DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2016/69

Pituffik Titanium Project: Results of 2016 Fieldwork

Onshore sampling and sedimentology

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1. Overview

In July and August 2016 a geological sampling and observational program was conducted on raised and active beaches close to Moriusaq in the Pituffik region of North West Greenland (figure 1). The purpose of the investigation was to (i) sample onshore sediment units that are known to hold high concentrations of ilmenite sand, and (ii) understand the processes that are key to the formation of the placer deposit. The work was conducted by GEUS for FinnAust Mining Plc.

The results presented in this report build on recent onshore sampling activities (Weatherley, 2015) and offshore geophysical surveys (Jensen & Rödel, 2015), and complement an onshore GPR survey (Jakobsen et al, 2016), near-shore sediment echo sounding survey (Jensen et al., 2016) and offshore sampling program (Bennike et al, 2016) that were run concurrently during the 2016 field season.

During this field season, a total of 244 samples were collected using an auger drill and from hand-dug trenches. The maximum depth below the surface from which material was taken is 1.1 m. Additionally, sedimentary profiles were studied in stream cuts, cliff sections and in trenches.

The beach systems were observed to be enriched to variable degrees in metallic sand. In-field estimates suggest that the metallic fraction can be higher than 80%, although metallic fractions of 20-40% are more common. Cliff sections reveal that the raised beach systems can have thicknesses in excess of 3 m. This thickness, however, is not necessarily representative of the whole study area. For example, the sediment body making up the angle foreland at Iterlak is possibly closer to 12 m in thickness. Additional work is needed to make a regional determination of the sediment thickness and estimate sediment volumes.

New field observations revealed that ilmenite is concentrated in placer system by a positive feedback loop involving (i) erosion of previously enriched raised beach sediments and transportation of those sediments to active beaches, (ii) further refinement of the sediment on active beaches by wave action and longshore currents, (iii) preservation of ilmenite-enriched active beach sediment by long-term change in relative sea level. Fluvial systems that cut through the raised beaches are thought to be the most important mechanism for transporting ilmenite-enriched sediment to the active beaches. Many of the onshore deposits have been preserved by an overall fall in relative sea level. New observations show that the overall marine regression was punctuated by short periods of marine transgression. These observations lend support to suggestions from earlier work (Jensen & Rödel, 2015) that additional ilmenite-rich beach systems can be found offshore.

Figure 1. *Map showing the location of Moriusaq, Iterlak and Thule Air Base. Blue line shows the approximate extent of the study area.*

2. Introduction

The Thule black sand province located between 76.5°N and 77°N in North West Greenland and is roughly centred on the abandoned settlement Moriusaq. The Quaternary geology of this region (referred to here as the 'Pituffik' region) is characterized by raised, active and possibly submerged beach systems that are enriched in ilmenite and other heavy minerals (Dawes, 1997; Dawes, 2006; Steensgaard et al., 2015; Jensen & Rödel, 2015; Weatherley, 2015, Steensgaard et al, 2016). These placer deposits have formed in the context of relative sea level change, triggered by melting of the Greenland and Labrador ice sheets. Numerical models of glacial-isostatic rebound and relative sea level (RSL) change by Flemming & Lambeck (2015) predict that the RSL started to fall at the onset of deglaciation at c. 16 ka, when the RSL was located 20 – 40 m above the present sea level. The fall in RSL is predicted to have continued to 7 ka and -35 m below the present sea level, at which point the RSL started to rise to the present day. On the basis of this model, and offshore geophysical studies (Jensen & Rödel, 2015), submerged beach systems are expected to be present in the Pituffik region.

Aerial photographs of the Pituffik region in Appendices 1–6 show that the onshore part of the Quaternary system in the present study area extends approximately 1 km inland and for more than 20 km along the coastline. In this region raised beach systems have been sampled to elevations of 43 m above the present sea level and found to contain significant proportions of black metallic sand. A sampling program run by GEUS for Blue Jay Mining Ltd in 2015 (Weatherley, 2015) sampled active beach zones and portions of the raised beach systems to a depth of 0.3 m beneath the present land surface. Promising results from this program motivated a more detailed sampling and study of the onshore beach systems in the Pituffik area.

2.1 Aims

The aims of this study were to:

- conduct detailed sampling of the raised beach systems in the Pituffik region
- identify the different sedimentary environments that are represented in the system, and the processes responsible for concentrating heavy minerals in the beach systems.

3. Methods

3.1 Sampling strategy

Onshore samples were collected with the aim of (i) characterising the sedimentary material in the Pituffik region and (ii) collecting material for later metallurgical analysis. These sample sets are referred to as material and metallurgical samples, respectively.

Figure 2 shows the areas around Moriusaq and Iterlak from where samples were collected. Material samples were taken from area 1, 2, 4 and 5 and metallurgical samples were taken from areas 1, 2, and 3. In each area the strategy was to generate a set of samples distributed over a grid with spacings of approximately 150 m in the coast-parallel (NW–SE) direction and 100 m in the coast-perpendicular (NE–SW) direction.

In areas 1 and 2, collection of material samples was conducted in two phases. On the first pass of the license area, samples were taken along coast-perpendicular lines spaced approximate 300 m apart, with approximately 100 m space between each sample along the each line. On the second pass of the field area, in-fill sampling was conduced along additional coast-parallel lines that reduced the overall line spacing to approximately 150 m. During the in-fill sampling phase, the sample spacing along the line was maintained at approximately 100 m. In areas 3–5 samples were collected in a single pass using the smaller grid spacing. Samples were obtained by auger drilling or by trenching and, in general, weighed about 5 kg each. The sampling methods are described in detail below.

Metallurgical samples were taken from a series of 11 hand-dug trenches from within the license area. The sampling strategy adopted in this instance was to achieve reasonable coverage of both the geographical area of the license area and geomorphological environments within it. These samples were much larger than the material samples, and weighed between 7 and 85 kg each. At all sample sites, contamination of samples was avoided by thoroughly cleaning all equipment before and after taking the sample.

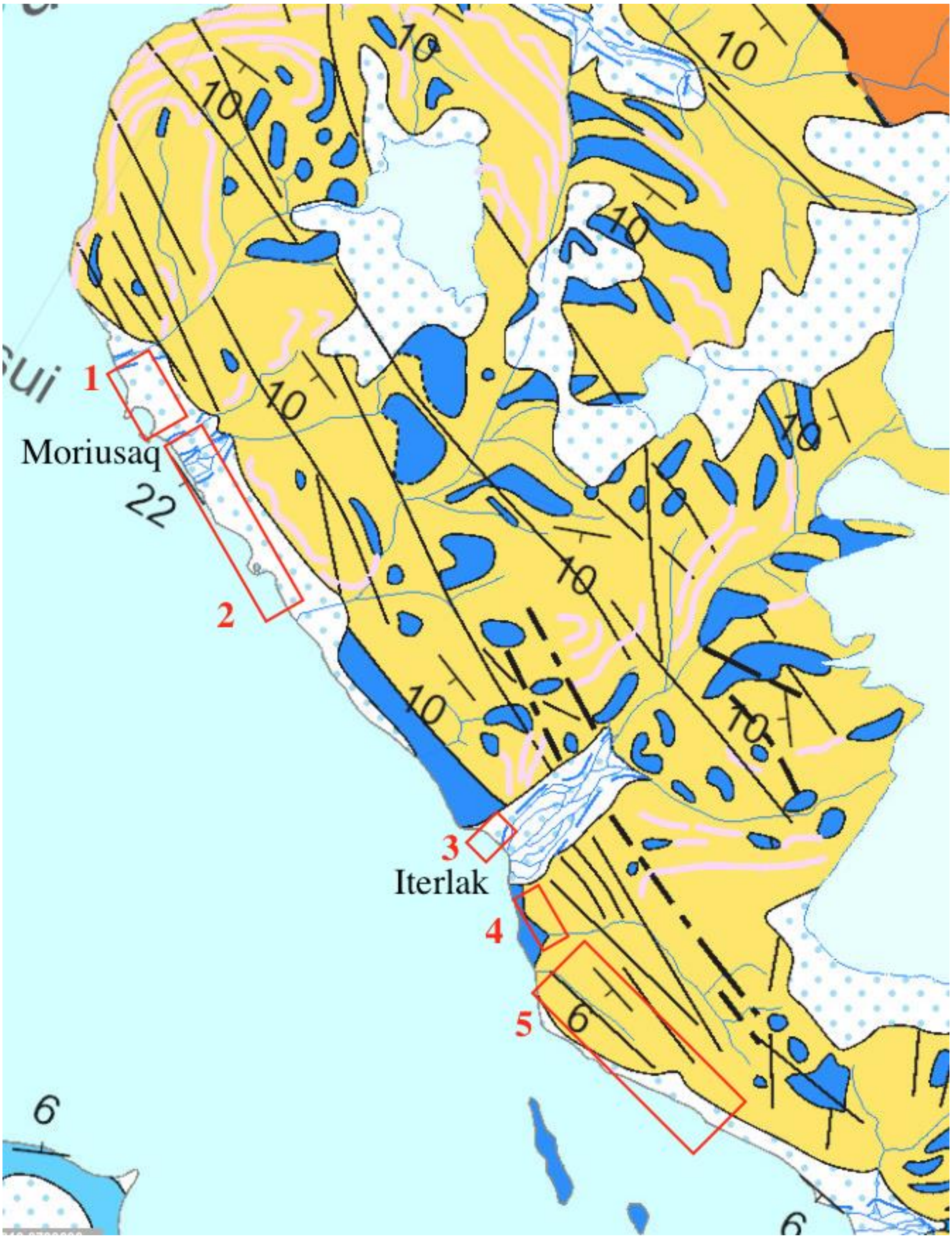

Figure 2. *Geological map of the Pituffik region. Red boxes 1-5 define the approximate areas where samples were taken from. Blue and pink colours correspond to dolorite sheets and dykes, yellow indicates sediments of the Dundas group, and the stippled region adjacent to the coast indicates marine sediments. More detailed maps of sample locations with aerial photos as the background are provided in Appendices 1–6*

3.2 Sampling techniques

3.2.1 Auger Samples

3.2.1.1 Sampling techniques and recovery

The majority of samples were obtained using a motorized auger that was towed by a 4-wheel drive all terrain vehicle (Figure 3a). The auger was equipped with a 1.1 m long, 0.15 m diameter flighted and lipped auger bit (Figure 3b). Since auger drilling is an open-hole sampling method, a lipped bit was specifically chosen to maximise the amount of sample retained on the bit during extraction of the bit from the hole (Figure 3c). All holes were drilled at a dip between 85° and 90° to the horizontal, and typically to a maximum depth of 1.0–1.1 m in a single pass. To recover the sample, the bit was extracted from the hole without counter rotation. If counter rotation was needed to extract the bit from the hole, the auger was moved slightly and the hole was re-drilled. Any vegetation was removed from the surface prior to drilling. In waterlogged areas it was found that the sample slipped easily off the flights and the integrity of the samples was therefore poor. These samples were discarded. As a consequence, auger drilling was conducted primarily in ground that was not waterlogged.

Two methods were adopted to avoid contamination of the sample by any surrounding sediment; the choice of method for any given hole was determined by the local terrain. The first method involved placing a stainless steel tray with raised edges between the auger bit and the machine prior to the start of drilling. The tray had a 20 x 20 cm window cut out from one edge, and the tray was positioned so the window fitted around the auger bit. Any vegetation was removed and the hole was drilled to maximum depth. As the bit was extracted from the hole, the sample was transferred onto the tray. The auger bit was then thoroughly cleaned over the tray and removed to allow easy access to the sample material. Next, the sample was transferred onto a clean, white coloured sheet and mixed thoroughly by taking the side of the sheet and tipping the sample over itself.

Where the local terrain made it impractical to use the metal tray, a clean, white coloured sheet was placed between the auger bit and the machine. The hole was then drilled in a single pass and any spoil around the auger bit was transferred to the sheet. To avoid contamination, this part of the sample was taken a few centimetres above ground level. Next, the auger bit was extracted from the hole, the sheet was slid under the auger bit, and the sample was transferred to the sheet. The auger bit was then thoroughly cleaned over the sheet and removed to improve access to the sample. The sample was then mixed in the same manner described above.

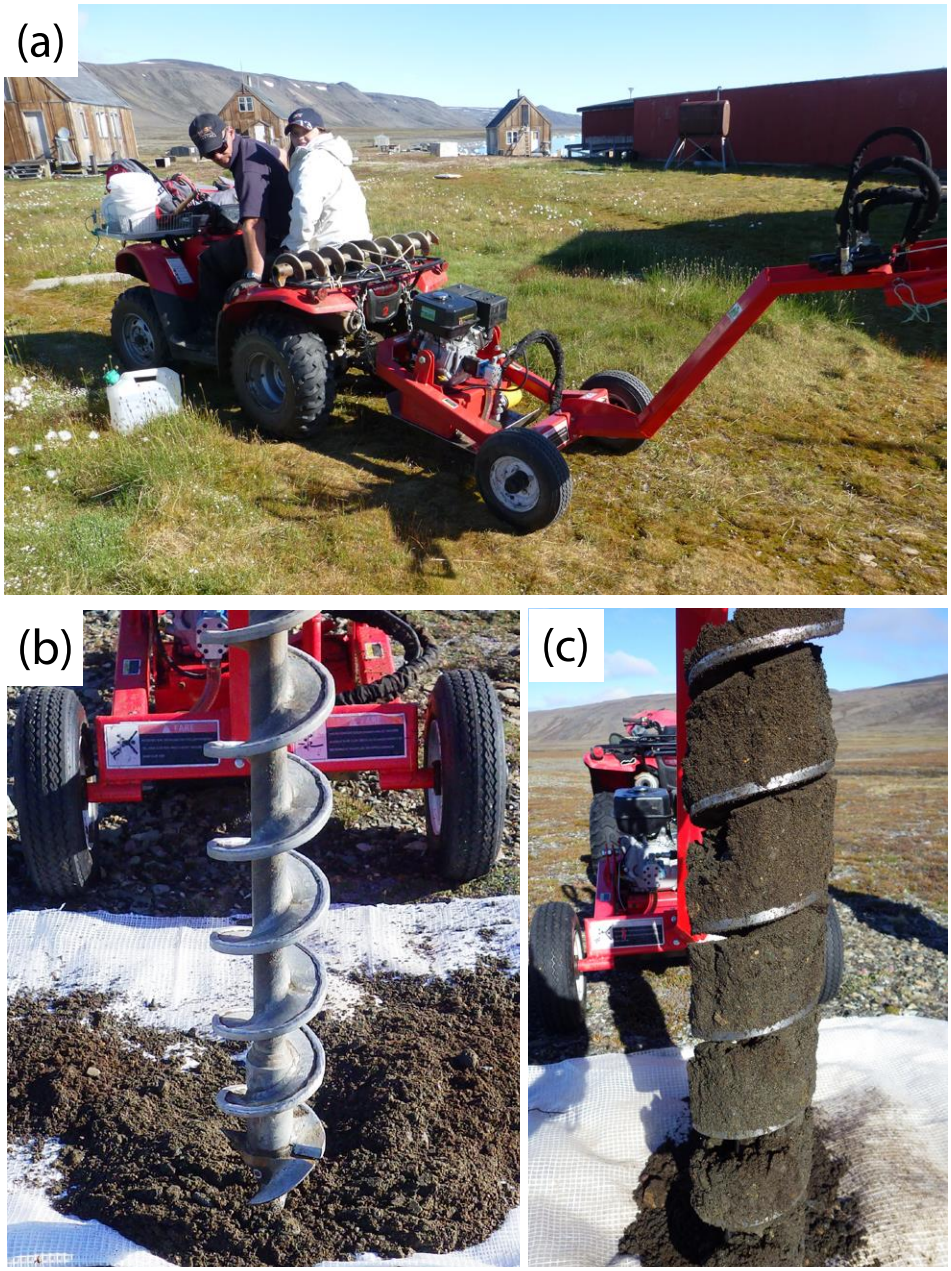

Figure 3. *Photos illustrating the setup for auger drilling. (a) Motorized auger towed by 4 wheel drive ATV. (b) View of the lipped auger bit. Note that the sample has been transferred to the white sheet positioned between the hole and the machine. (c) The auger bit fully loaded and positioned over the sample collection sheet.*

3.2.1.2 Sample preparation, subsampling techniques, logging

After mixing, the material was shaped into a cone on the sheet and quartered using a shovel. A magnetic susceptibility reading was taken over the cone, and a quarter was taken as the sample.

Most samples were placed in a white plastic 5 l sealable bucket with a sample tag displaying the sample number, locality name, date and position. The lid was secured to the bucket

with a strip of duct tape and the sample number was written on the outside (Figure 4). If a bucket was not available, the sample and sample tag were double bagged in colourless plastic bags, the bags were sealed with zip ties, and the sample name was written on the outside of the bag.

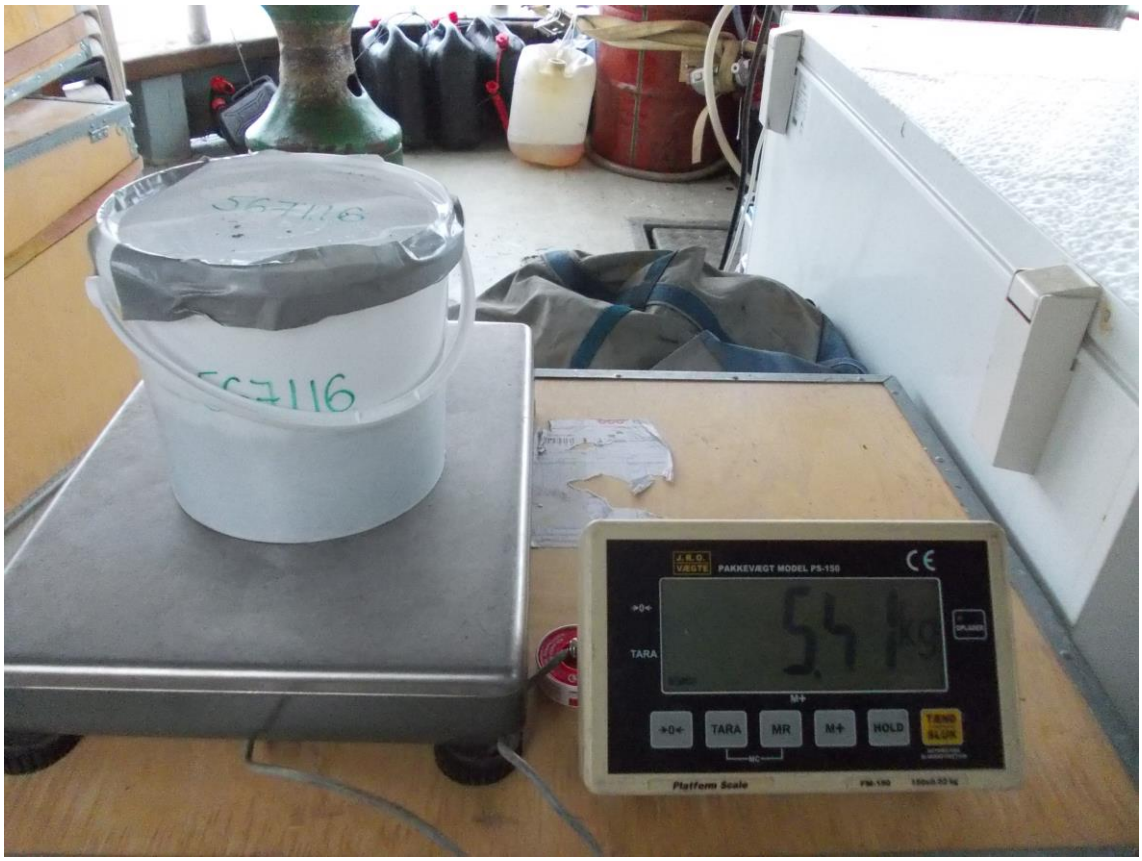

Figure 4. *Example of a sealed and labelled 5 l sample bucket.*

Duplicate samples were added throughout the process (approximately 1 duplicate every 20 samples) by taking the opposite quarter of the cone. Additionally, blank samples were inserted with a frequency of approximately 1 every 20 samples, and the blank product was added at a later date after the samples had arrived in Copenhagen.

The remaining material was placed by the side of the hole, photographed and the site was marked by a strip of flagging tape and the sample number. Later, the remaining material was logged at the auger site by a sedimentologist. Logging involved (i) visually estimating the grain size and reporting it using the Wentworth classification (Table 1), (ii) estimating the fraction occupied by gravel, (iii) measuring the three largest outsized clasts to give an indication of stream power, (iv) qualitatively estimating the degree of sorting, (v) noting the angularity of the individual grains (vi) guesstimating the average heavy mineral sand content, and (vii) noting the overall colour of the sediment pile. After logging, the hole was filled with the remaining material and any vegetation was replaced. The flagging and sample number remained on top of the hole until the end of the field season.

Table 1. *Wentworth scale for sediment grain sizes.*

Grain size, µm	Notes
1410-2000	Very coarse-grained, coarse part
1000-1410	Very coarse-grained, fine part
710-1000	Coarse-grained, coarse part
500-710	Coarse-grained, fine part
350-500	Medium-grained, fine part
250-350	Medium-grained, fine part
177-250	Fine-grained, coarse part
125-177	Fine-grained, fine part
88-125	Very fine-grained, coarse part
62-88	Very fine-grained, fine part

3.2.2 Trenches

3.2.2.1 Sampling techniques

Trenches were hand-dug using long handled spades and shovels. In most places, digging was stopped as soon as the permafrost was reached. In some places, however, such as active beaches or in especially wet sediment, digging was stopped when the water table was reached, since trenches would collapse soon after reaching the water table. In the Iterlak region, trenches were dug with a spacing of approximately 100 m.

3.2.2.2 Sample preparation, subsampling techniques, logging

The method chosen to produce the sample was to lay a clean white sheet next to the trench and create a series of spoil piles on top of the sheet, so that each pile was approximately 30 cm deep. Typically there were 3 to 5 spoil piles from each trench. An equal portion was then taken from each pile to make a representative sample. A magnetic susceptibility reading was then taken and the sample was double bagged in clear plastic bags along with a tag displaying the sample number. The bags were sealed with a zip tie, the sample number was written on the outside of the bag, and the trench was identified with a strip of flagging tape and the sample number. The trench was then logged by a geologist following the same procedure outlined in section 3.2.1. In addition, sedimentary structures and any layering of the sediments were recorded. After logging, the trench was filled with the remaining material and any vegetation was replaced. The flagging and sample number was also replaced on top of the in-filled trench and remained in place until the end of the field season.

Duplicate and blank samples were inserted throughout the process using the methodology outlined above.

3.3 Location of data points

GPS positions were recorded in WGS 1984 UTM Zone 19 N using a Garmin GPSMAP 64S GLONASS prior to taking the sample at each sampling site. At a later date the position of each sample site was re-recorded using a RTK DGPS to give decimetre precision in three dimensions. The DGPS setup included a Trimble 5700 5800 recievers; one was mounted on a pole and used as a rover, the other used as a base. The base was mounted onto one of the houses in Moriusaq using an existing pole (figure 5) at position N76°45'04.61551", W69°50'53.56409", ellipsoid height: 25.369m. All data were recalculated to WGS84, UTM Zone 19 N and the EGM96-geoid. The position of the base station was found using the Trimble CentrePoint™ RTX™ postprocessing service.

Figure 5. *The base antenna mounted onto a house in Moriusaq.*

3.4 Recording of field data

All geological, sample and locality data was entered into a spread sheet at the end of each working day. At each locality, the date, UTM position and sample number was written onto a whiteboard that was then photographed. Additional photographs of the surroundings were taken in the N, E, S, and W directions, along with photographs of a representative sample placed on a scale sheet. Figure 6 provides an example of the typical photo documentation of a sample site prior to logging.

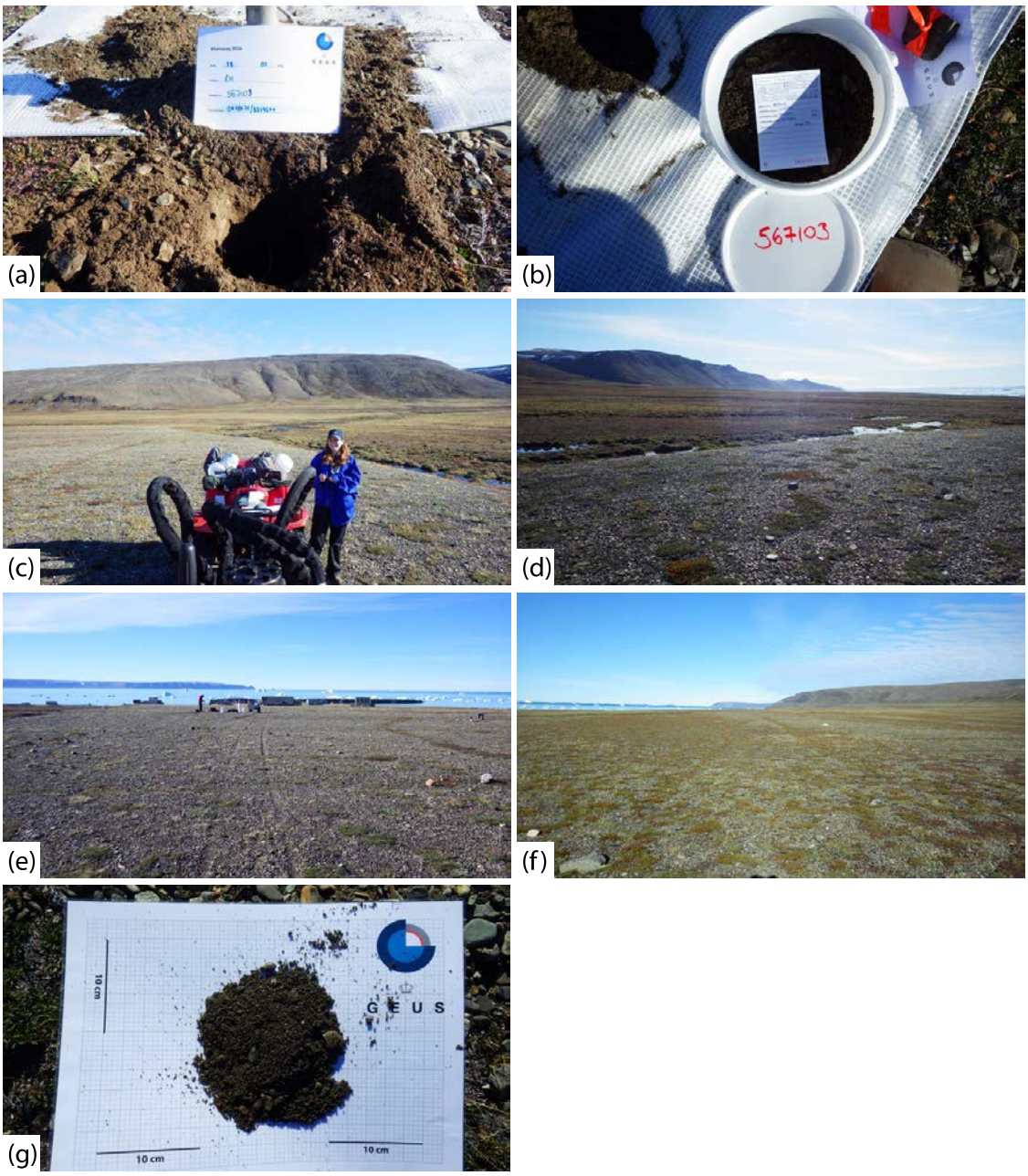

Figure 6. *An example of the photo-documentation made for each site prior to logging of the material by the geologist. (a) Photograph of the hole. The information on the white board includes the date, driller's initials, sample number and UTM position. (b) Photograph of the sample in the sample bucket, with sample tag and sample name written on the lid of the bucket. The sample number was also written on the side of the bucket. (c-f) Views N, E, S, W from the sample site. (g) Photograph of the sample material on a scale sheet.*

3.5 Sample security

Sealed samples were left next to each drill location to make it easier for the geologists following the auger drilling / trench digging team to locate the hole. At the end of each working day, the samples were collected and transported to the onshore base camp where they were weighed. They were then immediately transferred to Kisaq for secure storage. At the mid-point and end of the field season, all samples within the field area were taken to the settlement Qaanaaq by GEUS personnel and placed into a shipping container that was then securely padlocked. At the end of the field season the container was additionally secured with a customs seal.

4. Results

4.1 Sedimentary material

A total of 244 samples were taken from the onshore region. These samples comprise:

- 192 unique auger samples
- 40 samples from trenches
- 12 duplicates.

A generalized description of material observed on the active and raised terraces is presented below. This description is based on field notes and is intended to give the reader a general impression of the sediment within the study area. For detailed results, the reader is referred to Appendices 1–6 for maps of the sample localities; Appendices 7–9 for descriptions of individual samples; and Appendices 10–11 for sedimentary logs of trenches in the Moriusaq and Iterlak areas.

In general, the sediment in the study area consists of medium- to coarse-grained sand that is moderately sorted and sub-rounded. Gravel is a common component of the sediment across much of the area, typically accounting for approximately 5% of a sample. Outsized clasts are generally of tabular habit, and measure in the range of 5–7 cm along the long axis and 1-1.5 cm along the shortest axis. Visual estimates of the heavy metal content of the bulk sand vary between 10% and 80%; the metallic fraction of most of the material, however, appears to fall in the range 20–40%. It is important to note that these percentages are visual guesstimates. Quantitative chemical analyses of the sediment are needed to accurately determine the metallic fraction of the sediment and calibrate the guesstimations. Individual descriptions for samples are presented in Appendices 7–9. On the basis of the information available, there appears to be no systematic deposit-scale variation in the metallic mineral content of the sediment.

From the trenches it is evident that the sediment is often layered (Figure 7a). Layers are typically 10-20 cm thick, but can be thicker, and often exhibit internal structures that are weakly defined and horizontally oriented. Most commonly metallic sand is disseminated throughout a given layer and occurs alongside minerals such as feldspar and clinopyroxene. Observations from the active beaches show that some layers are several tens of centimetres thick and are composed of nearly pure metallic sand (Figure 7b). Two other features commonly observed in the trenches include (i) a thin pebble pavement at the surface or at a discrete horizon within the trench; (ii) a notable increase in the metallic fraction of the sand close to the top of the permafrost.

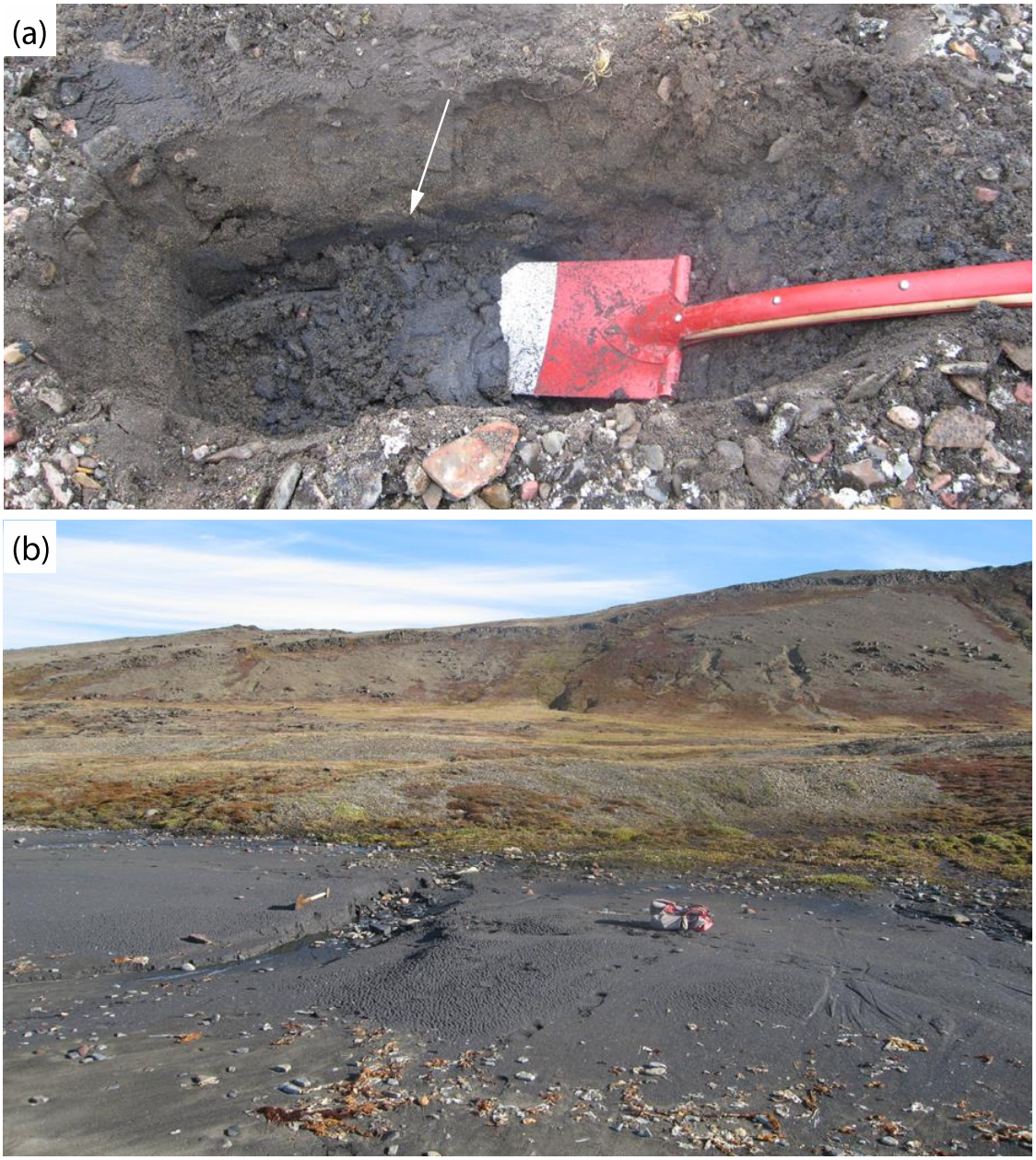

Figure 7. *Photographs showing different ways in which black metallic sands are distributed throughout the beach sediments. (a) Arrow indicates a 10 cm thick layer of nearly pure metallic sand. A 30 cm thick containing approximately 25% metallic sand overlies this high-purity layer. (b) Photo shows an active beach capped by a layer of near-pure metallic sand that is at least 30 cm thick.*

4.2 Sedimentary processes and environments

4.2.1 Near-shore and recent beach dynamics

The foreshore and backshore on the active beach zones is in often up to 25 m broad. On the landward edge, a steep cliff section 1–5m high often terminates the active beach zone. Field observations indicate that longshore drift processes play an important role in enriching beach sediments in dense, metallic grains. Shore parallel marine currents, generated by obliquely incoming waves, transport sand, gravel and pebbles along the shore. As the sediment is being transported, the interaction of wave swash, back-wash and coast-parallel currents winnows light density grains away from the beach. These processes increase the content of high-density grains and mineral phases on the active beach. High-energy storms can cause large stretches of the coast to be eroded. During these events, sand that is highly enriched in metallic grains may be transported from the shore onto the shoreface. This sediment will probably remain on the sub-marine shoreface and will not be transported to the active beach again.

Cliff sections found at the back of most beaches commonly consist of loose sand, pebbles and gravel, and in some cases, in-situ bedrock (Figure 8). In some places, the loose sedimentary material is derived from older coastal sediments (mostly sand) found inland of the active beach zone; in other places the loose material is sandy alluvial sediment with gravel and pebbles. Raised beach sediments often cap the cliff sections that expose bedrock. The overlying sediments can have thicknesses up to several metres. Section 4.3 discusses the thickness of the cover and depth to basement in more detail.

Two processes may have led to the formation of cliff sections at the back of active beaches. One possibility is that the cliff sections are a manifestation of recent storm events that have eroded the low-lying part of the original beach sand. A more likely alternative, however, is that the cliff sections are the result of past – and possibly still on-going – relative sea level rise. If this is the case, the cliff sections may support the interpretation that shore-parallel, submarine sand ridges on the near-shore sea floor are drowned beach ridges (Jensen & Rödel, 2015).

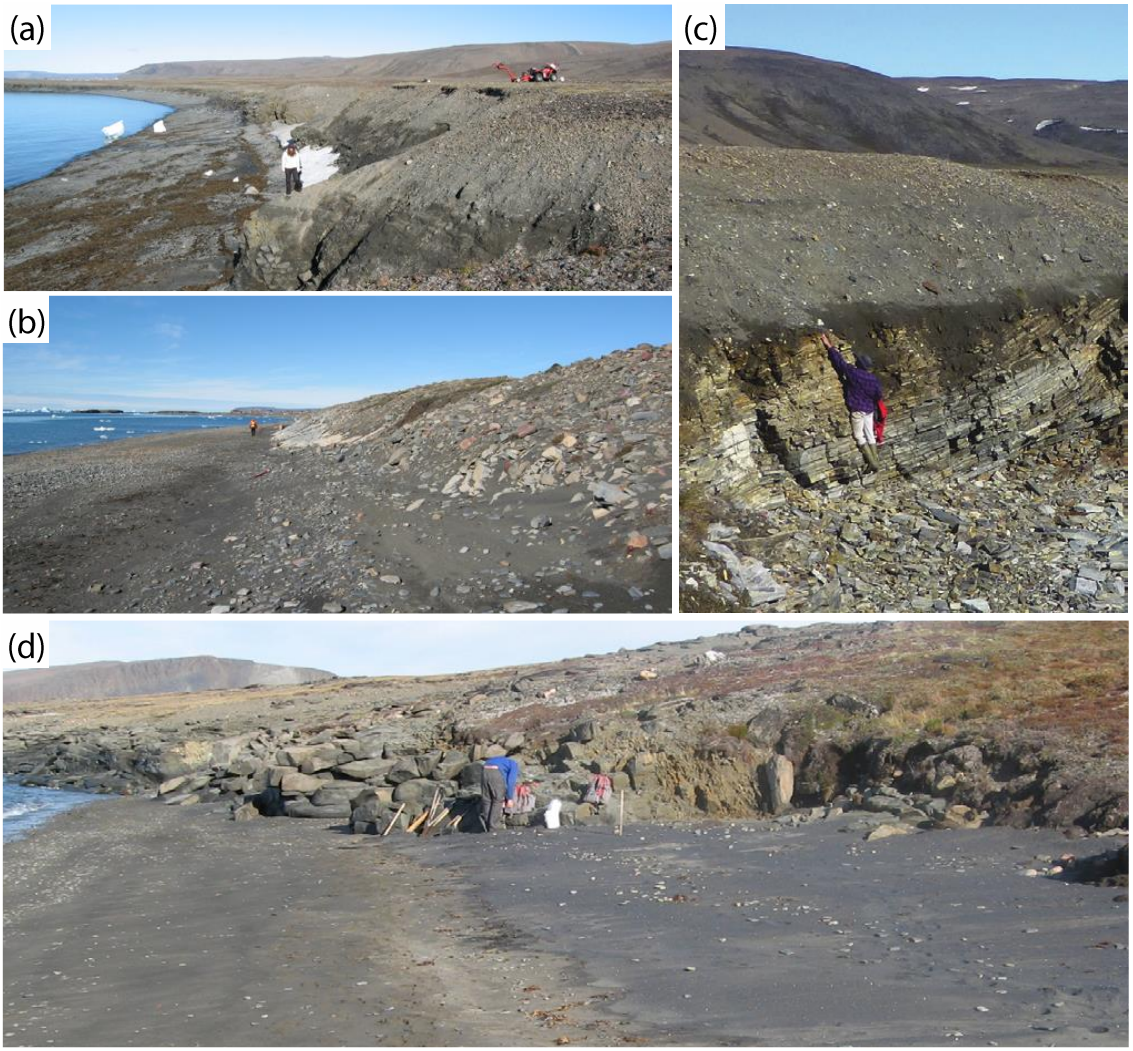

Figure 8. *Photos of cliff sections found at the back of active beaches. (a) 1.5 m cliff of dolorite capped by approximately 3 m of raised beach sediments. Photo taken east of Moriusaq. (b) 1m high cliff of basement rock close to Moriusaq capped by sandy sediment that contains blocks and cobbles. (c) A 3 m thick package of beach sediments overlying a 2.5 m high cliff of bedrock. Photo taken west of Moriusaq. (d) 1m high cliff of doloritic basement rock overlain by a wedge-shaped cap of sediments that appears to thicken inland. Photo taken close to Iterlak.*

4.2.2 Raised beach systems

Raised beach systems in the Pituffik area have been preserved by a relative sea level fall and marine regression that were triggered by recent melting, retreat of ice sheets and post-glacial rebound. Aerial photograph (Appendices 1-6) show that the raised beach systems are confined to a region, up to 1 km wide, that is bounded to the SW by the present shoreline, and by mountains to the NE. Close to the mountains, the raised beach systems reach an elevation of approximately + 50 m above sea level.

The aerial photos in Appendices 1–6 also show the region between the mountains and the recent shoreline is dominated by NW-SE trending, coast parallel lineaments. It is also possible to observe the lineaments when standing on the ground (Figure 9). Field observations indicate that many of these lineaments are strand terraces, or ancient shorelines. Heavy mineral concentrations probably occurred on each beach system by the processes outlined in section 4.2.1. The steepest seaward-facing beach ridges are interpreted as strand terraces. Strand terraces represents a period of marine erosion of the beach ridge. Possible causes of the erosion include (i) a period of still-stand in relative sea-level fall, (ii) periods with stronger storms from the southwest.

Figure 9. *An example of well defined lineaments on raised beach systems inland of Moriusaq.*

An important consequence of mechanism (i) is that erosion will remove beach sand that is already enriched in metallic minerals from raised terraces to the active beach, where nearshore and active beach processes will further increase the concentration of metallic minerals in the sediment. A result of mechanism (ii) is that storms may lead to an increase in the concentration of heavy minerals in the shore face. Only a few well-developed beach ridges with well-developed swales in between were observed on the raised beach system as well as at recent active beach systems.

In some places the raised beach systems are capped by a pebble-strewn surface (Figure 10). These surfaces result from wind erosion of loose sand from in between the pebbles. The remaining pebbles consequently settle to form a pavement. Once the pavement is

established, erosion of any loose material is severely reduced. Figure 11 provides a schematic summary of the occurrence of pebble strewn-surfaces and the morphology of the raised beach systems. The implications of wind erosion for the thickness of the raised beach systems are currently unknown. One possible consequence of wind erosion, however, is that it preferentially removes less dense mineral phases from the sand, and therefore leads to an increase in the fraction of metallic grains in the sediment.

Figure 10. *Example of a pebble-strewn surface close to Iterlak.*

4.2.3 Fluvial systems

The onshore region west of Iterlak is characterized by several river systems that transport sediment south-westwards from the mountains and raised beach systems to the coast. In the mountains inland of Moriusaq the major fluvial systems are generally narrow, but become broader and braided in the region between the hills and the active beach. The braided character of the rivers starts at the highest lying raised beach complex at the foot of the hills. Approximately 300 m inland of the coast, the braided river systems often lose their character and converge to form several narrow rivers systems that flow to the coast.

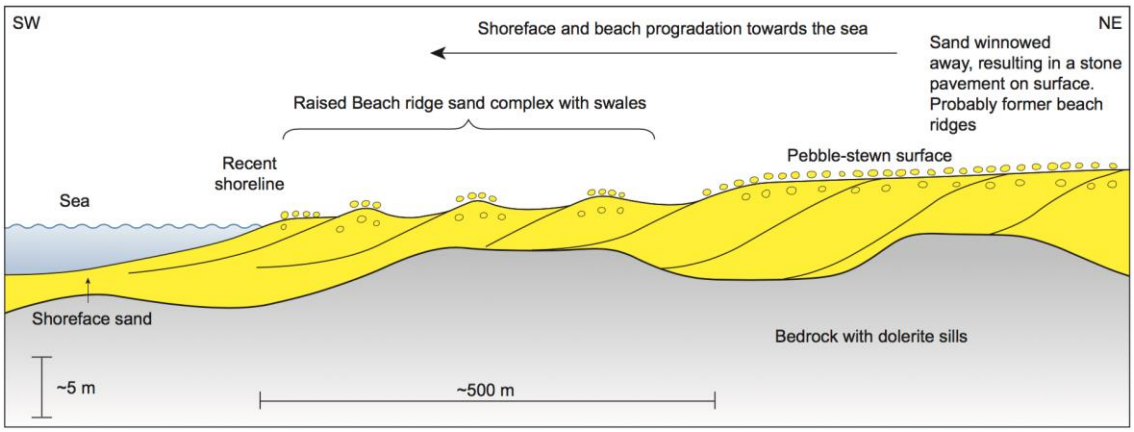

Figure 11. *Schematic illustrating the morphology of the raised beach systems and the occurrence of pebble-strewn surfaces. Pebble-strewn surfaces are generally confined to local topographic highs, such as beach ridges.*

Since the braided rivers cut through and erode the raised beach systems, they play an extremely important role in increasing the concentration of ilmenite in the Pituffik placer system. Because the raised beach systems are already enriched in ilmenite and other heavy minerals from when they were active, the river systems transport pre-enriched ilmenite-bearing sand to the active beaches. On the active beaches, wave swash, back wash and coast-parallel currents refine this sediment further still, and produce an even higher purity ilmenite-rich sand. It might be expected, therefore, that the raised beaches represent a series of positive feedbacks, whereby any given beach system is more enriched in ilmenite than ones at higher elevations. However, there is currently no field data to support this hypothesis. A second important point is that some of the sediment eroded by the rivers does not reach the active beach zone, and is instead trapped within the river system itself. In the field it was noted that some river systems contain sediments that are highly enriched in metallic minerals. Thus the fluvial systems themselves may also be prospective.

The coastward change in morphology of the fluvial system within the area of raised beach systems from braided to narrow is not yet fully understood. Superficially, the change in morphology reflects a change in slope of the land surface: the region in which braided river systems exist dips more gently towards the sea than the region within 500 m of the present shoreline. However, the reason for the change in slope of the land surface is unclear. One possibility is that it reflects a feature of the basement, such as the presence of a fault, dyke or sill, or erosion profile of the bedrock.

4.3 Depth to basement

In several cliff sections along the coastline, beach sediments were observed to overlie the basement. The cover is of variable thickness. Some of the best outcrops are in Moriusaq bay; here the cover is approximately 3 m thick (Figure 8). Figure 12 shows a schematic interpretation of the situation at Moriusaq. Several stream sections also indicate that the

raised beach systems can also have thicknesses of at least a few metres (Figure 13). Generally, however, there are few places inland of the coast where the full sediment thickness can be observed. Figure 14 shows part of the sedimentary package that makes up the angle foreland at Iterlak, which appears to be approximately 12 m in thickness.

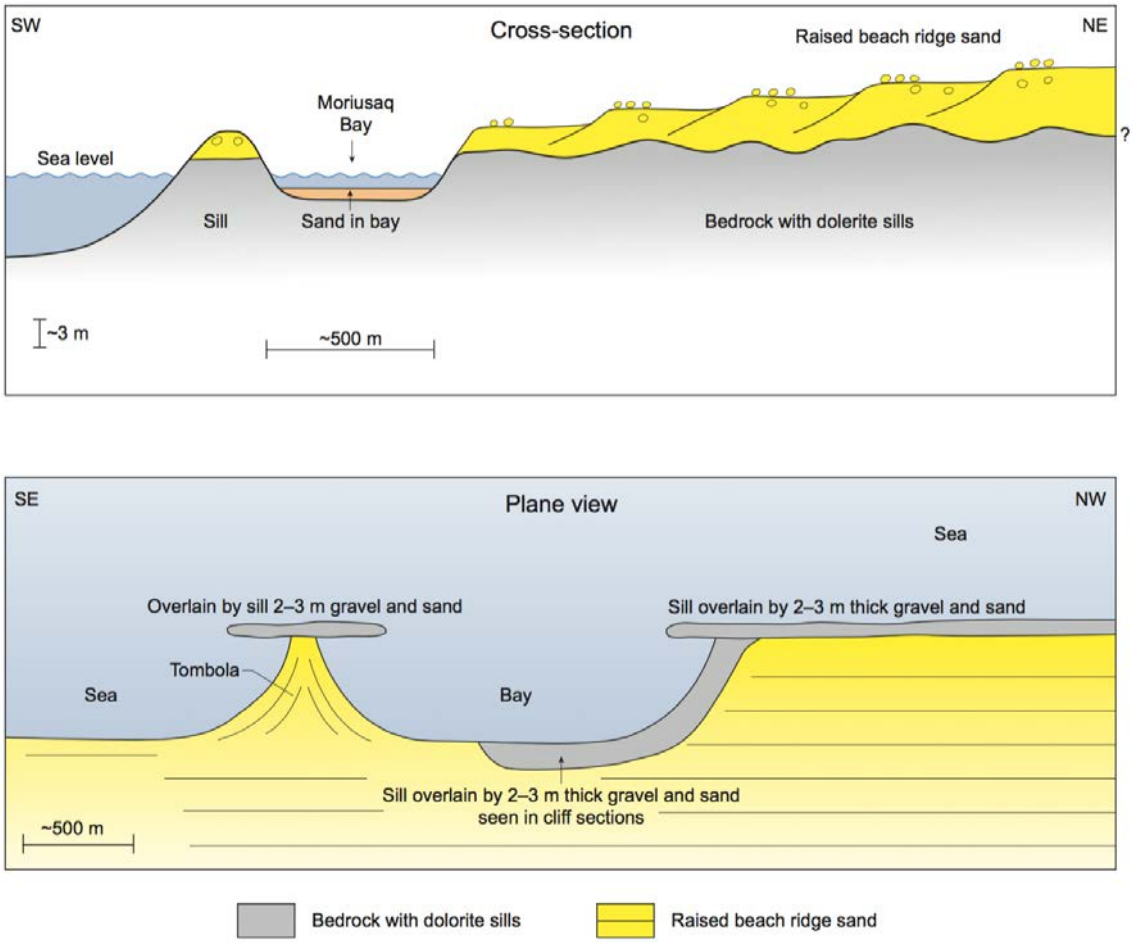

Figure 12. *Schematic interpretation of the raised beach system inland of Moriusaq. Top: NE-SW oriented cross section through the raised beach and coastal system at Moriusaq. The bay is separated from the sea by a sill that is overlain by an approximately 3 m thick cap of raised beach sediments. On the landward side, the undulating top to the bedrock indicates that the depth to the bedrock is uncertain. Bottom: Plan view of the area around Moriusaq bay. The grey areas indicate the places where 2–3 m of raised beach sediments were observed to overlie the bedrock.*

Figure 13. *Stream cut through the raised beach systems inland of Moriusaq exposing a scarp approximately 3 m high that is built entirely of sediment.*

Figure 14. Photograph of the sedimentary package that makes up the angle foreland at Iterlak. At this location the package is approximately 12 m thick.

4.4 Relative sea level rise and fall

The onshore sediments in the Pituffik area preserve a record of long-term relative sea level fall. However, some observations in the fluvial systems indicate a more complicated relative sea level history. At one of the major fluvial systems, c. 2 km WNW of Moriusaq, three beach sand systems are observed to cut or overlie the braided river system (Figure 15). This indicates that the beach sand complexes here are younger than the braided river system. To generate the observed cross cutting relationships, there must have been a short period of relative sea-level rise, which transgressed the older fluvial sediments and probably also the older beach systems. After this short episode of transgression, the regression resumed and the relative sea-level adjusted to its present position. Owing to the action of waves on former strandlines and hydrodynamic processes in the active beach zone, the net effect of transgression and subsequent regression may be enrichment of heavy minerals in the young regressive beach system. Similar small transgressions may have occurred several times in the older and higher-lying part of the regressive beach system, although none are presently recognized. The fact, however, that beach systems related to a transgression occur close to the present shore line raise the possibility that further, drowned beach systems exist in the near-shore marine environment, and give weight to the interpretation by Jensen & Rödel (2015) that a submarine, elongate beach system exists offshore.

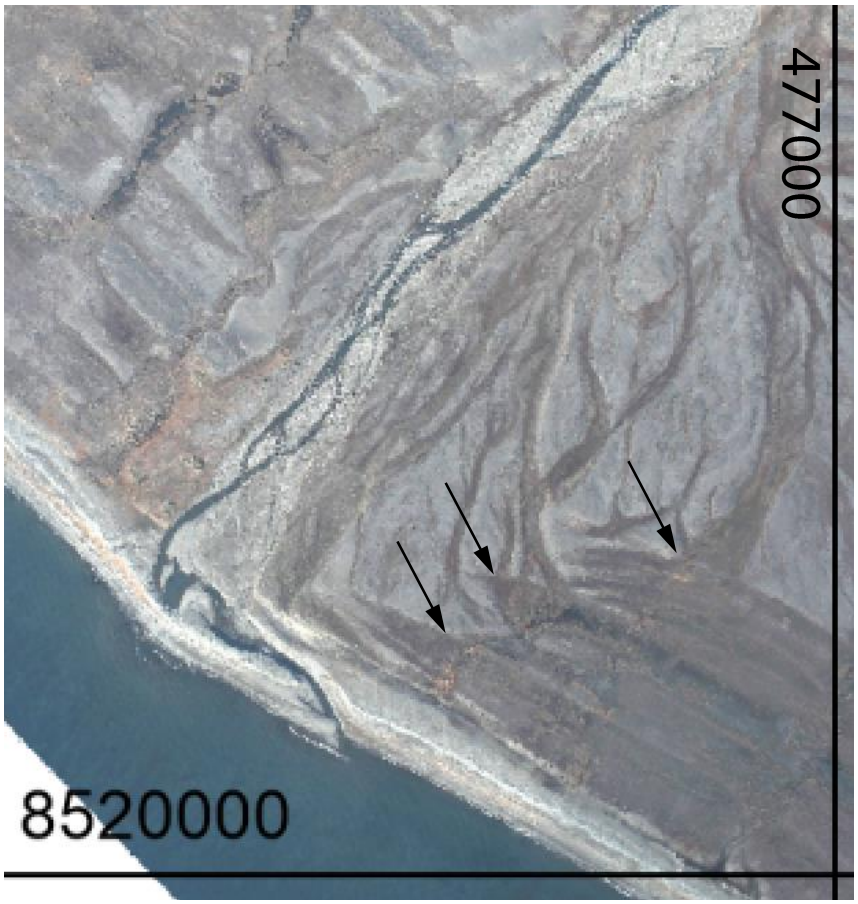

Figure 15. *Aerial photo showing part of the fluvial system located 2 km NWN of Moriusaq. The three black arrows indicate locations where the beach sand complexes cross-cut and overlie the braided river system. The beach sand complexes at this locality are younger than the fluvial system and indicate a marine transgression.*

To place constraints on the overall sea level curve, several samples were taken from the raised beach systems for optically stimulated luminescence (OSL) dating. Results are expected in late 2017. Additionally a whale bone found onshore at E 0477128, N 8520238, at a present day elevation of 16 m was radiocarbon dated to 7450 +/- 30 BP. The position of the whale bone is unrelated to the small transgression detailed above.

4.5 Sediment transport direction

The transgression-regression-related beach systems shown in figure 14 extend across the top of the braided river system for more than 150 m in a northwesterly direction. This indicates that the dominant sediment transport direction during that time period was towards the northwest. Observations of particle movement on the active beach during the field season also indicated a present day transport direction towards the northwest. In contrast, the river system 2 km NW of Moriusaq is observed to bend towards the east at the active beach, immediately before entering the sea, suggesting sediment transport towards the east. This feature, however, may represent a day to day situation, rather than a permanent feature, and could be removed by storms on a time scale of a few years.

5. Summary

244 samples were taken from the onshore study region at Pituffik during the 2016 field season. These samples and field observations indicate that the raised and active beach systems contain a significant fraction of metallic grains. Previous laboratory investigations show that the metallic component of the sediment in the Pituffik region is dominantly ilmenite. Estimates of the metallic contents of samples collected in 2016, provided in Appendices 7–9, fall typically in the range 20–40%, but can be higher than 80%.
Coastal cliff sections and stream cuts indicate that the thickness of the cover is variable. In the Iterlak area, some cliff sections appear to show that the cover is approximately 1 m thick at the shore and thickens inland. In the Moriusaq area, cliff sections along an approximately 2 km stretch of coastline are capped by a 2-3 m thick layer of sedimentary cover. The average thickness of the cover is presently unknown. The sediment body making up the angle foreland at Iterlak is possibly to closer to 12-15 m thick.

At Pituffik, field observations revealed the key processes that concentrated ilmenite in the placer system. The formation of the placer system is characterized by a positive feedback that involves

(i) erosion of raised beach systems that are pre-concentrated in ilmenite and other heavy minerals, and transport of that sediment to the active beaches,
(ii) further enrichment, or up-concentration, of heavy minerals in the eroded sediment on the active beaches by wave swash, back wash and longshore transport,
(iii) preservation of the active beach sediments by long-term marine regression or transgression.

These processes repeatedly rework and enrich ilmenite in the beach systems and result in a high-grade placer deposit.

At Pituffik, the raised beach systems can be eroded by (i) braided river systems and (ii) storm and wave action on the active strandline, which may occur in the context of both marine regression and transgression.

Whilst the onshore beach systems document a long-term marine regression, cross cutting relationships require that it was punctuated by intermittent periods of marine transgression. This observation lends further support to the proposition that drowned beach systems exist in the near-shore submarine environment.

6. Recommendations

Extensive sampling of the top metre of onshore and active beach systems revealed the widespread occurrence of sediments that are strongly enriched in metallic grains. Whilst the thickness of the sedimentary cover is in most places obviously greater than 1 m, the average thickness is unknown. On this basis it is recommended to sample the sediments to greater depths using a technique that can penetrate through the sedimentary cap to basement.

It is also recommended that the data presented in this report is merged with, and reinterpreted in the context of results from the Ground Penetrating Radar survey, offshore geophysics, onshore and offshore sampling programs in 2015 and 2016.

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Appendix

Appendix 1

Pituffik Titanium Project 2016

Auger Samples
General overview

Sampling position

477000
478000
479000
480000
481000
8520000
8519000
8518000

0 1
kilometers
Scale: 1:12500

GEUS

Appendix 2

Pituffik Titanium Project 2016

Auger Samples, Moriusaq

Sampling Position

570850 570851 570852 570849 570853 570848 570854 570847 567132 570845 570855 567133 570860 570856 567134 567131 570891 570859 570892 567135 567130 570858 570893 567129 570894 570857 570866 570895 567128 570867 570896 570868 567126 570897 570872 570877 567112 570871 570878 567127 570898 567111 570870 569401 570879 570869 567110 570881 570880 567109 570890 567101

567116 570862 567117 570863 567118 570864 567119 570875 567115 567120 570874 567114 567123 570873 570876 567113 567124 570886 567106 570887 567104 570883 567107 570888 567103 570882 567125 570889 567108 567102

569403 567145 567142 567143 567146 567147 569402 567148 567149 567165 567151 567150 567152 567162 567160 567158 567157 567156 567153 567155 567167 567154 567137 567140 567138 567136

0 0.5

kilometers

Scale: 1:6000

8520500 8520000 8519500 8519000

477000 477500 478000 478500

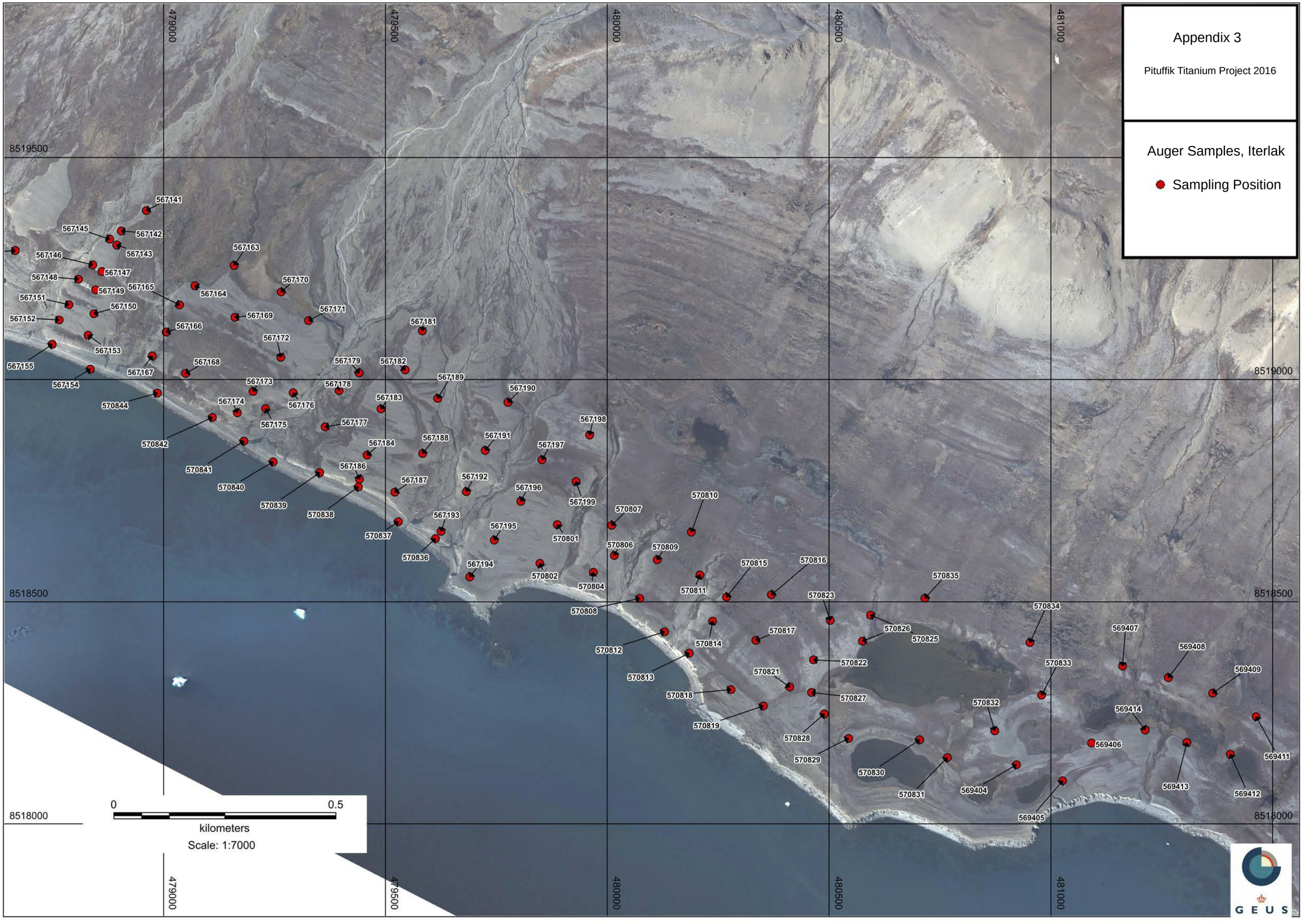
GEUS

Appendix 3

Pituffik Titanium Project 2016

Auger Samples, Iterlak

● Sampling Position

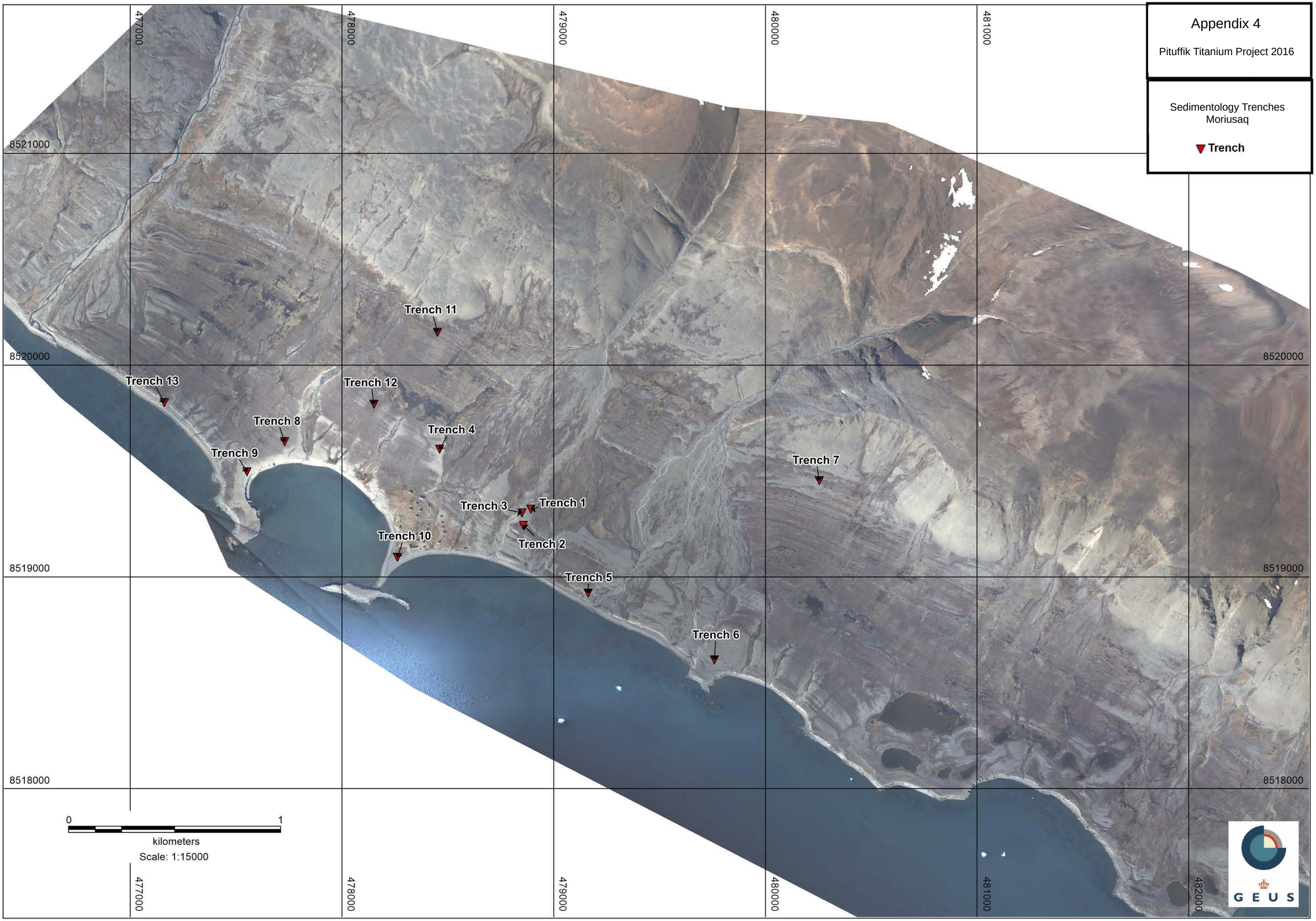


Appendix 4

Pituffik Titanium Project 2016

Sedimentology Trenches
Moriusaq

▼ Trench



Appendix 5

Pituffik Titanium Project 2016

Trench

492500

493000

493500

494000

8512000

8511500

8511000

569415
569416
569417
569418
569419
569420
569421
569422
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569436
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569438
569439
569440
569442

0
0.5
kilometers
Scale: 1:5000

GEUS

Appendix 6

Pituffik Titanium Project 2016

Metallurgy
Sample Trenches

Sample position

480000
482500
485000
487500
490000

8520000
8517500
8515000

16BMS003
16BMS004
16BMS008
16BMS005
16BMS007
16BMS006
16BMS010
16BMS011
16BMS009
16BMS001
16BMS002

0 2
kilometers
Scale: 1:30000

GEUS

Appendix 7

Auger Sample Notes

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
567101	16JAD001	478413.54	8519455.02	13.59	dgps	1	Coarse part of medium - grained sand. Badly sorted. 3.5x3.5x0.5cm outsized clasts. 5x3x2cm outsized clasts. 3.5x2x2.5cm outsized clasts. The sample is taken on the most seaward side of the broad beach ridge.	
567102	16JAD002	478443	8519547.62	18.25	dgps	1	Fine grained part of coarse grained sand. Pebbles: 2x3x2.4cm 2x1.5x4cm. Badly sorted	
567103	16JAD003	478469.99	8519642.75	19.55	dgps	1.1	Badly sorted. Fine part of coarse grained sand. Outsized clasts 2x1x1.5cm 3x2x1.5cm 4x2x2cm. Sand = Medium Sand (Fine part) to coarse-grained (coarse-grained part)	
567104	16JAD004	478482	8519721		gps	1	Badly sorted. More silt-clay taken than other samples today. Coarse with part medium grained sand. The sand is tighter due to more fine-grained silt and clay. Outsized clasts 6x5x3.5cm. 4x3x3cm. 8x6x1cm.	Sample is taken 20m from a creek (20m broad) with running water and vegetation…… ?
567105	16JAD005	478265.22	8519849.58	20.17	dgps	0.5	Coarse - medium grained. At the boundary of these two grain sizes. Outsized clasts 4x2x1.5cm. Sub-rounded to rounded. 3.5x2x0.5cm outsized clasts. 1x1.5x2cm outsized clasts. Moderately sorted. 10% gravel.	
567106	16JAD006	478216.54	8519764.41	19.41	dgps	1	Medium to coarse grained. Sub-rounded. 3x2.5x4cm outsized clasts. Moderalely sorted. 10% gravel.	
567107	16JAD007	478176	8519637		gps	1	Coarse grained (Fine part of coarse grained sand). Outsized clasts: 4x3x1cm 2x3x1.5cm 2.5x1.5x1cm. 20% Gravel in sand.	
567108	16JAD008	478142.25	8519580.66	10.62	dgps	1	Medium grained (coarse grained part of medium grained sand). Sorting of sand is much better than samples 1-2-3-4. Well rounded sediment grains. Outsized clasts: 9x6x3cm 6x4x0.5cm 3x3x1cm	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
567109	16JAD009	478077.93	8519514.01	6.31	dgps	1	Medium grained (coarse part of medium grained sand) 5.5x2x5cm diameter of clast.	
567110	16JAD010	477799.3	8519548.67	4.33	dgps	0.8	Coarse grained with gravel (10% gravel). Rounded grained. Outsized clasts: 4.5x3x1cm 4x3x0.5 cm 3x2.5x1cm. Modeately sorted.	
567111	16JAD011	477800.62	8519642.58	9.37	dgps	1	Medium sand (at the border of fine to medium). No pebbles in well. 3x2.5x1cm outsized clasts in pile of sand. May come from the surface which is covered in pebbles. 5% gravel. Well sorted. Rounded to well rounded.	
567112	16JAD012	477881.26	8519726.61	12.55	dgps	0.8	Medium grained (coarse part of medium-grained) 5x3.5x1cm outsized clasts. Moderately sorted.	
567113	16JAD013	477918.68	8519819.04	16.46	dgps	0.7	Coarse part of medium grained sand. NO gravel. Outsized clasts: 3.5x3x1cm 2.5x2.5x1cm 4x3x1cm. Rounded. Well-sorted. No pebbles on the inner side of bore hole.	
567114	16JAD014	477964.16	8519905.45	20.96	dgps	0.9	Medium grained (coarse grained part of medium grained sand). Less than 5% gravel. Outsized clasts: 4.5x2.5x1cm 7x3.5x1.5cm 4x3x1cm. Outsized clasts in bore hole wall. Moderately sorted.	
567115	16JAD015	478032.47	8520001.23	22.81	dgps	0.8	Coarse grained sand (fine and coarse part of the coarse-grained sand). Poorly sorted. Subangular sand and gravel grains. 5-10% gravel grains. Outsized clasts: 4x3x2cm 4x3x1cm 2.5x2x1.5cm	Could not feel any outsized clasts in the wall of the well.
567116	16JAD016	477922.61	8520236.51	28.53	dgps	0.85	Coarse grained sand (fine part). Large outsized clasts in bore hole wall. Poorly sorted and sub-rounded sand grains. Outsized clasts: 8x4x4cm 3x3x2cm 3x3x1cm 7x4x3cm. 5-10% gravel. 3-5mm diam.	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
567117	16JAD017	477863.42	8520154.55	24.55	dgps	0.8	Coarse grained sand (fine part). Many gravel clasts: 4-6cm diameter. 10-15% gravel. Poor sorting. Sub rounded sand. Outsized clasts: 5x4x3cm 5x2x1cm 3x2x0.5cm.	
567118	16JAD018	477804.26	8520073.39	21.4	dgps	0.9	Between the boarder of medium grained sand and coarser-grained sand. Moderately sorted. Rounded sand. Outsized clasts: 5x7x3cm 5x1.5x1cm 3x1x1cm	
567119	16JAD019	477726.07	8520013.31	17.83	dgps	0.8	Coarse grained (fine - grained part) sand. Moderately sorted. Sub-rounded. Outsized clasts: 5x3x1cm 5x3.5x1cm 3x4x1cm	Could not feel any outsized clasts in bore hole wall.
567120	16JAD020	477669.54	8519933.48	18.37	dgps	0.8	Coarse part of medium grained sand. Well sorted, well rounded sand. Outsized clasts: 3.5x2.5x1.5cm 3x2x1cm 3x2x0.5cm. Very few outsized clasts.	
567121	16JAD021	477669.54	8519933.48	18.37	dgps	0.8	Duplicate	Duplicate
567122	16JAD022	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	
567123	16JAD023	477594.83	8519868.3	13.99	dgps	0.85	Sand is medium grained (between coarse and fine medium grained sand). Sand fraction is moderate to well sorted. Outsized clasts: 5x4x0.5cm 5x5.5x2cm 5x4x1cm	Hole filling w.water. Could not feel outsized clasts in stones on the inner side oof borehole.
567124	16JAD024	477526.33	8519794.39	11.93	dgps	0.75	Medium grained sand (the coarse part of medium grained sand). Sand fraction = well sorted. Could feel stones on inner side of borehole. Sand fraction = rounded. Outsized clasts: 4x3x0.5cm 3x3.5x2.5cm 4x2.5x0.5cm.	
567125	16JAD025	478463	8519603		gps	1		Met trench 1. Sample taken from permafrost layer
567126	16JAD026	477444.66	8519725.76	8.01	dgps	1	Boundary between medium and coarse grained sand. Moderately to poorly sorted. Sand fraction = sub-rounded. Felt a few pebbles in well. Outsized clasts: 5x4x1cm 3x2x1cm 3x2.5x1cm.	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
567127	16JAD027	477349.18	8519644.7	2.78	dgps	1.1	At the medium to coarse grained booundary. Well - moderately sorted sand. Outsized clasts: 2x1.5x0.5cm 2x3x0.5cm 2x2x0.5cm.	Lots of pebbles on surface
567128	16JAD028	477161.28	8519823.42	3.82	dgps	1.1	Medium grained sand (coarse part). Moderately sorted sand grains. Rounded sand grains. Outsized clasts: 6x4x1cm 5x4x1cm 5x3x0.1cm	Banding visable all through drill sample
567129	16JAD029	477218	8519919		gps	0.8	Coarse grained sand (fine part). Moderately sorted. Sub-rounded grains. Outsized clasts: 4x4x0.5cm 3x4x1cm 4x2x1cm	Hit Permafrost
567130	16JAD030	477325.06	8520010.75	9.87	dgps	0.6	Medium grained. Moderately sorted sand. Sub rounded sand. Outsized clasts: 10x10x1cm 9x6x3cm 7x5x1cm	Noticably finer and darker sample than others today
567131	16JAD031	477404.97	8520072.06	12.39	dgps	0.75	Medium grained. Poorly sorted. Sub rounded sand. Outsized clasts: 5x4x0.5cm 4.5x3.5x1cm 4x3.5x1cm	
567132	16JAD032	477237.17	8520258.46	8.78	dgps	1	Medium grained (coarse part). Moderately sorted. Subrounded sand grains. A fer outsized clasts seen in bore hole wall. Outsized clasts: 6x4x1.5cm 5x3x1.5cm 4.5x4x1cm	Pebbles on surface
567133	16JAD033	477160.72	8520184.09	8.02	dgps	0.8	Medium grained sand (coarse part). Rounded sand grains. Moderately sorted. Outsized clasts: 3x3x0.5cm 7x5x1cm 7x5x0.5cm	
567134	16JAD034	477085.66	8520113.64	5.17	dgps	0.7	Coarse grained sand. Moderately sorted. Subrounded. Outsized clasts: 5x4x0.5cm 7x4x1cm 7x5x2cm	Lots of pebbles above and below surface making drilling very difficult
567135	16JAD035	476998.29	8520029.12	0.08	dgps	0.65	Medium grained. Rounded sand grains. Moderately sorted sand. Outsized clasts: 10x7x1cm 12x9x1cm 11x7x1cm	Lots of pebbles above and below surface making drilling very difficult
567136	16JAD036	478168	8518973		gps	1.5		
567137	16JAD037	478154	8519011		gps	1		
567138	16JAD038	478221	8518986		gps	0.6		
567139	16JAD039	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
567140	16JAD040	478265	8519029		gps	0.6		
567141	16JAD041	478961.11	8519380.97	20.73	dgps	1.1	Medium grained (coarse part). Moderately sorted. Subrounded sand grains. 20% gravel. Outsized clasts: 4x2.5x1.5cm 4x3x1cm 5x2x1.5cm	
567142	16JAD042	478904.71	8519334.93	21.18	dgps	1.1	Boundary between medium and coarse grained sand. Moderately sorted sand. Subrounded sand grains. Outsized clasts: 5x3x1cm 5x3x1cm 4x2x2cm	
567143	16JAD043	478894.34	8519303.34	20.15	dgps	1.1	Medium grained sand (fine part). 10% gravel, Moderately sorted sand. Subrounded sand grains. Outsized clasts: 7x7x1cm 6x7.5x4.5cm 7x5x1cm	
567144	16JAD044	478894.35	8519303.31	20.18	dgps	1.1	Duplicate	Duplicate
567145	16JAD045	478878.61	8519316.44	23.27	dgps	1.1	Boundary between medium and coarse grained sand. 10% gravel. Moderately sorted sand. Sub rounded sand grains. Outsized clasts: 5.5x4x2cm 5x4x2cm 4.5x2.5x1cm	
567146	16JAD046	478840.48	8519258.94	16.19	dgps	1.1	Coarse grains. Moderately sorted sand. Subrounded sand. Outsized clasts: 5.5x3.5x1.5cm 4x3x2.5cm 4x3x2cm	
567147	16JAD047	478861.04	8519244.03	13.79	dgps	1	Fine grained part of coarse grained sand. Moderately sorted sand. Rounded sand. Outsized clasts: 8x3x1.5cm 3x2x1.5cm 4x4x3cm	
567148	16JAD048	478808.36	8519226.8	14.2	dgps	0.9	Coarse grained (fine part). Moderately sorted sand. Subrounded sand. Outsized clasts: 1.5x4x3cm 3x2x1cm 3.5x3.5x1cm	
567149	16JAD049	478847.1	8519202.83	13.68	dgps	0.65	Mid part of medium grained sand. Subangular sand. Poorly sorted sand. Outsized clasts: 2x3x1.5cm 4x2x0.5cm 3.5x2x1cm	
567150	16JAD050	478843	8519149		gps	1.1	Medium grained. Moderately sorted sand. Rounded sand. Outsized clasts: 7x4x2cm 5x4x1cm 4.5x3.5x7cm	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
567151	16JAD051	478786.93	8519169.41	8.62	dgps	1.1	Medium grained. Moderately sorted. Subrounded. Outsized clasts: 6xx5x2cm 7x3x3.5cm 5x3x1cm	
567152	16JAD052	478764.71	8519134.85	7.68	dgps	1.1	Medium grained sand (coarse part). Gravel. Moderately sorted sand. Subrounded sand. Outsized clasts: 4.5x2.5x1cm 5.5x4x1.5cm 7.5x3x1cm	
567153	16JAD053	478829.86	8519100.3	7.07	dgps	1.1	Medium grained sand. Well sorted. Rounded. Outsized clasts: 4.5x4x1.5cm 4.5x2.5x2cm 5.5x3.5x1cm	
567154	16JAD054	478835	8519024		gps	0.8	Medium grained.	
567155	16JAD055	478749	8519080		gps	0.9	Fine - medium grained sand	
567156	16JAD056	478612	8519109		gps	0.65	Fine - medium grained sand	
567157	16JAD057	478262.66	8519092.67	0.63	dgps	0.9	Fine - medium grained sand	
567158	16JAD058	478227	8519092		gps	0.9	Fine - medium grained sand	
567159	16JAD059	478227	8519092		gps	0.9	Duplicate	Duplicate
567160	16JAD060	478240	8519150		gps	0.85	Fine - medium grained sand	
567161	16JAD061	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	
567162	16JAD062	478247.15	8519209.94	-0.28	dgps	1.1		
567163	16JAD063	479159.04	8519257.72	22.61	dgps	1.1	Coarse grained sand (fine part). Soil not much sand. Poorly sorted sand. Rounded sand. Gravel 5-10%. Outsized clasts: 4x2.5x1cm 3x2.5x1.5cm 6x3x1.5cm	
567164	16JAD064	479070.45	8519212.09	22.85	dgps	1.1	Coarse grained sand (fine part). Moderately sorted. Rounded sand. 10% gravel. Outsized clasts: 5x3x2.5cm 7x4.5x1cm 4x3.5x1cm	
567165	16JAD065	479035.96	8519168.73	18.6	dgps	0.9	Medium grained (coarse part) sand. Moderately sorted. Rounded. Outsized clasts: 5x6x2cm 5x3x2.5cm 5x3.5x2cm	
567166	16JAD066	479006.06	8519107.6	12.45	dgps	1.1	Medium grained (coarse part). Well sorted sand. Rounded sand. 10% gravel. Outsized clasts: 8x5x10cm 2.5x2x1cm 3x2.5x0.5cm	
567167	16JAD067	478974.46	8519054.29	8.56	dgps	1.1	Medium grained sand (coarse part). Well sorted sand. Rounded sand. Outsized clasts: 4x3x2cm 4x3x1cm 4x2x1cm	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
567168	16JAD068	479049.66	8519014.33	9.57	dgps	1.1	Coarse grained (fine part). Moderately sorted sand. Subrounded sand. Also gravel. Outsized clasts: 4x2x1cm 6x3.5x2cm 6x2.5x0.5cm	
567169	16JAD069	479160.89	8519140.94	20.69	dgps	1.1	Coarse grained (fine part). Moderately sorted sand. Subrounded sand. Outsized clasts: 8x7x1cm 4x5x2cm 6x3.5x1cm. 20% gravel	
567170	16JAD070	479264.97	8519198.05	23.61	dgps	1.1	Coarse grained sand coarse part. Moderately sorted sand. Rounded sand. 10-20% gravel. Outsized clasts: 5x5x1cm 8x3x1cm 3.2x2x2cm	
567171	16JAD071	479326.42	8519133.4	22.91	dgps	1	Coarse grained sand (fine part). Moderately sorted sand. Rounded sans. 10% gravel. Outsized clasts: 5x4x1.5cm 4x4x1cm 4x3.5x1.5cm	
567172	16JAD072	479264.27	8519050.79	18.5	dgps	0.6	Coarse grained (fine grained part). Moderately sorted sand. Rounded sand. Outsized clasts: 6x4x3cm 5x5x1cm 7x6x1cm	
567173	16JAD073	479201.5	8518973.65	8.49	dgps	0.9	Coarse sand (fine part). Moderately sorted sand. Rounded sand. 5% gravel. Pebbles in borehole wall. Outsized clasts: 10x4x1cm 7x5x1cm 5.5x3.5x1.5cm	
567174	16JAD074	479166.29	8518925.56	6.22	dgps	1.1	Medium grained sand (coarse part). Moderately sorted sand. Rounded sand. Less than 5% gravel. Outsized clasts: 7x6x1cm 5x3.5x3cm 5x3.5x0.5cm	
567175	16JAD075	479230	8518935		gps	0.7	Coarse grained sand (fine part). Rounded sand. Moderately sorted sand. 10% gravel. Stones seen in well wall. Outsized clasts: 6x4x3cm 6x4x4cm 4x3.5x2.5cm	
567176	16JAD076	479291.95	8518970.84	9.61	dgps	0.85	Coarse grained (fine part). Moderately sorted sand. Rounded sand grains. 5% gravel. Outsized clasts: 6x5x3cm 7x5x3cm 9x3x0.5cm	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
567177	16JAD077	479364.15	8518894.02	8.28	dgps	0.75	Coarse grained (fine part). Moderately sorted. Rounded sand grains. 10% gravel. Outsized clasts: 5x7x1cm 5x4x3cm 5x4x2cm	
567178	16JAD078	479395.46	8518975.7	14.79	dgps	1.1	Coarse grained (fine part). Well sorted sand grains. Rounded sand grains. 10% gravel. Outsized clasts: 7x2.5x2.5cm 6x4x3cm 5x6x1cm	
567179	16JAD079	479440.68	8519015.52	18.04	dgps	1	Coarse grained (coarse part). Moderately sorted sand grains. Rounded sand grains. 5% gravel. Outsized clasts: 5x4x2cm 5x2.5x2cm 8x4.5x1cm	
567180	16JAD080	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	
567181	16JAD081	479582.96	8519110.04	20.02	dgps	0.9	Coarse grained sand. Moderately sorted. Subrounded sand. 10-20% gravel. Outsized clasts: 6.5x5x1.5cm 5.5x3x1.5cm 3.5x3x3cm	
567182	16JAD082	479544.7	8519022.57	17.77	dgps	1.1	Coarse grained sand. Moderately sorted. Rounded sand. 10-20% gravel. Outsized clasts: 6x3.5x2cm 5x4x3cm 5.5x2x1cm.	
567183	16JAD083	479489.94	8518934.19	14.6	dgps	0.9	Coarse grained sand. Moderately sorted. Rounded sand. 10-20% gravel. Outsized clasts: 4x3x1.5cm 4x4x1cm 6x5x1.5cm	
567184	16JAD084	479458.56	8518830.25	10.24	dgps	1.1	Coarse grained sand. Moderately sorted. Rounded sand. 10-20% gravel. Outsized clasts: 6x4x3cm 7x6x1.5cm 4x4x1.5cm	
567185	16JAD085	479458.56	8518830.25	10.24	dgps	1.1	Duplicate	Duplicate
567186	16JAD086	479441.46	8518776.57	5.02	dgps	1.1	Coarse grained sand (fine part). Moderate sorting of sand. Rounded sand grains. 5-10% gravel. Outsized clasts: 6x6x1.5cm 3x3x2cm 4.5x3x1cm	
567187	16JAD087	479520.98	8518747.36	5.62	dgps	1	Coarse grained sand (fine part). Well sorted sand. Rounded sand grains. 5-10% gravel. Outsized clasts: 5x3x0.5cm 6x4x0.5cm 4.5x4x0.5cm	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
567188	16JAD088	479583.69	8518834.23	10.08	dgps	0.9	Coarse grained sand (fine part). Well sorted sand. Rounded sand grains. Less than 5% gravel. Outsized clasts: 6x5x1cm 4.5x4x1cm 5x3.5x1.5cm	
567189	16JAD089	479617.51	8518957.93	16.78	dgps	1	Coarse grained sand (coarse part). Moderately sorted sand. Rounded sand grains. 15% gravel. Outsized clasts: 6x3x3cm 5.5x4.5x2cm 5x4x1cm	
567190	16JAD090	479775.96	8518949.07	18.9	dgps	0.85	Coarse grained sand (fine part). Well sorted sand. Rounded sand grains. 10% gravel. Outsized clasts: 7x6x2.5cm 6x5x2cm 3.5x2x3cm	
567191	16JAD091	479724.75	8518840.93	13.46	dgps	1	Coarse grained (fine part). Moderately sorted sand grains. Rounded sand grains. 10% gravel. Outsized clasts: 6x5x1.5cm 6x3x3cm 6x4x1cm	
567192	16JAD092	479682.33	8518748.4	9.04	dgps	1.1	Coarse grained sand (fine part). Moderately sorted sand. Rounded sand grains. Outsized clasts: 6x4.5x0.5cm 5.5x4x0.5cm 3x4x1cm	
567193	16JAD093	479625.41	8518659.55	2.49	dgps	0.9	Coarse grained sand (fine part). Moderately sorted sand. Rounded sand grains. 10% gravel. Outsized clasts: 6.5x4x1cm 7x4x3cm 4x3x2cm	
567194	16JAD094	479690	8518557		gps	0.6	Coarse grained (fine part). Moderately sorted sand grains. Rounded sand grains. 30-40% gravel. Pebbles in well wall. Outsized clasts: 3.5x4x1cm 7x4x3cm 7x4x1cm.	
567195	16JAD095	479745.24	8518639.93	9.68	dgps	1.1	Coarse grained (fine part). Moderately sorted sand grains. 5% gravel. Rounded sand grains. Stones seen in the bore hole wall. Outsized clasts: 12x7x1cm 7x4x1cm 4.5x4x1cm.	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
567196	16JAD096	479805.06	8518727.33	12.96	dgps	0.9	Coarse grained (fine part). Moderately sorted sand grains. Rounded sand grains. 5% gravel. Stones seen in bore hole wall. Outsized clasts: 10x8x3cm 10x6x1.5cm 7.5x5.5x1.5cm.	
567197	16JAD097	479852.54	8518819.92	14.86	dgps	0.9	Medium grained (coarse part). Moderately sorted sand grains. Rounded sand grains. Stones in well wall. 5% gravel. Outsized clasts: 5x3x1.5cm 4x3x1.5cm 4.5x3x2cm.	
567198	16JAD098	479960.15	8518875.77	18.43	dgps	1.1	Medium grained (coarse part). Well sorted, well rounded sand. 5% gravel. Stones in well wall. Outsized clasts: 8x6x2cm 5x3x2.5cm 4x2x2cm	
567199	16JAD099	479929.43	8518771.44	16.1	dgps	0.85	Coarse grained sand (fine part). Well sorted and rounded sand. 1-5% gravel. Not many stones in well or in sand pile. Outsized clasts: 4x3x1cm 5x4x0.1cm 4x2.5x1cm	
569401	16JAD199	477323	8519622		gps	1.1	Medium grained sand (coarse part). Poorly sorted sand. Rounded sand. 15% gravel. Gravel beds are seen in bore hole. Some stones on the beach. Gravel is well sorted. Outsized clasts: 5.5x4x1.5cm 3.5x3x1cm 3x2x1cm	
569402	16JAD200	478634	8519224		gps	0.9	Medium grained sand (coase part). Moderately sorted sand. Rounded sand. Less than 5% gravel. Many stones 10-20cm on land surface, smaller stones in bore hole. Outsized clasts: 3x3x4.5cm 5x3x3cm 5x3x1.5cm	
569403	16JAD201	478666	8519291		gps	1	Medium grained sand (coarse part). Soft soil with posible organic material. Poorly sorted sand. Rounded sand. Some clay between sand grains. Gravel 5%. Outsized clasts: 4x2.5x1.5cm 4x3x2.5cm 4.5x2.5x1cm	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
569404	16JAD202	480922	8518134		gps	1	Coarse grained sand (fine part). Poorly sorted sand. Rounded sand. 20% gravel. Many stones on surface. Outsized clasts: 9x5x5cm, 5x3x2cm, 3x3x2cm	
569405	16JAD203	481026	8518098		gps	1	Coarse grained sand (fine part). Moderately sorted, rounded. 20% gravel. Many stones on surface. Outsized clasts: 6x6x3cm, 5x5.5x4cm, 4x4x3cm	
569406	16JAD204	481091	8518183		gps	1.1	Coarse grained (coarse part). Poorly sorted sand. Rounded sand. 20% gravel. Many stones on surface (approx. 10-15cm). Outsized clasts: 5x4x2.5cm, 4.5x2.5x1cm, 3.5x3x1cm	
569407	16JAD205	481161	8518356		gps	1	Medium grained sand (fine part). Rounded sand. Well sorted sand. Less than 10% gravel. Many stones on surface. Outsized clasts: 5x3.5x2cm, 4.5x2.5x1cm, 3x1.5x0.5cm	
569408	16JAD206	481264	8518330		gps	1.1	Medium grained sand (coarse part). Rounded sand. Moderately sorted sand. 10% gravel. Many stones on surface. Outsized clasts: 7x4x2.5cm, 4.5x3x1.5cm, 4x3x1cm.	
569409	16JAD207	481364	8518295		gps	1	Medium grained sand (coarse part). Moderately sorted sand. Subrounded sand. Less than 5% gravel. Stones and boulders on surface (15-100cm). Outsized clasts: 5x3x2.5cm, 4x3x2.5cm, 3.5x3.5x2cm	
569410	16JAD208	481364	8518295		gps	1	Duplicate	Duplicate
569411	16JAD209	481462	8518242		gps	1	Medium grained (coarse part). Well sorted sand. Rounded sand. Stones and boulders on surface (20-100cm). Outsized clasts: 4x4x1cm, 5x3x1.5cm, 2.5x2.5x1cm	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
569412	16JAD210	481404	8518158		gps	1.1	Very coarse grained sand (fine part). Poorly sorted sand. Subrounded sand grains. 5-10% gravel. Boulders on surface up to 50cm. Outsized clasts: 5x3.5x1.5cm, 3x2x1.5cm, 3x2x1cm	
569413	16JAD211	481306	8518184		gps	1.1	Medium grained sand (coarse part). Moderately sorted sand. Rounded sand. Less than 5% gravel. Stones and boulders on surface (up to 40cm). Outsized clasts: 3x2x2cm, 4x2x1.5cm, 3x2x1.5cm.	
569414	16JAD212	481212	8518212		gps	1.1	Medium grained sand (coarse part). Well sorted sand. Rounded sand. 10% gravel. Stones on surface (8cm diameter). Outsized clasts: 4.5x3x3cm, 4x3x1.5cm, 4x3x1cm	
570801	16JAD100	479887.47	8518674.79	14.2	dgps	1.1	Medium grained sand (coarse part). 1-5% gravel. Well sorted sand. Rounded sand. Stones seen in well wall. Outsized clasts: 7x6x2cm 7x5x2cm 6x4x1cm	The surface of this flat pebble strewn surface has some irregular features. Holes 1.5x1.5m in diameter and c. 0.5m deep. May suggest that floovial streams have covered this area for a short time? Or is it a melting/freezing feature?
570802	16JAD101	479847.95	8518587.48	10.21	dgps	1.1	Coarse grained sand (fine part). 5% gravel. Well sorted and rounded sand. Stones in bore hole wall. Outsized clasts: 5x3x2cm 6x4x1.5cm 6x4x2cm.	
570803	16JAD102	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	
570804	16JAD103	479968.52	8518567.18	12.11	dgps	1.1	Coarse grained sand (fine part). Well-sorted and well rounded sand. 1-5% gravel. Stones in well wall. Outsized clasts: 7x6x1cm 6x5x2cm 5x3x1cm	
570805	16JAD104	479968.52	8518567.18	12.11	dgps	1.1	Duplicate	Duplicate
570806	16JAD105	480015.79	8518605.24	14.36	dgps	1.1	Coarse grained (fine part). Well sorted sand. Well rounded sand grains. 5% gravel. Stones in well wall. Outsized clasts: 5.5x4x1cm 5x3x1cm 5x3.5x1cm	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
570807	16JAD106	480009.64	8518673.15	15.39	dgps	1.1	Medium grained sand (coarse part). Rounded sand. Well sorted sand. 1-5% gravel. Stones in well wall. Outsized clasts: 5x5x0.5cm 7x5x1.5cm 8x4x0.5cm	
570808	16JAD107	480072.92	8518508.51	12.55	dgps	1	Coarse grained sand (fine part). Moderately sorted sand. Rounded sand. 10% gravel. Stones in well wall. Outsized clasts: 4x4x1cm 4x3.5x1cm 4x3x2cm	
570809	16JAD108	480112.52	8518595.4	14.89	dgps	1.1	Medium grained sand (coarse part). Moderately sorted sand. Rounde sand. 5% gravel. Stones in well wall. Outsized clasts: 5x3x1cm 4x3x1cm 3.5x2.5x1cm	
570810	16JAD109	480189.32	8518657.95	14.67	dgps	0.9	Coarse grained sand (coarse part). Well sorted sand. Rounded sand. 5% gravel. Well filled with ground water. Outsized clasts: 5.5x4x1cm 6x3x1cm 3.5x2x1cm.	
570811	16JAD110	480208.55	8518561.38	12.78	dgps	1	Medium grained sand (coarse part). Moderately sorted sand. Rounded sand. Outsized clasts: 7x6x3cm 4.5x4x1cm 4.5x3x0.5xm.	
570812	16JAD111	480128.74	8518433.06	7.81	dgps	1	Coarse grained sand (fine part). Moderately sorted sand. Rounded sand. This well consists mostly of stones. Outsized clasts: 6x3.5x2cm 5x3x1cm 4x3x1cm	
570813	16JAD112	480184.41	8518385.11	8.1	dgps	1.1	Coarse grained sand (fine part). Moderately sorted sand. Rounded sand. 10% gravel. Outsized clasts: 7x6x1cm 7.5x2x2cm 3x3x1.5cm	
570814	16JAD113	480237.2	8518457.34	11.24	dgps	1.1	Coarse grained sand (fine part). Moderately sorted sand. Rounded sand. 10% gravel. Stones seen in well wall. Outsized clasts: 4x4x3.5cm 5x4x1.5cm 5.5x3x1.5cm.	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
570815	16JAD114	480268.49	8518511.73	11.63	dgps	1	Medium grained sand (coarse part). Moderately sorted sand. Rounded sand. Very few outsized clasts. Gravel <5%. Borehole in creek. Drilled in a wet marshy area. Outsized clasts: 3.5x2x1cm 4x2x1cm 3x2x0.5cm	
570816	16JAD115	480369.76	8518516.91	12.89	dgps	0.85	Coarse grained sand (fine part). Moderately sorted sand. Rounded sand. Borehole in wet marshy area. 5% gravel. Outsized clasts: 4.5x4.5x2cm 4x3x1cm 3.5x2.5x1cm	
570817	16JAD116	480334.57	8518413.81	10.86	dgps	0.8	Coarse grained sand (medium part). Moderately sorted sand. Rounded sand. 10% gravel.Outsized clasts: 5x3x1cm 4x2.5x1cm 3x2x1cm.	
570818	16JAD117	480278.69	8518303.16	6.35	dgps	1.1	Coarse grained sand (fine part). Moderately sorted sand. Rounded sand. 5-10% gravel. Outsized clasts: 7x4x1cm 5x3.5x1cm 6x3x2cm	
570819	16JAD118	480351.52	8518266.14	8.45	dgps	0.9	Coarse grained sand (coarse part). 5% gravel. Moderately sorted sand. Rounded sand. Outsized clasts: 7x3x2cm 4x4.5x1cm 3.5x2.5x1.5cm Many outsized clasts.	
570820	16JAD119	480351.52	8518266.14	8.45	dgps	0.9	Duplicate	Duplicate
570821	16JAD120	480411	8518309		gps	1	Very coarse grained (fine part). Not many outsized clasts in bore hole wall. Well-sorted to very well sorted sand. Rounded sand. Outsized clasts: 6x1x1cm 3x1.5x1cm 4x2x1cm. The sand grains in this well is much more corse grained than in all other wells.	
570822	16JAD121	480464.48	8518370.3	12.87	dgps	1	Very coarse grained sand (coarse part). Very well to well sorted sand. Rounded sand grains. 10-15% gravel. Outsized clasts: 3x2x1.5cm 3x1.5x0.5cm 2x1.5x1.5cm.	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
570823	16JAD122	480502.07	8518458.76	13.16	dgps	1.1	Coarse grained (fine part). Moderately sorted sand. Rounded sand grains. 5-10% gravel. Outsized clasts: 6x5x2.5cm 5x3x1.5cm 5x4x3cm	
570824	16JAD123	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	
570825	16JAD124	480593.17	8518470.89	12.32	dgps	1.1	Coarse grained sand (fine part). Moderately sorted sand. Rounded sand. 5-10% gravel. Outsized clasts: 4x3x3cm 6x3.5x1cm 3x3x2cm	
570826	16JAD125	480574.73	8518412.19	10.54	dgps	1.1	Coarse grained sand (coarse part). Moderately sorted sand. Sub rounded sand. 5-10% gravel. Outsized clasts: 3x2x1cm 2x2x1.5cm 2.5x2x1cm	
570827	16JAD126	480460.1	8518296.68	11.64	dgps	1	Medium grained sand (coarse part). Moderately sorted sand. Rounded sand. 5-10% gravel. Outsized clasts: 3.5x3.5x1.5cm 4x3x1.5cm 3x3x1cm	
570828	16JAD127	480489	8518248		gps	0.8	Coarse grained sand (coarse part). Moderately sorted sand. Rounded sand. 20-30% gravel. Outsized clasts: 6x3.5x1cm 3.5x2.5x1.5cm 4.5x3.5x2cm	
570829	16JAD128	480543.8	8518193.3	8.61	dpgs	1.1	Coarse grained sand (coarse part). Moderatetly sorted sand. Rounded sand. 20-30% gravel. Outsized clasts: 5x2x1cm 5x4x2cm 3.5x3x1cm	
570830	16JAD129	480703.62	8518190.09	7.12	dpgs	1	Coarse grained sand (fine part). 30% very coarse grained sand and gravel. Poorly sorted sand. Subrounded. Outsized clasts: 9x7x2cm 7x5x1cm 5x7x4cm	
570831	16JAD130	480765.99	8518150.07	8.04	dpgs	1	Medium grained sand (coarse part). Moderately sorted. Rounded. Less than 5% gravel. Outsized clasts: 6x6x2cm 4x3x3cm 5x4x2.5cm	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
570832	16JAD131	480872.85	8518210.45	10.93	dpgs	1.1	Coarse grained sand (coarse part). Moderately sorted sand. Rounded sand . 5% gravel. Outsized clasts: 5x3.5x2cm 4.5x2.5x2cm 5x3.5x0.5cm	
570833	16JAD132	480978.65	8518290.52	11	dpgs	1.1	Very coarse grained (fine part). Moderately sorted sand. Rounded sand. 10-15% gravel. Outsized clasts: 6.5x2x2cm 3.5x3x1cm 3x3x2cm	
570834	16JAD133	480952.38	8518408.98	14.56	dpgs	1.1	Coarse grained sand (coarse part). 15% gravel. 70-80% stones. This sample consists mostly of stones not sand. Sand is rounded and moderately sorted. Outsized clasts: 7x3x1cm 5x3x1cm 3x5x1cm.	
570835	16JAD134	480715.7	8518508.98	14.63	dpgs	0.8	Medium grained. Moderately sorted sand. Rounded sand. Less than 10% gravel. Very few stones. Outsized clasts: 7x4x1.5cm 5x3x1cm 3x3x1.5cm.	
570836	16JAD135	479612.59	8518643.27	-0.46	dpgs	1.1	Coarse grained sand (fine part). No gravel. Well sorted sand. Well rounded sand. Outsized clasts: 4.5x4x1cm 4x3x1cm 4.5x3x1cm.	
570837	16JAD136	479528.94	8518681.32	-1.99	dpgs	0.6	Very coarse grained sand (coarse part). 30% gravel. Moderately sorted. Rounded sand. Outsized clasts: 6x5x2.5cm 6x3x3cm 4x3x1.5cm	
570838	16JAD137	479438.83	8518759.03	0.8	dpgs	1	Coarse grained sand (fine part). 5% gravel. Moderately sorted. Rounded sand. Outsized clasts: 6x6x2cm 7.5x5x1cm 6x3.5x2cm	
570839	16JAD138	479352	8518791		gps	0.8	Medium grained sand (coarse part). Well sorted sand. Well rounded sand. No gravel. Outsized clasts: 13x11x2.5cm 5x3x2cm 4x3.5x1.5cm	
570840	16JAD139	479247	8518815		gps	0.6	Coarse grained sand (coarse part). Poorly sorted sand. Rounded sand. 5-10% gravel. Outsized clasts: 8x12x1.5cm 7x4x4cm 6x4x3cm	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
570841	16JAD140	479181	8518862		gps	0.65	Medium grained sand (coarse part). Well sorted sand. Rounded sand. 5% gravel. Outsized clasts: 5x6x2.5cm 6x4x2cm 5x3x2cm	
570842	16JAD141	479110	8518915		gps	1	Medium grained (coarse part). Very well sorted. Well rounded sand. Many soft clasts of light brown clay (sticky). Probably derived from vegetated area 10m towards land. No gravel. Outsized clasts: 5x3x1cm 3x4x2cm 4x3x1cm	
570843	16JAD142	479110	8518915		gps	1	Duplicate	Duplicate
570844	16JAD143	478986	8518970		gps	1	Coarse grained (coarse part). Moderately sorted sand. Rounded sand. 5% gravel. Outsized clasts: 8x4x1cm 5.5x3x3cm 4x3.5x1cm	
570845	16JAD144	476637.84	8520198.23	6.87	dgps	0.65	Coarse grained sand (fine part). Moderately sorted sand. Rounded sand. 5% gravel. Outsized clasts: 6x4x2.5cm 3x5x2cm 5x3.5x2cm	
570846	16JAD145	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	
570847	16JAD146	476719.89	8520281.07	11.61	dgps	0.6	Coarse grained (coarse part). Moderately sorted sand. Rounded sand. 5-10% gravel. Many outsized clasts (50% outsized clasts). Outsized clasts: 18x7x10cm 15x10x3cm 12x6x3cm	
570848	16JAD147	476797.7	8520341.85	15.14	dgps	0.65	Very coarsed grained sand (coarse part). Poorly sorted sand. Rounded sand. 5-10% gravel. Many outsized clasts (20%). Outsized clasts: 18x12x3cm 12x10x6cm	
570849	16JAD148	476857.59	8520414.67	20.58	dgps	1	Very coarse grained sand (coarse part). Poorly sorted sand. Subrounded sand. 10-15% gravel. 20% outsized clasts. Outsized clasts: 7x7x4cm 8x4x2cm 7x4.5x2.5cm	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
570850	16JAD149	477002.04	8520551.81	23.43	dgps	1.1	Coarse grained sand (coarse part). Poorly sorted sand. Subrounded to rounded sand.15% gravel. Many stones. Parallel bedding in drill hole. Outsized clasts: 22x16x14cm 14x12x7cm 12x7x7cm	
570851	16JAD150	477215.19	8520482.81	23.92	dgps	1.1	Coarse grained (coarse part). Moderately sorted sand. Rounded sand. Less than 5% gravel. Most stones on surface. Outsized clasts: 10x12x2cm 3x4x1cm 5x4x0.5cm	
570852	16JAD151	477138.81	8520402.34	17.31	dgps	1	Coarse grained (coarse part). Moderately sorted sand. Rounded sand. 10% gravel. Many stones on surface. Outsized clasts: 7.5x3x1.5cm 6x3.5x2.5cm 4.5x4x2cm	
570853	16JAD152	477083.52	8520320.23	13.84	dgps	0.5	Medium grained sand (coarse part). Well sorted sand. Rounded sand. No gravel. Many stones on surface. Outsized clasts: 25x16x4cm 12x7x1cm 9x11x3cm	
570854	16JAD153	477024.98	8520248.32	9.92	dgps	0.6	Coarse grained (coarse part). Moderately sorted sand. Rounded sand. Many stones on surface. 15% gravel. Outsized clasts: 16x8x3cm 6x7x5cm 9x6x1.5cm	
570855	16JAD154	476945.48	8520186.39	8.74	dgps	0.9	Coarse grained (fine part). Poorly sorted sand. Rounded sand. Many stones on surface. 10% gravel. Parallel bedding in well. Outsized clasts: 5x3x3cm 5.5x3.5x1cm 4x3.5x1.5cm	
570856	16JAD155	476865.13	8520084.88	2.83	dgps	0.85	Coarse grained sand (fine grained part). Moderately sorted. Rounded sand. Many stones on surface (beach ridge). 10% gravel.	
570857	16JAD156	477049.59	8519907.06	-1.03	dgps	1	Medium grained sand (coarse part). Well sorted sand. Rounded sand. 5% gravel. Outsized clasts: 7x6.5x0.5cm 6.5x5x2cm 8.5x6.5x3cm	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
570858	16JAD157	477148.73	8519997.4	3.44	dgps	1	Coarse grained (fine part). Rounded sand. Moderately sorted. 5% gravel. Stones on surface. Outsized clasts: 9x5x5cm 8.5x4.5x3.5cm 10x6.5x3cm	
570859	16JAD158	477220.02	8520080.14	8.47	dgps	1	Medium grained (coarse part). Well sorted sand. Rounded sand. 5% gravel. Many stones on surface. Outsized clasts: 8.5x6x2.5cm 7x4.5x4.5cm 9x8x2cm	
570860	16JAD159	477294.37	8520168.95	11.59	dgps	1.1	Medium grained sand (coarse part). Moderately sorted sand. Rounded sand. Some stones on surface. 5% gravel. Outsized clasts: 3x3.5x1.5cm 3x2.5x2.5cm 6.5x3x0.5cm	
570861	16JAD160	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	
570862	16JAD161	477625.9	8520167.49	17.76	dgps	1.1	Medium grained sand (coarse part). Moderately sorted sand. Rounded sand. 5% gravel. Outsized clasts: 4.5x3x1.5cm 6x4.5x1cm 7.4x7x3cm	
570863	16JAD162	477563.8	8520093.81	14.01	dgps	1	Coarse grained sand (fine part), Rounded sand, moderately sorted. Less than 5% gravel. Outsized clasts: 4x3x0.5cm 3x2.5x0.1cm 4.5x2x1cm	
570864	16JAD163	477514.82	8520021.4	12.04	dgps	1.1	Coarse grained sand (fine part). Rounded sand. Moderately sorted sand. Less than 5% gravel. Outsized clasts: 5.5x2x0.5cm 5x2x1cm 4x3x1cm	
570865	16JAD164	477514.83	8520021.33	12.04	dgps	1.1	Duplicate	Duplicate
570866	16JAD165	477439.3	8519880.91	8.14	dgps	0.9	Medium sand (coarser part). Rounded sand. Well sorted sand. Less than 5% gravel. Outsized clasts: 5.5x5x1.5cm 7.5x6.5x3cm 5x2.5x2.5cm	
570867	16JAD166	477355.11	8519815.35	4.19	dgps	0.9	Coarse grained sand (coarse part). Moderately sorted, rounded. Less than 5% gravel. Outsized clasts: 2.5x2x0.3cm 1.5x1x0.5m 4x3x0.3cm.	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
570868	16JAD167	477274.05	8519733.86	1.08	dgps	1.1	Well sorted sand. Well rounded. Medium grained sand (coarse part). No gravel. Rounded sand. Outsized clasts: 6x5x0.5cm 6x3.5x5.5cm 6.5x3.5x0.5cm	
570869	16JAD168	477424.9	8519528.35	-2.31	dgps	1.1	Medium grained sand (coarser part), rounded, moderately sorted. <5% gravel. Outsized clasts: 5x5.5x3cm 6x4x1cm 4.5x3x0.5cm	Same material all the way down. Small but many rocks on surface.
570870	16JAD169	477475.56	8519601.44	0.57	dgps	1.1	Coarse grained sand (smaller part), rounded, moderatly sorted. Aprox. 10% gravel. Outsized clasts: 3.5x3x5cm 3x1x2cm 5x5x1cm	. Small rounded to subrounded rocks on surface (up to approx. 4cm long).
570871	16JAD170	477548.14	8519692.97	3.19	dgps	1	Medium grained (coarse part). Moderately sorted. Rounded. 5% gravel. Outsized clasts: 7x7x0.5cm 3x3.5x1cm 6x3.5x1cm	
570872	16JAD171	477621.95	8519778.59	6.62	dgps	1	Coarse grained (fine part). Well sorted, rounded. Less than 5% gravel. Outsized clasts: 9x6x0.5cm 5x4x2.5cm 5.5x4.5x1cm	Lots of vegetation on surface. Auger stopped working. Hole contained lots of up to 3cm flat rocks. High groundwater level. Part dug manually.
570873	16JAD172	477698.39	8519846.06	10.45	dgps	1	Medium grained sand (coarse part), well sorted, rounded. 5% gravel. Outsized clasts: 6x3.5x1.5cm 4.5x3.5x2.5cm 5x3.5x1cm	Very wet sample. Lots of vegetation on surface. Lots of dirt in the top part of the hole.
570874	16JAD173	477792.5	8519901.22	13.65	dgps	1.1	Coarse grained (fine part), well sorted, rounded. 5% gravel. Outsized clasts: 6.5x3x2cm 6x3x0.5cm 3x3.5x0.5cm	Lots of vegetation and soil on surface. Not many rocks present in hole.
570875	16JAD174	477857.82	8519990.19	19.11	dgps	1.1	Coarse grained (fine part) sand. Moderately sorted, rounded. 10% gravel. Outsized clasts: 10x6x2cm 4x3.5x1cm 5.5x4x0.3cm	Lots if vegetation and dirt on surface. Very wet sample. Grey material in hole covered by brown soil.
570876	16JAD175	477806.52	8519838.9	13.7	dgps	1.1	Coarse grained (fine part). Moderately sorted, rounded. 15% gravel. Outsized clasts: 5x3.5x1.5cm 4x2x1.5cm 3.5x3.5x1cm	Wet sample. Rocky surface with some vegetation. Small (most less than 5cm) rocks on surface. No visable ground water table. Many small pebbles in hle.
570877	16JAD176	477785.84	8519755.26	11.84	dgps	1.1	Medium grained sand (coarse part). Well sorted, rounded. Less than 5% gravel. Outsized clasts: 3.5x2x0.5cm 2.5x2x0.5cm 2x2.5x0.5cm	Rocky surface, all over 5cm. Little vegetation, same material all through drill hole. No visable ground water table.

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
570878	16JAD177	477680.61	8519670.86	8.81	dgps	1	Coarse grained (fine part), moderately sorted, rounded sand. 15% gravel. Outsized clasts: 10.5x5.5x2.5cm 5.5x5.5x0.5cm 6x3.5x1cm	Lots of vegetation on surface, some rocks, visable ground. Water table in the hole.
570879	16JAD178	477623.89	8519583.17	5.4	dgps	1	Medium grained sand (coarse part), rounded. Well sorted. Less than 5% gravel. Outsized clasts: 4x3.5x1cm 3.5x3x1cm 3x2x0.5cm	Lots of vegetation on surface and rocks. Visable ground water table approx 40cm down.
570880	16JAD179	477560.7	8519494.36	3.95	dgps	1	Medium (coarse part) grained sand, well sorted, rounded. <5% gravel. Outsized clasts: 10x8x6cm 9x6.5x5.5cm 8x4x4cm	Rocky surface, mid sized rocks (4-20cm), only few patches of vegetation.
570881	16JAD180	477948.16	8519569.12	9.42	dgps	1.1	Medium grained sand (coarse part). Moderately sorted, rounded sand. 10% gravel. Outsized clasts: 6.5x2.5x1.5cm 5x4x2cm 7x4.5x0.5cm	Rocky/Pebbly surface, no vegetation
570882	16JAD181	478015.87	8519641.83	15.88	dgps	1	Medium grained (coarse part). Moderately sorted. Rounded. Less than 5% gravel. Outsized clasts: 5x4x1cm 5x4x2cm 7x5x1cm	Surface covered in vegetation and soil
570883	16JAD182	478083.15	8519718.72	17.83	dgps	0.8	Medium grained sand (coarse part). Rounded, well sorted sand. 10% gravel. Outsized clasts: 4x4x1cm 2x1.5x1.5m 3x1x1cm	Surface covered in vegetation and soil.
570884	16JAD183	478083.15	8519718.72	17.83	dgps	0.8	Duplicate	Duplicate
570885	16JAD184	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	
570886	16JAD185	478127.89	8519822.03	23.35		0.9	Coarse grained sand (fine part). Rounded sand. Moderately sorted. 15% gravel. Outsized clasts: 6.5x5x0.5cm 3.5x2x1.5cm 4.5x3x0.5cm	Wet sample. Surface covered by vegetation and soil. Lots of rocks down the hole (up to 5cm). Drill stopped by permfrost. Water flushed through in bottom.
570887	16JAD186	478344.6	8519773.87	25.55		0.9	Coarse grained sand (coarse part). Poorly sorted sand. Rounded sand. No stones on surface. 20% gravel. Outsized clasts: 6.5x5x1cm 4x3.5x2cm 4x2.5x2cm	
570888	16JAD187	478301.72	8519681.59	24.24		1.1	Coarse grained sand (fine part). Moderately sorted sand. Rounded sand. Stones on the ground surface. 15% gravel. Outsized clasts: 3.5x3x1.5cm 4x3x1cm 4x2.5x1cm	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
570889	16JAD188	478277.61	8519585.8	18.19		1	Coarse grained sand (coarse part). Moderately sorted sand. Rounded sand. No stones on surface. Less than 5% gravel. Outsized clasts: 4.5x4x2cm 2x2.5x2cm 2.5x2x1cm	
570890	16JAD189	478228	8519464.74	13.28		1	Medium grained sand (coarse part). Moderaely sorted sand. Rounded sand. Few pebbles on surface. Less than 5% gravel. Outsized clasts: 3x3x1.5cm 4x1.5x0.5cm 2x1.5x1.5cm	
570891	16JAD190	476672	8520116		gps	1	Medium grained (coarse part). Moderately sorted sand. Rounded sand. Many pebbles on surface. Less than 5% gravel. Outsized clasts: 7x4x1cm 4.5x5x1cm 5.5x4.5x1cm	
570892	16JAD191	476758	8520067		gps	1	Medium grained sand (coarse part). Well sorted sand. Rounded sand. Less than 5% gravel. Outsized clasts: 4.5x3x1cm 4x3x1.5cm 4x2x1.5cm	
570893	16JAD192	476845	8520016		gps	1.1	Medium grained sand (coarse part). Well sorted sand. Rounded sand. Less than 5% gravel. Horizontal and parallel bedding in bore hole. Many big stones greater than 20cm on beach surface. Outsized clasts: 8x5.5x3cm 5x4.5x2cm 5x4x1cm	
570894	16JAD193	476933	8519963		gps	1	Medium grained sand (coarse part). Well sorted sand. Rounded sand. Less than 5% gravel. Many big stones on back of beach ridge. Horizontal and parallel bedding in bore hole. Outsized clasts: 9x4x3cm 4x3x0.5cm 5x2.5x1cm	

Sample	Locality	UTM_X	UTM_Y	Height (m)	method	Depth (m)	Grain size	Other notes
570895	16JAD194	477016	8519904		gps	1	Medium grained sand (coarse part). Well sorted sand. Rounded sand. 5% gravel. Many big stones on the beach surface. Nearly no stones in the bore hole. Parallel and horizontal bedding in the bore hole. Outsized clasts: 5x3x1cm 5x3x0.5cm 3x3.5x3.5cm	
570896	16JAD195	477088	8519838		gps	1	Medium grained sand (coarse part). Moderately sorted sand. Rounded sand. Less than 5% gravel. Many stones on beach surface. Nearly no stones in bore hole. Outsized clasts: 5x4x2.5cm 3x3x2cm 2.5x2x1cm	
570897	16JAD196	477173	8519779		gps	1.1	Medium grained sand (coarse part). Well sorted sand. Rounded sand. 5% gravel. Nearly no stones in borehole. Many stones on beach surface. Outsized clasts: 3.5x3x2cm 3.2x2x1cm 4x2x1cm	
570898	16JAD197	477254	8519706		gps	1.1	Medium grained sand (coarse part). Moderately sorted sand. Rouded sand. Less than 5% gravel. Some stones on beach surface. Parallel bedding in bore hole. Nearly no stones in bore hole. Outsized clasts: 4x3x1cm 3x3x1.5cm 3.5x2x2cm	
570899	16JAD198	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	

Appendix 8

Notes for samples from sedimentology trenches

Sample	Locality	UTM_X	UTM_Y	Height (m)	Method	Depth (m)	Grain size
569415	16JAD213	492599	8512275		gps	0.90m	Medium grained sand (fine part). Well sorted sand. Rounded sand. Parallel laminated. 10 cm thick medium-grained sand bed contains may out-sized clasts: 10x5x3cm, 8x5x1cm, 4x4x1cm. Stones on surface of beach
569416	16JAD214	492660	8512206		gps	0.95m	Medium grained sand (fine- to coarse part). With soil in the lower 30 cm part (probably transported or derived from top, due to colapse of trench. Stones on surface of beach
569417	16JAD215	492719	8512129		gps	0.70m	Coarse grained sand (fine part) to medium-grained sand (fine to coarse part). Parallel laminated. Many out-sized clasts up to 8 cm i diameter. Stones on surface of beach. Stribes of white sand in black sand in top part og trench.
569418	16JAD216	492766	8512061		gps	0.70m	Medium- fine-grained sand. Mostly medium-grained (fine-part). Parallel laminated. No out-sized clasts. Stones on surface of beach. White stribes of sand in black sand in top of trench.
569419	16JAD217	492811	8511989		gps	0.65m	Very coarse-grained sand (coarse part) to medium-grained sand (coarse- fine part). Pebbles in the middle part of trench. Parallel laminated sand. Stones on surface of beach. White stribes of sand in black sand in top of trench.
569420	16JAD218	492731	8512199		gps	1.00m	Medium-graind sand (coarse part). The loermost 10 cm in trench is Medium-grained sand (fine part), Parallel laminated. Pebbles strewn surfaces are common. Out-sized clasts: 6x5x2 cm, 6.5x5x1.5 cm. Permafrost at botom of trench.
569421	16JAD219	492786	8512127		gps	1.55m	Medium-grained sand (mostly coarse part). Parallel lsaminated. Three surfaces are pebble strewn. Out-sized clasts: 6x4x2 cm, 6x5.5x1 cm, 14x9x0.5 cm, 8.5x8x2 cm. One bed is coarse-grained (10 cm thick). Rootlets and soil development at top of trench. Surfave: grass.
569422	16JAD220	492841	8512061		gps	1.05m	Top 70 cm is medium-grained sand (coarse part). The lower 30 cm is fine-grained sand (coarse part). Out-sized clasts are seen on internal surface. In places parallel laminated . Rootlets in the uppermost 5 cm of trench.
569423	16JAD221	492911	8511953		gps	1.15m	Lowest 30 cm is coarse-grained (coarse part). The rest of the trench is medium-grained sand (coarse-grained). Some parallel lamination. The uppermost 35 cm are characterised by out-sized clasts: 9x6.5x1 cm, 6x5x1 cm. Gravel in the uppermost 20 cm.
569424	16JAD222	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK
569425	16JAD223	493222	8511392		gps	0.85m	Lowest 60 cm is clay with pebbles. The upper 25 cm is medium-grained sand (coarse part) with horisontal lamination.
569426	16JAD224	493266	8511305		gps	0.6m	Lowest 30 cm is clay with pebbles. The upper 18 cm is medium-grained sand (coarse part) with horisontal lamination.
569427	16JAD225	493248	8511369		gps	0.6m	Lowest 50 cm is clay (sticky some places hard) with stones c. 7 cm in diameter. Clay is similar to clay in beach cliff section. The uppermost 30 cm of trench is coarse-grained sand (fine part) with pebbles. Flat pebbles on surface.

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Sample	Locality	UTM_X	UTM_Y	Height (m)	Method	Depth (m)	Grain size
569428	16JAD226	493312.65	8511406.30	17.52	dgps	0.95m	A fining-upward succession. Lowest 5 cm is pebbles. Overlain by 25 cm coarse-grained sand (corasest part). Overlain by 30 cm corase-grained sand (fine part). Overlain by 35 cm medium-grained sand (coarse part). Parallel lamination in all sands.
569429	16JAD227	493261	8511458		gps	1.0m	Very coarse to medium-grained sand. Parallel laminated. Gravel (5-30%) in the lowermost 0.5 m part of trench. The uppermost 55 cm concists of alternating dark and light layers.
569430	16JAD228	493261	8511458		gps	1.0m	Duplicate
569431	16JAD229	493490.56	8511603.95	42.65	dgps	1.0m	Very coarse sand to coarse sand, with two layers of fine-medium grained pebble beds, 2-5 cm thick. Sand is poorly sorted and sub-rounded and contains up to 35% gravel. Rootlets in top of profile.
569432	16JAD230	493619.32	8511561.22	43.19	dgps	1.0m	The trench is fining upward from coarse- to medium-grained sand. Three, up to 5 cm thick, pebble beds are seen. The sand is moderate- to well-sorted and rounded- to sub-rounded. The sand concists of light and dark layers. Rootlets in top of profile. Pebbles on land surface.
569433	16JAD231	493715.76	8511510.24	38.60	dgps	0.5m	The trench is fining upward from medium-grained pebbles (up to 10 cm in diameter) to medium-grained sand (coarse part). Rootlets in the uppermost 20 cm of the profile. The lowermost sand contains 5% gravel. Sand is moderate sorted rounded.
569434	16JAD232	493842.83	8511424.38	35.99	dgps	0.9m	Medium-grained sand (fine- to coarse part). Several (3) bedding planes with stones. Top surface of trench has vegetation and flat pebbles. Rootlets are seen in the upper 5 cm og trenvh.
569435	16JAD233	493997.56	8511358.68	36.22	dgps	0.7m	Overall upward finning succession from rounded blocks through coarse- grained and medium-grained sand (fine part). Moderately sorted sand. Rounded sand
569436	16JAD234	494147.50	8511329.75	34.14	dgps	0.9m	Medium-grained sand (fine part) 40 cm thick is overlain by coarse-grained (fine part) 10 cm thick. Whole sand section is parallel bedded.
569437	16JAD235	494031.52	8511200.51	17.04	dgps	0.8m	Medium-grained sand (coarse part) with gravel in the uppermost 60 cm. Coarse-grained sand (fine-grained part) with 15 % gravel in the lowermost 20 cm.
569438	16JAD236	493921.79	8511204.53	16.29	dgps	0.85m	Pebble bed overlain by coarse-grained sand. Modrerately- to well-sorted sand. Sand-grains are rounded.

Sample	Locality	UTM_X	UTM_Y	Height (m)	Method	Depth (m)	Grain size
569439	16JAD237	493768.00	8511257.32	17.64	dgps	0.95m	Coarse-grained sand (fine part) (40 cm thick) is overlain by medium-grained sand (coarse part) (60 cm thick). A few pebble clasts and gravel is seen. Parallel lamination and through shaped bedding is seen.
569440	16JAD238	493623.42	8511306.40	19.57	dgps	0.90m	Coarse-grained sand (coarse part) (10 cm thick) poorly sorted with pebbles and 20% gravel is overlain by medium-grained sand (coarse part) (80 cm thick) with some pebbles.
569441	16JAD239	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK
569442	16JAD240	493457.85	8511383.90	17.76	dgps	0.85m	Medium-grained sand (coarse part). Some horisontal laminations. Some pebbles are seen in uppermost 35 cm of the profile. Two dark grey layers, c. 2-3 cm thick, are characterised by black sand (20%).

Appendix 9

Notes for metallurgy trenches

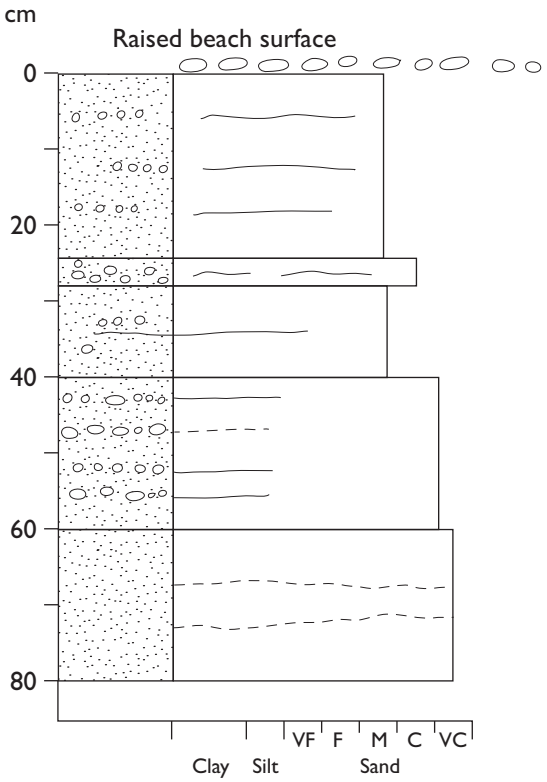
Sample	Locality	X	Y
565901	16BMS001	489886	8514726
565902	16BMS001	489886	8514726
565903	16BMS001	489886	8514726
565904	16BMS001	489886	8514726
565905	16BMS002	490132	8514624
565906	16BMS003	478465	8519604
565907	16BMS003	478465	8519604
565908	16BMS004	478893	8519318
565909	16BMS005	478860	8519244
565910	16BMS006	478206	8519016
565911	16BMS007	479160	8518922
565912	16BMS008	480165	8519226
565913	16BMS009	479201	8518862
565914	16BMS010	479159	8518886
565915	16BMS011	479149	8518872

Appendix 10.

Trench logs from Moriusaq

Moriusaq, Trench 1

E: 478893
N: 8519320
Elevation: 23,6 m
Position method: dgps
Samples: 567143, 567145, 565908



Top surface with stone pavement. Often flat stones stones up to 20 cm

50 % black sand
Outsized clasts: 4x4x2 cm

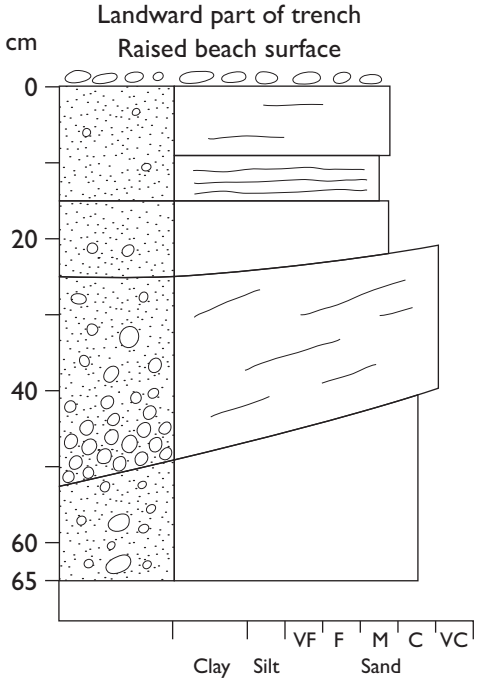
35 % black sand
Outsized clasts: 4.5x3x2 cm
10–20 % black sand

25–30 % black sand
Outsized clasts: 4x2x1.5 cm

25 % black sand
Outsized clasts: 3.5x2.5x1 cm

Moriusaq, Trench 2n

E: 478857
N: 8519243
Elevation: 15,56 m
Position method: dgps
Samples: 567147, 565009



Pebbles on top of land surface dipping towards the sea

Well-sorted sand
90–100 % black sand

10 % black sand

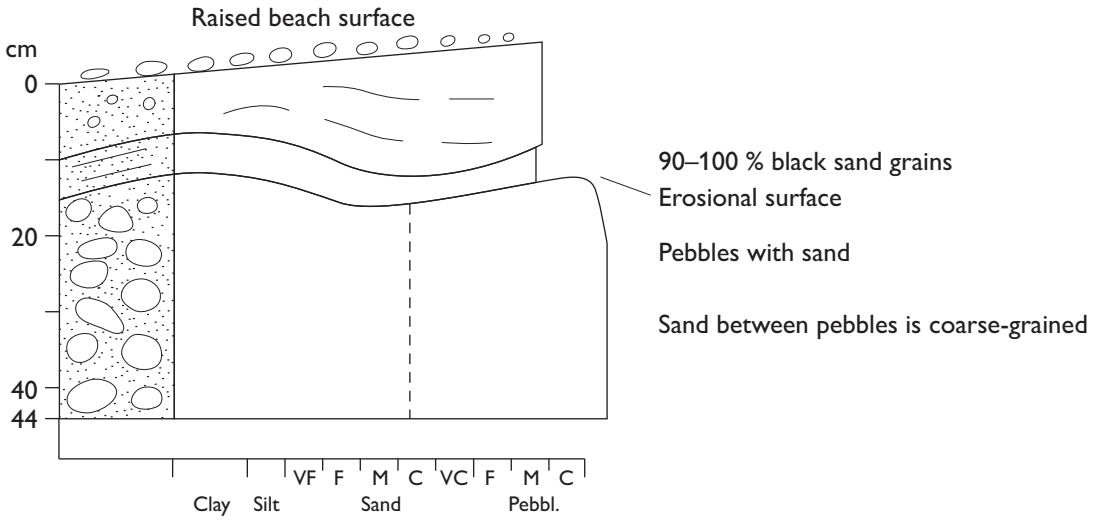
Clast supported pebbles

Gravel mostly 4–5 mm (10 %)
20 % black sands

Moriusaq, Trench 2s

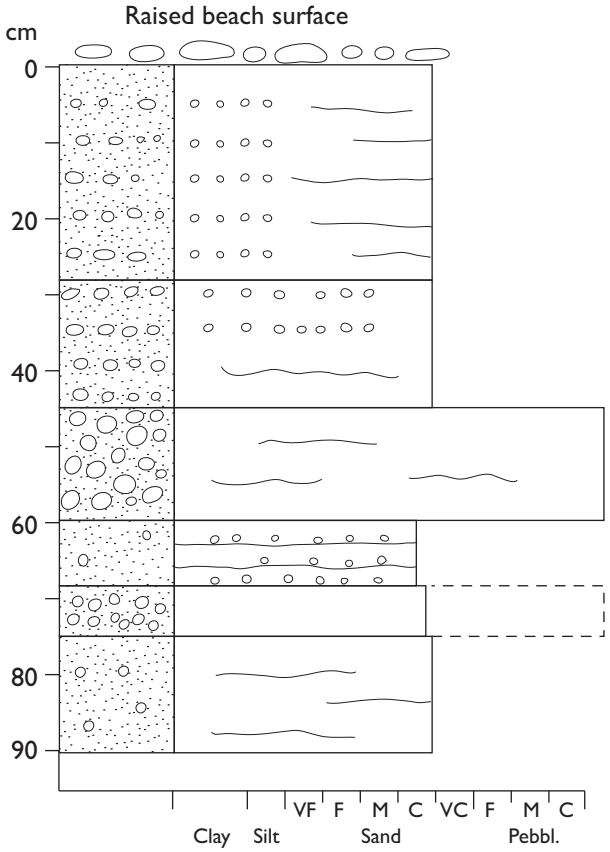
E: 478857
N: 8519243
Elevation: 15,56 m
Position method: dgps
Samples: 567147, 565009

Seaward part of trench
Seaward-dipping surface with pebbles on top



Moriusaq, Trench 3

E: 478850
N: 8519302
Elevation: 18,59 m
Position method: dgps



Pebbles/cobbles lie
on the horizontal surface

10–15 % black sand

20 % black sand

15–20 % black sand, clast supported

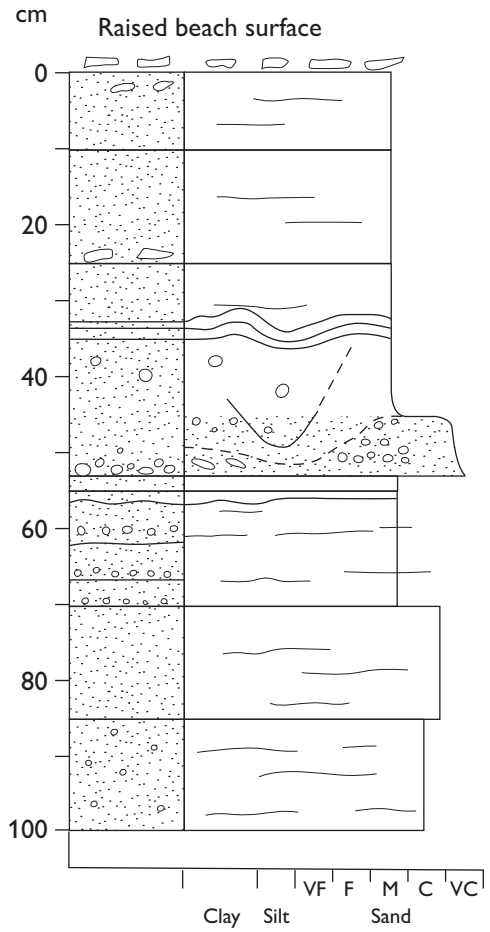
10–15 % black sand, clast on bed surfaces

10–15 % black sand. Clast supported

10–15 % black sand, gravels

Moriusaq, Trench 4

E: 478462
N: 8519603
Elevation: 20,38 m
Position method: dgps
Samples: 565906



Surface with pebbles

Outsized clasts: 3x4x2 cm/5x3.5x1.5 cm/6x4x1.5 cm/10x6x2 cm
Outsized clasts: 2x1.5x0.5 cm/2x3x1 cm

Outsized clasts: 2.5x2x0.6 cm/2.5x3.5x0.6 cm

Cryoturbation

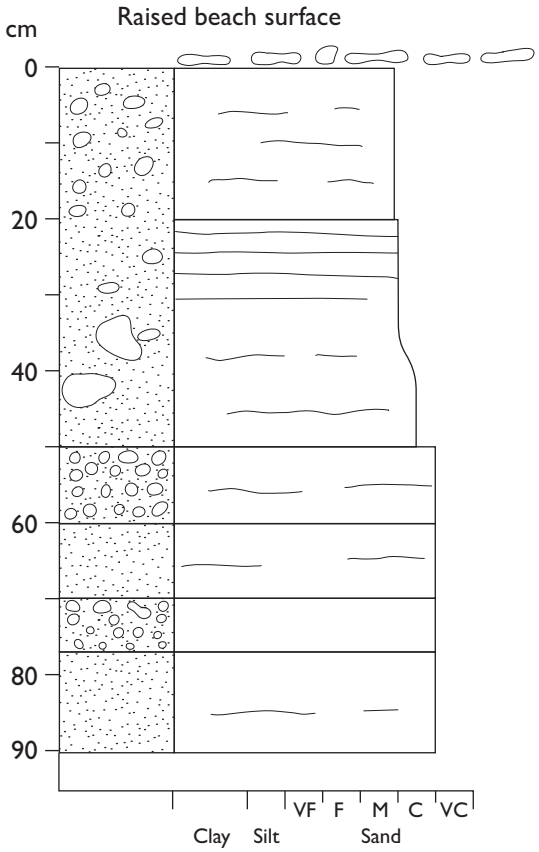
Outsized clasts: 1.0x1.5 cm/0.7x1.0 cm/1x1.5 cm

Well rounded, well sorted sand

Top of permafrost layer very high amounts of black sand, 70%

Moriusaq, Trench 5

E: 479163
N: 8518923
Elevation: 8,39 m
Position method: dgps
Samples: 567174, 565911



Many platy stones on surface
c. 1–3 cm thick, 4–10 cm long

Outsized clasts: 25x12.5x10 cm

10–15 % black sand

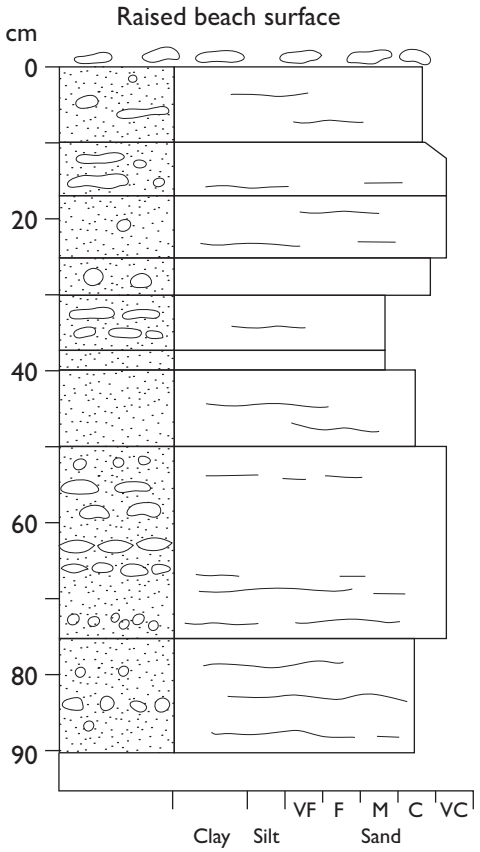
Outsized clasts: 9x8x5 cm

Sand with clast-supported pebbbles
rounded to sub-rounded

Sand with clast-supported pebbbles
rounded to sub-rounded
1–2 cm in diameter

Moriusaq, Trench 6

E: 479759
N: 8518608
Elevation: 10,29 m
Position method: dgps
Samples: 567195



Many flat pebbles on surface
Outsized clasts: 10x8x2 cm

Outsized clasts: 11x7x4 cm
10 % black, rounded sand
Mostly well-rounded sand
10 % black sand

Outsized clasts: 5x5x4 cm
Many flat pebbles in sand

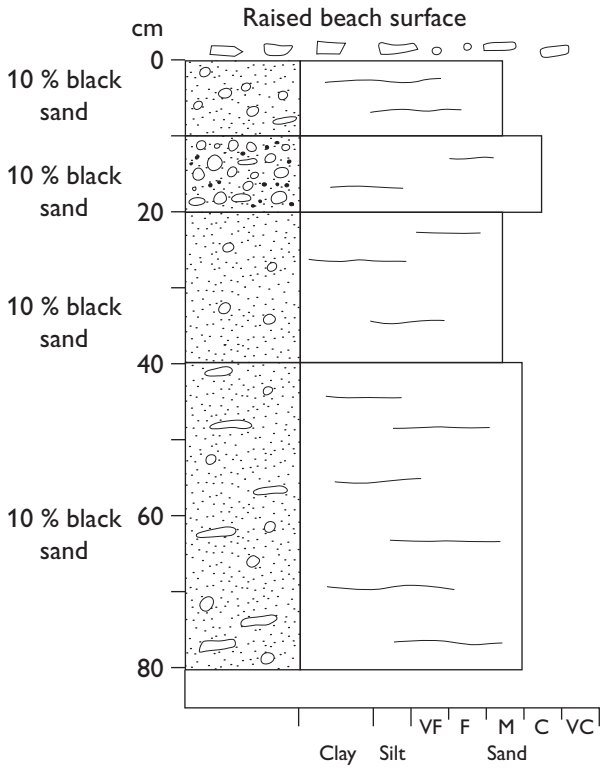
20 % black sand

Flat pebbles 2–5 cm in diameter. 0.5–1 cm on flat side

10 % black sand.
Pebbles 1.5 cm in diameter

Moriusaq, Trench 7

E: 480255
N: 8519455
Elevation: 45,37 m
Position method: dgps



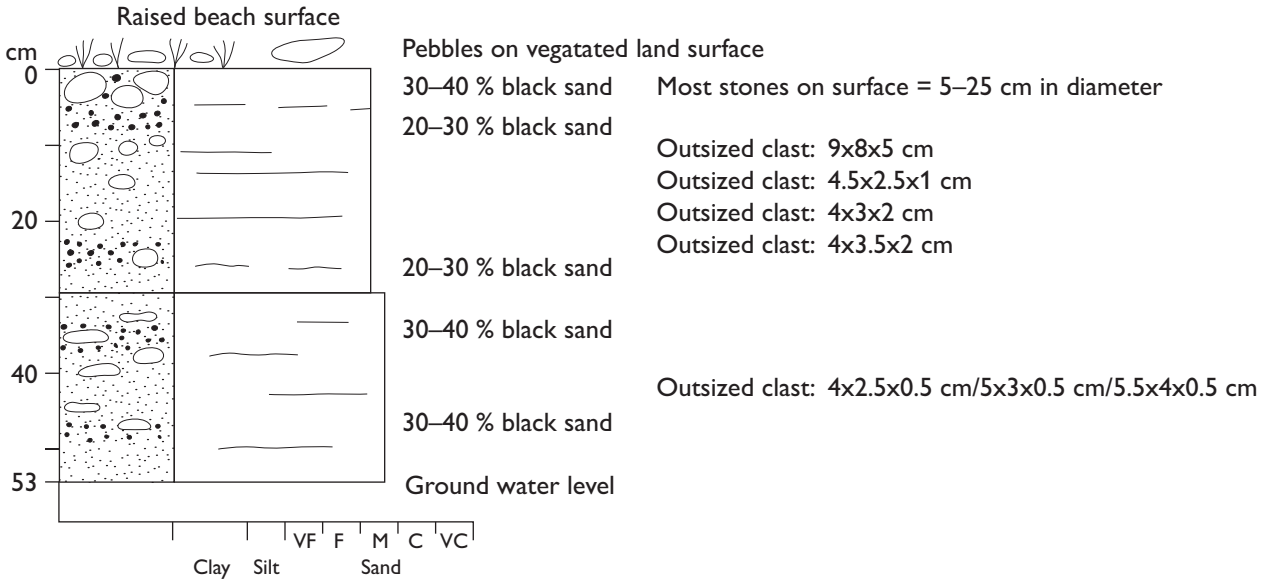
Pebbles on land surface
Outsized clasts: 5x3x1 cm/9x9x4 cm/7x5x0.5 cm
Outsized clasts: 3.5x2.5x2.3 cm/7.5x3.5x1 cm/7x3.5x4 cm

Outsized clasts: 4.5x3.5x2 cm/2x2.5x1.5 cm
Outsized clasts: 7x4.5x1 cm
Outsized clasts: 4x2x1.5 cm
Outsized clasts: 3x2.5x10 cm

Outsized clasts: 5x2.5x0.5 cm
Outsized clasts: 6x2.5x7 cm
Outsized clasts: 7x8x5 cm

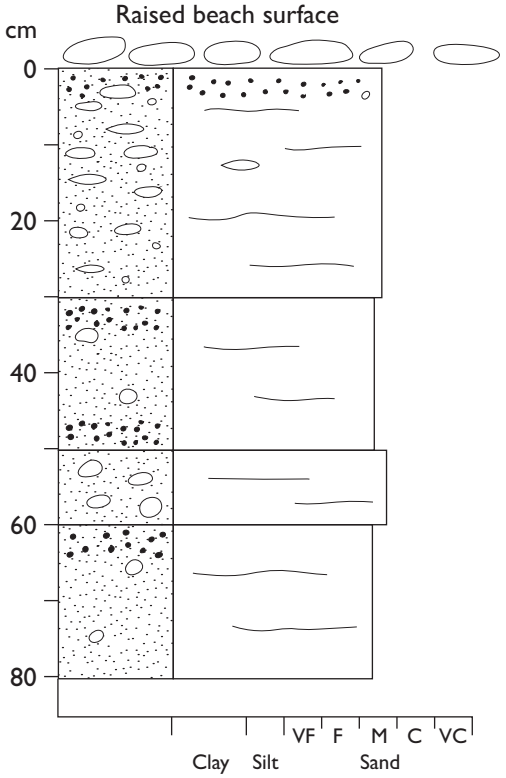
Moriusaq, Trench 8

E: 477729
N: 8519639
Elevation: 9,8 m
Position method: dgps
Samples: 560878



Moriusaq, Trench 9

E: 477551
N: 8519497
Elevation: 5,97 m
Position method: dgps
Samples: 570880



Land surface pebble strewn with flat clasts

20 % black sand

Outsized clast: 3x1.5x0.5 cm/2.5x1.5x0.5 cmx/3.5x3.5x0.5 cm

20 % black sand

5 % black sand

10 % black sand

Outsized clast: 7x4x1 cm

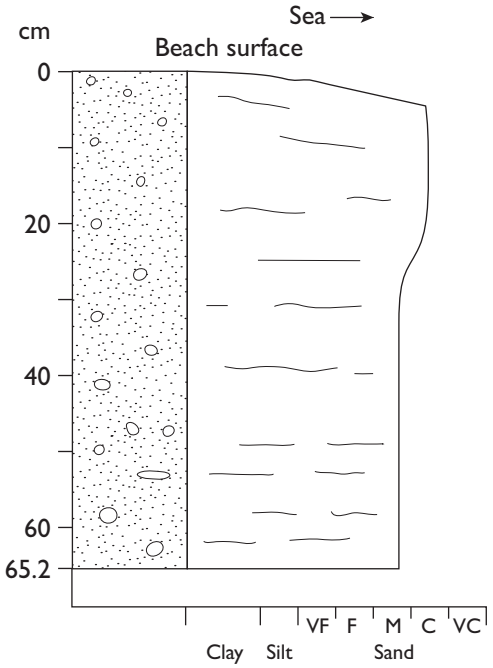
5 % black sand

15–20 % black sand

5 % black sand

Moriusaq, Trench 10

E: 478262
N: 8519092
Elevation: 0 m
Position method: gps
Samples: 567157, 565910



Trench at "spit" at bay near Moriusaq
closest towards the sea

The whole section has high amounts of black sand

Outsized clasts: 5.5x4x1.5 cm
Outsized clasts: 5.5x2.5x1.5 cm
Outsized clasts: 5.5x2x1.5 cm
Outsized clasts: 4.5x2x2.5 cm

4x3.5x1.5 cm

5x5x2 cm

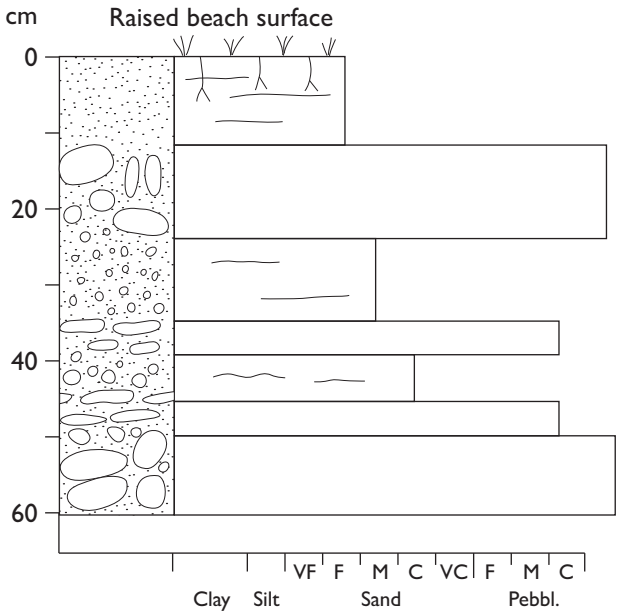
6x3x2 cm/4x4x2 cm

Stribes of black sand up to 3 cm thick
Outsized clast: 1.5x1.5cm

Outsized clast: 6x4x1.5cm

Moriusaq, Trench 11

E: 478451
N: 8520155
Elevation: 38,63 m
Position method: dgps



Vegetation on land surface
Rootlets

Outsized clasts: 11x8x2 cm/5x7x17 cm/9x7x3 cm

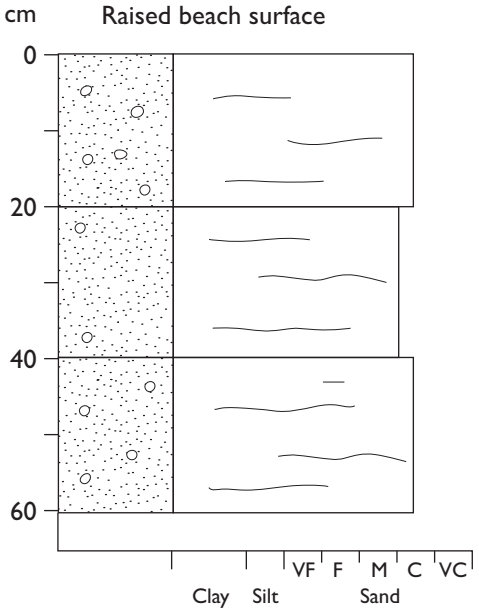
80 % black sand

Many horizontially flat pebbles
Outsized clasts: 5x3x2/4x3x1/4x2x2 cm
17x12x8/12X8X2/8x7x2 cm

Outsized clasts: 20x14x4/18x10x7/17x13x9 cm

Moriusaq, Trench 12

E: 478151
N: 8519816
Elevation: 23 m
Position method: dgps
Samples: 570886



Outsized clasts: 10x4.5x3 cm
7.5x4.5x2 cm
7x2x2 cm

Large amounts of black sand

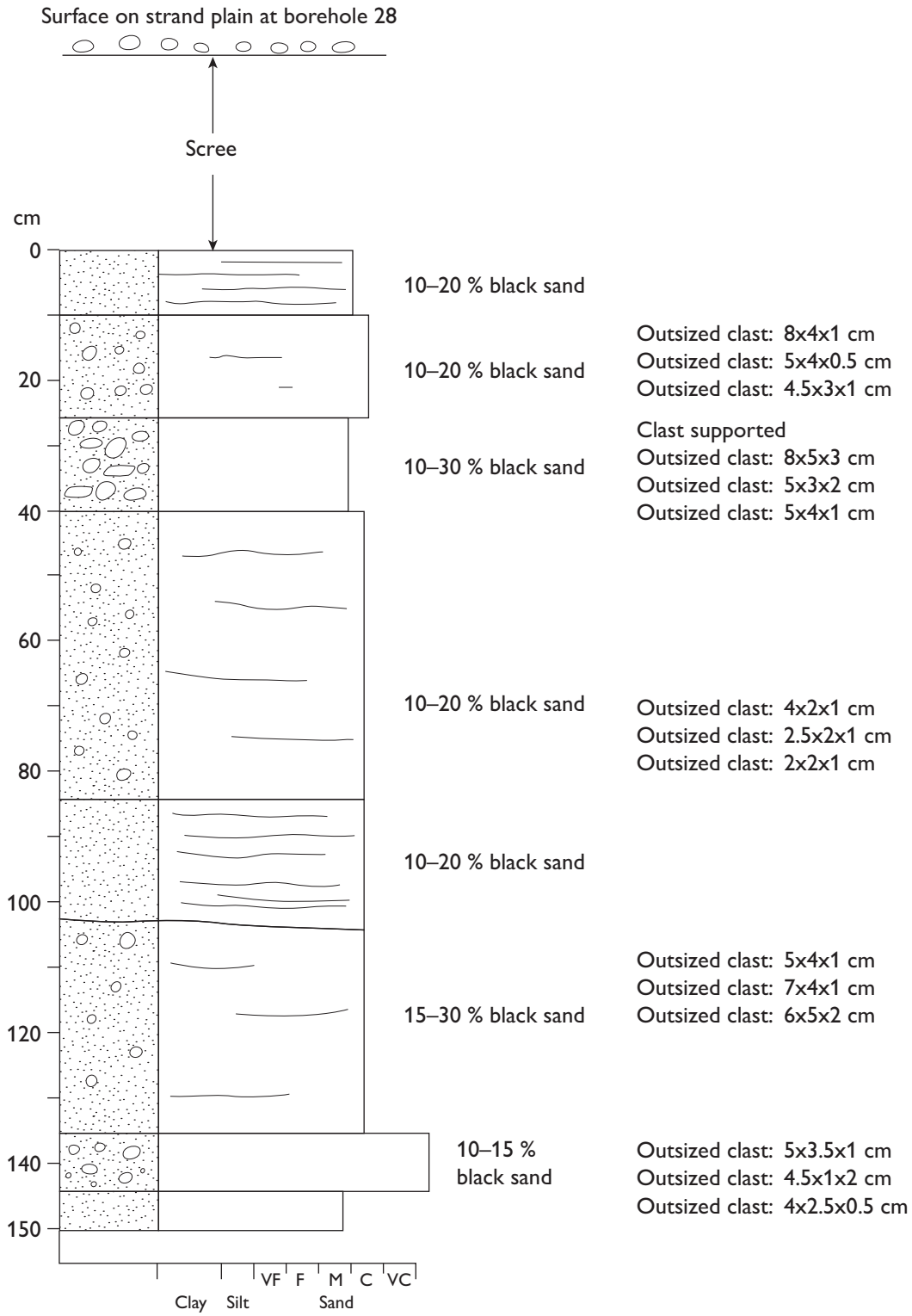
Few 2.5x1x0.5 cm
Outsized clasts: 2.5x2x0.5 cm

Outsized clasts: 2x1x1.5 cm
3x1.5x0.5 cm

Moriusaq, Trench 13

E: 477161
N: 8519823
Elevation: 3,82 m
Position method: dgps
Samples: 567128

Photo 680 (2)



Appendix 11.

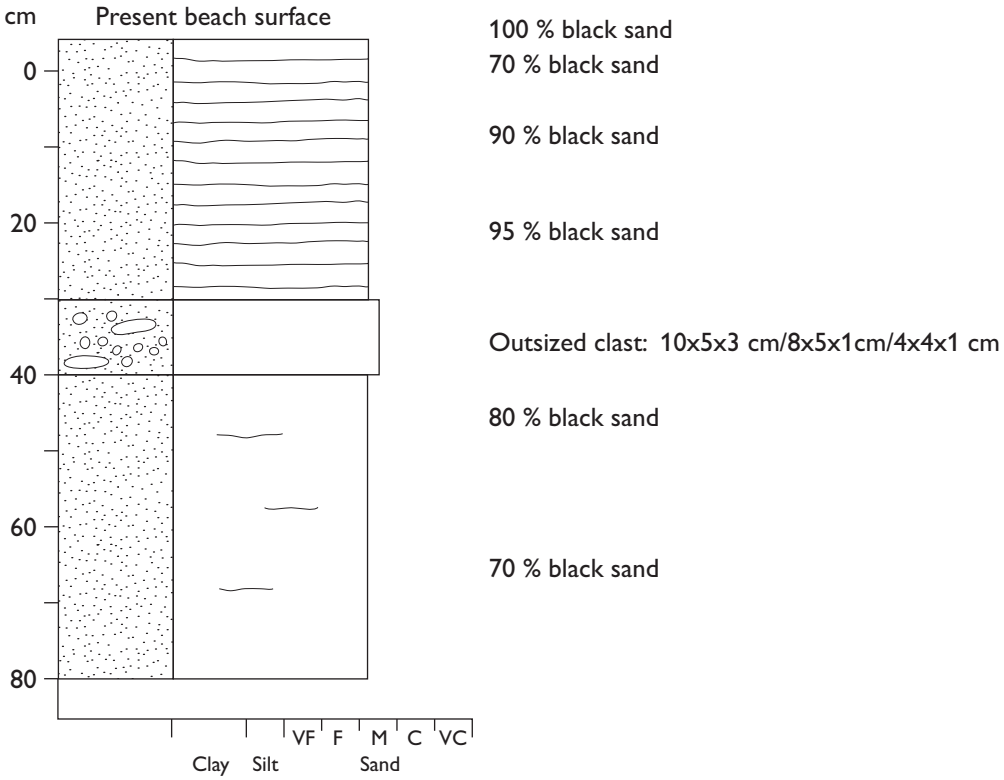
Trench logs from Iterlak

Iterlak

FinnAust
Hand-dug trench on present beach
16.08.2016
GPS coordinate (UTM 19)
E: 0492599
N: 8512275

GEUS
No high resolution GPS survey were made

Trench #569415

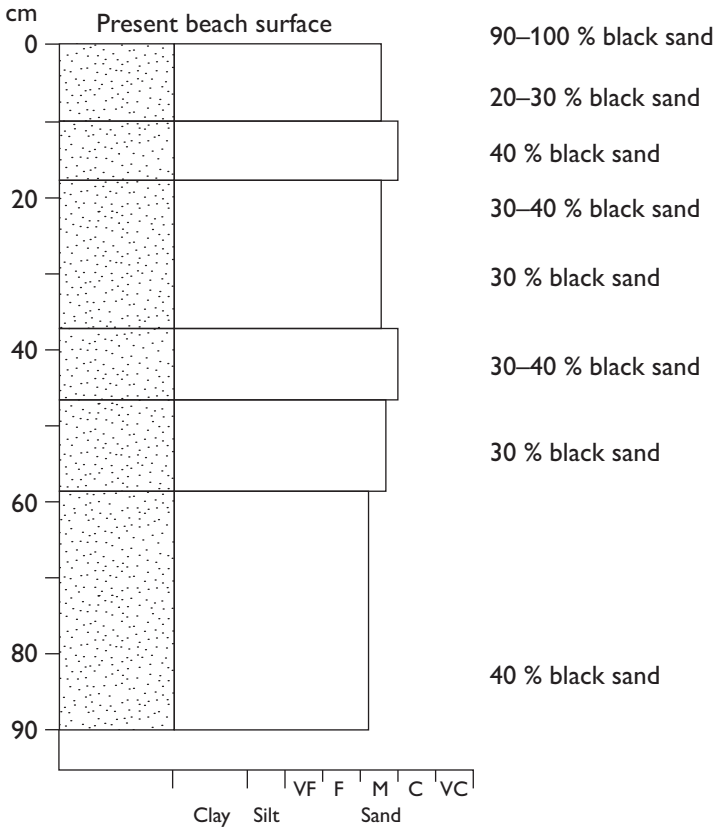


Iterlak

FinnAust
Hand-dug trench on present beach
16.08.2016
GPS coordinate (UTM 19)
E: 0492660
N: 8512206

GEUS
No high resolution GPS survey were made

Trench #569416

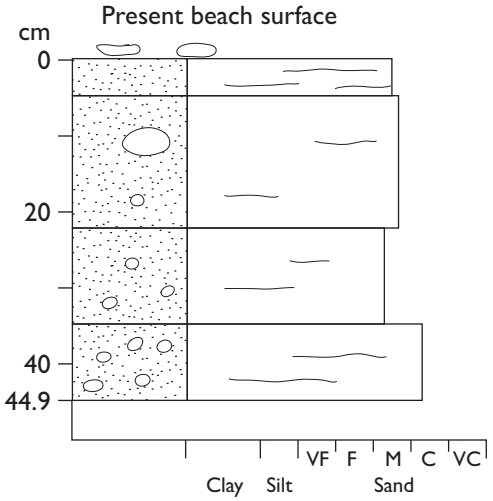


Iterlak

FinnAust
Hand-dug trench on present beach
16.08.2016
GPS coordinate (UTM 19)
E: 0492719
N: 8512129

GEUS
No high resolution GPS survey were made

Trench #569417



80 % black sand. Stribes of white sand in black sand dipping towards sea

8 cm clast
80 % black sand

90 % black sand

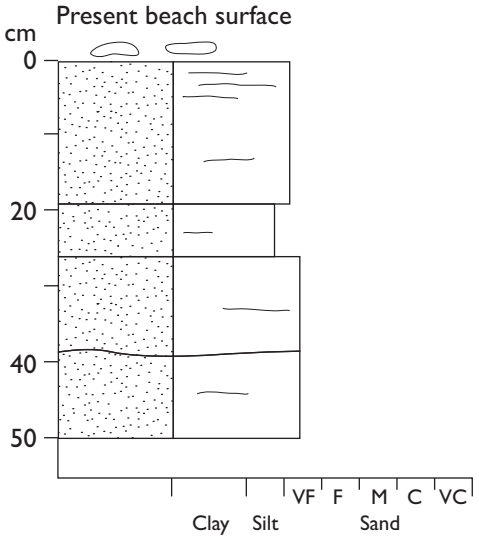
60 % black sand

Iterlak

FinnAust
Hand-dug trench on present beach
16.08.2016
GPS coordinate (UTM 19)
E: 0492766
N: 8512061

GEUS
No high resolution GPS survey were made

Trench #569418



90 % black sand white stribes of sand in black sand

95 % black sand

90 % black sand

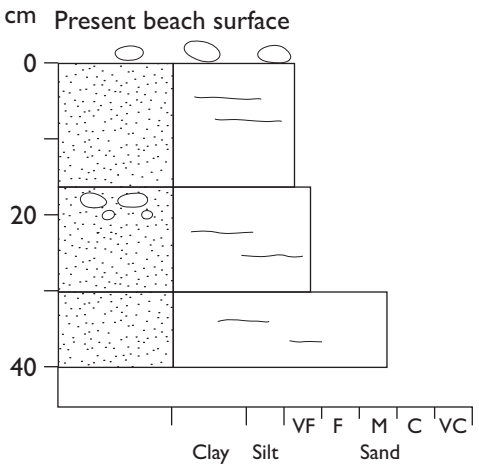
70 % black sand

Iterlak

FinnAust
Hand-dug trench on present beach
16.08.2016
GPS coordinate (UTM 19)
E: 0492811
N: 8511989

GEUS
No high resolution GPS survey were made

Trench #569419



100 % black sand

95 % black sand

Some thin stribes (0.5–1 cm) of white sand in black sand

20 % black sand

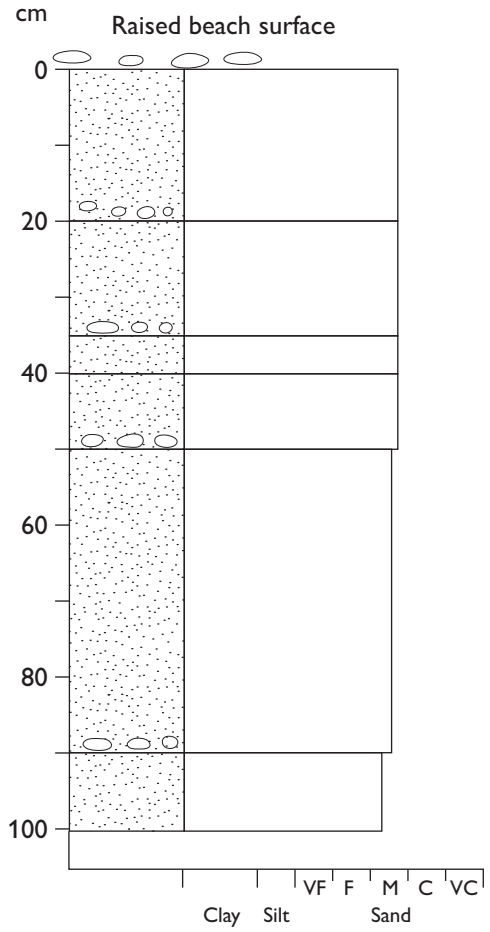
20–40 % black sand

Iterlak

FinnAust
Hand-dug trench on raised beach
16.08.2016
GPS coordinate (UTM 19)
E: 0492731
N: 8512199

GEUS
No high resolution GPS survey were made

Trench #569420



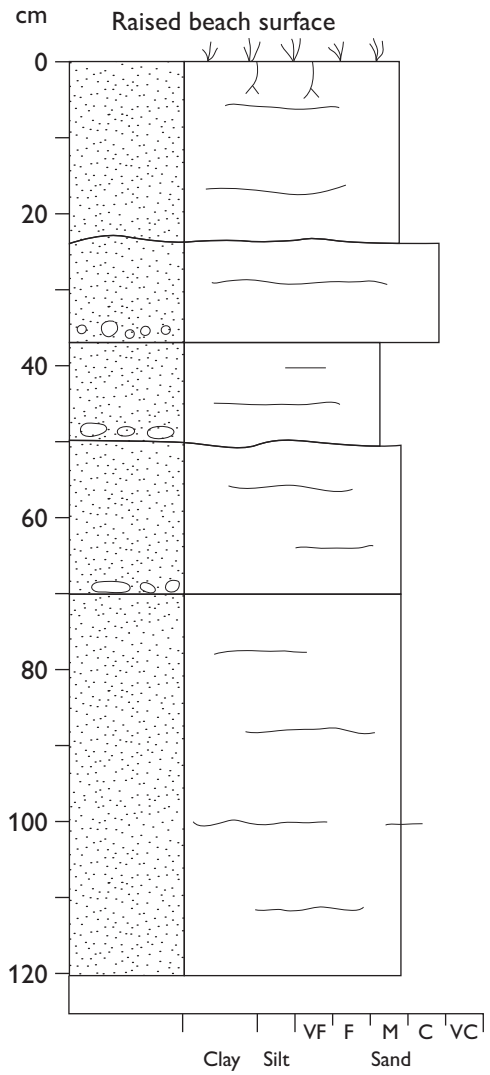
Stones on land surface
50 % black sand
60 % black sand
80 % black sand
85 % black sand
15 % black sand
50 % black sand
60 % black sand
Outsized clasts: 6x5x2 cm/6.5x5x1.5 cm
95 % black sand
Perma frost surface

Iterlak

FinnAust
Hand-dug trench on raised beach
16.08.2016
GPS coordinate (UTM 19)
E: 0492786
N: 8512127

GEUS
No high resolution GPS survey were made

Trench #569421



Land surface grass
Rootless
30 % black sand

40 % black sand

30 % black sand

Outsized clasts: 14x9x0.5 cm/8.5x8x2 cm
30 % black sand

Outsized clasts: 6x4x2 cm/6x5.5x1 cm

30 % black sand

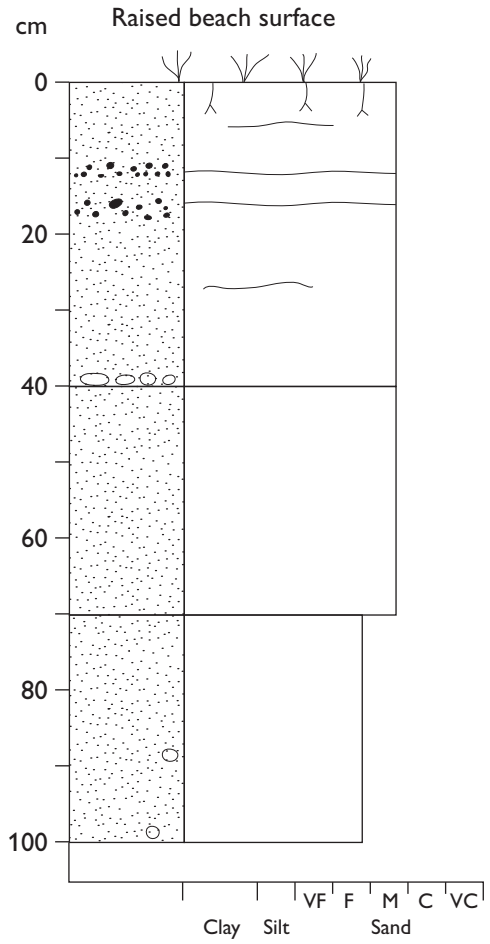
10–15 % black sand

Iterlak

FinnAust
Hand-dug trench on raised beach
16.08.2016
GPS coordinate (UTM 19)
E: 0492841
N: 8512061

GEUS
No high resolution GPS survey were made

Trench #569422



Land surface
Rootlets

80 % black sand

Thin 2–3 cm thick sand layers: 95 % black sand

60 % black sand

80 % black sand

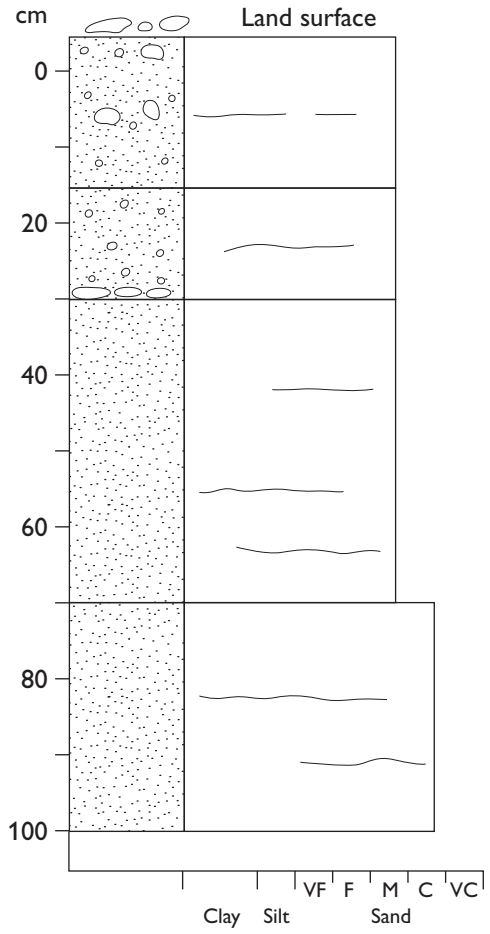
Iterlak

FinnAust
Hand-dug trench on raised beach
16.08.2016
GPS coordinate (UTM 19)
E: 0492911
N: 8511953

GEUS
No high resolution GPS survey were made

Trench #569423

Raised beach surface



40 % black sand

40 % black sand

Outsized clasts: 9x6.5x1 cm/6x5x1 cm

90 % black sand

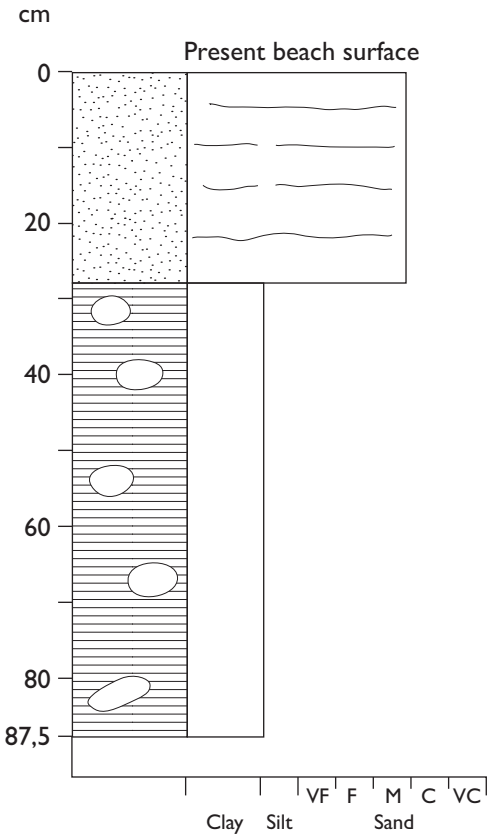
80 % black sand

Iterlak

FinnAust
Hand-dug trench on present beach
18.08.2016
GPS coordinate (UTM 19)
E: 0493222
N: 8511392

GEUS
No high resolution GPS survey were made

Trench #569425



Well-sorted sand
90 % black sand
Laminae with 30 % black sand

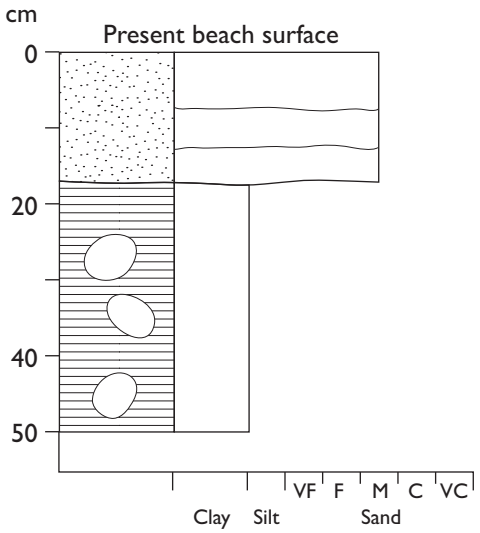
Clay with stones

Iterlak

FinnAust
Hand-dug trench on present beach
18.08.2016
GPS coordinate (UTM 19)
E: 0493266
N: 8511305

GEUS
No high resolution GPS survey were made

Trench #569426



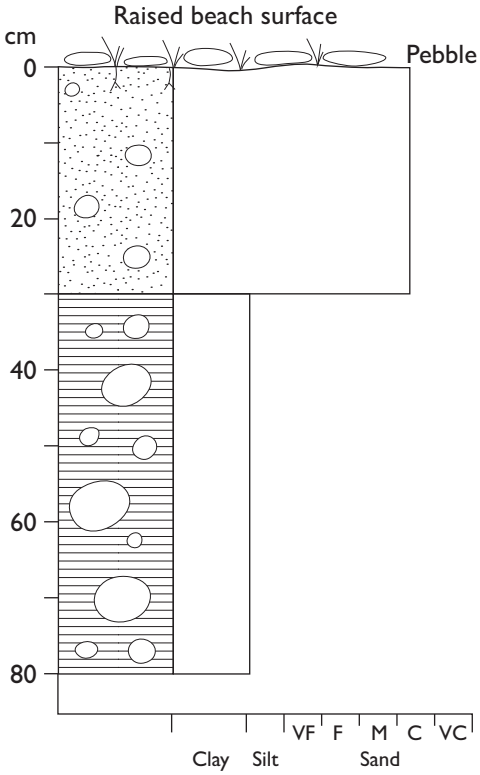
Clay with pebbles

Iterlak

FinnAust
Hand-dug trench on raised beach
18.08.2016
GPS coordinate (UTM 19)
E: 0493248
N: 8511369

GEUS
No high resolution GPS survey were made

Trench #569427

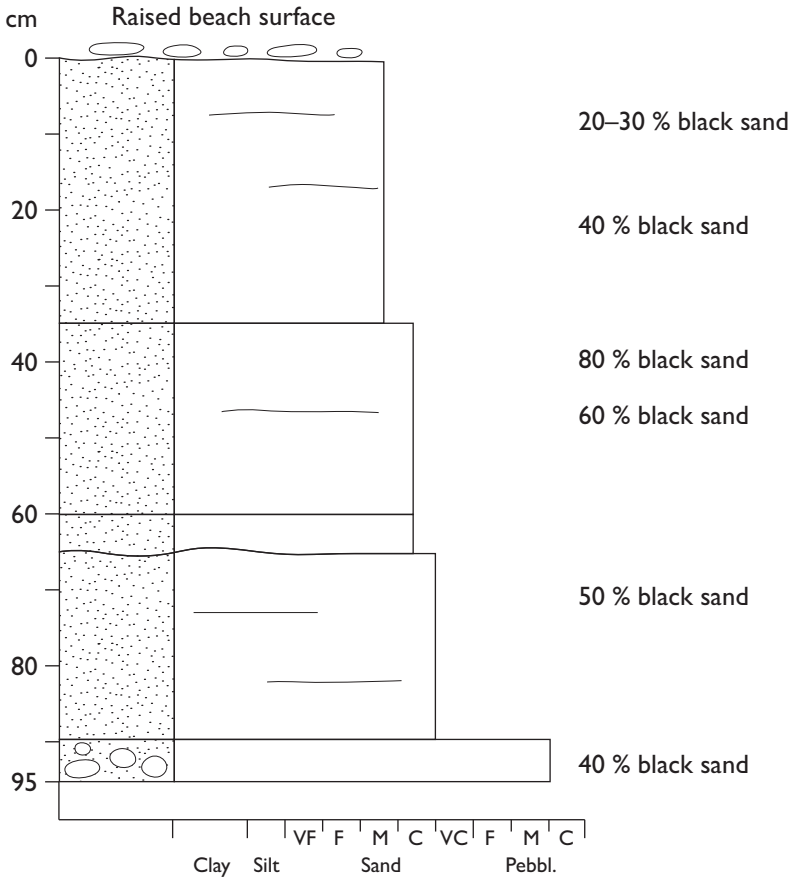


Iterlak

FinnAust
Hand-dug trench on raised beach
18.08.2016
GPS coordinate (UTM 19)
E: 0493312
N: 8511405

GEUS
High resolution GPS data survey (UTM 19)
18.08.2016
E: 0493312.65
N: 8511406.30
Height above sea-level: 17.52 m

Trench #569428

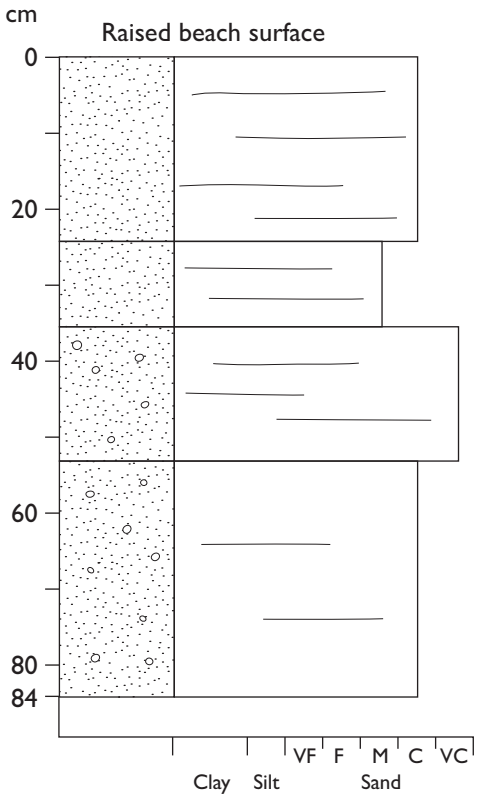


Iterlak

FinnAust
Hand-dug trench on raised beach
18.08.2016
GPS coordinate (UTM 19)
E: 0492361
N: 8511458

GEUS
High resolution GPS data survey (UTM 19)
18.08.2016
E: 0493262.10
N: 8511457.37
Height above sea-level: 17.59 m

Trench #569429



Inter-bedded dark and light layers
Dark layers: 30–35 % black sand

Rounded and well-sorted sand
40 % black sand

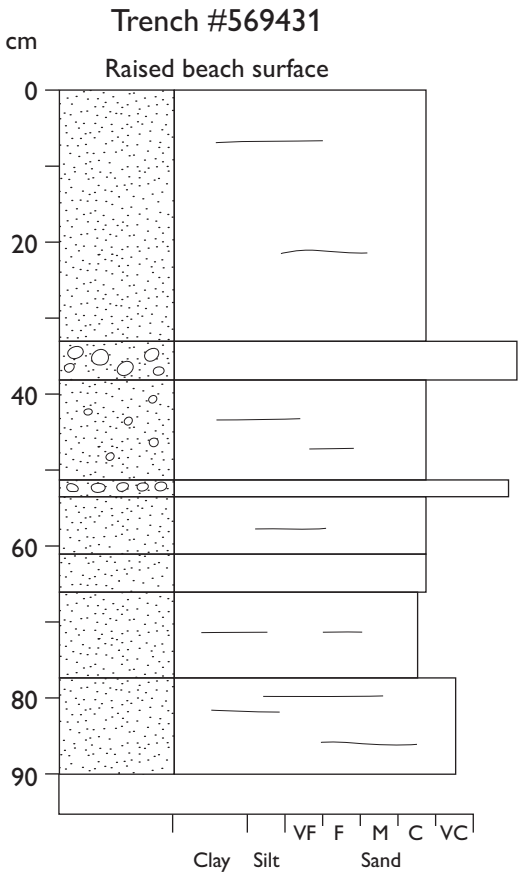
Inter-bedded dark and light layers
Well-sorted sand. 5 % gravel

Gravel in sand
25–30 % black sand

Iterlak

FinnAust
Hand-dug trench on raised beach
18.08.2016
GPS coordinate (UTM 19)
E: 0493488
N: 8511605

GEUS
High resolution GPS data survey (UTM 19)
18.08.2016
E: 0493490.56
N: 8511603.95
Height above sea-level: 42.65 m



Poorly sorted, sub-rounded sand

Sub-rounded sand. 10 % gravel

30 % black sand
40–45 % black sand

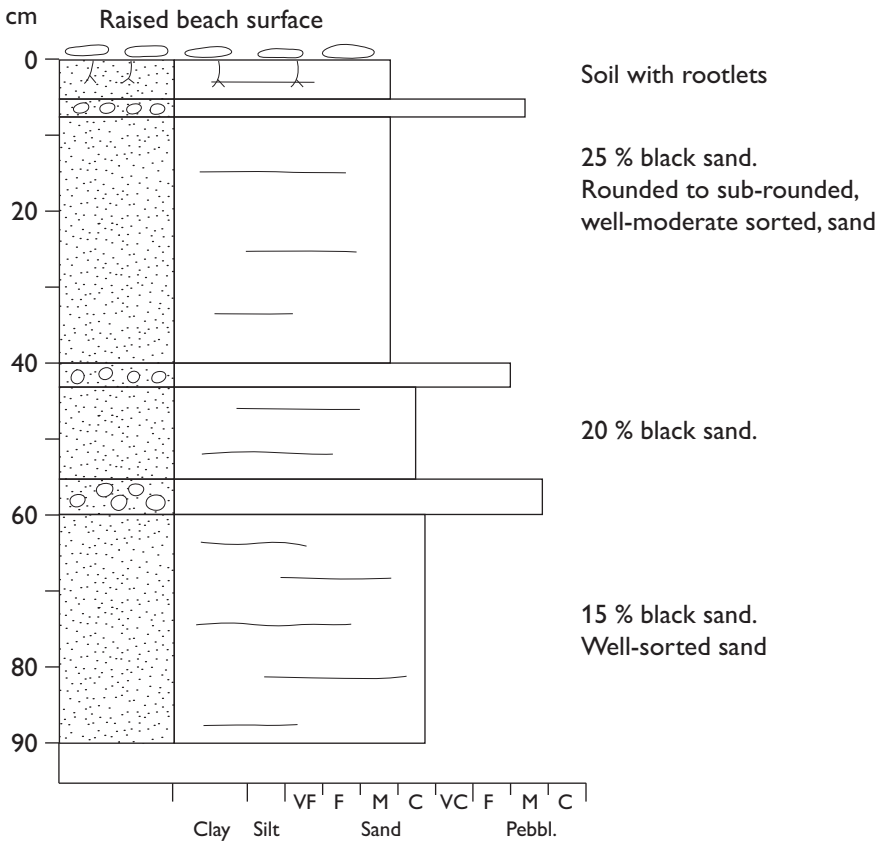
30–35 % black sand
Poorly sorted sand. Very compact
10 % gravel

Iterlak

FinnAust
Hand-dug trench on raised beach
18.08.2016
GPS coordinate (UTM 19)
E: 0493618
N: 8511560

GEUS
High resolution GPS data survey (UTM 19)
18.08.2016
E: 0493619.32
N: 8511561.22
Height above sea-level: 43.19 m

Trench #569432

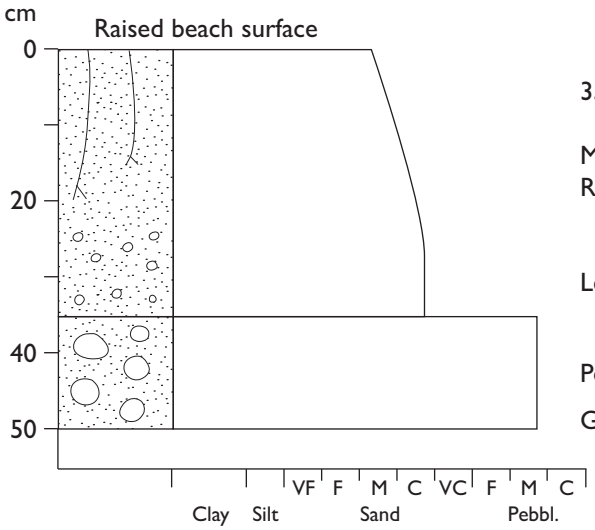


Iterlak

FinnAust
Hand-dug trench on raised beach
18.08.2016
GPS coordinate (UTM 19)
E: 0493714
N: 8511509

GEUS
High resolution GPS data survey (UTM 19)
18.08.2016
E: 0493715.76
N: 8511510.24
Height above sea-level: 38.60 m

Trench #569433



35–40 % black sand, up to 55 % black sand

Moderately sorted sand
Rounded sand

Less than 5 % gravel

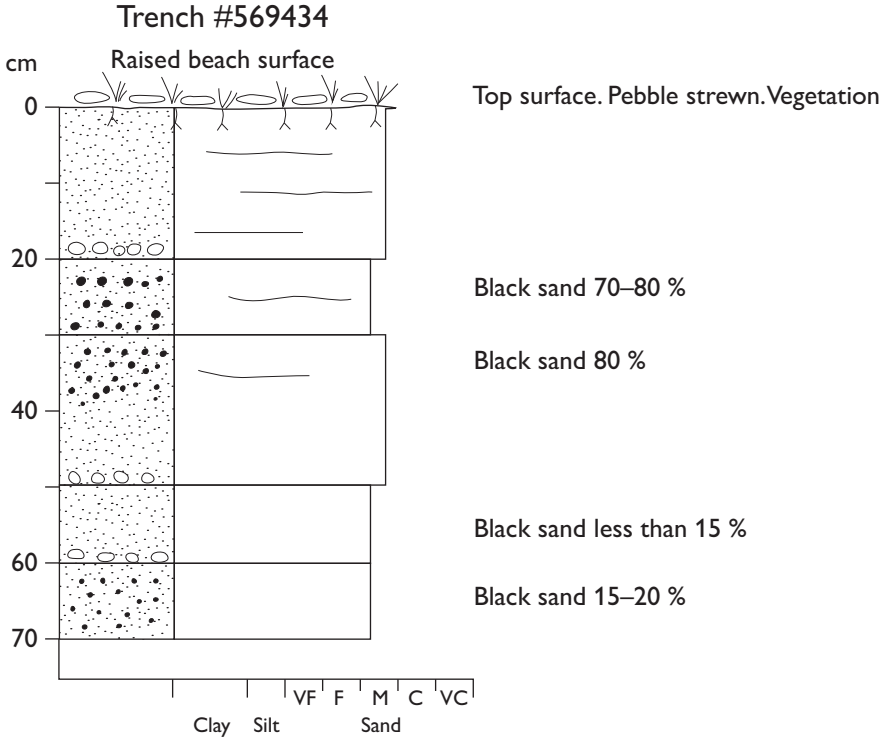
Pebbles up to 10 cm in diameter

Ground water

Iterlak

FinnAust
Hand-dug trench on raised beach
18.08.2016
GPS coordinate (UTM 19)
E: 0493841
N: 8511423

GEUS
High resolution GPS data survey (UTM 19)
18.08.2016
E: 0493842.83
N: 8511424.38
Height above sea-level: 35.99 m

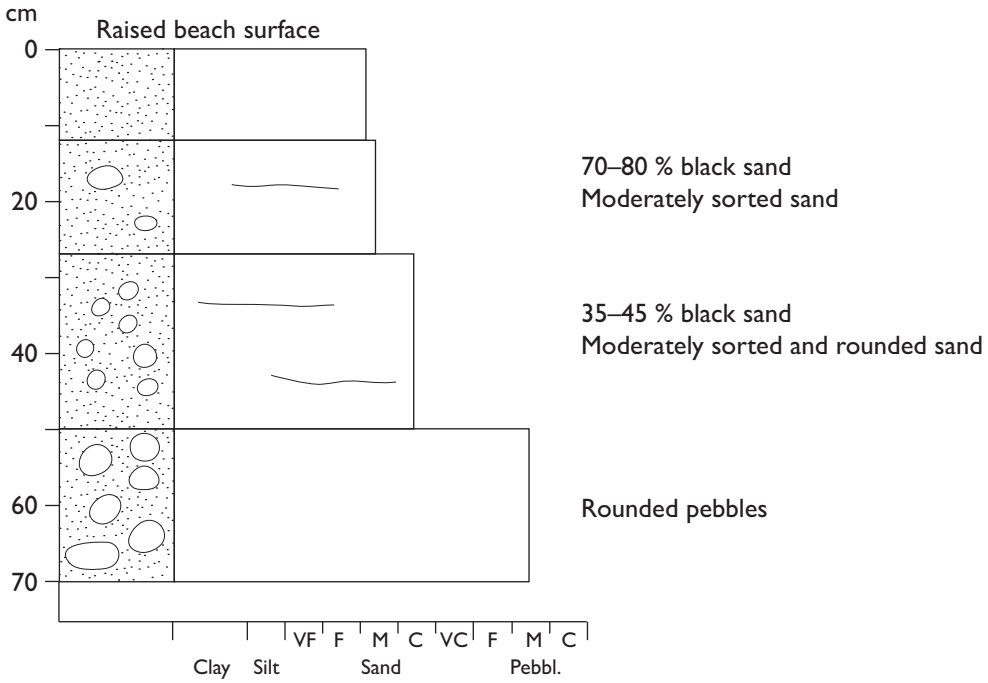


Iterlak

FinnAust
Hand-dug trench on raised beach
18.08.2016
GPS coordinate (UTM 19)
E: 0493996
N: 8511358

GEUS
High resolution GPS data survey (UTM 19)
18.08.2016
E: 0493997.56
N: 8511358.68
Height above sea-level: 36.22 m

Trench #569435

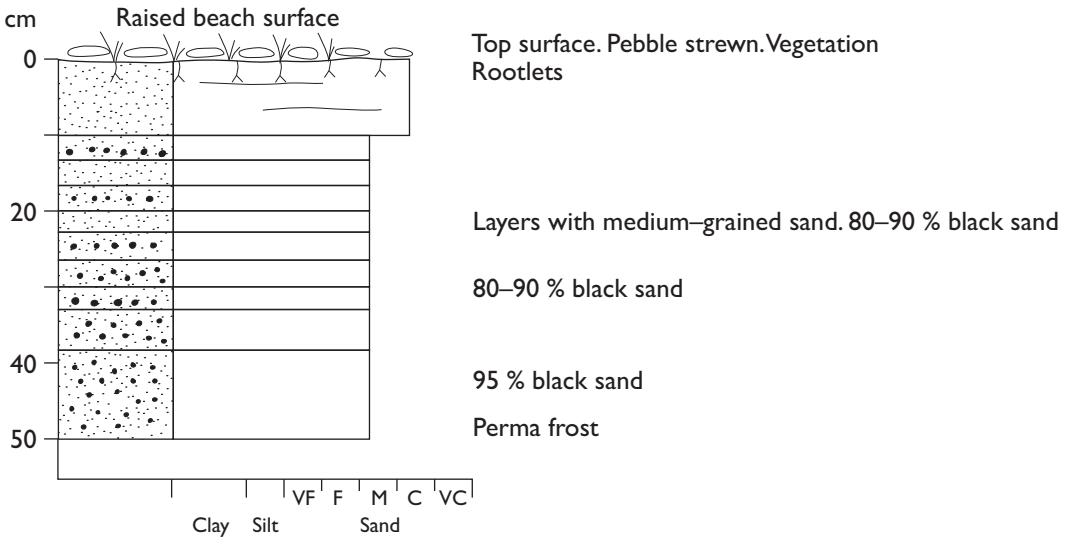


Iterlak

FinnAust
Hand-dug trench on raised beach
18.08.2016
GPS coordinate (UTM 19)
E: 0494148
N: 8511327

GEUS
High resolution GPS data survey (UTM 19)
18.08.2016
E: 0494147.50
N: 8511329.75
Height above sea-level: 34.14 m

Trench #569436

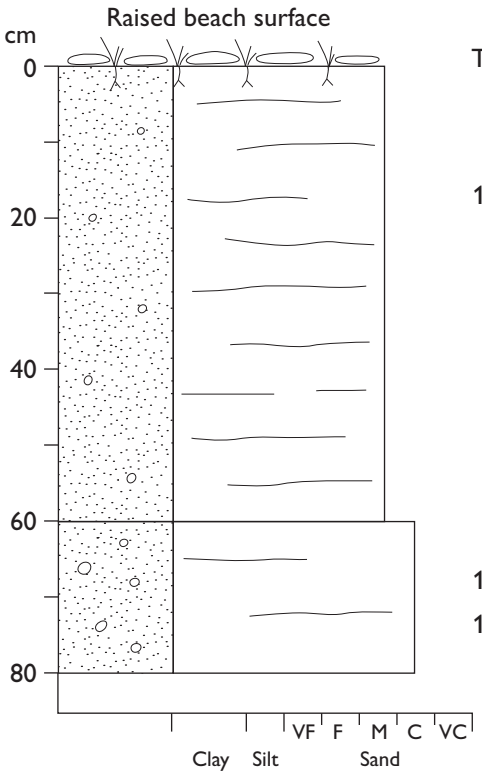


Iterlak

FinnAust
Hand-dug trench on raised beach
18.08.2016
GPS coordinate (UTM 19)
E: 0494032
N: 8511197

GEUS
High resolution GPS data survey (UTM 19)
18.08.2016
E: 0494031.52
N: 8511200.51
Height above sea-level: 17.04 m

Trench #569437



Top surface. Pebble strewn. vegetation

10–15 % black sand

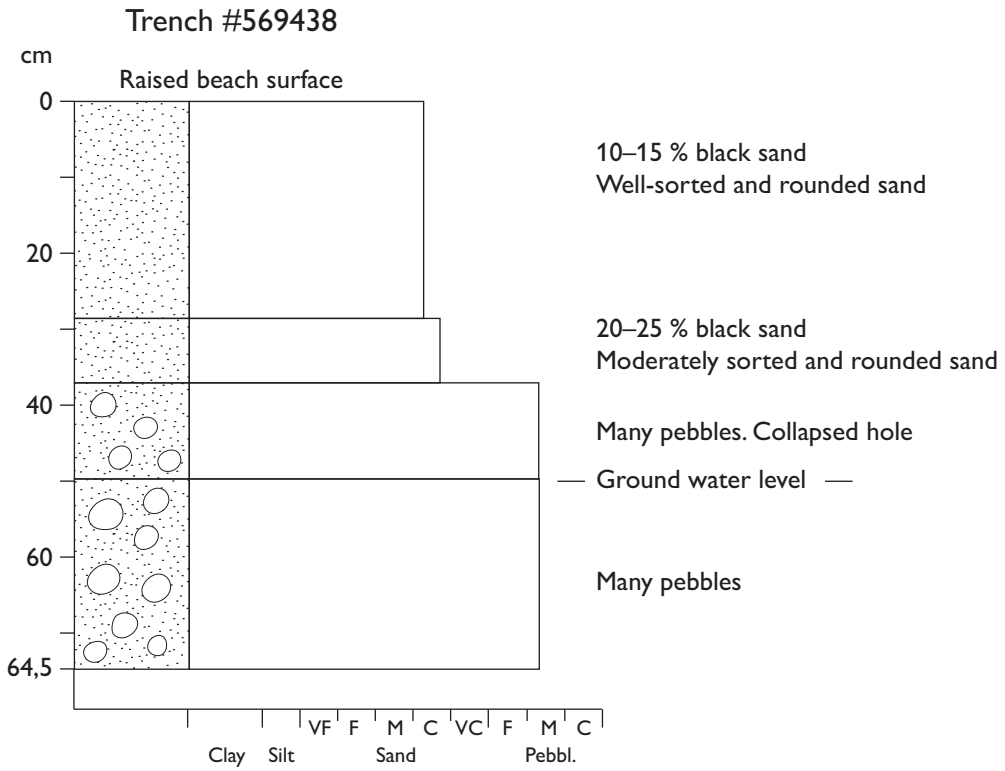
10–15 % black sand

15 % gravel

Iterlak

FinnAust
Hand-dug trench on raised beach
18.08.2016
GPS coordinate (UTM 19)
E: 0493921
N: 8511201

GEUS
High resolution GPS data survey (UTM 19)
18.08.2016
E: 043921.79
N: 8511204.53
Height above sea-level: 16.29 m

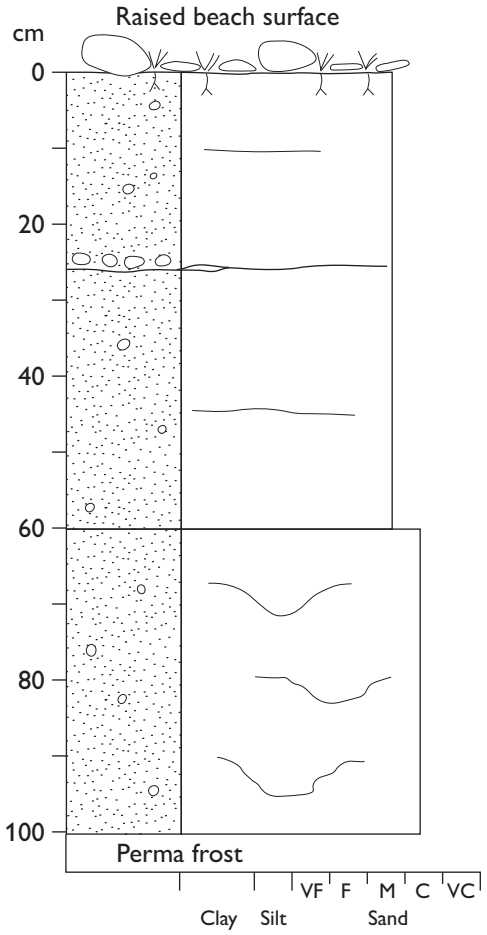


Iterlak

FinnAust
Hand-dug trench on raised beach
18.08.2016
GPS coordinate (UTM 19)
E: 0493769
N: 8511257

GEUS
High resolution GPS data survey (UTM 19)
18.08.2016
E: 0493768.00
N: 8511257.32
Height above sea-level: 17.64 m

Trench #569439



Flat pebbles and big boulders, 50–100 cm on surface

10–15 % black sand

10–15 % black sand

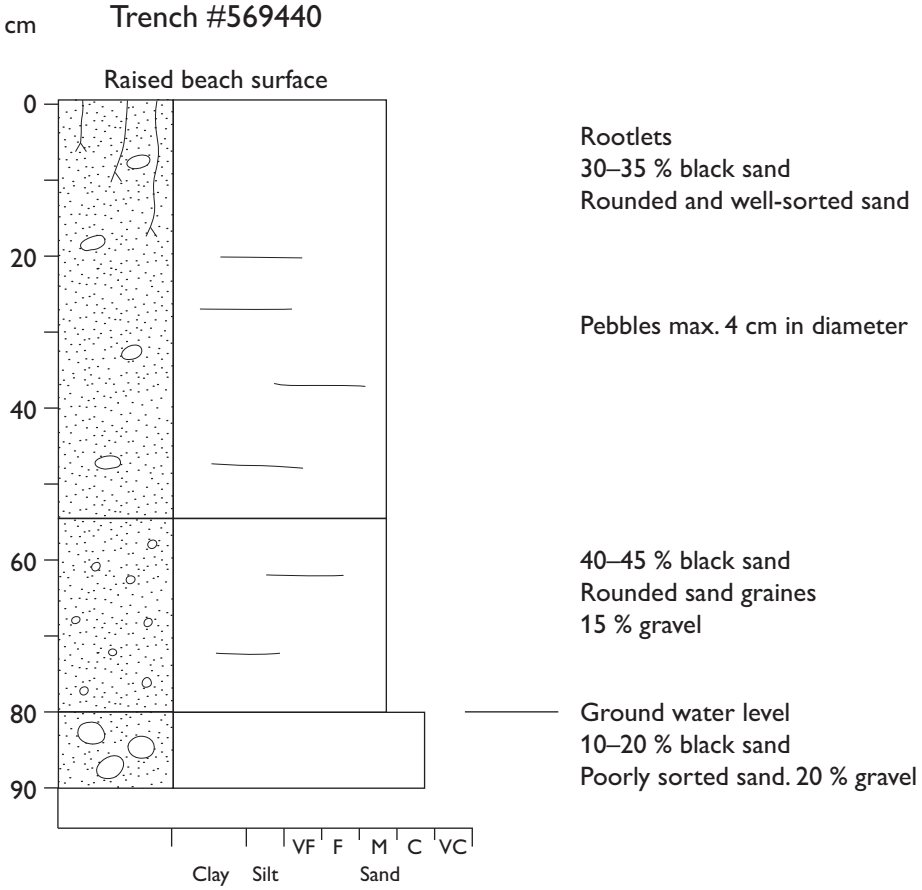
10–15 % black sand

20 % black sand

Iterlak

FinnAust
Hand-dug trench on raised beach
18.08.2016
GPS coordinate (UTM 19)
E: 0493625
N: 8511306

GEUS
High resolution GPS data survey (UTM 19)
18.08.2016
E: 0493623.42
N: 8511306.40
Height above sea-level: 19.57 m



Iterlak

FinnAust
Hand-dug trench on raised beach
18.08.2016
GPS coordinate (UTM 19)
E: 0493469
N: 8511385

GEUS
High resolution GPS data survey (UTM 19)
18.08.2016
E: 0493457.85
N: 8511383.90
Height above sea-level: 17.76 m