GARY WALLIS:   
Hello and welcome to Summer by the Sea here at Waratah Bay, where at the end of Walkerville North Road we’ve come down onto the beach, and we have the cliffs beside us, beautiful beach at low tide. And we look across to the hills of Wilsons Promontory. I'm Gary Wallis, I’m a geologist. I live at Fish Creek. This is a part of the Summer by the Sea program run by Coastcare Victoria. Coastcare have many activities that teach us about the natural beauty and biodiversity of our state's coastal and marine environments. And there's something for everyone, people of all ages, abilities and backgrounds. Hopefully by the end of this tour, you'll be inspired to learn more, and maybe even get involved with Coastcare yourself.

SAJITHRA NITHIANANTHAN:   
And how long have you been with Coastcare?

GARY WALLIS:   
I’ve lost count. (LAUGHS) Well over ten years. I've done geology walks around this coast for, well, probably over thirty years.

SAJITHRA NITHIANANTHAN:   
Probably know the place like the back of your hand, then.

GARY WALLIS:   
I know very well. So, I used to run geology walks at Inverloch, down on the coast. I've run walks Wilsons Promontory and each summer; I've run a number of walks at Walkerville. I really enjoy working with Coastcare. For many years now I've led family groups and I've run activities for the children. So, they get a better insight into the environment and particularly the rocks. It attracts very enthusiastic people. And it's really nice to share what we see here with others.

I'd like to acknowledge the Traditional Owners of the land on which we are meeting, the Gunaikurnai people, and pay my respects to their Elders past, present and emerging. Now this talk takes half an hour, but I'd recommend you set aside up to two hours for this activity if you'd like to take your time and explore every feature that I talked about.

You'll be walking over rocks, so you need good footwear. You need sun protection, a hat, sunscreen. Sunglasses are helpful. The hazards to be aware of are tripping on rocks. The tide is also important, because as the tide comes in, some sections of the walk could be difficult to cross.

SAJITHRA NITHIANANTHAN:   
What would you say is the best time to visit here, then?

GARY WALLIS:   
The ideal time is to check the tides and you want to start the walk when the tide is going out. Otherwise, there's a danger that you'll get caught. There are a number of tracks that have been put in, so that if you find you can't get back the way that you came, you will be able to go inland and avoid walking around the cliffs on the coast. One of the other dangers is the cliffs, so keep well back from the cliffs. I'd recommend from the higher cliffs, at least several metres. So, as you listen to this talk, just be aware of your surroundings.

The rocks of the Liptrap Peninsula contain some of the oldest rocks in the state, at five hundred and fifty million years old. They also have a story to tell about changing sea levels, and also about earthquakes. But the environment that you can see standing at Walkerville North, I guess the obvious feature is Wilsons Prom. It's a three hundred and ninety-five million-year-old granite intrusion. It originally had about three kilometres of rock above it.

SAJITHRA NITHIANANTHAN:   
So, it was three times as high as what we’re seeing now.

GARY WALLIS:   
So, the granite itself wasn't very much higher than you see today. But there were three kilometres of rock sitting above that granite when it formed. So, it came in as a molten material, very slowly squeezed its way into the earth’s layers, may have made room for itself by pushing the rocks above up. But those rocks that used to sit on top of the granite have been eroded away in the last four hundred million years. And this story is a common one for granites around the world.

In the slide set, I'll include a geological map. The geological map is really useful because it has different colours for different rock types of different ages. Within these windblown sands, they're very lime rich. We have found fossils of megafauna that used to roam this landscape, and footprints of them.

SAJITHRA NITHIANANTHAN:   
What kind of megafauna?

GARY WALLIS:   
Wombats the size of rhinoceros and three-metre high wallabies. So, there was some pretty amazing marsupials around up until about forty-six thousand years ago.

The first site we're going to have a look at is some of the beautiful folded rocks of the, what geologists call the Liptrap Formation. OK, so let's have a look. We have some beautiful folded materials. They were originally flat on the sea floor. Due to compression, they have been buckled and folded. And if you look into the cliff, you will be able to see these beautiful features. If you rub your fingers on the rock, some of the layers are smooth, and we call those mudstone. And some are gritty, and we call those sandstone. So, this is alternating beds of mudstones and sandstones. The rocks must have had a fair degree of moisture in them at the time that they were compressed, because there's very tight folding. They also have been intruded by quartz veins, and the quartz veins can contain gold, there have been very rich gold mines at Foster. And there's gold also found on the coast.

The other feature at this site is if you look to the West at the Bluff, you can see a line in the cliff, where you have very pale material, pale clay above. And then below it is the grey, contorted mudstones and sandstones. The line that's quite clear and has large quartz pebbles in it has been dated at one hundred and thirty-two thousand years old. And it is, in fact, a marine surface, a marine terrace similar to what we see on the beach today, where the rocks have shattered, largely due to being wet and dry. And then in storms, the sea will remove the rocks and you end up with a platform or a flat-ish area at current sea level. So, this has happened a number of times. There are at least twelve of these old marine terraces that have been mapped on Cape Liptrap.

SAJITHRA NITHIANANTHAN:   
How come so many?

GARY WALLIS:   
The reason that we have so many of these marine terraces at Cape Liptrap is that when you look at the Bluff, you're looking at some shattered rock on the Walkerville North side, which is a fault, major fault line. It's called the Waratah Fault. It cuts across Cape Liptrap, coming out at Point Grinder, and it goes across Waratah Bay, cuts in front of the Hoddle Range and then goes to the North of Foster. So, the Liptrap Peninsula is still an actively uplifted area and it is one of the most active earthquake areas in the state.

So, we're walking along beside the cliff, heading towards the Bluff. On our right is a pebble layer, you can see the white quartz and the clay above it. And that was a change in environment, where there must have been a huge amount of erosion and very rapidly, streams brought in large pebbles and then it settled down a little bit and you got the finer clay settling that the…layer that we can see in the cliffs is several metres thick.

SAJITHRA NITHIANANTHAN:   
What are those trees up there?

GARY WALLIS:   
Casuarinas. So, they're a common coastal tree. There is also some tea-tree that you can see there, and some banksias.

Coming back to the rocks, where we had nice neat folded rocks that we saw at the end of the road, the folds start to break up a lot as you get close to the Bluff. And that's because of the fracturing associated with movement along the Waratah Fault. We’ll stop when we get to the Bluff, just before we walk around and look back into the cliff, and you'll see the rocks there. And they’re vertically fractured and obviously easily eroded. And that's because they're they've been crushed within movement along the fault zone.

And then if you turn one hundred and eighty degrees and look out to sea, you'll see a gap in the rocks. This is where fishermen launch their boats. It's over fifty metre wide and it's a very, one of the few convenient launching sites on this part of the coast. And the reason it's there is due to the fracturing of the rocks on the Waratah fault. And then the sea has eroded those fractured rocks away and covered the area with nice, compact sand.

SAJITHRA NITHIANANTHAN:   
What are we seeing on the beach here, like, little dark circles everywhere?

GARY WALLIS:   
Yeah, looking at the sand on the beach. So, it is a nice compact sand. It has lots of very fine shell fragments in it. It's over thirty percent lime. Soldier crabs, little pink crabs, can often be seen. And when you walk close to them, they burrow into the sand and they leave little heaps of sand up above. You will also get trails on the sand due to shellfish moving around. But once the tide is low, most of that marine life is going to hide until the next incoming tide.

SAJITHRA NITHIANANTHAN:   
And we don't want to bother them while we’re here.

GARY WALLIS:   
Obviously, you leave the marine life alone. There's no need to turn over any of the rocks. They're the homes of many creatures.

We’ve now come around the Bluff, and you may notice that the rock looks a little different. We've now left the mudstone and sandstone of the Liptrap Formation and we’ve come across some of the limestone. And if you look to the West, you'll see the remains of the lime kilns and the shedding that went with them. And I'll talk about the history of those shortly. But immediately around the corner of the Bluff you'll see this grey limestone, and it has white bands in it. If you bring a hand lens with you, or you've got good eyesight, just have a close look at the white veins. They have little cleavage planes in them, little flat layers.

Also, you could scratch them relatively easily, whereas quartz breaks like glass. And the only flat layers on quartz is when you actually get a crystal. It never breaks with cleavage. But calcite, which is the white mineral, has three cleavage planes, and it has a hardness of three, whereas quartz has a hardness of seven. So, it's a lot softer. There's a scale of hardness that geologists use. Talc has a hardness of one, diamond has a hardness of ten. It's called the Mohs scale, m-o-h-s. And you could look that up. And you'll know what minerals can be used to test the relative hardness of other minerals.

SAJITHRA NITHIANANTHAN:   
And I’m seeing some little black growths on the side of the rocks here. What sort of creatures are they?

GARY WALLIS:   
So, there's marine life that will cling to the rocks. The common one here are black mussels. They show you where high tide comes in. So, the mussels live at that intertidal zone. The other life that you'll see here, commonly there are both Pacific gulls, which are the big black, and white gulls, with a tip of red on their beak. And the more grey Silver gull.

SAJITHRA NITHIANANTHAN:   
Is that the one we’re seeing up there?

GARY WALLIS:   
Yes. So, when we're here today, right on the Bluff is a lovely Pacific gull.

SAJITHRA NITHIANANTHAN:   
Beautiful.  
  
Gary, I'm seeing, you know, little shiny black streaks in the sand, along with the ripples on the beach as we walk. What's that?

GARY WALLIS:   
So, as the sea washes the sand, some of the heavy minerals in it concentrate. These black streaks that you'll see is a mineral called ilmenite. It's an iron titanium mineral. Beach sand minerals are mined at various places around the Australian coast. Stradbroke Island and Fraser Island in Queensland have been very famous areas. And the minerals that they can find is in addition to ilmenite, which doesn't have great value, is rutile, which is a very rich source of titanium. They can also find garnet, which is used for garnet paper. They have moissanite, which is…it contains rare earth minerals. And these have become extremely important in recent years, because they're used in such things as smartphones.

So, the weathering of the rock has broken down sometimes rarer minerals within rock, and then they get preferentially concentrated by…and sorted within the sands. Now, at Waratah Bay here, near Walkerville South that we're just coming up to, you can get gold in the beach sands. It's recorded on the geological map…

SAJITHRA NITHIANANTHAN:   
Gold?

GARY WALLIS:   
..along with osmiridium. Osmiridium is a platinum-like mineral. And the origin of these will be the greenstones that we'll see around the corner.

SAJITHRA NITHIANANTHAN:   
What's this man-made structure on the right here?

GARY WALLIS:   
We're now standing opposite the lime kilns. And in walking here from the Bluff - you will have walked past a lot of limestone. There are some layers of grey mudstone interbedded with the limestone. You may also have noticed an old railway line. Now that railway line was a part of a tram line, where, in the late 1800s, they opened up the lime kiln here. There's actually six kilns. And there's a crucible-like structure that you can see. And then there's a shed. The process was that they would have a team of men digging out the limestone with crowbars and hammers, break it down into lumps. They would then put it in a trolley, which was drawn by horses, and bring it up to the top of the crucible. And then they would drop the rock inside.

SAJITHRA NITHIANANTHAN:   
How long since the lime kilns were used, or last in use?

GARY WALLIS:   
So, I think about 1926. At one stage there were fifty families living here, over seventy people. They had a long pier that went for about four hundred metres out to the sea. And the lime from here, which was used for a number of things, but mainly cement making, was really important for the buildings in Melbourne. And Flinders Street Station is actually made from cement that came from Waratah Bay lime.

SAJITHRA NITHIANANTHAN:   
Amazing!

GARY WALLIS:   
The difficulties of shipping the lime to Melbourne was, your, particularly during storms, they lost a number of ships. And limestone was then discovered at Lilydale, closer to Melbourne. They were able to extend the railway line out there. And so, Waratah Bay could no longer compete economically with Lilydale limestone. So, this little post here is all that’s left of a four hundred metres long pier. And it's rather sad. I've got nice photos of it.

SAJITHRA NITHIANANTHAN:   
What happened, did it just get washed out?

GARY WALLIS:   
It’s just washed away.

SAJITHRA NITHIANANTHAN:   
Wow!

What have we come up to now?

GARY WALLIS:   
So, we're now looking at another limestone. It's not as grey as the one that we were looking at, at the Bluff. It's doesn't seem to have the same calcite white veins cutting through it, either. So, it's a darker grey. And it's actually another one hundred million years older. So, you get these two limestone types against each other. This one is called the Digger Island dolomite. It has a slightly different composition than the limestone, it has a bit of magnesium in it. And there is a contact, that I'll have a photograph of, that shows a little grit layer between the two. So, limestones form in shallow marine environments over hundreds of millions of years. Walkerville in the past had a shallow marine environment in which, at different times, limestone deposits could form.

And one of the interesting things is that the limestone at Waratah Bay between the Bluff and Bird Rock sits on this other limestone with a little grit layer in between, which represents the sea floor, five hundred million years ago. So, we're just at the edge of the beach at Walkerville South, we have come to the end of the sand and we're now on the rocks. And this is where on the Western side into the hill is the older limestone the Digger Island dolomite, and then on the seaward side is the layered limestone of the type that was mined for the kiln. And in between is this grit layer. It's tilted at an angle of about fifty degrees. But originally, it was the flat sea floor of the old limestone on which the new limestone was deposited.

OK, now we've come to Bird Rocks or the start of it. They're a sort of creamy coloured rock, so different colour to the grey limestone. And if you look carefully, there are coral remains in these rocks. The weathering of the rock over time, the coral is a little bit more resistant to erosion, and so it's quite prominent. So, definitely worth having a careful look around the rocks. Again, take photos, don't touch them. The wonderful thing here in Victoria, is that anybody can access these sites, and as long as everybody leaves what's here, it's then available for people in the future. If you look on the other side of the boulders on the coast there, you'll find a cave, and the cave goes all the way through the headland, and comes out at Magic Beach, at Bird Rocks.

SAJITHRA NITHIANANTHAN:   
Wow, are you allowed to walk into the cave?

GARY WALLIS:   
You're definitely allowed to walk into the cave. It's quite structurally sound.

OK, so we're now in the cave. And if you look at the gap, going out to Bird Rock, a couple of things you will notice, one is that there is a log there. That's part of the old pier. So, as the pier is broken up over the years, one of the posts of the pier has washed into the cave. Now depending on your tide level, if the tide is low enough, you can walk through the cave, come out onto the beach, then walk around to Bird Rocks, and walk around the corner, you'll see the rocks change from dipping limestone to the grey Digger Island dolomite, and then if you look in the distance, you'll see Digger Island.

SAJITHRA NITHIANANTHAN:   
So, what happened here? How was this cave formed?

GARY WALLIS:   
So, what's happened is there has been a fault line with powdered rock, and the sea has slowly washed its way in at high tide, and particularly during storm events. And it's created a cave. And when you look at the roof of the cave, you can see that there's a circular hole heading up vertically. Now that vertical hole meant that the end of the cave had a wall there, and the sea was just swirling around, and eventually it could have broken through the surface. And during storms and high tide, you could have a blow hole where water and compressed air would shoot up into the air. But what's happened, is the sea has managed to break through the end of the cave. And so, we now have what really is an arch. And this is classic coastal erosion. You can see it right around the coast of the world down at Inverloch, for example. Eagle's Nest is a rock stack. Originally, it would have had an arch or a bridge, linking it to the mainland. The Twelve Apostles is another famous area where you have a lot of rock stacks. And up until about ten years ago, there was one called London Bridge, and some people walked out there and it collapsed behind them and they had to be rescued by a helicopter. They were very lucky that didn't happen, they you know, they weren't on it.

So, what will happen here the rocks are quite hard so the roof is not going to collapse on you. It's quite safe to be here. But eventually what will happen, is the sea will continue to erode this and you will have a rock stack rather than a cave. So, from the cave, it is about two hundred metres to go around the edge of Bird Rock, and we're going to finish the walk at the greenstones. So, I'll talk about those in a minute.

We've now walked through the cave, and fortunately the tide is low enough that we can do this. And you do need to be very mindful of the tide, because people can get caught coming back, but there is a walkway that goes up near the Lighthouse Point, that will take you on to the Walkerville South Road, so you won't get stranded here. There is a similar walking track at the Bluff, which is the other spot that people can get stranded. People have been stranded before. In the old days, you used to be allowed to drive your car from Walkerville North around to Walkerville South at low tide, and I can remember being here and just seeing the bonnet of the car floating in the water.

SAJITHRA NITHIANANTHAN:   
I hope the person was okay!

GARY WALLIS:   
I'm sure everybody was fine, but their car certainly was not. Now, that's not allowed anymore. So, cars other than going on to the beach to launch your boat, the cars must remain on the road.

SAJITHRA NITHIANANTHAN:   
Fair enough. What do we know about the greenstones?

GARY WALLIS:   
The greenstones represent one of the oldest rocks in Victoria. They're about five hundred and fifty million years old. And they formed from submarine lavas. The original rock was similar to basalt, or bluestone. But we know that it erupted under the sea, because it has what are called ‘pillow structures’. So, you get these rounded features within the rock, and these only form when the lava cools underwater. There's some wonderful videos that were made in I think the 1960s off Hawaii, where the eruption of Kilauea had lava flowing across the land and then under the sea, and you get a steam layer, and it almost explodes and then implodes. And that leaves a quite distinctive structure on the rock.

SAJITHRA NITHIANANTHAN:   
And that's sort of what happened here?

GARY WALLIS:   
Yes, so that's the sort of feature that has happened here. So, greenstones are found in a number of, they're known as greenstone belts cutting across the state. They're generally very, approximately North-South. There's one at Mount Wellington. There's another one in the Grampians. So, these rocks have been up-faulted from depth. They are interesting, in that they do contain, can contain gold, they can contain platinum minerals, and the green might be due to chromium. So, yeah, greenstones are important, and they're the oldest rocks that we have exposed in Victoria. But if we go into the Western part of Australia, we have some of the oldest rocks in the world, going back nearly four billion years old.

SAJITHRA NITHIANANTHAN:   
Four billion?

GARY WALLIS:   
Four billion. So, the earth itself is about four point six billion years old. Although we talk in hundreds of millions of years here. These are relatively young rocks compared to others elsewhere in Australia.

You'll notice that between the greenstone and Bird Rock is a rusty rock. It has a whole lot of iron in it. And it has infilled caves, which were common in the Digger Island dolomite. So, if we look back over the walk, what we've done is we started looking at stones made of mud and sand, which we call mudstone and sandstone. And we came across some rocks made of lime, which we call limestone. And then we saw some rusty rocks, which we call ironstone. And then we get some greener-coloured rock, we call greenstone. So, geology really is quite straightforward. And anybody can understand it. I think the important thing is to keep your eyes open. And to ask questions. And a lot of things you will be able to work out for yourself. But if you need to do a little bit of reading, I recommend geological maps, and you can get those online.

So, the tour ends at the greenstones. And what you need to do now is just work your way back at your own pace. Maybe have another look at some of the features that you observed on the walk here. Coastcare and Summer By The Sea would like to thank you for coming along on this walk. And we hope in the future, you might like to join me, if I'm doing it again in real life.

Now, this is only one of many Coastcare activities around the Victorian coastline. So, if you go online and look up the Summer By The Sea programs, there's quite a wide variety of activities for families. The other opportunity here is to volunteer for Coastcare. So, we have a number of groups that do volunteer work. So, have a look online, you can register, and the Coastcare people will keep you informed with activities that will be available for you to join in the future.