

## The Continental Shelf – five decades of progress (1966-2016)

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**Abstract:** In the inaugural (July 1966) issue of the Newsletter of the Geological Society of Malaysia, the Society's founding president, Neville S. Haile, wrote an interesting note on the enactment by Malaysia's parliament of the Continental Shelf Act 1966. At that time, offshore oil exploration in Malaysia was just beginning and the geology of the continental shelf was virtually unknown. Fifty years have passed since, and we now have a much better understanding of the geology of the continental shelf, thanks to academic research and petroleum exploration. In parallel with the rapid advances in geoscientific understanding of continental margins and ocean basins and in the theory of plate tectonics, legal instruments have been put in place, internationally and nationally, to enable coastal States<sup>3</sup> to exercise jurisdiction over their maritime spaces, in particular the continental shelf, which may include the "extended" continental shelf beyond 200 nautical miles<sup>4</sup> (M) from the coastlines, for the purpose of exploration and exploitation of natural resources. This note is a brief progress update of the continental shelf in the Malaysian context after five decades of the enactment of the Continental Shelf Act 1966.

**Keywords:** continental shelf, UNCLOS, marine geology, Continental Shelf Act 1966

### THE NOTE OF N.S. HAILE (1966)

In the inaugural issue (no. 1, July 1966) of the Geological Society of Malaysia's newsletter (later renamed "Warta Geologi"), the Society's founding president, Neville S. Haile, wrote a brief note entitled '*The Continental Shelf – Malaysia's new frontier?*', which is reproduced verbatim below.

#### THE CONTINENTAL SHELF – MALAYSIA'S NEW FRONTIER?

*An act entitled the Continental Shelf Act was passed by the Malaysian Parliament (Dewan Ra'ayat) at the session held in July 1966. The bill lays claim to the sea-bed and subsoil off Western Malaysia (Malaya) beyond the 3-mile territorial limit and as far as the 200-meter isobaths. Supplementary legislation, the Petroleum Mining Enactment, regulates prospecting and exploration for oil. These acts empower the Federal Minister of Lands and Mines to issue licenses over the continental shelf for exploration, prospecting, and mining of natural resources. Resources within the 3-mile limit will be under the control of State Governments.*

*It is known that a number of companies have applied for prospecting licenses for tin and oil on the continental shelf off the coasts of Malaya. Interest by oil companies has so far been confined to the east coast offshore area, whereas interest in tin is centered on the shelf off the west coast. The shelf off eastern Malaya is over 600 kilometers wide; it forms part of the Sunda shelf which joins Malaya,*

*Sumatra, Borneo, and Java, and is one of the most extensive shelf seas of the world. It has an average depth of only about 70 meters. The delineation of the boundaries between the parts of the shelf owned by Malaysia, Thailand, Vietnam, and Indonesia may present some problems, and does not seem to have been attempted yet, but the parts of the shelf over which Malaysia claims sovereignty probably exceed the land area of Malaysia.*

*The mineral potential of the continental shelf off Sabah and Sarawak (Eastern Malaysia) has long been recognized, and legislation laying claim to the shelf was enacted there as long ago as 1954. The Shell Group of Companies has been vigorously prospecting and drilling over the large areas of the Shelf off Sarawak, Brunei, and western Sabah, but so far has met with only minor successes. Many promising structures, however, remain to be drilled.*

*Now that Malaysia has assumed sovereignty over such a huge area, it may be hoped that some attention will be given to the responsibilities of conducting scientific surveys, including marine geological surveys, over the shelf, and the adjoining marine South China Sea. So far, apart from oil company work, the results of which are mostly confidential, only one expedition, by the Geological Survey (Borneo Region) in 1963, in co-operation with the Shell Group and the British Navy, has been made. In spite of being done on a shoe-string budget and without sophisticated equipment, this produced significant results, indicating the wide scope for future work on the shelf off Malaysia's coasts.*

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2. The author is an elected member of the Commission on the Limits of the Continental Shelf (2012-2022), a UN body established under the UN Convention on the Law of the Sea 1982. The views expressed in this paper are solely of the author's and do not necessarily reflect the views of the Commission on the Limits of the Continental Shelf or PETRONAS or any other parties.
3. "States" herein refers to Nation States (approximately synonymous with "Countries"), as opposed to the states that constitute the Federation of Malaysia. "Coastal States" are those States (or countries) that have an adjacent marine area.
4. Nautical mile (M) = 1.852 km

*Virtually nothing is known of the geology of the shelf off Malaya, although a single aero-magnetic traverse is said to have indicated a sedimentary basin off the northeast coast, giving hopes of possible oil-bearing strata. Since most of Malaya has probably been emergent, and subject to active erosion, since late Mesozoic times, something must have happened to the eroded material, and it seems reasonable to suppose that it was dumped on the continental shelves; sedimentary rocks of Palaeozoic and early Mesozoic age may also exist beneath the continental shelf, and these may, unlike their on-shore counterparts, be unmetamorphosed. Thus wide possibilities exist for potentially oil-bearing basins under the shallow seas of Malaysia.*

*Intelligent prospecting for oil and tin off-shore will depend on an understanding of the geological history of peninsular Malaya and of Borneo, as well as of the shelf itself. Geological exploration of the shelf will, in turn, deepen our understanding of the on-shore geology.*

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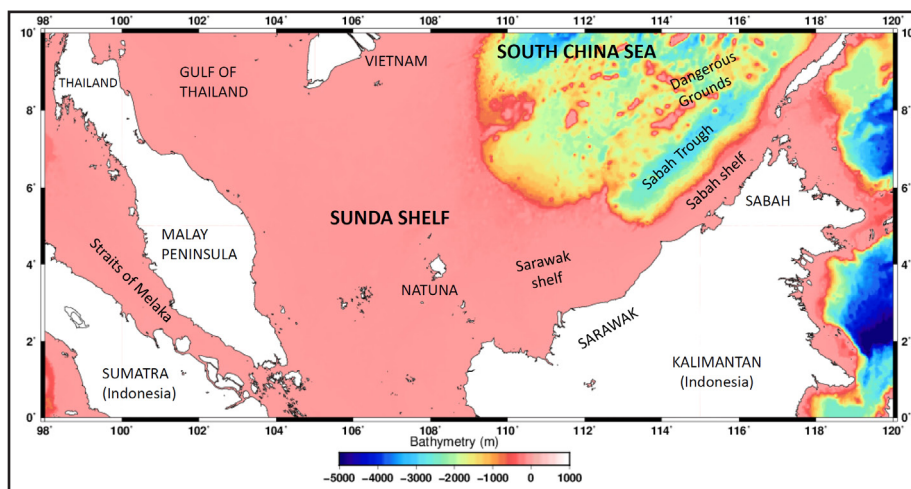
Haile wrote his note fifty years ago, around the time the Geological Society was being established and only a few years after the formation of Malaysia in 1963. In the note, he highlighted the Parliament's enactment on 28 July 1966 of the Malaysia Act of Parliament No. 57, known as the Continental Shelf Act 1966 (herein referred to as the "Act"). Haile's note is interesting in two respects. From a scientific standpoint, it was written at a time when, as Haile put it, "virtually nothing is known of the geology of the shelf of Malaya". From a legal standpoint, the "continental shelf" as a legal entity was still a relatively new and developing concept that came out of the First and Second United Nations Conferences on the Law of the Sea in 1958 and 1960, respectively. It was at the Third Conference on the Law of the Sea in 1982 that the current legal regime of the continental shelf was agreed upon under the United Nations Convention on the Law of the Sea 1982 ('UNCLOS', in short), specifically Part VI on "Continental Shelf". In commemoration of the Society's fiftieth anniversary and of the enactment of the Act, this paper gives an overview of the development of the concept of the continental shelf

and its application in the Malaysian context during the last five decades (1966-2016).

## ADVANCES IN MARINE GEOLOGY AND PLATE TECTONICS

Along with the development of the legal regime of the continental shelf, major advances were also achieved in the geological sciences, particularly in marine geology and the theory of plate tectonics. Indeed, as noted by Haile, the continental shelf (Figure 1) was a 'new frontier' in 1966, for our understanding of the nature and origin of the continental shelf and ocean basins were still developing. Fundamental concepts in plate tectonics were just being developed and published in the early sixties. For instance, the idea of "sea-floor spreading" – that oceanic crust, created at mid-ocean ridges, spreads laterally away from the ridges, and thereby drives tectonic plates and continents around – was introduced in separate but almost simultaneous publications by Dietz (1961) and Hess (1962). The "hotspot" concept, in which lithospheric plates move over fixed 'hotspots' in the mantle, resulting in volcanic island chains, was proposed by Wilson (1963). Transform plate boundaries were also described by Wilson (1965) as a third type of plate boundary, along with convergent and divergent types. Sea-floor magnetic 'stripes', long observed since the 1950s, were explained by a mechanism of sea-floor spreading by Vine & Matthews (1963). Subsequently, mantle convection as a driving mechanism for plate tectonics was proposed by McKenzie (1966).

Incidentally, it was also in 1966 that an important meeting was held at NASA's Goddard Institute for Space Studies in New York City, called the "History of the Earth's Crust Symposium", when all the geological knowledge on the oceans up to that time were discussed and collated into the unified idea of global plate tectonics (Phinney, 1968). At that historic two-day conference on 11-12 November 1966, eminent geologists and geophysicists brought together their ideas on the evolution of continents and oceans in relation to continental drift and sea-floor spreading, based on the then new evidence from analysis of surface rocks, ocean sediment cores and shipboard geophysical data.

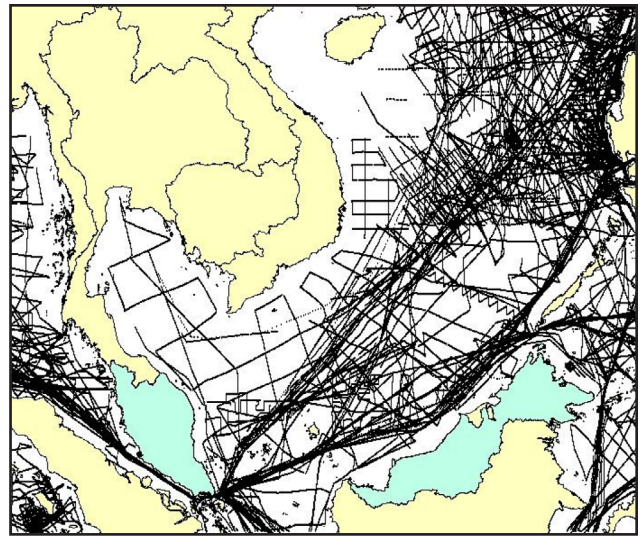


**Figure 1:** Physiographic map of the continental shelf of Malaysia (Malay Peninsula, Sarawak and Sabah) and surrounding regions. The physical continental shelf (shaded in pink) is the offshore areas in which the water depth is generally less than 200 m. The "continental shelf" has a different meaning under UNCLOS.

While all these concepts in plate tectonics were being developed based on research in the Atlantic Ocean, very little was known about the geology of the continental shelves of Malaya and Borneo in 1966. The one expedition on board the HMS Dampier in 1963, which Haile mentioned in his note, was a collaboration between the Geological Survey (Borneo Region), the Shell oil company and the British Navy. The preliminary results of that expedition were published in Haile *et al.* (1964). Most of the early works on the continental shelf geology of the region were not published, however, until the early 1970s (e.g., Hamilton, 1979; Ben Avraham & Emery, 1973; Mammerickx *et al.*, 1976; Ludwig *et al.*, 1979; Houtz & Hayes, 1984). During the past five decades, numerous scientific cruises by academia and industry have plowed the continental shelves and adjacent seas in this region, collecting bathymetric, seismic (mainly single-channel), gravity and magnetic data (Figure 2). The later advent of satellite altimetry technology has also made it possible for high-quality satellite-derived gravity, topographic and bathymetric data to be acquired on a global scale and made accessible for regional studies (Figure 3).

Haile's (1968) own seminal work on the NW Borneo "geosynclines", which was published two years after his Newsletter article, predicted the presence of a 'foreland' or continent beneath the present-day Sarawak continental shelf. Much of the knowledge on our continental shelf has been achieved, however, through oil exploration in the offshore areas off Malaya and NW Borneo (Scherer, 1980; Doust, 1977, 1981; ASCOPE, 1981). Important papers by Shell on the structure and stratigraphy of the Sabah and Sarawak continental shelves during the 1980s and 1990s were based on the oil industry's multichannel seismic reflection data (Bol & van Hoorn, 1980; Epting, 1980). By the early 1980s, most regional tectonic models have incorporated the idea of an attenuated continental crust underneath the margins of the South China Sea, including in the Dangerous Grounds region (e.g., Holloway, 1981; Taylor & Hayes, 1983; James, 1984). Some of these important ideas were evolving through exploration and research in the oil industry up to the late 1990s and were summarized in a major compilation by PETRONAS on the petroleum geology and resources of Malaysia (Leong, 1999).

Besides oil exploration, marine geoscientific research in collaboration with the oil industry has also contributed significantly to our understanding of the continental margins in the region. In 1986 and 1987, PETRONAS and the Federal Institute for Geosciences and Natural Resources of Germany (BGR) jointly undertook geophysical and geological studies in the deep water area offshore west Sabah. These important marine surveys helped to provide a new understanding of the continental margin and, in particular, the origin of the Sabah Trough (Hinze & Schluter, 1985; Kudrass *et al.*, 1986; Hinze *et al.*, 1989), and subsequently led to refinements of the tectonic models (Tan & Lamy, 1990; Hazebroek & Tan, 1993). A later survey in 2001 by BGR revealed an even more complex deformation history of the Sabah continental margin (e.g. Franke *et al.*, 2008; Hesse *et al.*, 2009). We are

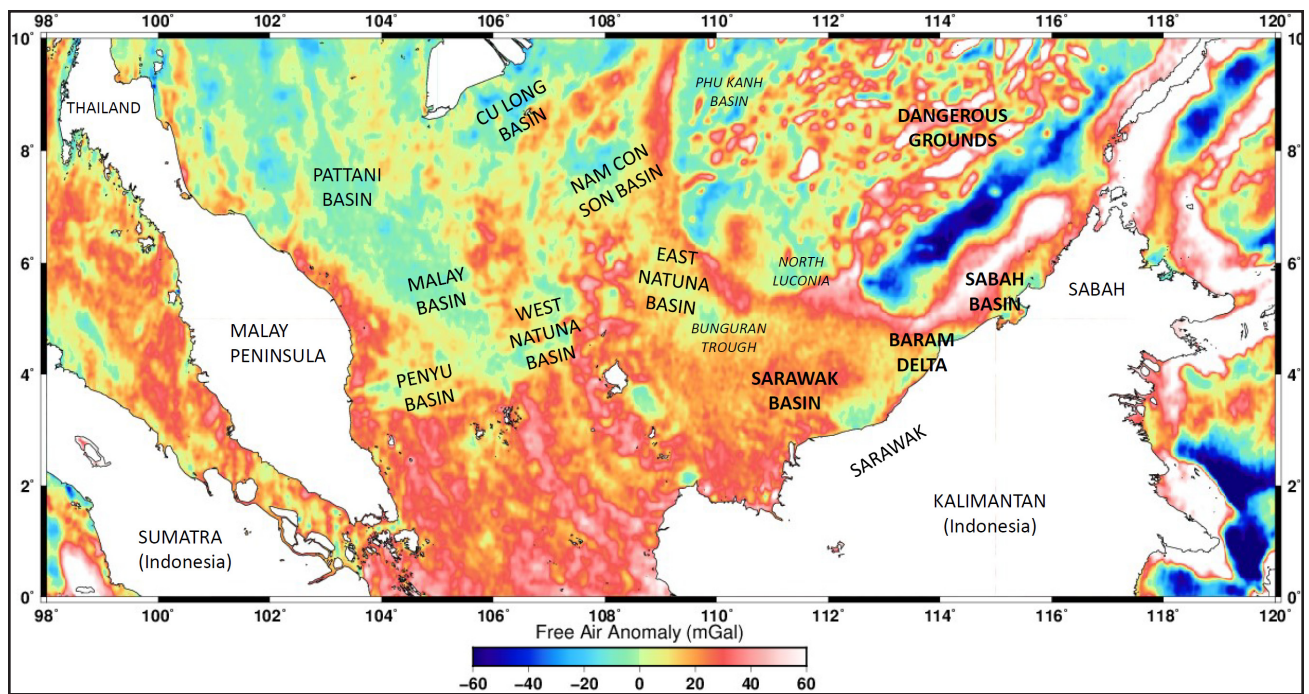


**Figure 2:** Geophysical data track lines data, including single-beam bathymetry, gravity and magnetic data from the US National Centers for Environmental Information (NCEI), formerly National Geophysical Data Center (NGDC) (<https://www.ngdc.noaa.gov/mgg/mgdd.html>).

still a long way from a full understanding of the complex geology of the continental shelf and margin of this region. Further work is being carried out not just in offshore NW Borneo but in other parts of the South China Sea (e.g., Guo *et al.*, 2016).

### OIL AND GAS EXPLORATION ON THE CONTINENTAL SHELF

Haile had also noted in 1966 that 'wide possibilities exist for potentially oil-bearing basins under the shallow seas of Malaysia'. Offshore oil exploration off the east coast of Malaya was just beginning in 1966. At that time, interest in offshore prospecting was mainly for mineral deposits, primarily tin and iron ores. Haile's prediction therefore was based on, firstly, an aeromagnetic traverse that indicated the presence of a sedimentary basin off the east coast of Malaya. Secondly, which is more interesting, he reasoned that since Malaya was an emergent continent since late Mesozoic times (more than 60 million years ago) it would have been subjected to erosion and supplied sediments to the sedimentary basins on the continental shelves. In 1968 Esso and Conoco were awarded the first oil concessions, comprising large tracts of the continental shelf offshore Malaya. Aeromagnetic and seismic reflection data acquired subsequently revealed the presence of deep sedimentary basins (Malay and Penyu basins), where sediment thickness is now known to be in excess of 12 km (Figure 3). Haile's prediction was proven to be true; the Malay Basin became one of the most prolific oil basins in Malaysia, producing hydrocarbons from the Cenozoic basin fill sediments. Exploration efforts have also revealed, as Haile predicted, that the geology of Malaya extends offshore and that Paleozoic and early Mesozoic sedimentary rocks exist beneath the continental shelf. Oil wells penetrated a variety



**Figure 3:** Satellite-derived free-air gravity anomaly map for the offshore regions, showing features associated with sedimentary basins and major structures beneath the continental shelf and beyond. Map based on gridded data from Sandwell & Smith (2009).

of igneous, metamorphic and sedimentary rocks in the pre-Cenozoic basement, e.g., Triassic limestones (Fontaine *et al.*, 1990) but the pre-Cenozoic sedimentary rocks are for the most part highly indurated and metamorphosed. Some of the metamorphic rocks, however, contain hydrocarbons in fracture porosity and are being targeted for exploration (Mohd Kadir, 2010).

Compared to Malaya, the continental shelf off NW Borneo has had a longer history of offshore oil exploration, which began in 1957 in the Baram Delta region, and resulted in the first offshore oil discovery in Sarawak in 1963. In 1965 Shell acquired regional aeromagnetic survey over the entire Sarawak and Sabah continental shelves and confirmed the existence of a major sedimentary basin. Further surveys and mapping from gravity and seismic data resulted in drilling and discoveries of major oil and gas fields further away from the Baram Delta, both in carbonate and clastic reservoirs (Doust, 1981). The “NW Borneo basin” (offshore Sarawak and Sabah combined) is also one of the most prolific petroleum basins in the South China Sea region.

### THE CONCEPT OF THE CONTINENTAL SHELF

The term ‘continental shelf’ was probably first used in a geomorphological sense in the late 19<sup>th</sup> century by the English geographer H.R. Mill in his “Realm of Nature” (1897). To most geologists, the continental shelf is generally defined as the submarine area that extends seaward from the shore to the point at which there is a marked fall-off of the seabed into the flat and deep ocean floor. The relatively steep area of the seabed between the continental shelf and deep ocean floor is known as the continental slope. As Morris (1958, p. 38) stated:

*“Geologically, the land-mass drops seaward at an angle or gradient to an average depth of 200 metres, where (usually) there is a marked increase of slope to the ocean bottom. The isobath of 200 metres forms, in this simplified picture, an edge. The sea bottom between the shore and the edge is called the “continental shelf”, and that part of the sea bed between the edge and the sea bottom is the “continental slope”.*

The ‘continental shelf’, therefore, is that part of the continent that lies in relatively shallow water, usually less than 200 m water depth. What actually separates the continents from oceans are not the coastlines but the “continental shelves”, or more strictly in the geological sense, the “continental margins”. Since the continental shelf is considered part of the continent and not the ocean, its seaward limit is not the coastline but the ‘outer edge of the continental margin’. In some older literature the continental shelves are referred to as ‘continental borderlands’, which may be morphologically complex and include deep submarine troughs and sub-basins (Shepard & MacDonald, 1938). In geomorphology, the outer edge of the physical continental shelf is the “shelf-slope break”, which marks a sharp increase in the seabed gradient, from less than 0.1° to greater than 1.5° (Gündüz, 1990). Typical sea-floor gradients for the continental slope, based on research in the Atlantic margin, range from 2° to 4° (Emery, 1966), but depending on various geological factors, such as tectonic setting and sedimentary processes, some continental slope gradients can be up to 12° (Dowdeswell *et al.*, 2004).

The development of the legal concepts of the continental shelf could be traced back prior to 1966 when concerns were raised by States regarding their rights to the seabed

and subsoil beyond their territorial waters, primarily in relation to the exploitation of sedentary fisheries (Gündüz, 1990). States also recognised that those rights could not restrict the freedom of navigation in the superjacent waters by other States. Until the late 1950s there was no clear concept in international law regarding the continental shelf, apart from the geophysical possibilities that the continental shelf is abundant with natural resources and that science and technology would make it feasible for exploration and exploitation of the shelf. In 1945, U.S. President Harry Truman issued two proclamations – one, pertaining to fisheries in the high seas contiguous to the territorial sea and, second, pertaining to the natural resources of the seabed and subsoil of the continental shelf. The “Truman Proclamation” on continental shelf is generally regarded as the starting point of positive law on the subject of continental shelf. With this proclamation, the term “continental shelf” acquired a legal connotation and significance, in addition to its geological definition.

In 1958, the first United Nations Conference on the Law of the Sea concluded a Continental Shelf Convention, also known as the Geneva Convention, which embodies the principle of sovereign rights for the purpose of exploiting the natural resources of the seabed and subsoil of the continental shelf. UNCLOS incorporated the above principles, which in some instances have been refined and expanded. The continental shelf of a coastal State is now defined in paragraph 1 of Article 76 of UNCLOS:

*“The continental shelf of a coastal State comprises the seabed and subsoil of the submarine areas that extend beyond its territorial sea throughout the natural prolongation of its land territory to the outer edge of the continental margin, or to a distance of 200 nautical miles from the baselines from which the breadth of the territorial sea is measured where the outer edge of the continental margin does not extend up to that distance.”*

Legal acts relating to the continental shelf were introduced subsequently at the national level by coastal States, e.g., Continental Shelf Act 1966 for Malaysia, to ensure that their rights to the oil and mineral resources in the marine areas adjacent to their land territories are protected. Under the provisions of Annex II of UNCLOS, States Parties elect every five years 21 members of the Commission on the Limits of the Continental Shelf (CLCS) who are experts in geology, geophysics, or hydrography “from among their nationals, having due regard to the need to ensure equitable geographical representation” for a five-

year term, serving in their personal capacities (UNCLOS, Annex II, Article 2 (1)). As a States Party, Malaysia has contributed significantly to the work of the Commission in carrying out its mandate with regards to the implementation of the Article 76 of UNCLOS by having her experts elected to the CLCS since its inception in 1997, with Dr Abu Bakar Jaafar (1997-2012) and Dr Mazlan Madon (2012-2022).

### CONTINENTAL SHELF LEGISLATIONS

Haile’s note was written to inform the Society members of the new acts that had just been passed in parliament, namely the Continental Shelf Act 1966. This act effectively defined the continental shelf off Malaya according to the Geneva Convention on the Continental Shelf (1958) which Malaysia had acceded in 1960 along with other related conventions<sup>5</sup>. Under the Act, the continental shelf was defined as “*the sea-bed and subsoil of those submarine areas adjacent to the coast of Malaya but beyond the limits of the territorial waters adjacent to those States, the surface of which lies at a depth no greater than 200 metres below the surface of the sea, or, where the depth of the superadjacent<sup>6</sup> waters admits of the exploitation of the natural resources of the said areas, at any greater depth*”. The Act therefore stipulates that the continental shelf includes areas beyond the territorial waters (3-mile zone around the coast, according to Haile) up to the 200 m isobath. The phrase “*depth of the superjacent waters admits of the exploitation of the natural resources of the said areas*” effectively added another criterion to the definition of continental shelf, i.e., the notion of ‘exploitability’ of natural resources, even if the water depth is greater than 200 m.

The Continental Shelf Act 1966 was initially intended to be applicable only to the continental shelf off Malaya (“West Malaysia”). Subsequently, the Emergency (Essential Powers) Ordinance No. 10, which was promulgated on 3 November 1969, stated among others that the Continental Shelf Act 1966 and the Petroleum Mining Act 1966 should apply throughout Malaysia. Thus, paragraph 2 of article 1 in the 1966 enactment, which states that the Act “shall apply only to the States of Malaya”, was omitted from the 1972 revised version of the Act (Act 83). The phrase “the States of Malaya” was replaced with “Malaysia” to include all states of the federation post-1963. As noted by Haile, Sabah and Sarawak (“East Malaysia”) had extended jurisdiction over the continental shelf adjacent to their territorial waters in 1954 while they were under the British colonial administration. In separate Orders in Council (1954)<sup>7</sup>, Her Majesty’s

5. On 21 December 1960 Malaysia acceded four conventions related to the continental shelf, agreed to under the United Nations First Conference on the Law of the Sea, or “UNCLOS I”: Convention on the Territorial Sea and Contiguous Zone (entry into force 10 September 1964), Convention on the High Seas (entry into force on 30 September 1962), Convention on Fishing and Conservation of the Living Resources of the High Seas (entry into force on 20 March 1966) and the Convention on the Continental Shelf (entry into force 10 June 1964).

6. Typographical error in the document; the word is “superjacent”.

7. In 1954, two Alteration of Boundaries Orders in Council were made by Her Majesty’s government; one for North Borneo (as Sabah was then known) and the other for Sarawak. These two Orders in Council purported to extend the boundaries of Sabah and Sarawak offshore onto the continental shelf.

government had extended the boundaries of the colonies of Sarawak and North Borneo (as Sabah was known then) “to include the area of the continental shelf being the seabed and its subsoil which lies beneath the high seas contiguous to the territorial waters of Sarawak [and North Borneo]”.

Minor amendments to the Act made subsequently went almost unnoticed by the general public. Under article 3 of the Act (amended up to 2009), “all rights to the exploration of the continental shelf and the exploitation of its natural resources are [hereby] vested in Malaysia and shall be exercisable by the Federal Government”. The Territorial Sea Act 2012 which was tabled in the parliament on 18 April 2012 also specifies that the width of the territorial sea (or “territorial waters”) of 12 M comes under the jurisdiction of the Federal Government.

As Malaysia is a State Party to UNCLOS, which it signed on 10 December 1982 and ratified on 14 October 1996<sup>8</sup>, relevant national acts were drafted and amended to be in line with UNCLOS. Accordingly, in preparation of Malaysia’s submission<sup>9</sup> of its extended continental shelf information to the CLCS in 2009, the provisions of Article 76 of UNCLOS were incorporated into the Act through the Continental Shelf (Amendment) Act 2009. Section 2 of the 2009 amendments essentially incorporates language taken directly from Article 76. Thus, the Continental Shelf (Amendment) Act 2009 redefined “continental shelf” as “the sea-bed and subsoil of the submarine areas that

extend beyond the territorial sea throughout the natural prolongation of the land territory of Malaysia to the outer edge of the continental margin, or to a distance of 200 M from the baselines from which the breadth of the territorial sea is measured..”

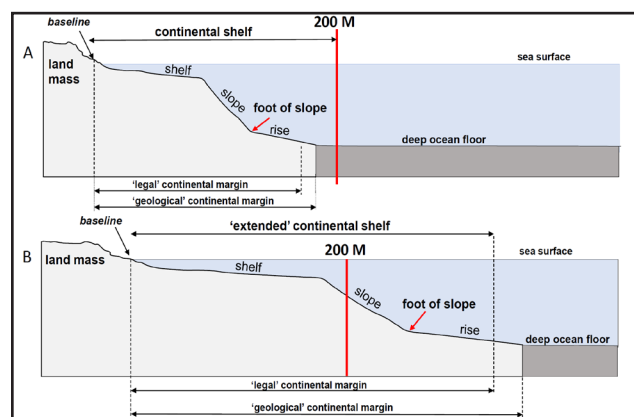
With regards to the limits of the continental shelf, the 2009 document replicates the provisions of paragraphs 3 of Article 76, e.g., “The continental margin comprises the submerged prolongation of the land mass of Malaysia and consists of the sea-bed and subsoil of the shelf, the slope and the rise but does not include the deep ocean floor with its oceanic ridges or the subsoil thereof.” The phrase “natural prolongation of the land territory” (paragraph 3) has a similar but not exactly the same meaning as “submerged prolongation of the land mass” (paragraph 1). Whereas the former defines prolongation in relation to land territory, which is a political entity, the latter defines prolongation in relation to the land mass (a geomorphological feature).

#### ARTICLE 76 OF UNCLOS AND THE “EXTENDED” CONTINENTAL SHELF

In the event that the continental shelf extends beyond 200 M (Figure 4), Article 76 provides for the coastal State to submit to the CLCS scientific and technical justifications including supporting geological, geophysical and bathymetric data. The CLCS shall consider the information and make recommendations to the State on matters related to the establishment of the outer limits of its continental shelf. The limits of the shelf established by a coastal State on the basis of these recommendations shall be final and binding.

Article 76, in particular paragraph 3, contains the fundamental geological concepts upon which the legal definition of “continental shelf” are based, such as continental shelf, continental slope and continental rise (Figure 4). The outer limits of the continental shelf are delineated essentially by a line joining fixed points determined using the formulae prescribed in Article 76 paragraphs 4 and 5. That line is calculated either at a distance of 60 M from the foot of the continental slope (sometimes referred to as the ‘Hedberg’ or ‘distance’ formula), or where the sediment thickness is at least 1% of the shortest distance to the foot of the continental slope (sometimes referred to as the ‘Gardiner’ or ‘sediment thickness’ formula). Applicable constraints to the determination of the outer limits of the continental shelf are provided in paragraph 5 of Article 76 in order to safeguard from excessive claims of extended continental shelf into what is termed “the Area”, i.e. the seabed and subsoil beyond the limits of national jurisdiction (Figure 5).

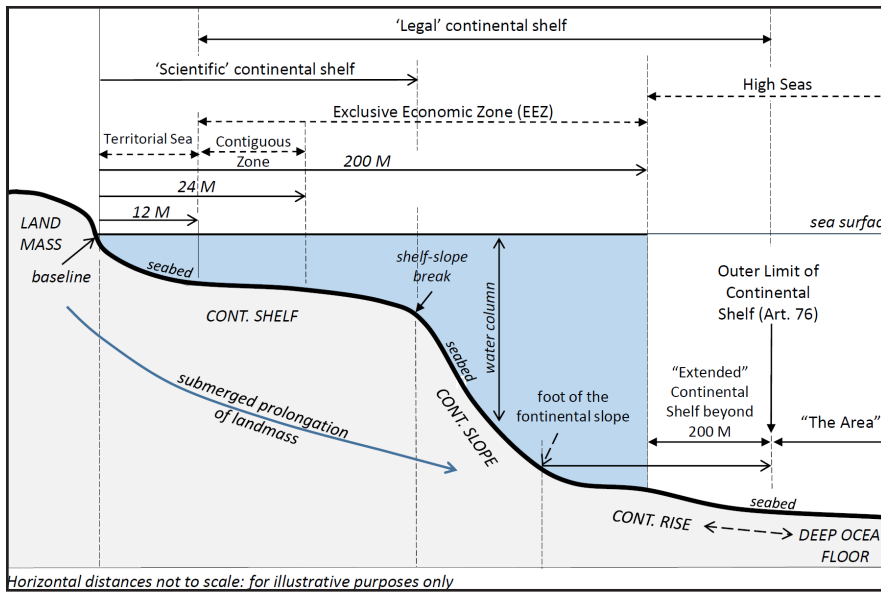
According to paragraph 5 of Article 76, the fixed points that define the outer limits should not extend beyond the constraint line determined at 350 M seaward of the baseline



**Figure 4:** Legal concept of a continental shelf in relation to the 200 M limit measured from the baseline of a coastal State. (A) In the case of a narrow continental margin, the ‘legal’ continental shelf equals the breadth of the exclusive economic zone (EEZ) defined by the 200 M limit. (B) A wide (geological) continental margin may extend beyond 200 M, in which case a coastal State is potentially entitled to an “extended” continental shelf beyond 200 M. (Modified figure from “**The Law of the Sea: Training Manual for Delineation of the Outer Limits of ...**” United Nations. Division for Ocean Affairs and the Law of the Sea (DOALOS, 2006)).

8. UNCLOS 1982 opened for signature on 10 December 1982 and entered into force on 16 November 1994 upon the deposition of the 60th instrument of ratification. The convention came into force for Malaysia on 13 November 1996. As of 23 September 2016, the convention has been ratified by 168 parties, which includes 167 states (164 member states of the United Nations plus the UN Observer state Palestine, as well as the Cook Islands, Niue and the European Union).

9. Joint submission by Malaysia and Vietnam to CLCS was made on 6 May 2009; the Continental Shelf (Amendment) Act 2009 was tabled in Parliament on 17 March 2009 and came into operation on 1 May 2009.

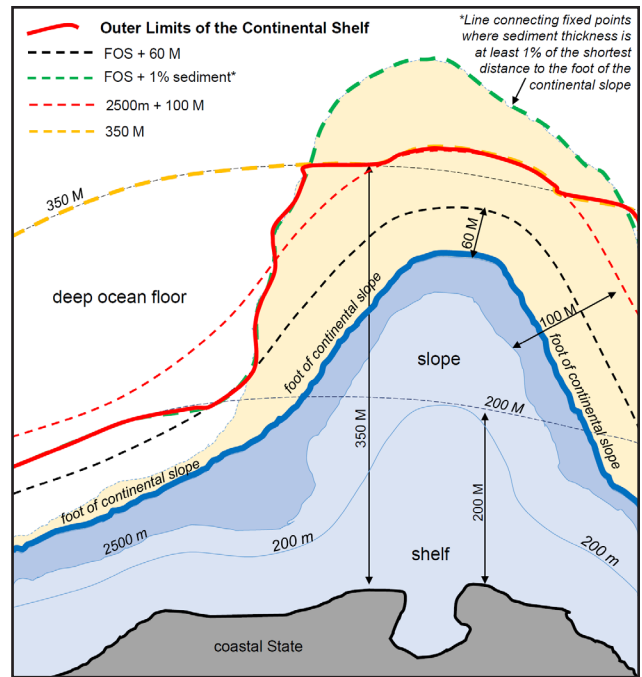


**Figure 5:** According to Article 76 of UNCLOS, wherever its continental margin extends beyond 200 M a coastal state may delineate the outer limits of its ‘legal’ continental shelf by establishing the foot of the continental slope and the outer limit of the continental margin, using the provisions in paragraphs 4 to 7 of Article 76. Figure modified from CLCS website [http://www.un.org/depts/los/clcs\\_new/marinezones.jpg](http://www.un.org/depts/los/clcs_new/marinezones.jpg).

or at 100 M seaward of the 2500-metre isobath. Figure 6 attempts to illustrate in one diagram the rather complicated method of applying the formulae and constraints to determine the outer limits of the continental shelf, as outlined above. To assist coastal states in making their submission to the CLCS in the Scientific and Technical Guidelines of the Commission (“Guidelines”; document CLCS/11 published in 1999). The Guidelines is regarded as an essential document that explains the understanding of the CLCS on the practical application of the provisions of Article 76. In addition, the Division of Ocean Affairs and the Law of the Sea (DOALOS) published a Training Manual (DOALOS, 2006) to assist coastal states in preparing their submission. Both the Guidelines and Manual are available on the CLCS website.

At the 11<sup>th</sup> Meeting of States Parties to UNCLOS in New York on 14-18 May 2001, it was decided that for states for which the Convention entered into force before 13 May 1999, which was the publication date of the Guidelines, the date of commencement of the 10-year time period for making submissions to the CLCS is 13 May 1999. The rush to meet this deadline was described by some commentators as a maritime ‘land grab’ or ‘scramble’ for extended continental shelf by the affected coastal states (e.g., van der Poll & Schofield, 2010). As of 31 December 2016, the CLCS has received a total of 77 submissions from coastal States, including five revised submissions.

The extended continental shelf information provided by coastal states in these submissions may result in significant addition to the maritime spaces under the national jurisdiction of the submitting coastal State, as shown in Figure 7. So far, 39 submissions have been considered by the Commission according to the order in which they were received, including joint, partial and revised submissions. Since the first recommendations were adopted in 2002 for the submission made by the Russian Federation, at the end of 2016, the CLCS has issued in total only 26 recommendations.

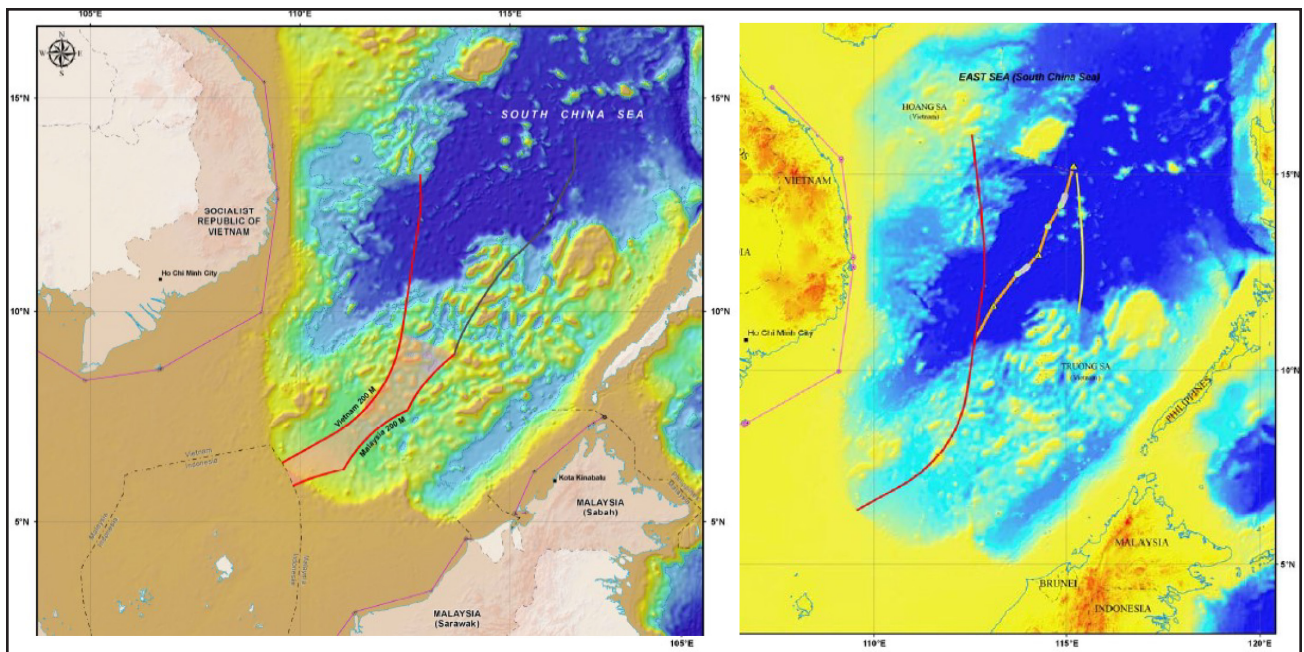


**Figure 6:** Delineation of the outer limits of the continental shelf, based on the formulae and constraints in accordance with the provisions in Article 76 of UNCLOS. (FOS – foot of the continental slope).

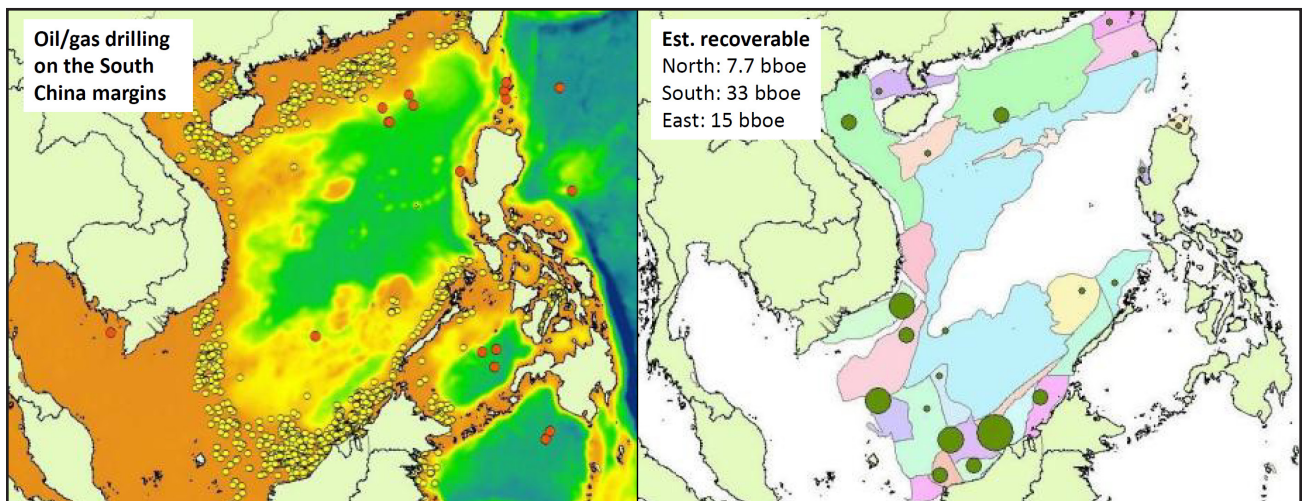
According to the information posted on the CLCS website, it takes between several months to more than five years for the Commission to examine a submission, from the time a subcommission is established to the time recommendations are adopted by the Commission, bearing in mind that the CLCS does not meet continuously throughout the year.

### THE MALAYSIAN CONTINENTAL SHELF PROJECT

Under article 4 of annex II to UNCLOS, a coastal State intending to establish the outer limits to its continental shelf



**Figure 7:** Extended continental shelf information in the South China Sea submitted to the CLCS in 2009. (Left) Malaysia-Vietnam joint submission in the shaded area between the two coastal States. (Right) Vietnam submission in the “Northern area”. Red lines represent the 200 M limit measured from the baselines of the respective State. Maps are from the Executive Summary of respective submissions posted on the CLCS website: [http://www.un.org/depts/los/clcs\\_new/commission\\_submissions.htm](http://www.un.org/depts/los/clcs_new/commission_submissions.htm).

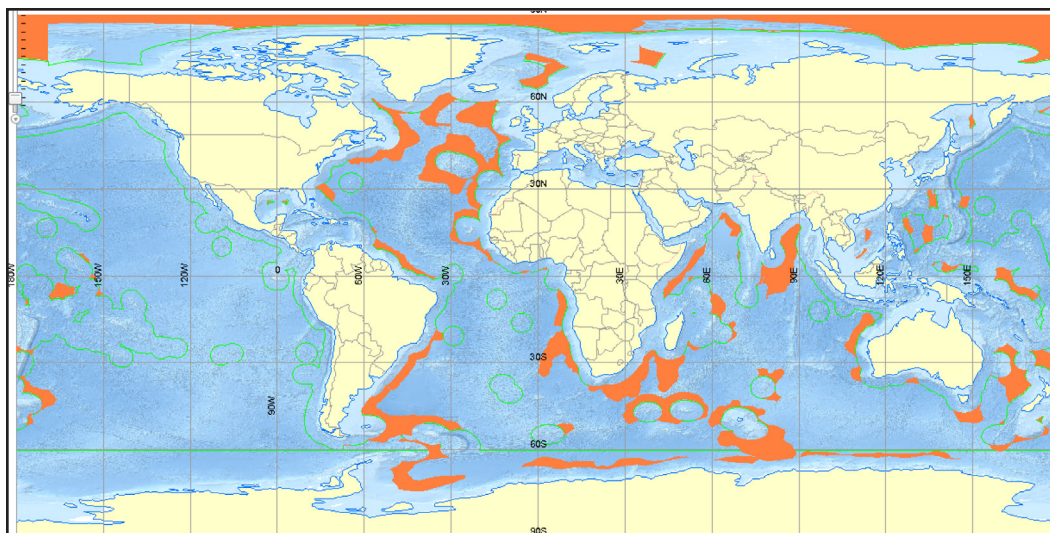


**Figure 8:** Oil and gas resources in the South China Sea margins. (Left) Oil/gas wells (yellow circles) on continental shelves. Red dots are DSPD/ODP wells. (Right) Estimated recoverable reserves for North, South, East margins (based on IHSenergy data in 2012); the bigger the circles the larger the contribution.

beyond 200 M is obligated to submit particulars of such limits to the CLCS along with supporting scientific and technical data within 10 years of the entry into force of the Convention for that State. The deadline for Malaysia was to have been 13 November 2006. The time limit was amended after some developing States raised concerns regarding the difficulty in meeting the deadline due to inadequate resources and expertise. Hence, pursuant to a Decision adopted by the Meeting of States Parties (SPLOS/72), a State for which UNCLOS entered into force was before 13 May 1999, the date of commencement of the 10 year time limit for making submissions was 13 May 2009. This new deadline of 13 May 2009 applied to Malaysia as well.

For the purpose of the submission, Malaysia embarked on the continental shelf project in 2002, first through a desktop study. A Cabinet Paper was then prepared and tabled in 2006 for approval. Following that, from 2007 to 2008 a Malaysian Marine Research Survey, with the acronym “MyMRS”, dedicated towards the preparation of the submission was carried out on the shelf off Sarawak and Sabah in the southern part of the South China Sea. During that survey, new geophysical, geological and hydrographic data on the continental shelf off Sarawak and Sabah were acquired to supplement the existing data from PETRONAS and public domain sources (e.g., NCEI). Some results of the studies, detailing the geological and geophysical





**Figure 9:** Global map of extended continental shelves (orange shaded areas) based on the information submitted to CLCS by coastal States. From UNEP website, [www.continentalsheff.org](http://www.continentalsheff.org).

characteristics of the NW Borneo margin and Dangerous Grounds area, were published in several papers (e.g., Hutchison & Vijayan, 2010; Vijayan *et al.*, 2013).

The joint submission by Malaysia and Vietnam was successfully delivered to the CLCS on 6 May 2009, followed by a presentation to the Commission in New York at its 24<sup>th</sup> session on 27 August 2009. A day after the joint submission was delivered to the CLCS, Vietnam delivered another submission to the CLCS concerning an area to the north of the joint submission (Figure 7). Both these submissions in the South China Sea are awaiting to be considered by the Commission.

### NATURAL RESOURCES OF THE CONTINENTAL SHELF

There is a reason for the “scramble” for an extended continental shelf. The rights of the coastal state over its continental shelf is stipulated in Article 76 of UNCLOS, primarily in that the coastal states exercise sovereign rights over the continental shelf for the purpose of exploring it and exploiting its natural resources. Natural resources here includes mineral and other non-living resources on the seabed and subsoil, as well as living organisms belonging to sedentary (benthic) species. Hence, it is to be expected that coastal states, especially the developing states, have been submitting since 2001 information on their extended continental shelves to the CLCS, due to the enormous political and economic implications.

Seabed resources on the continental shelf include oil, gas and minerals. This could be one of the main reasons for the overlapping territorial claims by coastal States in the South China Sea region. Natural resources exploration activities so far have been focused on the exploration for and exploitation of oil and gas, which is mainly in water depths of less than 200 m within the Exclusive Economic Zones (EEZ). There have been over 6000 wells drilled to date in the entire South China Sea region (Figure 8). Most of the wells, from offshore Taiwan and South China, through the Vietnamese margin to the northern Sarawak,

Brunei and Sabah margins are on the shelf areas, but an increasing number of wells are being drilled in the deep-water areas, in water depths of down to 2500 m. UNCLOS, in particular Article 76 therein, is important in this regard, as it provides for the coastal States the rights to explore for natural resources in areas beyond 200 M to the outer limit of their extended continental shelves. In the South China Sea, it is expected that States will follow suit in submitting information on extended continental shelves (Figure 9).

It is estimated that the continental margins surrounding the South China Sea has an estimated total (recoverable) oil/gas reserves of 56 billion barrels of oil equivalent, and half of this is found in the 300+ fields on the Sarawak, Brunei and Sabah continental shelves. As the search for conventional hydrocarbons continues further into deeper waters and onto the outer continental margins, not just here but globally, significant future resources may prove to lie in the gas hydrate deposits as well as conventional hydrocarbons in the deep-water regions, including those of the South China Sea. In the deep waters off Northwest Sabah, hydrates have been reported from sediments in water depth between 300 m and 3000 m, and may prove to be significant in the future. For non-hydrocarbon resources, such as metallic minerals, Malaysia has so far not been actively involved in exploration. New research findings indicate, however, the presence of manganese nodules on the deep seabed of the South China Sea (Hao *et al.*, 2013), and this would no doubt spur interest in the exploration for seabed minerals in the region.

Besides hydrocarbons and metallic minerals, the continental shelf has abundant non-metallic mineral resources, particularly sand as a raw material for the construction industry, mainly as sand aggregates as well as fill material for land reclamation projects. The demand for sand resource in a rapidly developing country like Malaysia requires proper management plan for coastal and offshore sand mining within the existing legal and regulatory framework. Prior to the enactment of the Continental Shelf Act 1966, sand mining activities were regulated by

the state government as the licensing authority. With the implementation of the Act, and under Section 4 (2) of the Emergency (Essential Powers) Ordinance No. 7 of 1969 (Revised), the marine areas beyond 3 M measured from the low water mark on the coastline constitute part of the continental shelf in the sense of the Act, and therefore they come under the jurisdiction of the Minister of Natural Resources and Environment as the licensing authority for minerals and sand mining.

Another outcome of the marine scientific surveys conducted for the purposes of continental shelf delineation by the Malaysian Continental Shelf Project was the identification of a potential ocean thermal energy source in the Sabah Trough (Jaafar, 2012). Water temperature in the deep trough 2900 m below sea level is about 3°C, giving rise to a temperature differential of ~20°C relative to sea surface temperature, and has the potential for generating renewable energy. This is an on-going initiative, and a pre-feasibility study is under way for a pilot plant at a suitable location.

### CONCLUSIONS

This paper gives a brief outline of the development of the “continental shelf” concept in parallel with the advances in the geological understanding of continental margins and ocean basins during the past five decades. Our knowledge of the geology of continental shelves has advanced tremendously since 1966 when N.S. Haile wrote his note on the enactment of Continental Shelf Act 1966 by Malaysia in the first issue of the Newsletter of the Geological Society. Scientific understanding gained during the past five decades was made possible through research and exploration of the continental shelves and margins, especially for hydrocarbons, which started around the time the Act was enacted. During the same period, the Act has also been amended several times in order to suit national situations. Article 76 of UNCLOS, in particular, provides a basis for which coastal States like Malaysia to extend their jurisdiction over maritime spaces for the purposes of exploration and exploitation of seabed resources.

In order to achieve this, like many other coastal States, Malaysia has also embarked on its own continental shelf project to delineate the outer limit of its continental shelf, as provided for in Article 76 of UNCLOS and detailed in the Guidelines of the CLCS. Geology and geophysics, including plate tectonics and sedimentology, are important elements in support of geomorphological evidences in the definition of the continental shelf under Article 76. Consequently, the methodology for the determination of the outer limits of the continental shelf based on geological and geophysical principles, as laid out in the Guidelines of the CLCS, is essential and useful in making the submission for extended continental shelf.

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