

Moeraki boulder: Otago Museum

Site 2: Campus Geosites @ Otago

Location: Walk north along State Highway 1 on the west side of Otago Museum. 170.5105°E 45.8650°S

Learning outcome: Understand the formation and key characteristics of sedimentary concretions.

Keywords: Concretions; Mudstone; Abbotsford Formation; Rock Density



The *Moeraki boulders* are a famous tourist attraction in North Otago, but what are they and how do they form? The boulders are geological “concretions”, which are created by alteration and cementation of siltstones and mudstones in the Abbotsford Formation. The Abbotsford Formation is extensive throughout Otago and has been dated to the Eocene. It represents a relatively deep marine sedimentary formation that formed by gradual accumulation of sediments at the bottom of the ocean.



Figure 1: The Moeraki Boulder visible on the west side of the Otago Museum (State Highway 1 northbound).



Exercises

- 1) How would you describe the overall shape of the boulder?
- 2) Describe the range of colours that you can see on the surface of the boulder. Try to differentiate colours of freshly exposed rock, and colours created by weathering processes.
- 3) Look at the freshest surface closely – this is the surface with the camera lens resting on it in Figure 1. Can you see any grains or rock components with the naked eye?
- 4) Sometimes, small chips of rock fall off the boulder and can be picked up from the concrete platform. If you can find a piece, examine it carefully using a hand lens or magnifier. Use the charts on the back page to help describe the textural characteristics of the rock: grain size, grain shape (sphericity and roundness of the individual grains), and the sorting.

Grain size:

Grain shape (sphericity and roundness):

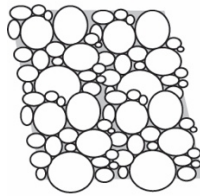
Grain sorting:



5) Are there significant variations in grain size or shape, or is the rock quite texturally homogenous?

6) Based on the highly simplified cartoons and descriptions of crystalline and granular rock textures below, what is the correct textural term to describe sedimentary rocks?

Granular



Crystalline



A *granular rock* contains grains that were deposited. Most sedimentary and volcaniclastic rocks are granular. The areas between grains can either be empty (pore space) or filled. A very wide variety of granular textures occurs.

A *crystalline rock* is composed entirely of crystals that formed during cooling and crystallization of magma/lava, or by recrystallization during metamorphism. The crystals are often tightly-packed. A very wide variety of crystalline textures occurs.

7) If you have a weak acid (dilute hydrochloric acid, HCl), put one droplet of acid on a small rock chip that you have collected and see what happens (Hint: does the rock fizz and react?). Based on this, what might the composition of some of the grains (or matrix) be?

8) Choose a part of the boulder and (on the next page) sketch the pattern of fractures that you can see on the surface. What descriptive words or terms could you use to describe the fractures? (e.g. curved, sharp, angular, discrete, open, filled, long, short).





- 9) The Director of Otago Museum would like to move the boulder to another place that is more accessible to the public, and he needs to advise the transport company of the approximate weight of the boulder. Use your answer to exercise 1 to approximate the shape of the boulder, and assume that the boulder is completely intact. A table of representative rock and mineral densities is provided below to help you calculate the total mass: you should decide which density is most appropriate for this material.

Mineral or rock	Density (kg m ³)
Volcanic pumice	1,000
Mudstone	2,500
Granite	2,750
Peridotite	3,300
Gold	19,320



