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Unearthing Our Past And Future – Resourcing Tomorrow

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Fraser Island - Natural and Geological Beauty on the World's Largest Sand Island

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IGC 2012 – Fraser Island field trip guide

Introduction

Welcome to the Fraser Island Field Trip for the 2012 International Geological Congress. Although Fraser Island is the main focus of the trip, we will also be looking at some of the other landscape features of coastal south-east Queensland to provide a wider Quaternary geological context.

Over the next five days you will see a range of coastal landforms and sedimentary environments ranging from low wave energy mangrove-fringed estuaries — mind the sandflies and mosquitoes — to high wave energy open ocean coasts — pack the sunscreen. You will also see a range of vegetation including pioneering Casuarina (She-oak) on the youngest beach ridges, and rain forest with tall trees, palms, and ferns on Pleistocene dune sand.

Most of the coast of south-east Queensland experiences high wave energy, which produces a continuous line of surf beaches from the New South Wales border to the northern tip of Fraser Island. For the population of south-east Queensland, the beaches are a major drawcard. North and south of Brisbane, the Sunshine Coast and Gold Coast respectively have developed as accessible recreational areas for the population of greater Brisbane. South-east Queensland also has large offshore sand islands such as Stradbroke, Moreton and Fraser. These are not so accessible, and contain National Parks to preserve their wilderness values adjacent to the most densely populated part of the state.

Fraser Island is a favourite destination for 4WD-equipped visitors who travel the length of the eastern shore looking for the best fishing spots. Keep a careful look out for vehicles while on the beach. Low tide is the safest time to travel since at high tide, the beach becomes impassable due to soft sand and humicrete outcrops. Unwary drivers attempting to drive at high tide risk losing their vehicles in the surf, or becoming severely bogged in soft sand.

Historical exploitation of the island's resources has been in two areas: forest logging, and heavy mineral sand mining. Neither of these continues, and the island was listed on the World Heritage Register in 1992.

This field guide lists a number of field stops to allow you to appreciate Quaternary landscapes and processes. Accessibility and time constraints may require a revision of the order and selection of field stops.

Fraser Island is well known for its wild Dingo population. While naturally a fascination for tourists, they must be treated as dangerous animals. Fatalities have occurred from Dingo attacks. There are strict regulations against feeding Dingoes under any circumstances. Read the warning information and ensure your safety at all times.

Mal Jones
Geological Survey of Queensland

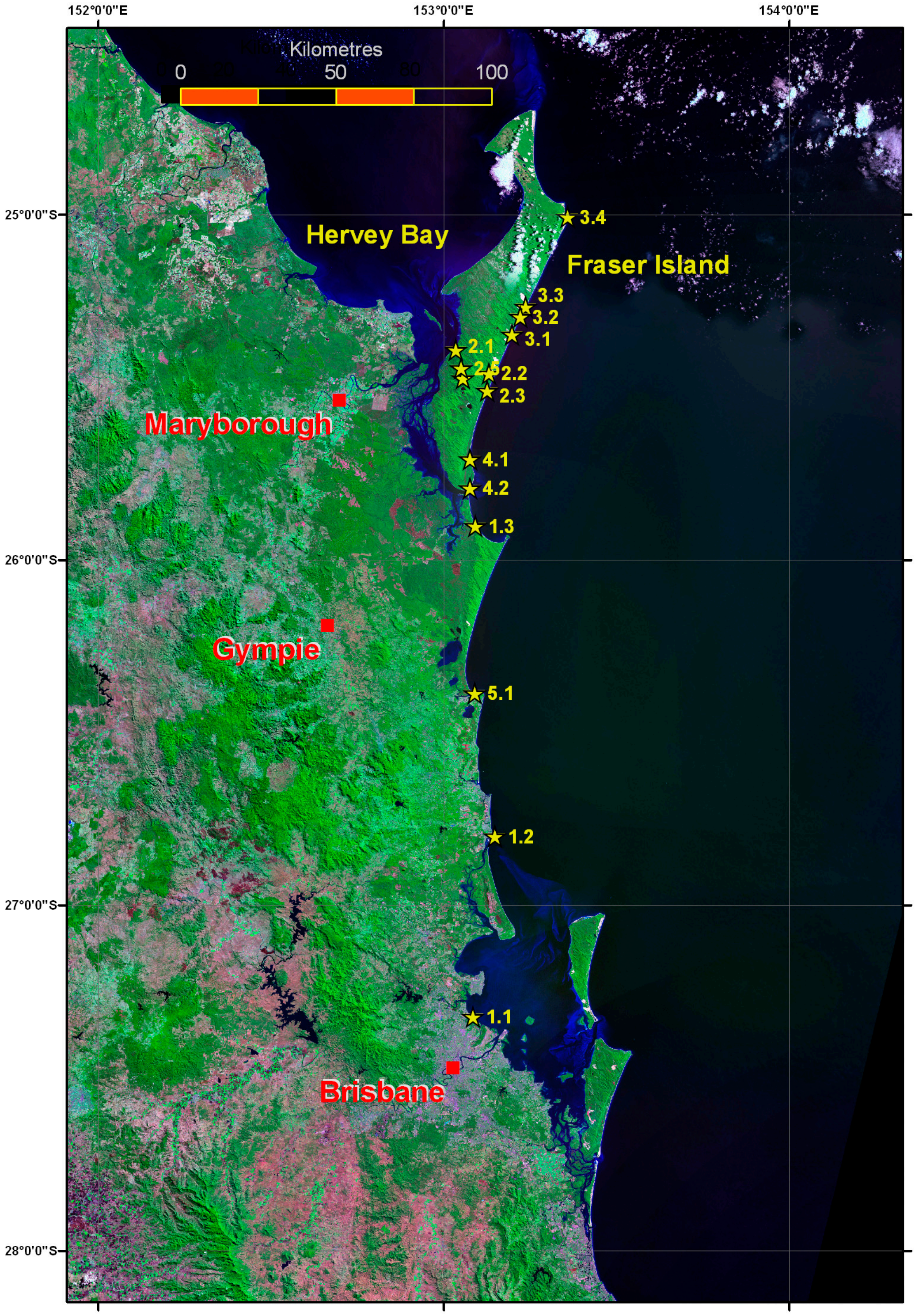

Figure 1. Location of Field Stops. The south coast of Queensland consists of a series of zetaform embayments along the mainland and major islands. Fraser Island is the largest island and lies at a point where the alignment of the coast changes significantly from approximately N-S in the south, to NW in the north. The change in orientation is matched by a change in the character of Quaternary coastal accretion.

Program

- **Day 1: Travel to Fraser Island**
- **Days 2 - 4: Fraser Island**
- **Day 5: Return to Brisbane via Sunshine Coast**

Day	Stop	Location	Description	Page
1	1.1	Shorncliffe	Low wave energy bay shoreline; fluvial sediment supply	11
	1.2	Caloundra	Tide-dominated entrance; Tidal delta; Bribie Island – low to moderate wave energy	13
	1.3	Rainbow Beach	Erosional coast; heavy minerals, humicrete and coloured sand Overnight at Kingfisher Bay, Fraser Island	15
2	2.1	Kingfisher Bay	Pleistocene dunes on western side of Fraser Island	16
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	3.4	Indian Head/Middle Rocks	Littoral drift coast, high wave and wind energy; offshore sediment transport Overnight at Kingfisher Bay, Fraser Island	22
4	4.1	Heavy Minerals	Heavy minerals in Holocene beach ridge and foredune deposits	24
	4.2	Hook Point	Prograded shoreline; Tidal delta as a soft anchor to coastal alignment to north Overnight at Kingfisher Bay, Fraser Island	25
5	5.1	Noosa	Sediment transport around Noosa Head; coastal engineering works Return Brisbane	25

Coastal landscapes of south-east Queensland

The coastal landscapes of south-east Queensland are linked with Quaternary sea level rises and falls (Stephens, 1982). During low sea level periods, the east coast rivers supplied sediments to the continental shelf. Because the shelf is relatively flat, the rivers produced extensive but thin sand sheets. The sandy sediments of the ancient fluvial deltas and coastal plains were reworked by the sea during a succession of rises and falls that saw the coastline march backwards and forwards across the inner shelf in the Quaternary period.

The most recent episode of sea level rise was the Post Glacial Marine Transgression (PGMT), during which the sea rose from about -125 m to its present position. This occurred in the time period from about 21000 to 7000 years ago (Figure 2). In this period, the coast migrated from a position close to the edge of the continental shelf, to its present location up to 55 km to the west (Figures 3–5). During the last 7000 years, sea level has been comparatively stable.

The seafloor off south-east Queensland comprises a relatively steep nearshore zone extending to depths of 20–25 m, continuing eastwards with a comparatively gently sloping inner-, mid- and outer-continental shelf. The continental shelf edge occurs at depths of around 200–250 m (Figures 3, 4).

The principal forces moulding the coastline during the late Pleistocene were similar to those of today, namely the predominant south-easterly waves and winds. Those agents transported shelf sediments northwards as littoral drift, and onshore as tidal deltas, beach ridge plains, and dunes.

Tidal deltas were established in passages between islands such as North and South Stradbroke Islands and at the entrance to bays such as Moreton and Hervey Bays. Such deposits comprise large volumes of sand — 5400 Mm^3 was estimated for the two largest tidal deltas in Moreton Bay (Jones & Holmes, 1993). Pleistocene deposits are the core to many active Holocene tidal deltas and also form relict tidal deltas on coastal plains.

- ***Fraser Island is 120 kilometres long, and has an (exposed) area of 1840 km^2***
- ***Fraser Island is the termination of a littoral drift system that has its origins hundreds of kilometres away in New South Wales (NSW)***
- ***From northern NSW to the northern tip of Fraser Island there are no rivers supplying sand to the open ocean coast at present***
- ***Littoral drift transports sand eroded from coastal Quaternary landforms***
- ***Both Pleistocene and Holocene aeolian dunes, beach ridge plains and tidal deltas occur in South-east Queensland.***
- ***Fraser Island is not within the Great Barrier Reef Province***
- ***The first of the Great Barrier Reef islands is Lady Elliott, a sand cay on top of a coral pinnacle, 85 km to the NW of Sandy Cape, the northern tip of Fraser Island***
- ***Although there are fringing reefs in Hervey and Moreton Bays, and corals grow on bedrock reefs off the Sunshine and Gold Coasts, and off Moreton and Stradbroke Islands, there are no true coral reefs analogous to the Great Barrier Reef south of Fraser Island***

The repeated reworking and transport of sand by waves and winds created mature deposits of fine quartz sand containing small amounts of heavy minerals. The sand accumulated primarily landwards of the high sea level shoreline of today, developing a range of features from beach ridge plains, to massive dunes that prograded inland. Bedrock hills formed headland anchor points for a coastline that evolved into a series of zetaform embayments. Beach ridges generally occur in the southern wind-sheltered parts of embayments whereas dunes occur in northern exposed parts. In general, the coastal sediments now show little evidence of their fluvial origins.

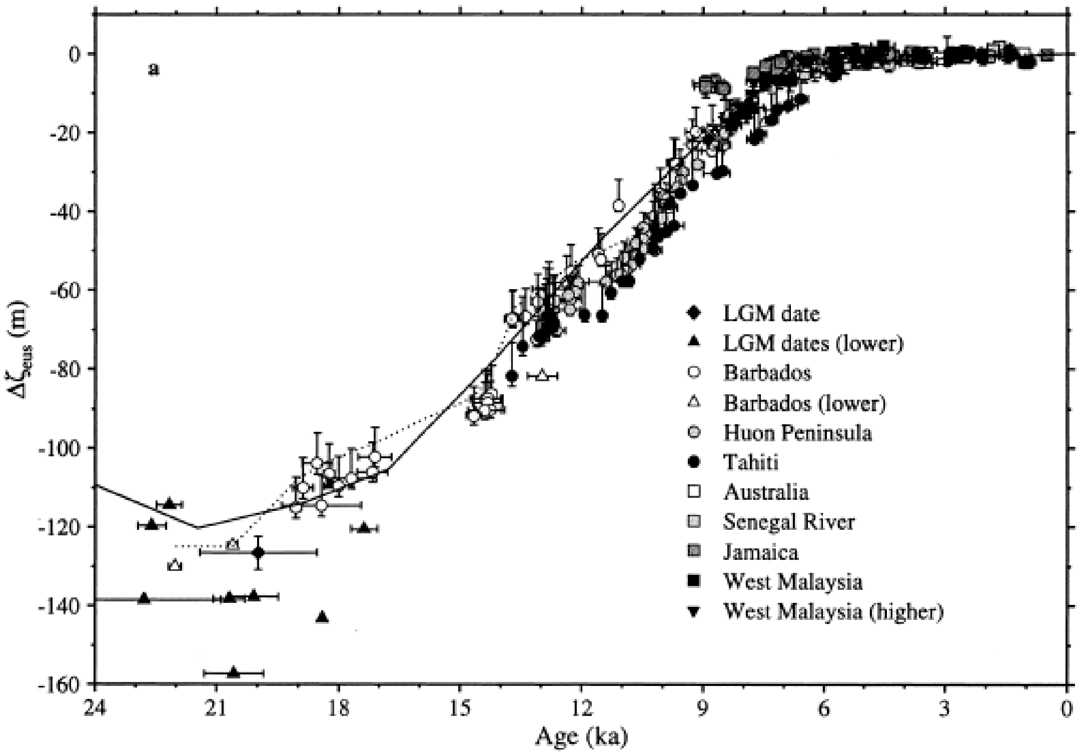

Figure 2. Eustatic sea level curve (Fleming & others, 1998) shows a low stand at approximately 125±5 m below present sea level during the Last Glacial Maximum (LGM). Over the last ~7000 years, sea level has been high and stable, unusual for the last 24 000 years.

At the time of the Last Glacial Maximum (LGM) at about 21 Ka (Figure 2), the coast was much closer to the edge of the continental shelf and experienced high wave energy which generated substantial capacity to transport sand northwards as littoral drift (Figure 3). The Barwon Banks, a linear feature which parallels the isobaths, preserve an old shoreline on the outer part of the continental shelf off the Sunshine Coast in water depths of about 60 m (Figure 4). The banks consist of cemented calcium carbonate clastics and occur at an inflection point on the outer shelf beyond which the seafloor slopes more steeply (Figure 5). Similar features occur off Fraser Island as the North Gardner Banks — 15 km ENE of Waddy Point, and South Gardner Banks — 20 km east of Indian Head.

The inner shelf is quartz-dominated whereas the outer shelf, including the Gardner and Barwon Banks, is carbonate-dominated. The carbonate content of the arcuate Barwon Banks suggests an up-drift source to the south was able to supply a shelly beach ridge plain. It is possible that shallow bedrock reefs in the nearshore zone provided a substrate for marine encrustings that yielded calcium carbonate detritus to the nearshore and beach zone. Modern day analogues exist off the Sunshine Coast north of Caloundra Head (Shelly Beach). Solution and re-precipitation of calcite during periods of exposure enabled the deposits to be lithified whereas quartz sediments remained unconsolidated and available for transport. The difference in consolidation enabled the carbonate ridges to be preserved on the shelf, whereas quartz beach ridges and possibly dunes were rolled westwards during the PGMT.

The quartz sand was not entirely immune from lithification. Fine-grained humic material derived from vegetation in swamps percolated into the sand and accumulated along the water table. The humic material acted as a weak cement and formed dark brown to black humicrete. Locally, humicrete is referred to as sand rock or coffee rock, and has a wide distribution. It is found in depths of 5–10 m near the northern tip of Bribie Island (Stop 1.2), where it traces the alignment of swales on a submerged beach ridge plain. It also outcrops on erosional beaches of the Sunshine Coast and Fraser Island as well as in dune deposits.

Repeated rises and falls in sea level produced a series of similar deposits of different ages. The large sand islands and onshore areas such as Cooloola north of Noosa comprise overlapping dunes of different ages. The complete cover of vegetation on most dunes indicates that they are now inactive. Extensive dune morphologies however reflect a much more active past. Other depositional environments such as beach ridges and tidal deltas have also formed similar accumulations of different ages which form “inner barrier” Pleistocene and “outer barrier” Holocene deposits.

As Quaternary sea levels rose and fell, the coastline migrated backwards and forwards across the continental shelf. The nature of the shoreline varied during these episodes in response to changes in wave energy in the littoral zone. At the beginning of the PGMT, the shore was far to the east and subject to high wave energy due to a comparatively steep offshore zone. As the sea level rose, a wide shallow offshore zone evolved as the shoreline moved quickly to the west. A low to moderate wave energy coast existed in this period. The final stages of the PGMT involved sea level rising from around 25 m to 0 m up a comparatively steep nearshore slope at the foot of the dune field. Wave energy gradually rose as the offshore zone became deeper. One of the aims of the field trip is to envisage these changes by examining some examples of shorelines experiencing different wave climates and seeing the resultant landforms.

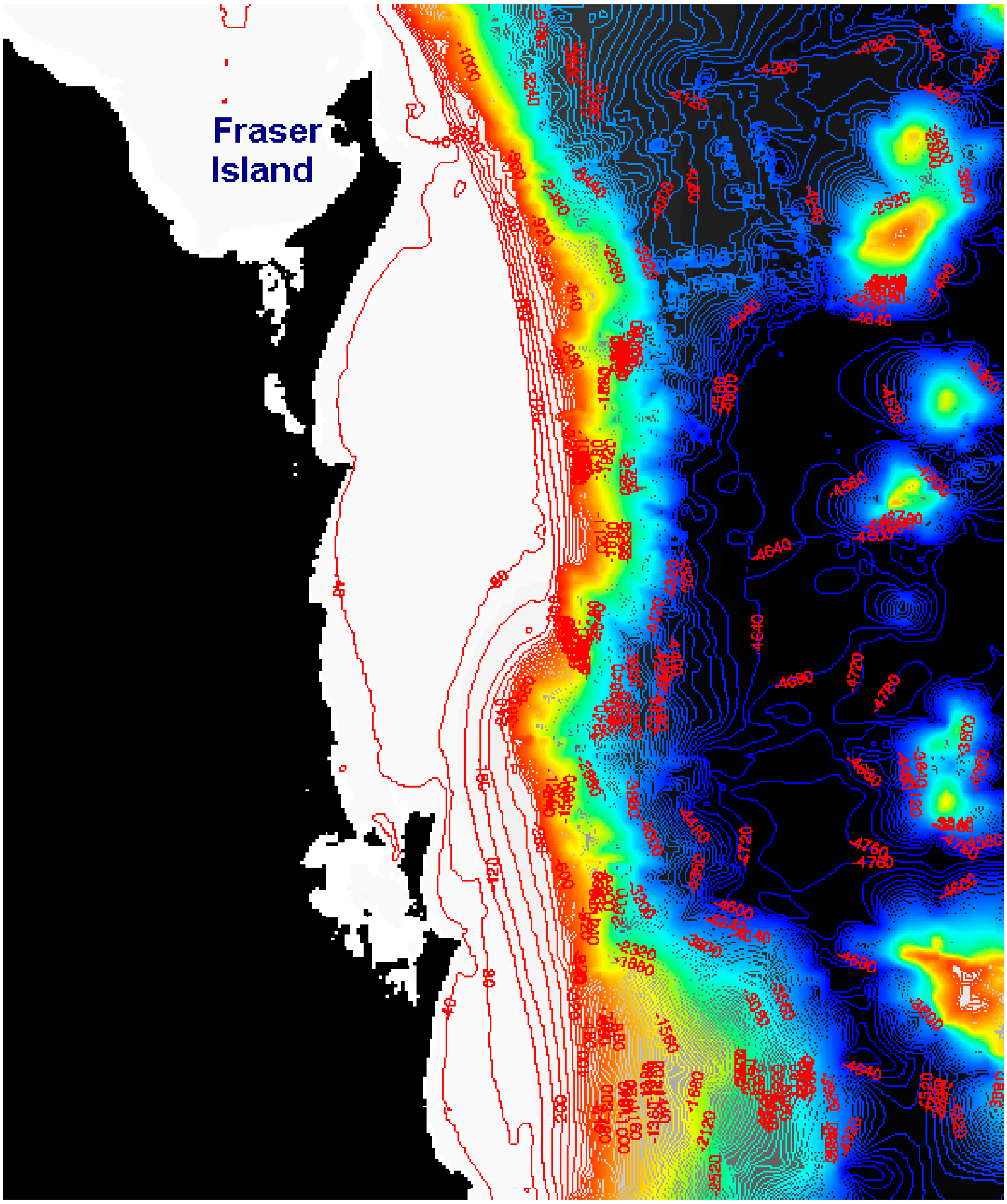

Figure 3. Low sea level during the LGM reached ~-125 m, exposing much of the continental shelf. Even during low sea level periods, Fraser Island intercepted wind blown sand derived from a littoral drift coast. (Bathymetry from Petkovic & Buchanan, 2002.)

- ***A stratigraphic drillhole at Sandy Cape at the northern tip of Fraser Island identified: unconsolidated sediments (marine and aeolian sand) to about 104 m; Cainozoic sediments continuing to 421 m, overlying a Mid-Tertiary sequence of volcanics and terrigenous sediments to 592 m; Jurassic Tiaro Coal Measures continue to end of hole at 623 m.***
- ***Burrgum Hill on Fraser Island has an elevation of 235 m, so maximum sand thickness could be up to 340 m***
- ***The volume of sand contained in Fraser Island, assuming an average thickness of 100 m, is about 184 km^3; this estimate excludes Breaksea Spit, the northward submarine continuation of Fraser Island***

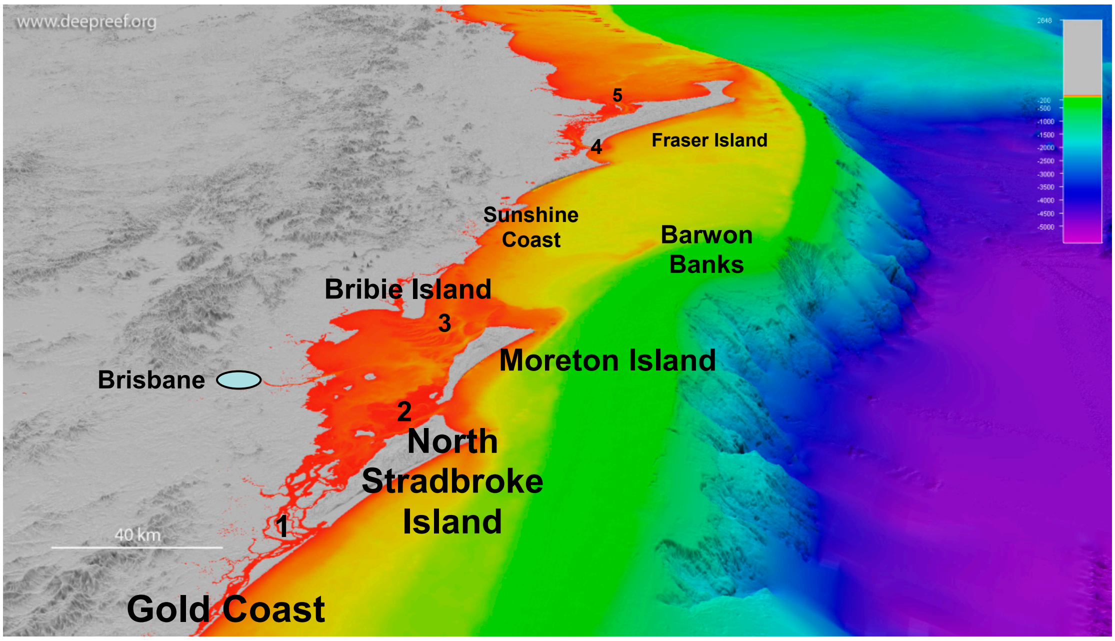

Figure 4. Oblique view to the north shows the relationship between the south-east Queensland coast and continental shelf. Active tidal deltas (1–5) occur at all major entrances along the coast. The Barwon Banks (along the green-yellow boundary) are a residual of a low sea level coastline. (Background image from www.deepreef.org)

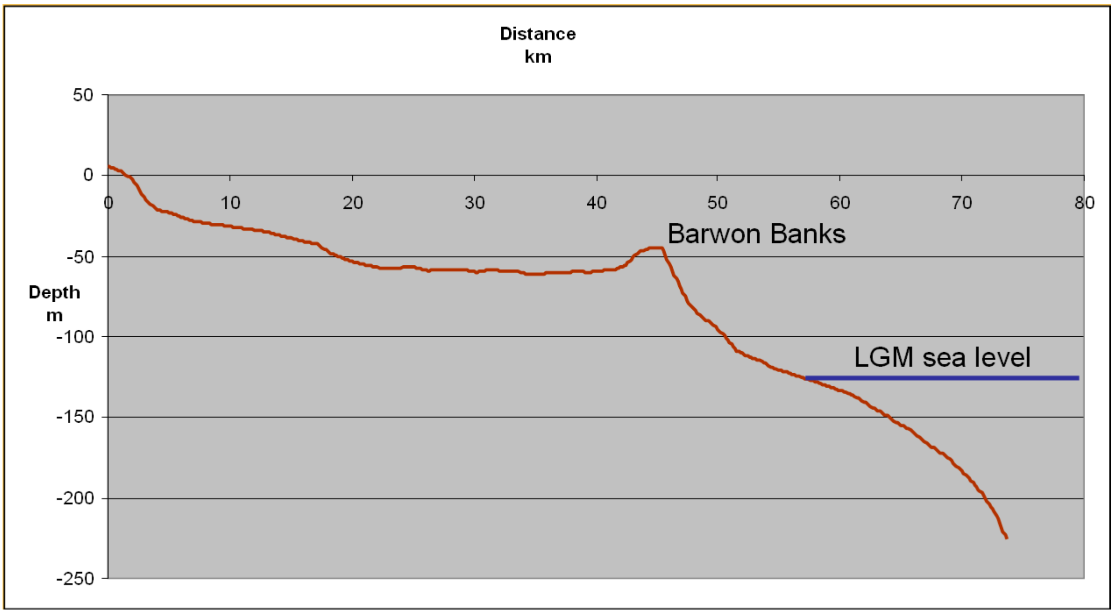

Figure 5. East-west transect across the continental shelf on the Sunshine Coast shows the former shoreline of the Barwon Banks which comprises lithified calcareous sediments. Since the LGM, the shoreline has retreated about 55 km to the west. (Data from Petkovic & Buchanan, 2002.)

- ***The rivers only supply sand to the shelf during low sea level episodes***
- ***The continental shelf contributed sand to the littoral drift system during the early part of the PGMT, but ceased to supply sand when sea level stabilised in the mid Holocene***
- ***Littoral drift along SE Queensland beaches is around 500 000 m^3/yr (Pattearson & Patterson, 1983)***

Heavy Mineral Sands

Queensland's major deposits of heavy minerals are present along the beaches from the New South Wales border to the northern tip of Fraser Island. Although there were a number of sand mining operations working beach deposits in the past, all have now ceased. The only heavy mineral sand mine in Queensland is on North Stradbroke Island to the east of Brisbane where Sibelco-CRL uses floating dredge and dry sand mining methods to process large low grade deposits in Pleistocene dunes.

Waves in the swash zone at the top of a beach are effective in concentrating heavy minerals (Figure 6). Mineral sand seams up to 2.5 m thick created by wave activity were mined from beaches in south-east Queensland from the 1940s (Connah, 1961) but concentrations such as these are now rarely seen. At the top of the beach, wind erosion further concentrates heavy minerals placed there by the high tide waves, and incorporates them in coastal dunes.

Figure 6. Black heavy minerals are concentrated by waves in the swash zone at the top of the beach near the southern end of Fraser Island.

Fraser Island landforms are predominantly dunes, indicating a long-term windy environment. The dunes are formed from sand blown from the top of the beach and it is likely that the dune heavy mineral deposits have formed by tapping concentrations originally present on the beach. As the dunes move inland, revegetation at the top of the beach cuts off the source of sand including heavy minerals. The dunes continue their onshore movement by tank-tread-like recycling of sand. Dunes are depositional along their advancing margins but much of the remainder of the exposed sand is erosional. Laminations of heavy mineral sand originally deposited along the dune slip face are later re-exposed in the floor of the dune as it transitions to being erosional (Figure 7). Most dunes are eventually immobilised by vegetation, and so a low concentration of heavy minerals is locked into a large sand mass.

The history of sand mining shows that rutile and zircon were the principal saleable products from mining. Monazite and ilmenite were generally stockpiled rather than sold. Other components included garnet and in some places, small amounts of gold and tin. On Fraser Island, the heavy mineral suite is composed of about 61% ilmenite, 21% zircon, 17% rutile, and <1% monazite (Connah, 1961).

Offshore areas have also been prospected for heavy minerals, including tidal deltas, the nearshore zone (0–~25 m) and continental shelf (>~25 m), and lobes of sand on the inner shelf derived from the nearshore zone (depths up to ~40 m). However, these environments are more typically diffusive for heavy minerals rather than concentrating, and analyses reveal low abundances. Jones & others (1982) concluded that the likelihood of finding significant offshore heavy mineral deposits is low.

Figure 7. Black heavy mineral laminations, originally formed on the prograding dune slip face, are exposed in the eroded floor of the Lake Wabby dune field. Wind direction is from right to left.

Field Stops

Stop 1.1 Shorncliffe

The Shorncliffe headland (Figure 8) is a knoll of Triassic to Jurassic fluviatile sediments of the Woogaroo Subgroup. It lies on the western shore of Moreton Bay, on the northern margin of the **sub-aerial** Brisbane River Delta.

From the top of the low cliffs, the view extends eastwards to Moreton Island, over 30 km away. Moreton Island, and Stradbroke Island to the south, form a continuous barrier that prevents ocean swells from reaching the western shores of Moreton Bay. Hence the Bay is dominated by wind waves developed over fetches of up to 45 km by the predominant south-easterlies. The offshore islands are well vegetated, but patches of white show where active dune fields exist.

To the south of Shorncliffe, the Brisbane River has developed a subaerial delta extending into the bay and forming an arcuate coastline about 18 km long. The Brisbane airport is located on this deltaic plain which is comprised of sand sheets and mud-filled channels, cheniers, beach ridges and estuarine flats. Airport construction required substantial volumes of sand to provide adequate foundations. The sand was dredged from the eastern side of Moreton Bay from tidal delta and channel sand deposits which originated from the longshore drift systems of the south-east Queensland open coast.

The Brisbane River has delivered large volumes of sand and mud to Moreton Bay, but most has remained in the west. The sand is mostly in the intertidal and near subtidal zone, whereas the much more voluminous mud contributes to a prodelta that extends across much of the western bay in depths less than about 11 m. Note that the prodelta mud extends less than half-way to Moreton Island. The mud is readily resuspended by wave activity so that the waters of the western bay are commonly turbid. How does it look today?

Wave transport of sand from the Brisbane Delta is to the north-west to Shorncliffe and around the base of the headland. The wide intertidal zone along the coast is characterised by immature brown to grey brown quartz-feldspar-lithic sand with small amounts of heavy minerals and shell. The fluvial sand here contrasts markedly with the sand on the ocean beaches we will see later.

A Holocene beach ridge plain to the north-west of Shorncliffe is now covered by urban development. The plain developed through the accumulation of deltaic sand transported around the Shorncliffe headland over the last 6–7000 years of modern high sea level.

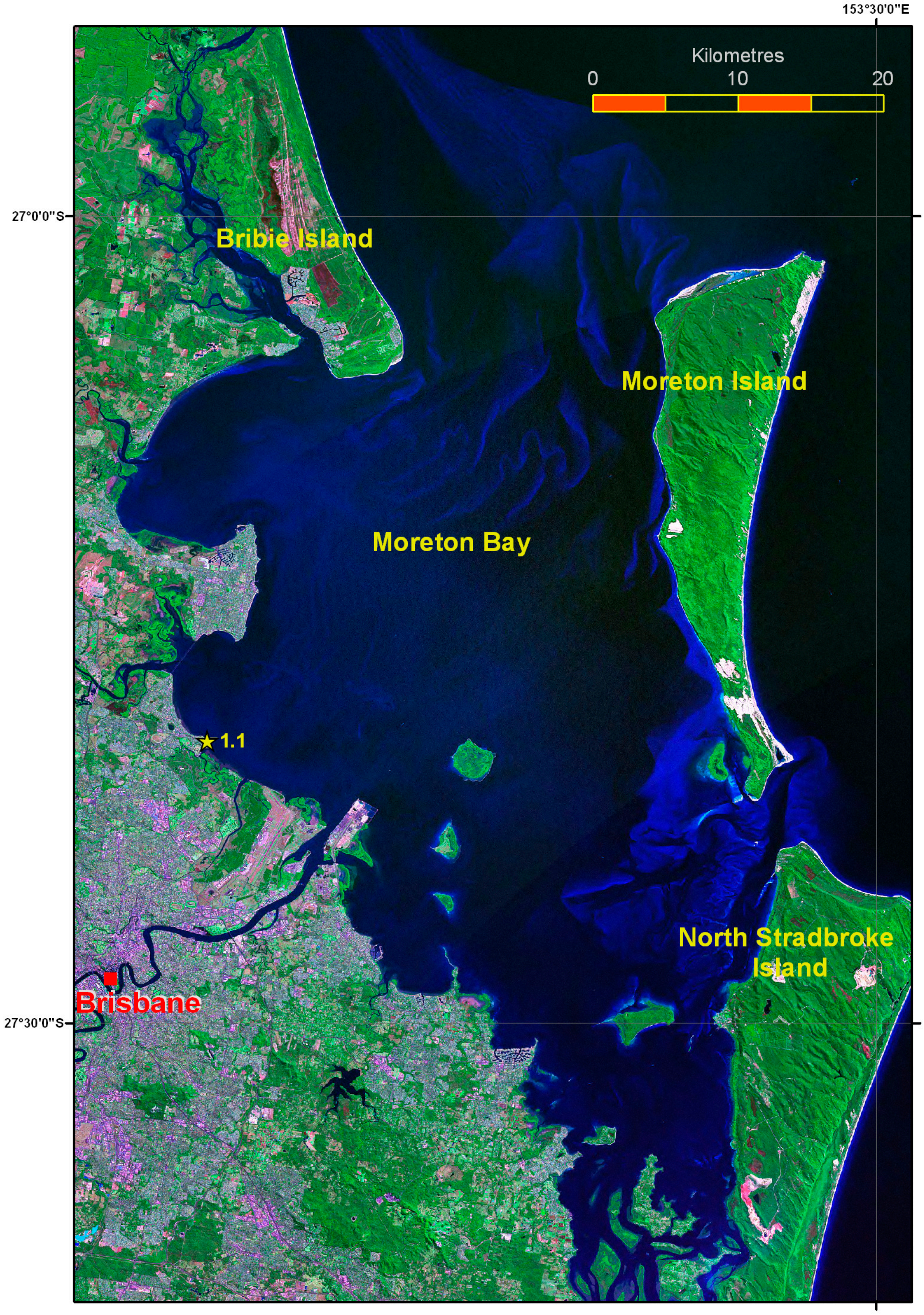

Figure 8. Field Stop 1.1 is located at Shorncliffe on the fluvial coast on the western side of Moreton Bay. Moreton and North Stradbroke Islands prevent ocean swells from entering the bay. Tidal deltas occur at the main entrances in the east and north.

- ***Coastal evolution reflects the balance between sediment supply and demand, the dominance of winds, waves, tides, or rivers, and the location of soft and hard anchor points to control coastal alignment***

Stop 1.2 Caloundra

Caloundra headland is comprised of Landsborough Sandstone, a Triassic to Jurassic sequence of fluviatile sediments.

From Caloundra, the view east is of the Pacific Ocean whose swells impinge on the south-east coast of Queensland (Figure 9). The continental shelf edge (at a depth of about 250 m) is over the horizon, about 55 km distant. The prevailing Pacific Ocean swells are from the south-east and when they meet the north–south aligned coastline, create northward littoral drift currents.

On the horizon to the south-east are the white sand patches along the northern margin of the large dune accumulation which makes up Moreton Island. Sand moving north in the littoral zone on the east coast of Moreton Island rounds the headland at its northern tip, Cape Moreton, and finds no continuity of shoreline leading to the Sunshine Coast at Caloundra. Instead there is the wide northern entrance to Moreton Bay between Moreton and Bribie Islands. Looking to the south from Caloundra Head, the view is across a narrow tidal channel that separates Caloundra from Bribie Island. The littoral drift that travels north beyond Moreton Island becomes entangled in a large region of shallow sand banks between Bribie and Moreton Islands. Between the **southern** tip of Bribie Island and Moreton Island, the sand transport is dominated by tidal currents and a large tidal delta occurs at the entrance to Moreton Bay. Between the **northern** tip of Bribie Island and Moreton Island are extensive shallow sand banks whose eastern margin traces an arc from Cape Moreton to Caloundra Head. This region of shallow sand banks is an overstepped beach ridge plain that existed during the later stages of the PGMT in the early Holocene. The massive sand bank has also acted as a wave break for Bribie Island such that the island's dominant landforms are beach ridges, low dunes and tidal deltas. Low to moderate wave energy acts on the eastern Bribie shoreline. Both Holocene and Pleistocene landforms are present on Bribie Island, indicating that the coastal deposits are the product of multiple episodes of Quaternary high sea levels.

Tidal flows in the channel between Bribie Island and Caloundra have created an ebb tidal delta offshore, and a much more extensive flood tidal delta in the Pumicestone Channel to the west.

The sand on the beaches is much more mature than previously seen at Shorncliffe. The majority is supplied from the littoral drift system. However in the vicinity of headlands there is a proportion of local input as evidenced by lithic particles and iron-tinted rather than clear quartz.

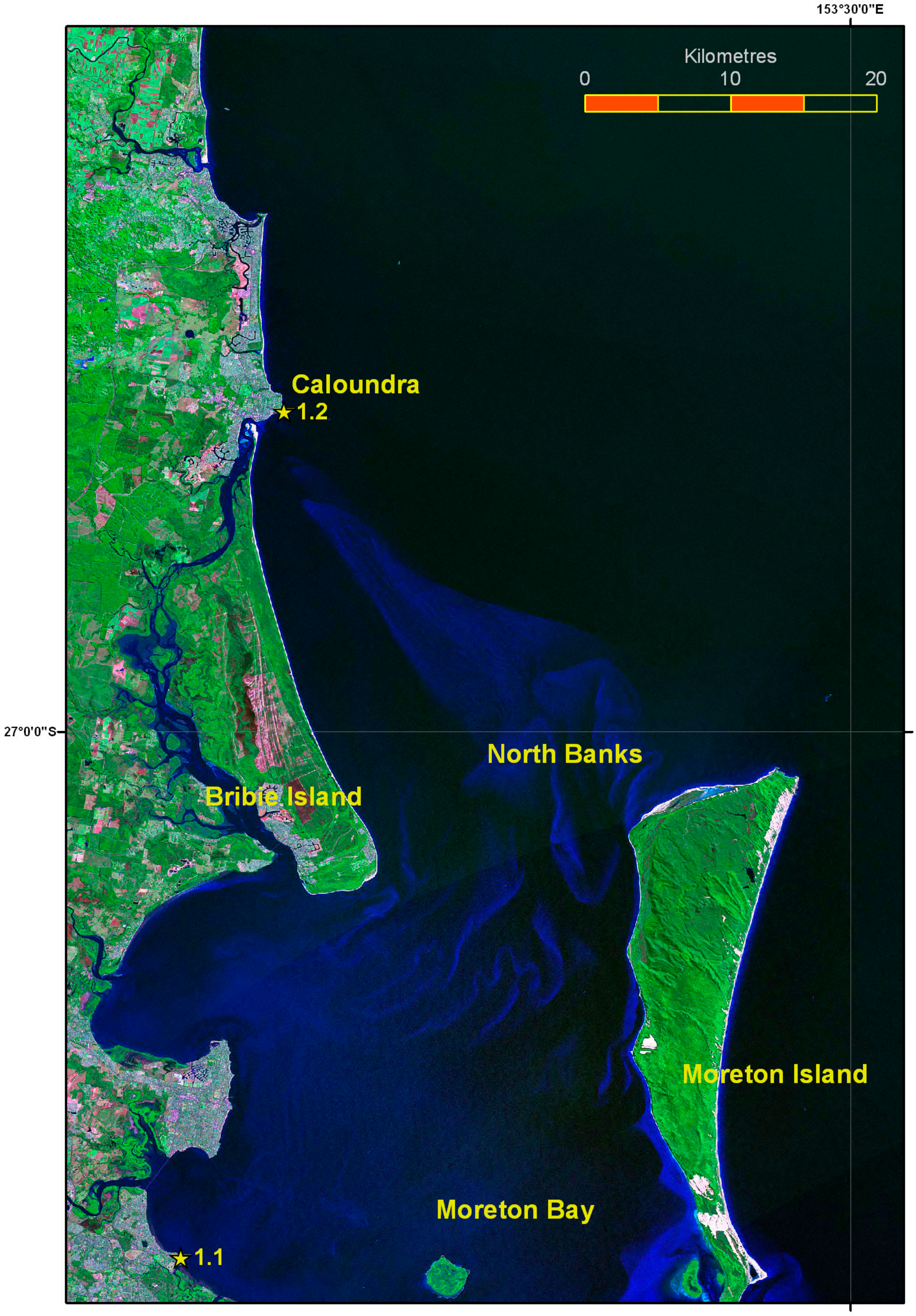

Figure 9. Field stop 1.2 is at Caloundra on the southern end of the Sunshine Coast. Bribie Island to the south is protected from ocean swells and comprises largely Pleistocene beach ridges and minor Holocene beach ridges and dunes. In contrast, the wave- and wind-exposed Moreton Island is formed of high Pleistocene and Holocene dunes. Between the Moreton Island and Caloundra, North Banks is an overstepped beach ridge plain modified in the south by tidal currents.

Stop 1.3 Rainbow Beach

Rainbow Beach represents a once more extensive dune field now truncated by erosional margins on its north and south-east, caused by high sea level wave activity. Double Island Point is a prominent bedrock headland 10 km to the east-south-east. An eroded dune shoreline extends from the headland to Rainbow Beach township and beyond (Figure 10). Coloured sand to the south-east gives the area its name and is similar to that on Fraser Island.

Outcrops of humicrete are found at the top of the beach near the car park. Short term accretion or erosion determines how much humicrete is exposed on the beach.

Heavy minerals can also be abundant in the upper beach. Heavy mineral sands were previously mined from the beach to the south of Double Island Point, and also in the beach ridges north of Rainbow Beach. Although resources are still present, mining activity is prohibited.

Away from the shoreline, the dunes are mostly vegetated and stable. Satellite imagery reveals their parabolic nature and episodic development with younger dunes prograding over older equivalents. The dune orientation is consistently to the north-west, once again due to the prevailing south-easterly winds.

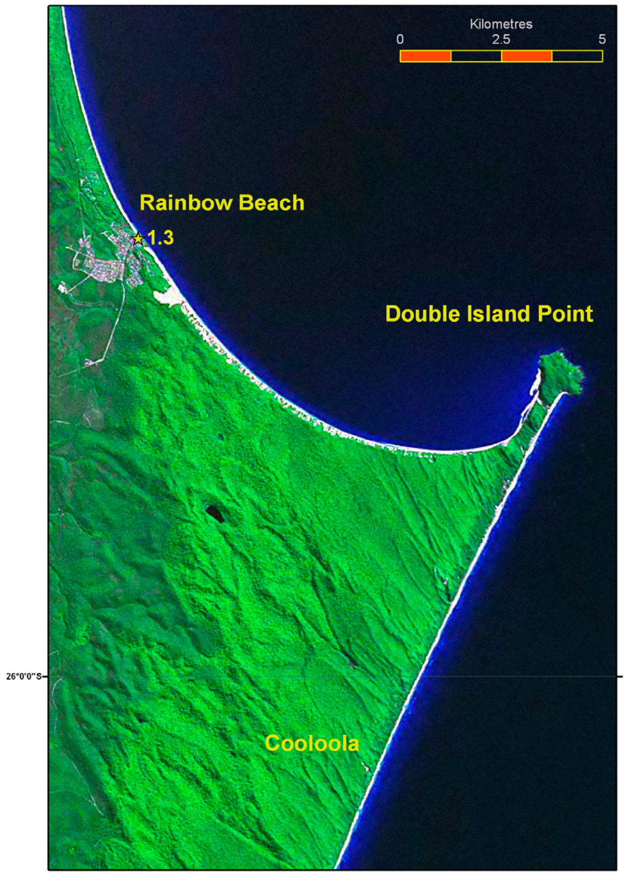

Figure 10. Field stop 1.3 is at Rainbow Beach which is at the southern end of an embayment that stretches from Double Island Point 115 km north to Indian Head on Fraser Island. The modern shoreline truncates inactive Cooloola dune deposits.

Stop 2.1 Kingfisher Bay Resort

The Kingfisher Bay Resort is located near the western shore of Fraser Island on Pleistocene dune sand. As the winds have blown from the south-east and the sand supply has been episodic, Fraser Island consists of a series of overlapping dune sheets which become younger to the south-east. Kingfisher Bay resort is located on some of the oldest dune units on Fraser Island.

The dune sand had a long journey to its final destination. The quartz commenced as a component of fluvial sediments in rivers in New South Wales, was transported onto the continental shelf during low sea level periods, then moved northwards as littoral drift before being blown inland as dune sand. The process entailed repeated episodes of transport during times of fluctuating sea level in the Quaternary.

The dune sand contains very little nourishment for vegetation and the older dunes in particular only support heathland and low open forest.

The western shoreline of Fraser Island at Kingfisher Bay overlooks the tide-dominated Great Sandy Strait between the island and the mainland. The tidal flows create an erosional shoreline, truncating the dunes of Fraser Island and revealing their internal structure. A white A2 soil horizon typical of Pleistocene dunes overlies grey to grey brown humicrete along the shoreline.

Stop 2.2 Lake Wabby Dune Field

Lake Wabby is a water table lake at the boundary between an active dune field and vegetated Pleistocene to early Holocene dunes. The dune field is one of a number along the eastern side of Fraser Island that is completely encircled by vegetation. As they are disconnected from the modern shoreline, there is no upwind source of sand. The dune fields are mainly erosional, with depositional areas largely confined to down wind areas. The dune fields prograde to the north-west and form a steep angle-of-repose slope of loose sand encroaching into an open Eucalyptus forest. Remnants of the forest that the sand has prograded over are present as isolated stumps in the dunefield. Laminations formed by sedimentation along the earlier prograding front can be seen in eroded parts of the dune floor (Figure 7).

The group of dune fields of which the Lake Wabby field is an example (Figure 11) occurs at a consistent distance from the modern shoreline. It seems likely that they started in response to a common initiator at some time in the past. It may be that the dunes were active during the PGMT, during which they had a direct link with the eroding and westward retreating shoreline. After sea level stabilised around 6–7000 years ago they were disconnected from the shoreline by vegetation colonising a set of younger and smaller mid-to late Holocene dunes now forming the youngest dune unit along the coast. Since then the dunes have continued to advance inland at similar rates, recycling the sand in their paths.

Stop 2.3 Eurong

The east coast of Fraser Island from a few kilometres south of Eurong all the way northwards to Sandy Cape is erosional in the long term. This results in truncated parabolic dunes along an erosional scarp at the top of the beach, with the lateral arms of the dunes forming high pinnacles. In the vicinity of Eurong, the landscape comprises vegetated Holocene dunes extending inland over an older dune unit of probable late Pleistocene to early Holocene age.

Distinguishing Holocene from Pleistocene dunes is largely based on morphology and interpretation of the stacking history of the overlapping units. Holocene dunes are typically the most up-drift of all the dunes, and preserve the fine detail of closely spaced parabolic dunes. In contrast, the Pleistocene dunes generally form large units that preserve gross details of morphology such as the curvilinear advancing front and lateral elongate ridges parallel to the direction of progradation. Older dunes are characterised by increasingly degraded dune morphologies. Soil profiles also show differences that can be used to assist correlations and determine relative ages. Increasing podzol development indicates increasing age of coastal dunes (Thompson, 1992).

The intertidal beach is wide and gently sloping and there is a low erosional scarp at the top of the swash zone. Freshwater seeps at the top of the beach produce an orange colouring on the sand.

Stop 2.4 Central Station

Central Station is known for its impressive rainforest and crystal clear water in a shallow stream. Despite Fraser Island being composed of essentially uniform infertile quickly draining or waterlogged sandy soil, there are distinctive vegetation communities on the island. The forests are the result of plant community evolution which commenced with hardy pioneering species. The evolving communities eventually built up a self mulching environment able to support rainforest. The rainforest occupies a niche environment between open forest vegetation on areas to the east, and low heath and forest on dunes to the west. The boundary of the rain forest and open scrubland is commonly very sharp. The rainforest that occurs in the centre of the island is similar to other forests in dune landscapes of south-east Queensland.

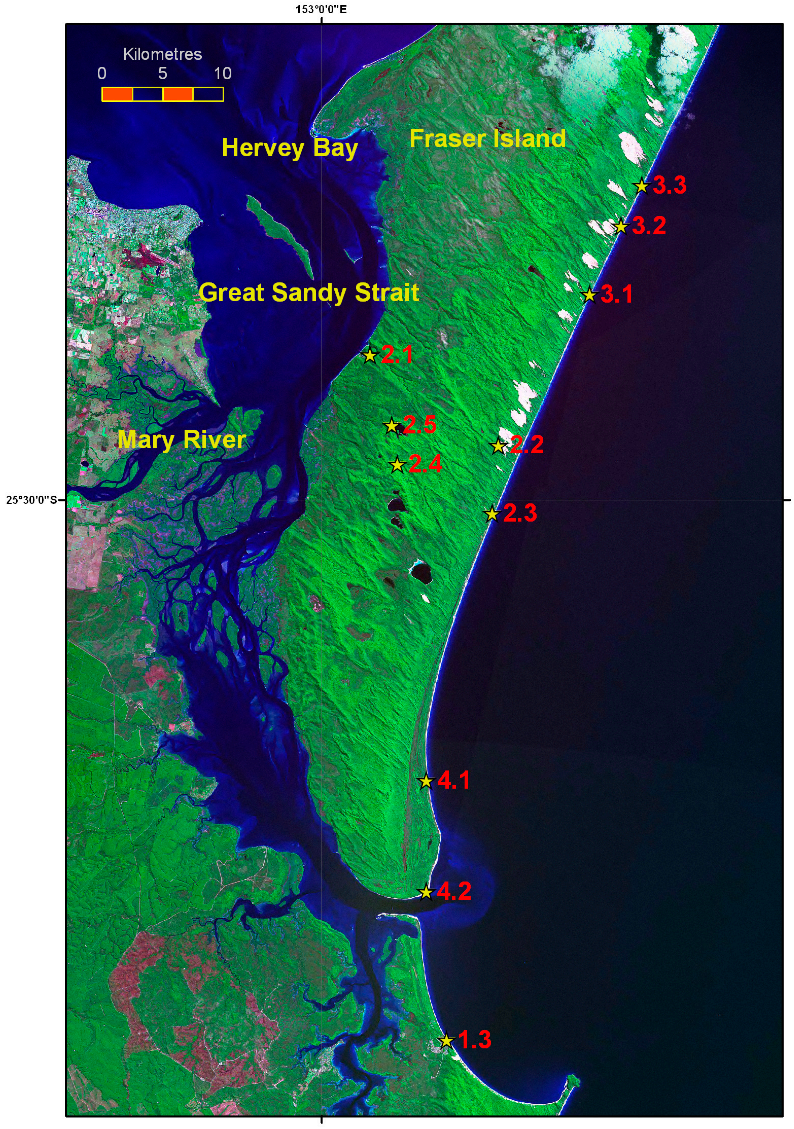

Figure 11. Overlapping north-west dune morphologies are evident on Fraser Island. In the south, a beach ridge plain (between 2.3 and 4.2) represents the only significant coastal progradation since the end of the PGMT. The 6–7000 year old shoreline can be seen as a fine line on the coastal plain between 2.3 and 4.2. The tidal delta east of 4.2 has influenced the coastal alignment to the north by acting as a "soft" anchor point.

Stop 2.5 Lake Mackenzie

The dune landscape of Fraser Island creates a varied relief, so low areas provide the opportunity for the water table to be exposed at the surface in the form of freshwater lakes. Impermeable layers within the dune sand such as humicrete horizons can produce perched water tables which can be exposed as lakes in depressions that are rather high in the overall landscape. Lake Mackenzie is one such lake. The Pleistocene dune sand that encloses the lake forms striking white beaches around its edge (Figure 12).

Many of the larger Fraser Island lakes have beaches on their north-west shore, reflecting the influence of south-easterlies in creating small waves sufficient to modify the downwind lake margin.

Figure 12. Small waves erode white dune sand along the beach on the north-west shore of Lake McKenzie. Beach ridges produced by wind and waves occur along the downwind shore of several lakes on Fraser Island.

Stop 3.1 Yidney Rocks

Yidney Rocks area exposed on the ocean beach of Fraser Island, and are composed of humate-cemented sand referred to as humicrete. Freshwater in swamps and lakes dissolves humic material from the vegetation and becomes tea-coloured, and the humate-rich water percolates laterally along the water table. The humate forms a weak cement that binds the sand to form "rock" outcrops on an eroding beach. In some instances, humicrete also contains logs and twigs and so likely represents freshwater lake-bed accumulation. Fluctuating water tables can assist the development of quite thick (several metres) humicrete horizons, as at Yidney Rocks. The presence of humicrete is commonly taken as an indicator of Pleistocene deposits, as the Holocene is not a sufficient time interval for its formation.

Stop 3.2 Eli Creek

Because of the porosity of the sand dunes on Fraser Island, there is a substantial storage capacity for ground water. Along the eastern coastline, freshwater seeps are common at the top of the beach, and in places there are sufficient flows to create shallow freshwater creeks. Eli Creek is the largest permanent creek on the eastern side of Fraser Island and is noted for the clarity of its water (Figure 13). Clear water indicates that the stream is draining ground water directly from the dunes In contrast, groundwater that migrates from the dunes to swamps before flowing to the beach has a pronounced tea-colour due to dissolved humic material.

The northward littoral drift along the coast deflects the stream outflow point to the north behind a low swash zone berm with incipient foredune. However, from time to time the creek re-establishes a more direct connection to the sea by breaking through in the south, as is the case at present. This is followed by a period of gradual movement to the north once again.

To the north, the erosion scarp at the rear of the abandoned beach-parallel channel has exposed a cross section of the dune structure including unconsolidated sand on top of a grey to dark brown layer of humicrete.

Figure 13. Clear freshwater in Eli Creek flows over white dune sand containing heavy minerals.

Stop 3.3 Maheno/coloured sands

In 1935 during an unusual winter cyclone, the SS Maheno was washed ashore on Fraser Island and could not be retrieved. The remains of the ship are still there, confirming that there has been no significant accretion in 77 years.

At the top of the beach there is commonly a narrow ledge of Holocene swash zone/foredune accretion which is only temporary. Periodically, the Holocene accretion is removed and the erosional scarp in the high Pleistocene dunes behind is reactivated. The steep slopes along the scarp are subject to occasional land slip and erosion, exposing coloured sand within the Pleistocene dunes. The colours are due to degradation of iron-rich grains in the dune sand, and transport and deposition of iron by percolating water.

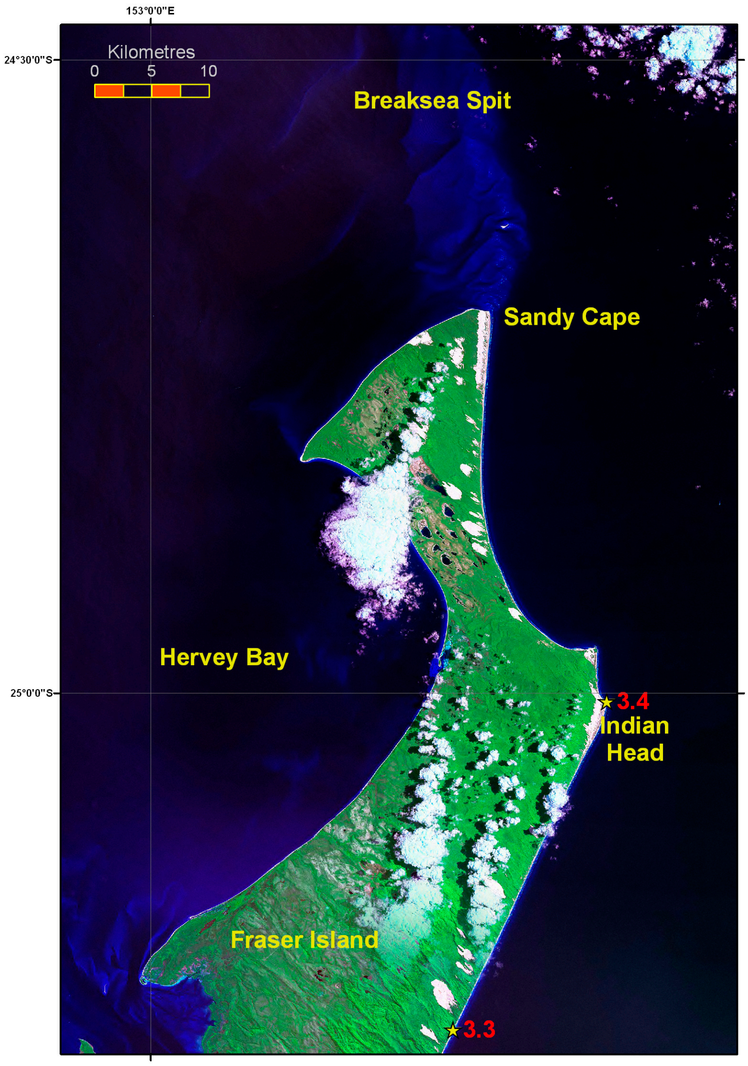

Figure 14. The alignment of the east coast is tied to bedrock headlands at Indian Head. The embayment to the north continues beyond Sandy Cape as the largely sub-tidal Breaksea Spit. This is the termination of the littoral drift system from the south. The coastal orientation indicates that the shoal was present during the PGMT and was overstepped during the late stages of Holocene sea level rise. Tidal flows across Breaksea Spit rework the sand and deliver quantities to the edge of the continental shelf and beyond, resulting in a permanent loss from the littoral drift system.

Stop 3.4 Indian Head

Indian Head and the nearby headlands to the north at Middle Rocks and Waddy Point are the only bedrock outcrops on Fraser Island. The rocks comprise the Waddy Point Volcanics, a Tertiary unit of trachyte flows and agglomerate, with basalt dykes.

Indian Head provides spectacular views, particularly to the south. Here, the high wave energy surf zone drives littoral drift northwards along a zetaform embayment that starts at Double Island Point 115 km distant. This is the longest such embayment on the east coast of Australia. The coastline south of Indian Head has a seaward bulge, indicating an excess of littoral drift sand. Of the four major headlands on the southeast Queensland coast, Indian Head is the only one to have such an expression (Figure 15, 16).

Figure 15. South of Indian Head, the convex shoreline is due to a surfeit of longshore drift sand. Twin offshore sand bars are marked by breaking waves (white zones).

Coastal erosion is the main source of littoral drift sediments. Other sources of sand can be discounted. Rivers for example cannot supply sand to the open ocean coast because their entrances are plugged by tidal deltas, or they flow into disconnected inlets such as Moreton Bay. Another option is the transport of sand from the inner continental shelf into the nearshore zone but this is considered highly unlikely. That leaves recycling of existing deposits in the beach and nearshore zone as the only option. Of course, sand is transported from one embayment to the next along the northern NSW and southern Queensland coast. Hence some of the sand grains on the beach at the base of Indian Head could have been sourced from erosion over the last kilometre whereas others may have been transported all the way from NSW.

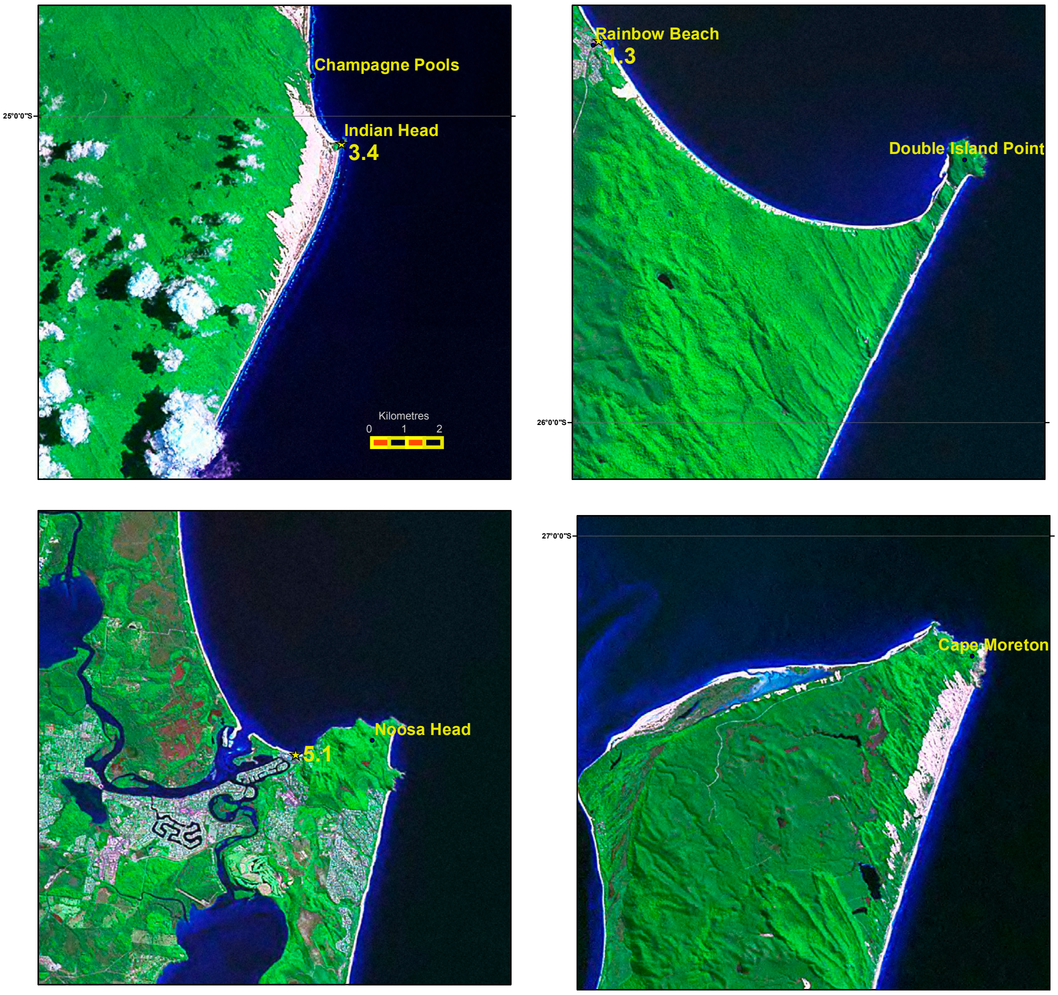

Figure 16. A coastal bulge such as that at Indian Head is not present at any of the other major headlands, indicating excess supply relative to rate of sand passing northwards. (All at same scale.)

Some sand is transported onshore from the top of the beach by wind, as shown by the large area of un-vegetated sand immediately to the south of Indian Head. Some is also transported around Indian Head in the nearshore zone, forming prominent sand bars in the bay to the north. What is not so apparent is that the southward-flowing East Australia Current impinges on the lower part of the nearshore zone and transports some sediment southwards to form a lobe on the inner continental shelf contained by the 40 m isobath (Stephens, 1982a, b; Kudrass, 1982).

At Indian Head, the continental shelf slopes gently from the base of the nearshore zone at depths of about 25–30 m to about 80 m, 22 km offshore. The seabed then slopes more steeply to the shelf edge at about 30 km offshore.

Sand transported beyond Indian Head and into the Sandy Cape embayment continues on beyond Fraser Island to Breaksea Shoal, a large tidal delta of sand shoals that extends north of the Cape for 40 km. This is the terminus for littoral drift sand on the northern NSW and southern Queensland coast and probably has a core of low sea level dune and beach deposits. Tidal flows across Breaksea Shoal transport sand offshore and over the edge of the continental shelf (Figure 17), representing a permanent loss (Jones & others, 1991; Boyd & others, 2008).

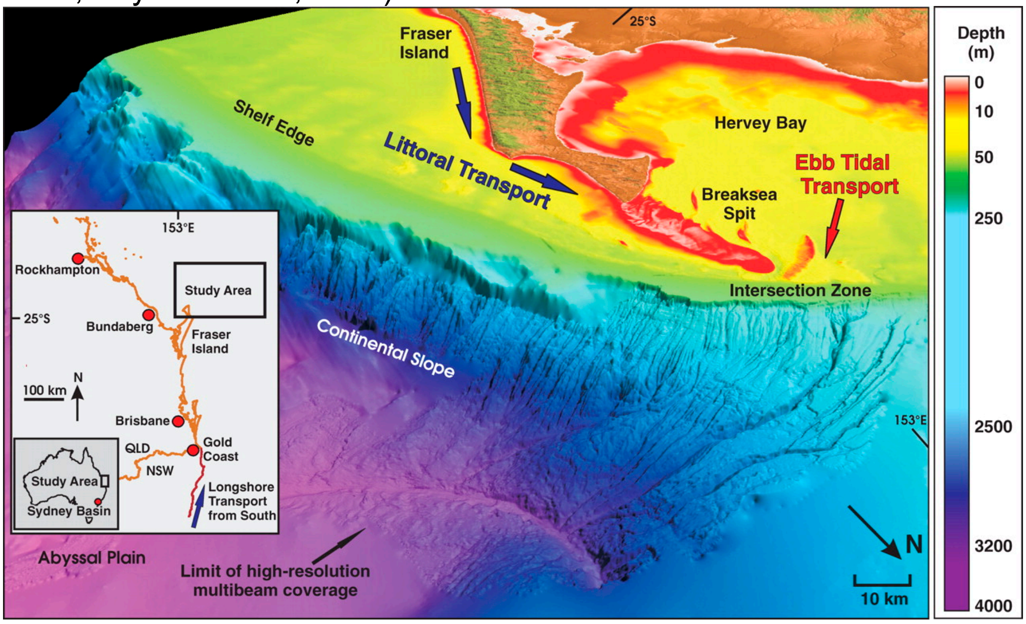

Figure 17. Littoral drift is entrained in ebb tidal flows that transport the sand over the edge of the continental shelf east of Breaksea Spit, at the northern tip of Fraser Island (Boyd & others, 2008).

Stop 4.1 Heavy Minerals

On the east coast of Fraser Island from about 2.5 km south of Eurong, the shoreline is accretionary (Figure 6, 11). At the end of the PGMT, an erosional scarp had formed along the eastern side of the Pleistocene dunes. While the remainder of the eastern shoreline continued to be dominated by erosion, a beach ridge plain accreted in front of the erosional scarp for a distance of about 26 km from the southern tip of the island. The plain is widest in the south and wedges out in the north against the degraded PGMT erosional scarp that continues to Eurong and beyond.

Heavy minerals comprise a very small proportion of the sand involved in littoral drift. For economic deposits to form, a concentrating mechanism is essential. One of the most effective mechanisms is swash-zone concentration on a beach. The process can create heavy mineral seams on prograding beach ridge coasts. This is exactly the environment on the southern end of Fraser Island, and heavy mineral sand mining was carried out there in the 1970s. Ilmenite, rutile, zircon, and monazite are the principal heavy minerals present.

Because of the proximity of relatively high Pleistocene dunes west of the erosional scarp at the rear of the Holocene beach ridge plain, a high water table has extended into Holocene areas. Hence the rear of the Holocene plain is swampy. Nevertheless, the alignment of beach ridges is apparent on aerial photography and satellite images. Heavy mineral accumulations will be investigated along the coast south to Hook Point.

Stop 4.2 Hook Point

Hook Point is at the southern tip of Fraser Island on the edge of a Holocene beach ridge plain. It is also at the southern entrance to Great Sandy Strait which forms the passage between the mainland and the western margin of the island. Tidal flows in Great Sandy Strait developed an extensive tidal delta at the entrance, with the ebb portion extending over 6 km out to sea and forming the Wide Bay Bar. The sand in the tidal delta is provided by littoral drift from the south and it is eventually passed on to the littoral drift system along the Fraser Island ocean beach where the beach ridge plain is at its widest.

The tidal channel and ebb delta does not maintain a fixed position or orientation in the long term. However its position influences coastal stability to the north and south. In the north on Fraser Island, the beach ridge plain contains beach ridges with varying alignments and truncations associated with movement of the tidal channel. On the southern side of the channel at Inskip Point, a narrow peninsula of west-curving beach ridges are influenced by channel movement. Hence the tidal channel has caused local perturbations in coastal stability that influenced the coastline northwards for up to about 30 km. From Inskip Point on the mainland, the coastline continues south to Rainbow Beach and Double Island Point at the end of the embayment.

Stop 5.1 Noosa

Noosa lies at the southern end of a zetaform embayment that extends for 55 km from the bedrock headland of Noosa Head along the Cooloola coast to Double Island Point. Noosa lies between the headland and the Noosa River entrance, where there is a narrow Holocene beach ridge plain. Noosa is protected from the influence of south-easterly wind and waves by the headland but is exposed to infrequent north-easterlies (Figure 16).

The tidal entrance to the Noosa River has a history of channel movement, and erosion and deposition that did not compliment plans for business development on the narrow beach ridge plain south of the river. Engineering works were implemented to stabilise the beach and foreshore. These comprised a rock wall at the top of the beach, a groyne approximately 130 m long part way along the beach, and a training wall at the mouth of the river. The last also acted as a second groyne projecting about 40 m from the coast to stabilise an extended length of beach to the east.

Noosa Beach experiences periodic episodes of erosion which may expose the rock wall at the top of the beach and reduce access to the beach to low tide only. However, the beach recovers when offshore sand returns under lower wave energy conditions. Neither groyne extends sufficiently seawards to completely disrupt littoral drift, but rather aims to limit erosion during the infrequent activity of northerly swells.

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