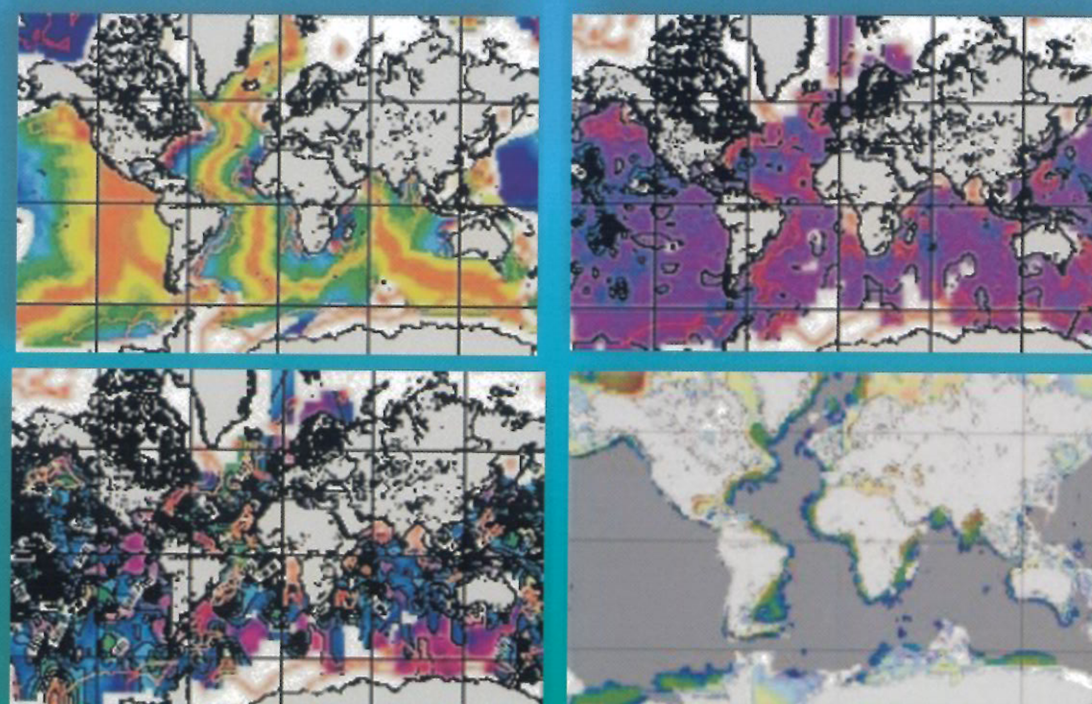
International Seabed Authority

Global Non-Living Resources On The Extended Continental Shelf: Prospects at the Year 2000



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Global Non-Living Resources on the Extended Continental Shelf: Prospects at the Year 2000

Compiled for the International Seabed Authority

By

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Summary

This report examines the non-living resource potential within the extended "legal" continental shelf (ELCS). These areas lie beyond the 200 nautical mile jurisdiction of nation states' exclusive economic zones, and their outer limits are defined by the criteria established by the United Nations Convention on the Law of the Sea, Article 76, 1982.

The offshore non-living resource potentials described in this report are based on a statistical evaluation of known occurrences and reserves, the geologic environments favourable for their formation, models for sediment type and thickness, and basement composition. The result is an assessment of the potential for non-living resources to occur. These estimates are based on the current state of, largely, publicly available information. In many instances these data are incomplete. Hence these resource estimates are to be considered as a guide to the relative potential for occurrence only, and not a definitive statement of the resources or reserves present.

Placer deposits comprising heavy minerals, gold and diamonds are limited to near-shore areas and have negligible resource potential in the ELCS regions. Similarly, phosphorites occur in the equatorial oceans, mainly between 400 m and 1,500 m depth, but have limited resource potential in ELCS areas. Evaporite deposits occur on many continental margins. However, they only overlap with ELCS regions off eastern North America and western central Africa, where their resource potential is low. Polymetallic sulphides (PMS) are formed at active plate boundaries. With the exception of the West Pacific, Mid-Atlantic (adjacent to the Azores islands) and off the western coast of North America, PMS resources are low in all remaining ELCS regions.

The major resource potential within the ELCS regions is held in iron-manganese nodules and crusts, conventional oil and gas and gas hydrates. In manganese nodules and crusts, four elemental metals comprise the main components of commercial value: manganese, copper, nickel and cobalt. World-wide, the total value of these metals within the ELCS regions is: US$ 4,05,377 millions of manganese; US$ 179,779 millions of copper; US$ 1,316,566 millions of nickel, and US$ 1,603 millions of cobalt. Conventional oil and gas comprise an estimated US$ 2,402,680 millions with a similar estimated value of US$ 2,373,000 millions for gas hydrates. In total, the resource potential (excluding recovery and production costs) contained within the ELCS regions of the world amounts to an estimated US$ 10, 328 trillions.

The real value of the non-living resources in the ELCS regions depends on their cost of recovery and production. With the probable exception of conventional gas and oil, most of these resources will remain unrecoverable until technological advances allow recovery from deep water. In addition, economic conditions must be favourable for the relatively expensive recovery and production of these marine resources compared with their onshore equivalents. Such conditions may be met through a reduction in onshore availability, an increase in demand, or technological innovation leading to lower recovery costs. The medium term future (i.e. the next 5 to 10 years) is likely to see exploration for, and exploitation of, marine gas hydrates. These have substantial economic potential. As conventional hydrocarbon reserves dwindle, the prospect of gas hydrate exploitation becomes increasingly probable.

1 Introduction

1.1 Background

The non-living resources of the seabed and the oceans are increasingly being turned to as an alternative to land-based resources. For example, offshore oil and gas reserves now constitute a major portion of overall energy sources (International Energy Agency, 1996). As other non-living resources become scarce on land, or offshore exploitation becomes more feasible through technological advances, more minerals can be expected to be mined from the offshore areas. Many of these resources are usually found on the continental shelf and its extensions and therefore give to the adjacent coastal state a potential for control over their exploitation. In some circumstances, these offshore resources may come to acquire a strategic significance to the coastal state by providing a reliable, if presently expensive, source for certain minerals (anon, 1984).

In response to the growing potential of sub-sea resources, basic questions have arisen about who has a right of access to sub-sea resources in the deep oceans, and how may this right be enjoyed. As a result, in 1967, Malta called upon the UN General Assembly to declare the deep sea bed and the ocean floor beyond the limits of national jurisdiction as areas for the benefit of common humanity. It was requested that an international agency be established to define, control and regulate all activities in these areas. This proposal eventually resulted in the adoption of the United Nations Convention on the Law of the Sea ("the 1982 Convention") and the establishment of the International Seabed Authority.

The main types of mineral deposits of potential economic value that occur on and beneath the seafloor in the extended continental shelf areas are: conventional hydrocarbons (crude oil and natural gas), gas hydrates, placer deposit, phosphorite deposits, evaporite deposit, polymetallic sulphides (PMS), and manganese and cobalt-rich nodules and crusts (Kesler, 1994; Cronan, 1980). Aggregates are not considered relevant here since we regard their economic value beyond any 200 nautical mile limit is unlikely to be significant.

1.2 Aims

This report aims to examine the non-living resource potential offered by offshore minerals in areas that lie beyond the 200 nautical mile jurisdiction of nation states' exclusive economic zones, but have the potential to lie within the extended "legal" continental shelf. The outer limits to these areas are defined by the criteria established by the 1982 United

Nations Convention on the Law of the Sea, Article 76. These criteria are based on bathymetry, sediment thickness and an assessment of geological continuity from the adjacent land masses.

1.3 Resources

The oceanic regions of the world's continental margins are those areas primarily located in deep water beyond a depth of 2,500 m. They have evolved either as rifted continental masses have been moved apart or modified by converging seafloor and landmasses. Many "continental shelf" areas adjacent to oceanic islands or ridges have seafloor characteristics different to those close to large land masses in that they generally occur in deep-water and on oceanic basement. Consequently they contain different non-living resource potentials. Although many of these natural, non-living resources will be common throughout the world's oceans, there are significant differences dependent on plate-tectonic location, geological history, basement structure and sediment supply (Kesler, 1994).

Technology developed in recent years has enabled direct observation and research on the deep parts of the seafloor. There is already a capability for drilling for oil and gas in water depths beyond 1,500 m, and this is expected to increase as future deep-water prospects are realised (International Energy Agency, 1996). Similarly, exploration of the deep seafloor using manned submersibles and remotely operated vehicles has been highly rewarding scientifically. Since the 1960s, reconnaissance surveys have had a profound impact on our understanding of seafloor mineralisation. As a result of academic-led research, substantial mineral deposits are now known or predicted to occur on the seafloor in many parts of the world (Gross and McLeod, 1987; Herzig, 1999, Herzig and Hannington, 2000).

Offshore non-living resource potentials described in this report are based on a statistical evaluation of known occurrences and reserves, the geologic environments favourable for their formation, models for sediment type and thickness, and basement composition. The result is an assessment of non-living resources. These estimates are based on the current state of, largely, publicly available information. In many instances these data are incomplete. Hence these resource estimates are to be considered as a guide to the relative potential for occurrence only, and not a definitive statement of the resources or reserves present.

The term "resource" is used here to describe the potential for materials to occur. It is not, and should not be taken as, an assessment of non-living reserves. "Reserves" are, by definition, proven deposits of known abundance and volume. Feasibility projections for resource exploitation are based on surveys of current activities and those projected over several decades. These projections will almost certainly change with technological advances, variations in supply and demand, and evolving local and global economic conditions.

The offshore non-living resource potentials described in this report are based on a statistical evaluation of known occurrences and reserves, the geologic environments favourable for their formation, models for sediment type and thickness, and basement composition. The result is an assessment of the potential for non-living resources to occur. These estimates are based on the current state of, largely, publicly available information. In many instances these data are incomplete. Hence these resource estimates are to be considered as a guide to the relative potential for occurrence only, and not a definitive statement of the resources or reserves present.

1.4 Data Sources

Data for this report have been compiled from the resources of the United Kingdom's National Oceanographic Library (NOL) including published literature and manuscripts at the facility, atlases, charts, CD-ROMs and core texts on marine resources, as well as the data bases of the British Oceanographic Data Centre (BODC) and Marine Information and Advisory Service (MIAS). Electronic sources such as the broad science and technology databases (e.g. the ISI Web of Science, PASCAL, GeoRef, Geobase, EEVL (Engineering Virtual Library), MOFR (Marine Oceanographic and Freshwater Resources), OCEANIS (Ocean Information System), Ocean Treaties data-set, and online data inventories) are used to further support the data bases. These sources are utilised alongside the in-house and international databases of world bathymetry (GEBCO), sedimentology and geophysics (such as the National Geophysical Data Centre, NGDC) to enable a comprehensive and quantitative synthesis of the offshore, non-living resource potential. A list of References and Bibliography containing web-site addresses of all sources researched for this assessment is included at the rear of this report.

2 Physiography of the Ocean Floor and its Bearing on Non-Living Resources

In order to apply the criteria defined by the 1982 United Nations Convention on the Law of the Sea, Article 76, to identify those areas of the global oceans that lie beyond 200 nautical miles of coastal baselines, it is necessary to consider the regional geology and physiography of the seafloor. This is essential before considering the potential for, and occurrence of, non-living resources forming in or on the deep seafloor.

Figures 1 to 5 respectively are preliminary maps showing the age, physiography, tectonic boundaries, sub-division of basement types, and sediment thickness underlying the global oceans and their continental margins.

The solid earth's surface consists of two physiographic provinces (Figure 2): the ocean basins with a mean depth of 5,000 metres, and the continents that rise to a mean height of about 5,800 metres above the ocean floor. The oceans extend over the margins of the continental masses for distances ranging from a few tens of kilometres to more than 1,300 km. The boundary between the continents and ocean basins is everywhere submarine, generally ranging in depth from 2,000 to 4,000 m. The physiographic contrast between the continents and the ocean basins reflects fundamental geologic differences between them. Continental crust (being richer in silica and the alkalis and poorer in iron and magnesia) is less dense, and averages about 35 km in thickness, compared with the approximately 5 km-thick oceanic crust. Many physiographic features of the ocean basins are related to volcanism, crustal stretching and subsidence, and seafloor spreading that brings basaltic igneous rock to the surface along mid-ocean ridges and carries new crust away from the mid oceanic ridge at the rate of up to 25 cm per year.

2.1 Physiographic features of the seafloor.

The deep seafloor is dominated by the following features:

(1) Continental margins that contain the continental shelf (down to a depth of about 300 m), the continental slope (with typical gradients of 1:20) and the continental rise (typically down to 4,000 metres below sea-level). These features were formed during rifting of larger continental blocks and the subsequent development of oceanic crust by seafloor spreading (Figure 4). The continental margins have a history of subsidence and are, therefore, mainly covered in thick sedimentary sequences. These sequences may approach 20 km

in thicknessand are typically composed of clastic material (sand and mud), evaporites (salt deposits), carbonates, and pelagic clays. In areas where volcanic activity accompanied initial continental rifting, many continental margins also comprise voluminous extrusive layers (flood basalt) that occur over wide regions of many thousand square kilometres. In places, the initial continental rifting may have involved several failed episodes. During these, continental fragments may have been partially separated from the main land-mass by the formation of deep sedimentary basins underlain by stretched and thinned continental crust and volcanic material. These partially separated continental fragments often form shoals or plateaux located seaward from the continental margins.

(2) Oceanic ridges, often called mid-ocean ridges or spreading ridges, are developed where parts of the earth's crust or plates are separating along linear belts at rates of up to 25 cm/yr. or more. As a result, compared with continental crust, oceanic crust is relatively young. It ranges from zero age (at the spreading ridges) to a maximum near the continental margins of about 140 Ma (Figure 1). The spreading ridges form global systems, with a total length of about 100,000 km, along which major volcanism, PMS formation, and deep-seated fractures develop (Figure 2 & 3). Immense amounts of mineralised fluid and thermal energy are discharged from the seabed through open vents and fissures, from seepage springs and by exhalation through the bedrock (hydrothermal activity).

(3) Transform fault zones are deep-seated fault and fracture systems that separate segments of the spreading ridges and form an integral part of the major tectonic ridge system. They are also important focal areas for seismic activity, limited volcanism and effusive hydrothermal activity. In continental settings, large-scale fault structures are recognised as common foci for mineral deposit formation.

(4) Abyssal plains and hills occur on both sides of the mid-ocean ridges. They are overlain by a thin veneer of pelagic sediments and lie between 3,000 and 6,000 m below sea-level. Individual volcanoes and composite volcanic ridges formed by overlapping volcanoes, are scattered throughout the ocean basins. These structures are often locally clustered to form groups of islands, seamounts, plateaux and linear chains along, or adjacent to, continental margins.

(5) Deep-ocean trenches reach depths of 11,000 metres below sea-level and are commonly present adjacent to volcanic island chains (island arcs) at the periphery of the large ocean basins. They can extend to thousands of kilometres in length and are focal areas for intense volcanic and hydrothermal activity.

Subduction zones, major components of deep-ocean trenches, are formed where one plate or a part of the earth's crust is under-thrust or overridden by another plate. These zones are usually marked by thrust faulting, folding, uplift, seismic and volcanic activity. In some places small ocean basins and spreading ridges lie adjacent to deep-ocean trenches and can have an abyssal plain below a depth of 2,000 metres. Those that border landmasses often contain thick accumulations of sediment.

(6) Seamounts are formed on the oceanic crust in conjunction with the spreading ridges, subduction zones, and mantle plumes (hot spots). They form circular, conical or irregular structures that may rise more than 1,000 m above the seafloor. Many Island States have developed on seamounts that have subaerial summits, some with coraline overgrowths (i.e. atolls). These seamounts are developed by a combination of geological processes involving mainly volcanism, but also including tectonic uplift of the earth's crust.

2.2 Composition of oceanic and continental crust

In contrast with continental crust, oceanic crust is thin (5-10 km), of relatively uniform composition and exposed at or near the surface over much of the mid-ocean ridges. Sediments increase in thickness, on the older parts of the ocean floor (reflecting greater accumulation time), toward the ocean/continent boundary, continental rises and continental margins. Throughout the majority of the ocean basins, away from continental rises, sediments do not attain a thickness of more than a few hundred metres (Figure 5).

The oceanic crust originates by partial melting of rocks in the underlying mantle during seafloor spreading. Other rocks and minerals produced by this process include polymetallic sulphides (PMS). In addition, the ocean basins contain large concentrations of manganese oxide nodules and crusts on the surface of the seafloor that are rich in manganese, nickel, copper and cobalt (and other trace metals). The areas of the sub-sea physiographic provinces are summarised in Figure 2. Compared to the ocean floor, submerged continental margins and small ocean basins contain the majority of potential sub-sea non-living resources. This is both in terms of their variety and potential value. Most important among these are the hydrocarbons, most of which probably occur beneath the continental shelf and slopes, and possibly in small ocean basins. Although only a relatively small number of other minerals are presently recovered from the continental shelf, it potentially contains a similar array of minerals currently returned from the land-based mining. The total amount of these metals in the ocean basins and crust is very likely far larger than in the continents, but significant technological advances will be required to make them economically viable.

3 Methodology

3.1 Determination of the area of interest

For the purposes of this report, we have used the criteria provided in the 1982 Convention to identify legal continental shelf areas beyond 200 nautical miles from baselines. We have not identified all of the potential outer limits of individual states, as our aim was to make a general assessment of resources and resource potential. Instead we have relied on published sources for this information, and integrated these data with our own results of investigation of marine mineral and other deposits.

Article 76 of the 1982 Convention is the principal set of guidelines by which a coastal state may define an outer limit to its legal continental shelf beyond 200 nautical miles. The Article includes the definition of, and the criteria for, the location of the outer limit of the legal continental shelf. It also provides details of a combination of geodetic, geophysical, geological and hydrographic techniques for determining this outer limit. The Commission for the Outer Limits of the Continental Shelf has published technical guidelines that further discuss these criteria and their application. These details may be found at the United Nations Division for Ocean Affairs and Law of the Sea website at http://www.un.org/Depts/los/index.htm.

We here summarise the main parametres of the guidelines:

Article 76, paragraph 1, states:

"The continental shelf of a coastal State comprises the sea-bed 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".

It continues: "For the purposes of this Convention, the coastal State shall establish the outer edge of the continental margin wherever the margin extends beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured".

"The continental margin comprises the submerged prolongation of the land mass of the coastal State, and consists of the sea-bed and subsoil of the shelf, the slope and the rise. It does not include the deep ocean floor with its oceanic ridges or the subsoil thereof".

The second provision, contained in paragraph 4 (a) (i) and (ii) of the Article, determines the position of the outer limit of the continental margin by means of complex formulae:

> "(i) a line delineated in accordance with paragraph 7 by reference to the outermost fixed points at each of which the thickness of sedimentary rocks is at least 1 per cent of the shortest distance from such point to the foot of the continental slope; or
>
> (ii) a line delineated in accordance with paragraph 7 by reference to fixed points not more than 60 nautical miles from the foot of the slope."

In practice, this means that if a coastal state can prove that its submarine extension is a natural prolongation of its continental mass, then the continental shelf can be continued by reason of a extensive sediment deposit lying beyond its morphological shelf edge, or if the morphological shelf edge lies a considerable distance from the coastal baseline. In some cases this can be an enormous additional area of maritime jurisdiction. But it is not without limit. The Article also carries a set of restrictive or constraining paragraphs, viz:

"The fixed points comprising the line of the outer limits of the continental shelf on the sea-bed, drawn in accordance with paragraph 4 (a) (i) and (ii), either shall not exceed 350 nautical miles from the baselines from which the breadth of the territorial sea is measured or shall not exceed 100 nautical miles from the 2,500 metre isobath, which is a line connecting the depth of 2,500 metres."

Using these criteria, a number of authors have made attempts to identify the areas of the worlds oceans which, as legal continental shelf, fall beyond 200 nautical miles from the baselines from which territorial limits have been determined. One of the most widely cited is Prescott's work of 1985, which although undoubtedly requiring some revision, is a useful starting point for an analysis and is used here as a guide to locating and assessing the non-living resource potential of the extended continental shelf regions (Figure 6). Other workers, notably Carrera (pers. comm. 2000), have attempted to summarise the general pattern of legal continental shelf areas for the world's coastal states. It is a certainty that the final determination of the outer limits of every coastal state's legal continental shelf will take a great deal of time, perhaps another decade – and will then have to pass through the endorsement process set up by the Commission. Even without the inevitable delays resulting from disputed boundaries which will beset the operation, it would seem unlikely that this process would near completion within the next twenty-five years. This factor may be significant in the view that the ISA may take on assessing the resource potential of the legal continental shelf, and indeed, the International Seabed Area.

3.2 Classification of mineral resources

Although sub-sea resources of petroleum and other minerals are potentially large and widely distributed, only a small part are likely to be economically recoverable within the next few decades and some may never be recoverable (Pearson, 1975; Kesler, 1994). To give economic and geologic perspectives to estimates of resource potentials, they must be examined in a framework that accounts for the degree of uncertainty of knowledge about their existence, formation and character. The feasibility of their recovery and sale also needs to be considered.

In the original classification of McKelvey (1968) and McKelvey and Wang (1969), individual mineral deposits evolve from being an estimated resource to a known reserve with progress in exploration, advance in technology, and changes in economic conditions. Recoverable reserves comprise known abundance and volume of materials that are both marketable and economically feasible to produce under local economic and technologic conditions. In contrast, resources comprise estimates of the potential occurrence and abundance of materials, regardless of their feasible exploitation. McKelvey and Wang (1969) further subdivide resources into: "para-marginal resources that are prospectively marketable materials recoverable at prices as much as 1.5 times those prevailing now or possible with likely advances in technology", and "sub-marginal resources that are materials recoverable at prices higher than 1.5 times those prevailing now but that have some forseeable use and prospective value".

Seen in this framework, the presently recoverable, proven reserves of most minerals are relatively small when compared with the estimated resources that may be found by future exploration or become recoverable as a result of technologic advances or changes in economic conditions. This is particularly true for sub-sea resources, because only a small part of the seabed has been explored and most of the resources it contains are not yet economically recoverable (Li, 1995).

3.3 Methods used to assess resource potentials

We use essentially four stages to assess potential non-living resources in the extended legal continental shelf (ELCS) regions. For some resources, not all stages are possible. In these cases we progress the stages as far as reasonable, or possible, to reach a qualitative ranking of resources by region.

(1) The first involves the identification of all known and documented occurrences of the potential resource materials in the global oceans. These occurrences include coastal, continental shelf, continental slope, continental rise and abyssal

locations, regardless of their relationship to the ELCS (legal extended continental shelf) regions.

(2) The second stage is to determine, where possible, all known and estimated determinations of the resource density in mass per unit area of various minerals and elements. For manganese nodules and crusts, for example, these are based on reports in the literature of seabed surface coverage determined from sampling and photographic observations. For conventional hydrocarbons (gas and oil), existing regions of production are identified, as well as reserve and resource estimates based on regional compilations.

(3) Where appropriate, a third stage assesses chemical compositional data for elements of significant economic value. These are largely restricted to manganese nodules and crusts, for which there is global data coverage. Other minerals, for which global coverage is absent, require further exploration prior to being treated this way.

(4) The fourth stage multiplies the occurrence, frequency or density of resource minerals (in mass per unit area) with elemental compositional data for those minerals (in wt. %) to arrive at abundance values in units of mass per unit area for individual elements. These values are further multiplied by the area occupied by each of the identified ELCS regions (including their sub-divisions) to arrive at estimates of the total mass of material in those ELCS regions.

The global data of both abundance and composition are compiled on a 1° latitude and longitude grid. Interpolation of data between sampled localities is based on a minimum surface tension routine (Smith and Wessel, 1990). This method has the advantage of adjusting value gradients locally according to the actual sample values, their location and frequency of occurrence. Interpolation is not believed to give meaningful results beyond 10° ranges from known localities and, therefore, the data grids do not extend beyond that limit.

Where abundance, density and compositional data are absent, the likelihood of occurrence of specific resource types have had to be estimated from predictive models. These models use knowledge of the presence or absence of conditions favourable for resource formation to establish often non-unique predictions of likely occurrence. This method is especially applicable for gas hydrates and conventional hydrocarbon resources, although the latter are also described with reference to adjacent known reserves and estimated resources.

Finally, a value is placed on the resources at current (June 2000) commodity prices. These estimates are valid only as far as they describe the total abundance and hence value of the resource in question. They do not include any recovery, treatment or other production costs that would be incurred but which, at present, are unknown. A state-by-state summary of the non-living resources within ELCS areas is given in appendix 1.

4 Non-Living Resources on the Seafloor: Their Formation, Occurrence and Magnitude

4.1 Marine Placer deposits

4.1.1 What marine placer deposits comprise

Marine placers are detrital heavy metallic minerals which have become separated from their normally associated light minerals, and can form in economic concentrations. The most economically important of these minerals are: cassiterite (tin), ilmenite (titanium), rutile (titanium), zircon (zirconium), chromite (chromium), monazite (thorium), magnetite (iron), gold and diamonds (Harben and Bates, 1990).

4.1.2 How marine placer deposits are formed

Marine placer deposits are formed in high-energy environments such as the surf-zone along beaches. As a result of their specific high density, placer minerals are generally confined to locations within a few tens of kilometres from their source rocks. The relationship between sea-level changes and the formation and preservation of placer deposits puts limits on their occurrence offshore. During the last glacial maximum 18,000 years ago sea level was lowered by ~120 m. At these times, fluviatile placer deposits may have extended to the edge of the present-day continental shelf. However, subsequent rises of sea level have produced a cover of transgressive sand and shelf mud, burying the placer. In general, two different types of marine placer deposits are recognised (Emery and Noakes, 1968; Kudrass, 1987, 2000; Jury and Hancock, 1989).

1. Fluviatile placer deposits of gold and cassiterite (tin oxide) on the inner shelf originated during glacial periods of falling sea level, when rejuvenated fluviatile erosion concentrated these heavy minerals in lag sediments. These were further transported and concentrated on the shallow continental shelf during periods of falling sea level occurring during interglacial-to-glacial transitions.

2. Beach placers originated during periods of stable or slightly fluctuating sea level, typical during extended intermediate glacial periods. Most of these beach placer deposits were subject to dispersion or shoreward removal during periods of rising sea level during interglacial periods. The wealth of placer deposits along present shorelines is largely a result of transgressive beach-barrier migration, by which much of the shelf sand with its pre-concentrated heavy-mineral assemblages was moved to its present coastal position. This lateral and vertical migration was especially effective during the last two transitions from glacial to interglacial periods.

4.1.3 Where marine placer deposits are found

Figure 7 shows the presently known placer deposits of economic significance (Emery and Noakes, 1968; Cronan, 1980; Earney, 1990). However, none are located within the areas of the ELCS regions (legal extension of the continental shelf) beyond 200 nautical miles.

In most placer deposits, economically valuable minerals have been mechanically concentrated in rivers along beaches, fan-aprons and river deltas as a result of their higher density (>3.2 gcm^{-3}) compared to the bulk of detrital minerals, which consist mostly of quartz and feldspar (with a density of 2.7 gcm^{-3}). These placer minerals, sometimes called heavy minerals, are derived by weathering from continental rocks of mostly volcanic, plutonic, or metamorphic origin and have a broad compositional range. Therefore, the majority of heavy mineral marine placer deposits are intrinsically linked close to their geological sources and to near-shore or shallow continental shelf environments.

The majority of placer deposits are found along many present shorelines and are predominantly a result of beach migration during periods of marine transgression. Although few shelf deposits large enough to survive the transgression are preserved, they form disseminated shelf deposits of low grade and hence little economic value (Komer and Wang, 1984).

Kudrass (2000) reports the main areas where placer deposits are currently known, are being mined, and their common usage. These are summarised below and their major locations shown on Figure 7 (Yim, 1991, 2000; Jones and Davies, 1979; Shilo, 1970).

The minerals rutile and ilmenite are the main sources of titanium and are or have been mined from placer-derived deposits from beach sand in south-east and south-west Australia, in east South Africa, south India, Mozambique, Senegal, Brazil, and Florida. Titanium is used as an alloy or, more commonly in its oxide form, as a pigment for paint.

The minerals zircon, garnet, sillimanite, and monazite are frequently recovered as by-products of mining ilmenite-bearing sands. They are used as refractory or foundry sand (zircon, sillimanite), as abrasives (garnet, zircon), or as raw material (monazite) for rare earth elements (cerium, lanthanum, neodymium and thorium), which are recovered for various purposes including: catalysts in refining crude oil, VDU screens, fluorescent lamps and some radioactive uses.

The iron-titanium-rich placer mineral magnetite has been mined in large quantities from the northwestern coast of New Zealand (North Island), Indonesia (Java), the Philippines (Luzon), and Japan (Hokkaido). In Japan this type of magnetite is added to other iron ores to prolong the durability of expensive furnace linings.

The fluviatile placer mineral cassiterite, a tin oxide, is recovered from near-shore and offshore sediments in the "tin-valleys" of the Indonesian Sunda shelf (extending from the islands of Bangka, Belitung, and Kundur), Malaysia, and Thailand, where about one third of the world's production derives. Tin is used as corrosion-resistant plating for steel and in alloys.

The majority of presently recovered gold is derived from fluviatile placer deposits. Although it sometimes occurs in beach placer deposits (New Zealand, Alaska), it is limited like other placer deposits to coastal areas and the shallow continental shelf. Thus it is not considered a resource in the ELCS regions. Besides being used for ornaments and bullion, its consumption for industrial purposes is increasing.

Diamonds are mined in beach and shelf sediments along the west coast of South Africa and Namibia and are used as jewellery and for industrial cutting and grinding processes.

4.1.4 Resource potential of marine placer deposits

Because marine placer deposits are generally confined to locations within a few tens of kilometres from their source rocks, and are related to Pleistocene sea-level changes, they are limited to continental shelf regions less than 120 m deep. Therefore, it is almost certain that no placer deposits will occur as resources in the regions identified as potential ELSC, since these regions generally lie deeper than 120 m. However, there remains a remote possibility that submarine mass-erosion and deposition may have reworked and transported shelf placer deposits to deeper water. It is not possible to predict the location, grade or abundance of such deposits under these circumstances which must, therefore, remain a sub-marginal resource.

4.2 Marine phosphorite deposits

4.2.1 What marine phosphorite deposits comprise and how they are formed

Phosphorite deposits are naturally occuring compunds containig phosphate in the form of a cement binding sediments in tropical to sub-tropical regions. They tend to occur in waters of medium depth and are widely distributed on the continental shelves and upper slopes in areas of upwelling currents. They also occur on oceanic islands, seamounts or the flanks of atolls (Burnett and Riggs, 1990).

Phosphates in the form of phosphorites are composed of calcium phosphate which is an important fertiliser, and thus are of principal use in agriculture. Phosphorite, consisting of varieties of the heavy mineral apatite, is not a detrital mineral like other heavy minerals, but is authigenically formed in sediments (Manheim, F. T., 1979; Cruikshank, 1992; Bentor, 1980).

4.2.2 Where marine phosphorite deposits are found

Present-day locations of phosphorite deposits are shown on Figure 8. Relatively rich deposits are known to occur in areas such as off the coast of Baja California, southern California, and east of New Zealand. However, in many places they consist of cemented nodules scattered within sediments, and are too sparsely distributed to be recoverable. Their phosphate content of known deposits varies considerably and is seldom more than 29 wt. % (Baturin and Savenko, 1985; Baturin 1998; Rao and Nair, 1991).

The large, commercially valuable deposits of Nauru, Ocean and Christmas Islands are well known, and there is the potential for similar deposits to occur on shallow (less than 120 m deep) submerged seamounts, within the Pacific region, which were above sea level prior to the last sea level rise (Bentor, 1980). There are also potential and low grade phosphorite deposits on the Chatham Rise off New Zealand, (~5 wt. % phosphate) and offshore from Cochin and Bombay, India. Other major localities include: south and south-western Africa, north-western Africa, the western and eastern margins of South America and western Australia (Cruikshank, 1992; Manheim, 1979).

None of these locations overlap with the extended continental shelf regions, except for a small portion on the south-eastern margin of Argentina.

4.2.3 Resource potential of marine phosphorite deposits

World sub-sea resources of phosphorite are probably at least of the order of hundreds of billions of tonnes (Kent, 1980; Pearson, 1975; Manheim, 1979). As a consequence of the prevailing economic conditions and the alternative availability of phosphates from non-marine sources no offshore deposits are being mined at present. Although land deposits are large enough to meet world demands, sub-sea production may become economically viable in local areas far removed from on-shore deposits. Although possibly a few billion tons of offshore deposits may be classed as para-marginal now (in those areas with already identified major deposits), the bulk of sub-sea phosphorite resources in ELCS regions must be classed as sub-marginal and hence of little economic value.

4.3 Marine evaporite deposits

4.3.1 What marine evaporite deposits comprise and how they are formed

Anhydrite and gypsum (calcium sulphates), common salt (sodium chloride), and potash-bearing minerals are termed evaporite deposits (Holser, 1979; Peryt, 1987; Holser et al., 1988). They are formed by evaporation of sea water and other natural brines in geologic basins of restricted circulation. Important deposits of magnesium bearing salts are also deposited in such basins. Elemental sulphur forms in some of them by biogenic processes involving the alteration of anhydrite. Because rock salt tends to flow at relatively low temperature and pressure, salt in thick beds squeezed by the weight of a few thousand metres of overlying sediment often protrudes upwards forming salt domes, plugs, and other structures. Such masses, which can be a few kilometres in diameter, may bring salt to or near the surface. They can also form structures in the intruded sedimentary layers that are favourable for the accumulation of hydrocarbons.

Evaporite deposits, including some potash and magnesium minerals and elemental sulphur can be recovered by the Frasch process, which involves solution mining methods of injecting hot water into reservoirs through bore holes. Thus the presence of geothermal water sources locate near evaporite deposits greatly enhances their potential value (Kildow J. T., 1979).

4.3.2 Where marine evaporite deposits are found

Figure 9 shows the present day occurrence of sub-sea anhydrite, potash and magnesium evaporite deposits. Although evaporite deposits formed in ancient marine basins are extensive on land, many of these also extend beneath the sea, not only under the continental shelves but also under some marginal ocean basins (for example, the Sigsbee Deep salt domes in the Gulf of Mexico). Other areas area: the Canadian Arctic (including Hudson Bay), the north-west African shelf, the Mediterranean Sea, north-eastern margin of Brazil, the Grand Banks and Newfoundland, parts of eastern African margin and western Australia (Warren, 1999; Teleki et al., 1987). However, very few of these known areas of anhydrite, potash and magnesium evaporite deposits occur within the ELCS regions. Possible exceptions to this are: the Grand Banks and Newfoundland deposits, west Africa and north-western Australian deposits. However, very little data exist on the abundance or concentration of these deposits.

4.3.3 Resource potential of marine evaporite deposits

Because of the widespread occurrence of anhydrite, gypsum, and common salt on land, and the ease of obtaining salt by evaporation from seawater in many coastal regions, these minerals are widely available at low cost. Consequently, there is little value in sub-sea sources, except perhaps in areas far removed from other sources.

To our knowledge, no attempt has been reported to quantitatively estimate potential sub-sea resources of salt and anhydrite, but they probably amount to at least tens of trillions of tonnes. Potash deposits in evaporite basins are not as widespread as salt and gypsum, but individual deposits are large generally in the range of hundreds of millions or billions of tonnes (Warren, 1999). World supplies from land sources are presently abundant, but because potash is a relatively valuable mineral, there are opportunities for the development of strategically located sub-sea deposits, particularly those amenable to dissolution extraction processes.

Potential world resources in sub-sea deposits are probably in the range of tens of billions of tonnes of potash, some of which maybe economically recoverable. Thick beds of a magnesium salt and tachydrite (calcium-magnesium hydrate) previously known only in trace amounts, occur in areas associated with potash in the Sergipe salt basin along the eastern coast of Brazil and in the Congo basin along the mid-south-western coast of Africa. Tachydrite is highly soluble, forms concentrated brines, and probably can be mined by dissolution methods. Magnesium is currently recovered economically from seawater and other natural brines (Pearson, 1975). However, if it can be produced more cheaply from marine tachydrite deposits, then these and other favourably situated deposits may have some economic value. Until then, however, all marine evaporite deposits must be regarded as sub-marginal resources.

4.4 Marine Polymetallic sulphides

4.4.1 What marine polymetallic sulphides deposits comprise

The majority of sub-sea polymetallic sulphides (PMS) are massive ore bodies containing varying proportions of pyrrhotite, pyrite/marcasite, sphalerite/wurtzite, chalcopyrite, bornite, and isocubanite. Some massive polymetallic sulphides located on spreading centres behind deep-ocean trenches also contain galena (lead sulphide) and native gold. Other minor sulphides of tin, cadmium, antimony, aresenic and mercury also occur in varying amounts at different localities (Rona and Koski, 1985; Herzig and Hannington, 1995).

4.4.2 How marine polymetallic sulphides deposits are formed

Polymetallic mineral deposits on the seafloor are intimately related to the formation of new oceanic crust by seafloor spreading. At mid-ocean ridges, convection-driven circulation of seawater through the oceanic crust is the principal ore-forming process (Scott, 1985; Herzig and Hannington, 1995). Hydrothermal fluid leaches and transport metals and other elements from their host rock to the surface of the seafloor. As they discharge, at temperatures up to 350°C from the "black smoker" chimneys (at depths in excess of 2,500 m), metal sulphides deposits form at the seafloor (as mounds) or as sub-surface stock-works. Lower temperature systems are also present and generate mineralisation of considerable economic potential. In the southern Lau Basin, for example, the first examples of actively forming, visible primary gold in seafloor sulphides were documented at "white smoker" chimneys (Hannington, M.D. and Scott, 1988; Herzig et al., 1993).

4.4.3 Where marine polymetallic sulphides deposits are found

Sub-sea massive polymetallic sulphide bodies are found along the earth's major tectonic belts (and identified in Figure 10). The main areas of occurrence are fast-, intermediate-, and slow-spreading mid-ocean ridges, on- and off-ridge volcanoes and seamounts, in sedimented rifts adjacent to continental margins and in volcanoes and spreading ridges related to deep-ocean trenches (Rona, 1988; Rona and Koski, 1985; Herzig, 1999; Herzig and Hannington, 2000). High-temperature hydrothermal activity and large accumulations of polymetallic sulphides are known at some 25 different sites world-wide (Figure 10).

Small oceanic basins related to deep-ocean trenches are important sites for PMS mineralisation. For example, the "PACMANUS" hydrothermal deposits are scattered along a 10 km-long crest of an active volcanic ridge in the Eastern Manus Basin, Papua New Guinea. Here, chimneys dominated by chalcopyrite and sphalerite, with barite and some bornite, have average compositions of 11 wt% Cu, 27% Zn, 230 ppm Ag and 18 ppm Au (Moss et al., 1997; Scott and Binns, 1995; Binns et al., 1993). The shallow depths (less than 1,500 m) and high gold content make such sites potentially viable for mining.

4.4.4 Resource potential of marine polymetallic sulphides deposits

Very little is known about the total metal content of sub-sea PMS deposits and their sub-surface extent. However, it is unlikely that sub-sea PMS deposits, such as those located in international waters on the mid-ocean ridges (e.g. the Mid-Atlantic Ridge, East, Northeast and Southeast Pacific Rises, and the Indian Ocean ridges), will become mining targets in the forseeable future (Agterberg, F.P. and Franklin, 1987). This is largely because of their depth (greater than 2500 m) and remote locations from shore. However, marine mining may become economically viable under some conditions where there are high gold and base-metal grades, sites are located close to land, and in water depths less than 2000 m. Under those circumstances, massive sulphide mining may become economically viable (Broadus, 1985).

With reference to Figure 10, showing the locations of known hydrothermal activity and PMS deposits and their geologic setting, it is possible to identify those areas where conditions for recovery may become viable. These are: the southwest Pacific, the Scotia Sea, the Guyamus Basin (Gulf of California), northern East Pacific Rise, the Mid-Atlantic Ridge south of the Azores islands, and possibly parts of the Juan de Fuca Ridge of western North America.

Only the PMS deposit known as Lucky Strike on the Mid-Atlantic Ridge, located to the south of the Azores islands lies within potential areas of extended legal continental shelf (ELCS). Even for those PMS deposits that are already known, and lie within 200 nautical miles of coastal states, the logistical difficulty for mineral recovery make them all currently para-marginal resources. The only exception to this is the PACMANUS deposit in the Eastern Manus Basin (Bismarck Sea, north of Papua New Guinea), for which the Papua

New Guinea authorities granted in 1999 two exploration and development licences to Nautilus Mineral Corporation PLC.

4.5 Marine manganese nodules and crusts

4.5.1 What manganese nodules and crusts comprise

Manganese nodules are concentrations of iron and manganese oxides, ranging from millimetres to tens of centimetres in diameter. They can contain economically valuable concentrations of nickel, copper and cobalt (together, making up to three weight percent). They occur mainly on the deep-seafloor. Apart from manganese and iron oxide, nickel, copper and cobalt, the nodules and crusts include trace amounts of molybdenum, platinum and other base metals (Cronan, 1980; Manheim, 1986).

Manganese nodules were first dredged by the HMS Challenger Expedition in the Pacific Ocean in 1872-76 (Murray, 1878; Murray and Irvine, 1895; Murray and Renard, 1891). The currently known distribution of manganese nodules and crusts on the ocean floor (shown on Figure 11) is based on information acquired by sidescan sonars, drill cores, dredged samples, seafloor photos, video camera records and direct observation from submersibles. The most up to date information of nodule and crust locations, their compositions and abundance, has been compilation by the USGS, NOAA and US Mineral Management Service (Anon., NOAA & MMS Marine Minerals CD-ROM Data Set, World Data Center for Marine Geology & Geophysics, Boulder, 1991) These data form the basis of the analysis of this resource assessed here in this report.

Manganese rich crusts, similar in composition to the nodules, are found in some areas and range from coatings and veneers a few millimetres thick to layered crusts that are several centimetres thick. They are deposited on sand grains, pebbles, rock fragments and bedrock, or blanket unconsolidated sediments. They occur as coatings or encrustations on hard rock substances, on seamounts and the submerged portions of islands, and can be enriched by up to two per cent in cobalt. (Mero, 1965; Glasby, 1977).

4.5.2 Mineralogy of manganese nodules and crusts

Nodules and crusts consist predominantly of amorphous and very fine grained hydrated manganese and iron oxide minerals with variable amounts of silica, carbonate, and detrital and biological materials (Gross and McLeod, 1987). The major mineral phases of iron and manganese oxides control the uptake and retention in the nodules of minor elements such as nickel, copper, cobalt, molybdenum and rare earth elements (Cronan, 1977). Identification of specific mineral phases is difficult because of the intimate intergrowth of the different mineral phases and associated detrital material. Of the large number of complex hydrous manganese oxide mineral phases identified in the nodules and crusts, todorokite and birnessite, are the most common. The ratio of different mineral phases and their relationship to different environments has been documented by Burns and Burns (1977).

In addition to the iron and manganese minerals, nodules and crusts contain a variety of non-metallic minerals, amorphous material and biological debris that may comprise up to 25 wt. % of their (dry) mass. These include clay minerals, quartz, feldspar and chlorite, mostly of detrital origin along with silica gels, chalcedony, calcareous and phosphatic components in varied proportions.

4.5.3 Chemical composition of manganese nodules

Gross and McLeod (1987) report that the major elements in dry nodules are oxygen, manganese, iron, silica, lesser amounts of aluminium, calcium, sodium, and magnesium and trace elements of which nickel, copper, and cobalt are of greatest economic interest. The amounts and proportions of constituents vary considerably within single nodules, in nodules of different sizes, and in nodules from different regions and ocean basins. (Calvert, 1978; Haynes et al.,l985).

The average composition of nodules from the Atlantic, Pacific and Indian Oceans are given below in dry wt. %, (Cronan, 1977, 1980, 2000; Gross and McLeod, 1987):

Table 1. Average elemental concentrations for manganese nodules (from Gross and McLeod, 1987).

Average content (In dry wt %)	Atlantic	Pacific	Indian
Manganese	15.46	19.27	15.25
Iron	23.01	11 79	13.35
Nickel	0.308	0.846	0.534
Copper	0.141	0.706	0.295
Cobalt	0.23410	0 290	0.247
Manganese/Iron	0.67	1.6	1.14

4.5.4 Chemical composition of manganese crusts

The composition of manganese crusts varies from 15 to 31 wt. % manganese, 7 to 18 wt % iron, and has Mn/Fe ratios from 1.0 to 3.4. In general, cobalt content is higher for crust than for nodules with up to 2 wt % cobalt being found in samples from seamount summit areas less than 1,500 m in depth. The average cobalt content in crusts is 0.8 wt %, which also contain significant amounts of nickel, lead, cerium, molybdenum, vanadium and other minor metals including platinum group elements (Manheim, 1986).

Manganese crusts that are rich in cobalt are widely distributed on the slopes of seamounts and islands in the equatorial Pacific, on the Blake Plateau in the north-west Atlantic, and with denser concentrations of nodules in many parts of the ocean basins. The main factors controlling distribution of cobalt rich manganese crusts in the central Pacific are described by Cronan (1983, 1985), Morgan (2000), Halbach (1983); Halbach and Manheim (1984); and Manheim (1986) as:

(1) elevated biological activity and extraction of cobalt from seawater by organisms;

(2) water depths less than 2,000 metres in the vicinity of seamounts;

(3) manganese enrichment at certain ocean depths related to zones of minimum oxygen;

(4) low rates or absence of turbidite sedimentation.

Clark and others (1984; 1985) state that "the most favourable areas for cobalt bearing crusts lie on seamounts older than 25 Ma, within water depths of 800 to 2,400 m, from 5° to 15° from the equatorial zone and in areas where two generations of crusts with ages from 16 to 9 Ma and 8 Ma or younger occur".

For example, cobalt concentrations in manganese-iron crusts and nodules in the Mid-Pacific Mountain and Line Islands area increase from less than 0.4 % at water depths of 4000 m to 1.2 % on seamount slopes and summits less than 2,500 m in depth (Gross and McLeaod, 1987). The thickness of these crusts ranges from 2 cm in the upper slope areas to 9 cm in the lower areas and may contain more than 16 kg/m (dry weight) of encrusted surfaces (Halbach and Manheim, 1984).

4.5.5 How manganese nodules and crusts are formed

Manganese nodules and crusts are formed through sedimentary, concretionary and biogenic processes. The metals contained in them are derived from hydrothermal, diagenetic, halmyrolytic, and sedimentary sources (Cronan, 1980; Eldesfield, 1977). The development and distribution of nodules are influenced by a variety of regional and local factors (Burns and Burns, 1977 – also see Cronan 2000 for references therein). These include:

(1) their size, morphology, mineralogy, age and rate of growth;

(2) the availability, size and composition of nuclei;

(3) bathymetry, paleo-bathymetry and seabed topography;

(4) the carbonate compensation depth;

(5) seawater composition;

(6) bottom currents and paleo-currents;

(7) redox potential at the sediment-water interface;

(8) composition, thickness and age of underlying sediments;

(9) thermal gradients in the sediment column;

(10) rates of detrital or chemical sedimentation, and biological productivity in the water column;

(11) activity of bottom organisms; and

(12) the proximity to volcanic, hydrothermal-effusive and tectonic activity.

However, both Eldersfield (1977) and Cronan (1980) state that the lack of detailed systematic sampling of nodules has limited research and understanding of the respective role and interrelationship of these factors.

The source of metals in the nodules is attributed to the following factors (Greenslate, et al. 1973: Glasby,1977; Calvert,1978):

(1) discharge of hydrothermal solutions along active tectonic belts;

(2) leaching of metals from the bottom sediments and volcanic rocks during diagenesis and consolidation and subsequent transport and deposition by interstitial water;

(3) solution and transport of metals by seawater with precipitation at favourable sites; and

(4) the deposition of metal-bearing elastic or colloidal sediment derived from a landmass.

Gross and McLeod (1987) identify a number of interrelated environmental factors which control the deposition and concentration of nickel and copper bearing nodules that are of significance as resources. These are found:

(1) below the carbonate compensation depth in abyssal areas isolated from the deposition of continental clastic detrital material, where sedimentation rates are low and bottom sediments commonly consist of siliceous ooze or red clay;

(2) in proximity to active spreading ridges, major fracture systems, and active volcanism that provide sources of metals and nuclei for nodule growth;

(3) where bottom currents are effective in transporting metals in solution and supplying oxygenated water conducive to the precipitation of metals and in promoting the growth of nodules by inhibiting sedimentation;

(4) in areas of high biological productivity, where metals are collected from the seawater by organisms and contributed to the pelagic sediments.

The size, shape, mineralogy, physical and chemical properties, and distribution of nodules are highly variable, on both broad and local scales reflecting the complex interplay of environmental factors and the dominant role of one or two genetic processes (Hein and Morgan, 1999; Hein et al., 1997; Frazer and Fisk, 1980; Halbach et al., 1989).

4.5.6 Distribution and composition of manganese nodules and crusts

Manganese nodules and crusts occur in many different environments including freshwater lakes, fiords, continental shelves, seamounts or abyssal plains and basins. The most extensive nodule fields are on oceanic crust that is Mesozoic or younger in age. At the present time, nodules are forming at a slow rate of a one to a few tens of millimetres per million years (Ku,1977; Cronan, 1980; Calvert, 1978). Their formation appears to be related to active tectonic belts such as spreading ridges and deep-ocean trenches. They are found chiefly below the carbonate compensation depth in areas with low clastic sedimentation and high biological activity in overlying surface waters (Cronan, 1980, 2000). Nodules with high nickel and copper contents are found in some of the deep ocean basins at depths of 4000 to 5000 metres.

Figure 11 shows the distribution of all known manganese nodules and crusts for which there are quantitative chemical analyses and where estimates of their abundance have been mapped. These data have been compiled from sites where dredges, cores, submersibles and bottom photographs have been taken. Although the chemical analyses cover wide regions, the same is not true for the abundance of nodules and/or thickness of crusts which are less well documented. Therefore, the analyses presented here is only preliminary and should not be taken as anything other than a guide to this resource.

Figures 12 (a) and (b) shows the density of nodules and crusts (in kg/m^2) on the seafloor (compiled from extensive reports in the literature (reference to NOAA and MMS CD-ROM data base; McKlevey and Wang, 1969; Rawson and Ryan, 1978)). There are four elements of economic importance in these deposits: manganese, copper, nickel and cobalt. Figures 13 to 20 show the composition of these elements in nodules and crusts, as well as the density of these elements (mass/unit area) on the seafloor. Estimates for the density of these four important elements (in mass per unit area) has been derived by multiplying the elemental compositions of the nodules and crusts (in dry wt. %) with their density on the seafloor (mass/unit area). These data have been compiled and contoured on a 1° latitude and longitude grid. Areas lying beyond 10° in either latitude or longitude are not contoured since extrapolation beyond these ranges is considered unreliable here.

Important areas where cobalt-bearing manganese crusts have been found in the Pacific include the Northwest Hawaiian Ridge, Johnston Island, Howland-Baker Islands, Marianas Island, Guam, Marshall Islands, Central Seamounts, Palmyra-Kingman, Micronesia and Wake Island (Manheim 1986). Clark et al., (1984, 1985) state that "the area around the Federated States of Micronesia and the Marshall Islands appear to have a much larger resource potential for cobalt, nickel, manganese and platinum than other island areas". Cobalt bearing manganese-iron crusts cover thousands of square kilometres in the Atlantic Ocean and are found on the Blake Plateau, Sierra Leone Rise, and the east flank of the Mid-Atlantic Ridge. Here crusts have a cobalt content of up to 1 wt. %. The mean content of cobalt in 77 samples of crusts from depths to 2,500 m in the Atlantic Ocean is 0.5 wt. % and the total content ranges from 0.5 to 0.85 wt. %, while the mean content of manganese is 20.15 wt. % and the total ranges from 17.9 to 22.28 wt. % (Manheim, 1986). The average metal content in crust samples from the Hawaiian Archipelago and Johnston-Palmyra region in the Pacific is: 0.90wt. % cobalt, 0.50wt. % nickel, 0.06wt. %

copper, and 24.7wt. % manganese (Clark et al. 1984). The average thickness of the crusts is 2.4 to 2.8 cm.

The composition of nodules and crusts is strongly effected by their geologic environment. Nodules and crusts containing appreciable amounts of nickel, copper and cobalt are distributed in a belt within 300 km of the equator in the Pacific and Indian oceans and in a large region of the south, central and southeastern Pacific. A region of special economic interest lies in the central northeast Pacific Ocean between the Clipperton and Clarion fracture zones (bounded by latitude 5° N and 25°N and longitude 270°E to 210°E). Here, abundant nodules have a up to 30 wt. % manganese, 1.5 wt % copper, 10,000 ppm cobalt and 2 wt % nickel. They have a combined content of nickel and copper of up to 3.5wt %. Nodules in this region are more concentrated than in most other areas, with averages up to 10kg/m^2. However, nodule abundance varies considerably within local areas, and in isolated sites ranges up to 30 kg/m^2 (Hayes et al.,1985; Frazer, 1977). Our estimates of the elemental concentration on the seafloor in this region are up to 3kg/m^2 for manganese, 80 g.m^2 for copper, 25 mg/m^2 for cobalt and 0.2 kg/m^2 for nickel.

A large area in the central Pacific Ocean (north of 28°N and between 180-200°E) has widespread concentrations of nodules with average densities up to 10kg/m^2 (Figure 12). These contain elemental concentration up to 20 wt. % manganese, 1wt.% copper, 4000 ppm cobalt and 1% nickel, with the combined nickel and copper concentrations of up to 2wt.%. The elemental density on the seafloor range up to 1.5 kg/m^2 for manganese, 60 g/m^2 for copper, 40 mg/m^2 for cobalt and 0.75 kg/m^2 for nickel.

A number of locations southwest of Hawaii (within an area 5°N to 10°N and 180°E to 195°E) have concentrations of nodules and crusts averaging 2kg/m^2. These contain elemental concentrations and densities on the seafloor of up to 10 wt. % manganese but with less than 1 kg/m^2, up to 1 wt.% copper with less than 10g/m^2, up to 4000 ppm cobalt with a maximum of 10 mg/m^2, and 0.5 wt. % nickel with less than 0.025 kg/m^2. The combined nickel and copper concentration is up to 2 wt. %.

Because of a number of factors including depth of water and sedimentation rates, the pattern of nodule distribution seen to the north of the equator is not found to the south (Halbach,1983).

Table 2. Average abundance of Mn, Fe, Ni, Co and Cu in manganese nodules and crusts from different environments (in weight per cent) (after Cronan 1977).

	Seamounts	Plateaux	Active Ridge	Other Ridge	Continental Margin	Marginal Seamount	Abyssal Plains
Mn	14.62	17.17	15.15	19.74	38.69	15.65	16.78
Fe	15.81	11.81	19.15	20.08	1.34	19.32	17.27
Ni	0.351	0.641	0.306	0.336	0.121	0.296	0.540
Co	1.15	0.347	0.400	0.570	0.011	0.419	0.256
Cu	0.058	0.087	0.081	0.052	0.082	0.078	0.370
Mn/Fe	0.92	1.53	0.80	0.98	28.8	0.81	0.97
Depth	1872	945	2870	1678	3547	1694	4460

Nodules densities of up to 8 kg/m^2 are found in the Pacific southern equatorial belt at the edge of the calcareous zone between 180°E and 220°E. However, occurrences are infrequent throughout much of the area. An exception is an area between the East Pacific Rise and South America densities of up to 6kg/m^2 are reported.

Manganese nodules with up to 2 wt. % of combined nickel and copper and up to 4000 ppm cobalt contents are found in an area in the Indian Ocean (Figures 1, 15, 17, 19) that extends from 10°S to 25°S and 70°E to 86°E, but have concentration of less than 1 kg/m^2 (Frazer and Wilson, 1980).

Other areas south-west of Australia (between 40-60°S and 70-95°E) and north-west of Austalia (between 10-25°S and 95-105°E) have scattered concentrations of nodules up to 2 kg/m^2. However, their metal content appears to be generally low (Cronan, 1980, 2000; Haynes et al., 1985; Gross and McLeod, 1987) with combined copper and nickel of only 2 wt. %. A more significant field of nodules lies in the western Pacific, between 20°N and the equator and 160-200°E where average densities are up to 6 kg/m^2. Here combined copper and nickel comprises 2-3 wt. %, and cobalt concentrations are up to 8000 ppm. This translates in to elemental abundance of copper, cobalt and nickel of up to 50 kg/m^2, 25 mg/m^2 and 0.05 kg/m^2 respectively (Figures 16, 18 & 20).

Nodules are sparsely and irregularly distributed through broad areas of the Atlantic. Probably the most economically interesting concentrations are found on the Blake Plateau, in shallow water east of Florida. Here, nodules and crusts with high Mn/Fe ratios make them economically attractive as a manganese resource (Manheim, 1972). Nodules off the west coast of Italy are of special interest for similar reasons. Good possibilities for finding nodules in other areas near continental margins where they have high Mn/Fe ratios

(Cronan, 1980; 2000; Glasby, 1977) include areas such as the southern and south-western African continental margin.

4.5.7 Resource potential of manganese nodules and crusts

Although the mineralogy, composition and origin of manganese nodules are relatively well known, assessments of their resource potential are not well documented. Potential resources estimates for copper, nickel and cobalt in nodules were made during the 1960s and 1970s and are summarised in Volume I of the United Nations Seabed Mineral Series (United Nations, 1982). However, most of the estimates of resource potential were based on a minimum abundance of 10 kg/m^2 and a minimum combined grade of 1.76 wt. % copper and nickel. However, the abundance of nodules remains a major source of uncertainty and any global estimates must be subject to an order of magnitude error. Despite this, potential world-wide resources of nodules range from 14 to 99 billion tonnes (Gross and McLeod, 1987). Mero (1977) states that "assuming an average concentration of 9 kg/m^2 of ocean floor over 6 million km^2, the high-grade area of the Clarion-Clipperton region in the north Pacific comprise a resource of about 38 billion tonnes of dry nodules, containing about 110 billion tonnes of manganese, 115 million tonnes of cobalt, 650 million tonnes of nickel, and 520 million tonnes of copper". In a more recent estimate, Morgan (2000) calculates the nodule potential in the Clarion-Clipperton zone as 34 billion tonnes containing elemental resources of 7500 million tonnes of manganese, 340 million tonnes of nickel, 265 million tonnes of copper and 78 million tonnes of cobalt.

Accepting the uncertainties and limitations of past and present resource estimates, and using the methods described in this report, it is possible to assess the resources held by manganese nodules and crusts within potential "extended legal continental shelf" (ELCS) regions. Table 3 gives the results of this exercise. Coastal states are listed against the area of their potential ELCS, the average concentration on the seafloor (mass/area) of elements found in manganese nodules and crusts, the total resource of that element.

The top ten countries, ranked in descending order, that have the greatest resource potential of nodules and crusts in their ELCS are: the United States of America, Madagascar, Brazil, Antarctica, Argentina, Japan, South Africa, Canada and India, ranging from 1.86 billion tonnes to 0.33 billion tonnes. In contrast, the bottom ten countries that have potential ELCS resource of nodules and crusts are: Guyana, Mauritania, Kenya, Congo, Zaire, Gambia, Sierra Leone, Guinea Bissau, Guinea, Venezuela, ranging from 15.3 million tonnes to 0.28 million tonnes respectively.

Elemental resources for the top ten ranked countries held by the nodules and crusts in their ELCS range from: 330 million tonnes of manganese (for Antarctica) to 44.5 million tonnes (for India); 28.3 million tonnes of copper (for Antarctica) to 0.9 million tonnes (for

Country	Area No.	Area (sq. km)	Total Area (sq. km)	Conc. Mn nods (kg/sq.m)	Total Mn nods (tonnes)	Total Mn nods for country
Angola	23	251,305	251,305	0.25	62,826,138	62,826,138
Antarctica	26	15,187	5,418,265	0.25	3,796,673	1,484,701,297
	27	1,235,520		0.68	840,153,314	
	28	1,113,819		0.5	556,909,560	
	29	1,376,905		ND		
	31	1,676,835		0.05	83,841,750	
Argentina	24	239,319	239,319	1	239,319,000	239,319,000
Australia	32	250,116	728,342	0.5	125,058,150	363,262,670
	33	23,100		1	23,100,210	
	34	29,776		1	29,775,750	
	35	56,215		1	56,214,560	
	36	48,230		ND	0	
	37	37,650		ND	0	
	38	25,027		ND	0	
	39	258,228		0.5	129,114,000	
Bangladesh	15	969,982	969,982	ND	0	0
Brazil	24	1,675,235	1,964,494	0.5	837,617,500	922,099,185
	25	240,591		0.25	60,147,710	
	42	48,668		0.5	24,333,975	
Burma	15	46,203	46,203	ND	0	0
Canada	1	19,778	2,193,712	ND	0	436,144,640
	2	57,143		ND	0	
	4	872,289		0.5	436,144,640	
	5	1,244,502		ND		
Congo	23	14,652	14,652	0.25	3,663,000	3,663,000
Denmark	7	237,431	237,431	ND	0	0
Equitorial Guinea	22	15,566	15,566	ND	0	0
France	30	34,653	258,768	ND	0	336,172,110
	39	224,115		1.5	336,172,110	
French Guiana	25	140,980	140,980	0.25	35,244,915	35,244,915
Gabon	23	136,752	136,752	0.25	34,188,000	34,188,000
Gambia	20	10,662	10,662	0.25	2,665,582	2,665,582
Ghana	22	25,943	25,943	ND	0	0
Greenland	5	103,312	103,312	ND	0	0
Guinea	21	27,897	27,897	0.05	1,394,871	1,394,871
Guinea Bissau	21	38,359	38,359	0.05	1,917,947	1,917,947
Guyana	25	61,003	61,003	0.25	15,250,628	15,250,628
Iceland	6	2,800	84,937	1	2,799,980	23,334,315
	7	82,137		0.25	20,534,335	
India	15	150,457	1,011,832	ND		646,031,250
	17	861,375		0.75	646,031,250	
Ireland	7	176,511	176,511	0.1	17,651,100	17,651,100
Japan	14	339,701	339,701	2	679,402,580	679,402,580
Kenya	18	20,782	20,782	0.5	10,390,995	10,390,995
Madagascar	19	2,087,434	2,087,434	1	2,087,434,000	2,087,434,000
Mauritania	20	53,312	53,312	0.25	13,328,000	13,328,000

Country	Area No.	Area (sq. km)	Total Area (sq. km)	Conc. Mn nods (kg/sq.m)	Total Mn nods (tonnes)	Total Mn nods for country
Mauritus	45	321,039	321,039	1.5	481,558,500	481,558,500
Morocco	20	824,562	824,562	0.25	206,140,415	206,140,415
Mozambique	19	123,258	123,258	1	123,258,000	123,258,000
Namibia	23	1,111,735	1,111,735	0.25	277,933,750	277,933,750
New Zealand	36	48,230	617,808	0.5	24,114,750	321,417,670
	37	37,650		0.5	18,824,770	
	38	25,027		1	25,027,030	
	39	506,902		0.5	253,451,120	
Nigeria	22	103,772	103,772	ND	0	0
Norway	8	92,181	158,920	ND	0	0
	9	49,231		ND	0	
	10	17,508		ND	0	
Oman	17	375,295	375,295	0.75	281,471,250	281,471,250
Pakistan	17	41,255	41,255	0.75	30,940,905	30,940,905
Phillippines	14	564,725	564,725	2	1,129,449,420	1,129,449,420
Portugal	43	61,738	123,476	1	61,738,000	123,476,000
	44	61738		1	61,738,000	
Russia	1	48,608	430,369	ND	0	0
	3	52,488		ND	0	
	11	218,421		ND	0	
	12	75,397		ND	0	
	13	35,456		ND	0	
Senegal	20	69,924	106,650	0.25	17,481,000	19,317,290
	21	36,726		0.05	1,836,290	
Seychelles	45	321,039	321,039	0.25	80,259,750	80,259,750
Sierra Leone	21	51,030	51,030	0.05	2,551,518	2,551,518
Somalia	18	242,676	242,676	0.5	121,337,985	121,337,985
SOPAC	39	224,115	324,192	ND	0	100,077,000
	40	79,365		1	79,365,000	
	41	20,712		1	20,712,000	
South Africa	19	123,258	184,863	1	123,258,000	138,659,250
	23	61,605		0.25	15,401,250	
Sri Lanka	15	768,758	768,758	ND	0	0
Suriname	25	89,110	89,110	0.25	22,277,450	22,277,450
Tanzania	18	55,681	55,681	0.5	27,840,520	27,840,520
Togo	22	15,566	15,566	ND	0	0
United Kingdor	7	243,679	243,679	0.25	60,919,750	60,919,750
United States	1	248,260	1,212,653	ND		1,860,660,625
	4	214,889		0.5	107,444,500	
	5	508,417		2.5	1,271,042,125	
USA (Guam)	14	241,087		2	482,174,000	
Uruguay	24	53,182	53,182	0.5	26,591,000	26,591,000
Venezuela	25	1,141	1,141	0.25	285,208	285,208
Zaire	23	13,431	13,431	0.25	3,357,750	3,357,750
Total			25,137,321		7,416,422,221	12,856,203,226

Table 3(a). Global distribution, concentration and abundance of manganese nodules and crusts.
Values obtained from averages for each ELCS, or portion of, potentially claimed by each coastal state.

Country	Area No.	Area (sq. km)	Total Area (sq. km)	Conc. Mn (kg/sq.m)	Total Mn (T) (tonnes)	Total Mn (T) for country
Angola	23	251,305	251,305	0.05	12,565,228	12,565,228
Antarctica	26	15,187	5,418,265	0.0005	7,593	156,216,951
	27	1,235,520		0.08	98,841,566	
	28	1,113,819		0.05	55,690,956	
	29	1,376,905		ND		
	31	1,676,835		0.001	1,676,835	
Argentina	24	239,319	239,319	0.25	59,829,750	59,829,750
Australia	32	250,116	728,342	0.1	25,011,630	51,642,810
	33	23,100		0.1	2,310,021	
	34	29,776		0.1	2,977,575	
	35	56,215		0.15	8,432,184	
	36	48,230		ND	0	
	37	37,650		ND	0	
	38	25,027		ND	0	
	39	258,228		0.05	12,911,400	
Bangladesh	15	969,982	969,982	ND	0	0
Brazil	24	1,675,235	1,964,494	0.1	167,523,500	181,986,440
	25	240,591		0.05	12,029,542	
	42	48,668		0.05	2,433,398	
Burma	15	46,203	46,203	ND	0	0
Canada	1	19,778	2,193,712	ND	0	130,843,392
	2	57,143		ND	0	
	4	872,289		0.15	130,843,392	
	5	1,244,502		ND		
Congo	23	14,652	14,652	0.05	732,600	732,600
Denmark	7	237,431	237,431	ND	0	0
quitorial Guine	22	15,566	15,566	ND	0	0
France	30	34,653	258,768	ND	0	11,205,737
	39	224,115		0.05	11,205,737	
French Guiana	25	140,980	140,980	0.01	1,409,797	1,409,797
Gabon	23	136,752	136,752	0.05	6,837,600	6,837,600
Gambia	20	10,662	10,662	0.05	533,116	533,116
Ghana	22	25,943	25,943	ND	0	0
Greenland	5	103,312	103,312	ND	0	0
Guinea	21	27,897	27,897	0.01	278,974	278,974
Guinea Bissau	21	38,359	38,359	0.01	383,589	383,589
Guyana	25	61,003	61,003	0.1	6,100,251	6,100,251
Iceland	6	2,800	84,937	0.1	279,998	4,386,865
	7	82,137		0.05	4,106,867	
India	15	150,457	1,011,832	ND		86,137,500
	17	861,375		0.1	86,137,500	
Ireland	7	176,511	176,511	0.02	3,530,220	3,530,220
Japan	14	339,701	339,701	0.2	67,940,258	67,940,258
Kenya	18	20,782	20,782	0.05	1,039,100	1,039,100
Madagascar	19	2,087,434	2,087,434	0.2	417,486,800	417,486,800
Mauritania	20	53,312	53,312	0.05	2,665,600	2,665,600

Country	Area No.	Area (sq. km)	Total Area (sq. km)	Conc. Mn (kg/sq.m)	Total Mn (T) (tonnes)	Total Mn (T) for country
Mauritus	45	321,039	321,039	0.4	128,415,600	128,415,600
Morocco	20	824,562	824,562	0.05	41,228,083	41,228,083
Mozambique	19	123,258	123,258	0.2	24,651,600	24,651,600
Namibia	23	1,111,735	1,111,735	0.05	55,586,750	55,586,750
New Zealand	36	48,230	617,808	0.05	2,411,475	82,831,991
	37	37,650		0.05	1,882,477	
	38	25,027		0.1	2,502,703	
	39	506,902		0.15	76,035,336	
Nigeria	22	103,772	103,772	ND	0	0
Norway	8	92,181	158,920	ND	0	0
	9	49,231		ND	0	
	10	17,508		ND	0	
Oman	17	375,295	375,295	0.1	37,529,500	37,529,500
Pakistan	17	41,255	41,255	0.1	4,125,454	4,125,454
Phillippines	14	564,725	564,725	0.2	112,944,942	112,944,942
Portugal	43	61,738	123,476	0.1	6,173,800	12,347,600
	44	61738		0.1	6,173,800	
Russia	1	48,608	430,369	ND	0	0
	3	52,488		ND	0	
	11	218,421		ND	0	
	12	75,397		ND	0	
	13	35,456		ND	0	
Senegal	20	69,924	106,650	0.05	3,496,200	5,332,490
	21	36,726		0.05	1,836,290	
Seychelles	45	321,039	321,039	0.05	16,051,950	16,051,950
Sierra Leone	21	51,030	51,030	0.01	510,304	510,304
Somalia	18	242,676	242,676	0.05	12,133,799	12,133,799
SOPAC	39	224,115	324,192	ND	0	15,011,550
	40	79,365		0.15	11,904,750	
	41	20,712		0.15	3,106,800	
South Africa	19	123,258	184,863	0.2	24,651,600	27,731,850
	23	61,605		0.05	3,080,250	
Sri Lanka	15	768,758	768,758	ND	0	0
Suriname	25	89,110	89,110	0.02	1,782,196	1,782,196
Tanzania	18	55,681	55,681	0.05	2,784,052	2,784,052
Togo	22	15,566	15,566	ND	0	0
United Kingdom	7	243,679	243,679	0.05	12,183,950	12,183,950
United States	1	248,260	1,212,653	ND		182,134,120
	4	214,889		0.15	32,233,350	
	5	508,417		0.2	101,683,370	
USA (Guam)	14	241,087	241,087	0.2	48,217,400	48,217,400
Uruguay	24	53,182	53,182	0.1	5,318,200	5,318,200
Venezuela	25	1,141	1,141	0.01	11,408	11,408
Zaire	23	13,431	13,431	0.05	671,550	671,550
Total			25,378,408			2,033,288,915

Table 3(b). Global distribution, concentration and abundance of elemental manganese in nodules and crusts. Values obtained from averages for each ELCS, or portion of, potentially claimed by each coastal state.

Country	Area No.	Area (sq. km)	Total Area (sq. km)	Conc. Cu (g/sq.m)	Total Cu (T) (tonnes)	Total Cu (T) for country
Angola	23	251,305	251,305	3	753,914	753,914
Antarctica	26	15,187	5,418,265	1	15,187	21,338,635
	27	1,235,520		15	18,532,794	
	28	1,113,819		1	1,113,819	
	29	1,376,905		ND	0	
	31	1,676,835		1	1,676,835	
Argentina	24	239,319	239,319	12	2,871,828	2,871,828
Australia	32	250,116	728,342	5	1,250,582	2,639,762
	33	23,100		8	184,802	
	34	29,776		8	238,206	
	35	56,215		8	449,716	
	36	48,230		ND	0	
	37	37,650		ND	0	
	38	25,027		ND	0	
	39	258,228		2	516,456	
Bangladesh	15	969,982	969,982	ND	0	0
Brazil	24	1,675,235	1,964,494	8	13,401,880	14,512,996
	25	240,591		3	721,773	
	42	48,668		8	389,344	
Burma	15	46,203	46,203	ND	0	0
Canada	1	19,778	2,193,712	ND	0	4,797,591
	2	57,143		ND	0	
	4	872,289		5.5	4,797,591	
	5	1,244,502		ND	0	
Congo	23	14,652	14,652	2	29,304	29,304
Denmark	7	237,431	237,431	ND	0	0
Equitorial Guinea	22	15,566	15,566	ND	0	0
France	30	34,653	258,768	ND	0	1,120,574
	39	224,115		5	1,120,574	
French Guiana	25	140,980	140,980	3	422,939	422,939
Gabon	23	136,752	136,752	2	273,504	273,504
Gambia	20	10,662	10,662	2	21,325	21,325
Ghana	22	25,943	25,943	ND	0	0
Greenland	5	103,312	103,312	ND	0	0
Guinea	21	27,897	27,897	2	55,795	55,795
Guinea Bissau	21	38,359	38,359	2	76,718	76,718
Guyana	25	61,003	61,003	3	183,008	183,008
Iceland	6	2,800	84,937	4	11,200	93,337
	7	82,137		1	82,137	
India	15	150,457	1,011,832	ND	0	1,722,750
	17	861,375		2	1,722,750	
Ireland	7	176,511	176,511	1	176,511	176,511
Japan	14	339,701	339,701	10	3,397,013	3,397,013
Kenya	18	20,782	20,782	2	41,564	41,564
Madagascar	19	2,087,434	2,087,434	5	10,437,170	10,437,170
Mauritania	20	53,312	53,312	2	106,624	106,624
Mauritus	45	321,039	321,039	10	3,210,390	3,210,390
Morocco	20	824,562	824,562	2	1,649,123	1,649,123
Mozambique	19	123,258	123,258	5	616,290	616,290
Namibia	23	1,111,735	1,111,735	7	7,782,145	7,782,145
New Zealand	36	48,230	617,808	8	385,836	1,901,053
	37	37,650		8	301,196	
	38	25,027		8	200,216	
	39	506,902		2	1,013,804	
Nigeria	22	103,772	103,772	ND	0	0
Norway	8	92,181	158,920	ND	0	0
	9	49,231		ND	0	
	10	17,508		ND	0	
Oman	17	375,295	375,295	2	750,590	750,590
Pakistan	17	41,255	41,255	2	82,509	82,509
Phillippines	14	564,725	564,725	8	4,517,798	4,517,798
Portugal	43	61,738	123,476	4	246,952	493,904
	44	61738		4	246,952	
Russia	1	48,608	430,369	ND	0	0
	3	52,488		ND	0	
	11	218,421		ND	0	
	12	75,397		ND	0	
	13	35,456		ND	0	
Senegal	20	69,924	106,650	2	139,848	139,848
	21	36,726		ND	0	
Seychelles	45	321,039	321,039	5	1,605,195	1,605,195
Sierra Leone	21	51,030	51,030	2	102,061	102,061
Somalia	18	242,676	242,676	2	485,352	485,352
SOPAC	39	224,115	324,192	ND	0	500,385
	40	79,365		5	396,825	
	41	20,712		5	103,560	
South Africa	19	123,258	184,863	5	616,290	1,109,130
	23	61,605		8	492,840	
Sri Lanka	15	768,758	768,758	ND	0	0
Suriname	25	89,110	89,110	3	267,329	267,329
Tanzania	18	55,681	55,681	2	111,362	111,362
Togo	22	15,566	15,566	ND	0	0
United Kingdom	7	243,679	243,679	1	243,679	243,679
United States	1	248,260	1,212,653	ND	0	8,999,262
	4	214,889		7	1,504,223	
	5	508,417		10	5,084,169	
USA (Guam)	14	241,087	241,087	10	2,410,870	
Uruguay	24	53,182	53,182	8	425,456	425,456
Venezuela	25	1,141	1,141	3	3,422	3,422
Zaire	23	13,431	13,431	1	13,431	13,431
Total			25,378,408			100,082,574

Table 3(c). Global distribution, concentration and abundance of elemental copper in nodules and crusts. Values obtained from averages for each ELCS, or portion of, potentially claimed by each coastal state.

Country	Area No.	Area (sq. km)	Total Area (sq. km)	Conc. Ni (kg/sq.m)	Total Ni (T) (tonnes)	Total Ni (T) for country
Angola	23	251,305	251,305	0.005	1,256,523	1,256,523
Antarctica	26	15,187	5,418,265	0.01	151,867	26,460,333
	27	1,235,520		0.01	12,355,196	
	28	1,113,819		0.005	5,569,096	
	29	1,376,905		ND	0	
	31	1,676,835		0.005	8,384,175	
Argentina	24	239,319	239,319	0.0075	1,794,893	1,794,893
Australia	32	250,116	728,342	0.01	2,501,163	5,347,823
	33	23,100		0.005	115,501	
	34	29,776		0.005	148,879	
	35	56,215		ND	0	
	36	48,230		ND	0	
	37	37,650		ND	0	
	38	25,027		ND	0	
	39	258,228		0.01	2,582,280	
Bangladesh	15	969,982	969,982	ND	0	0
Brazil	24	1,675,235	1,964,494	0.005	8,376,175	8,473,511
	25	240,591		ND	0	
	42	48,668		0.002	97,336	
Burma	15	46,203	46,203	ND	0	0
Canada	1	19,778	2,193,712	ND	0	8,722,893
	2	57,143		ND	0	
	4	872,289		0.01	8,722,893	
	5	1,244,502		ND	0	
Congo	23	14,652	14,652	0.005	73,260	73,260
Denmark	7	237,431	237,431	ND	0	0
Equitorial Guinea	22	15,566	15,566	ND	0	0
France	30	34,653	258,768	ND	0	4,482,295
	39	224,115		0.02	4,482,295	
French Guiana	25	140,980	140,980	ND	0	0
Gabon	23	136,752	136,752	0.002	273,504	273,504
Gambia	20	10,662	10,662	0.001	10,662	10,662
Ghana	22	25,943	25,943	ND	0	0
Greenland	5	103,312	103,312	ND	0	0
Guinea	21	27,897	27,897	0.001	27,897	27,897
Guinea Bissau	21	38,359	38,359	0.001	38,359	38,359
Guyana	25	61,003	61,003	0.001	61,003	61,003
Iceland	6	2,800	84,937	0.001	2,800	413,487
	7	82,137		0.005	410,687	
India	15	150,457	1,011,832	ND	0	4,306,875
	17	861,375		0.005	4,306,875	
Ireland	7	176,511	176,511	0.001	176,511	176,511
Japan	14	339,701	339,701	0.002	679,403	679,403
Kenya	18	20,782	20,782	0.0005	10,391	10,391
Madagascar	19	2,087,434	2,087,434	0.005	10,437,170	10,437,170
Mauritania	20	53,312	53,312	0.001	53,312	53,312

Country	Area No.	Area (sq. km)	Total Area (sq. km)	Conc. Ni (g/sq.m)	Total Ni (T) (tonnes)	Total Ni (T) for country
Mauritus	45	321,039	321,039	0.05	16,051,950	16,051,950
Morocco	20	824,562	824,562	0.001	824,562	824,562
Mozambique	19	123,258	123,258	0.005	616,290	616,290
Namibia	23	1,111,735	1,111,735	0.005	5,558,675	5,558,675
New Zealand	36	48,230	617,808	ND	0	5,319,293
	37	37,650		ND	0	
	38	25,027		0.01	250,270	
	39	506,902		0.01	5,069,022	
Nigeria	22	103,772	103,772	ND	0	0
Norway	8	92,181	158,920	ND	0	0
	9	49,231		ND	0	
	10	17,508		ND	0	
Oman	17	375,295	375,295	0.005	1,876,475	1,876,475
Pakistan	17	41,255	41,255	0.005	206,273	206,273
Phillippines	14	564,725	564,725	0.01	5,647,247	5,647,247
Portugal	43	61,738	123,476	0.001	61,738	123,476
	44	61738		0.001	61,738	
Russia	1	48,608	430,369	ND	0	0
	3	52,488		ND	0	
	11	218,421		ND	0	
	12	75,397		ND	0	
	13	35,456		ND	0	
Senegal	20	69,924	106,650	0.001	69,924	106,650
	21	36,726		0.001	36,726	
Seychelles	45	321,039	321,039	0.05	16,051,950	16,051,950
Sierra Leone	21	51,030	51,030	0.001	51,030	51,030
Somalia	18	242,676	242,676	0.001	242,676	242,676
SOPAC	39	224,115	324,192	ND	0	3,002,310
	40	79,365		0.03	2,380,950	
	41	20,712		0.03	621,360	
South Africa	19	123,258	184,863	0.005	616,290	924,315
	23	61,605		0.005	308,025	
Sri Lanka	15	768,758	768,758	ND	0	0
Suriname	25	89,110	89,110	0.001	89,110	89,110
Tanzania	18	55,681	55,681	0.001	55,681	55,681
Togo	22	15,566	15,566	ND	0	0
United Kingdom	7	243,679	243,679	0.001	243,679	243,679
United States	1	248,260	1,212,653	ND	0	12,186,013
	4	214,889		0.01	2,148,890	
	5	508,417		0.015	7,626,253	
USA (Guam)	14	241,087	241,087	0.01	2,410,870	
Uruguay	24	53,182	53,182	0.01	531,820	531,820
Venezuela	25	1,141	1,141	0.001	1,141	1,141
Zaire	23	13,431	13,431	0.005	67,155	67,155
Total			25,378,408			142,877,873

Table 3(d). Global distribution, concentration and abundance of elemental nickel in nodules and crusts. Values obtained from averages for each ELCS, or portion of, potentially claimed by each coastal state.

Country	Area No.	Area (sq. km)	Total Area (sq. km)	Conc. Co (mg/sq.m)	Total Co (T) (tonnes)	Total Co (T) for country
Angola	23	251,305	251,305	5	1,257	1,257
Antarctica	26	15,187	5,418,265	2	30	4,178
	27	1,235,520		2	2,471	
	28	1,113,819		ND	0	
	29	1,376,905		ND	0	
	31	1,676,835		1	1,677	
Argentina	24	239,319	239,319	4	957	957
Australia	32	250,116	728,342	1	250	720
	33	23,100		3	69	
	34	29,776		1	30	
	35	56,215		2	112	
	36	48,230		ND	0	
	37	37,650		ND	0	
	38	25,027		ND	0	
	39	258,228		1	258	
Bangladesh	15	969,982	969,982	ND	0	0
Brazil	24	1,675,235	1,964,494	3	5,026	5,412
	25	240,591		1	241	
	42	48,668		3	146	
Burma	15	46,203	46,203	ND	0	0
Canada	1	19,778	2,193,712	ND	0	1,745
	2	57,143		ND	0	
	4	872,289		2	1,745	
	5	1,244,502		ND	0	
Congo	23	14,652	14,652	1	15	15
Denmark	7	237,431	237,431	ND	0	0
Equitorial Guinea	22	15,566	15,566	ND	0	0
France	30	34,653	258,768	ND	0	2
	39	224,115		0.01	2	
French Guiana	25	140,980	140,980	2	282	282
Gabon	23	136,752	136,752	1	137	137
Gambia	20	10,662	10,662	2	21	21
Ghana	22	25,943	25,943	ND	0	0
Greenland	5	103,312	103,312	ND	0	0
Guinea	21	27,897	27,897	1	28	28
Guinea Bissau	21	38,359	38,359	1	38	38
Guyana	25	61,003	61,003	1	61	61
Iceland	6	2,800	84,937	2	6	88
	7	82,137		1	82	
India	15	150,457	1,011,832	ND	0	12,921
	17	861,375		15	12,921	
Ireland	7	176,511	176,511	1	177	177
Japan	14	339,701	339,701	8	2,718	2,718
Kenya	18	20,782	20,782	0.5	10	10
Madagascar	19	2,087,434	2,087,434	5	10,437	10,437
Mauritania	20	53,312	53,312	2	107	107

Country	Area No.	Area (sq. km)	Total Area (sq. km)	Conc. Co (mg/sq.m)	Total Co (T) (tonnes)	Total Co (T) for country
Mauritus	45	321,039	321,039	8	2,568	2,568
Morocco	20	824,562	824,562	2	1,649	1,649
Mozambique	19	123,258	123,258	5	616	616
Namibia	23	1,111,735	1,111,735	3	3,335	3,335
New Zealand	36	48,230	617,808	1	48	2,189
	37	37,650		1	38	
	38	25,027		3	75	
	39	506,902		4	2,028	
Nigeria	22	103,772	103,772	ND	0	0
Norway	8	92,181	158,920	ND	0	0
	9	49,231		ND	0	
	10	17,508		ND	0	
Oman	17	375,295	375,295	4	1,501	1,501
Pakistan	17	41,255	41,255	4	165	165
Phillippines	14	564,725	564,725	2	1,129	1,129
Portugal	43	61,738	123,476	2	123	185
	44	61738		1	62	
Russia	1	48,608	430,369	ND	0	0
	3	52,488		ND	0	
	11	218,421		ND	0	
	12	75,397		ND	0	
	13	35,456		ND	0	
Senegal	20	69,924	106,650	2	140	213
	21	36,726		2	73	
Seychelles	45	321,039	321,039	1	321	321
Sierra Leone	21	51,030	51,030	1	51	51
Somalia	18	242,676	242,676	2	485	485
SOPAC	39	224,115	324,192	ND	0	300
	40	79,365		3	238	
	41	20,712		3	62	
South Africa	19	123,258	184,863	2	247	370
	23	61,605		2	123	
Sri Lanka	15	768,758	768,758	ND	0	0
Suriname	25	89,110	89,110	1	89	89
Tanzania	18	55,681	55,681	1	56	56
Togo	22	15,566	15,566	ND	0	0
United Kingdom	7	243,679	243,679	1	244	244
United States	1	248,260	1,212,653	ND	0	5,409
	4	214,889		3	645	
	5	508,417		7	3,559	
USA (Guam)	14	241,087	241,087	5	1,205	
Uruguay	24	53,182	53,182	2	106	106
Venezuela	25	1,141	1,141	1	1	1
Zaire	23	13,431	13,431	1	13	13
Total			25,378,408			62,307

Table 3(e). Global distribution, concentration and abundance of elemental cobalt in nodules and crusts. Values obtained from averages for each ELCS, or portion of, potentially claimed by each coastal state.

India); 35.7 million tonnes of nickel (for Antarctica) to 2.2 million tonnes (for India); and 4458 tonnes of cobalt (for the USA) to 445 tonnes (for India). For the bottom ranked countries, with the lowest abundance of nodules and crusts present in their ELCS, the elemental resources range from: 2.7 million tonnes of manganese (for Mauritania) to 11,408 tonnes (for Venezuela); 0.18 million tonnes of copper (for Guyana) to less than 1,500 tonnes (for Zaire); 0.15 million tonnes of nickel (for Guyana) to 2,852 tonnes (for Venezuela); and 107 tonnes of cobalt (for Mauritania) to about 20 tonnes (for Gambia).

At the scale of this global study, it is not possible to determine specifically where resources contained in nodules and crusts occur at grades above or below economically viable cut-off limits (e.g. when considering recovery, transport and production costs against commodity prices). However, it may be useful to rank countries according to the average grade of manganese nodules and crusts in their ELCS. This does not give the maximum grade of occurrence (which may be as much as ten times greater), and hence is not an indication of exactly where the highest grades may occur.

It is useful to identify those ELCS areas where, on average, high grades are found and that may in future have selected locations exploited for manganese nodule and crust recovery. The top ten countries with the highest average grades of nodules and crusts (in tonnes per km^2) are: the Philippines, Japan and Guam (~2,000), the USA (~1,500), Madagascar, Mozambique, Argentina, Fiji (~1,000), and South Africa (~900). The Yemen, Pakistan, and Oman all have equal grades of ~750 tonnes per square kilometre. The Marshall Islands, Johnston Island (U.S.), Kiribati, the Federated States of Micronesia, and French Polynesia are the Pacific Island areas with probably the greatest manganese crust resources (Gross and McLeod, 1987; Kesler, 1994). However, at present, only the Marshall Islands EEZ has been most extensively studied.

It is generally considered that a cut-off limit for grades to be considered a viable resource is at 10 kg/m^2 (or 10,000 tonnes per km^2) (Mero, 1977). On this basis, there are no obviously viable resources within any of the ELCS areas, and hence, at a regions scale, all nodules and crusts in these regions must be considered para-marginal.

4.6 Marine hydrocarbon deposits

4.6.1 What marine hydrocarbon deposits comprise

Oil and natural gas are hydrocarbon deposits that occur naturally within thick sedimentary sequences. These are largely confined to the continental shelves, continental slopes, continental rises, and small ocean basins. Hydrocarbons provide the major part of the energy source for modern civilisation, providing power for heating, lighting, telecommunications, industrial and agricultural machines, as well as all forms of transport. It also forms the raw material for numerous products ranging from plastics to fertilisers.

4.6.2 How marine hydrocarbon deposits are formed

Hydrocarbons are formed over millions of years, mainly in marine sedimentary basins. These geologic environments contain strata comprising mineral and biochemical elements including, importantly, unoxidised organic matter. Over millions of years, the sedimentary sequences are subjected to high pressures and temperatures during burial. These conditions fractionate the unoxidised organic matter, forming liquid (oil) and gaseous hydrocarbons (natural gas). Oil may comprise between 50 to 90 percent hydrocarbons, with oxygen, nitrogen and sulphur in minor quantities.

Generally, large quantities of hydrocarbons can be formed only at depths within sedimentary sequences greater than 1,000 - 2,000 metres. Formation of exploitable reservoirs of hydrocarbons requires migration (from their source rocks), to geological traps comprising a porous reservoir rocks overlain by an impermeable horizon. Common geological traps for hydrocarbons include: shales, salt domes (evaporites), and anticlinal folds of permeable and non-permable rock layers. In addition to liquid hydrocarbons, natural gas is commonly formed in association with crude oil. However, because of its lower viscosity, gas is often found separate from oil reservoirs. Sedimentary sequences in excess of 1,000 m thick, in areas of high-heat flow, and comprising organic-rich layers at depth overlain by porous rocks that are in turn overlain by domed impermeable strata provide ideal environments for hydrocarbon formation and retention.

4.6.3 Where marine hydrocarbon deposits are found

Table 4 (with references to Figure 21) shows the "proved" reserves of oil and gas (in billions of barrels and trillions of cubic feet) in offshore fields around the world (Klett, 1997).

Province Number	Oil BB	Gas TCF	NGL BB	Total BBOE
1	1.6	6.6	0	2.7
2	<0.1	4.7	0	0.8
3	0.3	0.1	0	0.4
4	30.2	129.7	0.7	52.6
5	0.1	0	0	0.1

6	<0.1	0.9	0	0.1
7	<0.1	<0.1	0	<0.1
8	<0.1	<0.1	0	<0.1
9	0.1	0.2	<0.1	0.2
10	0.6	0.9	<0.1	0.8
11	0.7	1.4	<0.1	0.9
12	1.5	2	<0.1	1.9
13	<0.1	0.1	<0.1	<0.1
14	0.1	0.2	<0.1	0.2
15	10.1	6.2	<0.1	11.2
16	0.3	1.1	<0.1	0.5
17	3.3	3.6	<0.1	3.9
18	<0.1	0.1	<0.1	<0.1
19	0.1	3.3	0.1	0.7
20	<0.1	6	0	1
21	14.5	12.2	0.1	16.6
22	34.8	93.9	2.8	53.3
23	0.2	1.9	<0.1	0.6
24	<0.1	<0.1	0	<0.1
25	<0.1	<0.1	<0.1	<0.1
26	<0.1	0.1	0	<0.1
27	1.3	2	<0.1	1.6
28	2.7	15.7	0.7	6
29	0	0.1	0	<0.1
30	0	0.2	0	<0.1
31	0	70	0.1	11.8
32	0	8.1	0	1.4
33	<0.1	0.3	<0.1	0.1

34	0	0.1	0	<0.1
35	<0.1	0	0	<0.1
36	0	0.1	0	<0.1
37	0.1	1.4	<0.1	0.3
38	0.5	13.3	0.4	3.2
39	0	0.1	0	<0.1
40	0	<0.1	0	<0.1
41	<0.1	0	0	<0.1
42	<0.1	0.7	<0.1	0.1
43	<0.1	0.1	0	0.1
44	1.1	56.7	1	11.6
45	<0.1	18	0.2	3.2
46	0.7	25.6	0.9	5.9
47	0.1	10.3	0.1	2.5
48	<0.1	14.3	0.1	2.4
49	0.2	1.4	<0.1	0.4
50	0.1	0.4	<0.1	0.1
51	8.4	24.2	0.3	12.7
52	0.2	79.6	<0.1	3.5
53	<0.1	0	0	<0.1
54	8.4	1.8	0	0.3
55	0.2	0.1	<0.1	<0.1
56	<0.1	1.8	0	0.3

Offshore hydrocarbon provinces with identified reserves of oil, gas and natural gas liquid in billion barrels of oil equivilence.

These areas are almost exclusively on the continental shelves and contain sedimentary sequences greater than 1,000 m in thickness. Proved reserves are those that are currently available under present technology, and do not include those areas where favourable conditions for hydrocarbon formation and preservation occur. The location of fields ranges from the continental slopes of northern Alaska to Tierra del Fuego and from the South

China Sea to the Gulf of Mexico. With the exception of a small area off central western Africa, none of these areas lie within the ELCS regions.

According to the International Energy Agency (IEA, 1996): "The concentration of oil reserves and production is as pronounced in the offshore areas as onshore. The top ten offshore fields accounted for 25% of estimated 1995 world offshore production and the top 25 fields over 40%."

Table 5. World's twenty five largest off-shore producing oil fields* (in: thousand barrels per day), from: International Energy Agency, "Global Offshore Oil Prospects to 2000" 1996).

	Field	Country	Area	1995 Production	2000 Production	Expected Change
1	Safaniya-Khafji	Saudi Arabia/NZ	Persian Gulf	956	1210	254
2	Canterell	Mexico	North America	878	822	-56
3	Bern	Saudi Arabia	Persian Gulf	800	750	-50
4	Statfjord (+N. & E.)	Norway/UK	North Sea	634	255	-379
5	Oseberg (+W., E. & S.)	Norway	North Sea	499	496	-3
6	Upper Zakum	Abu Dhabi	Persian Gulf	485	500	15
7	Gullfaks (+W. & S. Satellites)	Norway	North Sea	484	270	-214
8	Tapis Area **	Malaysia	East Asia	329	427	98
9	Bombay High	India	Arabian Sea	320	275	-45
10	Zuluf	Saudi Arabia	Persian Gulf	300	250	-50
11	Abkatun	Mexico	Gulf of Mexico	285	280	-5

12	Ekofisk (+ satellites)	Norway	North Sea	279	221	-58
13	Rashid	Dubai	Persian Gulf	275	250	-25
14	Tia Juana	Venezuela	Lake Maracaibo	250	180	-70
15	Lower Zakum	Abu Dhabi	Persian Gulf	219	300	81
16	Umm Shaif	Abu Dhabi	Persian Gulf	199	180	-19
17	Snorre	Norway	North Sea	196	186	-10
18	Brent	United Kingdom	North Sea	187	165	-22
19	Bachaquero	Venezuela	Lake Maracaibo	185	155	-30
20	Abu Safah	Saudi Arabia	Persian Gulf	180	180	0
21	Scoff	United Kingdom	North Sea	180	140	-40
22	Takula	Angola	Gulf of Guinea	175	155	-20
23	Ku	Mexico	Gulf of Mexico	170	150	-20
24	Belayim	Egypt	Red Sea	168	134	-34
25	Salman/ABK	Iran/Abu Dhabi	Persian Gulf	161	155	6

*Based on average 1995 crude oil production figures.

** includes: Seligi, Guntong, Semangkok, Tinggi, Tiong, Pulai, Belkok, Irong, Barat, Palas, Tabu.

Table 5 (with reference to Figure 22), shows the current state of offshore hydrocarbons production. This is currently dominated by the Persian Gulf and the North Sea. Of the twenty five largest production fields, eight are in the Persian Gulf and eight others are in the North Sea. The remaining nine smaller ones are located in the Gulf of Mexico, East Asia, South Asia, South America, West Africa and North Africa. The IEA identify fifteen fields that produced in excess of 200 kb/d (thousand barrels of oil equivalent per day) in 1995. Another thirty fields are estimated to have had production levels of more than 100 kb/d.

Offshore oil supply growth is expected to come increasingly from areas outside the North Sea and the Persian. "By 2005, five fields, two off Brazil and one each in West African waters, the Gulf of Mexico and the Norwegian Sea, are expected to move into the top 25, and several other potential major producers off West Africa and in the deep-water Gulf of Mexico could be approaching similar production levels in the next decade" (IEA, 1996).

4.6.4 Resource potential of marine hydrocarbon deposits

According to the International Energy Agency (IEA, 1996), "world-wide offshore oil production in 1995 is estimated to have been 21.3 million barrels per day (mb/d) or just over 30% of total world supply of crude oil and natural gas, representing an increase of 3.9 mb/d versus 1990." The IEA also consider current offshore reserves "to be of the order of 200 billion barrels or about 20% of the world total. However, much of the undiscovered economically recoverable resource base is believed to lie offshore."

Much of the offshore hydrocarbon resource also lies within strata that does not allow production due to excessive water depth and/or difficulties in extraction. However, technological improvements in recovery efficiency and greater access to deep-water areas are increasing the range of economically recoverable resources offshore.

Thus the estimated proved reserves of oil world-wide at the beginning of the 21st Century is about one trillion barrels. Of this amount, about 252 billion barrels (25 per cent) are estimated to lie in sub-sea environments. Similarly, the total world-wide proved resources of natural gas is estimated as about 4,000 trillion cubic feet, of which about 26 percent are estimated to be sub-sea. However, these offshore resources may be as much as ten times larger, in which case they will provide the majority of future hydrocarbon production (IEA, 1996).

Here, we describe the offshore hydrocarbon resources that potentially lay within the ELCS areas of the world. The term "resource" is used here to include all the conventional hydrocarbons (oil and gas) that are in areas where conditions for hydrocarbon formation and accumulation are favourable. As with the term "resource" used elsewhere in this report, these are neither proved nor indicated, and their future exploitation is subject to exploration, discovery and prevailing economic conditions.

Reference to the global sediment thickness model (compiled by NGDC, based on work by Matthias et al., 1988; Ludwig and Houtz, 1979; Hayes and LaBrecque, 1991; Divins and Rabinowitz, 1991; Divins, D.L., and Eakins, in prep; and gridded on a 1° basis) shows that the continental margins contain the greatest thickness of sediment, of almost 20 km (Figure 5), and hence have the greatest potential for hydrocarbon reservoirs (Figure 23). The continental rises also contain considerable accumulations of sediment (often in excess of 1 km), and probably include organic-rich source rocks deposited when the proto-ocean basins were narrow and had restricted circulation (Rona, 1969; Schneider, 1969). The abyssal plains probably contain insufficient thickness of sediments (less than 1 km) to yield hydrocarbon accumulations. Parts of the deep trenches may be more favourable, as may some foundered remnants of continental blocks broken off during continental rifting.

Areas that contain wide continental shelves with sediment thickness in excess of 1 km (Figure 24), and hence are favourable for hydrocarbon deposits occur throughout the sub-arctic (north of 60°N) including the coasts of: Greenland, Norway, Alaska, northern Canada and Russia. In the Arctic Ocean, sedimentary thickness often exceed 4 km. Similarly, much of the continental margin of Antarctica also contains sediment in excess of 2 km thick. Elsewhere, favourable offshore conditions occur along the Atlantic seaboards of North, Central and South America (including Mexico, Trinidad-Tobago, Venezuela, Guyana, Surinam, French Guiana, Brazil, Uruguay, Argentina), western Europe and Africa, eastern Africa, the northern margin of the Indian Ocean, Indonesia and around Australia, New Zealand, off mainland China, Korea, Taiwan, and the Pacific seaboard of Russia (Sea of Okhotsk).

Small sub-sea basins that have thick sedimentary sequences and hence large petroleum resources include the Gulf of Mexico and the Caribbean Sea (2-6 km thickness), the Mediterranean Sea (up to 8 km), the Black Sea and Caspian Sea (4 km), the Bering Sea, the Sea of Okhotsk, the Sea of Japan, the South China Sea, and the seas within the Indonesian Archipelago (all 2-4 km) (Figure 24). However, several of these favourable areas have water depths of as much as 5,500 metres and extend 1,500 km or more from shore, making hydrocarbon production difficult.

Table 6 shows the coastal states with ELCS regions that coincide with offshore sedimentary sequences thickness in excess of 1 km. Against each state is the area of its ELCS (identified by number from Figure 7) and its percentage that contains sediment thickness greater than 1 km. Although this is not an assessment of the resource volume of hydrocarbons, the table serves to identify those coastal states with ELCS areas that have some hydrocarbon resource potential.

The top ten ranked countries, according to those with the greatest ELCS areas (cited in brackets by million km^2) containing sedimentary sequences in excess of 1 km thick and hence having potential hydrocarbon resources are: Antarctica (2.23), Canada (0.95),

Country	Area No.	Area (sq. km)	% area with >1 km sed thickness	Area with >1km sed thickness (sq. km)	Total area
Angola	23	251,305	65	163,348	163,348
Antarctica	26	15,187	0	0	2,133,702
	27	1,235,520	40	494,208	
	28	1,113,819	80	891,055	
	29	1,376,905	30	413,072	
	31	1,676,835	20	335,367	
Argentina	24	239,319	70	167,523	167,523
Australia	32	250,116	10	25,012	174,640
	33	23,100	20	4,620	
	34	29,776	0	0	
	35	56,215	98	55,090	
	36	48,230	0	0	
	37	37,650	0	0	
	38	25,027	0	0	
	39	102,675	80	82,140	
	39	155,553	5	7,778	
Bangladesh	15	969,982	100	969,982	969,982
Brazil	24	1,675,235	40	670,094	862,567
	25	240,591	80	192,473	
	42	48,668	0	0	
Burma	15	46,203	100	46,203	46,203
Canada	1	19,778	100	19,778	948,072
	2	57,143	100	57,143	
	4	872,289	0	0	
	5	1,244,502	70	871,151	
Congo	23	14,652	100	14,652	14,652
Denmark	7	237,431	55	130,587	130,587
Equitorial Guinea	22	15,566	100	15,566	15,566
France	30	34,653	0	0	112,057
	39	224,115	50	112,057	
French Guiana	25	140,980	70	98,686	98,686
Gabon	23	136,752	90	123,077	123,077
Gambia	20	10,662	0	0	0
Ghana	22	25,943	80	20,754	20,754
Greenland	5	103,312	50	51,656	51,656
Guinea	21	27,897	40	11,159	11,159
Guinea Bissau	21	38,359	65	24,933	24,933
Guyana	25	61,003	90	54,902	54,902
Iceland	6	2,800	0	0	53,389
	7	82,137	65	53,389	203,847
India	15	150,457	100	150,457	968,764
	17	861,375	95	818,306	880,085
Ireland	7	176,511	35	61,779	61,779
Japan	14	339,701	0	0	0
Kenya	18	20,782	100	20,782	20,782
Madagascar	19	2,087,434	30	626,230	626,230
Mauritania	20	2,962	100	53,312	53,312
	20	50,350	0	0	
Mauritus	45	321,039	0	0	0
Morocco	20	824,562	40	329,825	329,825
Mozambique	19	123,258	100	123,258	123,258
Namibia	23	1,111,735	25	277,934	277,934
New Zealand	36	48,230	0	0	228,106
	37	37,650	0	0	
	38	25,027	0	0	
	39	506,902	45	228,106	
Nigeria	22	103,772	100	103,772	103,772
Norway	8	92,181	50	46,090	68,522
	9	49,231	10	4,923	
	10	17,508	100	17,508	
Oman	17	375,295	100	375,295	375,295
Pakistan	17	41,255	100	41,255	41,255
Phillippines	14	564,725	0	0	0
Portugal	43	61,738	0	0	0
	44	61738	0	0	
Russia	1	48,608	98	47,636	408,124
	3	52,488	100	52,488	
	11	218,421	100	218,421	
	12	75,397	100	75,397	
	13	35,456	40	14,182	
Senegal	20	69,924	40	27,970	53,678
	21	36,726	70	25,708	
Seychelles	45	321,039	0	0	0
Sierra Leone	21	51,030	75	38,273	38,273
Somalia	18	242,676	100	242,676	242,676
SOPAC	39	224,115	45	100,852	100,852
	40	79,365	0	0	
	41	20,712	0	0	
South Africa	19	96,515	75	72,386	108,537
	19	26,743	20	5,349	
	23	61,605	50	30,803	
Sri Lanka	15	768,758	85	653,445	653,445
Suriname	25	89,110	55	49,010	49,010
Tanzania	18	55,681	100	55,681	55,681
Togo	22	15,566	100	15,566	15,566
United Kingdom	7	243,679	35	85,288	85,288
United States	1	248,260	98	243,295	751,711
	4	214,889	0	0	
	5	508,417	100	508,417	
USA (Guam)	14	241,087	0	0	0
Uruguay	24	53,182	100	53,182	53,182
Venezuela	25	1,141	100	1,141	1,141
Zaire	23	13,431	100	13,431	13,431
Total		25,137,321			13,170,814

Table 6: Global distribution of marine sedimentsgreater than 1km thick.
Values obtained from averages for each ELCS, or portion of, potentiall claimed by each coastal state.

Brazil (0.95), USA (0.75), Sri Lanka (0.65), India (0.58), Argentina (0.52), Madagascar (0.49), Russia (0.41) and Morocco (0.33). The bottom ranked countries are: Kenya (0.02), Sierra Leone (0.02), the Congo Republic (0.015), Zaire (0.013), Guinea (0.012), Bangladesh (0.005), Mauritania (0.003), Equatorial Guinea, Tonga and Venezuela (each with ~0.001).

In their report (Ranking Of The World's Oil And Gas Provinces By Known Petroleum Volumes), Klett et al., (1997), identify hydrocarbon resources for forty-one offshore provinces that contain known reserve volumes. These areas are shown on Figure 21 in green and listed on Table 4, which also show their oil and gas volume potentials. Although none of these provinces coincide with the ELCS regions, their proximity to those regions, accumulated thickness of sediment, and the basement type are combined to indicate hydrocarbon potential from high to low (Figure 25).

On the basis of known hydrocarbon volume reserve, the top ten ranked offshore provinces identified by Klett et al. (1997) are identified in Table 7 below (by province number – referred to on Figure 21, and billion barrels oil equivalence (BBOE) of oil and gas). Also identified are the ELCS regions (by number, referred to on Figure 7) and their coastal states, that lie closest to each of the USGS identified hydrocarbon provinces. The top ten ranked provinces are given in Table 7.

Table 7 gives an indication of the relationship between known reserve volumes and the adjacent ELCS regions where there is significant hydrocarbon potential. A qualitative indication of resource potential, and hence a qualitative ranking of ELCS regions and their coastal states, can be made by comparing the known reserve province against the location of those countries with significant sedimentary sequence thickness. However, it does not indicate the estimated resource volume.

The hydrocarbon resource potential, based on sediment thickness, crustal age and basement type is shown on Figure 25. High resource potential that coincides with ELCS regions are found throughout the Atlantic seaboard of North and South America (including the Labrador Sea); Antarctica; northern and western Norway; south and west of the United Kingdom and Ireland; parts of north-west Africa; south-west Africa, south-east Africa and East of the Horn of Africa; South of Pakistan; East and West of India; South of Tasmania (Australia); North of New Zealand and East of Australia; the Sea of Okhotsk; and the Alaskan Arctic seaboard. In all of these areas, conventional hydrocarbon resources are considerable and of high potential value.

Table 7. The top ten ranked offshore provinces ranked according to their combined oil and gas reserves in BBOE (billion barrels of oil equivalence).

USGS Province	Location	ELCS	BBOE	Coastal State(s)
22	(Central west Africa)	22	53.3	Togo Equatorial Guinea Gabon Ghana
4	(N.E. Venezuela)	25	52.6	Venezuela Suriname Guyana French Guiana Brazil
21	(West Africa)	23	16.6	Angola Congo Gabon
51	(Indus Fan)	17	12.7	India Pakistan
31	(Barents Sea)	10	11.8	Norway
44	(N.W. Australia)	32	11.6	Australia
15	(Amazon Fan)	24	11.2	Brazil
28	(N.E. Atlantic)	8	6	Norway
46	(Indonesia)	16	5.9	Indonesia
17	(Argentina)	24	3.9	Argentina

In many of the ELCS areas identified as having hydrocarbon resource potential, the seafloor lies beyond 500 m depth and 200 nautical miles from shore. In high latitudes there is both seasonal and permanent ice shelf cover. For these reasons, hydrocarbon resources in the ELCS regions are mostly sub-marginal to para-marginal. What can not be indicated or predicted is the size of individual oil fields, or whether sedimentary sequences that have a high potential for hydrocarbon resources have adequate geological traps. However, there is considerable potential for exploitation in the future when technology and economic conditions make exploration, proving, and ultimately exploiting of these resources viable.

4.7 Marine gas hydrate deposits

4.7.1 What marine gas hydrate deposits comprise

Gas hydrates occur widely in nature mainly beneath the seafloor in deep-sea sediments but also close to the seabed in shallow arctic seas. This is because the compound is stabilised by a pressure – temperature relationship. In water depths greater than 300 m it can form at temperatures well above freezing and cement loose sediments into a hard layer several hundred metres thick before natural processes provide that rigidity.

Gas hydrate is a crystalline compound composed of gas molecules, normally methane (Kvenvolden, 1993), en-caged within water molecules to form a solid similar to ice. It forms within the sediment spaces cementing the grains together. This dramatically changes the physical properties of the sediment. One volume of hydrate also stores 164 volumes of un-pressurised methane – a measure of the value of the resource.

The methane in gas hydrate forms naturally by organic decay in the thick sediments normally found in the deep water adjacent to continental margins. The deep-sea pressures (> 500 m depth) and intra sediment temperatures (increasing with depth) determine the gas hydrate stability. At depth in the sediment the temperature becomes too high for hydrate to be stable and the abrupt change of physical properties inherent with free gas in the sediment pore spaces generates a seismic reflect – the Bottom Simulating Reflector (BSR).

BSRs have been used to identify gas hydrate on seismic reflection profiles for some time. They are a useful way to identify the presence of hydrate, although other seismic characteristics also occur. The BSR at the base of the hydrate stability zone is to date poorly mapped world-wide (Max, 1990; Lee et al, 1994; Miles, 1995).

Gas hydrates are currently considered as hydrocarbon resources. They are also being exploited as methane reserves by Japan. Whether the methane in the hydrate or the free gas beneath the hydrate is targeted, they represent up to 10 times the fuel value of current conventional hydrocarbon reserves. (Gornitz & Fung, 1994). The distribution of potential gas hydrate resources continues to drive national research strategies as evidenced by the new US$ 27M USA initiative, and current research programmes in India and Japan.

4.7.2 How marine gas hydrate deposits are formed

Gas hydrates form and accumulate where marine sediments contain suitable and sufficient dissolved gas and where the geothermal (sub-surface temperature gradient) conditions are within the stability field of the hydrate. The source of the dissolved gas is from the breakdown of organic matter trapped within the sediment. Therefore, the un-oxidsed organic carbon content of the sediment is a significant factor in determining the potential for gas generation.

The methane hydrate pressure (depth) - temperature stability field (Figure 26) shows that these conditions may be met at water depths greater than about 500m on the continental slope (dependant on bottom water temperature) reaching some depth beneath the deep seafloor (determined by the geothermal gradient). The introduction of higher molecular-weight gases (ethane or propane) to the methane allows hydrate gas mixture to form at lower pressures and therefore to be stable in shallower water or at higher temperature (Kvenvolden, 1993). However, the presence of salts in pore water shifts the gas hydrate phase boundary to the left and decreases the gas hydrate stability area, requiring deeper and or colder conditions for formation and accumulation in marine environments.

4.7.3 Where marine gas hydrate deposits are found

Figure 27 shows the world wide locations of all known gas hydrates (Max, 1990; Lee et al., 1994; Kesler, 1994). However, this does not include the world wide occurrence of BSRs, for which seismic data are not compiled. The figure also shows the areas where water depths range from 500 to 4000 m on seafloor that is older than 30 Ma. These depths are appropriate for gas hydrate formation and the age of the underlying oceanic lithosphere is such that heat flow, based on plate cooling models, is expected to be low enough for hydrate stability (Miles, 1995).

Known hydrates are found on the Atlantic and Pacific margins of both North and South America, especially at equatorial latitudes. They are also found around off the coast of Canada, Alaska, off the west coast of Norway, the Black Sea and off the coast of Pakistan. Isolated occurrences are also found off New Zealand and Antarctica.

Production of gas from hydrate fields are currently limited to Japan and Russia. The Messoyakha field is a continental gas field in the permafrost region of Western Siberia (Krason and Finley, 1992). Because of the permafrost conditions, and low temperature gradient in the subsurface, part of this shallow gas reservoir is believed to be in the gas hydrate stability zone (Makogon, 1971). During the mid-1970s, over two million cubic metres of gas per day were produced (Makogon, 1984, 1988). Although on land, the Messoyakha field serves as an example of production from a gas hydrate reservoir that will be useful in developing future offshore technologies for gas hydrate exploitation. In Japan, gas hydrates are being exploited from the Nankai Trough, but as yet little information about this activity is available in the public domain.

4.7.4 Resource potential of marine gas hydrate deposits

BSRs indicate only the presence of a gas hydrate layer and not the total volume of hydrate or the volume of free gas in the sediment beneath the layer. It is not possible, yet, to estimate the potential resource that gas hydrates offer with any certainty. Instead, it is only possible to estimate the areas where conditions for hydrate formation are favourable (Kvenvolden et al., 1993 and others – see below). Table 8 below shows a compilation of current estimates for global methane gas and carbon resources in oceanic and continental settings. Although considerable uncertainty exists about the total gas resource potential of hydrates, it is clear that the oceanic potential is far greater than the continental one.

The know locations of gas hydrates is very likely to underestimate the total world wide occurrence. From considerations of the stability condition for hydrate, it is likely to occur everywhere that the seafloor exceeds 500 m (or 300 m in high latitudes), and where there is a source of unoxidised organic carbon in marine sediments. The greater the thickness of marine sediments, the greater the likelihood of there being suitable source material for the production of biogenic methane (the key fuel element in gas hydrates).

Figure 28 shows the location of areas favourable for gas hydrate formation, and hence with potential for hydrate resources. These areas lie in water depths greater than 500 m, on crust less than 30 Ma old and include data on sediment thickness. Areas with relatively high gas hydrate potential are coloured red, and those with low potential are coloured blue. These are relative indications of hydrate potential and are not indicative of actual known or indicated volumes. Areas where sediment thickness data are missing, but lie below 500 m and on crust more than 30 Ma old are coloured green. These regions lie in high northern latitudes, where bottom water temperatures are low. Thus they probably also have high gas hydrate potential, with possible hydrate resources at the seafloor.

Table 8. Estimates of methane gas and methane carbon resource contained in continental and marine gas hydrate accumulations (modified from Kvenvolden, 1993, by Prensky, 1995).

Methane Gas $M^3 x 10^{15}$	**Methane Gas** Tcf x 10^5	**Methane Carbon** Kg x 10^{15}	**Reference**
Oceanic Sediments			
3.1	1.1	1.7	McIver (1981)
5 - 25	1.8 - 8.8	2.7 - 13.7	Trofimuk et al (1977)
7600	2700	4100	Dobrynin et al (1981)
17.6	6.2	11	Kyenvolden (1988)
19.5	6.9	11	MacDonald (1990)
26.4 - 139.1	9.3 - 49.1		Gornitz and Fung (1994)
Continental Sediments			
0.014	0.005	7.5	Meyer (1981)
0.057	0.011	17	McIver (1981)
0.057	0.02	31	Trofimuk et al (1977)
34	12	1800	Dobrynin et al (1981)
-	-	400	MacDonald (1990)

The areas identified on Figure 28 as having high gas hydrate potential coincide with those localities where gas hydrates have been found already. Elsewhere, high potential exists in the Arctic and Antarctic, Bearing Sea, Barents Sea, Labrador Sea, eastern margin of North and South America, the African margin, Mediterranean Sea, Black Sea, off Pakistan and eastern India, north-west Australia, south-west New Zealand and the Sea of Okhotsk, Japan and the western European Margin. The ELCS (extended legal continental shelf) regions that coincide with these areas of high gas hydrate potential are ranked, from high to low, on Table 9 below.

Elsewhere, the potential for gas hydrate formation is probably negligible as a resource, although much research is needed to establish the occurrence of BSRs or other indicators of hydrate presence.

Table 9. ELCS regions that coincide with areas of high gas hydrate potential, ranked from high to low potential.

ELCS Region	Location	Hydrate Potential	Coastal States
1	ArcticOcean	High	Canada Russia USA
2	Arctic Ocean	High	Canada
9	North-East Atlantic	High	Norway
10	Barents Sea	High	Norway
15	Bay of Bengal	High	Burma India Sri Lanka
13	Sea of Okhotsk	High	Russia
12	Bering Sea	High	Russia
18	Arabian Sea	High	Kenya Somalia Tanzania
5	North-West Atlantic	Moderate	USA Canada Greenland
24 (southern)	South-West Atlantic	Moderate	Argentina
27 & 28	Southern Ocean	Moderate	Antarctica
7(east)	North-East Atlantic	Low	United Kingdom Iceland
23 (centra)l	West Africa	Low	Namibia Angola
19	Southern Madagascar	Low	Madagascar Mozambique South Africa
35	Southern Tasmania	Low	Australia

39	Tasman Sea	Low	Australia New Zealand France (New Caledonia)

Exploitation of gas hydrates has potential hazards, since the stability of hydrates has been implicated in the stability history of continental slopes. Any activity that may uncontrollably destabilise gas hydrate layers through changes of pressure and temperature must be viewed with caution until the technology for safe exploitation of hydrates is in place. Until such technologies are developed, all gas hydrate resources must be considered sub-marginal.

5 Conclusions

This report examines the non-living resource potential within the extended legal continental shelf (ELCS). These areas lie beyond the 200 nautical mile jurisdiction of nation states' exclusive economic zones, and their outer limits are defined by the criteria established by the United Nations Convention on the Law of the Sea, Article 76.

The offshore non-living resource potentials described in this report are based on a statistical evaluation of known occurrences and reserves, the geologic environments favourable for their formation, models for sediment type and thickness, and basement composition. The result is an assessment of the potential for non-living resources to occur.

Eight different types of non-living resource are assessed. These all occur on the seafloor. Table 10 gives a summary of these resources, their quantity, and estimated value (exclusive of recovery and production costs) for the nation states that have potential claim to ELCS regions.

Placer deposits comprising heavy minerals, gold and diamonds are limited to near-shore areas and have negligible resource potential in the ELCS regions. Similarly, phosphorites occur in the equatorial oceans, mainly between 400 m and 1,500 m depth, but have limited resource potential in ELCS areas. Evaporite deposits occur on many continental margins. However, they only overlap with ELCS regions off eastern North America and western central Africa, where their resource potential is low. Polymetallic sulphides (PMS) are formed at active plate boundaries. With the exception of the West Pacific and off the western coast of North America, PMS resources are low in the ELCS regions.

The major resource potential within the ELCS regions is held in iron-manganese nodules and crusts, oil, gas and gas hydrates. Four elemental metals are the main components of value in manganese nodules and crusts: manganese, copper, nickel and cobalt. World-wide, the total value of these metals within the ELCS regions is: US$ 4,534,487 millions of manganese; US$ 196,677 millions of copper; US$ 1,131,278 millions of nickel, and US$ 690 millions of cobalt. Conventional oil and gas comprise an estimated US$ 2,984,800 millions with a similar estimated value of US$ 3,085,600 millions for gas hydrates. In total, the resource potential (excluding recovery and production costs) contained within the ELCS regions of the world amounts to an estimated US$ 11, 934 trillions.

Country	Area (sq. km)	palcer deposits	phosphorite deposits	evaporite deposits	polymetallic deposits	total Mn nodules for country (tonnes)	nodules + crusts max av. grade (tonnes/sq. km)	total Mn metal for country (tonnes)	value millions US$ metal (LME) US$2,000/mtu	value millions US$ ore (USGS) US$2.4/mtu	Total Cu for country (tonnes)	value millions US$ metal (LME) US$1,739/mtu	Total Ni for country (tonnes)	value millions US$ metal (LME) US$9,298/mtu	Total Cobalt for country (tonnes)	value millions US$ metal (LME) US$25.24/kg	oil & gas (BBOE)	value millions US$ per BOE (OGJ) US$28/brl	gas hydrates (BBOE)	value millions US$ per BOE (OGJ) US$28/brl
Angola	251,305	ND	ND	ND	ND	62,826,138	250	12,565,228	25,130	30	753,914	1,311	1,256,523	11,683	1,257	32	0.1	2,800	0.1	2,800
Antarctica	5,418,265	ND	ND	ND	ND	1,484,701,297	680	156,216,951	312,434	375	21,338,635	37,108	26,460,333	246,028	4,178	105	20	560,000	30	840,000
Argentina	239,319	ND	P	ND	ND	239,319,000	1,000	59,829,750	119,660	144	2,871,828	4,994	1,794,893	16,689	957	24	6	168,000	9	252,000
Australia	728,342	ND	P	P	ND	363,262,670	1,000	51,642,810	103,286	124	2,639,762	4,591	5,347,823	49,724	720	18	1	28,000	1	28,000
Bangladesh	969,982	ND	ND	ND	ND	0	ND	0	0	0	0	0	0	0	0	0	1	28,000	ND	0
Brazil	1,964,494	ND	P	ND	ND	922,099,185	500	181,986,440	363,973	437	14,512,996	25,238	8,473,511	78,787	5,412	137	10	280,000	ND	0
Burma	46,203	ND	ND	ND	ND	0	ND	0	0	0	0	0	0	0	0	0	2	56,000	4	112,000
Canada	2,193,712	ND	ND	ND	ND	436,144,640	500	130,843,392	261,687	314	4,797,591	8,343	8,722,893	81,105	1,745	44	3	84,000	10	280,000
Congo	14,652	ND	ND	ND	ND	3,663,000	250	732,600	1,465	2	29,304	51	73,260	681	15	0	0.1	2,800	ND	0
Denmark	237,431	ND	ND	ND	ND	0	ND	0	0	0	0	0	0	0	0	0	1.5	42,000	ND	0
Equitorial Guinea	15,566	ND	ND	ND	ND	0	ND	0	0	0	0	0	0	0	0	0	1	28,000	ND	0
France	258,768	ND	ND	ND	ND	336,172,110	1,500	11,205,737	22,411	27	1,120,574	1,949	4,482,295	41,676	2	0	ND	0	0	1,400
French Guiana	140,980	ND	ND	ND	ND	35,244,915	250	1,409,797	2,820	3	422,939	735	0	0	282	7	0.1	2,800	ND	0
Gabon	136,752	ND	ND	ND	ND	34,188,000	250	6,837,600	13,675	16	273,504	476	273,504	2,543	137	3	1	28,000	ND	0
Gambia	10,662	ND	ND	P	ND	2,665,582	250	533,116	1,066	1	21,325	37	10,662	99	21	1	0.1	2,800	ND	0
Ghana	25,943	ND	ND	ND	ND	0	ND	0	0	0	0	0	0	0	0	0	8	224,000	ND	0
Greenland	103,312	ND	ND	ND	ND	0	ND	0	0	0	0	0	0	0	0	0	0.5	14,000	1	21,000
Guinea	27,897	ND	ND	ND	ND	1,394,871	50	278,974	558	1	55,795	97	27,897	259	28	1	0.05	1,400	ND	0
Guinea Bissau	38,359	ND	ND	ND	ND	1,917,947	50	383,589	767	1	76,718	133	38,359	357	38	1	0.05	1,400	ND	0
Guyana	61,003	ND	ND	ND	ND	15,250,628	250	6,100,251	12,201	15	183,008	318	61,003	567	61	2	0.1	2,800	ND	0
Iceland	84,937	ND	ND	ND	ND	23,334,315	1,000	4,386,865	8,774	11	93,337	162	413,487	3,845	88	2	ND	0	0	1,400
India	1,011,832	ND	ND	ND	ND	646,031,250	750	86,137,500	172,275	207	1,722,750	2,996	4,306,875	40,045	12,921	326	2	56,000	4	112,000
Ireland	176,511	ND	ND	ND	ND	17,651,100	100	3,530,220	7,060	8	176,511	307	176,511	1,641	177	4	3	84,000	2	56,000
Japan	339,701	ND	ND	ND	ND	679,402,580	2,000	67,940,258	135,881	163	3,397,013	5,907	679,403	6,317	2,718	69	ND	0	2	42,000
Kenya	20,782	ND	ND	ND	ND	10,390,995	500	1,039,100	2,078	2	41,564	72	10,391	97	10	3	0.3	8,400	1	28,000
Madagascar	2,087,434	ND	ND	ND	ND	2,087,434,000	1,000	417,486,800	834,974	1,002	10,437,170	18,150	10,437,170	97,045	10,437	263	0.5	14,000	1	14,000
Mauritania	53,312	ND	ND	P	ND	13,328,000	250	2,665,600	5,331	6	106,624	185	53,312	496	107	3	0.1	2,800	ND	0
Mauritius	321,039	ND	ND	ND	ND	481,558,500	1,500	128,415,600	256,831	308	3,210,390	5,583	16,051,950	149,251	2,568	65	0.1	2,800	0	1,400
Morocco	824,562	ND	ND	ND	ND	206,140,415	250	41,228,083	82,456	99	1,649,123	2,868	824,562	7,667	1,649	42	0.1	2,800	ND	0
Mozambique	123,258	ND	ND	ND	ND	123,258,000	1,000	24,651,600	49,303	59	616,290	1,072	616,290	5,730	616	16	0.5	14,000	1	14,000
Namibia	1,111,735	ND	ND	ND	ND	277,933,750	250	55,586,750	111,174	133	7,782,145	13,533	5,558,675	51,685	3,335	84	0.05	1,400	0	1,400
New Zealand	617,808	ND	ND	ND	ND	321,417,670	1,000	82,831,991	165,664	199	1,901,053	3,306	5,319,293	49,459	2,189	55	0.2	5,600	ND	0
Nigeria	103,772	ND	ND	ND	ND	0	ND	0	0	0	0	0	0	0	0	0	1	28,000	1	28,000
Norway	158,920	ND	ND	ND	ND	0	ND	0	0	0	0	0	0	0	0	0	2	56,000	4	112,000
Oman	375,295	ND	ND	ND	ND	281,471,250	750	37,529,500	75,059	90	750,590	1,305	1,876,475	17,447	1,501	38	2	56,000	ND	ND
Pakistan	41,255	ND	ND	ND	ND	30,940,905	750	4,125,454	8,251	10	82,509	143	206,273	1,918	165	4	0.5	14,000	ND	ND
Phillippines	564,725	ND	ND	ND	ND	1,129,449,420	2,000	112,944,942	225,890	271	4,517,798	7,856	5,647,247	52,508	1,129	29	0	0	ND	ND
Portugal	123,476	ND	ND	ND	P	123,476,000	1,000	12,347,600	24,695	30	493,904	859	123,476	1,148	185	5	0	0	0	0
Russia	430,369	ND	ND	ND	ND	0	ND	0	0	0	0	0	0	0	0	0	10	280,000	15	420,000
Senegal	106,650	ND	ND	P	ND	19,317,290	250	5,332,490	10,665	13	139,848	243	106,650	992	213	5	0.05	1,400	ND	ND
Seychelles	321,039	ND	ND	ND	ND	80,259,750	250	16,051,950	32,104	39	1,605,195	2,791	16,051,950	149,251	321	8	0.1	2,800	0	1,400
Sierra Leone	51,030	ND	ND	ND	ND	2,551,518	50	510,304	1,021	1	102,061	177	51,030	474	51	1	0.05	1,400	ND	ND
Somalia	242,676	ND	ND	ND	ND	121,337,985	500	12,133,799	24,268	29	485,352	844	242,676	2,256	485	12	1.5	42,000	3	84,000
SOPAC	324,192	ND	ND	ND	ND	100,077,000	1,000	15,011,550	30,023	36	500,385	870	3,002,310	27,915	300	8	0.1	2,800	0	1,400
South Africa	184,863	ND	ND	ND	ND	138,659,250	1,000	27,731,850	55,464	67	1,109,130	1,929	924,315	8,594	370	9	0.2	5,600	0	5,600
Sri Lanka	768,758	ND	ND	ND	ND	0	ND	0	0	0	0	0	0	0	0	0	0.25	7,000	1	14,000
Suriname	89,110	ND	ND	ND	ND	22,277,450	250	1,782,196	3,564	4	267,329	465	89,110	829	89	2	5	140,000	ND	ND
Tanzania	55,681	ND	ND	ND	ND	27,840,520	500	2,784,052	5,568	7	111,362	194	55,681	518	56	1	2.5	70,000	5	140,000
Togo	15,566	ND	ND	ND	ND	0	ND	0	0	0	0	0	0	0	0	0	1	28,000	ND	ND
United Kingdom	243,679	ND	ND	ND	ND	60,919,750	250	12,183,950	24,368	29	243,679	424	243,679	2,266	244	6	1.5	42,000	2	42,000
United States	1,212,653	ND	ND	ND	ND	1,860,660,625	2,500	182,134,120	364,268	437	8,999,262	15,650	12,186,013	113,306	5,409	137	10	280,000	20	560,000
USA (Guam)	241,087	ND	ND	ND	ND	482,174,120	2,000	48,217,400	96,435	116	2,410,871	0	2,410,871	22,416	1,205	0	0.01	280	ND	ND
Uruguay	53,182	ND	ND	ND	ND	26,591,000	500	5,318,200	10,636	13	425,456	740	531,820	4,945	106	3	0.5	14,000	ND	ND
Venezuela	1,141	ND	ND	ND	ND	285,208	250	11,408	23	0	3,422	6	1,141	11	1	0	5	140,000	ND	ND
Zaire	13,431	ND	ND	ND	ND	3,357,750	250	671,550	1,343	2	13,431	23	67,155	624	13	0	0.2	5,600	ND	ND
totals	**25,378,408**	**0**	**0**	**0**	**0**	**13,338,377,346**		**2,033,288,915**	**4,066,578**	**4,880**	**102,493,445**	**174,044**	**145,288,744**	**1,350,895**	**63,512**	**1,575**	**106**	**2,965,480**	**115**	**3,215,800**

TOTAL VALUE (June 2000)
(millions US$)
11,774,372

mtu = million tonnes
BOE = billion barrels of oil equivalent
LME = London metal Exchange
OGJ = Oil and Gas journal

Table 10. Summary of offshore resources in extended legal continental shelf (ECLS) areas and their commodity values at current (June 2000) prices. Prices are quoted from: (LME) London Metal Exchange, (USGS) United States Geological Survey and the (OGJ) Oil and Gas Journal. Prices for gas hydrates are based on conventional oil and gas prices at a barrel equivilence.

The value of the non-living resources in the ELCS regions depends on the technological developments that will allow their extraction and production. Because of this, with perhaps the exception of conventional gas and oil, and possibly gas hydrates, many resources on the ELCS will remain uncompetitive with onshore resources.

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http://www.mme.gov/omm/pacific/currentfacts.htm
http://www.mme.gov/alaska/lease/hlease/PLANMAP.HTM
http://www.hdr.com.au/Maurit.htm
http://www.hdr.com.au/Gayane.htm
http://www.hdr.com.au/Gabon.htm
http://www.bligh.com/au/html/exploration/images/new zealand interests.html
http://www.mbendi.co.za/cymzcy.htm
http://www.mbendi/co.za/cysncy.htm
http://www.mbendi.co.za/cysacy.htm
http://www.mbendi.co.za/cyaf.htm
http://www.abare.gov.au/research/minerals.html
http://www.agso.gov.au/marine/
http://www.dme.nt.gov.au/dmemain/Petroleum/facts.html
http://www.dme.wa.gov.au/minpetrol/petind.html
http://www.mbendi.co.za/cytaus.htm
http://www.gobi.co.uk/NaturalGas.HTML

Placer Deposits

http://www.mmaj.go.jp/mmaj_e/services.html
http://www.abare.gov.au/research/minerals.html
http://www.caledonian-pacific.com/pacificmap.cfm
http://www.ugs.state.ut.us/gseabst5.htm
http://www.uct.ac.za/depts/geolsci/mindep.html
http://www.economicdevelopment.gov.yk.ca/resource investment opportunities/Mining/Yukon

Placer/Mining History.asp
http://www.mbendi.co.za/indy/ming/mingsa04.htm#Marine
http://www.mbendi.co.za/a sndmsg/doc list.asp?P=0&C=1&M=0&R=0
http://www.mbendi.co.za/indy/ming/mingsare.htm
http://www.mbendi.co.za/indy/ming/mingsa01.htm
http://www.mbendi.co.za/indy/ming/mingwrc2.htm
http://www.www.geoscience.org.za/marine/diamond-.htm
http://www.ifremer.fr/drogm/Realisation/Miner/Placer/index.html

Phosporite Deposits

http://wwwserver.cup.cam.ac.uk/Scripts/webbook.asp?isbn=0521333709

Evaporite Deposits

http://www.blacksci.co.uk/../~cgukuv/bookpage.bin?File=5789

Polymetallic Sulphides

http://opal.geology.utoronto.ca/marinelab/research/seafldep.html
http://opal.geology.utoronto.ca/marinelab/research/feoxide.html
http://opal.geology.utoronto.ca/marinelab/research/pmetals.html
http://opal.geology.utoronto.ca/marinelab/research/plumes.html1#PLUMES
http://opal.geology.utoronto.ca/marinelab/intro/index.html
http://opal.geology.utoronto.ca/marinelab/research/index.html

Manganese Nodules and Crusts

http://www.gobi.co.uk/manganese market.HTML
http://roskill.co.uk/mangan.html
http://web.rgu.ac.uk/schools/egrg/mn.html
http://www.soc.soton.ac.uk/SUDO/PHYSICS/amt295/phd/litrev/chem/klinkhammer+85.noindex.html
http://www.ifremer.fr/drogm/Realisation/Miner/Nod/index.html

Gas Hydrate Deposits

http;//www.marine.ie/datacentre/projects/ENAM/BulletinBoard/gashyd.html-ssi
http://earthsky.com/1998/es980108.html
http://marine.usgs.gov/fact-sheet/gas-hydrate/title.html
http://ocean.tamu.edu/Quarterdeck/QD5.3/sassen.html
http://pangea.stanford.edu/~helgerud/gashydrates.html
http://www.aist.go.jp/GSJ/dMG/hydrate/hydrate.resources.html
http://www.ngdc.noaa.gov/

http://www.ngdc.noaa.gov:80/mgg/fliers/92mgg05.html
http://www.offshore-technology.com

General

http://www,mining-journal.com/GREENLAND/index.htm
http://www,mining-journal.com/MOZAMBIQUE/index.htm
http://www,mining-journal.com/GUINEA/index.htm
http://www.billiton.com/newsite/html/investor/aboutus/WhereAreWe.htm
http://www.infomine.com/countries/canada.html
http://www.infomine.com/countries//brazil.html
http://www.infomine.com/countries/australia.html
http://www.infomine.com/countries/africa.html
http://www.infomine.com/countries/russia.html
http://mbendi.co.za/cyaf.html
http://mbendi.co.za/cycocy.htm
http://mbendi.co.za/cycancy.htm#basic
http://mbendi.co.za/cymocy.htm
http://mbendi.co.za/indy/ming/mingafpj.htm
http://mbendi.co.za/afresnet/view mz/index.htm
http://www.bullion.org.za
http://www.un.org/Depts/los/tempclcs/docs/clcs/CLCS 11.htm
http://www.mgdc.noaa.gov/mgg/geology/mmdb/
http://www.ngdc.noaa.gov/mgg/imms/imms.HTML

7

Appendix 1

Summary Sheets for Non-Living Resources on the ELCS for each coastal state

Country	*Angola*	**Area of ELCS(km^2)** **Area of EEZ**	251,304 605,738	**Maritime Claims**	economic zone 200nm , territorial sea 12nm

Location Neighbours	Africa, Namibia and Congo	**Natural resources**	petroleum, diamonds, iron ore, phosphates, copper, feldspar, gold, bauxite
Population	10,145,267		
Coastline	1,600 km	**Law of the sea status**	signed but not ratified
Area (land)	1,246,700 sq km		

ECCS claim based on:	
Prolongation of continental land mass	-
Foot of slope over 60nm	y
1 % of sediment thickness	y
Potential deltaic sediments	y
Other (eg mid-ocean ridge activity)	-

Data sources

1) GEBCO http://www.ndgc/noaa.gov/mgg/gebco/
2) CIA http://www.cia.gov/cia/publications/factbook/
3) NGDC http://www.ndgc.noaa.gov/
4) ETOPO5 http:www.ndgc.noaa.gov/mgg/global/seltopo.html
5) http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/km2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	62,826,138	0.25		n	none	none	none
Mn metal	y	12,565,228		25,130				none
Cu metal	y	753,914		1,311				none
Ni metal	y	1,256,522		11,683				none
Co metal	y	1,257		32				none
Hydrocarbon (oil/gas) potential	y	0.1 BBOE	high	2800	n	exploration	exploration	exploitation
Gas Hydrate pot.	y	0.1 BBOE	high	2800	n	n	11	exploration

Comments

Extensive deltaic and deep-sea fan sediments give high hydrocarbon potential.

Country	*Antarctica*	Area of ELCS (km^2) Area of EEZ	5418265 n/a	Maritime Claims	None, research-based land claims by Argentina Australia Chile France New Zealand Norway & UK
Location Neighbours	Antarctic circle			**Natural land resources**	None presently exploited. Iron ore chromium, copper, gold, nickel, platinum, coal and hydrocarbons
Population	(4,000) summer (1,000) winter				
Coastline	17,968 km			**Law of the sea status**	
Area (sq km)	14,000,000 (280,000 ice free)				

ELCS potentially claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope plus 60nm	y	2)	GEBCO http://ww.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	y	3)	NGDC http://www.ndgc.noaa.gov/
Potential deltaic sediments	y	4)	CIA http://www.cia/publications/factbook/
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m2)	Potential Value (m$US)	Current Exploitation (Y/N)	5yr Exploitation Outlook	10yr Exploitation Outlook	25yr Exploitation Outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	899,640,942	0.273		n	none	none	none
Mn metal	y	330,809,982		312,434	n			
Cu metal	y	28256376		37108	n			
Ni metal	y	1,256,522		246,028	n			
Co metal	y	2471		105	n			
Hydrocarbon (oil/gas)	y	20 BBOE		560,000	n	none	none	none
Gas Hydrate	y	30 BBOE		840,000	n	none	none	none

Comments

Area subject to Antarctic Treaty (23 June 1961); Convention on the Conservation of Antarctic Marine Living Resources (20 May 1980); Convention on the Regulation of Antarctic Mineral Resources Activities (2 June 1988)

Country	Argentina	Area of ELCS (km^2) Area of EEZ	239319 1,164,485	Maritime Claims	contiguous zone 24nm, exclusive economic zone 200nm, territorial zone 12nm

Location	South America
Neighbours	Chile & Uruguay
Population	36,955,182
Coastline	4,989 km
Area (sq km)	2,736,690 (land) 30,200 (water)
Natural resources (land)	lead, zinc, tin, copper, iron ore, manganese, petroleum, uranium
Law of the sea status	Ratified 1 December 1995

ELCS claim potentially based on:

Prolongation of continental land mass	y
Foot of slope over 60nm	y
1 % of sediment thickness	N/A
Potential deltaic sediments	-
Other (eg mid-ocean ridge activity)	-

Data sources

1) ETOPO5 bathymetry http://www.ndgc.noaa.gov/mgg/global/seltopo.html
2) GEBCO bathymetry http://www.ndgc.noaa.gov/mgg/gebco/
3) NGDC http://www.ndgc.noaa.gov/
4) CIA http://www.cia.gov/cia/publications/factbook
5) http://www.ndgc.noaa.gov/mgg/sedthick

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	y	Unknown	Unknown	Unknown	n	n	n	n
Evaporites	n							
Polymetalic Sulfide	n							
Manganese Nodules + Crusts	y	239,319,234	1		n	none	exploration	exploration
Mn metal	y	59829804		119,660	n			
Cu metal	y	2,871,831		4,994	n			
Ni metal	y	1,794,894		16,689	n			
Co metal	y	957		24	n			
Hydrocarbon (oil/gas)	y	6 BBOE		168,000	y (but not in ELCS)	exploration	exploitation	exploitation
Gas Hydrate	y	9 BBOE		252,000	n	none	exploration	exploration

Comments

Country	*Australia*	**Area of ELCS (km^2)** **Area of EEZ**	728,341 6,359,220	**Maritime Claims**	contiguous zone 24nm, exclusive economic zone 200nm, territorial sea 12nm
Location **Neighbours**	between Indian and Pacific oceans, south of Indonesia	**Natural resources (land)**			bauxite, coal, iron ore, copper, tin, silver, uranium, nickel, tungsten, mineral sands, lead, zinc, diamonds, petroleum & natural gas
Population	19,169,083				
Coastline	25,760 km				
Area (sq km)	7,617,930 (land) 68,920 (water)	**Law of the sea status**			Ratified 5 October 1994

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 bathymetry http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO bathymetry http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www.ndgc.noaa.gov/
Potential deltaic sediments	-	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n				y (not from ELCS)			
Phosphorite	y	unknown		unknown	n	n	n	n
Evaporites	y	unknown		unknown	n	n	n	n
Polymetalic Sulfide	n				n			
Manganese Nodules + Crusts	y	363,262,485	0.499		n	none	exploration	exploration
Mn metal	y	51,642,792		103,286	n			
Cu metal	y	3,527,009		6,133	n			
Ni metal	y	5,347,819		49,724	n			
Co metal	y	720		18	n			
Hydrocarbon (oil/gas)	y	1 BBOE		28,000	y (not from ELCS)	exploration	exploitation	exploitation
Gas Hydrate	y	1 BBOE		28,000	y (not from ELCS)	exploration	exploration	exploration

Comments

Country	*Bangladesh*	**Area of ELCS (km^2)** **Area of EEZ**	969,982 76,832	**Maritime Claims**	contiguous zone 18nm, exclusive economic zone 200nm, territorial sea 12nm

Location **Neighbours**	Bay of Bengal between India and Burma	**Natural resources:**	natural gas
Population	129,194,224		
Coastline	580 km	**Law of the sea status:**	signed but not ratified
Area (sq km)	133,910 (land) 10,090 (water)		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	-	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	?	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	y	3)	NGDC http://www.ndgc.noaa.gov/
Potential deltaic sediments	y	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov.mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity tonnes	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetalic Sulfide	n							
Manganese Nodules + Crusts	n							
Mn metal	n							
Cu metal	n							
Ni metal	n							
Co metal	n							
Hydrocarbon (oil/gas)	y	1 BBOE		28,000	n	n	exploration	exploration
Gas Hydrate	n						exploration	exploration

Comments

Country	*Brazil*	**Area of ELCS (km^2)** **Area of EEZ**	1,964,493 3,169,320	**Maritime claims**	contiguous zone 24nm, exclusive economic zone 200nm, territorial sea 12nm

Location	South America	**Natural resources (land)**	bauxite, gold, iron ore, manganese, nickel, phosphates, platinum, tin, uranium, petroleum
Neighbours	French Guiana & Uruguay		
Population	172,860,370		
Coastline	7,491 km	**Law of the sea status**	Ratified 22 December 1986
Area (sq km)	8,456,510 (land) 55,455 (water)		

ELCS claim based on:	
Prolongation of continental land mass	-
Foot of slope over 60nm	?
1 % of sediment thickness	y
Potential deltaic sediments	y
Other (eg mid-ocean ridge activity)	-

Data sources

1) ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
2) GFBCO http://www.ndgc.noaa.gov.mgg/gebco/
3) NGDC nttp://www.ndgc.noaa.gov/
4) CIA http://www.cia.gov/cia/publications/factbook/
5) http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n				y (not from ELCS)			
Phosphorite	y	unknown			n	none	none	none
Evaporites	n							
Polymetalic Sulfide	n							
Manganese Nodules + Crusts	y	922,099,000	0.469			none	none	exploration
Mn metal	y	182,000,000		363,973	n			
Cu metal	y	14,513,000		25,238	n			
Ni metal	y	8,473,000		78,787	n			
Co metal	y	5,412		137	n			
Hydrocarbon (oil/gas)	y	10 BBOE		280,000	y (From edge of ECLS)	exploration	exploitation	exploitation
Gas Hydrate	n					none	exploration	exploration

Comments

Expect gas hydrate exploration within next 10 years, despite not being predicted. This is due to the extensive conventional oil and gas resources, for which exploration is currently active. Gas hydrate exploration will be concurrent with oil and gas exploration.

Country	*Burma*	**Area of ELCS (km2)** **Area of EEZ**	46,203 230,000	**Maritime Claims**	contiguous zone 24nm, exclusive economic zone 200nm, territorial sea 12nm

Location and Neighbours	Bay of Bengal SE Asia, Bangladesh & Thailand	**Natural resources**	petroleum, tin, antimony, zinc, copper, tungsten, lead, coal, precious stones, natural gas
Population	41 734 853		
Coastline	1930 km	**Law of the sea status**	party to
Area (sq km)	657 740 (land) 20 760 (water)		

ELCS claim based on:		**Data sources**
Prolongation of continental land mass	y	1) ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2) GFBCO http://www.ndgc.noaa.gov.mgg/gebco/
1 % of sediment thickness	-	3) NGDC nttp://www.ndgc.noaa.gov/
Potential deltaic sediments	-	4) CIA http://www.cia.gov/cia/publications/factbook/
Other (eg mid-ocean ridge activity)	-	5) http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity	Grade	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetalic Sulfide	n							
Manganese Nodules + Crusts	n				n	none	none	exploration
Mn metal	n							
Cu metal	n							
Ni metal	n							
Co metal	n							
Hydrocarbon (oil/gas)	y	2 BBOE		56,000	y (From edge of ECLS)	exploration	exploitation	exploitation
Gas Hydrate	y	4 BBOE		112,000	n	none	exploration	exploration

Comments

Expect gas hydrate exploration within next 10 years, despite not being predicted. This is due to the extensive conventional oil and gas resources, for which exploration is currently active. Gas hydrate exploration will be concurrent with oil and gas exploration.

Country	*Canada*	**Area of ELCS (km^2)** **Area of EEZ**	2,173,936 2,939,510	**Maritime Claims**	contiguous zone 24nm, exclusive economic zone 200nm, territorial sea 12nm

Location . Neighbours	North America	USA	**Natural resources**	iron ore, nickel, zinc, copper, gold, lead, molybdenum, potash, silver, coal, petroleum, natural gas
Population	31,281,092			
Coastline	243,791km		**Law of the sea status**	signed but not ratified
Area (sq km)	9,220,970(land) 755,170(water)			

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	EPOPO5http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N	3)	NGDC http://www.ndgc.noaa.gov/mgg/gebco/
Potential deltaic sediments	-	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.cia.gov/cia/publications/factbook

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetalic Sulfide	n							
Manganese Nodules + Crusts	y	463,145,000	0.201		n	none	none	exploration
Mn metal	y	130,843,000		261,687	n			
Cu metal	y	4,798,000		8,343	n			
Ni metal	y	8,723,000		81,105	n			
Co metal	y	1,745		44	n			
Hydrocarbon (oil/gas)	y	3 BBOE		84,000	n	exploration	exploitation	exploitation
Gas Hydrate	y	10 BBOE		280,000	n	exploration	exploration	exploration

Comments

Country	*Congo*	**Area of ELCS** **Area of EEZ (km2)**	14,652 24,696	**Maritime Claims**	territorial sea 200 nm
Location **Neighbours**	West Africa and Gabon, Angola			**Natural resources (land)**	petroleum, potash, lead, zinc, uranium, copper, phosphates, natural gas
Population	2,830,961				
Coastline	169 km			**Law of the sea status**	signed but not ratified
Area (sq km)	341,500 (land) 500 (water)				

ELCS claim based on:	
Prolongation of continental land mass	-
Foot of slope over 60nm	-
1 % of sediment thickness	y
Potential deltaic sediments	y
Other (eg mid-ocean ridge activity)	-

Data sources

1) ETOPO5http:// www.ndgc.noaa.gov/mgg/global/seltopo.html
2) GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
3) NGDC http://www.ndgc.noaa.gov/
4) CIA http://www.cia.gov/cia/publications/factbook
5) http:// www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetalic Sulfide	n							
Manganese Nodules + Crusts	y	3,663,000	0.25		n	none	none	none
Mn metal	y	733,000		1,465	n			
Cu metal	y	293,000		51	n			
Ni metal	y	73,200		681	n			
Co metal	y	15		<1	n			
Hydrocarbon (oil/gas)	y	0.1 BBOE		2,800	n	none	exploration	exploration
Gas Hydrate	n							

Comments

Country	Denmark	Area of ELCS (km^2) Area of EEZ	237,431 322,994	Maritime Claims	contiguous zone 24nm, exclusive economic zone 200nm, territorial sea 12nm

Location	Europe	**Natural resources (land+offshore)**	petroleum and natural gas
Neighbours	Germany Sweden Norway		
Population	5,336,394		
Coastline	7,314 km	**Law of the sea status**	signed but not ratified
Area (sq km)	44,796 land) 8431 (water)		

ELCS claim based on:

Prolongation of continental land mass	y
Foot of slope over 60nm	y
1 % of sediment thickness	-
Potential deltaic sediments	-
Other (eg mid-ocean ridge activity)	-

Data sources

1) ETOPO5http:// www.ndgc.noaa.gov/mgg/global/seltopo.html
2) GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
3) NGDC http:// www. ndgc.noaa.gov/
4) CIA http://www.cia.gov/cia/publications/factbook
5) http:// www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity	Grade	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetalic Sulfide	n							
Manganese Nodules + Crusts	n							
Mn metal								
Cu metal								
Ni metal								
Co metal								
Hydrocarbon (oil/gas)	y	1.5 BBOE		42,000	n	exploration	exploration	exploitation
Gas Hydrate	n				n			

Comments

Includes Faroe Islands

Country	*Equitorial Guinea*	Area of ELCS Area of EEZ (km2)	15,566 283,318	Maritime Claims	economic zone 200 nm, territorial sea 12 nm (boundary disputes with Cameroon, Nigeria and Gabon)

Location Neighbours	West Africa Cameroon and Gabon	**Natural resources (land)**	oil, petroleum, manganese, uranium, gold (small unexploited deposits)
Population	474 ,214		
Coastline	296 km	**Law of the sea status**	Ratified 21 July 1997
Area (sq km)	28,051 (land)		

ELCS claim based on:		Data sources	
Prolongation of continental land mass	y	1)	ETOPO5 http:// www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	CIA http://www.cia.gov/cia/publications/factbook
1 % of sediment thickness	N/A	3)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
Potential deltaic sediments	y	4)	NGDC http:// www. ndgc.noaa.gov
Other (eg mid-ocean ridge activity)	-	5)	http:// www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	n							
Mn metal	n							
Cu metal	n							
Ni metal	n							
Co metal	n							
Hydrocarbon (oil/gas)	y	1 BBOE		28,000	y	None	exploration	exploration
Gas Hydrate	n							

Comments

Country	*France*	**Area of ELCS** **Area of EEZ (km²)**	258,768 7,077,000	**Maritime Claims**	contiguous zone 24nm, exclusive economic zone 200nm, territorial sea 12 nm

Location **Neighbours**	(For mainland) Europe Spain Italy Belgium UK	**Natural resources**	coal, iron ore, bauxite, zinc, potash
Population	(59,329,691)		
Coastline	(3,427 km)	**Law of the sea status**	Ratified 11 April 1996
Area (sq km)	(545,630 (land) 1,400 (water))		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
Foot of slope over 60nm	y	2)	CIA http://www.cia.gov/cia/publications/factbook
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	-	4)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (Tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetalic Sulfide	n							
Manganese Nodules + Crusts	y	336,172,000	1.3		n	none	exploration	exploration
Mn metal	y	11,206,000		22,411	n			
Cu metal	y	1,120,000		1,949	n			
Ni metal	y	4,482,000		41,676	n			
Co metal	y	2		<1	n			
Hydrocarbon (oil/gas)	n							
Gas Hydrate	y	0.05 BBOE			n	none	exploration	exploration

Comments

Resources includes dependencies of: Guadeloupe, Martinique, New Caledonia, French Polynesia, Amsterdam/St. Paul, Bassas da India, Clipperton, Crozet, Europa Is., Glorioso, Juande Nova, Kerguelen, Mayotte, Reunion, St. Barthelemy, St Martin, St. Piere an Miguelon, Tromelin, Wallis and Futuna.

Country	*French Guiana*	**Area of ELCS** **Area of EEZ (km^2)**	140,980 126,000	**Maritime Claims**	exclusive economic zone 200nm, territorial sea 12nm

Location Neighbours	South America, Suriname and Brazil	**Natural resources (land)**	bauxite, gold (widely scattered) cinnabar, kaolin
Population	172,000		
Coastline	378 km	**Law of the sea status**	Ratified (French dependency) 11 April 1996
Area (sq km)	89,150 (land) 1,850 (water)		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http:// www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http:// www. ndgc.noaa.gov/
Potential deltaic sediments	y	4)	CIA http://www.cia.gov/cia/publications/factbook/
Other (eg mid-ocean ridge activity)	-	5)	http:// www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetalic Sulfide	n							
Manganese Nodules + Crusts	y	35,245,000	1.3		n	none	exploration	exploration
Mn metal	n	1,410,000		2,820				
Cu metal	y	423,000		735	n			
Ni metal	n							
Co metal	y	282		7	n			
Hydrocarbon (oil/gas)	y	0.1 BBOE		2,800	n	none	exploration	exploration
Gas Hydrate	n							

Comments

Overseas Department of France

Country	*Gabon*	**Area of ELCS** **Area of EEZ (km^2)**	136,752 213,689	**Maritime Claims**	contiguous zone 24nm, exclusive economic zone 200nm, territorial sea 12nm

Location	West Africa Equatorial	**Natural resources**	Petroleum, manganese, uranium, gold, iron ore
Neighbours	Guinea, Congo		
Population	1,208,536		
Coastline	885 km	**Law of the sea status**	Ratified 11 March 1998
Area (sq km)	257,667 (land) 10,000 (water)		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http:// www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	-	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http:// www. ndgc.noaa.gov/
Potential deltaic sediments	y	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http:// www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetalic Sulfide	n							
Manganese Nodules + Crusts	y	34,188,000	0.25		n	none	none	exploration
Mn metal	y	6,838,000		13,700	n			
Cu metal	n	273,500		476	n			
Ni metal	y	273,500		2,543	n			
Co metal	n	137		3	n			
Hydrocarbon (oil/gas)	y	1 BBOE		28,000	y	exploitation	exploitation	exploitation
Gas Hydrate	n							

Comments

Country	The Gambia	Area of ELCS Area of EEZ (km^2)	10,662 19,551	Maritime Claims	contiguous zone 18nm, exclusive fishing zone 200nm, territorial sea 12nm

Location	West Africa	**Natural resources**	
Neighbours	Senegal		
Population	1,367,124		
Coastline	80 km	**Law of the sea status**	Ratified 22 May 1984
Area (sq km)	10,000 (land) 1,300 (water)		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y*	1)	ETOPO5 http:// www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http:// www. ndgc.noaa.gov/
Potential deltaic sediments	y	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http:// www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	y	unknown			n	n	n	n
Polymetalic Sulfide	n							
Manganese Nodules + Crusts	y	2,666,000	0.25		n	none	none	exploration
Mn metal	y	533,116		1,066	n			
Cu metal	y	21.325		37	n			
Ni metal	y				n			
Co metal	y	10,663		99	n			
Hydrocarbon (oil/gas)	y	21		1	n			
Gas Hydrate	n	0.1 BBOE		2,800	n	none	exploration	exploration

Comments

* - Integral claim with Senegal

Country	*Ghana*	**Area of ELCS**	25,943	**Maritime Claims**	contiguous zone 24nm, exclusive economic zone 200nm, territorial sea 12nm
		Area of EEZ (km^2)	218,148		

Location Neighbours	West Africa Togo and Cote D'Ivoire	**Natural resources**	gold, diamonds (industrial) bauxite, manganese
Population	19,533,560		
Coastline	539 km	**Law of the sea status**	Ratified 7 June 1983
Area (sq km)	230,020 (land) 8,520 (water)		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http:// www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	-	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http:// www. ndgc.noaa.gov/
Potential deltaic sediments	y	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http:// www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetalic Sulfide	n							
Manganese Nodules + Crusts	n							
Mn metal	n							
Cu metal	n							
Ni metal	n							
Co metal	n							
Hydrocarbon (oil/gas)	y	2 BBOE		224,000	y	exploration	exploration	exploitation
Gas Hydrate	n							

Comments

Country	*Greenland*	**Area of ELCS** **Area of EEZ (km^2)**	103,312 2,244,500	**Maritime Claims**	exclusive fishing zone 200nm, territorial sea 3nm
Location and Neighbours	Northern North America NE of Canada			**Natural resources**	zinc, lead, iron ore, coal, molybdenum, gold, platinum, uranium
Population	56,309				
Coastline	44,087 km			**Law of the sea status**	unknown (likely same as Denmark)
Area (sq km)	341700 (ice free) 1833900 (ice covered)				

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
Foot of slope over 60nm	y	2)	CIA http://www.cia.gov/cia/publications/factbook
1 % of sediment thickness	N/A	3)	NGDC http:// www. ndgc.noaa.gov/
Potential deltaic sediments	?	4)	ETOPO5 http:// www.ndgc.noaa.gov/mgg/global/seltopo.html
Other (eg mid-ocean ridge activity)	-	5)	http:// www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade ((kg/m2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetalic Sulfide	n							
Manganese Nodules + Crusts	n							
Mn metal	n							
Cu metal	n							
Ni metal	n							
Co metal	n							
Hydrocarbon (oil/gas)	y	0.5 BBOE		14,000	n	none	exploration	exploration
Gas Hydrate	y	0.75 BBOE		21,000	n		exploration	exploration

Comments

Country	Guam	Area of ELCS of EEZ (km^2)	Area	241,087 176,500	Maritime Claims	exclusive economic zone 200nm, territorial sea 12nm

Location Neighbours	North Pacific	**Natural resources**
Population	154,623	
Coastline	125 km	**Law of the sea status**
Area (sq km)	541 km	*N.B - Territory of the USA*

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	-	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	-	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	-	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	-	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	y	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetalic Sulfide	n							
Manganese Nodules + Crusts	y	482,174,000	2		n	none	exploration	exploration
Mn metal	y	48,217,000		96,500	n			
Cu metal	y	2,411,000		4,193	n			
Ni metal	y	2,411,000		22,416	n			
Co metal	y	1,205		30	n			
Hydrocarbon (oil/gas)	n							
Gas Hydrate	n							

Comments

Dependency of the USA

Country	*Guinea-Bissau*	**Area of ELCS** **Area of EEZ (km^2)**	38,359 16,807	**Maritime Claims**	exclusive economic zone 200nm, territorial sea 12nm

Location **Neighbours**	West Africa Guinea and Senegal	**Natural resources**	bauxite, petroleum (unexploited)
Population	1,285,715		
Coastline	350 km	**Law of the sea status**	Ratified 25 August 1996
Area (sq km)	28,000 (land) 8,120 (water)		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	y	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	1,918,000	0.05		n	none	none	none
Mn metal	y	383,600		767	n			
Cu metal	y	76,700		133	n			
Ni metal	y	38,500		357	n			
Co metal	y	38		1	n			
Hydrocarbon (oil/gas)	y	0.05 BBOE		1,400		none	none	exploration
Gas Hydrate	n							

Comments

Country	*Guinea*	**Area of ELCS** **Area of EEZ (km^2)**	27,897 71,000	**Maritime Claims**	exclusive economic zone 200nm, territorial sea 12nm
Location	**Neighbours**	West Africa Guinea Bissau, Sierra Leone		**Natural resources**	bauxite, iron ore, diamonds, gold, uranium,
Population		7,466,200			
Coastline		320 km		**Law of the sea status**	Ratified 6 September 1985
Area (land)		245,857 sq km			

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc/noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	y	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	1,395,000	0.05		n	none	none	none
Mn metal	y	279,000		558	n	none	none	none
Cu metal	y	55,800		97	n	none	none	none
Ni metal	y	27,900		260	n	none	none	none
Co metal	y	28		1	n	none	none	none
Hydrocarbon (oil/gas)	y	0.05 BBOE		1,400	n	none	none	exploration
Gas Hydrate	n							

Comments

Country	*Guyana*	Area of ELCS EEZ (km^2)	Area of	61,003 130,300	Maritime Claims	exclusive fishing zone 200nm, territorial sea 12nm

Location Neighbours	South America Suriname and Venezuela	**Natural resources**	bauxite, gold, diamonds
Population	697,286		
Coastline	459 km	**Law of the sea status**	Ratified 16 November 1993
Area (sq km)	196,850 (land) 18,120 (water)		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	y	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value ($US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide								
Manganese Nodules + Crusts	y	15,250,000	0.25		n	none	none	none
Mn metal	y	6,100,000		12,200	n			
Cu metal	y	183,000		318	n			
Ni metal	y	61,000		567	n			
Co metal	y	61		2	n			
Hydrocarbon (oil/gas)	y	0.1 BBOE		2,800	n	none	none	none
Gas Hydrate	n							

Comments

Country	*Iceland*	**Area of ELCS** **Area of EEZ (km^2)**	84,937 867,100	**Maritime Claims**	exclusive economic zone 200nm, territorial sea 12nm

Location Neighbours	Between Greenland sea and Atlantic Ocean	**Natural resources**	diatomite
Population	276,365		
Coastline	4,988 km	**Law of the sea status**	Ratified 21 June 1985
Area (sq km)	100,250 (land) 2,750 (water)		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	-	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	y	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity	Grade	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	23,334,000	0.275					
Mn metal	y	4,387,000		8,774	n	none	none	none
Cu metal	y	93,337		162	n			
Ni metal	y	413,487		3,845	n			
Co metal	n	88		2				
Hydrocarbon (oil/gas)	n							
Gas Hydrate	y	0.05 BBOE		1,400	n	none	none	none

Comments

Extensive claims north and south along Mid Atlantic Ridge. Although no Polymetallic sulphides yet discovered, nor any evidence for hydrothermal activity in water deeper than 300m, hydrothermal PMS may be present. Exploration unlikely since Iceland has extensive hydrothermal activity and geothermal resources on land.

Country	*India*	**Area of ELCS Area of EEZ (km^2)**	1011812 2,015,500	**Maritime Claims**	contiguous zone 24nm, exclusive economic zone 200 nm, territorial sea 12nm
Location Neighbours	Asia, Burma and Pakistan			**Natural resources**	coal, iron ore, manganese, mica, bauxite, titanium ore, chromite, natural gas, diamonds, petroleum
Population	1,014,003,817				
Coastline	7,000 km			**Law of the sea status**	Ratified 29 June 1995
Area (sq km)	2,973,190(land) 314,400(water)				

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	y	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Grade (kg/m2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n				y (not from ELCS)			
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules +	y	646,031,000	0.638		exploration	exploration	exploration	exploitation
Mn metal	y	86,137,000		172,275	n			
Cu metal	y	1,723,000		2,996	n			
Ni metal	y	4,307,000		40,045	n			
Co metal	y	12,921		326	n			
Hydrocarbon (oil/gas)	y	2 BBOE		56,000	y (not from ELCS)	exploration	exploitation	exploitation
Gas Hydrate	y	4 BBOE		112,000	n	exploration	exploration	exploitation

Comments

Government of India has committed extensive resources to manganese nodule exploration already. Expected to continue with view to supplying some of her Mn, Cu and Ni industrial needs in next 25 years.

Country	*Indonesia*	**Area of ELCS (km^2)**	0	**Maritime Claims**	exclusive economic zone 200nm, territorial sea 12nm
Location Neighbours	SE Asia. Malaysia, Papua New Guinea, Australia			**Natural resources**	petroleum, tin, natural gas, nickel, bauxite, copper, coal, gold, silver
Population	224,784,210				
Coastline	45,716 km			**Law of the sea status**	Ratified 3 February 1986
Area (sq km)	1,826,440 (land) 93,000 (water)				

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5
Foot of slope over 60nm	y	2)	GEBCO
1 % of sediment thickness	N/A	3)	NGDC
Potential deltaic sediments	-	4)	CIA
Other (eg mid-ocean ridge activity)	?	5)	

Mineral Resource	Present (Y/N)	Quantity	Grade	Potential Value ($US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n				y (not from ELCS)			
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y				n			
Mn metal	n							
Cu metal	y				n			
Ni metal	n							
Co metal	n							
Hydrocarbon (oil/gas)	y				y (not from ECLS)			
Gas Hydrate	n							

Comments

ECLS claim potentially zero due to deep water trench within the southern limit of Indonesian EEZ

Country	*Ireland*	**Area of ELCS Area of EEZ (km^2)**	176511 380,300	**Maritime Claims**	exclusive fishing zone 200nm, territorial sea 12nm

Location Neighbours	Europe ~85% island west of UK	**Natural resources**	zinc, lead, natural gas, barite, copper, gypsum, silver
Population	3,797,257		
Coastline	1,448 km	**Law of the sea status**	Ratified 21 June 1996
Area (sq km)	68,890 (land) 1,390 (water)		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	-	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts		17,650,000	0.01		y (not in ELCS)	none	none	none
Mn metal		3,530,000		7,060				
Cu metal		176,500		307				
Ni metal		176,500		1,641				
Co metal		171		4				
Hydrocarbon (oil/gas)	y	3 BBOE		84,000	n	exploration	exploitation	exploitation
Gas Hydrate	y	2 BBOE		56,000	n	exploration	exploration	exploration

Comments

Conventional oil and gas exploration currently underway.

Country	*Japan*	**Area of ELCS** **Area of EEZ (km²)**	339,701 3,862,180	**Maritime Claims**	exclusive economic zone 200nm, territorial sea 12nm (3-12nm in international straits)
Location Neighbours	East Asia, China Russia N & S Korea		**Natural resources**	negligible mineral resources	
Population	126,549,976				
Coastline	29,751 km		**Law of the sea status**	Ratified 20 June 1996	
Area (sq km)	374,744 (land) 3,091 (water)				

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	-	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity	Grade	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n				y (not from ELCS)			
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	679,403,000	2		n	none	exploration	exploration
Mn metal	y	67,940,000		135,881	n			
Cu metal	y	3,397,000		5,907	n			
Ni metal	y	679,400		6,317	n			
Co metal	y	2,718		69	n			
Hydrocarbon (oil/gas)	n							
Gas Hydrate	y	1.5 BBOE		42,000	y (exploration)	exploration	exploitation	exploitation

Comments

The government of Japan already has an active gas hydrate exploration programme. With no conventional oil and gas resources, Japan is likely to use its advanced technological base to exploit gas hydrate energy resources, to support her industry, within the next 10 to 25 years.

Country	*Kenya*	**Area of ELCS Area of EEZ (km^2)**	20782 118,300	**Maritime Claims**	exclusive economic zone 200nm, territorial sea 12nm
Location Neighbours	East Africa and Tanzania	Somalia		**Natural resources**	gold, salt, barites, rubies, fluorspar, garnets
Population	30,339,770				
Coastline	536 km			**Law of the sea status**	Ratified 2 March 1989
Area (sq km)	569,250 (land) 13,400 (water)				

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	-	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	-	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	y	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	10,391,000	0.5		n	none	none	none
Mn metal	y	1,039,000		2,078	n			
Cu metal	y	41,564		72	n			
Ni metal	y	10,391		97	n			
Co metal	y	1,039		26	n			
Hydrocarbon (oil/gas)	y	0.3 BBOE		8,400	n	none	exploration	exploration
Gas Hydrate	y	1 BBOE		28,000	n	none	none	exploration

Comments

Country	Madagascar	Area of ELCS Area of EEZ (km^2)	208,7434 1,292,400	Maritime Claims	contiguous zone 24nm, exclusive economic zone 200nm, territorial sea 12nm

Location Neighbours	Southern Africa east of Mozambique	**Natural resources**	graphite, chromite, coal, bauxite, salt, quartz, tar sands, semi-precious stones
Population	15,506,472		
Coastline	4,828 km	**Law of the sea status**	signed but not ratified
Area (sq km)	581,540 (land) 5,500 (water)		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	-	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	2,087,433,000	1		n	none	exploration	exploration
Mn metal	y	417,486,000		835,000	n			
Cu metal	y	10,437,000		18,150	n			
Ni metal	y	10,437,000		97,045	n			
Co metal	y	10,437		263	n			
Hydrocarbon (oil/gas)	y	0.5 BBOE		14,000	n	none	exploration	exploration
Gas Hydrate	y	0.5 BBOE		14,000	n	none	none	none

Comments

Relatively large resources of Manganese nodules/crusts, plus relatively high average grade indicates exploration in medium to long term.

Country	*Mauritania*	**Area of ELCS** **Area of EEZ (km^2)**	53,312 154,300	**Maritime Claims**	contiguous zone 24nm, exclusive economic zone 200nm, territorial sea 12nm

Location Neighbours	North West Africa Western Sahara and Senegal	**Natural resources**	iron ore, gypsum, copper, phosphate
Population	2,667,859	**Law of the sea status**	Ratified 17 July 1996
Coastline	754 km		
Area (sq km)	1,030,700 (land) 300 (water)		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	y	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	y	unknown		unknown	n	none	none	none
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	13,328,000	0.25		n	none	none	none
Mn metal	y	2,665,500		5,331	n			
Cu metal	y	106,623		185	n			
Ni metal	y	53,312		496	n			
Co metal	y	107		3	n			
Hydrocarbon (oil/gas)	y	0.1 BBOE		2,800	n	none	none	none
Gas Hydrate	n							

Comments

Resource grades are too low for manganese nodules/crusts and oil/gas to make exploration economically viable.

Country	*Mauritius*	**Area of ELCS** **Area of EEZ (km^2)**	321,039 1,181,600	**Maritime Claims**	exclusive economic zone 200nm, territorial sea 12nm

Location Neighbours	W Indian Ocean island east of Madagascar
Population	1,179,368
Coastline	177 km
Area (sq km)	1,850 (land) 10 (water)

Natural resources

Law of the sea status Ratified 4 November 1994

ELCS claim based on:	
Prolongation of continental land mass	y
Foot of slope over 60nm	y
1 % of sediment thickness	N/A
Potential deltaic sediments	-
Other (eg mid-ocean ridge activity)	-

Data sources

1) ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
2) GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
3) NGDC http://www. ndgc.noaa.gov/
4) CIA http://www.cia.gov/cia/publications/factbook
5) http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	481,558,500	1.5		n	none	exploration	exploration
Mn metal	y	128,415,500		256,831				
Cu metal	y	3,210,000		5,583				
Ni metal	y	16,052,000		150,000				
Co metal	y	2,568		65				
Hydrocarbon (oil/gas)	y	0.1 BBOE		2,800	n	none	none	exploration
Gas Hydrate	y	0.05 BBOE		1,400	n	none	none	none

Comments

Relatively high resources and average grades of manganese nodules/crusts indicate likely exploration in medium to long term.

Country	*Morocco*	**Area of ELCS** **Area of EEZ (km^2)**	824,562 278,200	**Maritime Claims**	contiguous zone 24nm, exclusive economic zone 200nm, territorial sea 12nm
Location **Neighbours**	North West Africa, Western Sahara & Algeria		**Natural resources**		phosphates, iron ore, manganese, lead, zinc, salt
Population	30,122,350				
Coastline	1,835 km		**Law of the sea status**		signed but not ratified
Area (sq km)	446,300 (land) 250 (water)				

ELCS claim based on:	
Prolongation of continental land mass	y
Foot of slope over 60nm	y
1 % of sediment thickness	N/A
Potential deltaic sediments	y
Other (eg mid-ocean ridge activity)	-

Data sources

1) ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
2) GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
3) NGDC http://www. ndgc.noaa.gov/
4) CIA http://www.cia.gov/cia/publications/factbook
5) http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	206,140,000	0.25		n	none	none	none
Mn metal	y	41,228,000		82,456	n			
Cu metal	y	1,649,000		2,868	n			
Ni metal	n	824,500		7,667				
Co metal	y	1,649		42	n			
Hydrocarbon (oil/gas)	y	0.1 BBOE		2,800	n	none	none	exploration
Gas Hydrate	n							

Country	*Mozambique*	**Area of ELCS** **Area of EEZ (km^2)**	123,258 562,200	**Maritime Claims**	exclusive economic zone 200nm, territorial sea 12nm

Location Neighbours	Southern Africa, Tanzania South Africa	**Natural resources**	coal, titanium, natural gas
Population	19,104,696		
Coastline	2,470 km	**Law of the sea status**	Ratified 13 March 1997
Area (sq km)	784,090 (land) 17,500 (water)		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	-	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n				y (not from ELCS)			
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	123,258,000	1		n	none	none	exploration
Mn metal	y	24,651,500		49,500	n			
Cu metal	y	616,300		1.072	n			
Ni metal	y	616,300		5,700	n			
Co metal	y	616		16	n			
Hydrocarbon (oil/gas)	y	0.5 BBOE		14,000	n	none	exploration	exploitation
Gas Hydrate	y	0.5 BBOE		14,000	n	none	none	exploration

Comments

Country	*New Zealand*	**Area of ELCS** **Area of EEZ (km^2)**	617,808 6,149,304	**Maritime Claims**	exclusive economic zone 200nm, territorial sea 12nm

Location Neighbours	South Pacific SE of Australia	**Natural resources**	natural gas, iron ore, coal, gold
Population	3-+		
Coastline	15,134 km	**Law of the sea status**	Ratified 19 July 1996
Area (sq km)	268,670 (land) 10 (water)		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	-	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n				y (not from ELCS)			
Phosphorite	n							
Evaporites	n							
Polymetalic Sulfide	n							
Manganese Nodules + Crusts	y	321,418,000	0.5		n	none	none	exploration
Mn metal	y	82,832,000		165,600	n			
Cu metal	y	1,901,000		3,306	n			
Ni metal	y	5,320,000		49,500	n			
Co metal	y	2,190		55	n			
Hydrocarbon (oil/gas)	y	0.2		5,600	y (not from ELCS)			
Gas Hydrate	n							

Comments

Country	*Nigeria*	**Area of ELCS** **Area of EEZ (km^2)**	103,772 211,000	**Maritime Claims**	exclusive economic zone 200nm, territorial sea 12nm
Location Neighbours	Western Africa, Benin, Equatorial Guinea, Sao Tome and Principe and Cameroon			**Natural resources**	petroleum, tin, columbite, iron ore, coal, lead, zinc, natural gas
Population	123,337,822				
Coastline	853 km			**Law of the sea status**	Ratified 14 August 1986
Area (sq km)	910,798(land) 13,000(water)				

ELCS claim based on:	
Prolongation of continental land mass	
Foot of slope over 60nm	y
1 % of sediment thickness	y
Potential deltaic sediments	y
Other (eg mid-ocean ridge activity)	-

Data sources

1) ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
2) GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
3) NGDC http://www. ndgc.noaa.gov/
4) CIA http://www.cia.gov/cia/publications/factbook
5) http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	p	unknown	unknown	unknown	n	none	none	none
Polymetalic Sulfide	n							
Manganese Nodules + Crusts	n							
Mn metal	n							
Cu metal	n							
Ni metal	n							
Co metal	n							
Hydrocarbon (oil/gas)	1 BBOE			28,000	n	exploration	exploitation	exploitation
Gas Hydrate	1 BBOE			28,000	n	none	none	exploration

Comments

Extensive delta sediments indicate high oil and gas prospects.

Country	*Norway*	**Area of ELCS** **Area of EEZ (km^2)**	153,920 2,025,415	**Maritime Claims**	contiguous zone 10nm, exclusive economic zone 200nm, territorial sea 4nm

Location Neighbours	Europe Sweden Finland & Russia	**Natural resources**	petroleum, copper, natural gas, pyrites, nickel, iron ore, zinc, lead
Population	4,481,162		
Coastline	21,925 km	**Law of the sea status**	Ratified 24 June 1996
Area (sq km)	307,860 (land) 16,360 (water)		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov
Potential deltaic sediments	-	4)	http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)		Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	n							
Mn metal	n							
Cu metal	n				n			
Ni metal	n							
Co metal	n							
Hydrocarbon (oil/gas)	y	2 BBOE		56,000	y (but not from ECLS)	exploration	exploitation	exploitation
Gas Hydrate	y	4 BBOE		12,000	exploration	exploration	exploration	exploration

Comments

Country	*Oman*	**Area of ELCS** **Area of EEZ (km^2)**	375,295 562,000	**Maritime Claims**	contiguous zone 24nm, exclusive economic zone 200nm, territorial sea 12nm
Location Neighbours	Middle East , Yemen, UAE and Saudi Arabia			**Natural resources**	petroleum, copper, marble, chromium, gypsum, natural gas
Population	2,533,389				
Coastline	2,092 km			**Law of the sea status**	Ratified 17 August 1989
Area (sq km)	212,460				

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	y	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	-	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	281,471,000	0.75		n	none	none	exploration
Mn metal	y	37,500,000		75,000	n			
Cu metal		750,000		1,300	n			
Ni metal		1,876,000		17,500	n			
Co metal		1,500		38	n			
Hydrocarbon (oil/gas)	y	2 BBOE		56,000	n	none	exploration	exploitation
Gas Hydrate	n							

Comments

Relatively large oil and gas resources indicate likely exploration in medium term.

Country	*Pakistan*	**Area of ELCS** **Area of EEZ (km^2)**	41,255 318,700	**Maritime Claims**	contiguous zone 24nm, exclusive economic zone 200nm, territorial sea 12nm

Location Neighbours	Asia, India,Iran, China & Afghanistan	**Natural resources**	natural gas, petroleum (limited), coal, iron ore, copper, salt
Population	141,553,775		
Coastline	1,046 km	**Law of the sea status**	Ratified 26 February 1997
Area (sq km)	778,720 (land) 25,220 (water)		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	-	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	-	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	y	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	y	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value ($US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	31,000,000	0.75		n	none	exploration	exploration
Mn metal	y	4,125,000		8,251	n			
Cu metal	y	82,500		143	n			
Ni metal	y	206,000		1,900	n			
Co metal	y	165		4	n			
Hydrocarbon (oil/gas)	y	0.5 BBOE		14,000	n	exploration	exploration	exploitation
Gas Hydrate	n							

Comments

Extensive delta sediments indicate high potential for oil and gas resources.

Country	*Philippines*	**Area of ELCS** **Area of EEZ (km^2)**	564,725 1,891,300	**Maritime Claims**	exclusive economic zone 200nm, territorial sea 100nm up to 285nm in South China Sea

Location Neighbours	SE Asia, Malaysia, Indonesia, Taiwan, China	**Natural resources**	petroleum, nickel, cobalt, silver, gold, salt, copper
Population	81,159,644		
Coastline	36,289 km	**Law of the sea status**	Ratified 8 May 1984
Area (sq km)	298,170 (land) 1,830 (water)		

ELCS claim based on:	
Prolongation of continental land mass	y
Foot of slope over 60nm	y
1 % of sediment thickness	N/A
Potential deltaic sediments	N/A
Other (eg mid-ocean ridge activity)	N/A

Data sources

1) ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
2) GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
3) NGDC http://www. ndgc.noaa.gov/
4) CIA http://www.cia.gov/cia/publications/factbook
5) http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitatation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n				y (not from ELCS)			
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n				y (not in ELCS)			
Manganese Nodules + Crusts	y	1,129,500,000	2		n	none	exploration	exploration
Mn metal	y	112,945,000		225,900	n			
Cu metal	y	4,518,000		7,856	n			
Ni metal	y	5,647,000		52,500	n			
Co metal	y	1,129		29	n			
Hydrocarbon (oil/gas)	n							
Gas Hydrate	n							

Comments

Relatively high average grade and manganese nodules/crusts indicate potential for exploration in medium to long term.

Country	*Portugal*	**Area of ELCS** **Area of EEZ (km^2)**	123,977 1,774,700	**Maritime Claims**	exclusive economic sea zone 200nm, territorial 12nm

Location Neighbours	SW Europe, Spain	**Natural resources**	tungsten, iron ore, uranium ore, marble
Population	10,048,232	**Law of the sea status**	Ratified 3 November 1997
Coastline	1,793 km		
Area (sq km)	91,951 (land) 440 (water)		

ELCS claim based on:	
Prolongation of continental land mass	y
Foot of slope over 60nm	y
1 % of sediment thickness	N/A
Potential deltaic sediments	-
Other (eg mid-ocean ridge activity)	y

Data sources

1) ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
2) GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
3) NGDC http://www. ndgc.noaa.gov/
4) CIA http://www.cia.gov/cia/publications/factbook
5) http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	y (not in ECLS							
Evaporites	y (not in ECLS)							
Polymetallic Sulfide	y	unknown	unknown	unknown	n	exploration	exploration	exploration
Manganese Nodules + Crusts	y	123,476,500	1		n	none	exploration	exploration
Mn metal	y	12,348,000		24,700				
Cu metal	y	494,000		859				
Ni metal	y	124,000		1,148				
Co metal		185		5				
Hydrocarbon (oil/gas)								
Gas Hydrate								

Comments

Includes Azores Island Group Mid Atlantic Ridge resources include active hydrothermal deposits of PMS. Currently under exploration at 'Lucky Strike' and exploration for other sites. This work is likely to include concomitant manganese nodule/crust exploration.

Country	*Russian Federation*	**Area of ELCS** **Area of EEZ (km^2)**	430,369 4,491,600	**Maritime Claims**	exclusive economic zone 200nm, territorial sea 12nm
Neighbours	Finland, Norway, Japan, China, Georgia, Kazakhstan, N Korea, Mongolia, Poland, Ukraine			**Natural resources**	oil, natural gas, coal plus numerous mineral deposits
Population	146,001,176				
Coastline	37,653 km			**Law of the sea status**	Ratified 12 March 1997
Area (sq km)	16,995,800(land) 79,400(water)				

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	N/A	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	N/A	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	n							
Mn metal	n							
Cu metal	n							
Ni metal	n							
Co metal	n							
Hydrocarbon (oil/gas)	y	10 BBOE		280,000	n	exploration	exploitation	exploitation
Gas Hydrate	y	15 BBOE		420,000	y (not form ELCS)	exploration	exploration	exploration

Comments

High oil and gas resource potential coupled with industrial and domestic demands indicate likely exploration in near term with exploitation in medium and long term. Gas hydrate potential is also high. With historic exploitation of on land gas hydrates, interest in exploration off shore is likely to be high.

Country	*Senegal*	**Area of ELCS** **Area of EEZ (km^2)**	106,650 205,800	**Maritime Claims**	contiguous zone 24nm, exclusive economic zone 200nm, territorial sea 12nm
Location Neighbours	West Africa, Gambia Guinea-Bissau Mauritania			**Natural resources**	phosphates, iron ore
Population	9,987,494				
Coastline	531 km			**Law of the sea status**	Ratified 25 October 1984
Area (sq km)	192,000(land) 4,190(water)				

ELCS claim based on:	
Prolongation of continental land mass	y
Foot of slope over 60nm	y
1 % of sediment thickness	y
Potential deltaic sediments	y
Other (eg mid-ocean ridge activity)	-

Data sources

1) ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
2) GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
3) NGDC http://www. ndgc.noaa.gov/
4) CIA http://www.cia.gov/cia/publications/factbook
5) http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value ($US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n				y (not from ELCS)			
Phosphorite	n							
Evaporites	y	unknown	unknown	unknown	n			
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	19,317,000	0.2		n	none	none	none
Mn metal	y	5,333,000		10,665				
Cu metal	y	140,000		243	n			
Ni metal	n	107,000		992				
Co metal	y	213		5	n			
Hydrocarbon (oil/gas)	y	0.01 BBOE		1,400	n	none	exploration	exploration
Gas Hydrate	n							

Comments

Country	*Seychelles*	**Area of ELCS** **Area of EEZ (km^2)**	321,039 1,349,362	**Maritime Claims**	exclusive economic zone 200nm, territorial sea 12nm

Location Neighbours	Indian Ocean Islands group	**Natural resources**	
Population	79,326		
Coastline	491 km	**Law of the sea status**	Ratified 16 September 1991
Area (land)	455 km		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness		3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	-	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	80,260,000	0.25		n	none	none	none
Mn metal	y	16,025,000		32,104				
Cu metal	y	1,605,000		2,790				
Ni metal	y	16,025,000		149,250				
Co metal	y	321		8				
Hydrocarbon (oil/gas)	y	0.1 BBOE		2,800	n	exploration	exploration	exploitation
Gas Hydrate	n	0.05 BBOE		1,400	n	exploration	exploration	exploration

Comments

Country	*Sierra Leone*	**Area of ELCS** **Area of EEZ (km^2)**	51,030 156,000	**Maritime Claims**	territorial sea 200nm

Location Neighbours	West Africa, Guinea & Liberia	**Natural resources**	diamonds, titanium ore, bauxite, iron ore, gold, chromite
Population	5,232,624		
Coastline	402 km	**Law of the sea status**	Ratified 12 December 1994
Area (sq km)	71,620 (land) 120 (water)		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	y	4)	CIAhttp://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetalic Sulfide	n							
Manganese Nodules + Crusts	y	2,552,000	0.05		n	none	none	none
Mn metal		510,000		1,021	n			
Cu metal	y	102,061		177	n			
Ni metal	y	51,000		474	n			
Co metal	y	51		~1	n			
Hydrocarbon (oil/gas)	y	0.05 BBOE		1,400	n	none	exploration	exploration
Gas Hydrate	n							

Comments

Country	*Somalia*	**Area of ELCS** **Area of EEZ (km^2)**	242,676 782,000	**Maritime Claims**	territorial sea 200nm
Location Neighbours	East Africa, Kenya Ethiopia & Djbouti		**Natural resources**		uranium, iron ore, tin, gypsum, bauxite, copper, salt (largely unexploited)
Population	7,253,137				
Coastline	3,025 km		**Law of the sea status**		Ratified 24 June 1990
Area (sq km)	627,337 (land) 10,320 (water)				

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	N/A	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	121,338,000	0.5		n	none	none	none
Mn metal	y	12,134,000		24,268	n			
Cu metal	y	485,000		8.44	n			
Ni metal	n	243,000		2,256				
Co metal	n	485		12				
Hydrocarbon (oil/gas)	y	1.5 BBOE		42,000	n	none	exploration	exploration
Gas Hydrate	y	3 BBOE		84,000	n	none	none	exploration

Comments

Country	*SOPAC **	**Area of ELCS** **Area of EEZ (km^2)**	324,192 25,680,000	**Maritime Claims**	exclusive economic zone 200nm, territorial sea 12nm

Location Neighbours	South East Asia & South Pacific Ocean	**Natural resources**
Population	7,552,734	
Coastline	255,34.9 km	**Law of the sea status** party to
Area (land)	637,380 sq km	*N.B- New Zealand and Australia not included in figures*

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	-	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	N/A	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	100,077,000	0.3		n	none	exploration	exploration
Mn metal	y	15,011,000		30,000				
Cu metal	y	500,000		870				
Ni metal	y	3,002,000		27,916				
Co metal	y	300		8				
Hydrocarbon (oil/gas)	n							
Gas Hydrate	n							

Comments

** SOPAC comprises: Australia, Cook Islands; Federated States of Micronesia; Fiji islands; French Polynesia (Associate); Guam; Kiribati; Marshall islands; New Caledonia (Associate); Nauru; New Zealand; Niue; Papua New Guinea; Samoa; Soloman islands; Tonga; Tuvalu; Vanuatu*

Summary figures are presented for the SOPAC countries collectively (with the exception of Australia, New Zealand, Guam and their country dependencies.

Potentially large resources of manganese nodules/crusts indicate possible exploration in medium to long term. Low average grades indicate low possibility of exploitation in long term.

Country	*South Africa*	**Area of ELCS of EEZ (km^2)**	**Area**	184863 1,017,000	**Maritime Claims**: contiguous zone 24nm, exclusive economic zone 200nm, territorial sea 12nm

Location Neighbours	South Africa, Namibia & Mozambique	**Natural resources**	gold, chromium, antimony, coal, iron ore, manganese, nickel, phosphates, tin, uranium, gem diamonds, platinum, copper, vanadium, salt, natural gas
Population	43,421,021	**Law of the sea status**	Ratified 23 December 1997
Coastline	2,798 km		
Area (land)	1,219,912 sq km		

ELCS claim based on:	
Prolongation of continental land mass	y
Foot of slope over 60nm	y
1 % of sediment thickness	N/A
Potential deltaic sediments	-
Other (eg mid-ocean ridge activity)	-

Data sources

1) ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
2) GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
3) NGDC http://www. ndgc.noaa.gov/
4) CIA http://www.cia.gov/cia/publications/factbook
5) http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n				y (not from ELCS)			
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	138,660,000	0.75		n	none	none	exploration
Mn metal	y	27,732,000		55,464	n			
Cu metal	y	1,109,130		1,929	n			
Ni metal	y	224,315		2,594	n			
Co metal	y	370		9	n			
Hydrocarbon (oil/gas)	y	0.2 BBOE		5600	y (not from ELCS)	exploration	exploration	exploitation
Gas Hydrate	y	0.2 BBOE		5,600	n	none	exploration	exploration

Comments

Country	*Sri Lanka*	**Area of ELCS Area of EEZ (km^2)**	768,758 516,558	**Maritime Claims**	contiguous zone 24nm, exclusive economic zone 200nm, territorial sea 12nm

Location Neighbours	Asia, island south of India	**Natural resources**	graphite, mineral sands, gems, phosphates, clay
Population	19,238,575		
Coastline	1,340 km	**Law of the sea status**	Ratified 19 July 1994
Area (sq km)	64,740 (land) 870 (water)		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	?	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	?	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	y	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	y	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	n							
Mn metal	n							
Cu metal	n							
Ni metal	n							
Co metal	n							
Hydrocarbon (oil/gas)	y	0.25 BBOE		7,000	n	none	exploration	exploitation
Gas Hydrate	y	0.5 BBOE		14,000	n	none	none	none

Comments

Country	*Suriname*	**Area of ELCS** / **of EEZ (km^2)**	**Area** 89,110 101,185	**Maritime Claims**	exclusive economic zone 200nm, territorial sea 12nm
Location	**Neighbours**	South America Guyana	French Guiana &	**Natural resources**	kaolin, bauxite, gold, nickel copper, platinum, iron ore
Population			431,303		
Coastline	386 km			**Law of the sea status**	Ratified 9 July 1998
Area (sq km)	161,470 (land) 1,800 (water)				

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	y	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetalic Sulfide	n							
Manganese Nodules + Crusts	y	22,277,000	0.25		n	none	none	none
Mn metal	y	1,782,000		3,564				
Cu metal	y	267,329		465	n			
Ni metal	y	89,000		829	n			
Co metal	y	89		2	n			
Hydrocarbon (oil/gas)	y	5 BBOE		140,000	n	exploration	exploration	exploitation
Gas Hydrate	n							

Comments

Country	*United Republic of Tanzania*	Area of ELCS of EEZ (km^2)	Area	55,681 223,200	Maritime Claims	exclusive economic zone 200nm, territorial sea 12nm

Location and Neighbours	East Africa, Kenya and Mozambique	**Natural resources**	tin, phosphates, iron ore, coal, diamonds, gem stones, gold, natural gas, nickel
Population	35,306,126		
Coastline	1,424 km	**Law of the sea status**	Ratified 30 September 1985
Area (sq km)	886,037 (land) 59,050 (water)		

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	-	1)	NGDC http://www. ndgc.noaa.gov/
Foot of slope over 60nm	-	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	y	3)	CIA http://www.cia.gov/cia/publications/factbook
Potential deltaic sediments	y	4)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	27,841,000			n	none	none	none
Mn metal	y	2,784,000		5,568	n			
Cu metal	y	111,000		194	n			
Ni metal	y	55,681		518				
Co metal	y	56		1				
Hydrocarbon (oil/gas)	y	2.5 BBOE		70,000	n	exploration	exploration	exploration
Gas Hydrate	y	5 BBOE		140,000	n	none	none	exploration

Comments

Country	*Togo*	**Area of ELCS** **Area of EEZ (km^2)**	1,232 2,052	**Maritime Claims**	exclusive economic zone 200nm, territorial sea 12nm

Location Neighbours	West Africa Benin and Ghana	**Natural resources**	Phosphate, limestone, marble, arable land
Population	5,018,502		
Coastline	56 km		
Area (sq km)	54,385 (land) 2,400 (water)	**Law of the sea status**	Ratified 9 July 1998

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	-	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	-	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	y	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	n							
Mn metal	n							
Cu metal	n							
Ni metal	n							
Co metal	n							
Hydrocarbon (oil/gas)	y	1 BBOE		28,000	none	exploration	exploration	exploitation
Gas Hydrate	n							

Comments

Country	*United Kingdom **	**Area of ELCS**	243,679	**Maritime Claims**	exclusive fishing zone 200nm, territorial sea 12 nm
		Area of EEZ (km^2)	1,785,00		
Location Neighbours	Europe Ireland, Denmark, Argentina France,			**Natural resources**	coal, petroleum, natural gas, tin, iron ore, salt, clay, chalk, gypsum, lead
Population	59,511,464				
Coastline	12,429 km			**Law of the sea status**	Ratified 25 July 1997
Area (sq km)	241,590 (land) 3,230 (water)				

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	-	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	y	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitatation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	60,920,000	0.25		n	none	none	none
Mn metal	y	12,184,000		24,368	n			
Cu metal	y	244,000		424	n			
Ni metal	y	244,000		2,266				
Co metal	n	244		6				
Hydrocarbon (oil/gas)	y	1.5 BBOE		42,000	y (but not from ECLS)	exploration	exploration	exploitation
Gas Hydrate	y	1.5 BBOE		42,000	n	none	exploration	exploration

Comments

* Includes dependencies with potential ELCS claim (Ascension, Falkland Islands, South Georgia)

Country	*United States of America*	**Area of ELCS** **Area of EEZ (km2)**	12,12653 10,657,000	**Maritime Claims**	contiguous zone 24nm, exclusive economic zone 200nm, territorial sea 12nm
Location Neighbours	North America, Canada and Mexico			**Natural resources**	coal, copper, lead, molybedenum, phosphates, uranium, bauxite, gold, iron, mercury, nickel, potash, silver, tungsten, zinc, petroleum, natural gas
Population	275,562,673				
Coastline	19,924 km			**Law of the sea status**	Not signed
Area (sq km)	9,158,960(land) 470,131(water)				

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	-	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n				y (not from ELCS)			
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	1,860,661,000	1.5		n	none	exploration	exploration
Mn metal	y	182,134,000		364,268	n			
Cu metal	y	9,000,000		15,650	n			
Ni metal	y	12,186,000		113,306	n			
Co metal	y	5,409		137	n			
Hydrocarbon (oil/gas)	y	10 BBOE		290,000	y (not from ELCS)	exploration	exploration	exploitation
Gas Hydrate	y	20 BBOE		560,000	exploration	exploration	exploration	exploration

Comments

Includes Pacific Island dependencies. Gas hydrate exploration is currently active through academic studies and the Ocean Drilling Program. Government of the USA has committed $10-20 million for gas hydrate research, in recognition of its environmental and energy resource potential.

Country	*Uruguay*	**Area of ELCS of EEZ (km^2)**	**Area** 53,182 119,364	**Maritime Claims**	territorial sea 200nm
Location and Neighbours	South America, Argentina and Brazil			**Natural resources**	minor minerals
Population	3,334,074				
Coastline	660 km			**Law of the sea status**	Ratified 10 December 1997
Area (sq km)	173,220 (land) 2,600 (water)				

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	ETOPO5 http://www.ndgc.noaa.gov/mgg/global/seltopo.html
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	y	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	26,591,000	0.5		n	none	none	none
Mn metal	y	5,318,000		10,636	n			
Cu metal	y	425,500		740	n			
Ni metal	y	532,000		4,945	n			
Co metal	y	1,06		3	n			
Hydrocarbon (oil/gas)	y	0.5 BBOE		14,000	n	none	exploration	exploration
Gas Hydrate	n							

Comments

Country	*Venezuela*	**Area of ELCS** **Area of EEZ (km^2)**	14,431 364,000	**Maritime Claims**	contiguous zone 15nm, exclusive economic zone 200nm, territorial sea 12nm
Location and Neighbours	South America, Columbia and Guyana			**Natural resources**	petroleum, natural gas, iron ore, gold, bauxite, diamonds
Population	23,542,649				
Coastline	2,800 km			**Law of the sea status**	not signed
Area (sq km)	882,050 (land) 30,000 (water)				

ELCS claim based on:		**Data sources**	
Prolongation of continental land mass	y	1)	CIA http://www.cia.gov/cia/publications/factbook
Foot of slope over 60nm	y	2)	GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
1 % of sediment thickness	N/A	3)	NGDC http://www. ndgc.noaa.gov/
Potential deltaic sediments	-	4)	CIA http://www.cia.gov/cia/publications/factbook
Other (eg mid-ocean ridge activity)	-	5)	http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity	Grade	Potential Value ($US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	285,000	0.25		n	none	none	none
Mn metal	y	11,500		1,343	n			
Cu metal	y	3,400		23	n			
Ni metal	y	1,100		624	n			
Co metal	y	1		<<1	n			
Hydrocarbon (oil/gas)	y	5 BBOE		140,000	y (but not from ECLS)	exploration	exploration	exploitation
Gas Hydrate	n							

Comments

Delta sediments give high potential for rich oil and gas resources.

Country	*Zaire*	**Area of ELCS** **Area of EEZ (km^2)**	13,431 1,029	**Maritime Claims**	exclusive economic zone 200 nm, territorial sea 12 nm
Location Neighbours	Africa, Congo, Angola			**Natural resources**	gold, copper, off shore oil (potential)
Population	1,000,000				
Coastline	70 km			**Law of the sea status**	party to
Area (sq km)					

ELCS claim based on:	
Prolongation of continental land mass	-
Foot of slope over 60nm	-
1 % of sediment thickness	y
Potential deltaic sediments	y
Other (eg mid-ocean ridge activity)	-

Data sources

1) CIA http://www.cia.gov/cia/publications/factbook
2) GEBCO http://www.ndgc.noaa.gov/mgg/gebco/
3) NGDC http://www. ndgc.noaa.gov/
4) CIA http://www.cia.gov/cia/publications/factbook
5) http://www.ndgc.noaa.gov/mgg/sedthick/

Mineral Resource	Present (Y/N)	Quantity (tonnes)	Average Grade (kg/m^2)	Potential Value (m$US)	Current exploitation (Y/N)	5yr exploitation outlook	10yr exploitation outlook	25yr exploitation outlook
Placer	n							
Phosphorite	n							
Evaporites	n							
Polymetallic Sulfide	n							
Manganese Nodules + Crusts	y	3,358,000	0.25		n	none	none	none
Mn metal	y	671,500		1,343	n			
Cu metal	y	13,000		23	n			
Ni metal	y	67,000		624	n			
Co metal	y	13		<1	n			
Hydrocarbon (oil/gas)	y	0.2 BBOE		5,600	n	exploration	exploration	exploration
Gas Hydrate	n							

Comments

Delta sediments give high potential for rich oil and gas resources.

8

Appendix 2

Figures

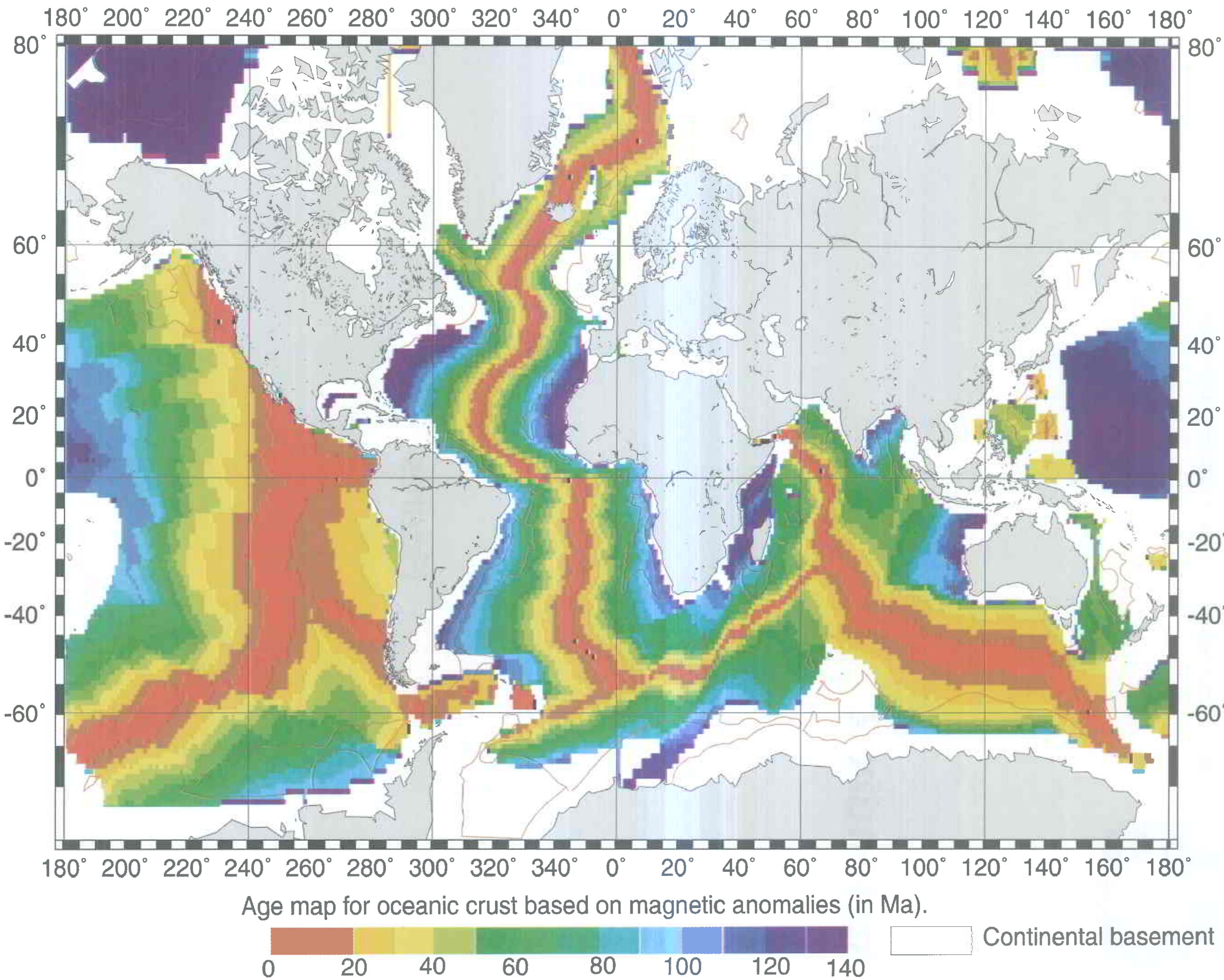


Figure 1. Age map of the ocean floor constructed from a digital data base based on magnetic isochron data (Müller, et al., 1997). Shown in red are the areas of the extended legal continental shelf identified in the text, and the subject of this report.

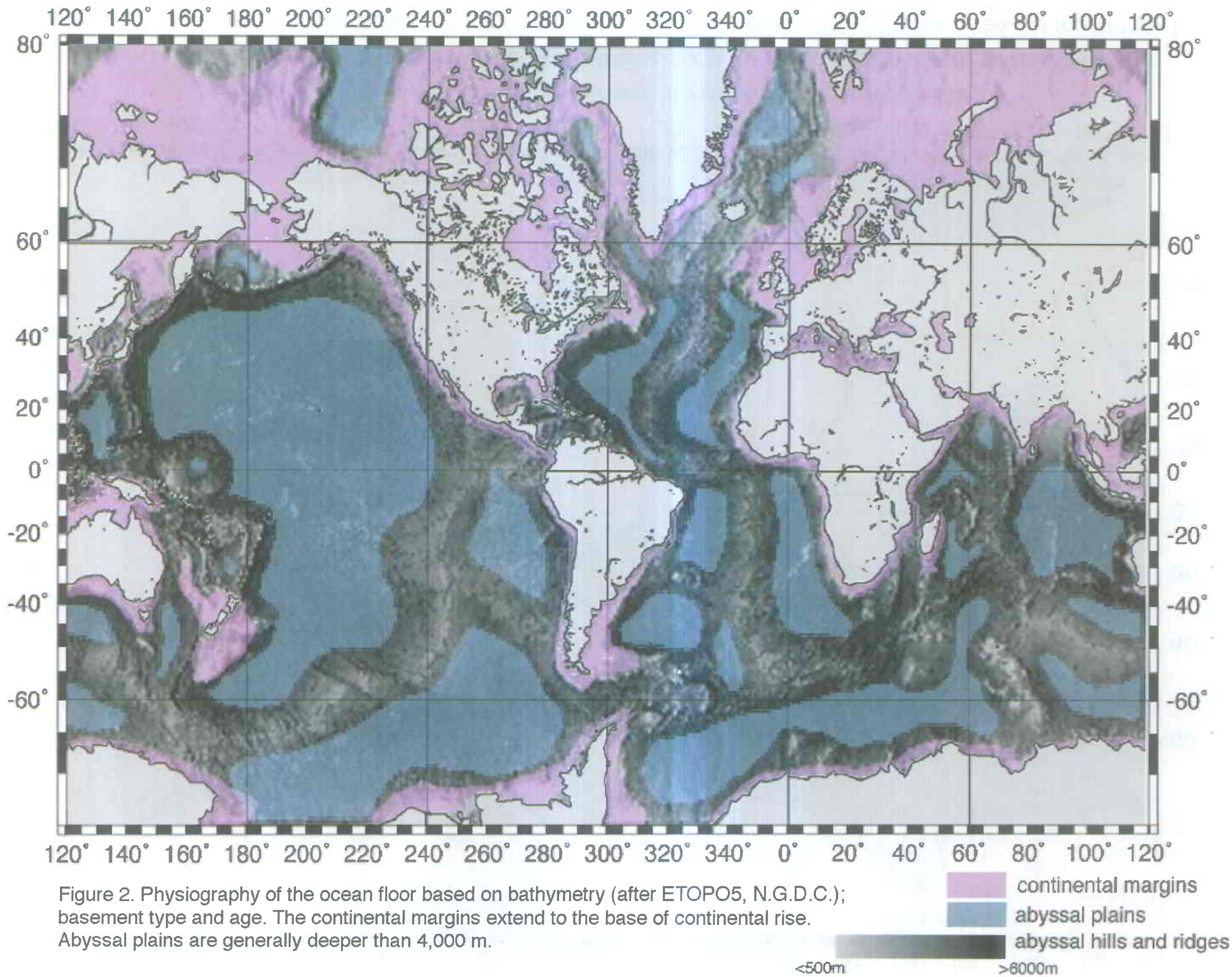


Figure 2. Physiography of the ocean floor based on bathymetry (after ETOPO5, N.G.D.C.); basement type and age. The continental margins extend to the base of continental rise. Abyssal plains are generally deeper than 4,000 m.

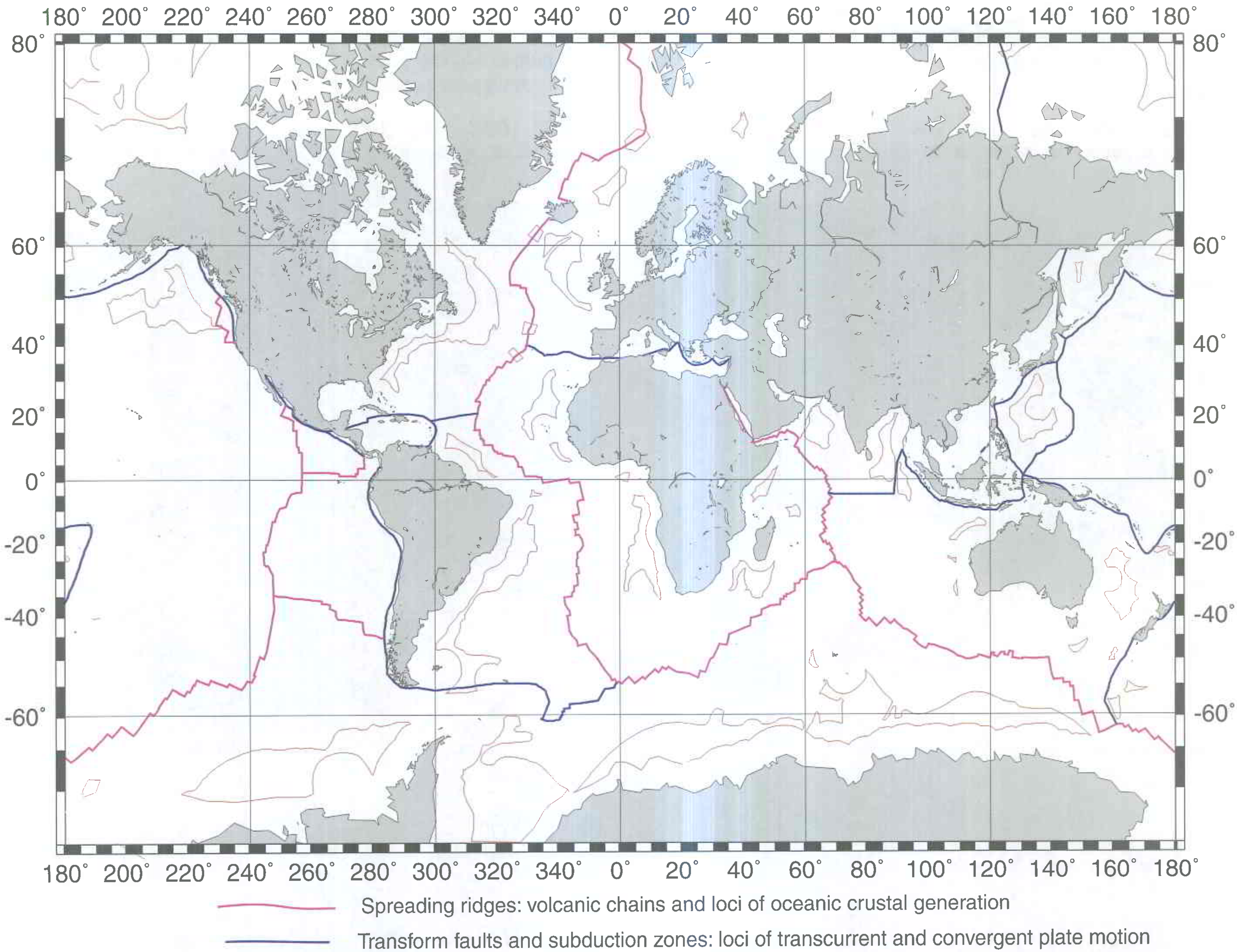


Figure 3. Map showing the major plate tectonic boundaries on the ocean floor. Shown in red are the areas of the extended legal continental shelf identified in the text.

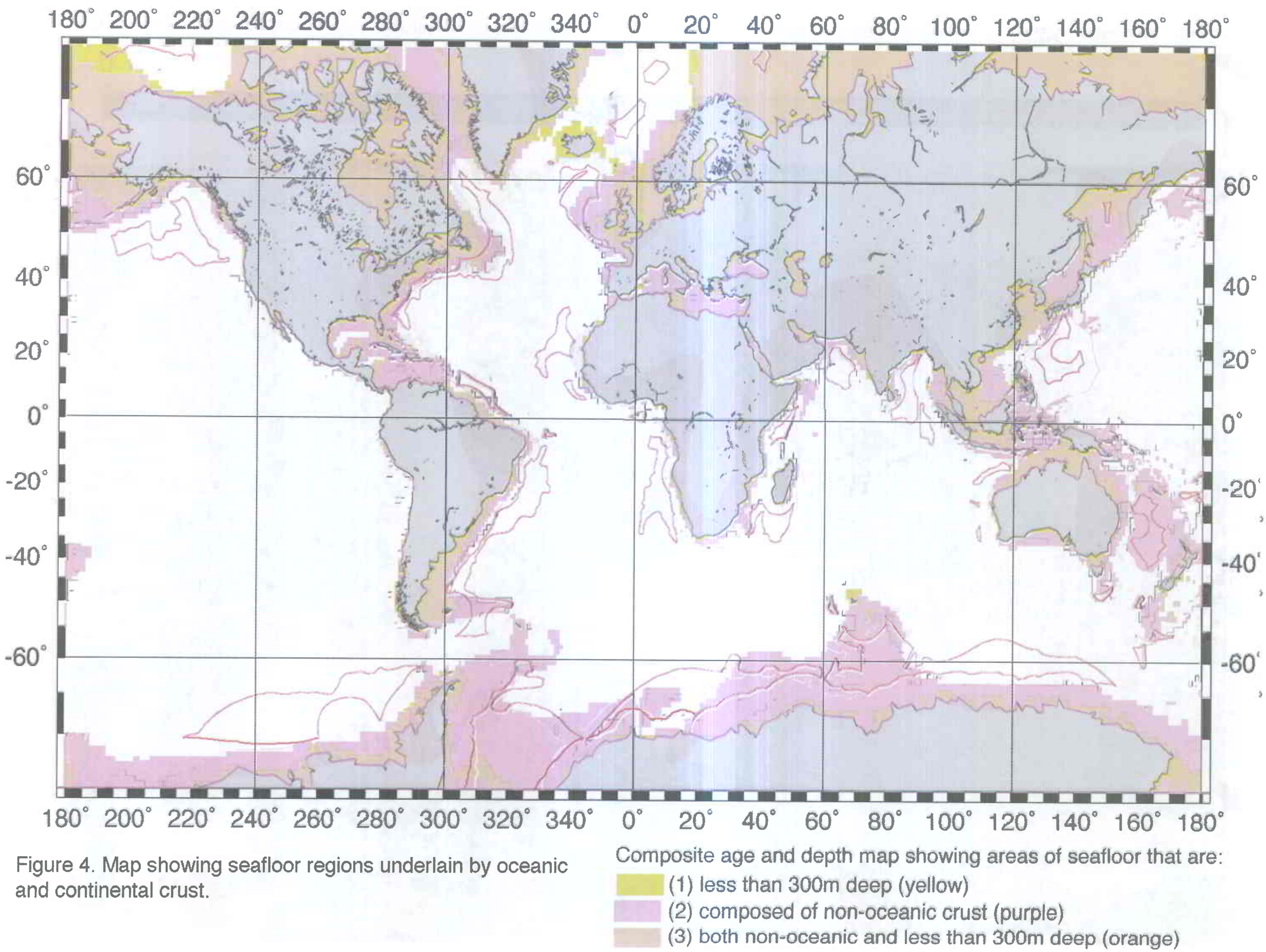


Figure 4. Map showing seafloor regions underlain by oceanic and continental crust.

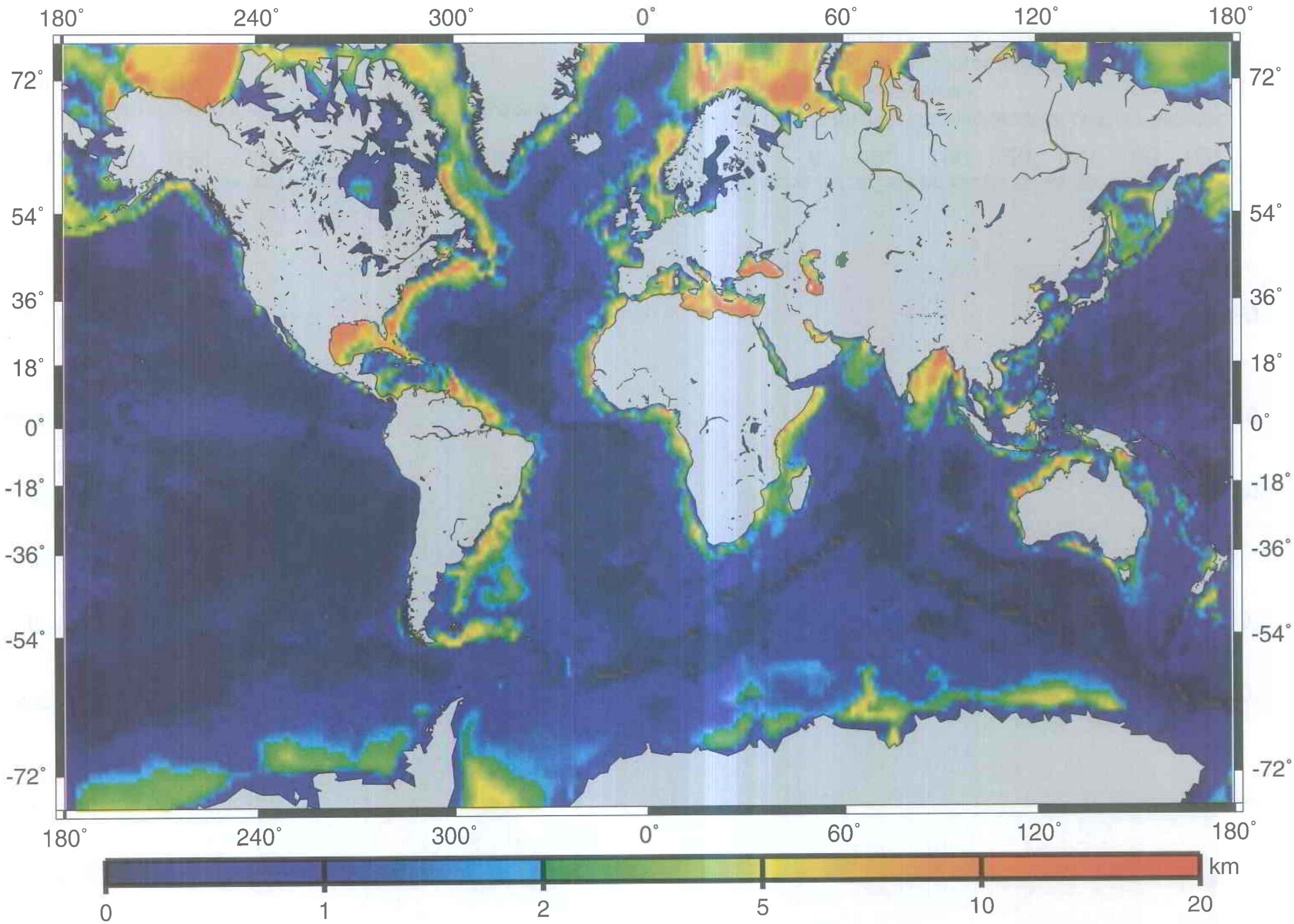


Figure 5. Sediment thickness model in kilometres and gridded on a 1° latitude and longitude basis (compiled by NGDC, based on work by: Matthias et al., 1988; Ludwig and Houtz, 1979; Hayes and LaBrecque, 1991; Divins and Rabinowitz, 1991; Divins, D.L., and Eakins, in prep).

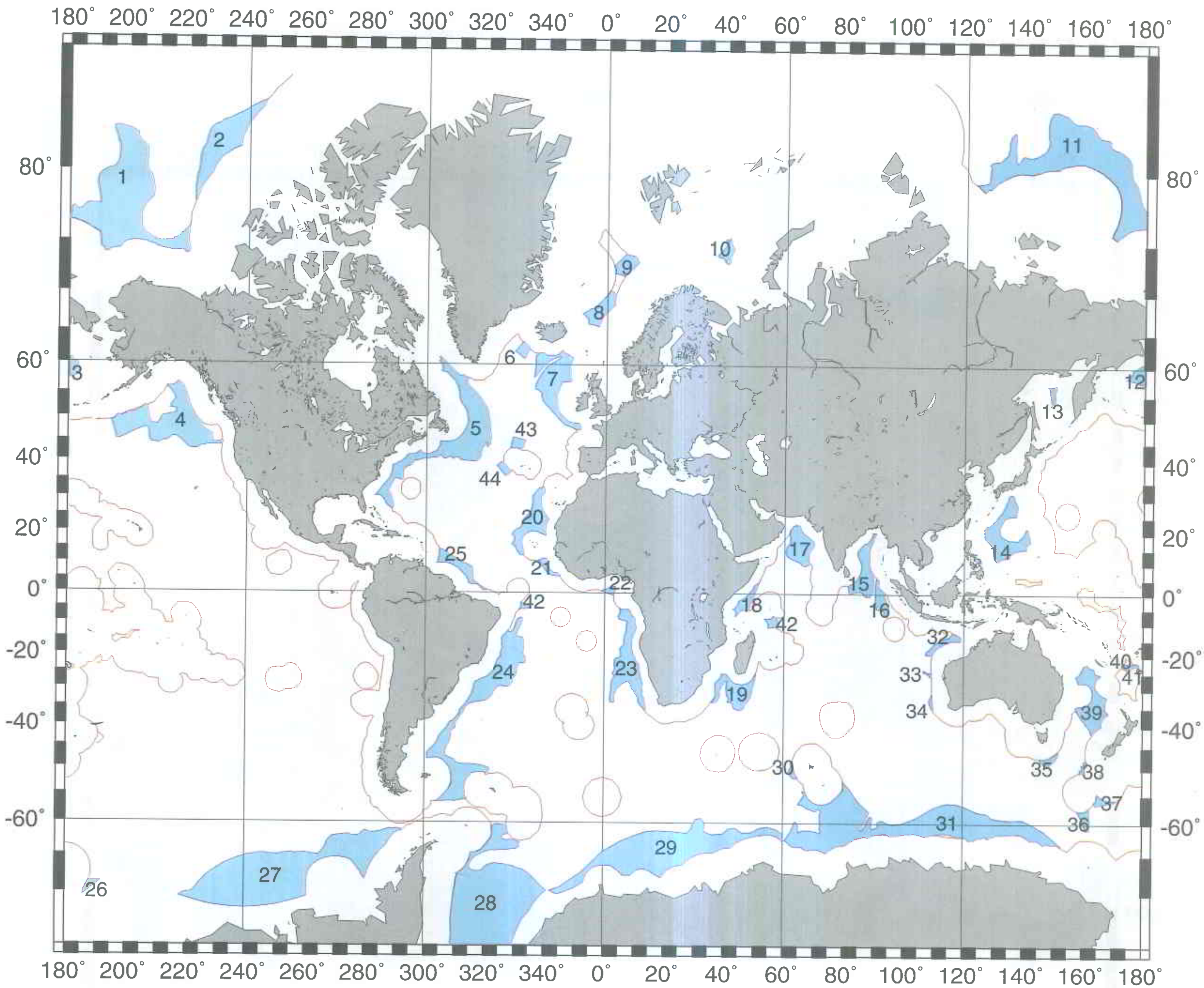


Figure 6. Areas filled in blue are the extended legal continental shelf (ELCS) regions identified in the text (after Prescott, 1985). Areas outlined in red are the 200nmile limits of EEZ claims. The criteria for the identification of these boundaries is described in the text (section 3.3.1). Each region is identified by a number that is referred to in the text.

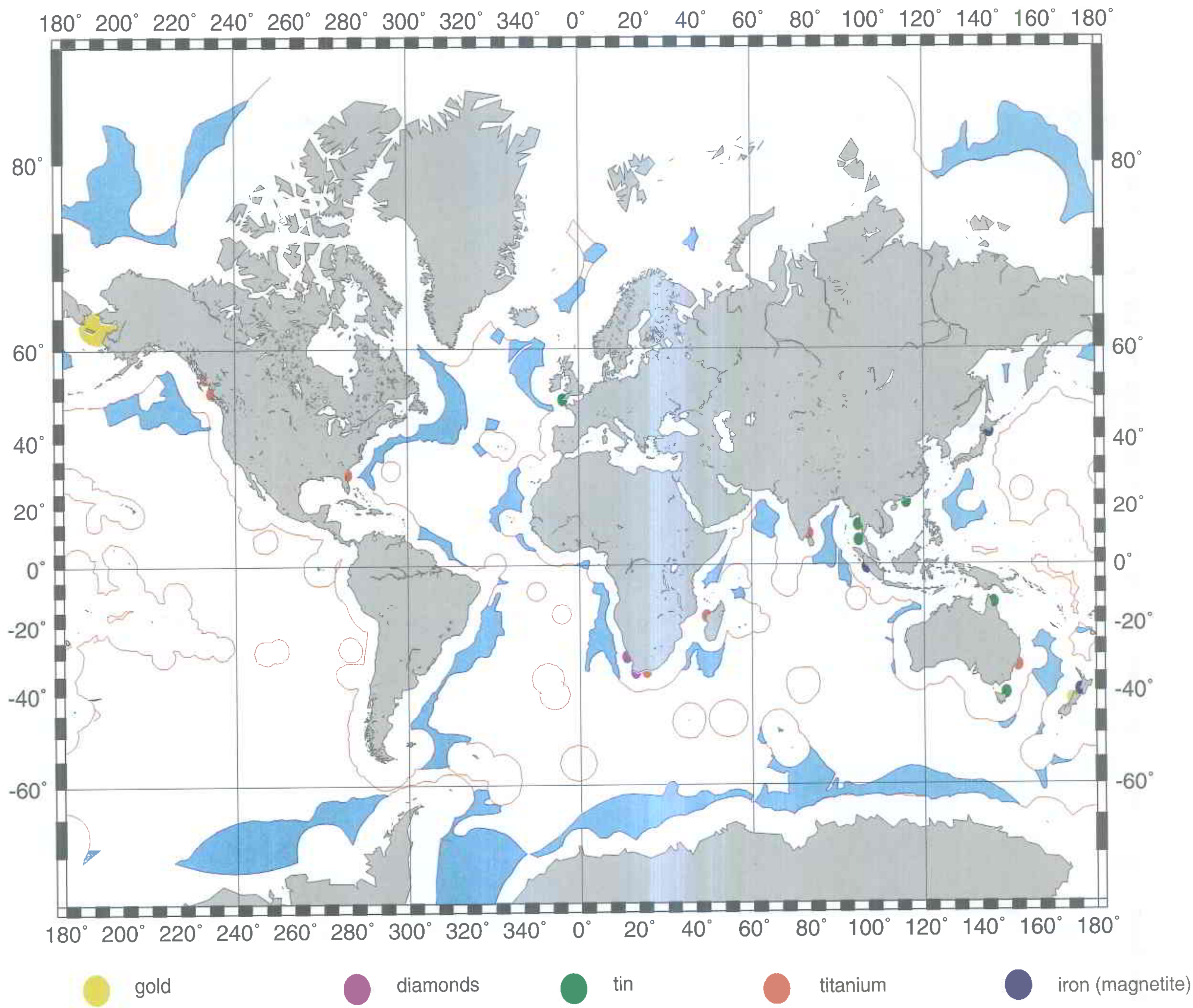


Figure 7. Map showing known locations of offshore placer deposits with reference to the ELCS regions (after Emery and Noakes, 1968; Cronan, 1980; Earney, 1990, and other sources cited in the text).

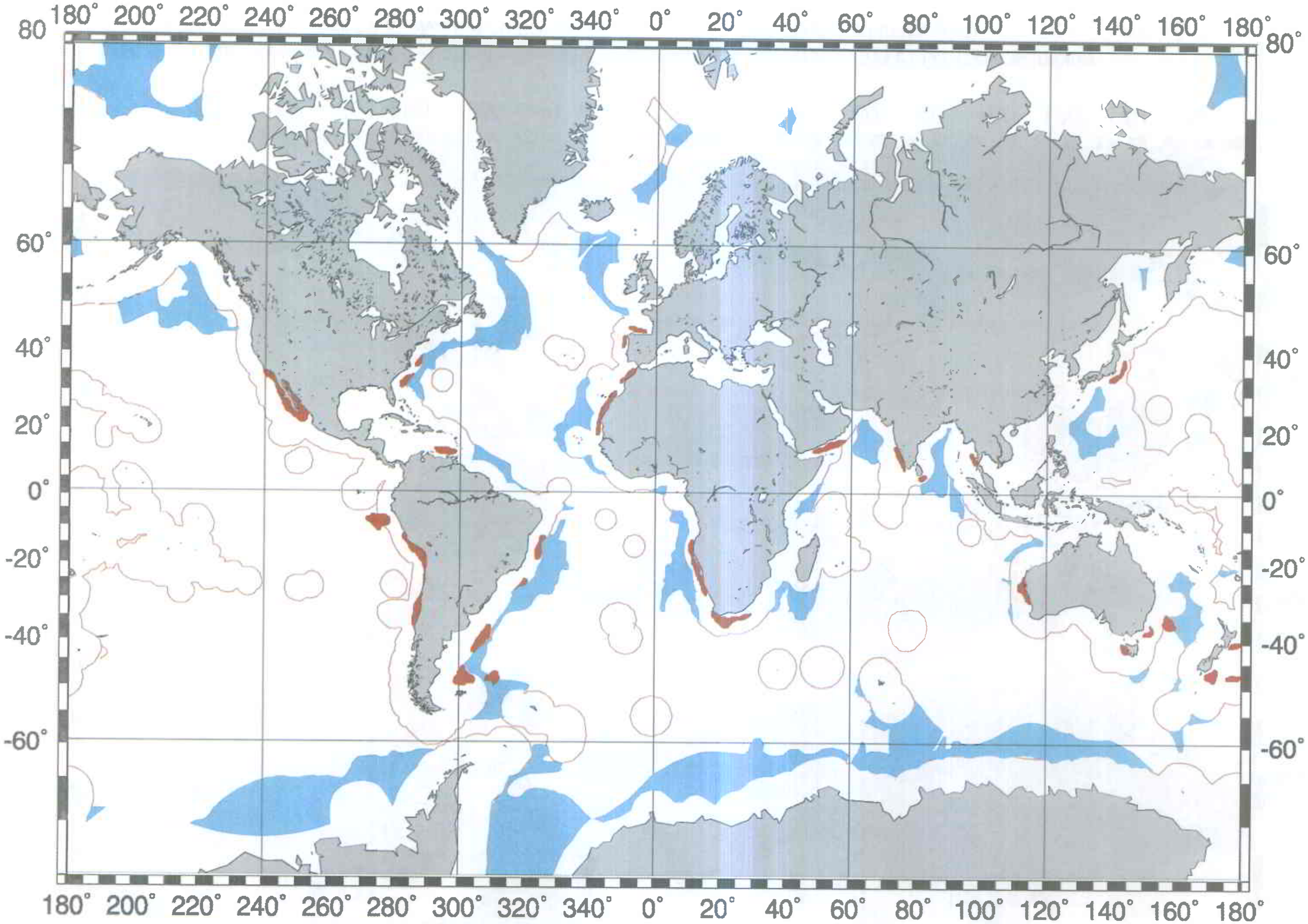


Figure 8. Location of known marine phosphorite deposits (in red) with reference to the ELCS regions in blue (after Baturin and Savenko, 1985; Baturin 1998; Rao and Nair, 1991; Earney, 1990).

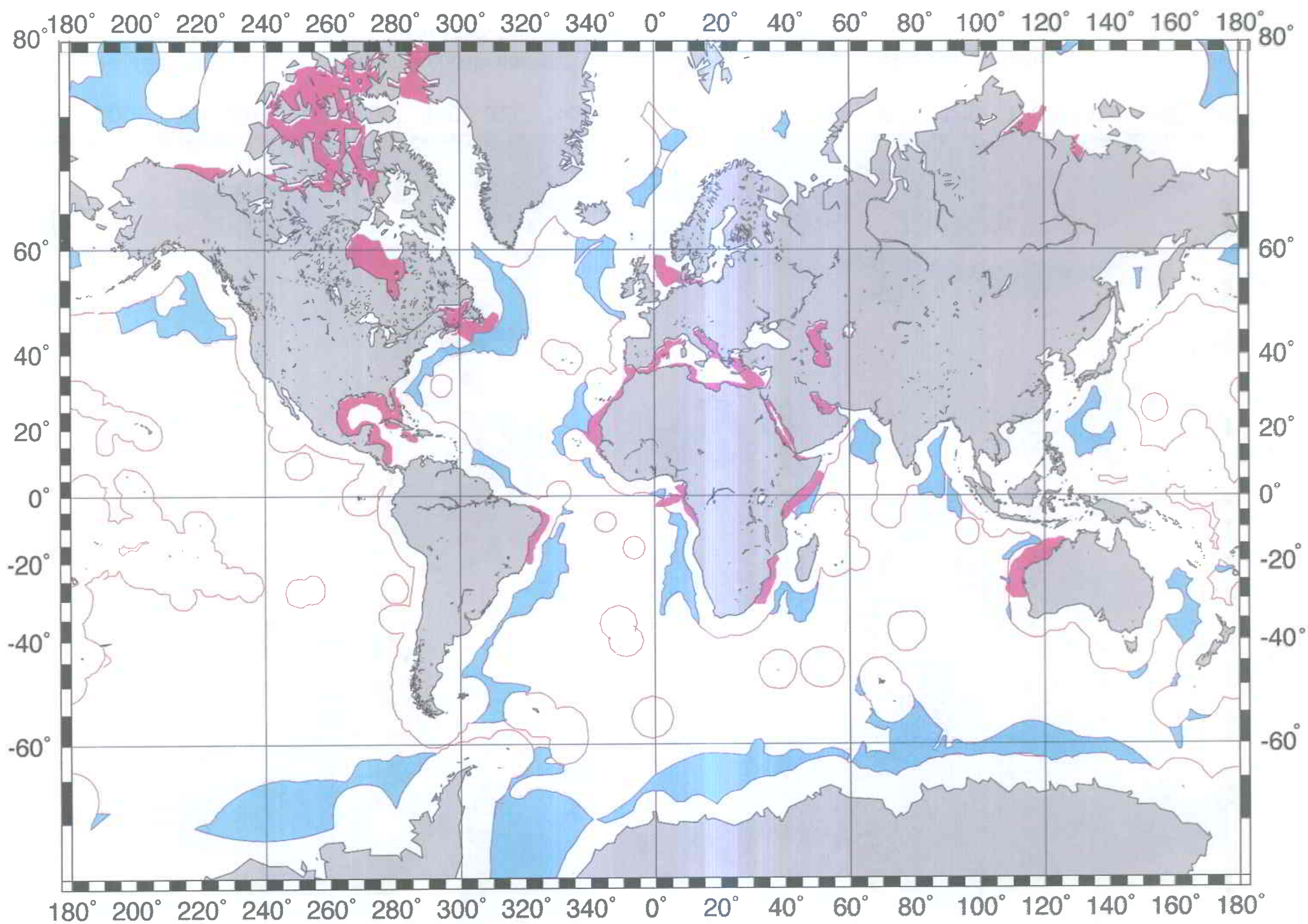


Figure 9. Location of known marine evaporite deposits (in purple) with reference to the ELCS regions in blue (after Cronan, 1980; Earney, 1990; Warren, 1999; Teleki et al., 1987 and others cited in the text).

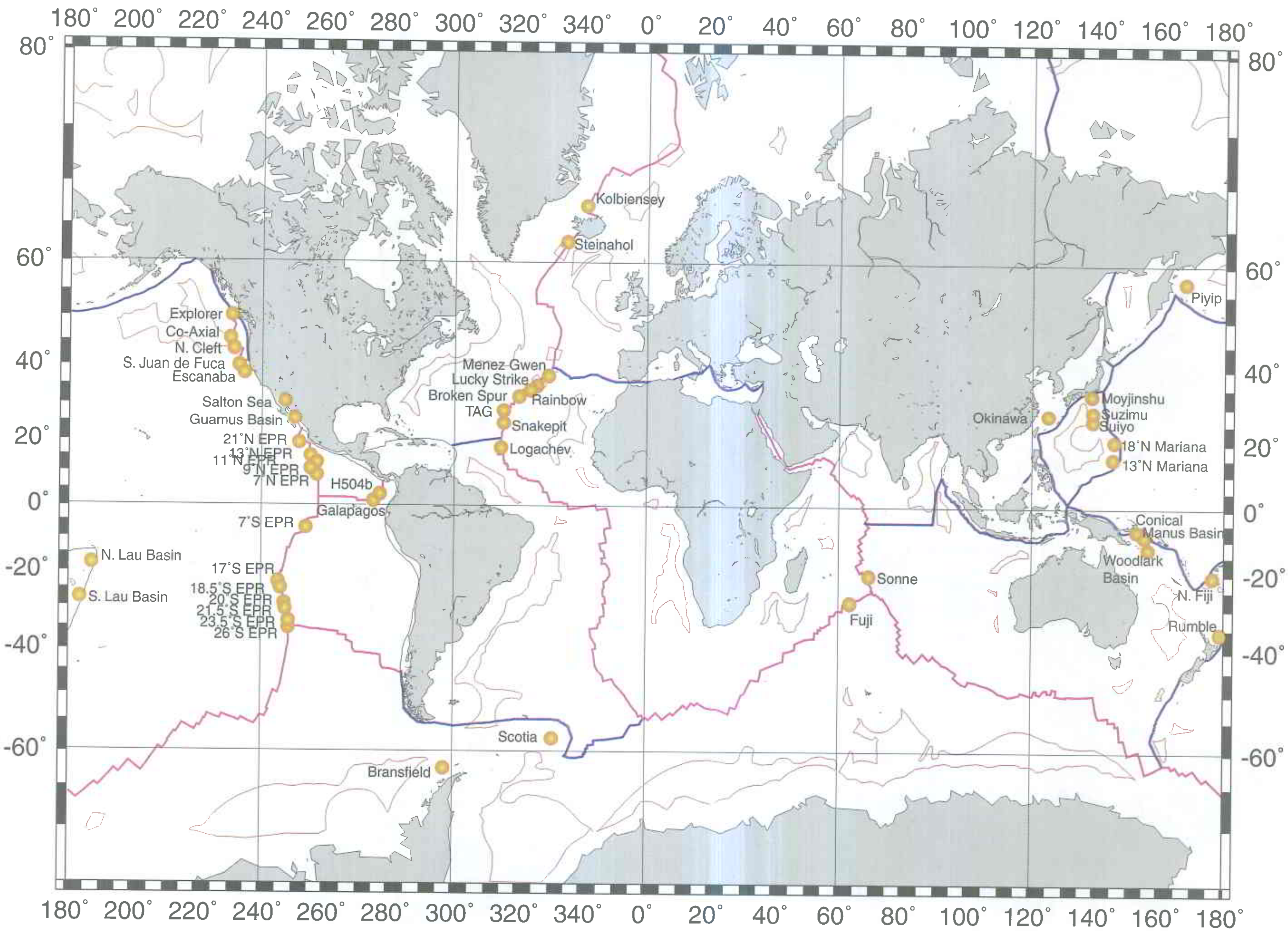
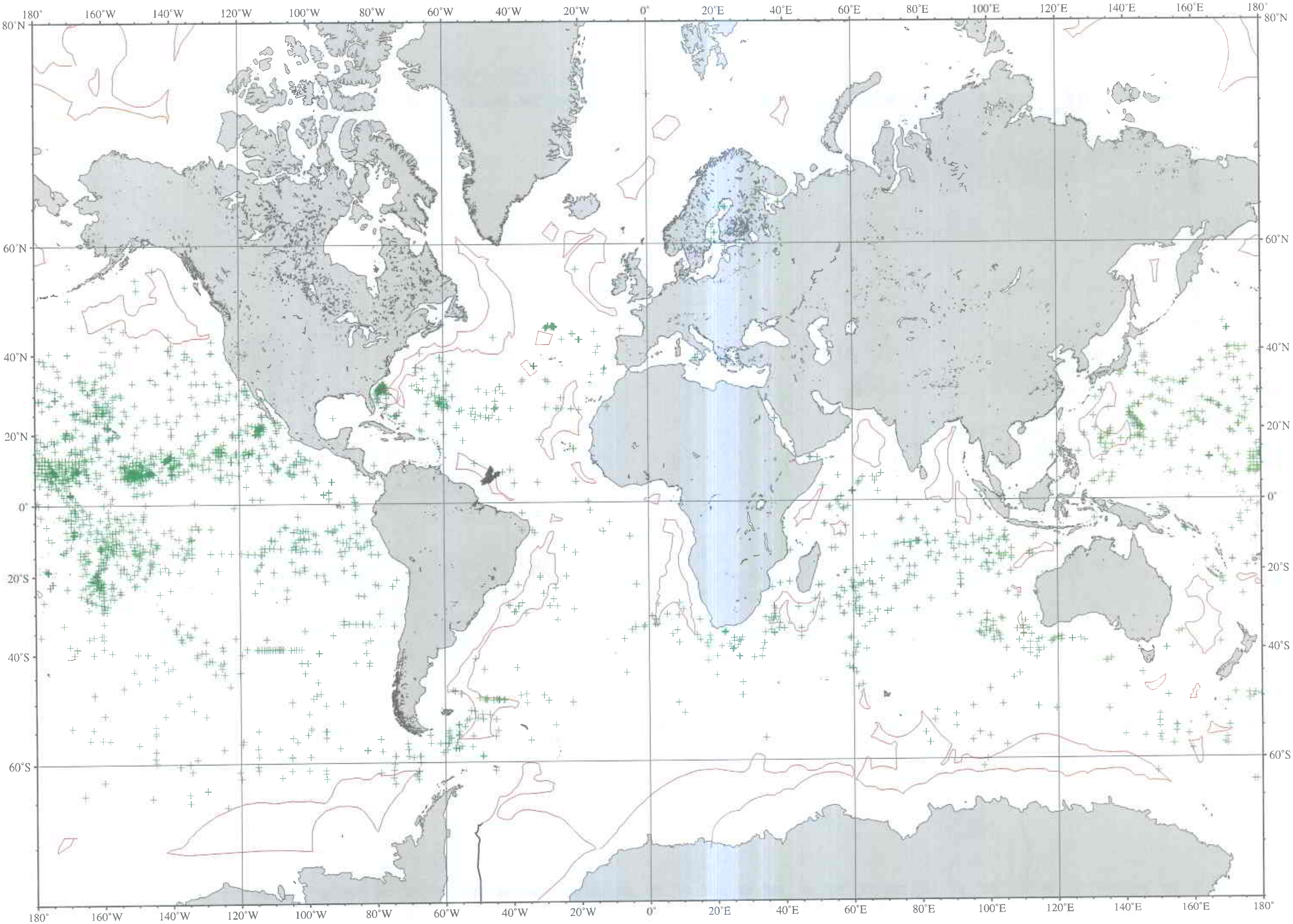


Figure 10. Location of known marine polymetallic sulphide (PMS) deposits (orange-filled circles) with reference to the ELCS regions outlined in red (after: Rona, 1988; Rona and Koski, 1985; Herzig, 1999; Herzig and Hannington, 2000 and others cited in the text).

Figure 11. Location of all reported marine manganese nodule and crust deposits (green crosses) with reference to the ELCS regions outlined in red (after: Anon., NOAA & MMS Marine Minerals CD-ROM Data Set, World Data Center for Marine Geology & Geophysics, Boulder, 1991; Gross and McLeod, 1987; Kessler, 1994, and other sources cited in the text).



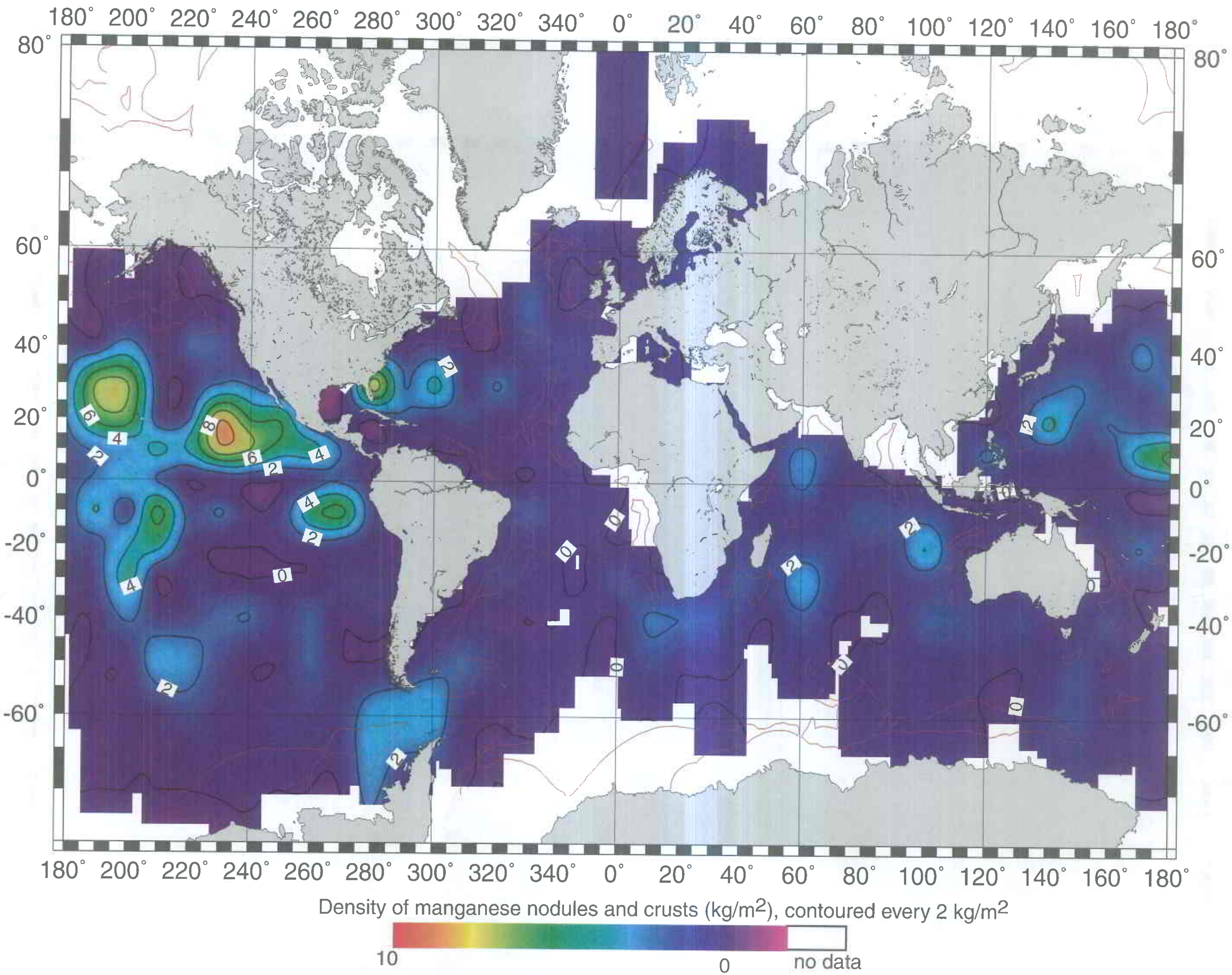


Figure 12a. Density of manganese nodules and crusts (kg/m^2) gridded on a 1° latitude and longitude basis from data compiled from the same sources cited on Figure 11.

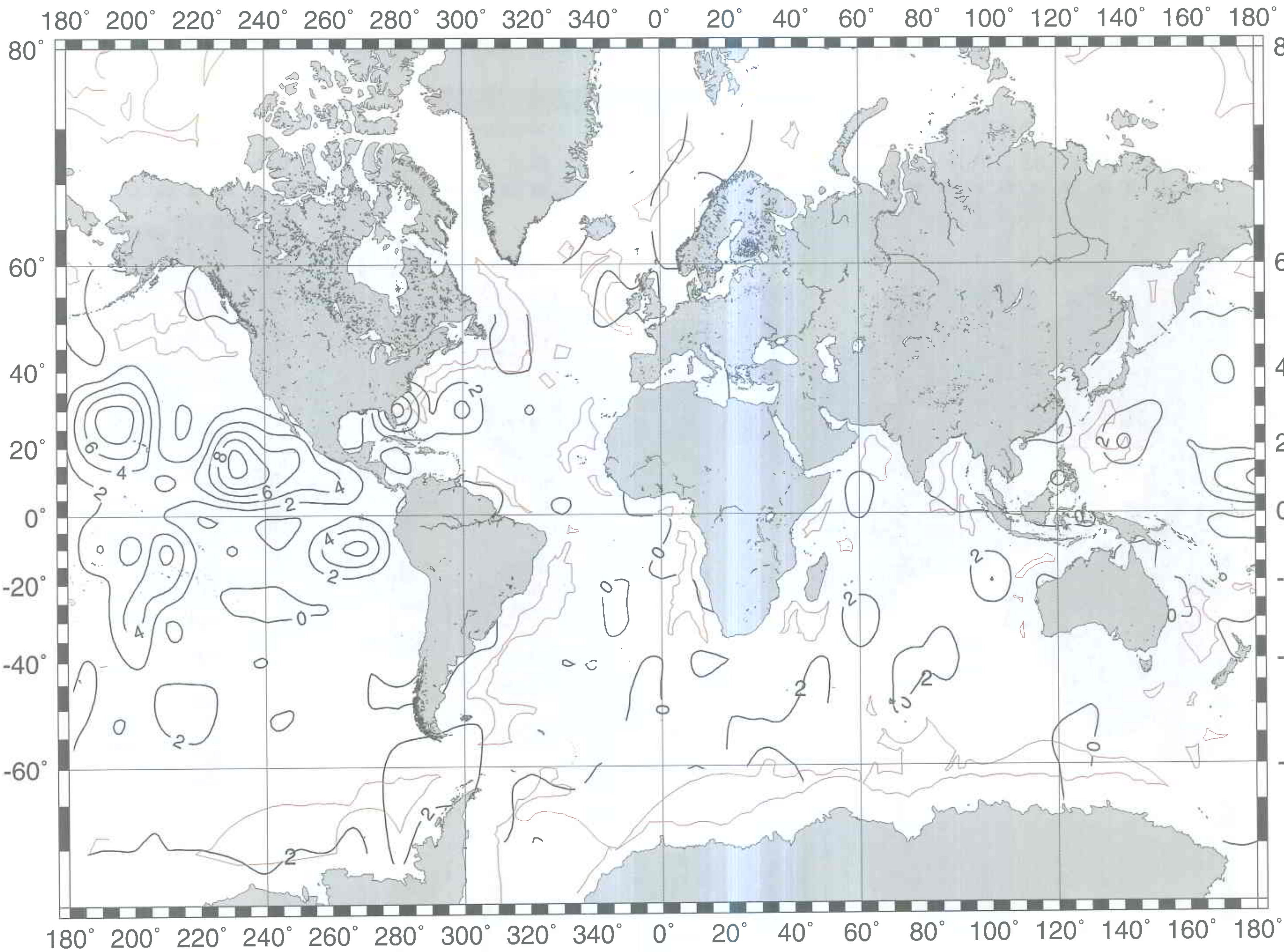


Figure 12b. Density of manganese nodules and crusts (kg/m^2) contoured every 2 kg/m^2 from a 1° latitude and longitude grid based on data compiled from the same sources cited on Figure 11.

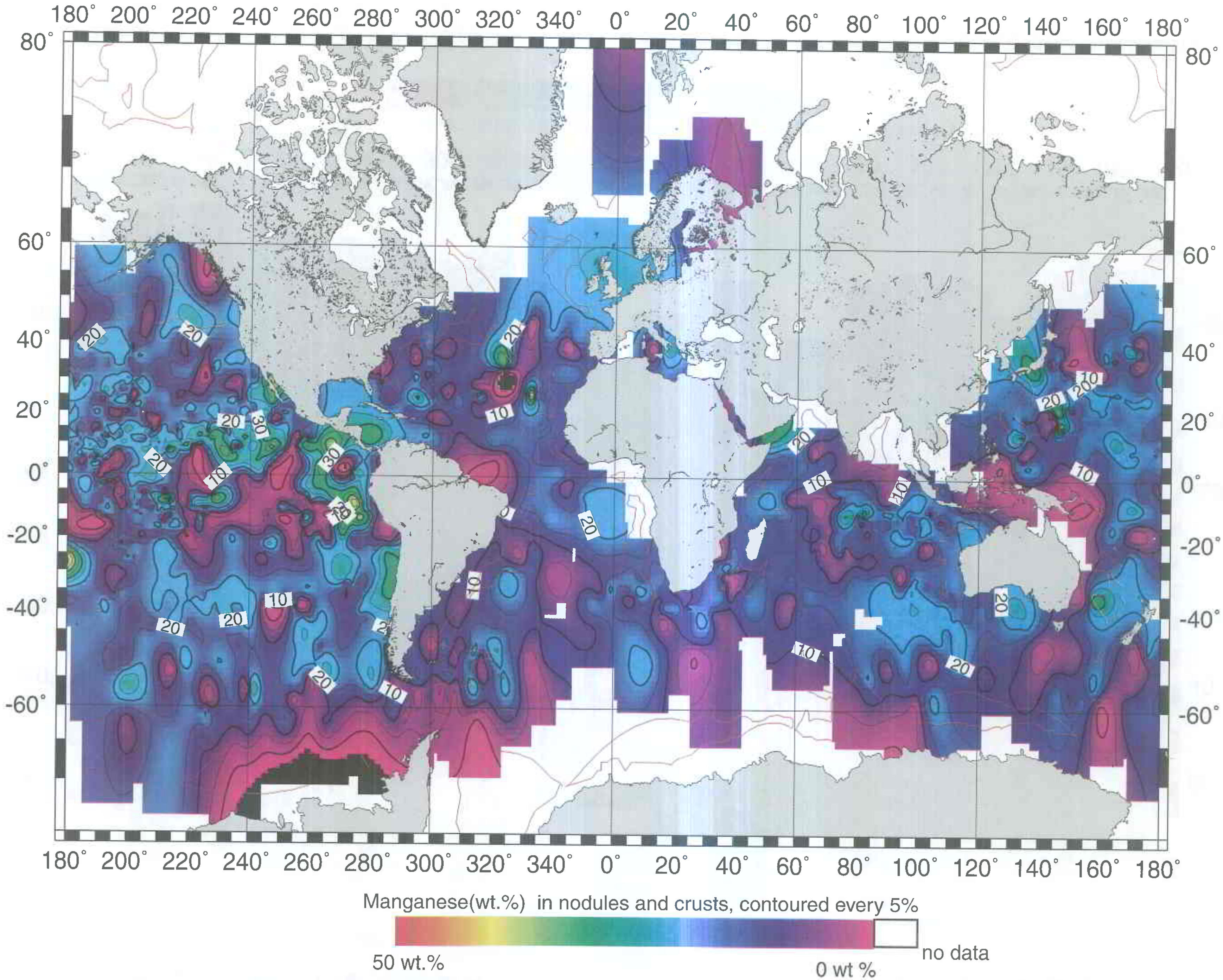


Figure 13. Concentration (in weight per cent) of elemental manganese in nodules and crusts, gridded on a 1° latitude and longitude basis from data compiled from the same sources cited on Figure 11.

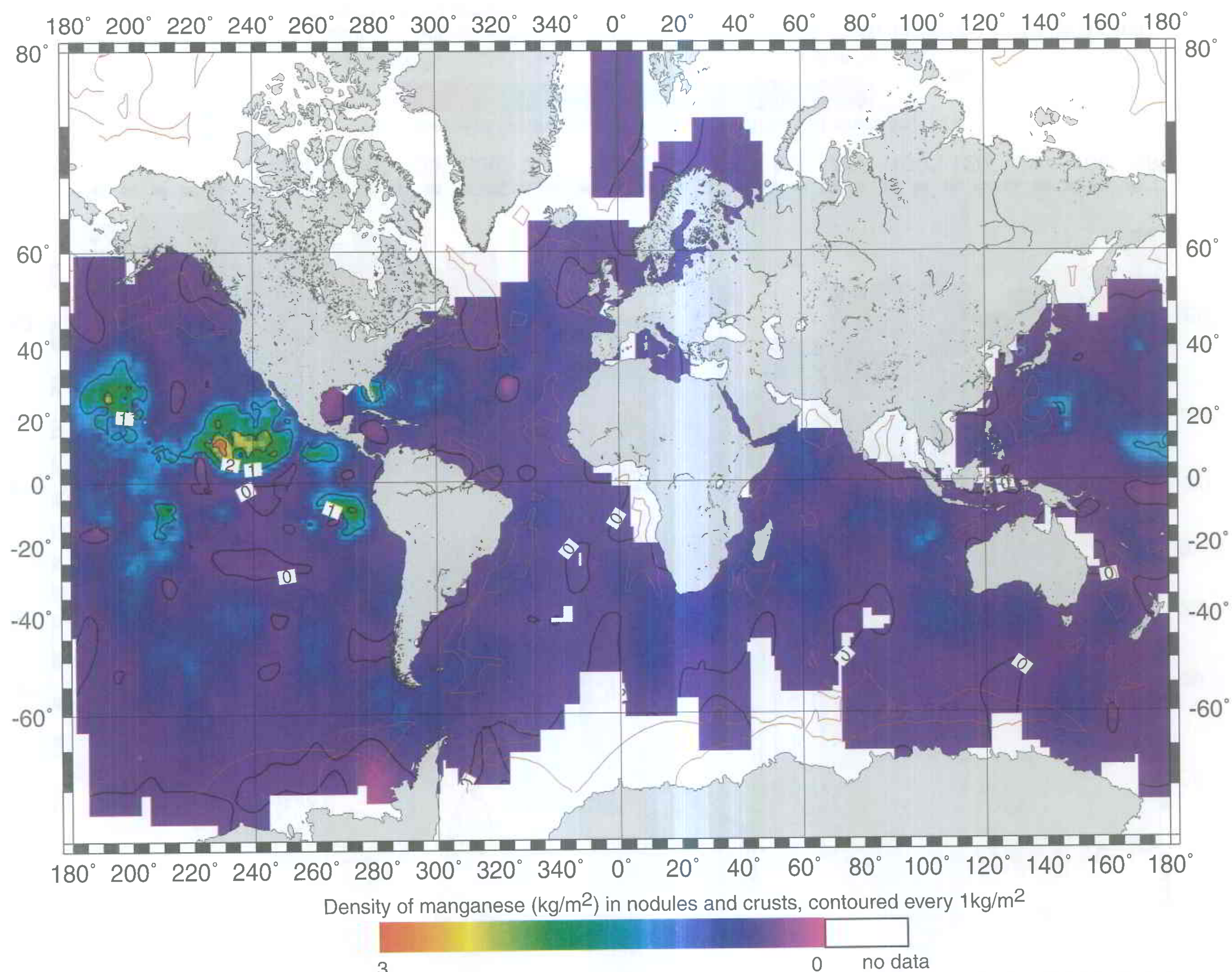


Figure 14. Density of elemental manganese (in kg/ m^2) on the seafloor, contained in nodules and crusts, gridded on a 1^{o} latitude and longitude basis from data compiled from the same sources cited on Figure 11.

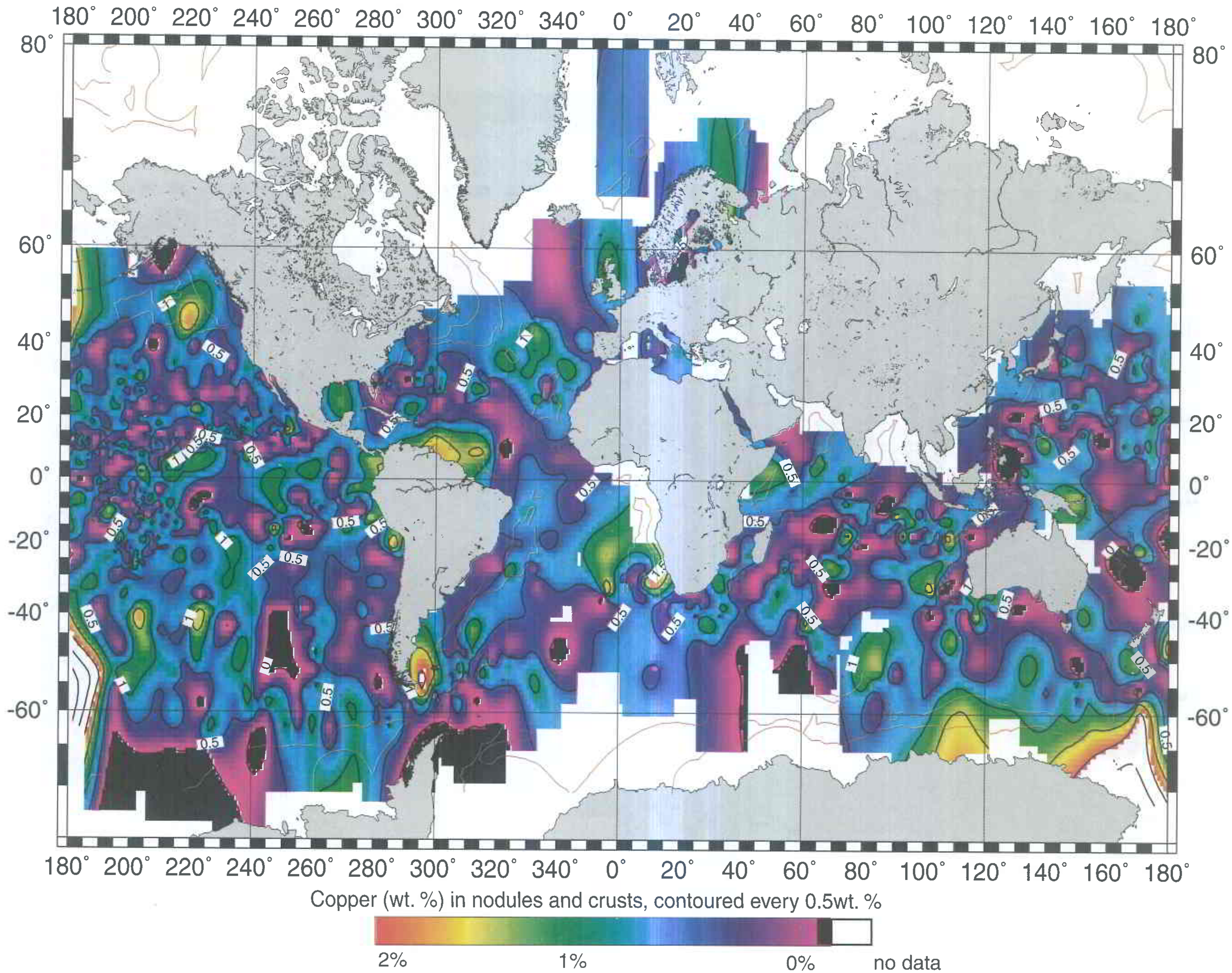


Figure 15. Concentration (in weight per cent) of elemental copper in nodules and crusts, gridded on a 1^0 latitude and longitude basis from data compiled from the same sources cited on Figure 11.

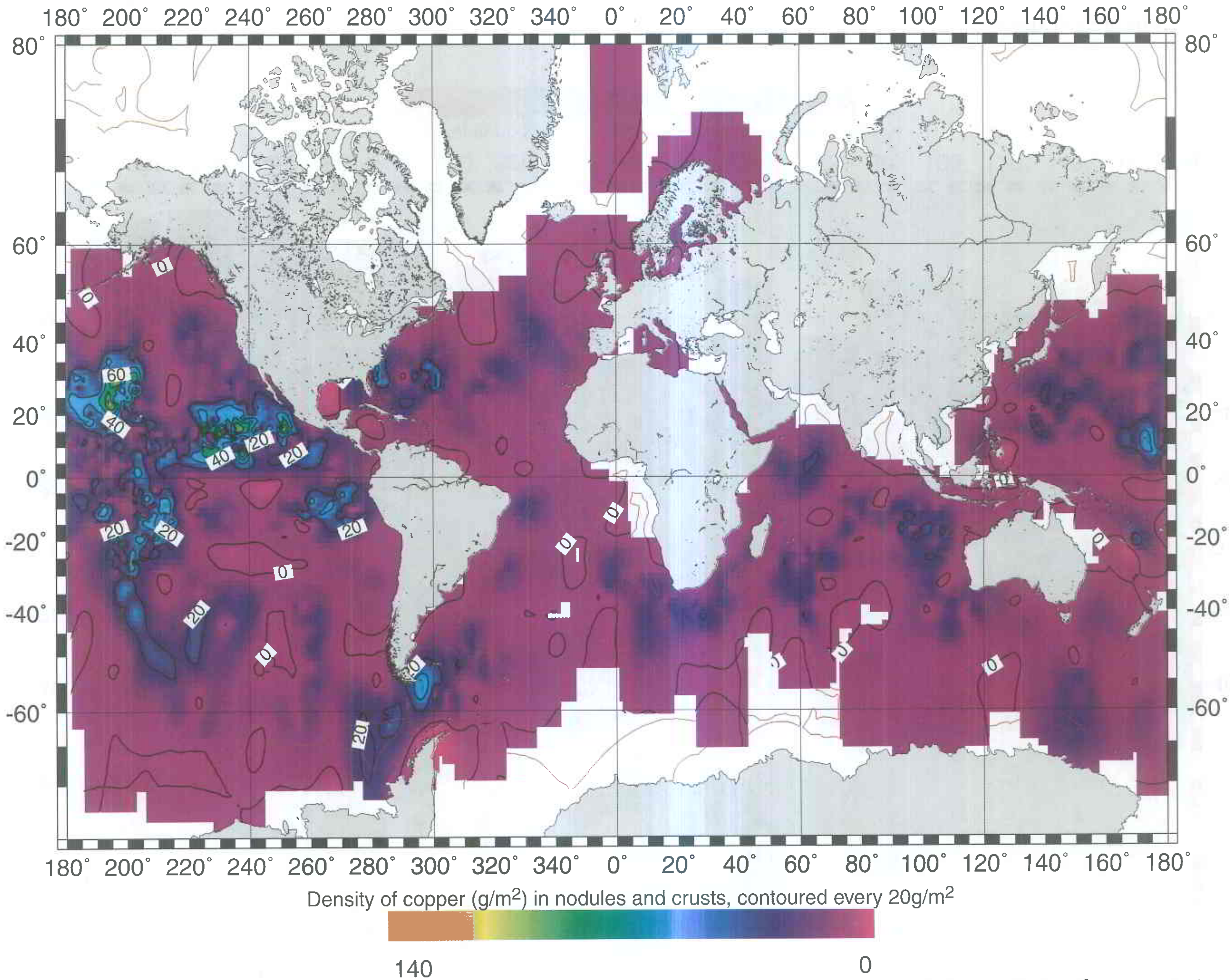


Figure 16. Density of elemental copper (in g/m^2) on the seafloor, contained in nodules and crusts, gridded on a 1^0 latitude and longitude basis from data compiled from the same sources cited on Figure 11.

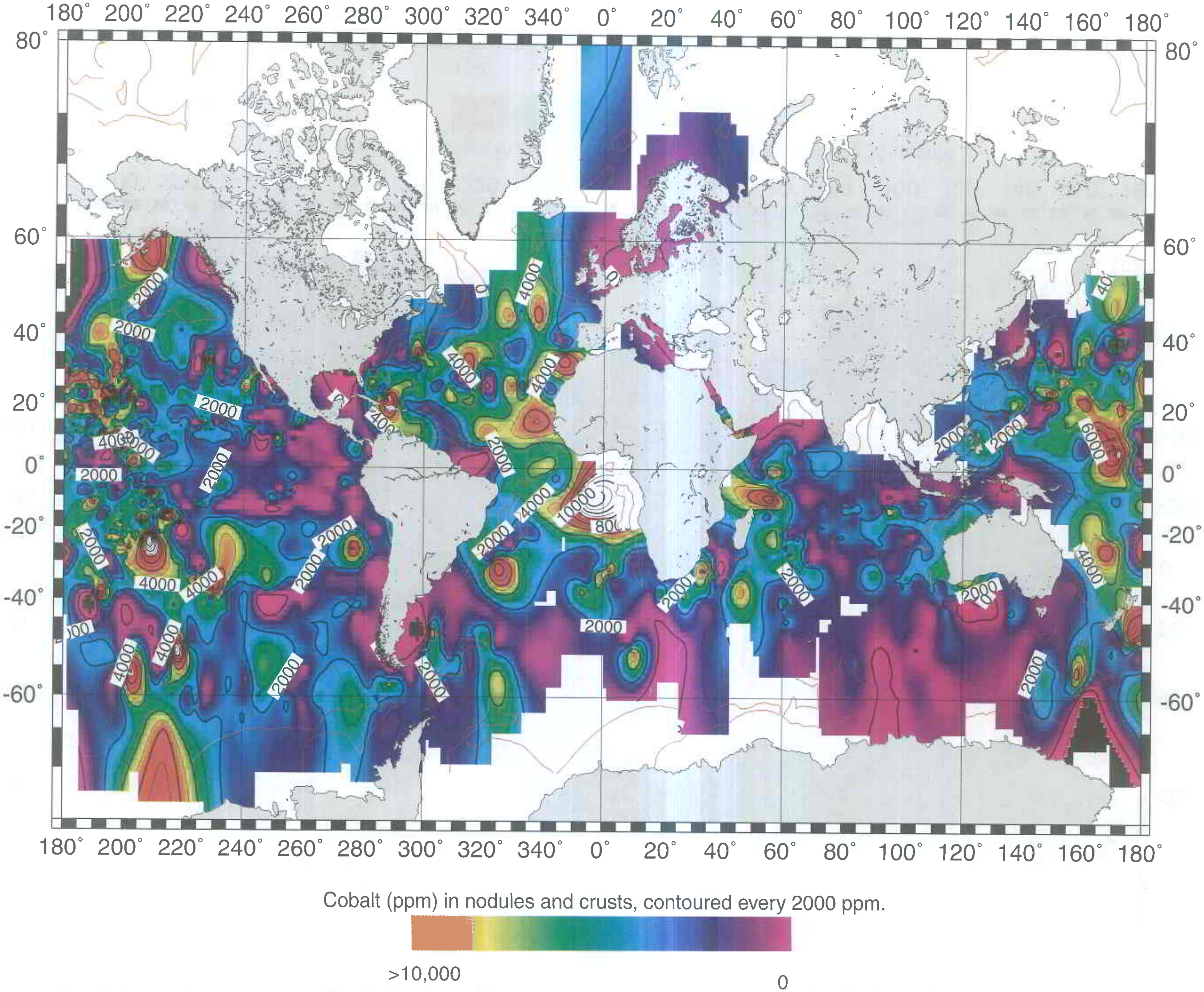


Figure 17. Concentration (in part per million) of elemental cobalt in nodules and crusts, gridded on a 1^0 latitude and longitude basis from data compiled from the same sources cited on Figure 11.

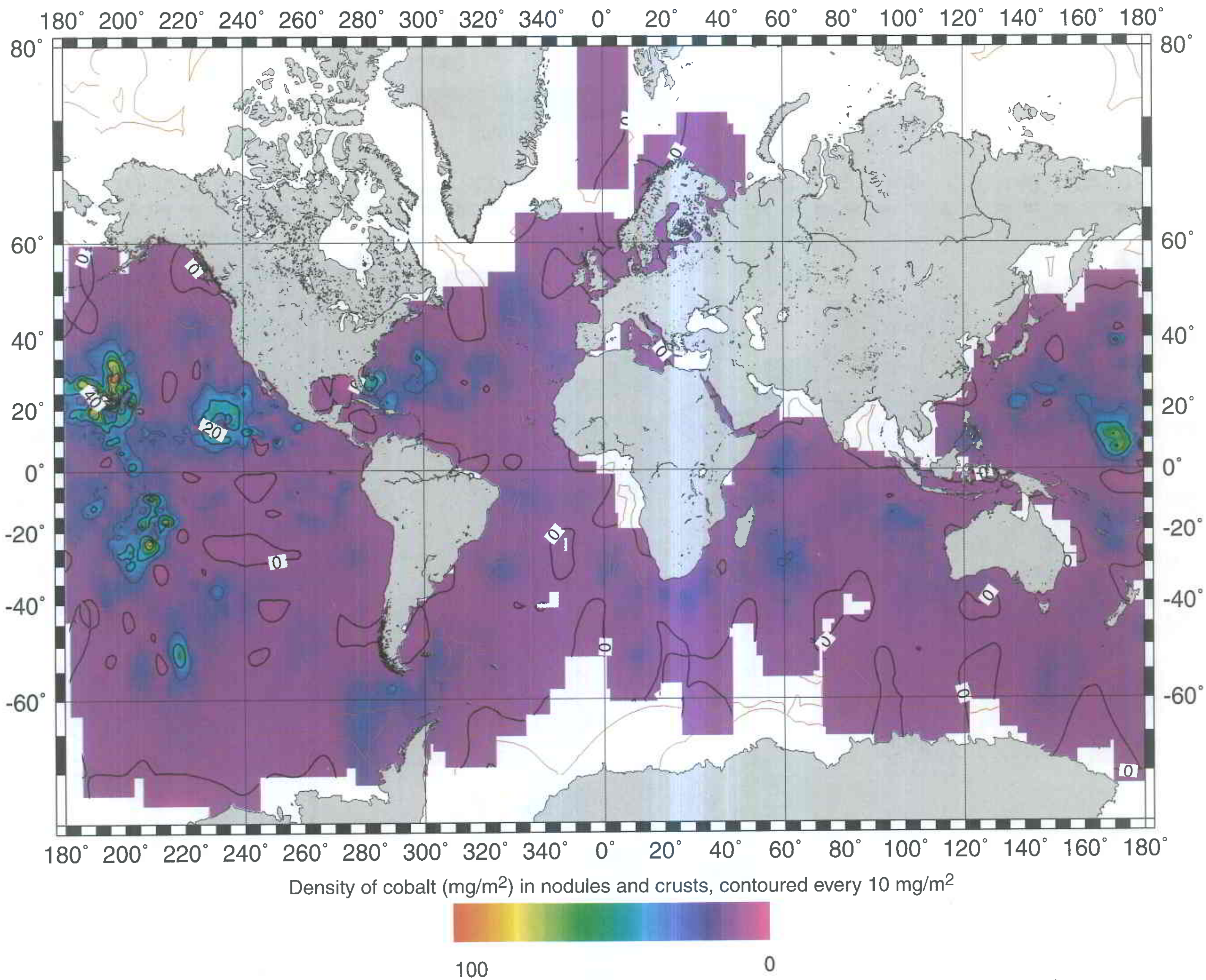


Figure 18. Density of elemental cobalt (in mg/m^2) on the seafloor, contained in nodules and crusts, gridded on a 1^o latitude and longitude basis from data compiled from the same sources cited on Figure 11.

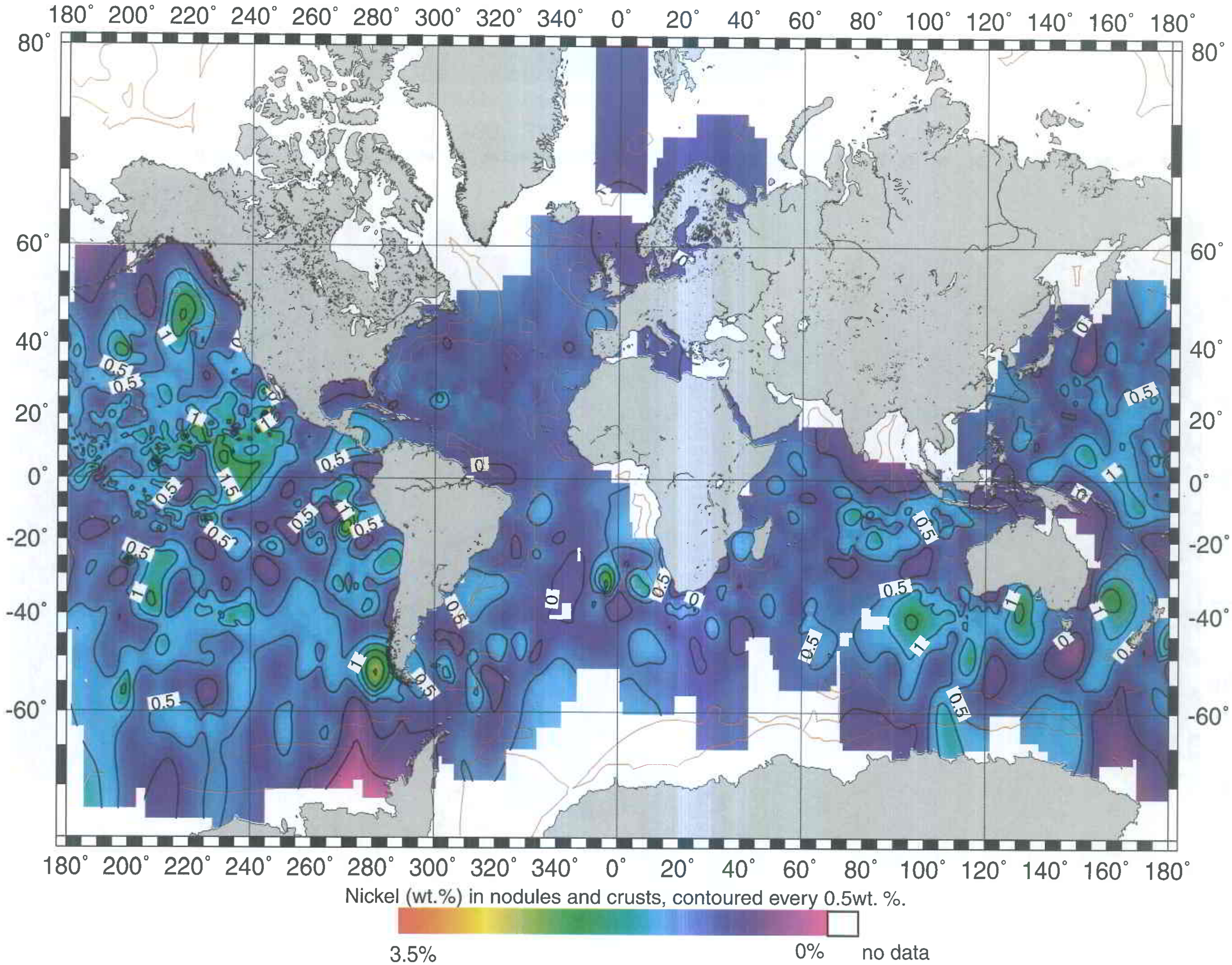


Figure 19. Concentration (in weight per cent) of elemental nickel in nodules and crusts, gridded on a 1º latitude and longitude basis from data compiled from the same sources cited on Figure 11.

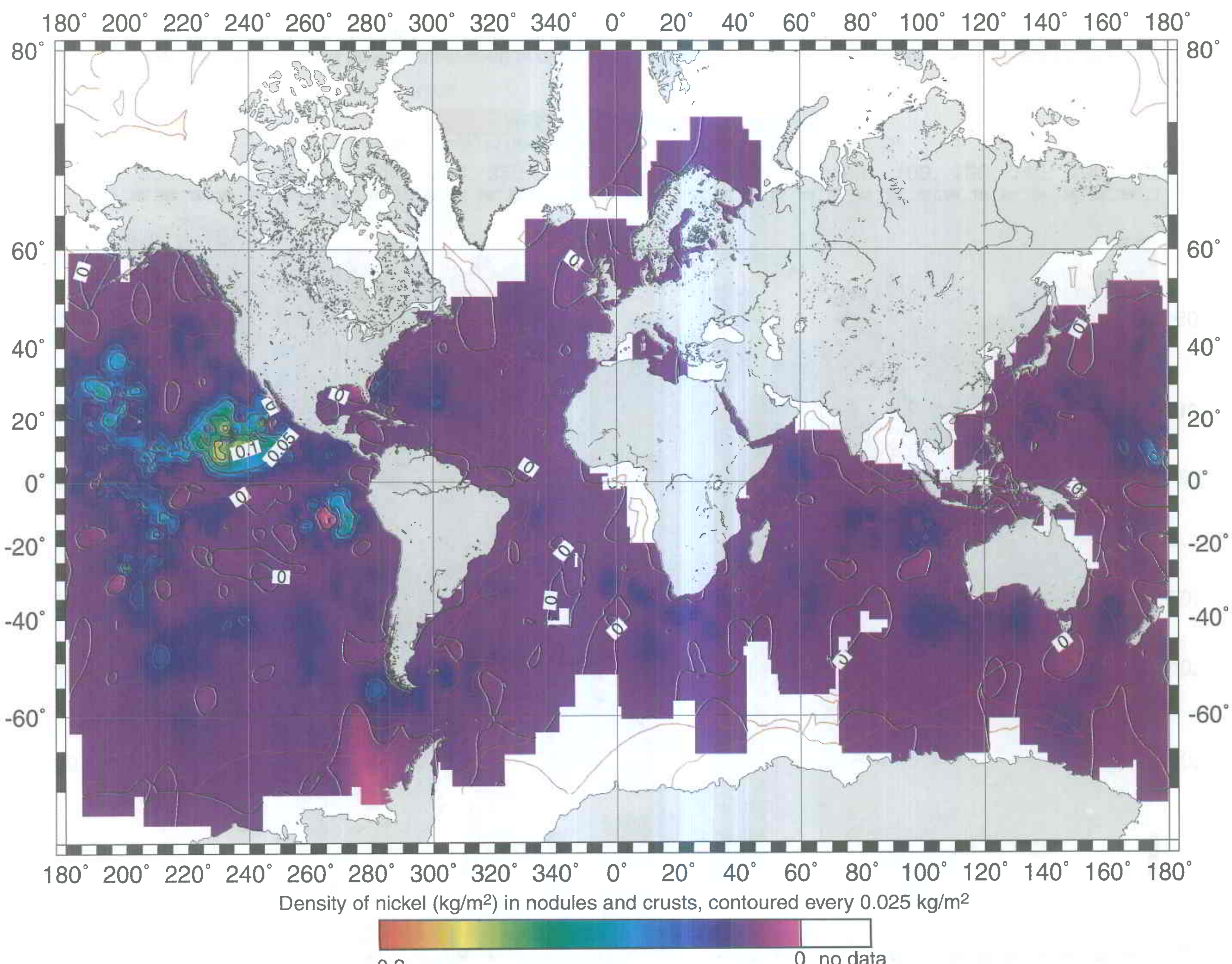


Figure 20. Density of elemental nickel (in kg/m^2) on the seafloor, contained in nodules and crusts, gridded on a 1^0 latitude and longitude basis from data compiled from the same sources cited on Figure 11.

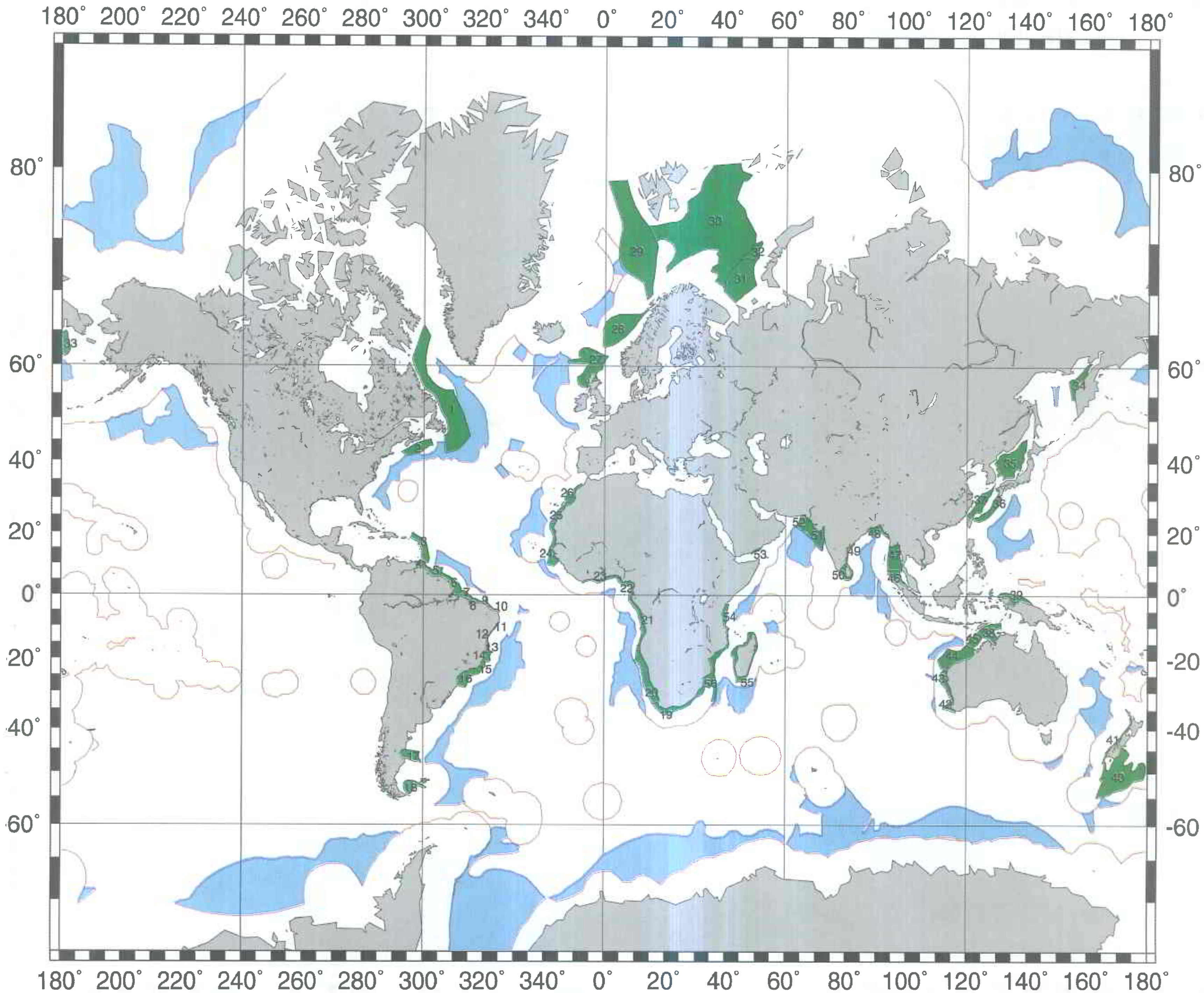


Figure 21. Oil and Gas provinces of the world, with identifying numbers referred to in the text (after Klett et al.,1997)

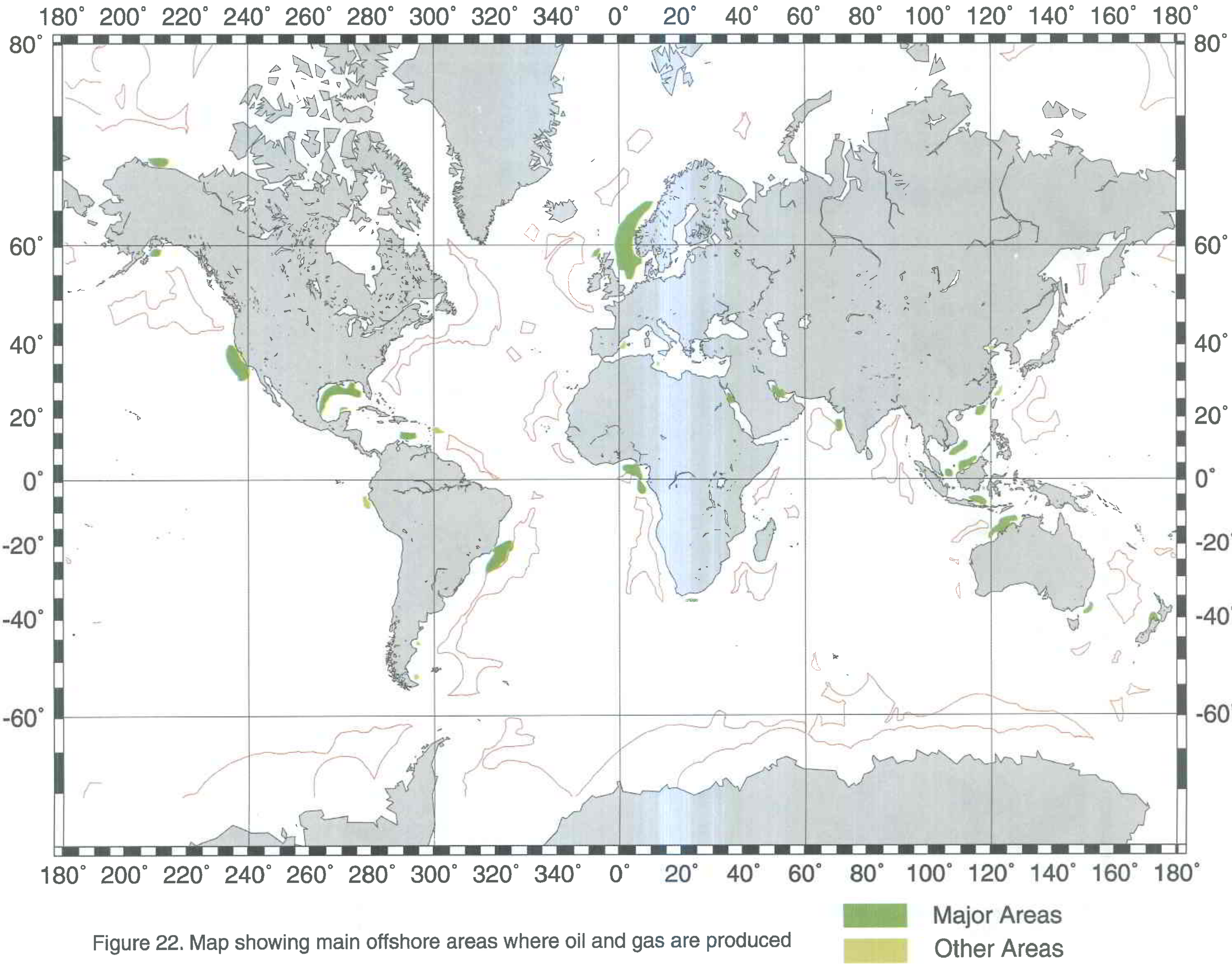


Figure 22. Map showing main offshore areas where oil and gas are produced

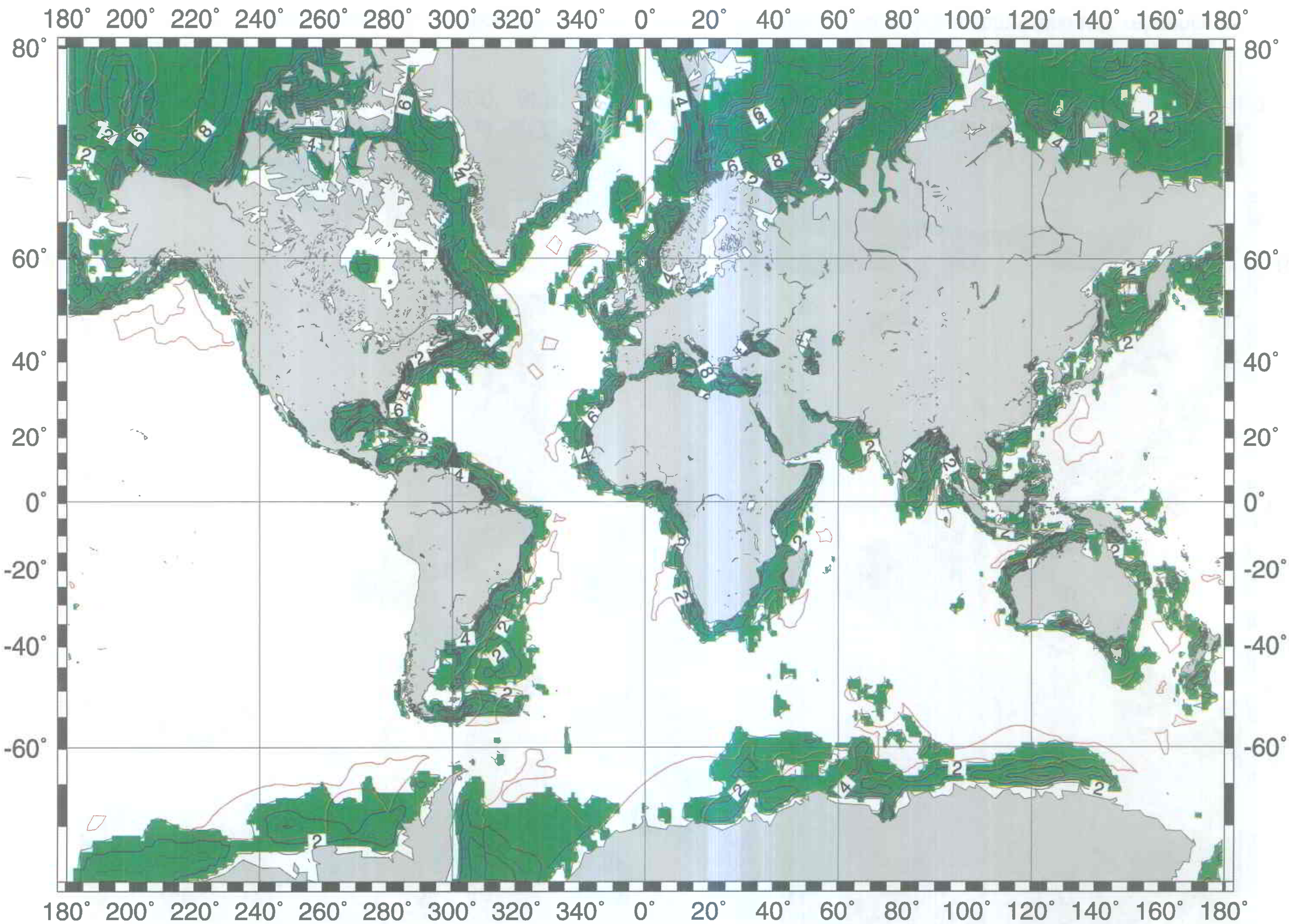


Figure 23. Map showing sediment thickness (contoured every 1 km - from the world sediment thickness model, Figure 5) for areas on the seafloor containing greater than 1 km sediment thickness and with reference to ELCS regions (outlined in red).

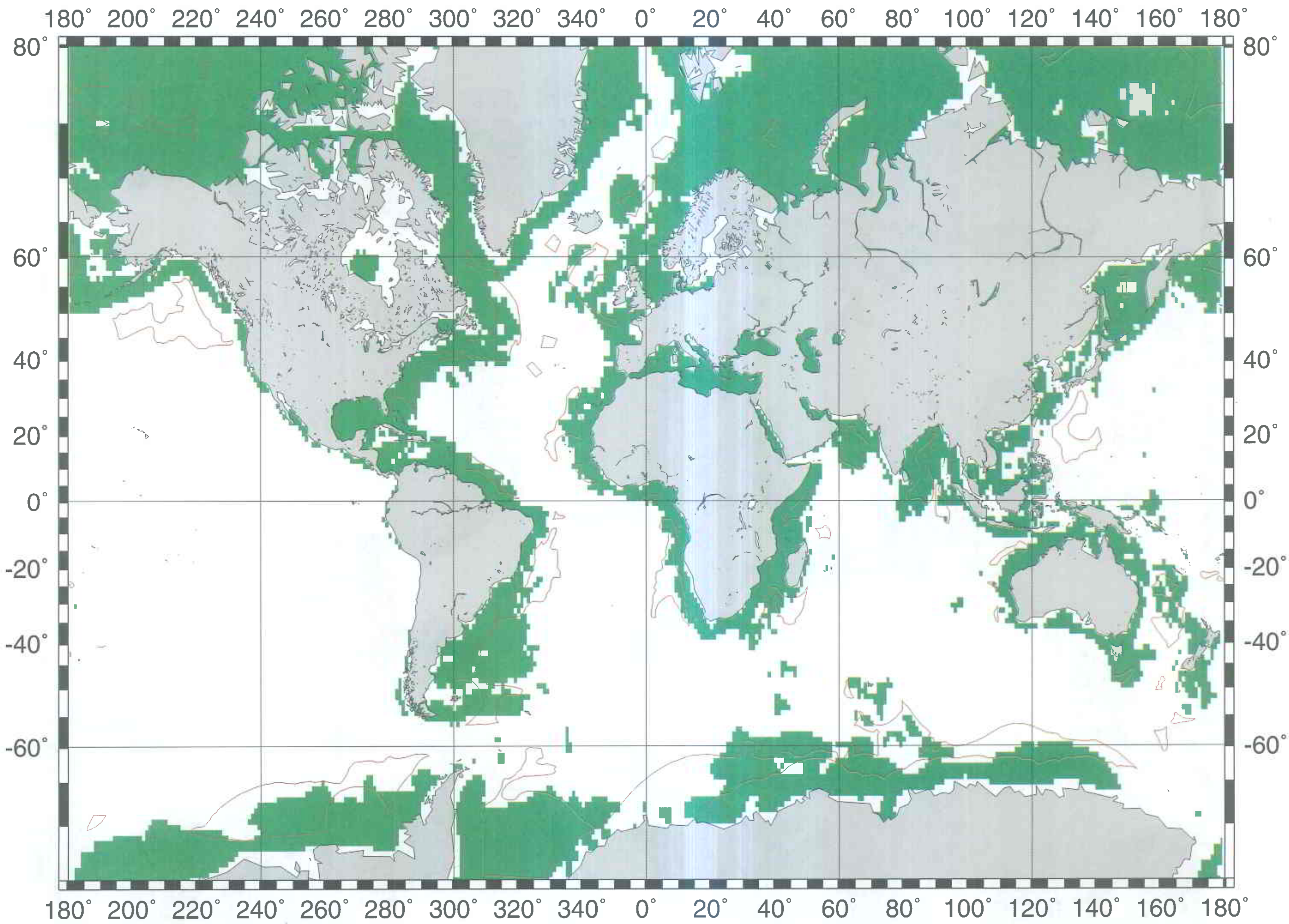


Figure 24. Map showing areas of the seafloor with greater than 1 km thickness of sediment accumulation with reference to ELCS regions (**outlined in red**).

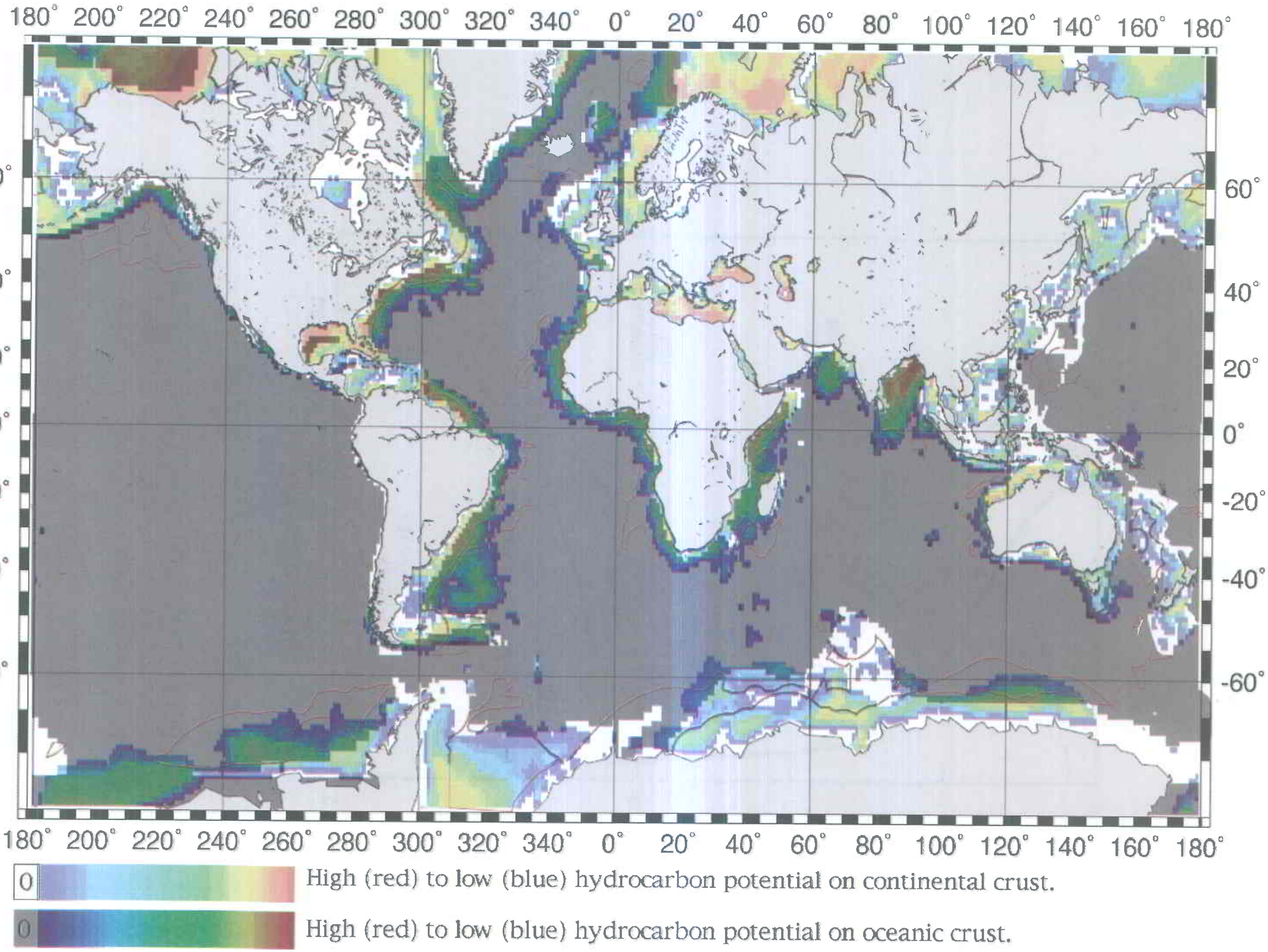


Figure 25. Map showing conventional hydrocarbon potential (qualitative and relative only) based on sediment thickness, crustal age and crustal type.

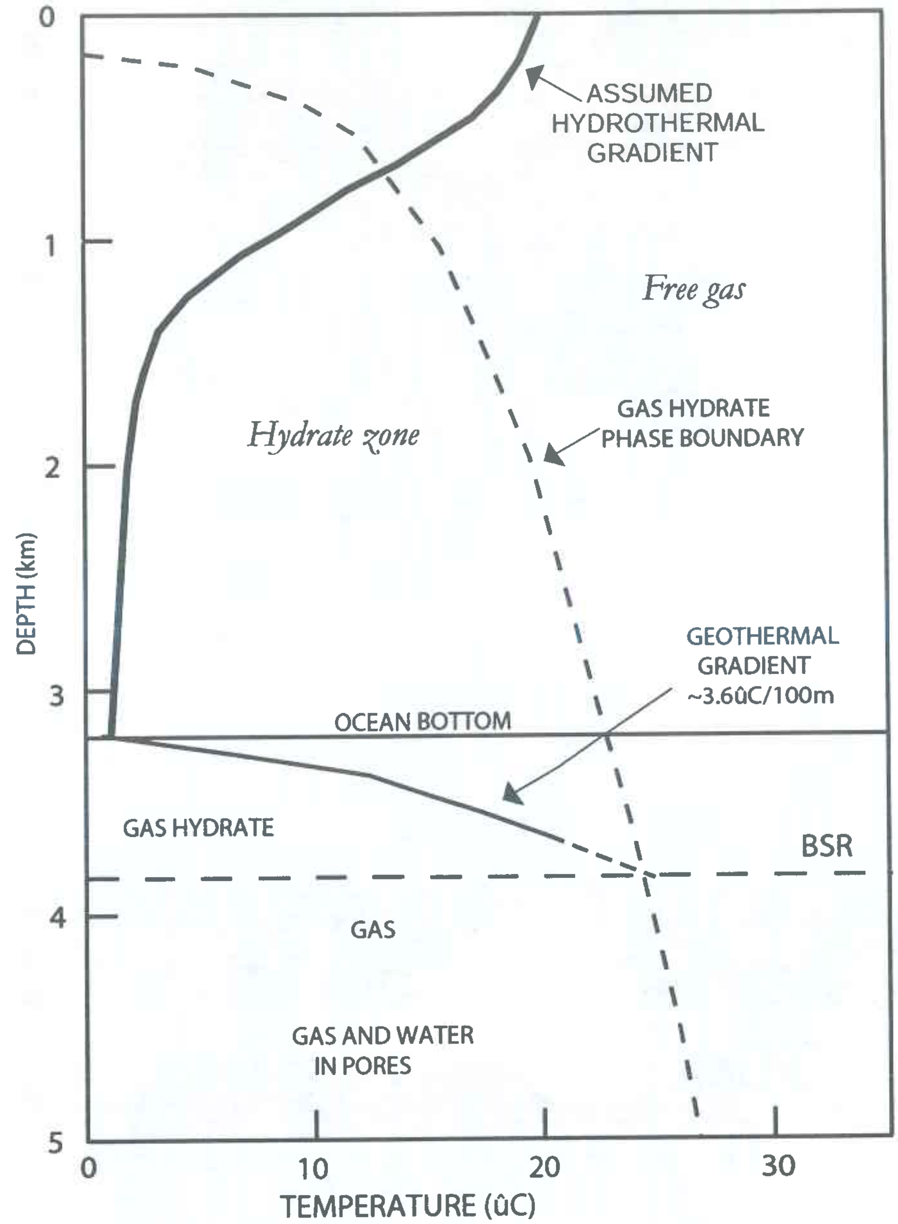


Figure 26. Phase equilibrium diagram for gas hydrate stability with pressure and temperature (after Prensky, 1995).

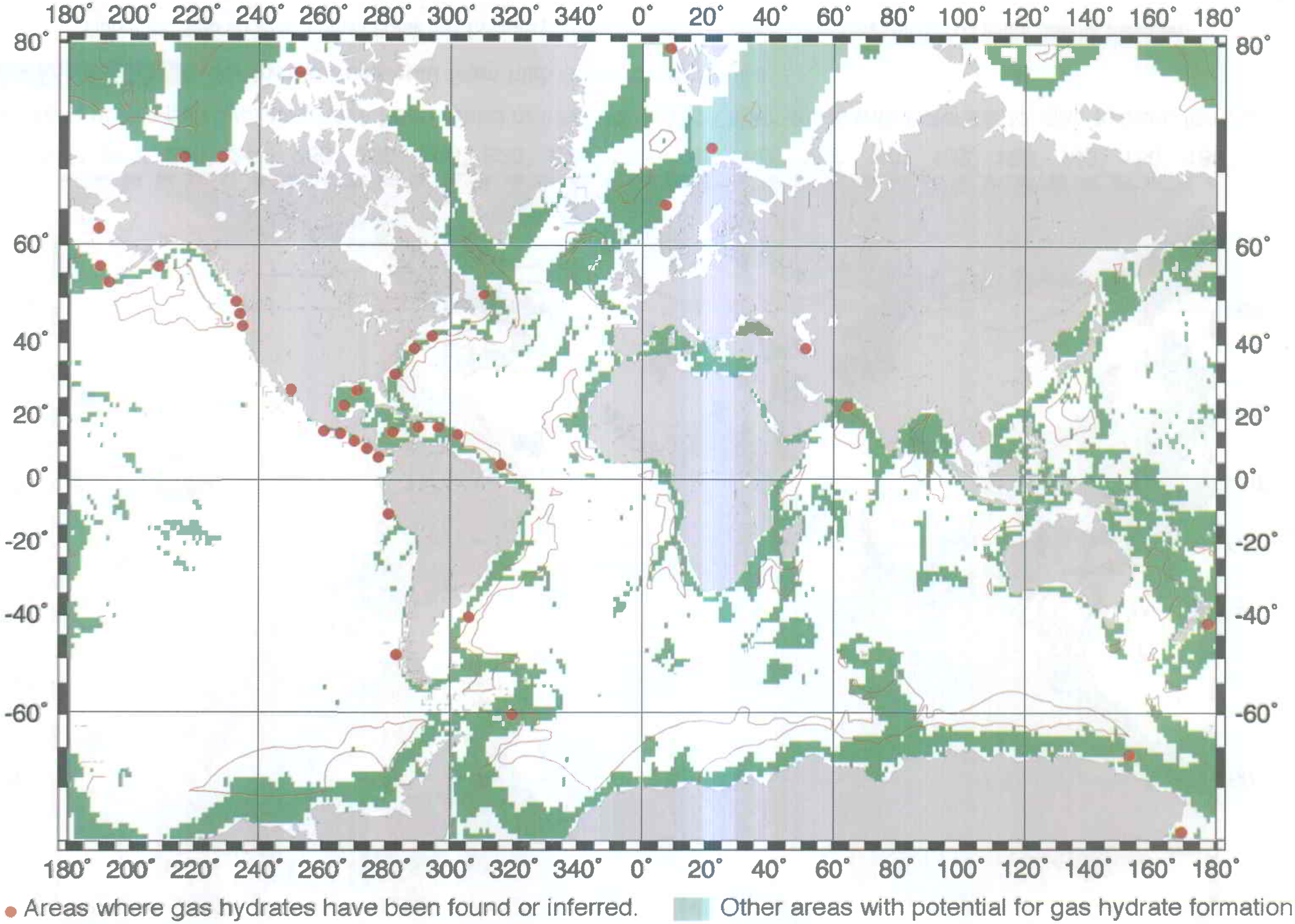


Figure 27. Location of known and indicated gas hydrate occurrences world wide, but excluding areas where bottom simulating reflectors are found (after Max, 1990; Lee et al, 1994; Kesler, 1994; Kvenvolden et al., 1993).

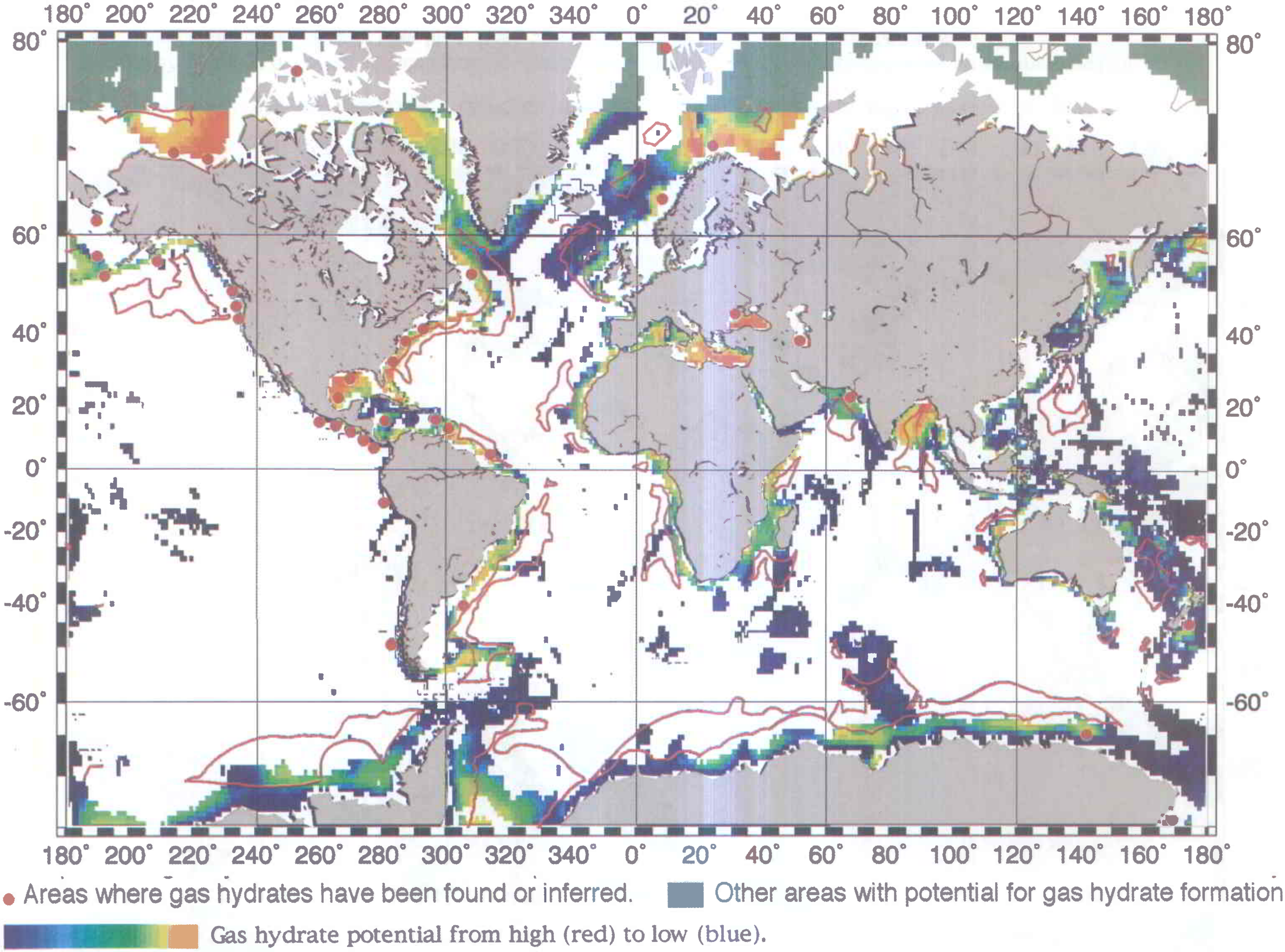


Figure 28. Map showing conventional gas hydrate potential (qualitative and relative only) based on water depths between 500 m and 4,000 m, seafloor greater than 30My old and sediment thickness.

International Seabed Authority

This technical report was prepared by the Challenger Division for Seafloor Processes at the Southampton Oceanography Centre, U.K. for the International Seabed Authority. It examines the global non-living resource potential within the extended "legal" continental shelf areas based on a statistical evaluation of known occurrences and reserves, the geologic environments favourable for their formation, models for sediment types and thickness, and basement composition. The result is an assessment of the potential for non-living resources to occur. The major resource potential within extended continental shelf areas is held in iron-manganese nodules and crusts, conventional oil and gas, and gas hydrates. In manganese nodules and crusts, four elemental metals comprise the main components of commercial value: manganese, copper, nickel and cobalt. However, the real value of these resources depends on the cost recovery and production. With the probable exception of conventional oil and gas, most of these resources will remain unrecoverable until technological advances allow recovery from deep water. The medium-term future is likely to see exploration for and exploitation of marine gas hydrates. These have substantial economic potential and, as conventional hydrocarbon reserves dwindle, the prospect of marine gas hydrate exploitation becomes increasingly probable.

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