lost Creatures* exhibition at the Queensland Museum, Brisbane. Look up your local Queensland Museum Network campus to find out about current exhibitions.

This resource may be used individually or with the Queensland Museum resources *'Plate Tectonics Part 1: Continental Drift'* and *'Plate Tectonics Part 2: Plate Tectonics and Australia'*. Likewise, the resources *'Volcanoes'* and *'Igneous Rocks'* may also complement this subject area.

Future Makers is an innovative partnership between Queensland Museum Network and Shell's QGC project aiming to increase awareness and understanding of the value of science, technology, engineering and maths (STEM) education and skills in Queensland.

This partnership aims to engage and inspire people with the wonder of science, and increase the participation and performance of students in STEM-related subjects and careers — creating a highly capable workforce for the future.

Activity Overview
Exploring Plate Boundaries

In this activity you will use your visual literacy skills to infer the significance of a location, and then explore how this location has changed over time. You will also use Mars bars to model tectonic plate boundaries, and investigate the geological features and events that occur at these boundaries.

Teacher Tips

- Scientists work collaboratively. Questions and activities can be conducted in groups of 3-4 to maximise learning.

Activity 1 Monsters in the Mountain - Visual Literacy

- 'Figure 1: What is it?' may be projected for class discussion.
- Students could use this activity to practice annotating a text.

Activity 2 Tasty Tectonics - Exploring Plate Boundaries

- You may want to model this activity with students so that they can follow your demonstration. It is recommended that teachers trial this activity before class.
- Ensure the activity is conducted in a food safe area and check allergies before allowing students to eat Mars bars.
- You may want to facilitate a discussion about the benefits and limitations of this model.
- Activity 2, pages 10-11 may be used individually for a quick, hands-on activity.

Assumed Knowledge

- Structure of the Earth.
- The lithosphere is broken into tectonic plates that move.
- Plate boundaries may be convergent (destructive), divergent (constructive) or transform (conservative).
- Theory of continental drift - the position of the continents has changed over time.

Australian Curriculum Links

Year 9

Science Understanding

The theory of plate tectonics explains global patterns of geological activity and continental movement (ACSSU180)

Science Inquiry Skills

Plan, select and use appropriate investigation types, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods (ACSIS165)

Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS174)

Year 6

Science Understanding

Sudden geological changes and extreme weather events can affect Earth's surface (ACSSU096)

Science Inquiry Skills

Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS107)

Compare data with predictions and use as evidence in developing explanations (ACSIS221)

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS110)

General Capabilities – Literacy

Comprehending texts through listening, reading and viewing.

Understand how visual elements create knowledge.

Activity 1
Monsters in the Mountains - Visual Literacy.

Look closely, what can you infer from a picture?

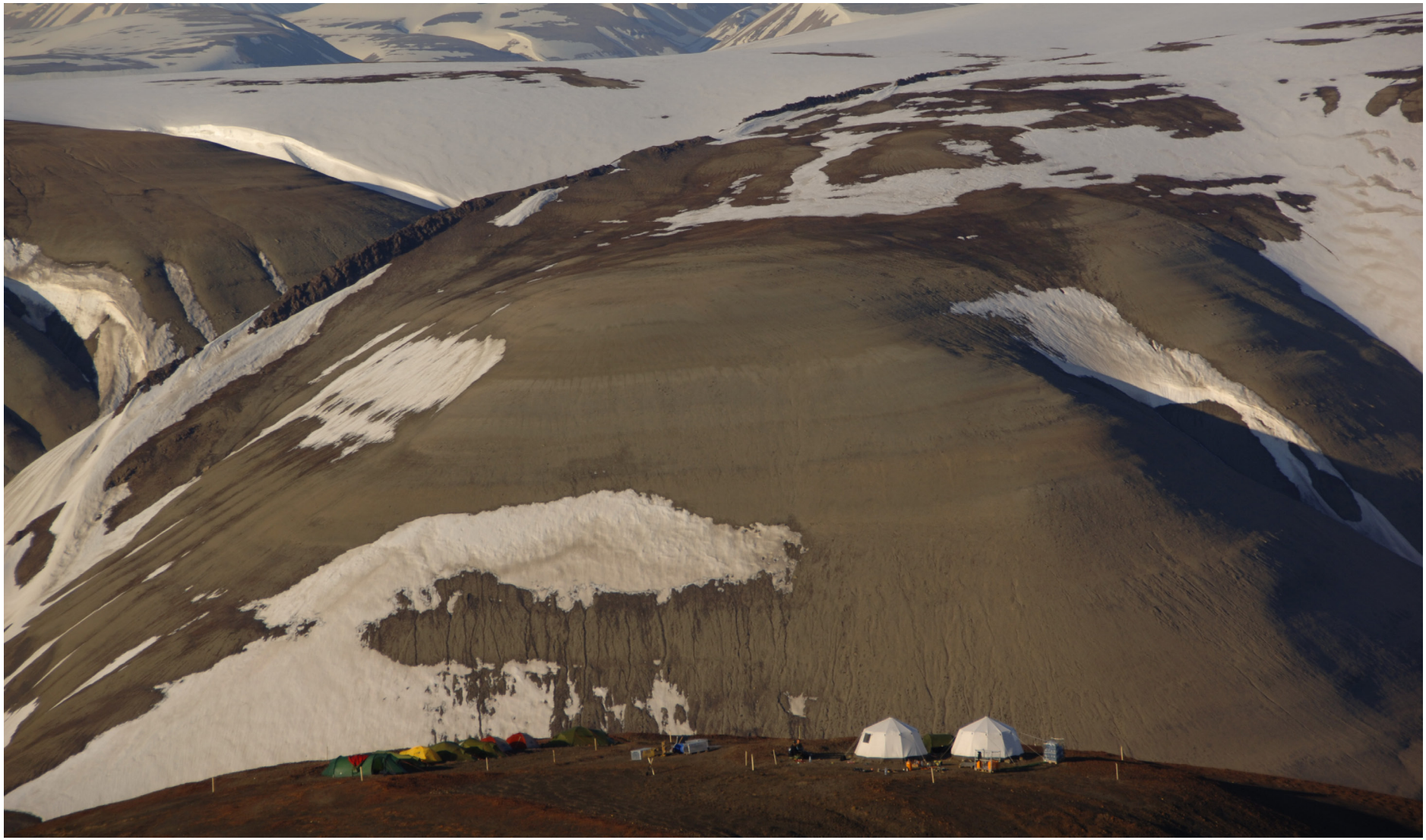

Figure 1: What is it? *Image: Jørn Hurum / NHM / UiO*

Group Discussion: Visual Literacy

Use Figure 1 to answer the questions below. Remember to justify your answers.

1. **Describe what you see in the picture.**

2. **Explain where the picture may have been taken.**

3. **Make an inference: there are people conducting scientific work in this location. What might they be doing?**

4. **What types of living things might you find in this environment?**

5. **What types of fossils might you find in this environment?**

Figure 2: Geographic location of Svalbard shown in green.

The Image Revealed

The freezing mountains seen in Figure 1 are in Svalbard, a mountainous island archipelago in the Arctic Circle (see Figure 2). This area reaches 4˚C to 6˚C in the summer, and is well below freezing in the winter. Svalbard is so close to the poles that during the winter it is dark all day long. This remote area has a population of approximately 2500 people, and an equal number of polar bears!

Figure 1 shows the field base 'Camp of the Crows', where palaeontologists stay while excavating fossils in Svalbard. One of the scientists on this expedition was Dr Espen Knutsen (Figure 3), who currently works with the Queensland Museum Network.

What fossils are found in Svalbard? Read below to find out!

STEM Careers in Real Life: Dr Espen Knutsen, Palaeontologist

Dr Espen Knutsen is the Senior Curator of Palaeontology with the Queensland Museum Network. He is a vertebrate palaeontologist and has spent the past 12 years conducting fieldwork in Australia, the Netherlands, the Arctic and the USA. During this time he has described five new species of Jurassic marine reptiles!

Figure 3: Dr Espen Knutsen working in Svalbard. *Image: QM*

His most famous discovery was that of the pliosaur from Svalbard (Figure 4 and 8). This huge aquatic carnivore is estimated to have been 15 m long and 45,000 kg in weight. Teeth from the pliosaur were 30 cm in length (the size of a ruler!) and the skull measured a whopping 2.5 m. Dr Espen Knutsen's discovery was featured in two TV documentaries - "Predator X" (History Channel/BBC) and "Death of a Sea Monster" (National Geographic).

Svalbard is incredibly rich in marine reptile fossils. Over 40 individuals have been found, predominately ichthyosaurs, pliosaurs and long necked plesiosaurs. These marine reptiles lived in warm, shallow seas during the Jurassic Period.

Svalbard is also a remote and cold region which poses extra challenges for scientists conducting field work. Digs can only occur in the summer when temperatures are above freezing, and during this time the sun never sets. All people and equipment (including food for the length of the stay) are dropped in via helicopter, and extra precautions need to be taken due to the high number of polar bears in the region (see Figure 5). While in the field, scientists look for exposed fossilised material, and when located, they mark the site for excavation. When it is time to excavate the site tonnes of material is removed by hand resulting in a very big hole!

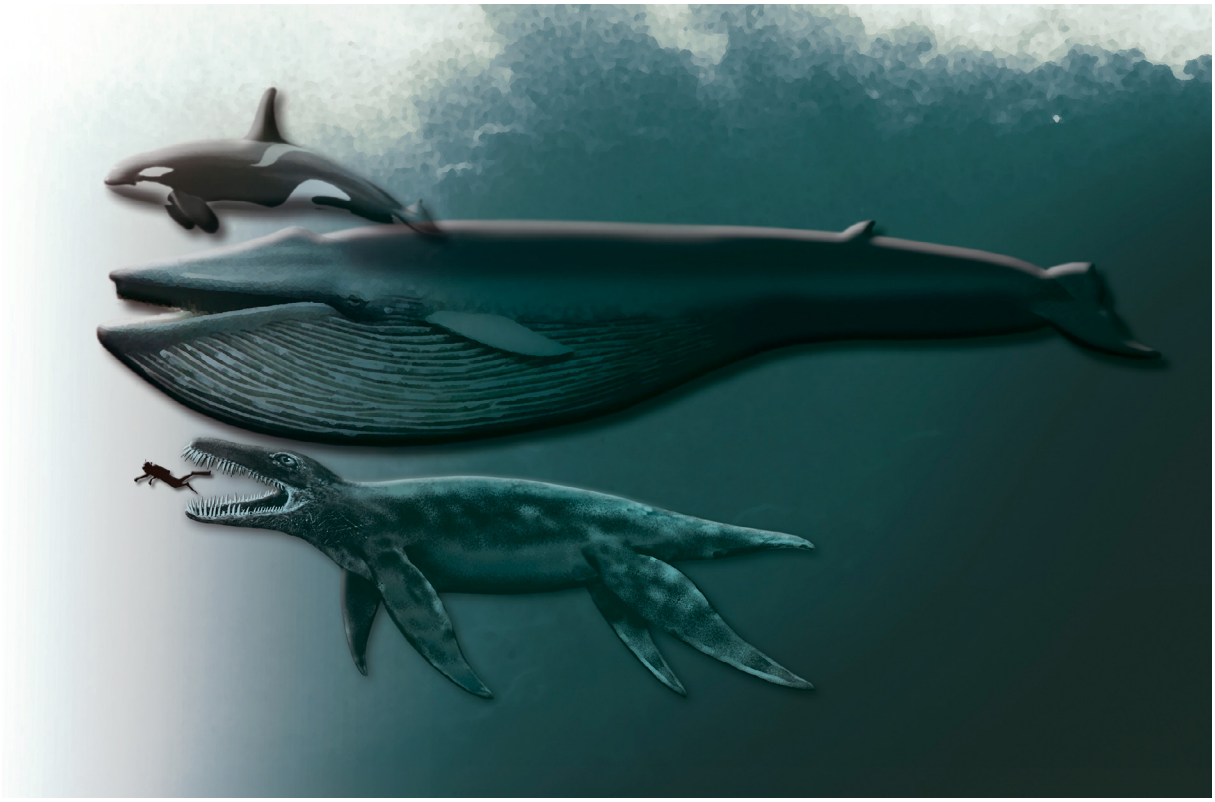

Figure 4: Size comparison - Killer whale, Blue whale, Pliosaur ("The Monster" or “Predator X”) and human diver. You would not have wanted to run into this animal while swimming! *Image: Tor Sponga, Bergens Tidende.*

Once fossils are exposed they are photographed in their location to help palaeontologists reconstruct them later. Fossils are then covered in wet toilet paper, plaster and iron to help hold them together in transit (Figure 9). Due to the high amount of freeze-thaw weathering, fossils from this area are very delicate, and take a lot of glue to put back together.

Dr Espen Knutsen is now based in Far North Queensland working to increase our understanding of Jurassic fauna in Australia. He works on projects with many volunteers and students from James Cook University, discovering and collecting new marine reptiles and dinosaurs from around Australia.

To learn more about life as a palaeontologist you can watch the videos of Dr Espen Knutsen on the Queensland Museum Learning Resources page.

Figure 5: Polar bear warning. The high number of polar bears adds an extra health and safety concern for scientists and volunteers. Trip wires around the camp are attached to flares to scare off polar bears that may wander too close (and alert anyone sleeping in the tents).

Everyone must have access to protective equipment at all times, and food tents are kept slightly separated from the sleeping tents, shown in Figure 1 on page 4 (food tents are in white and sleeping tents are green).
Image: Sprok, cc.

6. **Did you predict marine reptiles would be found in the Arctic mountains? Research and compare the ecosystem of Svalbard today, to that of the Jurassic period, including the environment, climate and fauna.**

7. **Predict how fossils from these Jurassic marine reptiles came to be buried in the mountains of Svalbard, a place with snow and polar bears.**

Figure 6: Ichthyosaur fossil found in Queensland. This specimen from the Queensland Museum is *Platypterygius australis*, which grew over five metres in length. It had a streamlined body to reduce drag while moving through the water, and, like most ichthyosaurs, it had enormous eyes, among the largest recorded for any animal. *Image: QM*

Activity 2 Tasty Tectonics - Exploring Plate Boundaries

Geological features and activity such as mountains, earthquakes and volcanoes mainly occur along tectonic plate boundaries. In this activity you will investigate how the movement of tectonic plates can affect the Earth's surface.

Objective

To model how geological features form as a result of moving tectonic plates.

Materials

- 1 x treat-sized Mars bar per person
- 6 x plastic butter knives to share around the class

THINK

Which part of the Mars bar represents the following:

- Earth's crust
- Mantle and magma
- Fault line/tectonic plate boundary

Method

1. Thoroughly wash your hands.
2. Unwrap the Mars bar.
3. Use the plastic butter knife to cut a straight line through the chocolate and top caramel layer of the Mars bar, without cutting through the nougat (see dotted line, Figure 7 below).
4. With the Mars bar facing up, push the ends of the Mars bar together, 'squishing' the Mars bar. What happens to the chocolate on top? What does this represent? Record results in Table 1 on page 11.
5. Using two hands, hold either end of the Mars bar with your thumb and index finger and gently pull the ends of the Mars bar away from each other (the Mars bar should stretch, not break into two). What do you observe? What does this represent? Record results and observations.
6. Repeat steps 4 – 5 a couple of times, looking at how this movement affects the chocolate and caramel.
7. Consider how you might model a transform boundary. Include your answer in Table 1.
8. Use your model to answer the remaining questions in Table 1.

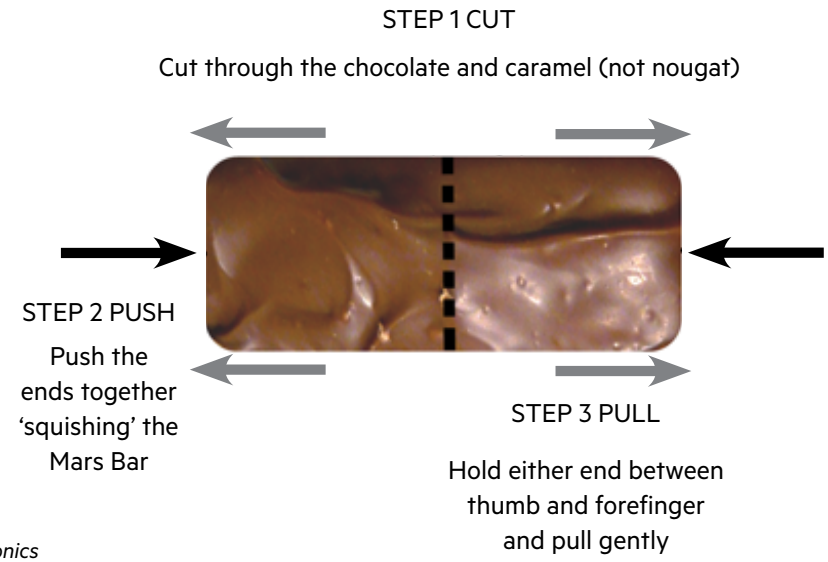

Figure 7: Tasty tectonics

Table 1: Modelling and comparing plate boundaries.

1. **Use your understanding from the Mars bar activity to complete Table 1 below. You may need to conduct further research to complete this task.**

	Transform boundary	**boundary**	**boundary**
Model	A transform boundary can be shown using the Mars bar model by :	Pulling the Mars bar apart represents a plate boundary.	Pushing the Mars bar together represents a plate boundary.
Diagram of plate movement			
Movement	At transform plate boundaries, plates slide past each other in opposite directions, or in the same direction but at different speeds.		
Effect of movement	As the plates slide past each other, they can get stuck, creating a build-up of stress. When the friction is eventually overcome, the plates slip past in a sudden movement, creating seismic waves which result in earthquakes. Places where these slips occur are called faults.		
Common geological features	• Minimal, as crust is not created or destroyed • Fault lines – where slips occur • Linear valleys where the rocks have been ground away due to plate movement		
Common geological events	Earthquakes		
Examples	Alpine Fault, New Zealand; San Andres fault, USA.		

2. Now that you have explored plate boundaries, use this knowledge (and your scientific understanding of continental drift), to explain how fossils from Jurassic marine reptiles are now found in the mountains of Svalbard.

Figure 8: A 45 tonne pliosaur attacks a plesiosaur. Fossil skeletons of both of these large marine reptiles have been found in Svalbard. *Image: Ill: Atlantic Productions.*

Additional Activity

You are a scientist working with Dr Espen Knutsen on a fossil dig site. Record a journal entry from a day in the field, including your favourite parts.

Figure 9: Dr Espen Knutsen (third from left) and the team working together to excavate fossils in Svalbard. Fossils are covered in a plaster jacket before being taken back to the lab. *Image: Jørn Hurum / NHM / UiO*