# BIOPROSPECTING AND THE GENETIC RESOURCES OF HYDROTHERMAL VENTS ON THE HIGH SEAS: WHAT IS THE EXISTING LEGAL POSITION, WHERE ARE WE HEADING AND WHAT ARE OUR OPTIONS?

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## I INTRODUCTION

As technology has advanced so has our understanding of the biodiversity of the deep-sea. Increasingly the deep-sea, and beyond it the deep biosphere,[1] are of increasing interest to both science and industry. Until recently most bioprospecting[2] in the oceans had been confined to the shallower waters of the coastal and near coastal zones. A lack of knowledge of the biodiversity of the deep-sea, together

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1 Living bacteria and archaea are believed to exist hundreds of metres below the sea-bed and probably to depths where thermogenic geosphere processes occur. Several research institutions are currently exploring the deep biosphere. For examples see the European Union funded research project 'DeepBug' (http://www.chm.bris.ac.uk/deepbug/index.htm) (accessed 1 July 2004), the Deep biosphere work of the Ocean Drilling Program (http://www-odp.tamu.edu/publications/185_IR/chap_01/c1_11.htm) (accessed 1 July 2004), or the Research Program for Deep-subsurface extremophiles at the Japan Agency for Marine-Earth Science and Technology (formerly the Japan Marine Science and Technology Centre) http://www.jamstec.go.jp/jamstec-e/bio/en/mesubex.html (accessed 1 July 2004).

2 There have been many attempts made to define bioprospecting. As Jeffery notes all 'such definitions denote an activity that involves the search of biodiversity (sometimes termed nature or natural sources) for resources, be they genetic or biochemical or both, for use in purely scientific and or commercial endeavours'. This is a useful description for the purposes of this paper. See M I Jeffery, 'Bioprospecting: Access to Genetic Resources and Benefit Sharing under the Convention on Biodiversity and the Bonn Guidelines' (2002) 6 *Singapore Journal of International and Comparative Law* 747.

with logistical difficulties of working in environments of high pressure and total darkness associated with the deep-sea, meant that bioprospecting in the deep-sea was unknown. However, now a range of biological communities and habitats in the deep-sea including hydrothermal vents, deep-sea sediments, methane seeps and even the deepest points in the ocean such as the Mariana Trench (a depth of 11,035 metres)[3] are of interest to science and industry alike. All have been sampled with an eye to their biotechnology potential.

This paper focuses on only one of these deep-sea habitats, namely deep-sea hydrothermal vents or deep-sea hot springs. It examines a number of key questions in relation to bioprospecting at hydrothermal vents on the high seas, with a view to making a contribution to the ongoing debate as to whether, if, and how we can or should regulate access to hydrothermal vents on the high seas. It begins by briefly introducing the hydrothermal vent ecosystem. The paper then outlines the nature and extent of bioprospecting and commercial research activity in relation to the genetic resources of hydrothermal vents. Who is this research being carried out by? Is it primarily industry, academia or a combination of both? To what extent has such research been commercialised? What products derived from hydrothermal vent genetic resources are on the market?

The paper then goes on to examine the extent to which existing international law regulates bioprospecting at hydrothermal vent sites on the high seas. This includes an examination of the recent Study of the Relationship between the Convention on Biological Diversity (CBD)[4] and the United Nations Convention on the Law of the Sea (UNCLOS)[5] with regard to the conservation and sustainable use of genetic resources on the deep seabed. This study was considered at the CBD Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) meeting in Montreal in March 2003, and at the subsequent meeting of the Conference of Parties (COP) of the CBD in Kuala Lumpur in 2004. The ongoing work of the International Seabed Authority (ISA) in relation to biodiversity of the deep-sea and hydrothermal vents is also briefly surveyed.

To the extent that there are gaps in the law the paper goes on to consider some alternate sources of law of relevance. Although there are clearly significant gaps in the major treaties UNCLOS and the CBD, it is argued that there are nonetheless other sources of law that to a limited extent have the potential to provide for regulation of bioprospecting and other activities at hydrothermal vent sites on the

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3 In March 1996 the then Japan Marine Science and Technology Centre successfully sampled some 3000 microbial strains from the Mariana trench which are now stored for future research by their Bio-Venture Center for Extremophiles (see http://www.jamstec.go.jp/jamstec-e/bio/seaex/mariana.html), (accessed 1 July 2004).

4 Convention on Biological Diversity, done at Rio de Janeiro, 5 June 1992, entered into force 29 December 1993, 31 ILM (1992).

5 United Nations Convention on the Law of the Sea, done at Montego Bay, 10 December, 1982, entered into force 16 November 1994, 21 ILM (1982).

High Seas which so far have not been considered in detail. These merit further examination as debate progresses on this issue.

## II THE HYDROTHERMAL VENT ECOSYSTEM

### A *Formation of Hydrothermal Vents*

To date more than 100 hydrothermal vent sites have been identified around the world.[6] The most studied sites are located in the eastern Pacific (principally the East Pacific Rise and the Juan de Fuca, Gorda, and Explorer Ridges) and the north-central Atlantic (principally the Mid-Atlantic Ridge).[7] Recently hydrothermal vents have been discovered at twelve sites located on the Gakkel Ridge, which runs under the Arctic Ocean from north of Greenland to Siberia.[8] Given that the mid-ocean ridges are known to circle the globe for some 75,000 kilometres it is probably reasonable to speculate that many more, possibly thousands, of hydrothermal vent sites lie hidden below the deep-sea waiting to be discovered. Little work if any, for example, has been done in the Southern Ocean close to Antarctica. Given the size of the ridge system associated with the Antarctic and Australian Plates it is probably reasonable to speculate that significant hydrothermal vent sites lie on or adjacent to the boundaries of these plates.

Hydrothermal vents generally form at mid-oceanic ridges[9] due to interaction of sea water with magma associated with the generation of new lithosphere. They are formed due to the close proximity of heat-laden magma chambers to the seafloor, in conjunction with tectonic plate movement which causes the convective circulation of dense, cold seawater through the cracked and fissured upper portions of the lithosphere.[10] Water circulates through the crust and heat transfers from the magma to the water. Due to intense pressure on the deep ocean floor the temperature of the fluid can be as high as 350°C. At such an extreme temperature the water is very

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6 P Ré, 'Deep-Sea Hydrothermal Vents "Oasis of the Abyss"' in J Beurier, A Kiss and S Mahmoudi (eds), *New Technologies and Law of the Marine Environment* (2000) 68.

7 C L Van Dover, *The Ecology of Deep-Sea Hydrothermal Vents* (2000) 26.

8 Reuters, 'Life, but not as we know it, on the boiling bed of a frozen ocean', *Sydney Morning Herald* (Sydney), 30th November 2001.

9 Some sites, such as those recently identified in New Zealand's EEZ and in the Manus Basin in Papua New Guinea's territorial sea are not associated with the mid-oceanic ridge system but are associated with back-arc and fore-arc spreading centres. Back-arc spreading centres form behind island arcs where old lithosphere is subducted beneath a continental plate moving in the same direction. The sinking slab [sic] of lithosphere pulls on the edge of the overlying plate splitting it open and forming a zone of extension. If sufficient heat is generated magma wells up in this zone, providing the heat source required for the formation of hydrothermal vents. Hydrothermal vents have also been found associated with seamounts. This occurs where ever there is sufficient heat and porosity to drive hydrothermal convection. Similarly on occasion they have been found in the centre of plates where there are active submarine volcanoes. Several sites have also been found associated with areas of high sediment deposition including those in the Guaynas Basin in the Gulf of California, Middle Valley of the Juan de Fuca Ridge and in the Escanaba Trough of the Gorda Ridge; see Van Dover above n 2.

10 R A Lutz, and M J Kennish, 'Ecology of Deep-Sea Hydrothermal Vent Communities' (1993) 6(2) *Earth in Space* 11**,** 12.

buoyant and when it finds a path through the sea floor it passes from the seafloor to the surrounding seawater at high velocity. The mixing of the fluid with the surrounding seawater causes changes in pH and temperature and the precipitation of minerals.[11] As the water exits the seabed minerals crystallise onto the volcanic rocks often forming black smoker chimneys.[12]

### B *A Species Rich Ecosystem*

The deep-sea is a species rich environment, although many of these species are spread out amongst the vast expanse of the soft sediments of the sea floor.[13] In contrast to the sparsely populated soft-sediments of other areas of the deep-sea, hydrothermal vents have been found to be literally teeming with life,[14] hosting one of the highest levels of animal abundance and microbial diversity on Earth.[15] It is hardly surprising, therefore that terms such as 'oases of the abyss',[16] the 'Oceanic Gardens of Eden',[17] and 'biological islands'[18] have all been applied to describe these amazing deep-sea communities.

Hydrothermal vents exhibit a unique range of habitat diversity with species so adapted to their particular niches that are not paralleled at other sites on the planet.[19] They support amazingly diverse and rich ecosystems with high levels of biodiversity and high levels of endemism. Of the approximately 500 species discovered around hydrothermal vents to date between 80%[20] to 90%[21] are endemic

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11 M K Tivey, 'Hydrothermal Vent Systems' (1991) 34(4) *Oceanus* 68, 69.

12 Although columnar chimney black smoker forms are common, not all hydrothermal vents fit this description. Apart from black smokers, complex sulphide mounds are perhaps the most impressive form of hydrothermal vent structure. These are typically huge structures, often towering metres above the adjacent ridge axis. Examples include several located at the Endeavour hydrothermal field on the Juan de Fuca Ridge. These are freestanding sulphide mounds 10-30 metres in diameter and up to 40 metres or more in height. One such mound known as 'Godzilla', because of its height, until it collapsed towered some 45 metres above the ocean floor. These huge structures also typically have multiple black smoker chimneys projecting from them. There are several other variations of morphology and mineral composition, including, white smokers, beehives, flanges and massive sulfide deposits. Massive in a geological sense means material made up entirely of sulphide minerals. The term massive does not refer to the size or volume of such a deposit. As such a very small black smoker chimney can be a massive sulphide deposit. See Van Dover, above n 7, 49.

13 A J Butler and J A Koslow, *A Review of the Biodiversity of the Deep-sea* (2001) 11.

14 Van Dover, above n 7, 19.

15 Canada, Department of Fisheries and Oceans, Endeavour Hydrothermal Vents Marine Protected Area Management Plan (2001), copy on file with author, 5.

16 Ré, above n 6.

17 C H Allen, 'Protecting the Oceanic Gardens of Eden: International Law Issues in Deep-sea Vent Resources Conservation and Management' (2001) 13 *Georgetown International Environmental Law Review* 563.

18 C M Baker *et al*, 'An environmental perspective' in WWF/ IUCN *The Status of natural resources on the high seas.* (2001) 18.

19 Ibid.

20 P Dando and S K Juniper, *Management and Conservation of Hydrothermal Vent Ecosystems: Report from an InterRidge Workshop* (Sidney, British Columbia, 2001) 2.

21 Baker *et al*, above n 18, 18.

to hydrothermal vents and new to science. Three phyla dominate (i.e. they constitute 92% of the species identified): molluscs (34%), anthropods (35%) and annelids (23%).[22] In addition 32 octopus and fish species have also been observed in and around hydrothermal vents.[23] Individual species include giant clams, mussels, the giant tube worm, brachyuran crabs, galatheid crabs, turrid gastropods, limpets, polychaetes, pink bythitid vent fish, barnacles, brittle stars, sea stars, anemones, sponges, soft corals.[24] While the total number of new species discovered is high, at individual vent sites local species diversity is typically low with dominance by a few species at each site. Over 75% of vent species occur at only one site.[25] This endemism may mean that species are restricted to individual vent sites. It also appears as if different oceans support quite different biological communities. Very few species have been found in more than one ocean.[26]

## III BIOPROSPECTING, RESEARCH AND PRODUCT DEVELOPMENT

The food chain of hydrothermal vent ecosystem is based upon chemosynthetic microbial processes rather than photosynthesis.[27] In essence it is the geological and geochemical processes responsible for forming the mid-oceanic ridges and hydrothermal vents that provide the food upon which the associated ecosystem thrives. Microbial forms of life oxidise sulphides, together with other chemicals released from hydrothermal vents such as hydrogen, iron or manganese. These microbes thus serve as the base of the hydrothermal vent food chain.[28] These microbial life forms are the main focus of biotechnology interest.

While the full extent of scientific and commercial research interest in extremophiles from the deep-sea (including hydrothermal vents) has not yet been quantified, there is a substantial body of evidence to show strong scientific and commercial interest in relation to the commercial and industrial uses of extremophiles more generally, and hydrothermal vent thermophiles and hyperthermophiles in particular.[29]

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22 V Tunnicliffe, A G McArthur and D McHugh, 'A biogeographical perspective of the deep-sea hydrothermal vent fauna' (1998) 34 *Advances in Marine Biology* 355, 364.

23 Baker *et al*, above n 18, 18.

24 R A Lutz and M J Kennish, ' Ecology of deep-sea hydrothermal vent communities: A review' (1993) 31(3) *Reviews of Geophysics* 211, 211-214.

25 Butler *et al*, above n 13, 5.

26 Baker *et al*, above n 18, 18.

27 J A Baross and S E Hoffman, 'Submarine Hydrothermal Vents and Associated Gradient environments as sites for the origin and evolution of life' (1986) 2 *Naval Research Reviews* 2, 6.

28 Ibid. Many of these microbes have formed symbiotic relationships with several other species. Examples of such species include the tubeworms and some species of clams and mussels Van Dover, above n 7, especially Ch 6. The tubeworm, which has no eyes, mouth or digestive tract relies on these symbiotic bacteria to survive. They absorb oxygen and other inorganic compounds from the water, with the microbes living inside them then using the absorbed compounds for chemosynthesis. Tubeworms are often therefore found in the area just above vent openings clustering in thickets to direct the exiting fluids past the tips of their tubes. R D Ballard, *The Eternal Darkness: A Personal History of Deep-Sea Expoloration* (2000) 182.

29 At a superficial level the interest in this field is clearly demonstrated by the wealth of scientific literature including a specialised journal *Extremophiles*. In 2003 alone two major international

Derivatives from thermophiles and hyperthermophiles from sources other than hydrothermal vents, such as terrestrial hot springs are already utilised in a wide range of industrial processes. Of particular significance have been a number of enzymes useful in industrial processes requiring high temperatures. Examples of some of the known uses of thermophile and hyperthermophile derivatives are listed in Table 1 below.

**Table 1: Examples of thermophile and hyperthermophile dervivatives and their applications[30]**

| **Thermophile and hyperthermophile Products** | **Industrial/commercial applications** |
|---|---|
| DNA polymerases | DNA amplification by PCR[31] used in research and diagnostics, especially genetic engineering |
| Lipases, pullulanases and proteases | Detergents, food processing and waste water treatment |
| Amylases | Baking and brewing |
| Xylanases | Paper bleaching, pulp and paper processing |
| Cellulases | Pulp and paper recycling |

Research and product development in similar fields is also under way with respect to hydrothermal vent thermophile and hyperthermophile derivatives. To date research and product development have centred mainly on development of novel enzymes for use in a range of industrial and manufacturing processes, and DNA polymerases for use in research and diagnostics. More recently some research has been directed towards possible pharmaceutical and therapeutic applications such as antifungals.[32] While researchers interested in tubeworm colonies around

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conferences, namely the 6th International Marine Biotechnology Conference in Chiba, Japan (and its associated satellite symposia Marine Microbes and Extremophiles) (see http://www.tuat.ac.jp/%7emarine/ accessed 9 October 2003) and Thermophiles 2003 (see http://www.ex.ac.uk/thermophiles/welcome.htm last accessed 15 July, 2004) considered papers and presentations in relation to marine biotechnology and extremophiles from the deep-sea in particular.

30 Adapted from S Maloney 'Extremophiles. Bioprospecting for antimicrobials' http://www.mediscover.net/Extremophiles.cfm, accessed 10 July 2003; C Schiradi and M De Rosa, 'The production of biocatalysts and biomolecules from extremophile' (2002) 20(12) *Trends in Biotechnology* 515; A Aguilar and A T Ingemansson, 'Extremophile microorganisms as cell factories: support from the European Union' (1998) 2 *Extremophiles* 367; E Blochl and S Burggraf, 'Isolation, taxonomy and phylogeny of hyperthermophilic microorganisms' (1995) 11 *World Journal of Microbiology and Biotechnology* 9; D A Cowan 'Hyperthermophilc enzymes: biochemistry and biotechnology' in L M Parson and C L Walker, *Hydrothermal Vents and Processes* (1995) 351-363; and J W Deming, 'Deep ocean environmental biotechnology' (1998) 9 *Current Opinion in Biotechnology* 283.

31 Polymerase Chain Reaction.

32 C H Phoebe and J Combie, 'Extremophilic Organisms as an Unexplored Source of Antifungal Compounds' (2001) 54(1) *The Journal or Antibiotics* 56.

hydrothermal vents are also investigating the possibility of making artificial blood from the hemoglobin found in the blood of tubeworms.[33]

A least seven biotechnology companies are currently actively involved in product development and or collaboration with research institutions with a view to product development in relation to derivatives of thermophiles and hyperthermophiles from hydrothermal vents. Three of these companies, Diversa Corporation, New England Biolabs Inc, and Invitrogen Corporation already market products derived from hydrothermal vent thermophiles and hyperthermophiles. A number of other companies are also involved in research in relation to biotechnology involving hydrothermal vents species other than bacteria and archaea. Details of companies that have been involved in research and product development, and products currently marketed by these companies are presented in Table 2 below.

**Table 2 : Biotechnology Companies involved in research and/or product development in relation to hydrothermal vents: potential applications of ongoing research and products developed and currently on the market[34]**

| **Company** | **Areas of research interest and product development from thermophiles and hyperthermophiles from terrestrial and marine sources and other relevant areas** | **Products currently on the market developed from hydrothermal vent thermophile or hyperthermophile derivatives** |
|---|---|---|
| *Diversa Corporation*[35] | Agricultural, chemical processing, industrial and pharmaceutical applications. This company is especially interested in potential uses of thermophiles in animal feed additives, agricultural product processing enzymes, industrial and consumer product enzymes and high performance specialty chemicals and polymers. | • **Pyrolase™ 160** enzyme, which can be employed in industrial applications at pH 5-9 and at high temperatures. |
| *Innovase LLC*<br><br>(50/50 joint venture of Diversa | Industrial enzymes including applications such as detergents, starch processing, textile manufacturing, oil and gas production, pulp and paper | |

33 S K Juniper, 'Description of ecosystems of the deep seabed and impacts' presentation to the fifth meeting of the United Nations Open-ended informal consultative process on oceans and the law of the sea, 7-11 June 2004, available from http://www.un.org/Depts/los/consultative_process/consultative_process.htm, accessed 7 July, 2004

34 Sourced from individual company web sites, annual reports and literature as cited.

35 See www.diversa.com, last accessed 12 July, 2004.

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| Corporation and The Dow Chemical Company). | processing, and the production of baked goods, beer, wine and dairy products. Also investigating applications in areas such as water treatment, industrial cleaning and biofilm removal. | |
| *Invitrogen Corporation*[36]<br><br>Under licence from Diversa Corporation. | Commercialisation of three of Diversa Corporation's thermostable DNA-modifying enzymes. | • **ThermalAce™ DNA Polymerase**, a novel enzyme that improves the performance of DNA amplification for the widely used polymerase chain reaction**.** |
| *New England Biolabs Inc.*[37] | Restriction endonucleases and other related products for molecular biology research/recombinant DNA technology | • **Vent $_R$ ® DNA Polymerase** a high-fidelity thermophilic DNA polymerase, which is purified from a strain of *E. coli* that carries the Vent DNA Polymerase gene from the archaea *Thermococcus litoralis* isolated from a submarine hydrothermal vent near Lucrino, Bay of Naples, Italy.[38] The native organism is capable of growth at up to 98°C [39]<br>• **Vent $_R$ ® (exo$^-$) DNA Polymerase** genetically engineered version of Vent $_R$ DNA Polymerase that carries the Vent DNA Polymerase gene from the archaea *Thermococcus litoralis* isolated from the |

36 See www.invitrogen.com, last accessed 12 July, 2004.

37 See www.neb.com, last accessed 12 July, 2004.

38 F B Perler *et. al*, 'Intervening sequences in an Archaea DNA polymerase gene' (1992) 89 *Proc Nat. Acad Sci USA* 5577.

39 New England Biolabs Inc. Vent ® $_R$ DNA Polymerase Technical Bulletin # M0254 (26/8/02) available from http://www.neb.com, accessed 4 October 2002.

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| | | hydrothermal vent site noted above.[40]<br>• **Deep Vent $_R$ ® DNA Polymerase** a more stable form of Vent ®$_R$ DNA Polymerase. Purified from a strain of *E.coli* that carries the Deep Vent$_R$ DNA Polymerase gene from *Pyrococcus* species GB-D(1).[41] The native organism was isolated from a submarine thermal vent in the Guaymas Basin at 2010 meters. [42]<br>• **Deep Vent $_R$ ® (exo$^-$) DNA Polymerase** genetically engineered version of Deep Vent $_R$ ® DNA Polymerase purified from a strain of *E.coli* that carries the Deep Vent$_R$ DNA Polmerase gene from *Pyrococcus* species GB-D(1)[43] The native organism was isolated from the location noted above.<br>• **9°N$_m$™ DNA Polymerase** purified from a strain of *E.coli*. that carries a modified 9°N$_m$ DNA Polymerase gene from the extremely thermophilic marine archaea |

40 New England Biolabs Inc. Vent ® $_R$ (exo$^-$) DNA Polymerase Technical Bulletin # M0257 (26/8/02) available from http://www.neb.com, accessed 4 October 2002

41 New England Biolabs Inc. Deep Vent ® $_R$ DNA Polymerase Technical Bulletin # M0258 (26/8/02) available from http://www.neb.com, accessed 4 October 2002.

42 H W Jannasch *et al*, 'Comparative Physiological Studies om Hyperthermophilic Archaea isolated from Deep-Sea Hot Vents with emphasis on *pyroccus* strain GB-D' (1992) *Applied and Environmental Microbiology* 3472.

43 New England Biolabs Inc. Deep Vent ® $_R$ (exo$^-$) DNA Polymerase Technical Bulletin # M0259 (26/8/02) available from http://www.neb.com, accessed 4 October 2002.

44 New England Biolabs Inc. 9°N$_m$™DNA Polymerase Technical Bulletin # M0260 (26/8/02) available from http://www.neb.com, accessed 4 October 2002.

45 New England Biolabs Inc. Therminator ™DNA Polymerase Technical Bulletin # M0261 (26/8/02) available from http://www.neb.com, accessed 4 October 2002.

| | | |
|---|---|---|
| | | *Thermococcus sp*. Isolated from a submarine hydrothermal vent at a depth of 2,500 meters, 9º north of the equator at the East Pacific Rise[44]<br>• **Therminator™ DNA Polymerase**[45] |
| *Prokaria ehf*[46] | Development of products for biotechnology/genomics industry for research and diagnostics, for food, agricultural, chemical companies and the pharmaceutical industry, including thermostable DNA polymerases and ss RNA/DNA ligases.<br><br>Prokaria is currently the sole company licensed to access and sample Iceland's offshore submarine hydrothermal vents, and also has sole access to some of Iceland's prime terrestrial hot springs and geothermal areas. | |
| *Genencor International Inc*.[47] | Enzymes for use in applications such as detergents, converting starch to sweeteners, producing ethanol, "stone-washing" blue jeans, and enhancing the nutritional value of animal feed. | |
| Montana Biotech Corporation & Mycologics Inc.[48] | Discovery and isolation of novel antifungal compounds for therapeutic use. Especially interested in identification of extremophiles and thermophiles that have potent activity against human fungal pathogens. Fungal infections are a common | |

46 www.prokaria.com
47 www.genencor.com
48 www.mycologics.com
49 C H Phoebe and J Combie, 'Extremophilic Organisms as an Unexplored Source of Antifungal Compounds' (2001) 54(1) *The Journal or Antibiotics* 56.

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| | complication in kidney, liver, lung and heart transplants and have also been associated with AIDS.<br><br>Joint Research by these two companies resulted in the first reported screening of extremophiles for antifungal activity.<br><br>Although most research has focussed on extremophiles from terrestrial sources, the potential for hydrothermal vent extremophiles has been identified in such research.[49] | |
| Biopolymer Engineering Inc.[50] | Research in relation to polysaccharides, especially chitin for use in a range of applications including consumer products such as recycled paper, household sponges, diapers and feminine napkins and tampons, and medical uses such as wound dressings, hospital bedding, gowns and other medical products.<br><br>Chitin is found in the shells of crustaceans, the exoskeletons of insects and the cell walls of fungi. Biodegradation of these materials in nature involves processes similar to those used commercially to produce popular nutraceuticals. The progress of biodegradation has been modelled and quantified in various studies by this company, including one study involving the evolution of chitin and protein contents of the shells of | |

[50] www.biopolymer.com.

| | | |
|---|---|---|
| | a hydrothermal vent crab exposed to marine soil. [51] | |

So far sample collection from hydrothermal vents is exclusively conducted by scientific research institutions. There are numerous national research institutions involved in research in relation to hydrothermal vents. These include the Japan Agency for Marine Earth Science and Technology (formerly the Japan Marine Science and Technology Centre) (JAMSTEC), Australia's Commonwealth Scientific Industrial and Research Organisation (CSIRO), Institut français de recherche (IFREMER), the Korean Ocean Research and Development Institute (KORDI), the Woods Hole Oceanographic Institute, and the New Zealand Institute of Geological and Nuclear Sciences, to name but a few.

Commercial interests gain access to samples collected through research collaboration with such institutions, or through national culture collections where samples are deposited by research institutions.[52] There are a number of examples of scientific research institutions, Universities, and National Culture Collections that are involved in collaborative research with industry. For example, the Frontier Research program for extremophiles at JAMSTEC collaborates with industry on the development of biotechnology from extremophiles collected by JAMSTEC through its Bioventure Centre.

There is no substantiated evidence that any company has mounted their own dive (as distinct from those in collaboration with scientific research institutions) to hydrothermal vents for sample collection purposes. There is anecdotal evidence, though, that at least one company is planning its own series of dives, independent from any research institution. It is not known precisely what the purposes of these dives are or indeed whether such dives have taken place.[53]

## IV EXISTING POSITION OF HYDROTHERMAL VENTS UNDER INTERNATIONAL LAW

Two major international treaties are relevant to considering the legal status of hydrothermal vents and access to their associated genetic resources for

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51 See www.biopolymer.com and F Gaill *et al*, 'In Situ Biodegradation experiments of chitinous Exoskeletal structures of crabs and vestimentiferans coming from Deep-sea Hydrothermal Vents (1995) *Advances in Chitin Science* 143.

52 For example, the American Type Culture Collection (ATCC) offers a range samples of hydrothermal vent micro-organisms such as *Thiobacillus hydrothermalis* isolated from hydrothermal vents in the North Fiji Basin, and *Pyrococcus horikoshi* isolated from a hydrothermal vent in the Okinawa Trough in the Pacific Ocean, and *Idiomarina Ioihiensis* from hydrothermal vents on the Loihi Seamount, United States that can be purchased over the internet for between US$50 and US$190 per sample. See http://www.atcc.org , accessed 6 July 2004. Similarly the Japanese National Institute of Technology and Evaluation (NITE) offers ampules of hydrothermal vent micro-organisms for between JPY4,000 and JPY8,000 per ampule. See http://www.nite.go.jp/index-e.htm, accessed 6 July 2004.

53 Agnieszka Adamczewska, InterRidge Co-ordinator, interview 17 September 2003.

bioprospecting under international law. These treaties are UNCLOS (as modified by the 1994 Agreement on the Implementation of Part XI of UNCLOS)[54] and the CBD.

### A *UNCLOS*

UNCLOS divides ocean space into a number of jurisdictional zones. For present purposes the most significant zones are the 12 nautical mile territorial sea, the 200 nautical mile Exclusive Economic Zone (EEZ), the Continental Shelf, the High Seas and that portion of the sea-bed beyond national jurisdiction on the High Seas known as the Area. Within the territorial sea, coastal States possess sovereignty to regulate all access to and exploitation of all resources located within the territorial sea and seabed.[55] Within the EEZ, coastal States possess sovereign rights for the purposes of exploring, exploiting, conserving and managing the natural resources, whether living or non-living, of the waters superjacent to the sea-bed and its subsoil, and with regard to other activities for the economic exploitation and exploration of the EEZ.[56] Within the EEZ, coastal States also have jurisdiction with respect to, inter alia, marine scientific research (MSR) and the protection and preservation of the marine environment. This means that the coastal State has the right under international law to regulate activities including bioprospecting at hydrothermal vent fields within their EEZ and territorial sea.[57]

The extent to which the coastal State can regulate bioprospecting at hydrothermal vents on its continental shelf is unclear. Pursuant to Article 77(1) of UNCLOS , the coastal State has 'sovereign rights'[58] to explore and exploit the natural resources of the continental shelf. The term 'natural resources' as used in Part VI is defined in Article 77(4) of UNCLOS as the 'mineral and other non-living resources of the sea-bed and subsoil together with living organisms belonging to the sedentary species'. That is, 'organisms which, at the harvestable stage, either are immobile on or under

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54 Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December, 1982, 28 July 1994, 33 ILM 1309 (1994) (in force 28 July 1996).

55 UNCLOS, article 2.

56 UNCLOS, article 56.

57 Thus measures such as those implemented at the Endeavour hydrothermal vent sites within Canada's EEZ, at the Lucky Strike and Menez Gwen hydrothermal fields within the Portuguese EEZ, and the access regime currently being developed by Papua New Guinea, are entirely consistent with those countries' rights and obligations under UNCLOS and the CBD. For discussion of these regimes see D K Leary, 'Law Reaches New Depths: The Endeavour Hydrothermal Vents Marine Protected Area' in J P Beumer, A Grant and D C Smith (eds), *Aquatic Protected Areas. What works best and how do we know? Proceedings of the World Congress on Aquatic Protected Areas* (2002) 85; D Leary, 'Emerging Legal Regimes regulating bioprospecting for thermophiles and hyperthermophiles of hydrothermal vents' *Journal of Marine Biotechnology*, Special Issue (proceedings of the 6th International Marine Biotechnology Conference, Tokyo, September 2003) (forthcoming) and L Glowka, 'Putting Marine scientific research on a sustainable footing at hydrothermal vents' (2003) 27 *Marine Policy* 303.

58 This term is generally regarded as something less than full sovereignty.

the sea-bed or are unable to move except in constant physical contact with the sea-bed or the subsoil'.[59]

In the context of considering the rights of the coastal State to regulate access to hydrothermal vent sites on the Continental Shelf (including for bioprospecting), a key issue therefore is whether or not species (and importantly bacteria and archaea) associated with hydrothermal vents are sedentary species. However, as Allen notes, the definition of sedentary species 'has little or no relationship to biological taxonomy'.[60] Working out whether hydrothermal vent species fall within the definition of sedentary species presents a number of problems. Firstly, there are clearly difficulties in identifying the harvestable stage of many hydrothermal vent species. Indeed bacteria and archaea are not collected in a way that can be regarded as 'harvesting'.[61] More problematic, though, is the requirement that such species be either immobile on or under the seabed, or unable to move except in constant physical contact with the seabed or the subsoil. Some species found at hydrothermal vents arguably meet this requirement (for example molluscs and gastropods and possibly tubeworms), while others (such as fish and octopus species), are clearly capable of movement through the water without being in constant physical contact with the seabed, and therefore clearly fall outside the definition.[62]

Given the different miens in which microbes are found at vents sites, some such as those found in hydrothermal plumes[63] arguably fall outside the definition of sedentary species, while others such as those under the seabed may arguably fall within the definition if immobile at the harvestable stage. Therefore within the one ecosystem there will be both macrofauna and microfauna that meet the test for sedentary species and fall within the Continental Shelf Regime and may therefore be subject to coastal state regulation, as well as macrofauna and microfauna that will not fulfil the definition of sedentary species, which fall outside the Continental Shelf Regime.[64]

Korn and Friedrich have suggested that, since many species fall outside the sedentary species definition, this leads to a 'fractured regulatory approach regarding management and conservation' of hydrothermal vents and their associated biological resources.[65] Does the failure of some macrofauna and microfauna to fall within the definition of sedentary species really matter? Is the consequence as significant as Korn and Friedrich and Allen's detailed analysis suggest? Perhaps not

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59 Article 77(4), UNCLOS.

60 C H Allen, 'Protecting the Oceanic Gardens of Eden: International Law Issues in Deep-sea Vent Resources Conservation and Management' (2001) 13 *Georgetown International Environmental Law Review* 563, 621.

61 Allen, above n 60, 622-623.

62 Ibid 628.

63 The hydrothermal plume often extends for hundreds of metres into the water column above and around a hydrothermal vent.

64 Allen, above n 60, 627-628.

65 H Korn, H and S Friedrich *et al*, *Deep-sea Genetic Resources in the Context of the Convention on Biological Diversity and the United Nations Convention on the Law of the Sea* (2003) 40.

when one looks at the consequences for the ability of the coastal State to regulate activities in relation to hydrothermal vents. If the particular macrofauna or microfauna do not fall within the definition of sedentary species, but are located within the coastal States EEZ, then the coastal State nonetheless has the sovereign right to explore, exploit, conserve and manage such macrofauna or microfauna as natural resources under Article 56(1)(a) of UNCLOS, and the jurisdiction to take measures, such as requiring benefit sharing, and measures for the protection and preservation of such living resources, as part of the marine environment under Article 56(1)(iii). That is to say, if such species are found within the EEZ and are not sedentary species then the EEZ regime applies.

If the particular macrofauna or microfauna do fall within the definition of sedentary species, and are located within the coastal States EEZ and its Continental Shelf then the coastal State has sovereign rights to explore and exploit such natural resources under Article 77. Arguably such sovereign rights would include the right to prohibit any form of exploitation, and/or the right to make exploitation for any purpose subject to or conditional on compliance with measures to protect and preserve individual vent sites, or to minimise the environmental impact of such activities. Although such measures are not specifically mentioned, it is arguable that they would constitute a legitimate exercise of sovereign rights with respect to such resources.

The only situation where the distinction might matter is where a hydrothermal vent site is found outside the EEZ but on the continental shelf. That is, where a State claims a continental shelf that extends beyond the limit of the EEZ. However, by operation of Article 76(3) of UNCLOS, hydrothermal vent sites associated with the mid-ocean ridges (where the majority of hydrothermal vent sites discovered have been located) would be excluded from the Continental Shelf Regime anyway.[66]

### B *Hydrothermal vents and Part XI of UNCLOS.*

Pursuant to Article 136 of UNCLOS the Area and its 'resources' are declared the common heritage of mankind [sic]. In addition under Article 137 all claims or exercise of sovereignty or sovereign rights over any part of the Area or its resources are prohibited. All rights in the mineral resources of the Area are vested in mankind [sic] as a whole.[67] A novel feature of Part XI of UNCLOS is that, under Article 156, it created a specific entity with responsibility for regulating activities associated with deep-sea mining in the Area, namely the International Seabed Authority[68]

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66 Article 76(3) specifically excludes oceanic ridges of the deep ocean floor from the Continental Shelf Regime.

67 Article 138 provides that the general conduct of all States in relation to the Area must be in accordance with the provisions of Part XI, 'the principles embodied in the Charter of the United Nations and other rules of international law in the interests of maintaining peace and security and promoting international co-operation and mutual understanding'. Article 140 also requires that such activities be carried out for the 'benefit of mankind [sic]', and Article 141 requires the Area to be used exclusively for peaceful purposes.

68 Under Article 156(2), all parties to UNCLOS are ipso facto members of the ISA.

(ISA). UNCLOS Article 157(1) specifically provides that the ISA is the organization through which State Parties shall 'organize and control activities in the Area, particularly with a view to administering the resources of the Area'. However the expression 'activities in the Area' used so liberally in many provisions of Part XI[69] is narrowly defined in Part I, Article 1(3) to mean: 'all activities of exploration for, and exploitation of, the resources of the Area'.

More significantly, 'resources' are defined under Article 133(a) of UNCLOS as: 'all solid, liquid or gaseous mineral resources in situ in the Area at or beneath the seabed, including polymetallic nodules'.

This means that, until such time as a wider mandate is conferred on the ISA by the international community, the ISA's current mandate with respect to regulation of activities in the Area extends only to regulating activities associated with the exploration for, and exploitation of, the mineral resources of the Area. Its current mandate does not extend to bioprospecting.[70]

The situation is further complicated by the fact that UNCLOS and the Part XI Agreement specifically recognise the rights of all state parties and scientific research institutions to carry out MSR on the High Seas and in the Area. The right to carry out MSR on the High Seas is expressly recognised as a High Seas Freedom under Article 87(1)(f) of UNCLOS. Similarly Article 256 recognises all states have the right to conduct MSR in the water column beyond the limits of the EEZ. Article 257 recognises that all States and competent international organisations have the right to conduct MSR in the Area, provided such research is conducted in conformity with the provisions of Part XI of UNCLOS. This right is also recognised by Article 143(3). Under Article 143(2) the ISA is entitled to carry out MSR in the Area and in relation to its resources (as that term is defined in Article 133(a)), and the ISA may enter into contracts for that purpose.

Where research involves prospecting and exploration for mineral resources such applied research would be subject to the approval and control of the ISA.[71] Under Article 240(d) the ISA clearly has the mandate to implement measures to regulate MSR associated with the mineral resources of the Area. Such activity clearly falls within the definition of 'activities in the area' contained in Article 1(3). However, this authority appears not to extend to other forms of MSR including bioprospecting associated with such research. Given that research cruises in relation to hydrothermal vents often involve aspects of research in relation to mineral deposits,

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69 These provisions include the requirement that activities in the Area be conducted for the benefit of mankind [sic] under Article 140(1), the requirement of equitable sharing of financial and other economic benefits derived from activities in the Area under Article 140(2), and provisions dealing with transfer of technology and scientific knowledge under Article 144(1)(a).

70 L Glowka 'The Deepest of Ironies: Genetic Resources, Marine Scientific Research, and the Area' (1996) 12 *Ocean Yearbook* 154.

71 R R Churchill and A V Lowe, *The Law of the Sea* (1999) 404.

biology, microbiology and bioprospecting, this means that some research will be regulated and some will not. The possible exception to this is where such research interferes with 'activities in the area', that is to the extent of interference with activities for the exploration for, and exploitation of the mineral resources of the Area.

Thus, not only does UNCLOS fail to give a mandate to the ISA to regulate bioprospecting, in fact, specific provisions clearly recognise states and national research institutions have the right to carry out MSR which can include bioprospecting in the Area.

### C *United Nations Convention on Biological Diversity*

The provisions of UNCLOS and the Part XI Agreement must also be read in conjunction with the provisions of the CBD.[72] The CBD has three main objectives: the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources. It establishes a framework of general flexible obligations aimed at implementing these objectives.[73] However, these obligations are subject to several very significant qualifications. Firstly, the CBD is a framework treaty. It sets out overall goals and policies and general obligations only with respect to biodiversity conservation, and provides a limited structure for technical and financial cooperation. Responsibility for achieving its goals is left to the individual State parties. This is reinforced by Article 3 of the CBD, which recognises that States have the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction. Obligations under the CBD are subject to, and therefore secondary to each State's sovereign right to exploit their own resources and set their own environmental policies.

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72 Article 22 of the CBD makes clear that in the event of conflict between the provisions of the CBD and UNCLOS, UNCLOS prevails.

73 These include obligations to create plans, strategies, or programs for conservation and sustainable use of biodiversity (Article 6). States must also identify and monitor components of biodiversity important for its conservation and sustainable use, and identify processes and categories of activities which have, or are likely to have, significant adverse impacts on the conservation and sustainable use of biodiversity (Article 7). States also have an obligation to take various steps to regulate activities that threaten biodiversity, including through measures such as establishing a system of protected areas to conserve biodiversity (Articles 8, 9, 10 and 11).

Article 15 of the CBD is of particular relevance to bioprospecting and deals with access to genetic materials, including a requirement that access shall be on mutually agreed terms and subject to prior informed consent. The implementation of these provisions has been further clarified following the adoption of the Bonn Guidelines on Access to Genetic Resources and the Fair and Equitable Sharing of the Benefits Arising out of their Utilisation. For discussion of the Bonn Guidelines see M I 'Bioprospecting: Access to Genetic Resources and Benefit Sharing under the Convention on Biodiversity and the Bonn Guildines' (2002) 6 *Singapore Journal of International and Comparative Law* 747.

Of even more significance is the limitation imposed by Article 4. The coastal State is obliged to implement its obligations under the CBD in its inland waters, territorial sea, contiguous zone, within its EEZ and parts of its continental shelf.[74] However, beyond national jurisdiction the State parties may only regulate the activities of their own nationals to achieve the objectives of the CBD. So far no state has implemented measures specifically regulating activities of their nationals at hydrothermal vents on the high seas. Thus, under the existing provisions of the CBD, access to and use of the genetic resources of the oceans and the deep-sea beyond national jurisdiction is totally unregulated. As Glowka has noted this is ironic because the most immediately exploitable and lucrative resources of the deep-sea are arguably its genetic resources, yet such resources fall outside of the main legal regime applicable to the deep-sea, the deep-sea mining regime under Part XI of UNCLOS, and the main treaty dealing with biodiversity conservation, the CBD.[75]

Despite this significant lacuna in the law, until recently this issue has been subject to only scant consideration by the main organs of the CBD. The most important meetings that have considered the genetic resources of the deep-sea (including those associated with hydrothermal vents) so far are the meetings of the Conference of Parties (COP) in Jakarta in November 1995 and 2004 and the meeting of the SBSTTA in Montreal in March 2003.

### D *Jakarta 1995*

At the Jakarta meeting in 1995 the COP agreed on a program of action for implementing the CBD with respect to marine and coastal biodiversity, now known as the Jakarta Mandate on Marine and Coastal Biological Diversity.[76] More significantly though, in paragraph 12 of decision II/10 adopted at the COP meeting in Jakarta in 1995, the COP requested the Executive Secretary of the CBD, in

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74 A C de Fontaubert, D R Downes and T S Agardy 'Biodiversity in the Seas: Implementing the Convention on Biological Diversity in Marine and Coastal Habitats' (1998) X(3) *Georgetown International Environmental Law Review* 753.

75 Glowka, above n 70.

76 de Fontaubert and Downes, above n 74. Consistent with the Jakarta Mandate a number of states, including Canada, Portugal and Papua New Guinea, have begun to design and implement measures regulating access to particular hydrothermal vent sites within their territorial sea and EEZ. In the case of Canada this has included the establishment of the Endeavour Hydrothermal Vent Marine Protected Area, which was formally proclaimed in March 2003. However, it is worth noting that Canada's regulation of access to the Endeavour Hydrothermal Vent Marine Protected Area does not include any specific provision regulating bioprospecting, and in particular there is no requirement for benefit sharing. Portugal proposes to prohibit bioprospecting in the proposed marine protected area for the Lucky Strike and Menez Gwen hydrothermal vents sites. However, MSR will be permitted, subject to regulation. The legal status of samples collected as part of MSR which are subsequently provided to third parties commercialised is unclear. Papua New Guinea is currently developing an access and consent regime for MSR and bioprospecting that will involve informed prior consent for access for MSR and Bioprospecting and benefit sharing. For further discussion of these regimes see above n 57.

conjunction with the United Nations Office for Ocean Affairs and the Law of the Sea, to:

> undertake a study of the relationship between the Convention on Biological Diversity and the United Nations Convention on the Law of the Sea with regard to the conservation and sustainable use of genetic resources on the deep seabed, with a view to enabling the Subsidiary Body on Scientific, Technical and Technological Advice to address at future meetings, as appropriate, the scientific, technical, and technological issues relating to bioprospecting of genetic resources on the deep seabed.[77]

The study requested by COP II/10 took nearly 8 years to be prepared and was finally published in February 2003. Prior to the report's preparation a preliminary assessment of the areas that might be considered in the final study was published in an unofficial report in 1996. In some respects this preliminary assessment reflects the ultimate conclusions and recommendations of the study requested by COP II/10 released in 2003. In particular, the preliminary assessment concurred with Glowka's assessment noted above, recognising that the genetic resources of the deep seabed are 'unregulated resources'.[78] However, given the lack of information on the commercial potential of deep-sea genetic resources, the preliminary assessment concluded that the knowledge base on which to make informed and appropriate decisions about how this area might be controlled was then almost non-existent.[79] Despite this obvious and significant absence of a knowledge base, the preliminary report suggested several 'foreseeable scenarios' as to how bioprospecting in relation to these resources could develop. These are:

> (a) leaving marine genetic resources unregulated and freely available to those who spend the resources to collect them;
> (b) bringing them within the regime governing the Area and the [International Sea-bed Authority's] authority;
> (c) bringing them within the CBD regime; and
> (d) establishing an entirely new regime to deal with these special and new resources.[80]

These 'foreseeable scenarios', with the exception of the last one, were ultimately endorsed by the final study released in 2003.

### E *The SBSTTA Study on the Relationship between UNCLOS and the CBD*

The SBSTTA study released in early 2003 confirmed the existence of a lacuna in the law with respect to the genetic resources of the deep-sea as first identified by

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77 COP Decision II/10, para 2, UNEP/CBD/COP2/19.

78 Convention on Biological Diversity, Subsidiary Body on Scientific, Technical and Technological Advice, *Bioprospecting of Genetic Resources of the Deep-sea-Bed*, Note by the Secretariat, UN Doc UNEP/CBD/SBSTTA/2/15.

79 Ibid.

80 Ibid.

Glowka. The study concluded that there are three options available for a regime for the management of activities relating to genetic resources beyond national jurisdiction. They are:

- maintaining the status quo;
- application of the regime under Part XI of UNCLOS, currently limited to the management of mineral resources;
- application of the regime of conservation and sustainable use of genetic resources under the Convention on Biological Diversity.

The SBSTTA study noted that the last two of these options are not mutually exclusive and could be integrated. The SBSTTA study also noted two additional options for regulation that were not examined in detail or referred to in the study's conclusion and recommendations. These are the potential role of marine protected areas on the high seas, and intellectual property rights as incentives for benefit sharing and sustainable use of deep-sea genetic resources. It is unclear from the report why these alternatives were ruled out without further consideration. It seems inappropriate for a study of options to rule out two possible options without detailed consideration. This is especially so given the wealth of literature and interest in both options. Marine protected areas on the high seas especially has been the subject of detailed consideration at a number of recent international forums.[81]

The SBSTTA study stops short of endorsing any one option, but it appears from the tone of the report that it supports an expanded mandate for the ISA as a preferred option. There are, of course, immediately obvious benefits associated with such an option. Clearly expanding the mandate of an existing international institution might be more efficient than starting over and establishing an entirely new institution with possibly overlapping mandates. Although it has only been operational for 10 years, the ISA has accumulated a considerable level of expertise and data on the deep-sea environment. However, significant issues would need to be considered before proceeding with such an option. Some, but by no means all of these issues, include:

(1) To what extent will there need to be changes to the ISA's existing structure? The ISA is a body that has been designed to regulate a deep-sea mining industry. Accordingly its structure reflects many varied interests including producers and consumers of minerals.[82] This structure effectively

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81 See for example K Gjerde and C Breide, *Towards a Strategy for High Seas Marine Protected Areas: Proceedings of the IUCN, WCPA and WWF Experts Workshop on High Seas Marine Protected Areas* (2003).

82 The Council of the ISA consists of 36 members of the ISA who are elected in accordance with a formula set out in the Part XI Agreement. This formula, contained in the Annex, Section 3, paragraph 15, provides for the Council to be composed of 36 members elected on the following basis:

- Four members from among the States that are the major consumers of the categories of minerals to be derived from the Area. These four members must include one State which is the largest consumer in Eastern Europe (effectively Russia) and upon its accession to UNCLOS, the USA;

ensures that no decisions can be pushed through the Council of the ISA against the will of any of the recognised interest groups. This is further complicated by the fact that as a general rule decision-making in the organs of the ISA is by consensus.[83] To what extent do the interests of the biotechnology industry and the scientific community differ from those reflected in the ISA's existing structure?

(2) To what extent will the principles embodied in the CBD and the principals of international environmental law more generally be reflected in any amended structure?

(3) How will the proposed regime deal with the question of benefit sharing?

(4) Should the genetic resources of the deep-sea be regarded as the common heritage of mankind [sic]?

(5) Finally, to what extent would a new regime attempt to distinguish between MSR and bioprospecting? Is it even feasible to attempt such a distinction in law when at times it is almost impossible to distinguish the two in practice?

These and many more issues will need to be addressed in the future if such a proposal is to be advanced. However, this presupposes the ISA, and in particular member states, are willing to consider an expanded mandate for the ISA in the first place. However, as recent discussion on the issue of biodiversity at the ISA seems to indicate (see below), it would appear that an expanded mandate for the ISA currently has minimal support.

### F *Repeating the Mistake of the Sedentary Species Definition?*

It should also be noted that the SBSTTA study contained an important qualification in the following terms:

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- Four members from among the eight State Parties who have made the largest investment in preparation for mining;
- Four members from among State parties that are the major net exporters of the categories of minerals to be derived from the Area, including at least two who are developing States whose exports of such minerals have a substantial bearing upon their economies;
- Six members from developing State parties representing special interests. The special interests are defined as States with large populations, landlocked or geographically disadvantaged States, island States, States which are major importers of the categories of minerals to be derived from the Area, States which are potential producers of such minerals and least developed States;
- Eighteen members elected according to the principle of ensuring an equitable representation for each geographical region of the world. The regions are Africa, Asia, Eastern Europe, Latin America and the Caribbean and Western Europe and Others.

83 G French, 'The International Seabed Authority (ISBA) and the regulation of the Area' (paper presented at Oceans Management in the 21st Century: Institutional Frameworks and Responses under the Law of the Sea Convention Workshop, University of Sydney, Sydney, 22-23 November 2002).

> that the studies recommendations addresses only the biological resources attached to the ocean floor and not the free swimming fish above, which fall within the regime of fisheries on the high seas, covered by Articles 116-119 of the Convention, as well as by the United Nations Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (the 1995) Fish Stocks Agreement) where appropriate.[84]

COP Decision II/10, which authorised the preparation of the study, made no mention of resources 'attached to the ocean floor'. It refers only to the 'genetic resources on the deep seabed'. Is there any difference between genetic resources 'on' or 'attached to' the deep seabed? Perhaps, as the later parts of the above extract suggests, not if the intention is merely to exclude fisheries. It may be that this particular statement was included to allay any concerns that this report has any relevance to high seas fisheries, a contentious issue. However, there will be a significant defect in any future regime if it only applies to the resources 'attached to the ocean floor'. A regime along those lines would exclude integral components of the hydrothermal vent ecosystem. For example, it would exclude the genetic resources associated with microbes found in the hydrothermal plume. Likewise microbes that have formed symbiotic relationships with other species not necessarily attached to the seabed such as shrimp, crabs etc would also be excluded. It seems a somewhat arbitrary distinction that fails to take account of the entire ecosystem, of which those resources attached to the seabed only form part. It is inconsistent with an ecosystem based approach, and is reminiscent of the complex sedentary species definition under the Continental Shelf Regime discussed above.

### G *The Environmental Mandate of the ISA*

Perhaps just as significant is that the study seems to suggest that the ISA currently has a wide mandate to regulate the environmental impact of human activities in the deep-sea. In that respect the study notes:

> A substantial proportion of the regulatory responsibility of the Authority relates to the protection and preservation of the marine environment. The mandate for the Authority's work in this field is established both by the United Nations Convention on the Law of the Sea, which stipulates that the Authority shall adopt appropriate rules, regulations and procedures to ensure the effective protection of the marine environment and by the Authority's Regulations for Prospecting and Exploration for polymetalic Nodules in the Area, which also require the adoption of rules, regulations and procedures for environmental protection.[85]

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84 Convention on Biological Diversity, Subsidiary Body on Scientific, Technical and Technological Advice (2003) Marine and Coastal Biodiversity: Review, Further Elaboration and Refinement of the Programme of Work. *Study of the relationship between the Convention on Biological Diversity and the United Nations Convention on the Law of the Sea with regard to the conservation and sustainable use of genetic resources on the deep-seabed*. UN Doc UNEP/CBD/SBSTTA/8/1.

85 CBD SBSTTA, above n 78.

Similar comments are made elsewhere in the study, such as in the context of considering the advantages of utilising the ISA's existing structure because it: 'is already operational and has already a mandate relating to the protection and preservation of the Area's marine environment'.[86]

In light of these comments it is perhaps useful to consider the extent of the mandate of the ISA with respect to the deep-sea environment, and its work in relation to this component of its mandate to date. The core provision of UNCLOS of relevance is Article 145. Article 145 requires that necessary measures be taken with respect to activities in the Area to 'ensure effective protection for the marine environment from harmful effects which may arise from such activities'. Under article 145 the ISA is specifically required to adopt appropriate rules, regulations and procedures with respect to:

> (a) the prevention, reduction and control of pollution and other hazards to the marine environment, including the coastline, and of interference with the ecological balance of the marine environment, particular attention being paid to the need for protection from harmful effects of such activities as drilling, dredging, excavation, disposal of waste, construction and operation and maintenance of installations, pipelines and other devices related to such activities;
>
> (b) the protection and conservation of the natural resources of the Area and the prevention of damage to the flora and fauna of the marine environment.

A similar requirement is also found in UNCLOS, Annex III, article 17, paragraph 1(b)(xii), which requires the ISA to adopt and apply rules, regulations and procedures for the exercise of its functions in relation to 'mining standards and practices, including those relating to operational safety, conservation of the [mineral] resources and protection of the marine environment'. Likewise Annex III, article 17, paragraph 2(f) of UNCLOS requires rules regulations and procedures to be drawn up:

> in order to secure effective protection of the marine environment from harmful effects directly resulting from activities in the Area or from shipboard processing immediately above a mine site of minerals derived from that mine site, taking into account the extent to which such harmful effects may directly result from drilling, dredging, coring and excavation and from disposal, dumping and discharge into the marine environment of sediment, wastes or other effluents.

The provisions of the Part XI Agreement have further elaborated these requirements. In the interim period from the entry into force[87] of the deep-sea mining regime until the approval of the first plan of work for exploration, the ISA is required to, inter alia, focus on the adoption of rules, regulations and procedures incorporating applicable standards for the protection and preservation of the marine

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86 Ibid.

87 The regime entered into force on 28 July 1996.

environment pursuant to Part XI Agreement, Annex, Section 1, paragraph 5(g). So far the only regulations adopted by the ISA dealing specifically with environmental issues are the Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area (Nodule Prospecting Regulations). Adoption of the Nodule Prospecting Regulations cleared the way for the ISA to enter into the first contracts for exploration.[88]

These regulations include some curious provisions. For example, Regulation 2(2) provides that 'Prospecting shall not be undertaken if substantial evidence indicates the risk of serious harm to the marine environment'.[89] Serious harm to the marine environment is defined in the Nodule Prospecting Regulations as 'any effect from activities in the Area on the marine environment which represents a significant adverse change in the marine environment determined according to the rules, regulations and procedures adopted by the Authority on the basis of internationally recognized [sic] standards and practices'.[90] So far no such rules or regulations or procedures have been prepared.

The requirements for 'substantial evidence', 'serious harm' and 'significant adverse change' would appear to be at odds with a precautionary approach, as reflected in principle 15 of the Rio Declaration[91] and subsequent instruments. Firstly because even a minor environmental impact may have unforseen consequences given the current level of our understanding of the deep-sea environment. More importantly requiring 'substantial evidence' of environmental harm appears to be setting to high a threshold where there is already great scientific uncertainty as the environmental impact of mining on the deep-sea environment.

The use of these terms is even more curious given that specific provisions of the regulations dealing with protection and preservation of the marine environment contained in Part V of the Regulations seem to make application of a precautionary approach mandatory. Thus Regulation 31(2) provides:

> In order to ensure effective protection for the marine environment from harmful effects which may arise from activities in the Area, the Authority and sponsoring

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88 The first such contract was signed with the State enterprise Yuzhmorgeologia (Russian Federation) on 29 March 2001. Since then similar exploration contracts have been signed with Interoceanmetal Joint Organization (a consortium formed by Bulgaria, Cuba, the Czech Republic, Poland, the Russian Federation and Slovakia), the Republic of Korea, the China Ocean Mineral Resources Research and Development Association (China), Deep Ocean Resources Development Company (Japan), Institut français de recherche pour l'exploitation de la mer Association français pour l'étude et la recherche des nodules (France) and the government of India. See *Report of the Secretary-General of the International Seabed Authority under Article 166, Paragraph 4 of the United Nations Convention on the Law of the Sea*, 7th June, 2002, UN Doc ISBA/8/A/5.

89 International Seabed Authority, Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area, ISBA/6/A/18, hereinafter referred to as the Nodule Prospecting Regulations, Regulation 2(2).

90 Nodule Prospecting Regulations, Regulation 1(3)(f).

91 Rio Declaration, UN Doc A/Conf 151/26.

> States shall apply a precautionary approach, as reflected in principle 15 of the Rio Declaration, to such activities.

The ISA has recently commenced work on consideration of the appropriate type of regulation for prospecting for polymetalic sulphides associated with hydrothermal vents and cobalt-rich ferromanganese crusts, following a request from the Russian Federation. It is not yet clear to what extent provisions of these regulations will mirror the Nodule Prospecting Regulations. The Legal and Technical Commission of the ISA is currently working on drafts of these regulations. In accordance with its programme of work agreed upon during the eighth session of the ISA, the members of the Legal and Technical Commission convened informal working groups to consider certain aspects of the rules and regulations including one working group charged with analysing:

> Considerations relating to the development of environmental rules, regulations and procedures relating to prospecting and exploration for polymetalic sulphides and cobalt-rich crusts.[92]

This working group has produced a preliminary draft of regulations relating to the protection and preservation of the marine environment during prospecting and exploration, which is scheduled to be considered further at the Commission's next session in 2004. It is worth noting that in the course of its work, the working group has indicated that it is appropriate for the draft regulations to reflect 'developments in international environmental law achieved since the adoption of the Convention in 1982'.[93]

In the context of its work on these regulations and 'working within its mandate' the Legal and Technical Commission has also acknowledged that it does need to know more about seabed and deep-ocean biodiversity. Accordingly, at its 2003 meeting the Commission requested one of its members, Helmut Beiersdorf, to draw up a proposal for a seminar on seabed and deep-ocean biodiversity relevant to mineral resource prospecting and exploration, with participation by members of the Legal and Technical Commission and experts in the field. In addition, another member of the Legal and Technical Commission, Frida Mara Armas Pfirter is to co-ordinate the preparation of a paper on legal issues 'to ensure the Commission remained within its mandate' under UNCLOS. The Legal and Technical Commission will also review the idea of establishing a working group to study the issue further.[94]

While it is clear that environmental issues and, in particular protection of the biodiversity of the deep-sea (including hydrothermal vents), is increasingly of interest to the ISA, it is also clear from these recent developments that the ISA (and

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92 International Seabed Authority, *Report of the Chairman [sic] of the Legal and Technical Commission on the work of the Commission during the ninth session*, UN Doc. ISBA/9/C/4.

93 International Seabed Authority, *Report of the Secretary-General of the International Seabed Authority under Article 166, Paragraph 4 of the United Nations Convention on the Law of the Sea*, 7th June, 2002, UN Doc. ISBA/8/A/5.

94 International Seabed Authority, Press Release, UN Doc SB/9/7.

most member states) appear to want to confine its work within is existing mandate. Indeed, at its most recent session there were concerns expressed by several states lest the ISA go beyond this mandate. For example in debate during the closing session of the Assembly of the ISA, a number of States, including the Netherlands clearly expressed their concern that the ISA not exceed its defined mandate. For the time being, it appears as if the ISA intends to confine its consideration of deep-sea biodiversity strictly to the terms of its existing mandate. The implications of this are perhaps concisely summarised by statements made by the Secretary-General of the ISA to the meeting of the final session of the Assembly in 2003. In relation to the ISA's work on biodiversity Ambassador Nandan stated:

> Our purpose is not to deal with it in a comprehensive way; our purpose is to deal with it in a manner which would be of interest to the authority [ie in regard to the regulation of deep-sea mining] We are not looking to control or manage or regulate marine scientific research. We are not looking to licence bioprospectors or to deal with the patent rights of bioprospectors.[95]

Thus while the SBSTTA study discussed above seems to suggest an expanded mandate for the ISA as a preferred option for regulating access to hydrothermal vents for bioprospecting, it appears that such a proposal currently lacks support amongst members of the ISA.

### H *SBSTTA Meeting Montreal, March 2003 and COP VII*

#### 1 *Kuala Lumpur, March 2004*

The SBSTTA study was presented for consideration at the eighth meeting of the SBSTTA in Montreal from 10-14 March, 2003. The subsequent debate in relation to the report at the Montreal meeting revealed further significant differences of opinion between States on this issue. For example, Brazil, Argentina, Colombia and Peru and several other developing states objected to the competence of both the SBSTTA and the CBD to deal with issues related to the deep seabed beyond national jurisdiction.[96] In contrast the European Union, Greece and the Seychelles stated their position that these issues fell within the CBD's mandate under Articles 3 and 4. In addition, they noted that the SBSTTA was competent to deal with its scientific aspects under Decision II/10 on marine and coastal diversity.[97] Canada objected to a recommendation encouraging Parties to start working through the ISA on issues related to conservation and sustainable use of genetic resources, as this may, according to Canada, prejudice the outcome of more considered deliberations.[98]

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95 International Seabed Authority, Press Release, 7th August, 2003, UN Doc no SB/9/13.

96 Earth Negotiations Bulletin, Summary of the Eight Session of the Subsidiary Body on Scientific, Technical and Technological Advice of the Convention on Biological Diversity 10-14 March 2003, 9(252) *Earth Negotiations Bulletin.*

97 Ibid.

98 Ibid.

In the end the impasse was resolved by calling for further study of the issue. The Montreal meeting made three main recommendations to the COP. These recommendations were as follows:

1. That the Executive Secretary, in consultation with Parties and other Governments and in collaboration with relevant international organisations,[99] compile and synthesise information on the status and trends of deep seabed genetic resources and on methods to identify, assess and monitor genetic resources of the deep seabed in areas beyond the limits of national jurisdiction. This is to include identification of threats to such genetic resources and the means for their protection, with a view to addressing processes and activities under Article 4(b) of the CBD, and to report on progress thereon to the SBSTTA, which will prepare recommendations for the consideration of the COP at its eighth meeting.

2. Invite the UN General Assembly to call upon relevant organisations[100] to review issues relating to the conservation and sustainable use of genetic resources of the deep seabed beyond the limits of national jurisdiction and make appropriate recommendations to the General Assembly regarding appropriate actions.

3. Invite Parties and other States to identify activities and processes under their jurisdiction or control which may have significant adverse impacts on deep seabed ecosystems and species beyond the limits of national jurisdiction, in order to comply with Article 3 of the CBD.[101]

The recommendations of the SBSTTA outlined above were considered at the seventh meeting of the COP in Kuala Lumpur, Malaysia in March 2004. At that meeting the COP considered hydrothermal vents in the context of its review of the programme of work on marine and coastal biodiversity. Hydrothermal vents were considered in two parts of its ongoing work. Firstly in examining the issue of marine protected areas beyond national jurisdiction in COP Decision VII/5 the COP agreed that :

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99 Namely the United Nations Division for Ocean Affairs and the Law of the Sea, the United Nations Environment Programme, the International Seabed Authority and the Intergovernmental Oceanographic Commission of the United Nations Educational, Cultural and Scientific Organization.

100 Specifically the United Nations Environment Programme, the International Maritime Organisation, the International Seabed Authority, the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization, the International Hydrographic Organisation, the World Meteorological Organisation, the Secretariat of the Convention on Biological Diversity, and the United Nations Division for Ocean Affairs and the Law of the Sea.

101 Convention on Biological Diversity, Conference of the Parties, *Report of the Subsidiary Body on Scientific, Technical and Technological Advice on the work of its eight meeting.* UN Doc UNEP/CBD/COP/7/3, 90.

> there is an urgent need for international cooperation and action to improve conservation and sustainable use of biodiversity in marine areas beyond the limits of national jurisdiction, including the establishment of further marine protected areas consistent with international law, and based on scientific information, including areas such as seamounts, hydrothermal vents, cold-water corals and other vulnerable ecosystems.[102]

The COP endorsed no further action other than working with other international bodies to identify ways to establish marine protected area beyond national jurisdiction within the framework of UNCLOS.[103]

The second and more detailed consideration related to consideration of an agenda item headed 'Conservation and sustainable use of deep seabed genetic resources beyond national jurisdiction: issues arising from the study of the relationship between the Convention on Biological Diversity and the United Nations Convention on the Law of the Sea'. The COP resolved to request:

> the Executive Secretary, in consultation with Parties and other Governments and the International Seabed Authority, and in collaboration with international organizations, such as the United Nations Division for Ocean Affairs and the Law of the Sea, the United Nations Environment Programme, and the InterGovernmental Oceanographic Commission of the United Nations Educational, Cultural and Scientific Organization, if appropriate, to compile information on the methods for the identification, assessment and monitoring of genetic resources of the seabed and ocean floor and subsoil thereof, in areas beyond the limits of national jurisdiction; compile and synthesize information on their status and trends including identification of threats to such genetic resources and the technical options for their protection; and report on the progress made to the Subsidiary Body on Scientific, Technical and Technological Advice.[104]

The COP also invited the Parties:

> to raise their concerns regarding the issue of conservation and sustainable use of genetic resources of the deep seabed beyond limits of national jurisdiction at the next meeting of the General Assembly and [and invited] the General Assembly to further

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102 CBD COP Decision VII/5, para 30, available from http://www.biodiv.org/convention/cops.asp# accessed 15 July, 2004.

103 The complete text of this section of Decision COP VII/5 states that the COP 'Recognizes that the law of the sea provides a legal framework for regulating activities in marine areas beyond national jurisdiction and requests the Executive Secretary to urgently collaborate with the Secretary-General of the United Nations and relevant international and regional bodies in accordance with their mandates and their rules of procedure on the report called for in General Assembly resolution 58/240, paragraph 52, and to support any work of the General Assembly in identifying appropriate mechanisms for the future establishment and effective management of marine protected areas beyond national jurisdiction'. See COP Decision VII/5, para 31, available from http://www.biodiv.org/convention/cops.asp# accessed 15 July, 2004.

104 CBD COP Decision VII/5, para 54, available from http://www.biodiv.org/convention/cops.asp# accessed 15 July, 2004

> coordinate work relating to conservation and sustainable use of genetic resources of the deep seabed beyond the limits of national jurisdiction.[105]

Finally the COP invited:

> Parties and other States to identify activities and processes under their jurisdiction or control which may have significant adverse impact on deep seabed ecosystems and species beyond the limits of national jurisdiction, in order to address Article 3 of the Convention[106]

## V WHY BOTHER? DEFINING THE PROBLEM FOR THE LAW TO ADDRESS

After an 8 year study it is disappointing that the SBSTTA study and the COP consideration of this study has not really advanced consideration of this issue. The study and its consideration by SBSTTA and COP has largely done no more than re-state what was first identified by Glowka, namely that there is a significant gap in international law. Add to that the significant qualification contained in the SBSTTA report, the fact that the ISA appears to be reluctant to consider an expanded mandate at the moment, and it appears that very little real progress has been made in the last 8 years.

A significant problem in the approach of both the SBSTTA, COP and the ISA to this issue is that they both narrowly define the problem that they seek to address. In the case of the SBSTTA and COP, the issue is defined in terms of regulating access to hydrothermal vents for the purpose of bioprospecting for their genetic resources, albeit with the underlying goal of conservation of biodiversity. In the case of the ISA, the issue is defined in terms of minimising the environmental impact of mining on the biodiversity of the deep-sea. However, the issue of regulating access to hydrothermal vents on the high seas, and within territorial waters and the EEZ, is far more complicated than just these two issues. In fact, deep-sea mining and bioprospecting are only two of several at times conflicting uses of the deep-sea. Human activities at hydrothermal vents include marine scientific research, bioprospecting, mining, and other economic activities such as tourism. Each of these activities and their associated impacts in turn pose an as yet vaguely quantified threat to the biodiversity of hydrothermal vents.[107] Add to these associated impacts such as pollution and the possible risk of the introduction of alien invasive species, and the question of regulating access to hydrothermal vents becomes far more complicated.

A detailed consideration of these conflicting uses and threats is beyond the scope of this paper, however clearly any future regime to regulate access to hydrothermal

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105 CBD COP Decision VII/5, para 55, available from http://www.biodiv.org/convention/cops.asp# accessed 15 July, 2004

106 CBD COP Decision VII/5, para 56, available from http://www.biodiv.org/convention/cops.asp# accessed 15 July, 2004.

107 See Dando and P and S K Juniper, above n 20; Leary, above n 57.

vents must take account of all of these conflicting uses and stakeholders. To focus purely on the genetic resources of hydrothermal vents is to narrowly define the issue that confronts the international community. In that respect perhaps the only encouraging development is that hydrothermal vents are now being considered in tandem with the broader issue of marine protected areas beyond national jurisdiction. That development is entirely consistent with the policy objective underlying the CBD, and although the existing legal basis to establish marine protected areas beyond national jurisdictions is questionable moves by States in favour of such developments should be encouraged.

In essence the main reason why this issues should be considered at all by the international community is not so much the economic value of hydrothermal vent genetic resources but rather we should care about what happens to hydrothermal vents species simply because of the need to conserve biodiversity. The conservation of biodiversity on earth per se, quite apart from any benefits this may bring to humanity, has been recognised as a desirable objective in its own right under the CBD. The recognition of the intrinsic value of biological diversity is significant as it acknowledges the inherent right of all components of biodiversity to exist independent of their value to humankind.[108]

As the deep-sea constitutes the most typical habitat on earth and is where literally millions of species live,[109] we should take steps to conserve the biodiversity of this habitat, particularly where specific threats have been identified. Simply put, we should be concerned about the loss of species in the deep-sea and at hydrothermal vents just as much as in any other region or habitat on earth. Given the greater proportion of the earth's species diversity that is found in the deep-sea, our concern for species of the deep-sea arguably should be just as great, if not greater, than for other regions of the planet. With an emerging awareness that such threats do exist, the agreed objectives of biodiversity conservation and the intrinsic right of such species to exist recognised by the CBD and other international instruments, do provide a strong, and arguably the primary, justification for a shift in the focus of our efforts to the deep-sea and hydrothermal vent ecosystems in particular. Yet reconciling the conservation of biodiversity with the many conflicting uses of hydrothermal vents and their associated resources noted above is a difficult task. So far the efforts of both the CBD and the ISA have been unsatisfactory. Pending further developments in relation to marine protected areas on the high seas, perhaps it is time to look closely at other sources of international law and international institutions that may be able to assist in the conservation of the biodiversity of hydrothermal vents and the sustainable use of their resources. The following discussion highlights a number of possible sources that to date have not been closely examined. The purpose of the discussion is not to conclusively nominate a preferred option, but rather to suggest some additional sources of law and

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108 L Glowka and L F Burhenne-Guilmin, *A Guide to the Convention on Biological Diversity* (1994).

109 J D Gage and P A Tyler, *Deep-Sea Biology: A natural history of organisms at the deep-sea floor* (1991).

institutions that merit further examination. These were not considered in the SBSTTA study or in any of the literature to date.

## VI SOME ALTERNATE SOURCES OF LAW TO CONSIDER

Five additional sources of law would appear to merit further consideration. They are:

- Article 1(4) of UNCLOS;
- Article 162 of UNCLOS and Regulation 31(7) of the Nodule Prospecting Regulations;
- 1992 Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention);[110]
- 1986 Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (Noumea Convention);[111]
- 1980 Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR)[112] and the 1991 Protocol on Environmental Protection to the Antarctic Treaty (Madrid Protocol).[113]

### A *Light and Noise Pollution in the Deep Sea*

One of the unique environmental impacts of human activities in the deep-sea is the introduction of light to an otherwise totally dark environment. There is evidence that the introduction of light to the deep-sea environment may lead to blindness in species of shrimp associated with hydrothermal vents whose eyes are adapted to the total darkness of the deep-sea.[114] Light is introduced into the deep-sea environment by scientists carrying out research in the deep-sea, by bioprospecting and in the course of deep-sea tourism. Although deep-sea mining has not yet commenced, it is reasonable to expect that the introduction of light energy into the deep-sea environment will also be an environmental impact associated with deep-sea mining. Likewise, although little is yet known about the impact of noise pollution in the deep-sea environment, and on hydrothermal vent ecosystems in particular, it is conceivable that there may be some impact. Pending further scientific research to clarify this, a precautionary approach should be adopted.

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110 Convention for the Protection of the Marine Environment of the North-East Atlantic, done at Paris, 22 September 1992, 32 ILM (1992).

111 Convention for the Protection of the Natural Resources and Environment of the South Pacific Region, done at Noumea, 24 November, 1986, in force 22 August 1990 (1990) ATS 31.

112 Convention on the Conservation of Antarctic Marine Living Resources, done at Canberra, 20 May 1980, in force 7 April 1982; 19 ILM (1980).

113 Protocol on Environmental Protection to the Antarctic Treaty, done at Madrid, 4 October 1991, entered into force 14 January 1998; 30 ILM (1991).

114 P J Herring and E Gaten, 'Are vent shrimps blinded by science?' (1998) 398 *Nature* 116.

The most comprehensive provisions of UNCLOS dealing with protection of the marine environment are those relating to pollution. Article 1(4) of UNCLOS defines 'pollution of the marine environment' as

> the introduction by man [ sic], directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities.

While this definition obviously includes more typical types of pollution such as oil, polychlorinated biphenyls (PCB's), and heavy metals (such as lead, mercury and cadmium)[115], the definition has a potentially wider scope of operation. The reference to "energy" could be read to cover all forms of energy including noise[116] and light. The definition of pollution in Article 1(4) is based on an earlier version prepared by the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection.[117] The original definition referred only to the introduction of substances, but the term "energy" was added later following concerns about thermal pollution.[118] The definition was therefore not drafted with either noise or light pollution in mind, but a wide interpretation of the term "energy" could include such types of pollution as they are forms of energy. The use of the expression "results or is likely to result" in the definition in Article 1(4) indicates that the deleterious effects need not have manifested themselves yet, but can reasonably be expected to occur.[119] Even in the absence of full scientific certainty as to whether deleterious effects have occurred or are about to occur, there is a need to act with caution and not delay preventative action where the circumstances require such.[120] Such an interpretation is consistent with the precautionary principle.

So far there have been no steps taken specifically to implement measures to regulate the introduction of light or noise into the deep-sea environment. However, the use of the term 'energy' in Article 1(4) does appear to provide a legal basis for the adoption of such regulation at some future date, either pursuant to Article 209 of UNCLOS in respect of mining activities in the Area, or under the more general obligation imposed on States to adopt measures to prevent, reduce and control pollution of the marine environment under Article 194 of UNCLOS. In addition to UNCLOS, it should be noted that the definition in Article 1(4) has been

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115 R R Churchill and A V Lowe, *The Law of the Sea* (1999) 331.

116 H M Dotinga and A G Oude Elferink, 'Acoustic Pollution in the Oceans: The Search for Legal Standards' (2002) 31 *Ocean Development & International Law* 151, 158.

117 Ibid

118 Ibid.

119 Ibid.

120 Ibid.

incorporated verbatim into many other international and regional instruments dealing with the protection of the marine environment.[121]
There is therefore currently a sound legal basis under UNCLOS and many of these other treaties for adoption of specific measures to deal with light and noise pollution in the deep-sea.

### B *Can the ISA Create De-facto Marine Protected Areas under Article 162 of UNCLOS and Regulation 31(7) of the Nodule Prospecting Regulations?*

Article 162(2)(x) of UNCLOS provides that the Council of the ISA may 'disapprove areas for exploitation by contractors or the Enterprise in cases where substantial evidence indicates the risk of serious harm to the marine environment'.

In his recent statement to the Fourth Meeting of *UNICPLOS*[122] the Secretary-General of the ISA suggested that:

> There is no reason why, pursuant to this provision, the Council [of the ISA] should not develop criteria for the identification of particularly sensitive areas to be reserved for detailed scientific study as environmental baselines or as reference areas.[123]

The Secretary-General's comments appear to suggest the Council could designate particularly sensitive areas, which would act both as environmental baselines and arguably could also act as de-facto marine protected areas. Indeed this is further re-enforced by the provisions of Regulation 31(7) of the Nodule Prospecting regulations which provides:

> If the Contractor applies for exploitation rights, it shall propose areas to be set aside and used exclusively as impact reference zones and preservation reference zones. Impact reference zones means areas to be used for assessing the effect of each contractor's activities in the Area on the marine environment and which are representative of the environmental characteristics of the area. Preservation reference zones means areas in which no mining shall occur to ensure representative and stable biota of the seabed in order to assess any changes in the flora and fauna of the marine environment.

In addition it can be argued that the ISA may have a broad discretionary power to designate particular parts of the Area as sensitive no mining areas in the context of fulfilling its mandate under Article 145 of UNCLOS to protect and preserve the

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121 These include the OSPAR Convention, the 1974 Convention on the Protection of the Marine Environment of the Baltic Sea Area, the 1992 Convention of the same name, and most of the framework treaties adopted under the UNEP Regional Seas Program (including some protocols dealing with specific sources of marine pollution). See Dotinga and Elferink, above n 116.

122 The United Nations Informal Consultative Process on the Law of the Sea.

123 Statement by the Secretary-General of the International Seabed Authority to the Fourth Meeting of the Informal Consultative Process of the United Nations Convention on the Law of the Sea, available from http://www.isa.org.jm , accessed 7 November 2003.

marine environment from the impact of deep-sea mining.[124] Thereby also effectively creating de-facto marine protected areas. Indeed one site has already been suggested as a possible candidate site by the environmental NGO WWF. This site is the Logatchev vent field in the mid-Atlantic.[125] It is worth noting though that such action by the ISA could not restrict or control any other activities such as MSR, bioprospecting or tourism.[126]

### C *Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention)*

There are at least four known hydrothermal vent fields in the OSPAR maritime area.[127] These are the Menez Gwen, Lucky Strike, Saldanha and Rainbow vent fields.[128]

Under Article 2(1)(a) of the OSPAR Convention contracting parties are obliged to:

> take all possible steps to prevent and eliminate pollution and [obliges parties to] take the necessary measures to protect the maritime area against the adverse effects of human activities so as to safeguard human health and to conserve marine ecosystems and, when practicable, restore marine areas which have been adversely affected.

To this end, under Article 2(1)(b) contracting parties are obliged, individually and jointly to adopt programs and measures and to harmonise their policies and strategies. In that context the parties are also obliged to apply the precautionary principle and the polluter pays principle. Annex V of the OSPAR Convention, deals specifically with the protection and conservation of the ecosystems and biological diversity (defined in similar terms to the CBD) of the maritime areas to which the OSPAR Convention applies. Annex V and the accompanying *Sintra Statement*,[129]

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124 D K Leary, 'Emerging Legal Regimes regulating bioprospecting for thermophiles and hyperthermophiles of hydrothemal vents' *Journal of Marine Biotechnology*, Special Issue, (proceedings of the 6th International Marine Biotechnology Conference) (forthcoming)).

125 S Schmidt *et al*, 'Logatchev-A Potential MPA, WWF North-East Atlantic Programme briefing note' available at http://www.ngo.grida.no/wwfneap/overview/overfset, accessed 7 November 2003.

126 D K Leary, 'The International Seabed Authority and designation of sensitive no mining areas for the conservation of hydrothermal vent ecosystems on the high seas: Legal and practical realities' (paper prepared for the WWF/IUCN Experts Workshop on High Seas Marine Protected Areas, 15-17 January 2003, Malaga Spain, unpublished paper).

127 Under Article 1 the OSPAR Convention applies to a significant portion of the Maritime area of the North East Atlantic and Artic Oceans including the internal waters and the territorial seas of the Contracting Parties. It also applies to the sea beyond and adjacent to the territorial sea under the jurisdiction of the coastal State to the extent recognised by international law, and to the high seas, including the bed of all those waters and its sub-soil within certain defined limits.

128 S Gubbay *et al*, *The Offshore Directory, Review of a selection of habitats, communities and species of the north-east Atlantic* (2002).

129 Sintra Statement, Ministerial Statement of Ministers meeting within the framework of the OSPAR Commission for the Protection of the Marine Environment of the North East Atlantic,

which provides a strategy for implementation of Annex V, including provisions requiring an assessment of the species and habitats that may need protection as well as human activities that are likely to have an adverse effect on such species and habitats.[130] Following the *Sintra Statement* the parties to OSPAR have committed to promoting ' the establishment of a network of marine protected areas to ensure the sustainable use and protection and conservation of marine biological diversity and ecosystems'. Considerable work is now being carried out by parties to the OSPAR Convention and other interested parties such as WWF to design mechanisms to implement these obligations. The most significant of these is development of an overall framework for MPA's within the context of the OSPAR Convention.[131] Possible MPA Candidate sites within the maritime area of the OSPAR Convention that have been identified so far include the Lucky Strike,[132]and Rainbow fields.[133] Could measures be adopted under these provisions to regulate activities at hydrothermal vents such as bioprospecting? Arguably yes given that it has been suggested bioprospecting is one activity that poses a threat to the hydrothermal vent ecosystem. A range of activities including bioprospecting at these hydrothermal vent sites could be regulated in the context of a system of MPA's.

The obvious problem with any such measures, however, will be that they could not apply to nationals of non state parties to the OSPAR Convention on the high seas.

### D *Noumea Convention*

The Noumea Convention aims to contribute to the care and responsible management of the special hydrological, geological and ecological characteristics of the South Pacific Region. It also recognises the threats to the marine and coastal environment, their ecological equilibrium, resources and legitimate uses posed by pollution and by the insufficient integration of an environmental dimension [sic] into the development process.[134]

Within the Convention Area,[135] Papua New Guinea, New Zealand, Fiji, Solomon Islands, and Tonga, are all at various stages of considering development of

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23 July, 1998, reproduced at http://www.ospar.org/eng/html/welcome.html last accessed 16 July, 2004.

130 Gubbay, above n 128.

131 D K Leary, 'Recent developments in international law relating to activities around hydrothermal vent ecosystems' (2001) 10(2*) InterRidge News* 23.

132 S Christiansen, 'Lucky Strike-A potential MPA, WWF North-East Atlantic Program briefing note available from http://www.ngo.grida.no/wwfneap/overview/overset.htm accessed 30 May 2003.

133 S Christiansen and K Gjerde, 'Rainbow-A Potential MPA', WWF North-East Atlantic Program briefing note available at http://www.ngo.grida.no/wwfneap/overview/overset.htm accessed 30 May, 2003.

134 Noumea Convention, Preamble.

135 Article 2 of the Noumea Convention defines the Convention Area as the 200 nautical mile zones established in accordance with international law (ie the EEZ) of American Samoa, Australia (East Coast and Islands eastward including Macquarie Island) Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands,

resources (especially mineral resources) associated with hydrothermal vents within their territorial sea and or EEZ. Two of these nations, New Zealand and Papua New Guinea, have already granted exploration permits in relation to such mineral resources.

Under the Noumea Convention the State parties have assumed a number of significant obligations which arguably provide the legal basis for action to conserve, sustainably manage and use the resources of hydrothermal vent fields found within the Convention Area. At a general level under Article 4 of the Noumea Convention the parties are obliged to endeavour to conclude bilateral or multilateral agreements, including regional or sub-regional agreements, for the protection, development and management of the marine and coastal environments of the Convention Area. Similarly under Article 5 the parties are obliged, either individually or jointly, to take all appropriate measures in conformity with international law and the provisions of the Noumea Convention to prevent, reduce and control pollution of the Convention Area, from any source, and to ensure sound environmental management and development of natural resources.

Article 8 specifically addresses pollution from seabed activities, obliging all parties to take:

> all appropriate measures to prevent, reduce and control pollution in the Convention Area, resulting directly or indirectly from exploration and exploitation of the sea-bed and its subsoil.

The provisions of Article 8 are re-enforced by Article 13, which obliges parties to take:

> all appropriate measures to prevent, reduce, and control environmental damage in the Convention Area, in particular coastal erosion caused by coastal engineering, mining activities, sand removal, land reclamation and dregding.

The Noumea Convention also recognises specially protected areas as a means of biodiversity conservation. Thus Article 14 provides:

> The Parties shall, individually or jointly, take all appropriate measures to protect and preserve rare or fragile ecosystems, depleted, threatened or endangered flora and fauna as well as their habitat in the Convention Area. To this end, the Parties shall, as appropriate, establish protected areas, such as parks and reserves, and prohibit or regulate any activity likely to have adverse effects on the species, ecosystem or biological processes that such areas are designed to protect.

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Nauru, New Caledonia and Dependencies, New Zealand, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Pitcairn Islands, Toeklau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna and Western Samoa. The Convention Area also extends to include the areas of the high seas which are enclosed from all sides by the 200 nautical mile zones of the these States. This is a large area of the ocean.

In addition, Article 16 contains provisions requiring assessment of the environmental impact of "major projects" on the marine environment so that appropriate measures can be taken to prevent any substantial pollution of, or significant and harmful changes within the Convention Area.

While these provisions arguably provide some basis to act at the regional level, the obligations are subject to a number of qualifications. For example, the general obligation to reduce and control pollution under Article 5(1) is to be performed subject to the individual State's capabilities. Even more significantly, Article 4(6) provides that nothing in the Convention shall affect the sovereign rights of States to exploit, develop and manage their own natural resources pursuant to their own policies, taking into account their duty to protect and preserve the environment. Nonetheless, at a regional level the Noumea Convention might provide the legal basis for measures to regulate access to hydrothermal vents. Having the political will or economic means to act of course is a different matter, especially given the potential economic significance to these countries of such resources.

### E *The Antarctic Treaty system*

As noted earlier in this paper, so far no hydrothermal vent sites have been identified in the vicinity of Antarctica or within Antarctic waters. Nonetheless the possibility of the discovery of such sites cannot be ruled out. In such circumstances the provisions of a number of treaties within the Antarctic Treaty system may provide a means of regulating or coordinating access to and activities in relation to hydrothermal vents. For present purposes the most relevant instruments are CCAMLR) and the Madrid Protocol.

#### 1 *CCAMLR*

Under Article I(1) CCAMLR applies to:

> the Antarctic marine living resources of the area south of 60º South latitude and to the Antarctic marine living resources of the area between that latitude and the Antarctic Convergence which form part of the Antarctic marine ecosystem.

Article II (2) defines Antarctic marine living resources to mean 'the population of fin fish, molluscs, crustaceans and all other species of living organisms, including birds, found south of the Antarctic Convergence'.

Arguably species of molluscs and crustaceans associated with hydrothermal vents would fall within this definition. So, too other species, including bacteria and archaea found at hydrothermal vents, fall within the definition as 'other species of living organisms'. These species, if they exist within the area defined in Article I(1), would also form part of the Antarctic marine ecosystem, which is defined in Article I(3) as 'The complex of relationships of Antarctic marine living resources with each other and with their physical environment.'

Prima facie therefore CCAMLR would apply to hydrothermal vents in areas covered by the treaty.

Article II(1) of CCAMLR states that the objective of CCAMLR is the conservation of Antarctic marine living resources. Conservation is defined under article II(2) as including 'rational use' of Antarctic marine living resources. As such, harvesting of marine living resources and any associated activities must be conducted in accordance with a number of principles of conservation set out in Article II (3) of CCAMLR.[136]

To give effect to these principles CCAMLR established the Commission for the Conservation of Antarctic Marine Living Resources. Amongst other powers conferred on the Commission, Article IX(1)(f) grants power to the Commission to formulate, adopt and revise conservation measures on the basis of the best scientific evidence available, subject to compliance with the Agreed Measures for the Conservation of Antarctic Fauna and Flora adopted by the Consultative Parties to the Antarctic Treaty.[137] Pursuant to Article XXI of CCAMLR each contracting party is obliged to take appropriate measures within its competence to ensure compliance with the provisions of CCAMLR and measures adopted by the Commission pursuant to Article IX. If hydrothermal vents were to be found within the area covered by CCAMLR then arguably the provisions of this treaty could be applied to regulate activities associated with hydrothermal vents. However, like the continental shelf regime under UNCLOS, discussed above, there may be a number of problems presented by the terminology used in this convention. For example, in

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136 Those principles include: prevention of decrease in the size of any harvested population to levels below those which ensure its stable recruitment; maintenance of the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources and the restoration of depleted populations to defined levels; and prevention of changes or minimisation of the risk of changes in the marine ecosystem, which are not potentially reversible over two or three decades, taking into account the state of available knowledge of the direct and indirect impact of harvesting, the effects of the introduction of alien species, the effects of associated activities on the marine ecosystem and the effects of environmental changes, with the aim of making possible the sustained conservation of Antarctic marine living resources.

137 Pursuant to Article IX(2) these conservation measures can include :designation of the quantity of any species which may be harvested in the area to which CCAMLR applies; the designation of regions and sub-regions based on the distribution of populations of Antarctic marine living resources; the designation of the quantity which may be harvested from the populations of regions and sub-regions; the designation of protected species; the designation of the size, age and, as appropriate, sex of species which may be harvested; the designation of open and closed seasons for harvesting; the designation of the opening and closing of areas, regions or sub-regions for the purposes of scientific study or conservation, including special areas for protection and scientific study; regulation of the effort employed and methods of harvesting, including fishing gear, with a view, inter alia, to avoiding undue concentration of harvesting in any region or sub-region; the taking of such other conservation measures as the Commission considers necessary for the fulfilment of the objectives of CCAMLR, including measures concerning the effects of harvesting and associated activities on components of the marine ecosystem other than harvested populations.

the context of hydrothermal vent species do terms such as 'harvesting', 'harvested population', and 'fishing gear' have any real meaning? More significantly, given that so little is known about the hydrothermal vent ecosystem and the life span of individual hydrothermal vent fields, is it possible to identify 'changes in the marine ecosystem which are not potentially reversible over two or three decades' as required by the principles of Conservation under Article II(3) of CCAMLR?

Similarly, questions would remain about the applicability of such measures to non-party states on the high seas. However, unlike fisheries measures, most of the states active in hydrothermal vent research and bioprospecting are parties to CCAMLR. This includes countries such as South Korea, France, Australia, Germany, United Kingdom, Japan, USA, and New Zealand. None of the flag of convenience states such as Panama or Uruguay are involved in such activities. Diving to hydrothermal vents and carrying out research is an activity involving high technology and high cost. In that respect it is very different to other activities in Antarctic waters such as IUU fishing. CCAMLAR therefore may offer a further source of law and an institution that could regulate activities at hydrothermal vents.

2 *Madrid Protocol*

Measures adopted under CCMLAR could be re-inforced by similar measures adopted in accordance with the provisions of the Madrid Protocol. The Madrid Protocol serves as a framework convention which provides the basic features of the regime for environmental protection in Antarctica.[138]

Article 3(1) of the Madrid Protocol provides:

> The protection of the Antarctic environment and dependent and associated ecosystems and the intrinsic value of Antarctica, including its wilderness and aesthetic values and its value as an area for the conduct of scientific research, in particular research essential to understanding the global environment, shall be fundamental considerations in the planning and conduct of all activities in the Antarctic Treaty area.

To this end Article 3(2) requires that activities in the Antarctic Treaty area shall be 'planned and conducted so as to limit adverse impacts on the Antarctic environment and dependent and associated ecosystems'.

As such, pursuant to article 3(2)(b), activities in the Antarctic Treaty Area must be planned and conducted so as to avoid inter alia:

- significant changes in atmospheric, terrestrial (including aquatic), glacial or marine environments;

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138 C Redgwell, 'Environmental Protection in Antarctica: The 1991 Protocol' (1994) 43 *International and Comparative Law Quarterly* 599, 606.

- detrimental changes in the distribution, abundance or productivity of species or populations of species of fauna and flora; or
- degradation of, or substantial risk to areas of biological, scientific, historic, aesthetic or wilderness significance.

Significantly, Article 3(2)(c) also requires all activities to be 'planned and conducted on the basis of information sufficient to allow prior assessments of, and informed judgements about their possible impacts on the Antarctic Environment'. These principles apply to all activities in Antarctica.[139] To the extent that specific activities are not regulated by the Annexes to the Protocol, these fundamental principles provide a benchmark against which all activity must be assessed.

One significant innovation of the Madrid Protocol is the requirement for environmental impact assessments to be undertaken for activities in Antarctica. Under Article 8 activities undertaken in the Antarctic Treaty Area pursuant to scientific research programs, tourism and all other governmental activities are subject to prior assessment of the impacts of those activities on the Antarctic environment or on dependent or associated ecosystems according to whether those activities are identified as having:

(a) less than a minor transitory impact;
(b) a minor or transitory impact; or
(c) more than a minor or transitory impact.

The procedure for this prior assessment is set out in Annex I to the Madrid Protocol. Annex I, Article 1(1) requires that the environmental impacts of proposed activities be considered in accordance with appropriate national procedures. By virtue of Annex I, Article 1(2), if an activity is determined as having less than a minor or transitory impact such activity may proceed. However, if it is determined that a proposed activity will have more than a minor or transitory impact then compliance with the environmental impact assessment provisions of Articles 2 and 3 of Annex I become mandatory.

Article 2 of Annex I requires that, unless it has been determined that an activity will have less than a minor or transitory impact or unless a Comprehensive Environmental Evaluation is prepared under Annex I, Article 3, an Initial Environmental Evaluation (IEE) must be prepared. An IEE must contain sufficient detail to allow assessment of whether a proposed activity may have more than a minor or transitory impact. By virtue of Article 2(2) of Annex I if the IEE indicates that the proposed activity is likely to have no more than a minor or transitory impact then the activity can proceed. However, this is subject to implementation of appropriate procedures, including monitoring, to assess and verify the impact of the activity.

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139 C M Harris and J Meadows, 'Environmental Management in Antarctica: Instruments and Institutions' (1992) 25 *Marine Pollution Bulletin* 239, 244.

Annex 3(1) of Annex I requires that if an IEE indicates or if it is otherwise determined that a proposed activity is likely to have more than a minor or transitory impact, a Comprehensive Environmental Evaluation (CEE) must be prepared. The final decision on whether to allow an activity to proceed rests with the Antarctic Treaty Consultative Parties acting on the advice of the Committee for Environmental Protection, a permanent body established pursuant to Articles 11 and 12 of the Madrid Protocol.

The comprehensive provisions requiring environmental impact assessment would provide a sound basis for assessing the potential environmental impact of activities such as bioprospecting and MSR at hydrothermal vents, and for regulating such activities.

In addition, Annex V to the Madrid Protocol provides a mechanism for the establishment of protected areas and the regulation of activities in particular areas, which could also be used to regulate access to hydrothermal vents. Thus article 2 of Annex V provides that any area 'including any marine area, may be designated as an Antarctic Specially Protected Area or an Antarctic Specially Managed Area'.

Activities in both these types of areas are prohibited, restricted or managed in accordance with Management Plans adopted under the provisions of Annex V.

Antarctic Specially Protected Areas (ASPA's) can be designated to protect outstanding environmental, scientific, historic, aesthetic or wilderness values, any combination of those values, or ongoing or planned scientific research under Annex V Article 3(1). Article 3 of Annex V specifically requires parties to identify within a systematic environmental-geographical framework specific categories of areas to be established as ASPA's. Categories that are relevant to hydrothermal vents include:

- representative examples of major terrestrial and marine ecosystems (Annex V article 3(2)(b));
- the only known habitat of any species (Annex V Article 3(2)(d));
- areas of particular interest to on-going or planned scientific research (Annex V Article 3(2)(e); and
- examples of outstanding geological or geomorphological features (Annex V, article 3(2)(f)).

Entry into any ASPA is prohibited except with a permit granted only after vetting of the reasons for entry to the particular ASPA.

Under Annex V Article 4(1) Antarctic Specially Managed Areas (ASMA's) can be established in relation to areas, including marine areas, where activities are being conducted or may be conducted in the future so as to assist in the planning and co-ordination of activities, avoid possible conflicts, improve co-operation between

parties or minimise environmental impacts. ASMA's may also include areas where activities pose risks of mutual interference or cumulative environmental impacts (Article 4(2) (a)).

### 3 *Antarctica as a Model for Regulating Bioprospecting on the High Seas*

So far no measures have been implemented to specifically regulate bioprospecting in Antarctica or within Antarctic waters.[140] However, the legal instruments discussed above arguably could be utilised in designing a regime to regulate bioprospecting in Antarctica. The similarities between Antarctica and the deep ocean floor of the high seas are striking. Both are harsh environments. The ecosystems of both are heavily dependent on one form of life; in the case of Antarctica it is Krill, for hydrothermal vents it is bacteria and Archea. Both occur in areas beyond any one nations jurisdiction. Both are of interest to science and both have resources that many wish to exploit. Any future regime to be developed for the high seas could draw heavily on the experience of Antarctica. Developments in relation to regulating bioprospecting in Antarctica should be watched closely as they may provide an example for regulating activities in other parts of the high seas including at hydrothermal vents

## VII CONCLUSION

Access for bioprospecting at hydrothermal vents on the high seas is currently unregulated. The CBD (and contracting states) appears to have made little if any progress on this issue. Despite an 8 year study the response to the SBSSTA study has resulted in nothing more than further recommendations for yet further study of this issue. On the other hand the ISA (and some member states) seem to be reluctant at this stage to contemplate anything more than operating within the limits of the existing mandate of the ISA.

There are many reasons why activities at hydrothermal vents should be regulated, not the least of which is the importance of their associated biodiversity and the threats posed by human activity in the deep-sea. As activities such as bioprospecting occur more frequently in the deep-sea, we need to take effective measures to ensure protection of the unique biodiversity of one component of the most typical habitat of our planet. As interest in the potential of biotechnology from the deep-sea grows, so the need to take effective measures is becoming ever more urgent. This paper has outlined a number of possible options beyond the ISA and the CBD which could be explored.

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140 D Rothwell, 'Bioprospecting in the Southern Ocean under International Law, powerpoint presentation, *Bioprospecting in Antarctica, an Academic Workshop*, Gateway Antarctica, University of Canterbury, Christchurch, New Zealand, 7-8 April, 2003, www.anta.canterbury.ac.nz last accessed 30 May 2003.