Reconstructing Banks Peninsula's Geologic History through Sand

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Overview

Using a sand model, we can represent these stages of Banks Peninsula's volcanic activity by constructing a scaled version. The stages in making this sand model informs us of the relative style of volcanism, the morphology of the volcanoes, and the erosional process which have occurred to give us the landscape today.

This document provides the steps in creating the stages of Banks Peninsula's construction and destruction through sand modelling.

Purpose

To obtain an understanding of the stages of formation of Banks Peninsula through the construction of a sand model.

The model focuses on the volcanic evolution of Banks Peninsula, the eruptions of each stage, erosion, and the sculpting of the landscape we see today.

Model Scale

The sand model of Banks Peninsula is replicated to scale. This is important to gain dimensions of the erupted volcanoes.

1cm = 250m 4cm = 1km

Key Ages of volcanism

Lyttelton Volcanic Group ~12 – 9.7 Million Years Ago

Mt Herbert Volcanic Group 9.7 – 8.0 Million Years Ago

Akaroa Volcanic Group 9.4 – 8.0 Million Years Ago

Diamond Harbour Volcanic Group 8.0-5.8 Million Years Ago

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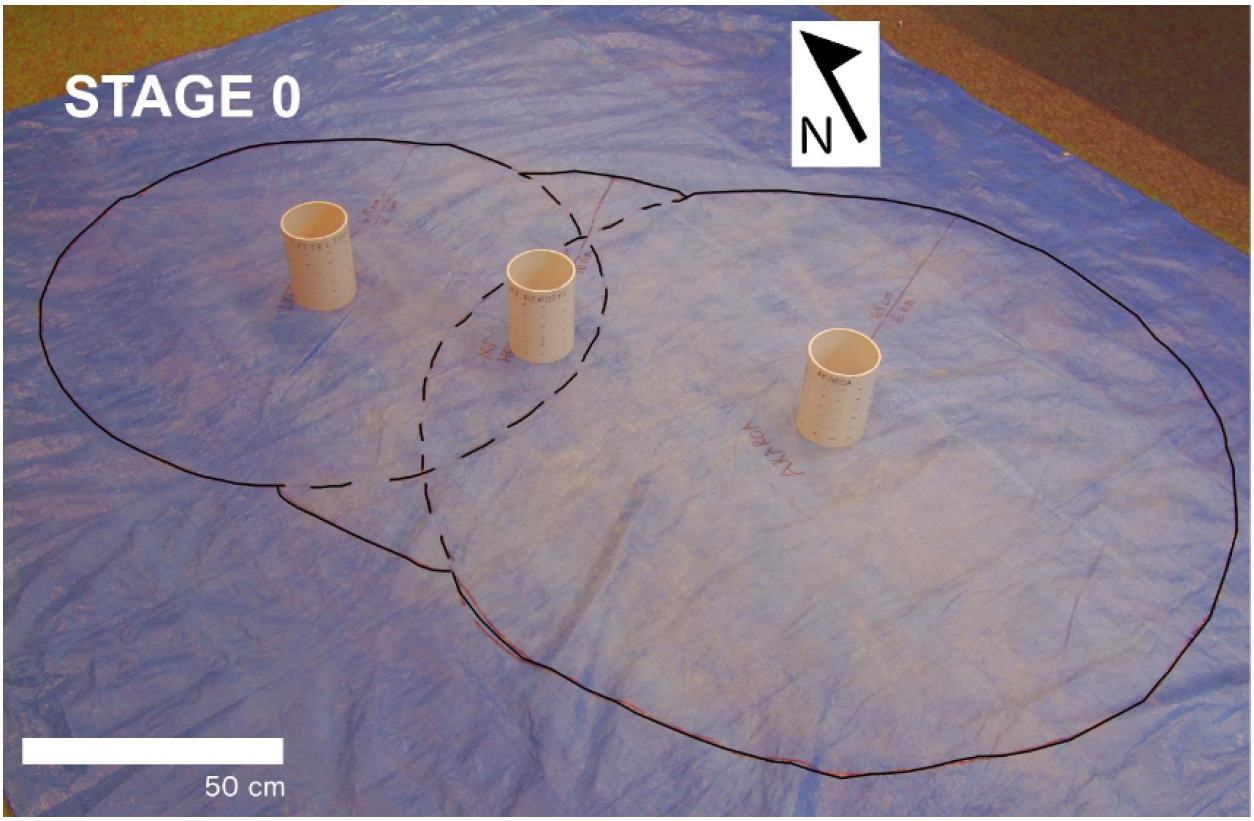
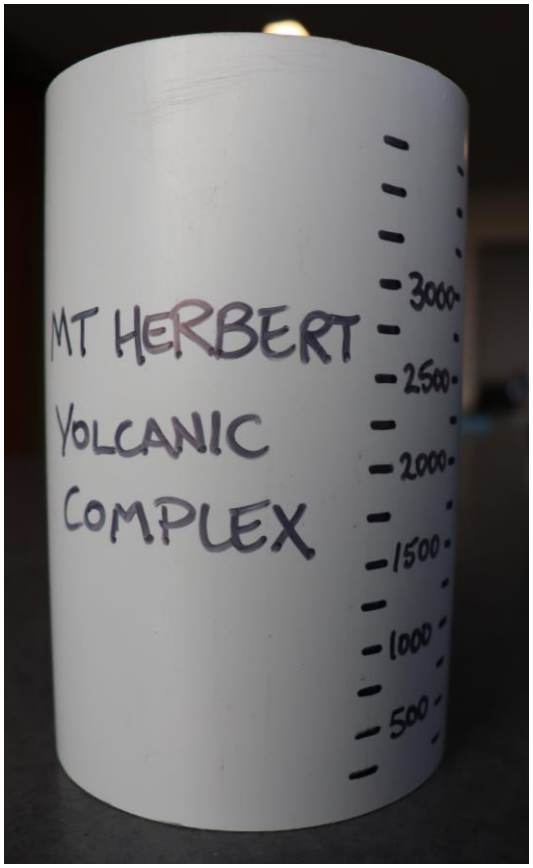


Base tarpaulinaulin and PVC volcanic centres



PVC Volcanic Centre

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Construction

Key to things to think about when using the sand to build the volcanoes.

- The peninsula developed over millions of years and the volcanoes were constantly being eroded. As you build your volcanoes try and incorporate not just the eruptive / constructive phases of volcanism, but the destructive / erosional processes as well

- Some eruptions occurred away from the central vents, with parasitic eruptions forming scoria cones and domes – you can add as much detail as you want

- What were the height of the volcanoes? The model can help inform us of this – it is currently highly debated – use the scale to measure the relative heights, use observations (slopes of the volcano are 8-10 degrees) look at the geomorphology – do you think this looks like a real volcano? Hint – a 9 degree slope has a rise of 160m for a run of 1000m.

- Make a cardboard slope template – measure a base line of 20cm, at one end measure a rise of 3.2cm, rule a line between the two ends of the line – this is you 9 degrees slope template.

- Start constructing the volcanoes. Begin with the oldest.

Stage 1: Volcanism of the Lyttelton Volcanic Complex

Build the Lyttelton Volcanic Complex on the tarpaulin with sand. The sand must be at ~9˚ angle with the lowest point being around the circumference of the circle and the highest being where the sand meets the PVC pipe.

Questions

What is the height of the Lyttelton Volcanic Complex? (Read this off the height marker)

What is the slope and shape of the Lyttelton Volcanic Complex?

What can the slope and shape of the volcano tell us about the type of lavas that formed it?

Stage 2: Radial erosion of the Lyttelton Volcanic Complex

Weathering and erosion occurred during volcanism. Erosion on a cone forms radial drainage, "like spokes on a bike wheel", creating valleys and ridges. Using your fingers, drag from the highest point of the volcano to the lowest, creating valleys.

Remove excess sand from the volcano.

Questions
Where would water flow down the sides of the volcano?

Where would have the removed material have gone?

Stage 3: Volcanism of the Akaroa Volcanic Complex and early Mt. Herbert Volcanic Group

Fill in the Akaroa circle of the tarpaulin with sand. Build the slopes so that they are at ~9˚ angle with the lowest point being around the circumference of the circle and the highest being where the sand meets the PVC pipe.

Build up some sand around the vent of Mt. Herbert, but do not fill out Mt. Herbert's footprint.

Mt. Herbert and Akaroa volcanism started at similar times, with Akaroa's rate of volcanism being greater than that of Mt. Herbert.

Questions
What is the height of the Akaroa Volcanic Complex? (Read this off the height marker)

What features formed between the two larger volcanic complexes of Akaroa and Lyttelton?

Stage 4: Later Eruptions of Mt. Herbert Volcanism

Due to being situated between the two larger volcanic complexes of Lyttelton or Akaroa, Mt. Herbert lavas infilled the landscape between them. Fill in the footprint of Mt. Herbert, with the sand at ~9˚ angle from the edges to the vent.

Questions
What directed where the lava flows of Mt Herbert went?

Mt Herbert is now the highest point on Banks Peninsula (922m). Mt Bradley and Mt Herbert have almost flat lying lava flows. What would have cause these to be flat lying?

Stage 5: Radial Erosion and Development of Lyttelton and Akaroa Harbours

Using your fingers, drag from the highest point of the Akaroa Volcanic Complex to the lowest, creating valleys. Do this also for the lava flows of Mt Herbert.

We know that extensive erosion, resulting in removal of material from Banks Peninsula occurred rapidly after the end of periods of volcanism. Remove the central PVC pipes and start to sculpt the landscape, do this be using an image of Banks Peninsula as a reference to remove the sand forming Lyttelton Harbour, Akaroa Harbour and major valleys between stages of volcanic stages.

Major valleys formed where two volcanic stages contacted, for example, Mt Herbert flows on top of Lyttelton Volcanic Complex forming Port Levy and Pigeon Bay valleys. Remove excess sand.

Questions
Why did the contact between different stages of volcanism control the development of the larger valleys and bays (Kaituna, Little River, Port Levy and Pigeon Bay)?

What is the main process that formed the harbours?

Stage 6: Diamond Harbour Volcanic Group Eruptions

We now have an eroded volcanic landscape on which the Diamond Harbour Volcanic Group erupted. The largest Diamond Harbour eruption occurred near the side of Mt Herbert, erupting lavas that invaded Lyttelton Harbour.

Lavas flows from these eruptions make up Diamond Harbour, the seaward end of Purau, Pile Bay, Ripapa Island, Shag Reef, Quail Island and Black Point. Using the geologic map as a guide, erupt lavas into Lyttelton Harbour.

Although this is the most significant flow of the Diamond Harbour Volcanic Group, it is not the only one.

Questions
In terms of landscape evolution, what had to be in existence when the Diamond Harbour Volcanic Group eruptions happened, and how did it influence the lava flows?

Stage 7: Millions of Years of Erosion Creating the Current Topography

This last stage is to create your model into the landscape we see today. Using a map or image of Banks Peninsula carefully erode and shape the sand to look like today's landscape.

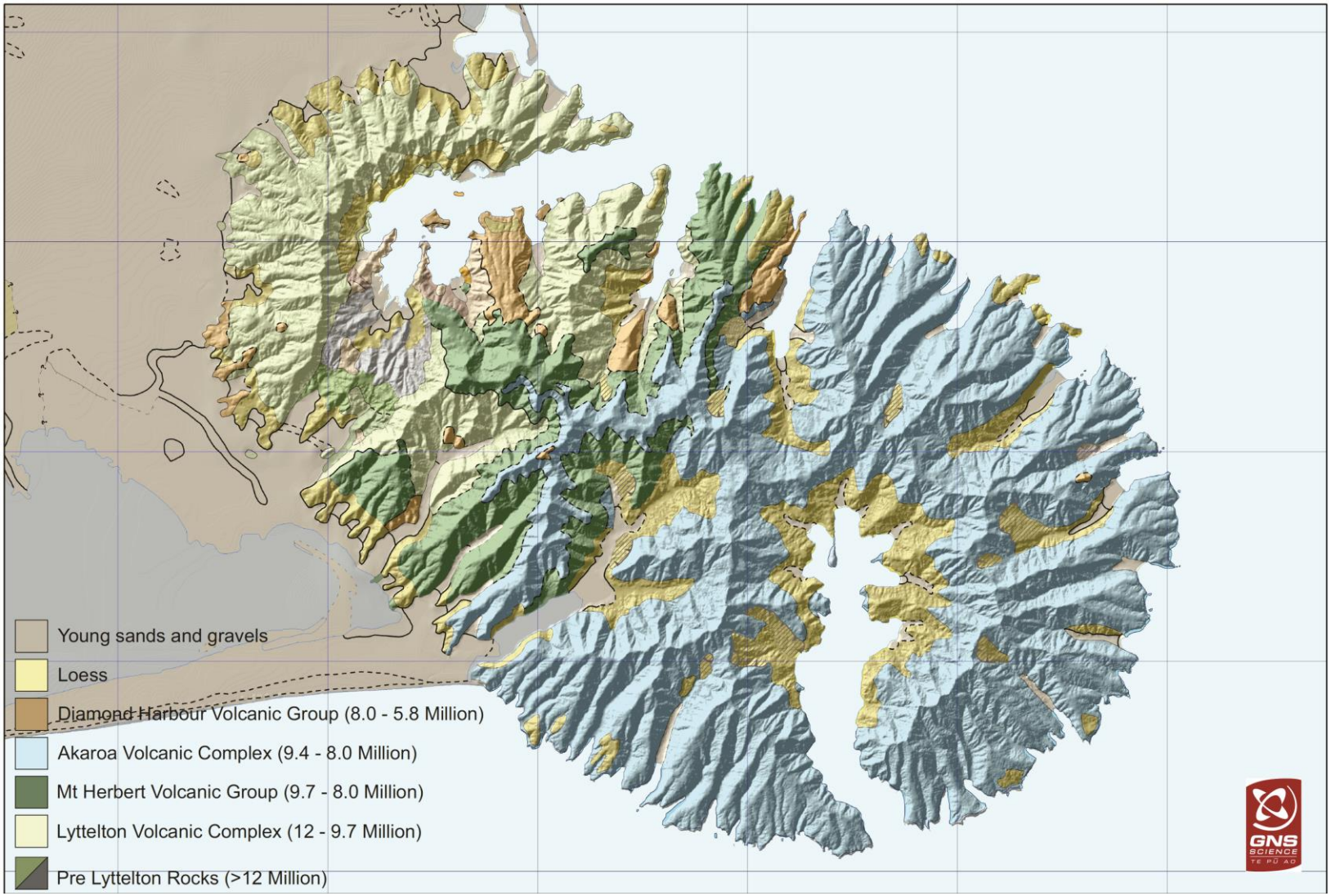
Remove excess sand.

Questions

Does your sand model look like todays landscape? If not what is missing?

What would you need to add to your sand model to match the present landscape, and what processes are responsible for this?

Additional Resources



Geological map of Banks Peninsula

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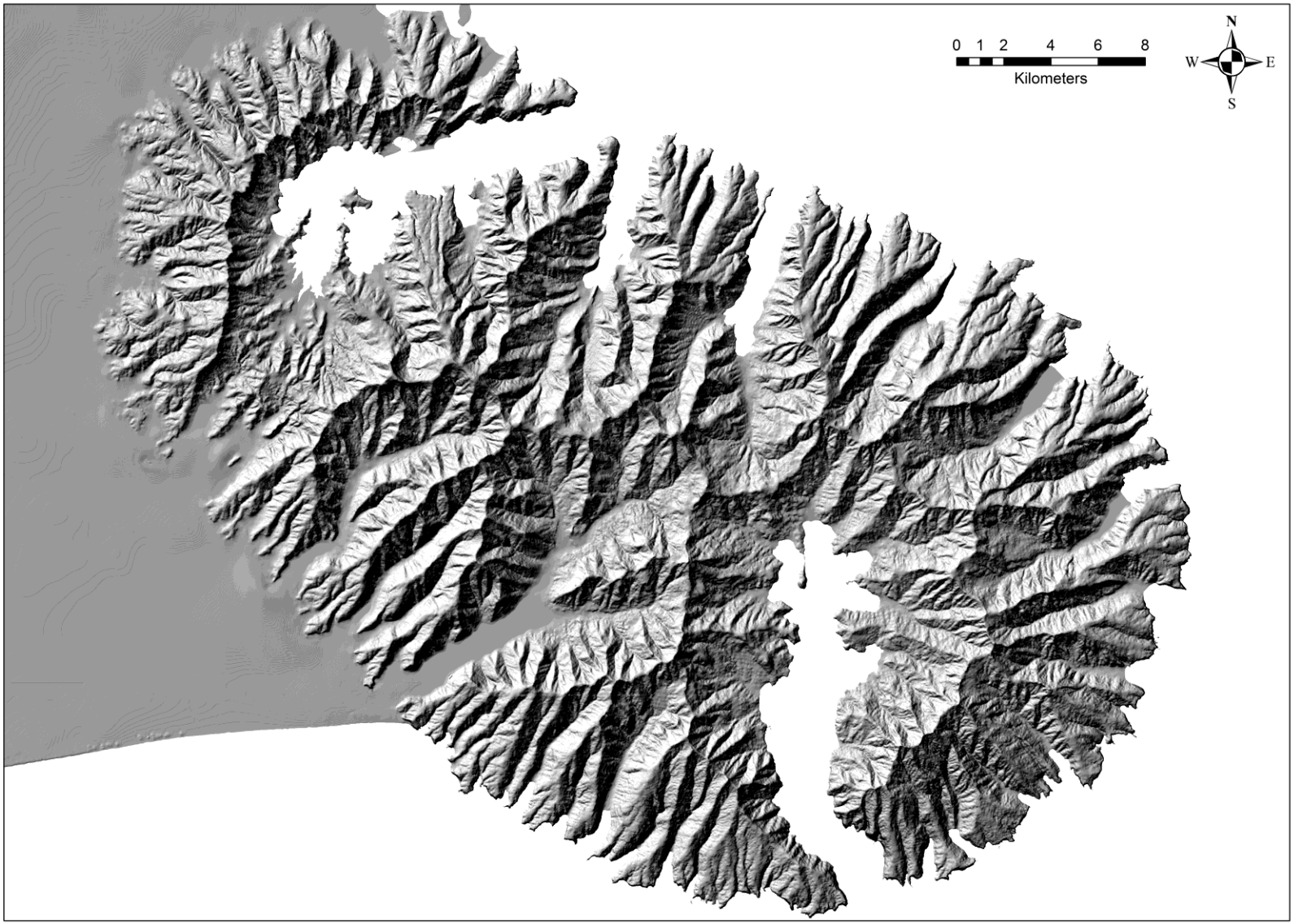

Digital elevation model of Banks Peninsula showing the present day topography

Banks Peninsula Sand Model Hampton et al 2018

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Satellite view of Banks Peninsula – white discolouration is suspended sediment in ocean currents and eddies. (NASA)