HFNC Grampians Region Geology excursion with Ross Cayley - 17 Nov. 2018

Rod Bird & Steve Martinich

Present: HFNC members who attended were Glenys Cayley, Elizabeth Arthur, Ross Simpson, Charlotte Davis & Frank Walker, Rod Bird & Diane Luhrs, Peter Hocking, Reto Zollinger & Yvonne Ingeme, Kate Kennedy, Sally Cunningham, Stephen & Debra Martinich. Visitors were Bill Funk, Keith Cumming, Heather Ward, Samantha Greiner and Ross Cayley.

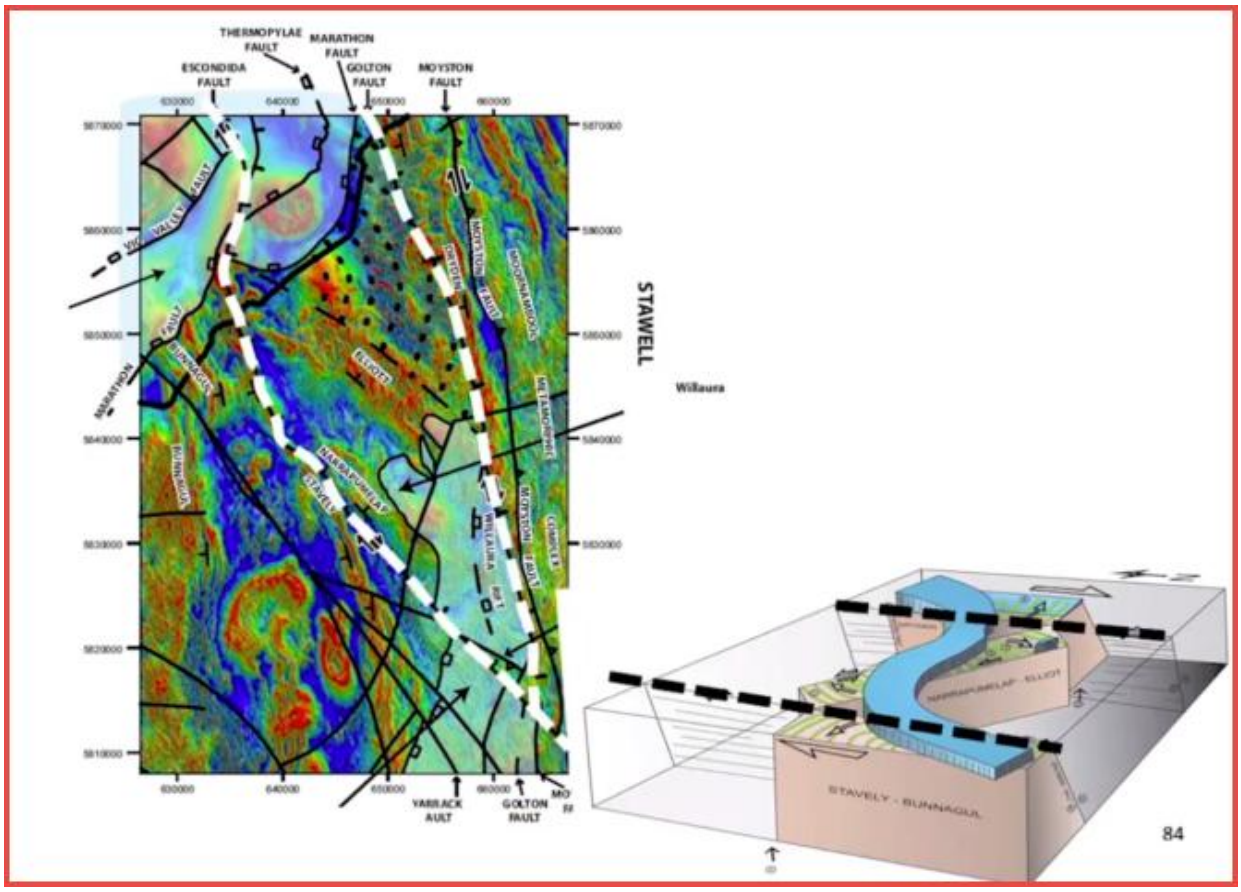
Our leader: Ross Cayley is a research scientist with Geological Survey of Victoria. He presented a lecture on the geology of the Grampians region on Friday evening and he led the excursion.

It is 20 years since geologists Ross Cayley and David Taylor began to investigate the geology of the Grampians/Gariwerd Ranges, upgrading studies undertaken in the 1960s. The Grampians sandstone and mudstone deposited along an ancient coastline appears to be cut by numerous ancient fault-lines. In some places giant sheets of rock are stacked across faults, like cards in a deck. In other places the 'deck' has been folded and torn apart along networks of younger faults.

In 1997 there were missing pieces in this geological story, hidden in even older rocks beneath the Grampians Ranges. Getting that information has taken 20 years of research, including walking along 500 km of streams in SW Victoria looking for rock exposures, and the use of a huge portable X-Ray Fluorescence analyser to image the older bedrock up to 45 km deep, thereby allowing detailed 4-dimensional (3d + time) models of geology to be made. Collaboration with Geological Survey of NSW and Monash University helped piece the jigsaw together, using very sophisticated computer geodynamics simulation software to show how the Grampians Ranges geology came to look the way it does.

These results are at the heart of an emerging, unifying 'Plate tectonic' theory for the formation of the geology of the whole of Eastern Australia 450 to 400 million years ago. Ross's presentation on the tour was based on the **Stavely Arc** (the area between the Yaramyljup and Moyston faults). For a more detailed, fascinating insight refer to https://www.youtube.com/watch?v=AD-70Vsnkaw.

The diagrammatic below is at the 25:48 point in the above Youtube video



Simplistically, the effect results from movement of the bedrock. Think of it as a cake with thick icing on top and when the light brown cake ('bedrock') bends around, the blue icing ('Grampians') buckles and heaves as it slides over the cake. Some of us may have cut a wedge from a cake, then pushed the cake to close the 'fault' and re-smoothed the icing to hide our 'subduction' efforts.

The tour: We left the Hamilton Visitor Centre at 9 am, driving through Dunkeld to our first stop at Astons Rd, Glenthompson to view in particular two fault areas to the south east of Glenthompson, followed later by inspections of rock outcrops south of Balmoral.

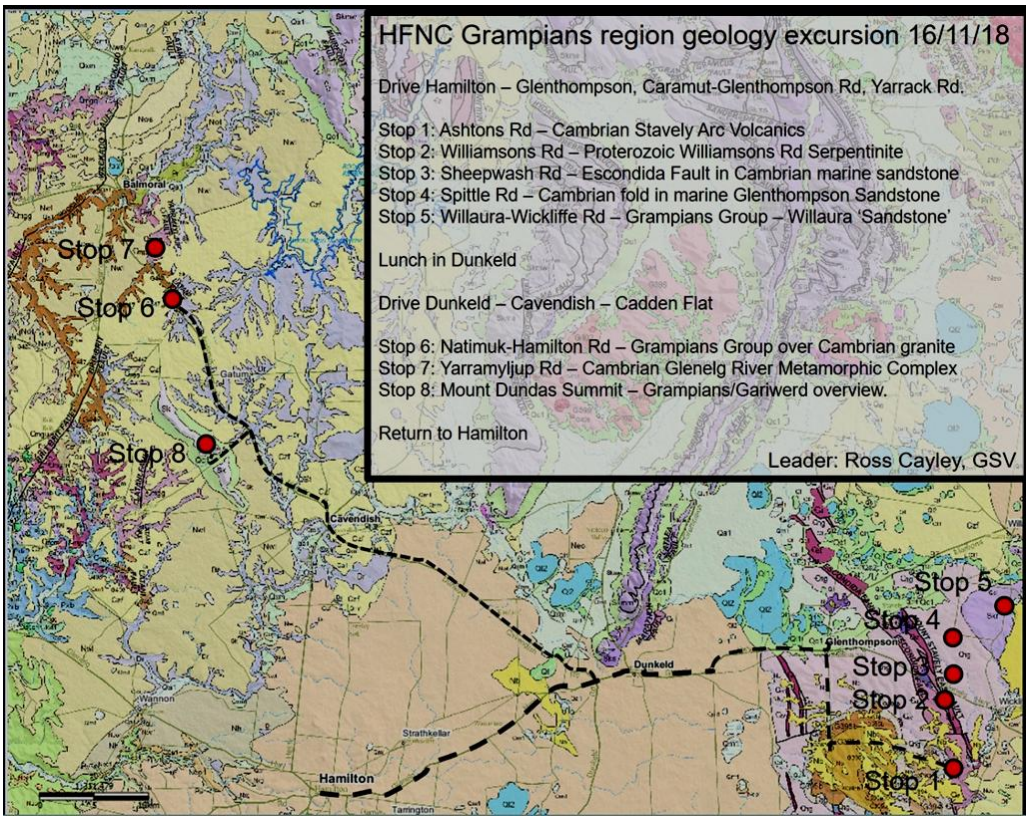
As a preface to the tour, Ross gave a lecture on Friday evening (16 Nov) giving details of the geological processes involved in the formation of the Grampian Ranges.

Briefly, the Grampians is of Silurian age (approx. 400 mya), a time when the first primitive fish were seen. The Grampians sandstone and mudstone resulted from infilling, over 30 myr, of a 3.5-km-deep 'hole' following earth movements (Plate Tectonics). This area was then under the sea, with mountains around. Erosion of those mountains resulted in mud settling above the sand in that 'hole'. Subsequently, the Grampians area was uplifted some 200 m, appearing as an island in a shallow sea. A new mountain range had been created from older mountains, now gone.

When viewing the layers now present in the Grampians it is apparent in some areas that there has been 'stacking' of the layers as a result of a major fault and subsequent movement of the original mass 30 km or more west from its original position. The 'stacking' could happen if the front edge of the sliding block catches on bedrock while the pressure continues to push the layers up and over the front edge in a fold. The result is a repeating sequence of the original sandstone & mudstone layers. Try holding fast one end of a sheet of paper on a flat surface and push from the other end and see the middle section roll over.

What we see now in the Grampian Range is sandstone quartz cliffs impacted in many areas by subsequent folds and thrust faults to create some puzzling landforms. The mudstone-sandstone soil on the slopes and valleys below is a result of erosion of the original mudstone and some sandstone. That erosion began some 90 myr before separation from the super continent in Antarctica and continues today.

The following summary of the excursion is based on notes and photos taken on the tour. The complexities of structural geology and the influence that New Zealand has on the geology of our eastern coast make it hard for those of us with little geological expertise to fully understand the 'new' information that has evolved. Readers are therefore asked to excuse any errors made in this report!



Stop 1. Astons Rd – Cambrian Stavely Arc Volcanics

From Glenthompson we drove south to the Yarrak Rd and east on Astons Rd.

The outcrop on the Hopkins River bank on Astons Rd is of Miocene Age. Some 30 mya the sea eroded and levelled the hills around but left 'islands' of rock that resisted that erosion. That igneous rock is Andesite (an extrusive lava intermediate between rhyolite and basalt) containing feldspar, hornblende, Na, Ca and other mater derived from the earth's mantle and sea water, but no quartz. It is a 'conglomerate' resulting from cementing of the extruded rock fragments in a shallow sea. The rock can be dated using XRF if it contains zirconium and, in this case, it indicates that this magnetic rock was erupted some 500 mya. Mt Stavely, Mt Dryden (NE of the Grampians) and Mt Elliot (Black Range) are of Andesite formation.

Stop 1. Astons Rd Miocene Andesite outcrop

Stop 1. Red Gums & bridge over Hopkins River

Stop 1. Ross Cayley and Andesite rock

Stop 1. Andesite rock igneous 'conglomerate'

Stop 2. Williamson Rd creek site – Proterozoic Williamsons Rd Serpentinite

From Astons Rd we continued east to the Narapumleup Rd, turning left, and then left again at Christies Rd, and then to Williamsons Rd, enjoying some fine views to the Grampians

Stop 2. Ross Cayley with Serpentinite rock

This site has an exposure of a metamorphosed mantle rock, Serpentinite. Some 700 mya, when the super-continent broke up, the rocky material was pulled up to the surface to form a new crust.

This is a significant geological site. The rock is 'slippery' and contains much magnetite (and thus is very magnetic, unlike the Grampians rocks). The rock can be said to be olivine and pyroxene with water added, but also has silica that was added later. (Note: Serpentinite is also present in a quarry near the junction of Retreat Hummock's Road & the Wando River not far from Coleraine).

Stop 3. Sheepwash Rd – Escondida Fault in Cambrian Marine Sandstone
From Williamsons Rd we travelled along Phillips Ln to the highway and then Sheepwash Rd.

This is the Type Locality for Glenthompson Sandstone. The rocks are Cambrian, not Ordovician. The rock is a siltstone from graded sediments which are a key indicator of the direction of time.

Stop 3. Creek on Sheepwash Rd

Stop3. Esconda fault zone and creek

We walked along the eroded creek to view the orange-coloured sediments in this 200 m section that is the width of the vertical fault that extends to Mafeking in the Grampians. This fault occurred some 400 mya and resulted in a 30 km displacement. This fault goes under the Grampians. The subduction resulted in an appearance of these sediments under the Wartook sediments. The stream banks show torn and twisted sediments of greywache (mica, feldspar, quartz, mudstone and fine sand) in the shatter zone. It was originally thought this fault was younger than the Grampians. Mica in small amounts here is very similar to rocks from Africa. This site's chaotic fracture and damage zone was most interesting.

The creek was saline, evident from the growth of Creeping Monkey-face (*Thyridia repens*) and Salt Pratia (*Lobelia irrigua*) on the bed. Nearby, birds were conspicuous and included a White-winged Triller, Grey Shrike-thrush, Common Skylark, White-naped Honeyeater and Shining Bronze-cuckoo.

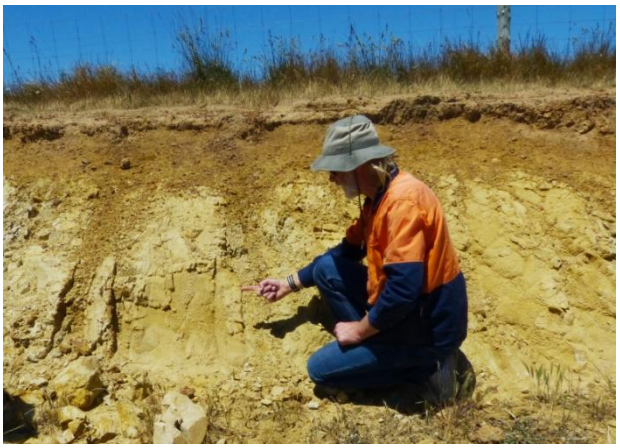
Stop 4. Eroded stream bank & rock shatter zone

Stop 4. Salt Pratia

Stop 4. Creeping Monkey-face

Stop 4. Spittle Rd – Cambrian fold in Marine Glenthompson Sandstone
From Sheepwash Rd we travelled to Spittle Rd where we stopped at a road cutting.

This site is not in the fault zone. Erosion of the cutting wall made it difficult to see much evidence of minor folding.



Stop 4 Spittle Rd Cambrian fold in sandstone

Stop 4 Marine Glenthompson Sandstone

Stop 5. Willaura-Wickliffe Rd – Grampians Group Willaura 'sandstone'
This stop was at a road cutting on the Wickliffe-Willaura Rd.

We looked at an exposure of the material that the Grampians is made of. In this case it has been eroded by the sea and turned into gravel.

Information on the Stavely Arc is available from the web. Some reports, such as that from Geoscience Australia, are very large files. http://www.ga.gov.au/scientific-topics/minerals/unlocking-resource-potential/stavely-project.

Stop 5. Willaura Sandstone

Lunch Stop
Willaura was our destination for a lunch stop. We found the picnic tables and facilities at the towns recreation oval a convenient place to stop, with shade under the trees.

From Willaura we drove back to Dunkeld and thence to Cavendish, to take the road to Balmoral.

Stop 6. Natimuk-Hamilton Rd – Grampians Group over Cambrian Granite
We stopped at the Yarramyljup Creek bridge and clambered down to the creek to view the exposed rocks.

The rocks are Yarramyljup Metamorphics – bedrock that has very large crystals of feldspar resulting from water saturation during formation some 506 mya. The large crystal surfaces could be plainly seen from the bridge, reflecting the sunlight. From a geological perspective this picturesque area might be considered a miniature 'Broken Hill'. It is the back arc of the Stavely Arc where the high temperatures (650°C) melted the metamorphic rocks to form the very large crystals.

Fairy Martins had built nests under the bridge and Striated Pardalotes were calling from the River Red Gums lining the creek banks. There were large pools in the creek, with water running.

Stop 6. Yarramyljup Ck bridge on Balmoral Rd

Stop 6. Yarramyljup metamorphics with large crystals

Stop 7. Yarramyljup Rd – Cambrian Glenelg River Metamorphic Complex
We did not have time for this stop.

Stop 8. Mt Dundas summit – Grampians/Gariwerd overview
We travelled along the Dundas Gap Rd to the track up to the Mt Dundas Lookout. Ross pointed out that the bedding planes of Mt Dundas dipped east at about 16 degrees and the Grampians (including Victoria valley) dip to the West. That dip in the Dundas landform can be seen in the photos below.

Mt Dundas is of similar material to Mt Difficult and, like the Western Black Range, is a disconnected outlier from the Grampians. However, Mt Dundas finishes in bedrock. It is not a syncline that been displaced. The other bits of Mt Dundas and the Black Range have simply been eroded away in the past 400,000,000 years.

Stop 8. Dundas Range looking north

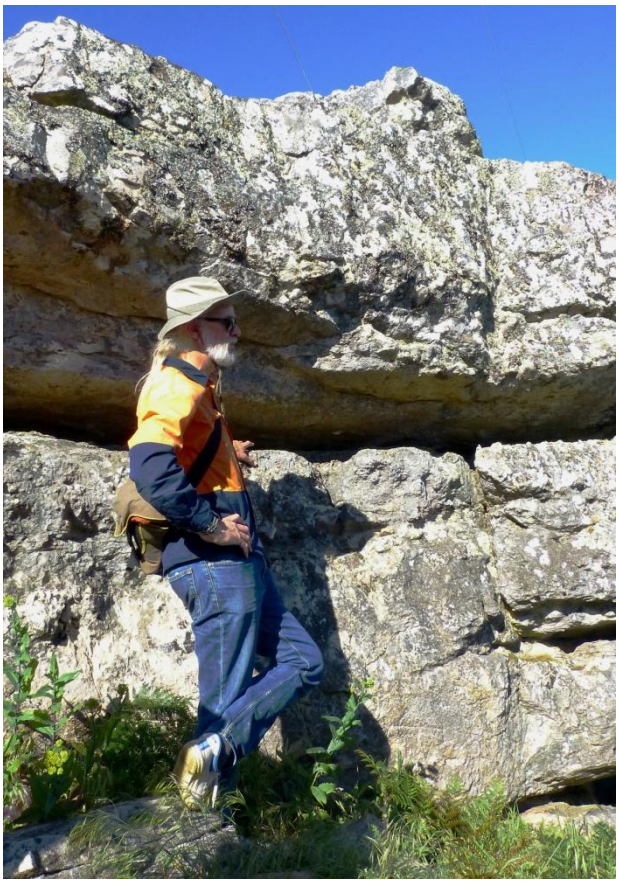
Stop 8. Dundas Range to the south

A fault of tangled rock about 10 m thick runs E-W from Mt Dundas and that happened about 400 mya, tearing the Grampians apart.

The Dundas Tableland, stretching far to the west, arose some 6 mya when the block was uplifted 200 m. Cambrian bedrock is exposed in a dam to the west and that is not Grampians Group rocks. The oldest rocks in Victoria – about 700 mya – occur in the far west (e.g. Steep Bank Rivulet).

The view from the Mt Dundas lookout was a little hazy but Mt Arapiles could be seen to the North.

The summit rocks (SE from the telecommunications building) showed evidence of beach worm activity and water current ripples. Near the rocks were showy wildflowers, incl. Variable Groundsel (*Senecio pinnatifolius*), Scented Groundsel (*Senecio odoratus*), and Austral Stork's-bill (*Pelargonium australe*).



Stop 8. Sandstone with beach worm holes

Stop 8. Variable Groundsel

Stop 8. Scented Groundsel

Stop 8. Austral Stork's-bill

Stop 8. Flying Duck-orchid

Stop 8. Smooth Parrot-pea

After leaving the summit, at around 5 pm, we stopped halfway down the access track to Dundas Gap Rd and looked for orchids among the Brown Stringybark (*Eucalyptus baxteri*) and heath. Soon we found Smooth Parrot-pea (*Dillwynia glaberrima*) and a few dozen Large Duck-orchid (*Caleana major*), a species to be looked for in November but one that appears to be fairly restricted in our region.

Our tour concluded at about 5.30 pm, after a very enlightening and pleasant day in which we drove 300 km to seek rocks that were instrumental in defining the geology of the Grampians area. We were very fortunate to have Ross Cayley guide us through this journey in time and space.