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Dr Peter Nichols, Project Leader, Marine Products, CSIRO, Hobart, Australia, 12
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Ms Carrol Oliver, Executive Officer, Australian Centre for Astrobiology, 11
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APPENDICES

APPENDIX 1

Table 2: Biotechnology and other companies involved in research and/or product development in relation to hydrothermal vents: potential applications of ongoing research and products developed and currently on the market¹.

Company	Areas of research interest and product development from thermophiles and hyperthermophiles from terrestrial and marine sources and other relevant areas	Products currently on the market developed from hydrothermal vent thermophile or hyperthermophile derivatives
<i>Diversa Corporation.</i> ²	Agricultural, chemical processing, industrial and pharmaceutical applications. This company is especially interested in potential uses of thermophiles in animal feed additives, agricultural product processing enzymes, industrial and consumer product enzymes and high performance specialty chemicals and polymers.	Pyrolase™ 160 enzyme, which can be employed in industrial applications at pH 5-9 and at high temperatures.
<i>Innovase LLC</i> (50/50 joint venture of Diversa Corporation and The Dow Chemical Company).	Industrial enzymes including applications such as detergents, starch processing, textile manufacturing, oil and gas production, pulp and paper processing, and the production of baked goods, beer, wine and dairy products. Also investigating applications in areas such as water treatment, industrial cleaning and biofilm removal.	
<i>Invitrogen Corporation</i> ³ Under licence from Diversa Corporation.	Commercialisation of three of Diversa Corporation's thermostable DNA-modifying enzymes.	ThermalAce™ DNA Polymerase, a novel enzyme that improves the performance of DNA amplification for the widely used polymerase chain reaction.
<i>New England Biolabs Inc.</i> ⁴	Restriction endonucleases and other related products for molecular biology research/recombinant DNA technology.	Vent _R ® DNA Polymerase a high-fidelity thermophilic DNA polymerase, which is purified from a strain of <i>E. coli</i> that

¹ Sourced from individual company web sites, annual reports and literature as cited.

² See www.diversa.com, last accessed 12 July, 2004.

³ See www.invitrogen.com, last accessed 12 July, 2004.

⁴ See www.neb.com, last accessed 12 July, 2004.

		<p>carries the Vent DNA Polymerase gene from the archaea. <i>Thermococcus litoralis</i> isolated from a submarine hydrothermal vent near Lucrino, Bay of Naples, Italy.⁵ The native organism is capable of growth at up to 98°C.⁶</p> <p>Vent_R[®] (exo⁻) DNA Polymerase, genetically engineered version of Vent_R DNA Polymerase that carries the Vent DNA Polymerase gene from the archaea <i>Thermococcus litoralis</i> isolated from the hydrothermal vent site noted above.⁷</p> <p>Deep Vent_R[®] DNA Polymerase, a more stable form of Vent_R[®] DNA Polymerase. Purified from a strain of <i>E.coli</i> that carries the Deep Vent_R DNA Polymerase gene from <i>Pyrococcus</i> species GB-D(1).⁸ The native organism was isolated from a submarine thermal vent in the Guaymas Basin at 2010 metres.⁹</p> <p>Deep Vent_R[®] (exo⁻) DNA Polymerase, genetically engineered version of Deep Vent_R[®] DNA Polymerase purified from a strain of <i>E.coli</i> that carries the Deep Vent_R DNA Polymerase</p>
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⁵ Perler F B and Jack W E et. al 'Intervening sequences in an Archaea DNA polymerase gene' (1992) 89 *Proc.Natl. Acad. Sci. USA* 5577.

⁶ New England Biolabs Inc. Vent_R[®] DNA Polymerase Technical Bulletin # M0254 (26/8/02) available from <http://www.neb.com>, accessed 4 October 2002.

⁷ New England Biolabs Inc. Vent_R[®] (exo⁻) DNA Polymerase Technical Bulletin # M0257 (26/8/02) available from <http://www.neb.com>, accessed 4 October 2002.

⁸ New England Biolabs Inc. Deep Vent_R[®] DNA Polymerase Technical Bulletin # M0258 (26/8/02) available from <http://www.neb.com>, accessed 4 October 2002.

⁹ H W Jannasch et al, 'Comparative Physiological Studies on Hyperthermophilic Archaea isolated from Deep-Sea Hot Vents with emphasis on *pyrococcus* strain GB-D' (1992) *Applied and Environmental Microbiology* 3472.

¹⁰ New England Biolabs Inc. Deep Vent_R[®] (exo⁻) DNA Polymerase Technical Bulletin # M0259 (26/8/02) available from <http://www.neb.com>, accessed 4 October 2002.

¹¹ New England Biolabs Inc. 9°N_m[™] DNA Polymerase Technical Bulletin # M0260 (26/8/02) available from <http://www.neb.com>, accessed 4 October 2002.

¹² New England Biolabs Inc. Therminator[™] DNA Polymerase Technical Bulletin # M0261 (26/8/02) available from <http://www.neb.com>, accessed 4 October 2002.

		<p>gene from <i>Pyrococcus</i> species GB-D(1).¹⁰ The native organism was isolated from the location noted above.</p> <p>9°N_m[™] DNA Polymerase purified from a strain of <i>E.coli</i> that carries a modified 9°N_m DNA Polymerase gene from the extremely thermophilic marine archaea <i>Thermococcus</i> sp. Isolated from a submarine hydrothermal vent at a depth of 2,500 metres, 9° north of the equator at the East Pacific Rise¹¹</p> <p>Therminator[™] DNA Polymerase¹²</p>
<i>Promega Corporation.</i> ¹³	Development of products for life sciences research.	<p>Pfu DNA Polymerase, a thermostable enzyme isolated from <i>Pyrococcus furiosus</i>.¹⁴</p> <p>Tth DNA Polymerase isolated from the archaea <i>Thermus thermophilus</i>.¹⁵</p> <p>Tli DNA Polymerase isolated from the archaea <i>Thermococcus litoralis</i>.¹⁶</p>
<i>Prokaria ehf.</i> ¹⁷	<p>Development of products for biotechnology/genomics industry for research and diagnostics, for food, agricultural, chemical companies and the pharmaceutical industry, including thermostable DNA polymerases and ss RNA/DNA ligases.</p> <p>Prokaria is currently the sole company licensed to access and sample Iceland's offshore submarine hydrothermal vents, and also has sole access to some of Iceland's prime terrestrial hot springs and</p>	

¹³ www.promega.com, accessed 17 September 2004.

¹⁴ Pfu DNA Polymerase Usage Information, accessed from www.promega.com accessed 15 September 2004. See also Huber H and Stetter K O, 'Hyperthermophiles and their possible potential in biotechnology' (1998) 64 Journal of Biotechnology 39, 48.

¹⁵ Promega Enzyme Resource Guide available from www.promega.com, accessed 17 September 2004.

¹⁶ Promega Enzyme Resource Guide available from www.promega.com, accessed 17 September 2004.

	geothermal areas.	
<i>Genencor International Inc.</i> ¹⁸	Enzymes for use in applications such as detergents, converting starch to sweeteners, producing ethanol, “stone-washing” blue jeans, and enhancing the nutritional value of animal feed.	
<i>Montana Biotech Corporation & Mycologics Inc.</i> ¹⁹	<p>Discovery and isolation of novel antifungal compounds for therapeutic use. Especially interested in identification of extremophiles and thermophiles that have potent activity against human fungal pathogens. Fungal infections are a common complication in kidney, liver, lung and heart transplants and have also been associated with AIDS.</p> <p>Joint Research by these two companies resulted in the first reported screening of extremophiles for antifungal activity.</p> <p>Although most research has focussed on extremophiles from terrestrial sources, the potential for hydrothermal vent extremophiles has been identified in such research.²⁰</p>	
<i>Biopolymer Engineering Inc.</i> ²¹	<p>Research in relation to polysaccharides, especially chitin for use in a range of applications including consumer products such as recycled paper, household sponges, diapers and feminine napkins and tampons, and medical uses such as wound dressings, hospital bedding, gowns and other medical products.</p> <p>Chitin is found in the shells of crustaceans, the exoskeletons of insects and the cell walls of fungi. Biodegradation of these materials in nature involves processes similar to those used commercially to produce popular nutraceuticals. The process of biodegradation has been modelled and quantified in various studies by this company,</p>	

¹⁷ www.prokaria.com, accessed 17 September 2004.

¹⁸ www.genencor.com, accessed 17 September 2004.

¹⁹ www.mycologics.com, accessed 17 September 2004.

²⁰ Phoebe C H and Combie J, et al ‘Extremophilic Organisms as an Unexplored Source of Antifungal Compounds’ (2001) 54(1) *The Journal of Antibiotics* 56.

	including one study involving the evolution of chitin and protein contents of the shells of a hydrothermal vent crab exposed to marine soil. ²²	
<i>QBiogene Inc.</i> ²³	This company describes itself as a fully integrated provider of molecular and cellular biology, drug discovery, and development of products focussing on genetic identification, cloning and manipulation.	
<i>Stratagene Inc.</i> ²⁴	This company's web site describes the company as a worldwide leader in developing innovative products and technologies for life science research. Its products are used in academic, industrial and government research sectors, including in molecular biology, genomics, proteomics, drug discovery and toxicology.	<p>This company markets a range of DNA polymerases containing the ArchaeMaxx™ Factor isolated from <i>Pyrococcus furiosus</i>, a hyperthermophilic archaeon found in hydrothermal vents. DNA polymerases marketed containing the ArchaeMaxx™ Factor include:</p> <p>Pfu DNA Polymerase; PfuTurbo® DNA polymerase; PfuTurbo® Hotstart DNA polymerase; PfuUltra™ Hotstart DNA Polymerase; Herculase® Enhanced DNA Polymerase; Herculase Hotstart DNA Polymerase; EXL™ DNA Polymerase; Easy-A™ High-Fidelity PCR Cloning Enzyme; and TaqPlus® Maxx™ DNA Polymerase.</p> <p>This company also markets the UITma™ DNA polymerase which was isolated from the hydrothermal vent hyperthermophile <i>T.maritima</i>.²⁵</p>
<i>Darphin</i>	This company is not a biotechnology company per se. Its principal	Darphin Stimulskin Plus Cream-a cosmetic product containing

²¹ www.biopolymer.com, accessed 17 September 2004

²² See www.biopolymer.com and Gaill F, Voss-Foucart M, Shillito B and Goffinet, G 'In Situ Biodegradation experiments of chitinous Exoskeletal structures of crabs and vestimentiferans coming from Deep Sea Hydrothermal Vents (1995) *Advances in Chitin Science* 143.

²³ <http://www.qbiogene.com> accessed 17 September 2004.

²⁴ <http://www.stratagene.com> accessed 17 September 2004.

²⁵ H.Huber and K.O. Stetter, 'Hyperthermophiles and their possible potential in biotechnology', (1998) 64 *Journal of Biotechnology* 39, 48.

	<p>area of business is cosmetics. It markets a number of products that contain the DEEPSANE active ingredient derived from a range of deep-sea microorganisms, including some sourced from deep sea hydrothermal vents in the Pacific ocean.²⁶ References on the IFREMER web site suggest that DEEPSANE was developed by researchers at IFREMER, although it was not possible to confirm this. DEEPSANE appears to have been derived from the hydrothermal vent bacteria <i>Alteromonas macleodii</i>. A related product is also marketed as ABYSSINE® 657.²⁷</p>	<p>DEEPSANE described on the manufacturer's web site as "an intensive skin-restructuring and lifting treatment".²⁸</p> <p>Darphin Stimulskin Plus Eye Contour-a cosmetic containing DEEPSANE described by the manufacturer as "a multi-action, antiaging defense system for your eyes"²⁹ In the advertising material for this product the manufacturer describes DEEPSANE as an ingredient which "stimulates the immune system to form a protective barrier against environmental irritants such as pollution and smoke".³⁰ ABYSSINE® 657.</p>
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²⁶ <http://www.google.com.au/search?q=cache:V7WOtVHfOY8J:www.renew4u.com/ski> accessed 17 September 2004.

²⁷ See in particular references to DEEPSANE on the IFREMER web site <http://www.ifremer.fr/anglais> accessed 17 September 2004 and the extended abstract of a papers by IFREMER scientist Guezennec J, 'Innovative Bacterial Exopolysaccharides from Hydrothermal Deep-Sea Vents' and by Vacher A M, 'Valorization of an exopolysaccharide excreted by a microorganism from hydrothermal vents. Valorization of Deepsan in the cosmetic industry' reproduced at http://216.239.37.104/translate_c?hl=en&sl=fr&u=http://www.cbb-developpement.co accessed 17 September 2004, as well as the published article M.A. Gambon-Bonavita M A, Raguénès G, and Jean J et.al, 'A novel polymer produced by a bacterium isolated from a deep-sea hydrothermal vent polychaete annelid' (2002) 93 *Journal of Applied Microbiology* 310.

²⁸ <http://darphin-vip.store.yahoo.com/darstimplusc1.html>, accessed 17 September 2004.

²⁹ <http://www.liposculpte.com/eye-wrinkle-cream/>, accessed 17 September 2004.

³⁰ <http://www.meimanmarcus.com/store/catalog/prod.jhtml?itemId=prod6100594&paren>, accessed 17 September 2004.

APPENDIX 2

Table 3 Patents granted in relation to biotechnology derived from hydrothermal vent microbes and other inventions.

Patent Number	Title of Invention	Assignee (Owner of the Patent Right)	Micro-organism, derivative or process	Source Micro-organism	Location of Source Micro-organism (if stated)	Product as Marketed
US5,506,137	Purified thermostable <i>Pyrococcus Furiosus</i> DNA Ligase	Stratagene	Derivative	<i>Pyrococcus Furiosus</i>		Pfu DNA Ligase
US5,602,011	Purified <i>Thermococcus Barossii</i> DNA Polymerase	Pharmacia Biotech Inc. and North Carolina State University	Derivative	<i>Thermococcus Barossii</i>	Endeavor Segment, Juan De Fuca Ridge, Washington State, USA. A strain of <i>Thermococcus Barossii</i> was deposited at DSM (Deutsche Sammlung Von [SIC] Mikro-organismen Und Zellkulturen GmVH, Federal Republic of Germany, DSM Accession No: DSN9535.	
US5,700,672	Purified Thermstable <i>Pyrococcus</i> DNA Ligase	Stratagene	Derivative	<i>Pyrococcus Furiosus</i>	Deutsche Sammlung Von Micro-organismen DSM Accession No: DSM-6217	

Patent Number	Title of Invention	Assignee (Owner of the Patent Right)	Micro-organism, derivative or process	Source Micro-organism	Location of Source Micro-organism (if stated)	Product as Marketed
US5,714,373	Thermococcus AV4 and enzymes produced by the same.	Recombinant Bio-Catalysis Inc.	Micro-organism and derivatives	<i>Thermococcus</i> AV4		
US5,789,220	Endoglucanases	Diversa Corporation	Derivative	Archael Bacterium AEPII1a	Vulcano, Italy	
US5,843,669	Cleavage of nucleic acid using thermostable methoanococcus jannaschii FEN-1 endonucleases	Third Wave Technologies Inc.	Derivative and process	<i>Methoanococcus jannaschii</i>		
US5,877,001	Amidase	Diverso [sic] Corporation	Derivative	Archael Bacterium <i>Thermococcus</i> GU5L5	Vulcano, Italy	
US5,925,749	Carboxymethyl Cellulase from <i>Thermotoga Maritima</i>	Diversa Corporation	Derivative	<i>Thermotoga Maritima</i>		
US5,942,740	Esterases	Diversa Corporation	Derivative	The subject matter of this patent was derived from a number of terrestrial and marine organisms including the following organisms from hydrothermal vents: <i>Staphylothermus Marinus</i> F1	Vulcano Italy	

Patent Number	Title of Invention	Assignee (Owner of the Patent Right)	Micro-organism, derivative or process	Source Micro-organism	Location of Source Micro-organism (if stated)	Product as Marketed
				<i>Pyrodictum</i> TAG11 <i>Acuifex Pyrophilus</i> KOI 5a <i>Thermococcus</i> CL 2 <i>Aquifex</i> VF5 <i>Archaeoglobus</i> <i>Fulgidus</i> VC16 <i>Sulfolobus</i> <i>Solfataricus</i> P1	Middle Atlantic Ridge Kolbeinsey Ridge, North of Iceland North Cleft Segment of the Juan De Fuca Ridge Vulcano, Italy Vulcano, Italy	
US5,958,751	β -Galactosidase	Diversa Corporation	Derivative	<i>Thermococcus</i> , <i>Alcaliphilus</i> AEDII12RA		
US5,962,258	Carboxymethyl Cellulase from <i>Thermotoga Maritima</i>	Diversa Corporation	Derivative	<i>Thermotoga Maritima</i>		
US5,962,283	Transminases and Amnotransferases	Diversa Corporation	Derivative	Derived from a number of micro-organisms including <i>Acuifex</i> VF5	Vulcano, Italy	
US5,985, 646	Amivase	Diversa Corporation	Derivative	Archael Bacterium <i>Thermococcus</i> GU5L5	Vulcano, Italy	
US6,001,626	Thermophilic Phospholipases and method for production thereof	Director-General of Agency of Industrial Science and Technology (Japan)	Derivative and method	<i>Pyrococcus</i> <i>Horikoshii</i>		

Patent Number	Title of Invention	Assignee (Owner of the Patent Right)	Micro-organism, derivative or process	Source Micro-organism	Location of Source Micro-organism (if stated)	Product as Marketed
US6,001,984	Endoglucanases	Diversa Inc.	Derivative	Archael Bacterium AEPII1a	Vulcano, Italy	
US6,004,796	Amidase	Diversa Corporation	Derivative	Archael Bacterium <i>Thermococcus</i> GU5L5	Vulcano, Italy	
US6,066,049	Re-enactment of a deep-sea voyage to the bottom of the sea	Cyrus Milamian	Machinery/process.	Not applicable	Not applicable	
US6,143,517	Thermostable Proteolytic Enzymes and uses thereof in Peptide and Protein Synthesis	University of Florida	Derivative and use.	<i>Pyrococcus Furiosus</i>		
US6,180,845	Transforming Biomass to Hydrocarbon Mixtures in Near-critical or Super-critical Water	Board of Supervisors of Louisiana State University et.al.	Process	Not applicable	Not applicable	
US6,280,998	Purified Thermostable <i>Pyrococcus Furiosus</i> DNA Ligase	Stratagene	Derivative	<i>Pyrococcus Furiosus</i>		
US6,436,680	Marine Bacterial Strain of the Genus <i>Vibrio</i> , Water-Soluble Polysaccharides Produced by said Strain and Their Uses	Institut Francais de Recherche Pour L'Exploitation de la Mer	Micro-organisms, derivative, and use	<i>Vibrio Diabolicus</i>	Isolated from Pompeii worm (<i>Alvinella Pompejana</i>), location not stated.	

Patent Number	Title of Invention	Assignee (Owner of the Patent Right)	Micro-organism, derivative or process	Source Micro-organism	Location of Source Micro-organism (if stated)	Product as Marketed
US6,440,715	Method for Cloning and Expression of <i>Rhodothermus Obamensis</i> DNA Polymerase I Large Fragment in E.coli.	New England Bio-labs, Inc.	Derivative and method	<i>Rhodothermus Obamensis</i>	Tachibana Bay, Japan	
US6,465,208B1	Amidase	Diversa Corporation	Derivative	Archael Bacterium <i>Thermococcus</i> GU5L5		
US6,468,775	Thermostable DNA Polymerase from <i>Carboxydothemus Hydrogenoformans</i>	Roche Molecular Systems Inc.	Derivative and method	<i>Carboxydothemus Hydrogenoformans</i>		
US6,492,511B2	Isolation and Identification of Novel Polymerases	Diversa Corporation	Derivative	Ammonifex Degensii KC4	Middle Atlantic Ridge	
US6,500,659B1	Amidase	Diversa Corporation	Derivative	Archael Bacterium <i>Thermococcus</i> GU5L5	Volcano, Italy	
US6,503,729	Selected Polynucleotide and Polypeptide Sequences of the Methanogenic Archaeon, <i>Methanococcus Jannaschii</i>	The Board of Trustees of the University of Illinois, The Institute for Genomic Research and Johns Hopkins University	Micro-organism (complete genome sequence)	<i>Methanococcus Jannaschii</i>		
US6,525,190B1	Amidase	Diversa Corporation	Derivative	<i>Thermococcus</i> GU5L5	Vulcano, Italy	

Patent Number	Title of Invention	Assignee (Owner of the Patent Right)	Micro-organism, derivative or process	Source Micro-organism	Location of Source Micro-organism (if stated)	Product as Marketed
US6,545,145	Purified <i>Alteromonas Macleodii</i> Polysaccharide and its Uses	Instit Francais de Recherche Pour L'Exploitation de La Mer and Cooperative Laitiere de Ploudaniel	Derivative	<i>Alteromonas Macleodii Subst.Fijiensis</i>	North Fiji Basin.	
US6,561,046	Sampling Apparatus for Collecting Samples from Underwater Hydrothermal Vents and the Marine or Limnological Water Column	McLane Research Laboratories	Not applicable	Not applicable	Not applicable	
US6,573,065	Thermostable Protolytic Enzymes and Uses Thereof in Peptide Protein Synthesis	David Michael Young	Derivative	<i>Pyrococcus Furiosus</i>		
US6,632,645	Thermophilic DNA Polymerases from Thermoactinomyces Vulgaris	Promega Corporation	Derivative	<i>Thermoactinomyces Vulgaris</i>		
US6,673,585	Heat-stable DNA Polymerase of Archaeo Bacteria of Genus Pyrococcus SP	Appligene-Oncor S.A.	Derivative	<i>Pyrococcus</i> SP. GE5	North-Fiji Basin in the South Pacific	
US6,686,075	Process for Producing Electrical Energy with the aid of a Fuel Cell	dmc2 Degussa Metals Catalysts Cerdec AG	Process utilising thermophilic micro-organisms	<i>Carboxidothermus Hydrogenoformans</i>		

Patent Number	Title of Invention	Assignee (Owner of the Patent Right)	Micro-organism, derivative or process	Source Micro-organism	Location of Source Micro-organism (if stated)	Product as Marketed
US6,692,932	Thermostable DNA Polymerase from <i>Anaerocellum Thermophilum</i>	Ankenbauer and Schmitz-Agheguin et.al.	Derivative	<i>Anaerocellum Thermophilum</i> SUP.1		
US6,743,618	Thermstable Protolytic Enzymes and uses thereof in Peptide and Protein Synthesis	University of Florida Research Foundation, Inc.	Derivative	<i>Pyrococcus Furiosus</i>		
GB2,391,881A	Mining Hydrothermal Vents	Michael Eugene Kavanagh	Method of mining	Not applicable		

APPENDIX 3

Table 4 Scientists engaged in hydrothermal vent research interviewed for the purposes of this thesis.¹

Date of Interview/Location of interview	Name of scientist interviewed	Position & Research Institution	Current area of hydrothermal vent research interest	Location of recent research
10 April, 2003, CSIRO North Ryde, Australia	Dr Timothy F. McConachy	Senior Principal Research Scientist, CSIRO, North Ryde, NSW, Australia.	Geology of modern day hydrothermal systems. Understanding formation of ore bodies in hydrothermal vent systems	Manus Basin PNG, Vanuatu, Solomon Islands and Indonesia
18 June 2003, High Seas Biodiversity Workshop, Cairns, Australia	Professor Kim Juniper	Centre for Research in Geochemistry and Geodynamics, Université du Québec à Montreal	Understanding hydrothermal vent faunal communities. Hydrothermal vent food chain. Hydrothermal vent microbiology and biochemistry.	North East Pacific, Juan de Fuca Ridge, Explorer and Gorda Ridges (USA & Canada)
19 June 2003, High Seas Biodiversity Workshop, Cairns, Australia	Prof Dr Ricardo Santos	Director, Department of Oceanography and Fisheries, University of the Azores	Aquatoxicology of hydrothermal vent organisms including mussels, shrimp, limpets, crabs and fish associated with hydrothermal vents. DNA repair mechanisms of some hydrothermal vent species. Development of technology to collect specimens for other studies	Azores, Mid-Atlantic ridge.
12 November 2003, CSIRO, Hobart, Australia	Dr Peter Nichols	Project Leader, Marine Products, CSIRO Marine Products, Hobart, Tas, Australia	Thermophile microbiology.	Manus Basin PNG.
25 November 2003. Institute of	Dr Alex Malahoff	Chief Executive, New Zealand Institute of		Hawaii (USA), PNG, Kermadec Arc (New Zealand)

¹ A number of other scientists engaged in related areas of research were also interviewed informally. Although not involved in hydrothermal vent research these scientists did give invaluable information on scientific research techniques and details of further useful contacts. Their contribution is gratefully acknowledged at the beginning of this thesis.

Geological & Nuclear Sciences, Lower Hutt, New Zealand		Geological and Nuclear Sciences		
25 November 2003. Institute of Geological & Nuclear Sciences, Lower Hutt, New Zealand	Dr Cornel de Ronde,	Principal Scientist, New Zealand Institute of Geological and Nuclear Sciences	Geology of hydrothermal systems.	Kermadec arc (New Zealand), Tonga, PNG, Mariana arc and Solomon islands.
11 September 2004. Macquarie University.	Dr Roberto Anitori	Post-doctoral fellow, Australian Centre for Astrobiology and School of Biological Sciences, Macquarie University	Microbiology of extremophiles including hydrothermal vent thermophiles. Extreme environments as analogues for life on other planets.	

APPENDIX 4

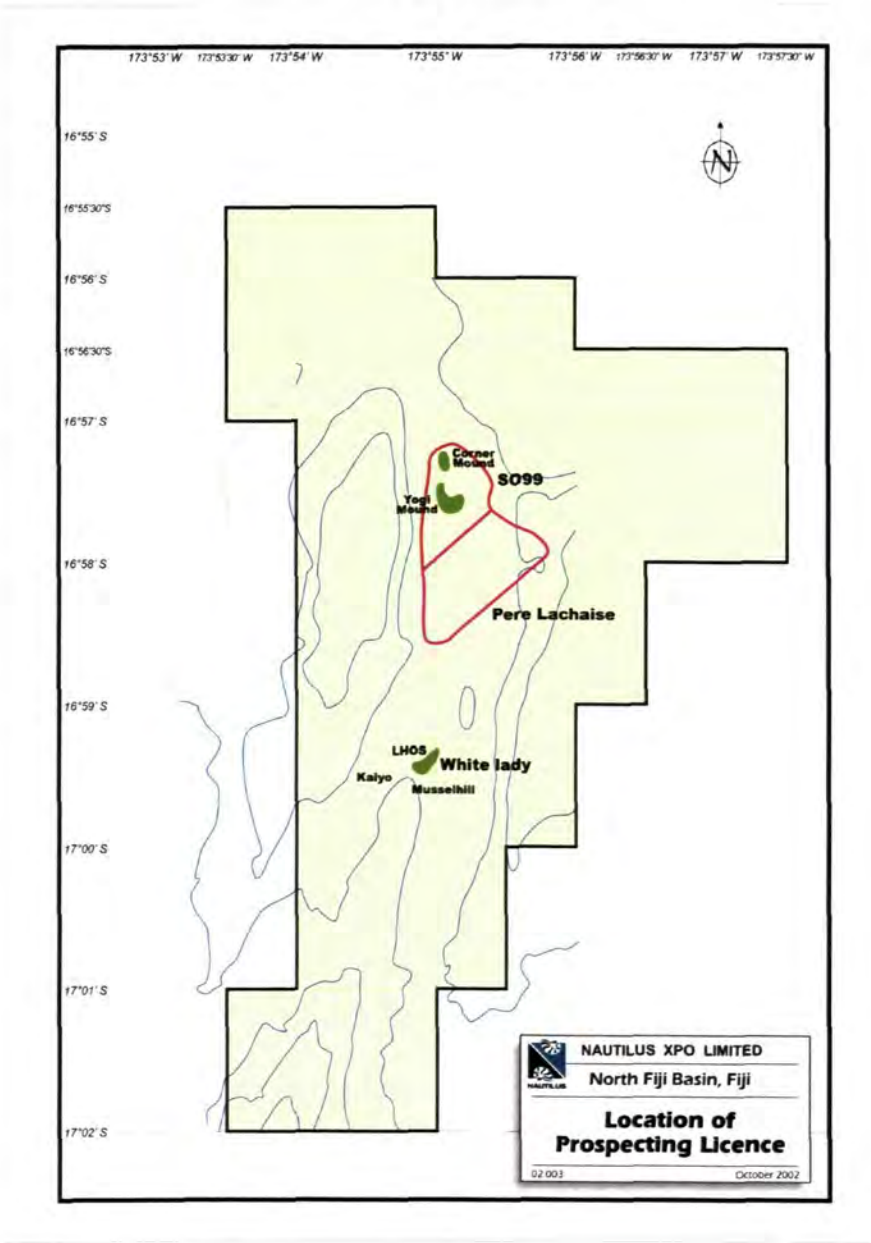


Figure 12 Location of Nautilus Minerals application for Prospecting Licences Fiji¹

¹ Image Courtesy of Mr David Heydon, CEO Nautilus Minerals, reproduced with consent.

APPENDIX 5

Figure 13 Location of site covered by Nautilus XPO Limited applications for prospecting licences, Tonga.

