Level 3 Geography, 2016
91426 Demonstrate understanding of how interacting natural processes shape a New Zealand geographic environment

9.30 a.m. Wednesday 16 November 2016
Credits: Four

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You should attempt the question in this booklet.

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Check that this booklet has pages 2–10 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.
INSTRUCTIONS

Use page 3 to identify a New Zealand geographic environment that you have studied, and the interacting natural processes that shape it; and to plan your response to the question below.

Draw relevant, detailed map(s) and/or diagram(s) on page 4.

Begin your written answer on page 5, integrating detailed, supporting case study evidence about your New Zealand geographic environment and the interacting natural processes that shape it.

QUESTION

Comprehensively analyse how spatial OR temporal variations occur in your named New Zealand geographic environment as a result of the operation of interacting natural processes.
New Zealand geographic environment: Muriwai Coastal Environment

Interacting natural processes that shape this environment:

Wave action (Longshore Drift, Saltation)
Wave erosion (Wave Refraction, Hydraulic Action, Corrosion)

PLANNING (OPTIONAL)

Longshore Drift
- winter 3 temporal
- summer
LSD interaction with Saltation
Wave erosion now vs. 1 million years ago
Title: Map showing operation of natural processes in the Muriwai Coastal Environment

- Movement of sediment by swash and backwash in long shore drift
- Regular wave trains so longshore drift occurs more frequently as waves uninterrupted by obstacles
- Waves approach from an oblique angle
- Energy converging on headlands
- Diverging into bays
- Prevailing Winds blow SW 58% of the time
Comprehensively analyse how spatial OR temporal variations occur in your named New Zealand geographic environment as a result of the operation of interacting natural processes.

In your written answer:
- integrate detailed, supporting case study evidence about your New Zealand geographic environment and the interacting natural processes that shape it
- refer to the map(s) and/or diagram(s) you have drawn on page 4, and/or integrate other relevant, detailed map(s) and/or diagram(s) as appropriate.

Interacting natural processes operate within the Muriwai coastal environment to shape its geographic characteristics and features. Those processes also operate uniquely of each other at different rates and different scales to create temporal variation within the environment, and as a result, the coastline is found to be constantly changing and eroding.

Longshore Drift is the process by which sediment is transported along a beach by the action of waves. Longshore drift occurs frequently at South Muriwai Beach, as it is characteristic of an exposed and wide foreshore of 2.5 km. The fetch itself is 2000 km long, and with prevailing winds blowing SW 58% of the time, the waves approach the beach at an oblique angle. The large fetch combined with wind speeds exceeding 16 km/hr 48% of the time, means that waves can gain a lot of energy, reaching up to 100,000 joules per m³. When the waves approach the beach, the base of the wave drags along the seabed, picking up sediment and causing the wave to break. The wave then smashes onto the beach face, carrying sediment with it and depositing that sediment, and dragging sediment back as the water recedes due to gravity. Because the waves approach at an oblique angle, a zigzag pattern of sediment movement takes place, creating longshore drift.

In the geographic environment there are differences in the way wave action operates during winter and during summer. Therefore wave action is a natural process that demonstrates temporal variation due to the different characteristics in each environment in each time period.
In harsher conditions, i.e. during winter (high wind speeds and low pressure weather systems dominate) processes of wave action (longshore drift, transportation, deposition) operate to erode South Muriwai Beach and create a dissipative beach profile. In longshore drift, waves are destructive and the swash is weak. This means that less water percolates onto the sand, and so the wave loses energy and erodes the beach, removing sediment in the water that recedes backwards in the strong backwash (due to gravity).

The energy of the backwash is greater than that of the swash, eroding the beach and transporting 175,000 m³ of sediment northwards annually whilst creating a slope angle between 1–2 degrees. In calmer weather conditions, i.e. during summer (low wind speeds and high pressure weather systems dominate), processes of wave action (longshore drift, deposition, transportation) operate to build the beach and create a reflective beach profile. The waves are construction and the swash moves up the beach on a low gradient in this low wave energy environment. The energy of the swash is greater than that of the backwash, and so waves are able to transport sediment up onto the beach face. Due to a loss in energy (in a process called dissipation) the waves deposit more material than is eroded in the backwash, creating a slope angle up to 10 degrees. Therefore there is a lot of loose (unconsolidated) sediment made up of heavy titanomagnetite, and lighter quartz, silica and feldspar that are more readily transported by the wind. In this way, temporal variation is demonstrated - although longshore drift does not occur consistently, it occurs more at times when conditions favour destructive waves, compared to times when the process is sparse, i.e. during the summer. This temporal variation has resulted in seasonal variation in the beach profiles - a dissipative beach profile.
Sallation is the transportation of sediment across uneven surfaces through a turbulence of air during winter and a reflective beach profile during summer. Longshore Drift interacts with the natural process of sallation, by providing sediment for sallation to occur. This interaction shapes the geographic environment. During constructive wave processes, unconsolidated sediment is deposited on the beach face. That sediment dries out during low tide when the foreshore becomes roughly 150 m wide. With wind speeds exceeding 16 km/hr 48% of the time, sallation is able to transport that sediment in a northward direction when prevailing SW winds are in action. Sallation also interacts with longshore drift to shape the environment. Although prevailing winds blow SW 58% of the time, in those times they do not, winds blow to the east. If those winds exceed 16 km/hr, sallation is able to transport sediment from the dunes and back of the beach into the swash zone, where longshore drift acts to erode away that sediment and carry it back in the receding backwash. In this way 175,000 m³ of sediment is transported northwards annually. Temporal variation is also demonstrated in the operation of sallation, with more sallation occurring at low tide and less sallation at high tide.

In the geographic environment, there is also temporal variation in the way wave action has operated at Otakamiro Headland. Processes of wave erosion, including wave refraction, hydraulic action and corrosion have operated differently in each time period as the environments contained different characteristics. Around 17 million years ago, a period of volcanic activity at Otakamiro Point led to volcanic extrusions entering gaps and fissures in the sedimentary rock, and that combination rock is called Piha Colgomerate rock. Volcanic uplifts and tectonic movement along the Helensville Faultline lead to the formation of Otakamiro Headland, and at 1 million years ago...
that time, Otaamiro Headland was exposed to the marine processes of wave erosion and biochemical weathering for the first time. Today, evidence of significant wave erosion is observed in the headlands' rocky outcrops, the base of Motutara Stack and in the caves, arches and stumps within the environment.

In wave refraction, high energy waves (due to fetch of 2000 km) approach the coastline and adapt to its gradient, as seen in the diagram. Incident waves (uninterrupted by any obstacle) reach their wave base along only apart of the wave front. This often occurs as waves approach the headland, as the headlands shallows reach some distance out to sea. As shoaling occurs, the part of the wave train closest to the headlands diverges around its jutting outcrops and smashes up onto the sides of the headlands with a lot of converging energy, vigorously eroding the headland and changing the shape of the geographic environment. Diverging energy is focussed on intervening bays (South Muriwai Beach, Māori Bay), where material is the product of erosional processes is also deposited.

Erosive potential of the headlands is increased during harsher weather conditions, when wind speeds are high (perhaps during a storm) and the waves have a lot of energy. Another process of wave erosion is hydraulic action. High energy waves approach the headland and refract around the stack, and so energy is concentrated on the sides of the headland. Because the rock is Dīha Conglomerate rock, there are a lot of fissures and weaknesses in it, and air is compressed into these gaps. When waves reflect, the air is released explosively, shattering fragments of rock from the headland. Corrosion is also a process of wave erosion. In corrosion, the
Sediment and products of erosional processes are present in the waves, and when high energy waves that reach up to 100,000 joules per m³ hit the sides of the headland, fragments are thrown with the waves and the headland begins to erode, slowly wearing away at the rock in a sandpaper action. Wave refraction, hydraulic action and corrosion are natural processes that interact to erode Otakamiro Headland. High energy waves from wave refraction smash into the sides of the headland and air is compressed within fissures in the rock, increasing hydraulic pressure. The air is released explosively when the wave retreats, shattering fragments of rock that then become present in the water. Corrosion acts when waves smash into the sides of headland and slowly wear away at the rock in a sandpaper action, creating fissures and gaps for air to be compressed in during hydraulic action. In this way, crevasses are formed that develop into notches from continual erosion. Eventually those notches become caves that form arches. Those arches are continually undercut by wave erosion processes mentioned above and weakened by vegetation growth, gravity and biochemical weathering to eventually collapse and form isolated stacks, e.g. Motuara Stack. This process is observable in the cave on the side of the headland that leads to Maori Bay and at the base of the rear of the stack, where wave energy is also intensively concentrated. The shore platform, Fisherman's Rock is also reflective of wave erosional processes, as it is constantly undercut and rubble is removed from the platform that is used in corrosion to wear the rock away.
Temporal variation is therefore demonstrated in the way processes of wave erosion have operated now compared to 1 million years ago. Variation is seen as a result of each time period being characteristic of different features in the environment. Temporal variation is also seen in the way wave erosion operates in harsher weather conditions and also in calmer weather conditions.
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| Temporal Variations | E7 | **Setting: Muriwai Coastal Environment**  
- The diagram on page 4 shows the selected natural environment. Annotations provide specific case study evidence and basic analysis of how processes operate differently at different locations across beach(es). The diagram adds to the answer, but is not directly relevant to the chosen focus of temporal variations. The diagram on page 10 is loosely linked to temporal variations, which helped the candidate to meet the requirements for Excellence.  
- One part of the question is selected (temporal variations) and is clearly referred to throughout the answer.  
- Two time periods are identified and named – summer vs winter, and 17 million years ago vs today, to provide evidence of temporal variations.  
- Comprehensive analysis of why two variations occur between these time frames is evident. This is shown through clear reasoning around why there is a difference in the Muriwai Beach profile between summer and winter, and why there is a difference in the feature of Otakamiro Headland between 17 million years ago and today. Technical detail and insight is demonstrated in the reasoning for the temporal variation of the beach profile between summer and winter.  
- Reasons for variations included sufficient process analysis, with evidence of a technical understanding of wave processes (erosion, transportation, and deposition). This is shown through an explanation of how at least two processes operate, in depth, as a series of steps, and this is linked to the temporal variations.  
- Interactions between wave processes are clearly explained, as the output of one process (volcanism), affects the operation of another process (wave refraction and erosion). This demonstrates the candidate clearly comprehends how processes operate together.  
- Comprehensive, relevant specific case study evidence is used throughout, which supports both the candidate’s written response and diagrams.  

The candidate gained Excellence due to their clear understanding of the requirements of this question, and focus on temporal variations. |
throughout. Their answer was well planned and executed – dividing their answer into two clear temporal variations, comprehensively explaining the reasons for the first one, before moving onto the second variation. Reasoning for each variation was clearly linked to the different operation of processes, or presence of different elements, at the different named time frames. Geographic insight was demonstrated in their response structure, the choice of correct terminology used in their explanation of processes, and the comprehensive understanding of interactions between processes shown throughout the answer.
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Begin your written answer on page 5, integrating detailed, supporting case study evidence about your New Zealand geographic environment and the interacting natural processes that shape it.

QUESTION

Comprehensively analyse how spatial OR temporal variations occur in your named New Zealand geographic environment as a result of the operation of interacting natural processes.
New Zealand geographic environment: Tongariro Fluvial environment
River (drainage basin)

Interacting natural processes that shape this environment:
Erosion, transportation, deposition
Slope and channel

PLANNING (OPTIONAL)
Title: Cross section of river gradient to show spatial variations

Upper Course
- Waipakahi Valley
- 1:5 slope
- 1-2m wide
- Low volume
- Low velocity
- High friction
- High energy
- Traction
- More load

Middle Reaches
- Patea Terrace
- 1:84 slope
- 4-6m wide
- Increased volume
- Velocity
- Decrease in friction and energy
- Solution, suspension, saltation
- Decreasing load
- 16 cusecs

Lower Course
- High volume
- High velocity
- Low friction
- Low energy
- Solution
- Less load
- 23 cusecs

Deposition landforms

Downward erosion
- Abrasion
- Unleaching

Lateral erosion
- Deposition more important

Lateral and downward erosion

Elevation above sea level (m)

Geography 91426, 2016
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In the Tongariro River environment there are three large scale processes that interact at different points in the river to give spatial variations. The processes act upon elements and the presence of and lack of process to give different spatial variations and landforms in each course of the river.

In the upper course, the process of erosion is the most dominant and interacts with elements to produce variation. These large scale erosion processes interact together to produce erosion landforms, commonly found in the upper course. The element of topography provides a steep gradient (1:5) as the upper course winds through the Kaimanawa Ranges (1200m-1600m). There are few tributaries in the upper course so the volume is lower than the middle reaches. The upper course runs through forest so overhanging trees drop materials into the river, adding to the high amount of friction. The velocity is not particularly high because of the limited volume, but due to the element of geology, the flow is very turbulent. The geology in the upper course is mainly hard basalt rock with underlying pumice (soft) so water flows strongly over these rocks, which causes the flow to become turbulent. The interaction between erosion processes, and topography and geology results in V-shaped valleys, gorges and waterfalls. The high energy of the river, provided by the topography (steep gradient) causes vertical and gravity
(downward) erosion and undercutting. These erosion processes interact together to cut and erode large and deep gorges in the hard basalt rock. These gorges are very deep and are only found in the upper course due to the downward and interacting erosion processes. Basalt gorge not only does the topography provide high energy for gorge, but the vertical erosion cuts through the hard rock and creates V-shaped valleys with narrow width (2–3m). The geology element in the upper course provides a hard basalt rock at the surface and underlying soft pumice rock further down stream. The rocks have different erosion rates, and the soft pumice is eroded faster. This creates a waterfall and plunge pool where bank cutting (erosion process), water hammering, vertical erosion and scouring erode the soft layer first, leaving an overhang of basalt. Constant hammering on the plunge pool causes cavities potholing were rocks chill into the bed and create a bigger hole (pool). The water falls to flow the have been as a result of two phases and is 6m in length and are downstream of the waterfall gorge. Due to the interaction between erosion processes and natural elements, different specific landforms have been created which are distinct to the upper course because of how erosion has interacted with topography and geology.

In the middle reaches, the transport processes

* The main form of transportation process in the upper course is traction, where large alluvium are "bounced" along the river. They are able to be carried due to the river's high energy, provided by steep gradient. The upper course river tends to have more load and this type of transportation interacts
with erosion to give high amounts of vertical erosion as the weak load scrape and scour the bed of the river (Abrasion). This interaction contributes to the formation of V-shaped valleys as the high energy and high load increase the erosion force on the river bed.

In the middle reaches, the process of transportation is the most dominant with some interaction with erosion to result in spatial variations. The volume in the middle reaches increases due to the flow of more tributaries, and a discharge of 16000m³ at the intake was recorded. The increase in volume affects other causes of increasing in velocity. However, because the gradient decreases (now 1:84) due to the closer distance to the Tuamotu and further from the Kaimanawa Ranges, the river loses energy since the river loses energy, it is not able to carry as much material and traction no longer occurs as the large particles have already dropped out (as energy is not enough for them to be carried) (see diagram below).

Therefore, the main types of transportation are sediment, solution and suspension as the river still has enough energy to carry medium-sized particles e.g., rocks up to 10cm. Since the transportation is of smaller particles, there is less interaction between erosion processes, as they are particles. The energy decreases in energy do not provide enough to erode the bed with instead the pore water contributes to lateral and vertical erosion. Due to this interaction, the banks are wider (between 4-6m) and more deposition rather than erosion, landforms are created.
The lower course of the river is dominated by deposition processes and the interaction between transportation processes, as erosion is no longer acting vertically (downward). The volume in the lower course increases from the middle course as there are more tributaries and the channel widens so allowing for the increase. At major jones pool, the discharge was measured at 23 cubic meters, which is a large increase from the middle course. The velocity therefore increases, but because the gradient is so low (1:325) the river loses a lot of energy and can no longer carry larger particles, thereby losing its load. Since the transport processes operating are solution and suspension as only the fine materials dissolved in the water and are suspended, are still able to be carried by the river's energy. This transportation interacts with erosion as resulting in lateral erosion of the river banks. This erosion makes the banks wider (now 15m) and allows for greater and laminar river flow. Due to the decrease in river's energy and load, deposition interacts with lateral erosion and solution and suspension load to result in deposition landforms such as delta, oxbow lake, meanders. A delta is formed at the lake mouth where the loss of the river's energy causes deposition to occur. The coarsest materials are deposited in the foreset beds, the finer materials make up the bottomset and the topset beds. This landform is only found in the lower course because of the interaction between lateral erosion and transportation (loss of energy and load) and deposition process.
Extra space if required.
Write the question number(s) if applicable.
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| Spatial Variations | E7 | Setting: Tongariro Drainage Basin  
- The diagram on page 4 demonstrates a clear understanding of the difference in features, elements, and processes over the Tongariro drainage basin environment (multiple examples of spatial variation are identified).  
- One part of the question is identified in the title of the diagram, and the first paragraph, as the focus for the written answer for **spatial variations**.  
- Two spatial variations in processes, elements, or features are fully described, and comprehensive reasons are given for both (one more in depth than the other).  
- Evidence of the above criteria is shown in the candidate’s response, by dividing the river into three separate regions, and discussing why key processes dominate in each region. Their first spatial variation of why fluvial erosion dominated in different parts showed a sound comprehension and understanding. Their second spatial variation of why fluvial transport differed over the course of the river provided evidence of comprehensive reasoning, and demonstrated insight through their process analysis and inclusion of technical detail.  
- Interactions between fluvial transport and fluvial erosion are clearly explained, as the operation of one process encourages the operation and effectiveness of the other process.  
- Comprehensive, relevant specific case study evidence is used throughout, which supports both the candidate’s written response and diagrams.  

The candidate gained Excellence due to their ability to explain, with some technical detail, the reasons why elements, features and processes operate differently over a geographic environment. The structure of this response was clearly divided into different regions of the environment and each area was fully analysed which demonstrated their understanding of how interacting processes caused or showed spatial variations. In parts, there was room for this candidate to further develop the links to their process analysis but requirements for Excellence were met.  