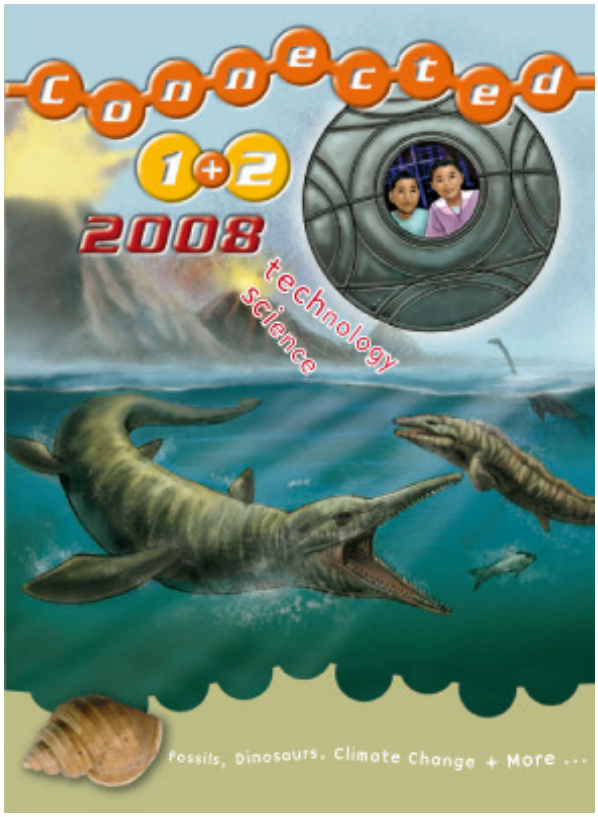
Notes for Teachers



Connected 1 and 2 2008

Contents and curriculum links

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Teachers' notes online format

The 2008 *Connected* teachers' notes are available in an online format only (HTML and RTF files). You can download and print out copies of these notes from this website.

PDF files of teachers' notes for issues of *Connected* published prior to 2008 are also being provided on this website.

Availability of the students' book

Further copies of *Connected* 1 and 2 2008 may be ordered from Ministry of Education Customer Services, freephone 0800 660 662, freefax 0800 660 663, email orders@thechair.minedu.govt.nz or online at www.thechair.minedu.govt.nz

Please quote item number 33241.

Introduction

Connected is a series designed to show mathematics, science, and technology in the context of students' everyday lives. The articles are intended to stimulate discussion and to provide starting points for further investigations by individuals, groups, or a whole class.

- *Connected* 1 is designed to appeal to **year 3 and 4** students who are working at **levels 1 and 2**.
- *Connected* 2 is designed to appeal to **year 4–6** students who are working at levels **1–3**.

For notes on the **key competencies** in relation to *Connected*, see the main *Connected* introduction page.

A **shared or guided reading approach** to using *Connected* texts will support students in their understanding of the concepts and the technical vocabulary. For suggestions on approaches to reading, see the introduction to the *School Journal* teachers' notes at

http://www.tki.org.nz/r/literacy_numeracy/professional/teachers_notes/school_journal/notes/introduction_e.php

General themes in Connected *1 and 2 2008*

1. The theme of discovering things that lived long ago provides a context to explore the science and technology in the first two articles. "Buried Treasure" describes an actual fossil-hunting expedition to find 700 000-year-old shells preserved in mudstone. "Bird Land" describes what travellers in an imaginary time machine might find if they were able to visit the New Zealand of, say, 16 or 40 million years ago.
2. The theme of our changing environment runs through all four articles in this issue.
    - "Buried Treasure" and "Bird Land" focus on evolutionary change (for example, species that have changed or become extinct) and geological change (for example, changing landforms and continental drift or plate tectonics).
    - "The Big Chill and the Big Drill" and "Making Lakes and Making Quakes" focus on aspects of climate change.
3. The latter two articles are also connected by a shared focus on the importance of evidence.

"Buried Treasure" and "Bird Land"

Possible achievement objectives

NB: All AOs are quoted from *The New Zealand Curriculum* (2007).

Science

Students will:

Nature of Science

Investigating in science (IinS)

- L1/2: Extend their experiences and personal explanations of the natural world through exploration, play, asking questions, and discussing simple models.
- L3/4: Ask questions, find evidence, explore simple models, and carry out appropriate investigations to develop simple explanations.

Understanding about science (UaS)

- L3/4: Appreciate that science is a way of explaining the world and that science knowledge changes over time.

Living World

Ecology (Ec)

- L1/2: Recognise that living things are suited to their particular habitat.
- L3/4: Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced.

Evolution (Ev)

- L1/2: Recognise that there are lots of different living things in the world and that they can be grouped in different ways.
- L1/2: Explain how we know that some living things from the past are now extinct
- L3/4: Explore how the groups of living things we have in the world have changed over long periods of time and appreciate that some living things in New Zealand are quite different from living things in other areas of the world.

Planet Earth and Beyond

Interacting systems (IS)

- L1/2: Describe how natural features are changed and resources are affected by natural events and human actions.

Technology

Students will:

Technological Knowledge

Technological products (TP)

- L1: Understand that technological products are made from materials that have performance properties.
- L2: Understand that there is a relationship between a material used and its performance properties in a technological product.

Nature of Technology

Characteristics of technological outcomes (CoTO)

- L1: Understand that technological outcomes are products or systems developed by people and have a physical nature and a functional nature.
- L2: Understand that technological outcomes are developed through technological practice and have related physical and functional natures.
- L3: Understand that technological outcomes are recognisable as fit for purpose by the relationship between their physical and functional natures.
- L4: Understand that technological outcomes can be interpreted in terms of how they might be used and by whom and that each has a proper function as well as possible alternative functions.

Specific learning intentions

By observing or collecting different fossil samples, and through supported reading and discussion, students will be able to:

- extend their experiences and personal explanations of the natural world, ask questions, and develop simple explanations about fossils and how they are formed (IinS, L1–4);
- recognise that fossils are a record of many different types of living things and that these once-living things can be grouped in different ways (Ev, L1/2);
- recognise and explain that these once-living things were suited to a particular habitat and that they may have changed or become extinct over long periods of time as a result of environmental change (Ec and Ev, L1–4);
- appreciate that some living things in New Zealand are quite different from living things in other areas of the world (Ev, L3/4);
- appreciate that fossils are important evidence for scientists seeking to explain the world and that these explanations have changed as new discoveries are made or methods for observing or dating fossils have developed (UAS, L3/4).

In relation to simple fossil-hunting tools and clothing, safety gear, and so on, students will be able to:

- understand that these technological products are made from materials that have performance properties and that there is a relationship between the material used and its performance properties (TP, L1/2);
- think about technological outcomes in terms of their physical and functional natures (COTO, L1–3).
- understand that technological outcomes have a proper function as well as possible alternative functions (COTO, L4).

Key ideas

The key idea in *Connected* 1 and 2 2008 is change over time.

Changes in thinking

Nature of Science

- In science, we learn about and make sense of the world by exploring, by making accurate observations, and by gathering evidence.
- Our explanations about the world change as we learn more about the world.

Environmental change

Living World

Planet Earth and Beyond

- Our physical environment and climate have changed (and continue to change) over time.
- Living things have to adjust to these changes or they may become extinct.
- Fossils provide a record of previous life forms.
- Studying the fossils of these organisms provides clues to how the Earth's climate and physical environment have changed over time.

Developing and using technological tools

Nature of Technology

- Tools developed to find and excavate fossils can be described in terms of their physical and functional nature.

Technological Knowledge

- We choose materials that will give tools certain performance properties.

Developing the ideas

Fossils: Treasures that provide clues to change

Studying fossils provides a context to explore the similarities and differences used to group and classify organisms that lived in long-ago environments.

The inside front cover of the Building Science Concepts (BSC) Book 41 *Fossils: Digging up the Past*, provides an overview of how teachers can

build students' ideas about fossils. It also contains simple classroom activities to help students understand fossil formation and a timeline activity that focuses on key periods and "star" animals.

The BSC resource *Fossils: A Picture Pack for Levels 2–4* offers photographs of different fossil types and images of past life forms to help engage and focus your students. There is also a map showing continental movement at 500, 237, and 14 million years ago.

In "Buried Treasure", the fossil molluscs dug out from soft mudstones by the girl and her father are largely unaltered, not mineralised, shells (that is, still constructed from calcium carbonate). As the narrator notes, they are "very brittle" and have "lost most of their colour". At some 700 000 years old, they date from the Cenozoic era, in the most recent or Holocene epoch. Deposited in soft sedimentary rock over the last 65 million years, Cenozoic molluscs are New Zealand's commonest fossils.

Focus questions

- How are fossils formed?
- Why are fossils important to scientists?
- What do fossils tell scientists about what the World was like long ago?
- How do fossils help scientists work out how climate has changed?
- What is unique about the birds of New Zealand?
- Why do scientists think New Zealand birds developed as they did?

Observations and gathering data

It's important to help students realise that the evidence needed to explain the world is based on making and recording accurate observations and gathering data. When students learn about the world through observations and gathering data, this is also how scientists learn about the world. You may need to reinforce this important point in subsequent science investigations or experiments.

You also need to make explicit that, as scientists learn more, ideas in science will continue to change, for many reasons. "Buried Treasure" and "Bird Land" highlight how new finds (fossil discoveries) generate new ideas about what organisms were present in New Zealand and at what times. New tools and/or refined techniques for finding and analysing fossils also contribute to developing new ideas. For example, improved mapping and dating tools and techniques may help scientists to draw more accurate conclusions. An everyday analogy would be comparing the data gathered from using our eyes with the data gathered from using a magnifying glass.

The ideas and theories of other scientists may also challenge, influence, and change the thinking of the scientists who are exploring New Zealand's fossils. An analogy might be listening to other students describing what they think and then incorporating some of these suggestions or explanations into our own thinking.

Focus questions

- In "Buried Treasure" and "Bird Land", what have fossil discoveries contributed to new science knowledge?
- Who discovered these fossils?
- In "Buried Treasure", what equipment does the girl use to find, extract, and clean her fossils?
- What equipment do scientists (palaeontologists) now use to extract, clean, and analyse fossils?
- What sort of equipment do you think they used when years ago when looking for fossils?
- How has the equipment changed?

Using technological tools

Tools allow humans to extend the use of their own bodies:

- to do more work;
- to do more accurate or precise work;
- to do work that requires manipulating materials in ways that cannot be done by hand.

Tools are examples of technological outcomes. They are developed through technological practice to be fit for a particular purpose. Tools have a physical nature that relates to their purpose. The purpose for which a tool has been designed is known as its proper purpose. However, tools can also be used successfully for purposes other than those they were designed for. These are known as alternative functions. A tool's ability to work successfully in an alternative function is based on its physical nature. In "Buried Treasure", a number of tools designed for other functions are used successfully as fossil-hunting tools, for example, the toothbrush and the knife:

- The handle makes the toothbrush easy to hold and manipulate when brushing the fossils. The malleability of plastic means that toothbrushes can be shaped to form a handle.
- The bristles on the toothbrush, designed for cleaning around teeth, enable it to be used for cleaning the grooves in the fossils.

- The lightness and flexibility of plastic means that the toothbrush is less likely to damage the brittle fossils.
- The handle, the shaped (but blunted) edge, and the strength of the knife allow it to be used for digging around the fossils in the soft rock with some precision and without the knife breaking. Being made of metal means that knives can be formed with a handle and given an edge (malleability) but the finished product will also have strength and rigidity.
- The rigidity of the knife also allowed it to be used as a lever, if used gently, to lever the fossils out of the soft mudstone.

Focus questions

- What tools are mentioned in "Buried Treasure"?
- Why does the girl use a knife, a toothbrush, and a darning needle?
- What functions were these tools originally designed for?
- What physical attributes make the three tools (knife, toothbrush, darning needle) good for fossil seeking (fit for this alternative purpose)?
- What functions were these tools originally designed for?
- Are there any similarities or differences between the intended (original) function of each tool and the function for which they are used in "Buried Treasure"?
- Can you think of how these tools could be redesigned to make them more effective for fossil hunting?
- What tools do scientists (paleontologists) now use to extract, clean, and analyse fossils?
- How have these tools changed over time?

Further references

Ministry of Education resources

For more about fossils:

- Refer to BSC *Fossils: Digging up the Past,* Book 41. The activities in this book build science understandings about how, where, and when fossils were formed and also how fossils provide a record of past life and living conditions on Earth. See also the BSC picture pack *Fossils: A Picture Pack for Levels 2–4.*
- BSC *Weathering and Erosion: The Shaping of Our Landscape*, Book 2 could be used to explore supporting concepts of how fossils become exposed and *Moulds Are Fungi: Structure, Function, and*

Interrelationships, Book 53 for exploring ideas about how soft tissues decompose.

- Refer to BSC *The Land Changes: Keeping Earth's Systems in Balance to Sustain Life*, Book 52. The activities in this book build science understandings about the Earth's geological history and the interdependence of the living and non-living systems that make up planet Earth.
- Refer to BSC *Is This a Plant?: Introducing the Plant Kingdom*, Book 35 and *Is This an Animal?: Introducing the Animal Kingdom*, Book 39. The activities in these books build science understandings about grouping and classifying the diverse living organisms on Earth, including the special characteristics of New Zealand plants and animals
- See also *Making Better Sense of Planet Earth and Beyond*, Levels 1 to 4, particularly the sections on and activities to do with the formation of sedimentary rocks, especially limestone, and the erosion that exposes fossils. This book also includes information on fossil types and an activity for creating a fossil cast.
- Read "A History of Rock" (*Connected* 2 2003). This article covers New Zealand's geological history. It explains about the three main rock types (metamorphic, igneous, and sedimentary).
- Read "How to Make a Limestone Cave" (*Connected* 1 2007). This article looks at how caves were formed from limestone deposited beneath the sea, before it was uplifted by earthquake activity.
- To read about Joan Wiffen, a New Zealand amateur paleontologist who has made remarkable fossil discoveries, you and your students can visit the student site Wicked at http://www.tki.org.nz/r/wick_ed/cool/archives/joan_wiffen.php

For more about how ideas in science change and about observation, gathering data, and evidence, visit Science IS. In particular, see

http://www.tki.org.nz/r/science/science_is/nos/theme_19_change_e.php

For more information about technological products and characteristics of technological outcomes, check out the learning experiences in the explanatory papers for Technological Products and Characteristics of Technological Outcomes in the curriculum support package of Techlink at

http://www.techlink.org.nz/curriculum-support/papers/knowledge/tech-products/index.htm

http://www.techlink.org.nz/curriculum-support/papers/nature/char-tech-out/

Other resources

For a New Zealand-focused overview of fossils, the geological ages, the main fossil types, and fossil uses and collections, visit Te Ara: The Encyclopedia of New Zealand at

http://www.teara.govt.nz/EarthSeaAndSky/Geology/Fossils/1/en

Visit the Crown Research Institute GNS Science's website to read more about fossils and fossil groups, including molluscs, New Zealand's most common fossils, at

http://www.gns.cri.nz/what/earthhist/fossils/molluscs.html

Check out fossil collection gear at
http://www.discoveringfossils.co.uk/Equipment.htm

Further activities

Rolling back through history

Palaeoecology (pale-ee-oh/ee-KOLL-ojee) is the study of ancient ecosystems.

To help your students imagine geological time, find a toilet roll and pen. Toilet rolls usually have about 500 sheets. If Earth's history is best estimated at 4 600 000 000 (4.6 billion) years, then this time, divided by 500 paper sheets, makes each sheet equivalent to 9 200 000 (9.2 million) years of time.

Note (from a palaeontology book or the Internet) the approximate dates of appearance of the earliest known fossils, the first land plants, the first fish, the dinosaurs, early mammals, and humans.

Then, carefully unravel your toilet roll, use a calculator to add on 9.2 million years per paper sheet, and write the dated events on the correct sheets.

This will give you and your students a way to think about geological time. You will be amazed at the stretches of white (un-commented) toilet paper between the events you have investigated and dated.

Finding fossils

Check whether fossils can be found in your area. If they can be, arrange a school trip. NB. Do some research beforehand on the type of fossils that can be collected and their likely age. Make sure that collecting rocks or fossils is allowed in the area you are planning to visit.

Making and using tools

Firstly ask the students to observe a variety of tools from different contexts (kitchen, garden, or classroom), beginning with some simple or familiar ones, and including some less familiar, for which the students might need to work out the function by looking at material properties. It might also be helpful to include two tools with similar functions but made with different materials and/or using a different design.

Focus questions

Look at the physical nature of the tools:

- What material(s) has/have been used to make this tool?
- What qualities (performance properties) make this/these materials good choices?
- What other materials could have been used to make this tool?
- Would any of these other materials have improved the performance of the tool?
- Why/why not?

Next, look at how each tool is used, making links between its physical nature and the ways in which it is used (function).

- What links can you make between the physical nature of this tool and what it is used for?
- Could you use this tool successfully for alternative purposes (that is, purposes other than what it is used for)?
- What might happen if you use this tool for another purpose?

Lastly, get the students to think of a particular function or "job" and develop conceptual ideas for a tool to do it. This may be an opportunity for some fun, for example, a tool for gathering up and putting away toys.

- What job does this tool have to do?
- What physical qualities will it need to do this work?
- What things does it have to work on or manipulate?
- What conditions does it have to operate in?
- What materials could be used to make the tool?

Read "Counting Koura" (*Connected* 1 2007). Analyse the traps in terms of their physical and functional natures. Compare to other sorts of traps What material was used to make the traps? Analyse the material in terms of its performance properties. Compare these traps to other sorts of traps.

"The Big Chill and the Big Drill" and "Making Lakes and Making Quakes"

Possible achievement objectives

NB: All AOs are quoted from *The New Zealand Curriculum* (2007).

Science

Students will:

Nature of Science

Understanding about science

- L1/2: Appreciate that scientists ask questions about our world that lead to investigations and that open-mindedness is important because there may be more than one explanation.
- L3/4: Identify ways in which scientists work together and provide evidence to support their ideas.

Communicating in science

- L1/2: Build their language and develop their understandings of the many ways the natural world can be represented.

Planet Earth and Beyond

Interacting systems

- L1/2: Describe how natural features are changed and resources affected by natural events and human actions.
- L3/4: Investigate the water cycle and its effect on climate, landforms, and life.

Living World

Ecology

- L/2: Recognise that living things are suited to their particular habitat.
- L3/4: Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced.

Technology

Students will:

Nature of Technology

Characteristics of technology

- L2: Understand that technology both reflects and changes society and the environment and increases people's capability.
- L3: Understand how society and environments impact on and are influenced by technology in historical and contemporary contexts and that technological knowledge is validated by successful function.

Technological Knowledge

Technological modelling

- L1: Understand that functional models are used to represent reality and test design concepts and that prototypes are used to test technological outcomes.
- L2: Understand that functional models are used to explore, test, and evaluate design concepts for potential outcomes and that prototyping is used to test a technological outcome for fitness of purpose.
- L3: Understand that different forms of functional modelling are used to inform decision making in the development of technological possibilites and that prototypes can be used to evaluate the fitness of technological outcomes for further development.

The key ideas

The key ideas are how scientists collect evidence, draw inferences from it, and use models to test how their ideas might work in reality.

"Making Lakes and Making Quakes" could also be used to introduce the idea of evidence and modelling in technology and science (with reference to the shake tables) and how technological modelling differs from the use of models in science.

These two articles also offer opportunities to explore the ideas of science from Planet Earth and Beyond and the Living World (as noted in the possible achievement objectives above). These opportunities will be explored in the section "Further activities".

Developing the ideas

Science evidence

Evidence is used in science to support ideas about observed physical phenomena. Evidence is based on data that is collected as scientists or

students explore, question, and investigate. Data becomes evidence if it appears to support or contradict an idea. It is important that students realise the difference between what they observe and what they infer from these observations because understanding this distinction is a precursor to understanding what a theory is and how theories develop.

An inference interprets what is observed. Therefore, when students make an inference, they have already accepted or discarded data in order to make sense of the observation in terms of their current science understanding.

When students make inferences, it is important that they can tell you what evidence they have used to support their ideas. In any science investigation, reinforce the difference between their observations and the inferences that the students make. Ask them to explain what evidence supports their inferences.

"The Big Chill and the Big Drill" begins by looking at the Antarctic Peninsula. Show the class a map of Antarctica and point out the Peninsula (top left of the small map on page 17). The Peninsula extends over 1000 kilometres northwards from mainland Antarctica and reaches outside the Antarctic Circle. Scientists' ideas about what the Antarctic Peninsula looked like 45 million years ago are based on the fossil record and also on the geography of the Peninsula, a narrow finger of land surrounded by sea and reaching towards less extreme latitudes.

Focus questions

- What physical data do Antarctic scientists collect? Answers could include: measurements, for example, the thickness of the ice sheets; drill samples (rock cores); drop stones; and several different kinds of fossils.
- What inferences have the scientists made from their data? (Refer to pages 17 and 18 of *Making Better Sense of Planet Earth and Beyond* for comments on the use of models in science.)

Science modelling

Science uses models to explore ideas about how things work. Science models also help scientists to communicate their ideas to others, so that the ideas can be discussed and debated.

Focus questions

- How many science models can you find in "Making Lakes and Making Quakes"? List them.
- Why do the scientists use each of these models?

Characteristics of technology

Evidence in technology is used to make decisions about the design and development of a technological outcome. Technologists must be able to justify a decision to continue working on an outcome, change the development, or abandon the development of the outcome. Evidence provides justification based on whether the outcome will be of benefit to people and be fit for purpose. This includes the outcome's ability to function as designed as well as its ability to meet the wider social and environmental needs of the context for which it was designed.

Focus questions

- What sort of evidence is useful for making decisions regarding technological developments?
- How do stakeholders decide which evidence is most important in arriving at a decision? Why do you think so?

Technological modelling

Technological modelling, including the development and trialling of prototypes, is used to provide evidence about whether an outcome being developed will be fit for purpose, as required by the brief.

(The drill rigs described in "Making Lakes and Making Quakes" and "The Big Chill and the Big Drill" would most likely be modelled mathematically factoring in ice flow, currents, sea depths, steel strength and flexibility, etc. Building prototypes would be unlikely because of the varied settings and environments where the drilling rig might be installed and the cost.)

Focus questions

- In what ways might the shake table be a useful model for technologists?
- What kind of things would they be able to find out by using the models?
- What other types of models might technologists use if they wanted to try and reduce the risks of buildings collapsing during and earthquake?

Further references

Ministry of Education resources

For more about collecting adequate data, visit Science Is:

http://www.tki.org.nz/r/science/science_is/nos/theme_09_adequete_data_e.php

http://www.tki.org.nz/r/science/science_is/nos/theme_11_think_critically_e.php

For more about using science models, go to

http://www.tki.org.nz/r/science/science_is/nos/theme_13_model_e.php

For more about technological modelling, check out the learning experiences in the explanatory papers "Technological Modelling" and "Characteristics of Technological Outcomes" in the curriculum support package of Techlink at

http://www.techlink.org.nz/curriculum-support/papers/knowledge/tech-model/

http://www.techlink.org.nz/curriculum-support/papers/nature/char-tech-out/

For more on our digging up the past and studying our changing environment:

- Read "Creeping Along" (*Connected* 2 2005).
- Check out the following BSC books: *Weathering and Erosion: The Shaping of Our Landscape*, Book 2; *Life between the Tides*, Book 21; *Fossils: Digging up the Past*, Book 41; *The Land Changes: Keeping Earth's Systems in Balance to Sustain Life,* Book 52*;* and *Ice: Melting and Freezing*, Book 58.
- Refer to *Making Better Sense of Planet Earth and Beyond,* pp. 63–89 (weather).

Other resources

Refer to *Alpha 120: Unlocking the Icehouse* at http://www.rsnz.org/education/alpha/

Check out the British Antarctic Survey website at

http://www.antarctica.ac.uk/index.php

Further activities

You can use "Birdland" and "The Big Chill and the Big Drill" to introduce ideas of climate change and the way that glaciation and sea levels are interlinked.

Note that this idea is not explicitly explored in either text. It may be useful to begin with some discussion on how glaciation and sea levels interlink to check students' existing ideas.

If you think scaffolding is necessary, set up a brief activity using a basin of water with an onion bag full of ice in it. Mark the water level at the start and ask students to predict what will happen to the water level as the ice melts. In relation to Antarctica, you will need to ask the students to think about where the melting ice originates, for example, from a glacier or

parts of the ice sheet that are on land, or from an iceberg that is floating in the sea. In the latter case, the level of the sea could go down, as liquid water takes up less volume than the same amount of ice – water expands as it freezes. Where melt-water from the land drains into the sea or parts of the land-based ice sheet fall into the sea, sea levels will rise.

Work with the students to explore one or more specific time periods, making connections between what was happening in New Zealand and what was happening in Antarctica and looking for links between glaciation and world sea levels. For example:

- In "Birdland" (page 12), the time machine swoops back to 40 million years ago on the north-west coast of New Zealand and observes giant penguins.
- A Walk Back in Time (page 15) in "The Big Chill and the Big Drill" visits a temperate Antarctic Peninsula 45 million years ago.

Ask each group of students to work with three cards for a selected time period: one for recording information about Antarctica, one for recording information about New Zealand, and a third card for any inferences they can draw about sea levels.

For example, at 40–45 million years ago:

Antarctica card

- No ice cap
- No significant glaciation
- Animals and plants that need a warm climate to survive.

New Zealand card

- Warm climate
- Animals and plants that need a warm climate to survive
- A series of small islands surrounded by warm shallow sea.

Explanation card

- Because there was no Antarctic ice cap, sea levels were much higher
- Much of New Zealand was under water.

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