Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | Candidate Number

Time 2 hours 15 minutes

Paper reference **9GE0/03**

Geography

Advanced
PAPER 3

You must have:
Resource Booklet (enclosed)
Calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- Any **calculations** must show all stages of **working out** and a **clear answer**.

Information

- The total mark for this paper is 70.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- Calculators may be used.

Advice

- You are **advised** to spend the first **15 minutes** reading the Resource Booklet.
- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- Good luck with your examination.

Turn over

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Answer ALL questions. Write your answers in the spaces provided.

You must use the Resource Booklet provided and your own knowledge and understanding from across your course of study to answer the questions in this paper.

1 Explain why future global warming may be inevitable.

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(Total for Question 1 = 4 marks)

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2 (a) Table 1 below shows the area of the northern hemisphere covered by either snow or ice in January and July for selected years between 1970 and 2020.

Year	Area in million km^2 January	Rank Order	Area in million km^2 July	Rank Order	d	d^2
1970	48.26	3	4.94	2=	0.5	0.25
1975	44.95	11	4.60	4	7	49
1980	45.91	9	5.40	1	8	64
1985	50.18	1	4.94	2=	–1.5	2.25
1990	45.67	10	2.97	8	2	4
1995	46.13	8	3.97	5	3	9
2000	47.61	4	3.55	6=	–2.5	6.25
2005	46.56	6	3.55	6=	–0.5	
2010	48.84	2	2.51	10	–8	64
2015	47.15	5	2.52	9	–4	16
2020	46.36	7	2.41	11	–4	16
					Σd^2=	

Table 1

Complete Table 1 by calculating the value of d^2 for the year 2005 and then calculating the value of Σd^2

(2)

Using the formula below, now calculate R_s.

$$R_s = 1 - \left(\frac{6\Sigma d^2}{n^3 - n} \right)$$

Give your answer to two decimal places.

You must show your working.

(2)

R_s = ...

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(b) Explain why the data used in Table 1 might not be a reliable guide to the impact of global warming on snow and ice coverage.

(4)

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(Total for Question 2 = 8 marks)

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3 Study Figure 1, Figure 2 and Figure 3 in Section A of the Resource Booklet.

Analyse the evidence that Arctic and Antarctic temperature changes are extreme.

(Total for Question 3 = 8 marks)

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4 Study Figure 4, Figure 5 and Figure 6 in Section A of the Resource Booklet.

Analyse the global implications of climate change in these polar regions.

(Total for Question 4 = 8 marks)

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5 Study the resources in Section B of the Resource Booklet.

Evaluate the view that the exploitation of resources in the Arctic and Antarctica will create more costs than benefits.

(18)

(Total for Question 5 = 18 marks)

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You should have read the whole of the Resource Booklet before attempting this question, including Section C.

6 Evaluate the view that the Arctic is more likely to be a focus of both short-term and long-term political conflict than Antarctica.

(24)

(Total for Question 6 = 24 marks)

TOTAL FOR PAPER = 70 MARKS

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Geography

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Resource Booklet

Do not return this Booklet with the question paper.

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SECTION A

To the ends of the Earth

The Arctic is the area that lies north of the Arctic Circle. The circle more or less marks the southern boundary of the region that experiences 24 hours of sunlight in summer and 24 hours of darkness in winter. Most of the continent of Antarctica lies within the southern hemisphere equivalent: the Antarctic Circle (see Figure 1).

The Arctic and Antarctic are contrasting in that the Arctic is an ocean almost completely surrounded by land whereas Antarctica is a continent completely surrounded by ocean.

The Antarctic continent and the Arctic Ocean are approximately the same size, at 15 million km^2. They include the two major ice sheets on the planet. Antarctica has approximately 26.5 million km^3 and Greenland 2.8 million km^3 of ice. Together this ice locks up about 70% of the Earth's freshwater, and if it melted would raise sea levels by 66 metres.

The climates of the two regions have similarities but also differences. Both poles are very dry and relatively cold. However, Arctic summer temperatures can reach 10° C, whilst on the thick high-altitude ice sheet temperatures stay considerably below 0° C.

In both regions there have been significant changes in average temperatures (see Figures 2, 3 and 4).

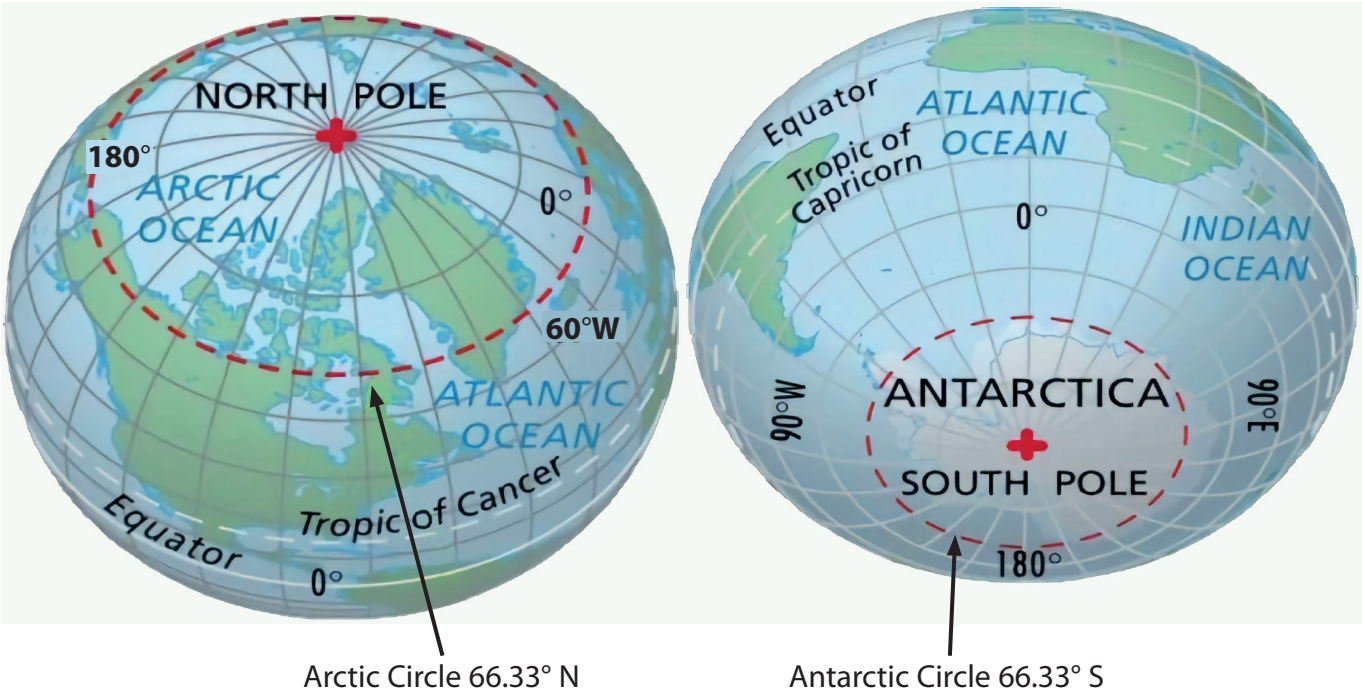


Figure 1

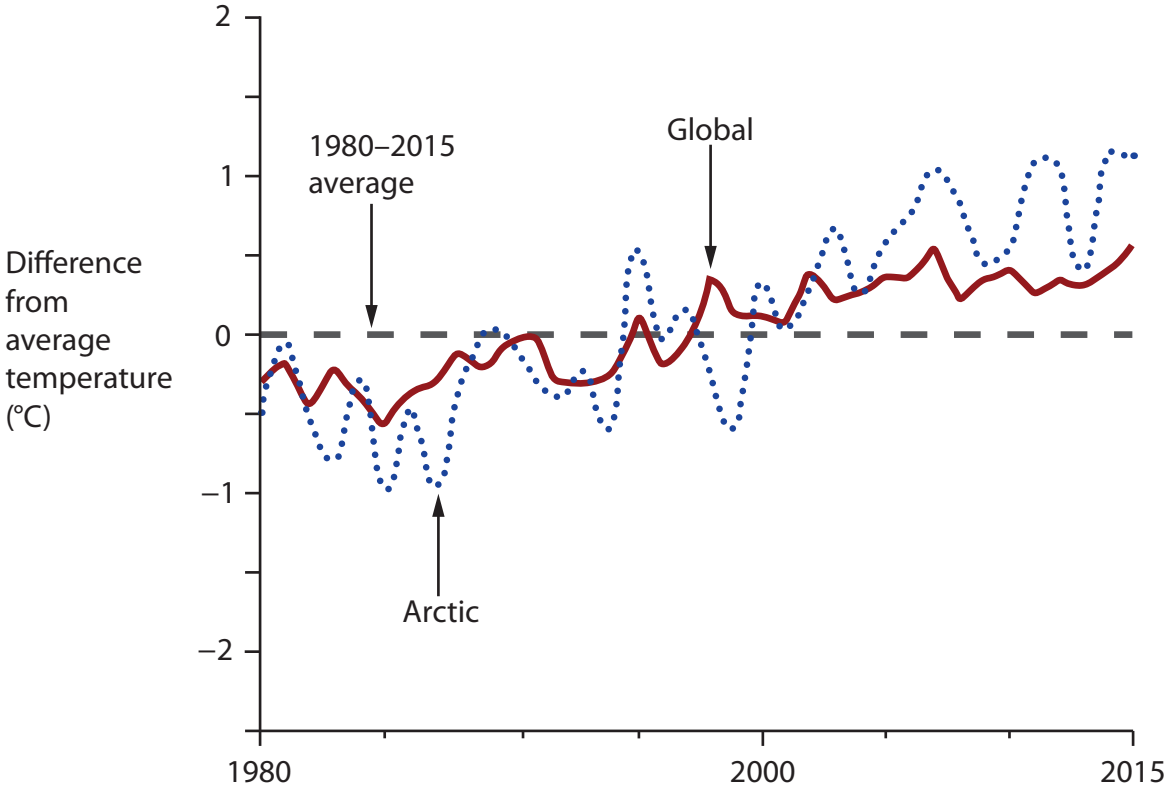


Figure 2

Global and Arctic temperature changes, 1980–2015

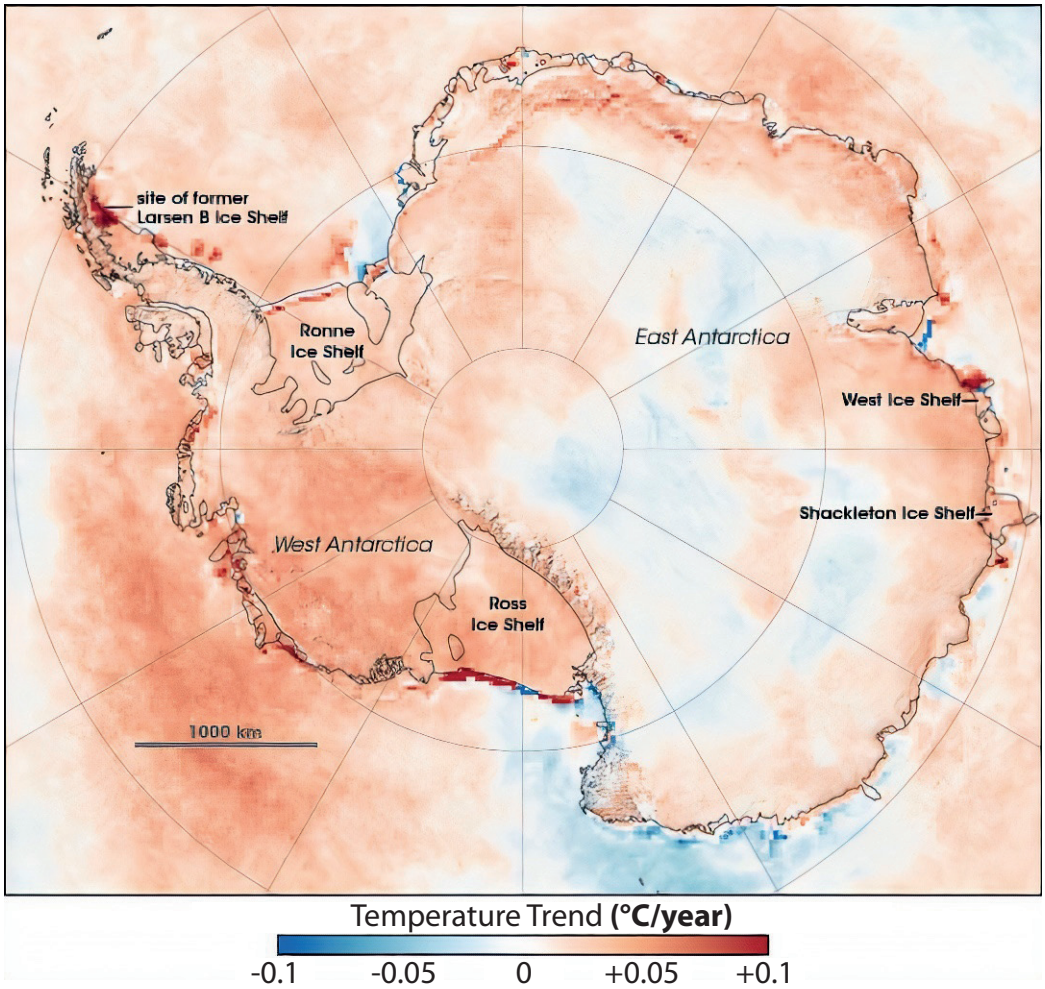


Figure 3

Mean annual Antarctic temperature changes, 1980–2016

Sea-ice is found in both regions but is rarely thicker than 2 metres. The area covered by sea-ice varies according to the seasons, and has varied over both historic and geological time. In both hemispheres sea-ice can reach an area of between 12–15 million km^2 (see Figure 4).

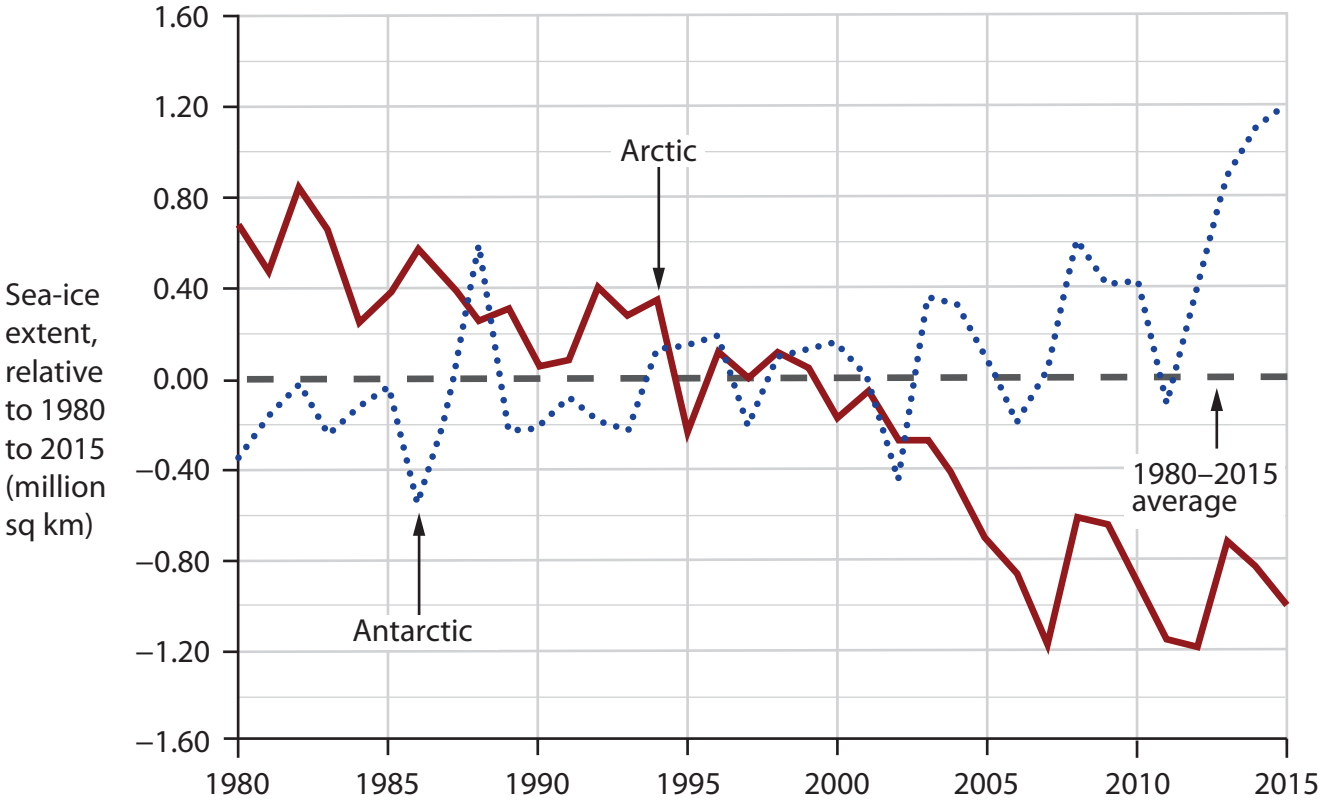


Figure 4

Sea-ice changes in the Arctic and Antarctic, 1980–2015

The impact of climate change has been significant in both polar regions and the long-term impacts of changes in Antarctica will be particularly challenging (see Figure 5). However, recently its impact has been especially notable in the Arctic. This is partly because of its greater geopolitical significance and partly because 2m thick sea-ice is much more vulnerable to global warming than large and very thick ice-sheets. Most climate models predict that summer sea-ice in the Arctic will disappear by the end of this century (see Figure 6).

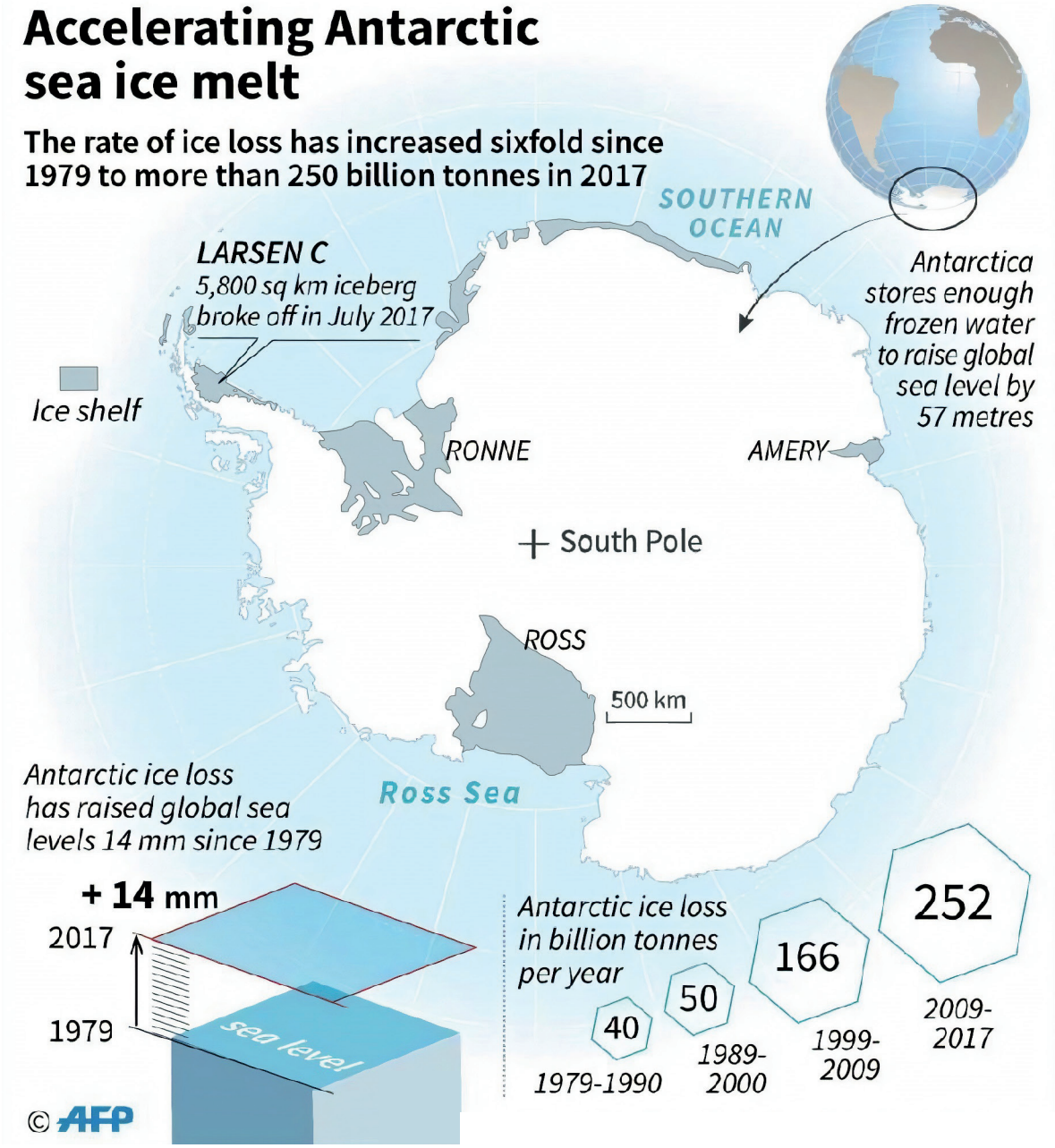


Figure 5

Antarctic changes

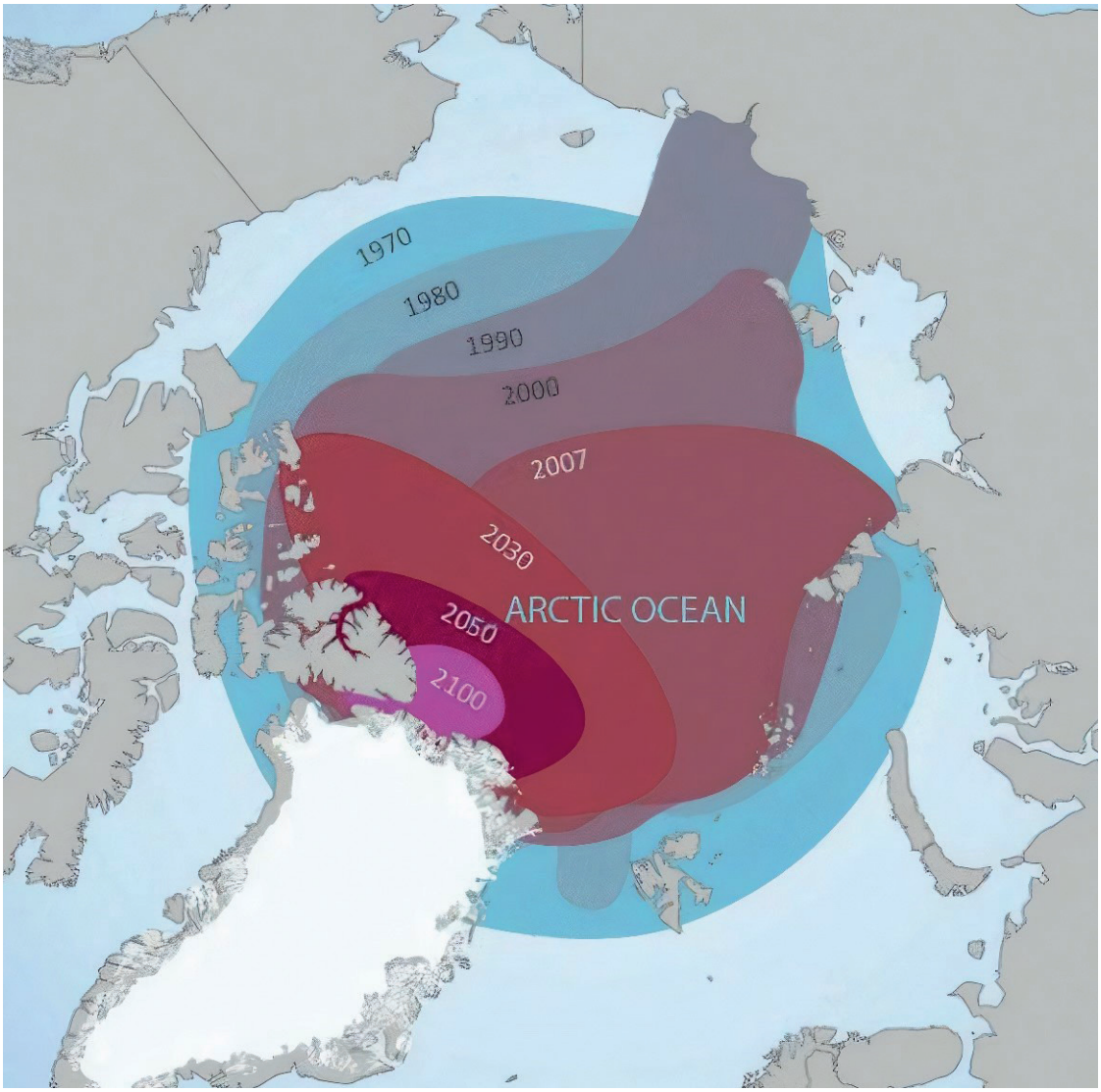


Figure 6

Past and future summer Arctic sea-ice

SECTION B

People and Resources

About 4 million people live within the Arctic Circle, which has been settled for at least 10,000 years. Indigenous peoples form a significant proportion of the Arctic populations of most of the countries with some part of their land mass inside the Arctic Circle: Norway, Russia, Greenland (Denmark), the USA and Canada (see Figure 8).

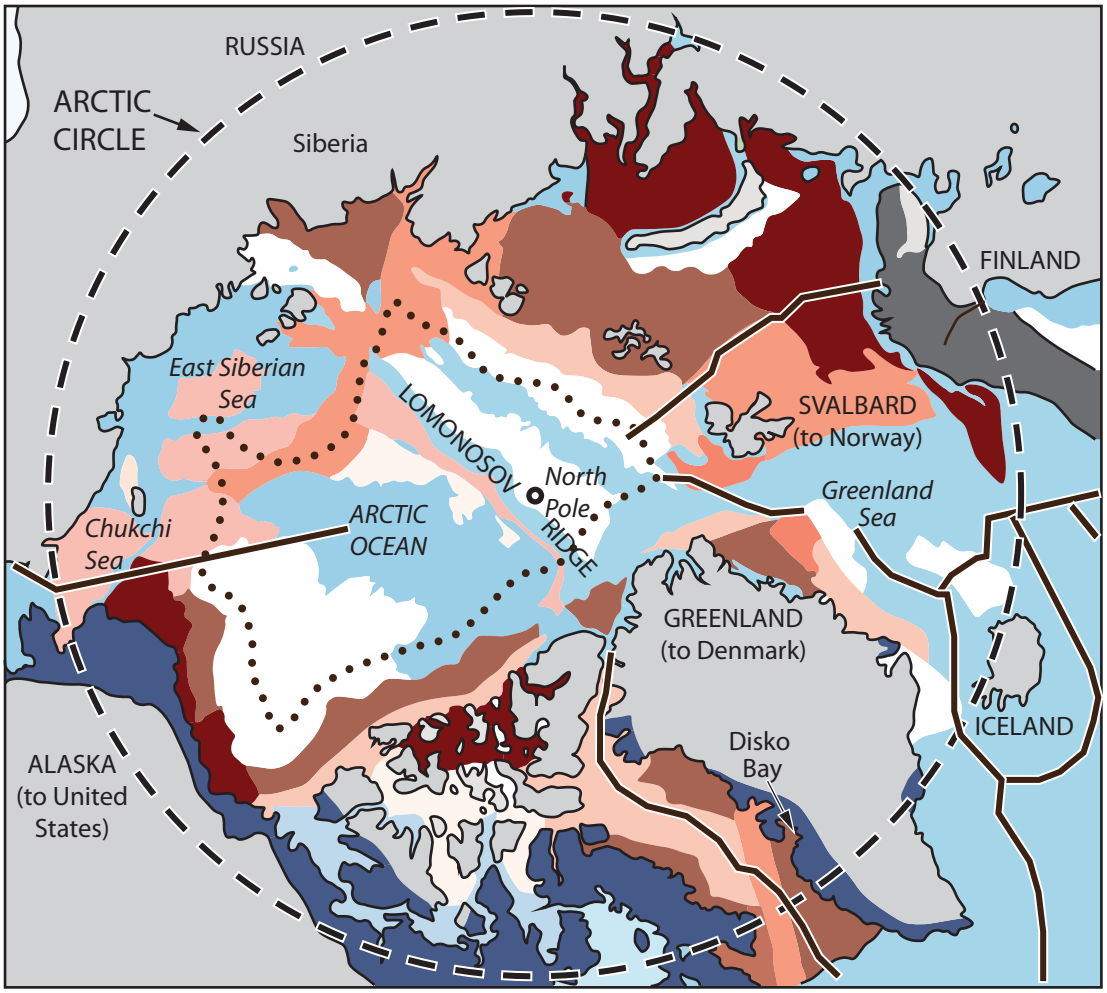
Antarctica was discovered in the first half of the nineteenth century and has no permanent population. It has a large number of polar research centres that are 'home' to between 1,000 and 5,000 scientists according to the season. There is also, controversially, a growing tourist industry that attracted over 50,000 visitors in 2019 (see Figure 7).

Figure 7

Antarctic tourism

Both regions have enormous mineral resources, not least oil and gas reserves. These have been inaccessible partly because of the technical and climatic challenges. At present, it is the Arctic resources that are attracting most interest (see Figure 8).

However, Antarctic waters have some of the richest and least exploited fisheries in the world. Antarctica's continental shelf is geologically very similar to the richest oil and gas bearing strata found in Australia and South Africa, once part of the same super continent as Antarctica. The Antarctic land mass probably has significant mineral resources, but with current technology they are beyond reach.



Key:

Areas where oil and gas might be discovered, showing the probability of making a discovery in this location as a %

100 | 50–99 | 30–49 | 10–29 | <10

Agreed national offshore boundaries | 200-nautical mile limit

Indigenous Inuit population | Indigenous Sami population

Figure 8

Oil and gas resources in the Arctic

Amongst the most significant 'resources' that may result from the changing environment of the Arctic is a possible new shorter trade route between East Asia and Europe. This is of value not just to Russia but also to China and Japan. It is estimated that the new route through the Arctic would reduce transport costs by as much as US$ 120 trillion a year.

Key:

• • • • • 35 days via northeast passage

▬▬▬ 48 days via Suez Canal

Figure 9

Trade routes between Asia and Europe

SECTION C

Power and borders

Antarctica is unique because no one country has control of its territory or its resources. Despite the claims made in the first half of the 20th century (see Figure 10) the Antarctic Treaty of 1961 established the continent as international, not national. Initially signed by 12 'local' southern hemisphere countries and northern hemisphere countries that had played a role in its exploration, it now has 53 members.

The aims of the treaty are to:

- ensure that it is only exploited for peaceful purposes
- promote international scientific cooperation
- set aside disputes and claims over territorial sovereignty.

There are currently 70 permanent research stations scattered across the continent of Antarctica. All the major superpowers are represented.

The treaty has yet to be tested and there are no powers of enforcement should it be breached in the future. It is due to be reviewed in 2048.

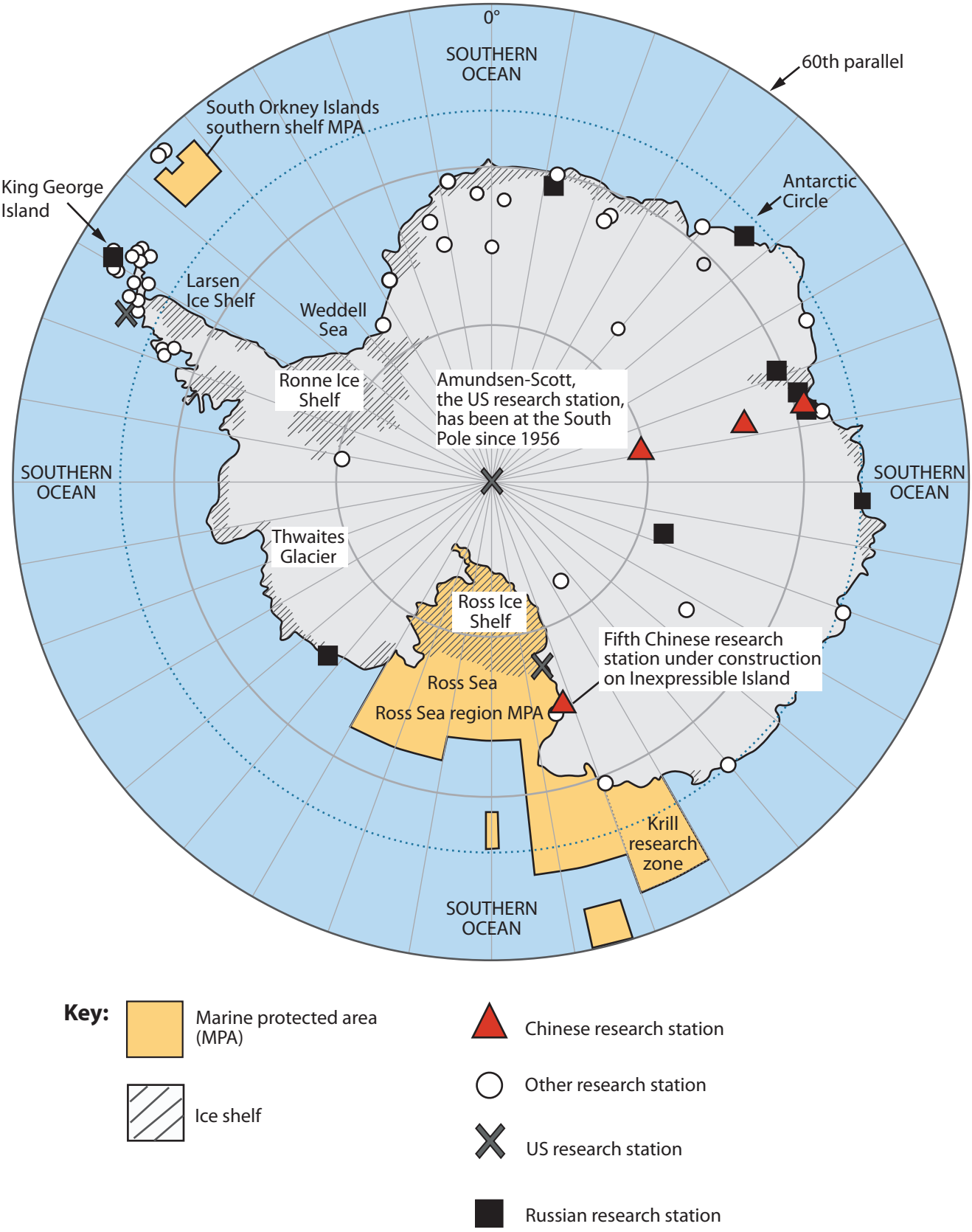


Figure 10

Territorial claims and research stations in the Antarctic, 2015

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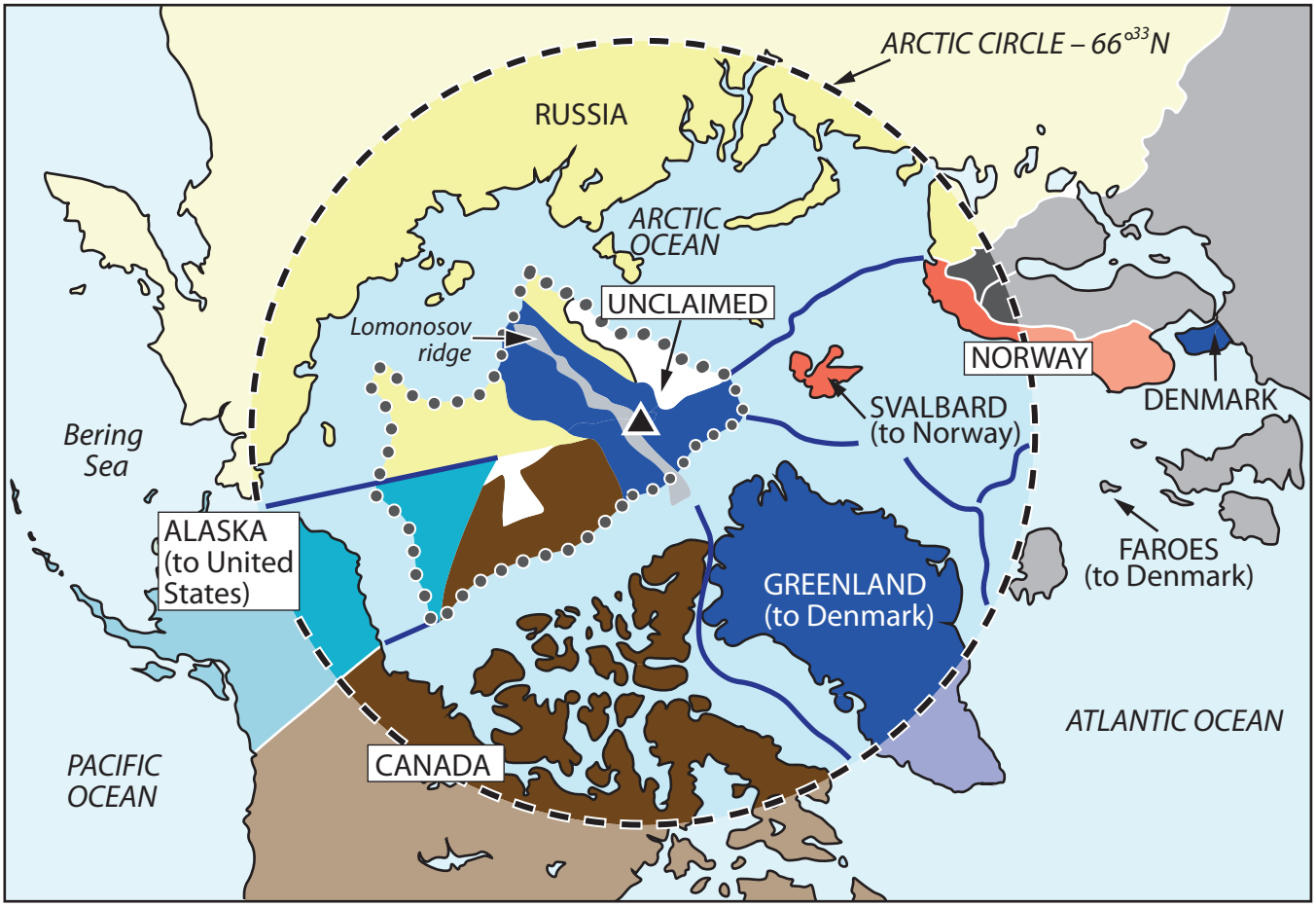
The laws governing the oceans are complex. All countries have territorial sovereignty over the first 200 nautical miles of sea bed off their coastline, called the EEZ (Exclusive Economic Zone).

Beyond the EEZs, the sea belongs to no nation. However, the Law of the Sea allows some nations to extend their claims if their continental shelf extends into international waters beyond their EEZ. Under this clause, Russia has claimed the seabed and the marine resources around the Lomonosov ridge, an underwater mountain ridge crossing the Arctic (see Figure 11).

In the case of Antarctica with no territorial sovereignty and its nearest land neighbour nearly 1,000 km away, its coastal waters are also international.



Key:

Agreed offshore national boundaries

200-nautical-mile limit

North Pole

Arctic territorial claims

Beyond 200-nautical-mile limit

Denmark

Canada

United States

Russia

Norway

Unclaimed

Figure 11

Territorial claims in the Arctic

With by far the longest Arctic coastline Russia has the most to gain from the opening up of the Arctic Ocean. Along with other regional powers it has militarised the region, reviving old bases and opening new ones. In the opinion of some, the Arctic is the next battleground in the Cold War (see Figure 12).

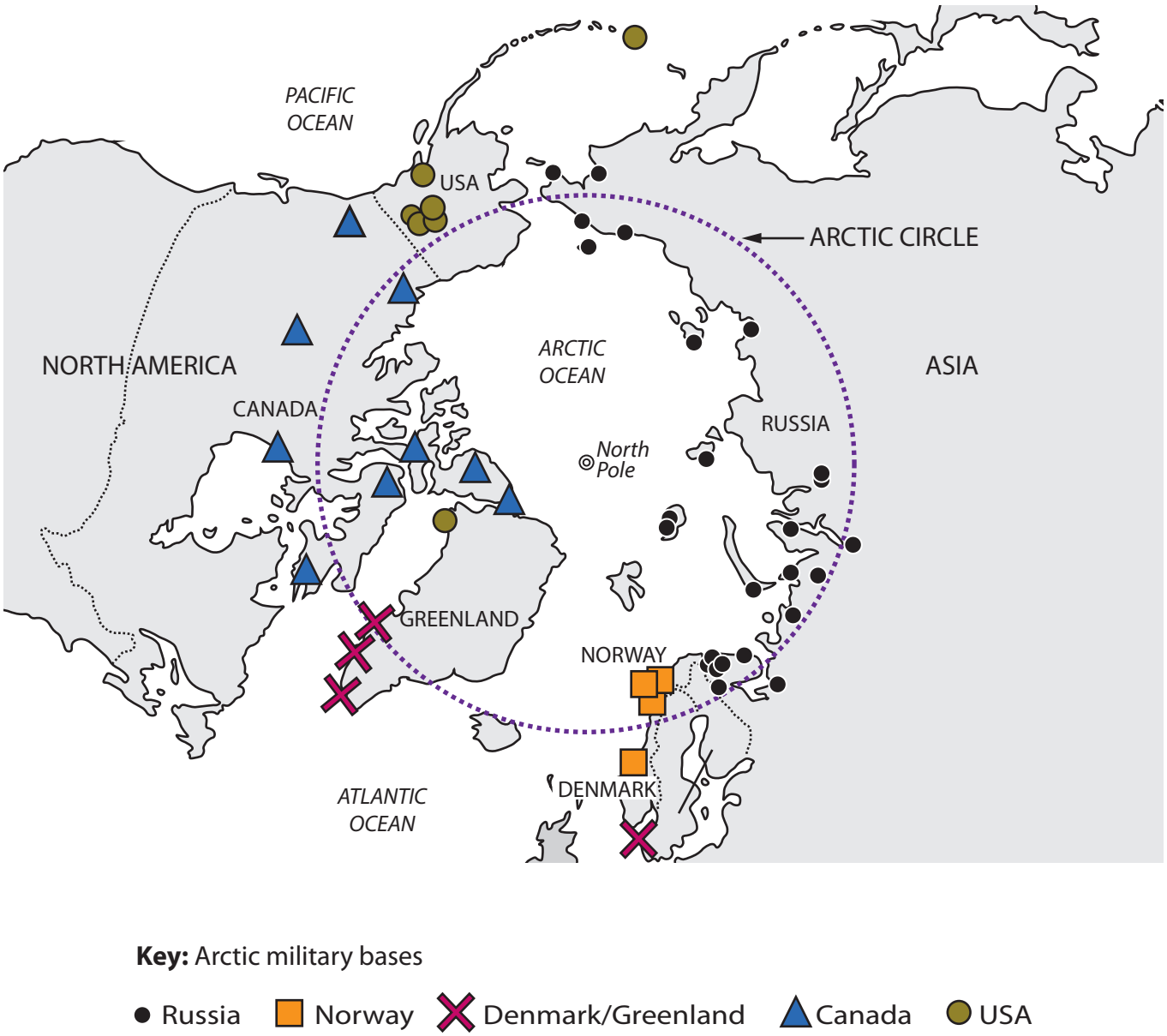


Figure 12

Military bases in the Arctic

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Pearson Education Ltd gratefully acknowledges all following sources used in preparation of this paper:

Figure 2 (Source: https://mashable.com/2016/12/13/warmest-year-arctic-ice-melt-report/?europe=true)

Figure 3 (Source: NOAA Climate.gov)

Figure 4 (Source: NOAA Climate.gov)

Figure 5 (Source: Proceedings from the National Academy of Sciences)

Figure 6 (Source: https://www.thearcticinstitute.org/future-arctic-shipping)

Figure 7 (Source: Joe Sohm/Visions of America / Contributor/Getty Images & Michel Setboun / Contributor/ Getty Images)

Figure 12 (Source: https://www.bloomberg.com/graphics/2017-arctic/the-political-arctic/)