

The geological heritage values and potential geotourism development of the beaches in Northern Sabah, Malaysia

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Abstract: A study was carried out on 13 beaches in Northern Sabah, Malaysia to identify their geological heritage values and geotourism potential. Northern Sabah has some of the finest beaches in Sabah and most of them are still undisturbed and in pristine condition. However, with the increasing demand for tourism facilities, considerable development is currently being undertaken in the coastal areas and the impact upon the beaches is considerable. The natural geomorphologic processes may be disrupted and the beaches in the area might be degraded and damaged. The main attractions of the beaches are their beautiful landscape. The geological heritage values usually go unnoticed and unappreciated due to lack of awareness and information. By unraveling and explaining their hidden natural qualities, the attractions of the beaches could be enhanced. This study has identified the scientific values of the beaches such as the composition, morphology and sources of the beach sediments. Black sand comprising mainly chromite was found at Marasimsim Beach and pink sand comprising mainly garnet was found at a pocket beach in Tanjung Simpang Mengayau. The study also revealed that several of the beaches in the area have aesthetic and cultural value as well as their obvious recreational value. Such aspects could be explained to visitors so that they can appreciate the importance of conservation. Geotourism could be developed and promoted on some of the beaches together with steps to ensure the sustainability and to protect these beach environments. The promotion of beach geotourism could be carried out together with other potential geotourism sites in Northern Sabah. The study on beaches for geotourism development is an innovative way to add-value to their existing aesthetic attractions and to enhance and sustain the tourism industry in the State.

Keywords: geological heritage, geotourism, beach, Sabah

INTRODUCTION

Beaches are one of the most important landscape assets for the tourism industry in Sabah. For instance, nearly all the highly rated hotels in Sabah are built near beaches such as the Nexus Karambunai Resort, Shangri-La Rasa Ria Resort and Shangri-La Tanjung Aru Resort.

Northern Sabah has some of the finest beaches in Sabah, especially in the western part of the Kudat Peninsula. The beaches in this area stretch from Teringkai, located south of the Kudat Peninsula to Kosuhui just south of Tanjung Simpang Mengayau (popularly known as the Tip of Borneo). Beaches can also be found at the eastern side of the Kudat Peninsula and at the western part of the Bengkoka Peninsula.

Beaches are formed where there is a sufficient supply of sediment and suitable sites for accumulation. Beaches are often associated with fishing, recreation and scientific research such as studies on geomorphology, coastal environmental and global sea level change. Beaches lure visitors because of their sandy nature and beautiful landscape. By unraveling more of their hidden natural qualities, the attractions could be enhanced. Most of the beaches in the study area are still undisturbed and in pristine condition. However, with the increasing demand for tourism facilities, developments is now being carried in the coastal areas and the impact upon the beaches are greater now than ever. The natural geomorphologic processes could be disrupted and

the beaches in the area might be degraded and damaged.

The main attraction of a beach is because of its sandy nature. Visitors naturally shun muddy or rocky beaches. The supplies of sand to a beach area are from various sources such as from the hinterland, coastal rocky outcrops and from the seabed. Disruption at the source or of the transport medium could alter the nature of a beach. Therefore, this study is timely and the outcome of this study could be used as a guide for sustainable development along coastal areas in Northern Sabah.

Each beach has its own heritage value. The value which is usually appreciated by the public is the aesthetic value while the other values such as the scientific values usually go unnoticed and unappreciated due to lack of awareness and information. The scientific values of beaches could be conveyed to the general public so that they can appreciate its importance. Visitors to beaches could thereby gain some knowledge concerning the history of the formation of these important landscapes of the earth.

Beach landscape is one of the youngest landscapes compared to many other types of landscape. The coastal areas are very dynamic and among the factors that form beach landscapes are sea level changes, tides, wave actions, rock types and geological structures. Visitors have to be made aware of the geomorphologic processes and geological features that shape and control the formation of beaches so that they can appreciate and protect them.

LOCATION OF STUDY AREA

The study area is located mainly in the Kudat Peninsula, Northern Sabah. A total of thirteen beaches were involved in the study (Figure 1). They are Kampung Kuala Tajau, Sampaping, Tanjung Simpang Mengayau, Kosuhui, Pongugadan, Bawang Jamal, Kulambu, Loro Kecil, Kamihang, Sikuati, Torongkonggan, Teluk Agal and Marasimsim Beach (Figures 2 and 3).

OBJECTIVES AND METHODOLOGY

The objectives of the study are to identify the geological heritage values and the geotourism potential of the beaches in Northern Sabah. This includes the study of the physical characteristics and composition of the beach sand and the beach landscape itself.

Beach sediment samples were collected for grain size, compositional and morphological analyses. Two types of samples were collected at each sampling site, one which is nearer to the sea (foreshore) and the other nearer to the land (backshore). Samples were also collected whenever coloured sediments were encountered. The beach sand samples were collected up to 10 cm deep using a small plastic scope and the amount of sample collected was at least 300 g. A duplicate sample was collected at each beach for quality control of the sampling procedure. All samples were washed with fresh water, air-dried and thoroughly dispersed before sieving. The amount of sample used for dry sieving was about 250 g. A mechanical riffle splitter was used to split samples before sieving. Sieve with sizes of 2.0, 1.0,

0.5, 0.25, 0.125 and 0.0625 mm were used and set up in order of decreasing mesh size. The results obtained from the sieve analysis were treated statistically using the Folk and Ward (1957) method.

The statistical parameters calculated in phi (Φ) units were mean particle size, standard deviation (sorting), skewness and kurtosis. Semi-quantitative estimation (QME) analysis was also carried out on selected beach sediment samples. The characteristics of the beach and its surrounding landscapes such as the profile, slope, width, rock outcrops, erosional features and vegetation were also recorded.

GEOLOGICAL SETTING

The oldest rocks in Northern Sabah, the basement rocks are consist of ophiolite and associated sedimentary rocks such as sandstone, mudstone and chert. These are overlain by sedimentary rocks comprising the Crocker, Kudat, South Banggi and Bongaya Formations together with minor mélange and Quaternary deposits of alluvium, terrace sand and gravel. The geological map of Northern Sabah is shown in Figure 4.

RESULTS

Two types of beach are observed in the study area; the linear type and pocket type respectively. Linear beaches are generally straight or slightly curved while pocket beaches are small interruptions of rocky shores. For the purpose of this study, pocket beaches are those less than 500 m in length. The characteristics of the beach sediments in the study area range from fine to coarse grained and poorly sorted to very well sorted. The summary of the landscapes and physical characteristics of the beach sediments in Northern Sabah is shown in Table 1.

According to King (1972), fine-grained sediments form beaches with a smooth profile. The beaches with fine-grained and well-sorted sediments are Kampung Kuala Tajau, Kosuhui, Bawang Jamal, Kulambu, Loro Kecil,

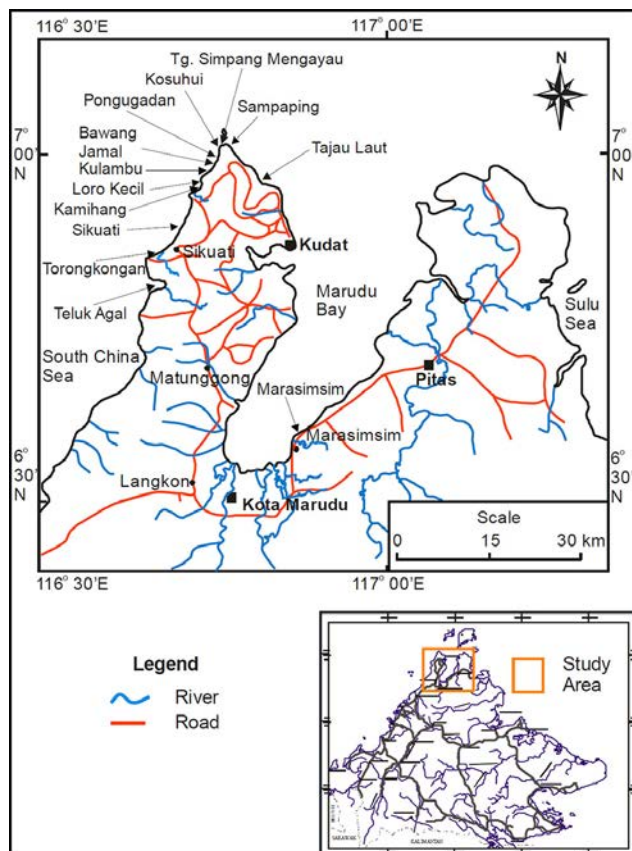


Figure 1: Location of study area and beaches in Northern Sabah.



Figure 2: The Kulambu Beach.



Figure 3: The Loro Kecil pocket beach.

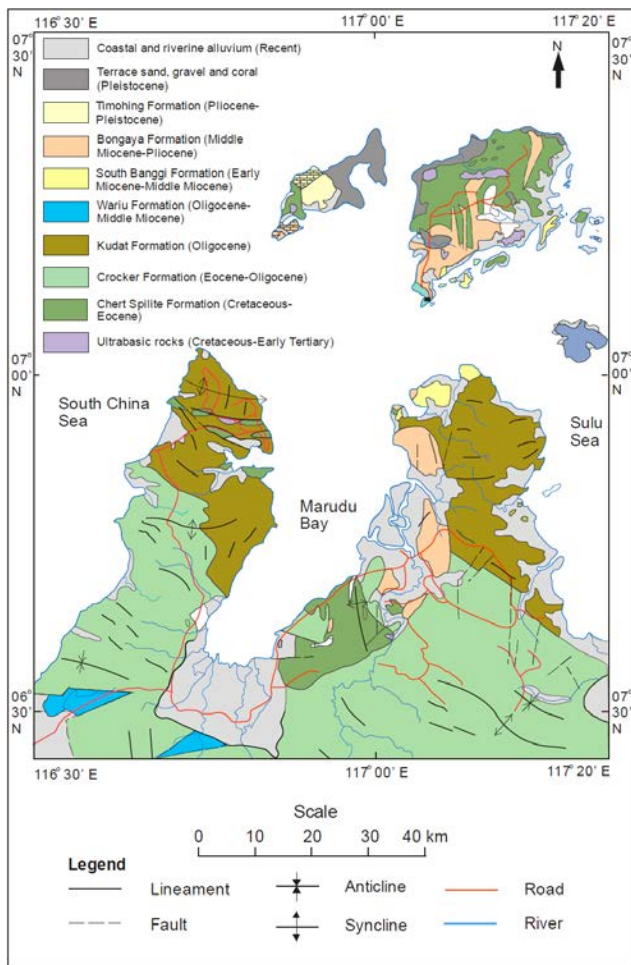


Figure 4: Geological map of Northern Sabah, Malaysia.

Kamihang, Sikuati, Teluk Agal and Torongkong. The occurrence of black sand was found at Marasimsim Beach and Torongkong Beach (Figure 5). The black sand at the Marasimsim Beach comprises mainly chromite (39-83%) which originated from the ultrabasic rocks in the hinterland. The patches of black sand at the Torongkong Beach comprise mainly zircon (39%) and chromite (35%) which probably derived from the ultrabasic rocks and basalt at Tanjung Bangau located just north of the Sikuati Beach (Figure 6). Pink sand was found at Tanjung Simpang Mengayau pocket beach (Figure 7). The QME analysis carried out on the pink sand shows it consists mostly of garnet (73%) with minor amounts of ilmenite, chromite, pyroxene, iron oxide, zircon, rutile, leucosene and other minerals. The garnet sand is medium grained and moderately well sorted. The colour of the garnet is various shades of pink (Figure 8). The grains are subangular to rounded and mostly spherical in shape due to attrition. The source of the garnet is not known with certainty but probably was derived from the reworking of older sediments.

EVALUATION OF THE GEOLOGICAL HERITAGE OF BEACHES

The evaluation of the geological heritage of beaches is carried out based on scientific, aesthetic, recreational,



Figure 5: Black sand at the Marasimsim Beach, Northern Sabah. The black sand comprises mainly chromite derived from the hinterland.

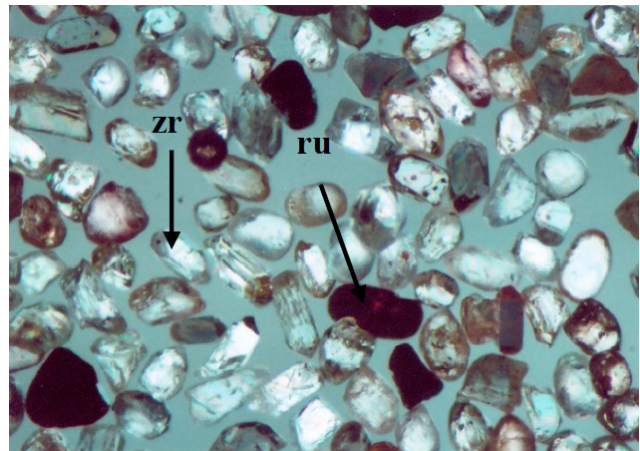


Figure 6: Zircon (Zr) and rutile (Ru) grains in the black sand of the Torongkong Beach.

cultural and ecological values (Table 2). The geological heritage values that are present in beaches usually go unnoticed and unappreciated by visitors. These values should be conveyed to the beach users and the general public so that they can appreciate their importance. Based on the evaluation, several beaches such as the Kosuhui, Kulambu, Loro Kecil, Torongkong and Marasimsim Beach have scientific, aesthetic, recreational and cultural values.

GEOTOURISM POTENTIAL

The target groups identified for geotourism development include amateur and professional geoscientists, school and university students, academics and teachers, ecotourism participants, landscape photographers, artists, historians, those interested in the physical natural wonders of the earth and ordinary tourists (Joyce, 2006). With these in mind, the geotourism potential of beaches is evaluated as based on research, educational and recreational activities. The geotourism potential of the beaches in Northern Sabah is shown in Table 3. Beaches such as the Tanjung Simpang Mengayau, Kulambu, Loro Kecil, Torongkong and Marasimsim Beach have research, educational and recreational values and therefore have high potential for geotourism.



Figure 7: A patch of pink beach sand at Tanjung Simpang Mengayau comprising mainly garnet.

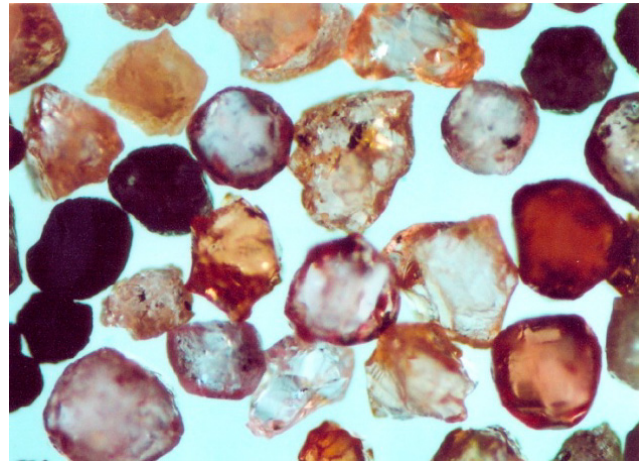


Figure 8: Garnet grains of various shades of pink that give the pink colour to the beach sand at Tanjung Simpang Mengayau.

Table 1: Summary of the landscape and physical characteristics of the beach sediments in Northern Sabah, Malaysia.

No.	Name of Beach	Type of Beach/Other Features Near Beach	Beach Sediment Analysis		
			Grain Size and Sorting	Colour/Composition	Grain Morphology
1	Kampung Kuala Tajau	Linear	Sandy sediment (fine-grained, moderately sorted to well-sorted).	Very light grey/Quartz (95%).	Subrounded to rounded
2	Sampaping	Linear/Remnant cliffs	Sandy sediment (fine- to coarse-grained, moderately sorted to poorly sorted).	Yellowish grey/Quartz (60-70%).	Angular to subrounded
3	Tanjung Simpang Mengayau	Pocket/Cliffs, faults, sea caves	Sandy to pebbly sediment (coarse-grained, moderately well-sorted), pink sand (garnet).	Light grey/Quartz (70-80%). Garnet (73%) in pink sand.	Subangular to subrounded
4	Kosuhui	Extensive linear	Sandy sediment (fine- to medium-grained, moderately well-sorted to well-sorted).	Light grey/Quartz (75-80%).	Subangular to subrounded
5	Pongugadan	Pocket/Cliffs, karren-like feature	Sandy sediment (medium- to very coarse-grained, moderately well-sorted to poorly sorted).	Yellowish grey/Quartz (85%).	Subangular to subrounded
6	Bawang Jamal	Linear	Sandy sediment (fine- to medium-grained, moderately well-sorted to very well-sorted).	Light-yellowish grey/Quartz (65-75%).	Subangular to subrounded
7	Kulambu	Linear/Remnant cliff, remnant island (Pulau Kulambu), tombolo	Sandy sediment (fine-grained, moderately well-sorted to well-sorted).	Light grey/Quartz (70%).	Subangular to rounded
8	Loro Kecil	Embayed pocket/Cliffs	Sandy sediment (fine- to very fine-grained, moderately well-sorted to well-sorted).	Light brownish grey/Quartz (75%).	Subangular to subrounded
9	Kamihang	Embayed pocket	Sandy sediment (fine- to very fine-grained, well-sorted to poorly sorted).	Dark grey/Quartz (75-80%).	Subangular to subrounded
10	Sikuati	Extensive linear/Terrace beach	Sandy sediment (fine- to medium-grained, moderately well-sorted to very well-sorted).	Light grey/Quartz (90-95%).	Subrounded to rounded
11	Torongkongan	Extensive linear/Remnant cliffs, rocky shore	Sandy sediment (fine- to medium-grained, moderately sorted to moderately well-sorted). Black sandy patch (chromite, zircon).	Yellowish grey/Quartz (80-85%). Chromite (35%) and zircon (39%) in black sand.	Subangular to rounded
12	Teluk Agal	Embayed pocket/Cliffs	Sandy sediment (fine- to medium-grained, moderately well-sorted to very well-sorted).	Yellowish grey/Quartz (55-65%).	Subangular to subrounded
13	Marasimsim	Linear	Sandy to pebbly sediment (medium- to very coarse-grained, poorly sorted), black sand (chromite).	Brownish to dark yellowish grey/Quartz (65-75%). Chromite in black sand (39-83%).	Subangular to subrounded

Table 2: The evaluation of the geological heritage of the beaches in Northern Sabah, Malaysia.

Name of Beach	Main Geological Heritage Resources	Evaluation of Geological Heritage Values				
		Scientific	Aesthetic	Recreational	Cultural	Ecological
Kampung Kuala Tajau	Linear beach, sandy sediment (fine-grained, moderately sorted to well-sorted).	Depositional history, coastal processes and source of beach sediment.	Attractive landscape.	Beach recreation.	-	Supports coastal biodiversity
Sampaping	Linear beach, sandy sediment (fine- to coarse-grained, moderately sorted to poorly sorted), remnant cliffs.	Depositional and erosional history, coastal processes and source of beach sediment.	Attractive landscape.	Beach recreation.	-	Supports coastal biodiversity
Tanjung Simpang Mengayau	Pocket beach, sandy to pebbly sediment (coarse-grained, moderately well-sorted), cliffs, faults, sea caves.	Depositional and erosional history, coastal processes and source of pink sediment.	Scenic embayment, attractive landscape.	Beach recreation.	-	Supports coastal biodiversity
Kosuhui	Linear beach, extensive sandy sediment (fine- to medium-grained, moderately well-sorted to well-sorted).	Depositional and erosional history and coastal processes.	Attractive landscape.	Beach recreation.	Probably visited by Ferdinand Magellan's Fleet in the 16 th Century.	Support coastal biodiversity
Pongugadan	Pocket beach, sandy sediment (medium- to very coarse-grained, moderately well-sorted to poorly sorted), cliffs, karren-like feature.	Depositional and erosional history and coastal processes.	Attractive landscape.	Beach recreation.	-	Supports coastal biodiversity
Bawang Jamal	Linear beach, sandy sediment (fine- to medium-grained, moderately well-sorted to very well-sorted).	Depositional history and coastal processes.	Attractive landscape.	Beach recreation.	-	Supports coastal biodiversity
Kulambu	Linear beach, sandy sediment (fine-grained, moderately well-sorted to well-sorted), remnant cliff, remnant island (Pulau Kulambu), tombolo, pocket beach.	Rare tombolo, depositional and erosional history and coastal processes.	Picturesque landscape.	Beach recreation.	The name Kulambu derived a from local story.	Supports coastal biodiversity
Loro Kecil	Embayed pocket beach, sandy sediment (fine- to very fine-grained, moderately well-sorted to well-sorted), cliff.	Depositional and erosional history and coastal processes.	Scenic embayment, attractive landscape.	Beach recreation.	Ship wreck site. Treasure hunting site.	Supports coastal biodiversity
Kamihang	Embayed pocket beach, sandy sediment (fine- to very fine-grained, well-sorted to poorly sorted).	Depositional and erosional history and coastal processes.	Scenic embayment, attractive landscape.	Beach recreation.	-	Supports coastal biodiversity
Sikuati	Linear beach, extensive sandy sediment (fine- to medium-grained, moderately well-sorted to very well-sorted), terrace beach.	Depositional history and sea level changes.	Attractive landscape.	Beach recreation.	-	Supports coastal biodiversity
Torongkon-gan	Linear beach, extensive sandy sediment (fine- to medium-grained, moderately sorted to moderately well-sorted), black sandy patch (chromite, zircon), remnant cliff, rocky shore.	Depositional and erosional history, coastal processes and source of black sediment.	Attractive landscape.	Beach recreation.	-	Supports coastal biodiversity
Teluk Agal	Embayed pocket beach, sandy sediment (fine- to medium-grained, moderately well-sorted to very well-sorted), cliff.	Depositional and erosional history and coastal processes.	Scenic embayment, attractive landscape.	Beach recreation.	-	Supports coastal biodiversity
Marasimsim	Linear beach, sandy to pebbly sediment (medium- to very coarse-grained, poorly sorted), black sand (chromite).	Depositional and erosional history, coastal processes and source of black sediment.	Modest landscape.	Beach recreation.	Historic mineral exploration site.	Support coastal biodiversity

Table 3: Evaluation of the geotourism potential of the beaches in Northern Sabah, Malaysia.

Name of Beach	Main Geological Heritage Resources	Evaluation of Geotourism Potential			Remarks
		Research	Education	Recreation	
Kampung Kuala Tajau	Linear beach, sandy sediment.	-	Education on coastal erosional and depositional processes.	Suitable for various beach recreational activities.	Potential for geotourism.
Sampaping	Linear beach, sandy sediment, remnant cliffs.	-	Education on coastal erosional and depositional processes.	Suitable for various beach recreational activities.	Potential for geotourism.
Tanjung Simpang Mengayau	Pocket beach, sandy to pebbly sediment, unique pink sand (garnet).	Research on formation of various coastal features and processes, source of pink sand.	Education on coastal erosional and depositional processes.	Suitable for various beach recreational activities.	High potential for geotourism.
Kosuhui	Linear beach, extensive sandy sediment.	-	Education on coastal erosional and depositional processes.	Suitable for various beach recreational activities.	Potential for geotourism. Probably visited by Ferdinand Magellan's Fleet in the 16 th century.
Pongugadan	Pocket beach, sandy sediment, cliffs, karren-like feature.	-	Education on coastal erosional and depositional processes.	Suitable for various beach recreational activities.	Potential for geotourism.
Bawang Jamal	Linear beach, sandy sediment.	-	Education on coastal erosional and depositional processes.	Suitable for various beach recreations.	Potential for geotourism.
Kulambu	Linear beach, sandy sediment, remnant cliff, remnant island (Pulau Kulambu), tombolo, pocket beach.	Research on formation of various coastal features and processes.	Education on coastal erosional and depositional processes.	Suitable for various beach recreational activities.	High potential for geotourism.
Loro Kecil	Embayed beach, sandy sediment, cliff.	Research on formation of embayed beach.	Education on coastal erosional and depositional processes.	Suitable for various beach recreational activities.	High potential for geotourism. Remains of World War II warship.
Kamihang	Embayed beach, sandy sediment, cliff.	-	Education on coastal erosional and depositional processes.	Suitable for various beach recreational activities.	Potential for geotourism.
Sikuati	Linear beach, extensive sandy sediment, terrace beach.	Research on terrace beach.	Education on coastal erosional and depositional processes.	Suitable for various beach recreational activities.	Potential for geotourism.
Torongkongan	Linear beach, extensive sandy sediment, black sandy patch (chromite, zircon), remnant cliff, rocky shore.	Research on formation of various coastal features and processes, source of black sand.	Education on coastal erosional and depositional processes.	Suitable for various beach recreational activities.	High potential for geotourism.
Teluk Agal	Embayed beach, sandy sediment, cliff.	-	Education on coastal erosional and depositional processes.	Suitable for various beach recreational activities.	Potential for geotourism.
Marasimsim	Linear beach, sandy to pebbly sediment, unique black sand (chromite).	Research on formation of various coastal features and processes, source of black sand.	Education on coastal erosional and depositional processes.	Suitable for various beach recreational activities, former mineral exploration site.	High potential for geotourism.

CONCLUSION

The study has unraveled the geological heritage values of beaches based on scientific, aesthetic, recreational and cultural values. The scientific values of beaches such as the composition, morphology and sources of the beach sediments have been identified. The occurrence of other geomorphologic and geological features at or near beaches such as remnant cliffs, faults, sea caves, tombolo and remnant island enhances the aesthetic values and attractiveness of beaches and therefore are appealing to visitors. These features also enhance the scientific value of the beaches. Any unregulated development, such as sand extraction along coastal areas, will affect the beaches of Northern Sabah.

It is recommended that the beaches of Northern Sabah to be conserved so as to protect the beautiful landscapes. Geotourism could be promoted on some of the beaches such as Tanjung Simpang Mengayau, Kulambu, Loro Kecil, Torongkongan and Marasimsim. The development of geotourism will ensure the sustainability and protection of the beaches. The promotion of beach geotourism could be carried out together with that at other potential geotourism sites such as the Tanjung Simpang Mengayau (Tip of Borneo) and the Kampung Minyak oil seeps. The study of beaches for geotourism development is an innovative way to add-value to their existing aesthetic attraction in order to enhance and sustain the tourism industry in the State.

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