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Introduction

Students from the University of Tasmania took part in a week-long field trip to western Tasmania in mid-August 2017. The trip was organised by the University of Tasmania (CODES) student chapter of the SEG and presented postgraduate students, most of whom are working on international research projects, and undergraduate students with an opportunity to learn about the geological evolution and mineral deposits of Tasmania.

The first three days of the trip were dedicated to regional-scale geology and geological history, with the group visiting key outcrops across the northwest coast guided by a post-doctoral researcher from the University of Tasmania. The next four days had an economic geology focus where the group toured a series of operating and legacy mine sites across western Tasmania with expert guides from Mineral Resources Tasmania, the state geoscience agency. This report compiles a series of student reports from each day of the trip.

Trip Leaders

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Day 1 – Hobart to Ulverstone

by Ayesha Ahmed

The purpose of this day was two-fold: (1) to walk a transect along the West Bank of Chaos and observe the exposed boundary between Proterozoic rocks of the Ulverstone metamorphic complex, and unmetamorphosed rocks of the Proterozoic Burnie Formation; and (2) to walk the trails at Leven Canyon and observe a 300 m vertical cross section through Ordovician limestone and sandstone.

West Bank of Chaos

The day started bright and early at 6:15 am, when the group met at the entrance to the Earth Sciences department at the University of Tasmania. The weather was perfect; bright blue sky and warm sun. We packed our food and equipment into two mini-buses and were on the road by 7:00 am. Four hours of driving, and 300 km later, we arrived at our first stop of the day at the West Bank of Chaos, Ulverstone.

At the West Bank of Chaos (location 1.1 in the field guide), we completed a 2 km long transect between Goat Island and Picnic Point, which crossed from unmetamorphosed Burnie Formation (sandy turbidite facies, quartzose wacke, and slaty mudstone) through to quartzite-clast conglomerate, and into slates and schists of the Ulverstone Metamorphic Complex. Jacob Mulder, who recently completed his PhD research on northwestern Tasmanian rocks at the University of Tasmania, provided a geological overview of the area and led the tour (Figure 1A). Jacob explained that the rocks at Picnic point represent a passive margin sequence. Proximal passive margin facies are dominated by quartzite (Figure 1B) and quartzite-clast conglomerate (Figure 1C). Distal facies include turbidite sequences, mudstones, and siltstones.

Since deposition of the passive margin sequence, the area has undergone multiple deformation events including westward directed thrusting during the Late Cambrian, and east-west folding followed by southwest-oriented thrusting in the Devonian. These deformation events are manifested in the rocks as broad open folds (Figure 1B), tight isoclinal folds, and crenulation cleavage. Pebble- to boulder-sized clasts in quartzite-clast conglomerate were affected by intense deformation (Figure 1C). The complex history of this area has resulted in a mélange of different rock types juxtaposed against one another by zones of faulting and brecciation.

Leven Canyon

Our last stop of the day was Leven Canyon (location 1.2 in field guide), located 40 km south of Ulverstone. Leven Canyon is over 300 m deep and was carved into the Ordovician Gordon limestone, Moina sandstone, and Roland conglomerate by the Leven River. We walked
through the bush to two lookout points; a lower lookout (Figure 1D) and the upper Cruickshanks lookout. The upper canyon lookout took us up 697 steps, but the view was worth the hike!

Upon our return to the parking lot, we were treated to an encounter with a very friendly echidna (Figure 1E). We travelled the 40 km back to Ulverstone and set up camp for the night at the Big4 Ulverstone Holiday Park.
Day 2 – Ulverstone to Stanley

by Joseph Knight and Brian McNulty

Day 2 took us from Ulverstone to Stanley, with stops at Sulphur Creek, Doctors Rocks, lunch at Fossil Bluff, columnar basalt outcrop at Burnie, peperitic-dolerite intrusions near the Little Penguin Observation Centre, and the Nut. This 115 km coastal drive introduced the group to: (1) an angular unconformity between Proterozoic and Ordovician sedimentary rocks; (2) placer gold deposits hosted in Permo-Carboniferous tillite; (3) xenoliths in Tertiary basalts; (4) fossiliferous Miocene sediments; (5) columnar basalt; (6) Cooee Dolerite; and (7) a prominent Tertiary hawaiite landform (the Nut).

**Sulphur Creek**

Sulphur Creek Point (location 2.1 in field guide) is located on the coast approximately 4 km to the west of the town of Penguin. Here we examined a major unconformity between the strongly deformed Neoproterozoic Burnie Formation (an equivalent of the Oonah Formation) and the overlying and relatively undeformed Ordovician Sulphur Creek Conglomerate (Figure 2). This unconformity likely reflects uplift and erosion during the middle Cambrian Tyennan Orogeny and represents an approximately 200 million year gap in the rock record. The Sulphur Creek Conglomerate was observed to contain upward-fining intervals of pebble conglomerate to coarse sandstone.

![Figure 2: Field trip photos from day two. (A) Members of the group examining the Sulphur Creek Conglomerate. (B) Our group gathered around the unconformity between the Neoproterozoic Burnie Formation and the overlying Ordovician Sulphur Creek Conglomerate.](image)

**Columnar Basalt and Cooee Dolerite**

A stop in Burnie for an morning coffee inspired Ralph Bottrill and Jacob Mulder to add two geology stops to our journey. These stops included: (1) a wonderful outcrop of columnar basalt and (2) coastal exposures of the ~700 Ma Cooee Dolerite near the Little Penguin Observation Centre.
Along North Terrace road, in downtown Burnie, we explored an outcrop of columnar jointed Tertiary basalt (Figure 3). Fantastically, the columnar basalts provide the foundation to the luxury apartments of the Bay Renaissance (Figure 3A). The 7-m high columnar basalt rock face is a Tasmanian heritage sight. A unique lava flow feature, “ball and socket” jointing, was observed by the group along the north-eastern side of the rock face (Figure 3B).

Figure 3: Photographs of Tertiary Basalt outcrop near Burnie. (A) Columnar basalt rock face, ~7 metres high. (B) “Ball and socket” jointing in basalt lava flow.

The group completed a short (~500 m) coastal traverse from the Little Penguin Observation Centre east towards Burnie. Here, we observed folded Oonah Formation sedimentary rocks intruded by sodic-altered dolerite. The nature of the contact between dolerite and the Oonah Formation is sharp and locally peperitic (Figure 4). Ralph Bottrill and Jacob Mulder discussed with the group the significance of these contact relationships. As the peperitic contacts suggest emplacement into unconsolidated, wet sediments, the ~700 Ma Cooee Dolerite provides a minimum age for the deposition of the Oonah Formation in this area.
Figure 4: Example of peperitic contact between dolerite intrusion and black mudstone, indicating that the Cooee Dolerite intruded wet, unconsolidated sediments of the Oonah Formation ~700 million years ago.

**Doctors Rocks**

The Doctors Rocks headland (location 2.2 in field guide) is located about 23 km to the west of Sulphur Creek Point. The headland comprises Tertiary alkali basalt (basanite) that contains abundant peridotite xenoliths (Figure 5A-B). The basanite overlies the Wynyard Tillite. We panned for gold in the bay to the east of the basalt headland near the contact between the Wynyard Tillite and the Burnie Formation (Figure 5C), and even found a few flecks!

![Figure 5](image_url)

**Fossil Bluff**

We lunched at Fossil Bluff (location 2.4 in field guide) while enjoying the beautiful coastline views. Afterwards, we observed abundant brachiopod, bryozoan, foraminifera and coral fossils in the Fossil Bluff Sandstone (Figure 6). The tide was out, which allowed for leisurely exploration of the entire bluff, with some larger mollusc fossils (up to 5 cm maximum diameter) encountered in the eastern portion (Figure 7).
This locality is the site of the earliest known fossilised marsupial remnants in Australia, *Wynyardia bassianna*, and the whale, *Prosqualodon davidis* Flynn, named after its discoverer, Theodore Thomson Flynn; father of the famous actor Errol Flynn.

![Figure 6: Field photos from Fossil Bluff. (A) The unconformable contact between Wynyard Tillite and overlying Fossil Bluff. (B) Fossil Bluff looking south; the unconformity is at the base of the cliff.](image)

![Figure 7: Examples of marine fossils observed at Fossil Bluff. (A) Example of abundant small gastropods and larger bivalve fossils in outcrop. (B) Example of a gastropod and coral fossils in outcrop.](image)

### The Nut

After leaving Burnie, we stopped in Wynyard for supplies and then drove ~50 km westward to Stanley. We then hiked up the steep switchback path to the summit of the Nut (location 2.5 in field guide), where Ralph Bottrill and Jacob Mulder told us more about the Nut and other nearby landforms. The Nut stands 143 m above sea level and has a diameter of less than 1 km (Figure 8). It is a Tertiary, coarse-grained nepheline hawaiite that is enveloped by pyroclastic deposits. Most of these pyroclastics are now eroded, but it is believed that the main hawaiite body of the Nut intruded into wet, unconsolidated pyroclastic deposits. Once discussions had finished and we had explored the track that tours around the top of the Nut, we returned to the local campsite for dinner and rest.
Figure 8: View from the top of the Nut near Stanley.
Day 3 – Stanley to Waratah: A transect through Tasmania's Proterozoic

by Josh Denholm and Sarah Gilmour

Day 3 was an intense day on the northwest, and marked the end of our tour through Proterozoic Tasmania. The group stopped at four locations with interesting Proterozoic exposures: (1) a low angle unconformity representing a ~600 million year hiatus in Proterozoic sedimentation at Black River Bridge; (2) folded Proterozoic quartzite in the Rocky Cape National Park; (3) a fault contact between black shale and quartz siltstone at Sisters Beach; and (4) Mesoproterozoic cross-bedded sandstones at Boat Harbour.

**Black River Bridge**

We started the day with a stop at Black River Bridge (location 3.1 in field guide; Figure 9). This is the site of an angular unconformity between older laminated siltstones of the Rocky Cape Group (Cowrie siltstone), and the younger Forest Conglomerate (shallow water equivalent of the Oonah Formation). This unconformity represents a 600 million year depositional hiatus and was once attributed to a Neoproterozoic orogenic event, the Wickham Orogeny, believed to have deformed rocks on King Island. This interpretation has been subject to recent revision, with the unconformity now thought to be the result of erosion of tilted, normal fault blocks during an extensional event.

Figure 9: Jacob Mulder (right) and the group at Black River Bridge, observing the angular unconformity between the Cowrie Siltstone and the Forest Conglomerate.
**Rocky Cape National Park**

After a quick stop at the local coffee shop, we arrived at the Rocky Cape National Park to investigate Proterozoic sandstone and siltstone of the lower Rocky Cape Group (location 3.2 in field guide). These rocks represent the oldest rocks in Tasmania, the Detention Subgroup (1.30—1.45 Ga). Jacob Mulder's research has highlighted that the detrital zircon age pattern of these rocks is unlike any contemporaneous Proterozoic sedimentary successions in Australia. Detrital zircon patterns in these rocks are a close match to those observed in the Belt-Purcell Basin in the United States. This initiated a discussion on the depositional setting and global tectonic implications of these zircon patterns, before the group moved onto more outcrops (Figure 10).

![Figure 10: Jacob Mulder (centre) and the group at the lighthouse in Rocky Cape, standing on outcrop of Rocky Cape Group quartzite at Rocky Cape Group National Park.](image)

The second outcrop visited within the park involved excellent exposures of complexly folded shale (Figure 11A). This minor lens within the Rocky Cape Group marks a short-lived change in sedimentation style from shallow to deep marine.

The third stop brought the group to an exceptionally clean, cross-bedded quartzite (99% quartz) of the lower Rocky Cape Group (Figure 11B). These mature sedimentary rocks suggest the sediment may have been subject to multiple erosion and deposition cycles. However, given that these were deposited in equatorial latitudes in the Proterozoic, prior to the evolution of stabilising vegetation, erosion rates were likely higher and chemical
weathering more intense compared to modern times. As a result multiple cycles of deposition may not have been required to produce such clean and mature sedimentary rocks.

Figure 11: Photographs in Rocky Cape National Park near Rocky Cape Headland. (A) Example of interbedded deep marine shale and siltstone member of the Rock Cape Group near boat launch on western side of headland. (B) Alex Cherry, Yi Sun and Jacob Mulder discussing the depositional significance of massive quartzite along eastern shore of headland.

Sisters Beach

The main rock type exposed at Sisters Beach (location 3.3 in field guide) is a heterogeneous package of ‘restricted basin’ black shales from the upper Rocky Cape Group. We stopped first at a fault breccia zone by a cliff at the northern end of the bay and discussed the overall structure of the outcrops (Figure 12). As we walked south and east, we stopped at an enigmatic bedding-parallel outcrop of green rock (Figure 13). There is no consensus on the origin of this lithology, with interpretations ranging from a carbonate-bearing rock to a highly altered mafic dyke. Further east, we observed textures in dolostones of the Irby Silstone that were reminiscent of ‘hieroglyphs’, which are interpreted to be modified syneresis cracks. Elsewhere in Tasmania these rocks contain stromatolites.
Figure 12: The bluff in the background is comprised of massive quartzite of the Lower Rock Cape Group. In the foreground are interbedded meta-mudstone and siltstone of the Upper Rocky Cape Group.

Figure 13: Image of the enigmatic section of bedding-parallel green rock observed by the group near the Sisters Beach boat launch. Dashed white lines mark out the contacts of the green unit with black shale.
**Boat Harbour**

The final location for the day was Boat Harbour (location 3.4 in field guide). Jacob Mulder would head back to Hobart after this stop, but not without showing us his favourite set of rocks from NW Tasmania, and the top of the Rocky Cape Group – the Jacob Quartzite. The group observed well-developed cross bedding in this unit and encountered a series of preserved ripple surfaces (Figure 14). We finished the day with a break for lunch, after which we farewelled Jacob Mulder before making our way to the south to start the more economic geology-focussed part of the trip.

![Figure 14: Examples of sedimentary structures in 1170 million year old Jacob Quartzite. (A) Field photograph of massive, thickly-beded quartzite. (B) Hematite concretion(?) in quartzite. (C) Examples of well-developed cross beds in quartzite. (D) Example of symmetrical ripples in quartzite.](image-url)
Day 4 – Mount Bischoff Mine Tour: The mine that built Tasmania

by Matthew Ferguson and Nathan Chapman

We began the day with a briefing at the current operations building for the historic Mount Bischoff tin mine (location 4.2 in field guide). We then drove to the main pit, parked next to the White Face dyke, and made our way to the Slaughter Face. After digging for small beryl specimens and talking about the geology of this part of the mine, we made our way north to view the remnants of vein-style cassiterite mineralisation at Brown Face that is typical of the highest-grade mineralisation. To finish off the day we inspected the topaz-replaced Western Dyke above the main pit wall, and then returned to the main pit briefly before departing for the fossicking area just outside the mine site. A last minute itinerary change added a trip to Mount Magnet, a historic Pb-Zn mining district.

Mount Bischoff Historical Context

Mount Bischoff was the first major mine in Tasmania, and is one of the richest tin mines in the world. The pre-production tonnage was estimated to have been around 11 Mt @ 0.4-0.6 wt.% Sn. Between discovery and 1947 it is believed that 6 Mt of ore was processed. After 1947, large sluices were brought in to help with processing of lower grade ore. Launceston was home to four tin smelters during Bischoff’s most productive years, and many buildings in Launceston owe their existence to equity generated from tin mining.

Initially Bischoff was worked for alluvial tin ore. As these resources were exhausted, Old Timers moved on to the gossans and weathered zones, before finally sending drives down faults and fractures. Fluorite-cassiterite vein ores were the main focus of the Old Timers’ hard rock mining operations. Talc-bearing ores were worked, but it was not possible to process massive sulfide ores for much of Mount Bischoff’s history.

Modern operation of the mine at Mount Bischoff was restricted to 9am to 5pm due to the close proximity of the town of Waratah. Community engagement and support was very important for the operators of Mount Bischoff, as ore trucks had to travel through the middle of town on the way to the Renison Bell for processing. In order to foster community support, the operators left ore dumps near the mine entrance for public fossicking, a lookout was created, environmental remediation measures were taken, beehives were kept on site, and other specialty groups were allowed access to the mining lease. The mine’s modern operations were supported by a 120 tonne excavator, three ore trucks, and two top loaders. Mount Bischoff has become famous around the world as much for its minerals as for its ore!

Tasmanian Tin

There are many granites in Tasmania, and many are associated with tin mineralisation. Tasmania boasted numerous major alluvial tin deposits, all of which likely owed their
existence to hard rock tin mineralisation found in the roof zones and peripheries of these Phanerozoic granites. The granites formed from the Late Devonian to Early Carboniferous and vary from I- to S-type. At a regional scale, the Carboniferous granites occur along two parallel east-west trends, with the northwest-trending fold hinges off the granites often hosting tin mineralisation. The style of tin mineralisation varies with distance (temperature and depth) from associated granites. Most of the tin deposits are thought to occur between 1 and 4 km from the granite bodies with which they are genetically-related. Mineralisation closer to the granites is widespread but tends to be of low grade.

Renison Bell, the only currently operational tin mine in Tasmania, averages 0.8 wt.% Sn, and in recent times Mount Bischoff ran at 0.5 wt.% Sn. When higher grades were encountered in these deposits, ores were blended with subgrade ore in order to be processed efficiently.

The Port Davie, Heemskirk, Interview and Meredith granites are all associated with tin mineralisation. The Meredith granite is linked to Mount Bischoff and Mount Cleveland which are all also hosted in similar lithologies (sedimentary rocks, including dolostone and greywacke).

Renison Bell is hosted in a fault off the Pine Hill granite and contains minor tungsten. Mount Bischoff is also tungsten- and copper-poor. Mount Lindsey is an Fe-mine with minor tin and tungsten – and is considered a true skarn deposit.

**Mount Bischoff Geology**

Mount Bischoff tin orebody occurs approximately 4 km from its related granite and is hosted in a structurally-thickened dolomite horizon that is part of the Oonah Formation. This zone corresponds to a parasitic fold on the limb of a regional anticline. The main mineralised zones are three carbonate replacement bodies in the dolomite, and additional mineralisation is observed at the contact of the Success Creek Group and Crimson Creek Group (Figure 15).

Porphyritic intrusions and dykes are the most obvious geological features of Mount Bischoff (Figure 16). These porphyritic units are believed to have originated from a Devonian granite pluton, and are typically nearly entirely replaced by very fine-grained topaz. The dykes are interpreted to have intruded pre-existing structures, and where they cut dolomite (and lesser argillite), formed topaz-sulfide greisens and sulfide skarns (including the massive sulfide lenses). The margins of the porphyritic intrusions typically corresponded to high Sn grades, though they tend to contain poor grades themselves (the White Face porphyry unit in the open pit remains unmined for this reason). The immediate footwall of the White Face porphyry is dominated by pyritic shales, and the hanging wall comprises massive sulfide-talc.
lodes. Porphyry and talc ores were difficult to mine, process and stockpile due to the huge contrasts in physical properties.

The argillite lodes are hosted in Oonah Formation siltstone. At the Brown Face on the summit of Mount Bischoff, cassiterite was observed in veins and fractures. The chondrodite and Mg-skarns are altered to serpentinite. At Mount Bischoff, intrusion-related alteration of uncommon lithologies has resulted in highly variable oxide-sulfide-silicate mineralogies. Fluorine is abundant in many mine lithologies and is one of the causes of the unusual mineralogy.

The Slaughter Face (named for its blood-red colouration from pyrrhotite oxidation) was one of the key mine site stops as this zone preserves the transition from dolomite, to dolomite skarn, to wrigglite skarn (banded pyrrhotite+diopside+pyrite+fluorite), to massive pyrrhotite, and finally overprinted by late stage polymetallic veins rich in fluorite, or pyrite, or sphalerite-galena. These polymetallic veins (up to 30 cm thickness) are also common on the peripheries of the skarns out to a kilometre from the deposits. Abundant As-Sb veins are also present peripheral to the tin ore zones. There is a general metal zonation from Sn (stannite-rich) to As-Sb to Pb-Ag dominated veins from core to the periphery of the mineralised area.

Figure 15. Mount Bischoff lithologies. (A) weathered 'wrigglite', comprising laminated pyrrhotite and diopside, (B) massive fluorite from the Slaughterhouse Face, which is associated with the complex Ag-Sb-As-Cu sulfosalt assemblages, and (C) coarse-grained cassiterite within drusy quartz veins crosscutting argillised felsic porphyry dyke.
Mount Bischoff is currently being progressed through mine closure, with rehabilitation requirements largely related to legacy issues from historical mining (Figure 17). Most of the current work at Mount Bischoff involves monitoring discharge from the mining lease. Sulfides are the main remediation issue, and the main closure concern is how much acid forming rock is stockpiled.

The care, maintenance and remediation teams try to maintain the main pit dam water pH at 12 through addition of lime every two weeks. If the dam is left alone, the water’s pH will drop to a pH of ~2-3 over several months.
**Historic Magnet Pb-Zn Mining District**

The historic Magnet mine area was visited towards the end of the day (Figure 18). Magnet ore comprises Pb-Zn veins around Sn-rich zones. Magnet was discovered in the 1880s and was mined until the 1940s, during which time the local town was home to several thousand people. The mine was renowned for its caverns filled with high-quality crystals. In the 1960s the Electrolytic Zinc Company transported waste with 10 wt.% Zn to Rosebery for processing.

Like the above tin deposits, Magnet occurs near a Devonian granite pluton, and there is similar mineralisation at the nearby Hazelwood and White River occurrences. The hydrothermal footprint of the Magnet deposit, as well as an associated dyke, runs north-south, parallel to an ultramafic complex. Tin is more abundant towards the ultramafic rocks. The gossan developed on the Magnet mineralisation was observed to contain a number of distinctive secondary Pb minerals, such as a yellow, Cr-rich cerrussite.

The ultramafic rocks at Magnet are altered to fuchsite + talc + serpentine, the mafic rocks to primarily chlorite. The Magnet dyke is completely altered to carbonate + fuchsite + others; the protolith of this dyke is uncertain. The mineralogy of Magnet mine is similar to distal Mount Bischoff (i.e., Pb-Zn). Vein (including colloform) and replacement-style mineralisation is widespread at Magnet, as well as minor breccia-hosted mineralisation. Magnesite skarns hosted in altered ultramafic lithologies occur proximal to the Magnet dyke and associated veins.

Figure 18: Field photos from the Magnet mine. (A) Typical ore-textures of the Magnet Ag-Pb-Zn mine. Coarse-grained galena with lesser sphalerite hosted in colloform dolomitic veins. Silver is in galena and sulfosalt minerals proustite-pyragyrite. Sulfide-dolomite breccias (matrix-dominated) are also present with clasts of fuchsite-altered ultramafic rocks. (B) Field trip participants scrambling up the side of a 50 m-high mullock and slag-heap.
Day 5 – Renison Bell Mine Tour and Serpentine Hill Quarry

by Yi Sun, Adam Abersteiner, Alex Cherry and Tom Ostersen

Day 5 introduced the group to the world-class Renison Bell hard rock tin mine (location 5.1 in field guide). The mine visit consisted of two themes: (1) economic geology, with a comprehensive overview of the deposit at the core shed; and (2) geometallurgy, with a tour through the mill and complex processing circuit. A lunchtime stop at Serpentine Hill introduced the group to a type example of the ultramafic ophiolite complexes found throughout western Tasmania. The group ended the day at the West Coast Heritage Centre in Zeehan.

Renison Bell Mine Core Logging Facility

Members of the mine geology and exploration division gave a brief introduction of the deposit geology and mineralisation with the aid of underground maps and recently drilled core from a production drill hole (Figure 19A-E). Two main styles of mineralisation occur at Renison Bell: (1) dolomite replacement, and (2) fault-associated. Three principal dolomite horizons host most of the replacement-style mineralisation, and are typified by massive pyrrhotite, minor pyrite and base metal sulfides, with gangue minerals including talc, siderite, calcite and quartz. Fault-controlled mineralisation is associated with a local normal fault (the Federal-Bassett Fault) and contains more base metal sulfides and less pyrrhotite compared to dolomite replacement mineralisation. The main ore mineral, very fine-grained cassiterite, is associated with sulfides in both styles of mineralisation.

Renison Bell Mine Mill Tour

After leaving the core shed, the group visited the Renison Bell processing plant. The group was shown all stages of processing, from early crushing and grinding through to sulfide floatation and heavy mineral separation using industrial Wilfley tables (Figure 19F-I). The final product is a cassiterite concentrate of 50-60 wt.% Sn. The outputs of the processing circuits are closely monitored using XRF analyses collected every minute, allowing the processing engineers to modify the processing parameters for best results.
Figure 19: Photographs from Renison Bell Tour. (A) Ben Hey explains some of the complex structure at Renison Bell to the group using a detailed cross section interpretation (from left to right: Juan Diago, Josh Denholm, Sarah Gilmour, Nathan Chapman). (B) A review of the Renison Bell core library (from left to right: Ralph Bottrill, Alex Cherry, Brett Kitchener). (C) Pyrrhotite, chalcopyrite, pyrite and arsenopyrite mineral assemblage in drill core. Fine-grained, light brown “frothy” cassiterite is typically associated with arsenopyrite. (D) Massive, coarse-grained arsenopyrite in drill core. (E) Fine-grained, hydrothermal garnet in drill core. (F) Ore stock pile and transfer site to mill. (G) A ball mill in the grinding circuit at the Renison Bell mill. (H) Image of a series of Wilfley Tables used to concentrate cassiterite. (I) Image of the final product, Sn-oxide concentration (from left to right: Carl Jackman, Alex Cherry, Brian McNulty).
**Serpentine Hill Quarry**

After completing the mine tour, the group stopped for lunch at the Serpentine Hill quarry (location 5.2 in field guide). This site is a type example of Cambrian ophiolite structurally emplaced in western Tasmania during the Cambrian Tyennan Orogeny. These rocks were once harzburgite, dunites and pyroxenite mafic rocks that contained abundant olivine and pyroxene, but are now largely altered to amphiboles, serpentine and magnetite (Figure 20). Serpentinite at this quarry and others nearby were once mined for asbestos (Figure 20A). Stichtite can also be observed in small quantities at this site. However, the majority of the stichtite at this locality has already been collected. Fibrous magnetite was observed in the serpentinite as thin veinlets (Figure 21).

![Historic Tailings](image)

**Figure 20:** Photographs from Serpentine Hill Quarry stop. (A) View of Serpentine Hill showing historic tailings piles from past asbestos mines. (B) Example of serpentine in outcrop. (C) Example of weathered surface of outcrop surface of harzburgite.
Figure 21: Photographs from Serpentine Hill Quarry stop. (A) Shawn Hood who hails from Canada scavenges the Serpentine Hill quarry for stichtite. (B) Serpentine with fibrous magnetite.

**West Coast Heritage Centre**

The last stop for the day was the West Coast Heritage Centre in Zeehan (location 5.3 in field guide; Figure 22). The centre contains a museum quality collection of mineral specimens from historic mines along the west coast as well as from around the world, and accounts of the history of mining of the west coast of Tasmania. A local gem and mineral dealer was also visited briefly before the end of the day.

Figure 22: Field trip participants entering the West Coast Heritage Centre in Zeehan.
Day 6 – Dundas Mineral Field

by Shawn Hood and Juan Diego Rojas

On the morning of Friday 15th December, we started our trip from Zeehan to the Dundas mineral field. After an introduction to the geology of the area by Ralph Bottrill, we headed to the Red Lead Mine; the first occurrence of crocoite in the Dundas mineral field discovered in 1890. We then visited the Adelaide Mine and, in the afternoon, the Dundas Extended Mine.

Red Lead Mine

At the Red Lead Mine (location 6.1 in field guide) we met with Shane Dohnt, owner of the mine since 1986. Shane led the group on a tour of a small pit and extensive underground workings (Figure 23). Shane informed us that in the pit area there are two main ore lodes and numerous tension gash structures filled with secondary minerals. The main lodes contain ferromanganese gossan minerals and some tension gashes contain abundant crocoite crystals. A major structure (breccia zone), which controls the location of mineral specimens at the Red Lead Mine, extends northwest where it intersects the Adelaide fault system.

Currently, the mine is being exploited underground. Crocoite is the main mineral extracted from breccia zone ore pockets. These breccia zones are the downward extension of those situated at the bottom of the open pit. Crocoite crystals observed during the visit ranged from approximately 0.1 to 3.5 cm in length. Shane disclosed that crocoite specimens are sold into the collector market and the best pieces go to museums. The value of crocoite specimens typically ranges from $40 to a few thousand Australian dollars, but the best can be over $100,000.
Figure 23: Images from the Red Lead mine. (A) A view from inside the Red Lead mine showing a fault zone (black-dark brown band) and breccia zones with crocoite pockets. (B) A Red Lead crocoite specimen ready for the collectors market.

**Adelaide Mine**

At the Adelaide Mine (location 6.2 in field guide) we met Bruce (one of the miners) who led the group through the upper and lower adits of the underground workings. This mine has a legacy of producing high quality crocoite specimens. The specimens are extracted from linked pockets where multiple generations of crocoite grow inwards from pocket margins. Figure 24 shows some of the unexcavated crocoite remaining in the mine, where thin, euhedral crocoite crystals line the walls.

Figure 24: Images from the Adelaide mine. (A) A breccia zone and the remnants of a crocoite pocket inside the mine. (B) Close up of a wall covered in crocoite crystals in an underground gallery of the mine.
**Dundas Extended Mine**

Our final stop was the Dundas Extended Mine (location 6.3 in field guide). We started out at the mine head quarters, the home of mine owners Mike and Eleanor Phelan. We were invited to view the Phelan’s personal mineral collection and non-profit museum of the Dundans Township. We also observed a number of blocks of stichtite-bearing serpentinite (transported from their Stitchtite Hill quarry).

We then partook in an underground mine tour. Inside the mine we were able to ascend up 10 metre high raises and inspect and collect samples from the mining zones. The occurrence of crocoite in the Dundas Extended mine is similar to the occurrence of crocoite in Red Lead and Adelaide mines – as secondary infill of breccias, and along fracture surfaces (Figure 25). Other minerals present include cerussite and galena.

![Figure 25: Images from the Dundas Extended mine. (A) Crocoite pockets in a wall of an underground gallery. (B) Well-formed crystals of cerussite (yellow-green crystals) and crocoite.](image)
Day 7 – Trial Harbour to Hobart

by Alex Cherry and Brett Kitchener

The final day of the trip involved travel from the campsite in Zeehan back to Hobart with stops at the Comstock Pb-Zn mine, Trial Harbour, Iron Blow lookout (near Queenstown) and Bill’s Creek.

Comstock Mine

The first stop of the day took place just outside of Zeehan at the Comstock mine, which currently comprises two main pits (South Pit and Allison’s Workings). This stop was another wonderful and spontaneous addition to the excursion by Ralph Bottrill. This site was first mined in the 1890s when high-grade Pb-Ag ore was exploited, and has been mined intermittently since then (currently under care and maintenance). Mineralisation occurs as Pb- and Zn-sulfides that are disseminated in the host rock, and less commonly as high-grade veins. The host rock comprises black shale and dolomite, which are understood to be equivalent to the Neoproterozoic Oonah Formation. Fuchsite-altered ultramafic rocks have been encountered at depth in the South Pit. No granite has yet been identified at depth.

While in the car travelling from the Comstock mine to the next stop, the nearby Queen Hill prospect was discussed, which comprises a large Sn prospect owned by Stellar Resources (as part of their Heemskirk Tin Project; Stellar Resources, 2017). The mineralogy of Queen Hill is similar to that of Renison Bell (stockwork and replacement-style cassiterite with minor stannite associated with pyrrhotite-pyrite-tourmaline-minor base metal sulfides) and hosted in Oonah Formation equivalents.

During the drive from the Comstock Mine to Trial Harbour, we also noted that the landscape changed from rainforest on Cambrian ultramafic/mafic rocks and Proterozoic Oonah Formation to shrubland/moorland with numerous granite tors on the Devonian Heemskirk Granite.

Trial Harbour

The next stop was at the Trial Harbour transfer station, on the hill overlooking Trial Harbour (location 7.1 in field guide). At this stop, we examined outcrop and road cuttings and observed the transitions between (and contacts of) the Heemskirk Granite, Oonah Formation and ultramafic rocks. Oonah Formation at the transfer station was noted to be highly deformed, sheared and contained fine tourmaline ± cassiterite-bearing veinlets. The veinlets and some of the deformation of the Oonah Formation are possibly related to the intrusion of the Heemskirk Granite (Figure 26A). A weakly deformed quartzite (relative to the Oonah Formation) was observed unconformably overlying the Oonah Formation and is likely to be Siluro-Devonian in age (Figure 26B).
Walking along Trial Harbour Road down the hill, we saw transitions between Oonah Formation, Heemskirk Granite and ultramafic rocks. Outcrops of Oonah Formation in proximity to Heemskirk Granite were contact metamorphosed to diopside hornfels (evident by pale green colouration). The contact metamorphism also caused the formation of secondary olivine in serpentinised ultramafic rocks.

The main stop at Trial Harbour was located north of the town, past pebbly beaches and rock platforms. A number of different rock types were observed in the well-rounded pebbles and boulders on the beach. These included: Owen(?) Conglomerate, granite, serpentinised ultramafic rocks (± magnetite veins or dendrites), quartzite (+ tourmaline blebs), and Oonah Formation sedimentary rocks. Outcrops nearest the town included Oonah Formation and serpentinised ultramafic rocks. The Oonah Formation was invariably steeply-dipping and diopside-hornfelsed (evident in the green colouration of parts of the outcrop). Veinlets of tourmaline, magnetite, actinolite and minor nephrite and diopside were observed in the Oonah Formation. The outcropping serpentinised ultramafic rocks contained numerous veins (up to 10 cm thick) of magnetite ± talc (the magnetite occurred as massive veins or formed euhedral crystals up to 5 mm in size within talc) and fine veins (up to 1 cm thick) of aragonite.
A spectacular contact between the Oonah Formation and the Heemskirk Granite (Figure 27A) was observed on the rock platform where the steeply dipping Oonah Formation was truncated by the Heemskirk “Red” Granite (fine- to very coarse-grained, pink granite/syenogranite). Key features within the granite included xenoliths (probable hornfelsed Oonah Formation or ultramafic rocks), aplite dykes (lined with quartz exhibiting unidirectional solidification textures; Figure 27B) and wavy, parallel bands of fine-grained dark minerals (possibly schlieren; Figure 27B). The Heemskirk “Red” Granite was intruded by the Heemskirk “White” Granite (fine- to medium-grained, leucocratic granite/syenogranite) which is a chemically distinct phase from the red granite.

One of the main features of interest of the Heemskirk Granite was the presence of patches/nodules and veins of tourmaline. The area of the platform where the tourmaline nodules are best exposed was not accessible due to high surf and wet, slippery rocks, but various occurrences of tourmaline were still encountered, including:

**Tourmaline + quartz/topaz(?) veinlets** – Tourmaline occurs as acicular sprays of black needles along the plane of veins (Figure 28A). The stubby white quartz (or topaz?) grains occur interstitial to the tourmaline needles.

**Early tourmaline nodules** – A core comprised entirely of tourmaline and rimmed by quartz. These nodules are considered to be early because no trace of the ‘granite texture’ is observed within the nodules and two nodules were observed to have coalesced (Figure 28B) which suggests they first formed when the granite still had a melt component.

**Late tourmaline nodules** – Tourmaline occurs as spheroidal bodies dispersed amongst quartz that have the same equigranular texture as the surrounding granite.

*Figure 28: Images of tourmaline from the Heemskirk Granite. (A) Tourmaline veinlet with acicular tourmaline and stubby quartz. (B) Two tourmaline nodules lined with quartz that have partly coalesced.*
Aboriginal History

Approximately a quarter mile from Trial Harbour there is large boulder of granite located above the average high tide watermark on the beach. On the flat surface of this boulder there are about a dozen ring-like structures with diameters ranging from 50 to 100 cm (Figure 29). The purpose of these rings is unknown. However, archeologists theorise they are hieroglyphs of important meaning to the ancient people that made them and lived on the west coast of Tasmania.

Iron Blow Lookout

The Iron Blow lookout (location 7.2 in field guide) was visited and the history of Mt Lyell was discussed. The Iron Blow deposit was originally a large hematite formation that was first mined for gold but high-grade chalcopyrite mineralisation (about 12% Cu) was discovered soon after; the orebody also included bonanza-style Au-Ag zones (including up to 3% Ag). The contact between the Owen Conglomerate and the host Mount Read Volcanics is well exposed in the Iron Blow pit. About 20 discrete orebodies occur in the Mt Lyell district (including Iron Blow). The most recently mined deposit (Prince Lyell) was the largest. The North Lyell deposit (the pit is visible on the side of a nearby hill) was bornite-rich and had a
higher grade than the other deposits. It also contained elevated concentrations of other metals like Sn (suggesting Devonian granites may have had an influence). Small Pb-Zn prospects are known in the vicinity of Mt Lyell.

**Bills Creek Area**

The purpose of the stop at Bill’s Creek was to examine amphibolite- and eclogite-facies metamorphic rocks (location 7.3 in field guide). The majority of the road cuttings in the vicinity of Bill’s Creek contain mica-garnet schist (amphibolite facies) with spectacular mica sheets (up to 2 cm) and reddish garnet grains (up to 4 mm; Figure 30A). Eclogite-facies rocks were found in a small quarry off the side of the highway and comprised fine-grained (<1 mm) green omphacite and red-pink garnet (Figure 30B). Some eclogite samples displayed banding defined by fine garnet grains.

![Figure 30: Samples from Bills Creek. (A) Mica-garnet schist. (B) Fine-grained eclogite composed of omphacite (green) and garnet (pink).](image-url)
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