CHAPTER 7

INTRODUCTION

Prior to the release of the SBSTTA Study discussed in Chapter 2, a preliminary assessment of the areas that might be considered in this final study was published in an unofficial report of the CBD in 1996.[1] The preliminary assessment released in 1996 reviewed the possible benefits that might be derived from the biotechnological uses of the genetic resources of the deep-sea. In that context a number of very significant observations were made in relation to these resources. Firstly, the preliminary assessment noted that there was then little reliable information on the collection of these resources, and that what information that did exist was largely unsubstantiated.[2] Secondly, the preliminary assessment also noted that the extent to which new commercially useful extremophiles may come from the deep-sea bed was not known. Consequently, the study concluded the economic value of this market was entirely speculative and, to date, unrealized.[3] In addition, the preliminary assessment noted that there was a lack of information and knowledge surrounding the use of genetic resources from the deep-sea bed.[4] Accordingly, the preliminary assessment concluded that the knowledge base on which to make informed and appropriate decisions about how this area might be controlled is almost non existent.[5]

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[1] 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, U N Doc UNEP/CBD/SBSTTA/2/15.
[2] Above n 1, at para 43.
[3] Above n 1, at para 65.
[4] Above n 1, at para 19.
[5] Above n 1, 16, para 67.

This chapter seeks in part to address this knowledge gap by considering the nature and extent of bio-prospecting and product development associated with hydrothermal vents and their genetic resources, as well as considering the interaction of that activity with intellectual property rights. Discussion in this chapter will show that there is significant scientific and commercial interest in biotechnology associated with the genetic resources of hydrothermal vents. The chapter begins by providing a definition of bioprospecting. It then gives an overview of the main areas of research into the biotechnology potential of hydrothermal vent genetic resources. It goes on to consider the process of bioprospecting as it relates to hydrothermal vents. This includes reporting on a desk top review of published literature available on the internet and in scientific journals, in relation to the nature and extent of commercial interest in biotechnology developed from hydrothermal vent genetic resources. A significant part of this desktop review is an analysis of the extent to which products derived from species sampled from hydrothermal vents are already marketed.

The third part of this chapter then goes on to consider the relationship between bio-prospecting, product development and patents. This includes a brief review of the existing international legal regimes in relation to patents as they relate to this field of biotechnology. This section of the chapter outlines the nature and extent of patents that have been granted or that are currently subject to applications of relevance to this field of biotechnology. This discussion is based on a desktop search of U.S. and European Patent Office databases.

The chapter then concludes with an examination of the missing link between the regimes of the CBD dealing with access and benefit sharing and the international legal regime dealing with patents. A proposal is outlined for an international global commons trust fund to provide for the sustainable management and use of hydrothermal vent ecosystems beyond national jurisdiction and the marine environment more generally. It is suggested that the Global Environment Facility and or other existing international institutions could take on such a role.

It does not canvass the issue of the environmental impact of bioprospecting. In some areas of marine biotechnology the distinction between sample extraction for MSR and sample extraction for bioprospecting is important because of the environmental impact of such activities. There is so far little information as to the environmental impact of sample extraction from the high seas marine environment and at hydrothermal vents in particular. However, anecdotal evidence would suggest there is no greater environmental impact associated with bioprospecting than other activities associated with MSR in these environments.[6] Accordingly the issue of regulating the environmental impact of bioprospecting is considered in chapter 8 in conjunction with MSR.

DEFINITION OF BIOPROSPECTING

In the 1996 preliminary assessment prepared by SBSTTA and referred to above bioprospecting was defined as:

[6] This was a conclusion reached by a workshop on bioprospecting in the High Seas in which the writer participated. See J J Green, 'Report of the Workshop on Bioprospecting in the High Seas', In Interim Summary-Deep Sea 2003, copy on file with the author.

> "The process of gathering information from the biosphere on the molecular composition of genetic resources for the development of new commercial products."[7]

Similar definitions are to be found in the literature. For example Farrier and Tucker define bioprospecting as:

> "The collection of small samples of biological material for screening in the search for commercially exploitable biologically active compounds or attributes such as genetic information. While the end focus is frequently on the design and development of pharmaceuticals, other types of commercial products sourced from biological...[materials include]...agrochemicals, industrial chemicals, construction materials, crops, cosmetics, food and flavouring."[8]

Similarly, in a recent submission to a Parliamentry inquiry into bioprospecting, Biotechnology Australia defined bioprospecting as the:

> "The search for naturally occurring chemical compounds, genes or other parts of organisms that have potential economic value."[9]

Much of the literature also canvasses debate on the extent to which bioprospecting includes processes beyond sample extraction down the path of commercialisation of biotechnology. If any future regime is to include mechanisms for benefit sharing in relation to the genetic resources of the deep-sea, and hydrothermal vents in particular, then this necessarily means that bioprospecting in the context of such a regime must be more widely defined as including all steps leading up to and including the commercialization of biotechnology products. Accordingly, for the purposes of this chapter in particular, bioprospecting will be taken to refer to

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[7] Convention on Biological Diversity, Subsidiary Body on Scientific, Technical And Technological Advice, note by the Secretariat Bioprospecting of Genetic Resources of the Deed Sea Bed, UN Doc. UNEP\CBD\SBSTTA\2\15, 8 at para 31.

[8] D Farrier and L Tucker, 'Access to Marine Bioresources: Hitching the Conservation Cart to the Bioprospecting Horse' (2001) 32 *Ocean Development and International Law* 214.

[9] Biotechnology Australia, *Submission to the House of Representatives Standing Committee on Primary Industries and Regional Services. Enquiry into Development of High Technology Industries in Regional Australia based on bioprospecting*, (2001), 6.

the much broader process of collection of genetic material from the deep-sea, subsequent research and product development and ultimately commercialisation. In that respect a definition proposed by Jeffery would appear an appropriate definition. He suggests bioprospecting denotes

> "an activity that involves 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".[10]

Accepting a wider definition of bioprospecting necessarily invites consideration of the processes involved in research and development of products by biotechnology companies which is outlined below.

WHY ARE HYDROTHERMAL VENTS SUBJECT TO BIOPROSPECTING?

The search for and exploitation of natural products and novel properties of naturally occurring substances have been at the core of the biotechnology industries for many years now.[11] Modern developments in biotechnology are attributable to two major developments in science in the last 50 years. The first was the discovery in 1953 of the structure of deoxyribonucleic acid or DNA by James Watson and Francis Crick.[12] The second important development occurred in 1985 with the invention of the Polymerase Chain Reaction or PCR technique which revolutionized molecular biology and molecular medicine.[13] The PCR

[10] M I Jeffery, 'Bioprospecting: Access to Genetic Resources and Benefit Sharing under the Convention of Biodiversity and the Bonn Guidelines' (2002) 6 *Singapore Journal of International and Comparative Law* 747, 755.

[11] A T Bull, A C Ward and M Goodfellow, 'Search and Discovery Strategies for Biotechnology: the Paradigm Shift' (2000) 64(3) *Microbiology and Molecular Biology Reviews* 573, 576.

[12] B Cicin-Sain et al, 'Emerging Policy Issues in the Development of Marine Biotechnology' 17 *Ocean Yearbook* 179, 180. For a personal account of this momentous event in the history of science see J D Watson, *The Double Helix. A Personal Account of the Structure of DNA*, (1969).

[13] M Somma and M Querci, *The Analysis of Food Samples for the Presence of Gentically Modified Organisms, World Health Organisation Report* (undated), 3

technique is an enzymatic procedure that uses a heat stable enzyme capable of replicating DNA.[14] PCR is an extremely powerful technique which amplifies (ie makes many copies of) a gene.[15] PCR techniques are now essential for many areas of molecular biology, diagnostic and forensic research.[16]

Rapid advances in molecular and microbial biology arising from these developments resulted in the emergence of new companies, which began to take advantage of this research and its applications in a wide range of commercial and industrial applications.[17] The systematic investigation of the biotechnology potential of the marine environment, especially with respect to novel biologically active agents suitable to develop, began in the mid 1970s.[18] Four areas have been the main focus of research and commercial interest since this time. These are the areas of (1) aquaculture and seafood supply enhancement, (2) commercial and industrial applications of marine substances and processes, (3) marine pharmaceuticals and biomedical applications and (4) improved environmental monitoring and resource management.[19] The last three of these areas have been the focus of biotechnology research in relation to hydrothermal vent genetic resources.

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[14] Australian Centre for Astrobiology, GEOS389 Astrobiology Practical. Using Molecular Genetics to Assess Environmental Microbial Diversity, copy on file with the author. This undergraduate unit was undertaken during the course of the authors PhD candidature.
[15] Ibid.
[16] Somma and Querci, above n 13.
[17] Cicin-Sain et al, above n 12, 180
[18] G Cragg, D J Newman and R B Weiss, 'Coral Reefs, Forests, and Thermal Vents: The Worldwide Exploration of Nature for Novel Antitumor Agents' (1997) 24(2) *Seminars in Oncology* 156, 158.
[19] Cicin-Sain, above n 12, 180

As deep-sea hydrothermal vent microbial communities are highly diverse metabolically, physiologically and taxonomically they have become of interest to researchers and commercial interests keen to investigate their biotechnology potential.[20] Each new hydrothermal vent site discovered in the deep-sea appears to be different chemically and biologically.[21] Hydrothermal vent biological communities are also exposed to extremes of temperature (both hot and cold), extreme hydrostatic pressure and high levels of toxic compounds such as heavy metals.[22] As such it has been suggested that, as a newly explored marine environment, hydrothermal vent sites promise a wealth of biotechnologically useful microorganisms.[23]

The most significant life forms in terms of developments in biotechnology have been the thermophilic and hyperthermophilic bacteria and archaea associated with hydrothermal vents. 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 various enzymes derived from such species, which are used in industrial processes requiring high temperatures and in life sciences research and diagnostics. Examples of some of the existing uses of thermophile and hyperthermophile derivatives from terrestrial sources are listed in Table 1 below.

[20] D Prieur, 'Microbiology of deep-sea hydrothermal vents' (1997) 15 *TIBTECH* 242, 244.
[21] H W Jannasch, 'Deep-sea hot vents as sources of biotechnologically relevant microorganisms' (1995) 3 *Journal of Marine Biotechnology* 5, 8.
[22] Prieur, above n 20, 244.
[23] Jannasch, above n 21, 8.

Table 1 Examples of thermophile and hyperthermophile derivatives and their applications[24]

Thermophile and Hyperthermophile products	Industrial/commercial applications
DNA polymerases	DNA amplification by PCR used in research and diagnostics, especially genetic engineering.
Lipases, pullulinases and proteases	Detergents, food processing and waste water treatment.
Amylases	Baking and brewing
Xylamases	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 derivatives from hydrothermal vent thermophile and hyperthermophile microorganisms. To date research and product development has centered mainly on development of novel enzymes for use in a range of industrial and manufacturing processes, and DNA polymerases for use in life sciences research and diagnostics. Some research has also been directed towards possible pharmaceutical and therapeutic applications, and environmental management technologies such as bioremediation. The following discussion outlines the focus of research and product development in each of these areas.

Enzymes for use in industrial and manufacturing processes

Enzymes are catalysts that facilitate a great number of chemical reactions, including reactions that build up or break down living tissue and that provide

[24] Adapted from S Maloney, 'Extremophiles. Bioprospecting for Antimicrobials' http:\4\www.medidiscover.net\Extremophiles.cfm, accessed 10 July 2003; C Chiradi and M De Rosa, 'The production of biocatalysts and biomolecules from extremophiles' (2002) 20 (12) *Trends in Biotechnology* 515; A Aguilar et al. 'Extremophile microorganisms as cell factories: support from the European Union' (1998) 2 *Extremophiles* 367; E Blochl et al. 'Isolation, taxonomy and thylogemy of hyperthermophilic microorganisms' (1995) 11 *World Journal of Microbiology and Biotechnology* 9; D A Cowan 'Hyperthermophilic enzymes: biochemistry and biotechnology' in L M Parson et al., *Hydrothermal vents and Processes*, (1995) 351-363; and J W Deming 'Deep Ocean Environmental Biotechnology' (1998) 9 *Current Opinion in Biotechnology* 283.

organisms with energy.[25] The first industrial enzymes were developed for use in detergents as long ago as 1915.[26] As well as their use in detergents, enzymes are now also widely used in industrial processes such as in the production of food and beverages.[27] The most widely used thermostable enzymes are the amylases used in the starch industry.[28] They are also used in textile and leather processing, in pharmaceuticals, waste treatment, or to enable process improvement through utilization of new types of raw materials or improving the physical properties of materials so they can be more easily processed.[29] They are also of considerable value in high temperature pulp and paper bleaching.[30]

Microbial enzymes, including proteases, amylases, glucoamylases, lipases, cellulases, xylanases and pullulanases, have typically been derived from terrestrial microorganisms and/or fungi.[31] Most enzymes from mesophilic organisms are not effective for processes above 45°C and at pH values outside the range of 5 to 8.[32] However, as microbes around hydrothermal vents have adapted to survive extremes of temperature and acidity that would be toxic to other life forms, their enzymes are an area of considerable interest for potential use in chemical and industrial processes requiring high temperatures or other extreme conditions. The

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25 Cicin-Sain et al, above n 12, 182.

26 S Fujiwara, 'Extremophiles: Developments of Their Special Functions and Potential Resources', (2002) 94(6) *Journal of Bioscience and Bioengineering* 518.

27 M Chandrasekaran, 'Industrial enzymes from marine microorganisms: The Indian scenario', (1997) 5 *Journal of Marine Biotechnology* 86.

28 G D Haki and S K Rakshit, (2003) 89 *Bioresource Technology* 17.

29 Chandrasekaran, above n 27.

30 C Leuschner and G Antranikian, 'Heat-stable enzymes from extremely thermophilic and hyperthermophilic microorganisms', (1995) 11 *World Journal of Microbiology & Biotechnology* 95, 98.

31 Chandrasekaran, above n 27.

32 University of Bath, 'Biotechnology. Tissue Engineering', http://www.bath.ac.uk/chem-eng/fundraising/biotechnology.htm accessed 10 July 2003.

general rule is the higher the growth temperature of the host organism, the greater the ability of their enzymes to sustain high temperature industrial processes.[33] Hence hydrothermal vent species are especially of interest for chemical and industrial processes involving high temperatures.

One example of research that has been undertaken includes the screening of nine extremely thermophilc archaea and bacteria for their ability to produce amyloytic and pullulytic enzymes. Some of these species were isolated from hydrothermal vents in the Guayamas Basin in the Gulf of California.[34] Thermoactive proteases have also been identified from a number of thermophilic and hyperthermophilic Archaea in the genera *Pyrococcus*, *Thermococcus*, and *Sulfolobus,* all of which are present at several hydrothermal vent sites.[35] Similarly a thermostable xylanase has been successfully synthesized from *Rhodothermus marinus*. This enzyme has potential application in biopulping.[36]

An unusual example of research in relation to enzymes from hydrothermal vent species relates to the poultry industry. One scientific project at the University of Hamburg carried out research to develop high temperature enzymes useful in the processing of chicken feathers, which are a waste product from poultry

[33] J M Bragger et al, 'Very stable enzymes from extremely thermophilic archaebacteria and eubacteria' (1989) 31 *Applied Microbiology and Biotechnology* 556.
[34] Leuschner and Antranikian, above n 30, 96.
[35] Leuschner and Antranikian, above n 30, 100.
[36] Aguilar et al, above n 24, 369.

processing. These enzymes were developed from thermophilic bacteria isolated from hydrothermal vents in the Azores.[37]

There is also some suggestion in the literature that enzymes from extremophiles including hydrothermal vent extremophiles, may have future application in devices such as biosensors and biochips.[38]

A number of commercially viable enzymes have already been developed from hydrothermal vent thermophiles and hyperthermophiles. Some of these are referred to in Table 2 in Appendix 1.

DNA polymerases for use in research and diagnostics

One of the major biotechnological uses of thermophilic and hyperthermophilc organisms is the use of such organisms in the isolation, coding, and commercial production of thermostable restriction polymerases for research applications, especially in the life sciences.[39] The development of the *Taq* polymerase derived from *Thermus aquaticus* isolated from a terrestrial hot spring in Yellowstone National Park, opened new frontiers in molecular biology with its use in the PCR technique referred to above.[40] There has been considerable research undertaken with respect to the development of polymerases from other thermophilic sources, including deep-sea hydrothermal vent thermophiles and hyperthermophiles. DNA polymerases have been isolated from several hydrothermal vent species including

[37] M Klingeberg, A B Friedrich and G Antranikian, 'Production of heat-stable proteases from thermophilic microorganisms and their application in the degradation of chicken feathers', (1992) 5 *DECHEMA Biotechnology Conferences* 173.
[38] Aguilar et al, above n24, 371.
[39] Jannasch, above n 21, 8.

[40] Sciraldi and Rosa, above n24, 516.

Thermotoga maritime, Thermococcis litoralis, Pyrococcus woesii and *Pyrococcus furiosus*.[41] Many of these are already on the market. Some of these are listed in Table 2 Appendix 1.

Therapeutic and Pharmaceutical research

Polysaccharides are carbohydrates that are composed of long chains of repeating units of a simple sugar.[42] Exo-polysaccharides of microbial origin are currently utilized as stabilizers, thickeners, gelling agents and emulsifiers in the paint, oil recovery, paper and textile industries, and in the manufacture of pharmaceuticals.[43] One of their major uses has been in the food industry.[44] In recent years there has been growing interest in biological activities of microbial polysaccharides, such as their antitumor activity and the immunostimulatory activities of some polysaccarides produced by marine bacteria.[45] While there is little discussion of such specific uses of biotechnology from hydrothermal vents in the literature, there are nonetheless a number of specific examples of on going biotechnology research involving exo-polysaccharides isolated from deep-sea hydrothermal vents.

Microbial exo-polysaccharides isolated from deep-sea hydrothermal vents which display interesting properties, which are currently under evaluation for therapeutic uses, principally in the areas of tissue regeneration and cardiovascular diseases.[46]

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[41] 'Extremophiles', http://www.micro.unsw.edu.au/rick/extremophiles.html accessed 10 July 2003.
[42] P W Davis, E P Solomon and L R Berg, *The World of Biology*, (1990), 61.
[43] A Ventosa and J J Nieto, 'Biotechnological applications and potentialities of halophilic microorganissms' (1995) 11 *World Journal of Microbiology & Biotechnology* 85, 87.
[44] H Rougeaux et al, (1996) 31 *Carbohydrate Polymers* 237.
[45] J Guezennec, 'Deep-sea hydrothermal vents: A new source of innovative bacterial exopolysaccharides of biotechnological interest?' (2002) 29 *Journal of Industrial Microbiology & Biotechnology* 204.
[46] J Querellou, 'Biotechnology of Marine Extremophiles' extended abstract reproduced at http://www.iasonnet.gr/abstracts/querellou.html accessed 21 October 2003.

One of the most promising research areas so far in this field relates to the use of exopolysaccharides as a new bone-healing material.[47] Researchers carrying out research at the French marine science research institution IFREMER have secreted a bacterial exopolysaccharide HE 800 from the bacterium *Vibrio diabolicus* originating from deep-sea hydrothermal vents.[48] Initial clinical research on rats shows promising signs that this exopolysaccharide may be of significant benefit in treating several bone diseases or as an aid to bone regeneration.[49]

Some of the same researchers from IFREMER have also been involved in research that has lead to the development of ingredients for cosmetics, including anti-aging creams.[50] Exopolysaccharides isolated from a polychaete annelid *Alvinella pompejana* (otherwise known as the Pompei worm) at a deep-sea hydrothermal vent on the East Pacific Rise have subsequently been included in cosmetics marketed under the DEEPSANE™ trademark. Examples of those cosmetics are marketed under the Darphin cosmetics label referred to in Table 2 Appendix 1.

There is also some evidence of research aimed at the discovery and isolation of novel antifungal compounds for therapeutic use. One company referred to in Table 2 Appendix 1 is especially interested in identification of extremophiles and

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[47] P Zanchetta, N Largarde and J Guezennec, 'A New Bone-Healing Material: A Hyaluronic Acid-Like Bacteria Exopolysaccharide', (2003) 72 *Calcified Tissue International* 74.
[48] Zanchetta et al, above n 47. See also H Rougeaux, N Kervarec, R Pichon and J Guezennec, 'Structure of the exopolysaccharide of Vibro diabolicus isolated from a deep-sea hydrothermal vent', (1999) 322 *Carbohydrate Research* 40.
[49] Zanchetta et al, above n 47.

[50] M A Cambon-Bonavita et al, 'A novel polymer produced by a bacterium isolated from a deep-sea hydrothermal polychaete annelid' (2002) 93 *Journal of Applied Microbiology* 310.

thermophiles that have potent activity against human fungal pathogens. Fungal infections are a common complication in kidney, liver, lung and heart transplants and have also been associated with AIDS. Although most research in this area has focussed on extremophiles from terrestrial sources, the potential for hydrothermal vent extremophiles in the development of antifungals has been identified in such research.[51]

Researchers interested in tubeworm colonies around hydrothermal vents are also investigating the possibility of making artificial blood from the hemoglobin found in the blood of tubeworms.[52] Related work is being undertaken with respect to the production of a substance that bares a chemical resemblance to heparin, an anti-coagulant that delays the onset of blood clotting.[53] This substance was isolated from a exopolysaccharide from a mesophile taken from a hydrothermal vent.[54]

Environmental management technologies such as bioremediation

It has also been suggested that hyperthemophiles including those from hydrothermal vents, may be suitable for use in novel biotechnological processes including oil, coal and waste-gas desulphurization.[55] Another area of interest is the possible use of extremophiles in the treatment of industrial effluents.[56] The ability

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[51] C H Phoebe et al, 'Extremophilic Organisms as an Unexplored Source of Antifungal Compound' (2001) 54 (1) *The Journal of Antibiotics* 56.

[52] 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.

[53] J W Deming, 'Deep ocean biotechnology' (1998) 9 *Current Opinion in Biotechnology* 283, 284. See also S Colliec-Jouault et al, 'Les polysaccharides microbiens d'origine marine et leur potential en thérapeutique humaine' (2004) 52 *Pathologie Biologie* 127.

[54] Ibid.

[55] E Blöxhl et al, 'Isolation, taxonomy and phylogeny of hyperthermophilic microorganisms', (1995) 11 *World Journal of Microbiology & Biotechnology* 9, 13.

[56] University of Bath, above n 32

of extremophiles, such as hydrothermal vent thermophiles and hyperthermophiles, to survive in extreme environments has also suggested that they may have a role treating industrial chemicals which are not treatable by conventional methods.[57]

Biomining and bioleaching

Some researchers, such as microbiologists from Australia's CSIRO, have been investigating the potential of thermophiles in the development of new mining techniques such as biomining and bioleaching.[58] These scientists have primarily been interested in thermophiles from terrestrial sources, such as volcanoes on Rabaul in PNG. However, they have also extracted and analysed thermophile specimens from the Manus Basin hydrothermal vent fields and elsewhere in the Pacific.[59] The CSIRO is currently involved in joint research projects with industry in relation to the development of biotechnology for use in biomining and bioleaching processes.[60]

THE PROCESS OF BIOPROSPECTING FOR DEEP-SEA GENETIC RESOURCES

In a recent study of bioprospecting in Antarctica and the Southern Ocean Jabour-Green and Nicol[61] suggest that the process of bioprospecting for Antarctic biological resources can be subdivided into a number of discreet phases. These are:

Phase 1: sample collection;

Phase 2: isolation, characterisation and culture;

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[57] Ibid.

[58] CSIRO, 'Biomining: the next mineral revolution', http://www.csiro.au/index.asp?type=featureArticle&id=Biomining&pf=yes accessed 21 November 2003.

[59] Interview Dr Peter Nichols, Project Leader Marine Products, CSIRO Marine Research, Hobart 12 November 2003.

[60] Ibid.

Phase 3: screening for pharmaceutical activity;

Phase 4: development of product, patenting, trials, sales and marketing.[62]

A similar process is involved in bioprospecting in relation to the genetic resources of hydrothermal vents. The only fundamental difference between hydrothermal vent genetic resources and the genetic resources in Antarctica and the Southern Ocean is that Phase 3 of bioprospecting in relation to hydrothermal vent genetic resources is not just limited to screening for pharmaceutical activity. In fact, as discussion above highlights, screening to identify product potential from hydrothermal vents organisms has been much wider than this. To date the screening for pharmaceutical activity has only been a minor component of overall bioprospecting research and product development in relation to hydrothermal vent genetic resources.

Despite these differences the framework proposed by Jabour-Green and Nicol is a useful framework for examining bioprospecting and product development in relation to the genetic resources of hydrothermal vents. Accordingly, the following discussion is structured around the four phases identified above.

Phase 1: Sample Collection

Sample collection from hydrothermal vents principally focuses on the microbial species associated with hydrothermal vents. Accessing microbes at hydrothermal vents is an exercise involving a high degree of skill and expensive technology.

[61] J Jabour-Green and D Nicol, 'Bioprospecting in Areas Outside National Jurisdiction: Antarctica and the Southern Ocean' [2003] 4 *Melbourne Journal of International Law 76.*
[62] Jabour-Green and Nicol, above n 61, 85.

Given that most hydrothermal vent sites are located at depths greater than 1½ kilometres below the ocean surface, it is only researchers who have access to high technology submersibles and or remotely operated vehicles[63] who are able to extract samples of these microbes. Few such submersibles and ROVs exist. Only a handful of research institutions have such technology. These include the research submersible *Alvin* operated by the Woods Hole Oceanographic Institute,[64] the *Mir* submersibles owned and operated by the PP Shirshov Institute, of the Russian Academy of Sciences,[65] the *Shinkai 6,500* operated by the JAMSTEC and the submersible *Nautile* operated by the Institut Francais de Recherche.[66] Some organizations also rely on ROVs. For example the Canadian Scientific Submersible Facility, a not for profit corporation established in Canada, operates the Remotely Operated Platform for Ocean Science or ROPOS, which is a ROV that can be operated without sending a crew into the deep ocean.[67]

The great risk and expense involved in operating such technology was demonstrated recently with the loss of the KAIKO, a ROV operated by JAMSTEC. The KAIKO was a 10,000 metre class deep-sea ROV that was able to survey every region of the ocean and was successful in diving to the Challenger Deep (a depth of 10,911 metres) in the Mariana Trench in 1995. However, on 29 May 2003 the KAIKO was lost overboard while being retrieved from a research

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[63] Hereinafter ROV.
[64] Alvin was the submersible used by researchers who discovered the first hydrothermal vent biological communities in 1977. For a description of Alvin and its equipment see http://www.ocean.udel.edu/extreme2001/mission/alvin/# accessed 7 September, 2004.
[65] See http://www.sio.rssi.ru/index_en.htm accessed 15 September 2004.
[66] For an overview of IFREMERs fleet and research capacity see http://www.ifremer.fr/fleet/index.htm accessed 15 September 2004.

[67] For a description of the ROPOS see http://www.ropos.com/ accessed 15 September 2004.

dive at a depth of 4,675 metres in the Nankai Trough. Despite an extensive search scientists from JAMSTEC were unable to locate the KAIKO and it now appears to have been lost forever.[68]

The need for such sophisticated high technology to carry out research and, in particular, sample extraction, means that such research can largely only be undertaken by countries with sufficient capital to invest in such technology. So far sample collection from hydrothermal vents appears to be conducted exclusively by scientific research institutions in wealthy developed countries. These include the research organizations mentioned above with submersible and ROV capacity, and other organizations that link up in joint research projects with those organizations such as Australia's CSIRO, the New Zealand Institute of Geological and Nuclear Sciences[69] and the Korean Ocean Research and Development Institute.[70]

As well as being an activity requiring sophisticated high technology, extracting samples of microbes from hydrothermal vents also requires adherence to strict protocols to ensure that there is no contamination of the samples, either while being returned to the surface or afterwards when being analysed in the laboratory. Accordingly, most scientific research expeditions to the deep-sea develop detailed protocols for the extraction and collection of microbes from hydrothermal vents.

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[68] For information on KAIKO and proposals to build a replacement ROV for JAMSTEC see http://www.jamstec.org.jp accessed 17 September 2004.
[69] Hereinafter GNS.
[70] Hereinafter KORDI.

One major problem that researchers face is the difficulty sampling and cultivating microorganisms extracted from extreme environments such as hydrothermal vents. This is especially a problem in the case of development of new enzymes from extremophiles.[71] For the time being this is one of the major obstacles to further developments in biotechnology in this field. Similar challenges are posed for chemical and mechanical engineers in universities and biotechnology companies in undertaking the development of novel fermentation equipment, because of the need to mimic in the laboratory the extreme environments from which these microbes have been extracted.[72]

The challenges are slowly being overcome with many researchers developing new technology for sample extraction and culturing, etc.[73] Thus biotechnology research has also indirectly contributed to developments in technology associated with MSR.

Phase 2: Isolation, Characterisation and Culture

Research collaboration between academia and industry.

There is no substantiated evidence that any company has mounted its own dive to hydrothermal vents (as distinct from those in collaboration with scientific research

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71 Schiraldi and De Rosa, above n 24, 517.
72 Schiraldi and De Rosa, above n 24, 518.
73 For example one scientist interviewed in the course of this research, Dr Alex Malhoff from GNS was involved in the development of sampling apparatus for sampling fluids at hydrothermal vents. This device is described in A Malahoff et al, 'A Seamless System for the Collection and Cultivation of Extremophiles From Deep-Ocean Hydrothermal Vents', (2002) 27(4) *IEEE Journal of Oceanic Engineering* 862. Another example of technology that has been developed includes the sampling equipment developed by the DEEPSTAR program at JAMSTEC. See Schiraldi and De Rosa, above n 24, 518 and http://www.jamstec.go.jp accessed 27 Januaray 2005. This technology was used to sample the Mariana Trench. For more recent developments in sampling technology see K E Wommack et al, 'An instrument for collecting discrete large-volume water samples suitable for ecological studies of microorganisms' (2004) 51(11) *Deep-Sea Research Part I* 1781. Another example is described in V Thor Marteinsson, J L Birrien and D Prieur, 'In situ enrichment and

institutions) for sample collection purposes. There is anecdotal evidence, though, that at least one company is planning its own series of dives, independent of any research institution. It is not known precisely what the purposes of these dives are or indeed whether such dives have taken place.[74]

It would appear, therefore, that the involvement of commercial interests in bioprospecting for hydrothermal vent genetic resources at this early stage involves either funding for research dives or, more usually, research collaboration in laboratories once the samples have been extracted. As Jabour-Green and Nicol point out in the second phase of bioprospecting there is a difference in the way that the samples are handled depending upon whether they are to be used by public research institutions or by commercial interests.[75] Isolation, characterisation and culture of microbes extracted from hydrothermal vents can occur either in laboratories operated by public research institutions such as universities, or in laboratories funded by commercial interests. Often such research is carried out as part of major collaborative research projects across several research institutions. For example, within the European Union there have been several major research projects on extremophiles (including hydrothermal vent species) within the framework of the ongoing Biotechnology Programme of the European Union. This has involved co-operative research between 39 academic and industrial laboratories.[76] This project was a major undertaking over

isolation of thermophilic microorganisms from deep-sea vent environments' (1997) 43 *Canadian Journal of Microbiology* 694.

[74] Interview, Agnieszka Adamczewska, InterRidge Co-ordinator, Tokyo, 17 September 2003.

[75] Jabour-Green and Nicol, above n 61, 86.

[76] A Aguilar, 'Exploring the last frontier of life: R & D initiatives of the European Union' (1995) 11 *World Journal of Microbiology & Biotechnology* 7, 8.

three years and resulted in as many as 270 scientific publications.[77] One specific example of a development in biotechnology from hydrothermal vents directly attributable to such research was the development of an Amylase from the hyperthermophile *Pyrococcus woesei,* which is an interesting enzyme for the starch industry.[78]

In addition to supporting this collaborative research, the European Union has also encouraged research exchange between academic researchers and industry through its Industry Platform for Microbiology.[79] This exchange has been successful in bringing European biotechnology companies closer to the multidisciplinary work being undertaken by the scientific community, thereby enhancing research, technology transfer and industrial exploitation of scientific research in this field.[80]

Another example of publicly funded research institutions involvement in collaborative commercial research with industry is the Frontier Research Program for Extremophiles at JAMSTEC. This involves collaboration with industry on the development of biotechnology from extremophiles collected by JAMSTEC through its Bioventure Centre. One of the largest of these projects at JAMSTEC is its Frontier Research System for Extremophiles (DeepStar) project, which is involved in research on micro-organisms from the deep-sea with an eye to their biotechnology potential. This work is being undertaken in close co-ordination

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[77] Aguilar et al, above n 25, 368.
[78] Ibid.
[79] A Aguilar, 'Extremophile research in the European Union: from fundamental aspects to industrial expectations' (1996) 18 *FEMS Microbiology Reviews* 89, 92
[80] Ibid.

with industry partners through JAMSTEC's Cooperative Research Project for Extremophiles. This project provides a forum for collaboration between academic and industrial researchers interested in exploiting the biological and chemical potential of extremophiles.[81] As part of the joint research programs conducted at the Centre, personnel from industry are invited to work alongside staff to utilize the expertise and facilities available for their own company's needs. Research includes genome analysis of extremophiles, software development for genome analysis, and useful enzyme and natural product discovery from microorganisms isolated from deep-sea and deep subsurface environments.[82]

Where biotechnology research is funded by the public sector, generally speaking such results will be openly published in the scientific literature.[83] However, where the research is funded by the private sector, these results are generally kept confidential and are ordinarily not disclosed until after patent applications have been filed.

In addition to gaining access to samples collected through research collaboration with publicly funded institutions, commercial interests can also gain access to samples through national culture collections where samples are often deposited by research institutions. For example, the American Type Culture Collection offers a range of samples of hydrothermal vents microorganisms such as *Thiobacioous Hydrothermalis* isolated from hydrothermal vents in the North Fiji Basin,

[81] JAMSTEC web site http://www.jamstec.go.jp/jamstec-e/XBR/bv/en/menubiov.html accessed 11 December, 2004.
[82] JAMSTEC web site http://www.jamstec.go.jp/jamstec-e/XBR/bv/en/menubiov.html accessed 11 December, 2004.
[83] Aguilar et al, above n 24, 368.

Pyrococcus Horikoshi isolated from hydrothermal vents in the Okinawa Trough in the Pacific Ocean, and *Idiomarina Ioihiensis* from hydrothermal vents on the Loihi Seamount in the United States. These can be purchased over the internet for between US$50 and US$190 per sample.[84] Similarly, the Japanese National Institute of Technology and Evaluation offers ampules of hydrothermal vent microorganisms for between JPY4000 and JPY8000 per ampule.[85]

The use of microorganisms deposited at many type culture collections is governed by the terms of the Treaty on the International Recognition of the Deposit of Microorganisms for the Purposes of Patent Procedure.[86] The role of the *Budapest Treaty* in the granting of patents in relation to microorganisms and derivatives is discussed in more detail later in this chapter.

Phase 3: Screening for Pharmaceutical Activity/Other Potential Uses and Phase 4 Development of Product, Patenting, Trials, Sales and Marketing

Discussion earlier in this chapter identified the main areas of research in relation to the potential of biotechnology from hydrothermal vent species. For the purposes of this thesis a brief desktop review was undertaken to determine to what extent there is existing commercial activity with respect to the screening, development, patenting and marketing of biotechnology developed from hydrothermal vents. This review highlights that there is already substantial commercial interest in biotechnology developed from deep-sea hydrothermal vent species.

[84] See http:\\www.nite.go.jp\index-e.htm, accessed 6 July 2004.
[85] Ibid.
[86] *Budapest Treaty on the International Recognition of the Deposit of Microorganisms for the Purposes of Patent Procedure*, opened for signature 28 April 1977, 9 ATS (1987) (entered into force 19 August 1980), hereinafter Budpapest Treaty.

The review of existing commercial interest in biotechnology developed from hydrothermal vents outlined in Appendix 1 and 2 is not intended to be a comprehensive statement of the existing state of commercial interest. Instead the review was undertaken with a view to gauging whether or not there is currently any commercial interest in biotechnology from hydrothermal vent microorganisms and derivatives. The review was based upon a search of the internet and, in particular, of information published by a number of leading biotechnology companies on the internet, from a number of published scientific sources and from anecdotal comments made by a number of members of the scientific community interviewed in the course of this research. Further more detailed research could be undertaken at a later date to more clearly define the nature and extent of commercial interest in biotechnology from hydrothermal vents and the deep-sea in general. Nonetheless, as the very rudimentary review shows, there does appear to be significant commercial interest in biotechnology from deep-sea hydrothermal vent microorganisms and from extremophiles from other sources more generally. This sector of the biotechnology industry is only in its infancy, and accordingly, over time, and subject to further developments in technology, greater commercial interest is foreseeable.

Desk top review: Survey of the market

At least 14 biotechnology and other companies were identified as being 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. It is important to note that the research and product development is directed primarily towards derivatives as opposed to specific uses of the microbes themselves. Six companies have been identified that already market products derived from hydrothermal vent thermophiles and hyperthermophiles. Details of companies that have been involved in research and product development and products currently marketed by these companies are listed in Table 2 in Appendix 1.

INTELLECTUAL PROPERTY RIGHTS, INTERNATIONAL LAW AND BIOPROSPECTING AT HYDROTHERMAL VENTS

Biotechnology research and product development is an expensive high technology process. The patent or monopoly on exploitation granted in relation to the invention the subject of the patent rewards the inventor for the effort and cost expended in developing the new invention. As the World Intellectual Property Organisation has noted

> "The basic function and role of the patent system is simple and reasonable. It is desirable in the public interest that industrial techniques should be improved. In order to encourage improvement, and to encourage also the disclosure of improvements in preference to their use in secret, any person devising an improvement in a manufactured article, or a method of making it, or a new substance and/or the process of making that substance, may, upon disclosure of the details to the Patent Office of a country, be given a set of exclusive rights for a certain period of time. After that period expires, the invention passes into the public domain. The exclusive rights are justified on the grounds that if it had not been for the inventor who devised and disclosed the improvement, nobody would have been able to use it at that or any other time since it and the manner of producing it may have remained unknown. In addition, the giving of the monopoly encourages the putting into practice of the invention, since the only way the applicant can make a profit is by putting the invention into practice, either by using it himself [sic] and deriving an advantage over his [sic] competitors by its use, or by allowing others to use it in return for royalties."[87]

Importantly, it is worth noting that the grant of a patent is essentially a sovereign act of a nation State. There is a considerable body of international law that relates to patents and, in particular, that sets minimum requirements for the grant of a

[87] World Intellectual Property Organization (ed), *Introduction to Intellectual Property. Theory and Practice*, (1997).

patent, some of which is examined below. But in the end it is a matter for each individual State to determine the terms on which a patent may or may not be granted under its domestic law, provided this is consistent with their international obligations. This is especially significant in the case of biotechnology derived from genetic resources beyond national jurisdiction because, regardless of from where the original genetic resource is obtained, the grant of a patent is always something that occurs within a States jurisdiction. This means that the rights of a patent holder are determined by the domestic law of the State in which the patent was granted. Thus rights in relation to patents (as opposed to the question of access rights) are not affected by the absence of law in areas beyond national jurisdiction.

This is a significant point when we seek to understand how we may bridge what could be called the "missing link" between the CBD and Intellectual Property rights. This missing link, and how it may be bridged, is explored in more detail below. But before exploring the "missing link", it is worth briefly considering the various sources of law at the international level that relate to patents in particular, and the nature and the legality of patents in relation to biotechnology more generally.

The nature of a patent and the patentability of biotechnology

The patent law of most countries includes three basic requirements for determining whether a claimed invention is patentable. These are that the invention, whether it is in relation to a product or a process, must be:

- new (or novel);
- involve an inventive step (or not be obvious); and

- be capable of industrial application (or have utility).[88]

In many countries patent protection for biotechnological inventions has been available and expanding for nearly 20 years.[89] An important legal landmark in the history of patenting of biotechnology that is often referred to is the 1980 decision of the United States Supreme court in *Diamond* v *Chakrabarty,* which held that inventions involving biological materials and some life forms were patentable under United States law.[90] Since this decision there has been a dramatic increase in the number of patents granted in relation to biotechnology and a whole new subset of patents covering "genetic inventions" (ie that relate to nucleotide DNA or RNA sequences that may encode genes or fragments of genes and their uses) has firmly taken hold in intellectual property law in most jurisdictions.[91]

Although there has been debate in some jurisdictions on the extent of patentability of some life forms (especially as they relate to human beings, medical treatment and, more controversially, genetically modified organisms), the patentability of biotechnology is now largely accepted in most jurisidictions. Claims in gene patent applications generally fall into a number of different categories as follows

> "Genes or partial DNA sequences such such as cDNAs, ESTs, SNPs, promoters and enhancers;
> Proteins encoded by these genes and their function in the organism;
> Vectors used for the transfer of genes from one organism to another;
> Genetically modified micro-organisms, cells, plants and animals;
> Processes used for the making of a genetically modified product; and

[88] Australia, Department of Foreign Affairs and Trade, *Intellectual Property and Biotechnology: A Training Handbook*, (undated), 1-8.
[89] Organisation for Economic Co-operation and Development (OECD), *Genetic Inventions, Intellectual Property Rights and Licensing Practices. Evidence and Policies*, (2002), 7.
[90] OECD, above n 89, 7.
[91] OECD, above n 89, 8

> Uses of genetic sequences or proteins which include: genetic tests for specific genetic diseases or predisposition to such diseases; drugs developed on the basis of the knowledge of proteins and their biological activity; industrial applications of protein functions."[92]

The biotechnology companies identified above have actively pursued protection of intellectual property rights in relation to developments in biotechnology arising from their research and product development. Several of the companies mentioned in Table 2 Appendix 1 have already obtained extensive patent protection for the products they have developed and for other developments in technology arising from their research and product development.

A brief desktop review and search of the databases of the European Patent Office and the United States of America Patent Office revealed 37 patents that have been granted as a result of such research and/or product development. Details of these patents are listed in Table 3 Appendix 2. The search of the European and US patent databases was by no means an exhaustive search. It is likely, therefore, that many other patents have been granted within these jurisdictions and elsewhere. A comprehensive review of patent databases for patents granted in relation to biotechnology and other technology arising from research and product development in relation to hydrothermal vents may be justified at a later date.

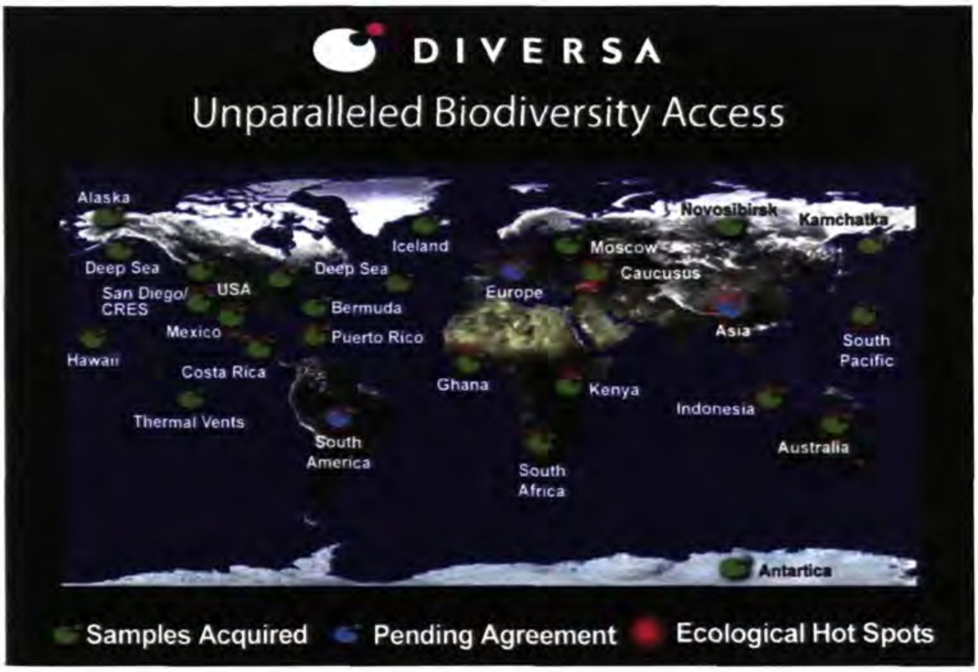
In addition to patents, several of the companies referred to earlier in this chapter have also obtained trade-mark protection for products developed from research related to hydrothermal vents. For example, New England Biolabs owns the trade marks "Vent" and "Deep Vent", which are utilised in the marketing of the DNA polymerase products by this company. Similarly, Stratagene Inc holds the

[92] OECD, above n 89, 28.

trademark for a derivative from the hydrothermal vent species *Pyroccocus furiosus* included in several products sold by this company and marketed as the ArchaeMaxx™ Factor. Similar examples can be found in the names and trademarks of products marketed by other companies.

One other interesting aspect worth noting in relation to these companies is the way in which the extreme environments in which the microbes form are included prominantely in marketing material of these companies. These companies emphasise that they are searching these areas because they are biodiversity hot spots that offer many unique and new potential leads for developments in biotechnology. The relevant companies are New England Biolabs Inc and Diversa Corporation. One example of such marketing material is reproduced below.

Figure 9 Advertising material for Diversa Corp.[93]



[93] From http://www.diversa.com/techplat/disc/diversa_map.htm accessed 24 January 2004.

INTERNATIONAL LAW AND PATENTS IN RELATION TO BIOTECHNOLOGY

The patentability of biotechnology is clearly contemplated by the international legal regime dealing with patents. Several international treaties are relevant to an understanding of the international legal regime in relation to patents. For present purposes the most significant treaties worth noting are[94]:

- the Paris Convention for the Protection of Industrial Property;[95]
- the Patent Cooperation Treaty;[96]
- the World Trade Organisation Agreement on Trade Related Aspects of Intellectual Property Rights ;[97]and
- the Budapest Treaty.

Each of these treaties has been examined at length in the existing literature and no purpose is served by considering these treaties in detail, except for the Budapest Treaty.

Microorganisms, patents and the Budapest Treaty

For a patent to be granted details of the invention must be fully disclosed to the public. For this to occur the patent application must contain a description of the invention in sufficient detail to permit a person skilled in the art to repeat the

[94] For detailed discussion of the major treaties see A D'Amato and D E Long (eds), *International Intellectual Property Law* (1997) and *World Intellectual Property Organization (ed) Introduction to Intellectual Property. Theory and Practice* (1997)
[95] *Convention for the Protection of Industrial Property*, Paris, 20 March 1883, ATS (1972) 12 (entered into force 26 April 1970).
[96] *Patent Cooperation Treaty*, Washington, 19 June 1970, ATS (1980) 6 (entered into force 24 January 1978).
[97] *Agreement on Trade-Related Aspects of Intellectual Property Rights*, 15 April 1994, Marakesh Agreement Establishing the World Trade Organisation, Annex 1C, Gatt Doc. MTN/FAII-A1C, 33 I L M 1197. Hereinafter TRIPS.

invention.[98] However, in the case of inventions involving new microorganisms, it is often impossible to provide an adequate written description.[99] As a consequence, under the provisions of the *Budapest Treaty,* samples of microorganisms can be deposited with certain culture collections recognized as "international depository authorities" for the purposes of patent procedure.[100] Under the *Budapest Treaty* any contracting State that allows or requires the deposit of microorganisms must recognize a deposit made in any international depository authority.[101]

In addition the *Budapest Treaty* includes certain Regulations concerning administrative requirements and procedures in relation to deposits made under the Treaty.[102] The Regulations deal inter alia with what information must be supplied with a deposit made under the regulations. For example Rule 6.1 provides

> "(a) The microorganism transmitted by the depositer to the international depositary authority shall, except where Rule 6.2 applies, be accompanied by a written statement bearing the signature of the depositor and containing:
>
> (i) an indication that the deposit is made under the Treaty and an undertaking not to withdraw it for the period specified in Rule 9.1;
>
> (ii) the name and address of the depositor;
>
> (iii) details of the conditions necessary for the cultivation of the microorganism, for its storage and for testing its viability and also, where a mixture of microorganisms is deposited, descriptions of the components of the mixture and at least one of the methods permitting the checking of their presence;

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98 World Intellectual Property Organisation, *Guide to the Deposit of microorganism under the Budapest Treaty*, (2000), 1.

99 World Intellectual Property Organisation, *Guide to the Deposit of microorganism under the Budapest Treaty*, (2000), 1.

100 World Intellectual Property Organisation, *Guide to the Deposit of microorganism under the Budapest Treaty*, (2000), 3. Specifically Article 3 of the Budapest Treaty provides

> "Contracting States which allow or require the deposit of microorganisms for the purposes of patent procedure shall recognize, for such purposes, the deposit of a microorganism with any international depositary authority. Such recognition shall include the recognition of the fact and date of the deposit as indicated by the international depositary authority as well as the recognition of the fact that what is furnished as a sample is a sample of the deposited microorganism."

101 World Intellectual Property Organisation, *Guide to the Deposit of microorganisms under the Budapest Treaty*, (2000), 3.

102 The Regulations are dealt with in Article 12 of the Treaty and were originally contained in Annex 2 to the *Budapest Treaty.*

(iv) an identification reference (number, symbols etc) given by the depositor to the microorganism

(v) an indication of the properties of the microorganism which are or may be dangerous to health or the environment, or an indication that the depositor is not aware of such properties".[103]

The Regulations under the *Budapest Treaty* do not currently require disclosure of the location from which a microorganism is sourced. However, under Article 12 of the *Budapest Treaty*, the Assembly of the Contracting Parties to the treaty is given express power to amend the Regulations. It is, therefore, possible for the Regulations to be amended to require the disclosure of the location from where a microorganism was sourced.

If the Regulations were to be amended in this way then it would be possible for national authorities granting patents to identify whether or not such microorganisms had been sourced from areas within national jurisdiction, in which case patents could be made conditional on proof of access and benefit sharing arrangements having been entered into in accordance with the provisions of the CBD and the *Bonn Guidelines*. Perhaps more significantly, such a mechanism could identify when microorganisms had been sourced from areas beyond national jurisdiction. Patents granted in relation to biotechnology from such microorganisms would then fall within the scope of the proposed global commons trust fund outlined below.

[103] Rule 6.1, *Regulations Under the Budapest Treaty on the International Recognition of the Deposit of Microorganisms for the Purpose of Patent Procedure*, Appendix 2, *Budapest Treaty*.

THE MISSING LINK-THE CBD AND PATENTS

One of the major challenges faced in conserving the planet's biodiversity is the inevitable conflict between trade and the conservation of biodiversity. A significant factor in this ongoing conflict is the failure of the CBD to adequately address the close relation between the exploitation of biodiversity and intellectual property rights. As one author has observed

> "Sustainable development means that current generations must leave future generations an environment and a stock of natural resources that is as good and as plentiful as those it received from past generations. The philosophy also says that technology and social organization affect the capacity of the biosphere to meet the economic demands placed on it. International trade is one of the most important forms of social organization by which natural resources are transformed into economic prosperity, but there has been little progress in clarifying the environment-related aspects of trade or the trade-related aspects of environmental protection. Intellectual property rights, already a contentious trade issue even without taking environmental arguments into account, is one piece of the sustainable development puzzle that needs deliberate and careful attention. Instead, the biodiversity convention deals with the issue in the worst possible manner: by equivocation in hopes that the controversy will simply go away".[104]

Indeed more than 12 years since the Earth Summit there can be no more obvious defect in the international regime for the conservation of biodiversity than the missing link between the CBD and the international legal regime dealing with intellectual property rights. This is more so in the areas beyond national jurisdiction, such as at hydrothermal vents and other parts of the deep-sea. In those places requirements of informed consent and benefit sharing mandated by the CBD, and subsequent instruments such as the *Bonn Guidelines,* do not apply. Beyond national jurisdiction there is no sovereign government or other community with whom to negotiate informed consent and with whom to share benefits. As noted in Chapter 2, access to such resources is free to anyone with the necessary technology to reach into the dark depths of the abyss.

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[104] A D'Amato and D E Long, *International Intellectual Property Law*, (1997), 86.

However, as discussion in the earlier parts of this chapter has highlighted, these freely exploitable resources ultimately become subject to intellectual property rights, principally patents, which grant a monopoly on exploitation and use. Intellectual property rights are clearly a key part of the economic incentive behind research and development in relation to deep-sea genetic resources. Without the monopoly on exploitation which a patent grants, it is unlikely that much of the research and product development outlined above would have occurred.

In responding to the question posed by Glowka[105], one of the obvious questions that needs to be addressed is how *could* the benefits associated with the exploitation of the genetic resources of the deep-sea be shared? Also, any such response needs to address how such resources *should* be shared? What is suggested is that the resources *could* be shared by means of royalties payable in relation to patents granted in relation to deep-sea genetic resources. It is also suggested that such resources *should* be shared by dispersing any such royalties received through the mechanisms of the Global Environment Facility.[106]

In this way funding for the sustainable manangement of specific hydrothermal vent sites in accordance with proposals outlined elsewhere in this thesis, and the sustainable management of the marine environment more generally, could be linked to patents granted in relation to biotechnology derived from organisms taken from commons areas, such as hydrothermal vents in the deep-sea beyond

[105] See the introduction to this thesis, page 1 above.
[106] Hereinafter GEF.

national jurisdiction. For the sake of clarity it is stressed that this proposal relates only to the genetic resources of hydrothermal vents beyond national jurisdiction. Genetic resources within areas of national jurisdiction are outside the scope of this proposal. This is because the status of resources within national jurisdiction is now firmly entrenched in international law and realistically this is not likely to change in the foreseeable future. While the proposal is limited to the genetic resources of hydrothermal vents beyond national jurisdiction, a similar structure might equally be adopted with respect to genetic resources in other parts of the deep-sea beyond national jurisdiction, the ocean more generally or perhaps even Antarctica.

How could the benefits associated with the exploitation of the genetic resources of the deep sea be shared? This could be achieved by establishing a form of trust fund from royalties or other fees collected from developers of biotechnology derived from hydrothermal vents on the high seas. This trust fund would become operational by linking existing international institutions associated with intellectual property rights and the conservation of biodiversity. This is an obvious option that was not canvassed in the so-called options paper prepared by the SBSTTA and discussed in Chapter 2. This idea has a respectable heritage and it is worth noting some proposals that have previously been put forward.

Ocean Development Taxes and Commons Trust Funds: re-interpretation of some old ideas.

The need for new and creative ways of funding biodiversity conservation and sustainable development has been recognised for some time.[107] In 1987 the Bruntland Commission observed

> "Given the current constraints on major sources and modes of funding, it is necessary to consider new approaches as well as new sources of revenue for financing international action in support of sustainable development. The commission recognizes that such proposals may not appear politically realistic at this point in time. It believes, however, that--given the trends discussed in this report--the need to support sustainable development will become so imperative that political realism will come to require it. The search for other, and, especially more automatic, sources and means for financing international action goes almost as far back as the UN itself. It was not until 1977, however, when the Plan of Action to Combat Desertification was approved by the UN General Assembly that governments officially accepted, but never implemented, the principle of automatic transfers. That Plan called for the establishment of a special account that could draw resources not only from traditional sources but also from additional measures of financing, including fiscal measures entailing automatacity. Since then, a series of studies and reports have identified and examined a growing list of new sources of potential revenue, including:
>
> > revenue from the use of international commons (from ocean fishing and transportation, from sea-bed mining, from Antarctic resources, or from parking charges for geostationary communications satellites, for example)
> >
> > taxes on international trade (such as a general trade tax; taxes on specific traded commodities, on invisible exports, or on surpluses in balance of trade; or a consumption tax on luxury goods)
> >
> > international financial measures (a link between special drawing rights and development finance, for example, or IMF gold reserves and sales....
>
> [G]iven the compelling nature, pace, and scope of the different transitions affecting our economic and ecological systems as described in this report, we consider that at least some of those proposals for additional and more automatic sources of revenue are fast becoming less futuristic and more necessary. This Commission particularly considers that the proposals regarding revenue from the use of international commons and natural resources now warrant and should receive serious consideration by governments and the General Assembly".[108]

Many different proposals have been put forward for the sharing of the oceans' resources over time. One example that has been debated extensively in the literature is the so called Ocean Development Tax. The leading advocate of such a

[107] D Hunter, J Salzman and D Zaelke, *International Environmental Law and Policy*, (2002), 1501.

[108] World Commission on Environment and Development, *Our Common Future*, (1987), 342-43 reproduced in Hunter et al, above n 107, 1510-1511.

proposal was noted scholar and environmentalist Elizabeth Mann Borgese. An Oceans Development Tax is essentially a consumption tax on the use of the oceans. As Borgese describes it

> "This tax is, in a way, on consumption of ocean space and resources. This proposal calls for a 1 percent tax (modified by population and GNP) on all the major commercial uses of the ocean-on fish caught, oil extracted, minerals produced, goods and persons shipped, water desalinated, recreation enjoyed, waste dumped, pipelines laid, and installations built. There would be no tax, however, on subsistence fisheries or on scientific research. This tax would be levied on activities no matter where located-in areas under national or international jurisdiction. This functional, not territorial, tax would be levied by governments and paid over to the competent ocean institutions (eg FAO, UNEP, IOC, International Maritime Organization [IMO], International Seabed Authority) for the purpose of building and improving ocean services (eg navigational aids, scientific infrastructure, environmental monitoring, search and rescue, disaster relief, etc)."[109]

However, there are some problems with an Ocean Development Tax as far as it might apply to the genetic resources of the deep-sea and hydrothermal vents in particular. Firstly, in the form proposed by Borgese, the Ocean Development Tax would not apply to MSR. But, as noted previously, often the distinction between MSR and bioprospecting is blurred. Without such a clear distinction, which in practice is is almost impossible to make, how will it be possible to determine when bioprospecting is said to occur and is then subject to taxation?

More problematic, though, is how the proceeds of such taxation would be distributed. Although potential uses of such a tax are outlined in the extract quoted above, it is unclear how decisions might be made as to how the Ocean Development Tax might be spent. Would it need the creation of a new institution or international bureaucracy? This is unclear.

[109] E M Borgese, *The Future of the Oceans. A Report to the Club of Rome*, (1986).

Another alternative that has been canvassed at length in the literature is the notion of the Global Commons Trust Fund. The idea of a Global Commons Trust Fund is not a new idea and there have been many varied proposals along similar lines over time.[110] One of the clearest articulations of the concept is by Stone, who has summed up the concept as follows

> "Essentially, on the funding side, the idea is to capitalize on revenues from all commons-connected activities, and not only from charges for carbon "storage" in the atmosphere, the most familiar fund-raising scheme; on the expenditure side, the funds so raised would be applied to the conservation and repair of the commons areas rather than to distribute them back to the individual nations to let them expend them on developmental projects of their choice, however tenuously connected the projects are to the environment"[111]

In essence the use of commons resources is made dependent on some of the benefits arising from their use flowing back into the protection of commons areas themselves. However, there are two problems with the way such an idea has been developed in the past. Firstly, as Stone explains, such a concept is based on the notion that the commons areas are the Common Heritage of Mankind. If they are regarded as the Common Heritage of Mankind this implies that they are therefore common property of all nations and that accordingly "one may argue that the users of the commons areas ought to be charged for their use".[112] However, for the reasons outlined in Chapter 5, the utility or, indeed, the desirability of invoking the common heritage of mankind is questionable. Is there a way around this inconsistency? Can we argue for a global commons trust fund without invoking the common heritage of mankind?

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[110] For an overview of the many different proposals that have been put forward over time see C D Stone, 'Mending the Seas through a Global Commons Trust Fund' in J M Van Dyke, D Zaelke and G Hewison (eds), *Freedom for the Sea in the 21st Century. Ocean Governance and Environmental Harmony*, (1993).

[111] C Stone, *The Gnat is Older than Man. Global Environment and Human Agenda* (1993), 208.

[112] Ibid.

The answer to this question is yes, and the way that it is done is by linking the global commons trust fund to the grant of patents in relation to the biotechnology derived from such commons resources, in this case patents derived from hydrothermal vent micro-organisms. Here it is not because such resources are regarded as the common heritage of mankind, but merely because, as a conscious policy choice, States may choose to make the grant of a patent conditional upon the patent holders' agreement to contribute to the global commons trust fund in the manner outlined in more detail below. The reason that this is possible is because the grant of the patent is something that lies within the competency of the State under international law. While the micro-organisms from which biotechnology may be derived are located beyond national jurisdiction, the grant of the exclusive monopoly to exploit such biotechnology is an act of each individual State that occurs within its jurisdiction.

One other significant objection that has also previously been raised with respect to the concept of a global commons trust fund, especially as it applies to biodiversity, has been a concern that such a concept would impinge upon the sovereignty of the nation State.[113] However, such a criticism could not be levelled against a global commons trust fund linked to patents granted in relation to biotechnology derived from micro-organisms sourced beyond national jurisdiction. By very definition such resources are not within the "sovereign space" of any one nation. More significantly, though, the very act of granting a

[113] Ibid.

patent is a sovereign act; it is the grant of a monopoly to exploit a particular invention within that State's jurisdiction. Thus, where a Global Commons Trust fund is linked to patents, the Global Commons Trust Fund does not undermine State sovereignty, but rather re-inforces it. This is done in a way that ultimately contributes to the protection of global commons areas and the conservation of biodiversity.

How much should that royalty be? The author is not an economist and therefore, it would be unwise for me to nominate a particular amount or percentage. However, a few parameters for any such royalty are worth noting. Firstly, a good benchmark figure may be similar amounts paid under access and benefit sharing arrangements within national jurisdiction. These figures may be a useful guide as to what is economic for biotechnology companies to afford, having regard to the return on investment required to justify undertaking such research and development in the first place. Although costs of accessing genetic resources may be greater in the deep-sea beyond national jurisdiction, royalties paid in relation to genetic resources within national jurisdiction might provide a useful benchmark.

Secondly, it would be preferable that any such royalty be linked to the actual sale of products derived from deep-sea genetic resources. If such a royalty were to be payable at the time the patent is granted this may well act as a disincentive to research and product development. Linking the royalty payable to actual product sold would enable research on new uses of deep-sea genetic resources to be carried out without the added expense or burden of a tax on what may well turn out to be a speculative exercise that yields no results.

No doubt other factors need to be considered in determining an appropriate royalty and that is work best left to economists and other policy makers to determine. This could be the subject of further detailed research.

THE GLOBAL COMMONS TRUST FUND AS A NEW SOURCE OF FUNDING FOR THE GLOBAL ENVIRONMENT FACILITY

The only remaining question then is what institution could act as the trust fund and be responsible for the disbursement of its funds. Clearly there are already several existing international institutions that play a role in funding sustainable development. These include organizations such as the GEF and the various regional development banks such as the Asian Development Bank, etc.

Each of these existing international organizations already has an extensive involvement in environmental programs. They have a certain degree of expertise and existing mechanisms for prioritizing where funding is to be spent. Although there may need to be some amendments to existing mechanisms and constituent documents, such mechanisms already exist. There would be no need to create a whole new international bureaucracy to manage and distribute the resources of the proposed trust fund.

CONCLUSION

This chapter has highlighted the extent of the commercial interest in deep-sea genetic resources and those of hydrothermal vents in particular. This is an exciting, emerging field of biotechnology and, on the basis of the available evidence presented above, it is reasonable to anticipate that this new field of commercial activity will expand as technology makes the deep-sea environment more accessible.

This chapter has put forward a proposal for how the benefits of the exploitation of these resources may be shared. Principally, through minor amendments to existing institutions, it has been shown how deep-sea genetic resources could provide a new source of funds for sustainable development. This new found wealth could likewise be a source of funding to provide for the sustainable management of hydrothermal vent ecosystems upon the basis outlined elsewhere in this thesis.

What appears to be the issue is not the lack of mechanisms to provide for benefit sharing as has previously been suggested. Rather it appears possible to provide for benefit sharing of deep-sea genetic resources with only slight modification to existing legal regimes and institutions. What probably will be a major obstacle to the realization of a benefit sharing regime will be the lack of political will to act. As this sector of the biotechnology industry grows, vested interests will be more forceful in their opposition to any such regime. Now is the time to act and to put such a regime in place before vested commercial interests make such a regime impossible to achieve. This is yet a further reason why, as suggested in chapter 5, it is futile for us to engage in the debate as to whether such resources are the common heritage of mankind. Engaging in this debate will delay the creation of a benefit sharing regime and will make it even less likely to be achievable.

CHAPTER 8

INTRODUCTION-MARINE SCIENTIFIC RESEARCH UNDER LOSC.

As noted in Chapter 1, MSR poses the most immediate threat to the hydrothermal vent ecosystem. Chapter 2 of this thesis outlined gaps in the existing law with respect to the regulation of the environmental impact of MSR on the continental shelf and in the Area. This chapter considers how MSR could be regulated in all areas of the oceans including ocean space beyond national jurisdiction. The chapter begins by outlining the nature of MSR conducted at hydrothermal vents in general terms. In part this discussion is based on a number of interviews conducted with several leading scientists active in hydrothermal vent research. It is not suggested that the material in this part of the chapter is the definitive dissertation on the nature and extent of hydrothermal vent related MSR. More detailed research may be warranted at a later date. This material nonetheless provides a useful insight into the nature of the activity for which regulation is proposed.

The second part of the chapter then goes on to explore what form regulation of MSR might take. This section considers the debates surrounding the MSR issue during the negotiation of LOSC in some detail. It is suggested that the arguments raised in relation to MSR over 40 years ago are equally valid today. Consideration of these arguments in the context of MSR at hydrothermal vents suggests how the issue of regulation of MSR should be approached. The chapter then concludes by outlining a proposal for a regulatory regime for MSR modelled on the regime of the Madrid Protocol to the *Antarctic Treaty*.

THE NATURE OF MARINE SCIENTIFIC RESEARCH IN RELATION TO HYDROTHERMAL VENTS-METHODOLOGY EMPLOYED.

Several scientists engaged in research in relation to hydrothermal vents were interviewed during the course of research for this PhD thesis. The purpose of these interviews was to obtain general background information on the nature of MSR conducted at hydrothermal vents. Interviews covered a range of issues including the type of research carried out in relation to hydrothermal vents by individual scientists and research organisations with which they were affiliated, research techniques, environmental impact, internal ethical and environmental impact assessment approval processes, potential for and extent of commercialisation of their research, approval processes of foreign governments for their research, and their views on regulation of activities associated with hydrothermal vents generally.

No particular methodology was employed in selecting these scientists for interview. Scientists were approached based upon their reputation in published scientific literature and or contacts or referrals provided by third parties, including the scientists initially interviewed. In total 9 scientists directly involved in hydrothermal vent research were interviewed. Details of each of the relevant scientists, including their research institution and area of research, are provided in Table 4 Annex 3. Subsequent to these interviews two researchers could not be contacted to obtain their consent to disclose there identity. Accordingly in accordance with the terms of ethics approval for this research the identity of both these scientists is withheld from Table 4. I was also fortunate to have informal discussions with a number of other scientists working in related fields, who provided further leads for research. These scientists' contributions are acknowledged at the beginning of this thesis.

It became clear during the early stages of these interviews that much of the information sought covered topics that individual researchers either were only able to comment on in general terms, or were unable to comment on at all. For example, most researchers were generally not involved in the process of obtaining foreign government approval to carry out MSR within coastal State waters and therefore could not comment on difficulties encountered in the process. This was the responsibility of other administrative staff within their respective research organisations. Likewise, for reasons of commercial confidentiality, scientists whose research had commercial applications were not able to comment on the status of such research. Accordingly, while a more comprehensive survey of the nature and extent of MSR in relation to hydrothermal vents was proposed at the outset of this research, instead more general conclusions on the nature of MSR are presented below based on these interviews and a range of published scientific literature and material. Later research may consider a more comprehensive survey of the nature of hydrothermal vent related MSR but the information below is sufficient for present purposes.

OVERVIEW OF THE NATURE OF MARINE SCIENTIFIC RESEARCH CONDUCTED AT HYDROTHERMAL VENTS

Research covers a wide area of scientific interest. Research in relation to the geology and geophysics of hydrothermal vents, includes the resource potential of associated minerals. Other forms of research includes research in relation to biology and microbiology of hydrothermal vent fauna, research in relation to the chemistry of hydrothermal vent fluid and their impact upon the chemistry and circulation of the surrounding ocean. A brief general overview of some of this scientific research is given below.

Geological and geochemical research at hydrothermal vent sites has the potential to lead to better understanding of the genesis of ore deposits and improve models for exploration of ores on land.[1] Research may also provide new geological knowledge about the formation, structural deformation and ageing of the Earth's volcanic ocean crust and associated sediments.[2] Such research may also lead to a better understanding of the tectonic history of the earth.[3]

Research is also being undertaken to expand fundamental knowledge of biological systems and physiological processes of vent species as well as other species that live in extreme environments.[4] Similarly, coastal species living at shallow vent sites have adapted to toxic conditions and high temperatures.[5] Study of these organisms could help predict how coastal ecosystems may respond to increasing anthropogenic pollution and global warming.[6]

[1] P Dando and S K Juniper, *Management and Conservation of Hydrothermal Vent Ecosystems: Report from an InterRidge Workshop* (2001), 4-5.
[2] Ibid.
[3] Ibid.
[4] Ibid.
[5] Ibid.
[6] Ibid.

Research at hydrothermal vents is also important to understand the role they play in maintaining the geochemical balance of the planet as a result of their output of chemicals.[7] It is estimated that all sea water re-circulates through the vents on average every 10^7- 10^8 years.[8] In addition, it is suggested that hydrothermal vents contribute to ocean productivity and the local circulation of seawater.[9] Continued research will enable a greater understanding of these processes.

While individual scientists may be conducting experiments in a discrete field of science or as part of individual research expeditions, on a much larger scale MSR is also being conducted as part of global research programs. One such program is the Census for Marine Life, a cooperative international research program that seeks to assess and explain the diversity, distribution and abundance of life in the oceans. This project involves more than 300 scientists from 53 different countries.[10] Perhaps ambitiously this research seeks to comprehensively answer three significant questions: (1) What did live in the oceans? (2) What lives in the oceans now? and (3) What will live in the oceans in the future? Hydrothermal vent ecosystems and other chemosynthetic biological communities are the focus of part of the research attempting to answer these questions. Two key components of the Census of Marine Life include the Biogeography of Deep-Water Chemosynthetic Ecosystems, the so called ChEss research program, which is a global study of the biogeography and biodiversity of deep-water chemosynthetic

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[7] Ibid.
[8] Ibid.
[9] Ibid.
[10] Census of Marine Life, *The Unknown Ocean. Baseline Report of the Census of Marine Life* (2003), 2-3.

ecosystems and the processes that drive them.[11] Similarly the Mid-Atlantic Ridge Ecosystem Project or MarEco, also part of the Census of Marine Life, seeks to carry out co-ordinated international studies of the macro fauna of the northern mid-atlantic ridge, including species associated with hydrothermal vents.[12]

There are several other international co-operative research programmes in relation to hydrothermal vents, including a number of research projects conducted under the auspices of international co-operative research bodies and loose networks of researchers such as InterRidge,[13] and the Integrated Ocean Drilling Program.

While the primary objective of such projects is what may traditionally be called pure scientific research, many researchers recognise that their research may have implications for biotechnology and developments in deep-ocean exploration technology. Several of the institutions visited in the course of this research, including JAMSTEC, CSIRO and GNS, were involved to varying degrees in on-going biotechnology research with possible commercial implications. One of the largest of these projects was at JAMSTEC. Its Frontier Research System for Extremophiles (DeepStar) project was mentioned in Chapter 7.

Individual national research institutions also often co-operate on joint research programs. For example, the very first research expedition to the PACMANUS field in PNG's waters was a collaborative project between researchers from PNG,

[11] Full details on the nature and goals of the ChEss research program are available from the programme's web site http://www.coml.org , accessed 22 November 2004.
[12] See the MarEco web site http://www.mar-eco.no accessed 22 November 2004.
[13] For detailed information on Interidge and its associated research see http://www.interridge.org accessed 22 November, 2004.

Australia and Canada.[14] Since then researchers have participated in several collaborative research expeditions with scientists from Japan, France and Germany. International collaborative work is not just confined to the PACMANUS field. Similar international collaborative research work occurs at many other hydrothermal vent sites. This co-operation also often extents to joint applications for funding from government bodies. For example, the Marie Curie Research Training Network (MOMARnet), a collaborative research network involving scientists in fourteen European laboratories in eight countries, recently secured funding of €2.5 million from the European Union.[15]

While MSR in relation to hydrothermal vents takes many forms and crosses many disciplines, and may also involve international collaboration, there are also many differences in relation to the size and scale of such research. There are vast differences in technology depending upon both the research being conducted and the participants in that research. This may be illustrated by comparing the research undertaken by the Japan Marine Science and Technology Centre and Australia's CSIRO.

JAMSTEC has been involved in a wide range of scientific research in relation to the marine environment. These include the study of the deep-sea floor dynamics

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[14] The PACMANUS field was named after this expedition ie the Papua New Guinea, Australia, Canada Manus Basin Expedition. See R A Binns, 'The PACMANUS Field, Eastern Manus Basin, Papua New Guinea: A Decade of Seafloor Investigation and the First Deep Drilling of an Active, Felsic-Hosted, Submarine Hydrothermal Field' In C J Yeats (Ed) *Seabed hydrothermal systems of the Western Pacific: Current research and new directions*-Conference Presentations, CSIRO Exploration and Mining Report 1113F, CD-ROM.

[15] MOMARnet project web site, http://beaufix.ipgp.jussieu.fr/rech/lgm/MOMAR/ accessed 12 December 2004.

and the movement of magma and the earth's plates. Studies of these processes are aided by observations of hydrothermal vent chimneys such as those associated with black smokers.[16]

To carry out its research JAMSTEC has several sophisticated vessels equipped for MSR in the deep-sea. These include the Shinkai 2000 capable of taking scientists to depths up to 2000 metres and its support vessel the R/V Natsushima. JAMSTEC also has the Shinkai 6500 capable of taking scientists to a depth of 6500 metres and its support vessel the R/V Yokosuka.[17] JAMSTEC utilises other sophisticated technology such as ROV's. These include ROVs such as the Kaiko (which, until its recent loss, was capable of diving to depths of up to 10,000 metres to carry out research and retrieve samples from the deep-sea), the Doplhin-3K, a large scale deep-sea research vehicle, and the Deep Sea ROV "UROV-7K a thin cable controlled ROV capable of operating at depths of up to 7,000 metres.[18]

While sending humans to carry out research at extreme depths is often only possible using submersibles or remotely by ROV's, MSR on hydrothermal vents is possible using far less sophisticated technology. For example, over the past decade the PACMANUS field in PNG's territorial waters has been studied as part of the Ocean Drilling Program and has been accessed by scientists using both the Shinkai 6500 and the Shinkai 2000 submersible. However, much of the research carried out for many years by researchers from Australia's CSIRO was carried out

[16] Japan Marine Science & Technology Centre, JAMSTEC Brochure (undated), copy on file with author, 14.
[17] Japan Marine Science & Technology Centre, above n 16, 6
[18] Ibid.

without using such sophisticated technology. Research often involved simple techniques such as dredging, sediment coring, towing of platforms carrying video recorders and echo sounding traverses.[19]

Figure 10 Deep-sea research equipment. (Clockwise) AUV Urashima, ROV Kaiko and ROV Hyper Dolphin.[20]

[19] Examples of techniques used on such research expeditions are set out in copies of research reports provided during the course of this research by Dr Tim McConachy, Principal Research Scientist, CSIRO Exploration and Mining including T F McConachy et al *Final Cruise Report FR08-2001, VAVE-2001, Vanuatu Australia Vents Expedition Aboard the RV Franklin 5-25 September 2001* (2001) and T F McConachy et al *Solavents-2002, Solomons Australia Vents Expedition Aboard the RV Franklin, CSIRO Exploration and Mining Report 1026F (2002).*

[20] Image source JAMSTEC web site http://www.jamstec.go.jp/jamstec-e/rov/index.html accessed 11 December 2004.

Figure 11 Jamstec research capacity-summary of deep-sea and surface vessels.[21]

While there are clearly significant differences in technology and capacity to carry out such research between different research institutions, regardless of these differences MSR in the deep-sea, and at hydrothermal vents in particular, is very expensive. For example, for a 30 day research cruise conducted by the CSIRO in the Manus Basin the total cost was AUD$500,000.[22] Similarly, for research involving the use of submersibles, the cost typically ranges from between C$30,000 to C$50,000 per day for research conducted at sites such as the Endeavour hydrothermal vents.[23] These figures only relate to the cost of research at sea. Extra expenses are often involved in the analysis of samples in laboratories

[21] Image source JAMSTEC web site http://www.jamstec.go.jp/jamstec-e/rov/index.html accessed 11 December, 2004.

[22] Interview, Dr Timothy McConachy, CSIRO 10 April 2003.

[23] Professor Kim Juniper, interview 18 June 2003.

on shore. One scientist interviewed indicated that this can add anything from C$50,000 to C$100,000 per year to the cost of research.[24] A range of other costs may be involved, such as the costs associated with obtaining foreign government approvals to conduct research in a coastal State's waters, a lengthy process usually conducted through diplomatic channels.

Conclusion-the nature of marine scientific research at hydrothermal vents.

The research that is being conducted by scientists in relation to hydrothermal vents takes many different forms. It is, therefore, not possible to identify any form of scientific research as "typical" scientific research on which to model the design of any legal regime for the regulation of MSR. However, a few significant observations are worth noting. Firstly, this research is multi-disciplinary. Hydrothermal vents are clearly of interest to many different areas of science. Secondly, the research is also multinational. Scientists from many nations are involved in this research. There is a large amount of co-operation across international borders. This has implications for legal regime design because it means that not only must various types of MSR be regulated, but also various national and international scientific research cultures must be considered. Similarly, MSR at hydrothermal vents can be both so called pure and applied scientific research. Often it is impossible at any one time to distinguish which form of research it may be.

MSR at hydrothermal vents also involves sophisticated and expensive technology, while on the other hand equally useful and valid scientific research is being

[24] Ibid.

undertaken with less sophisticated technology. It is clear that this research is largely the domain of wealthy developed states. Although to some degree developing countries such as India and China are also involved in this research, the expense and sophisticated technology involved mean that this area of MSR is dominated by the developed countries. This is a significant point worth noting because, unlike other ocean uses such as fishing, deep-sea MSR is unlikely to involve vessels from Flag of Convenience States simply because these states do not have the necessary capital to invest in this research, and the required sophisticated technology. This in turn has implications for the way in which regulation may be achieved and would suggest that, unlike other issues such as fishing, flag state enforcement could possibly be effective for regulating MSR. However, before turning to consider how enforcement should occur, it is perhaps first useful to consider the nature of the environmental impact of MSR at hydrothermal vents, because it is the environmental impact of MSR that is the reason that regulation is required.

ENVIRONMENTAL IMPACT OF MARINE SCIENTIFIC RESEARCH

While it is not possible to identify any one area of MSR in relation to hydrothermal vents as typical research, each area to varying degrees has an environmental impact. Further detailed scientific research is required before we have a full picture of the environmental impact, but, as already mentioned, there is a body of opinion that MSR research does have a measurable environmental impact. Threats that have been identified to date include:

- habitat loss and organism mortality as a result of removal of chimneys and rocks for geological investigations or chemical sampling;

- environmental manipulation, such as drilling, which can change fluid flow pathways and shut off the supply of fluids to colonies of vent organisms;
- clearing fauna for experimental studies;
- transplantation of fauna between locations;
- placement of instrument packages that disturb fauna and change water flows; and
- the use of submersibles and remotely operated vehicles (including the impact of light from submersibles on photosensitive organisms).[25]

This in turn can lead to a range of second order biological effects including:

> "A decrease in population numbers;Local extinction of species;Regional or global extinction of species; A change in community structure;The introduction of exotic species carried by underwater vehicles from another site."[26]

The impact of scientific research is further compounded by the fact that most research is highly localised and usually confined to only a few sites that are visited repeatedly.[27]

It would be wrong to generalise and say that all MSR has the same environmental impact. That is, the environmental impact of MSR varies depending on the nature of the research being conducted. The writer's survey of the scientific literature has not been able to identify any specific work that has been done to measure the environmental impact of MSR and clearly detailed studies may be warranted in

[25] Dando and Juniper, above n1, 6.
[26] Ibid.
[27] Ibid.

the future. On the basis of the interviews conducted with scientists during this research it is possible to provide a few examples to illustrate the nature of the environmental impact of MSR in more specific terms. For example, it might be reasonable to speculate that MSR involving acoustic imaging of the deep-sea floor would have negligible impact. Sampling water from the water column via niskin bottles would also probably have a negligible environmental impact.

Sampling biota or dredging rock samples may have more of an environmental impact. For example, one of the research cruises mentioned in the course of the interviews conducted, collected 486 samples of rock and sediment totalling 2.7 tonnes of material over 27 days, of which less than 0.5% was hydrothermal in origin. 2.7 tonnes of rock is equivalent to one cubic metre. The balance of material was collected from a wide range of features on the seafloor including seamounts, ridges and valley floors.[28] To a lay observer such as the writer this seems a considerable amount of material to be removed from the ocean floor in just one cruise, but in the view of some scientists interviewed in the course of this research the removal of such materials has quite negligible environmental impact.[29] Given the current state of scientific knowledge it is arguable that the environmental impact of such MSR is still unclear.

While more scientific research is clearly warranted as to the environmental impact of MSR one very significant matter worth noting from the interviews conducted

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[28] T F McConachy et al, *Solavents-2002, Solomons Australia Vents Expedition Aboard the RV Franklin, CSIRO Exploration and Mining Report 1026F* (2002).

[29] Dr Tim McConacy interview 10 April 2003.

with scientists is that few, if any, processes currently exist for considering the environmental impact of MSR when scientists plan research cruises. Only one scientist out of nine scientists interviewed from 5 different countries active in MSR at hydrothermal vents indicated that there was any formal consideration of the environmental impact of their research in assessing whether or not to proceed with such research.

This example was MSR conducted in Canada. As part of the formal approval process for research funding in Canada all scientific research to be funded by the Canadian Government may be subject to environmental impact assessment. This is a formal requirement of the funding process for scientific research managed by the Natural Sciences and Engineering Research Council of Canada,[30] which is tasked with implementing the provisions of the Canadian Environmental Assessment Act[31] and associated regulations with respect to the funding it administers. This process and the associated legislation is examined in detail later in this chapter. Before turning to consider this regime it is useful to consider what the key concerns raised when the issue of MSR was raised during the negotiations that lead to LOSC.

THE LAW OF THE SEA NEGOTIATIONS AND MARINE SCIENTIFIC RESEARCH. TO REGULATE OR NOT TO REGULATE?

Until the middle of the twentieth century regulation of MSR was not perceived to be necessary.[32] However, by the mid 1950s the increasing importance of the

[30] Hereinafter NSERC.
[31] Hereinafter CEA Act.
[32] R R Churchill and A V Lowe, *The Law of the sea* (1999), 400.

resources of the continental shelf lead to calls for the regulation of MSR by the coastal State in the territorial sea and on the continental shelf. In the case of the territorial sea, regulation was essentially an act of sovereignty.[33] The coastal State was able to regulate MSR as it saw fit, subject only to the right of innocent passage recognised under Article 14 of the 1958 *Convention on the Territorial Sea and the Contiguous Zone.*

Article 5 of the 1958 *Convention on the Continental Shelf* explicitly recognised that the exploration of the continental shelf, and the exploitation of its natural resources must not result in any unjustifiable interference with fundamental oceanographic or other scientific research carried out with the intention of open publication. However, article 5(8) specifically provided

> "the consent of the coastal State shall be obtained in respect of any research concerning the continental shelf and undertaken there. Nevertheless the coastal State shall not normally withhold its consent if the request is submitted by a qualified institution with a view to purely scientific research into the physical or biological characteristics of the continental shelf, subject to the proviso that the coastal State shall have the right, if it so desires, to participate or to be represented in the research, and that in any event the results shall be published."

Thus, MSR on the continental shelf was subject to limited control by the coastal State, especially where such MSR was of direct significance for the commercial exploitation of the resources of the continental shelf.

On the high seas, although the 1958 *Convention on the High Seas* did not explicitly refer to MSR as a high seas freedom, it was generally accepted as such. The non-exclusive list of high seas freedoms provided for in Article 2 of the 1958 *Convention on the High Seas* and the inclusion of the qualifying term "inter alia"

[33] Churchill and Lowe, above n 3,, 401.

were said to indicate that other high seas freedoms recognised by customary international law, such as MSR, were not excluded merely because they were not mentioned in Article 2.

By the time of the negotiation of LOSC freedom of MSR in the high seas and in other jurisdictional zones in the oceans was under question. The parties to the LOSC negotiations were therefore called upon to consider various proposals for the regulation of MSR. One of the most ambitious proposals was that put forward by Malta in a working paper submitted to the Committee on the Peaceful Uses of the Seabed and the Ocean Floor beyond the Limits of National Jurisdiction on 23 March 1973.[34] The Maltese proposal dealt with all areas of ocean space. Significantly, though, in areas beyond national jurisdiction the Maltese proposal called for the establishment of International Ocean Space Institutions that would have responsibility for authorising and regulating MSR in the ocean beyond national jurisdiction. Draft article 9 of the Maltese proposal listed the purposes of the proposed International Ocean Space Institutions inter alia as

> "To encourage the scientific investigation of ocean space and the dissemination of knowledge thereon, to promote international cooperation in the conduct of scientific research therein and to strengthen the research capabilities of technologically less advanced countries;....
> ...To promote the development and the practical application of advanced technologies for the penetration of ocean space and for its peaceful use by man [sic] and to disseminate knowledge thereof;...
> ...To assist Contracting parties and their nationals in all matters relating to knowledge and development of ocean space and its resources and in particular to assist Contracting Parties to train their nationals in scientific disciplines and technologies relating to ocean space and to its peaceful uses"[35]

[34] Malta: draft articles on scientific research; UN Doc No. A/AC. 138/ SC.III/L.34, reproduced in United Nations, *The Law of the Sea. Marine Scientific Research. Legislative History of Article 246 of the United Nations Convention on the Law of the Sea*, (1994), 14-20.
[35] Draft article 9, Malta: draft articles on scientific research; UN Doc No. A/AC. 138/ SC.III/L.34, reproduced in United Nations, *The Law of the Sea. Marine Scientific Research. Legislative History of Article 246 of the United Nations Convention on the Law of the Sea*, (1994), 18.

The Maltese proposal was not motivated by the desire to control the environmental impact of MSR. However, other proposed institutions and provisions in the draft articles contained in the Maltese proposal, if included in LOSC, could have been used to control or minimize the environmental impact of MSR.

The Maltese proposal called for the creation of four principle organs of the International Ocean Space Institution, namely an Assembly, a Council, an International Maritime Court and a Secretariat.[36] It was proposed that these institutions be vested with authority to regulate MSR in all areas of ocean space beyond national jurisdiction. The Assembly would be vested with authority to approve such standards and rules of a general and non-discriminatory character relating to the conduct of scientific research as recommended by the Council.[37] Under the Maltese proposal these standards and rules would be obligatory for all users of ocean space beyond national jurisdiction two years after their adoption by the Assembly.[38] Draft article 12(3) also provided that violation of these standards and rules would entail legal responsibility when injury is caused to the rights and interests of others.

[36] Draft article 10, Malta: draft articles on scientific research; UN Doc No. A/AC. 138/ SC.III/L.34, reproduced in United Nations, *The Law of the Sea. Marine Scientific Research. Legislative History of Article 246 of the United Nations Convention on the Law of the Sea*, (1994), 14

[37] Draft Articles 11 and 12, Malta: draft articles on scientific research; UN Doc No. A/AC. 138/ SC.III/L.34, reproduced in United Nations, *The Law of the Sea. Marine Scientific Research. Legislative History of Article 246 of the United Nations Convention on the Law of the Sea*, (1994), 14

[38] Draft article 12 (2), Malta: draft articles on scientific research; UN Doc No. A/AC. 138/ SC.III/L.34, reproduced in United Nations, above n 37.

The last sentence of draft Article 12(3) of the Maltese proposal was even more ambitious because it went on to provide that:

> "Persistent violators may be excluded from the use of ocean space beyond national jurisdiction."

Just how this proposed organisation was to effectively police such exclusion in the vast expanse of millions of square miles of ocean space beyond national jurisdiction was not articulated.

The Maltese proposal also involved a system of licensing for MSR beyond national jurisdiction. Thus, States or their organs, intergovernmental organisations, scientific institutes and scientific organisations, as well as physical or juridical persons possessing such qualifications as determined by the proposed Scientific and Technological Commission, were eligible to be entered in a central register to be maintained by the International Ocean Space Institutions.[39] Registered persons or entities would then be authorised to freely conduct MSR in ocean space beyond the territorial sea, subject to such general and non-discriminatory regulations as prescribed by the Institutions proposed under the draft article.[40]

The proposal, if adopted, would have imposed liability for damage or environmental harm caused by MSR. Thus draft article 17(3) provided

> "The person or entity inscribed in the register is legally responsible for damages to the environment or for injury to the legitimate rights and interests of States or to those of the

[39] Draft article 17, Malta: draft articles on scientific research; UN Doc No. A/AC. 138/ SC.III/L.34, reproduced in United Nations, above n 37.
[40] Draft article 17(2), Malta: draft articles on scientific research; UN Doc No. A/AC. 138/ SC.III/L.34, reproduced in United Nations, above n 37.

> international community caused in the course of scientific research in ocean space by physical or juridical persons under its sponsorship."[41]

Proposed draft article 17(4) then went on to provide that any member or associated member of the Institutions could bring to the attention of the Scientific and Technological Commission any instance where it believes that scientific research conducted by such a person or entity has caused significant damage to the marine environment, or injury to its legitimate rights or interests. Draft article 17(5) provided

> "If the Scientific and Technological Commission finds that scientific research conducted by a person or entity inscribed in the register has caused significant damage to the marine environment or injury to the legitimate rights and interests of a member or associate member, it may (a) issue a warning to the person or entity which was responsible for the research; (b) suspend the person or entity which was responsible for the research for a fixed period of time not exceeding two years, or (c) remove the person or entity from the register. The action taken by the Scientific and Technological Commission may be appealed to the International Maritime Court."

Presumably the imposition of the ultimate sanction of removal from the register would mean that, once a particular person or entity was removed from the register, it would be unlawful for them to conduct MSR in areas beyond national jurisdiction.

A similar but less detailed proposal was put forward by Canada in a Working Paper submitted to the Committee on the Peaceful Uses of the Seabed and the Ocean Floor Beyond the Limits of National Jurisdiction on 25 July 1972. Canada's proposal centred around so called "Principles on marine scientific research." Thus Canada proposed that MSR concerning the sea-bed and ocean floor, and the subsoil thereof beyond the limits of national jurisdiction, should

[41] Draft article 17(3), Malta: draft articles on scientific research; UN Doc No. A/AC. 138/ SC.III/L.34, reproduced in United Nations, above n 37.

> "comply with any regulations developed by a competent international organization [sic] to minimize [sic] disturbance and to prevent pollution of the marine environment and interference with exploration and exploitation activity."[42]

Consistent with these obligations the Canadian principles also proposed that

> "States shall devise means to enable responsibility to be fixed with States or international organizations [sic] that have caused damage in the course of marine scientific research or where such damage had been caused by the activities of persons under their jurisdiction, to the marine environment or to any other State or to its nationals".[43]

Several other countries put forward proposals or expressed support for an international body responsible for regulating MSR in ocean space beyond national jurisdiction. The Colombian delegation, for example, expressed support for such a body believing that

> "an international authority would be the ideal place for the preparation and implementation of a world policy for marine scientific research."[44]

Despite the bold nature of such proposals many members of the international community at that time had grave reservations about regulating MSR in areas beyond national jurisdiction, and especially in vesting an international institution with authority to regulate MSR. Ultimately when the negotiations for LOSC were concluded no institutional mechanism was provided to regulate MSR. One of the major objections of those opposed to such proposals was the impact that such regulation may have had on MSR. For example, the United Kingdom objected strongly to any regulation of MSR in the ocean beyond national jurisdiction. The

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[42] Canada, Working paper submitted by the Canadian delegation; A/AC/138/SC.III/L.18 of 25 July 1972, reproduced in United Nations, *The Law of the Sea. Marine Scientific Research. Legislative History of Article 246 of the United Nations Convention on the Law of the Sea*, (1994), 12.

[43] Ibid.

[44] Comments by the Colombian delegate, recorded in record of the General debate Committee on the Peaceful Uses of the Seabed and the Ocean Floor Beyond the Limits of National Jurisdiction reproduced in United Nations, *The Law of the Sea. Marine Scientific Research. Legislative History of Article 246 of the United Nations Convention on the Law of the Sea*, (1994), 53.

United Kingdom delegate to the meeting of the Committee on the Peaceful Uses of the Seabed and the Ocean Floor beyond the Limits of National Jurisdiction commented

> "British marine scientists had great difficulty in appreciating the underlying motives of some of the proposals that had been made. The United Kingdom was firmly convinced that the close regulation of all marine scientific research was unnecessary and that undue restrictions were bound to discourage research....The scientific staff of the suggested international authority would have to be very large and highly qualified to deal with all the different kinds of research concerned, to check conclusions based on the enormous amount of data involved, to translate and study all the relevant literature and thus to understand what was going on. Moreover, the effort required would clearly be much more extensive if the authority were to be made responsible for the regulation of research...In conclusion, his delegation wished to reassert that, with a few exceptions, scientific research should remain as free of regulation as it was at present, so as to promote the objective of improving and increasing knowledge of the marine environment for the benefit of all mankind [sic]."[45]

Concerns were also expressed by several other delegates that too tight a regulatory regime would stifle MSR. Thus the U.S. delegate, who was also a scientist, argued

> "to ensure, through appropriate treaty agreement, that the realization [sic] of the commonly accepted goals of scientific research at sea was facilitated, not hindered....restrictions on research in the oceans would not benefit mankind [sic]. The effort to understand the natural world was one of the noblest pursuits of human kind. Free intellectual inquiry about the oceans should be encouraged, not only because of its importance to man's [sic] understanding of the world but because of its importance to the human spirit. Recent studies of the ocean bed had led to revolutionary concepts .... the history of the Earth, current studies of ocean circulation might lead to better understanding of climatic fluctuations, and many biologists were convinced that the clues to the puzzle of species development and differentiation were to be found in a study of oceanic life. Of course, the society which allocated some of its resources to the conduct of ocean science hope to be compensated by material as well as by intellectual and spiritual growth, and some of the information of marine science might become of economic significance. It could not be too strongly emphasized, however, that the primary purpose of marine geologists was to achieve a better understanding of the recent geological history of the Earth. There was also the risk that close regulation of scientific oceanography would result in a stifling of scientific creativity. He hoped that the Seabed Committee would not unduly attempt to minimize creativity by agreeing to unnecessary controls and regulations. Regulations would not, of course mean the end of oceanography; research would continue, but the more it was subject to controls, the greater the danger that it would become second-class research....The world could not afford any reduction in the quantity or quality of ocean research...Basic research could not flourish in a regulated environment, and it must flourish if the contribution of science to the benefit of mankind [sic] was to continue to be truly meaningful. Accordingly, the

[45] Comments by the delegate of the United Kingdom before Committee on the Peaceful Uses of the Seabed and the Ocean Floor Beyond the Limits of National Jurisdiction, reproduced in United Nations, *The Law of the Sea. Marine Scientific Research. Legislative History of Article 246 of the United Nations Convention on the Law of the Sea*, (1994), 50.

> new regime which the Committee was engaged in constructing should impose no restrictions on basic research beyond the territorial sea."[46]

The concerns expressed by countries such as the United Kingdom and the USA were in part affected by their views on other related and ongoing divisions in international affairs, including those associated with the cold war and the developed countries' response to the demands of the third world and the New International Economic Order. However, the main thrust of their argument was that too much regulation and a bloated international bureaucracy posed a very real threat to further advances in marine science. These arguments are as equally valid today as they were some 30 years ago. There is a very real risk that ill-conceived regulation runs the risk of stifling MSR.

Similarly, given the amount of MSR conducted in the world's oceans today, its complexity and the vast amount of data that is being collected, it would be impossible for any one international institution to regulate MSR in the oceans. Simply to assess applications for approval to conduct MSR, let alone to police compliance with any international regulatory regime, would require vast amounts of human resources, technical and scientific skills and money to operate effectively. For that reason alone the arguments made in the 1960s and 1970s against any single international institution being vested with the mandate to regulate MSR, or even only the environmental impact of MSR, are equally valid today. Simply put, the idea of creating an international institution to regulate and

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[46] Comments by the delegate of the United States of America, Committee on the Peaceful Uses of the Seabed and the Ocean Floor Beyond the Limits of National Jurisdiction, reproduced in United Nations, *The Law of the Sea. Marine Scientific Research. Legislative History of Article 246 of the United Nations Convention on the Law of the Sea*, (1994), 71-72.

authorise MSR in the high seas was a bad idea in the 1960s and 1970s and it is still a bad idea today.

In any event, it is highly unlikely that the scientific community would allow any such regime to be imposed on them. As we saw in Chapter 3 similar concerns have already been expressed by the scientific community involved in hydrothermal vent research within national jurisdiction. Concerns were expressed by scientists about the regulation of their activity within the Endeavour Marine Protected Area in Canada's EEZ and in the Portuguese EEZ around the Azores. Similarly, concerns have been expressed by the scientific community about the impact of regulation of other activities, such as mining, on their ability to carry out MSR. As was concluded in Chapter 3, the success of any regime to regulate MSR will depend on both the level of stakeholder involvement and the degree to which scientists support the objectives of regulation. If the regulation is perceived by the scientific community as the imposition of an unnecessary burden on their work, then such a regime is likely to encounter stiff opposition and in all probability is doomed to failure. While the environmental impact of scientific research may be of concern, the scientific community must nonetheless be involved in the creation and implementation of any regime to be created.

SELF REGULATION-THE INTERRIDGE DRAFT CODE OF CONDUCT

There are clearly emerging signs of the willingness of the scientific community to engage with this issue. Within the scientific community there is already debate as to whether or not the environmental impact of their research should be subject to some form of regulation. The first proposal for regulation of MSR has in fact come from the scientific community. This has emerged from the work of the Biology Working Group of InterRidge.

For the past two to three years the InterRidge Biology Working Group, co-chaired by Professor Kim Juniper and Dr Françoise Gaill in conjunction with Lyle Glowka, has been working on a draft Code of Conduct for the sustainable use of hydrothermal vent sites by both scientific researchers and tourist operators.[47] In its initial form it was proposed that the Code would consist of a concise statement of principles applicable to MSR and tourist activities, plus a set of Operating Guidelines applicable to organisations and individuals operating generally and at specific sites.[48] It has been proposed that they would operate as follows

> "The Guidelines could function as benchmarks against which to judge the performance of the organisations undertaking marine scientific research, their affiliated researchers and tour operators. They could provide principles with which to develop institutional environmental management systems. They may also provide principles for regulatory agencies developing or applying vessel clearance and other regulatory procedures or conservation measures such as marine protected areas."[49]

Also included in the Code would be operations guidelines developed around four basic principles to which organisations and individuals undertaking MSR and tourist activities adopting the Code would commit. They are

> "(1) Identify and comply with international, national and sub-national laws and policies;
> (2) Minimise or eliminate adverse environmental impacts through all stages of an activity;
> (3) Minimise or eliminate actual or potential conflict or interference with existing or planned MSR activities; and

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[47] An overview of this draft Code of Conduct was recently published. See S K Juniper and L Glowka, 'Biology Working Group. A Code of Conduct to Conserve and Sustainably Use Hydrothermal Vent Sites' (2003) 12(1) *InterRidge News* 8. The Code and a number of other international initiatives such as those at Endeavour and in the Azores discussed in chapter 3 are canvassed in L Glowka, 'Putting marine scientific research on a sustainable footing at hydrothermal vents' (2003) 27 *Marine Policy* 303.
[48] Juniper and Glowka, above n 47.
[49] Ibid.

(4) Monitor, evaluate and report on the Code's application."[50]

It is proposed that the Code would apply to organisations and affiliated individuals undertaking MSR and tourism activities at hydrothermal vents located within and beyond the limits of national jurisdiction.[51]

While the idea of a Code of Conduct is worth encouraging, several difficulties with this proposal are worth noting. Firstly, the first basic principle of the Code noted above really does not represent any significant change. If there are particular national laws that apply to MSR then clearly scientists are already under a binding legal obligation to comply with such laws. The Code of Conduct in that respect does no more than state the obvious; scientists like all other citizens and legal persons are obliged to comply with the law. More significantly, though, as this thesis has already outlined at length, there really is no effective international legal regime that applies in areas beyond national jurisdiction. In that respect the operation principles in the proposed Code of Conduct are no more than aspirational or rhetorical statements. What is the point of scientists abiding by international law when essentially international law says that their activities beyond national jurisdiction are unregulated?

A further significant omission is the lack of any sanction or, alternatively, any incentive for researchers to comply with the Code of Conduct. Apart from the obvious ethical imperatives that underlie the proposed Code, why would scientists adhere to it when there is no sanction or adverse consequence for failing to either

[50] Ibid.
[51] Ibid.

sign up to it or to adhere to it? Of course many scientists will sign up and adhere to such a code simply because they recognise the importance of these ecosystems and the need for their sustainable management. But those scientists who already recognise the need for their activities to be sustainably managed will probably already be trying to minimise the environmental impact of their research. It is not these scientists whose activities need to be regulated. Rather it is scientists who fail to recognise the need for regulation or who don't even believe their research has a negative environmental impact who should be subject to regulation. It is precisely the latter who need to be regulated and this cannot be achieved through a voluntary Code of Conduct.

One strength of the proposal is that it calls for the establishment of certain benchmarks and standards against which sustainable MSR could be assessed. This latter idea has merit and could be one way to involve the scientific community in designing sustainable management regimes for their research, which are balanced against the need for MSR to continue.

The proposed Code of Conduct, therefore, has both strengths and weakness. However, at this stage it is only a draft proposal. It is not clear whether the Code will ever come into operation. At the first detailed consideration of the proposal concerns were expressed that, in its current form, it is too legalistic. Instead, consideration is being given to watering it down to be much more of an aspirational statement rather than one containing any detailed obligations. What form the Code of Conduct will take if it ever comes into existence is unclear at this stage.[52]

For the time being, other more effective mechanisms need to be considered. The following discussion outlines a proposal for such a regime.

ENVIRONMENTAL IMPACT ASSESSMENT AND INTERNATIONAL ENVIRONMENTAL LAW.

In putting forward a proposal for a protocol on marine environmental impact assessment to LOSC Tanaka notes the increasing inclusion of principles of environmental impact assessment in binding international legal instruments, soft law documents and other international legal materials.[53] Examples cited by Tanaka[54] include the adoption of the United Nations Environmental Program's *Goals and Principles of Environmental Impact Assessment* (UNEP Guidelines)[55] which provide a set of non-binding guidelines to adequately assess environmental impacts at national, regional, and international levels; the *Convention on Environmental Impact Assessment in a Transboundary Context*[56] adopted at the United Nations Economic Commission for Europe which was modelled on the UNEP Guidelines; the subsequent 1997 EC Directive[57]; the *North American Commission for Environmental Cooperation Draft North American Agreement on*

[52] Professor Kim Juniper, personal communication on file with author.
[53] M Tanaka, 'Lessons form the protracted MOX Plant Dispute: A Proposed Protocol on Marine Environmental Impact Assessment to the United Nations Convention on the Law of the Sea' (2004) 25 *Michegan Journal of International Law* 337
[54] Ibid.
[55] UNEP Governing Council, *Goals and Principles of Environmental Impact Assessment*, Dec 14/25 UN Doc. UNEP/GC/DEC/14/25 (1987) available at http://www-penelope.drec.unlim.fr/penelope/library/Libs/Int_nal/unep.html
[56] *Convention on Environmental Impact Assessment in a Transboundary Context*, Espoo, 25 February 1991, 30 I L M 800 (1991).
[57] Council Directive 97/11/EC, 1997 OJ (L73) 5.

Transboundary Environmental Impact Assessment;[58] the Draft Articles on Prevention of Transboundary Harm from Hazardous Activities adopted by the International Law Commission in 2001[59]; lending decision making processes of the World Bank and regional banks[60]; and finally and perhaps most significantly for present purposes, the *Madrid Protocol* to the *Antarctic Treaty* which provides for detailed environmental impact assessment of all activities in Antarctica. It is clear that environmental impact assessment is now a widely utilised mechanism under international law. No doubt this is due in part to the fact that it has been an accepted mechanism under numerous domestic legal regimes for decades.[61]

Tanaka's proposed protocol for environmental impact assessment under LOSC is quite interesting, but, as it is confined essentially to environmental impact assessment in the context of marine pollution and transboundary movement of hazardous waste, detailed consideration of his proposal is beyond the scope of this thesis. Nonetheless one treaty referred to by Tanaka as evidence of the increasing incorporation of environmental impact assessment processes in international legal

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[58] North American Commision for Environmental Cooperation, Draft North American Agreement on Transboundary Environmnetal Impact Assessment (June 21, 1997) available at http://www.cec.org/pubs_info-resources/law_treat_agree/pbl.cfm?varian=english

[59] Draft Articles on Prevention of Transboundary Harm from Hazardous Activities, in *Report of the International Law Commission on the Work of Its Fifty-third Session*, UN GAOR, 56th Sess., Supp. No. 10, at 370-77, UN Doc A/56/10 (2001).

[60] Eg World Bank, Environmental Assessment, in The World Bank Operational Manual: Operational Policies 4.01, 2 (1999) available at http://wbln0018.worldbank.org/Institutional/Manuals/OpManual.nsf/944eea1d5fb31d95852564a30060b223/9367a2a9daeed38525672c007d972?OpenDocument

[61] One of the earliest examples of legislation incorporating environmental impact assessment is the United States National Environmental Policy Act 1969, which Robinson claims established the first systematic procedure for environmental impact assessment. See N Robinson, 'Questionnaire Response: USA Report", International Environmental Conference on Codifying The Rio Principles In National Legislation, 22-24 May, The Hague, Netherlands, 1996, reproduced in D G Craig, N A Robinson and K Kheng-Lian, *Capacity Building for Environmental Law in the Asian and Pacific Region-Approaches and Resources*, Volume 1 (2003), 549.

instruments that warrants detailed consideration is the *Madrid Protocol* to the *Antarctic Treaty*.

Chapter 3 introduced the provisions of the *Antarctic Treaty* system that could arguably be utilised in regulating human activities at hydrothermal vents in Antarctica. The following builds on that discussion and considers the environmental impact assessment process under the *Madrid Protocol* as a model for how the environmental impact of MSR at hydrothermal vents on the high seas could be regulated. The provisions discussed in this section are already applicable to MSR conducted at hydrothermal vents in Antarctic waters. Perhaps more importantly the *Madrid Protocol* provides an example of how environmental impact assessment can be utilised to manage the environmental impact of scientific research in areas beyond national jurisdiction.

ENVIRONMENTAL IMPACT ASSESSMENT AND SCIENCE IN ANTARCTICA- THE MADRID PROTOCOL MODEL

The significant innovation introduced by the *Madrid Protocol* was 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"[62] 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".[63]

[62] *Madrid Protocol*, article 8(2).

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 becomes mandatory. Article 2 of Annex 1 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[64] 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. In particular it must include:

> "(a) a description of the proposed activity, including its purposes, location, duration, and intensity; and
> (b) consideration of alternatives to the proposed activity and any impacts that the activity may have, including consideration of cumulative impacts in the light of existing and known planned activities".[65]

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. What is not clear, however, is what is meant by the benchmark "minor or transitory impact",

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[63] *Madrid Protocol*, article 8(1).
[64] Hereinafter IEE.
[65] *Madrid Protocol*, Annex I, article 2(1).

as this term is not defined.[66] This will become important in determining whether a Comprehensive Environmental Evaluation is required.

Article 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[67] must be prepared.

Under Article 3(3) of Annex I, a draft of the CEE must be made publicly available and a copy circulated to all Parties to the *Madrid Protocol*, who are also required to make it publicly available. 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 function of the Committee is to "provide advice and formulate recommendations to the Parties in connection with the implementation"[68] of the Protocol and annexes.

There are two important points to note about this entire process. Firstly, it allows parties to make informed decisions with respect to any proposed activity. In theory decisions will only be made after rigorous scientific scrutiny of the likely environmental impact. Secondly, and perhaps more significantly, transparency is introduced into the process with wide public circulation of CEEs.

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[66] F O Vicuna, 'The Protocol on Environmental Protection to the Antarctic Treaty: Questions of Effectiveness.' (1994) 7 *Georgetown International Environmental Law Review* 1, 3.
[67] Hereinafter CEE.
[68] Madrid Protocol, Annex I, Article 12.

Individual State implementation of the Antarctic model- the Australian example

While the provisions of the *Madrid Protocol* apply to all activities in Antarctica, implementation is effectively achieved as the result of measures taken by the individual signatory State in accordance with its own domestic legal system. For some States this may involve the enactment of legislation that directly regulates the way scientific research can be carried out in Antarctica. One example of a country that has enacted laws applying to scientific research in Antarctica is Australia. It is useful for present purposes to examine how Australia regulates the environmental impact of scientific research in Antarctica.

The main legislation that implements Australia's obligations under the *Madrid Protocol* and applies to Australia's Antarctic Territory is the *Antarctic Treaty (Environment Protection) Act 1980 (Cth)*[69] and subordinate legislation such as the *Antarctic Treaty (Environmental Protection) (Environmental Impact Assessment) Regulations 1993 (Cth).*[70] By virtue of section 4 of the ATEP Act, the Act applies both to Australia's Antarctic Territory and outside of Australia to Australian citizens, Australian expeditions and members of expeditions, Australian organizations, members of the crew (including persons in charge) of aircraft, vessels or vehicles that are Australian property and Australian property.

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[69] Hereinafter the ATEP Act.

[70] Other Commonwealth legislation that implements Australia's obligations under the suite of treaties that constitute the Antarctic Treaty System include inter alia the *Environmental Protection and Biodiversity Conservation Act 1999* and associated *Environment Protection and Biodiversity Conservation Regulations 2000*, the *Antarctic Marine Living Resources Conservation Act 1981*, the *Antarctic Mining Prohibition Act 1991*, the *Protection of Sea (Prevention of Pollution From Ships) Act 1983*, the *Australian Antarctic Territory Act 1954*, the *Australian Antarctic Territories Acceptance Act 1933* and subordinate legislation. Specific legislation such as the Commonwealth *Heard Island and McDonald Islands Act 1953* and the Tasmanian *Macquarie Island-*

The Act as a whole (together with the other legislation noted above) implements Australia's obligations under the *Madrid Protocol* in Antarctica.[71] Part 3 in particular implements the obligations of the *Madrid Protocol* dealing with Environmental impact assessment. Thus Section 12B of the ATEP Act provides

> "The object of this Part is to provide for:
> (a) the assessment of proposed activities in the Antarctic to identify the impact that they are likely to have on the environment; and
> (b) the regulation of activities that are likely to have an adverse impact on the environment".

Mirroring the provisions of the *Madrid Protocol* the ATEP Act implements a graduated process of environmental impact assessment for all activities in Antarctica. This commences with a mandatory preliminary assessment of the likely impact of any activity on the Antarctic environment.[72] The preliminary assessment is then considered by the Minister responsible for administering the ATEP Act. Reflecting the provisions of Article 8(1) of the *Madrid Protocol*, under section 12E of the Act, the Minister has to make a determination as to whether the activity is likely to have:

> "(i) more than a minor or transitory impact; or
> (ii) a minor or transitory impact; or
> (iii) no more than a negligible impact;
> on the environment".[73]

The Minister must then inform the proponent of his or her determination.[74] The ATEP Act goes on to provide that, if the determination is that the activity is likely

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Environmental Management and Pollution Control Act 1994 (Tas) also apply to specific territories claimed by Australia in the Southern Ocean.

[71] Section 3 of the ATEP Act defines the " Antarctic" as "the area south of 60° south latitude, including all ice shelves in the area".

[72] Section 12A of the ATEP Act provides that, for the purposes of Part 3 of the Act, "environment means the Antarctic environment and dependent and associated ecosystems".

[73] Section 12E(a) ATEP Act.

[74] Section 12E(b) ATEP Act.

to have no more than a negligible impact on the environment, the Minister must authorise the proponent to carry on the activity.[75]

Under section 12G(1) of the ATEP Act, if the Minister determines that the activity is likely to have a minor or transitory impact on the environment, then an initial environmental evaluation must be prepared. The initial environmental evaluation must cover matters required by the regulations, and assess the impact that the activity is likely to have on the environment in a manner that allows for a reasoned conclusion to be reached as to whether the activity is to have either a minor or transitory impact or more than a minor or transitory impact on the environment.[76] If the assessment indicates that the impact on the environment is likely to be minor or transitory the initial environmental evaluation must also make recommendations as to the measures necessary for assessing and verifying any impact on the environment.

If, after considering the initial environmental evaluation, the Minister determines the activity is likely to have a minor or transitory impact then he or she must authorise the activity subject to conditions if appropriate.[77] Alternately, under section 12J, if at this or any earlier stage the Minister determines that the activity is likely to have more than a minor or transitory impact on the environment then the proponent of the activity must prepare draft and final comprehensive environmental evaluations in accordance with the provisions of the regulations.

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[75] Section 12F ATEP Act.
[76] Section 12G(2) AETP Act.
[77] Section 12J ATEP Act.

The regime for implementation of the *Madrid Protocol* by Australia outlined above is managed by the Australian Antarctic Division.[78] The AAD seeks to implement this legislation and Australia's obligations under the *Madrid Protocol* in collaboration with other Antarctic Treaty States, and in accordance with guidelines adopted by these States for Environmental Impact Assessment. Australia's legislation outlined above is broadly consistent with these guidelines.[79]

This regulatory regime applies to all activities in Antarctica. Accordingly, scientific research in Antarctica is regulated under the provisions of the *Madrid Protocol* and the legislation outlined above, together with similar legislation implemented by other signatory states.

The regulation of the environmental impact of scientific research-the Canadian model

Canada is another country that has established a detailed legal regime for environmental assessment beyond its borders. Most Canadian scientific research is not regulated under this regime simply because the environmental impact of such research is negligible, and, therefore, it does not trigger the relevant legislation. However, what is interesting for present purposes about this regime is how Federal Government funding for scientific research is linked to an environmental impact assessment process. The following discussion outlines the main features of this regime before proceeding to discuss the implications of this and the Australian regime for designing a regime to regulate MSR in areas beyond national jurisdiction.

[78] Hereinafter AAD.
[79] Australian Antarctic Division Web site http://www.aad.gov.au/default.asp?casid=756 accessed 16 December 2004.

Most MSR conducted by Canadian researchers based in universities and other research institutions is funded by grants provided by the Natural Sciences and Engineering Research Council of Canada,[80] which is currently responsible for allocating approximately C$771 million dollars per year in research funding.[81] This also includes administering funding for researchers who may use vessels operated by the Canadian Department of Fisheries and Oceans, the ROPOS or other similar research platforms, and any other Canadian or foreign vessels to which the provisions of the *Canada Shipping Act* apply.[82]

As a federal authority the NSERCC is subject to the provisions of the *Canadian Environmental Assessment Act 1992 (Canada).*[83] Section 5(1) of the CEA Act requires that an environmental assessment be carried out before a federal authority exercises a number of powers or performs one of a number of duties or functions in respect of a project.[84] A project is defined in section 2(1) of the CEA Act as

[80] Hereinafter NSERCC
[81] Natural Sciences and Engineering Research Council of Canada web site http://www.nserc.gc.ca/about/history_e.asp accessed 16 December 2004.
[82] Natural Sciences and Engineering Research Council of Canada web site http://www.nserc.gc.ca/professors_e.asp?nav=profnav&lbi=d3 accessed 16 December 2004.
[83] Hereinafter referred to as the "CEA Act".
[84] Specifically section 5(1) provides as follows:
"An environmental assessment of a project is required before a federal authority exercises one of the following powers or performs one of the following duties or functions in respect of a project, namely, where a federal authority
(a) is the proponent of the project and does any act or thing that commits the federal authority to carrying out the project in whole or in part;
(b) makes or authorizes payments or provides a guarantee for a loan or any other form of financial assistance to the proponent for the purpose of enabling the project to be carried out in whole or in part, except where the financial assistance is in the form of any reduction, avoidance, deferral, removal, refund, remission or other form of relief from the payment of any tax, duty or impost imposed under any Act of Parliament, unless that financial assistance is provided for the purpose of enabling an individual project specifically named in the Act, regulation or order that provides the relief to be carried out;
(c) has the administration of federal lands and sells, leases or otherwise disposes of those lands or any interests in those lands, or transfers the administration and control of those

"(a) in relation to a physical work, any proposed construction, operation, modification, decommissioning, abandonment or other undertaking in relation to that physical work, or

(b) any proposed physical activity not relating to a physical work that is prescribed or is within a class of physical activities that is prescribed pursuant to regulations made under paragraph 59(b)".

The NSERC routinely screens all applications for funding to determine whether the environmental assessment processes required by the CEA Act applies to the activities for which funding is sought. All applicants for funding by the NSERC are required to provide information on their research activities, and outline possible environmental effects of their proposal and what measures they intend to minimise any negative environmental effect. After considering this and other information provided by researchers in a two part appendix to their application for funding, the NSERC then makes a determination as to whether the proposal is subject to the CEA Act.[85] If it is, then the applicant will be obliged to prepare an environmental assessment under section 5 of the CEA Act, and, if the scale or type of research merits it, the application would be subject to the environmental assessment process, which may involve a screening or comprehensive study, mediation or assessment by a review panel in accordance with procedures laid down under the Act.

The NSERC web site provides some useful examples of the sort of applications that are routinely assessed. Thus it notes

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lands or interests to Her Majesty in right of a province, for the purpose of enabling the project to be carried out in whole or in part; or

(d) under a provision prescribed pursuant to paragraph 59(f), issues a permit or licence [sic], grants and approval or takes any other action for the purpose of enabling the project to be carried out in whole or in part."

[85] NSERC web site http://www.nserc.gc.ca/programs/EA_e.htm accessed 16 December 2004.

"In general, proposals dealing exclusively with the following will be considered not to constitute a "project" and therefore not be subject to the assessment process under the Act:

- Equipment grants: Requests for equipment that can be transported, i.e., that will not have a fixed location even though it might be difficult to transport, such as a mass spectrometer;
- Scholarships and fellowships;
- Research grants: applications that propose work to be carried out exclusively in a laboratory or office, and that does not contribute to the construction, operation, modification, decommissioning, abandonment or other undertaking in relation to a physical work that is constructed and fixed in place, or that is set out in the Act's Inclusion List Regulations

The following applications are subject to a pre-screening under NSERC's environmental assessment and review process. These include research activities conducted abroad or with researchers in other countries.

- Research proposals for which some phase of the work takes place outside a laboratory or office, whether the work is done by the applicant, co-applicants, technicians, graduate students, postdocs, or others;
- Grant proposals for equipment that is built and fixed in place (for example, experimental greenhouses or aquaculture installations)."[86]

Based on these comments by the NSERC it is reasonable to conclude that the majority of research projects would not be subject to any further consideration of their environmental impact beyond the initial screening conducted by the NSERC. However, what is significant is that the environmental impact assessment process is integrated into the funding process, and that funding is conditional on this process having been undertaken. By virtue of the CEA Act it is the responsibility of the funding agency to ensure environmental impacts are addressed in planning scientific research. Although the peer review of the scientific merit of particular research is a separate process from the environmental effects screening, the two are effectively integrated. If the CEA Act is triggered then the NSERC is prohibited from releasing funding unless the provisions of the CEA Act have been complied with.

[86] Natural Sciences and Engineering Research Council of Canada web site http://www.nserc.gc.ca/programs/EA_e.htm accessed 16 December 2004.

This process applies to scientific research funded by the NSERC that occurs outside of Canada. In the case of MSR this means that this regime applies not only to MSR conducted in Canada and Canadian waters, but also arguably to research being carried on the high seas or within other countries' maritime jurisdiction by Canadian researchers or on Canadian Vessels.

CONCLUSION- THE MODEL ENVIRONMENTAL IMPACT ASSESSMENT PROCESS FOR MSR BEYOND NATIONAL JURISIDICTION.

How then are the Australian experience in implementing the Madrid Protocol and the Canadian regulation of funding scientific research relevant to MSR in the deep-sea beyond national jurisdiction? They are both relevant because they suggest a way we may be able to design a regime for managing the environmental impact of MSR in the deep-sea beyond national jurisdiction, without the need to create a new international institution or entity responsible for regulating MSR. Rather what is proposed is that an international treaty could be prepared modelled on the *Madrid Protocol* to apply to all MSR beyond national jurisdiction and especially at deep-sea hydrothermal vents, which could be implemented under domestic legislation.

Specifically such a treaty could include provisions on environmental impact assessment modelled on the *Madrid Protocol* provisions. These could be implemented by signatory parties to such a treaty adopting implementing legislation, if required, along the lines of the Australian ATEP Act. Similarly, adopting the Canadian model, national bodies responsible for funding MSR could incorporate environmental impact screening processes modelled on the Canadian regime into the funding process. For research not funded by government, authorisation to carry out such research on the high seas could be made conditional on compliance with similar environmental impact procedures.

Is such a scheme workable?

Clearly there are several issues that need to be addressed before any such scheme could be negotiated or indeed implemented. One of the major issues that must be addressed is whether the scale of the environmental impact of MSR even warrants regulation in the first place. As this is a very new and emerging issue we simply do not yet know if that is the case. A review of legal, policy and scientific literature undertaken for this thesis has identified little in the way of published information on the nature and scale of the environmental impact of MSR. Clearly further comprehensive scientific research is required before we can determine if regulation is even required, and if it is what form it should stake. The benefits derived from MSR means that it would be totally unjustified to ban MSR or to impose to tight regulation on it. On the other hand as evidence is emerging that MSR does have some environmental impact a precautionary approach would mandate that we consider seriously the nature and scale of its impact, and the extent to which regulation is warranted.

Given that the design of such regime will clearly need to be built on a sound scientific basis, as the examples of the Endeavour MPA in Canada, and Lucky Strike and Menez Gwen in Portugal discussed in Chapter 6 show, clearly scientists, as the major stakeholders must be intimately engaged in the design and implementation of such a regime. Failing to engage scientists or regulating MSR too closely or bureacraticaly will undoubtedly lead to the failure of such a regime. While many scientists would dispute that their research should be regulated, there is nonetheless, recognition by many scientists that MSR does have an environmental impact. In the end scientists should not be approached as people whose activities should be regulated, but rather as partners in a process of providing for the sustainable management of hydrothermal vent sites, so that these sites may be available for future scientific research and the conservation of the biodiversity of the deep-sea. For the benefit of future generations MSR should be encouraged, but sustainably managed. The notion of intergenerational equity is at the core of the concept of sustainable development, which in turn shows us how we should approach all human activity (including MSR) in the deep-sea and at hydrothermal vents in particular. MSR, like all human activity in the oceans, needs to be sustainably managed. The proposal canvassed in this chapter illustrates how this could be achieved.

CHAPTER 9

INTRODUCTION

As noted in Chapter 2 there is already a detailed international legal regime governing mining in the deep-sea in areas beyond national jurisdiction. This regime is provided for in Part XI of LOSC and the associated 1994 Part XI Agreement. The 2003 SBSTTA options paper discussed in Chapter 2 noted that one possible option for regulating access to the genetic resources of the deep-sea was to expand the mandate of the ISA to include these new resources. This chapter considers whether an expanded mandate should be given to the ISA to regulate all activities, including bioprospecting, in the deep-sea. The chapter commences by examining the extent of the ISA's existing mandate with respect to the marine environment. The work of the ISA to date in fulfilling that mandate is then critically examined. The chapter also examines a possible role for the ISA in contributing to the creation of a network of MPAs on the high seas. In that respect the ability of the ISA to designate "de-facto" MPAs in accordance with its existing mandate is considered. Finally, a brief examination of the ISA's existing structure will highlight difficulties that might be encountered should an expanded mandate be granted to the ISA.

ENVIRONMENTAL MANDATE

While the primary objective of Part XI is to facilitate the commercial exploitation of deep-sea mineral resources, Part XI also recognises that uncontrolled exploitation of these mineral resources may have an adverse impact on the marine environment. The core provision of LOSC that deals with the protection of the marine environment is contained in 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 LOSC, Annex III, article 17(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(2)(f) of LOSC 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[1] of the deep-sea mining regime until the approval of the first plan of work for exploration, the ISA was required to, inter alia, focus on the adoption of rules, regulations and procedures incorporating applicable standards for the protection and preservation of the marine 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.*[2] Adoption of the Nodule Prospecting Regulations cleared the way for the ISA to enter into the first contracts for exploration.[3]

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'.[4] 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".[5]

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

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[1] The regime entered into force on 28 July 1996.
[2] 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.
[3] 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.
[4] Nodule Prospecting Regulations, Regulation 2(2).
[5] Nodule Prospecting Regulations, Regulation 1(3)(f).

reflected in Principle 15 of the Rio Declaration[6] and subsequent instruments.[7] The Precautionary Principle dictates that the onus of proof should be carried by the Prospector to prove that the environmental impact of the proposed activity would not cause unacceptable levels of environmental harm. Even a minor environmental impact may have unforseen consequences given the current level of our understanding of the deep-sea environment. Regardless of the exact way in which the Precautionary Principle is characterised, requiring 'substantial evidence' of environmental harm appears to be setting too high a threshold given there is great scientific uncertainty as to 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 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 polymetallic sulphides associated with hydrothermal vents and cobalt-rich ferromanganese crusts, following a request from the Russian Federation. In accordance with its programme of work agreed upon during the eighth session of the ISA, the members of the Legal and

[6] Rio Declaration, UN Doc A/Conf 151/26.

[7] For discussion on the nature of the Precautionary Principle see Chapter 2.

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 polymetallic sulphides and cobalt-rich crusts." [8]

It is worth noting that, in the course of its work, the working group has indicated it is appropriate for the draft regulations to reflect 'developments in international environmental law achieved since the adoption of the Convention in 1982'.[9] This working group has produced a draft of regulations relating to the protection and preservation of the marine environment during prospecting and exploration, which, as the following discussion outlines, is inconsistent with some recent developments in international environmental law. These draft regulations were scheduled to be considered at the meeting of the Council of the ISA in 2004. At the date of completion of this thesis the Council has not yet voted to approve the draft regulations. The draft regulations are considered below.

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[8] 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.

[9] 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.

THE DRAFT POLYMETALLIC SULPHIDE PROSPECTING REGULATIONS

The draft polymetallic sulphide prospecting regulations apply to prospecting and exploration for polymetallic sulphides[10] and cobalt crusts[11] in the Area.

Prospecting is defined in draft Regulation 3(g) as:

> "the search for deposits of polymetallic sulphides or cobalt crusts in the Area, including estimation of the composition, sizes and distributions of deposits of polymetallic sulphides or cobalt crusts and their economic values, without any exclusive rights".

Exploration is defined in draft regulation 3(d) as

> "the searching for deposits of polymetallic sulphides or cobalt crusts in the Area with exclusive rights, the analysis of such deposits, the use and testing of recovery systems and equipment, processing facilities and transportation systems, and the carrying out of studies of the environmental, technical, economic, commercial and other appropriate factors that must be taken into account in exploitation".[12]

The regulations, therefore, will apply to a range of activities in the deep-sea marine environment[13] just short of full scale commercial mining operations.

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[10] Draft Regulation 3(f) defines "polymetallic sulphides" as "hydrothermally formed deposits of sulphide minerals which contain concentrations of metals including, inter alia, copper, lead, zinc, gold and silver"

[11] Draft Regulation 3(b) defines "cobalt crusts" as "hydroxide/oxide deposits of cobalt-rich iron/manganese (ferromanganese) crust formed from direct precipitation of minerals from seawater onto hard substrates containing minor but significant concentrations of cobalt, titanium, nickel, platinum, molybdenum, tellurium, cerium, other metallic and rare earth elements".

[12] "Exploitation" is in turn defined in draft regulation 3(c) as the recovery for commercial purposes of polymetallic sulphides or cobalt crusts in the Area and the extraction of minerals therefrom, including the construction and operation of mining, processing and transportation systems, for the production and marketing of metals".

[13] Draft regulation 3 (e) defines the terms "marine environment" as including "the physical, chemical, geological and biological components, conditions and factors which interact and determine the productivity, state, conditions and quality of the marine ecosystem, the waters of the seas and oceans and the airspace above those waters, as well as the seabed and ocean floor and subsoil thereof".

The operation of the draft regulations is subject to one major qualification. Draft regulation 4 provides:

> "The Regulations shall not in any way affect the freedom of scientific research, pursuant to article 87 of [LOSC], or the right to conduct marine scientific research in the Area pursuant to articles 143 and 256 of the Convention. Nothing in these regulations shall be construed in such a way as to restrict the exercise by States of the freedom of the high seas as reflected in article 87 of [LOSC]."

Thus the freedoms of the high seas and, in particular, freedom of MSR recognised by LOSC are unaffected.

Under the current draft it is proposed that prospecting and exploration for polymetallic sulphides and cobalt crusts will be controlled through a system of notification of prospecting under Part II, and a system of contractual licences for exploration under Parts III and IV of the regulations.

The notification scheme under Part II of the draft regulations provides that prospecting may only commence after notification by the entity concerned of its intention to carry out prospecting has been recorded in a register to be maintained by the Secretary-General of the ISA.[14] The notification must comply with provisions of the draft regulations, and in particular, must include the details set out in Annex 1 of the draft regulations. Significantly, draft regulation 4(3), although not explicitly saying so, seems to suggest that the Secretary-General may refuse to enter a notification in the register, thereby effectively denying a potential prospector authority to carry out prospecting. Thus draft regulation 4(3) provides:

> "The Secretary-General shall, within 45 days of receipt of the notification, inform the proposed prospector in writing if the notification includes any part of an area included in

[14] See specifically draft regulation 2(1) and 4(2).

> an approved plan of work for exploration or exploitation of any category of resources, or any part of an area which has been disapproved by the Council for exploitation because of the risk of serious harm to the marine environment, or if the written undertaking is not satisfactory, and shall provide the proposed prospector with a written statement of reasons. In such cases, the proposed prospector may, within 90 days, submit an amended notification. The Secretary-Geneal shall, within 45 days, review and act upon such amended notification".

Thus the right to prospect would be subject to any other existing rights or measures implemented by the ISA to protect certain areas of the marine environment such as disapproved areas.

Prospecting, if authorised under this procedure, must then be carried out in accordance with the provisions of the draft regulations and, in particular, the provisions dealing with protection of the marine environment discussed in more detail below.

The provisions relating to exploration are far more detailed than those relating to prospecting, and are contained in draft regulations 9 through to 31 in Parts III and IV. They incorporate provisions dealing with an application for approval of a plan of work for exploration to obtain a contract set out in Annex 2, and a model Contract for Exploration set out in Annex 3 to the draft regulations.

The draft polymetallic sulphide prospecting regulations include extensive provisions dealing with the marine environment. Issues associated with the marine environment are addressed in draft regulations 2(2), 2(3), 3(4), 4(3), 4(5), 5, 7(1), 23(4)(b), 23(6)(c) , all of Part V (ie draft regulations 33 to 37 inclusive)[15], as well as portions of Annex 2 and the model contract for exploration set out in Annex 3.

A significant term used throughout the regulations is the expression "serious harm to the marine environment". Draft regulation 3(h) defines "serious harm to the marine environment" 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 standards and practices".

Draft Regulation 2(2) provides that

> "Prospecting shall not be undertaken if substantial evidence indicates the risk of serious harm to the marine environment"

The polymetallic sulphide regulations are permissive, ie they authorise the conduct of prospecting activities unless it can be proved to a high standard (ie substantial evidence) that there is a risk of serious harm to the marine environment. As with the Nodule Prospecting Regulations discussed above, this is inconsistent with a precautionary approach which would place the burden on the prospector to show there is not a serious risk of harm.

Environmental impact assessment

As noted in Chapter 8, increasingly procedures for environmental impact assessment are being incorporated into international legal instruments. The draft regulations contain at times contradictory provisions on the the requirement to carry out environmental impact assessments. There appears to be no provision in

[15] Draft regulation 37 deals with objects of objects of an archaeological or historical nature. Only the most significant provisions of these regulations are examined below.

the draft Polymetallic Sulphide Prospecting Regulations per se requiring environmental impact assessments to be carried for prospecting.[16] There is some suggestion that such procedures may be developed at a later date, but there is no explicit obligation imposed on a prospector to carry out an environmental impact assessment by the regulations. Thus draft regulations 5(1) to 5(3), which deal with protection and preservation of the marine environment during prospecting, provide

> "(1) Each prospector shall take necessary measures to prevent, reduce and control pollution and other hazards to the marine environment arising from prospecting as far as reasonably possible using for this purpose the best practicable means at its disposal. In particular, each propsector shall minimize [sic] or eliminate:
>
> (a) Adverse environmental impacts from prospecting; and
>
> (b) Actual or potential conflicts or interference with existing or planned marine scientific research activities, in accordance with the relevant future guidelines in this regard.
>
> (2) Prospectors shall cooperate with the Authority in the establishment and implementation of programmes for monitoring and evaluating the potential impacts of the exploration and exploitation for polymetallic sulphides and cobalt crusts on the marine environment.
>
> (3) A prospector shall immediately notify the Secretary-General in writing, using the most effective means, of any incident arising from prospecting which poses a threat of serious harm to the marine environment. Upon receipt of such notification the Secretary-General shall act in a manner consistent with regulation 35."

Whether regulations in relation to environmental impact assessment will be developed at a later date is unclear.

Similarly, when prospecting eventually becomes exploration[17] there is also no procedure for environmental impact assessment contained in the draft regulations per se. Draft regulation 13 requires each applicant seeking approval of a plan of work to carry out exploration to provide enough information for the Council to

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[16] As that term is defined in draft regulation 3(g) discussed above.

[17] See comments in relation to draft regulation 3(d) above.

determine whether the applicant is financially and technically capable of carrying out the proposed plan of work. There is no requirement contained in the draft regulations that the applicant is to provide an environmental impact assessment with the proposed plan of work. Curiously, draft regulation 23(4)(b) provides that in considering an application for approval of a plan of work for exploration, the Legal and Technical Commission are required to consider if the proposed plan of work will

> "Provide for effective protection and preservation of the marine environment."

Just how the Legal and Technical Commission is expected to reach conclusions on that issue is unclear. What is also unclear is how this provision should be reconciled with the draft regulation 2(2) discussed above. Can the Legal and Technical Commission always reject an application for approval of a proposed plan of work if they form the view that the plan does not provide for the effective protection and preservation of the marine environment, or can they only do so when there is substantial evidence of the risk of serious harm to the marine environment as those terms are used in draft regulation 3(h)? Simply put, it is unclear when approval for a plan of exploration might be rejected on environmental grounds.

Clarification can partly be obtained from reading the draft regulations in conjunction with the standard clauses for exploration contracts contained in Annex 4 to the draft regulations. Section 5.2 of the standard clauses provide

> "Prior to the commencement of exploration activities, the Contractor shall submit to the Authority:
> (a) An impact assessment of the potential effects on the marine environment of the proposed activtities;

(b) A proposal for a monitoring programme to determine the potential effect on the marine environment of the proposed activities; and
(c) Data that could be used to establish an environmental baseline against which to assess the effect of the proposed activities".[18]

There is an obligation imposed upon the Contractor to undertake environmental impact assessment, but this is imposed as a matter of contract rather than by virtue of operation of law via the regulations. The standard clauses for exploration contracts must be included in any exploration contract by virtue of Regulation 25. The ultimate source of law governing the obligation to carry out an environmental impact assessment lies in contract law. This then raises interesting questions as to which legal system's principles of contract law will apply. Section 25.1 of the standard clauses makes clear that all disputes between the parties concerning the interpretation or application of the contract will be settled in accordance with Part XI, section 5 of LOSC. It is clear under article 187 that the Sea-Bed Disputes Chamber of the International Tribunal of the Law of the Sea[19] would have jurisdiction to hear any such dispute. Thus article 187(c) of LOSC provides that the Sea-Bed Disputes Chamber has jurisdiction in relation to

> "(c) disputes between parties to a contract, being State Parties, the Authority or the Enterprise [sic], state enterprises and natural or juridical persons referred to in article 153, paragraph 2(b) concerning:
> (i) the interpretation or application of a relevant contract or a plan of work; or
> (ii) acts or omissions of a party to the contract relating to activities in the Area and directed to the other party or directly affecting its legitimate interests".

While ITLOS would clearly have jurisdiction in relation to any such dispute, it is not clear how ITLOS would resolve what would essentially be a contractual dispute. That is, ITLOS would not be called on to apply principles of International

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[18] Section 5.2, Annex 4-Standard clauses for exploration contract, *Draft regulations on prospecting and exploration for polymetallic sulphides and cobalt-rich ferromanganese crusts in the Area*, UN Doc. No. ISBA/10/C/WP.1, 24 May 2004.

[19] Hereinafter ITLOS.

Law or Law of the Sea as it traditionally has , but rather ITLOS would be required to rule on principles of contract law. Which contract law it will apply is unclear. Contract law or Laws of Obligations (as it is called in some juridisctions) vary between nations and legal systems. If there were ever any dispute as to the nature and extent of the obligation to carry out an environmental impact assessment it would be unclear how ITLOS would resolve such a dispute.

Given the expertise of ITLOS lies in resolving Law of the Sea disputes based in principles of international law questions are raised as to the ability of ITLOS to effectively deal with such disputes.

This problem only arises because the obligation to undertake an environmental impact assessment is a contractual obligation. This uncertainity could be removed simply by imposing a positive obligation to undertake environmental impact assessment under the regulations as distinct from including these provisions in the standard contract clauses.

Other provisions of the standard clauses introduce further ambiquity with respect to the contractor's obligations. In particular Section 5 of the standard clauses provides

> "The contractor shall take necessary measures to prevent, reduce and control pollution and other hazards to the marine environment arising from its activities in the Area as far as reasonably possible using for this purpose the best praticable means at its disposal".

Two interesting questions are raised by this provision. Firstly what is meant by the term "as far as reasonably possible"? Does this mean that a contractor would be able to enagage in activities that have an impact on the marine environment if it was not reasonably possible to take mitigating measures to minimize the environmental impact? This is not clear. More fundamentally, the use of the expression "the best practicable means at its disposal" seems to suggest that the principle of common but differentiated responsibility would be incorporated into what is essentially a commercial contract. [20] Presumably a higher environmental standard would be imposed on a contractor from a developed country than a contractor from a developing country. Does this then represent an extension of the concept of common but differentiated responsibility into new and unintended fields? Is such an extension desirable? It would be consistent with the designation of the mineral resources of the Area as the common heritage of mankind, but might not the consequence be undesirable? That is, by imposing a lower standard on contractors from developing countries do we not permit possibly greater harm to the environment for the same commercial gain? A detailed examination of such issues is beyond the scope of this thesis, but such issues may warrant further examination at a later date.

To add to the confusion, in contradiction to the provisions of the standard clauses, the draft regulations include several other detailed provisions relating to the environmental impact of activities in the area[21] which are more consistent with recent trends in international environmental law. Part V of the draft regulations, and especially draft regulations 33-35, contain quite detailed provisions on

[20] For present purposes it is not necessary to consider whether this is a principle of customary international law or merely soft law, although the writer is of the view that the better interpretation is that it merely represents soft law.
[21] Regulation 1 (1) provides that "Terms used in the Convention [ie LOSC] shall have the same meaning in these Regulations". As such the expression "activities in the area" would be interpreted as a reference to the definition of "activities in the area" contained in LOSC. It is not clear

protection and preservation of the marine environment. One provision worth highlighting is Regulation 33(2). Thus

> "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 States shall apply a precautionary approach, as reflected in principle 15 of the Rio Declaration, to such activities. The Legal and Technical Commission shall make recommendations to the Council on the implementation of this paragraph"

This provision on face value is encouraging. However, when read in conjunction with the other provisions outlined above, it is unclear how a precautionary approach can be applied. It is inconsistent with the other provisions of the draft regulations. This ambiquity in such an important legal instrument is regrettable.

THE EMERGING INTEREST OF THE ISA IN MARINE BIODIVERSITY ISSUES

While the draft regulations are far from satisfactory, there are some encouraging signs that the ISA is taking a closer interest in the potential environmental impact of mining on marine biodiversity. In the context of its work on these regulations and 'working within its mandate', the Legal and Technical Commission of the ISA 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,[22] 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

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therefore whether the Legal and Technical Commission intends these regulations to extend beyond prospecting and exploration.

[22] Unfortunately Helmut Beiersdorf was subsequently killed in a boating accident on 30 May 2004 and it is not clear at this stage who will complete his work.

preparation of a paper on legal issues 'to ensure the Commission remained within its mandate' under LOSC. The Legal and Technical Commission will also review the idea of establishing a working group to study the issue further.[23] As at the date of submission of this thesis this issues paper has not yet been published and accordingly it is not possible to examine it in this thesis.

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 most member States) appear to want to confine its work within its existing mandate. At its session in 2003 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 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."[24]

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[23] International Seabed Authority, Press Release, UN Doc SB/9/7.
[24] International Seabed Authority, Press Release, 7th August, 2003, UN Doc no SB/9/13.

On the other hand, at the recent meeting of the Assembly a number of delegations did express support for a role for the ISA in regulating management of the Area's genetic resources[25]. Thus, while the SBSTTA study in chapter 2 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 has only minimal support amongst members of the ISA.

THE ISA AND DE-FACTO MARINE PROTECTED AREAS UNDER ARTICLE 162 OF LOSC AND THE REGULATIONS

Despite criticisms of the draft regulations outlined above, one positive aspect of the ISA's work to date within the terms of its existing environmental mandate is the way it is exploring a possible role in designating de-facto MPAs in the high seas. Article 162(2)(x) of LOSC 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 a recent statement to the Fourth Meeting of *UNICPLOS*[26] 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".[27]

The Secretary-General's comments appear to suggest the Council could designate particularly sensitive areas, which would act both as environmental baselines and arguably as de-facto marine protected areas. This is further re-inforced by the

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[25] United Nations, International Seabed Authority, *Statement of the President on the work of the Assembly at the tenth session,* UN Doc. ISBA/10/A/12, at para 26.
[26] The United Nations Informal Consultative Process on the Law of the Sea.
[27] 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.

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."

Similarly regulation 33 (4) of the draft polymetallic sulphide propsecting regulations provide

> "Contractors, sponsoring States and other interested States or entities shall cooperate with the Authority in the establishment and implementation of programmes for monitoring and evaluating the impacts of deep seabed mining on the marine environment. When required by the Authroity, such programmes shall include proposals for areas to be set aside and used exclusively as impact reference zones and preservation reference zones. "Impact reference zones" mean areas to be used for assessing the effect of activities in the Area on the marine environment and which are representative of the environmental characteristsics 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".

Designating such sites in accordance with both sets of regulations is arguably consistent with the ISA's existing mandate under Article 145 of LOSC to protect and preserve the marine environment from the impact of deep-sea mining.[28]

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.[29]

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[28] D K Leary, 'Emerging Legal Regimes regulating bioprospecting for thermophiles and hyperthermophiles of hydrothemal vents' *(2004) 6 Marine Biotechnology* s351.
[29] See 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.

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.[30] Nonetheless such measures by the ISA would be consistent with the terms of its existing mandate and should be encouraged.

STRUCTURAL IMPEDIMENTS TO EFFECTIVE SUSTAINABLE MANAGEMENT OF DEEP-SEA HYDROTHERMAL VENTS BY THE ISA

Part of the explanation for the ambiguity contained in the regulations outlined above probably lies in the very political nature of the ISA itself. Its structure and the way it operates are the result of very complex political negotiations. However, this explanation of itself highlights further difficulties that may be encountered in expanding the ISA's mandate. Any proposal to expand the mandate of the ISA needs to deal with the very difficult issue of the reform of the structure of the ISA. This is problematic not only in the event of an expansion of the ISA's mandate, but also for States that would like to see the ISA take a greater role in the conservation of marine biodiversity within the scope of its existing mandate. The existing structure of the ISA favours States that might be reluctant to see the ISA implement more environmentally responsible and progressive measures.

The two principal decision-making organs of the ISA are the Council and the Assembly. All State parties are members of the Assembly.[31] The Council consists

[30] 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).

[31] LOSC, Article 159(1).

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 of the Part XI Agreement, 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.[32] These four members must include one State which is the largest consumer in Eastern Europe (effectively Russia) and upon its accession to LOSC, the USA.[33]
- Four members from among the eight State Parties that have made the largest investment in preparation for mining[34].
- 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 that are developing States whose exports of such minerals have a substantial bearing upon their economies.[35]
- Six members from developing State parties representing special interests.[36]
- Eighteen members elected according to the principle of ensuring an equitable representation for each geographical region of the world.[37]

[32] Part XI Agreement, Annex, Section 3, paragraph 15(a).
[33] One author notes this effectively guarantees permanent seats to Russia and (and upon its accession to LOSC) to the USA. See 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, Australia, 22-23 November, 2002.
[34] Part XI Agreement, Annex, Section 3, paragraph 15(b).
[35] Part XI Agreement, Annex, Section 3, paragraph 15(c).
[36] Part XI Agreement, Annex, Section 3, paragraph 15(d). 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.

This structure effectively ensures that no decisions can be pushed through the council against the will of any of the recognised interest groups.[38] This is further complicated by the fact that, as a general rule, decision-making in the organs of the ISA is by consensus.[39] As such any proposal to create de-facto MPAs or to implement measures to conserve biodiversity will need to negotiate the very tortured and complex web of interests represented in the Council of the ISA.

If an expanded mandate were to be given to the ISA then there would need to be considerable reform of this structure. The existing structure and, in particular the balancing of various interest groups, was established after long and tortuous negotiation. Such a structure may not be appropriate when other more varied interests are at stake. The ISA is a body that has been designed to regulate a deep-sea mining industry. Accordingly, its structure reflects varied interests including producers and consumers of minerals. These interests are significantly different from those of the biotechnology industry, the tourist industry and the scientific community. Attempting to reform the structure of the ISA to balance the interests of those stakeholders against those of the minerals industry, while at the same time, enhancing the ability of the ISA to deal with environmental issues would require very complex changes to the ISA structure. It is questionable if such changes would be achievable.

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[37] Part XI Agreement, Annex, Section 3, paragraph 15(e). The regions are Africa, Asia, Eastern Europe, Latin America and the Caribbean, and Western Europe and Others.
[38] French, above n 32, 8.
[39] Pursuant to Part XI Agreement, Annex, Section 3, paragraph 2.

Similarly, while it may be true that the ISA has expertise in deep-sea mining and a wealth of information on the mineral resources of the Area, it is unclear, and probably unlikely, that it has the required knowledge or expertise to deal with the complex nature of MSR[40] and to a lesser extent deep-sea tourism.

More fundamentally, the ISA definitely does not have expertise to deal with benefit sharing and deep-sea genetic resources. As we saw in Chapter 7, the issue of benefit sharing is intimately connected with intellectual property rights such as patents. The ISA clearly does not have any expertise in the area of patents, and in particular, patents associated with biotechnology. Unlike the mineral resources of the Area, the commercial exploitation of the genetic resources of the deep-sea is not simply a process of digging something up, bringing it to the surface and processing it for sale. While the mining of minerals from the deep-sea is perhaps a slightly more sophisticated process than this, in essence the primary issues relate to engineering and commercial feasibility. As outlined in Chapter 7, the process of development of biotechnology from the deep-sea's genetic resources is a far more complicated and lengthy process. The reward for those who engage in such activities is the monopoly on exploitation that comes with the grant of a patent and the associated profit which flows from its exploitation.

If the ISA is to be entrusted with the management of benefit sharing from the genetic resources of the deep-sea and from hydrothermal vents in particular, on one interpretation this implies that the ISA would be entrusted with some role to

[40] This issue was dealt with in detail in chapter 8 and to avoid repetition is not canvassed any further in this Chapter.

play in the grant of patents, perhaps as some huge international patent office for the deep-sea. This would involve a significant infringement on the sovereignty of nation States.

Even if the assessment and grant of patents in relation to biotechnology derived from the deep-sea were to remain primarily within the jurisdiction of nation States what role would the ISA play in this process? One significant role that would remain would be the distribution of the benefits associated with the exploitation of the genetic resources of the deep-sea and of hydrothermal vents in particular. Even if patent royalties were to flow into the accounts of the ISA to be distributed by the ISA in accordance with whatever mechanism is agreed, again the ISA has no expertise in co-ordinating the distribution of funds such as these. In theory the ISA will one day have a role to play in the distribution of benefits flowing from the exploitation of the mineral resources of the Area, but for the time being it does not. One the other hand, as discussed in Chapter 7, a number of international institutions, such as the GEF and various regional development banks, all have vast experience in the distribution of funding for sustainable development. These institutions would be better suited to the task than the ISA.

The only remaining role left for the ISA would be the regulation of the environmental impact of bioprospecting in the deep-sea. As we saw in earlier chapters, this would essentially mean giving the ISA a role in regulating MSR, which, for the reasons previously discussed, would not be a desirable option.

Perhaps, realistically, the only role that the ISA should play is in the dissemination of knowledge about the deep-sea and in facilitating (as opposed to regulating) MSR. In large part these are activities already undertaken within the terms of its existing mandate.

DO STATES CONSIDER THE ISA IRRELEVANT?

Even without these obstacles there is also some evidence to suggest that states consider the activities of the ISA largely irrelevant to their national interests. It is true that there has been widespread acceptance of the ISA's mandate by the international community. As at 31 January 2005 148 States and the European Community were parties to LOSC, and hence members of the ISA.[41] However, several countries, including the USA, have not yet ratified the Part XI Agreement.

More significantly, even amongst those countries that are part of the ISA, there is poor participation in the work of the ISA. A major problem for the ISA has been securing broad participation in the work of the Assembly. Article 159(5) of LOSC and the rules of procedure of the Assembly require a majority of ISA member States to be represented for there to be a quorum for the deliberations of the Assembly.[42] However, since 1998 each year there has been great difficulty in securing the required quorum for meetings at the ISA's headquarters in Kingston, Jamaica.[43] On at least one occasion the lack of a quorum meant that the meeting of the Assembly had to be adjourned to the United Nations headquarters in New

[41] 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*, Tenth Session of the Assembly, UN Doc ISBA/10/A/3 (2004), 4.
[42] International Seabed Authority, above n 41, 6.

[43] Ibid.

York just to adopt the budget of the ISA. Although measures were implemented to better co-ordinate the schedule of the Assembly meeting in 2003, no significant increase in attendance was noted in 2003.[44] In his recent report the Secretary-General of the ISA expressed concern that lack of participation may become worse. Thus he commented

> "As the number of States parties to the Convention continues to increase, so the required number for a quorum increases. Given that many States parties have little or even indirect interest in the exploratory phase of deep seabed mining, it is inevitable that the Assembly will continue to have difficuly in securing a quorum for taking important decisions on matters such as the budget, the scale of contributions and election to subsidiary bodies. This situation remains of grave concern to the Authority and needs to be addressed."[45]

Given the lack of participation of members in the existing work of the ISA, serious concerns must be raised as to whether the mandate of a body many States clearly consider irrelevant should be expanded.

CONCLUSION-EXPANSION OF THE ISA MANDATE

The ISA is currently the main international body with responsibility for regulating the environmental impact of the deep-sea mining on the high seas. It should be encouraged in its increased focus on the conservation of the biodiversity of the deep-sea and environmental matters more generally within the scope of its existing mandate. In that context it is worthwhile for the ISA to give serious consideration to the designation of defacto MPAs on the basis outlined in this chapter. However, for the reasons set out above, any attempt to expand the mandate of the ISA should be approached with caution. It is questionable, given the ISA's track record, whether it is appropriate to expand its mandate into more general responsibility for the sustainable management of human activities in the

[44] International Seabed Authority, above n 41, 7.

[45] Ibid.

deep-sea other than mining. More fundamentally, given its existing structure and expertise, it is an organisation ill suited to play a much broader role in the sustainable management of the deep-sea and in benefit sharing of the deep-seas genetic resources.

Even if there were a willingness on the part of States to accept an expanded mandate for the ISA, long and complicated negotiations would be required. It would seem, therefore, that if sustainable management of activities other than mining could be achieved by other means, then perhaps those means should be pursued in preference to expanding the mandate of the ISA.

EXPANDING MANDATES, MODIFIED MANDATES AND THE CHALLENGE OF ACHIEVING GLOBAL OCEANS GOVERNANCE

While this chapter has rejected an expanded mandate for the ISA, other chapters of this thesis have advocated changes to exsiting laws and mechanisms to deal with varied issues. However, in this thesis there is no grand plan or vision to create a new global organisation to deal with all of the environmental issues associated with the sustainable management of hydrothermal vents both beyond and within national jurisdiction. This thesis could have taken the courageous leap in calling for the establishment of a global body responsible for the sustainable management of the deep-sea.

This would not be a new idea and it is not necessarily a bad idea either. Like many concepts examined in this thesis the idea of an international agency for the environment has a respectable heritage and has been debated at length in the academic and policy literature. In a recent paper on the concept of a global body responsible for the environment Charnovitz surveys several such proposals that have been put forward over time.[46] Proposals he cites include an International Environmental Agency, an International Environmental Authority, a World Environmental Organization and International Environmental Organization.[47]

The idea of a global body to sustainably manage the global marine environment has also been advocated extensively. One of the leading proponents of such an idea was the leading scholar Elizabeth Mann Borgese. Throughout her distinguished carreer right up until her death she passionately advocated for such an institution.[48] Similarly as was discussed at length in Chapter 8 similar proposals were canvassed and rejected by the international community when LOSC was negotiated.

The calls for organisations such as a World Environmental Organisation or a World Oceans Organisation are one of many responses to concerns about the lack of governance in relation to the global environment and in the oceans more specifically. These ideas have merit and if it were politically possible at some future date they might be worth exploring. But as noted in Chapter 5 in the context of the concept of the common heritage of mankind, the nature of international relations has changed dramatically since the 1960 and 1970s when LOSC was negotiated. The idea of a global marine organisation was rejected by the

[46] S Charnovitz, 'A World Environment Organization' (2002) 27 *Columbia Journal of Environmental Law* 323.
[47] Ibid.
[48] See for example E M Borgese, *The Oceanic Circle: Governing the Seas as a Global Resource*, (1998).

international community back in the 1960s and 1970s and the possibility of such an idea being realised in todays geopolitical climiate is even less likely.

If there is no desire for new global environmental institutions today then to achive better global marine environmental governance in the deep-sea we have to look for other possibilities. This is why this thesis has instead canvassed the extent to which existing mechanisms, laws and institutions might be utilised. Thus what has been proposed is incremental change to global oceans governance in the deep-sea. Protocols to existing treaties to deal with some issues, and a more thorough implementation of existing laws and regimes to deal with other issues is a more viable option than creating new global institutions or negotiating a new global high seas biodiversity treaty. Thus for the foreseeable future improving global oceans governance in the deep-sea is more likely to be achieved by building on existing laws and using existing institutions more creatively. For some issues this may involve expanding the mandates of existing institutions (such as is proposed for the GEF in Chapter 7), for others such as the ISA it will simply be a matter of more effective implementation of existing mandates consistent with modern principles of international environmental law.

Thus environmental governance in the deep-sea and at hydrothermal vents in particular will involve more effectice use of, and linkage between existing laws, and institutions and incremental changes to others.

CONCLUSION

While the deep-sea may be alien to humans, regulating human activity at deep-sea hydrothermal vents involves exactly the same core legal issue as elsewhere on our planet. That is, how to achieve the sustainable management of human activities with the overall goal of conservation of biodiversity. As emerging threats are becoming obvious, there is a need for international action to address the threats to hydrothermal vent ecosystems and the deep-sea more generally.

The growing international interest in the potential role of MPAs as a tool for sustainable management of ocean space beyond national jurisdiction reflects the success of MPAs as a tool for the sustainable management of ocean space within areas of national jurisdiction. The success of many (but not all) MPAs within national jurisdiction suggests that well planned, funded and managed MPAs can be an effective tool for managing a range of activities in the marine environment. Although MPAs have only recently been extended to vulnerable deep-water habitats such as hydrothermal vents within national jurisdiction, experience to date suggests MPAs can be just as effective in the deep-sea as they are elsewhere in the ocean. The MPAs for hydrothermal vents in Canada and Portugal outlined in this thesis demonstrate the feasibility of MPAs for hydrothermal vent sites, and also provide models for how to go about creating similar MPAs on the high seas. Therefore MPAs should be a central element of a future regime for the sustainable management of human activities at deep-sea hydrothermal vents both within and beyond national jurisdiction. The efforts of like minded states who wish to create mechanisms for the establishment of MPAs for vulnerable deep-water ecosystems, including hydrothermal vents beyond national jurisdiction, should be encouraged.

While MPAs within national jurisdiction are often an effective tool they should not be viewed in isolation. The sustainable management of hydrothermal vent sites beyond national jurisdiction should involve the establishment of MPAs, but a range of other issues will need to be addressed.

First and foremost, the most immediate issue relates to the extent of regulation of the exploitation of hydrothermal vent genetic resources. There is very clear evidence of strong commercial and scientific interest in the biotechnology potential of hydrothermal vents species, especially microbial life forms. As scientific understanding of the deep-sea grows and technology makes these areas more accessible the commercial interest will increase.

The most obvious way that this subsidiary issue could be dealt with would be by expanding the existing mandate of the ISA to include the genetic resources of the deep-sea beyond national jurisdiction. This would involve bringing the genetic resources of hydrothermal vents, and the deep-sea more generally, within the complicated and cumbersome common heritage of mankind regime established under Part XI of LOSC. The two are interchangeable. In terms of law the common heritage of mankind concept means only one thing, the institutional regime established under Part XI of LOSC. Conversely at its core the Part XI regime is predicated on the common heritage of mankind concept. But it is clear that the ISA lacks the expertise to deal with the complex issue of intellectual property rights which are intimately connected with regulating access and benefit sharing in relation to these resources. More generally serious questions arise as to the ability of the ISA to adequately deal with biodiversity issues even within the scope of its existing mandate. Having said that though the ISA should be encouraged to explore ways it can play an effective role in the sustainable management of deep-sea biodiversity within the scope of its existing mandate, including its potential role in creating de-facto MPAs outlined in chapter 9.

We can avoid all the complications of the debate surrounding the Common Heritage of Mankind and complicated negotiations to further revise Part XI of LOSC, if we reject this option outright. It is a simplistic solution to the issues at stake that brings with it a whole range of unnecessary complications. In fact, it is possible to envisage a regime for the equitable utilization and sharing of benefits associated with the genetic resources of hydrothermal vents without recourse to the concept of the common heritage of mankind, or the need to add to the mandate of the ISA. This could be achieved by the creation of a global commons trust fund linked to international and national legal regimes for the grant of patents. While the micro-organisms from which biotechnology are derived are sourced beyond national jurisdiction, the grant of the exclusive monopoly to exploit such biotechnology is an act of each individual State that occurs within its jurisdiction, and as such the status of these resources beyond national jurisdiction as the Common Heritage or otherwise is not in issue.

A regime such as this would not impinge upon the sovereignty of the nation State. By very definition such resources are not within the sovereign territory of any one nation. More significantly though the very act of granting a patent is a sovereign act, it is the grant of a monopoly to exploit a particular invention within that States jurisdiction. The grant of a patent could then be made conditional on payment of a royalty to the global commons trust fund. The royalties from the exploitation of the genetic resources of deep-sea hydrothermal vents and other deep-sea genetic resources could then be utilized to fund measures such as MPAs beyond national jurisdiction, as well as other measures for the sustainable management of the marine environment.

There are a number of international institutions that already play a role in funding sustainable development that could be utilised to provide mechanisms for the fair and equitable distribution of the benefits associated with the exploitation of these genetic resources. These include the Global Environment Facility and the various regional development banks. The experience of these existing organizations in dealing with the sustainable management of ocean space within national jurisdiction could be utilized in designing and implementing measures for the sustainable management of ocean space beyond national jurisdiction. There would be no need to create a whole new international bureaucracy to manage and distribute the resources of the proposed trust fund.

Perhaps as contentious as the issue of benefit sharing, questions also arise as to how MSR beyond national jurisdiction should be regulated. Of the options canvassed in this thesis the integration of environmental impact assessment procedures into existing mechanisms associated with MSR is the most desirable option. The Madrid Protocol to the Antarctic Treaty provides a model of how environmental impact assessment can be utilized to manage the environmental impact of scientific research in areas beyond national jurisdiction. The significant innovation introduced by the Madrid Protocol was a graduated scheme of environmental impact assessment for activities in Antarctica. A regime should be established to regulate MSR at hydrothermal vents based on the provisions on environmental impact assessment contained in the Madrid Protocol. The experience of a number of countries that regulate scientific research in Antarctica suggests that regulation of MSR in areas beyond national jurisdiction can be achieved by individual nations implementing measures under their domestic law. Compliance with these provisions could be enhanced by linking them with government funding for MSR, as is currently the case for scientific research in countries such as Canada.

For the time being the environmental impact of bioprospecting and tourism should be regulated by the proposed regime for MSR, as these activities are currently closely associated with MSR. The regulation of the environmental impact of bioprospecting and tourism may need to be revisited at a later date if there is any significant change from this pattern of activity.

One of the most difficult questions in relation to hydrothermal vents relates to a limited number of sites located on the continental shelf, but not associated with the mid-oceanic ridge system. Uncertainty centres on the extent of the coastal States jurisdiction under the continental shelf regime. A historical analysis of the origins of the continental shelf regime showed that the reason for this uncertainty was the way in which two totally different concepts, namely States historic claims to sedentary species and claims to the mineral resources of the continental shelf, were intermingled during the work of the ILC in the early 1950s. As a consequence modification to the continental shelf regime is required. Consideration should be given to bringing hydrothermal vent sites on the continental shelf (that is beyond the EEZ) within the regime that is created for the high seas. Mechanisms to do this were not explored in detail this thesis, but further research on this issue could explore such an option as well as the alternative of co-ordinating management of these areas by the coastal state with the regime suggested for the high seas. This may be a difficult issue to resolve but the resolution of difficult issues are nothing new to international law or diplomacy. However, the significance of the continental shelf problem should not be overstated. It should not distract the international community from the more urgent need for regulation of activities on the high seas.

While negotiation of a treaty to give effect to the proposed regime outlined in this thesis may take some time, measures could also be developed under a range of regional and other treaties to both supplement the new regime, and as separate regimes in their own right. Regional measures and measures under other treaties discussed in this thesis such as the various Antarctic Treaties, the OSPAR Convention, the Noumea Convention and the World Heritage Convention are perfectly consistent with the existing framework under LOSC and the CBD. These could be as equally effective under the proposed regime for the areas beyond national jurisdiction set out in this thesis. State parties to these treaties should therefore give further consideration to the potential role they might play in an integrated international regime for the sustainable management of hydrothermal vents sites, both within national jurisdiction and beyond national jurisdiction.

One of the key factors for the successful negotiation and implementation of the regime proposed by this thesis will be stakeholder involvement. Any future legal regime will need to accommodate multiple and at times conflicting uses and interests. In reconciling the conflicting uses it will be important to harness the skills of key stakeholders such as the scientific community. It is vital to the success of the propsed regime that there be full engagement of all stakeholders in the process that leads to the creation and implementation of the regime. Stakeholders who should be involved in the creation and ongoing management of any such regime include, inter alia, scientists, the mining industry and the biotechnology industry. The significance of the biotechnology industry will increase the longer establishment of the proposed regime is delayed. Although only in its infancy in the field of deep-sea genetic resources, the biotechnology industry will exert considerable influence over negotiations for an international legal regime. The longer negotiation of such a regime is delayed the more influential this industry will become. The larger the vested interest at stake the less likely a regime will emerge.

There is an urgent need for a comprehensive response by the international community. In that respect the emerging interest of the international community in these issues reflected in recent developments within the forums of the CBD and the UN system is timely. It would seem appropriate therefore that proposals such as those outlined in this thesis should be fed into the work of the Ad Hoc Open-

Ended Informal Working Group recently established by the United Nations General Assembly, as well as the work currently underway in other forums such as those associated with the CBD.

Changes to international law contemplated by the recommendations set out in this thesis should be implemented by means of an international treaty. There are a number of possible ways such a treaty could be structured and the final outcome will depend very much on the positions adopted by individual nation States during negotiations. The most desirable outcome would be a protocol to the LOSC, and in particular to implement the environmental impact assessment scheme proposed in Chapter 8.

The reason why a protocol to the LOSC is the most desirable option is simply because the LOSC is the closest thing we have to a Constitution for the Oceans. The LOSC was the result of a very long and complex diplomatic negotiation process. Although it is not a perfect Constitution for the oceans, it is a Constitution nonetheless and in order to enhance the rule of law in the oceans and foster good oceans governance it would be best to build on that Constitution rather than operate around or outside it. The successful negotiation of the LOSC necessarily involved compromises and ambiguities were perhaps unavoidable. A protocol to the LOSC could potentially resolve the ambiguities associated with deep-sea hydrothermal vents while not unravelling the compromises struck in negotiating the LOSC.

However, in maintaining the base of oceans governance that is contained in the LOSC, this does not mean that we need to ignore more recent developments in international environmental law such as the Precautionary Principle and the ecosystem approach recognised in later instruments such as the CBD. A desirable outcome therefore would be a protocol to the LOSC that integrates modern concepts and principles of international environmental law, and which fosters greater linkages between existing mechanisms such as those associated with the CBD, regional environmental organisations, and other existing international institutions such as the GEF.

As this thesis has demonstrated, we can work with concepts with which we are familiar and we can utilise a range of existing international institutions. It would appear therefore that we now only lack the political leadership or vision to guide us towards an effective regime. The issues at stake are more than just questions associated with "bugs" and bioprospecting in the dark depths of the abyss. The question remains whether our political leaders have the vision to see that the future of conservation and sustainable management of our planets biodiversity does lie in the deep-sea. Will they continue to see only the scary monsters of the dark depths of the abyss, or will they see the deep-sea for what it is, one of the most important habitats on earth desperately in need of sustainable management?