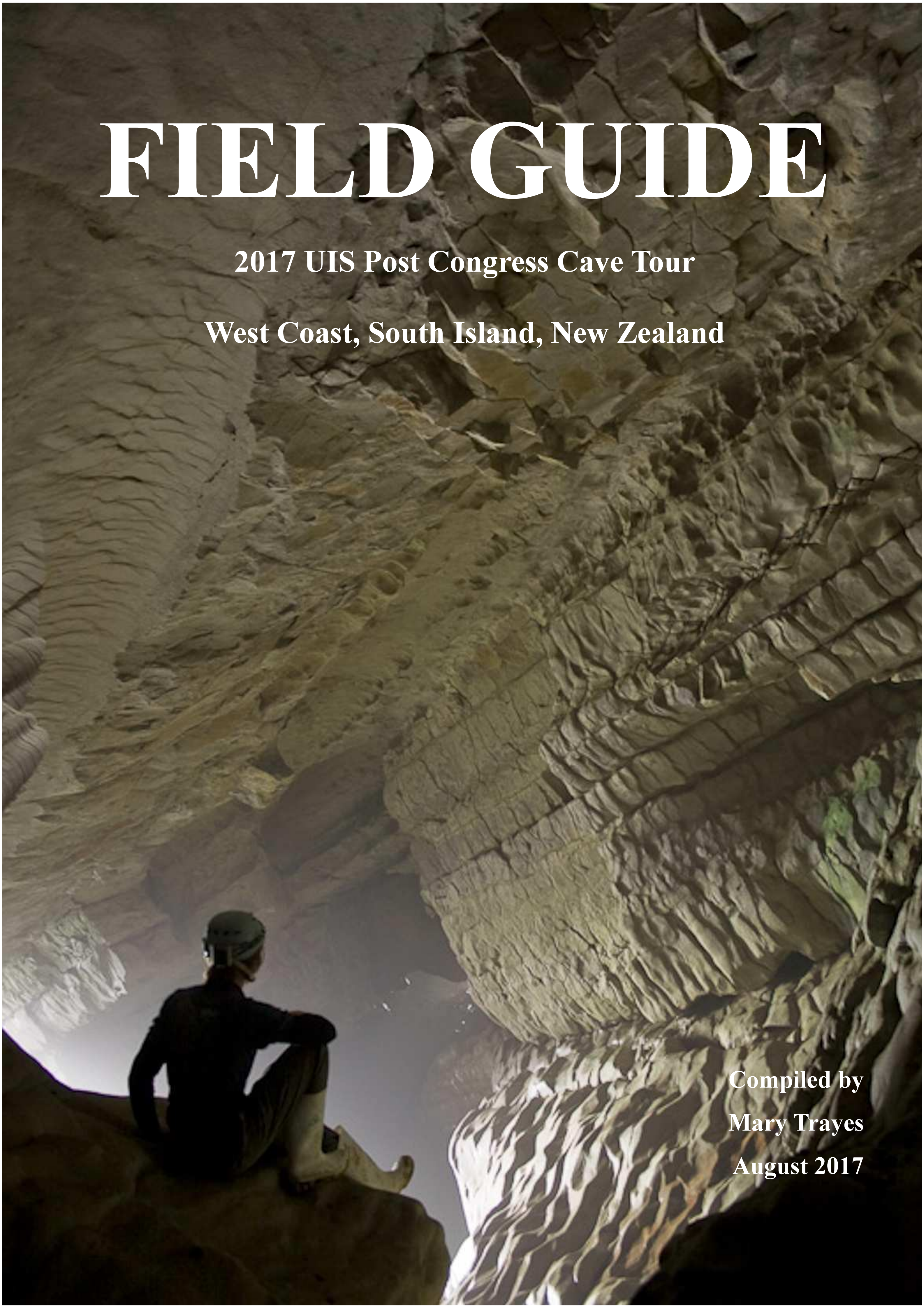
FIELD GUIDE

2017 UIS Post Congress Cave Tour

West Coast, South Island, New Zealand



Compiled by
Mary Trayes
August 2017

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Introduction

This publication has been compiled from a variety of reports with the aim of giving those coming to the West Coast after the Sydney UIS Congress, July 2017, a 'good taste' of what the coast has to offer. We look forward to taking you around our cave and karst areas, and answering your questions.

The information which follows has been designed to ensure there is something for everyone with a mix of karst geology, cave exploration history, cave science and specific information about the caves which are on the itinerary. Not to mention a little local information. The maps presented vary in type, depending on what has been published for any given area and what was available to the compiler.

Our region is large and there are many more caves than it will be possible to visit on such a short tour but your tour organisers are hoping many of you will come back ……. for more.

It should be noted that as it is winter in New Zealand, and the West Coast has a wet climate, it may not be possible to visit all caves on your itinerary. Flooding has the potential to be an issue at both Bullock Creek and Castle Hill.

Mary Trayes

Alice Shanks, organiser

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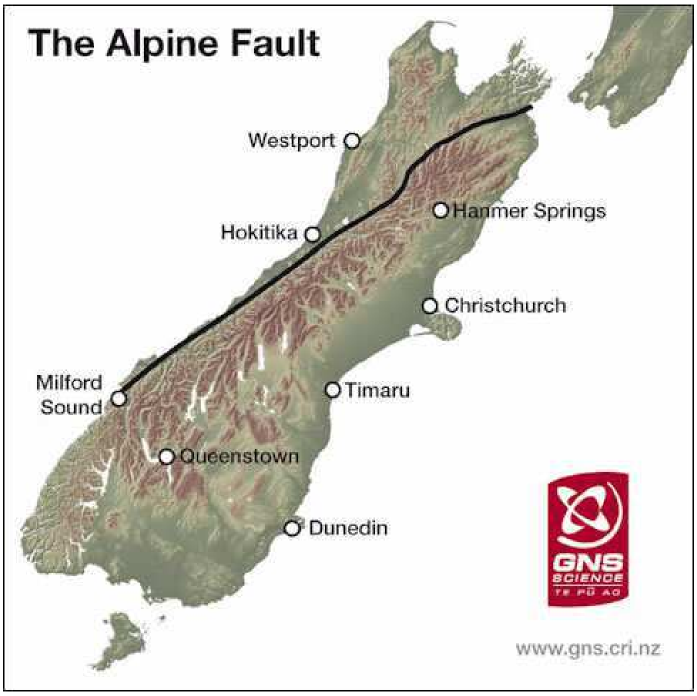
Front page photograph
Te Ana Puta's second sea cave entrance, Point Elizabeth
Nic Barth, 2010

Photograph at right
"Come caving with us, we will light your way……."
Metro Cave, G Thomas, 2015

West Coast Karst Overview

Map of the West Coast (lighter green) showing the main towns of Westport, Greymouth and Hokitika. The coastline is 600kms in length from Kahurangi Point in the north to Awarua Point in the south.



Map showing the Alpine Fault in relation to the West Coast. Karst areas on the West Coast are all to the west (left) of the fault which denotes the boundary between the Australasian Plate (to west) and the Pacific Plate (to east).

On the West Coast of the South Island all karst areas lie west of the Alpine Fault and apart from one small area of Paleozoic limestone (late Cambrian – Ordovician Mt Arthur Group), which has been metamorphosed to marble, this karst is formed from mid Tertiary aged limestones. A small area of fossiliferous Paleozoic Limestone near Reefton (Devonian Reefton Group) is significant to New Zealand's geochronological history, but not karst forming.

The Alpine Fault is a major New Zealand geological feature which marks the convergence of two active continental plates, the Pacific Plate and the Australasian Plate. Convergence at the boundary between these two plates began around 50 million years ago and continues to this day, with movement on the fault being dextral-reverse, i.e. there is both horizontal slip (northward) and vertical uplift (forming today's Southern Alps). Scientists estimate that the next Alpine Fault earthquake—the probability is quite high in our lifetime) - will generate sufficient energy (Moment Magnitude 8+) to cause 1 - 3m of uplift and 7 - 8m of horizontal movement in the central Southern Alps area.

Over the Tertiary period strike-slip movement has separated large blocks of rock which used to be continuous across the fault. The Red Hills ultramafic area in South Westland and the allied Dun Mountain ultramafic area near Nelson are now 480 kilometres apart while the marbles of Mt Arthur are linked to the many marble remnants found throughout Fiordland.

During the Oligocene period (37 – 25Mya) almost all of New Zealand was under the sea and large beds of carbonate sediments were laid down, blanketing the older sediments and Paleozoic basement rocks. Those carbonate sediments began to surface in Miocene times (about 20 million years ago), along with some of the strata below, as a result of tectonic uplift and dropping sea levels. Much of the uplift has been along the Alpine Fault (since around 9Mya) but there has also been uplift along other NE – SW trending faults further west, which have formed the Paparoa Ranges.

Currently the mountains in and around Mt Cook are "growing" at 10mm per year. But they also eroding at much the same rate so that on the coastal shelf there are large depths of recently eroded sediments, plus earlier glacial gravels, overlying large areas of carbonate rocks.

As the non-marine coal-bearing sediments under the carbonate rocks have the potential to contain gas and oil, much of the coastal shelf off the West Coast was explored by petroleum companies in the 1960-70's using seismic reflecting methods. The limestones in particular are good seismic reflectors and have contributed greatly to our current understanding of West Coast bathymetry.

The 600 kilometre coastal strip from Kahurangi Point in the north to Big Bay in the south, otherwise known as the "West Coast," is under-pinned by some of New Zealand's oldest rocks. These basement rocks are Paleozoic remnants from proto-New Zealand, when this country, along with eastern Australia and Antarctica, formed the southwest segment of Gondwanaland.

Basement (oldest) rocks on the West Coast are either Ordovician metasediments (sandstones and mudstones known as greywacke) or Devonian plutonic rocks (granites). Both have eroded down over time as well as being metamorphosed, the greywackes becoming indurated and the granites changing to gneiss.

Extensive outcrops of the granitoid basement rocks, from which overlying sediments, including limestones, have been eroded, can be found in the Paparoa and Victoria Ranges and large outcrops of Greenland Group greywackes can be found at Ross and Waiuta. Small areas of both types of basement rock can also be found along the coast.

The only Paleozoic karst found on the West Coast is a small area at Springs Junction. Here the Sluice Box Limestone formation forms the southern-most known outlier of the Ordovician Mt Arthur Group.

In some places mid-Tertiary limestones lie unconformably over basement rocks – for instance pockets of Oligocene age Takaka Limestone in Kahurangi National Park rest on an ancient peneplain formed of Karamea Granites – but in most places there other Mesozoic – early Tertiary sediments in between.

These include breccias (mid Cretaceous Hawkes Crag Breccia), coal measures (late Cretaceous Paparoa Coal Measures and Eocene Brunner Coal Measures), sandstones (Eocene Island Sandstone:) and mudstones (early Oligocene Kaiata Mudstone). The Oligocene Limestones are in turn topped in many places by various Miocene formations such as the Welsh Formation (calcareous mudstones and limestones) and Stillwater Mudstone (often known as Blue Bottom or simply "papa").

The final cap which lies over much of the lowland West Coast landscape, is a layer of Pliocene non-marine gravels (Old Man Formation) and Quaternary glacial gravels. In many places relatively recent Tectonic activity has uplifted the beaches to form raised beaches or terraces behind the present coastline. In some places gravels on these terraces lie directly over limestone, e.g. at Darkies Terrace, Point Elizabeth. Sluicing these gravels for gold was difficult due to the propensity for water to drain away underground from dams and water-races.

With the exception of a very small area of strongly foramineral late Paleocene limestone in South Westland (the Abbey Limestone Formation at Abbey Rocks, south of the Paringa River), the remaining limestones of the West Coast region have all been formed during the Oligocene period between 37 and 25 million years ago. They are all considered to be sufficiently similar in age and structure to be placed in the one group, the Nile Group.

Outcrops of Nile Group limestones increase from south to north as the gap between the coast and the Alpine Fault widens, i.e. there is far more limestone and consequently more karst and caves north of the Taramakau River than south.

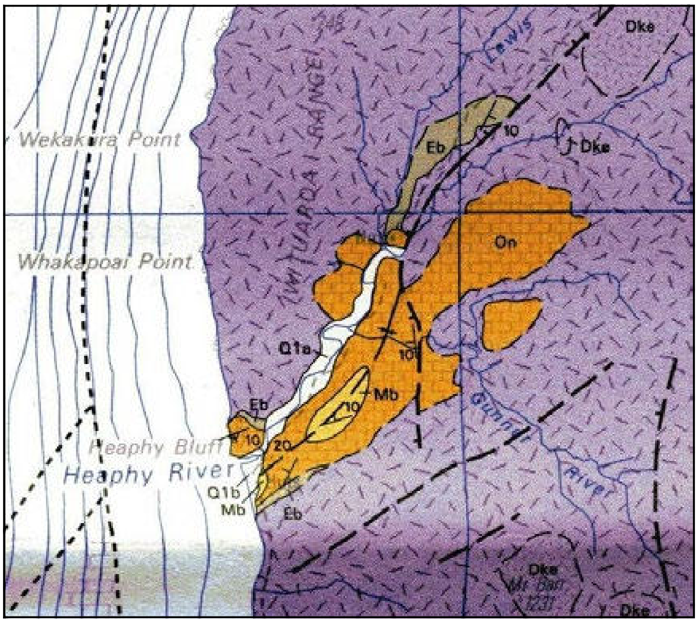
In fact there is a large gap between the Taramakau and Paringa Rivers with only two minor outcrops of limestone, at Ross and Mt Camelback. From Paringa south most of the limestone is found along the coast and on offshore islands, the last being Brig Rock off the mouth of Milford Sound.

North of the Taramakau the best karst and caves are formed in Potikohua Limestone which is found, in varying thicknesses, from Fox River to the Punakaiki River. It overlies a less calcareous, more sandy formation, the Tiropahi Limestone. Potikohua Limestone is formed from a hard white flaggy polyzoan biosparite which averages 90% CaCO3. About half the karst and caves in Potikohua Limestone are in Paparoa National Park.

All the other formations are more variable, often with muddier bands grading down to actual mudstone, and of variable thickness. The Tarapuhi Limestone Member, which forms the Point Elizabeth area, is the best ranked (highest $CaCO_3$) of the Cobden Limestone Formation while well decorated caves can be found in Takaka Limestone (Megamania), Stony Creek Limestone (Honeycomb), and in the unnamed formation at Jackson's Bay (Serendipity).

On the West Coast karst development is best amongst higher ranked limestones where there has been sufficient water flow. For instance in the capture of Bullock Creek waters to Cave Creek South through the Potikohua Limestone Xanadu Cave system and the capture of Cave Creek North waters to Fox River through the Armageddon - Babylon - Fox River Cave system .

In contrast karst formation in the muddier, lower ranked formations is often hindered by poor drainage resulting in small, muddy caves, sumped passages and tomos without ongoing leads, all typical features of the Cobden Limestone, Tiropahi Limestone, Matiri and Welsh Formations. The development of the large Honeycomb Cave in the moderately ranked Stoney Creek Limestone has been much facilitated by the high rainfall and strong drainage patterns of the area (Oparara River and in-cave streams).



The above extract from the Nelson Geological Map 1:250, 000 is about 15kms square. Takaka Limestone (On, orange) and other sediments overlay granite basement (purple) . There is considerable karst development with a number of caves on both sides of the syncline.

The photographs at right were both taken in Megamania Cave, currently New Zealand's 5th longest at 15,077m. Set in heavy West Coast bush, the cave was found in 1994 by air reconnaissance.. Photos: N Barth, 2010

Inangahua Junction Area

INTRODUCTION

At Inangahua Junction karst can be found either side of the Buller River. Known caves are mostly on the south side, the highway down the valley giving more ready access. Access to the north side is more difficult and there is still scope for finding more caves. A major earthquake in 1968 caused major damage . to the karst , the epicentre being on the north side.

GEOLOGY

Formation: Whitecliffs Formation (part of calcareous sediments, Tertiary Nile Group)

Distribution: Limestone scarps between headwaters of McMurray Creek and northern boundary of mapped area near Pensini Creek and surrounding area; single outcrop in Landing Creek.

Description: sandy conglomeratic limestone (basal part near Whitecliffs), massive sandy micaceous limestone, and interbedded muddy limestone and calcareous mudstone; boulders of flaggy organic limestone and muddy limestone seen beneath Berlins Bluff; conformably overlies Kaiata Formation. *Thickness:* 60-360m.

Age: Whaingaroan to Waitakian (possibly to lower Otaian).

Depositional Enviroment: Marine, middle to outer shelf; rapid sedimentation.

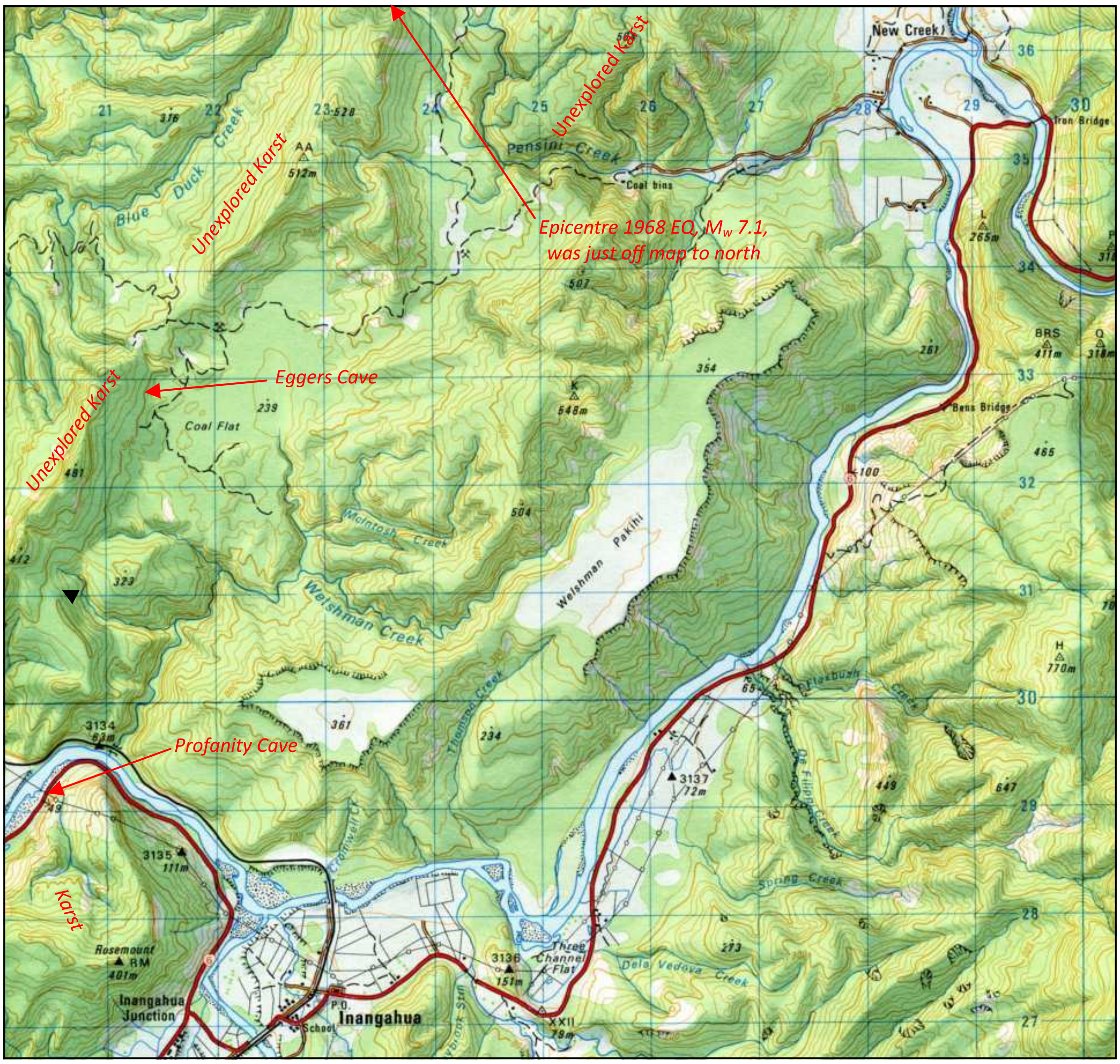
Reference: Handbook to NZ Buller – Lyell Geological Map, Sheets S31 & 32, 1:63,360, Simon Nathan, DSIR, 1978

At left: The "Whitecliffs" looking eastwards from the roadside. The resurgence entrance of Profanity Cave is at the bottom of the cliffs underneath the power lines. Photo: M Trayes, 2006

Extract about 10km square from NZ Topo Map, Sheet L29, Inangahua 1:50,000, 1979

Whitecliffs Formation Limestone runs in a curve from south to north across the Buller River.

About 3kms further east there is another smaller band of karst abounding the Inangahua Fault (east side).



THE CAVES

The Inangahua Junction area has a number of caves in the Whitecliffs Formation which extends both south and north of the Buller River along a syncline. Some of the caves were explored as far back as the 1870's by goldminers and prospectors. A major earthquake in 1968 on the Inangahua Fault affected a number of caves in the area, Eggers being the closest known cave to the epicentre.

Locals told cavers who explored the area in the 1970's that the area has never been quite the same since, some caves now being 'lost' including Golden Cave, the underground passages of which were staked out by goldminers early in 1879 (see more below). Today the Inangahua area is less well visited by cavers than other parts of the West Coast due to its remoteness from town centres, although a highway passes right through the area.

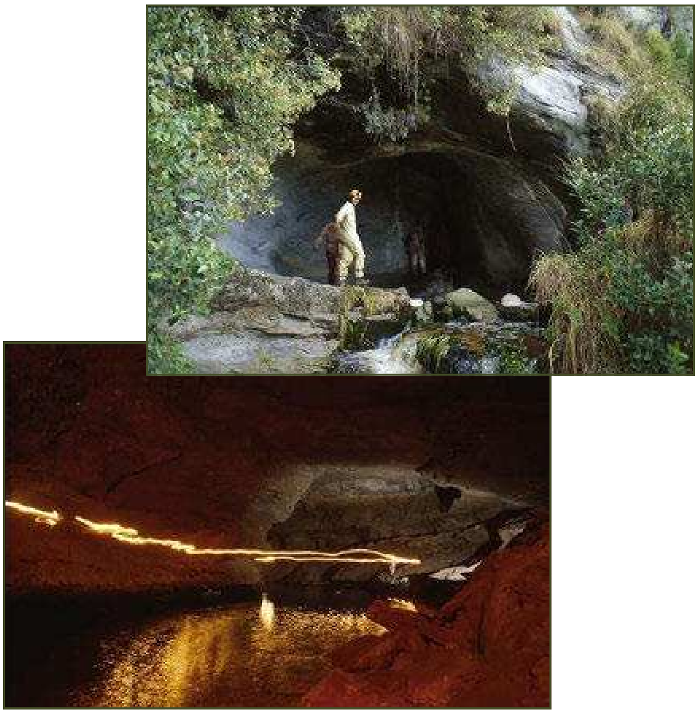
Eggers Cave is on the north side of the Buller River, west of the Iron Bridge (near Lyell) and is an easy, but interesting stream cave with several entrances. Eggers is a 'bit off the beaten track" but has been known of for many years, originally being called Coal Flat Cave. However of recent years it's become known as Eggers' Cave, Egger being the name of a bulldozer driver who almost drove 'over it' when the area was being logged about 30 years ago.

Being an 'easy' cave (despite being both remote and unmapped) Eggers Cave is popular with scientists. In 2002 –'03 DOC staff collected freshwater snails from the cave which were identified in 2008 as a new species, *Opacuincola permutata Haase* and in 2016 a new species of Carabid Beetle from the cave was added to the latest update of the Catalogue of New Zealand Carabidae. In 2005 cavers assisted a PhD student, with a DOC permit to collect stalagmite cores for climate change research, in his work at the cave.

References

T.E. Whittaker: High Resolution Speleothem-Based Paleoclimate Records from New Zealand Reveal Reveal Robust Teleconnection to North Atlantic During MIS 1-4: Ph D Thesis, Uni. of Waikato, 2008

A. Larochelle: Taxonomic Supplement (2001 to 2015) to the Catalogue of N.Z. Carabidae (Insecta Coleoptera): University of Nebraska - Lincoln, 2016



Two views of Eggers Cave, the lower one showing the stream running through the cave. Photos: M Rodgers

Profanity Cave is on the south side of the Buller River just west of Inangahua Junction. It is a large cave with streamway which resurges from the toe of the high 'Whitecliffs' bluffs. The cave was described by CCG caver Steve Wilkinson in the 1970's as *"An arduous cave, not fully explored. Has quite a variation of formation, the best being possibly 3.2 km from the entrance. Sports a varied cross-section of passages, wet, clean and wet, muddy, rocky, sandy etc. Part way in a 'lake' passage adds to the sport, especially for non-swimmers."*

In July 1980 the cave was the site of a major cave rescue when 3 cavers were trapped by rising floodwaters after torrential rain. Searchers dug out an old entrance, which bypassed the flooded section to find the cavers alive. It was surmised that the old entrance had collapsed as a result of the 1968 earthquake.

Reference

S. Wilkinson: Inangahua Prospects: NZ Speleological Bulletin, Vol. 5, No.88, May 1974

Profanity Cave resurgence is just off the highway at the base of the Whitecliffs, Inangahua Junction Photo: M Trayes, 2006

Westport Times, Volume XII, Issue 1644, 26 November 1878

DISCOVERY OF LIMESTONE CAVE AT THE WHITE CLIFFS, BULLER ROAD.

GOLD FOUND IN CREEK RUNNING THROUGH THE CAVE

Mr Warden Broad, who on Friday returned from the Lyell, brought the news that a day or two since Mr Reuben Waite's nephews went out to the claim of Knopp and another, who are working in a creek about two miles from Waite's Accommodation House, in the limestone ranges to the right of the Buller Road. This creek disappears through a hole, and it has previously been a mere matter of conjecture where it again found an outlet. The young Waite's ventured to get down the crevice through which the creek disappears, and to their astonishment found themselves in a spacious limestone cavern hung with stalactites and arched like a cathedral dome. They lit up some grass as a torch, and they say the sight was grand in the extreme. The creek forms a pretty water fall into the cavern, and then flows onward until it finds an outlet in the cascade at the White Ciiffs, near the boundary of the Buller and Inangahu Counties. Following up their discovery the explorers prospected the bed of the bed of the creek as it runs through the cavern, and found payable gold in it. They purpose making a track up the range, and opening the entrance to the cave so that tourists may visit this great natural curiosity.

Paparoas Area

INTRODUCTION

The Paparoas are a range of mountains lying west of the Southern Alps between the Buller and Grey Rivers. A significant area of karst exists on the coast side of the range, most of it on the western limb of the Barrytown Syncline. High limestone cliffs denote the western margin of the limestone (the Punakaiki Anticline) and parallel the coast from the Nile River in the north to the Punakaiki River in the south.

A number of rivers flow west from the main divide of the Paparoas (essentially basement rocks with some older sediments) to reach the sea. The rivers have all cut down through the limestone anticline to form gorges (i.e. river flows are antecedent to the downcutting). There are also many other karst features including caves, karren, grykes, stream capture and polje.

The karst south of the Tiropahi River to the Punakaiki River is managed as part of Paparoa National Park and the rest (apart from an outlier of the National Park around the Metro Cave) is lower ranked conservation land, some of it having been logged in the past. The recent review of the Park's management plan recommended that all the karst become part of the Park but this has not been actioned yet.

As the whole of the karst is too large for a single map, for the purposes of this Field Guide the Paparoas Karst has been subdivided into the Charleston and Punakaiki Areas (the Fox River Area not being part of the planned tour). Generally the geology is the same but as there are some interesting differences between the two areas, the geology is outlined for both.

A. Charleston Karst

GEOLOGY

Most of the karst-forming limestone in the Charleston area is Potikohua Limestone overlying Tiropahi Limestone. Only a few small caves are known from the Tiropahi Limestone where it outcrops along the coast (Pahuatane). Caves are known from the high quality Waitakere Limestone but around Charleston and at Cape Foulwind much of it has been quarried for farm lime and cement production.

***Waitakere Limestone* ne (Nathan 1974), 6-20m**

Description: White light grey algal limestone, locally with thin bands of mudstone or quartz sand: highly calcareous (averages 94% $CaCO_3$); petrographically and algal biosparite (Folk 1959); occurs mainly north of the Nile River, south of which it appears to grade laterally into the lower part of the Tiropahi Limestone; conformable on the underlying Little Totara Sand.
Age: Lower Whaingaroan
Depositional Environment: shallow marine clear-water conditions (probably shoal within the zone of light).

***Tiropahi Limestone* nt (Nathan 1974), 15- 180m**

Description: Massive white or light brown muddy limestone, locally sandy; extensively burrowed; $CaCO_3$ averages 68%; petrographically an impure foraminiferal biomicrite (Folk 1959); thickens southwards, conformably overlies the Waitakere Limestone.
Age: Lower Whaingaroan to Duntroonian
Depositional Environment: Middle to outer shelf, possibly shallowing towards the north

***Potikohua Limestone* np (Nathan 1974), 60 – 105m**

Description: Hard, white, flaggy, polyzoan limestone; $CaCO_3$ averages 90%; petrographically a polyzoan biosparite (Folk 1959); conformably overlies the Tiropahi Limestone.
Age: Duntroonian to Waitakian
Depositional Environment: Shallow marine, open water but with a little clastic material.

Reference: S Nathan: Handbook to Geological Map Foulwind & Charleston, Sheets S23 & 30, 1:63.360, DSIR, 1975

* *see a more detailed description with Punakaiki Karst, p. 10*

The cave in Tiropahi Limestone which was exposed during roadworks to re-align the highway at Pahuatane in 2009. The works were stopped thanks to due diligence by locals and West Coast cavers. Photo: F McDonald, Limestone Creek

Above: Bluffs of white Potikohua Limestone on the north side of the Nile River not far from the road end. Photo: M Trayes, 2007

Extract from LINZ BS20 Charleston topo map showing Charleston Area with roads, key cave and karst features. Map is approx. 9 x 8 kms.

THE CAVES

Via the Nile River

A number of caves can be found in the Nile River area, the largest being the **Metro** (or Ananui/Nile River Caves). The block of karst in which the cave is located forms an outlier of Paparoa National Park. A local tourist operator has a concession to take commercial tours into the cave. The Metro has been gated since 1972 to protect the cave and control visitor numbers.

The Metro is on the north bank of the Nile River near the top end of the Nile River Gorge. The cave has been formed by the underground capture of Ananui Creek, a true right tributary of the Nile. The stream has carved its way down through the Potikohua Limestone to the contact below with the Tiropahi Limstone, forming about 8 km of cave passage in an area about 600m long and 100m high.

The cave has formed on or about the contact between the two limestones with the Potikohua being overlain by the late Miocene – early Pliocene O'Keefe Formation (part of the Blue Bottom Group), (fine grained, muddy sandstone). Topping this off again are glacial gravels (Addison Formation) dated back to the interglacial period before last or about 200,000 thousand years ago. As the cave could not have formed before these gravels were uplifted, this also gives a maximum age for the cave.

The Metro has gone through six formative stages before reaching its present state. The stages were linked with the rate at which the Nile River cut down through the limestone to form its gorge.

As the baseline to which the Ananui Creek had to sink kept changing, the creek too had to readjust, both in its route through the cave, and at the point where it submerged. Each submergence moved progressively back up the creek leaving previous entrances stranded. The earliest resurgence was at today's gated Triclops Entrance, which is now 37m above the river), whilst today's large main entrance, which was the location of the second last main submergence, now only receives water if the present main submergence overflows.

The progressive abandonment of the older passages by active streams has allowed sediment deposition and speleothem formation but this process has not proceeded at an even pace, given the climatic and sea-level changes linked to the last two glaciations. Sediments vary from large rounded boulders to thick beds of fine sand and silt. Many excellent white speleothems, formed from the Potikohua Limestone are found in the cave and a large number of sub-fossil bones have also been recorded from the cave's sediments.

Reference: P. Crossley, P. Millener, C. Pugsley, P. Williams: Metro Cave - A Survey of Scientific & Scenic Resources: edited P. Williams, Professor of Geography, Uni. of Auckland, 1980.

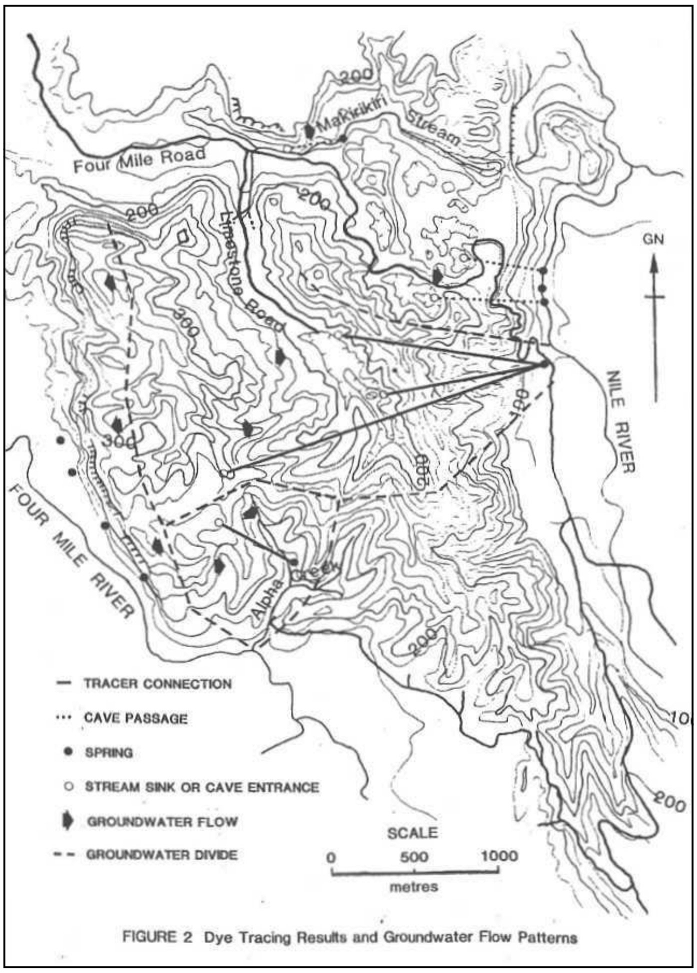
The Metro Cave was surveyed in the early 1960's by Greymouth cavers led by Malcolm Laird., who had earlier taken up caving whilst doing a geology degree at the University of Auckland. When he got a job with the NZ Geological Survey at Greymouth he began taking young West Coasters caving including trips to the Metro. As part of his job Malcolm also compiled the Punakaiki Geological Map

Via Four Mile Road

Four Mile Road, a former logging road gives access into the karst between the Nile and Tiropahi Rivers. The many caves in this block are popular with recreational cavers and there is still scope for more finds in the thick bush. In recent years there has been a push by cave divers* to try and connect some of the resurgences along the Nile River, and a couple of its tributaries, with caves above. Cavers are hoping that this block of karst will soon be added to Paparoa National Park because of the quality and quantity of caves.

* N. Thorpe, West Coast Cave Diving: NZB, Vol. 11. No. 210, pp.195-197, December 2015

Cavers preparing to dive the Winchhead Resurgence in 2015. Photo: T Crisp



Map showing underground drainage in the Four Mile Road—Alpha Creek area from Scott Crawford's Karst Hydrology of the Alpha Creek Area and Potential Impacts of Quarrying. Report to Milburn NZ Ltd (1990).

The **Hole in the Wall (**or Hill) is a large natural arch located in Makirikiri Creek, a tributary of the Nile River (see map). The arch has been formed by the gradual eroding of a large block of Potikohua Limestone, and is the only one known from the Paparoa Karst. Access is via Four Mile Road then a rough walking track which skirts a very large doline before dropping down into the creek where the large arch spans the full width of the creek. There are also a number of caves in this area.

Hollywood Cave is off the same foot track which gives access to the Hole in the Wall. As its name suggest Hollywood has both "glam and glitter" however besides being well decorated this cave is also quite fragile. In consequence the one entrance has been gated to regulate the number of those visiting and protect the cave. The entrance series is a narrow and time-consuming rift, which eventually opens into the decorated parts of the cave. Hollywood Cave was found in 1984 by Buller Caving Group cavers. A survey was then done by Canterbury and Buller Caving Club cavers and the map published in 1994.

As the name suggests**, Golf Course Cave** has many holes to contend with, making it quite a 'sporty 'cave. Access to the cave from Four Mile Road is via an old logging road (Limestone Road) which is becoming overgrown, then a rough bush track. If water levels in the cave are down ,and the body is agile, it's possible to get through all the holes without getting wet, but one never quite knows with this cave until the day.

Buller Caving Group members explored the cave thoroughly in the 1980's but did not publish a map so most people complete the through trip without realizing how extensive the cave is. Canterbury Caving Group members are currently surveying the cave with plans to publish a map soon.

Taken in the upper levels of Hollywood Caves on a joint trip by Sydney and West Coast cavers in 2002. Photo: A. Pryke, SUSS

B. Punakaiki Karst

GEOLOGY

Distribution: The formation crops out on both limbs of the Barrytown Syncline.

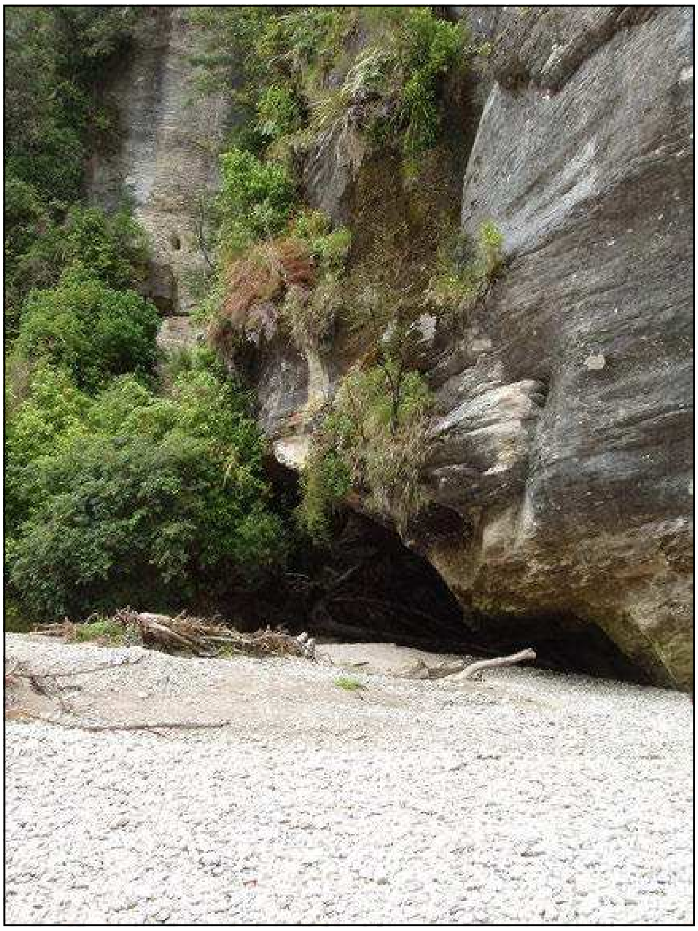
Description: Hard, white, flaggy, polyzoan limestone, locally sandy. Petrographically it is a polyzoan biosparite (Folk 1959). It is highly variable in thickness, reaching a maximum of 600m south of the Pororari River on the east limb of the Barrytown Syncline, and thins rapidly to the southwest to less than 18m in the headwaters of Lawson Creek. At Dolomite Point a horizon of phosphatic nodules and quartz granules up to 1 cm in diameter divides the 44 m thick lime-stone almost equally into a lower thicker-bedded non-platy limestone and an upper stylobedded platy limestone. The hiatus represented by this horizon has not been recognised elsewhere in the region, and it may be only of local significance. More rapid weathering of softer layers in the platy limestone have accentuated the bedding to form the well known Pancake Rocks.

Stratigraphic Relations: In the northwest the formation rests conformably on or interdigitates with Tiropahi Limestone. In the coastal area south of Hatters Bay, Potikohua Limestone rests in most areas apparently conformably on and with transition over a few decimetres into Island Sandstone (e.g., on the road-side immediately north of the Pancake Rocks). However, a local discordance of 10° between these two formations (Fig. 12) is visible in the lower gorge of Bullock Creek and the basal few centimetres of the Potikohua Limestone contain phosphatic nodules and quartz pebbles up to 1 cm.

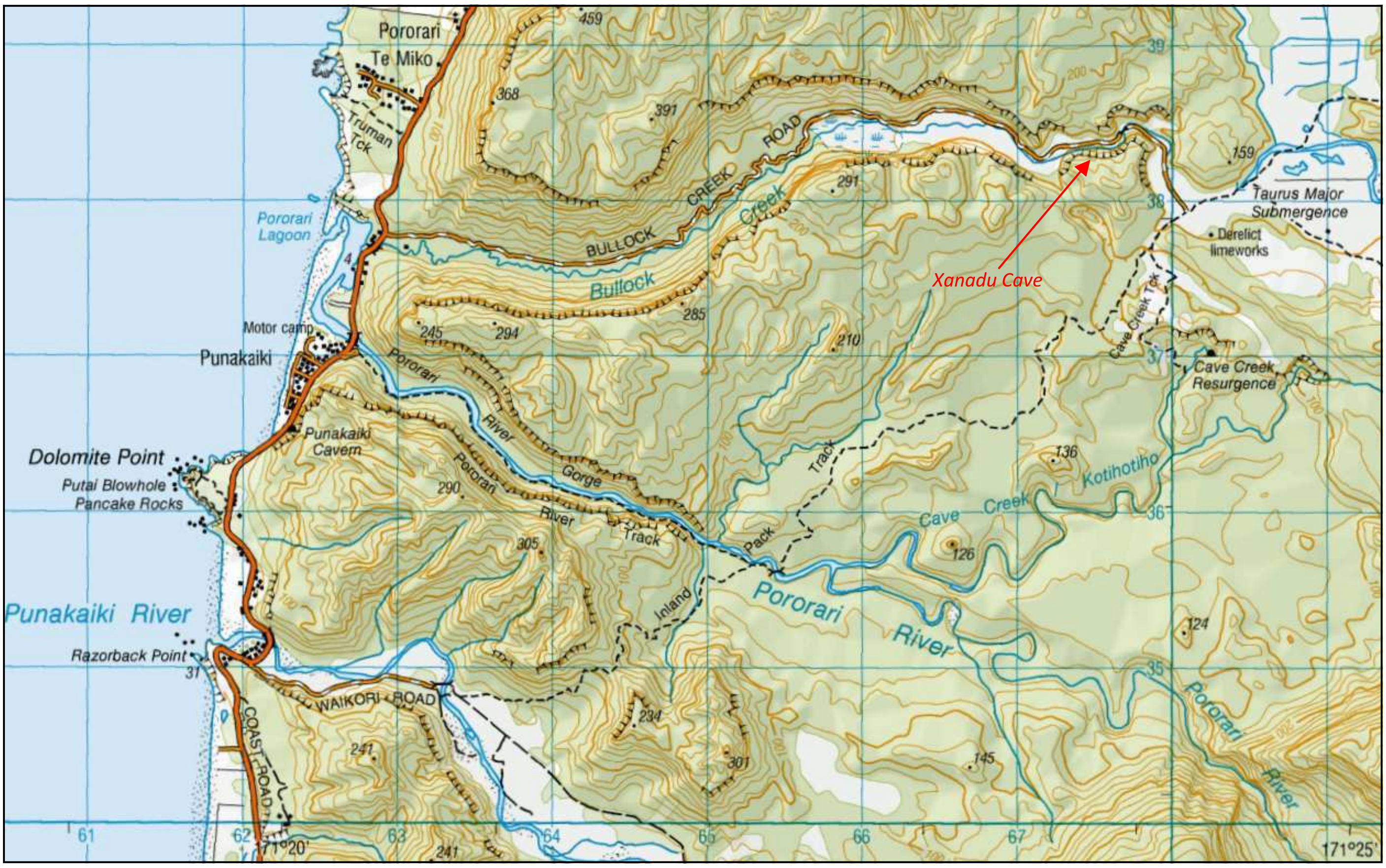
Age: Lower Whaingaroan to Waitakian on microfossil evidence.

Environment of Deposition: Transgressive deposits, inner shelf (locally) to outer shelf (Anderson 1984).

Reference: M. Laird: Handbook to the Punakaiki Geological Map, 1:63,360, DSIR, 1988



Potikohua Limestone in the south side of Bullock Creek near the entrance to Cairns Catacombs. Note the dry creek bed and gently dipping limestone. Photo. M Trayes, 2008



Extract from NZ Topo Maps (online) of the Punakaiki—Bullock Creek Area showing key cave and karst features. Map is approx. 9 x 5.5 kms

CAVE & KARST FEATURES

The **Bullock Creek Cave System** is a significant caves and karst system with Bullock Creek being one of the of the six streams which have cut down through the limestone belt which runs parallel to the coast between Punakaiki and Charleston. About 3kms up the Bullock Creek road the gently dipping limestone reaches creek level and as it sinks karst features such as caves and sinkholes begin to appear. These continue right back to the syncline where a calcareous, muddy sandstone (Welsh Formation) begins to overlie the Potikohua Limestone.

In places gravels overlie all other formations still on the valley floor and these are the remains of the last interglacial deposition, the Waites Formation, in this area. The bed of Bullock Creek itself contains many medium to small sized granite boulders eroded from the main Paparoa Range and washed down the creek by the high rainfall in the area. Granite pebbles act as an effective grinding agents within the caves, adding to the rate at which solution passages are formed.

A key feature of the Bullock Creek drainage is the capture of most of its water, which comes off the main Paparoa range, by an underground system of passages to the Cave Creek South - Pororari River catchment. In fine weather the bed of Bullock Creek below the main sinks (Taurus Major) is often dry but when it rains heavily (not uncommon) the main sinks overflow and water travels on down the creek to find its way into other sinkholes in the bed of the creek) and into the many fissures and cave entrances on the south side of the creek. If it rains for long enough, the other sinks and caves all fill as well so the creek begins to flow on down, filling the swamp and then on down to the sea.

This stream capture has been caused by a landslide which came off the north side of the valley about 45,000 years ago. This dammed the creek and raised the creek bed. Creek waters then began to find their way southward through a network of floodwater maze passages (the present Xanadu Cave system) to emerge through a number of springs in the upper reaches of Cave Creek South.

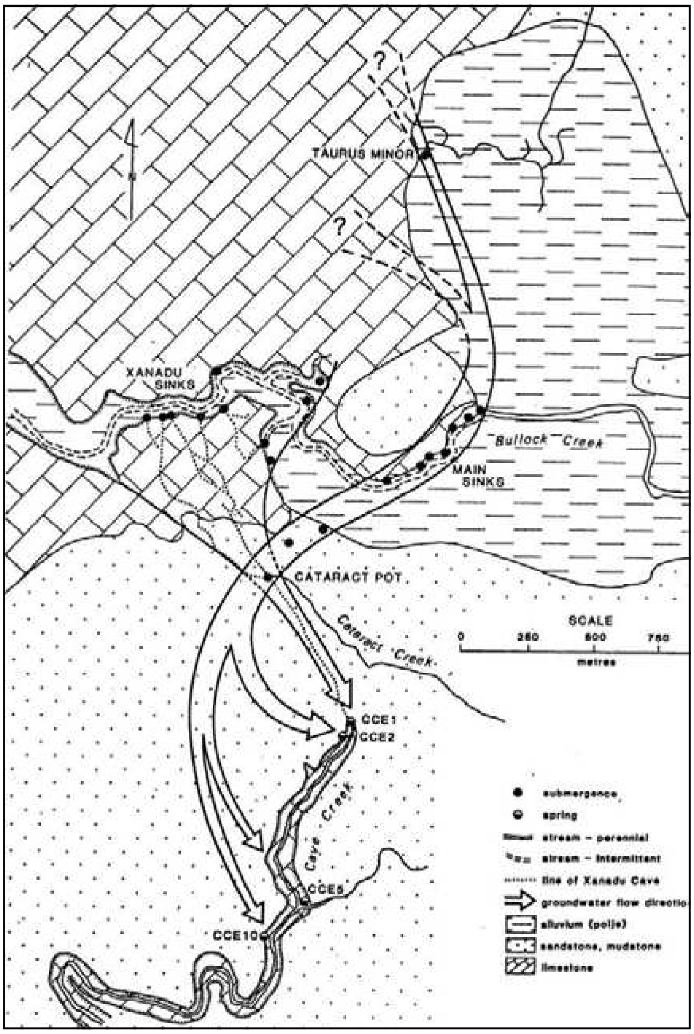
Since European times this natural change to the drainage has been further changed by both grazing and logging of the area upstream of the main sinks (Taurus Major). This includes a system of drains having been dug on the north side of the creek about 50 years ago.

Anecdotal evidence points to the sinks flowing more often due to the affects of deforestation, causing more frequent flooding of the caves and swamp downstream. Whilst these effects are difficult to quantify, at least one cave was highly impacted in the early 1970's, its speleothems being covered in mud.

It's unclear yet what the effects the cessation of grazing (about 10 years ago) will be for this large wetland area, but DOC have closed the drains off, and are allowing the cleared area to revegetate naturally. Although not technically a 'polje' this shallow depression area where Bullock Creek crosses the Barrytown Syncline, acts in very similar fashion, and is often referred to as such.

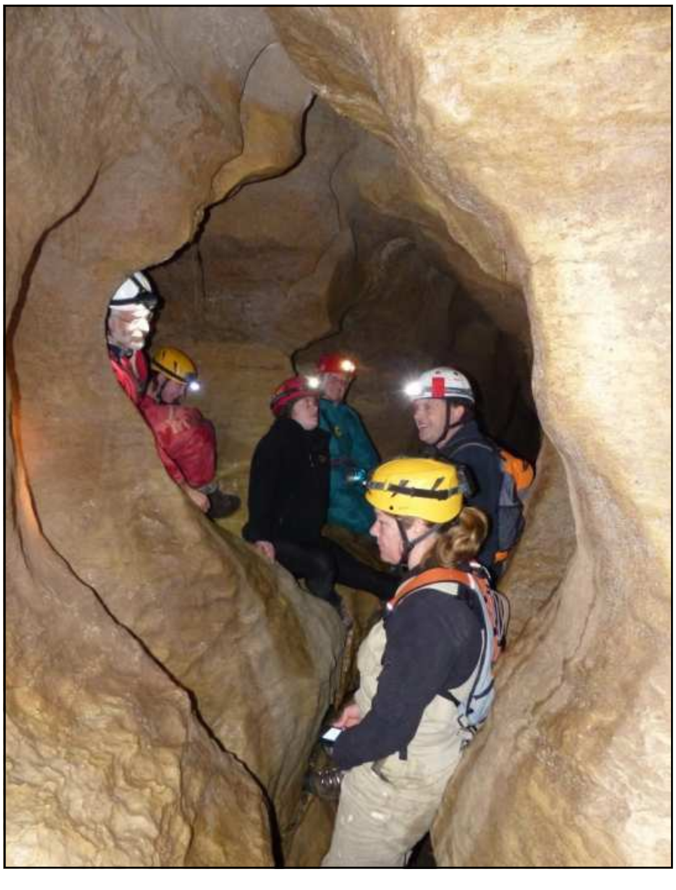
In 1989 a major study was made of the Bullock Creek karst hydrology by Scott Crawford., a student at the University of Auckland. Whilst cavers had long since suspected that the captured waters resurged into Cave Creek South, it took a comprehensive study using dye tracing and measurement of aquifer recharge (water level monitoring, rain gauges) to prove this without doubt.

Reference: S. Crawford: The Hydrological Behaviour of a High Flooding Frequency Karst System in New Zealand: Geography Dept., University of Auckland, 1989



Above : Diagram from Crawford, 1989 re Bullock Creek stream capture

Below: Cavers in the Keyhole Passage, Xanadu Cave, 2015 Photo: G Thomas



The triangular area between Dolomite Point and the Coast Road at Punakaiki is generally known as the **Punakaiki Pancake Rocks.** The rock strata see here is Potikohua Limestone and an overlying layer of Waites Formation gravels. The limestone contains no Mg_2CO_3 component despite the name "dolomite," a fact which continually misleads visitors and locals alike.

Close scrutiny of a rock stack out at the Pancake Rocks will reveal that they are formed from two types of limestone: non-platy and platy. The contact point can generally be distinguished from a layer containing quartz granules and phosphatic nodules. The non platy lower section of the stacks has normal limestone bedding similar to the strata found in the Xanadu Caves system at Bullock Creek. The upper platy layer with its "pancaking effect" is more unusual and over the years there have been many attempts to explain how this has come about. The following is derived from the 1999 GNS "Guide to the Pancake Rocks" and is the generally accepted explanation for the pancaking effect.

"The origin of the mudstone bands, referred to here as seams, has been the subject of much scientific interest. It was popular belief that this type of layering limestones formed at the time of deposition. However, geologists now consider a secondary process is responsible. When sediments are buried and compacted by the enormous load of overlying material, grains of shell material and silt are forced against each other.

At their points of contact where the pressure is concentrated, the calcite in the shell fragments is least stable and begins to pass into solution. For reasons still unclear these sites of solution eventually merge to form an irregular boundary (styolite), oriented approximately perpendicular to the axis of pressure. As permeating solutions continue to carry dissolved calcite away, insoluble minerals are left as a residue, in time becoming concentrated along the boundary to form a seam of mudstone.

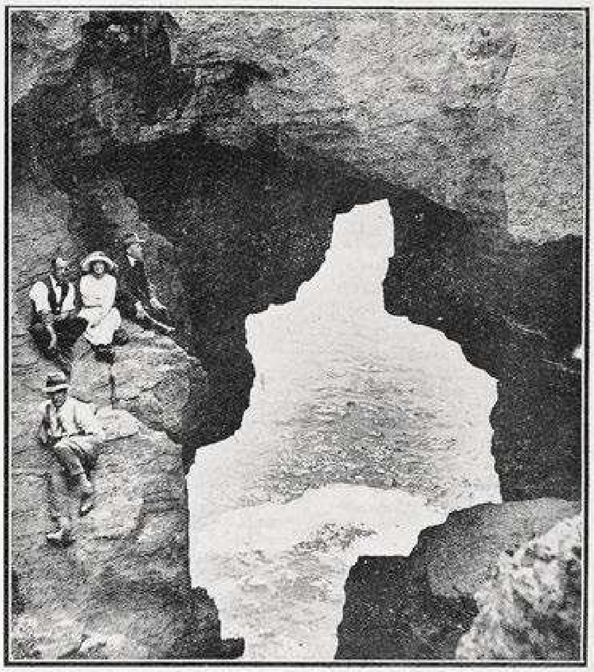
This type of layering, found in limestones worldwide, is known as stylobedding. In the Pancake Rocks the seams forming the stylobedding are more or less parallel to the original sedimentary bedding. However, in limestones from other parts of the world, the seams cut across bedding demonstrating that the stylobedding formed sometime after deposition, by a secondary process."

The constant battering of the sea and prevailing south-westerlies fronts off the Tasman combine to weather the mudstone layers more quickly than the limestone ones, leaving the limestone more sharply profiled. The same elements, combined with a rainfall of 2500mm per year, are also continuously eroding the whole area from the coast back to the road.

At the Pancake Rocks, the many tomos, caves, blowholes and rock arches are an attraction for thousands of visitors every year. The infrastructure is checked annually for corrosion and the rocks for erosion by GNS scientists who have predicted that 'one day' the land bridge near the big pool will collapse.

There are plans to improve the various services needed to meet visitor demand at the Pancake Rocks (toilets, cafes, Information centre, more car-parks etc) but this is no easy task in this karst environment, especially as the sea caves behind the big pool probably reach back as far as the road, and at least one hole - a 4m deep grike - has opened up under the present Visitor Centre since it was opened in 1987.

Reference: G Coates & M Laird: Guide to the Pancake Rocks, Punakaiki: GNS Science, 1999. Order online for $5 at http://shop.gns.cri.nz/is_70/



ONE OF THE INTERESTING "BLOWHOLES" AT PUNAKAIKI, A NEW SCENIC RESORT OF GREYMOUTH, WEST COAST, SOUTH ISLAND OF NEW ZEALAND. King and Son, photo.

Proof that the Punakaiki Pancake Rocks have long been popular.
Photo: Auckland Weekly News, AWNS, 23rd February 1922

The same young men who explored and mapped the Bullock Creek Caves in the early 1970's also conquered this rock, known locally as the 'Punakaiki Overhang.' See a photo of their climb in the Punakaiki Tavern.
Photo: M Trayes, 2006

Greymouth Area

GEOLOGY *[The following is an extract only from the four detailed pages about this strata in the map handbook]*

Nile Group (Nathan 1974)

Cobden Limestone nc (McKay 1877)

Distribution: As a result of the southwest plunge of the Brunner Anticline, the Cobden Limestone crops out in a horseshoe shape extending from Greymouth in the northwest to lower Stillwater Creek in the north centre of the district. It forms narrow steep escarpments and wider dip slopes, the latter being up to 2 km wide south of Greymouth where dips average c. 15°, but less than 0.5 km wide on the northwest sides of Card and Stillwater creeks where dips progressively increase northeastwards from 18° to 50°. To the southwest along the axis of the Brunner Anticline, it crops out in small inliers west of Marsden (632486) and in Fireball Creek (612447).

Apart from the area from which it has been eroded in the core of the anticline in the north, the Cobden Limestone underlies almost the whole of the Kumara-Moana district northwest of the Hohonu Fault. Only in the area of the Kawhaka-1 well is it absent, probably as a result of Late Miocene uplift and erosion.

Two small areas of outcrop lie within the Hohonu Fault zone at Deep Creek, Hohonu, and at Knoll Point on the south side of Lake Brunner.

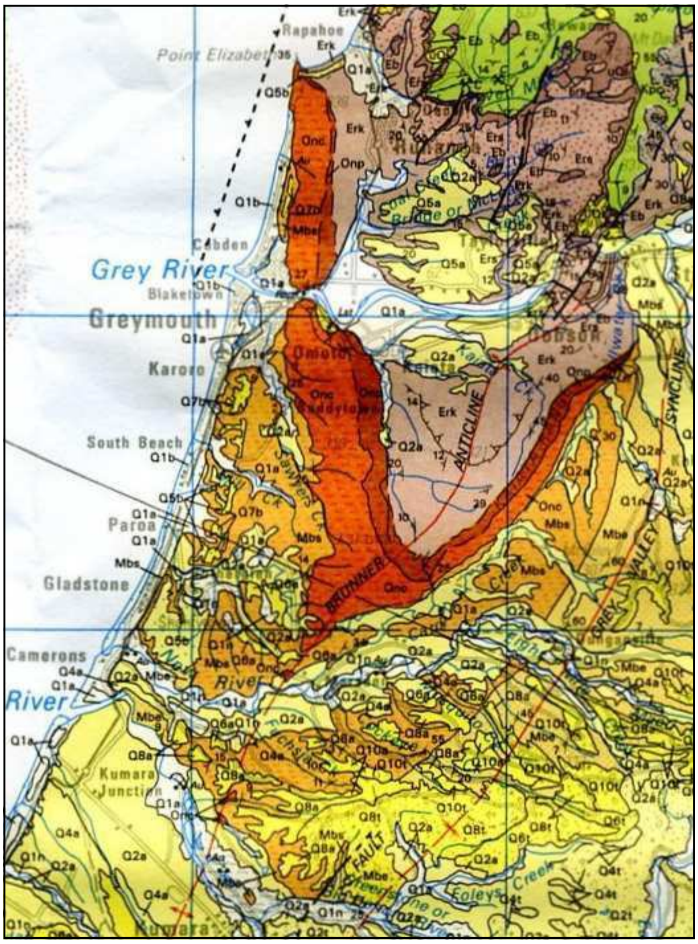
Because of both its extent and the lithological contrast between it and the overlying sediments, it forms an excellent seismic reflector for structural interpretation, except along the very steeply dipping west limb of the Grey Valley Syncline. ………

In the Greymouth area, where the Cobden Limestone is 370m thick, it is muddy throughout, apart from glauconitic bands which allow its separation (Nathan, 1978) into three members, the Ngarimu and Tarapuhi Limestone Members, and at the top, the Puketahi Mudstone Member. …………….

Environments of Deposition: The prevalence of limestone throughout the Kumara –Moana district, as indeed over the West Coast as a whole, reflect the culmination of the Paleogene marine transgression over eastern peneplaned areas not reached earlier. In the west, deposition was mainly in an outer shelf to upper bathyal environment, rather deeper in the Greymouth area in the north. Inner shelf environment prevailed in the west.

Age: Age data are few but taken as a whole the age range for the Cobden Limestone is from late Whaingaroan to early Waitakian.

Reference: R.P Suggate, T.E. Waight: Geology of the Kumara – Moana Area, GNS, 1999



Extract from 1999 Kumara - Moana Geology Map showing the Cobden Limestone as 'nc' in bright orange. The small area just across the Taramakau River from Kumara has the best karst development for the Cobden LS.

Stalagmites 'retrieved' from blasting at Cobden Quarry in 1999. The smaller one is at Melbourne University for dating, the 'double' one is on display at Shantytown. Photo: M Trayes, 2013

CAVES

Karst development is widespread in the Cobden Limestone but most caves found to date are muddy and smaller than those of the Potikohua Limestone. The outlier out at Cape Terrace where the limestone is higher grade, has the best karst features including a stream capture from Fireball Creek to Tansey Creek.

Te Ana Puta is a sea-cum-solution cave at the Point Elizabeth end of the Rapahoe Range (also known as the Twelve Apostles). The cave has formed in the Tarapuhi Limestone Member of the Cobden Limestone Formation, and runs for about 1km along under the Point Elizabeth Walkway.

The sea entrances into the cave have been known of for many years, being noted on a 1911 Geological Map of the area, but it wasn't until the 1990's that the cave was fully explored and mapped by local cavers. As the sea entrances are impossible to enter other than at spring low tide with very calm sea conditions, initial exploration concentrated on finding a tomo entrance seen from inside the cave.

Finding it took nearly 5 months of 'flax bashing' during which time other tomos were also found, all enabling further exploration without having to worry about sea conditions. However those exploring the cave soon realised that the state of the tide was important because a key passage, which links the sea caves area with the further parts of the cave (the "The Lakes"), is in fact tidal.

As a general rule, through trips in this cave are best done at mid to low tide but for those wanting to see - and hear! – the effect of big south-westerly rollers slamming into a cliff face, the best time to visit the Second Sea Cave entrance is around high tide. On such visits it should be noted that the sudden changes in air pressure can be hard on the ears. And cause other odd effects ……..

The **Grey River Gorge** with associated cave and karst features is at the south end (Greymouth) end of the Rapahoe Range. The river has cut down through the limestone on the western limb of the Brunner Anticline to form a gorge which in early days of the town, came right down to the water on both sides.

Bridge building (four to date) has been made difficult over the years by the depth of the gorge. When the present road bridge was being built in the early 1970's, engineers drilled down over 50m trying to find a stable base for the piles. In doing so they went right through the limestone into caves in some places. They also found that the river bottom was very uneven so that all the piles had to be custom made of different lengths.

In developing the town as a port in the early days, quarrying on both sides of the river has destroyed a number of caves and tomos. However some still remain including two small caves, two large resurgences and many tomos and grikes. In the 1990's further quarrying on the south side exposed a repository of bones which were noticed by a local man. When investigated by palaeontologists in 1998 they turned out to be those of the extinct New Zealand Snipe, a valuable find.

Recent research points to at least six caves having been quarried away on the Cobden side of the river between 1877 and 2005. Today the remnants of the last cave uncovered (1999) can still be seen in the top corner of the quarry and some of the speleothems which were retrieved are on show at the West Coast Gem & Mineral Club's Hall at Shantytown *(see photograph on previous page).*

References:

T.H. Worthy, C.M. Miskelly, R. A. Ching, Taxonomy of North and South Island snipe (Aves: Scolopacidae: Coenocorypha), with analysis of a remarkable collection of snipe bones from Greymouth, New Zealand, 2002, New Zealand Journal of Zoology 29: 231-244.

Point Elizabeth at left with Te Ana Puta's sea cave entrances mid-photograph. Photo: P Caffyn, 2013

Castle Hill Area

GEOLOGY

Abstract (from the paper referenced below)

A basin analysis of the Oligocene Porter Group rocks in Castle Hill Basin, Canterbury, was completed. The Porter Group contains the Coleridge Formation which comprises a lower sandstone unit and an upper micritic limestone unit, and the Thomas Formation which consists of biosparite limestone and interbedded tuffs. Basin analysis provided evidence that the Coleridge Formation lower sandstone unit was deposited in an inner shelf setting based upon its moderate sorting, large grain size range, laterally continuous geometry and lack of bedforms due to intense bioturbation. The upper micritic limestone is a mid shelf deposit composed of micrite and minor clastic grains. Provenance analysis has classified the lower sandstone unit as a quartz arenite. Both metamorphic and plutonic source areas are likely for the sandstone, along with reworked grains from underlying Formations based on QFL, SEM-CL, heavy mineral and glauconite analysis. The Thomas Formation limestone is a typical New Zealand cool water biosparite deposited on the inner shelf as a result of storms and debris flows, with the upper cross-bedded limestone lithofacies being reworked by currents in shallow water. Petrographic data showing multiple stages of diagenesis at the upper contact of the Thomas Formation provides evidence for a major tectonic event. The interbedded tuffs are a result of basaltic marine volcanism on the inner to mid shelf. The tuffs are reworked and deposited by turbidity current, debris flow and storms. Analysis of a dike within the Thomas Formation volcanics showed a weakly alkaline geochemical signature that is indicative of volcanism related to extension.

A regional synthesis compared the Porter Group rocks in Castle Hill Basin with Oligocene rocks in North Canterbury, West Coast and North Otago. Oligocene quartz-rich sandstones are found in Castle Hill Basin, Harper Valley, Avoca and Culverden while micritic limestone is found on the East Coast from Marlborough to Otago. Oligocene basaltic volcanics interbedded with limestone and karst unconformities are found in Castle Hill Basin, Culverden and Otago. Normal faulting may be responsible for thickness variations and several regional karst unconformities in the eastern South Island. Plate reconstructions based on sea floor magnetic anomalies also suggests the New Zealand region was tectonically active during the Oligocene. Mounting evidence, including Eocene-Oligocene faulting and volcanism in the South Island, suggests that New Zealand may not be best described as a passive margin during the Early-Mid Tertiary.

Paper Reference:
L.M. Congdon**:** Basin Analysis of the Porter Group, Castle Hill Basin, Canterbury: Implications for Oligocene Tectonics in New Zealand: University of Canterbury. Geological Sciences, 2003: http://ir.canterbury.ac.nz/handle/10092/1488

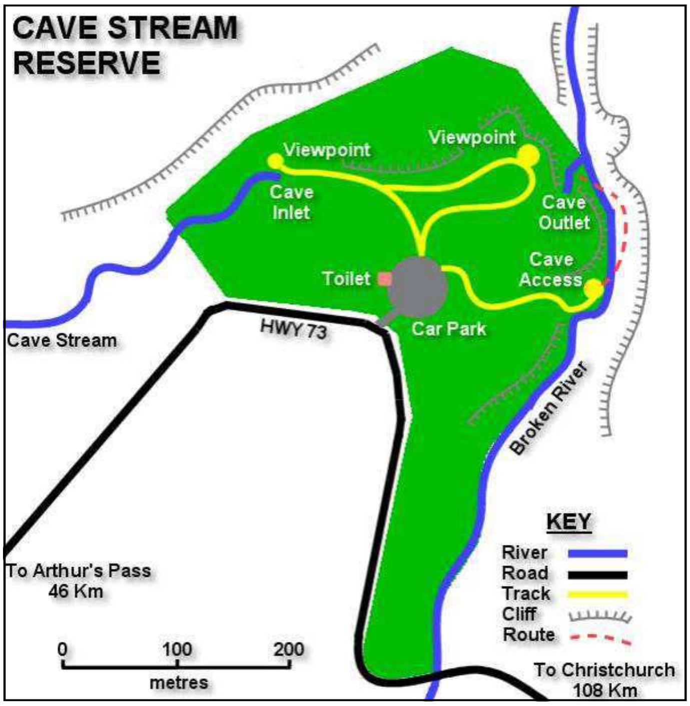
Other References:
N. Reznichenko: A Field Guide to the Geology of the Castle Hill Basin: Geological Sciences, University of Canterbury, 2012

S.C. Cox, D.J.A. Barrell (compilers): Geology of the Aoraki Area: Handbook & 1:250,000 Map, GNS Science, 2007

Looking down Cave Stream toward the northern part of Castle Hill Basin. The stream sinks underground for 600m just left of centre photo. [Photo: A Shanks]

CAVES

One moderate size stream cave and several smaller ones can be found in the limestone at Castle Hill Basin, the main streams being Cave Stream, Broken River and the Thomas River**.** The other main karst features are the many limestone boulders both in the southern part of the Basin at the Castle Hill Conservation Area and up above the cave in Cave Stream Reserve. A number of walks link these. Tracks in both reserves are used by walkers and rockclimbers.



Broken River or Cave Stream Cave is located in the high county at Castle Hill Basin on the main highway between the West Coast and Christchurch. The karst parts of the basin are in two main areas with that on the south side nearer Castle Hill Station being popular with rockclimbers and walkers. On the northern side where Cave Stream goes underground to exit into the Broken River, there are futher walking tracks and more boulders.

The cave is about 600m long and a relatively easy trip if conditions are good – low water, summer temperatures. However it can become impassable in spring thaw conditions or heavy rainfall events, and the cold water can lead to inexperienced cavers rapidly becoming hypothermic. There have been at least three deaths in the cave due to people ignoring good advice and undertaking the trip without adequate gear. The high country climate, proximity to a main road and open access make this cave a risky venture at times. On the other hand it can be a fun cave if you pick the right day, have warm clothing and good lights, and do the trip upstream (recommended).

Maori, particularly the Waitaha people, have long had links to the wider Castle Hill Basin. Evidence of Māori occupation in the Cave Stream area includes rock-art, artefacts and signs of seasonal camps.

References

Cave Stream Scenic Reserve: http://www.doc.govt.nz/parks-and-recreation/places-to-go/canterbury/places/cave-stream-scenic-reserve/

Cave Stream Scenic Reserve: http://www.arthurspass.com/pdf/cave_stream.pdf

Cave Stream SAR Callout, Saturday June 21: NZSS Tomo Times, No. 160, August 2003

Above left: Cave Stream Cave submergence

Above right: Resurgence of Cave Stream into the Broken River

Below: the writing on the sign as you enter the cave……. a reminder that caves in the area were used by Maori people - the 'Waitaha' - in pre-European times

Map above courtesy of http://www.arthurspass.com/index.php?page=169

Photos this page: M Trayes, 2013

Inner Topographies and Red Chair Library installations at the Moonah Art Centre. The viewer is invited to become part of the Hastings Caves experience by sitting in the red chair and reading stories from the cave that are held in the Inner Topographies artist book. In the background are some of Janelle's drawings from the caves.

Photo: Peter Mathew