HL Paper 2

a. (i) Define the term *aridity*. [4]

(ii) Define the term *infertility*.

b. Explain **three** factors, **other than** aridity and infertility, that affect the sustainability of human activities in extreme environments. [6]

c. “Periglacial areas offer more opportunities for human activities than hot, arid areas.” Discuss this statement. [10]

Markscheme

a. (i) Aridity refers to a lack of moisture ***[1 mark]***. Award a further ***[1 mark]*** for quantification (precipitation less than 250 mm), or a link with evapo-transpiration rates.

(ii) Infertility refers to the lack of nutrients/bases in soils ***[1 mark]***. Award a further ***[1 mark]*** for recognition of lack of biomass; or low weathering rates/inputs of nutrients; partial decomposition; insufficient to supply plant-based agriculture/crops.

b. The factors may either promote or reduce sustainability. Possible factors include population density (possibly leading to usage exceeding carrying capacity), changes to natural vegetation/habitat (likely to decrease carrying capacity), overuse (whether for agriculture, grazing, mining, tourism), the implementation of conservation measures, provision of irrigation (provided source of water is sustainable), *etc*. Award ***[1 mark]*** for identifying/describing each valid factor and a further ***[1 mark]*** for development or exemplification.

c. Opportunities in both cases are widespread and include farming/cattle herding, mineral extraction, and tourism. Problems are likely to include climate, remoteness, and inaccessibility – as well as low temperatures in periglacial areas, as opposed to a lack of water in hot desert areas.

Opportunities could be for a range of players/stakeholders, including local people, TNCs/energy companies, tourists.

Answers should cover opportunities in both periglacial areas and hot, arid areas.

The use of only one extreme environment which includes a range of opportunities is unlikely to progress beyond the D/E border.

To access band E both environments should be considered.

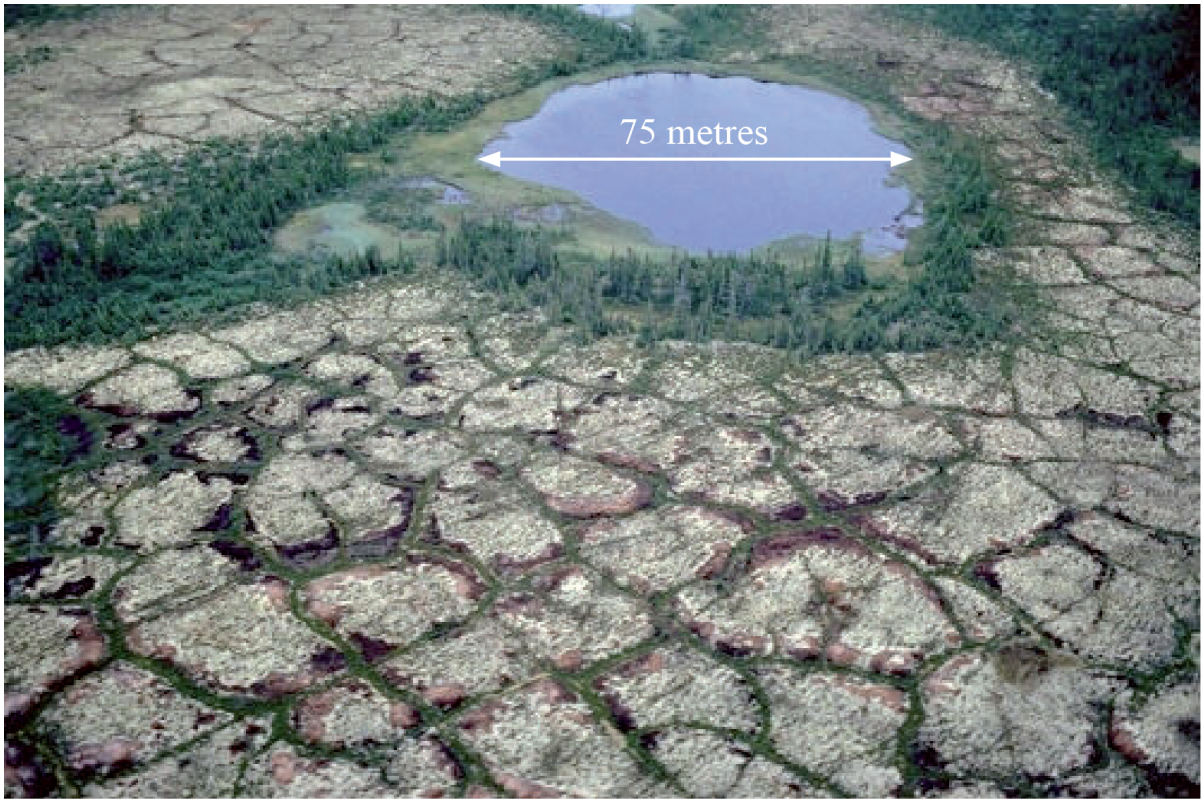
At band F expect detailed examples of opportunities in both environments and a clear conclusion.

Marks should be allocated according to the markbands.

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]

The photograph shows a periglacial environment.



["Reproduced with the permission of Natural Resources Canada (Photo "10ag-7")."]

a. Name and describe **two** landforms shown on the photograph. [2+2]

bi. Explain the process of solifluction. [3]

bii. Explain the formation of pingos. [3]

c. Examine the impacts of permafrost on human activities. [10]

Markscheme

a. Patterned ground/ice wedge polygons/netting [1 mark] described as large irregular polygons with darker areas at edges [1 mark].

The pond/hollow/kettle hole lake/collapsed pingo [1 mark] with a further 1 mark for an accurate descriptive statement, for example, size, vegetated edges.

Credit other valid suggestions.

bi. The movement downwards/on a slope/under gravity [1 mark] of thawed soil/material over frozen ground [1 mark].

Additional explanatory points include: liquid limit in the soil is exceeded causing flow, seasonal variability, speed of movement will depend on the slope angle, [1 mark].

bii. A pingo, also called a hydrolaccolith, is a mound of earth-covered ice [1 mark]. The ice lens/ice core is formed by the accumulation of water [1 mark].

Award a third mark for any elaboration (for example, distinction between open/closed pingos, segregation/injection).

c. Human activities are fundamentally affected by the presence of permafrost. The ever-present threat of thawing and melting requires a range of adaptations in order to avoid harm to subsistence livelihoods, and damage to buildings, roads, and other infrastructure. Normal activities and techniques must often be modified at additional costs in construction and maintenance of railroads, buildings, water and sewer lines, oil and gas

pipelines, dams, roads, bridges, and airfields, because of permafrost.

Future improvements in scientific and engineering approaches, plus careful geological site selection and further study of the permafrost problem, will allow successful expansion into polar areas.

Not all of the above points are required for an answer to reach band F, but good answers are expected to examine negative impacts and also consider that the challenges of permafrost on activities can be overcome.

To access bands E and F, candidates may offer some analysis of spatial or temporal variability in the level of impacts, for example, greater challenges in areas of discontinuous permafrost/areas with more active layer activity or climate change associated issues.

While examples are not a specific requirement of the question, those answers that provide supporting examples are likely to access the higher markbands.

Marks should be allocated according to the markbands.

Examiners report

a. Many candidates struggled with this question – many even omitted this part of question 5. Very few were able to suggest a name for the lake as a possible kettle lake or collapsed pingo.

bi. Solifluction was either explained very well or very poorly – there was little in the middle.

bii. The formation of pingos was not very well understood. Some were excellent but many were weak, merely describing the shape and size of pingos.

c. Surprisingly, this was not done very well. Many answers were very descriptive and lacking in support. It appeared that permafrost (and periglaciation in general) was not well understood.

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a(i). Identify **one** type of cold extreme environment. [1]

a(ii). State **three** physical characteristics of the cold extreme environment that you identified in (a)(i). [3]

b. Explain why semi-arid areas are considered to be extreme environments. [6]

c. "Global climate change will prevent people from living in extreme environments." Discuss this statement with reference to **one or more** extreme environments. [10]

Markscheme

a(i).
- Polar/glacial (equally acceptable)
- Periglacial/tundra
- Alpine/high mountains.

Do not accept regions, such as Arctic.

a(ii). Exact answer will depend on the cold environment chosen. Credit three valid statements that can be linked to the example chosen in (a)(i).

Polar/glacial – year-round/permanent snow/ice/cold all year ***[1 mark]***, extreme seasonality ***[1 mark]***, high latitudes above 65–70°N and some parts of the southern hemisphere ***[1 mark]***, limited biological activity but does have ecosystem *eg* polar bears ***[1 mark]***.

Periglacial/tundra – seasonal ground ice cover/fluctuating temperatures ***[1 mark]***, underlain by sporadic/discontinuous permafrost ***[1 mark]***, tundra biome *eg* low-lying perennials ***[1 mark]***, found on edges of polar/glacial areas/latitude 60–70°N ***[1 mark]***.

Alpine/high mountains in non-tropical latitudes – year-round/permanent snow/ice/cold all year due to altitude/snow line ***[1 mark]***, extreme diurnal temperature variations ***[1 mark],*** limited biological activity *eg* limit of tree-line but does have ecosystem *eg* alpine meadows ***[1 mark]***.

b. Semi-arid environments are areas with 250–500 mm rain per year ***[1 mark]*** and suffer seasonal water shortages ***[1 mark].*** Average temperatures are high (25°C upwards) for most of year ***[1 mark]***.

The remaining ***[3 marks]*** should be allocated either for an in-depth explanation of these physical factors or for showing how they create challenges for resource development and human habitation. For instance, this creates difficulty maintaining sedentary agriculture as insufficient water supply without irrigation – and even then high evapotranspiration rates reduce effective water availability. Salinization is a common problem where over-abstraction has taken place. Credit explanation that incorporates other factors such as remoteness, inaccessibility, relief.

c. Responses could deal with indigenous populations, settlements and/or economic activity in extreme environments (responses that do not deal with extreme environments should not progress beyond band C). Responses may argue that climate change will/will not have a major/minor impact on extreme environments. Some may argue that the impacts will vary from extreme environment to extreme environment. Some will examine the varying ability of different populations to adapt to change through technology.

To access band D, some impacts on people in extreme environments should be described.

To access bands E and F, responses must discussboth sides of the argument and draw conclusions.

Marks should be allocated according to the markbands.

Examiners report

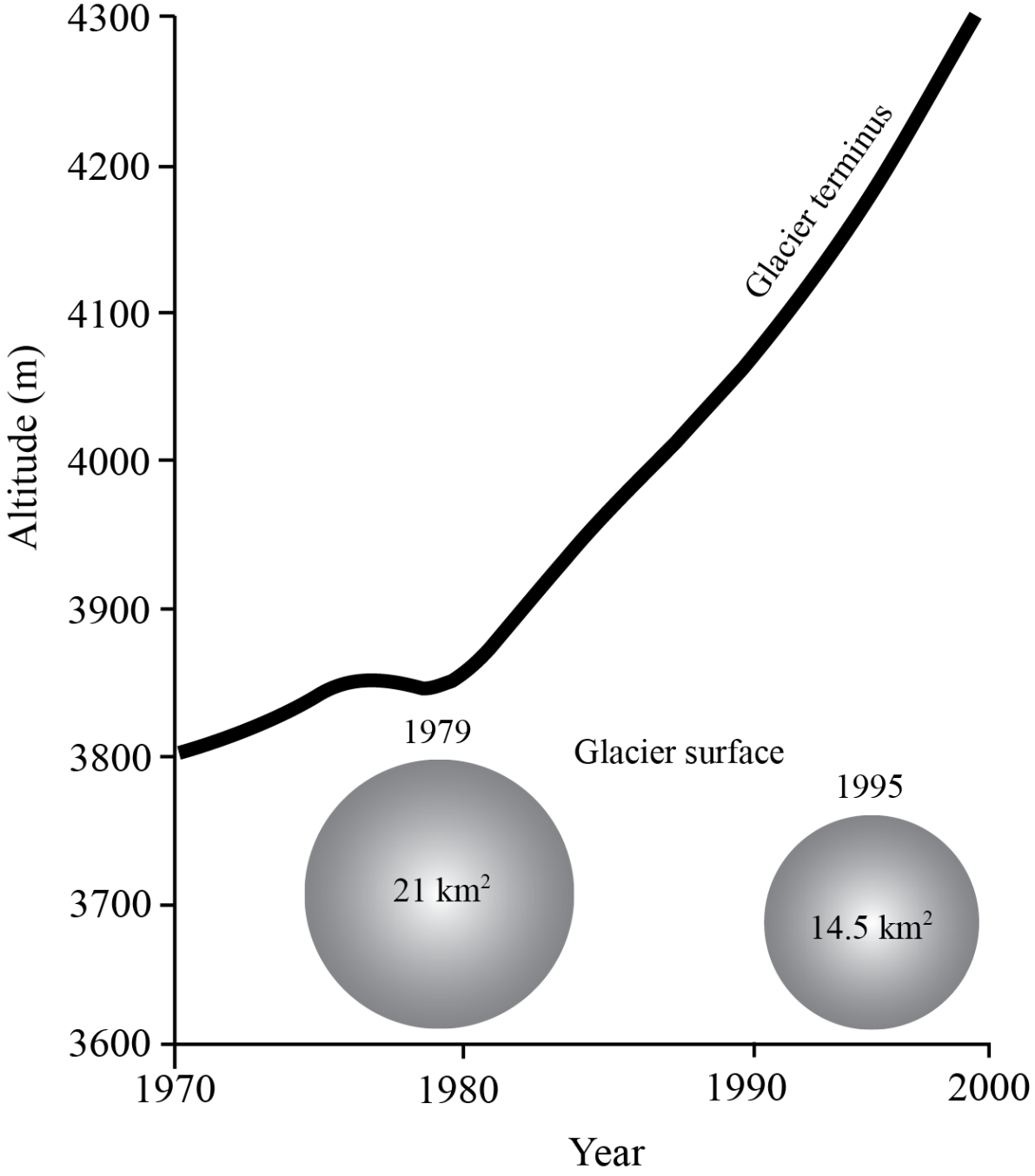
a(i).Some candidates had difficulty identifying characteristics of an extreme environment, and many cited a region rather than a type of environment.

a(ii)Some candidates had difficulty identifying characteristics of an extreme environment, and many cited a region rather than a type of environment.

b. Many candidates were able to describe the physical characteristics of semi-arid areas, but relatively few were able to show how these created a challenge for human activity.

c. This proved to be a challenging question, and there were relatively few good responses.

The graph below shows the retreat (by altitude) and the surface area of the Santa Rosa glacier in Peru.



[Source: Peru National Communication to the UNFCCC2001]

a. Referring to the graph, describe the changes in the terminus of the Santa Rosa glacier from 1970–2000. [4]

b. Explain the processes involved in the advance and retreat of glaciers. [6]

c. Discuss the main environmental problems caused by tourism in **one** extreme environment. [10]

Markscheme

a. The glacier has been retreating over this time period [1 mark]. The rate of retreat has become increasingly rapid [1 mark] and there is an anomaly (1977 to 1979) which shows an expansion of the glacier [1 mark]. Award 1 mark for supporting quantification.

b. Advance: When inputs such as snow and avalanches in the accumulation zone are greater than the rate of melting in the zone of ablation [3 marks].

Retreat: When inputs such as snow and avalanches in the zone of accumulation are less than the rate of melting [3 marks].

The balance of marks between advance and retreat may be varied slightly at examiner discretion in the event of responses which explain either advance or retreat in more detail. For example, some responses may consider seasonal effects or climatic change.

It is acceptable for annotated diagrams to be used instead of text.

c. The problems associated with tourism may include impact on mass movement and erosion; land degradation; loss of biodiversity, increased vulnerability to hazards; aesthetic change; water usage, pollution and waste disposal.

The discussion may refer to seasonal increases in population, with increasing demand on services and expansion of settlements.

Depending on the environment chosen, only some of these problems may be relevant.

Responses which discuss a limited number of problems in depth may be awarded full marks, as may responses which discuss a wider range of problems in less depth.

Marks should be allocated according to the markbands.

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]

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ai. Define *glacial environment*. [2]

aii. Define *periglacial environment*. [2]

b. Explain how and why glaciers retreat. [3+3]

c. “Periglacial areas offer more opportunities for human activity than glacial areas.” Discuss this statement. [10]

Markscheme

ai. Definitions may include any two of the following, 1 mark each:

- Area covered with snow and ice
- Permanent/long-term basis
- Area where glacial processes are operating
- Different scales include ice sheet, ice caps, glaciers.

aii. Definitions may include any of the following, up to a maximum of 2 marks:

- A region with widespread permafrost (permanently frozen) [1 mark].
- Without ice cover or an area on the edge of areas permanently covered by ice/glaciers [1 mark].
- Distinctive periglacial processes and/or landforms [1 mark].
- May have categories – continuous, discontinuous, sporadic [1 mark].

b. Glaciers retreat when the ablation of ice [1 mark] exceeds [1 mark] the accumulation of snow and ice [1 mark].

Possible reasons include: climate change, which may be attributed to natural or human causes; volcanic activity; changes in the tilt or orbit of the earth; sunspot activity; cosmic rays and changes in the position of the land masses (tectonics).

Award 1 mark for each point made up to a maximum of 3 marks.

A list of points with no elaboration should only receive 1 mark.

Other valid reasons may be cited.

c. Periglacial areas, due to the lack of permanent ice, may offer opportunities for the extraction of minerals, and this is arguably being accelerated by climate change. They also offer opportunities for indigenous people (Inuit) who may herd reindeer in response to the seasonal climatic regime of freezing and thawing. Glacial areas also have opportunities. The opportunities may include tourism, outdoor pursuits, areas of outstanding natural beauty which are designated as parks, reserves of water and the generation of HEP.

Some candidates may choose to explore the net opportunities of each environment (looking at how opportunities outweigh challenges). This approach is equally valid.

Challenges may include the possibility of glacial surges, avalanches, landslides, road instability and flooding from glacial melt. While examples are not a specific requirement of the question, those answers that provide supporting examples are likely to access the higher markbands. Responses including explicit discussion of the statement are likely to be credited at bands E/F. It is likely that most responses will conclude by disagreeing with the statement but this is by no means the only possible conclusion. All responses should be judged strictly on their own merits.

Marks should be allocated according to the markbands.

Examiners report

ai. Most candidates were able to define glacial environments.

aii. Most candidates were able to define periglacial environments.

b. Most were able to describe how glaciers retreat but why they retreat was less clearly explained.

c. Basic knowledge and understanding of the opportunities for human activity in glacial and periglacial areas was often lacking. Some answers saw "glacial" as synonymous with "polar" and completely ignored the numerous opportunities for human activity in the Alpine-type glacial areas of the world.

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a. (i) State **and** locate **one** example of mineral extraction in an extreme environment. [4]

(ii) Outline **one** economic reason why the mineral identified in (a)(i) is extracted in this extreme environment.

b. Explain **two** physical challenges for resource development posed by extreme environments. [6]

c. Examine why desertification has become a problem in some parts of the world. [10]

Markscheme

a. (i) Award **[1]** for identification of a mineral and **[1]** for valid location.

Possibilities include: oil in Alaska/gas in Siberia/uranium mining in Niger/copper mining in the Atacama desert/oil in Saudi Arabia.

(ii) Award **[1]** for identifying a reason, *eg* market value or local job creation and **[1]** for further outlining.

For example: “Declining world reserves of oil **[1]** have made prices very high **[1]**”, or “extreme environments lack many employment opportunities **[1]** due to low density population **[1]**”.

b. In each case award **[1]** for identifying the challenge and **[2]** for development.

One or more extreme environments may be used (no penalty for using only one). Both periglacial and hot, arid environments are acceptable.

Responses may focus on mining and/or associated settlement and communications. Challenges include climatic factors, other physical characteristics, remoteness, inaccessibility, inhospitable living conditions, specific characteristics for area or example chosen.

c. Desertification is an environmental issue resulting from pressure on resources.

Candidates should show knowledge of the causes of desertification: social, political, economic, and climatic factors (infrequent or irregular rainfall, overgrazing, over-cultivation, deforestation, poor irrigation, over-population *etc*).

The problems/consequences could be environmental, economic, or social (for example, poor vegetation growth, damaged soils, vulnerability to soil erosion, reduced land available for crops and pasture, expanding sand dunes, reduced income, increased rural poverty, reliance on food aid, forced migration).

There is opportunity to discuss strategies to prevent desertification (managing land use and livestock, managing water usage, afforestation, population control, availability of capital).

Good answers may examine reasons why some parts rather than others have been affected despite similar climatic conditions regions (may examine different degrees of problem or challenge and/or include the uneven success of management). Another approach might be to carefully structure an answer to highlight different types of problem, or different groups/stakeholders/perspectives who are adversely affected (or not). Another approach might be to examine/synthesize how a range of factors combine to trigger desertification.

For band D, expect some description of some problems/causes associated with desertification (may assert the problem is getting worse).

At band E, expect either more detailed explanation of the causes of desertification in particular places or a structured examination of different kinds of problem/places.

At band F expect both of these elements.

Marks should be allocated according to the markbands.

Examiners report

a. (i) No problems.

(ii) Answers were sometimes unable to develop beyond the obvious and some failed to focus on economic reasons.

b. Some answers failed to focus on physical challenges. Many answers gave relevant points but these were often not developed; some gave several brief ideas rather than two developed physical challenges.

c. Some responses were well done with effective use of case studies. Weaker answers sometimes focused on issues related to water supply in general and not to desertification. Other weak answers discussed the general challenges of living in arid areas. The understanding of "desertification" was not clear in these cases. Some candidates referred to desertification in areas that were not extreme environments, such as the tropical rainforest, which was not acceptable. Some answers were strong on causes or strong on examination of impacts but few did both.

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a.i. Briefly outline **two human** factors that are possible causes of desertification in a hot, arid environment. [2]

a.ii. Briefly outline **two physical** factors that influence the occurrence of flash floods in hot, arid environments. [2]

b. Explain **three** reasons why there are concentrations of people in some parts of hot, arid areas. [6]

c. Examine the severity of the different challenges for resource development in periglacial areas. [10]

Markscheme

a.i. *Award **[1]** for a description of the following, up to **[2]**:*

- overgrazing
- over-cultivation
- deforestation

- overpopulation
- global warming
- mismanagement of water resources.

a.ii. *Award **[1]** for a description of the following, up to **[2]**:*

- intensity of rainfall
- rain exceeding infiltration
- impermeable desert surface
- lack of vegetation
- other possible answers.

b. *Award **[1]** for each valid reason, and **[1]** for development/exemplification.*

Possible reasons include:

- mineral deposits
- tourist attractions
- irrigation/oases
- accessible aquifers
- military installation.

Accept other valid reasons.

For example: In Niger, the presence of uranium **[1]** has led to the development of the town of Arlit / associated settlement and infrastructure **[1]**.

For example: Retirement resorts *eg* Palm Springs, have been built **[1]** which attract elderly/retired people who enjoy the hot, dry desert climate **[1]**.

c. Resource development in periglacial areas is affected by the presence of permafrost. The challenges of coping with the constant thawing and melting require a range of measures in place in order to pursue resource development. Activities and techniques must be constantly monitored and modified in order to maintain infrastructure (transport, pipelines, bridges, airfields), buildings and settlement requirements. Other challenges might include relief, climate, accessibility/remoteness.

There are economic and social challenges for the successful extraction of minerals, for scientific research and for ensuring the long-term viability of the nomadic lifestyles of indigenous people who rely on resources found in these areas.

Good answers might examine explicitly the relative severity of a range of challenges. Another approach might be to examine different periglacial areas and the contexts and challenges they present, *eg* greater/more severe challenges in areas of discontinuous permafrost / areas with more active layer activity or climate change associated issues. They may also examine the extent to which some challenges may be overcome if the opportunities merit investment.

At band D, expect description of some challenges for resource development in permafrost areas.

At band E, expect either explanation of a range of challenges for resource development in periglacial areas, or a structured examination of the severity of these different challenges (may examine the degree to which they can be overcome).

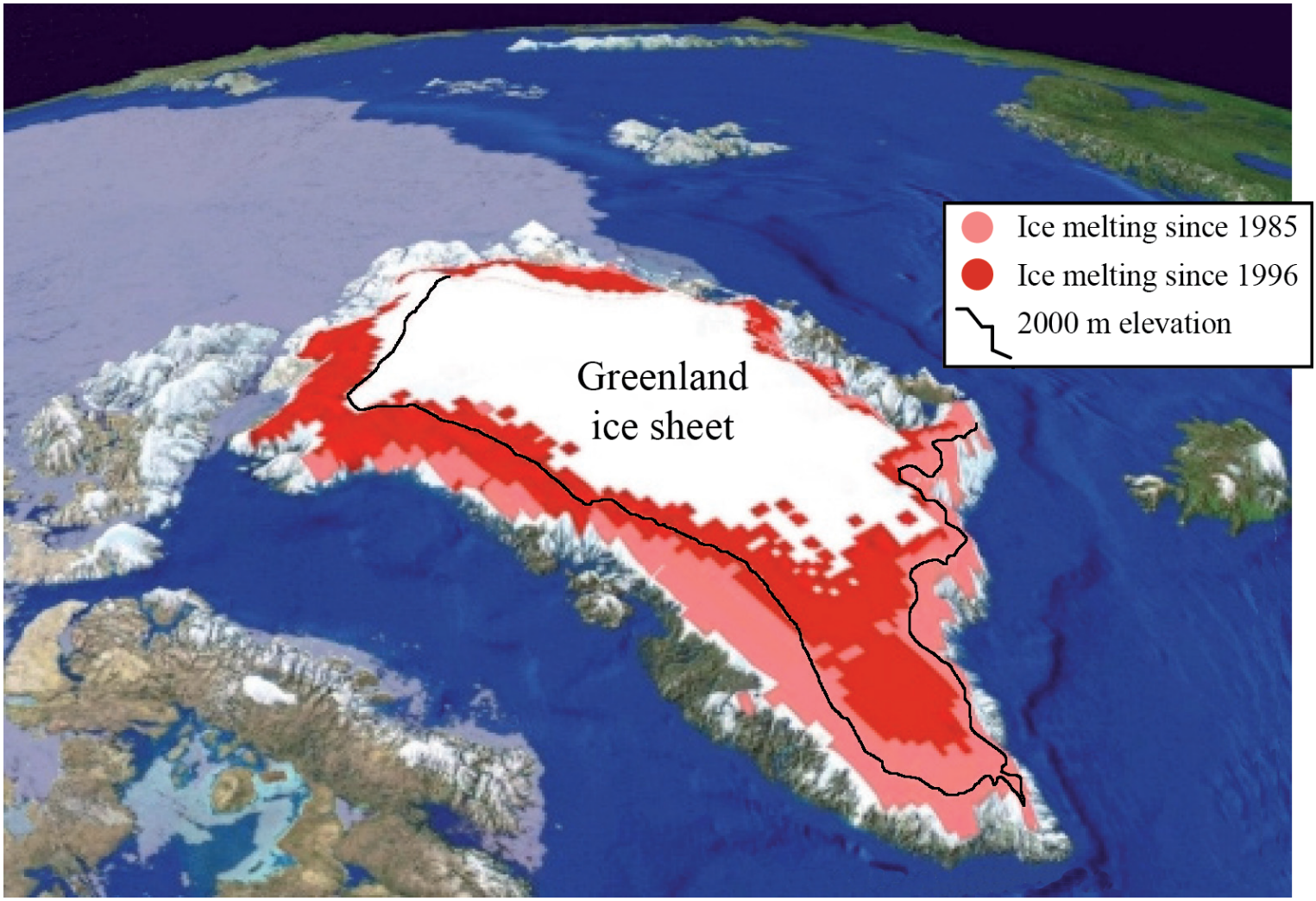
At band F, expect both.

Marks should be allocated according to the Paper 2 HL and SL markbands.

Examiners report

a.i. [N/A]
a.ii. [N/A]
b. [N/A]
c. [N/A]

The image shows changes in the melting of the Greenland ice sheet.



[©University of Colorado CIRES, courtesy Russel Huff and Konrad Steffen]

a. Describe the changes that have taken place in the Greenland ice sheet since 1985. [4]

b. Explain how and why glaciers and ice masses have sometimes advanced. [3+3]

c. “Agriculture in hot, arid areas inevitably results in desertification.” Discuss this statement. [10]

Markscheme

a. While the image shows an area where ablation exceeds accumulation, candidates can gain full marks even if they interpret this as ice retreat.

The ice has melted/retreated around the coasts [1 mark]. The greatest melt is in the south [1 mark]. There is greater melting in the west than the east [1 mark].

Attempts to quantify or relate to the 2000 metre contour or to consider change over time may gain the additional 1 mark.

b. Glaciers and ice masses advance when the accumulation of ice and snow [1 mark] exceeds [1 mark] the ablation of ice [1 mark].

Generally, this occurs when the climate is becoming cooler [1 mark], most likely due to natural causes, such as changes in the tilt or orbit of the Earth, sunspot activity, cosmic rays and changes in the position of land masses.

Award 1 mark for each of two causes if they are explained only briefly, or 2 marks for one cause explained in depth.

c. Candidates are expected to consider points on both sides of this question. The strongest responses may choose to challenge the statement, and may well conclude that while agriculture in such areas may result in desertification, such an impact is by no means inevitable but depends, in part, on the nature of the agriculture involved. Careful choice of crops, cultivation techniques and continuous monitoring may enable successful small-scale or commercial agriculture in hot arid areas. It is likely to be easier to avoid desertification in areas where irrigation is possible than in areas where, for financial, technological, or other reasons, irrigation is not possible.

Desertification is often the result of unsustainable farming, in which more minerals and nutrients are taken out of the soil than are replenished, or where the density of grazing animals exceeds the normal carrying capacity. Some experts also attribute desertification in some areas to on-going climatic change.

Answers that consider only one side of the question should not be credited above band D. It is expected that answers reaching bands E and F will offer supporting evidence and/or exemplification before arriving at a clear conclusion to the question.

Marks should be allocated according to the markbands.

Examiners report

a. In general, this was not answered very well. Surprisingly, there was relatively little on the spatial element, and little attempt at quantification.

b. Some candidates confused glacial advance and glacial movement. Candidates were generally quite good on accumulation and ablation but less confident on the reasons for these – apart from on an annual basis.

c. This attracted some excellent responses with a wide range of examples and reasons. The best answers gave both sides of the argument with support.

This topic was well understood and there were some excellent contemporary examples, though at standard level many responses simply described desertification and effects on named areas without providing a balanced discussion with regard to whether or not it is inevitable.

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a. Outline **two** ways in which people have adapted their **outdoor** activities to extremes of weather in hot, arid environments. [4]

b.i. Distinguish between the terms “accumulation” and “ablation” in the glacial environment. [2]

b.ii. Explain **two** reasons why many glaciers are retreating. [4]

c. “Global climate change will create more opportunities than challenges for indigenous populations.” Discuss this statement, with reference to **one or more** extreme environments. [10]

Markscheme

a. *In each case, award **[1]** for the factor and **[1]** for further development/ exemplification*.

For example: People wear long, loose / light-coloured robes/clothes **[1]** as such garments allow air to circulate / reflect insolation **[1]** / provide protection from the sun during the day and are warm at night **[1]**.
Turbans provide protection from the sun **[1]** and can be wrapped around the face in sand storms **[1]**.
Nomadic herders stay in tents **[1]** that are easily dismantled and moved **[1]**.
Daily routine **[1]** – work done in the cool of the morning **[1]**.
Nomadic herders move their animals **[1]** in order to be close to sources of water during a dry season **[1]**.

Long term-agricultural adaptations that reflect climatic conditions (such as irrigation) are not acceptable.

Accept other valid suggestions.

b.i. *Award **[1]** for each statement. Two simple statements (no need for explicit distinction) acceptable for **[2]**.*

- Accumulation – increase of snow and ice on the glacier **[1]**.
- Ablation – the melting of glacial ice **[1]**.

b.ii. *In each case, award **[1]** mark for the factor and **[1]** for further development*.

Possible reasons include:

- global warming (either caused by humans or part of a natural cycle)
- changes in precipitation levels
- increased volcanic activity
- changes in ocean currents
- El Niño
- sunspot activity.

For example: Many glaciers retreat due to higher temperatures / global warming **[1]** caused by enhanced greenhouse effect **[1]**.

c. There are many different indigenous populations that may be used. Examples include, but are not limited to, the San, Tuareg, Fulani, Inuit, Nenet,

Saami.

The question is not limited to one area, so references may be made to more than one indigenous population and more than one extreme environment.

Indigenous peoples are among the first to face the direct consequences of climate change, owing to their dependence on, and close relationship with, the environment and its resources (for food, cultural identity). Climate change exacerbates the difficulties already faced by vulnerable indigenous communities, including political and economic marginalization, loss of land and resources, human rights violations, discrimination and unemployment.

However, global climate change in the Arctic may bring increased navigation during the winter, and a warmer climate has lengthened the growing season so potential yields may increase, more opportunities for sedentary agriculture / forestry / tourism / sea fishing / hunting.

Opportunities / benefits in hot, arid areas may include better grazing potential, more food production and more reliable water supplies.

Some may argue that climate change will have little or minor effect on their chosen example.

Good answers should progress beyond simply agreeing with, or rejecting, the statement and will discuss the validity of the statement by considering such things as the scale of the climate change, the degree to which indigenous population groups have assimilated in society, *etc*.

Another approach might be to provide a structured discussion of different kinds of opportunities and challenges found in an extreme environment and arrive at an evidenced conclusion.

At band D, expect some description of impacts on an indigenous population. (including answers that do not specify who the indigenous peoples are).

At band E, expect <u>either</u> more detailed explanation of opportunities and challenges for indigenous populations <u>or</u> a structured evaluation of the statement.

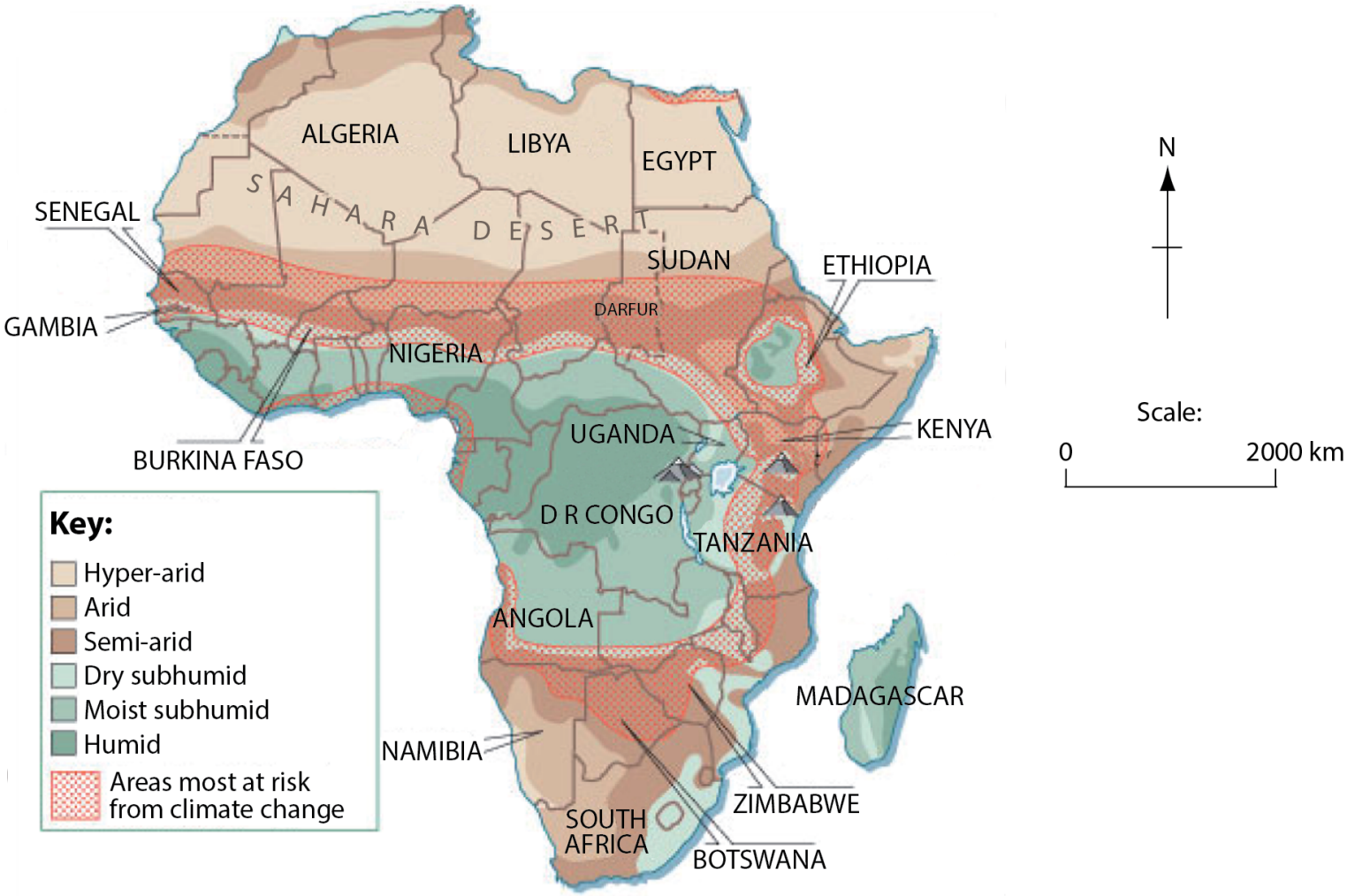
At band F, expect both of these elements.

Marks should be allocated according to the markbands.

Examiners report

a. [N/A]
b.i. [N/A]
b.ii. [N/A]
c. [N/A]

The map shows different levels of aridity in Africa and the areas at most risk from climate change.



[Source: *The Economist*, 12 May 2007]

a. Describe the distribution of hyper-arid and semi-arid regions in Africa. [2+2]

b. Using located examples, suggest possible socio-economic impacts of climate change for arid and/or semi-arid environments. [6]

c. Examine the importance of water in the development of the landforms in any **one** extreme environment (glacial, periglacial, or hot, arid). [10]

Markscheme

a. Hyper-arid: a very broad band across much of north Africa (may list countries but expect a distribution-type comment) [1 mark]. Award [1 mark] for a further aspect of distribution, such as smaller distributions in south-west (Namibia) and in north-east Africa (accept east).

Semi-arid: award [1 mark] for each aspect of the distribution that is well-described or exemplified (e.g. found either side of the arid in the north); encircling the central/D R Congo/humid regions; discontinuous distribution in east Africa; widespread in southern Africa, especially in Botswana and Zimbabwe.

b. Climate predictions for arid and semi-arid areas are extremely varied. The approach taken will depend on the example used (e.g. some predictions for Sahel show increased, not decreased, rainfall).

Possible economic impacts include reduced crop yields, increased cost of irrigation water, cost of imports, the need for more dams etc. Negative impacts on economic activity may be linked to increased evaporation, water shortages, soil erosion, land degradation etc.

Social impacts for indigenous populations and settlements could include out-migration/loss of traditional nomadic cultures etc., increased prevalence of disease, conflict due to resource shortages, etc.

Award up to [4 marks] for the explanation of a range of socio-economic impacts and up to [2 marks] for the effective use of examples.

c. For example, in hot, arid areas, water action includes erosion and deposition by exotic, endoreic and ephemeral rivers. Flash floods can produce sheetwash. Features include canyons, wadis, alluvial fans and bajadas. Water is also important in weathering in desert areas (Griggs' experiments). However, water action is not responsible for all desert land forms. Wind action forms dunes (barchans, seif, star etc.), deflation hollows, yardangs and zeugens.

   A similar approach is valid for each of the other extreme environments. To achieve band E and above, particular landforms should be correctly identified and explained in a way that may acknowledge the contribution that other processes may also be making.

   For answers examining more than one environment, only the highest scoring environment should be credited.

   Marks should be allocated according to the markbands.

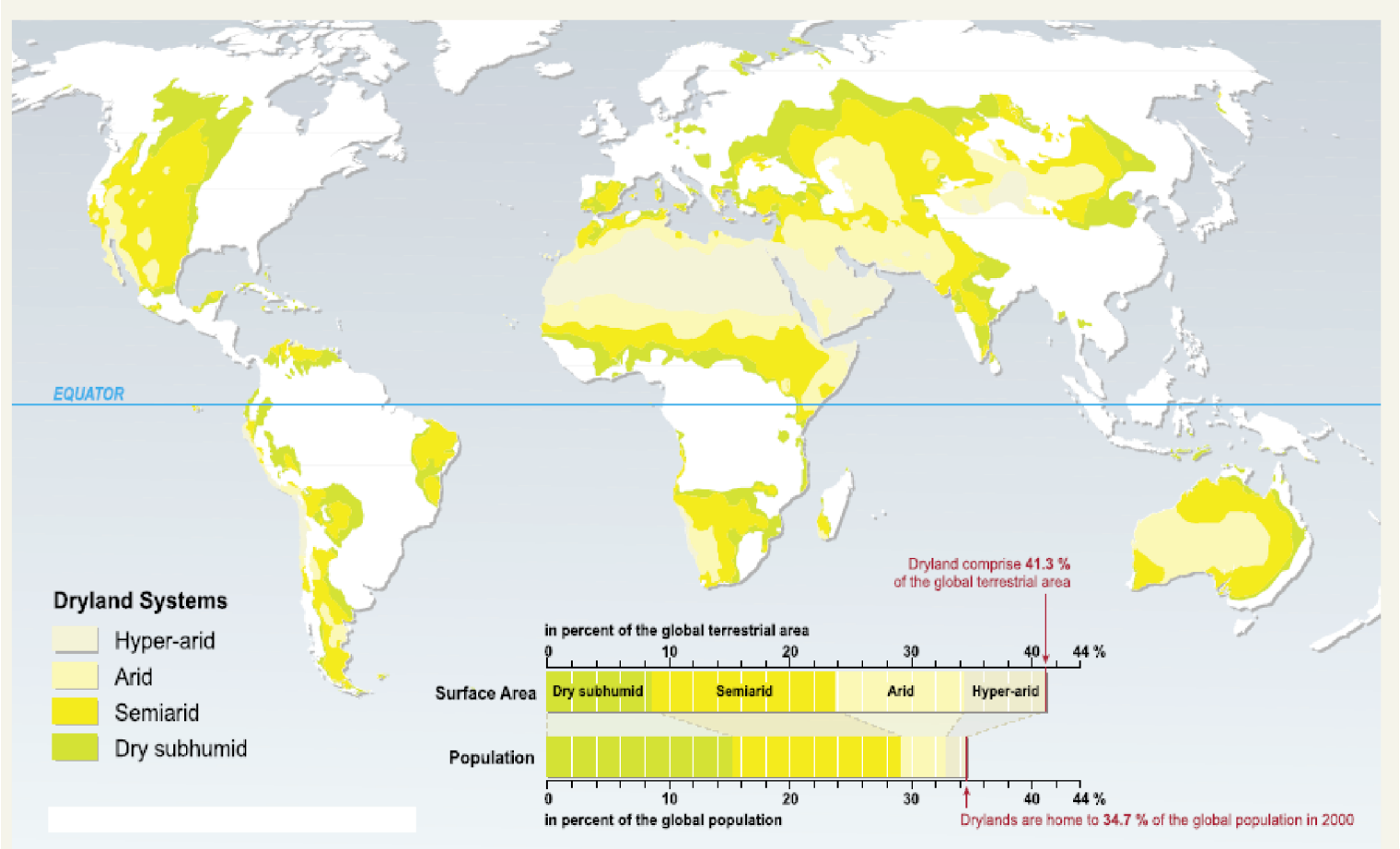
Examiners report

a. This was well done and the best candidates were able to articulate the patterns clearly. Weaker answers were vague and not geographical in nature.

b. Numerous answers were unable to suggest socio-economic impacts with located examples and/or simply referred to aridity problems and did not relate these to climate change; others lacked detail or elaboration.

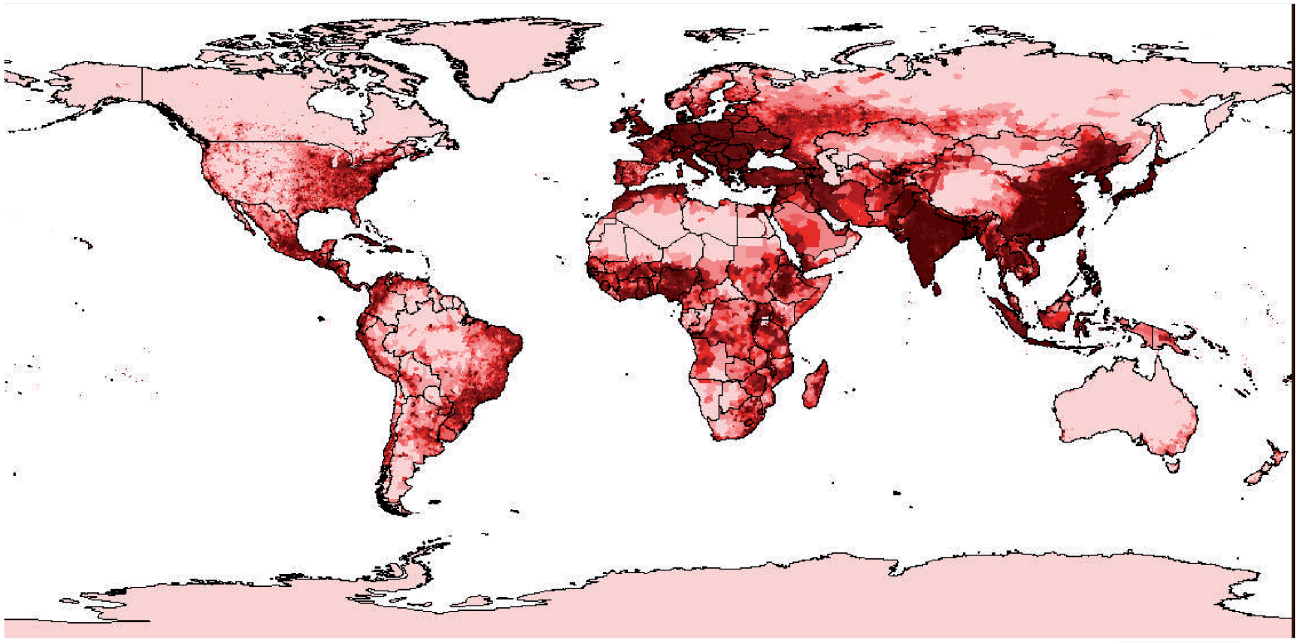
c. This part was very poorly done and only a few candidates were able to identify relevant landforms although there was little understanding shown regarding their development.

The maps show world population density and the location of hot, arid environments.



[Source: Millennium Ecosystem Assessment]

Global Population Density



Population density (persons per km²)
Less than 1
1
2 - 4
4 - 7
7 - 12
12 - 25
25 - 50
50 - 125
Greater than 125
No Data

Map Projection: Geographic
Citation: WRI, 2000 based on CIESIN 2000
Notes:

[Source: ©Earth Trends 2001 World Resources Institute]

a. Using the two maps, describe the population density in hot, arid areas. [4]

b. Explain how and why the following factors may influence population density in hot, arid areas: [6]

- human discomfort,
- inaccessibility.

c. Using examples, examine how extreme environments offer both challenges and opportunities for mineral extraction. [10]

Markscheme

a. Generally hot, arid areas have a low population density [1 mark]. The lowest population densities are found in the largest hot, arid areas such as central Sahara and central Australia [1 mark]. The highest population densities in hot, arid regions are found in coastal regions [1 mark] or in close proximity to major rivers [1 mark].

b. Human discomfort: This could be related to a number of possibilities including lack of water (for drinking, washing and production of food), extreme temperatures, wind, exposure [3 marks].

Inaccessibility: Difficulty to access services such as medical and educational facilities, transport and communications. Hard to import and export goods resulting in low employment opportunities [3 marks].

Other relevant reasons should also be credited.

c. There are a wide variety of answers possible, depending on the mineral resources examined. The opportunities and resulting benefits may be at a local, national or international scale. There may be economic, social and political benefits to mineral extraction. The opportunities and challenges may be influenced by market forces, demand, competition, existing technology and probable future innovations. Challenges include overcoming inaccessibility, environmental restrictions, the investment required, human discomfort, fluctuations in economic and political conditions.

The breadth or depth of treatment of challenges and opportunities need not be equal. Examples are a specific requirement of the question and are required to access band D and above.

Marks should be allocated according to the markbands.

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]

The photograph shows an arid landscape.

[Source: Trevor Cole ©www.coleimages.com]

ai+aii. (i) Name the landform in the background of the photograph. [1+2+

(ii) State **two** processes of wind transport found in areas such as this.

(iii) State the direction from which the wind normally blows.

b. Explain the occurrence of flash floods in areas like the one shown in the photograph. [6]

c. "The opportunities for tourism outweigh the challenges." Discuss this statement with reference to **one** extreme environment. [10]

Markscheme

ai+aii. (i) Barchan dune or sand dunes or erg (also accept sand sea).

(ii) Responses should identify two of the following processes: suspension, saltation, rolling/traction of sediments.

(iii) East.

b. Rainfall intensity [1 mark] exceeds infiltration capacity [1 mark] generating surface runoff/overland flow/flooding [1 mark].

Award additional marks for extra detail of the processes and/or the factors promoting them in an arid environment, for example, summer convection rainfall; unvegetated desert surfaces thus less interception and infiltration; concentrations of water in wadis, gullies or channels; presence of desert crusts and other barriers to infiltration.

c. Answers should examine both opportunities and challenges for tourism in either "cold and high altitude environments" or "hot, arid environments".

In desert regions the opportunities may focus on scenery (dunes, salt flats, canyon lands), indigenous culture and outdoor pursuits, for example. Challenges may include extremes of temperature, accessibility, water shortages and a lack of resources to sustain tourism.

In cold or high altitude regions opportunities may focus on skiing and other outdoor activities, scenery and the indigenous people who inhabit such regions. The challenges may include remoteness, power supply, access and the mitigation of natural hazards such as landslides and avalanches.

While examples are not a specific requirement of the question, those answers that provide supporting examples are likely to access the higher markbands. At least two opportunities and challenges should be given for the chosen environment but the marks need not be allocated equally. For band E and above a clear conclusion is expected.

Marks should be allocated according to the markbands.

Examiners report

ai+aii. Most candidates could identify sand dunes in part (a)(i) but at standard level few were able to accurately state two processes of wind transport in (a)(ii).

b. Very few answers adequately explained the occurrence of flash floods.

c. Responses were generally relevant, but the "challenges" were often poorly covered and many answers simply discussed the advantages and disadvantages of tourism in extreme environments without directly referring to challenges and opportunities afforded by the environment chosen.

---

a. Describe the climatic characteristics of **either** periglacial **or** glacial environments. [4]

b. Explain **two** landforms associated with deposition by glaciers. [3+3]

c. Examine the opportunities and challenges for agriculture in hot, arid areas. [10]

Markscheme

a. Key aspects will be temperature, temperature range, seasonality, precipitation.

Award 1 mark for each valid statement, supported by some quantification or development.

b. The most likely landforms to be chosen will be terminal moraine, lateral moraine, erratic, till plains and drumlins. Also accept fluvio-glacial features, such as kettle holes, eskers, kames and outwash plain.

Award 1 mark for a description of the landform and 2 marks for explanation.

The explanation is likely to focus on the unsorted, ungraded, angular nature of deposits as well as other key features. An explanation of a fluvio-glacial feature may focus on the rounded, stratified, sorted nature of deposits.

c. Annual rainfall varies between 250 mm and 500 mm, so there is some possibility for farming, especially where water conservation methods are used.

Opportunities include:

- nomadism (the traditional way of dealing with insufficient amounts of rainfall and pasture)
- irrigation in areas close to rivers or oases
- increased use of drought-tolerant species
- irrigating with silt-laden river water to restore soil in badly eroded areas
- land enclosure to reduce wind erosion.

Challenges include the shortage of water and the high temperatures. All arid and semi-arid areas have a negative water balance. The shortage of water can be made up by using irrigation water – including central pivot irrigation and drip irrigation.

Desert soils are arid (dry) and often infertile, due to:

- a low organic content because of the low levels of biomass
- being generally very thin with few minerals
- lack of clay (the amount increases with rainfall).

Salinization may occur in areas where annual precipitation is less than 250 mm. The saline soils adversely affect the growth of most crop plants by reducing the rate of water uptake by roots and germinating seeds. Desertification occurs when already fragile land in arid and semi-arid areas is overexploited.

Answers accessing markbands E/F should include both the opportunities and challenges of farming in hot arid areas, and refer to examples or case studies.

Answers that only examine either opportunities or challenges should not be credited beyond band D.

Marks should be allocated according to the markbands.

Examiners report

a. Knowledge and understanding in this question was not strong, with many responses venturing far away from climate into vegetation and relief.

b. With some notable exceptions, better knowledge and understanding was evident in this question than in part (a).

c. Accounts of agriculture were disappointingly weak, with few candidates showing the required depth of knowledge and understanding.

---

a. The photograph shows a periglacial landscape in southern Iceland. [2+2]

[Source: Copyright Bruce Molnia, Courtesy Earth Science World Image Bank (http://www.earthscienceworld.org/images)]

Briefly describe **two** erosional landforms shown in this photograph.

b. Explain **three** ways in which the characteristics of periglacial environments hinder resource development. [2+2+

c. With reference to **one or more** extreme environments, discuss whether human activities can be sustainable. [10]

Markscheme

a. Award 1 mark for correctly naming an erosional landform with a further 1 mark for a matching description.

Landforms include: corries, arête, pyramidal peak, u-shaped valley (which counts only as the name, not the description).

b. Resource development in periglacial environments is hindered by:

- low temperatures that reduce plant growth and make the working environment difficult
- low temperatures that make it difficult/expensive to provide services such as water and sewage disposal
- long hours of darkness in winter that limit plant growth and affect human disposition (biometeorology)
- some machines having to be kept running the whole time in winter or they shut down
- vehicles needing to be equipped with special wheels to deal with the snow and ice in winter
- thawing of permafrost causing subsidence – the weight of vehicles or buildings may cause subsidence too.

Award 1 mark for each valid characteristic and 1 mark for an explanation.

c. Extreme environments are characterized by very low population densities. They are generally relatively inaccessible and tend to be viewed as inhospitable to human habitation. Despite this, they provide numerous opportunities for settlement and economic activity.

Agriculture can be sustainable, as long as the carrying capacity of the land is not exceeded. In some areas, this means migrating with herds rather than practising sedentary farming. Tourism offers some possibility for sustainable economic activity, especially in hot areas. However, water shortages may be an issue. Mineral development is unsustainable but can be used as a catalyst for economic development.

Answers should show a good understanding of sustainability.

Answers accessing markbands E/F should include located examples and a range of human activities.

Marks should be allocated according to the markbands.

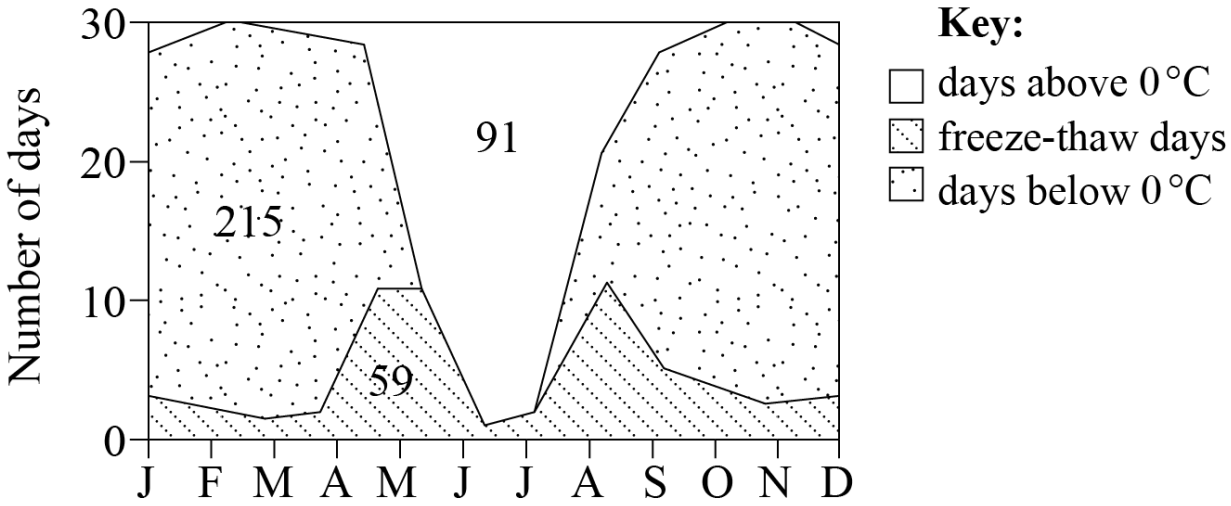
Examiners report

a. The command term was "describe", not "explain". Many candidates identified landforms correctly, but failed to describe them.

b. There were some very strong answers to this question.

c. There were some sound discussions. Weaker responses tended to be descriptive, did not show a good understanding of sustainability and failed to look at specific human activities.

The diagram shows temperature conditions for a year in a periglacial region of the northern hemisphere.



[Source: H French, *The Periglacial Environment*, Longman, (1996), page 24]

ai. Define the term *freeze-thaw*. [1]

aii. Describe the seasonal variations in the number of freeze-thaw days. [3]

b. Explain the importance of freeze-thaw cycles and solifluction processes for the development of periglacial landforms. [6]

c. Examine how the physical characteristics of any **one** extreme environment (glacial, periglacial, or hot, arid) affect resource development. [10]

Markscheme

ai. The freezing and subsequent thawing of water / when temperature rises above and falls below freezing/0°C [1 mark].

aii. There appears to be two peaks (bimodal): one in late spring and one in Fall/Autumn [1 mark]. There are fewer in the summer and also in winter [1 mark]. Credit attempts at quantification or any other significant detail [1 mark].

A list of monthly data should receive no more than [2 marks].

b. Award up to [4 marks] for an explanation of how either process is linked to the development of one or more landforms. For instance, freeze-thaw (and associated frost heave) play a key role in the development of patterned ground and pingos (could also include tors or aspects of thermokarst). Solifluction is likely to be linked with patterned ground (also possibly lobes, terracettes). For the award of the full [6 marks], both processes should be included and related to the landform(s).

c. For a periglacial environment, the characteristics are likely to include climate, permafrost, hours of daylight, length of winter, waterlogging, poor soils and subsidence (thermokarst). There are also a number of hazards such as avalanches, rock falls, icings and frost heave. These make resource development such as mining and associated infrastructure construction difficult. Services need to be provided in insulated pipes called utilidors. Waste disposal is difficult because of the low temperatures. Credit other ideas, for instance, management or risks associated with resource development, e.g. oil spills are broken down very slowly in cold temperatures; or ideas about farming / tourism / nature of ecosystem services.

A similar approach is valid for the other extreme environments. For glacial environments, the physical characteristics might include altitude, gradient, temperatures, depth of snow/ice, annual snowfall, speed of glacial movement, ablation, etc.

For hot, arid environments, the characteristics might include water availability (aquifers, oases), evaporation, type of surface (sand, rock, pebbles), gradient, temperature range (diurnal/seasonal) etc.

To access band E and above, answers should refer to named examples.

For answers examining more than one extreme environment, only the highest-scoring environment should be credited.

Marks should be allocated according to the markbands.

Examiners report

ai. The definition was covered adequately.

aii. Too many candidates failed to recognize the importance of mentioning changes in temperature or identifying freezing point, merely stating it was a cycle of freezing and melting in winter and summer.

b. Responses did not often relate the process of freeze-thaw to the landforms named and in fact knowledge of periglacial landforms was sketchy.

c. The periglacial environment was the most popular extreme environment chosen. Resource development was well exemplified using the Trans-Alaskan pipeline at the expense of looking at a range of physical characteristics. The factors tended to be described rather than analysing the link.

---

b. With reference to a **named** hot, arid environment, explain **two** geographic factors (**other than** climate) that can make them extreme. [6]

c. Contrast the landforms that result from erosional and depositional glacial processes. [10]

Markscheme

b. Likely factors should include human discomfort, inaccessibility, remoteness and relief (credit other valid factors, such as poor soils). Award ***[1 mark]*** for each factor that is identified and a further ***[1 mark]*** for the named example of a recognizable extreme arid environment.

The remaining ***[3 marks]*** should be allocated for the explanation of the factors, for instance explaining how inaccessibility could limit development and habitation opportunities because tourism, or other forms of economic activity, cannot be easily implemented.

c. The landforms could be contrasted in terms of shape, size, material, location and origin/formation, links to advance/retreat of ice.

Likely erosional features will include cirques, arête, pyramidal peaks, glacial troughs, hanging valleys, roche moutonnées and striations. Depositional features are likely to include till plains, moraines, kames, eskers, erratics and drumlins.

Erosional features are more likely to be located in upland areas, while depositional features are more commonly found in lowland areas. Erosional features are often formed of solid rock while depositional features are formed of unconsolidated material, whether sorted (fluvioglacial) or unsorted (glacial). Erosional features tend to be rugged, whereas depositional features are usually subdued with lower amplitude of relief.

To achieve band D, both erosion and deposition features should be covered and described with an attempt to contrast.

At band E and there should be a clear attempt at contrasting the features.

At band F, answers should show an awareness that many landforms owe their origin to a combination of erosional and depositional processes.

Marks should be allocated according to the markbands.

Examiners report

b. [N/A]

c. Appropriate command term not available

---

a. Outline **two** physical causes of aridity in hot, arid environments. [4]

b. Explain **two** processes of weathering commonly found in hot, arid environments. [6]

c. “Human activity within periglacial environments is unsustainable.” Discuss this statement. [10]

Markscheme

a. Sub-tropical high pressure **[1]** brings dry, descending air **[1]**.

Continentality / interior has higher temperatures than coastal margins **[1]** due to lack of proximity to the sea **[1]**.

Cold offshore currents **[1]** mean air does not rise / limits potential precipitation over land **[1]**.

Rain shadow effect **[1]** means a lack of moisture/rain/water for places on lee side/far side/downwind of relief features/mountains **[1]**.

[4 marks]

b. Possibilities include:

- exfoliation (involves layers of rock peeling off)
- granular and block disintegration (rock breaks down into grains/blocks)
- freeze-thaw (blocks break off due to ice expansion)
- salt crystal growth (crystals in pores create stress).

Do not credit erosion processes such as sand abrasion.

*Award **[1]** for each process outlined (not simply named) and a further **[2]** for the brief explanation offered.*

For example: Exfoliation involves layers of rock peeling off **[1]** due to expansion/contraction due to (large) temperature range/changes **[1]** in the presence of some moisture/water **[1]**.

[6 marks]

c. Sustainability has been defined in a number of ways. One common one is using resources wisely without compromising the needs of future users.

Within an extreme environment the resource base is quite fragile. There are a variety of approaches to analysing the question based on sustainable

activities.

Indigenous people have generally lived sustainably in these environments. More recent activity by newer arrivals has not been as sustainable. Human activity includes settlement, infrastructure, communications, and resource development, including tourism. This more recent development has had adverse effects not only on the environment, *eg* degradation of soil or fauna within ecosystems, but perhaps on the culture of indigenous people.

Good answers may discuss the concept of sustainability and the degree to which environmental, social and economic needs can all be met in periglacial environments. Good answers might be carefully structured around different periglacial environments/places/levels of development and may discuss the extent to which sustainable goals can be met in each.

At band D, two human activities should be described and their sustainability commented on.

At band E, expect <u>either</u> more detailed explanation of different activities, <u>or</u> some discussion of the concept of sustainability in relation to periglacial environments.

At band F, expect both.

Marks should be allocated according to the markbands.

[10 marks]

Examiners report

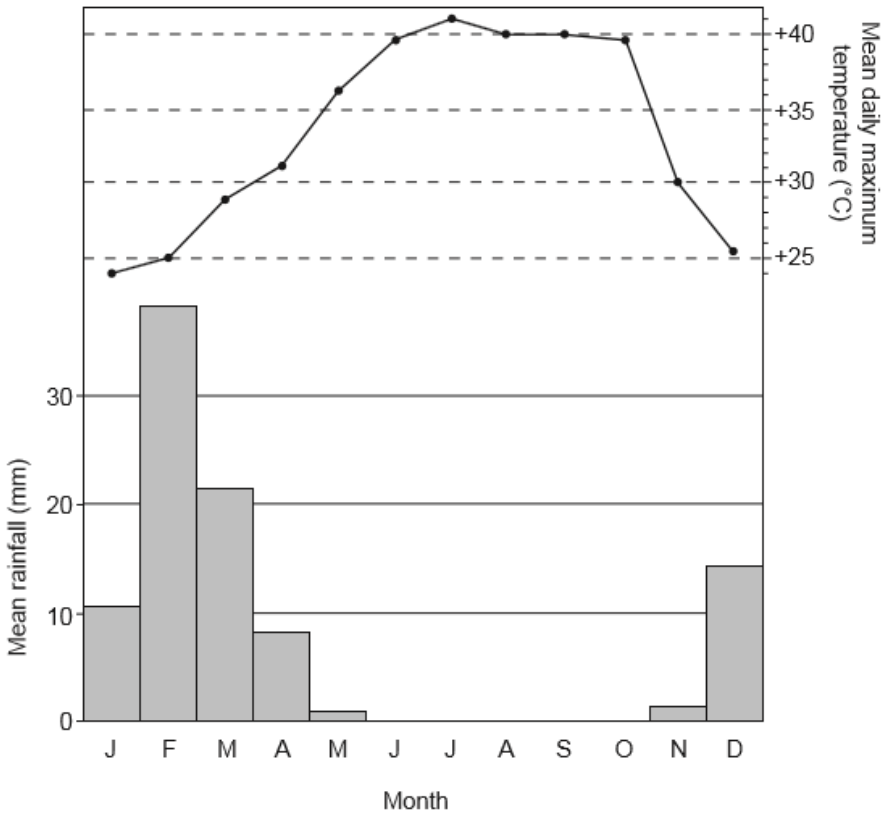
a.

b.

c.

---

a. The graph shows climatic data for an extreme arid environment. [4]



[Source: From the World Weather Information Service (WWIS) website: http://worldweather.wmo.int/en/home.html]

(i) Identify the month with the highest rainfall.

(ii) Estimate the annual temperature range.

(iii) Suggest why October is a more challenging month for human activity than June.

b. Explain **two** processes of weathering or erosion that operate in hot, arid areas. [6]

c. "All cold extreme environments are equally challenging for human activity." Discuss this statement. [10]

Markscheme

a. (i)

February **[1]**

(ii)

17°C (*allow 16–18°C*) **[1]**
(*accept "from 24 to 41°C"*)

(iii)

Two valid points required, such as:

- same temperature
- October has had longer (the previous four months) without rain
- water stores used up (dry).

b. *Award **[1]** for identifying a specific weathering, wind or water process, **[1]** for a basic explanation of how the process operates, and **[1]** for further development*.

For example:
Wind abrasion **[1]** occurs when wind blows sand particles against rock **[1]**. This process operates mainly close to the ground/results in undercutting of rock near ground level **[1]**.

Exfoliation/onion skin weathering **[1]** is when repeated heating and cooling **[1]** affects the outer layers of the rock, causing them to peel away **[1]**.

Hydraulic action and/or abrasion (by water) **[1]** occurs after flash floods (and high energy run-off) **[1]** causing wadis/canyons **[1]**.

c. The question can be answered in different ways. An account of different periglacial areas would be sufficient. Candidates may equally compare polar/glacial/periglacial/high mountains.

Challenges include extreme cold, permafrost, remoteness, isolation, daylight hours, fragile ecosystem, climate change.

Likely human activities include mining, tourism, agriculture (nomadic herding), fishing, settlement and communications.

Good candidates may explicitly discuss the very different types of challenge (permafrost or high altitudes), or may discuss ways in which different societies or activities encounter different challenges.

At band D, expect a general description of the challenges and possible human activities in one or more cold extreme environments.

At band E expect either explanation of some range of activities in two cold environments or some explicit discussion of whether all cold extreme environments are equally challenging.

At band F expect both.

Marks should be allocated according to the markbands.

Examiners report

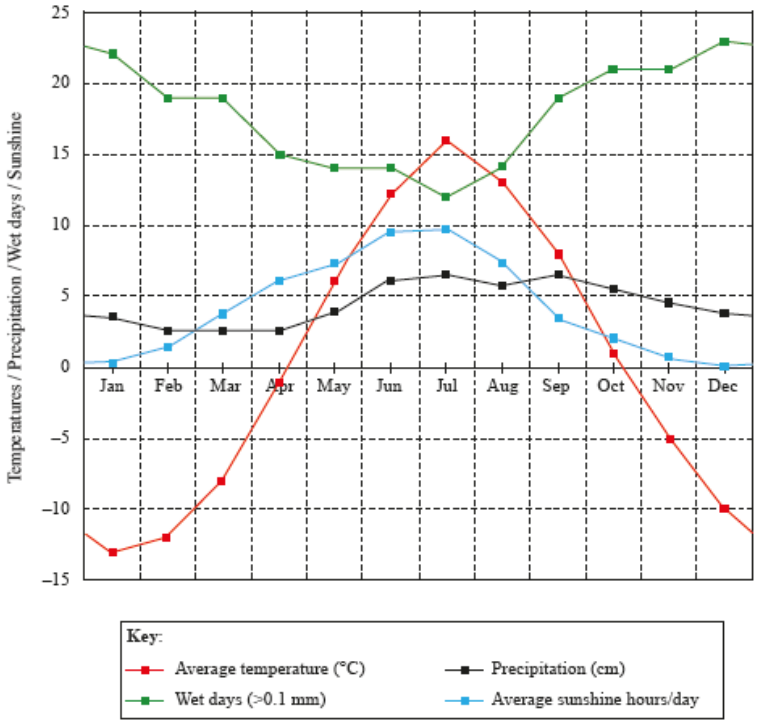
a. (i/ii) This presented few difficulties. Most were able to correctly identify the month and estimate the temperature range.

(iii) Some had difficulty in suggesting why October was a more challenging month.

b. Generally poorly answered. There was limited understanding of the processes of weathering and erosion in hot, arid areas.

c. Generally reasonably well answered and exemplified; there were some very sound responses. However, how challenges have been overcome was often descriptive. Weaker candidates tended to focus on living conditions and adaptations.

The climate graph is of Arkhangelsk (64°N, 60°E), a periglacial area in northern Russia.



[Source: www.arkhangelsk.climatemps.com]

a. From information shown on the graph: [4]

(i) State the number of months of the year when the average temperature is below 0°C.

(ii) Estimate the annual temperature range in °C.

(iii) Apart from temperature, outline **one other** climatic characteristic shown on the graph that indicates Arkhangelsk is located in an extreme environment.

b. Explain **three** ways in which people have adapted to the extremes of weather and climate in periglacial areas such as Arkhangelsk. [6]

c. "Desertification is the main environmental risk for agriculture in hot deserts and semi-arid areas." Discuss this statement, with reference to examples. [10]

Markscheme

a. (i) Six months ***[1 mark]***

(ii) 28 to 30 inclusive, or a range of -13°C (or -14°C) to +16°C

(iii) Award ***[1 mark]*** for one of the following:

- identifies no sunshine in December and January
- the number of wet days is high (over 20 in 4 months of the year)
- relatively low precipitation throughout the year.

Award ***[1 mark]*** for outlining an implication for people or the environment that shows why this can be regarded as extreme.

For example: "There is no sunshine in December ***[1 mark]***, which means even evergreen plants cannot photosynthesize at all ***[1 mark]***."

b. Award ***[1 mark]*** for each adaptation and a further ***[1 mark]*** for an explanation that links this with periglacial weather and climate (should be specific about season, and not generalized).

If more than three adaptations are considered, accept only the first three.

A variety of responses are possible at different scales from individual to communities within a large urban area:

- clothing needs to be wind proof/insulated/layered ***[1 mark]*** as strong winds contribute to wind chill in winter months ***[1 mark]***
- cars having extra heaters ***[1 mark]*** to stop diesel fuel freezing due to extreme cold in winter ***[1 mark]***
- buildings on stilts ***[1 mark]*** to avoid potential issues with permafrost thaw in summer ***[1 mark]***
- clearance of snow on roads/gritting of roads ***[1 mark]*** during winter months, snow and long periods of ice on roads ***[1 mark]***
- extra use of lighting to work ***[1 mark]*** during winter when daylight is limited/absent ***[1 mark]***
- some people may take vitamin D supplements ***[1 mark]*** in winter to make up for a lack of sunshine ***[1 mark]***
- costs of adapting to such a wide range of conditions ***[1 mark]*** *eg* winter and summer clothing ***[1 mark]***.

Credit other valid adaptations and specific links to seasonal challenges.

For a simple list of "cold" adaptations award a maximum of ***[3 marks]***.

c. *Credit all content in line with the markbands. Credit unexpected approaches wherever relevant.*

Desertification is the extensification or intensification of desert conditions and a major risk in many parts of the world today. Other environmental risks include salinization, flash floods, and saline intrusions. Some risks are linked (*eg* desertification could encourage irrigation and trigger salinization).

There are a number of ways to discuss the statement. One way is to compare desertification with the severity of other risks *eg* salinization. Another way is to discuss how the risk of desertification varies according to climate and wealth of different countries (*eg* Sahel and Gulf states), or between hot deserts and semi-arid areas.

For band D, candidates should describe the risk to agriculture of desertification and/or another environmental threat for named arid/semi-arid area(s) (may not distinguish at this level).

Band E should either provide much greater detail of how desertification affects agriculture in different areas (may contrast hot deserts and semi-arid areas) or evaluates the severity of at least one additional risk, such as salinization.

At band F, expect both elements.

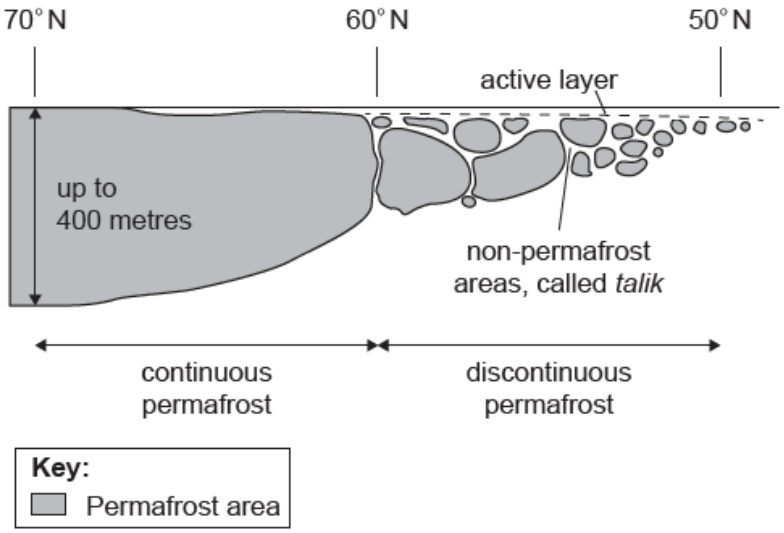
Examiners report

a. Candidates had few problems in interpreting the given graph for parts (a)(i) and (ii) but in part (iii) there was often no link to explain why another climatic characteristic made it extreme for the environment or people.

b. Adaptation to weather extremes was answered adequately but linking it to the extreme weather in seasons was not done well, often being descriptive and lacking in detail.

c. There seemed to be few problems describing desertification and the problems for agriculture, albeit very superficially, but very few looked at any other environmental threats to agriculture risk, for example, salinization. Whether or not desertification is the main environmental risk was often ignored.

The diagram shows a cross-section of the location of permanently frozen ground (permafrost).



[Source: *Conceptual Frameworks in Geography*, by Alan Clowes and Peter Comfort, copyright Pearson Education Limited, 1987, page 228]

a. Describe how the characteristics of permafrost vary with latitude. [4]

b.i. Outline how the seasonal changes taking place in the active layer differ between 50°N and 60°N. [2]

b.ii. Explain **two** ways in which the active layer creates challenges for settlement and/or communications in a permafrost area. [4]

c. "The opportunities for mineral extraction outweigh the challenges in hot, arid areas." Discuss this statement. [10]

Markscheme

a. *Award **[1]** for each valid point, including*:

- permafrost becomes thicker towards 70°N / the north **[1]**
- changes from discontinuous to continuous at 60°N **[1]**
- thin active layer becomes deeper towards the south/50°N **[1]**
- blocks of permafrost become smaller south of 54/55°north **[1]**.

*Maximum **[3]** if no quantification using depth or latitude*.

b.i. *Award **[1]** for summer thawing and subsequent refreezing at both, and **[1]** for recognizing that the active season is much shorter at 60°north / shortens as latitude increases.*

b.ii. *In each case, award **[1]** for each challenge that is identified and **[1]** for further development/exemplification*.

Challenges include:

- the action of solifluction
- thermokarst/subsidence heat from buildings
- heat from pipelines
- changes in vegetation cover
- frost heave
- the weight of vehicles
- keeping cold water flowing to towns
- accessibility of settlements.

For example: The heat from buildings leads to thawing of the active layer **[1]** causing subsidence of buildings **[1]**.

c. Areas of mineral extraction include, but are not limited to, oil in the Middle East, diamonds in Botswana/Namibia, uranium in Australia, uranium in Niger, copper in Arizona, copper in the Atacama (Chile).

The opportunities are economic gains from the resources being mined, which provides revenue for the country and for improvement of local infrastructure, *eg* communications, investment made into local area, *eg* health care, employment (and higher wages) provided for local people.

Challenges tend to be environmental and include contamination of scarce water resources, effects on local water supply/tables, aesthetic changes in the natural landscape, pollution, accelerated wind/water erosion, economic exploitation by the TNCs (mining companies), little regard for local environment or people; disagreements over land ownership and rights (*eg* aborigines in Australia), decreased sustainability in the long term.

Good answers should progress beyond simply agreeing with, or rejecting, the statement and discuss the validity of the statement. Another approach might be to provide a structured discussion of different kinds of opportunities and challenges found in hot, arid areas and arrive at an evidenced conclusion.

At band D, expect a description of some of the challenges and/or opportunities associated with mining in hot, arid areas.

At band E, expect either an explanation of the challenges and opportunities associated with mining in hot, arid areas or a structured discussion of the statement, which may include scale, wealth or power.

At band F, expect both of these elements.

Marks should be allocated according to the markbands.

Examiners report

a. [N/A]
b.i. [N/A]
b.ii. [N/A]
c. [N/A]

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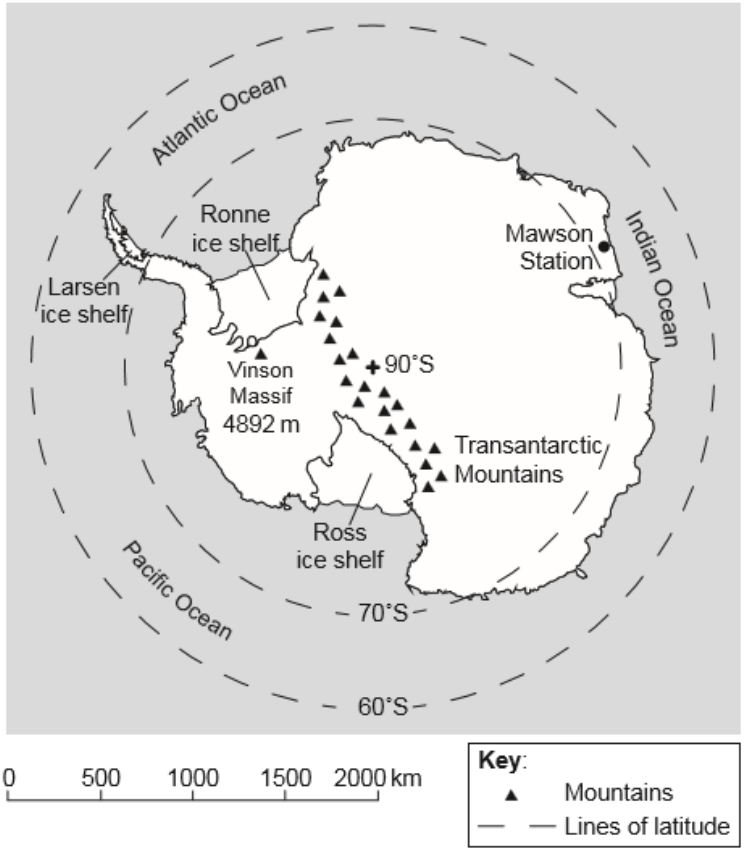
a. The map shows a polar view of the Southern Hemisphere and locates Antarctica, an area experiencing an extreme environment. [4]



[Source: © International Baccalaureate Organization 2016]

(i) Estimate the distance of Mawson Station from the South Pole.

(ii) Estimate the latitude of the Vinson Massif.

(iii) State **two** reasons why most of Antarctica is covered in ice.

b. Referring to **at least one** example, suggest **three** reasons why mineral extraction has led to the growth of settlements in extreme environments. [6]

c. Using located examples, discuss the opportunities and risk associated with the use of irrigation in hot, arid environments. [10]

Markscheme

a. (i)

1400 km (*accept 1300 km to 1500 km*)

(ii)

80° / 80°S **[1]** (*accept 78° to 82°*)

(iii)

high latitudes / high altitude / lack of insolation / high albedo

*Accept any two for **[1]** each*.

b. *Award **[1]** for each valid reason and a further **[1]** for development of each reason, up to a maximum of **[5]**, reserving the final **[1]** for an example*.

For example:

- in-migration of workers **[1]** increases demand for housing **[1]**
- export of mineral/resource **[1]** leads to the development of roads and other transport infrastructure **[1]**
- growth of population creates demand for services **[1]** *eg* retailing, electricity, gas **[1]**
- identifies located resource, *eg* uranium mining in Niger for final **[1]**.

c. Responses may include some description of the techniques of irrigation. There should be an understanding of what is meant by opportunity, *ie* in this case an ability to support human occupation by increasing food supply and security. Terms such as “water balance” might be included in better answers as well as why irrigation is necessary. Risks may include salinization, depletion of groundwater, pollution. Accept other reasonable suggestions.

Good candidates may recognize that there are a range of societies in hot, arid environments, some of whom have the capital and technology to unlock considerable opportunities. Credit should also be given to candidates who understand that though the risk is present it can be managed. Some may even discuss how the extraction of water for irrigation in one area may lead to problems elsewhere, *ie* risk and opportunity are not in the same place.

A good discussion might evaluate how risks vary between different irrigation techniques.

At band D, describes some opportunities and/or risk.

At band E expect <u>either</u> a more detailed explanation, with located examples, of some opportunities and risk (do not expect balance) <u>or</u> a discussion of the overall balance between opportunity and risk.

At band F expect both.

Marks should be allocated according to the markbands.

Examiners report

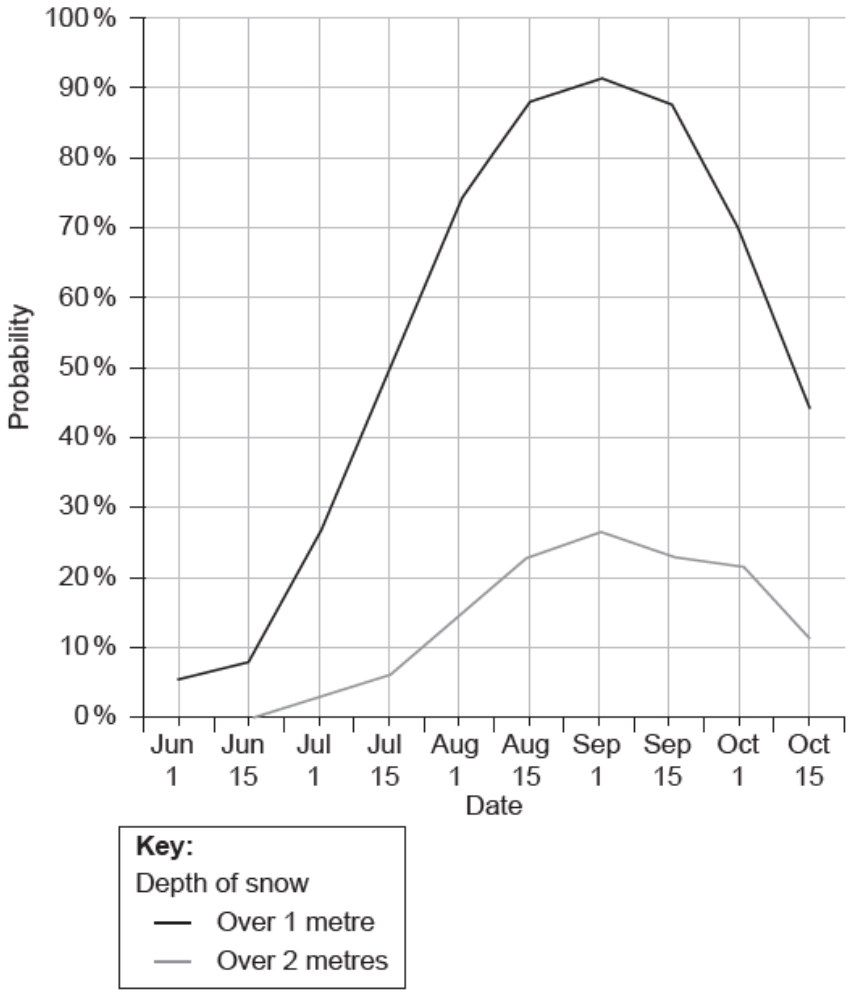
a. (i/ii) No problems.

(iii) Many struggled with this question. Some correctly referred to high albedo, latitude, and lack of solar radiation.

b. There were some sound answers. Most were able to refer to a relevant example; sometimes the responses lacked development.

c. This was often well answered, with good exemplification, with the Aral Sea being frequently used. There was good understanding of risks and opportunities involved with irrigation; some referred to different irrigation techniques.

The graph shows the probability (likelihood) of the depth of snow on a ski field being over 1 metre, and over 2 metres, between June and October.



[Source: Michael Paine]

a.i. State the earliest date on which there is a 50 % probability of snow depth exceeding 1 metre. [1]

a.ii. Estimate the probability of snow depth exceeding 2 metres on 1 September. [1]

a.iii Briefly explain how the graph provides evidence that this ski field is located in the southern hemisphere. [2]

b. Explain **two** environmental impacts of tourism in **one named** extreme environment. [6]

c. Compare the importance of water and wind in the development of landform features in hot, arid areas. [10]

Markscheme

a.i. July 15th **[1]**

a.ii. 27 % (accept 26–28 %) **[1]**

a.iii. *Award **[1]** for evidence from the graph showing heaviest snow cover is in August/September and **[1]** for explaining that this must be winter in the southern hemisphere.*

b. *In each case, award **[1]** for each identified environmental impact linked to a tourist activity, and **[2]** for further development and explanation of how the physical environment is affected.*

Possibilities include erosion, mass movement, land degradation, vulnerability to hazards, water usage, waste disposal, disruption to biodiversity. Positive changes are possible, *eg* irrigation, restoration.

For example: Erosion of land surface in high altitude areas by creating ski-field infrastructure (pistes, chair lifts, restaurants) **[1]**. This destroys the vegetation which helps stabilize the slopes **[1]**, which can then contribute to soil erosion/avalanches/unsightly bare ground **[1]**.

*Award up to a maximum of **[3]** for a generic account of tourism impacts with no reference to the specifics of a named extreme environment (either type or named region, eg Alps).*

c. In hot, arid areas, water action includes erosion and deposition by exotic, endoreic and ephemeral rivers. Flash floods can produce sheetwash.

Features formed by river action include canyons, wadis, alluvial fans and bajadas. The role of water in weathering processes should also be credited.

Wind action includes abrasion and deflation and landforms include dunes (barchans, seif, star, *etc*), deflation hollows, yardangs and zeugens.

***N.B.**: Responses do not need to consider more than a few of these landforms for the award of full marks.*

Good answers might recognize that water and wind are equally important in forming features in hot, arid areas or may attempt to give credence to one over the other. Alternatively, a temporal element may be introduced with recognition of past pluvial periods or seasonal flash floods or a recognition that some landforms may be formed by a combination of both processes.

At band D, expect some description of the development of both water- and windformed features.

At band E, expect either a greater explanation of water- and wind-formed features in hot, arid areas or an attempt to compare the processes/features.

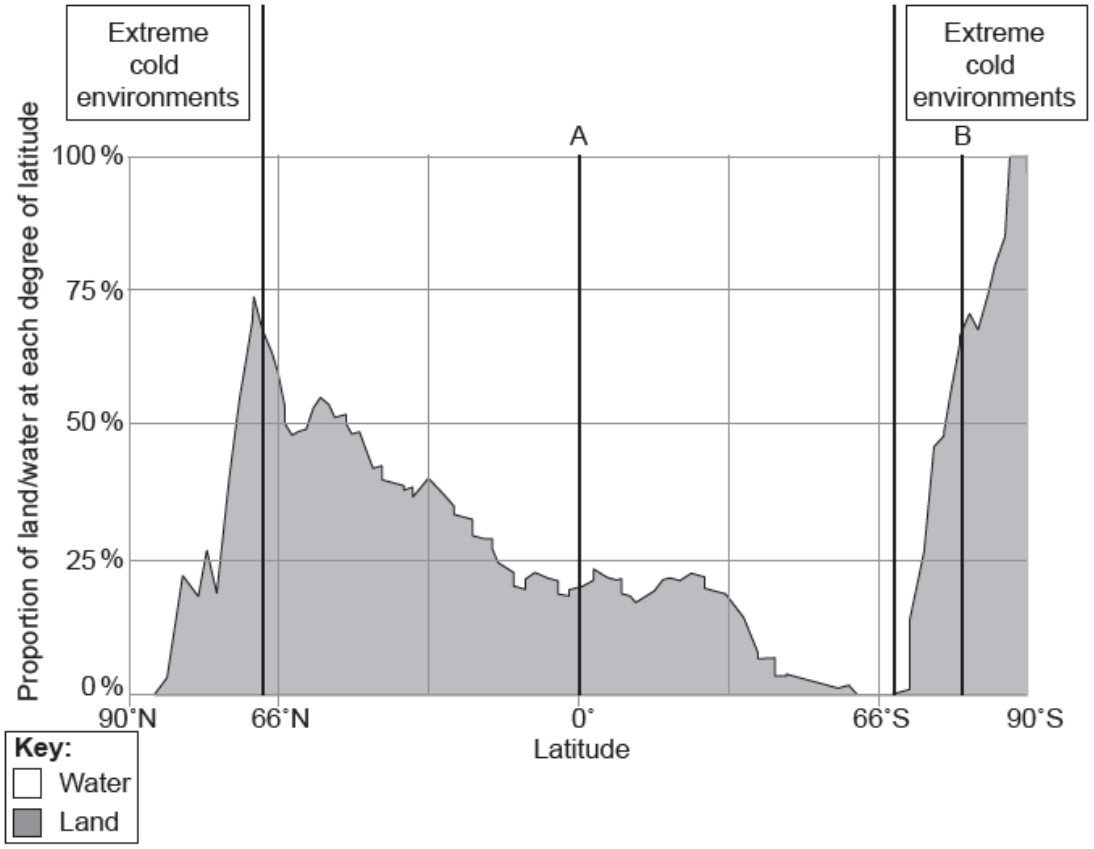
At band F, expect both.

Marks should be allocated according to the Paper 2 HL and SL markbands.

Examiners report

a.i. [N/A]
a.ii. [N/A]
a.iii. [N/A]
b. [N/A]
c. [N/A]

The diagram shows the proportions of land and water at each degree of latitude and the locations of some cold extreme environments.



[Source: adapted from http://radicalcartography.net]

a. (i) Estimate the latitude at which the percentage of land is highest in the Northern Hemisphere. [4]

(ii) State **one** reason why extreme cold environments can even be found at latitude A.

(iii) Briefly outline the seasonal variations in temperature likely to be found at latitude B.

b. Explain the characteristics **and** formation in periglacial environments of: [6]

(i) patterned ground;

(ii) thermokarst.

c. Referring to examples, evaluate the varied economic opportunities in hot, arid environments. [10]

Markscheme

a. (i) latitude: 67° North (accept 65–70° N inclusive) **[1]**

[1 mark]

(ii) altitude/elevation **[1]**

[1 mark]

(iii) *Award **[1]** for each of the following:*

- most months below freezing
- wide range of monthly temperatures
- lowest temperatures (–40°C) in June/July
- highest temperatures (could reach +5°C) in November/December.

[2 marks]

b. (i) *Award up to **[2]** for a description of the characteristics and up to **[2]** for an explanation of formation, up to a maximum of **[3]**.*

Characteristics include:

- patterned ground consists of stone-circles, polygons and stripes **[1]**
- they can be up to several metres wide **[1]**.

Formation points include:

- formation occurs in soils that have experienced intense frost heave **[1]**
- steep slopes/gradient cause the circles to be replaced by polygons **[1]**
- role of ice sorting/differential frost heave **[1]**
- solifluction may play a role **[1]**.

[3 marks]

(ii) *Award up to **[2]** for a description of the characteristics and up to **[2]** for an explanation of formation, up to a maximum of **[3]**.*

Characteristics include:

- wet hollows/depressions/lakes **[1]**
- uneven/irregular relief/hummocks **[1]**.

Formation points include:

- permafrost melting, leading to wet areas/lakes **[1]**
- ice lens growth explaining hills/hummocks/higher areas **[1]**
- doming due to frost heave **[1]**
- warming climate may explain increased thermokarst **[1]**.

[3 marks]

c. Most hot environments are not densely populated due to the challenging nature of the environment. Expect details of opportunities to include

forms of agriculture including nomadism (the traditional way of dealing with insufficient amounts of rainfall and pasture) or commercial crops in

places with irrigation (in areas close to rivers or oases), *eg* cotton, dates.

Other examples include mineral and oil exploitation, or possibly tourism using the arid environment as an attraction (either natural features or cultural landscape, *eg* world heritage sites).

Good answers may evaluate the relative merits of these opportunities (*eg* high value of oil and some tourism industries compared with the low profitability of some forms of agriculture). Good answers may also evaluate the sustainability/durability of some types of activity. Another approach might be to evaluate the likelihood of opportunities being exploited, or not, in different places (*eg* conflict or local poverty could deter potential visitors in some arid places).

At band D, two opportunities should be described.

At band E, expect <u>either</u> more detailed explanation of two opportunities <u>or</u> some evaluation of how the opportunities may vary in terms of potential/realized benefits (eg for different places, environments, societies or levels of development).

At band F, expect both.

Marks should be allocated according to the markbands.

[10 marks]

Examiners report

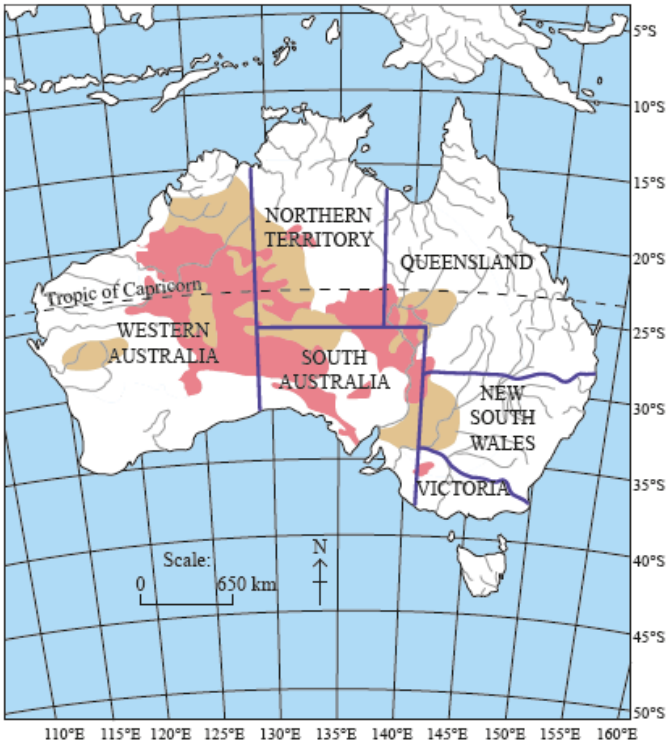
a.

b.

c.

Optional Theme C — Extreme environments

6. The map of Australia shows regions that are at high risk of desertification.



[source: adapted from *Philip's Australian School Atlas*, page 20]

a. (i) Define the term *desertification*. [4]

(ii) Describe the pattern of areas with a high risk of desertification shown on the map.

b. Suggest **three** reasons why some rainstorms in hot, arid environments result in flash floods. [6]

c. Examine how human activity may be affected by global climate change in **one named** extreme environment. [10]

Markscheme

a. (i) The spread/intensification of desert/arid conditions. Credit alternative phrasing which implies change, such as turning/becoming *eg* "the desert has expanded".

(ii) Award ***[1 mark]*** for each of the following to a maximum of ***[3 marks]***:

- adjacent to existing deserts
- identification of anomalies *eg*, Western Australia
- limited to central and western Australia (not east)
- reference to place names/tropics/latitude.

b. Award ***[1 mark]*** for each reason and ***[1 mark]*** for a suggested link with flooding.

Reasons could include:

- torrential precipitation ***[1 mark]*** leads to overland flow/surface water ***[1 mark]***
- precipitation exceeds infiltration rate ***[1 mark]*** thereby causing overland flow ***[1 mark]***

- sparse vegetation leads to less interception ***[1 mark]*** and rapid run-off/less storage ***[1 mark]***
- run-off may be rapidly concentrated in wadis and canyons ***[1 mark]*** which overflow ***[1 mark]***
- nature of desert surfaces (crusts, rocky, impermeable) ***[1 mark]*** also causing rapid run-off ***[1 mark]***.

Award a maximum of ***[4 marks]*** if the reasons do not clearly relate to flash floods in an arid environment, as opposed to generic flooding.

c. Candidates may choose to approach this question in terms of current observable changes or predicted change. Either approach is acceptable.

In cold environments, melting permafrost may give benefits or costs. Benefits could include longer growing seasons, potential for sedentary agriculture, potential for commercial forestry, more rainfall in cold environments, more potential for tourism, and increased accessibility of minerals. There may also be less, but unpredictable sea ice making sea routes more accessible but potentially more hazardous/increased fish availability due to changing sea conditions (increasing fishing potential).

Problems could include traditional ways of life based on hunting and fishing are threatened; out-migration of the younger people, unstable buildings and infrastructure.

Possible loss of snow and its impact on ski resorts in mountainous areas, and the loss of water supply from retreating glaciers, impacting on a range of human activities, is also a valid response.

In hot environments: changes in rainfall patterns may give benefits or costs, benefits may lead to better grazing potential, more food production and more reliable water supplies. Lower rainfall could make marginal land impossible to live on as grass disappears and fuel wood becomes limited. Rainfall patterns could become more extreme, either more flash floods or extreme droughts. Food shortages may become more frequent/intense leading to environmental migration.

Award credit for an evaluation that takes a considered view of how wealthy people in extreme environments may be in a better position to adapt to change *eg*, water management in Dubai.

Do not credit tropical rainforests.

At band D, expect some description of two ways in which human activity may be affected by climate change in a recognizable extreme environment.

At band E expect either a more detailed account of a greater range of impacts, or some explicit evaluation of a variety of different kinds of impact (positive/negative or short-term/long-term).

At band F, expect both.

Marks should be allocated according to the markbands.

Examiners report

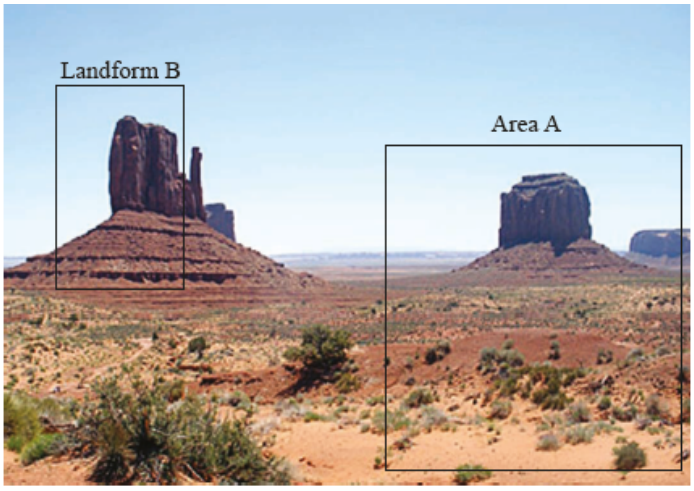
a. There was little difficulty in defining the term desertification. The map question was generally well answered, although weaker candidates did not refer to places on the map, or refer to latitude, longitude and the Tropic of Capricorn.

b. This question was generally well done, with good knowledge and understanding of the causes of flash floods in deserts.

c. This question did not cause significant problems, as long as candidates related the human activity to a specific extreme environment. There were some good case studies, such as the loss of snow/glaciers in Switzerland and a change in economic focus. Permafrost or cold areas were done better than the rather repetitive attempt to relate the question to arid areas. Weaker responses tried to look at climate change as a whole and were not related to a named extreme environment.

Option C — Extreme environments

The photograph shows a hot, arid landscape.



[Source: The American Southwest, www.americansouthwest.net]

a. (i) Identify any **one** landform shown in area A on the photograph. [4]

(ii) Suggest how landform B in the photograph was formed.

b. Explain **two** environmental impacts of tourism on **one named** extreme environment. [6]

c. Contrast the challenges for mineral extraction in periglacial environments and hot, arid environments. [10]

Markscheme

a. (i) Butte, cliff, plateau, pediment, plain, scree/talus slope, mesa.

(ii) Basic understanding of the weathering and erosional processes in arid extreme environments should be demonstrated. Landform (butte) need not be named. If an incorrect landform is identified in part (i) (such as a zeugen), award a maximum of ***[2 marks]***. Do not credit wind erosion.

Award ***[1 mark]*** for each of the following suggestions:

- original land surface was eroded by backwearing/slope retreat
- a specific weathering process has played a role (*eg* heating and cooling, or freeze-thaw), or erosion by water
- sloping talus layer is produced by mass movement.

b. In each case, award ***[1 mark]*** for each identified environmental impact linked to a tourist activity and ***[2 marks]*** for further development and

explanation of how the physical environment is affected.

Possibilities include erosion, mass movement, land degradation, vulnerability to hazards, water usage, waste disposal, disruption to biodiversity. Positive changes are possible *eg* irrigation, restoration.

For example: “Erosion of land surface by off-road vehicles ***[1 mark]***. This destroys what little vegetation helps bind the soil together in semi-arid areas ***[1 mark]*** which can then contribute to desertification ***[1 mark]***.”

Award up to a maximum of ***[3 marks]*** for a generic account of tourism impacts with no reference to the specifics of a named extreme environment.

c. *Credit all content in line with the markbands. Credit unexpected approaches wherever relevant.*

The challenges for mineral extraction in periglacial areas include low temperatures, seasonal lack of daylight, permafrost, thermokarst, remoteness, inaccessibility, water supply, transport difficulties, environmental conservation, attracting and retaining workforce.

Challenges in hot, arid areas include the high temperatures, lack of water, dust and sandstorms, remoteness, inaccessibility, attracting and retaining workforce, environmental conservation and transport difficulties.

Remoteness, inaccessibility and the challenge of attracting a workforce are features that can be described in relation to either environment. However, good answers will seek contrasts (such as inaccessibility due to low numbers of tundra travel days, linked with active layer thawing, as opposed to mobile dunes in arid areas).

For band D candidates must describe some challenges found in periglacial and arid areas (all of the above list are not necessary), with some basic link to mineral extraction established, rather than all human activity in general. Do not expect contrasts to be made explicit at this level.

Band E should either provide greater detail of how specific challenges for mineral extraction arise in both cases, or can offer a strongly contrasting account of the two extreme environments.

At band F, expect both elements.

Examiners report

a. Very few could accurately identify the landform or explain its formation. Only some were able to show basic knowledge of processes.

b. Straightforward but too many gave generic environmental impacts and did not refer to a named extreme environment.

c. Many seemed to look at the challenges for living in periglacial/arid areas and did not relate it to mineral extraction. In some no actual mineral was mentioned. The better responses were able to describe some of the challenges, but few offered a contrast between the different environments.

The photograph shows a feature formed by erosion in the Atacama Desert in Chile.

[Source: © International Baccalaureate Organization 2015]

a. (i) Outline the main erosional process that accounts for the feature shown in the photograph. [6]

(ii) Identify **and** explain the formation of **one** water-formed feature commonly found in a hot, arid environment.

b. Explain how **two** factors (other than heat) restrict human settlement in hot, arid environments. [4]

c. "Some human activities in extreme environments are more sustainable than others." Discuss this statement, with reference to **one or more** types of extreme environment. [10]

Markscheme

a. (i) Wind/Aeolian (or abrasion) **[1]**.

Softer rock strata are removed by sand blasting/abrasion **[1]** leaving the more resistant layers.

(ii) Award **[1]** for identification of any valid water-formed feature *eg* wadi, mesa, butte, canyon, inselberg, pediment, alluvial fan/bahada, salt lake/playa.

Do not credit oasis.

Award **[1]** for a valid description or sketch of the landform if provided and up to **[3]** for a valid explanation.

For example, wadi **[1]**. A dry, steep-sided river bed **[1]** formed by water erosion/downcutting through the rock layers **[1]**. Flash floods/ephemeral streams have high energy **[1]**.

b. Award **[1]** for each factor and a further **[1]** for a link to human settlement.

For example, remoteness **[1]** means that it is very difficult to provide services to people **[1]**.

Possible factors include: inaccessibility, remoteness, lack of water, possibility of salinization with irrigation, perceived infertility of soils, increasing desertification.

c. Responses may either look at a range of activities in one extreme environment or a narrower range of activities across two or more extreme environments.

Extreme environments are generally considered to be very fragile environments and largely inhospitable. However, they do provide numerous opportunities for economic activities (mining, tourism, agriculture), settlement, *etc*.

Possible themes include:

- in cold environments, governments have to carefully balance economic and environmental agendas, *eg* the state of Alaska has to balance the energy needs of the USA (further exploration and production) with the requirement for conservation and environmental management
- possible conflicts may exist between tourism, wildlife movement and the transport of oil; or with the fragility of the permafrost (insulation, oil infrastructure)
- in arid environments, the focus of sustainability could be agriculture or mineral extraction, *eg* uranium extraction in Niger
- tourism in alpine areas.

Good answers may progress beyond simply agreeing or rejecting the statement and may discuss the validity of the statement with reference to different strands of sustainability (economic/social/environmental). Another approach might be to discuss how sustainability could be dependent on factors other than environmental challenges, such as access to capital (for irrigation, air conditioning *etc*).

For band D, expect some description of the impacts of human activity in one or more extreme environments (sustainability may not be explicit).

At band E, expect either more detailed explanation of the sustainability/impacts of human activities in one or more extreme environments or a structured discussion of what is meant by sustainability in this context.

At band F expect both of these elements.

Marks should be allocated according to the markbands.

Examiners report

a. (i) Some candidates had difficulty in identifying the relevant erosional process: wind/abrasion.

(ii) Many candidates could name a water-formed feature (wadi or canyon were the most common) but few could give detailed explanations of the formation. A description, or sketch, of the water-formed landform was also required.

b. Straightforward question, but some responses lacked full development to be awarded full marks.

c. Quite well answered, with reference to a range of activities such as agriculture, tourism or mineral extraction. In many answers the concept of sustainability remained implicit.

The two photographs show the Qori Kalis Glacier, Quelccaya Ice Cap, Peru. Photograph A was taken in summer 1978; photograph B was taken in summer 2002.

Photograph A (1978)

Photograph B (2002)

[Source: L Thompson, http://arizonaenergy.org]

a. Describe **two** changes in the landscape shown by the two photographs that demonstrate glacial retreat. [4]

b. Explain the formation of **two** features resulting from the processes of glacial and/or fluvioglacial deposition. [6]

c. Using examples, discuss the opportunities for agriculture in hot, arid areas. [10]

Markscheme

a. *In each case, award **[1]** for a valid change and **[1]** for a description that demonstrates a link with glacial retreat.*

Possibilities include:

- snout of glacier has moved up the valley **[1]** demonstrating it has got shorter
- there is a new lake **[1]** which shows the glacier is melting/shrinking **[1]**
- land is exposed on valley sides **[1]** as glacier is not as deep/wide **[1]**
- other valid suggestions.

b. Possible depositional or fluvioglacial depositional features could include: tills, lateral moraine, medial moraine, terminal moraine, kame terraces,

esker, drumlin, outwash plains, erratics.

*In each case, award **[1]** for identifying a feature, **[1]** for description if given and up to **[2]** for explanation of how the feature has formed.*

Credit should be given for use of an explanatory diagram.

*For example: Lateral moraine **[1]** is the material on margin/sides of a glacier **[1]**. This material is deposited along the valley edge when the glacier retreats **[1]**.*

c. Hot, arid areas are characterized by high temperatures and low/variable annual rainfall. There are various opportunities for agriculture that can be

explained:

- pastoral nomadism (the traditional way of dealing with insufficient amounts of rainfall and pasture)
- settled farming making use of/access to aquifers and artesian basins or irrigation close to rivers or oases, with increased use of drought-tolerant and/or disease-resistant species.

Good answers may critically discuss one or more factors that determine whether agricultural outcomes can be optimized/realized or not; or may discuss whether opportunities have increased or lessened over time. Themes might include unequal or improving access to technology; poverty; conflict; climate change *etc*.

At band D, expect answers which describe a few real or perceived opportunities that are appropriate for hot, arid areas, with few or limited examples.

At band E, expect <u>either</u> the well-exemplified explanation of a wider range of opportunities for recognizable arid areas, <u>or</u> some critical discussion of whether one or more opportunities have actually been realized.

At band F, expect both.

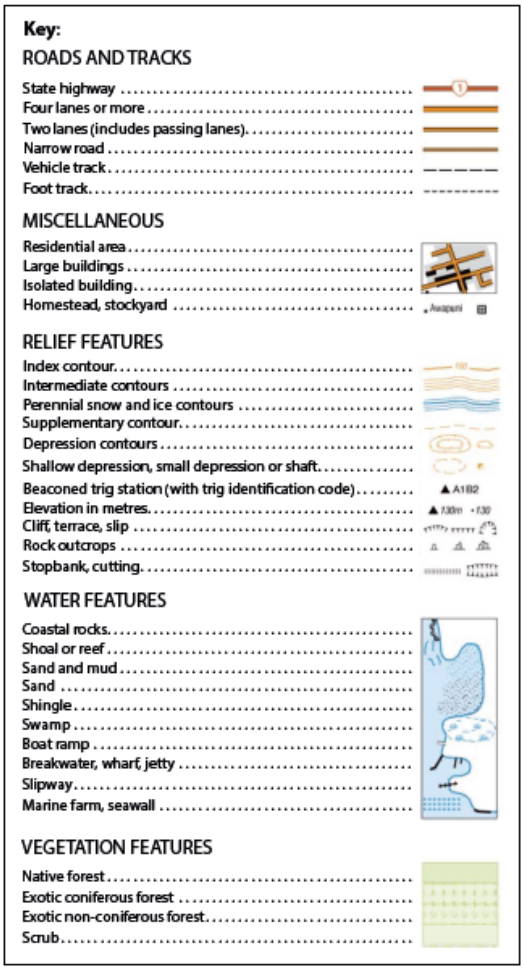
Marks should be allocated according to the markbands.

Examiners report

a. [N/A]
b. [N/A]
c. [N/A]

Optional Theme C — Extreme environments

5. The map extract shows a glaciated area of South Island, New Zealand. The scale of the map is 1:250 000. The contour interval is 100 m.



a. (i) Identify **and** describe a landform of glacial erosion in area A on the map. [4]

(ii) Identify **and** describe a landform of glacial erosion in area B on the map.

b. Using map evidence, suggest **two** reasons why the area shown on the map has a low population density. [6]

c. "Mineral resources in extreme environments rarely bring benefits to the local people." Discuss this statement. [10]

Markscheme

a. (i) A – Glacial trough/U-shaped valley; accept truncated spurs, hanging valleys.

Award ***[1 mark]*** for the identification and ***[1 mark]*** for a brief description of shape, size or appearance. For example, a glacial trough ***[1 mark]*** shown as a deep, straight valley ***[1 mark]***.

(ii) B – Corrie/Cwm/Cirque. Accept corrie lake/tarn. Do not accept "lake".

Award ***[1 mark]*** for the identification and ***[1 mark]*** for a brief description of shape, size or appearance of the landform. For example, a corrie lake ***[1 mark]*** which is about 1 km wide ***[1 mark]***.

b. Award ***[1 mark]*** for a reason, ***[1 mark]*** for map evidence and ***[1 mark]*** for some development.

Reasons may include, but are not limited to:

- steep relief/gradients/rugged ***[1 mark]*** so a challenge for economic activity/construction/settlement ***[1 mark]*** and identifies area of map using names or grid reference ***[1 mark]***
- high relief/altitude ***[1 mark]*** leading to low temperatures/short growing season so less than optimum conditions for agriculture ***[1 mark]*** and identifies area of map using names or grid reference ***[1 mark]***

- likely to be poor, thin soil ***[1 mark]*** due to mass wasting or gravity down slope ***[1 mark]*** and identifies area of map using names or grid reference ***[1 mark]***
- inaccessibility/remoteness ***[1 mark]*** due to limited transportation ***[1 mark]*** and identifies area of map using names or grid reference ***[1 mark]***.

c. Some candidates may argue benefits are not/rarely realized due to environmental challenges. Others may focus on the inequities of who benefits.

Either approach is acceptable. A range of mineral deposits offer potential wealth to people in extreme environments (*eg* uranium, silver, gold, rare earths *etc*). However, there are physical challenges to resource exploitation *eg*, permafrost in cold environments or lack of transport infrastructure in sparsely populated arid areas. Indigenous people may lack the technology to overcome challenges so outsiders/TNCs gain some/most benefits. However, there may still be gains for local people. Potential benefits include more employment, higher wages, investment, health care and infrastructural improvements.

Another approach might be to argue that minerals bring problems not benefits. Problems could include dependency on benefits among indigenous people, conflict with economic migrants, leakage of money overseas (remittances), possible environmental pollution, conflict over scarce resources (water and land) in arid areas. The environment and local society may no longer be sustainable as a result of mineral exploitation.

Do not credit tropical rainforests.

At band D, responses are likely to be descriptive accounts of the benefits local people could gain/do not gain. Alternatively, a simple account is given of why local people do not gain benefits.

At band E expect either a more detailed account of the mineral resources found in extreme environments and the benefits they bring/do not bring to local people/others or an evaluation of who benefits most from mineral resources (carefully weighs up the benefits for local people and TNCs, for example).

At band F, expect both.

Marks should be allocated according to the markbands.

Examiners report

a. This question was very poorly answered. Topographic map interpretation was often weak and there was little specific reference to the map.

Although correctly identified, many candidates did not describe the glacial trough. There was a lack of knowledge and understanding of glacial landforms. Many candidates thought the corrie/tarn was a pingo. Even if identification was correct the subsequent description was not valid in many cases.

b. Many candidates did not refer to map evidence, as specified by the question. There were some good attempts at describing relief, slope, remoteness and low population density, but also some rather fanciful ideas about needing oxygen to survive.

c. This question elicited some excellent answers with good contrasting and well developed case studies such as Niger and Alaska. There was often good evaluation of the question and discussion of the benefits to local people. Some introduced the idea of the controlling TNCs and the environmental effects that the local people had to endure (*eg* in Niger).

The photograph was taken at 68° North.

[Source: www.finnmark2007.com]

a. Referring to the photograph, briefly describe how people have adapted their clothing **and** transport in order to live in extreme cold environments. [4]

b. Explain **two** causes of low rainfall in hot, arid environments. [6]

c. Examine how tourism in **one** type of extreme environment has led to a wide range of adverse environmental impacts. [10]

Markscheme

a. *In each case, award **[1]** for identifying an aspect(s) of clothing/transport and **[1]** for describing why it is needed/linked to cold environments.*

Possibilities for clothing are skins/heavy clothing/heavy boots/head protection/gloves **[1]** because of below-freezing temperatures/wind chill/might get frostbite/other specific point (do not accept "very cold" or "extreme cold") **[1]**.

Possibilities for transport are specific modifications including ski style transport/rugged construction/wide tracks **[1]** because of extensive/permanent snow cover/ice cover/permafrost **[1]**.

b. *In each case, award **[1]** for an identified cause of rainfall and up to **[2]** for the explanation, which may include **[1]** for an example.*

Possibilities could include:

- latitude – dry descending air heated above dew point, absence of clouds *ie* anticyclonic conditions, the Hadley Cell
- continentality – large areas of dry land, due to wind blowing over large land areas
- rain shadow effect – air descends and warms on the leeward side of mountains
- cold, offshore currents – air is cooled travelling over cold water and is unable to hold moisture.

Diagrams should be given credit.

For example: Rain shadow effect **[1]** – the high ground forces air to rise where it cools and forms rain **[1]** and as it descends, it warms and dries **[1]**.

c. Increased tourism activity in extreme environments has sometimes resulted in increased pressure on a delicate environment. Environmental impacts that might be explained can include mass movement, erosion and land degradation, water usage, vulnerability to hazards, loss of biodiversity, waste disposal issues. These impacts could in turn threaten social sustainability with further knock-on effects for the environment.

Good answers may do more than explain/list different, unconnected impacts. They may additionally examine the interrelations, complexity or timescale of different impacts, for instance by stressing the possible irreversibility of certain impacts (*eg* permafrost melting, desertification, species loss), or showing **interrelated** impacts *eg* how ecosystems are affected by water shortages, *etc*.

At band D, expect answers which describe some negative impacts of tourism for a recognizable extreme environment.

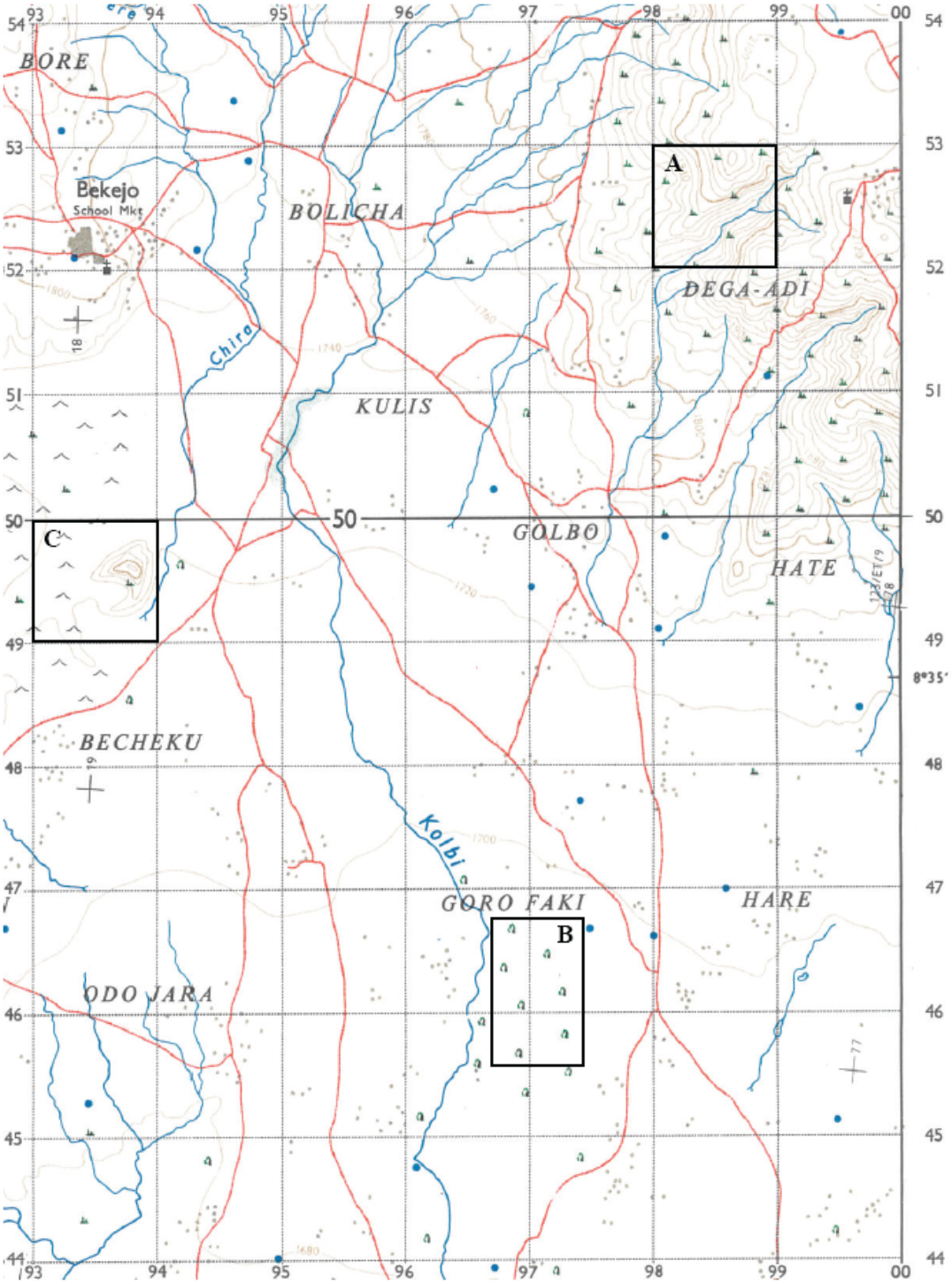
At band E expect either an explanation of a wider range of environmental impacts in named extreme area(s), or some critical examination of a narrower range of impacts.

At band F, expect both.

Marks should be allocated according to the markbands.

Examiners report

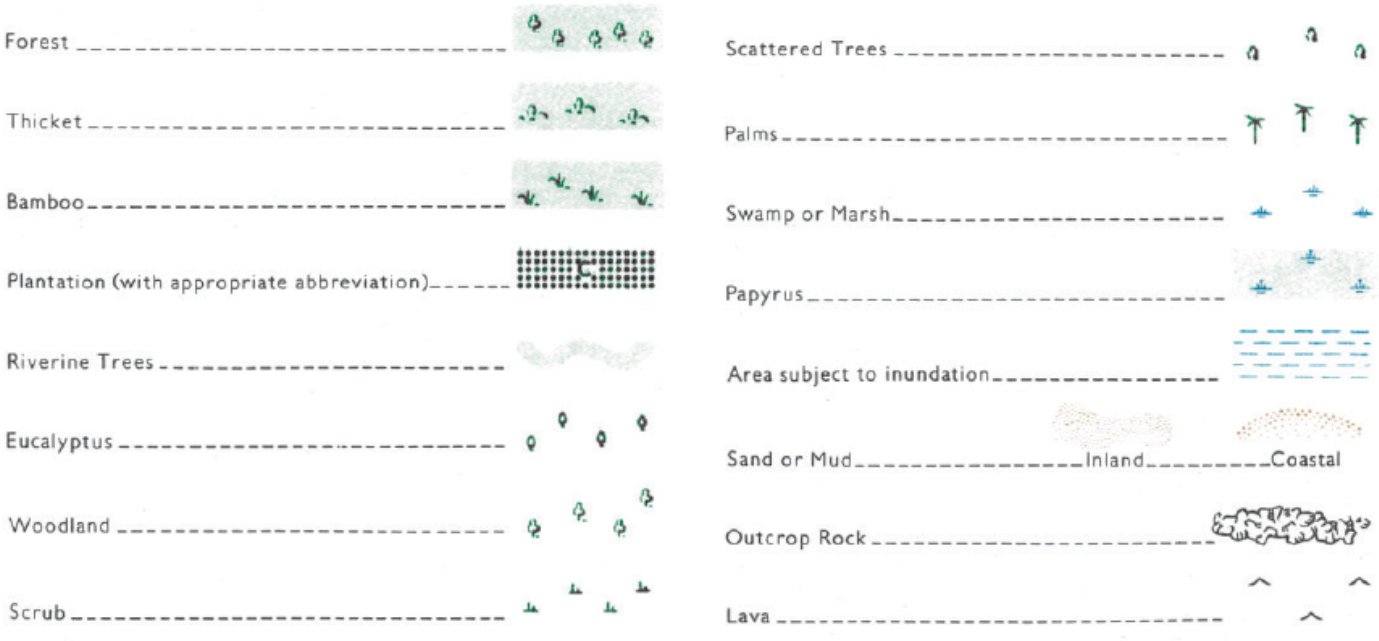
a. [N/A]
b. [N/A]
c. [N/A]



[Source: Ethiopian Mapping Agency, *Zikwala*, Series SMD 4, Sheet 0838 B4, Edition 1, 1975 (Reprinted 2008)]

Key for map:


Town or area with permanent buildings including public buildings
Tukul Settlement
Tukul or other small building
Road : Asphalt Surface
7
Road Number
Loose Surface
Culvert
Bridge
Dry Weather, with Kilometre Stone
30
Trail
Cut Line
Railway, Station, Level Crossing
Sta
LC
Light
Airport
Airfield (Asphalt)
Airstrip (Grass)
Telegraph or Telephone Line
along Road or Trail
Power Line
Antiquity, Ruin
Site of Battle, Mineral Working
Mosque, Church
Boundary : International
Kifle Hager
Awraja
Wereda
National Park Reserve
Trigonometrical Station : Primary, Secondary, Other
International Boundary Pillar
BP23/1
Spot Height (Surveyed)
1419
(Photogrammetric)
2256
Contours (VI 20m)
Depression
2000
1980
1960
Supplementary (VI 10m)
Air Photo Principal Point with Film No
123/ET/8
010
Watercourse, Waterfall, Rapids, Dam
(Wide): Waterfall, Rapids
disappearing, indefinite
Well, Spring, Waterhole, Water Tank
OW OS WH WTk
Mill, Lighthouse
School, Hospital or Clinic
Cemetery : Christian, Moslem



a(i). Identify the vegetation types found at A and B. [2]

a(ii). Using the map extract and key, suggest **two** reasons why the area shown could be considered an extreme environment. [4]

b. Briefly explain **two** weathering processes likely to operate in area C on the map. [4]

c. For **one named** type of extreme environment, examine the impacts of tourism on the natural environment. [10]

Markscheme

a(i). A (Dega-Adi 9852) – Scrub.

B (Goro Faki 9646) – Scattered trees.

a(ii). Likely reasons include the lava flows, the lack of settlement could be used as a surrogate for extreme conditions, seasonal rivers, disappearing streams, scattered trees, waterholes. Many of these suggest a seasonally wet-dry climate. Award ***[1 mark]*** for each valid reason and an additional ***[1 mark]*** for the development of a factor in a way that is clearly linked with the inaccessible/inhospitable nature of extreme environments.

b. Possibilities include exfoliation, granular and block disintegration, freeze-thaw, salt crystal growth, carbonation, oxidation, hydrolysis. Do not credit erosion processes such as sand abrasion. Award ***[1 mark]*** for each process identified and a further ***[1 mark]*** for the brief explanation offered.

c. The impacts on the natural environment include mass movement, erosion, land degradation, hazards, aesthetic changes, water shortages (and salinization), waste, introduction of exotic species, habitat removal. These can be positive/negative, short-term/long-term, intentional or unintentional.

Responses which deal with the human environment only cannot achieve above band C. To access band D, a named and located extreme environment should be addressed and candidates must examine the environmental impacts of tourism.

To access bands E and F, a variety of impacts should be examined.

Marks should be allocated according to the markbands.

Examiners report

a(i). Most candidates were able to correctly identify the two vegetation types, but many found it difficult to use map evidence to suggest why the area might be an extreme environment.

a(ii). [N/A]

b. This was poorly answered, with many confusing processes of weathering and erosion.

c. This proved difficult for many candidates. Detailed knowledge of extreme environments was lacking, with some confusion between the Arctic and Antarctica. Many considered human impacts, rather than focussing on the natural environment. Some answers were not on extreme environments, for example the tropical rainforest.