All about Limestone

Limestone is one of the most common types of rock found on the surface of the Earth. About 10% of the land surface of our planet is made of limestone or similar types of rock; while around 25% of the world's population either live on or take their water from limestone. It is thought that 50% of all our oil and gas reserves are trapped in limestone buried beneath the surface.

The rock limestone is mostly made up of one of two types of mineral – either calcite or aragonite. Both of these are different crystal arrangements of the same chemical compound – calcium carbonate ($CaCO_3$).

Limestone found in New Zealand

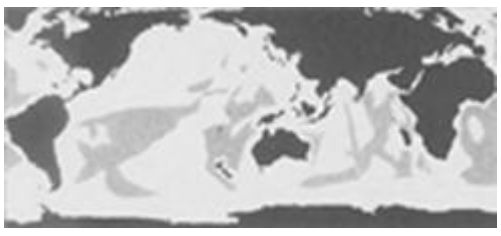
Limestone is a special type of rock for several reasons-

- It is most commonly made by microscopic organisms living in the sea
- It can be dissolved in natural waters – allowing caves, shafts, natural bridges and sculptured rock outcrops to form (like those found in the Waitomo area).
- It is the essential ingredient in making agriculture lime and cement.
- Limestone was also used to build the Egyptian pyramids, the Taj Mahal and the Greek Parthenon (all of these are now being slowly dissolved by acids in the atmosphere).

Making a Limestone

Step 1: Form a calcareous ooze

The ocean is full of tiny organisms such as plankton and foraminifera. Many of these organisms take chemicals from the sea to produce skeletons or shells. Over a lifetime the skeleton is continually replaced, and the old material is squeezed out into the ocean. This produces a continual rain of calcium carbonate debris falling onto the ocean floor. Some of the calcium carbonate that slowly accumulates on the seafloor also comes from the dying organisms themselves, as well as from larger species like oysters, echinoderms and even occasionally from whales. The whole mixture is known as a calcareous ooze.

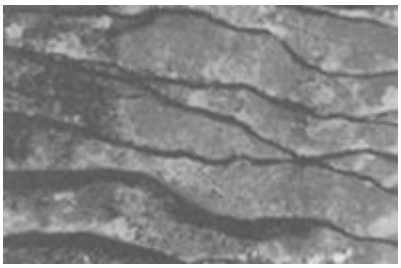


Barrier reefs are probably the most famous example of limestones being formed today. However, "reef limestones" are only a small proportion of the limestone found on land today.

Limestone is not all calcium carbonate. It also contains "detritus" – sands and muds that are excreted by the organisms, have fallen off higher parts of the seabed, or have eroded off the land in rivers. Detritus is what gives limestone its grey or brown colour – without it the calcium carbonate would be pure white.

Step 2: Compress the ooze

The ooze lying at the bottom of the sea is 40-80% empty space at first. As more and more calcium carbonate settles down on top, the accumulating weight forces the sediments at the bottom to compact (a process called "diagenesis"). Often this involves such large force that the particles will dissolve. They then recrystallise with very little space left. The detritus is forced into its own narrow bands, giving the limestone that flaggy look (although there are also other theories to explain the layered appearance of the limestone). The depth of the ooze as it forms the limestone can be a kilometre or more.



Typical "flaggy" Waitomo limestone

Step 3: Lift it out of the sea

Tectonic forces beneath the Earth's surface can lift the limestone out of the sea. As the seawater drains out at the bottom, fresh water circulates down into the rock, and often much of the original material is dissolved and redeposited as a cement. Once exposed to the atmosphere; wind, rain, streams and gravity begin eroding away the limestone, producing the very characteristic "karst" landscape of caves, gorges, depressions, blind valleys and rock outcrops.

Like Limestone

Marble
Buried limestone that has been caught in an active part of the Earth's crust can suffer huge increases in temperature and pressure. These can compress, melt, and then recrystallize the original limestone further to form a very beautiful and hard rock – the famous marble. New Zealand's deepest caves are found in the marble mountains of the northwest South Island.

Dolomite
Magnesium (Mg) is an element similar to Ca that also forms a carbonate. While limestone is mostly $CaCO_3$, if it has high levels of magnesium then it is known as a dolomite – as found in the Dolomite Mountains of Italy.

Chalk
This variety of limestone is entirely made up of small "coccoliths" - shells from a form of algae. It is uncompacted and little cemented compared to other limestones – it is found today almost as it was when laid down on the seabed.

Waitomo's Limestone

Limestones in the Waitomo area were laid down on the bottom of a warm shallow sea around 25 to 40 million years ago. This period of time, and the limestone, is referred to as Oligocene.

Limestone around Waitomo ranges from 40% to 100% calcite (calcium carbonate). The rest of the limestone is made up of volcanic fallout and local basement rocks carried by rivers into the ancient sea.

About 80-90% of the calcite is composed of skeletal fragments, while the rest is a calcite cement that was naturally precipitated form the sea. Fossils of echinoids (like sea-eggs) and scallops are quite common. Sharks teeth and whale bones are also found. West of Waitomo is a limestone layer mainly made up of giant oyster shells up to 40cm across. These can easily be seen in the rocks behind the Mangapohue Natural Bridge, and in the accessible Piripiri Caves.

About 10 million years ago the pressure of the Pacific and Australian tectonic plates pushing together forced that area to be lifter above the sea. This uplift occurred over most of New Zealand, and is known as the Kaikoura Orogeny.

Since then the elements have worked to erode away the land – in some places eroding overlying sedimentary rocks to expose the limestone, and in some places eroding the limestone. In one area of Waitomo it is estimated that $70m^3$ of limestone per square kilometre is being dissolved away each year.