2014

CHATHAM RISE PROJECT

Independent JORC (2012) Technical Report and Mineral Resource Estimate on the Chatham Rise Project in New Zealand

Report prepared for:	Chatham Rock Phosphate Ltd Level 1, 93 The Terrace Wellington, New Zealand
Signed by Competent Person:	René Sterk
Effective Date:	3rd March 2014

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Competent Person's Consent Form

Pursuant to the requirements of ASX Listing Rules 5.6, 5.22 and 5.24 and
Clause 9 of the JORC Code 2012 Edition (Written Consent Statement)

Report name

Independent JORC (2012) Technical Report and Mineral Resource Estimate on the Chatham Rise Project in New Zealand

(*Insert name or heading of Report to be publicly released*) ('Report')

RSC Consulting Ltd

(*Insert name of company releasing the Report)*

Chatham Rise

(Insert name of the deposit to which the Report refers)

3rd March 2014

(Date of Report)

Statement

I, René Sterk confirm that I am the Competent Person for the Report and:

- I have read and understood the requirements of the 2012 Edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (JORC Code, 2012 Edition).
- I am a Competent Person as defined by the JORC Code, 2012 Edition, having five years' experience that is relevant to the style of mineralisation and type of deposit described in the Report, and to the activity for which I am accepting responsibility.
- I am a Member or Fellow of *The Australasian Institute of Mining and Metallurgy* or the *Australian Institute of Geoscientists* or a 'Recognised Professional Organisation' (RPO) included in a list promulgated by ASX from time to time.
- I have reviewed the Report to which this Consent Statement applies.

I am a full time employee of RSC Consulting Ltd and have been engaged by Chatham Rock Phosphate Ltd to prepare the documentation for the Chatham Rock Phosphate deposit on which the Report is based, for the period ended 3rd March 2014.

I have disclosed to the reporting company the full nature of the relationship between myself and the company, including any issue that could be perceived by investors as a conflict of interest.

I verify that the Report is based on and fairly and accurately reflects in the form and context in which it appears, the information in my supporting documentation relating to Exploration Targets, Exploration Results and Mineral Resources.

Consent

I consent to the release of the Report and this Consent Statement by the directors of Chatham Rock Phosphate Limited

	3rd March 2014
Signature of Competent Person	Date
Australasian Institute of Mining & Metallurgy	303499
Professional Membership	Membership Number
	Sean Aldrich 20 Park Rd, Warrington, NZ
Signature of Witness	Print Witness Name and Residence: (eg town/suburb)

Executive Summary

Chatham Rock Phosphate Ltd ("CRP") has commissioned RSC Consulting Ltd ("RSC") to undertake an independent Mineral Resource estimation study on its Chatham Rise Phosphorite Project ("Project") and prepare a report ("Report") compliant with the JORC Code (JORC 2012).

The Project covers an area of seabed phosphorite nodules that is situated about 450 km offshore of the east coast of New Zealand at approximately 350 to 450 m water depth.

CRP holds 100% of Mining Permit 55549 granted in December 2013 ("Mining Permit") along with the Continental Shelf licence MPL 50270 granted in February 2010 ("Prospecting Licence"). The Mining Permit is not due to expire until 2033 and, subject to the granting of a Marine Consent from the Environmental Protection Authority, will allow CRP to conduct mining operations. The Prospecting Licence (MPL 50270) expired on the 25 February 2014 and an application for an extension of a term for a further four years was submitted in December 2013. RSC understands that while this application is being considered, CRP can continue to explore MPL 50270 (and the licence remains in force) until the application is determined. RSC has no reason to doubt that the extension will be granted.

Two prospecting permit applications, that allow for low impact exploration to be conducted over a period of two years, have been made for separate areas east and west of the Prospecting Licence. A summary of these licence holdings and applications in shown in Table 1 below.

Table 1: CRP licence holdings and applications.

Asset	Holder	Interest (%)	Status	Licence expiry date	Licence area (km^2)	Comments
MP 55549 Mining Permit	CRP	100	Exploration	5 Dec 2033	820	
MPL 50270 Prospecting Licence	CRP	100	Exploration	24 Feb 2014 (expired)	3,905	Term expired on 24 February 2014, but CRP has sought an extension of term through to 24 February 2018 for a reduced area of 2,887m^2
PPA 55967 Prospecting Permit	CRP - Under application	100	Exploration	Application	4,985	Application
PPA 55971 Prospecting Permit	CRP - Under application	100	Exploration	Application	1,501	Application

Boskalis Offshore Subsea Contracting B.V. ("Boskalis") is a technical partner in the Project and holds a 17.6% shareholding of CRP.

The phosphorite deposit occurs as a thin layer of phosphorite-bearing glauconitic sand with thicknesses typically ranging from 0 to 1 m at depths of 350 to 450 m below sea level. The sand layer consists of mainly silt and sand-sized sediments, with phosphatised chalk nodules up to 15 cm in diameter.

Phosphorite nodules were first discovered on the Chatham Rise in the 1950s by a New Zealand Government survey. During the 1960s to 1980s several private and government sponsored cruises explored the Chatham Rise and surrounding seafloor area. The most extensive surveys were conducted by an agreement between the New Zealand Department of Scientific and Industrial Research and the West German Government on cruises by the German research vessels *R.V. Valdivia* in 1978 and *R.V. Sonne* in 1981.

The 1978 *R.V. Valdivia* cruise was the first intensive sampling and research campaign to be conducted over the Chatham Rise; a total of 655 samples from 689 attempts were collected over a 300 km^2 area in the west of the Project area. The majority of the samples were collected using a large Van Veen-style grab of 0.12 m^3 volume, weighing approximately 400 kg.

The 1981 *R.V. Sonne* Cruise was the most comprehensive exploration effort to assess the Chatham Rise phosphorite deposit. In addition to oceanographic, meteorological and geophysical data, the cruise collected 19 hours of video recordings of the sea floor as well as 519 sediment samples taken by a pneumatic grab-sampler. The seafloor sediment samples collected during this cruise are the most representative sample data collected on the Chatham Rise and are considered to be of a high enough quality to include in a resource estimation.

Since acquiring the licence in 2010, CRP has conducted six cruises in two programmes in the Project area. The key task of the cruises was to validate the previous work conducted on the Chatham Rise and collect further geological, geotechnical, geophysical and environmental data. For phosphorite grade estimation purposes the *M.V. Tranquil Image* cruise collected 55 samples using a Van Veen grab. The *R.V. Dorado Discovery* conducted four cruises to the Project area and collected 206 box core and grab samples.

Sample quality and QA/QC measures varied considerably between the cruises and within each cruise. A critical part of the assessment of the data collected in the Project area was to determine what quality thresholds to use to allow or disallow data to enter into the estimation process. As part of the data verification process, the relative and absolute quality of the data was assessed in as much detail as practically possible. In general, the best samples were those that were collected using the pneumatic grab, sampled the full sand horizon, had a small survey error and had no other apparent data ambiguities. Samples collected from the *R.V. Sonne* are considered to represent the better quality samples collected in the licence area, followed by some of the *R.V. Valdivia* samples and then the box core samples from the *Dorado Discovery*. Samples not included in the resource estimate are samples that failed due to technical failure, samples collected but which have no data recorded, samples with no location coordinates, non-validated data and samples documented as washed or otherwise biased.

Definition of the domains used for modelling was based on seismic facies delineated during the *R.V. Sonne* cruise. A 2D block model was constructed based on 1 km by 1 km blocks that covers the main sampled area based on the average data spacing in the main sample areas. A maximum search radius of 3,000 m was used based on variogram modelling.

Estimation was performed in each domain using ordinary kriging using the accumulation method on the parameters Ph kg/m^2 (phosphorite grade), Depth and Sample Quality Ranking ("SQR"). The grade (Ph kg/m^3) was then calculated by dividing Ph kg/m^2 by the estimated Depth for each block.

A total of 80 million m^3 at an average grade of 290 kg/m^3 is classified as a global Inferred Mineral Resource at a cut-off grade of 100 kg/m^3 for a total contained 23.4 Mt of phosphorite (Table 2). The specification of the phosphorite (i.e. the *phosphate* content) has been studied by various operators including CRP, and, even though a representative average grade cannot be determined for the Mineral Resource, the tenor of the specification (in the order of 18-19% P_2O_5 of screened material) is suitable to allow classification into the Inferred Resource category.

The average thickness of the resource is 0.20 m. There are no resources classified in Indicated or Measured categories.

Table 2: Statement of Mineral Resources (phosphorite) for Mining Permit 55549, Chatham Rise. Estimates are rounded to reflect the level of confidence in these resources at the present time.

Classification	Volume (m^3)	Thickness (cm)	Ph kg/m^3	Contained Ph Mt
Inferred	80,000,000	20	290	23.4

Notes:

1. *The Mineral Resource is reported in accordance with the JORC Code, 2012 edition*
2. *The Mineral Resource is contained within MP 55549*
3. *All resources have been rounded to the nearest 0.1 million tonnes*
4. *Ph kg/m^3 is the weight of phosphorite per cubic metre*
5. *Contained Ph Mt is contained weight of phosphorite per million tonnes*
6. *Even though a representative average grade for the specification (phosphate grade) cannot be determined for the Mineral Resource, the tenor of the specification (in the order of 18-19% P_2O_5 of screened material) is suitable to allow classification into the Inferred Resource category*
7. *Mineral Resource is reported at 100 kg/m^3 cut-off grade*

RSC's analysis to date indicates that a potentially economically extractable phosphorite Mineral Resource exists in the Project area. Several high-profile sampling cruises, most independent from each other, have all identified grades of economic interest within the same area. These cruises have been well documented and specific knowledge on sampling systems has been retained and included in this Report.

In addition to the Inferred Mineral Resource above, in RSC's opinion, there is significant exploration potential to extend the Mineral Resources within the mining permit MP 55549. Based on existing sampling data (that was not included in the resource because of lower density of sampling or lower SQR numbers), the exploration target would be in the order of 40,000,000 m^3 with 8 to 12 Mt of contained phosphorite at grades between 200 and 300 kg/m^3. Exploration potential also exists outside MP 55549 and within CRP's MPL 50270 permit; however, there is insufficient suitable information to quantify a target range.

RSC recommends that further seafloor sampling is undertaken to both increase the confidence in the established Mineral Resource as well as to extend the boundaries of the Resource, predominantly towards the west where currently low-quality *Valdivia* data indicate an exploration target of at least 5 Mt phosphorite. Increasing the confidence in the current Mineral Resource by additional sampling will give CRP the grade and geological confidence in the phosphorite deposit to allow them to further develop mining plans and economic studies.

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1 Introduction

Chatham Rock Phosphate Ltd ("CRP") has commissioned RSC Consulting Ltd ("RSC") to undertake an independent Mineral Resource estimation study on its Chatham Rise seabed phosphorite deposit and prepare a report ("Report") compliant with the JORC Code, 2012 edition. This report has been prepared to document that Mineral Resource with an effective date of 3 March, 2014.

The Chatham Rise Phosphorite Project (the "Project") covers an area of seabed phosphorite nodules that is situated approximately 450 km offshore of the east coast of New Zealand at between 350 m and 450 m water depth.

The work that RSC has undertaken for this Project includes a thorough review of all available data and reports, review of sampling procedures, statistical analysis and validation of data, Mineral Resource estimation, review of conceptual mining methods and review of conceptual economic assumptions and metallurgy.

1.1 Definitions

This Report contains a number of terms, denominations and calculation methods that are specific to this type of deposit (Table 3).

This deposit has been assessed, both at present and in the past, using measurements and estimations of the weight of phosphorite nodules relative to sample volumes collected from the sea floor. These measurements have either been expressed as *phosphorite grade,* expressed as weight per volume (kg/m^3), or as *phosphorite coverage* expressed as weight per area (kg/m^2).

The determination of this grade and coverage is carried out using conventional methods (weighing and simple measurements of volume) and does not involve a chemical analysis in a laboratory to determine P_2O_5 content. Therefore, typical industry sample quality control measures such as inserting certified reference materials (i.e. "standards" and "blanks") do not apply.

Table 3: Phosphate mineral nomenclature use in the Report.

Definition	Grade	Description
P	%	The element phosphorus. It is a non-metallic chemical element and occurs in phosphate minerals in phosphate rocks.
P_2O_5	%	Phosphorus pentoxide (chemical compound).
Phosphorite		Synonym: "rock phosphate". A non-detrital sedimentary rock or nodules which contain high amounts of phosphate bearing minerals.
Rock phosphate		A general term that refers to a rock with high concentrations of phosphate minerals.
Phosphorite minerals		The phosphate class of minerals is a large and diverse group; however, only a few species are relatively common.
Phosphorite grade	Ph kg/m^3	The weight of phosphorite nodules per cubic metre.
Phosphorite coverage	Ph kg/m^2	The weight of phosphorite nodules per square metre of sea floor.
Penetration depth	m	The thickness of the mineralised sediment component in a sampling bucket.
True depth	m	The true depth of the mineralised sediment.

1.2 Personnel

The primary author ("the Author") of the Report and Competent Person is Mr. Rene Sterk. Mr Sterk holds a MSc. in Structural Geology and Tectonics from the Vrije Universiteit Amsterdam (2002) and is a Member of the Australasian Institute of Mining and Metallurgy and a Member of the Australian Institute of Geoscientists. Mr. Sterk is the Principal Consultant of RSC, an independent consulting group based in Dunedin, New Zealand. His experience includes more than five years in the exploration, assessment and evaluation of alluvial deposits that, whilst not marine in nature, are consistent with the distribution of mineralisation displayed at the Chatham Rise Phosphorite Project.

Since the style of mineralisation is relatively rare with only a few similar deposits currently of economic potential known worldwide, this Mineral Resource study has involved collaboration as a team, with Mr Sterk taking overall responsibility. Other team members have direct applicable experience with regards to the type of deposit and mineralisation under investigation and are regarded as specialists in their field. The team includes:

- Mr Sean Aldrich – a Member of the Australasian Institute of Mining and Metallurgy and a long-term contract Principal Geologist with RSC with responsibility for compilation of most parts of the Report. Mr. Aldrich has had previous exposure to a similar mineralisation style through a short third party appraisal study of the Sandpiper deposit offshore from Namibia;
- Dr. John Youngson – a Member of the Australasian Institute of Mining and Metallurgy and Associate with RSC who provided an independent review of the Report. Dr Youngson has extensive experience in offshore gold and diamond deposits; and
- Dr. Robin Falconer and Dr. Hermann Kudrass – professional marine scientists and seabed phosphorite mineralisation experts.
- Professor Willem Vlasblom - provided an independent review of section 12.9.1 in the Report which discusses technical matters regarding the conceptual mining plans. Professor Vlasblom is an experienced civil engineer and an expert in hydraulics and dredging technology.

1.3 Data Sources and Reliance on Other Experts

In preparing this Report RSC has relied upon third parties for information and matters relating to property ownership, property titles, legal, environmental or engineering matters. This information has been collected from various sources:

- CRP tenement details and renewal documents;
- NZIER economic benefits study;
- New Zealand Petroleum and Minerals permit data;
- New Zealand Government Acts: Continental Shelf Act 1964, Crown Minerals Act 1991, The Exclusive Economic Zone and Continental Shelf Act 2012, Biosecurity Act 1993, Fisheries Act 1996, Marine Mammals Protection Act 1978, Maritime Transport Act 1994, Resource Management Act 1991 and the Wildlife Act 1953;
- geoscience publications;
- National Institute of Water and Atmospheric Research (“NIWA”) digital compilation of original sample data;
- Boskalis Offshore Subsea Contracting B.V. mining technology design; and
- CRP public releases and published economic assumptions.

Information from other third party sources is referenced in this Report as it is used. RSC used information from these sources on the assumption that the contents were reliable and accurate and has verified that data where possible, and checked calculations etc for appropriateness. The Author has attempted to accurately portray the content of those records in this technical Report but cannot guarantee the accuracy of the source information further than that.

RSC acknowledges the assistance, comments and written notes from three people who had direct involvement with the historical and CRP managed exploration programmes (Table 4). They have provided key technical insight into the sampling methodology, phosphorite analyses, geology, and historical resource estimations:

- Dr. Robin Falconer, who is a Member of the Australasian Institute of Mining and Metallurgy. He is a Director and the Chief Scientist with CRP, a professional marine scientist and seabed phosphorite mineralisation expert. Dr. Falconer has visited the site, aboard the first and third legs of *R.V. Sonne*, during the 1981 sampling campaigns. At the time of the cruise he was a consultant to Fletcher-Challenge Corporation Ltd and held the position of geophysicist. He was involved with the sediment sampling, bulk sample processing and phosphorite analyses conducted on the cruise. Since July 2010, Dr. Falconer has worked as a Chief Scientist for CRP and has been directly involved with the planning and execution of the 2011 and 2012 sampling programmes conducted by the *Dorado Discovery* and *Tranquil Image*. He has recently also joined the board of CRP.
- Dr. Hermann Kudrass, a former director of the German Federal Institute for Geosciences and Natural Resources ("BGR") and a seabed phosphorite mineralisation expert. Dr. Hermann Kudrass first visited the Project site in 1978 aboard the *R.V. Valdivia* working under a joint West German-New Zealand Agreement for Scientific and Technological co-operation and was involved with both legs of the cruise. At the time of the cruise he was a marine geologist working with the BGR. Dr. Kudrass was involved with all aspects of the development of sample procedures, sampling, and grade analyses conducted on the cruise. Dr. Kudrass was also a marine geologist working with the BGR on the *R.V. Sonne* cruise leg 2 where he was involved in all aspects of sampling. He has published a number of scientific papers detailing the work conducted on the *R.V. Valdivia* and *R.V. Sonne* cruises including previous resource estimations of the deposit. Dr. Kudrass also visited the Project aboard the *Dorado Discovery* for approximately 12 days during the April 2012 geotechnical survey.
- Dr. Simon Nielsen, a Senior Geologist with Kenex Knowledge Systems Ltd ("Kenex") visited the Project three times aboard the *Dorado Discovery* in 2012. He has spent approximately five weeks on site. Dr. Nielsen was closely involved with collecting geological samples on the *Dorado Discovery*, logging the samples and onshore separation analyses of the samples
- Professor Vlasblom, a former Chair of Dredging Technology at Delft University, Rotterdam (1994 to 2007) is a highly experienced dredging engineer and researcher. Professor Vlasblom has a Master's of Science in Civil Engineering with a speciality in Hydraulics. His experience includes over 30 years working in research and numerous dredging operations, including Head of Planning and Production for the marine works for the Chek Lap Kok Airport, Hong Kong. Professor Vlasblom has not visited the

Project. Professor Vlasblom provided an independent review of the mining and recovery methods presented in this Report.

1.4 Site Visits

Mr. Sterk (the Competent Person responsible for this Report and for the Mineral Resource), has not visited the Project site as the mineralisation is 400 m below the sea surface. Mr. Sterk has, however, visited CRP's sub-sampling site in Wellington in January 2014.

For site-specific information, RSC has relied on the experience of people who were directly involved with sampling and estimating phosphorite coverage (Dr. Falconer, Dr. Kudrass, Dr. Nielsen, Table 4).

The Author considers that the personal inspections by Dr. Falconer and Dr. Kudrass between 1978 and 1981 are current, because there has been no material change to the property. Nodule formation is measured on the scale of millions of years and sedimentation rates on the scale of thousands of years. No significant surface disturbance to the area has occurred due to the recent surface sampling by CRP.

Table 4: Site visits conducted by third party experts.

Name/organisation	Site visits	Expertise
Dr. Robin Falconer, Director, CRP	*R.V. Sonne*, leg 1 and 3, March – April, May, 1981	*R.V. Sonne* sampling methodology, geophysical techniques, seismic facies
Dr. Hermann Kudrass, former Director, German Federal Institute for Geosciences and Natural Resources ("BGR")	*R.V. Valdivia,* October-November, 1978; *R.V. Sonne*, leg 2, April – May, 1981	*R.V. Valdivia* and *R.V. Sonne* sampling methodology; geology and geochemistry; historical resource estimations
Dr. Simon Nielsen, Senior Geologist, Kenex Knowledge Systems Ltd ("Kenex")	*R.V. Dorado Discovery* cruise legs 2, 3, 4, Feb, March, April 2012	*R. V. Dorado Discovery* sediment sampling, Remotely Operated Underwater Vehicle ("ROV"), Cone Penetration Tests ("CPT")

2 Property Description and Location

The Chatham Rise Project is located in the Pacific Ocean approximately 450 km south-east of Wellington, New Zealand within New Zealand's Exclusive Economic Zone and on New Zealand's Continental Shelf (Figure 1). The centre of the Project area is 43° 30' South Latitude and 179° 30' East Longitude and is fully within New Zealand's jurisdiction according to international law.

CRP holds 100% of Mining Permit 55549 (820 km^2) and the 3,906 km^2 (formerly 4,726 km^2) Continental Shelf Licence MPL 50270. RSC has sighted the signed document granting Mining Permit 55549 by the Ministry of Energy and Resources. In addition, its details including MPL 50270, PPA 55967 and PPA 55971 are shown on the New Zealand Petroleum and Minerals permit map website. Two prospecting permit applications (PPA 55967 and PPA 55971) have been made for separate areas east and west of the prospecting licence (Table 5). Boskalis Offshore Subsea Contracting B.V. ("Boskalis") has provided technical services to CRP in respect of the Project and holds a 17.6% shareholding of CRP (as at 28 February 2014).

Table 5: CRP licence holdings and applications.

Licence	Type	Area km^2	Ownership	Expiry
MP 55549	Mining Permit	820	CRP 100%	5 Dec 2033
MPL 50270	Prospecting Licence	3,905	CRP 100%	Term expired on 24 February 2014, but CRP has sought an extension of term through to 24 February 2018 for a reduced area of 2,887m^2
MPL 50270 renewal	Prospecting Licence	2,887	CRP 100%	Under Application
PPA 55967	Prospecting Permit	4,985	CRP 100%	Under Application
PPA 55971	Prospecting Permit	1,501	CRP 100%	Under Application

<u>Mining Permit 55549</u>

The Minister of Economic Development granted Mining Permit 55549 to CRP for the extraction of rock phosphate on the Chatham Rise on 6 December 2013. The permit was granted for 20 years. The licence location details are shown in Appendix I. As part of the permit conditions, CRP is required to obtain a Marine Consent from the Environmental Protection Authority ("EPA") before it is able to begin mining. If granted, the consent would set out any conditions imposed on CRP to address the effects of mining on the environment. The process to apply for the Marine Consent is expected to take approximately six months and CRP intends to start this process in March 2014.

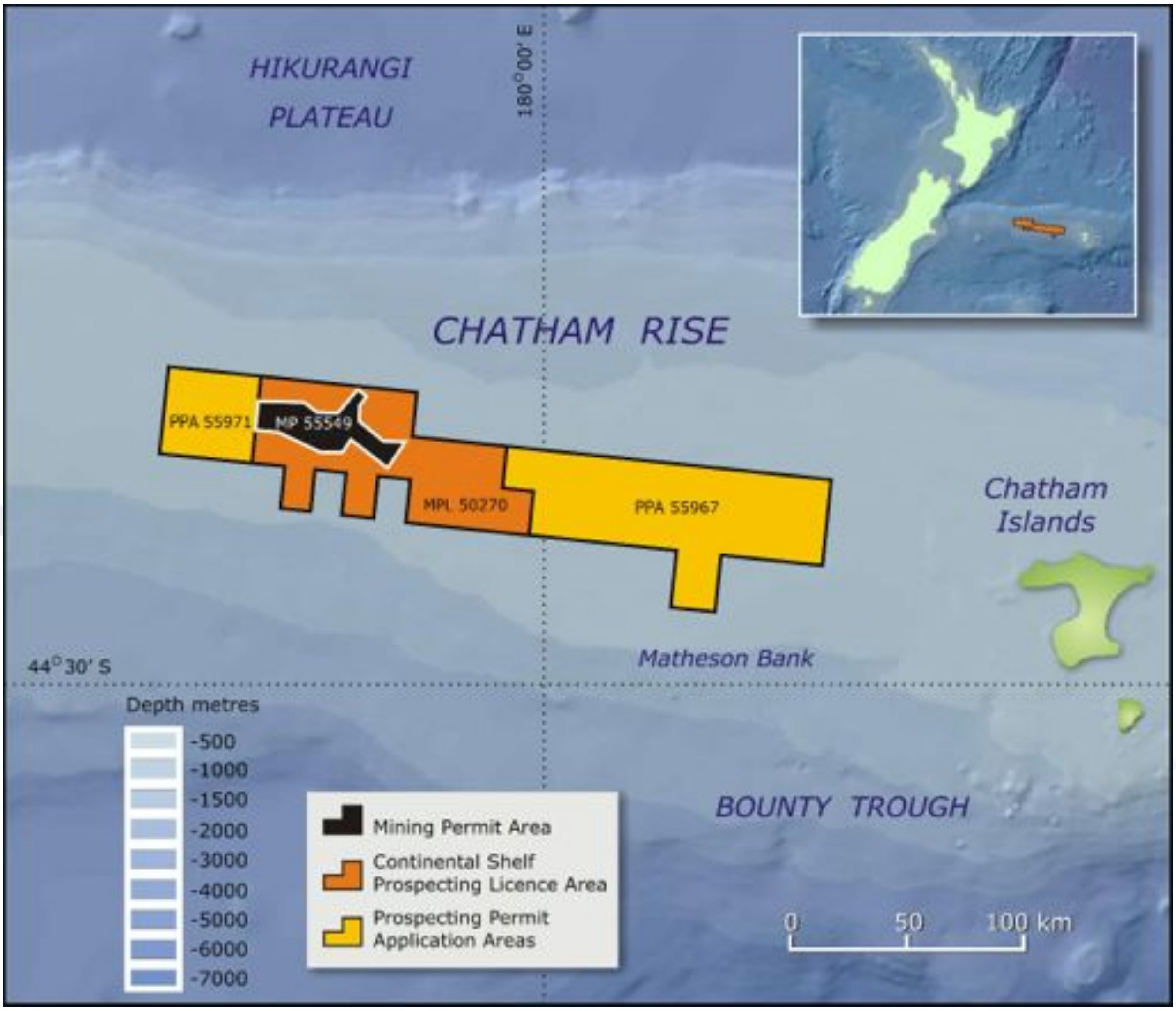

Figure 1: Chatham Rise Phosphorite Project location.

CRP has consulted with existing interests (as required by the Exclusive Economic Zone Act), indigenous peoples, the Chatham Islands community and other stakeholders. Parties with existing interests in the area mainly consist of the commercial fishing industry, including the indigenous fishing industry. The nature of this consultation and the issues raised during consultation will be included in an Environmental Impact Assessment ("EIA") that forms part of the application for Marine Consent, which is currently being prepared. The EIA will consist of an analysis of CRP's proposed activities, the potential effects of those activities and it considers the way that adverse impacts arising from the Project can be managed.

As part of the preparation of this EIA, expert technical assessments have been commissioned by CRP to more fully understand the nature of the Chatham Rise environment and the potential impacts associated with CRP's proposed mining operations. These assessments will be documented in the EIA and, along with the outcomes of stakeholder consultation, used by CRP to inform and guide avoidance, remediation and mitigation measures.

Prospecting Licence 50270

The Continental Shelf Licence (MPL 50270) was originally granted to Widespread Energy Limited (90%) and Widespread Portfolios Limited (10%) on 25 February 2010 (Appendix I). Widespread Portfolios Ltd. sold its 10% holding in the joint venture to Widespread Energy Ltd. (31 March 2011), after which Widespread Energy Ltd. changed its name to Chatham Rock Phosphate Ltd. (April 2011).

The original term of the MPL 50270 licence expired on the 25 February, 2014 and an application to extend the term for a further 4 years has been submitted on 20 December, 2013 to the NZPM. CRP is refining the area of focus and reducing the footprint of the licence. Figure 2 below highlights the area that will be retained and the area that will be surrendered. The licence will be reduced from 4,726 km^2 to 2,887 km^2. This area excludes the removed area which has had the Mining Permit granted over it.

As part of the application for extension of the Prospecting Licence, CRP has proposed a work programme for the initial 24 months of the renewal to address existing deficiencies in the knowledge of the area under renewal application. CRP's proposed work programme activities, as included in the Prospecting Licence renewal application (CRP, 2013), are budgeted at NZD 950,000 (USD 805,000) over the initial 24 months of the licence tenure from the date that the renewal is granted, but this amount may be increased as results warrant.

CRP understands that while this application is being considered, CRP can continue to operate on MPL 50270 (and the licence remains in force) until the application is determined. RSC has no reason to doubt that the extension will not be granted.

There are no statutory timescales in relation to the application for extension of the licence therefore CRP and RSC are unable to provide guidance as to when it is expected that the extension will be granted.

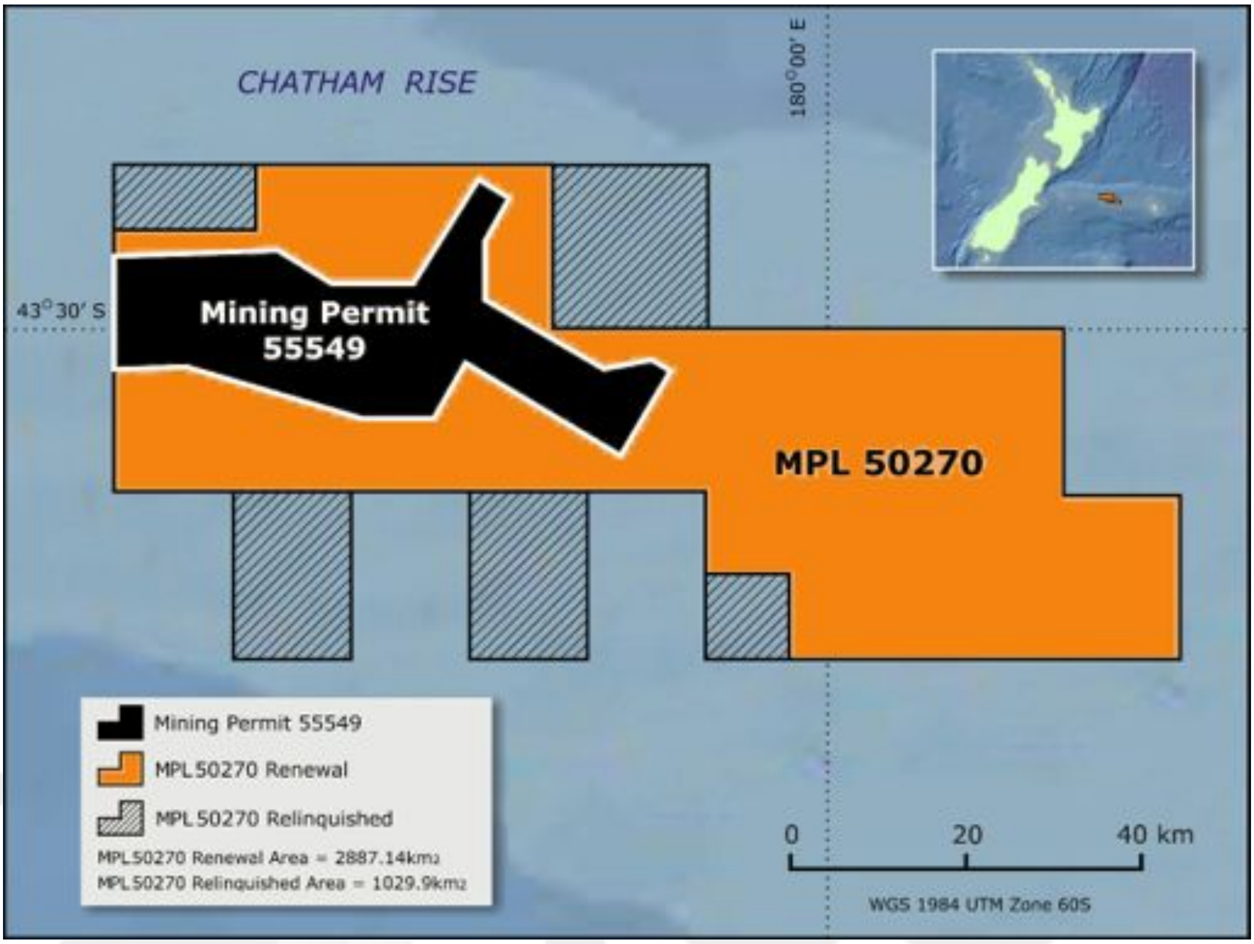

Figure 2: MPL 50270 licence extension.

Continental Shelf Act 1964 and Crown Minerals Act 1991

The Minerals Prospecting Licence (MPL 50270) was granted by the Minister of Economic Development under the Continental Shelf Act ("CS Act"). The CS Act, until its recent amendment, established the legislative framework for the exploration and exploitation of the Exclusive Economic Zone ("EEZ") and New Zealand's Continental Shelf and its natural resources, including minerals. Under the CS Act, a licence was required before any "person" could prospect, mine, or carry out any operations associated with the recovery of minerals from the "seabed or subsoil of the continental shelf" (Section 5.1 of the Act). The MPL 50270 licence came with environmental conditions that required the licence owner to comply with environmental guidelines published by the International Marine Minerals Society *Code of Environmental Management of Marine Mining* conduct environmental baseline studies and monitor and report effects of exploration activity on the environment.

The passing of the Crown Minerals Amendment Bill in April 2013 resulted in the transfer of minerals resource allocation considerations to the Crown Minerals Act. This means that prospecting, exploration and mining activities within the EEZ will now fall under the same legislative framework as that for similar activities on land.

The EEZ Act fills the legislative gaps that previously existed in terms of the lack of an environmental management framework for many activities taking place outside of the territorial sea (i.e., outside the 12 NM limit) but within New Zealand's EEZ and Continental Shelf.

3 Accessibility, Climate, Local Resources, Infrastructure and Physiography

The deposit lies on the crest of the Chatham Rise approximately 450 km offshore south-east of Wellington, New Zealand (Figure 1). Water depth in the area of main interest varies from 350 to 450 m.

Exploration operations are conducted by ocean-going vessel and there are no restrictions of access to the site. The site is outside major shipping lanes; however, public notices to mariners would have to be filed for any deployment of equipment, moorings, or operations that could affect shipping.

The site is between 43° and 44° South latitude and subject to the climate and weather patterns of the southern Pacific Ocean, but these are not anticipated to be extreme. Sea conditions were considered in the mining design studies that have been undertaken to date.

The Chatham Rise lies at the boundary between warm, saline subtropical waters to the north and cooler, less saline sub-Antarctic water to the south. The boundary is known as the Subtropical Convergence or Subtropical Front. Although the surface sea conditions can be harsh, these do not influence water movement at the water depths in the proposed Mining Permit area. Current measurements in the Mining Permit area indicate that seabed currents tend to be generally oriented towards the north-west, south-west and south-east.

Sea temperatures normally range between 8°C and 15°C. Therefore, vessel icing or sea ice is not expected to be a significant factor in the mining operation. Although icebergs have been observed historically in the area of the Project, they are rare as they originate in Antarctica over 2,000 km to the south. It is not anticipated that icebergs would represent a threat to the mining operation.

Boskalis have outlined general port requirements for the type of vessel that they have proposed for the mining and transporting of phosphorite for the Project. A key requirement is the ability to handle dry bulk goods and having a draft capability of 11 m (including access channels). Major ports close to the site for logistical support and potential future off-loading sites are located throughout the country (Figure 3, Table 6). Many of these ports are already handling bulk fertilisers. Potential ship-to-ship transfers could also occur in the sheltered areas of the Marlborough Sounds, near Picton.

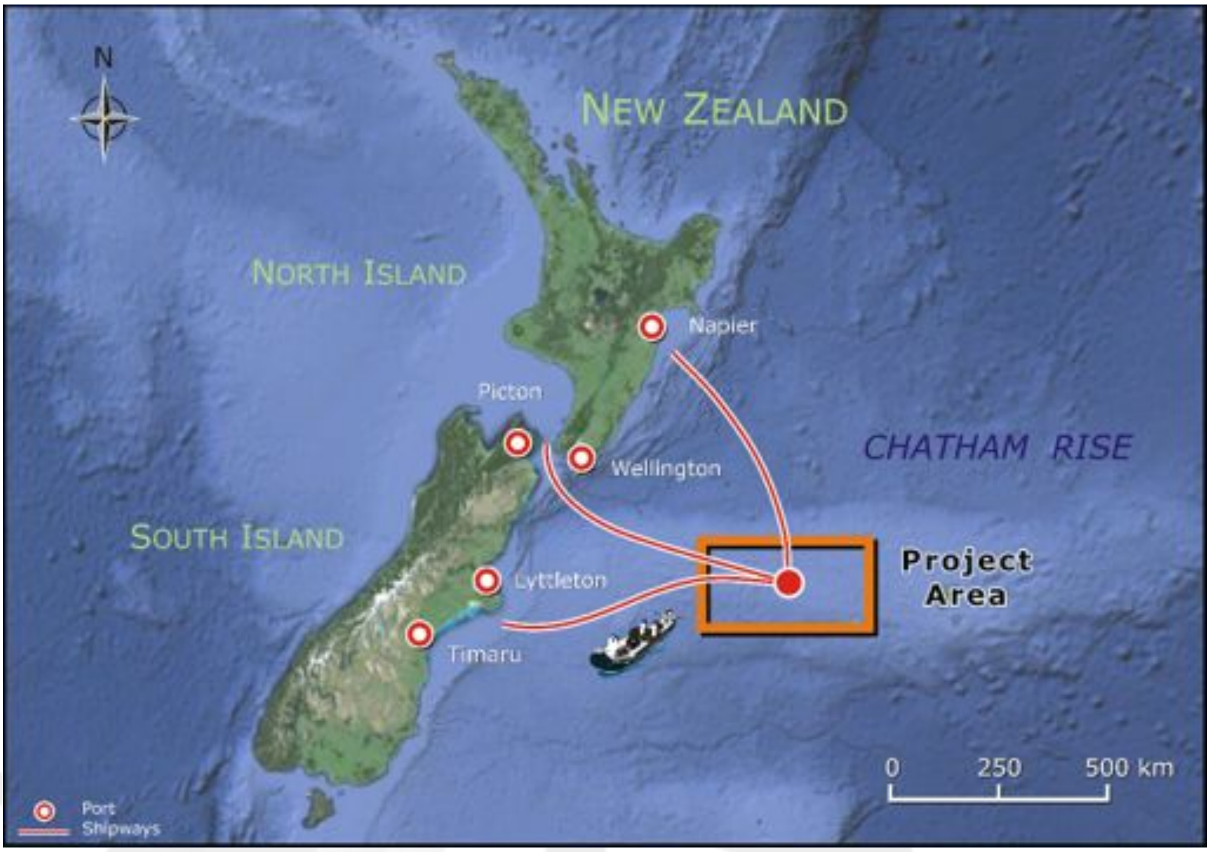

Figure 3: Project location and potential New Zealand ports.

All exploration and mining operations will have to be undertaken from vessels. The mining vessel will supply its own power requirements. Water for mining and processing (washing and sieving) will be sourced from the sea. Fine material (tailings) would be returned to the sea floor via a return pipe. The retained phosphorite would be stored within the ship's holds. It is anticipated that mining will be from a specialised deep water dredging/mining vessel. Material transport to shore will be by the mining vessel or by transport vessels loaded at the mine site.

The licence area is elongated east-west along the crest of the Chatham Rise. Figure 4 shows the bathymetry of the Project area.

Within the licence area, water depths increase from a minimum of 300 to over 600 m to the south and north. The area of primary interest is on the crest of the rise in water depths of 350 to 450 m, with a saddle depth of 390 m.

Within the detailed sampling areas there are sub-areas of pronounced micro-relief of up to 5 m height and roughly 50 m horizontal extent that are superimposed upon broader topographic variations of 20 m relief and 500 m to 1 km extent. Maximum seabed slopes seldom exceed 10° but some steeper scarps may be present.

Table 6: Potential New Zealand ports for offloading bulk phosphorite.

Port	Distance (km)	Max Draught (m)	Dredging required	Dry bulk handling facilities
Napier	556	12.2	no	yes
Wellington	592	11.6	no	no
Picton	682	15.3	no	yes
Lyttelton	660	13.1	no	yes
Timaru	780	11.5	no	yes

The surface sediments of the Chatham Rise are predominantly an unconsolidated mixture of greenish-grey muddy sands and sandy muds containing spatially-varying amounts of phosphorite grains and nodules. The nodules formed about 5 million years ago, and the surrounding sediment is the eroded remains of limestones and chalks which are 10 to 20 million years old. These overlay an older Oligocene chalk. In shallower parts of the Chatham Rise, away from the proposed mining area, outcrops of hard igneous or metamorphic basement rock occur.

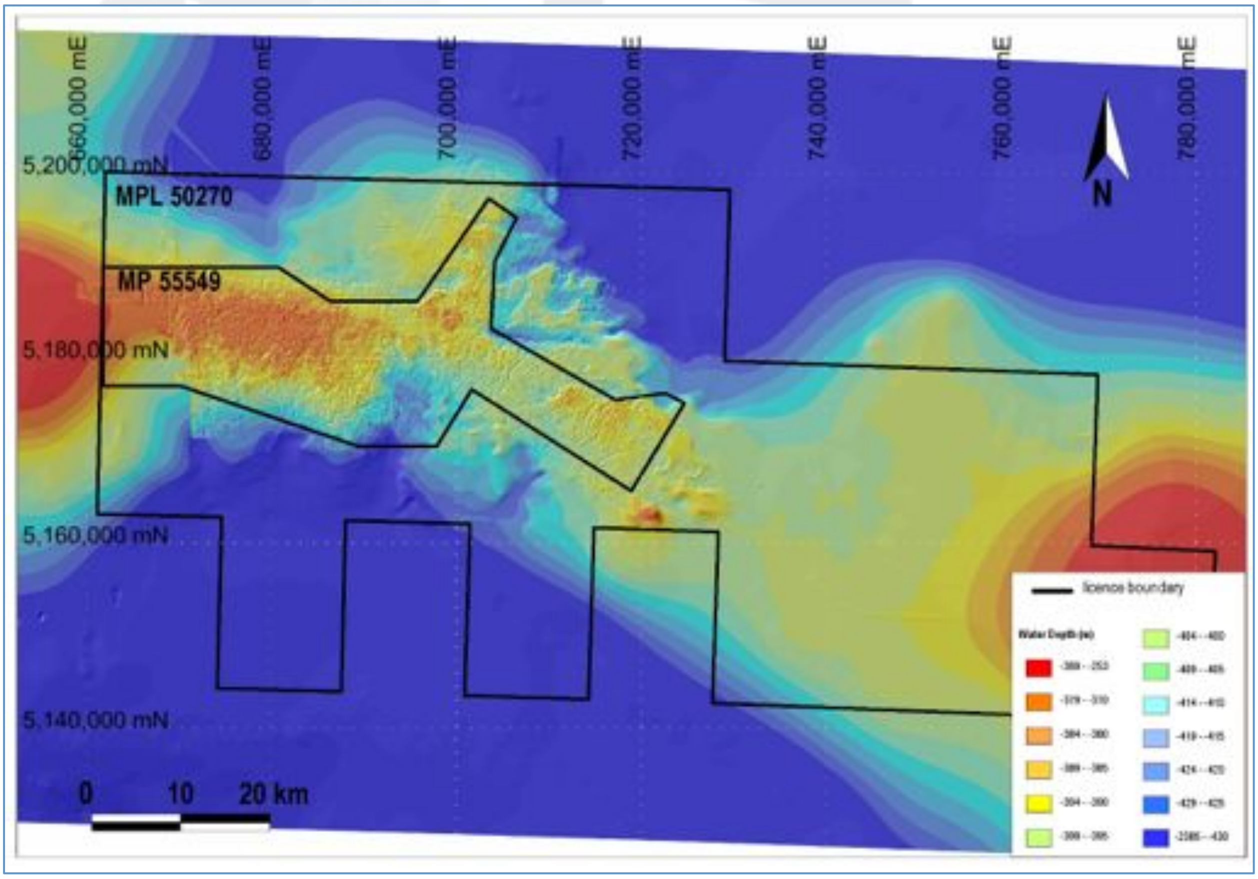

Figure 4: Bathymetry of the Chatham Phosphorite Project Area.

4 History of Ownership and Exploration

This section describes the history of exploration and previous resource estimates carried out on the Chatham Rock Phosphate Project. The work conducted on the Chatham Rise has been completed by a mixture of private and government funded organisations. All information pertaining to these exploration programmes, including detailed information on ownership, sampling, grade calculations, quality control and quality assurance, depth measuring, geophysical and other work is therefore described in this section.

4.1 Previous Ownership

Various programmes have been undertaken since the 1950s. These have been described in chronological order.

Initial reconnaissance surveys were conducted by the New Zealand Geological Survey in 1952 and later Global Marine Inc. in 1967–68. Global Marine Inc. held the first mineral prospecting licence (MPL) over the Chatham Rise extending over 100,000 km^2. These surveys undertook dredge sampling over much of the Chatham Rise, noting the presence/absence of phosphorite nodules, and helped to prioritise areas for later expeditions.

From 1971, JBL Exploration NZ Ltd. (JBL) held a prospecting licence covering a portion of the MPL previously held by Global Marine Inc. From 1975 – 1978 the New Zealand Oceanographic Institute ("NZOI") conducted a more localised survey to determine the distribution and thickness of phosphorite-bearing sediments over an area now covered by MP 55549.

Subsequent to this campaign a collaboration between the West German Government and the New Zealand Department of Scientific and Industrial Research ("DSIR") launched two extensive sampling surveys, one in 1978 utilising the *R.V. Valdivia,* and the second in 1981 utilising the *R.V. Sonne.* Together the two campaigns collected over 1,100 sediment samples, the vast majority from within the area presently encompassed by MPL 50270. Data from these cruises provides the most comprehensive data for phosphorite grade determination collected to date.

The New Zealand company Fletcher Challenge Ltd. was involved in the 1981 work and was granted a prospecting licence for further investigation of the phosphorite deposits, but no further data collection surveys were undertaken and the licence was allowed to lapse in 1984.

No mineral permits were issued over the Chatham Rise until MPL 50270 was granted to CRP in 2010.

4.2 Previous Exploration

4.2.1 *R.R.S. Discovery II* (1952)

Officers of the New Zealand Geological Survey discovered the occurrence of marine phosphorite deposits in sediments on the Chatham Rise in 1952 when mineralised material was dredged by the *R.R.S. Discovery II* from the sea floor approximately 130 km west of the Chatham Islands. RSC is not aware of any information being available from this cruise.

4.2.2 *M.V. Moray Rose* and *M.V.* Taranui (1967 - 1968)

Global Marine Inc. conducted an extensive exploration programme including reconnaissance sampling over much of the Chatham Rise from February – March 1967, followed by a detailed sampling survey of the area between 178°48’ E and 177°50’ W from February – March 1968 (Figure 5). In total 337 samples were collected with phosphorite nodules recovered in 137 samples in an area of ca. 18,500 km^2 (Ross, 1967; Global Marine Inc., 1968). The primary purpose of this investigation was to identify the extent of phosphorite on the Chatham Rise and to determine its origin (Pasho, 1976). The *M.V. Moray Rose* conducted the first phase of sampling, while the larger *M.V. Taranui* was utilised during the second stage. Both ships used celestial navigation to position themselves on pre-determined sample locations (Global Marine Inc., 1968).

4.2.2.1 Sampling Method

Sampling was conducted using a custom built pipe dredge with a diameter of 45 cm. The length of the pipe has not been recorded, but estimating from faded photographs of sampling aboard the *M.V. Taranui* (Global Marine Inc., 1968) the pipe was approximately 1.5 m long. Upon reaching a sampling station, the ship’s engines were stopped and the pipe dredge lowered to the bottom at a moderate rate to prevent fouling of the 1.27 cm (1/2 inch) gauge wire line. The pipe dredge was then towed behind the slow moving vessel in the case of the *M.V. Moray Rose*, and dragged behind the drifting vessel in the case of the *M.V. Taranui*; this change in procedure was due to the increased level of work involved in stopping and starting the larger vessel. In both cases the pipe dredge was dragged along the bottom until it was full (noticed by increased strain on the line), at which point it was retrieved (Global Marine Inc., 1968). Once on board the pipe was upended and its contents dumped on the deck of the ship. A subsample was taken (the method of subsampling is not recorded) and the remainder of the material was washed overboard using a fire hose (Global Marine Inc., 1968).

Sample collection occurred at regular 4 mile (6.44 km) intervals along north-south trending lines spaced 5 miles (8.05 km) apart. Samples collected by Global Marine Inc. are considered low quality due to the pipe dredge sampling apparatus penetration depths, the inaccuracies inherent in using celestial navigation to determine sample locations, and the limited detail recorded in documentation of the data collected.

Celestial navigation was used to position each ship at the predetermined sample locations (Global Marine Inc., 1968). The accuracy of this method of navigation depends entirely on the skill of the navigator and the quality of the instruments used and at best is thought to have an accuracy of 3-4 nautical miles (5.5 – 7.4 km) (Wood *et al*., 2003).

While the accuracy and quality of the samples is considered low, the samples were an important first step in identifying phosphorite potential on the Chatham Rise, and its results were critical in guiding later surveys.

RSC considers the Global Marine data to not be representative for resource grade estimation as the error on the location of samples is excessive and the sampling is of poor quality.

4.2.2.2 Sample Preparation and Analysis

Raw data for the Global Marine samples is presented in Ross (1967). All of the 331 samples were briefly geologically described at the time of collection. A total of 41 samples were sieved into 3 size fractions (< 0.152 mm, 0.152 – 2.38 mm and >2.38 mm) and the main constituents of each fraction noted. A further six samples were sieved into 12 size fractions (<0.152 mm, 0.152 – 0.211 mm, 0.211 – 0.297 mm, 0.297 – 0.599 mm, 0.599 – 1.20 mm, 1.20 – 2.38 mm, 2.38 – 4.763 mm, 4.763 - 9.525 mm, 9.525 – 19.05 mm, 19.05 – 38.1 mm, 38.1 – 76.2 mm and >76.2 mm). All size fractions from these samples were analysed for P_2O_5, $CaCO_3$ and K content. Assay equipment and method has not been recorded for the samples, but analyses were variably conducted at Smith-Emery Laboratory, Los Angeles, and an unknown New Zealand laboratory. In addition, 35 bulk sediment samples were assayed for their P_2O_5 content using XRD equipment at Raymond G Osborne Laboratories, Los Angeles. A discrepancy between laboratory analyses is reported by Ross (1967); it is not clear whether this was resolved, the author only indicating that the discrepancy meant that some of the assays may have been higher than reported.

In addition to the Global Marine analyses, phosphorite nodules from the Global Marine cruises were investigated by Pasho (1976). Pasho analysed nodules from 51 samples for their P_2O_5 content, using splits of crushed whole nodule cross-sections or in some cases a specific region of a nodule interior. The analytical samples were ground to minus 0.125 mm and oven dried for 24 hours at 110ºC, then fused with La_20_3 and $Li_2B_40_7$ and pressed into sample wafers. Analyses were performed on a Norelco X-ray fluorescence unit (Pasho, 1976).

As well as XRF analysis, Pasho (1976) used modal analysis of 43 thin sections from 40 nodules to determine the composition and abundance of the nodule constituents. An unspecified number of polished sections were etched with formic acid to distinguish phosphatic material from carbonate. Finally, the mineralogy of the contained clastics in the nodules was determined by performing a grain count on the residue of an unspecified number of nodules digested in HCl. Grain size distributions were determined by point counting grains within sieve intervals (sieve sizes not reported) (Pasho, 1976).

4.2.2.3 Density and Moisture Content

No density or moisture content data is reported by Global Marine. Pasho (1976) reports from collected nodule data that phosphorite nodule densities vary from 2.4 - 3.0 g/cm^3 with a negative correlation between nodule size and density.

4.2.2.4 QA/QC

RSC can find no evidence of any QA/QC procedures being implemented during collection of the Global Marine samples. No data survives that outlines the technique that was used to subsample the pipe dredge samples or which might constrain how representative these samples were. The deck of the ship that was used for processing sample material is described as having been washed down with a fire hose in between sampling (Global Marine Inc., 1968) which ought to have minimised cross-contamination between samples. As far as the author is aware no field duplicates were collected; sample 46A is reportedly the same as sample 46 according to the sample description, but the latitudes recorded for each sample indicate the samples were not collected at the same location (Ross, 1967). Pasho (1976) describes how “duplicates of all samples” were provided by Global Marine for assessment purposes, but there is no record of when, where or how these were collected or separated out from the original sample material. Pasho also does not mention inclusion of certified reference materials for the laboratory analysis for P_2O_5 content.

4.2.2.5 Logging

A geological description of each sample was recorded at the time of collection. Though not reported in detail these descriptions included observations of the presence/absence of phosphorite nodules, lithological affinity (i.e. indurated limestone), texture (borings, encrustations), grain shape, size and colour; brief descriptions and general grain size ranges are reported in the literature (Global Marine Inc., 1968).

4.2.2.6 Estimation of Phosphorite Grade (Ph kg/m^3) in Samples

RSC has estimated phosphorite grade from the samples by multiplying the reported volume percentages of phosphorite for each sample by an assumed average density of phosphorite nodules of 2.72 g/cm^3 (based on the most recent density data collected by CRP, Section 9.2.2). This yielded phosphorite grades ranging up to 2720 kg/m^3 (100% phosphorite) with an average grade of 210.0 kg/m^3.

The average P_2O_5 content of the 35 bulk (i.e. including the fine <1 mm fraction material) sediment samples submitted to Raymond G Osborne Laboratories, Los Angeles is 4.7% P_2O_5 (Ross, 1967). Analysis of phosphorite nodule material isolated from 51 Global Marine sediment samples yielded an average P_2O_5 content of 20.5% (Pasho, 1976).

RSC notes that due to the nature of the pipe dredge sampling apparatus and technique, representative phosphorite grade estimations cannot be made from the Global Marine Inc. sampling data. While Pasho (1976) states that the pipe dredge was of sufficient diameter to prevent grain size bias during sample collection, accurate constraints on sampling area cannot be applied as the pipe was retrieved only when full, whatever time or distance that took to occur. This information was not recorded. Additionally, Global Marine and subsequent workers inferred that the pipe dredge was only capable of sampling the top "few inches" of sediment (Ross, 1967) and this is considered insufficient penetration to be representative of a resource that is vertically variable and has a thickness averaging approximately 22 cm. Numerous Global Marine samples were analysed for their phosphorite content and the data used to prioritise areas for subsequent exploration. The data is not of sufficient quality to be included in phosphorite resource grade calculations.

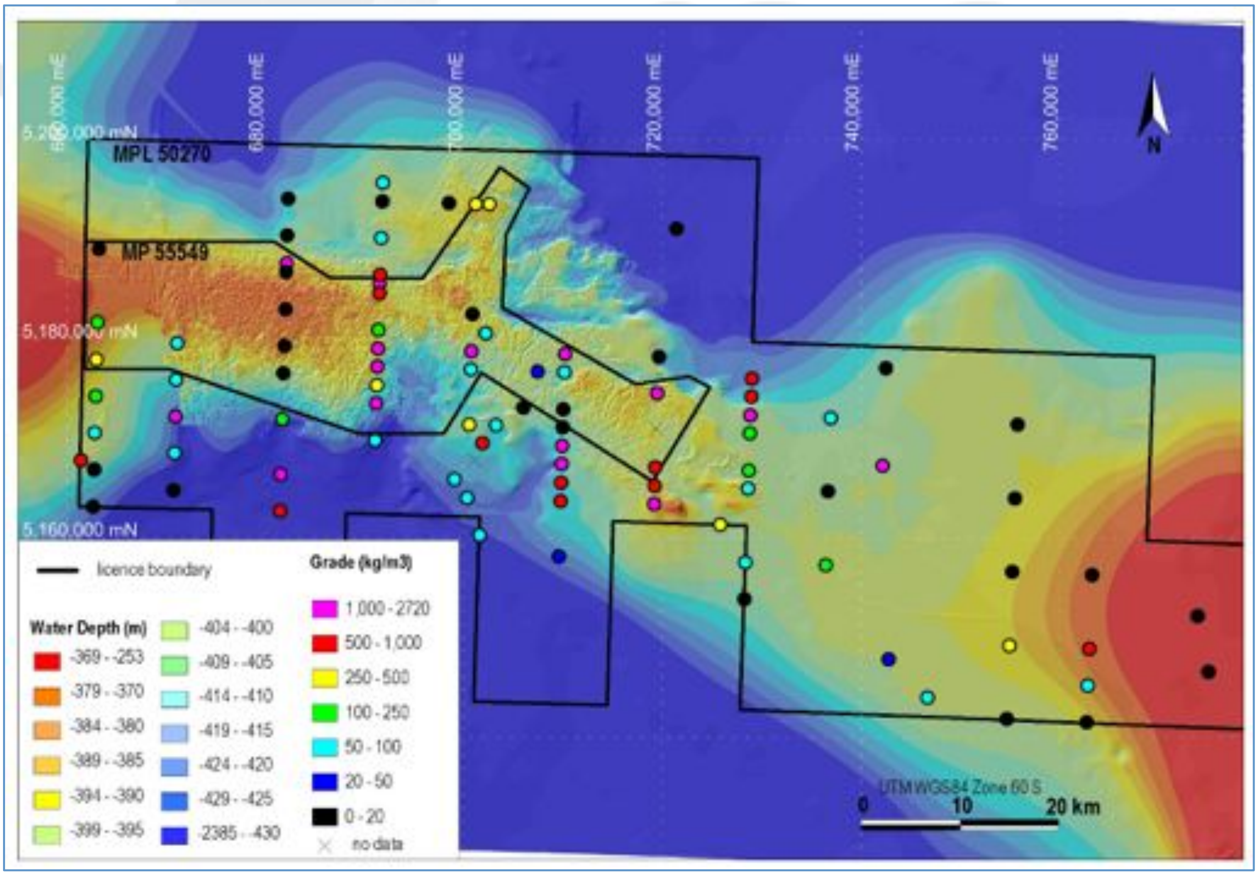

Figure 5: Global Marine sample locations within MPL 50270 and updated phosphorite grade (Ph kg/m^3) from unvalidated Global Marine phosphorite percent data.

4.2.3 JBL Exploration NZ Ltd. (1971 - 1975)

From 1971, JBL Exploration NZ Ltd. ("JBL") held a prospecting licence covering a portion of the MPL previously held by Global Marine Inc. and proposed to undertake a detailed exploration programme. Over the next few years JBL produced reports outlining resource estimates, economic potential and mining feasibility studies but did not provide any further sampling surveys over their licence area. All work was completed prior to introduction of proper international reporting codes, and is not compliant with the JORC Code (JORC 2012).

4.2.4 *R.V. Tangaroa* (1975 – 1978)

Between 1975 and 1978, the New Zealand Oceanographic Institute ("NZOI") carried out four major site investigation cruises with *R.V. Tangaroa*. The cruises predominantly undertook seabed photography and seabed sampling in the area of the Chatham Rise. Results of the cruises have been reported in Cullen (1978). In an attempt to trace the extent of the sub-surface phosphorite-bearing sediments and to gauge the thickness of the deposit, cores were collected from 53 stations on the central Chatham Rise; they comprised 21 piston cores, 4 gravity cores and 28 box cores. Piston core were collected initially using a 5.5 m long, 76 mm diameter barrel, with 340 kg of lead weights, then a 1.8 m barrel with 681 kg of lead weight in an attempt to better penetrate phosphorite-bearing sediments; penetration depth of the piston cores ranged from 0.32 to 4.67 m. The gravity corer, with a 0.6 m long barrel and internal diameter of 76 mm, was weighted with 91 kg of lead but never exceeded 0.25 m penetration depth. Box cores were collected using a Friedrech Leutert designed corer with internal dimensions of 0.225 m (width) x 0.295 m (length) x 0.47 m (height) and effective height of 0.3 m. Maximum penetration obtained was 0.22 m and reported phosphorite weight percent data from the box cores ranges from 0.9% to 69.9%, with an average of 19.6% (Cullen, 1978) (Figure 6).

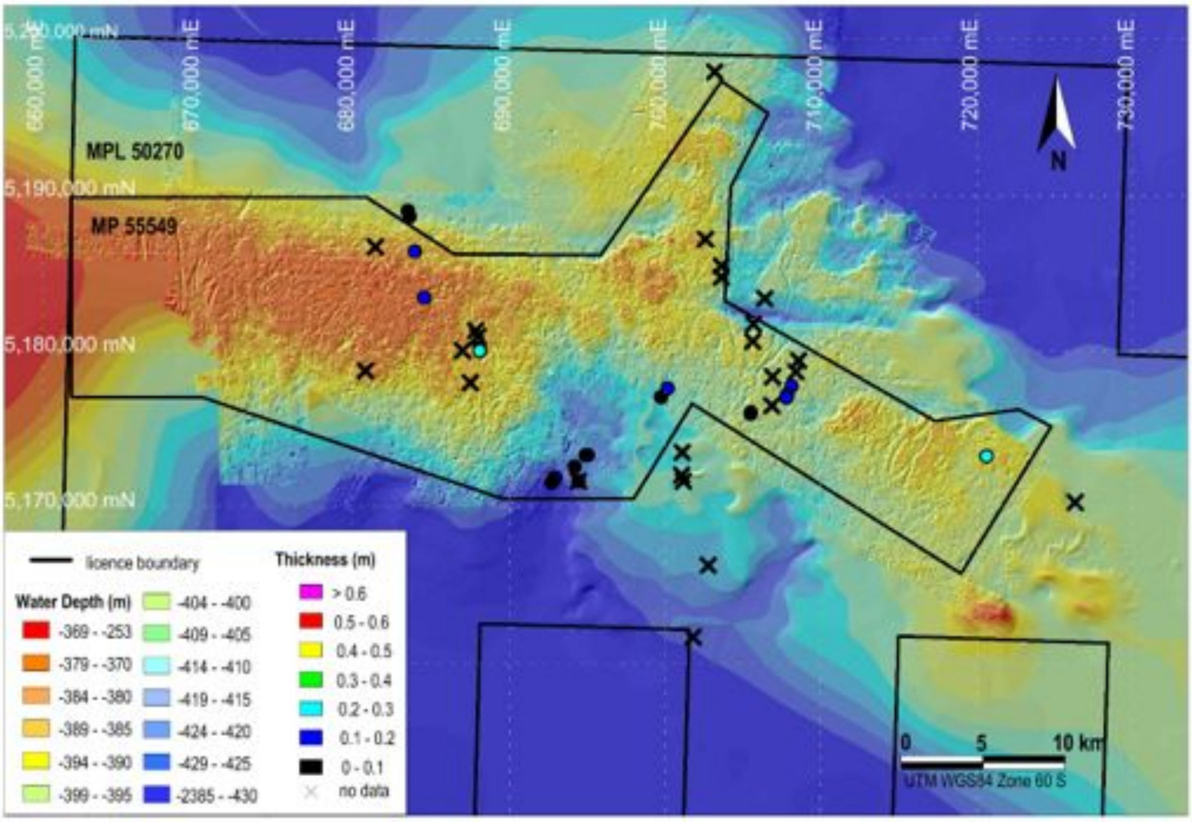

Figure 6: *Tangaroa* sample locations showing reported penetration depths of samples.

The *Tangaroa* sample locations were determined using satellite navigation. Estimated accuracy of this method as used in the 1970s is approximately 0.25 – 0.5 nautical miles (0.5 to 0.9 km) (Wood *et al*., 2003). From the data presented in Cullen (1978) it is apparent that piston cores were geologically logged using standard logging sheets; published data includes brief geological descriptions accompanied by percentage estimates and/or graphic logs of sand occurrence and the presence/absence of component minerals. Box core samples were analysed for their grain size distributions and phosphorite content. No information has been reported on how the phosphorite estimation was conducted.

The only available information pertaining to the sampling was from Cullen (1978). No information detailing sampling procedures or the raw data collected was available. Multiplying reported weight percentages of phosphorite for the *Tangaroa* samples by the average density of phosphorite nodules (taken as 2.72 g/cm^3 based on the most recent density data collected by CRP, Section 9.2.2) yields phosphorite grades ranging up to 1901 kg/m^3 and averaging 532.4 kg/m^3 (Figure 7). RSC notes these grades are considered to be not representative as there is insufficient data to reliably calculate phosphorite grade and the sample data is unable to be verified; RSC has reduced the SQR ranking on data collected from the Tangaroa to a level outside the ranking levels that are included in the resource estimation.

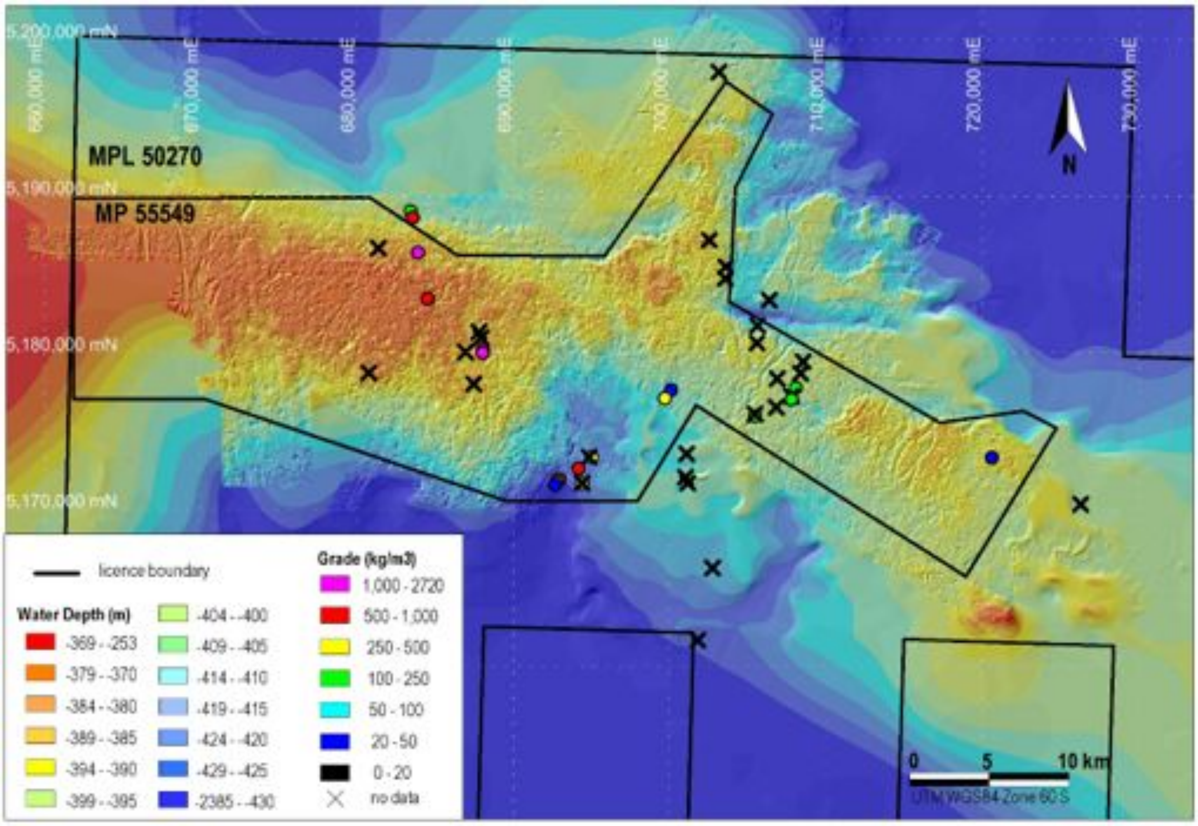

Figure 7: *Tangaroa* sample locations within MPL 50270 and updated phosphorite grade (Ph kg/m^3).

4.2.5 *R.V. Valdivia* (1978)

West German industrial organisations including Preussag AG, Metallgesellschaft and Saltzgitter ASG became interested in the results of the early work and results from the NZOI cruises. Through a government agreement between New Zealand and Germany on scientific and technological cooperation, the New Zealand Department of Scientific and Industrial Research ("DSIR") and the West German government collaborated on cruises by the German research vessels *R.V. Valdivia* in 1978 and *R.V. Sonne* in 1981.

The 1978 *R.V.* Valdivia was the first intensive sampling and research campaign to be conducted over the Chatham Rise. The campaign was conducted in two stages during October and November 1978. Results from previous surveys had helped in selecting the most promising area for this survey, between 179°00' E and 179°40' E on the crest of the Chatham Rise. In total 655 samples from 689 attempts were collected over a 300 km^2 area.

4.2.5.1 Sample Locations

Sample locations were determined using a combination of satellite navigation ("SATNAV") with an integrated Doppler sonar system, and a network of underwater acoustic transponders ("ATNAV"). Eight transponders were deployed in the east of the sampling area and three transponders were deployed in the west. The ATNAV system was used to determine the location of 647 samples, with the location of the remaining samples determined solely using SATNAV (Kudrass & Cullen, 1982). As the transponders were located using SATNAV the overall accuracy of sample locations is estimated to be within 0.25 – 0.5 nautical miles (0.5 - 0.9 km) (Stewart & Black, 2013; Wood *et al*., 2003), however the precision of applicable sample locations relative to each other is increased by the use of the transponder network reducing the error associated with relative sample locations to approximately 5 – 10 m (Kudrass & Cullen, 1982).

Most grab samples were taken while the ship was drifting, which resulted in an irregular pattern of sampling, but allowed an increased number of samples to be taken. Wire lengths to the grabs were less than ten metres longer than the water depths so the positions of the samples are approximately equivalent to the ship's position.

Even though best practice positioning available at that time was used, RSC notes the relative inaccuracy of the sample positions. Sampling from a drifting boat has meant the sample spacing was at times erratic and has resulted in clustering issues. Generally the sample spacing is on the order of 250 to 500 m, but increases up to 1 to 2 km.

4.2.5.2 Sampling Methods

The majority of the samples were collected using a large Van Veen-style grab of 0.12 m^3 volume, weighing approximately 400 kg, and having a sampling area of approximately 66 cm x 66 cm (Figure 8). Other methods of collecting sediment samples were trialled, including: a smaller Van Veen grab with a sampling area of approximately 45 cm x 45 cm, a box grab sampler, a 3 m piston corer equipped with a pilot corer, a box core sampler and chain bag dredge (Table 7). The main issues with these methods were poor sample penetration and sample recovery. The large Van Veen-style grab had its shortcomings, including lower penetration power into nodule-rich sediment and insufficient jaw closing power resulting in large nodules occasionally getting caught between the jaws, preventing complete closure of the grab and causing sediment loss. However, despite these shortcomings, it was regarded as the best of the sampling systems available on the market at the time (Hermann Kudrass, *Pers. Comm.*), and was utilised up until it was lost overboard trying to collect sample 578. From this point on the smaller Van Veen grab sampler was used.

Sampling using both the large Van Veen-style grab and smaller Van Veen grab sampler involved lowering it to the sea floor and on contact with the sediment, the slackening of the cable disengaged the mechanism holding the grab jaws open. Recalling the cable would raise the outer arms of the jaws, pulling them closed before retrieving the grab to the ship (Figure 9). This process relies on the weight of the grab both to penetrate the sediment and to force the jaws to close. Weights were added to the grab during the programme to improve penetration of the sand (Hermann Kudrass, *Pers. Comm.*), however, RSC is unaware of when during the sampling programme the weights were added and which samples were affected. Flaps at the top of the large grab prevented the development of a bow wave as the grab was lowered and protected the sample from being washed out as it was retrieved.

Figure 8: Large grab sampler (left) and smaller Van Veen grab sampler (right) used to collect sediment samples aboard the *R.V. Valdivia.*

Table 7: Summary of sampling conducted aboard the *R.V. Valdivia* (compiled from *R.V. Valdivia* raw data).

Sampling Method	No. of Attempts	No. Successful	No. Empty*	No. Washed Out	No. Failed
Large Van Veen-style grab	561	495	8	32	26
Small Van Veen grab	110	105	0	4	1
Box grab	8	8			
Box corer	2				2
Piston Corer	6	3			3
Chain bag dredge	2				2
TOTAL	**689**	**611**	**8**	**36**	**34**

*samples coming up empty despite no apparent equipment malfunction (assigned a phosphorite grade of 0 kg/m^3.)

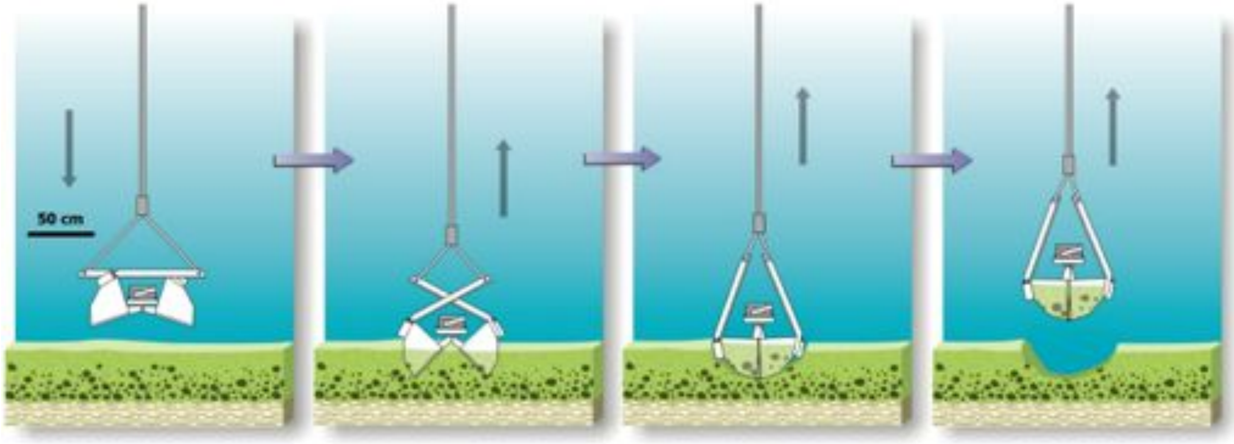

Figure 9: Large Van Veen-style sampling method.

RSC notes that the majority of samples were unable to penetrate the full depth of the sand and therefore do not provide a representative sample of the entire mineralised profile. In contrast to other cruises (Section 4.2.6) it is unknown whether the samples underwent any lateral compression during closure of the grab. RSC has not made any adjustments to penetration data and has assumed that the recorded thickness of sand in the grab reflects the true thickness of sediment that was sampled. However, the sample is slightly biased toward the collection of surface sediments due to the semi-circular cross-section of sediment a Van Veen-style grab collects. RSC has taken these and other issues into consideration when assigning SQR values to the *Valdivia* samples.

4.2.5.3 Sample Preparation and Analysis

Upon reaching the ship deck the grab samples were briefly described. The penetration depth was measured for all successful samples by accessing the samples through the top of the grab and using a ruler to measure the distance from the top of the sediment to the top of the grab and subtracting this from the height of the grab. The volume of samples was measured by transferring them into calibrated bins. The vast majority of samples were then sieved in their entirety; however, 37 grab samples had only large (20 – 80 litres) subsamples of their sediment sieved. How these subsamples were extracted from the grab samples is not recorded.

Sampled sediment was washed through a 1 mm screen. The >1 mm fraction volume was measured using the water displacement method in graduated cylinders (Hermann Kudrass, *Pers. Comm.*), and its phosphorite concentration estimated as a phosphorite volume percent (Kudrass & Cullen, 1982). These values are reported to have been measured; however, there is some error in the relationship between penetration thickness and volume (Figure 10). The spread of the data suggests that one or other of the parameters may have been estimated in a number of samples, although volume estimates below the general trend of the curve may indicate sediment loss during sample handling and recovery from the grab. Water-rich sediments may have been washed out as they were retrieved from the grab for measuring, resulting in a decrease in volume. Conversely, disturbance of tightly packed sediments during measuring would have resulted in an increase in volume due to loosening of the sediment causing an increase in the spacing between grains. The limited information recorded on the raw data sheets makes it difficult to determine the cause for the variation seen in the sample measurements, but RSC notes it as a factor impacting on the SQR ranking of the sample, with large variance resulting in a lower rank.

Dried nodules from 330 of the grab samples were sieved into <2 mm, 2–4 mm, 4–8 mm, 8–16 mm, 16–32 mm and >32 mm fractions. For three bulk samples, these fractions were also split, crushed and sent for bulk chemical analysis using XRF (Kudrass & Cullen, 1982). The method used to split the samples is not recorded.

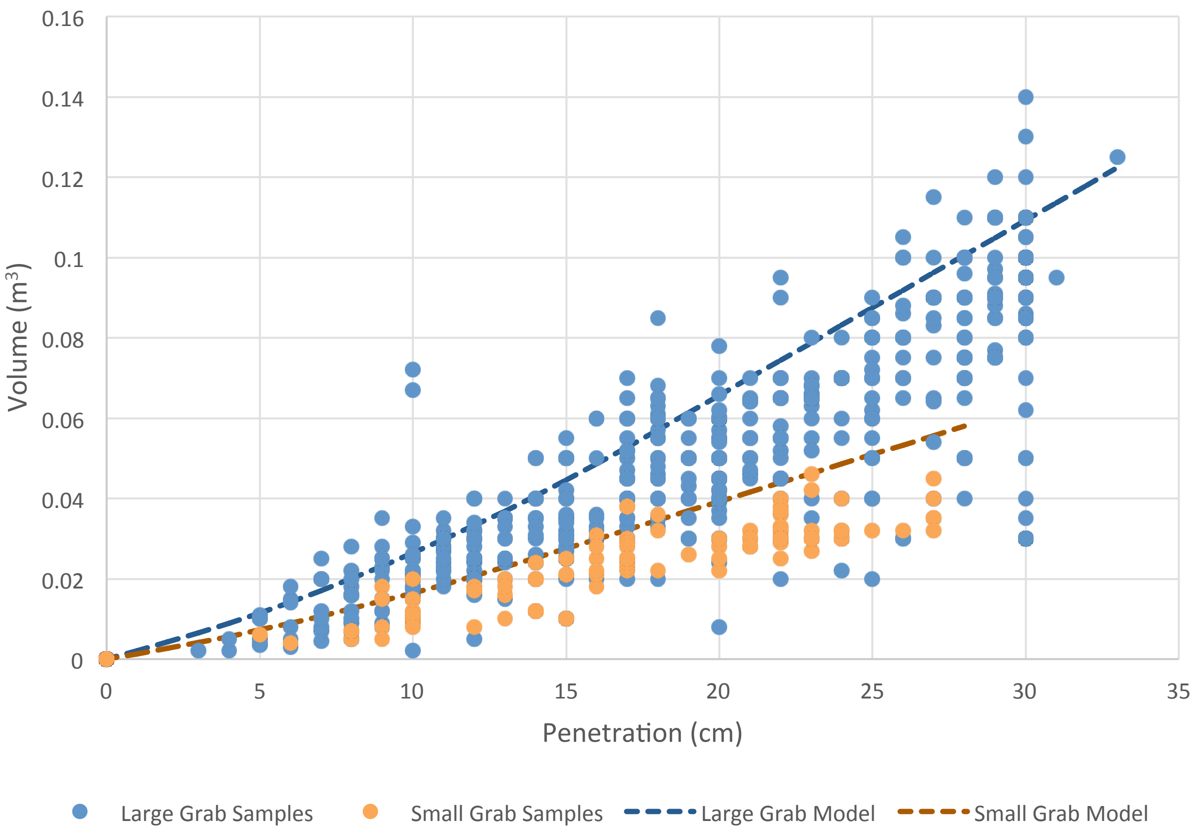

Figure 10: Reported penetration depth of sediment versus reported volume of sediment in *R.V. Valdivia* grab samples, compared to modelled theoretical bucket volumes-depth relationship (dotted lines).

4.2.5.4 Density and Moisture content

Density and moisture contents were determined both for the total sediment as well as for the phosphorite concentrate.

Density tests on the sediment were conducted on five subsamples of bulk sediment from the *R.V. Valdivia* cruise. The bulk sediment samples ranged from 1.2 to 2.8 kg (wet weight), yielding a range in wet density of 1.62 to 2.06 g/cm^3, and an average density of 1.92 g/cm^3. Two of the samples were further measured for their dry weight, yielding dry densities of 1.45 and 1.53 g/cm^3. Moisture content ranged from 24.7 to 29% for the bulk sediment samples.

Density tests on the phosphorite concentrate were carried out on six grab samples and one chain bag dredge sample which were subsampled for nodules representing a range of different grain sizes. Volume and wet weights were measured in order to calculate their wet density. Four of the samples were further measured for their dry weight and their dry density calculated. The nodule samples ranged from 0.76 to 37.9 kg (wet weight), had a range in wet density of 2.53 to 2.81 g/cm^3, and an average wet density of 2.67 g/cm^3. The four samples processed for dry density had a range of 2.52 to 2.73 g/cm^3 and an average dry density of 2.64 g/cm^3. Moisture content ranged from 1.8 to 5.9% for the phosphorite nodules.

RSC is unable to verify the density sampling procedure, the depth of samples within the sediment column, or the volume and weight measurement methods used to determine the above densities and moisture contents. The limited number of samples also makes it impossible to draw reliable conclusions about the uniformity/variability of the density of the Chatham Rise phosphorite resource. Overall sand density is strongly affected by phosphorite content so it is important to collect a range of samples to understand the variability of the sand density.

4.2.5.5 QA/QC

No known quality control measures were applied during the *Valdivia* sampling. Some sampling procedures are documented in research papers in summary format. After investigation of the various available reports and comments, RSC concludes that sampling procedures were more or less adjusted as new information came to the attention of the sampling crews. Some noted procedures include:

- sample data was recorded onto standard logs and signed off;
- samples were classified as unsuccessful if equipment failed or if significant sample loss was noted during logging of the sample (by observation); and
- geological descriptions were recorded using a prescribed set of logging codes.

4.2.5.6 Logging

Upon retrieval, samples were briefly geologically described using a prescribed set of logging codes, then grab and box core samples had their volume and/or penetration depths measured. Penetration depth and/or core length were recorded for piston cores.

4.2.5.7 Estimation of Phosphorite Grades (Ph kg/m^3) in samples

Available data for the *Valdivia* cruise includes the proportion of the total sample that was put through the sieve ("the sieved sample volume"). For 37 samples, a sub-split was processed and therefore for those samples the *sieved sample volume* is not the same as *total sample volume*. For all other samples the entire sample was sieved and therefore the *sieved sample volume* is the same as *total sample volume*. Available data also includes the volume of the >1 mm fraction and the visually estimated percentage of phosphorite within the >1 mm fraction (i.e. these concentrates could still contain large shell fragments etc.). This applies to all successful grab and box core samples.

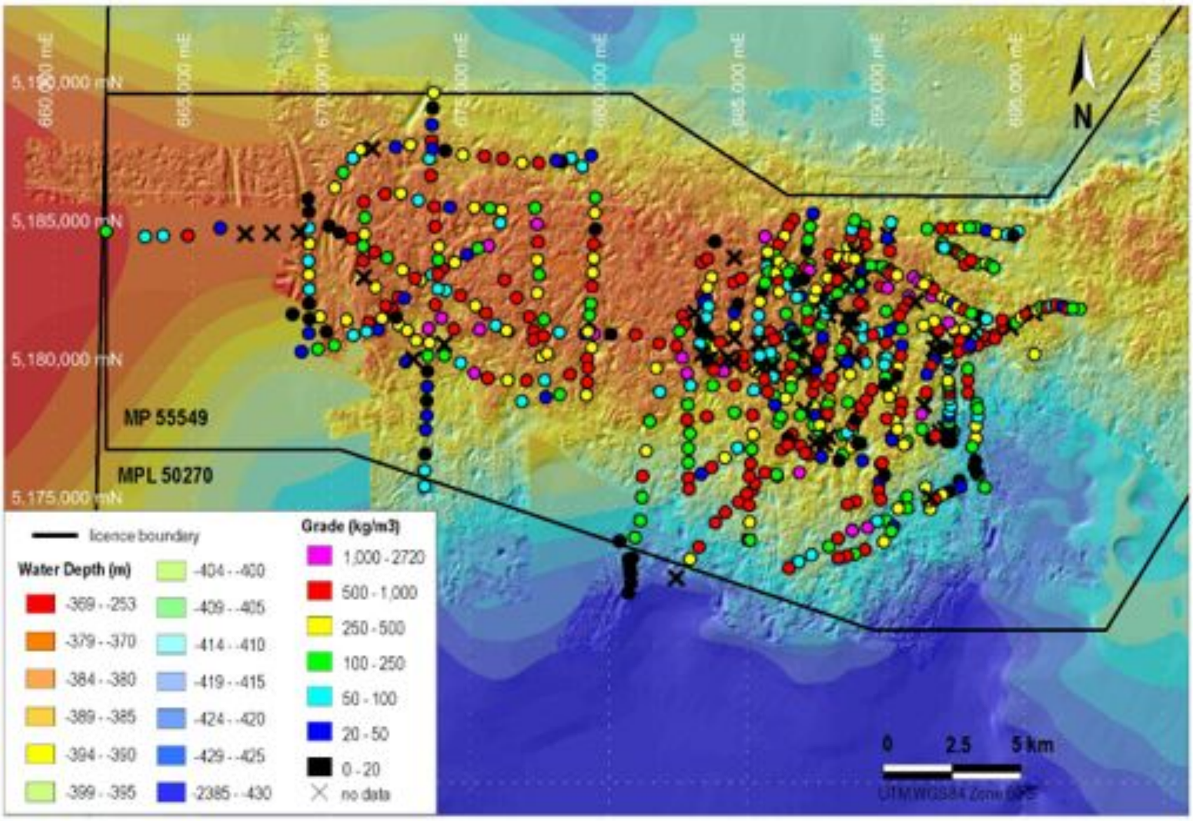

Figure 11: *R.V. Valdivia* sample locations within MPL 50270 and updated phosphorite grade (Ph kg/m^3).

Phosphorite volume percent was calculated by first multiplying the estimated percentage of phosphorite within the >1 mm fraction by the volume of this fraction which yielded the volume of phosphorite in the >1 mm fraction (i.e. excluding shell fragments, etc.). This volume was then divided by the sieved sample volume to give phosphorite volume percent for the sieved sample. Phosphorite grade is then determined by multiplying the calculated phosphorite volume percent by the average density of phosphorite nodules (taken as 2.72 g/cm^3 based on the most recent density data collected by CRP, Section 9.2.2).

Phosphorite grade can be determined for 623 of the 689 attempted *R.V. Valdivia* samples for which sediment was recovered. Calculated grades range up to 2,380 kg/m^3 and average 367.0 kg/m^3 (Figure 11). Phosphorite coverage can then be determined by multiplying grade by the thickness of sand in the sample (this is equal to the penetration depth for the majority of samples); however, where geological descriptions included sand thicknesses these values were used. It is important to note that for the purpose of the calculations, the penetration thickness and/or sand thickness recorded for each sample is assumed to be equal to the true sample/sand depth of the samples, as it is unknown whether grab samples underwent any lateral compression during closure of the grab. Thickness of sand in the *Valdivia* samples varies from 2 to 33 cm for the grab samples and from 12 to 37 cm for the box core samples. Combined, these yield an average sampled sand thickness of 18 cm (Figure 12). Using this parameter the *R.V. Valdivia* samples have a coverage range up to 285.6 kg/m^2, with an average coverage of 54.4 kg/m^2.

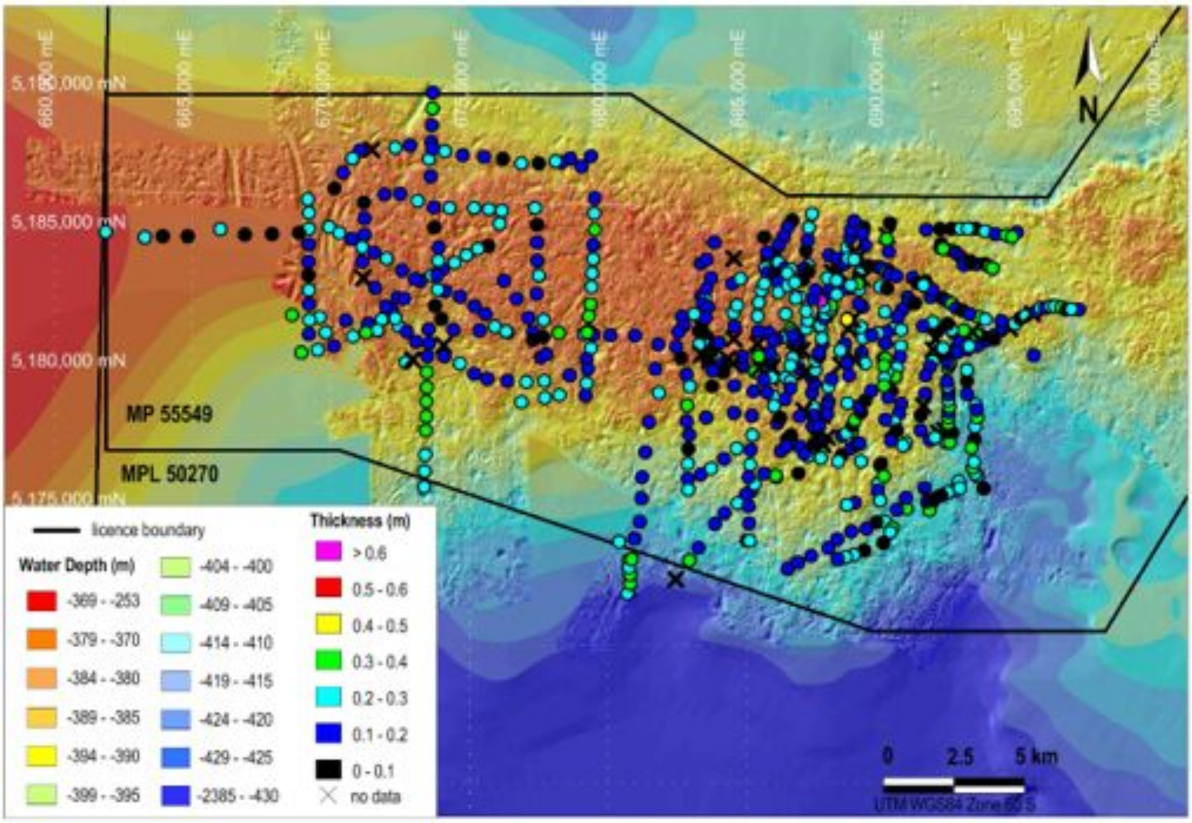

Figure 12: *R.V. Valdivia* true depth sample map (showing samples within MPL 50270).

In summary, RSC notes a number of concerns with the sampling process and grade estimations used on the *R.V. Valdivia* due to the sampling system used and measurement assumptions, in particular:

- large positional error due to SATNAV survey methods available at the time and no physical reference points in the ocean;
- sampling while drifting has created a non-uniform clustered dataset;
- the Van Veen-style sampler was mechanically controlled and lacked the ability to penetrate into nodule–rich sediment;
- weights were added on the grab to assist with penetration, but the weights were not recorded on the sample sheets when or how much additional weight was used;
- nodules could get caught in the Van Veen jaws resulting in the sample being partially or completely washed out, leading to sample bias;
- the Van Veen grab size (in terms of sampled area and volume) is small for the thickness and style of deposit being sampled;
- penetration depths were taken as an observed measurement of the distance between the top of the sediment and the top of the grab and are prone to human error and inconsistency between people taking the measurements for different samples;
- the precise dimensions of the grab samplers used are not known; RSC has estimated dimensions based on reported grab sampling area and photographs of the grabs used, as well as known volumetric capacity in the case of the large grab sampler;
- thirty-seven samples were split before being washed through the sieve and the method of subsampling in these instances is not documented in the literature or noted clearly on the sample sheets;
- the methods of sample processing including measuring volume, subsampling and sieving are not recorded on the available data sheets; and
- RSC has assumed that the Van Veen-style grab samplers did not compress samples as they closed and that the penetration depth recorded from the grab is equal to the true sample depth.

In addition, historic analysis of the *Valdivia* phosphorite volume percentages showed a trend toward smaller volume samples having higher phosphorite content, and this is reflected in the calculated phosphorite grades (Figure 13 and Figure 14). This was determined at the time to be a reflection of the poor penetration power of the grab samplers in phosphorite rich sediment, highlighting a bias in the sampling method.

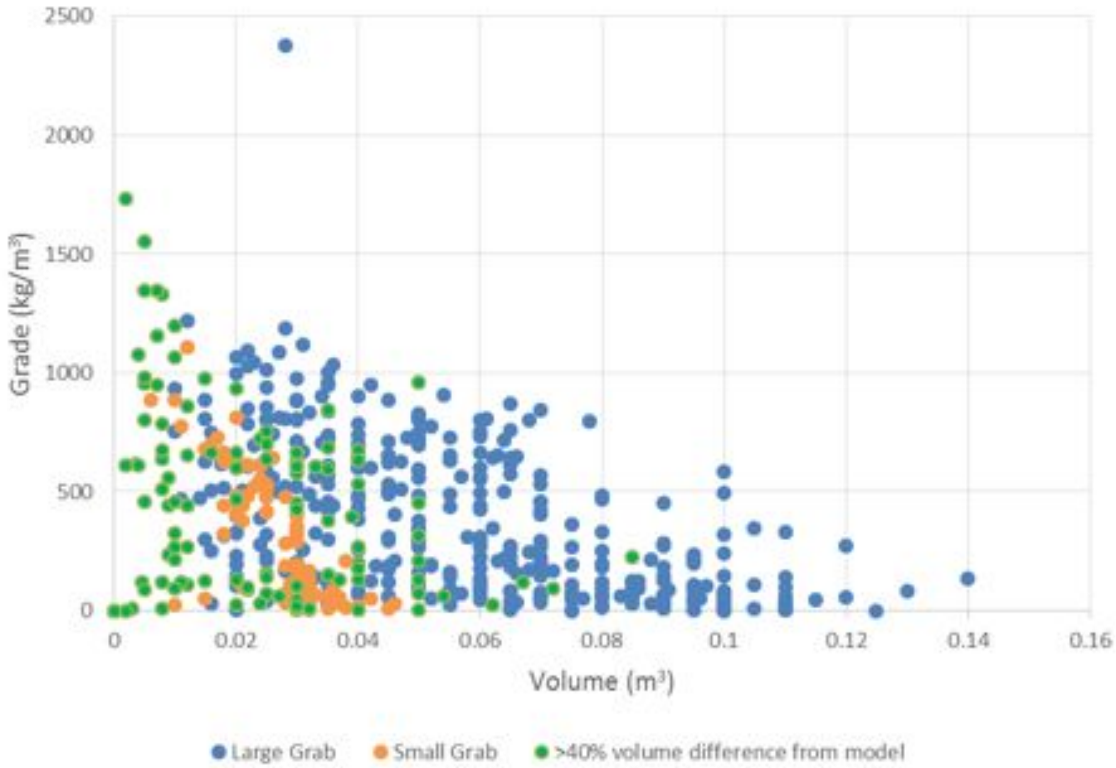

Figure 13: *R.V. Valdivia* sample volume vs. calculated grade for all samples (including those with poor quality).

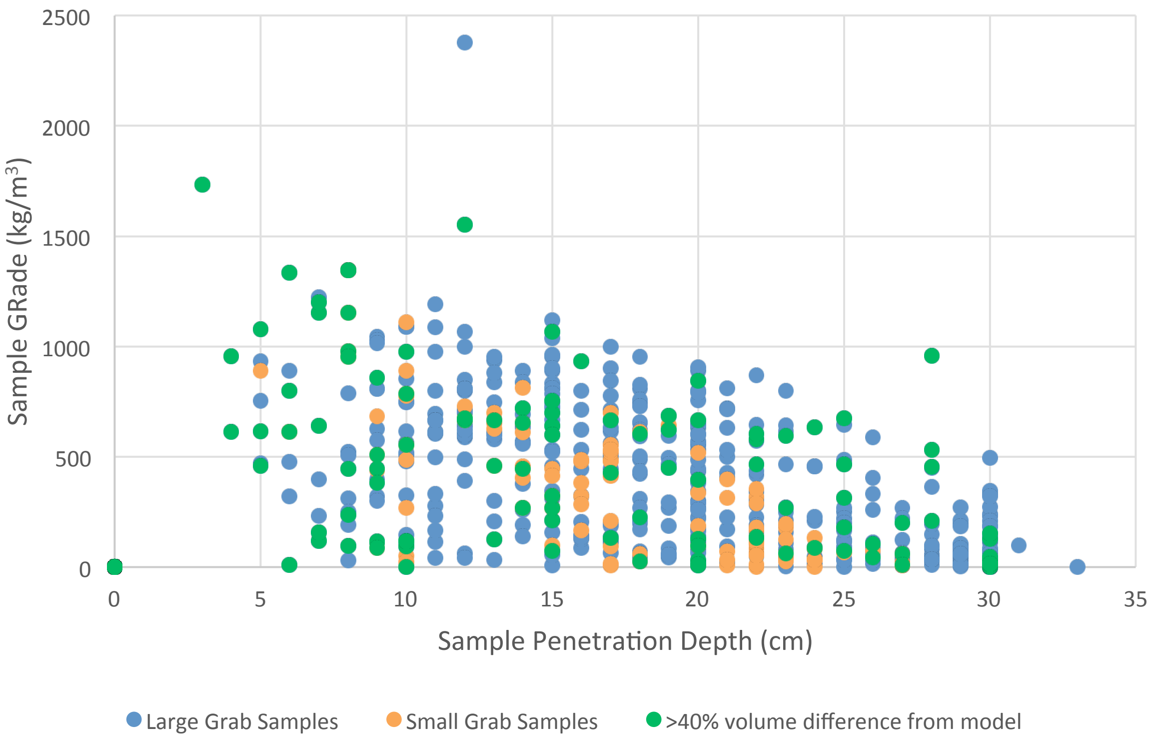

Figure 14: *R.V. Valdivia* sample penetration vs. calculated grade.

4.2.6 *R.V.* Sonne (1981)

The 1981 *R.V. Sonne* Cruise SO-17 was the most comprehensive exploration effort to assess the Chatham Rise phosphorite nodules. It was carried out under the auspices of the German-New Zealand Agreement on Scientific and Technological Cooperation and of a special agreement between DSIR and German Federal Institute for Geosciences and Natural Resources ("BGR").

The cruise included a detailed investigation of four special study areas, each about 50 to 80 km² in area, as well as reconnaissance mapping of larger areas (about 14,000 km²), to get an overview of the structure and phosphorite prospectivity of larger areas between 178°E and 178°W.

The areas selected for special study were chosen on the basis of seafloor roughness (micro relief) determined from interpretation of seismic data (Falconer *et al*., 1984). A positive correlation was recognised between phosphorite nodule abundance and seafloor roughness, and the seafloor was divided into "seismic facies" which denoted variations in roughness. The study areas were those in which the seafloor roughness was greatest.

In addition to oceanographic, meteorological and geophysical data, the cruise collected 19 hours of video recordings of the sea floor as well as 530 sediment samples, the vast majority taken by a pneumatic grab-sampler. Maximum penetration depth of the pneumatic grab was up to 70 cm, however approximately 100% sample recovery could only be obtained down to a depth of 38 cm due to the volume capacity of the grab. This was normally sufficient to penetrate both the phosphorite-bearing sand as well as the top of the underlying chalk and to produce relatively undisturbed samples. Maximum sample size was 1.3 tonnes.

The New Zealand Company Fletcher Challenge Ltd. was involved in the *Sonne* work and in 1981 formed a partnership with the German industrial parties. It was subsequently granted a prospecting licence for further investigation of the phosphorite deposits. Several reports were produced, detailing feasibility studies and resource estimates, but no further data collection surveys were undertaken and the licence was allowed to lapse in 1984.

4.2.6.1 Sample Locations

The *R.V. Sonne* was equipped with a MAGNAVOX satellite navigation system coupled to a Doppler sonar to determine its geographic position (Von Rad, 1984). Using this system a position accuracy of 200 to 500 m was achieved. To increase the location accuracy of samples an underwater acoustic transponder navigation (ATNAV) system consisting of 6 to 8 transponders was laid 3,000 to 4,000 m apart on the sea floor. Under favourable conditions the system had an accuracy of 30 to 50 m within the central parts of the grid and 100 m near the edges. Geographical coordinates were determined by ATNAV positions and satellites fixes. With ten satellite fixes available the accuracy of latitude and longitude estimates within the ATNAV areas was 180 m. A total of four ATNAV areas were used for the *R.V. Sonne* grab sampling, each utilising 5 – 8 transponders (Kudrass, 1984).

Sample positions for the *R.V. Sonne* and *R.V. Valdivia* cruises recorded in the supplied database have been sourced from original hard copy maps, digitised and registered by NIWA. A handful of samples that did not have location data in this database were digitised using the latitudes and longitudes recorded on the raw data sheets; some samples with valid phosphorite data only had a record of local grid coordinates on the raw data sheets and it is not known how these translate to a standard regional datum and so their sample location cannot be determined.

CRP contracted GNS Science Consultancy to try and improve sample location accuracy using measured seafloor depths recorded at both the *R.V. Sonne* and *R.V. Valdivia* sample locations with modern bathymetry data collected on the four cruises conducted by the *R.V. Dorado Discovery* (Section 9.2). Results from the work (Stewart & Black, 2013) show that for the *R.V. Sonne* areas 1 and 2 show that the survey position could not be improved. Whereas, *R.V. Sonne* 3 and *Sonne* 4 samples show a better correlation to bathymetry if the samples are moved 280 m northwest and 230 m southeast, respectively. RSC has not validated this work or made any positional adjustments based on this work.

4.2.6.2 Sampling Methods

The *R.V. Sonne* cruise was carried out in three stages from March to May 1981; its main objectives were to investigate the regional distribution and conduct a quantitative assessment of the phosphorite potential on the Chatham Rise, focusing on four main areas eastward of the *R.V. Valdivia* sampling area. A multi-method approach was used to investigate the near-surface geological structure and stratigraphy, and the facies-association, age, and genesis of phosphorite nodules and related sediments. This was done by combining continuous methods such as underwater television and photography, side scan sonar, a 3.5 kHz sub-bottom profiler, and HUNTEC high-resolution deep tow boomer systems with narrow-spaced, well-positioned sediment samples. Current meters and wave riders were also employed. In 53 days, more than 2,600 km of seismic lines were traversed in four areas between 179°50’ E and 178°05’ W, and 550 bottom samples were obtained (Von Rad, 1984). In total, 527 samples were collected in an area of ca. 700 km^2 within MPL 50270. Most of the *R.V. Sonne* samples were collected using a 0.8 m^3 pneumatic grab sampler which was specifically designed for the *R.V. Sonne* cruise (Figure 15). The grab was built by Preussag AG and Peiner AG and had a weight of 1.8 tonnes. The heavy weight of the grab allowed the grab to penetrate deeper into the nodule-bearing sands than grabs used on previous surveys. The coarse nature of the phosphorite deposits means that lighter grabs have difficultly penetrating past the larger nodules and consequently have reduced sample penetration and recovery; the weight and additional pneumatic closing power of 1.5 tonnes of the *R.V. Sonne* grab meant that many samples were able to be collected over the full depth of the phosphorite-bearing sand horizon and into the top of the chalk unit. However the data show that even the pneumatic grab experienced a reduction in penetration depth where the percentage of phosphorite nodules in the sediment exceeded 30%, though this affect was less pronounced than the with the *R.V. Valdivia* grab (Von Rad, 1984). The closing power of the *R.V. Sonne* grab did eliminate the problem of having large nodules wedging the jaws of the grab open and causing sediment loss, as had been previously encountered with the *R.V. Valdivia* grab samples.

Figure 15: The *R.V. Sonne* pneumatic grab, hopper and separation plant.

The nuggety nature of this type of sea floor phosphorite nodule deposit means that the larger the sample, the lower the sample variability caused by the coarse grained nodules. The open pneumatic grab sampled an area of 1.9 x 1.06 m of the seafloor surface (2 m^2). The sample collected was relatively undisturbed, however observations of the samples in the bucket (Hermann Kudrass, *Pers. Comm.*) and the known reduction of the bucket length from 1.9 m open to 1.6 m closed indicates that samples must have been compressed during closure of the jaws. This resulted in sediment thicknesses as observed in the bucket to be greater than the true in-situ thickness of the sediment. RSC has used the known dimensions of the grab to develop a sample penetration-volume relationship that determines the true depth of the sample (Section 4.2.6.8).

Once the pneumatic grab was closed the sample was fully enclosed and not exposed to water movement as it was retrieved from the sea floor and onto the deck of the boat. Sediment loss at the retrieval stage is not considered to be a significant issue and consequently recovery in the grab is generally considered to be 100%, except where the bucket was observed to be completely full of sediment. In these instances it is possible the bucket penetrated the sediment to a depth of up to 70 cm, but due to its volume capacity of 0.8 m^3 it could not have collected all sediment contained within its sampling area beyond a depth of 38 cm as the volume of in situ sediment exceeds the volume of the bucket. Consequently it is inferred that all full bucket samples have an unknown sediment recovery of <100% (Figure 16). In addition, Kudrass (1984) notes that with increasing penetration depth the grab's own closing force caused it to lift by up to 30 cm during closure. For these reasons it is impossible to determine true penetration depth and sample recovery for full grab samples.

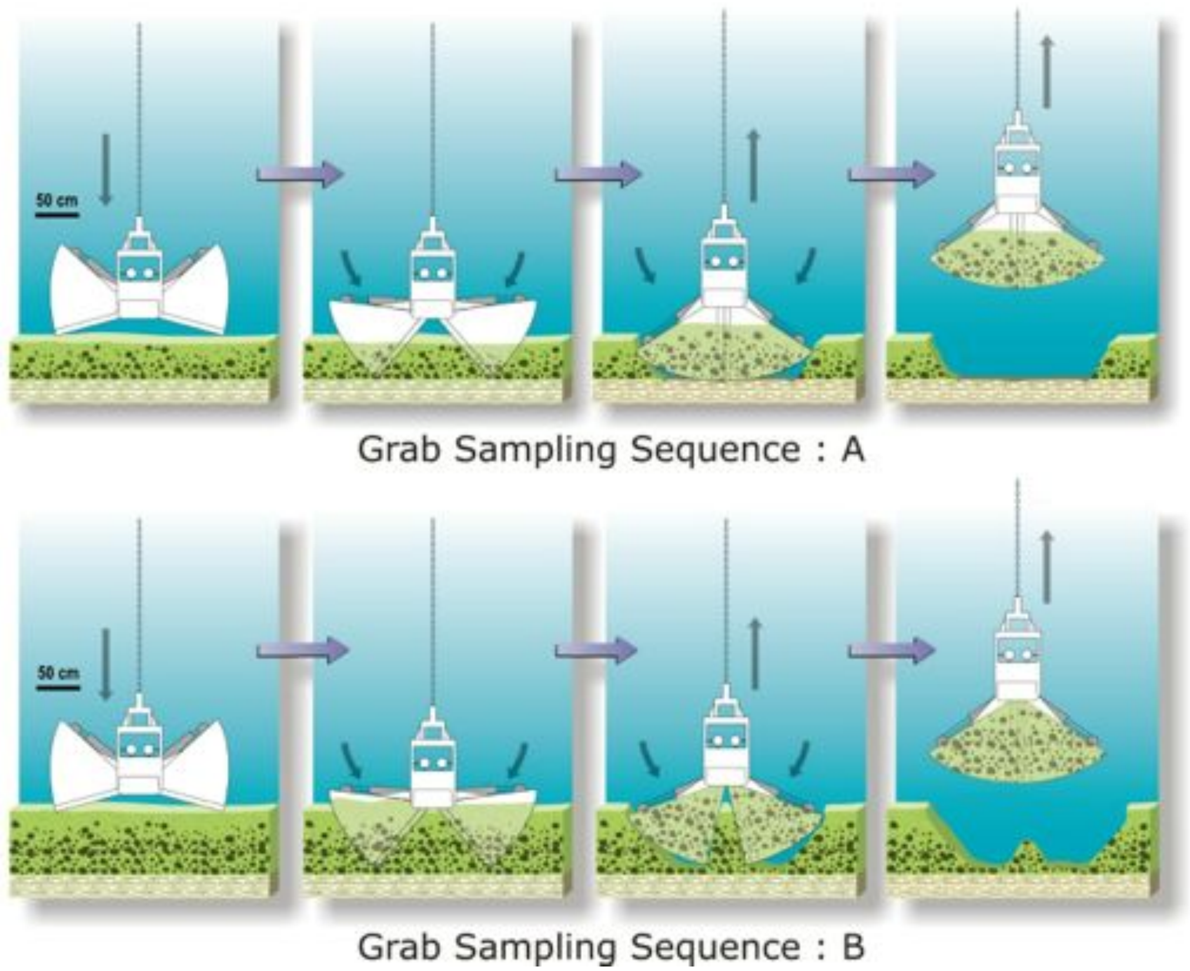

Figure 16: Interpretation of the sampling process using the *R.V. Sonne* pneumatic grab showing A) approximately 100% recovery where sand thickness <0.38 m and B) where >0.38 m sand would result in the bucket becoming full before it had completely closed, resulting in sediment loss from the sample.

While the large pneumatic grab was the primary *R.V. Sonne* sediment sampling tool, a number of other sampling systems were used for a limited amount of samples including a small Van Veen grab; a 1,200 kg Kastenlot box corer (KAL) measuring 25 cm x 25 cm square, with 6.5 or 3 m long tubes; a Kieler Hammer vibrocorer (KH) (this was lost on its second deployment and was unable to be recovered); a 5 m long piston corer; and a chain bag dredge. Sampling using the various equipment methods is summarised in Table 8.

Table 8: Summary of sediment sampling conducted aboard the *R.V. Sonne* (compiled from *R.V. Sonne* raw data).

Sampling Method	No. of Attempts	No. Successful	No. Empty	No. Washed Out	No. Failed
Pneumatic grab	525	515	3	2	5
Small van veen grab	2	0	0	0	2?
Kiel vibrocorer	2	0	0	0	2
Heavy kastenlot/box corer	14	6	2	2	4
Piston corer	3	3	0	0	0
Chain bag dredge	3	2	0	0	1
TOTAL	**549**	**526**	**5**	**4**	**14**

*samples coming up empty despite no apparent equipment malfunction (assigned a phosphorite grade of 0 kg/m^3.)

With the exception of the pneumatic grab the other sampling systems were unsuccessful at retrieving quality samples and further sampling attempts using the equipment were abandoned. Only the Kastenlot box corer showed some success but there were difficulties getting the core catcher mechanism to operate properly. Several initial attempts failed to retain core. Modifications to the closing mechanism were made with limited success and the sampling tool was not used further.

RSC regards the pneumatic grab sampling system used on the *R.V. Sonne* as a robust sampling system for wide spaced sampling of sea floor phosphorite nodules. Smaller grab, box-core and vibrocore samples will suffer from increased variance between the samples, and are likely to encounter other issues including poor penetration power into nodule-rich sediment, resulting in a sampling bias toward phosphorite-poor sediment.

4.2.6.3 Sample Preparation and Analysis

Samples collected on the cruises were processed on board the ship. Upon retrieval of the pneumatic grab the contents of the bucket were geologically described and the thickness of the total sediment (penetration thickness) in the bucket and thickness of the glauconitic sand component was measured (Figure 17). Sediment was slightly compressed by the closing of the grab and chalk was often observed to be collected in the corners of the bucket in larger samples. Consequently penetration depth and sand thickness were recorded as the average for each parameter. Penetration depth was initially measured but later it was visually estimated based on the height of the sample within the grab. This change in procedure is not documented.

The bulk sample weight was determined initially using the shipboard crane, by subtracting the weight of the grab apparatus (1,800 kg) to determine the net sample weight, however this proved difficult to conduct accurately due to the constant motion of the ship. Consequently the sample processing procedure was adapted during the first cruise so that net sample weight was estimated from the volume of sediment in the bucket. The dimensions of the bucket were measured and the volume of the bucket calculated to determine its volume in 5 cm depth increments. The penetration depths and thicknesses of the sediment, sand and chalk (if present), were then used to determine the volume of each lithology in the sample. These volumes were multiplied by an average density of each lithology as measured on the *R.V. Valdivia* (1.91 and 1.79 g/cm^3 for sand and chalk, respectively) to estimate the weights of each component in the bucket. These weights were then summed to estimate the net weight of the grab sample (Hermann Kudrass, *Pers. Comm.*). From the raw data sheets this transition in standard procedure appears to have taken place after sample SO069, as grab gross weights were no longer routinely recorded beyond this sample. RSC notes that this undocumented change in procedure reduces the level of confidence in the *Sonne* data and introduces a number of assumptions into the sample processing procedure (see QA/QC below).

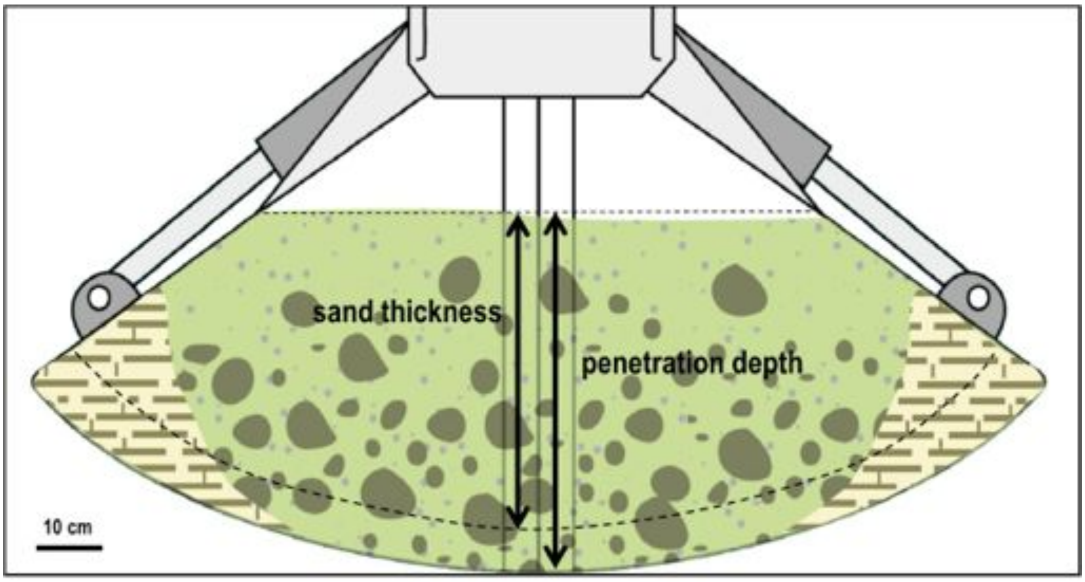

Figure 17: Stylised section showing sediment in the pneumatic grab.

Small subsamples for onshore analyses were taken using a shovel leaving the bulk of the sample for processing. Once logging was completed the entire contents of nodule-bearing grabs was dumped into a hopper. The hopper funnelled the sediment onto a custom-built vibrating sieve device containing an 8 mm and a 1 mm screen. Any material observed not to have phosphorite was discarded overboard without being sieved and the sample was recorded as not containing phosphorite. Samples were washed through the sieve and the >8 mm and 1-8 mm fractions retained; the <1 mm fraction was washed overboard (Figure 18).

Each retained fraction was then weighed, initially using spring weights but again this proved difficult to do accurately due to the constant motion of the ship. As such the procedure was again adapted and volume-calibrated bins were used to determine the weight of the >8 mm and 1-8 mm fractions. It is not clear when this change in procedure was adopted. Trials were run to determine the graduated weight of different volumes of the separate fractions in bins and thereafter the >8 mm and 1-8 mm fractions were placed in the bins and their weight assigned based on their volume (Hermann Kudrass, *Pers. Comm.*). Unlike the calculation for net sediment weight this process does not use a numeric assumed density, however it does assume that the density of all the >8 mm and 1-8 mm fractions (respectively) were approximately the same.

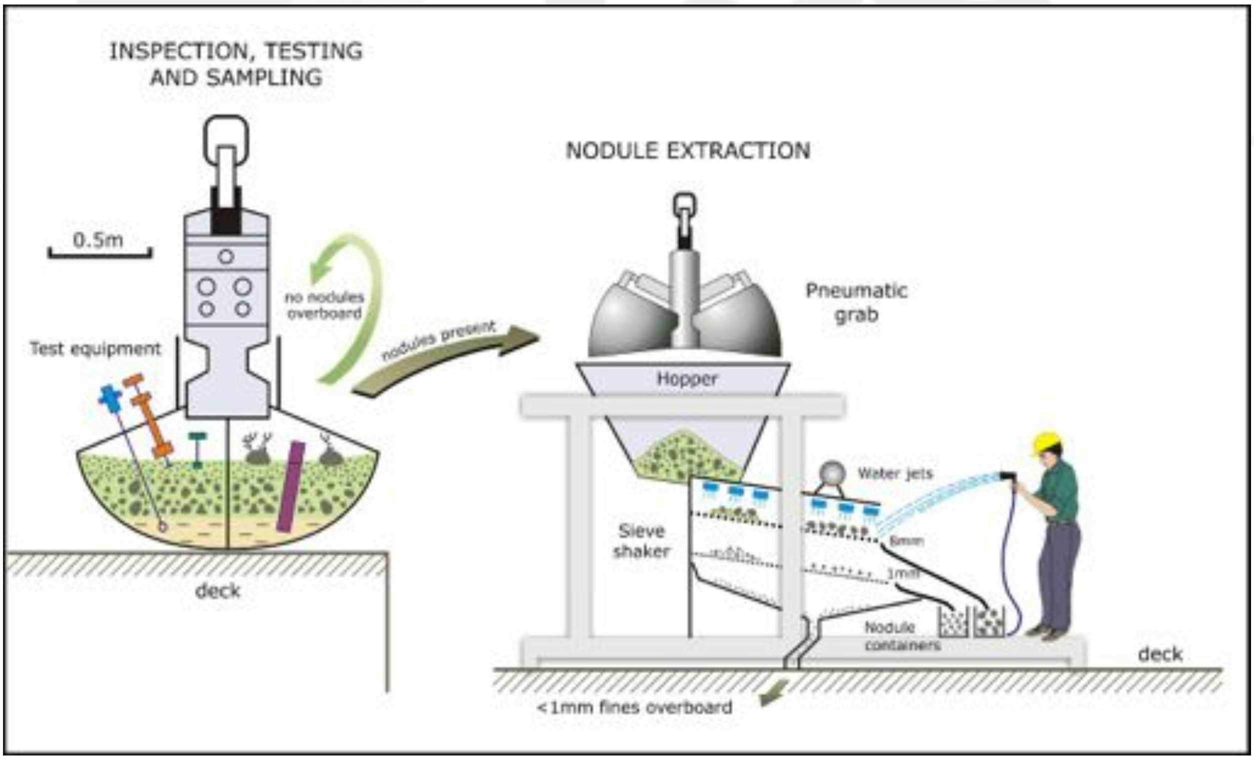

Figure 18: Processing of grab samples aboard the *R.V Sonne* (adapted from Kudrass & Cullen, 1984).

RSC notes that the majority of sieved samples had estimated phosphorite percentages in excess of 90% for both fractions, but that some were significantly lower. Fractions with less or no phosphorite may have had their weights overestimated unless multiple calibrated bins were used and chosen depending on the estimated phosphorite percentage of each fraction. As the process was not documented in enough detail this cannot be assessed.

The weight percent of each fraction relative to the estimated total weight of the sand was calculated from the volume-calibrated kilograms of the >8 mm and 1-8 mm sieved fractions. The percentage of contained phosphorite in each fraction was estimated visually and multiplied by the weight of the fraction in order to calculate the amount of phosphorite (kg) in each fraction. These weights were summed to determine the total amount of phosphorite (kg) in each sample.

RSC notes that a visually estimated phosphorite percentage is equivalent to a volume percent and therefore cannot be used to calculate contained kilograms of phosphorite from a sample or sieved fraction weight without assuming that the density of all the constituents are similar.

While these values were recorded for each sample that was sieved, the volume of the >8 mm and 1–8 mm fractions was not always recorded. Consequently, contained phosphorite for each fraction cannot be recalculated if and when detailed density data are obtained in the future for sand with varying proportions of contained phosphorite. Therefore, the weights of the sieved fraction are accepted *as-is* and form the basis of all subsequent grade estimates (Section 4.2.6.8).

4.2.6.4 Sediment Density and Moisture content

Density and moisture content test work was completed on 0.1 m^3 samples taken from the grab sample. The density for tests completed on different sediment layers is shown in (Table 9). The weight was assessed with above balance (triple beam soil test balance), the volume by means of water displacement in measures (Meyer & Toan, 1984). For moisture content Meyer and Toan (1984) state that sediment samples were dried over 24 hours at 100°C.

Table 9: *R.V. Sonne* density and moisture content (Meyer & Toan, 1984).

Sediment	Sample	Wet density (t/m^3)		Dry density (t/m^3)		Moisture (%)	
		From-to	Average	From-to	Average	From-to	Average
Silt/sand, upper 10cm	33	1.51-1.77	1.64	0.85-1.28	0.98	50 - 82	68
Sand from 10 - 50	24	1.59-1.99	1.72	0.91-1.45	1.15	32 - 74	51

cm							
Ooze	13	1.69-1.92	1.81	1.16-1.4	1.27	35 - 54	43

4.2.6.5 Phosphorite nodule Density and Moisture content

The density of phosphorite nodules was tested from different size fractions. Meyer and Toan (1984) do not explicitly state whether the nodules were treated in the same manner as sediment samples. The wet density of phosphorite nodules ranges from 2.55 to 2.96 g/cm^3 and average 2.76 g/cm^3. The density tends to increase with increasing nodule diameter due to larger nodules having lower P_2O_5 and higher $CaCO_3$ contents (Von Rad & Rosch, 1984). The moisture content varies from 2 to 7%, being higher in larger nodules.

For the purpose of grade estimations calculated during the sampling process on the ship, Kudrass used the *Valdivia* wet density of 2.65 g/cm^3 for phosphorite nodules, 1.91 g/cm^3 for the glauconitic sand (containing phosphorite) and 1.79 g/cm^3 for the chalk. RSC notes that due to the significant difference in densities between the sands and phosphorite nodules in the recovered samples, true density would vary considerably depending on the proportions of each fraction. This is likely to cause underestimation bias of phosphorite grade as the phosphorite content increases.

Table 10 lists nodule size range and wet density for 11 values (nine stations, two have two size ranges) and a value for each of Areas A, B, C and D. It is not clear whether the area results are averages. It is also not clear whether reporting a size range for each station implies that the single density value is an average of several samples or just a single nodule with a shape variation was measured.

Table 10: Wet densities of phosphorite nodules (Meyer & Toan, 1984).

Point/survey area	Size (mm)	Wet density (t/m^3)
149	7-53	2.83
153	1-8	2.61
153	>8	2.69
156	13-37	2.83
212	30-40	2.65
216	>8	2.80
351	70	2.59
354	9-37	2.96
387	32	2.55
388	6-20	2.77
388	9-26	2.76

Area A	7-19	2.90
Area B	2-19	2.86
Area B	7-19	2.82
Area C	19-37	2.79
Area D	26-53	2.71

4.2.6.6 QA/QC

With regards to quality assurance and control, the work carried out on the *Sonne* was the most controlled of all cruises, with a lot of forms, procedures, and methodologies described in personal notebooks, reports and scientific literature. The amount of operating procedures is also evident from the log sheets. Adjustments were made during the sampling programme, and the majority of these were properly documented. The quality was controlled through these procedures, and accuracy and bias of estimates contained as much as possible through the various systems in place. Duplicate sample information was not collected and therefore no comment can be made on the precision of the sampling process.

4.2.6.7 Logging

When the grab was lowered onto the deck the sample was initially inspected through opening lids on top of the grab. From here the surface of the sample could be observed, penetration depth of sediment in the grab measured and biota noted. The presence and position of nodules was determined and recorded in a simple graphic log and each sample briefly geologically described. An estimation of the vertical thickness of sand and chalk was made either by digging into the sample, or by observing the cross-section of coherent samples upon opening of the bucket, which could be paused at any time using the pneumatic controls (Von Rad, 1984). Soft samples made estimating sediment thickness less reliable. Initially these measurements were done using tape measures, however as the project continued the depth estimates were estimated from observations.

RSC notes that the depth measurement process was not optimally controlled and could have been prone to errors. These measurements have some influence on the sample volume estimates and eventual estimation of the samples' true thickness.

From sample SO103 onward shear vane measurements were conducted through the lids on top of the grab, but RSC is concerned that these measurements may not be reliable due to the observed and/or inferred compaction of the sediments as they were collected by the closing of the grab.

4.2.6.8 Estimation of Phosphorite Grades (Ph kg/m^3) in Samples

Phosphorite coverage was expressed on the original logging sheets as phosphorite kilograms per square metre (Ph kg/m^2). As described above, the phosphorite content was estimated from 1–8 mm and > 8 mm grain size fractions separated from the whole grab sample. These sieved fractions were either weighed or had their weight estimated from the volume measurements taken from a calibrated container. The phosphorite percent was then estimated for each retained sieved fraction and used to calculate the contained kilograms of phosphorite in each sample. This value, though not recorded on the shipboard analysis raw data sheets, was divided by the assumed sampling area of the grab in order to calculate phosphorite coverage.

The open grab has a sample area of 1.90 x 1.06 m (2 m^2). According to Kudrass (1984) the grab area was reduced for large volume samples due to the inferred sediment loss during collection of full grab samples (Figure 16). When the volume of recovered sediment was less than 0.4 m^3 (half grab volume) the sample area for grade calculation was reportedly kept at 2 m^2, but reduced to a minimum of 1.6 m^2 for samples up to 0.8 m^3 volume (a full grab). After thoroughly reviewing the entire *Sonne* dataset, RSC notes that this calculation had not actually been applied on the log sheets or in the database with almost all grade calculations using the internal area of the closed grab, 1.58 m^2, irrespective of sample volume.

RSC has reviewed the grade calculations and has re-estimated the *R.V. Sonne* grades using a volume-penetration relationship based on the volume of the grab and penetration depth of the sediment. Based on the grab specifications, a detailed 3D model of the closed grab was generated and the volume calculated in 1 cm vertical increments (Figure 19). These were compared to the recorded penetration depths of total sediment and thickness of sand for each sample in order to calculate the volume of sand in each sample. As previously described, the amount of phosphorite (kg) in each sample was calculated from the estimated percentage of phosphorite and volume-calibrated weight of the 1–8 mm and >8 mm sieved fractions. RSC calculated the phosphorite grade (kg/m^3) by dividing the total calculated phosphorite (kg) by the calculated volume of sand (m^3) in each sample. This yielded grade ranges up to 2,680 kg/m^3 with an average of 236.9 kg/m^3. As with the *R.V. Valdivia* data higher grades are often in close proximity to lower grade samples, highlighting the short range variability of phosphorite grade (Figure 20).

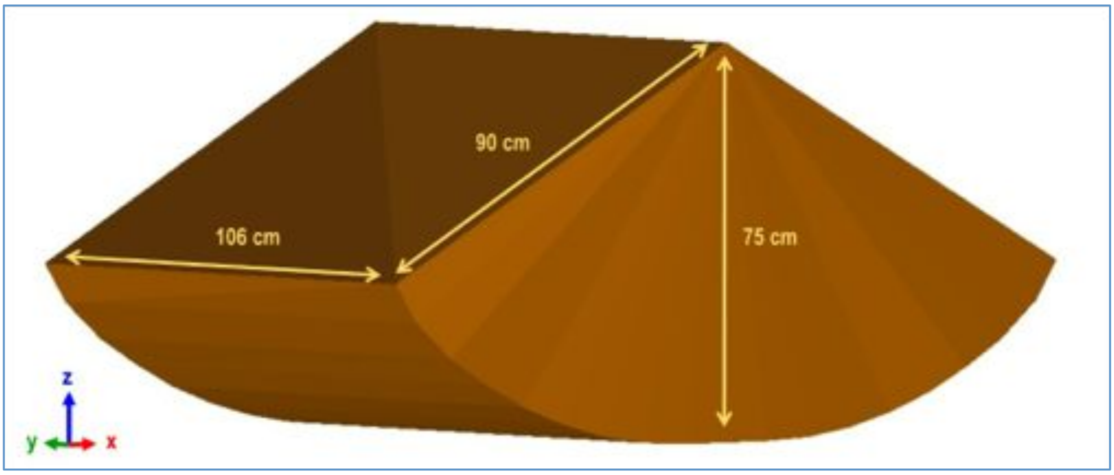

Figure 19: 3D model of the *R.V. Sonne* pneumatic grab volume, used to estimate bulk sample and sand volume from recorded penetration depths and sand thicknesses.

RSC has concerns about the accuracy of grades calculated using the *R.V. Sonne* data due to the assumption that all the samples have the same density that is inherent in using volume-calibrated bins to estimate the weight of the 1–8 mm and >8 mm sieved fractions. Due to the contrast in the average density of glauconitic sand (1.91 g/cm^3) and of phosphorite nodules (2.72 g/cm^3), the density of samples would be expected to vary between these values depending on phosphorite content.

RSC also notes that penetration depths are based on the average thickness of sediment in the bucket, but that sediment thickness varied across the cross-section of the bucket due in part to natural variation in the sediment morphology but also as a result of compression of the sampled sediments as the grab closed. Consequently volume calculations based on penetration depth, while considered to be a good approximation, are not considered optimal. RSC also notes that grades based on this calculation are only valid for samples which did not completely fill the grab. In instances where samples did fill the grab (taken as any penetration depths recorded as ">60" or ">70" cm or more) it is not known at what point during bucket closure the bucket became full, nor how much sediment from the original 2 m^2 sampling area was left behind. While penetration depth can still be used to calculate the volume of these samples, it must be noted that such samples potentially have recoveries that are significantly less than 100%, and that samples will also be biased toward collecting near surface sediment. Consequently samples representing full grabs have been given a lower SQR for the purposes of resource modelling.

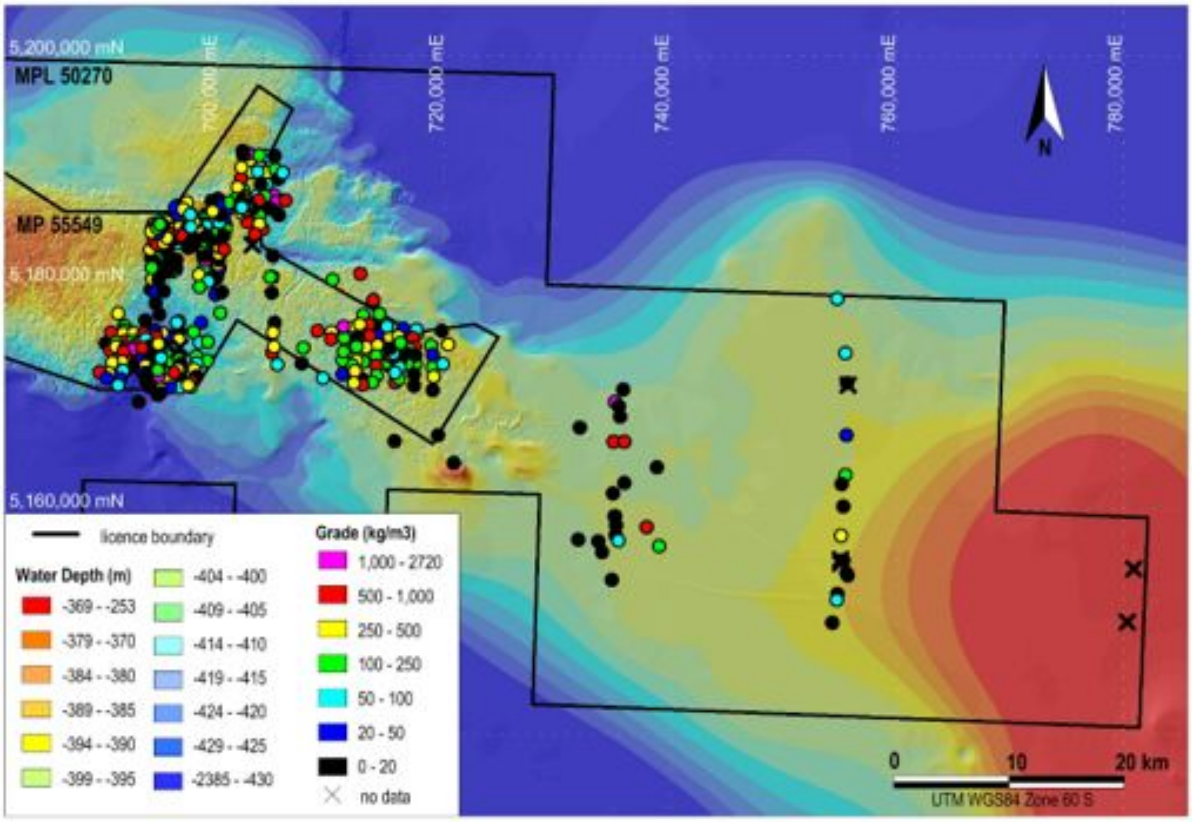

Figure 20: *R.V. Sonne* sample locations within MPL 50270 and updated phosphorite grade (Ph kg/m^3).

In order to calculate phosphorite coverage from the *R.V. Sonne* samples it was necessary to determine the true thickness of the sampled sand. Due to the compression of the sampled sediment during bucket closure this cannot be taken as the penetration depth. To calculate this depth, it has been assumed that down to a depth of 38 cm the grab was able to sample 100% of the sediment contained within the 2 m^2 area of its open jaws. Beyond this depth the volume of insitu sediment within the open area of the grab would exceed the capacity of the bucket and result in increasing sediment loss with greater sampling depth. By comparing the volume of in-situ sediment in 1 cm increments with the 1 cm incremental cumulative volumes previously determined for the grab it was possible to generate a conversion table for penetration depth to true depth of sediment for the *R.V. Sonne* grab (Table 11). Using this conversion sample, true thicknesses for all the successful *R.V. Sonne* samples average 23 cm (Figure 21). However, it is emphasized that due to the volume capacity of the grab true thicknesses in excess of 38 cm cannot be determined due to the necessity of sediment loss during sample collection; consequently true thicknesses for full buckets have been capped at 38 cm.

Table 11: Conversion table for penetration depth to true depth of sediment for *R.V. Sonne* samples.

Penetration Depth (cm)	True Thickness (cm)	Penetration Depth (cm)	True Thickness (cm)	Penetration Depth (cm)	True Thickness (cm)
0	0	26	15	52	33
1	0	27	16	53	33

2	0	28	17	54	34
3	1	29	17	55	34
4	1	30	18	56	34
5	2	31	19	57	35
6	2	32	20	58	35
7	2	33	21	59	35
8	3	34	22	60	36
9	4	35	22	61	36
10	4	36	23	62	36
11	5	37	24	63	36
12	5	38	25	64	37
13	6	39	25	65	37
14	6	40	26	66	37
15	7	41	27	67	37
16	8	42	27	68	37
17	8	43	28	69	37
18	9	44	29	70	38
19	10	45	29	71	38
20	11	46	30	72	38
21	11	47	30	73	38
22	12	48	31	74	38
23	13	49	31	75	38
24	13	50	32		
25	14	51	32		

RSC notes that the assumption of 100% recovery for samples down to a depth of 38 cm within the grab area of 2 m^2 may not be accurate due to the slightly curved nature of the grab jaws (Figure 16). The determination of true depth from the penetration depth of samples similarly assumes that, though the sediments are compressed, they undergo no net change in volume during sample collection as the thickness of the sample in the grab increases vertically to accommodate the horizontal compression.

The phosphorite coverage can be determined by multiplying true depths by the grade of the *R.V. Sonne* samples. These range up to 252.9 kg/m^2 and average 34.6 kg/m^2.

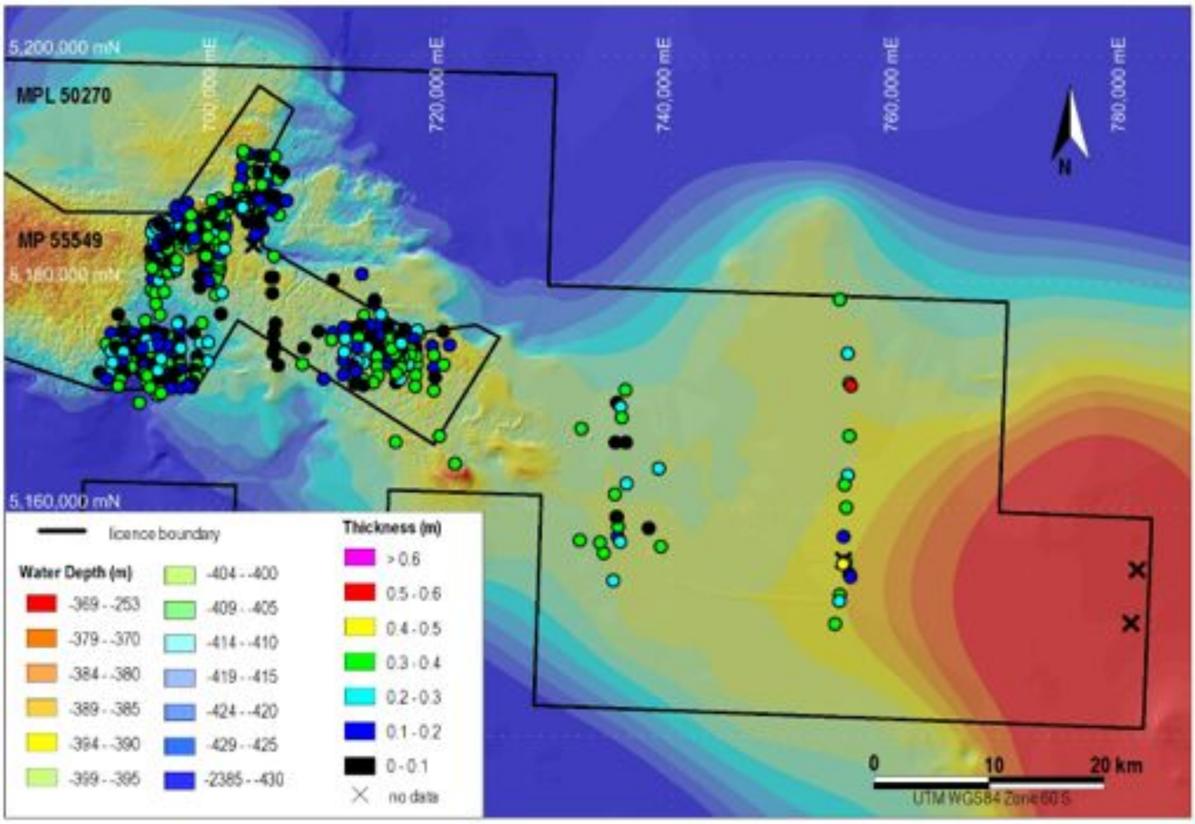

Figure 21: *R.V. Sonne* sample sand true thicknesses calculated from the recorded penetration depth and sand thickness of samples and the modelled internal volumes of the pneumatic grab (for samples within MPL 50270).

In addition to determining true thickness of sand for the *R.V. Sonne* samples, RSC has attempted to gauge the vertical variation in phosphorite content by assessing the graphic logs recorded for the grab samples. The logs simplify the sediment contained in the grab into horizons, graphically coded them according to whether the sediment was chalk, sand containing no visible phosphorite, sand with dispersed phosphorite or sand with concentrated phosphorite nodules (Robin Falconer, *Pers. Comm.*), and record the depth to the top and base of the horizons in the grab. RSC digitised the graphic logs for the grab samples and adjusted the depths to horizons using the same conversion table as for determining the true depth of samples (Table 11). The total contained phosphorite (kg) for each sample was then divided by the total thickness of phosphorite-bearing sand in the samples as determined from the graphic logs, to determine the average phosphorite content of the horizons in 1 cm increments. These were summed as appropriate to determine the contained phosphorite in the sand over 5 cm depth ranges, using the calculated true depth and thickness of the phosphorite-bearing horizons as a reference. The average calculated contained phosphorite (kg) across all *R.V. Sonne* samples is presented in Table 12. While the graphic logs indicate that the phosphorite distribution is vertically variable within the phosphorite-bearing sands, this analysis further suggests that phosphorite is most concentrated in the upper parts of the sediments. RSC notes that this analysis assumes that the phosphorite is evenly distributed within the graphically logged phosphorite-bearing horizons, and is also susceptible to the surficial sediment sampling bias exhibited by other sampling equipment (Section 4.2.5.7). However the 1.5 tonne closing power and resultant greater penetration power of the pneumatic grab means it is less susceptible to this bias, as indicated by the lack of an obvious strong inverse relationship between sample penetration depth and calculated grade (Figure 22). This suggests the pattern of phosphorite distribution indicated by the graphic log data, though imprecise, is valid.

Table 12: Average phosphorite content (kg) calculated for true sand depth ranges from *R.V. Sonne* graphic logs.

Depth range	0-5cm	5-10cm	10-15cm	5-20cm	20-25cm	25-30cm	30-35cm
Average Phosphorite kg	20.5	11.6	9	6.6	5.24	3.9	2.7

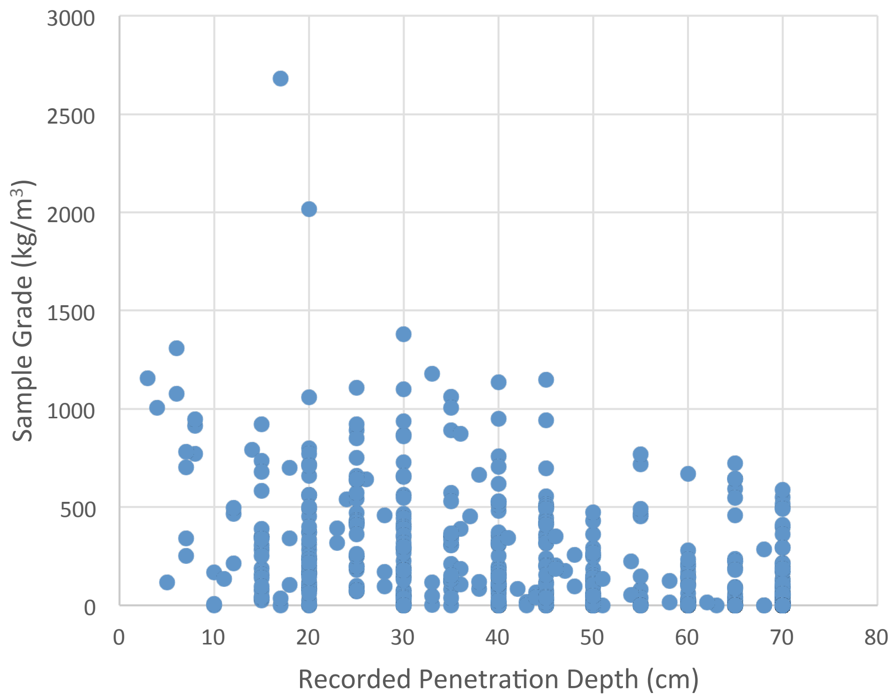

Figure 22: *R.V. Sonne* sample penetration depth vs. calculated grade.

For the purposes of assigning a Sample Quality Ranking (SQR) to the *R.V. Sonne* samples, the presence of chalk at the base of the sediment in the bucket is taken as an indication that the grab has sampled the full thickness of the nodule-bearing glauconitic sand. Where no chalk is seen it is unknown whether the full sand profile has been sampled. Where the grab was full of sediment (0.8 m^3) it is inferred to have sampled depths greater than or equal to 0.38 m and assumed that sediment recovery was less than 100%. For these reasons it is impossible to determine true penetration depth and sample recovery for full grab samples.

In general, RSC considers the pneumatic grab sample data from the *R.V. Sonne* to be generally representative for the purpose of resource estimation, based on:

- the ability to collect a large sample volume (up to six times larger than the Van Veen-style sampler used on the *R.V. Valdivia*), and the ability to collect relatively undisturbed samples, as this decreases the volume-variance issue;
- pneumatic jaws mean that large nodules do not prevent the grab from closing completely, avoiding sample loss experienced by grabs with less closing power;
- pneumatic jaws allow the grab to dig into the sand under its own weight and penetrate up to 70 cm depth, and can theoretically achieve 100% recovery down to 38 cm depth, therefore sampling the entire sand profile in most cases;
- sample penetration, sample weights, sieved weights, and phosphorite percent of sieved fractions are well documented on sample sheets; and
- sampling procedure is documented.

However, RSC notes the following concerns for potential sources of sample bias and errors for the *R.V. Sonne* grab data:

- potential for positional error due to survey methods available at the time (SATNAV) and no physical reference points in the ocean (however ,sample positions relative to each other is acceptable in the case of ATNAV-located sample);
- penetration depths and sand thickness were taken as observed measurements determining the distance between the sediment and the top of the grab;
- densities used in the *R.V. Sonne* sand/chalk grab volume calculations are based on results from the *R.V. Valdivia* and may not be representative;
- sieve weights were estimated using a calibrated volume that was determined by estimating a number of samples at the beginning of the survey for both weights and volumes and applying that relationship to all subsequent samples; and
- phosphorite percent is taken as an observed measurement and open to variability between assessors.

The assumptions RSC has made in recalculating phosphorite grades from the *R.V. Sonne* data are:

- RSC has estimated the volume of the grab based on design configurations documented in ship notes from Hermann Kudrass and Robin Falconer;
- RSC has assumed that the volume cut into the sea floor with the sampling method is a vertical-sided cut, equal depth across the sample, and no curved edges or central ridge where the jaws close is left behind; and

- RSC has assumed 100% sample recovery for samples coded as "successful" partial recovery for samples coded as "washed out" and 0% recovery for samples recorded as "failed".

4.3 Historic Mineral Resource Estimates

The historical Mineral Resource estimates in this section were generated prior to the implementation of the JORC Code and therefore should not be considered reliable.

4.3.1 *R.V. Valdivia*

A first attempt at estimating the phosphorite resources in the Project area was made on board the *Valdivia* (Kudrass, 1980). For each sample, the phosphorite coverage was calculated by multiplying the phosphorite concentration with the thickness of the phosphorite sand (measured as "penetration" in the bucket). Individual sample grades were interpreted to be representative of the area of sea floor around the sample site. In the eastern part of the survey area an average of 1 sample was taken per 0.33 km^2, and in the western part of the survey area it was 1 sample per 0.77 km^2. The sum of all coverage values, multiplied by 0.33 and 0.77 respectively, gave an estimate of 43 million m^3 of mineralised sand at an average of 61 kg/m^2 for a contained 13.8 Mt of phosphorite covering an area of 227 km^2 (Kudrass & Cullen 1982).

This method resulted in high standard deviations of the phosphorite nodules and their skewed distribution with three sub-populations making this kind of calculation (using a mean representative area and a mean coverage) fairly unreliable (Kudrass & Cullen 1982). Therefore, a second method using a better geo-statistical approach was implemented to improve the estimation of the phosphorite reserves defined by the *Valdivia*. The amount and grades of phosphorite were computed using kriging and was revised to 39 million m^3 of mineralised sand at an average coverage of 69 kg/m^2 for a contained 14.3 Mt of phosphorite covering an area of 207 km^2. Kudrass (1984) increased the *Valdivia* resource area to 54 million m^3 of mineralised sand at an average coverage of 66 kgm^2 giving a resource of 18.8 million tonnes phosphorite covering an area of 284 km^2.

4.3.2 R.V. Sonne

Phosphorite resources for the *Sonne* cruise were estimated by two methods. The first approach used the geo-statistical method previously employed on the *Valdivia*. Calculated variograms showed the phosphorite coverage had a very high nugget effect indicating high local variability. Efforts were made to deal with this effect by conducting close spaced sampling at 100 m spacing. Sampling was unable to be conducted at a closer distance due to the limitations with the navigation tools used on the *Sonne*. Kudrass and Von Rad (1984) suggest that this short-range variability is caused by icebergs gouging the sea floor.

Kriging was then performed with the nugget effect deducted from the variograms. Estimations were made in blocks of 1 km by 1 km, based on the local average of 20 sample points or a maximum search radius of 5,000 m. The results of the kriging estimation process of the *Sonne* are shown together with the *Valdivia* model in Figure 23. Kudrass (1984) estimated the phosphorite resources in the *Sonne* area to be 36 million m^3 of mineralised sand at an average coverage of 57 kg/m^2 for a contained 9.5 Mt of phosphorite covering an area of 167 km^2.

The overall patchiness of the phosphorite-rich areas, however, complicated the assessment of reserves (Von Rad, 1984). In the second approach the resources were calculated separately for the four areas surveyed in greater detail. These results showed 31 million m^3 of mineralised sand at an average coverage of 54 kg/m^2 for a contained 7.5 Mt of phosphorite covering an area of 140 km^2.

When *Valdivia* and *Sonne* areas were combined, the total resource area was 378 km^2 with resources of 25 million tonnes phosphorite and an overall coverage of 66 kg/m^2 (Kudrass & Von Rad, 1984) (Figure 23). Based on correlation between the phosphorite-rich areas and seismic facies interpreted by Falconer *et al.* (1984), Kudrass and Von Rad (1984) suggests that additional resources of approximately the same magnitude may be found in the neighbouring areas, but concentrations and coverage would be much lower.

The historical Mineral Resource estimates in this section are not compliant with the JORC Code (JORC, 2012).

Table 13: Historical phosphorite tonnage grade estimates conducted on *Valdivia* and *Sonne* data.

Model	Model number	Method	Data	Area km^2	Volume M m^3	Thickness cm	Coverage (kg/m^2)	Contained Phosphorite Tonnage (Mt)
Kudrass and Cullen, 1982	1	Nearest neighbour	*Valdivia*	227	43	19	61	13.8
	2	Kriging	Valdivia	284	54	19	66	18.8
Kudrass, 1984	3	Kriging (all data)	*Sonne*	167	36	22	57	9.5
	4	Kriging (4 areas)	*Sonne*	140	31	22	54	7.5
Total	2+4		*Sonne+Valdivia*	378	76	20	66	25

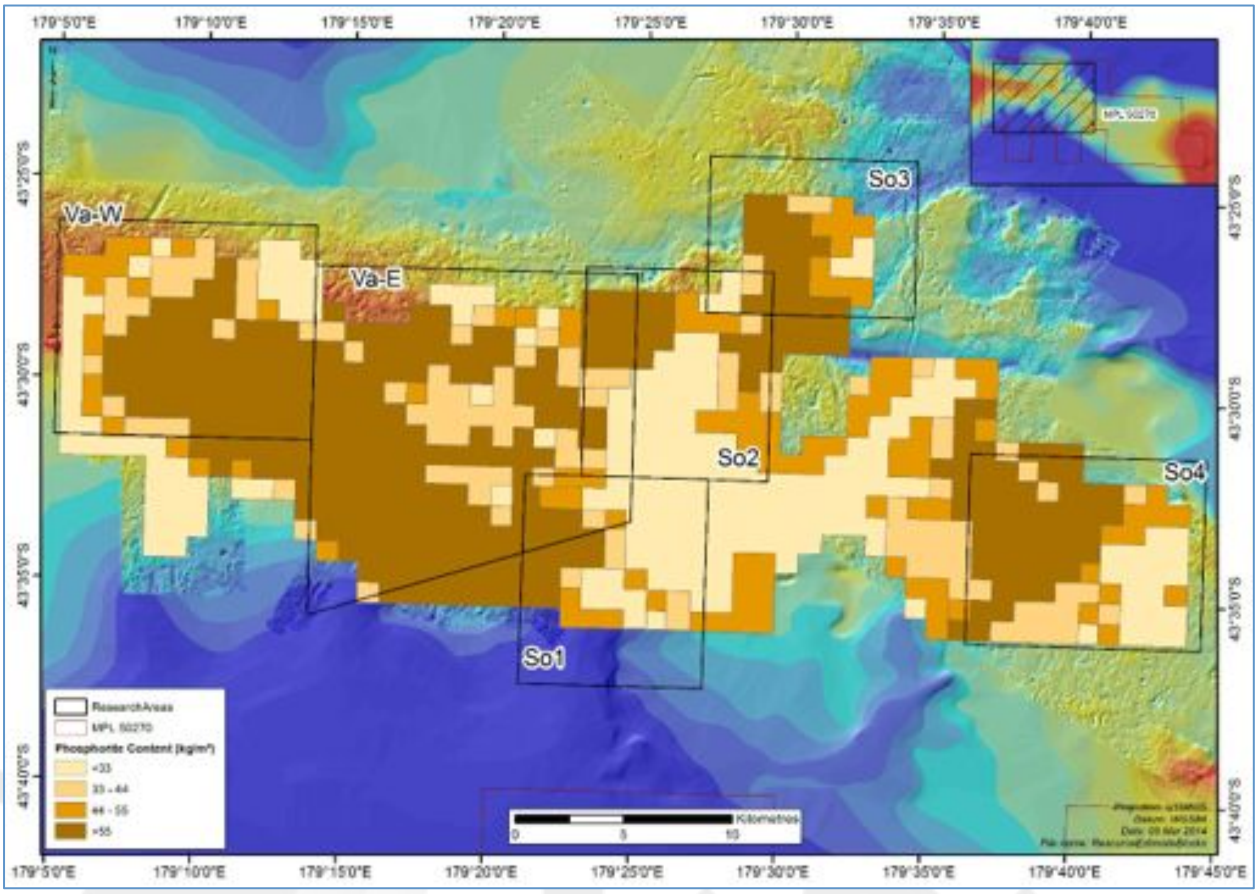

Figure 23: Previous resource estimate showing the distribution of kriged phosphorite coverage (kg/m^2) calculated in blocks of 1km^2 for *Valdivia* and *Sonne* areas.

5 Geological Setting and Mineralisation

5.1 Geological Setting

The geological history of the Chatham Rise dates back to the Permian-Triassic (300–200 Ma), when an extremely thick sequence of turbidite-type deposits was laid down in a subsiding trough at the Pacific margin of Gondwana (Sporli, 1980). These rocks were later involved in the second episode of the Rangitata orogeny in the Early Cretaceous (Wood *et al*., 1989). This resulted in an east-west structural grain defined by half-grabens hinged to the south, in response to the rifting in the Bounty Trough to the south in the same period (Figure 24). There are suggestions of en-echelon stepping of the faults. Minor movement has occurred on the same faults during the Cenozoic. Another set of faults are north-south trending sinistral transcurrent faults, and movement along these may be what gives the Rise the appearance of bending (Wood *et al*., 1989).

A major unconformity overlying the Late Cretaceous to early Palaeogene graben fill can be observed on most seismic profiles from the *R.V. Sonne* (Figure 24, Falconer *et al*., 1984). This unconformity represents a time of erosion, non-deposition and slow subsidence, before the nanno oozes and chert layers accumulated during the Eocene and Oligocene (Figure 25, Kudrass & Von Rad, 1984). Sedimentation from pelagic material formed nanno oozes until the mid-Oligocene, when rapid cooling occurred which resulted in changes in the foraminiferal and nannoplankton associations (Burns, 1982). On the crest of the rise, late Cretaceous sediments are usually less than 300 m thick, suggesting accumulation rates of <5 m/Ma (Burns, 1984).

Seismic profiles show intense block faulting (with throws up to 65 m) and by the end of the Cretaceous, Wood *et al.* (1989) notes that 1,000 to 2,500 m of sediments were deposited in newly formed half-grabens, with the thickest accumulations in the west.

After the late Oligocene period of non-deposition and erosion, foraminiferal ooze was deposited again in the Early Miocene, with its thickness increasing towards the flanks of the Chatham Rise (Kudrass & Von Rad, 1984).

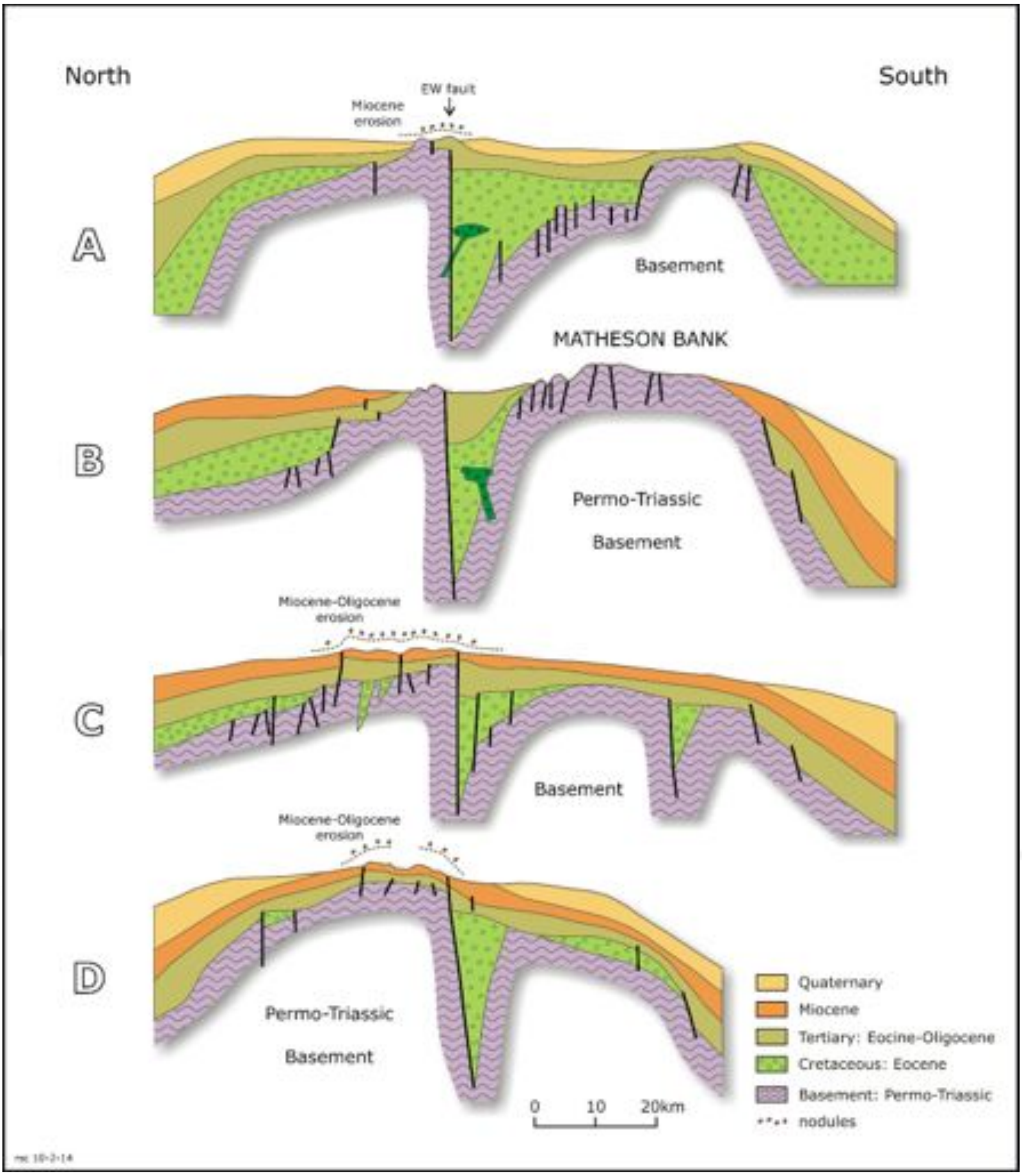

Figure 24: Sectional interpretation of the development of the Chatham Rise and associated phosphorite deposition (adapted from Falconer *et al.*, 1984).

During the Mid-Cretaceous (100 Ma), the first phase of Gondwanan break-up resulted in the regional formation of isolated lacustrine depositional centres that formed in east-trending extensional half-grabens. Initial terrigenous graben fill was followed by shallow marine sediments. The northern margin of the Chatham Rise formed as a plate subduction boundary. Subduction stopped following collision of the Hikurangi Plateau, a large igneous province, with the margin. The Bounty Trough, a failed extension of the New Caledonia and deep-water Taranaki basins, formed what is now the southern margin of the Chatham Rise.

Faulting had essentially ceased by the end of the Cretaceous (66 Ma) and, during the Palaeocene (65–55 Ma), was followed by land subsidence and shallow marine deposition punctuated with shallow marine volcanism. Igneous activity has persisted throughout the Cenozoic on the Chatham Islands, and igneous features are interpreted on seismic profiles to be Cretaceous and Cenozoic in age (Figure 24, Falconer *et al.* 1984).

Some faults were reactivated during the Eocene (55-33 Ma) giving rise to local depositional centres and regional subsidence on the flanks of the Chatham Rise. Pelagic nanno-ooze sedimentation continued during the Miocene, but ended in the late Miocene with erosion and phosphatisation. This time coincides with the general cooling of the oceans, the evolution of upwelling currents and increase in radiolarians (Kudrass & Von Rad, 1984).

Geochemical results indicate that the present size and shape of the phosphorite nodules is likely to be inherited from the original disintegration of Miocene chalks prior to phosphatisation, as almost all of the geochemical parameters of the nodules are size dependent (Kudrass & Cullen, 1982).

Evidence presented by Kudrass and Von Rad (1984) suggest the surface chalk pebbles were phosphatised during several Miocene phases of submarine erosion and hard-ground formation (Figure 25). Small elevations on the seafloor on the central part of the rise appear to be the result of Late Oligocene faulting. Kudrass and Von Rad (1984) suggest these areas may have been more favourable for the erosion processes and phosphorite formation. In the deeper areas phosphatisation was limited due to a slower rate of erosion and limited exposure of the nodules. Each phosphatisation cycle added new phosphorite nodules to the elevated areas. During each cycle the pebbles were phosphatised up to size dependent saturation levels of 17 – 21% P_2O_5. Less phosphatised nodules were mostly eroded by the next erosional phase. These processes resulted in fairly uniform P_2O_5 concentrations of the nodules, irrespective of their provenance from phosphorite-rich or phosphorite-poor areas (Kudrass & Von Rad, 1984).

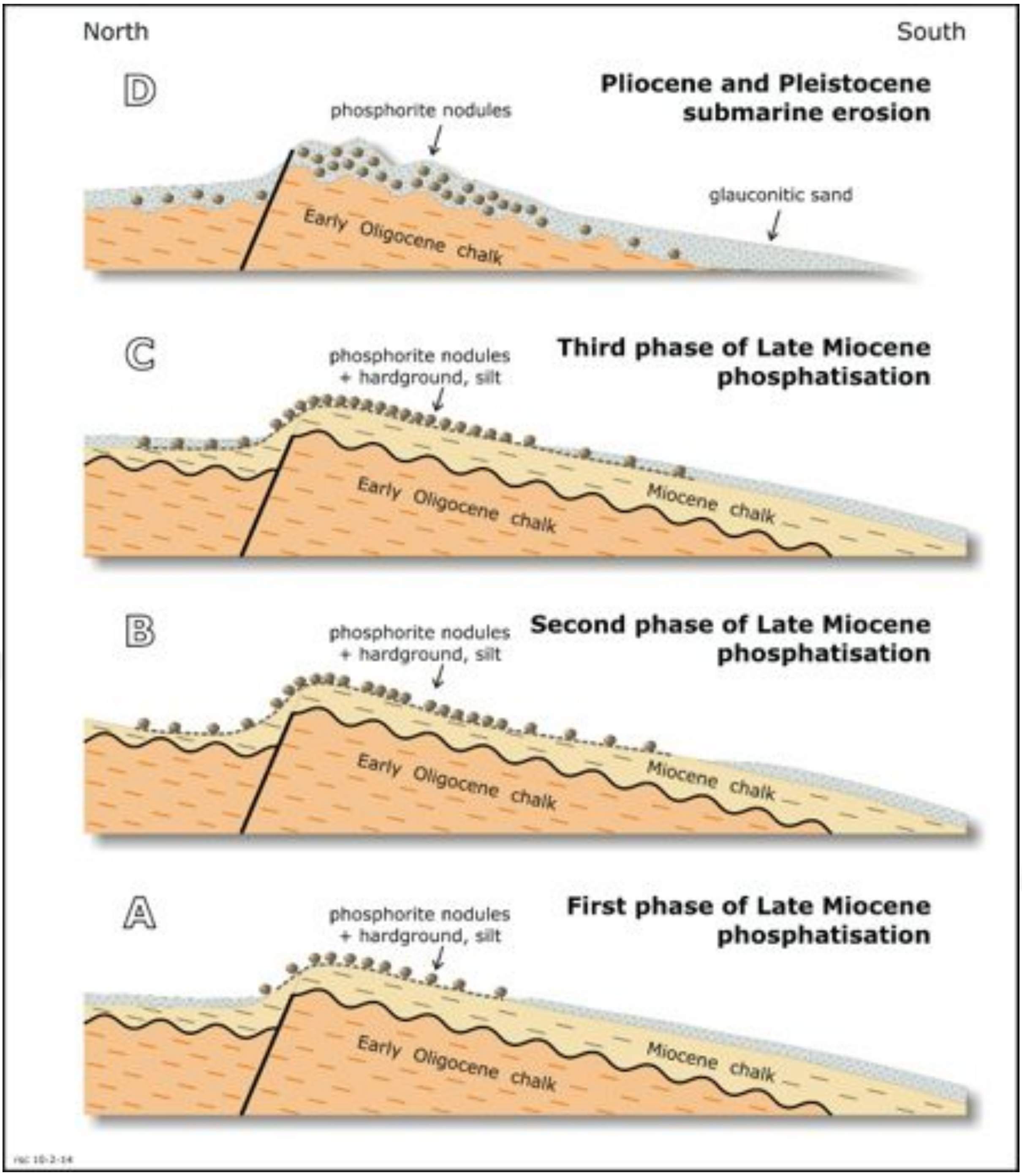

Figure 25: Schematic illustration of probable morphological control of phosphatisation with repeated cycles of partial burial, phosphatisation, erosion, and hard ground formation (adapted from Kudrass & Von Rad, 1984).

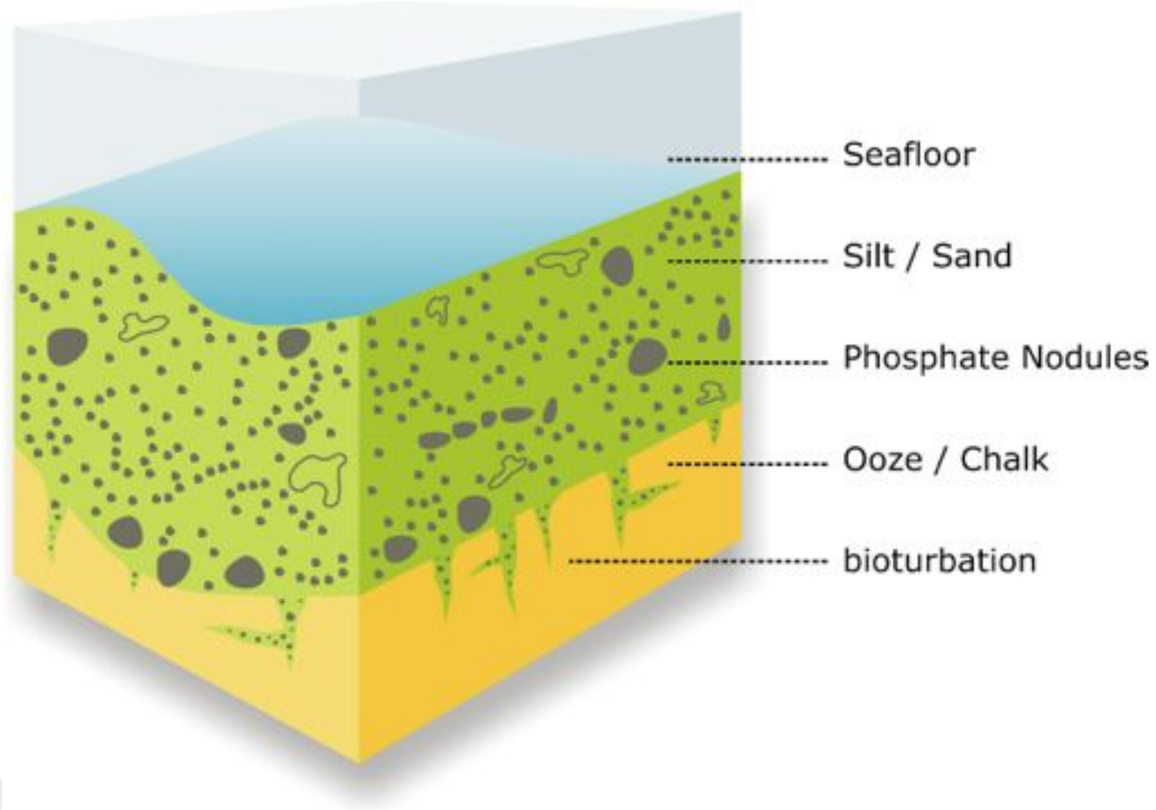

Figure 26: Schematic cross-section of phosphorite-bearing sand zone (adapted from CRP, 2012).

More recent studies by Zachos *et al*. (2001) and Haywood *et al*. (2004) on palaeoceanographic history of the Pacific Ocean and areas east of New Zealand have further detailed ocean current models and sea chemistry changes since the Miocene. Some of these findings have implications for the development and timing of phosphorite nodules on the Chatham Rise suggesting possible phases of phosphatisation being younger and the phosphorite deposits forming over shorter timespans.

The phosphorite deposit occurs as a thin layer of phosphorite-bearing glauconitic sand with an average thickness of 0.2 m, but can reach thicknesses of more than 0.5 m in places (Figure 26). The sand layer consists of mainly silt and sand-sized sediments, with the phosphatised chalk pebbles up to 15 cm in diameter. The layers would have been originally stratified with phosphorite nodule layers representing the periods of erosion and phosphatisation; however, later post-depositional modifications have resulted in these layers becoming disrupted. The underlying chalk layer occurs as a white ooze at the base on the sand. The upper 20-30 cm of this zone can be mixed due to bioturbation and include burrows filled with the overlying sand. The ooze also contains weathered chalk, an important constituent for phosphorite nodule formation. At depth, the ooze grades into an indurated chalk layer.

5.2 Seismic Facies

Mapping of the seafloor sediment units was undertaken on the *R.V. Sonne* using a Huntec high-resolution seismic system. The seismic facies are based on seabed morphology, amplitude of bottom reflection, distinct sub-bottom reflectors, and seismic stratigraphy of the sub-bottom geology (Falconer *et al.*, 1984). There is a wide variety of seismic character even over short (100 m) distances, with boundaries showing both abrupt and subtle changes. The boundaries of the ten mapped facies are shown in Figure 27. Minor modifications have been made to the boundaries by Kenex (2014) based on recent structural analysis and updated bathymetric data.

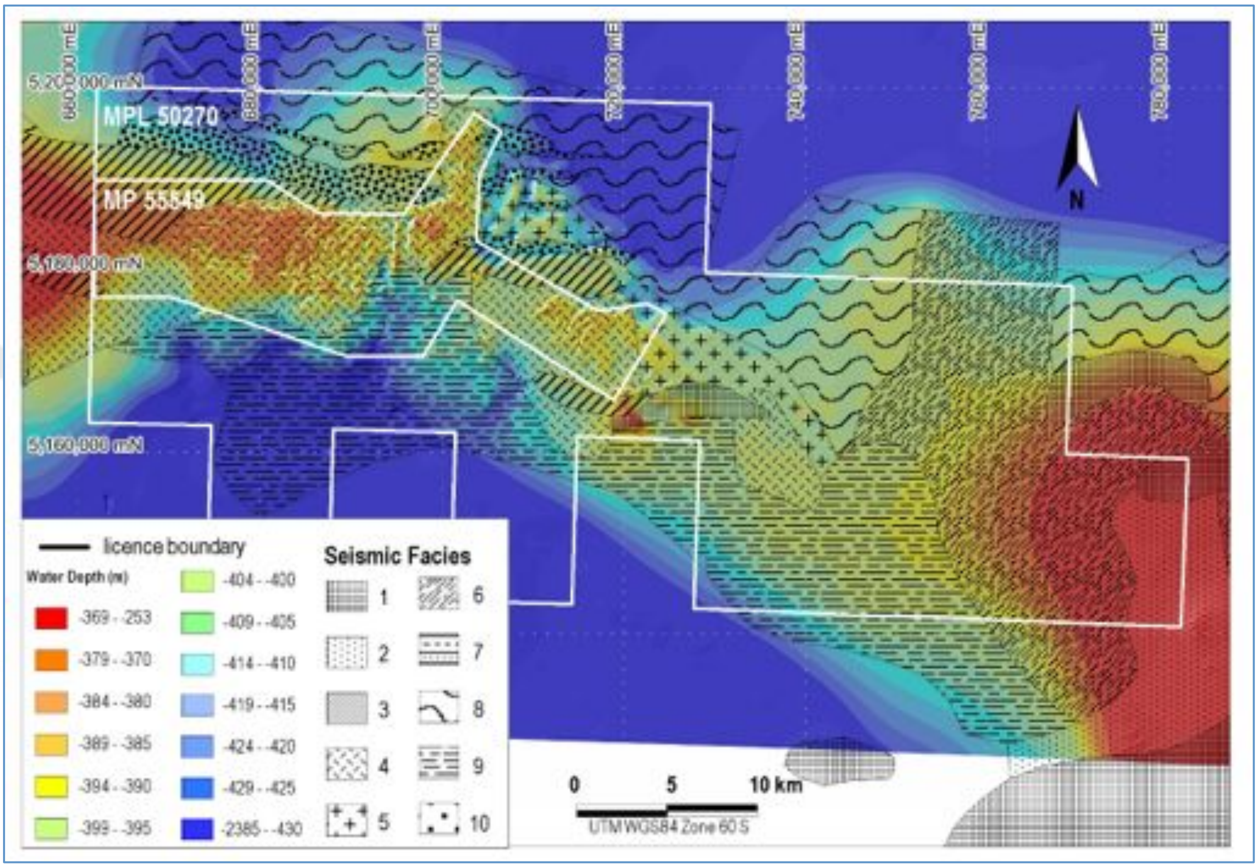

Figure 27: Seismic facies map (updated from Falconer *et al.*, 1984).

Based on the seismic work Falconer *et al.* (1984) suggested that the distribution of phosphorite did not appear to be directly related to structure or thickness of the major sedimentary units. However, there were correlations between the seismic facies and increased concentration of phosphorite. In the central part of the survey area the highest phosphorite grade is concentrated on unit 4 which spans the Early to Middle Oligocene and which is underlain by the older Unit 3. Unit 5 also flanks Unit 4 and may be associated with Unit 4. Prospectivity modelling by Kenex (2014) also showed the most prospective targets occur in areas of Oligocene and Miocene chalk in the central saddle region, near local topographic highs and faults, in areas of samples with high relative nodule abundance. The largest and highest ranked deposits occur mainly within seismic facies 3, 4, 5 and 9.

5.3 Post Depositional Modifications

Glacio-tectonic processes have had a significant influence on the morphology of the phosphorite resource and Chatham Rise in general. Kudrass and Cullen (1982) first suggested the idea that gouging icebergs have a significant influence on the redistribution of the phosphorite and may partially explain the high short-range grade variability.

Furrows caused by movement of grounded icebergs and pits probably produced by rotating icebergs are the most important elements, ranging in scale from a few meters to hundreds of meters. These impacts shaped the morphology by excavating the chalk to a depth of 15 m along furrows and in the pits. The excavated chalk together with the top layer of phosphorite sand was displaced along the rims of the furrows and pits.

This process was probably repeated during each of the five main Pleistocene glacial periods. In the long interglacial periods the sea floor was smoothed by winnowing of the silt and sand, filling of the depressions, bioturbation and dissolution of the exposed chalk. Some previously buried phosphorite nodules were thus exposed and available for further phosphorite enrichment at the surface.

Furrows are the most prominent sea floor features on the multibeam swath bathymetry data in the CRP licence area. They appear at all scales of observation. Their widths range from one metre to 240 m. The largest furrow has excavated 30 m of chalk. Most of the larger furrows can be traced a few kilometres. The longest furrow is more than 25 km long (Figure 28). Large furrows are predominantly oriented northwest-southeast to northeast-southwest. Smaller furrows are much more variable in their directions. The larger furrows often have elevated rims of a few meters, where chalk is frequently exposed or is covered by a thin layer of glauconite-phosphorite sand. Many furrows are interpreted to have been partly filled by silt and sand. Preferential filling from one side, indicative of a preferred direction of sediment transport, was not observed.

Pit marks with a diameter of a few metres are visible on the ROV multibeam data; the larger ones visible on the regional bathymetric maps have a diameter of up to 700 m. The smaller pits are frequently round (up to diameter 50 m), the larger pits (up to a diameter of 300 m) have two different shapes: a triangular and lenticular shape with smooth well-defined rims or a sub-rounded shape with highly irregular rims. The depth of the medium-sized pits is about 10 m. Pits occur in almost all water depths of the investigated area. Kudrass and Cullen (1982) suggest the pits are thought to be made by grounded icebergs. Recent research conducted by Davy *et al*. (2010) and current research been undertaken by Geological and Nuclear Sciences suggest that the pock marks seen on the Chatham Rise are from gas release from dissociating hydrates during glacial-interglacial cycles. Pockmarks, observed in water depths of 500–700 m, may have formed during glacial periods by the movement of the seafloor out of the gas hydrate stability zone as sea level fell and, possibly, bottom-water warmed.

In the current environment the phosphorite layer continues to be modified through bioturbation, reworking and locally by slow deposition (Kudrass & Von Rad, 1984). The bioturbation holes and furrows can be up to 20 cm deep and 70 cm wide.

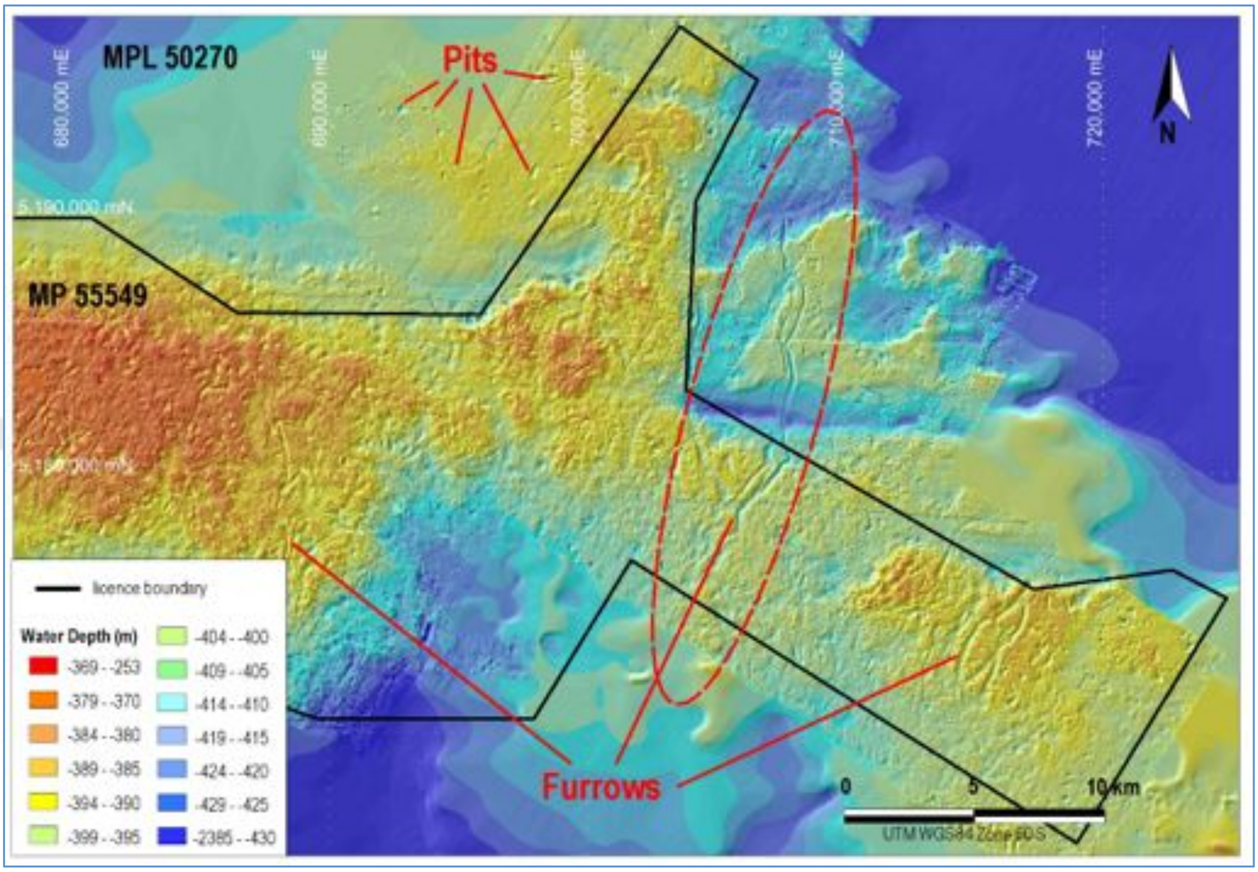

Figure 28: Interpreted iceberg furrows as seen on bathymetry data.

5.4 Mineralisation

The Chatham Rise phosphorite is comprised of phosphorite nodules that are loosely distributed within a layer of Neogene-age glauconitic sand commonly about 20 cm thick but locally over 1 m thick. This sand is a pelagic lag deposit comprised of 20% to 40% silt and 30% to 60% fine to very fine-grained sand. Thickness of the glauconitic sand varies over distances of tens of metres or less. The concentration of phosphorite nodules varies both vertically and laterally.

Kudrass and Von Rad (1984) suggested two possible modes of phosphatisation resulting from diagenetic processes.

1. Replacement of CaO in pore water of organic-rich anoxic sediments, with phosphorus released through bacterial activity (Figure 29). This process is common on the upper continental slopes and outer shelf areas with upwelling nutrient rich water.
2. Replacement of CaO by direct uptake of phosphorus dissolved in seawater (Figure 29). Absorption of phosphorite onto organic coating of the chalk may enhance this process. The process seems to be limited to areas with phosphorus-rich seawater, but recent examples have not been found.

Kudrass and Von Rad (1984) suggest phosphatisation during burial is the most likely option, but that further studies were required.

Phosphatisation was followed by glauconitisation and silicification of the nodules. Sand and mineral-filled fractures and borings on the surface of nodules were subsequently cemented by later stage diagenetic processes (Figure 29).

The present composition of the phosphorite nodules originated during the late Miocene by diagenetic replacement of the chalk pebbles (Figure 29, Kudrass & Von Rad, 1984). Apatite based cement replaced pre-existing glauconite suggesting that the main Late Miocene phosphatisation event was followed by minor authigenic phosphatisation which mainly cemented fractures and bore holes (Kudrass & Von Rad, 1984).

Later stage mineral input is derived from volcanic ash which added rhyolite glass and pumice into the phosphorite-glauconite sand. The source of this material is thought to be from eruptions at North Island volcanic centres in the last 40,000 years (Kudrass & Von Rad, 1984).

Later modification by icebergs (see Section 5.3) resulted in the reworking of phosphorite material to create a highly irregular distribution. It is possible that the gouging icebergs removed the phosphorite in the furrows and created higher grade phosphorite accumulations along parallel ridges beside the furrows (Figure 29).

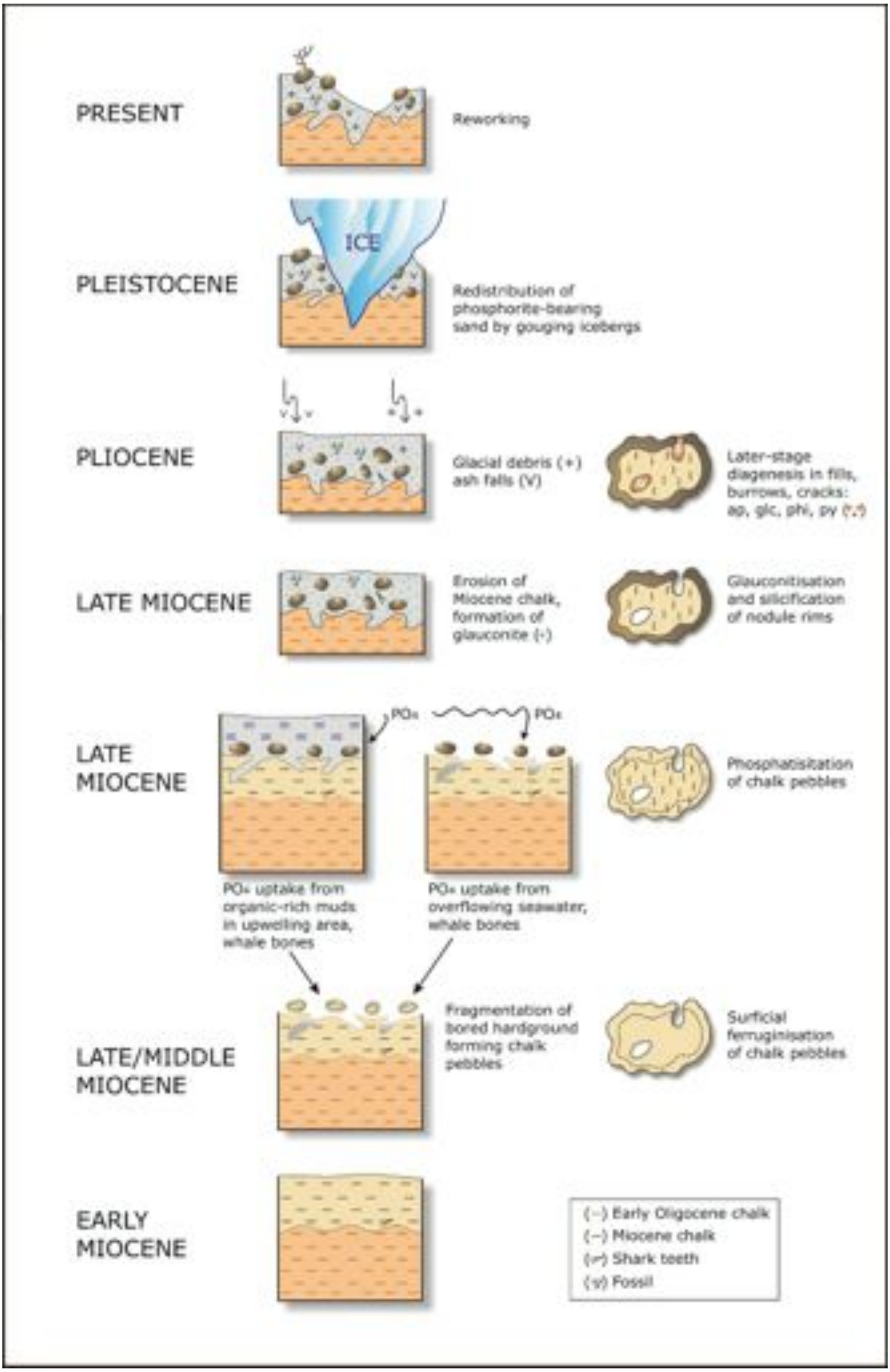

Figure 29: Evolution of the Chatham Rise phosphorite deposit and associated sediment with alternative models for the phosphatisation process (adapted from Kudrass & Von Rad, 1984).

The main diagenetic minerals are collophane, goethite, glauconite and amorphous opal. The concentric zonal distribution of these minerals within phosphorite nodules is described by Von Rad and Rosch (1984; Figure 30) and is detailed below, from core to rim:

1. Weakly phosphatised chalk core;
2. Outer phosphatised chalk zone;
3. Goethite zone;
4. Collophane zone;
5. Glauconitisation of nodule rim, with local silicification (opal); and
6. Minor pyrite.

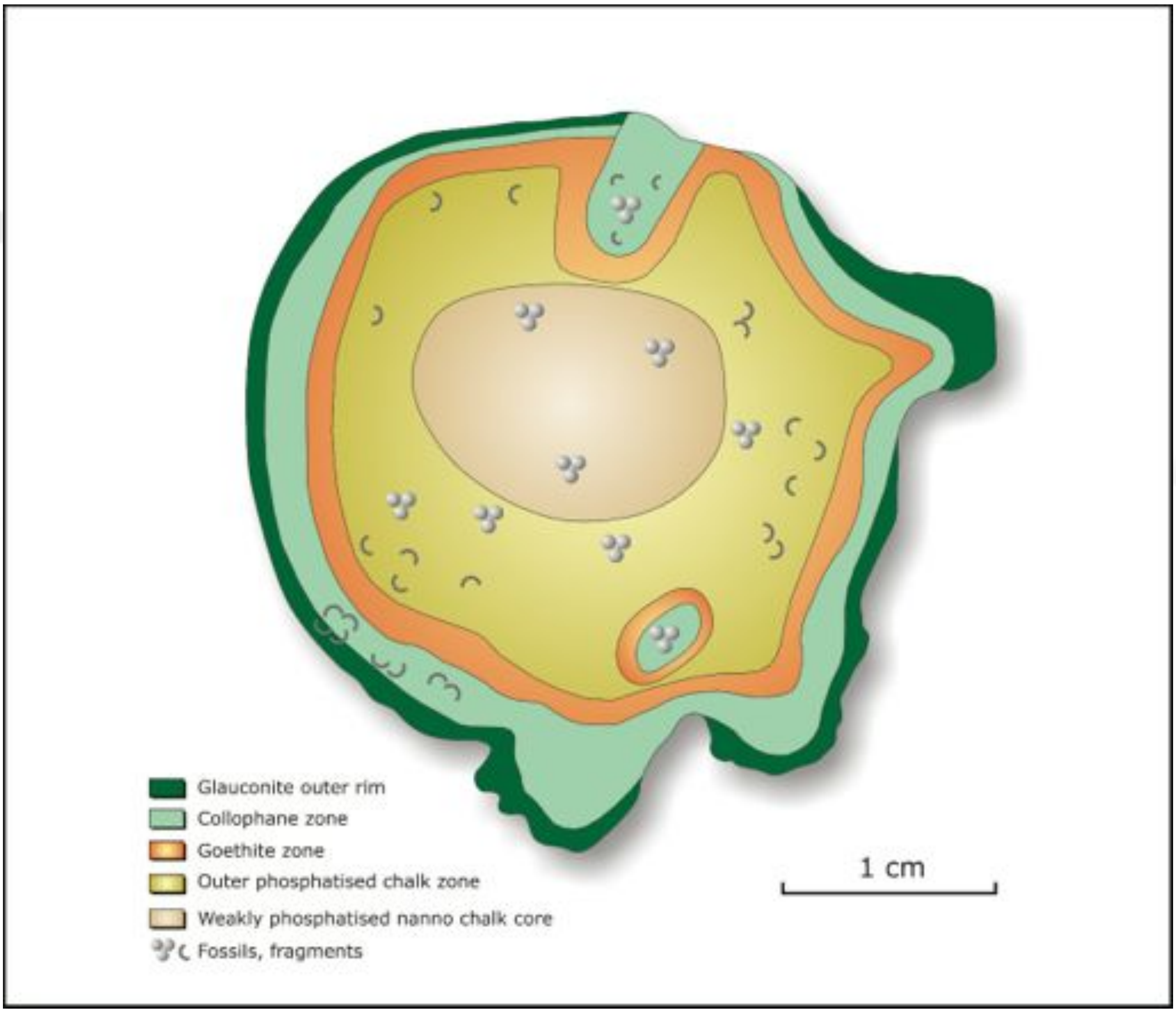

Figure 30: Schematic cross-section of a typical phosphorite nodule (adapted from Von Rad & Rosch, 1984).

The phosphorite nodules are commonly covered with bioturbation structures and have been overgrown on the surface by various marine organisms. Some of this activity has occurred on the chalk prior to phosphatisation and is filled by calcite, collophane, opal, or older glauconite cement.

The goethite (-collophane) zone grades outward into a carbonate-free collophane zone and into a 0.3 to1.2 mm-thick greenish-black, carbonate-free glauconite (collophane) rim.

Phosphorite is very rare in the 250–500 µm grain size fraction of nodule constituents (5%), and becomes more frequent above 500 µm. A thin-section study of small grains revealed that their composition is similar to that of the larger phosphorite pebbles (Von Rad & Rosch, 1984). Von Rad and Rosch (1984) distinguish the following types of phosphorite nodules:

- round pellets consisting of structureless, slightly brownish collophane with relief of glauconitic pellets;
- phosphorite pebbles with a thin 15-25 µm glauconitic rim and marginal cracks filled with glauconite; and
- partly glauconised phosphorite with glauconite rim, collophane matrix and foraminiferal ghosts replaced by cellophane, fresh glauconite or iron oxides.

Major element and trace element geochemistry has been studied by Pasho (1976), Kudrass and Cullen (1982) and Von Rad and Rosch (1984). Significant differences were noted between coarse and fine fractions:

- large nodules (>8 mm) have higher CaO (48.6%) and lower P_2O_5 (19.4%), K_2O, SiO_2, and Fe_2O_3 values; and
- smaller nodules have lower CaO (39.6 %), but higher P_2O_5 (21.8%), SiO_2, Fe_2O_3 and K_2O CaO. The elements Si, Al, K, Rb, Mg, and Fe are positively correlated with glauconite; only Ca, Sr, and loss on ignition correlate positively with calcite abundance.

Analyses by x-ray diffraction show that apatite and calcite are the main mineral constituents. Analyses on separated *Sonne* samples show apatite contains P_2O_5 up to 30.05% (see Section 11, Jim Johnston, 2013). The apatite mineral is assumed to be francolite (carbonate-fluorite-apatite) (McClellan & Gremillion, 1980). RSC notes that the assays and geochemistry discussed here are not necessarily representative for the Mineral Resource and further work is required to establish more accurate phosphate grades for the Chatham Rise deposit.

6 Deposit Types

Phosphorites are classified as sediments that include significant portions of authigenic and biogenic phosphorite minerals, mainly the calcium-fluorapatite mineral francolite ($(Ca, Mg, Sr, Na)_{10}(PO_4CO_3)F_{2\text{-}3}$). Most commonly, a lower threshold of 18% P_2O_5 is used for the definition of phosphorite (Paytan & McLaughlin, 2007).

Phosphorite deposits are known in ocean basins around the globe and have formed during numerous time intervals throughout geological history as the result of intensive phosphorus accumulation and subsequent authigenic francolite formation. Many phosphorite deposits were formed during the Miocene approximately 23 to 5 million years ago.

Input of phosphorus into the oceans is by fluvial transport of organic and inorganic phosphorus compounds (usually carried by iron oxyhydroxide) from the weathering of sedimentary and igneous rocks. Phosphorus is eventually transferred into the deep ocean where most of it is reintroduced into the photic zone by upwelling. A small fraction (~5%) is removed from the water column predominantly by primary production as organic phosphate, and partially as inorganic phosphate through adsorption to Fe and Mg oxyhydroxides, or authigenic phosphate mineralisation (Figure 31, Paytan & McLaughlin, 2007).

Diverse theories regarding the genesis of phosphorites have been published. In all of these, the association of extensive phosphorite deposits with the fringes of oxygen minimum zones and reducing sediments has led to the conclusion that the dissolution of phosphorus is initiated by the oxidation of organic matter during sulphate reduction. When saturation of dissolved phosphorus is reached in the interstitial water, phosphorite can precipitate in an inorganic form through physical-biochemical processes.

Modern marine phosphorite deposits are not widespread and are restricted to the continental margins off South Africa, the Gulf of California, South America, Eastern Australia and New Zealand. A number of these regions (Chile-Peru, California, offshore South Africa and New Zealand) are almost exclusively associated with the upwelling of cold nutrient-rich waters onto continental shelves, organic-rich diatomaceous sediments, low net sediment-accumulation rates and low oxygen availability at the sediment-water interface. Upwelling provides a continual supply of nutrients to the surface waters, resulting in high primary productivities.

Phosphorite forms diagenetically within anoxic sediments due to the microbial decay of organic matter which enriches interstitial water in dissolved inorganic phosphorite. These areas are also characterised by current-dominated sedimentary regimes that are responsible for cycles of sediment reworking and subsequent phosphorite lithification.

However, phosphorite deposits in some of these regions, in particular western South Africa and Eastern Australia, have shown that decaying organic matter does not seem to supply the majority of dissolved inorganic phosphorite that sustains francolite growth; other sedimentary processes, such as Fe-redox cycling or fish-bone dissolution, might contribute much of the dissolved inorganic phosphorus required to form phosphorite.

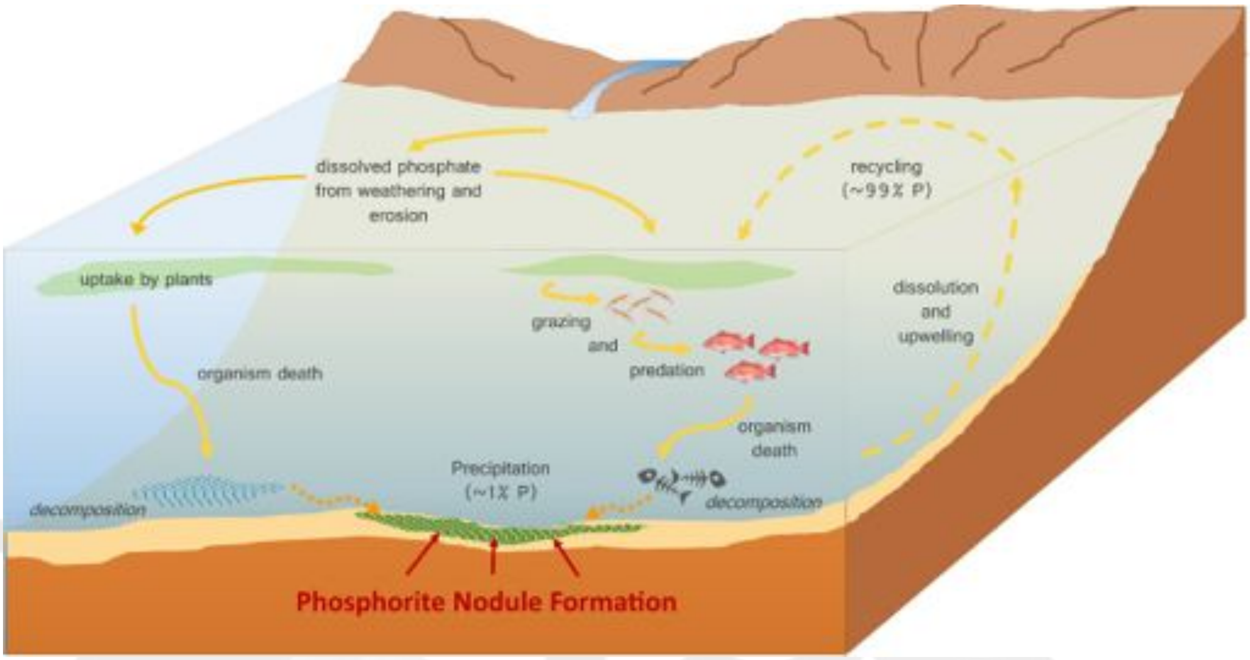

Figure 31: Phosphate Cycle (adapted from Paytan & McLaughlin, 2007).

7 Exploration by CRP

CRP has conducted two exploration programmes between 2010 and 2012 which have consisted of a total six cruises. The purpose of the cruises was to collect a variety of data including samples for phosphorite grade estimation, geochemical analysis, geotechnical samples, geophysical surveys and environmental base line data.

7.1 *M. V. Tranquil Image* (CRP, 2011)

The two campaigns of seafloor sampling that were carried out by CRP in early 2011 were done under contract by IXSurvey Australia Pty Ltd (IXSurvey 2010, 2011). The vessel used for both cruises was the *M.V. Tranquil Image* owned and operated by Western Work Boats Ltd. of Tauranga, New Zealand.

Table 14: *Tranquil Image* cruise activity.

Cruise No	Date	Activity	Amount
1	May 2011	Van Veen sampling	23
		Deployment of current meter mooring	1
		CTD casts	4
2	May 2011	Van Veen sampling	32
		Deployment of Turbidity monitors	2

7.1.1 Sample Locations

During the two cruises sample locations were determined by GPS. The approximate location was established by the navigation equipment installed on the vessel and the actual sample location was recorded using a hand-held GPS at the time the sample was taken on board. GPS is a satellite-based radio-navigation system with precision of 5 m.

Penetration depths were not recorded for the *Tranquil Image* grab samples so the depth of sampled sediment is unknown, however the dimensions of the grab mean maximum sample depth is approximately 30 cm.

7.1.2 Sampling Method

Sediment samples were collected at pre-determined locations. The samples were collected using a Van Veen grab sampler provided by NIWA. The Van Veen grab sampler used for this programme was small and had a surface area of 0.25 m^2 (Figure 32). The range of total sample weights varied from 2 to 40 kg. Due to the Van Veen grab's limited weight and non-powered jaws it had a maximum sample depth of 30 cm. As with the *R.V. Valdivia* the grab also had issues with stones and nodules being caught in the jaws and allowing sample loss.

Sample volumes have not been evaluated as penetration depths for the samples were not recorded. The shallow depth of the sample penetration and lack of chalk or ooze in samples indicate that the Van Veen grab has generally failed to test the full thickness of the glauconitic sand layer. Sampling activity undertaken during the *Tranquil Image* cruises is summarised in Table 14.

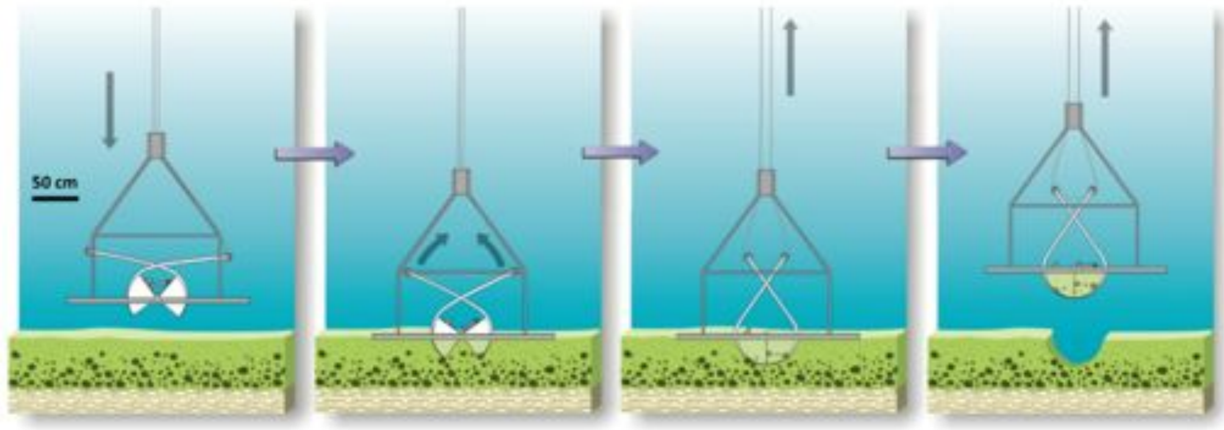

Figure 32: Sampling method with NIWA Van Veen.

7.2 *R.V. Dorado Discovery* (CRP, 2011 and 2012)

CRP chartered the *Dorado Discovery*, a 100 m long fully equipped research vessel, from Odyssey Marine Exploration for work on four consecutive cruises:

Cruise 1: In December 2011 the *Dorado Discovery* completed a 12-day voyage mapping the seafloor and collected 715 km^2 multi-beam swath bathymetry data, 199 km^2 side scan sonar data, and 263 km of sub-bottom seismic reflection and magnetic data. The main objectives of this cruise were to improve knowledge of the distribution of phosphorite on the Chatham Rise, to provide information that will support the development of suitable mining technology and strategy, and to establish target areas for a follow-up geotechnical cruise. Four areas in the western part of MPL 50270 were identified as primary survey targets, with another four areas as possible targets. The two oceanographic moorings previously deployed by IXSURVEY were also retrieved during this cruise and the current and turbidity data were downloaded for processing and analysis (Wood, 2012).

Cruise 2: From January 31st to February 10th 2012, the *Dorado Discovery* was used to collect additional multi-beam swath bathymetry and to test a large clamshell grab sampler for sediment sampling. The grab sampler weighed approximately 2 tonnes and had a cross-sectional sampling area of 1.42 m (width) x 2.03 m (length). Remotely operated underwater vehicle ("ROV") dives were undertaken to view the seabed before and after grab sampling to assess the size and shape of the 'scar' left by the grab. Although it was planned as a test-run, all 50 of the potential sites were sampled, recovering more than 32 tonnes of sediment. Sample sizes ranged from approximately 300 kg to almost 2,000 kg. A total of forty-three 30 cm push cores were taken from suitable grab samples. In addition to the cores, 172 subsamples totalling more than 500 kg were taken from the grabs, and the remaining material collected into bulker bags (Nielsen & Berthelsen, 2012).

Cruise 3: During March 2012, the bottom dwelling pelagic and benthic ecology of the Chatham Rise was investigated, with a view to examining the potential impact of mining on seabed ecology. A team of ecologists and geologists from NIWA, GNS Science, Golder Associates ("Golder"), and Kenex conducted the data collection and sampling, using a ROV to conduct photographic traverses to document the seafloor (totalling 17,003 still photographs and 143 hrs video footage) and a 20 x 30 x 45 cm box corer to collect 130 sediment samples. Three attempts to collect sediment using a small Van Veen grab were unsuccessful and one grab sample was collected using the large clamshell grab previously used during Cruise 2. Additional multi-beam swath bathymetry data were also collected on this cruise (Nielsen *et al.,* 2012a).

Cruise 4: During April 2012, the geotechnical properties of the seabed were determined by performing in-situ tests and collecting sediment samples, with the aim of optimising the design of the dredging equipment proposed by Boskalis for mining the Chatham Rise phosphorite deposits. Sediment sampling was conducted using a 400 kg vibrocorer equipped with interchangeable 3 m barrels of 80 mm and 150 mm diameter; and a 1200 kg box corer measuring 50 x 50 x 50 cm with dual closing shovels that could have an additional 600 kg of weight added. Cone penetration tests ("CPT") were conducted using a 2 cm^2 cone and 1,000 kg thrust capacity capped at 25 MPa and ROV jetting tests were conducted to establish the jetting strengths needed to mobilise the target sediment. When weather did not permit safe operations on deck, multi-beam swath bathymetry data were collected to expand the existing mapped area (Nielsen *et al.,* 2012b).

Table 15: *Dorado Discovery* cruise activity.

Cruise No	Date	Activity	Amount
1	Dec 2011	Multi-beam swath bathymetry	715 line km
		Magnetometer	217 line km
		Sub-bottom profiler	271 line km
		Side scan sonar	197 line km
2	Jan to Feb 2012	ROV dives and seabed descriptions	3
		Multi-beam bathymetry	
		Grab samples	50 attempts
		Push cores	43
		Subsamples	172
		Vane shear test	29

3	Mar 2012	ROV dives	14
		ROV lines	42
		Multi-beam bathymetry	
		Box cores	130 attempts
		Van Veen grab samples	3 attempts
		Grab sample	1
		Push cores	81
4	Apr 2012	ROV jet tests	3
		Multi-beam bathymetry	426 km^2
		Vibrocores	21 attempts
		Box cores	8 attempts
		CPT testing	134
		Bulk density	10
		Vane shear tests	24

7.2.1 Sampling Method

Seafloor sampling was conducted using the large clamshell grab and box corer. Despite its size and weight, the large clamshell grab sampler had poor penetration power, especially in nodule-rich sediment. It was lowered to the sea floor and closed by recalling the cable, causing the hinge of the bucket to rise and the jaws to close under their own weight (Figure 33).

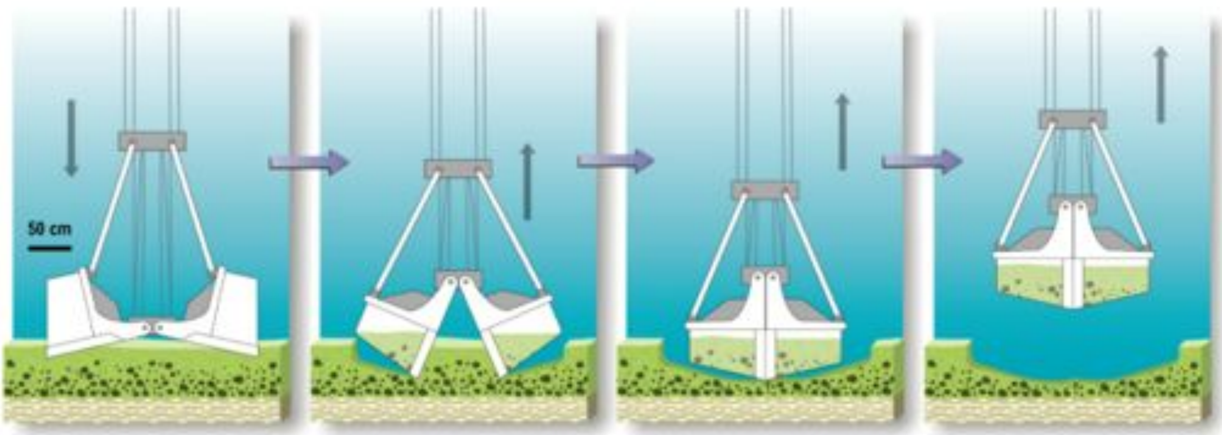

Figure 33: *Dorado Discovery* clamshell grab sampling process.

The grab was an "ex-junk yard" grab and not specifically designed for undersea sampling. In addition to poor penetration power relative to its size, the main drawback of the clamshell grab as a sampling tool is that it was not enclosed, resulting in washing of the contained sediment when the grab was retrieved, particularly at the sea surface where it was exposed to wave action (Figure 34). Most samples were noted as having some degree of washing, and this was more pronounced when the grab contained smaller volume samples (Simon Nielsen, *Pers.Comm.*). How much material was lost to washing is unknown. In addition, geometry of the grab, 2.03 x 1.42 m when open and approximately 1.4 x 1.42 m when closed, indicate that the sampled sediment in the clamshell grab undergoes compression as the bucket closes (in a similar way to the sediment in the *R.V. Sonne* grab, discussed in Section 4.2.6), which has implications for the determination of true sample depth of the grab samples.

In addition to the large grab samples, 138 box cores were attempted during Cruises 2 and 3 of the *Dorado Discovery.* The first 130 samples were attempted using a 20 cm x 30 cm x 45cm box corer (Figure 36), and the remaining eight cores were collected using a 50 cm x 50 cm x 50 cm box core with dual-closing shovels. A total of 119 bulk samples were collected using the box cores. Problems were encountered with the dual-shovel closing mechanism not operating correctly and several attempts to adjust the apparatus were unsuccessful. Sampling with the box corer was discontinued during Cruise 4.

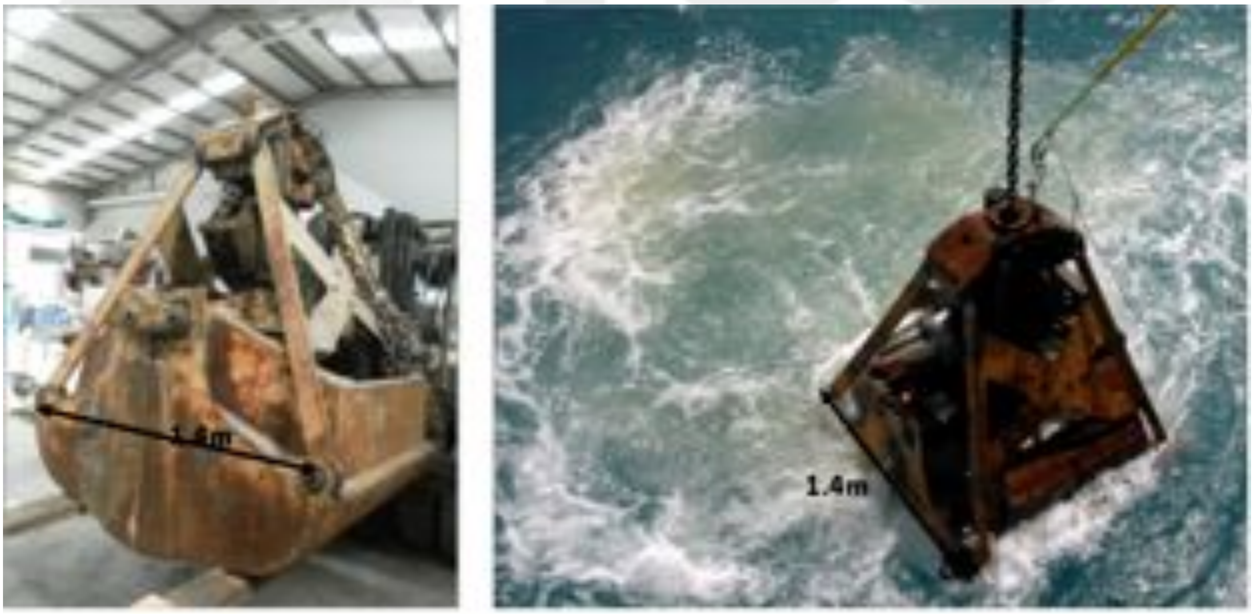

Figure 34: The clamshell grab used on the *Dorado Discovery*; as it was not enclosed (left) sediment was washed from the bucket during retrieval as can be seen from discolouration of the water surrounding the grab (right).

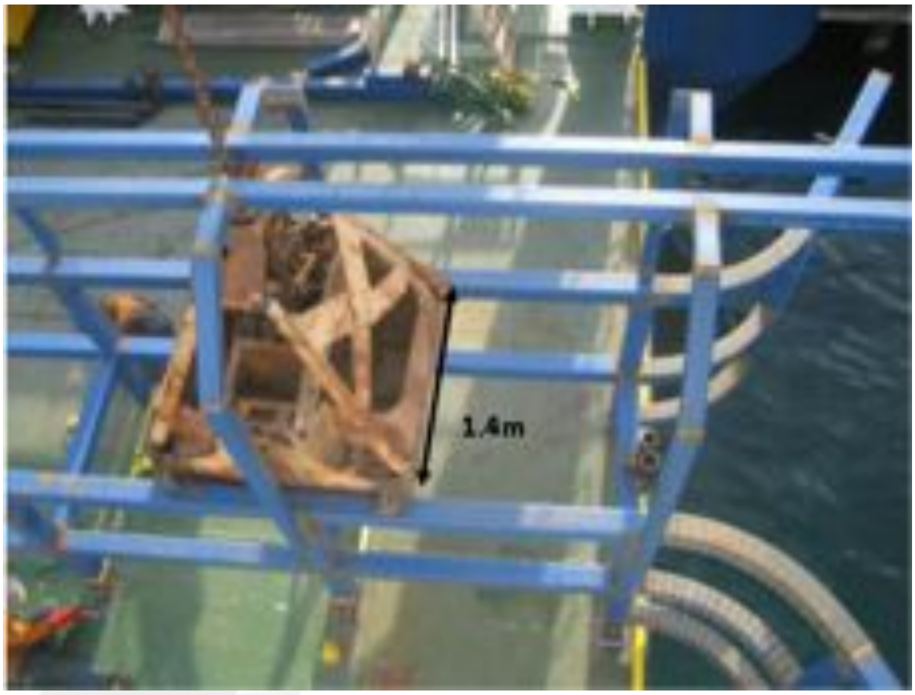

Figure 35: Dorado Grab sample retrieval.

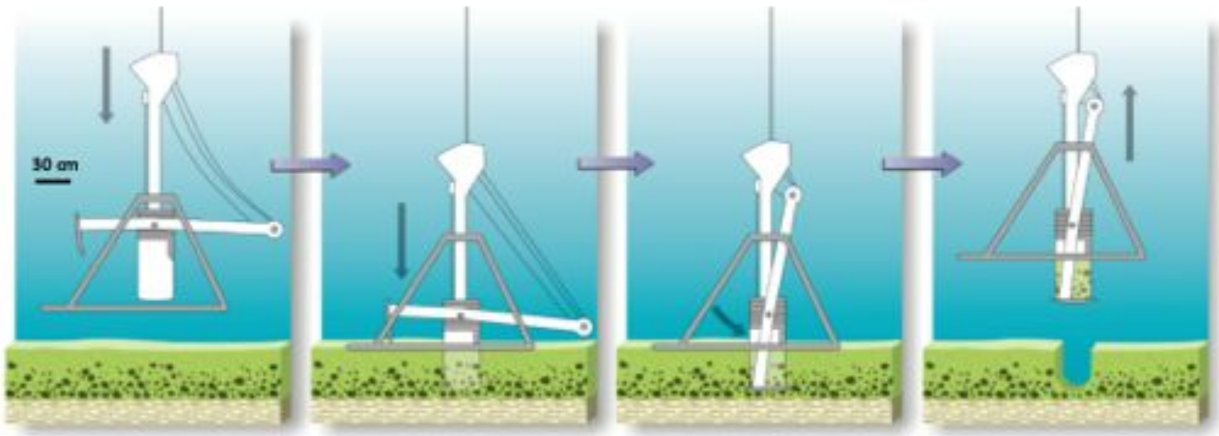

Figure 36: *Dorado Discovery* box core sampling.

Cruise 4 of the *Dorado Discovery* also collected 14 vibrocore samples (from 21 attempts) using a 400 kg, 3.5 m long vibrocorer equipped with a 3 m long, 80 mm diameter barrel. In addition, 134 CPT tests were conducted using a Neptune 3000 Miniature Coiled Rod cone penetration test system utilising 2 cm^2 rods and a 1,000 kg thrust capacity. For safety the maximum applied pressure was capped at 25 MPa.

8 Drilling

No drilling has been conducted within CRP's tenements. All sampling conducted within the licence has been discussed under Sections 9.

9 Sample Preparation, Analyses and Security

9.1 *M.V. Tranquil Image* Cruise

9.1.1 Sample Preparation and Analysis

When the Van Veen sampler was retrieved, water was drained from the closed shell to minimise water in the sample material. The shell was then opened and the sample material collected in a plastic tub. Material that did not fall freely from the sampler was scraped into the tub. Two subsamples were taken from the bulk sample using a shovel. Provided that sufficient material was retrieved, samples from the Van Veen sampler were normally divided into three portions. Two samples of approximately 5 kg each were placed into sealed plastic bags; one was frozen within several hours of collection and the second was refrigerated. Any remaining sample material was placed in a large, open-topped plastic bag and stored on deck. From the 55 sampling attempts, 45 samples were collected. On the second cruise, the sampling process and the taking of sub-samples was witnessed by a consultant geologist on behalf of CRP.

On return to Tauranga and Napier (for the first and second cruises, respectively) the samples were freighted to the GNS facility in Lower Hutt where they were weighed and visually examined. Subsamples from ten grab samples were submitted to Waikato University for analysis. Samples were wet sieved into gravel (>2 mm), sand (2 mm – 0.063 mm) and mud (<0.063 mm) fractions. A small representative volume of the mud fraction was analysed using a Malvern Mastersizer 'S' laser diffraction particle size analyser to determine the percent of silt (0.063 – 0.004 mm) and clay (<0.004 mm) in the mud fraction. Each fraction was then dried at 50 – 105°C and weighed to determine the weight percent of gravel, sand and mud in each original sample. The sand fraction was then passed through a Franz-magnetic separator three times, with the level of discrimination between magnetic and non-magnetic material increased each time, to separate the sand into glauconite-rich and glauconite-poor fractions. These fractions, along with two bulk sediment samples, were weighed and analysed using a Spectro X-Lab 2000 fully automated X-ray Fluorescence (XRF) spectrometer to determine their major and trace element composition.

In addition, subsamples from 45 of the grab samples were sent to CRL Energy's Gracefield Laboratory for grain-size distribution analysis. After being washed through a 4 mm screen the >4 mm fraction was dry sieved and the <4 mm fraction wet sieved, separating the samples into a total of 21 size fractions ranging from <0.063 mm to 100 mm. A total of 73 sub-samples of the fractions were analysed for major element oxides by CRL using XRF.

9.1.2 Density and Moisture Content

Ten samples made up of composited material from 1 to 4 samples each were submitted to Boskalis Dolman Laboratory for Environmental and Geotechnical Research, to test nodule density and water absorption. One to six nodules from each composite were tested, totalling 36 analyses. Sample density was determined using the weight in water and weight in air method. Samples were dried at 110ºC for an unspecified length of time to determine their dry density. The samples' dry weights ranged from 1.9 to 69.8 g. When two outliers are excluded the samples yielded an average dry density of phosphorite nodules of 2.65 g/cm^3, an average wet density of 2.72 g/cm^3, and average water absorption of 2.8%.

9.1.3 QA/QC

Quality assurance and quality control was limited with only a basic description of the sampling process interpreted to represent the standard operating procedure. It is not reported what steps were taken to prevent sample bias or to control the accuracy and precision of the measurements and calculations.

9.1.4 Logging

For each grab sample the grab number, date, time (GMT), latitude, longitude and water depth were recorded and geological description made of the grab contents. A photograph of each sample was also taken. Data were entered directly into a spread sheet on-board the vessel.

9.1.5 Estimation of Phosphorite Grades (Ph kg/m^3) in Samples

RSC received lab test results for the 45 successful *Tranquil Image* grab samples which record sample wet weight and the dry weight percent of the >2 mm fraction of the sediment. However four of these samples are missing sample weights. This is insufficient information to reliably calculate the phosphorite grade of the samples. RSC also notes that the method of subsampling prior to sieving is not reported.

Phosphorite coverage has previously been estimated from the available data by assuming that the >2 mm fraction of sieved sediment was 100% phosphorite and multiplying the dry weight percent of this fraction by the wet bulk sample weight to estimate contained kilograms of phosphorite in the sample. This weight has been divided by the sample area of the grab (0.25 m, based on information provided by NIWA) to calculate phosphorite coverage for the samples. This estimated coverage ranges up to 45.0 kg/m^2 and averages 9.6 kg/m^2. RSC is concerned that the assumption that the entirety of the >2 mm fraction of the sampled sediment is comprised of phosphorite is not valid (see Section 9.2.5) and that the use of a weight percent determined from dry material proportioned against a wet sample weight will similarly lead to an overestimation of grade, as moisture content is not taken into account. The practice of removing subsamples for various onshore tests resulted in the original sample being reduced in size in a manner that is likely to add further error and possibly bias to the calculated phosphorite content.

RSC estimated grade for the samples by multiplying the dry phosphorite weight percentages of the samples by the average dry density of phosphorite nodules (2.65 g/cm^3), yielding unreasonably high grades ranging up to 2,246.8 kg/m^3 and averaging 677.4 kg/m^3 (Figure 37). Although this calculation may remove the error associated with calculating contained kilograms of phosphorite from a sample that has previously had material removed, it assumes that the sieved portion of the grab sediment is representative. In addition, using a dry weight percentage assumes that all the constituents of the bulk sediment have the same density, which is demonstrably not the case, and will therefore yield calculated grades that are significant overestimates of true grade. As grab samples were not processed in their entirety and data on the weight, volume and moisture content of the sieved samples are not included in the supplied analysis data, reliable phosphorite grades cannot be determined for the *Tranquil Image* samples.

In summary, RSC notes a number of concerns with the sampling process used on the *Tranquil Image*. Potential sample bias and assumptions affecting the *Tranquil Image* samples include:

- the Van Veen sampler was not mechanically controlled and lacked the ability to sample the entire nodule–rich sediment layer; no weights were used to facilitate greater penetration as was done with *R.V. Valdivia* sampling;
- nodules/erratics could get caught in the Van Veen jaws resulting in the sample being washed out;
- the Van Veen grab sample volume is too small to reliably sample the thickness and style of deposit;
- penetration depths were not documented;
- some sub-sampling has taken place on the ship, but it is unknown how representative these subsamples are;
- it is not clear from the sample data if the phosphorite weight percentages have been calculated from the whole sample or a sub-sample, and moisture content has not been adjusted for in calculating these weight percentages; and
- the phosphorite grade of the samples has been estimated using dry sieved weight percentages for sieved material over 2 mm and proportioned against the wet weights, resulting in an over estimation of grade.

RSC has only partially validated the *Tranquil Image* sample data. As with all other data sets the *Tranquil Image* samples have been assigned SQR values, but due to the incomplete record of sample processing results the samples have been assigned low quality rankings and have not been included in the data used for the resource model (Section 10.2).

No special security measures were taken in regard to the collection and storage of the samples.

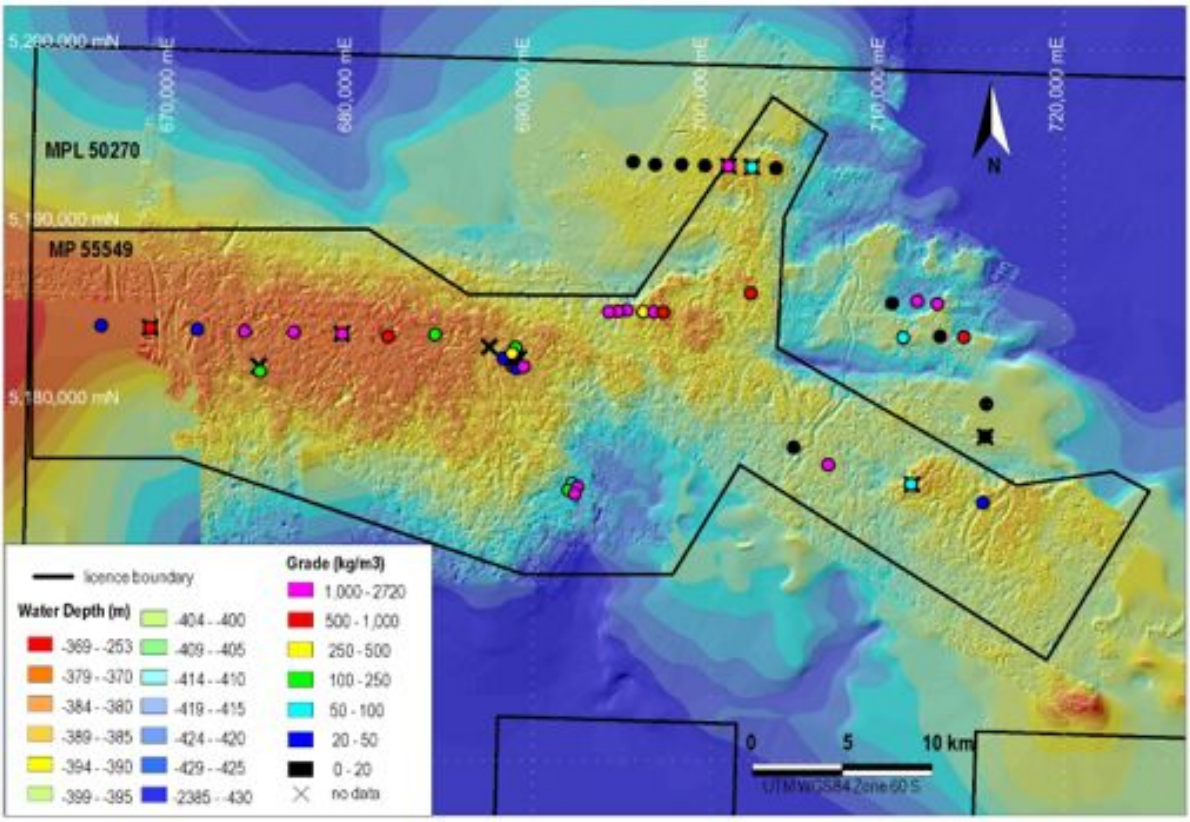

Figure 37: *Tranquil Image* sample locations and updated phosphorite grade (Ph kg/m^3).

9.2 *R.V. Dorado Discovery* Cruises

9.2.1 Sample Preparation and Analysis

Upon retrieval of the grab to the ship, the grab was guided into a custom-built cage to hold the grab steady while the sample was observed through openings in the top of the grab and push cores inserted. The grab was then slid into position over the hopper where the sample could be dumped and collected.

The grab samples were observed and logged through openings in the top of the grab. Geologists carried out shear vane tests and then assessed the sample for its suitability for push coring. Grab samples containing concentrations of nodules with little greensand matrix were difficult to core due to the core tube being stopped if the tube edge hit a large nodule. To core, PVC tubes of approximately 20 cm length were capped in one end and marked with “up” arrows. The open end was slightly sharpened to give a cutting edge and pushed vertically into the sediment near the centre of the grab, well away from the often washed edges. If necessary, the cores were pushed as far in as possible by standing on them until they sank in fully.

Once preliminary observations and measurements were completed the grab was emptied over the collection hopper. The bulk sediment was described, the push cores were retrieved, capped and sealed (Figure 38). Further subsampling was undertaken for lithological samples; two to four samples (ca. 2 kg each) of the significant lithologies in each grab (including chalk/ooze if present) were collected into clear plastic bags, double bagged and labelled. Biota samples were collected if specimens were new, particularly well preserved or exhibited interesting features. All samples were stored on board at 4°C in a temperature-controlled container. Photographs were taken of the sediments in the sample pan. The remaining sample was then scrapped into large sample bags for storage. Weights of the bags were recorded before being stored.

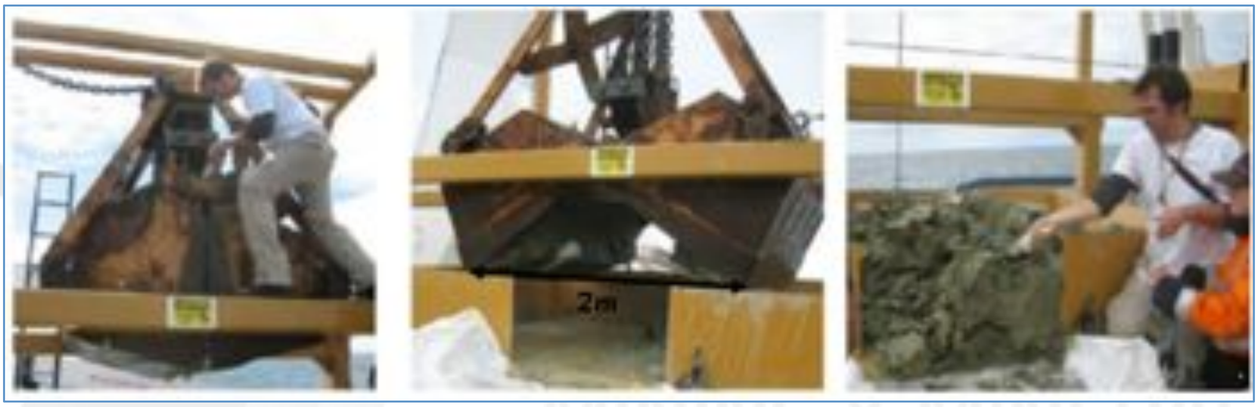

Figure 38: *Dorado Discovery* clamshell grab sample processing.

The main focus of the box core sampling on Cruise 3 was for ecological rather than resource assessment. Once box core samples were retrieved, surface characteristics of the sediment were noted and two push cores per box core sample were collected for geotechnical and biological assessment. The samples were processed aboard the *Dorado Discovery* with the top 15 cm of sediment being washed through a 500 µm sieve and the underlying sediment through a 1,000 µm sieve. Biological specimens were collected and both biological and sediment samples were stored in formaldehyde solution. Remaining sediment was bagged for geological analysis. Box cores from Cruise 4 were collected for geotechnical assessment. During Cruise 4 the box corer used had a detachable box so that samples could be weighed and have their bulk density determined prior to removal from the box. The sediment was described by a geologist and sampled in 10 cm intervals by Boskalis geotechnical engineers.

Vibrocores were retrieved by SEAS core technicians. When removing the core catcher, any sediment recovered was tagged as geo sample, bagged and labelled, and placed in cold storage. After determining the length of the recovered samples, the cores were marked in 1 m intervals starting from the top and labelled in sequential order. The cores were laid out on a rack for sectioning, and cut into the marked lengths using a pipe cutter. After inspection of the exposed ends, the sections were capped and moved to the refrigerated storage. The exceptions were any sections containing greensand and the transition to the chalk, which instead were taken aside for further logging and sampling.

Grab samples from Cruises 2 and 3 were processed post-voyage for geotechnical purposes by GNS and Kenex. Samples were separated into three size fractions: >8 mm; 0.8–8 mm and <0.8 mm. Geological analysis of the >8 mm and 0.8-8 mm fractions was carried out; the <0.8 mm fraction was not studied.

Forty-five >8 mm sample fractions were processed in detail. The grain lithologies were separated and described and phosphorite nodules were further classified by size. Each sub-fraction was then weighed to establish their proportion of the total >8 mm fraction weight. After analysis samples were returned to storage; no special security measures were necessary and the possibility of contamination or alteration of the samples was deemed extremely unlikely.

The 0.8 – 8 mm fraction of twelve of the grab samples was submitted to GNS where they were air dried and a subsample of the fraction spread out under a stereoscope and observed under ca. 50x magnification. Grain types were determined and classified using Powers Roundness Scale and ASTM 2488-00 for grain shape; grains were picked at random until a total of at least 200 grains were analysed per sample.

Samples from box cores collected during Cruise 3 were submitted to Boskalis for detailed grain size distribution analysis. Samples were dried, weighed and sieved into >8 mm, 2-8 mm and <2 mm fractions. Sample material from the box cores collected during Cruise 4 of the *Dorado Discovery* were assessed for geotechnical parameters by Boskalis.

9.2.2 Density and Moisture content

Push core samples collected from the grab samples yielded an in situ sample of the phosphorite-bearing glauconitic sand that was analysed for density. The samples had been sealed to retain the moisture content and were analysed by Boskalis in Netherlands. Density tests were conducted using the New Zealand Standard for soil testing: NZS 4402.5.1.3:1986 (Soil density tests - Determination of the density of soil - Test 5.1.3 Sampling tube method for the determination of the in situ density).

Due to higher concentrations of phosphorite nodules inhibiting core penetration into the sediment, the cores retrieved are biased toward the samples from fuller grabs containing less phosphorite.

Density analyses from the *Dorado Discovery* samples are summarised in Table 16. Analysis of the 44 push cores yielded bulk sediment densities ranging from 1.26 to 2.15 g/cm^3, with an average of 1.63 g/cm^3. Bulk density (nodules plus void space between nodules) analysis was also conducted on the >8 mm sieved fractions of seven grab samples and the 0.8-8 mm sieve fractions from five grab samples. The majority of the fractions are described as being 'clean nodules' with three also containing 'few limestones' or 'some shells'. Excluding one coral-rich outlier, the >8 mm and 0.8-8 mm fractions had a bulk density ranges of 1.57 – 1.68 g/cm^3 and 1.54 – 1.77 g/cm^3, respectively.

Table 16: Bulk sediment and bulk nodule densities determined from *Dorado Discovery* samples.

Sample type	Average wet bulk density	Number of samples
Push Core Bulk Sediment	1.63	44
Bulk phosphorite nodules >8 mm	1.57 – 1.68	5
Bulk phosphorite nodules 0.8-8 mm	1.54 – 1.77	5

9.2.3 QA/QC

Quality assurance and quality control was moderate. Even though detailed descriptions are available of the sampling process itself, flaws in the procedures and equipment used led to the quality of the sampling not being optimally assured. The accuracy and potential bias has not been assessed and no duplicate samples were collected to adequately assess precision.

9.2.4 Logging

Upon retrieval of the large clamshell grab the geologist assessed the sample by viewing it through openings in the top of the closed grab. For a full grab, the sample surface was easily reached but with limited overview of the surface. For a very small sample, the surface was unreachable safely, but easily viewed through ports in the grab. The surface composition and condition of the sample were described and biota and signs of disturbance were noted. The completeness of fill (penetration depth) of sediment in the grab was estimated and photographs were taken to visually record the sample surface.

Following emptying of the sample in the collection hopper a description of the bulk sediment was made; this emphasised sediment type and texture and, abundance of black sand and nodules, and recorded any layering and difference in sediment types in heterogeneous samples. The presence/absence of glauconitic sand, phosphorite nodules, clays and chalk was noted. The size and frequency of nodules were estimated, as well as overall sediment firmness. Infaunal or other biota not seen or unreachable from the top of the closed grab was logged and sampled. Photographs were taken of the bulk sediment in the hopper.

Upon retrieval of the box core samples, the surface composition of the samples was described prior to the corer being opened and the thickness of sediment in the box estimated. Descriptions used standard sedimentary descriptors, with emphasis on the presence/absence of black sand and phosphorite nodules (including descriptions of their size and frequency). Visible biota was described and sampled if possible and photographs were taken of the sediment surface.

After the core sample was dumped into a collection bucket a bulk description was recorded, with an emphasis on sediment type and texture, the abundance of black sand and nodules, and the noting of any layering or difference in sediment types that was apparent in the samples. Photographs were also taken of each bulk sample in the collection bucket.

9.2.5 Estimation of Phosphorite Grades (Ph kg/m^3) in Samples

Grade estimation for the *Dorado Discovery* data was completed for the large clamshell grab and box core data. Grades needed to be calculated differently for each data set due to the differences in data collection and recorded parameters for the different sampling methods and analyses.

Coverage had previously been calculated for the grab data by summing the weights of the >8 mm and 0.8–8 mm sieved sediment fractions and dividing these by the sample area of the open grab (2.8 m^2), yielding a range in coverage up to 92.3 kg/m^2 and averaging 22.8 kg/m^2. RSC notes that:

- The weights of the sieved fractions reflect all of the sediment in that fraction; although the data indicate that phosphorite is the dominant constituent in both fractions for the majority of samples, non-phosphorite sediment constituents (such as shells, erratics and other lithics) have not been accounted for, and are known to be present in the samples (Berthelsen *et al*., 2012; Nielsen, 2012c); and
- Not all of the sediment in each grab sample was sieved, therefore calculated phosphorite content (kg) is likely to be an underestimate of the total amount of phosphorite in any given sample, which when divided by the sample area of the grab will yield a coverage lower than the actual coverage for that sample.

These concerns are in addition to the fact that the grab used for sampling was not fully enclosed, resulting in documented washing of the samples and sediment loss. This washing is likely to have preferentially removed fines from the grab samples, which would result in concentration of the coarser, denser phosphorite in the samples. This effect may have been somewhat mitigated by the size of the majority of the grab samples in that the proportion of sediment loss through washing may be overall smaller, but without detailed observations/estimates of the degree of washing that has occurred for each sample, all samples must be treated as having been "washed out". RSC notes that the quality of samples and sample data is significantly reduced by the unconstrained recovery losses associated with sampling using an un-enclosed grab.

RSC re-calculate grades for the *Dorado Discovery* grab samples using the available data. The detailed work conducted on the >8 mm sieved fractions of the grab samples (Berthelsen *et al*., 2012) yields the total contained kilograms of phosphorite in that fraction, which can be expressed as a percentage of the bulk sieved sample weight. This is a necessary step to remove the error caused by calculating phosphorite content in kilograms from sieved samples that are only a subsample of the original bulk grab sediment sample; however, it assumes that the sieved samples were representative of the bulk grab sample.

Volume percentages of phosphorite were determined for the 0.8—8 mm fractions of 12 grab samples by Nielsen (2012). Plotting the weight percent of phosphorite measured in the >8 mm sieved fractions against the volume percent of phosphorite observed in the equivalent sample 0.8—8 mm fractions (excluding outliers) yields a relationship that was used to roughly estimate the volume of phosphorite in the 0.8—8 mm fraction of samples that did not have that fraction assessed (Figure 39).

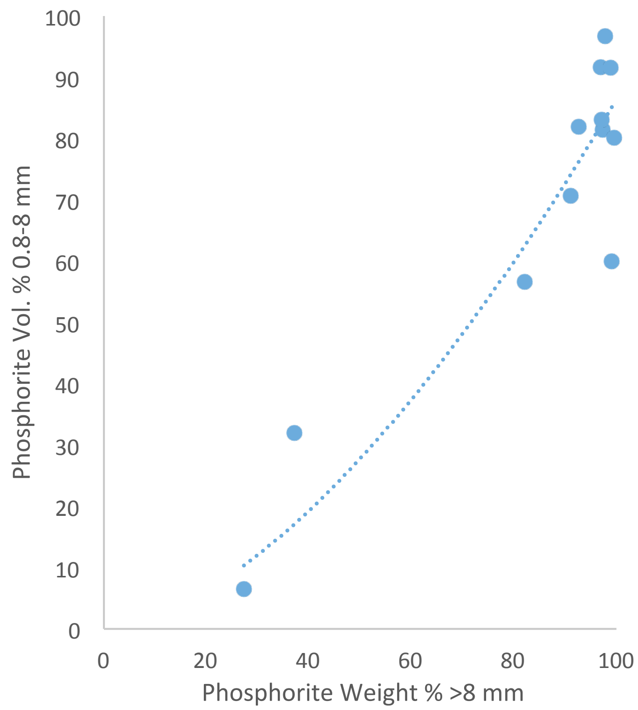

Figure 39: Relationship between sieved fraction phosphorite content in the *Dorado Discovery* grab samples.

Assuming comparable density of all constituents in the >8 mm fractions the phosphorite percentage for material >0.8 mm contained in the grab samples can be estimated. This multiplied by the average density of wet phosphorite nodules (2.72 g/cm^3) yields grades ranging up to 1,464 kg/m^3 and averaging 392.6 kg/m^3 (Figure 40).

RSC notes that the grade calculations are based on a large number of sometimes flawed assumptions and has coded those data with a lower SQR allowing them to be identified and restricted from being used in resource estimation.

True depth of the grab samples was calculated in an equivalent manner to the *R.V. Sonne* data. The clamshell grab was modelled in 3D and its cumulative volume calculated in 1 cm increments. These volumes were compared to the calculated volume of sediment sampled by the 2.03 x 1.42 m open grab in 1 cm increments to generate a conversion table of penetration depth to true depth for the clamshell grab. This assumes that the observed penetration depth of sediment in the grab reflects the penetration depth of sediment as it was originally sampled on the seafloor and has not been altered by washing. Since the grab was not enclosed and all samples are therefore considered washed it is likely that true sample thickness has been underestimated for the *Dorado Discovery* grab samples (Figure 41).

Multiplying the calculated grade of the grab samples by their calculated true depth yields coverages up to 209 kg/m^2 and averaging 51.7 kg/m^2. However, RSC notes that although the original coverages calculated for the Dorado Discovery grab samples are likely to be an underestimate, these coverages are likely to be an overestimate due to the use of a weight percentage in the grade calculation, assumptions of comparable density of sample constituents, and an underestimation of true sediment thickness due to losses during sample recovery. Due to the number of assumptions required to calculate grade from the grab sample data RSC has assigned the samples a low SQR resulting in their exclusion from resource estimations.

In addition to grab samples, 117 box core samples were collected during the *Dorado Discovery* sampling campaign, of which 21 were sieved into >8 mm, 2—8 mm and <2 mm fractions. The supplied data contain the calculated dry weight percentages of these fractions as well as the original sample wet and dry weights for the samples. As data from the *Dorado Discovery* grab samples indicate that >1 mm sieved fractions contain significant constituents other than phosphorite, RSC has factored the dry weight percentages of the >8 mm and 2—8 mm box core fractions down to account for non-phosphorite material in these fractions, using the grab sample sieve data for reference. For the >8 mm fraction of the grab samples the weight percent of phosphorite averaged 91% of the fraction weight, and for the twelve measured 0.8—8 mm grab sample fractions the phosphorite volume percent averaged 74% (excluding outliers). The box core >8 mm and 2—8 mm sieved fractions were multiplied by these percentages, respectively. RSC notes that applying a volume percent to a weight percent in the case of the 2—8 mm sieved fraction assumes that the density of all constituents is the same, which is not the case. RSC also notes that the difference between the sieved fraction ranges of 0.8—8 mm and 2—8 mm for the grab and box core samples, respectively, means that using the volume percent of phosphorite from the grab samples to proportion the weight percent of phosphorite in the box core samples is likely to be inaccurate and lead to an underestimation in grade as it does not take into account the removal of the 1–2 mm sand fraction (assumed to be comparatively phosphorite poor) from the box core sieved fraction. This is in contrast to the overestimation in grade expected if no correction factors are applied.

Summing the factored weight percentages of the sieved fractions and multiplying by dry weight of the sieved sample estimates gives the contained kilograms of phosphorite. Dividing this weight of contained phosphorite by the volume of each sample (estimated from the box area, 0.2 m x 0.3 m, multiplied by the thickness of the sediment in the box) yields sample grade (kg/m^3). Using this method, phosphorite grades range up to 707 kg/m^3 and average 186.6 kg/m^3 for the 21 analysed box cores (Figure 40). Excluding the sediment thickness from the equation calculates the coverage of the samples; this ranges up to 64 kg/m^2 and averages 17.9 kg/m^2. RSC notes that as push cores had already been collected from the box core samples prior to processing, calculated contained kilograms of phosphorite may be less than the total amount of phosphorite that was in the original sample. Similarly, dividing this value by the volume of the box corer sample rather than the volume of the sieved sample means that the calculated grades for the 21 measured box core samples are an underestimation of true grade. The errors and assumptions inherent in the calculation of the grades of these samples make them unreliable and consequently they have been assigned low SQR for the purposes of resource estimation.

For the remaining 96 box cores that weren't sieved, a visually estimated phosphorite percentage recorded for 82 of the samples is the only available data pertaining to their phosphorite content. Multiplying this, by the average wet density of phosphorite nodules (2.72 g/cm^3), yields rough grade estimates that range up to 2,720 kg/m^3 and average 4,438.5 kg/m^3 for the 82 cores (Figure 40). Multiplying grade by the thickness of sediment in the box for each sample, yields phosphorite coverages that range up to 204.0 kg/m^2 and average 28.5 kg/m^2. RSC notes that due to the lack of precise, measured data for these cores their calculated grades are not of sufficient quality to be included in resources estimations.

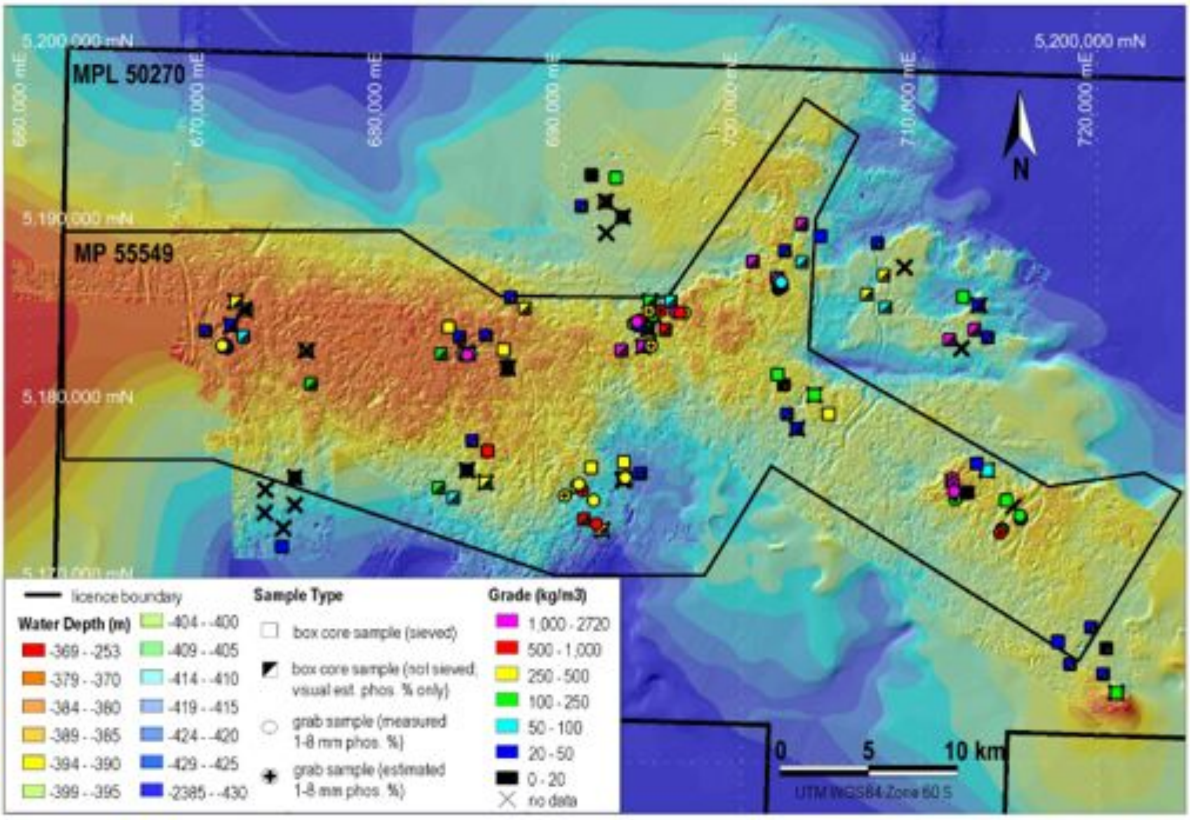

Figure 40: *Dorado Discovery* sampling methods, sample locations and estimated grades (Ph kg/m^3).

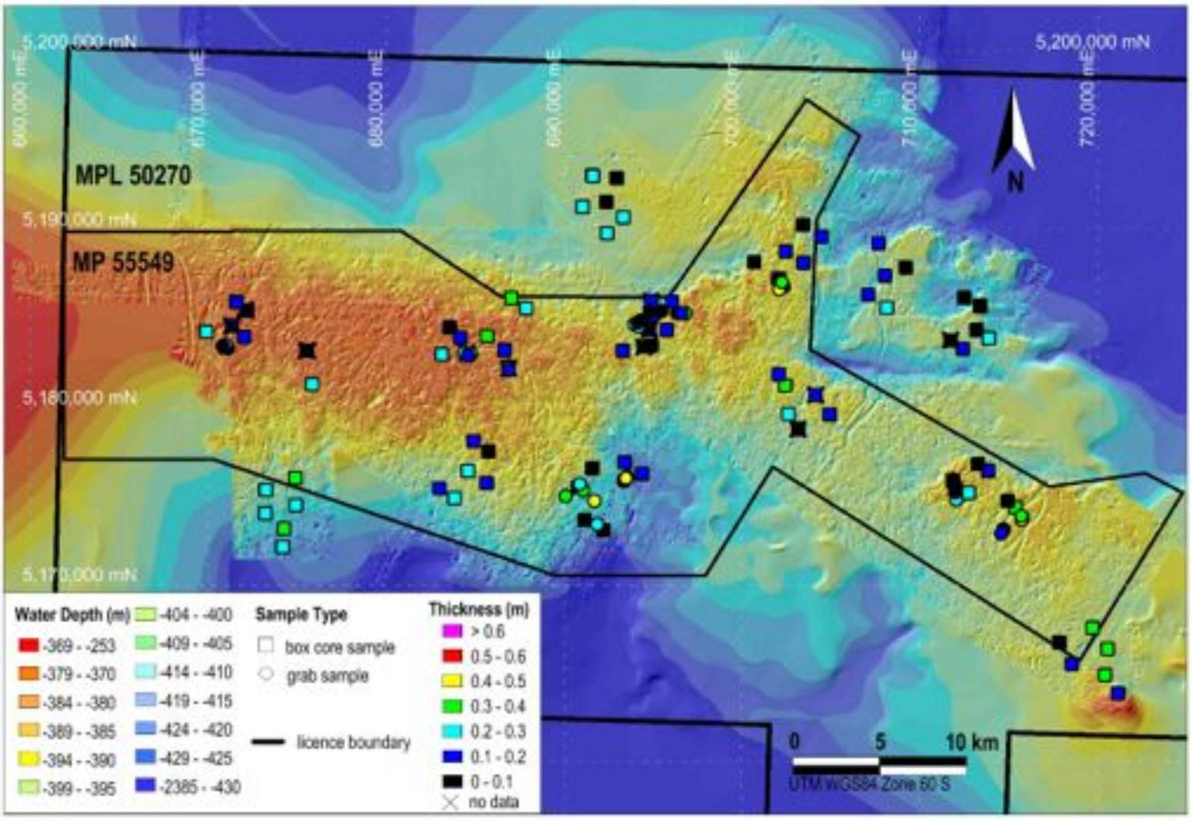

Figure 41: *Dorado Discovery* sampling methods, sample locations and penetration depths.

In summary, RSC notes a number of concerns with the sampling process used on the *Dorado Discovery*. Potential sampling bias and assumptions affecting the *Dorado Discovery* samples include:

- all grab samples have been exposed to some degree of washing, which will result in loss of fines and overestimation of phosphorite concentration; the samples are therefore likely biased to higher grades;
- phosphorite estimation for the grab samples is based on a weight percent phosphorite in the >8 mm size fraction, and assumes density is the same for all constituents in the fraction;
- phosphorite volume percentages for the 0.8-8 mm grab sample fractions were determined by point counting very small subsamples of the total sediment fraction; there is a risk the small samples were not representative of the bulk sediment fraction;
- phosphorite volume percentages for the 0.8-8 mm grab sample fractions were only quantitatively determined for 12 of the 45 successful grab samples, the remainder were estimated based on a poorly constrained relationship between the amount of phosphorite in each sieved fraction;
- RSC has estimated the volume of the large grab based on dimensions provided by Simon Nielsen and estimated from images of the grab;
- RSC has assumed that the volume cut into the sea floor with the sampling method is a vertical-sided cut, with equal depth across the sample, and no curved edges or central ridge of sediment left behind where the jaws close; based on the sample volume of 1.31 m^3 the maximum depth sampled can be 47 cm assuming no sample loss;
- box core penetration depths have been visually estimated;
- RSC grade estimations from the box core data assume that the constituents of the >8 mm sieved fractions have the same density;
- RSC correction factors for phosphorite content in the box core sieved fractions assume that the grain size distribution of sediment is comparable between samples collected by the different grab and box core methods and that the sieved fractions are equivalent despite different mesh sizes (>8 mm and 0.8—8 mm for grab samples and >8 mm and 2—8 mm for box core samples).

RSC has only partially validated the *Dorado Discovery* sample data. As with all other data sets the *Dorado Discovery* samples have been assigned SQR values, but due to the incomplete record of sample processing results the samples have been assigned low quality rankings and have not been included in the data used for the resource model (Section 10.2).

No special security measures were taken in regard to the collection and storage of the samples.

10 Data Verification

10.1 Data Verification Procedures

A digital database was supplied to RSC by consultants from Kenex Knowledge Systems Ltd who had been involved with the data management from the start of the Project and data collection for the *Dorado Discovery* cruise. Compilation of the database was a collaborative effort by Kenex and NIWA. Initially, NIWA compiled the *Valdivia* and *Sonne* data from hard copy maps and scanned sample sheets. The Global Marine, *Tranquil Image* and *Dorado Discovery* data were later added by Kenex. No data were compiled from the *Tangaroa* cruise and these have been sourced by RSC from Cullen (1978). Kenex has added some calculation fields from the historic data to further analyse sample grade estimations and prospectivity analyses.

The data was stored in Microsoft Access tables and exported by RSC into flat Microsoft Excel tables to facilitate verification.

In addition to the MS Access Database, the following data were provided to RSC from each cruise.

R.V. Valdivia Cruise – 1978

Scanned copies of the raw data sheets for all 689 samples collected aboard the *Valdivia* were made available to RSC. The information recorded on these sheets included sample number, sample apparatus, penetration depth and/or sample volume, as well as a brief shorthand geological description using prescribed logging codes that included a rough estimate of phosphorite content. A search of archived material at BGR by Hermann Kudrass further provided scanned copies of hand-written data tables detailing the sample number, presence/absence of ooze, volume of sample that was processed by sieving, volume of >1 mm sieved fraction, estimated phosphorite content (%) of the >1 mm fraction, maximum phosphorite nodule size and calculated phosphorite volume percent for each sieved sample. This information was duplicated on a printout of an old digital database found with the hand-written data tables, with a few historic corrections having occurred between the sheets. It is not clear if the hand-written data tables are the original field sheets that sieve data were recorded on to or not. These hand-written data sheets also record information on the grainsize distribution of 65 samples sieved into >32 mm, 16–32 mm, 16–8 mm, 8–4 mm 4–2 mm and <2 mm fractions; however, the records of these fractions are barely legible.

R.V. Sonne Cruise – 1981

Scanned copies of the raw data sheets for all 550 samples collected aboard the *Sonne* were provided. The information recorded on these sheets detailed the sample number, sample apparatus, penetration depth, sample weight, sand/chalk thickness, sieved fraction weights, phosphorite percent, and shorthand geological description. The shipboard analyses sheet included, all of the above details plus, phosphorite weight percent, phosphorite coverage (kg/m^2), and simple geological log. The ship station sheet included all positioning recording and times used for the location of the samples.

M.V. Tranquil Image - 2011

Copies of the IX survey reports detailing the cruise activity and samples taken were provided. Data in these reports detailed the sample number, sample location, depth to sample, sample method, photo and brief sample description. Separation, density and geochemical analyses were supplied as individual Excel files.

R.V. Dorado Discovery – 2011/12

Copies of the CRP *Dorado Discovery* cruise reports detailing cruise activity and collected samples were provided. Data in these reports detail the sample number, sample location, depth to sample, grab fill percent, bag weight, glauconitic sand percent, percent nodules, nodules max size, brief geological description and shear strength. Separation analyses were also received from CRL in the form of Excel files.

RSC conducted a thorough validation of *Valdivia* and *Sonne* data, and a best-possible validation of the *Tranquil Image* and *Dorado Discovery* data.

The review of the *Valdivia* data was limited to the available data presented on the raw sample sheets, and a tabulated record dating from the time of the cruise recording the results of the shipboard processing. The raw data sheets for sieving were unavailable. Combined, these data recorded sample penetration depth, sample volume, geological descriptions, presence/absence of foraminiferal ooze, volume of samples/subsamples that were sieved, volume of >1 mm sieved fraction, visually estimated phosphorite content of >1 mm sieved fraction, maximum phosphorite nodule diameter and calculated phosphorite volume percent. RSC validated the recorded values for penetration depth, sample volume, sieved >1mm fraction volume and estimated phosphorite percent with values in the database.

The review of the *Valdivia* data revealed a number of inconsistencies including:

- transcription errors between the written sample sheets and the database;
- missing data;
- minor calculation errors between fields; and
- rounding errors.

All inconsistencies have been either fixed or the ranking of the sample quality appropriately downgraded. No other *Valdivia* data collected on the cruise were validated by RSC.

The review of the *Sonne* data revealed a number of data inconsistencies including:

- transcription errors between the written sample sheets and the database;
- missing data;
- minor calculation errors between fields;
- rounding errors; and
- grade calculations not consistent with documented methods.

All inconsistencies have been either fixed or the ranking of the sample quality appropriately downgraded where fixing was not possible. RSC has completed a validation of the *Sonne* data and these numbers have been used in updated grade calculations. RSC has not validated other geotechnical, geochemical and geophysical data collected on the *Sonne* cruise.

Dorado Discovery and *Tranquil Image* have had 10% of the data validated with no significant issues noted. Data from the *Global Marine* and *Tangaroa* work have been accepted at face value as original data was not available. None of the *Global Marine* or *Tangaroa* data have been included in any Mineral Resource estimation in this Report.

10.2 Sample Data Quality

As part of the data verification process, the relative and absolute quality of the data was assessed in as much detail as practically possible. This is a critical part of the assessment of the data as it depicts what the quality threshold is to either allow or disallow data to enter into the estimation process. Across and even within the various sampling campaigns, different sampling, sub-sampling, logging, volume and depth measurements, grade calculations, and location measurements have occurred and a matrix was constructed to rank the impact of all these factors (Table 17). Quality assurance and quality control measures varied significantly between the various campaigns.

Table 17: Sample quality ranking.

SQR	CATEGORY DESCRIPTION	NUMBER OF SAMPLES					
		GLOBAL MARINE	TANGAROA	VALDIVA	SONNE	TRANQUIL IMAGE	DORADO DISCOVERY
1	SONNE only; ATNAV, grab samples, chalk present (sampled full profile); not full bucket (assume ~100% recovery)				221		
2	SONNE: grab sample, ATNAV, no chalk (not sampled full profile); not full bucket (assume ~100% recovery) VALDIVIA: large grab sample, ATNAV, <5% difference in volume from modelled, not subsampled for sieving			37	50		
3	SONNE: grab sample, ATNAV, full bucket (possible sediment loss/sampling bias) or minor data inconsistencies VALDIVIA: large grab sample, <10% difference in volume from modelled, not subsampled for sieving; OR small grab sample, ATNAV, <5% difference in volume from modelled, not subsampled for sieving			67	119		
4	SONNE: grab sample, SATNAV, chalk present or absent, partial or full bucket VALDIVIA: large or small grab sample, ATNAV or SATNAV, <15% difference in volume from modelled, subsampled for sieving or not			102	115		
5	SONNE: grab sample, SATNAV, data inconsistencies VALDIVIA: large or small grab or box core sample, ATNAV or SATNAV, >15% but <40% difference in volume from modelled DORADO DISCOVERY: box core sample, GPS, average PH% factored fraction weight			278	2		21
6	SONNE: any kind of sample, washed out sample, ATNAV or SATNAV VALDIVIA: large or small grab sample, washed out sample or >40% difference in volume from modelled, ATNAV or SATNAV TRANQUIL IMAGE: grab sample, PH% > 2mm fraction recorded DORADO DISCOVERY: box core sample, visually estimated PH% only; OR grab sample GLOBAL MARINE: dredge sample, non-validated data, estimated PH% TANGAROA: box core sample, non-validated data measured PH weight % or visually estimated PH%	337	26	136	4	45	129
7	ALL: successful samples with non-usable data (no PH% recorded, no location data); OR samples that failed due to technical failure	0	27	69	38	10	56
TOTAL SAMPLES:		337	53	689	549	55	206

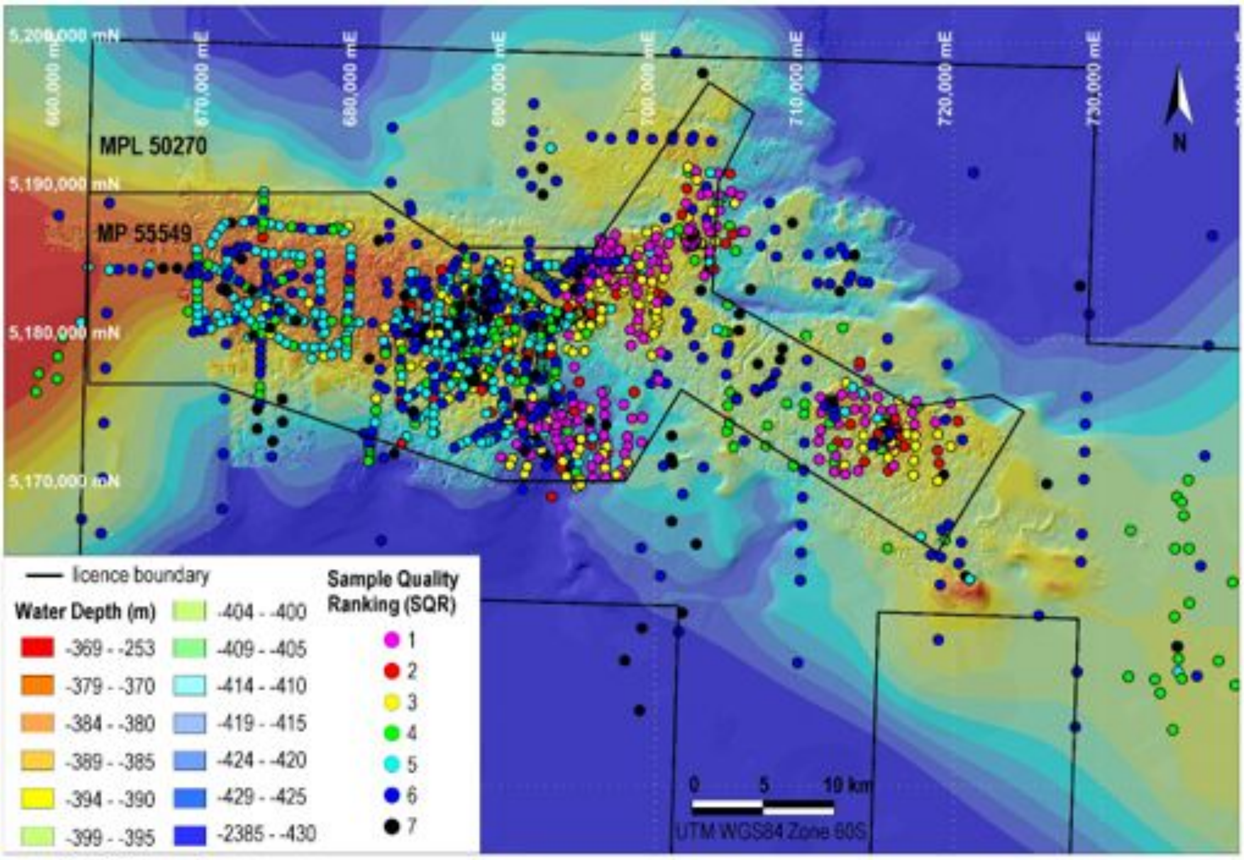

Figure 42: Sample location and Sample Quality Rankings.

In general, the best quality samples were those that were collected using the pneumatic grab, sampled the full sand horizon, had high survey accuracy, and had no other apparent data ambiguities. In general, these highest-quality samples involve a large and a representative sample, with appropriate and consistent measurements (i.e. good relative quality control). Samples collected from the *Sonne* are considered to represent the better quality of samples collected in the licence area, followed by some of the *Valdivia* and then the box core samples from the *Dorado Discovery*. Best quality samples were ranked 1 and worst quality samples were ranked 7. Samples ranked 5 – 7 were not included in the Mineral Resource estimation process. Samples classified as 7 included samples that failed due to technical failure, samples with no recovered sediment due to technical failure, samples collected but no data recorded (phosphorite percent, weights, or location) and samples with no location coordinates. Samples classified as 6 include non-validated data, samples documented as washed or otherwise biased. Samples classified as 5 include validated samples with acceptable location accuracy but with demonstrated unacceptable bias in the grades due to suspected washing of the samples or errors in visual estimation of the grade.

RSC notes that the pneumatic grab sampling is likely the best possible sampling mechanism for this deposit. It collects a large sample and therefore suitably deals with the high sample variance (within the boundaries of practicalities). The pneumatic system provides a good control on representativeness of the sample. Core drilling has been considered and attempted for this deposit but would collect a much smaller sample and is impractical as the underlying ooze and chalk layer are difficult to core, resulting in lost core and lost equipment.

10.3 Visual Validation of Nodules

During the 2nd, 3rd and 4th cruises on the *Dorado Discovery* a remote underwater operated vehicle ('ROV") was deployed and images recorded from the seafloor in a number of detailed transects with a rough station spacing of 1 – 20 m on each transect. Part of the data collected included the occurrence of phosphorite nodules on the surface of the seafloor. Where nodules were seen they were described further with an average size and general abundance.

RSC attempted to determine if there is a relationship between the general nodule abundance and the phosphorite grade of the nearest samples with doubtful sample quality rankings. However, with the lack of suitably close samples, a positive correlation between phosphorite grade and counted slides of phosphorite abundance could not be demonstrated. ROV images confirm the existence of phosphorite nodules at a few *Dorado Discovery* sample sites as seen in Figure 43 and Figure 44 and also show the visual differences between higher and lower grade sites. Importantly, along the ROV sample line transects, the images and nodule counts also confirm the high short-range variability of the sample grades.

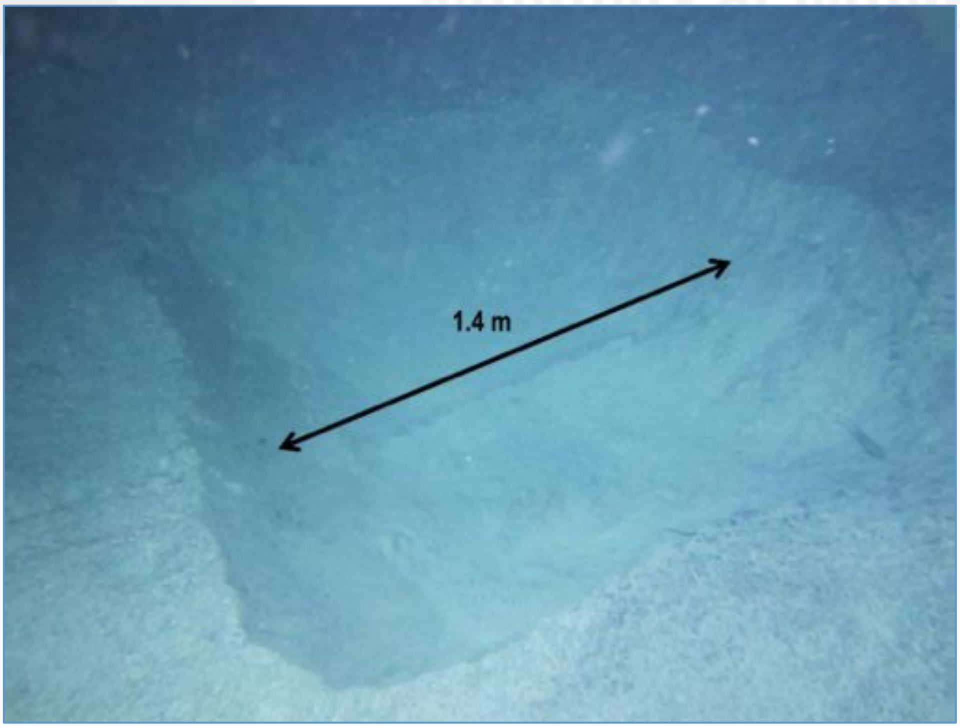

Figure 43: Grab sample site of DD016 (193 kg/m^3).

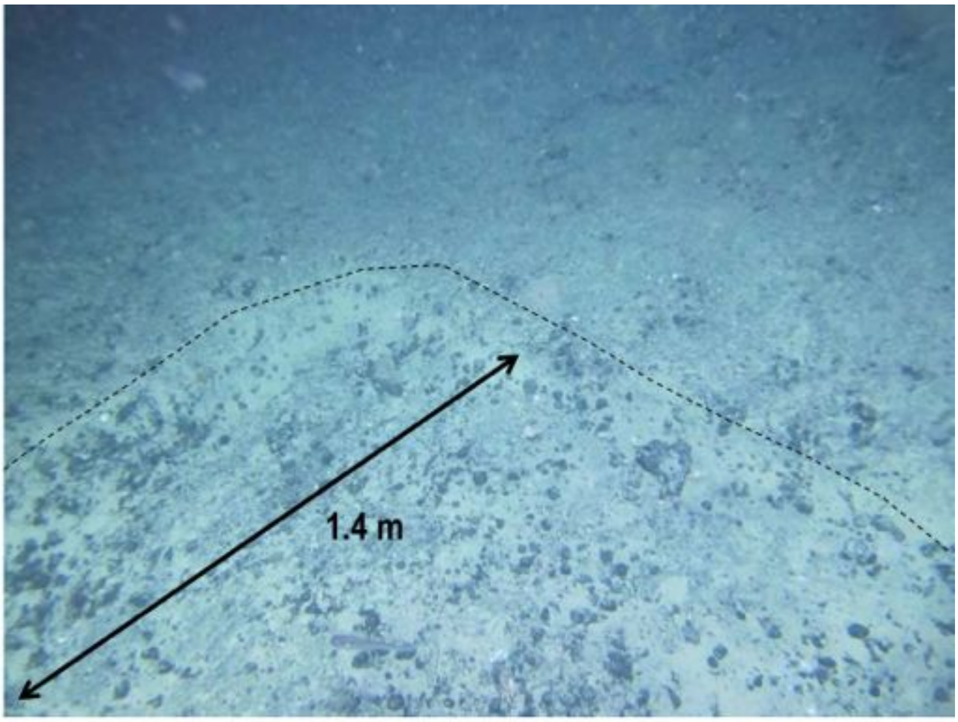

Figure 44: Grab sample site of DD025 (695 kg/m³).

10.4 CPT Depth Data vs. Sample Depth

During the third *Dorado Discovery* cruise CPT were conducted in the licence area. In total 125 tests were conducted along 26 transects with tests 50 m apart (Figure 46). CPT results along each transect have been assessed by RSC with respect to the interpreted thickness of glauconitic sand and the variability of that thickness along each transect. The results of the work showed sand depths which were often considerably thicker than the sample depths determined by the seafloor sampling with an average from the CPT showing a sand depth of 0.47 m with a maximum of 2.27 m. This is significantly thicker than the depth of the sediment as indicated by the samples, which averages 0.23 m. However, the CPT data appears to include several mixed populations and it is clear that the main population ranges from 10 – 40 cm in thickness. When a full bucket was collected in the sampling programmes, the thickness was set to the maximum penetration depth of the bucket, although the sediment could have been much thicker as the CPT data indicate. Comparing the averages between the sample depths and CPT depths therefore needs to be seen in this context.

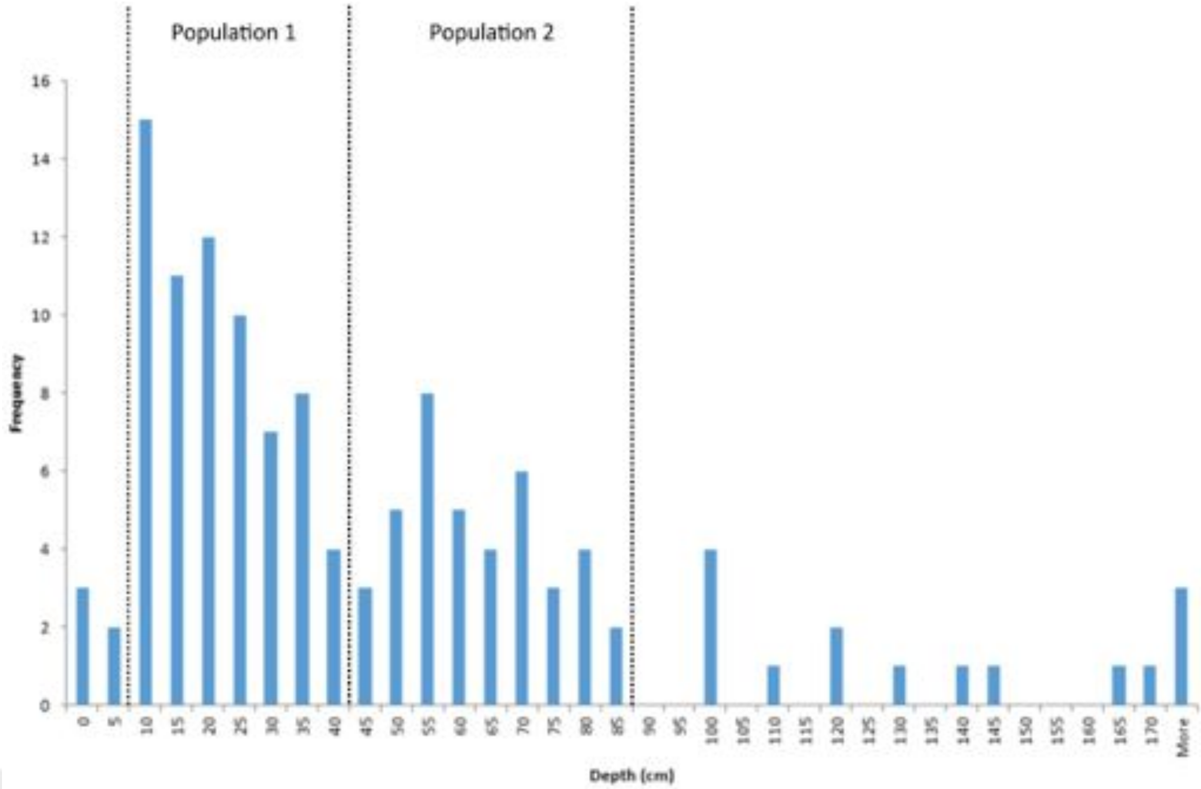

Figure 45: Histogram showing the CPT depth data. Mixed populations are visible, indicating two or more areas with different thickness. The dominant depth appears to range between 10 and 40 cm, which corresponds with the data recorded from the sampling programmes.

The CPT depth data shows the base of the sand is generally deeper than the depths obtained from sampling, indicating additional exploration potential. The Mineral Resource estimate presented in this Report is based on the thickness as determined from the sampling, which was limited to only the top 40cm. Although current mining concepts focus on resources in the top 30 – 40 cm of the sand unit, additional resources could be developed at depths greater than 40 cm if these zones area shown to host economic phosphorite content (Figure 47).

The quality of the CPT depth data has not being validated by RSC and the data was not used in the resource estimation.

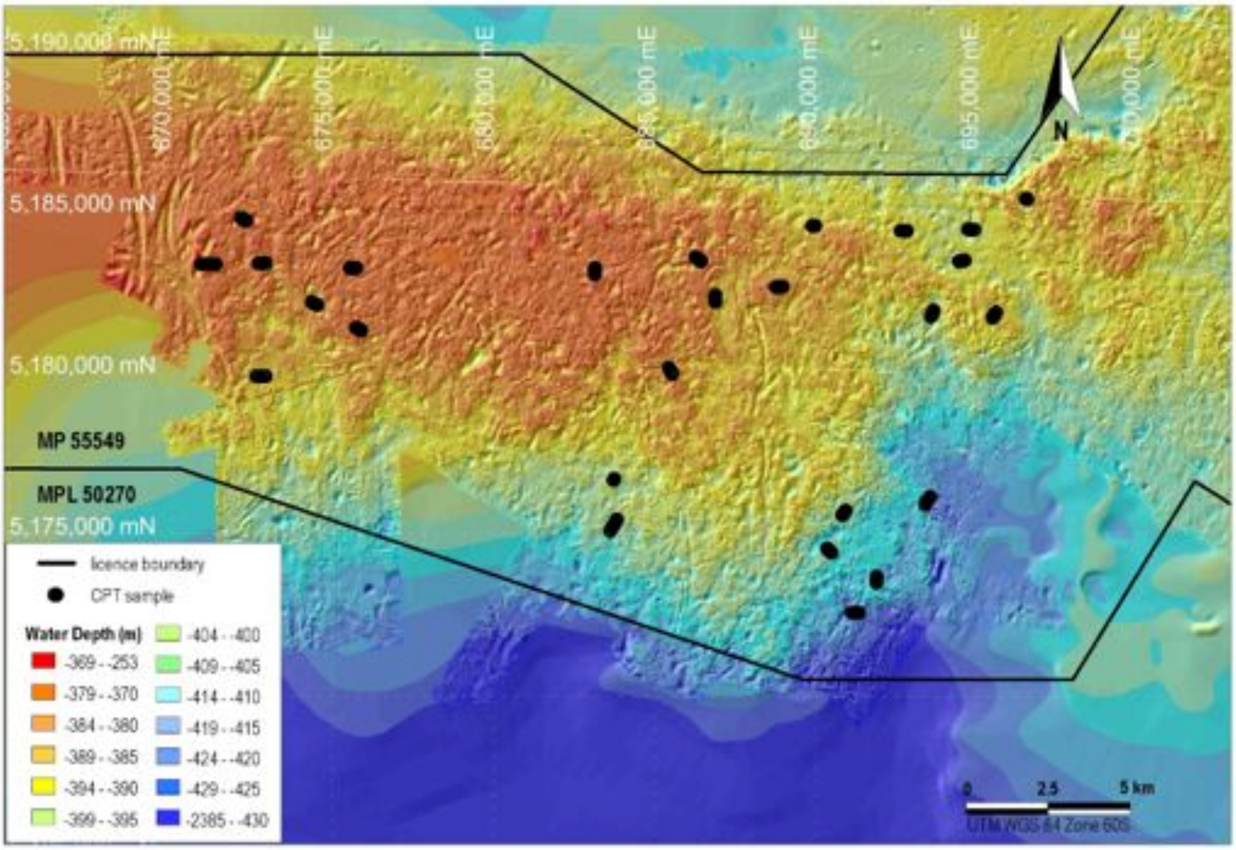

Figure 46: CPT sample areas denoted by black dots

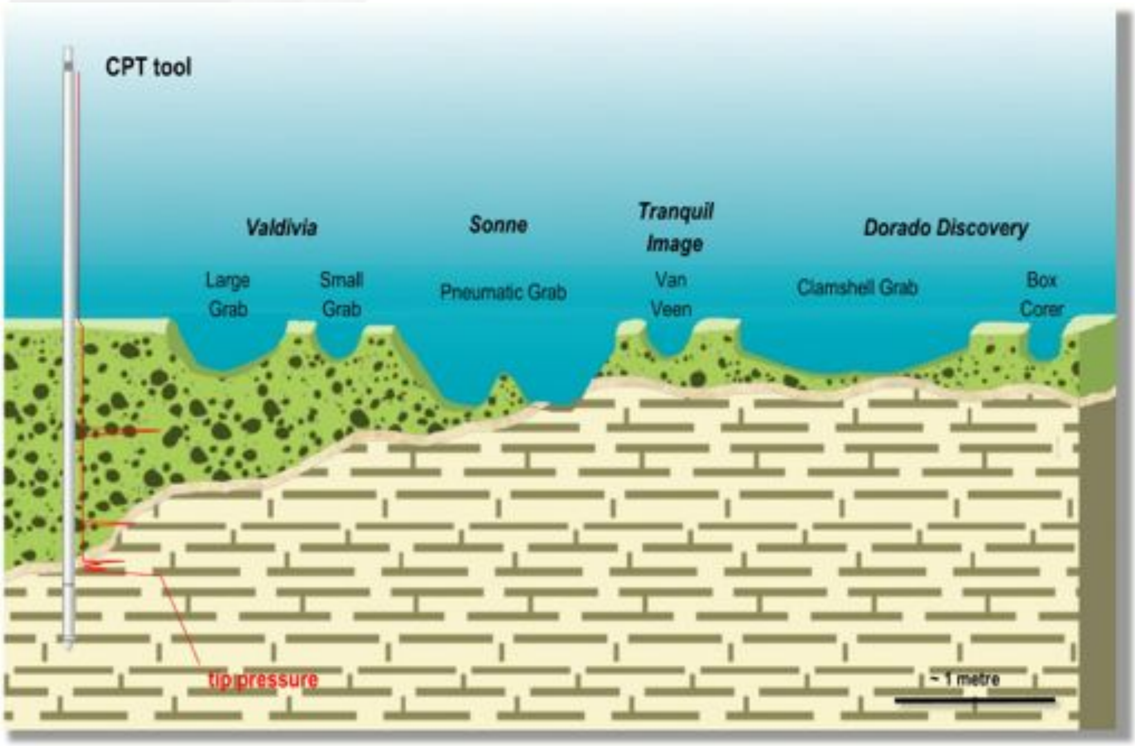

Figure 47: Schematic sand and chalk profile showing potential tonnages below the grade sampled depth.

11 Mineral Processing and Metallurgical Testing

11.1 Beneficiation

It is proposed that the phosphorite material to be mined from the Chatham Rise is a bulk product that will be sold to customers in its recovered raw state. Recoveries of the phosphorite resource from the sea floor will be controlled by the dredging (mining) process and all material received at the ship will be processed through a separation plant, with the >2 mm fraction retained and stored in the ship's hold.

The final product will be an unsorted >2 mm size fraction recovered from the sea floor and will include shell, chalk, limestone and other rock fragments. These components will be a diluting factor for the final phosphorite grade. The *R.V. Sonne* data shows that the average visual estimation of non-phosphorite content in the >1 mm fraction is 15 volume % (samples with no phosphorite were not counted). It is noted that the density of the impurities is less than the phosphorite nodules and therefore by weight percentage, this number is expected to be lower.

Several beneficiation tests have been conducted by CRP. Grinding and flotation tests were carried out by Mintek in 2011 and results showed only beneficiation of less than 1 wt% P_2O_5 with an 88.6% recovery into a concentrate. The difference in P_2O_5 content between the concentrate and tailings is about 1 wt% P_2O_5, which Johnston (2013) suggests is because the conventional grinding and floatation process is not suitable for beneficiating the P_2O_5 levels in the CRP ore.

A laboratory scale study by Johnston and Tate (2013) on one sample from the DD cruise (DD06) showed that the preferred beneficiation conditions for increasing the P_2O_5 content of the ground CRP ore by calcination and ensuing acetic acid leaching are flash calcination of the CRP ore for ten minutes followed by quenching before leaching with 0.1 M acetic acid at a ratio of 1:4 solid ore to acetic acid for a period of 30 minutes. This should beneficiate the P_2O_5 by approximately 6–7% to give a final P_2O_5 content of about 27–28 wt %. However, at this stage this process is not being considered due to the predicted high processing costs.

11.2 Grain Size Separation

Boskalis investigated the implications of minimum grain separation scenarios (Figure 48). As the cut-off size increases the percentage material retained decreases, but the remaining grade of the concentrate increases. At the originally intended separation system cut-off of 1 mm, the effective retention of phosphorite material brought onto the vessel would be some 96%; only 4% would be lost and returned to the seabed. However, the product produced would contain 64% of rock phosphorite and 36% of impurities (erratic's, chalk, biological organisms). Separation at 2 mm would reduce the retention to some 92%, with 8% returned as tailings. But the quality of the product improves as about 73% of the retained material would be rock phosphorite, with 27% impurities. It is not clear on which samples this work was carried out and whether they are representative for the Mineral Resource. RSC does therefore not interpret the diluting percentages reported here by Boskalis to be comparable with the visual estimation of impurities from the *Sonne* data. Rather, they are the result of tests on one non-representative specific sample.

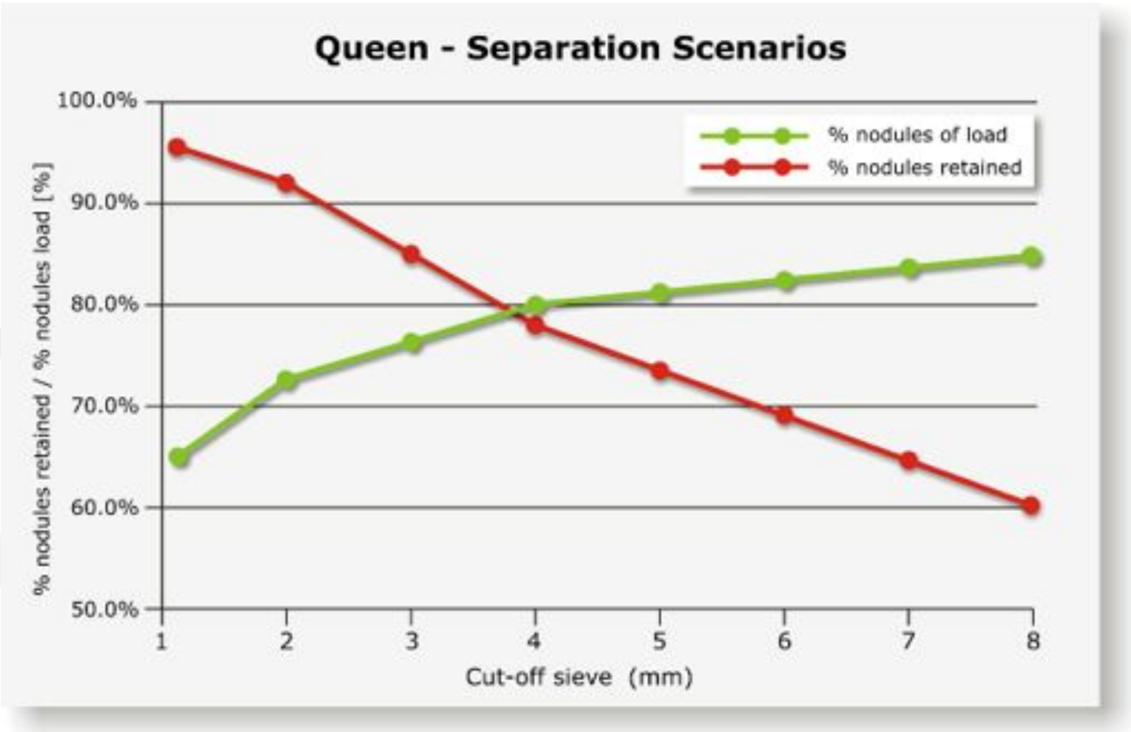

Figure 48: Separation scenarios.

11.3 Major Element Geochemistry

Analyses were completed for major element chemistry and trace elements on both *Valdivia* and *Sonne* samples in two size fractions >8 mm and 1-8 mm (Kudrass & Cullen, 1982; Kudrass, 1984). These showed significant correlation of chemistry with nodule size (Table 18). Larger nodules had lower P_2O_5 and higher CaO content than the smaller ones. In 78 analyses from 47 *Sonne* samples the >8 mm nodules averaged 19.8% P_2O_5 and the 1–8 mm nodules averaged 21.6%. In 63 *Valdivia* screened samples >1mm derived from their respective bulk samples the P_2O_5 average was 22.0%. The large nodules relative to the smaller ones have higher CaO and lower K_2O, SiO_2 and Fe_2O_3. The P_2O_5 concentration is reduced in smaller size nodules by the glauconite coating and in larger nodules by calcite in the core (Kudrass & Cullen, 1982). The relatively high Fe_2O_3 content of the outer layer of some nodules reflects the presence of goethite in the coating. P_2O_5 and U are slightly concentrated in the transition zone. The contribution of the outer layer to the total volume of the nodules decreases with increasing size of the nodules. The positive correlation of median nodule diameter with, for example, K_2O concentration is also a reflection of the presence of the coating glauconite. A concentration of 7.54% K_2O (which corresponds to 100% glauconite) results in a theoretical median of 0.25–0.125 mm, which is in agreement with the estimated thickness of 0.11 mm for the glauconite coating. The highest P_2O_5 concentrations occur in the 4–8 mm grain size fraction, in the *Tangaroa* sample data (Pasho, 1976) this was found to be in the 5–10 mm fraction. The histograms for the number of samples with a particular elemental oxide composition for the *Sonne* data are shown in Figure 49.

Table 18: Average chemical composition (wt%) bulk sample and 1(2)–8 mm and > 8 mm size fractions for Chatham Rise phosphorite nodules (Johnston, 2013).

Sample	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	P_2O_5	K_2O	SO_3	F	LOI
***Sonne* Average**	7.82	0.03	1.11	3.48	0.71	43.65	1	20.69	1.04	1.6		17.26
***Sonne* Av >8 mm**	3.17	0.02	0.47	2.09	0.41	48.41	0.89	19.84	0.42	1.38		21.27
***Sonne* Av1-8 mm**	12.48	0.04	1.75	4.87	1	38.88	1.11	21.53	1.65	1.83		13.25
DD Average	8.36		0.97	4.45	1	43.86	0.51	19.81	0.83	1.38	2.54	15.89
DD Av >8 mm	4.96		0.66	3.2	0.72	47.28	0.44	19.23	0.19	1.35	2.56	18.97
DD Av 2-8 mm	11.73		1.29	5.68	1.29	40.47	0.59	20.31	1.46	1.42	2.52	12.92
TI Average	9.38		1.28	4.59	1.03	42.85		19.92	0.89	1.4	2.47	15.13
TI Av >8 mm	6.2		1	3.34	0.74	46.12	0.42	19.62	0.37	1.38	2.58	17.61
TI Av 2-8 mm	12.56		1.56	5.84	1.32	39.59	.55	20.22	1.42	1.43	2.36	12.64

Note:

1. RSC notes that the assays and geochemistry discussed in this section are not necessarily representative for the Mineral Resource and further work is required to establish more accurate phosphate grades for the Chatham Rise deposit.

A detailed particle size and chemical analysis has been carried out on the suite of *Dorado Discovery* samples by CRP. The process involved a sieve analysis to provide split fractions of the bulk *Dorado Discovery* samples into the size ranges of the 1.18–1.70, 1.7–2.0, 2.0–4.0, 4.0–8.0, 8.0–25.4 and 25.4–80.0 mm. The chemical composition was determined for each fraction by XRF analysis. Figure 50 provides a graphical representation of the P_2O_5, CaO, SiO_2 and Fe_2O_3 contents of the *Dorado Discovery* samples across the sieve size ranges and follows the trends seen in samples from previous cruises. Johnston (2013) noted that if a particle size cut-off is to be invoked in the mining and processing operation, then as far as P_2O_5 is concerned, the particle size fraction smaller than about 2 mm should be separated and possibly discarded.

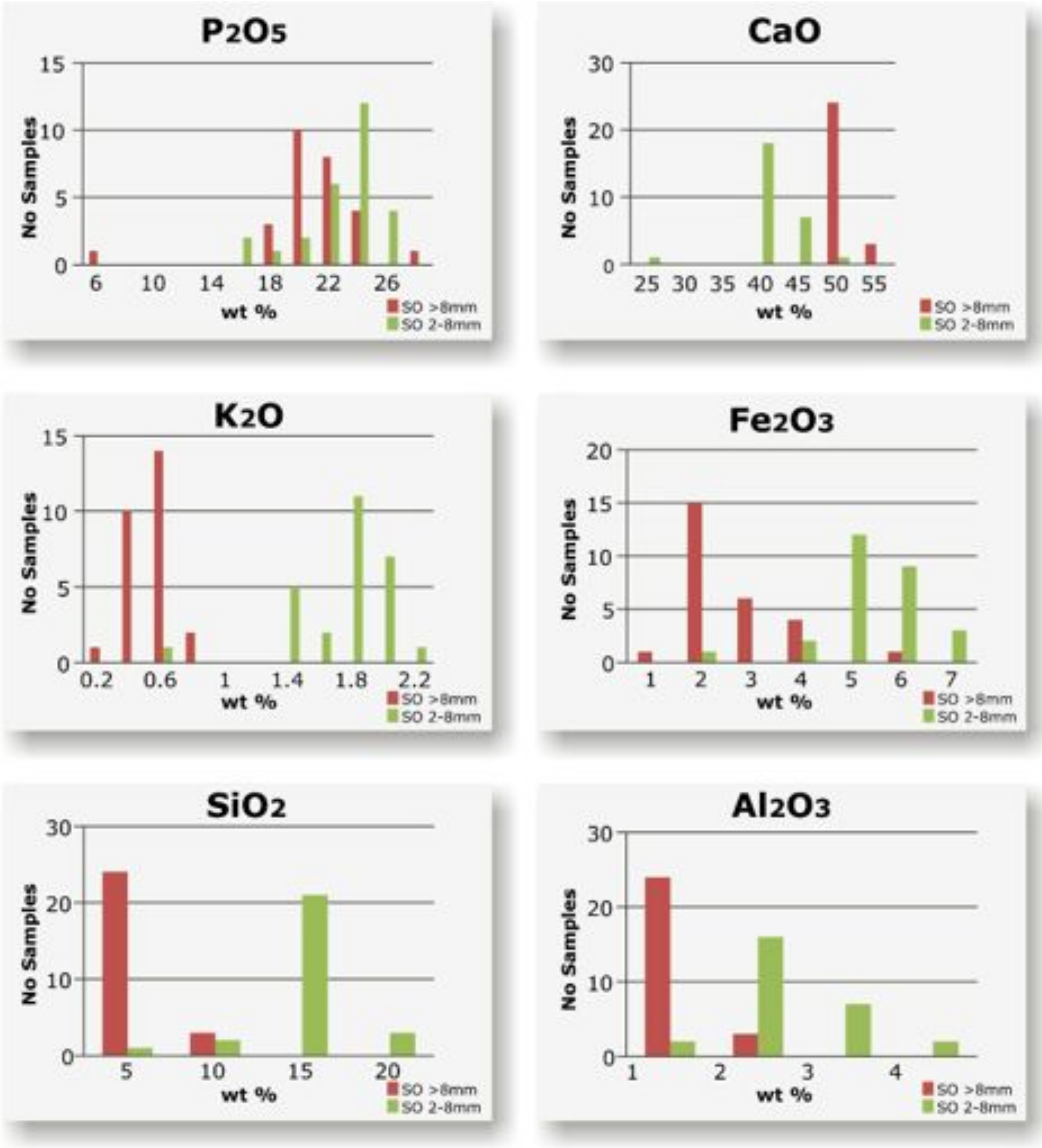

Figure 49: The average value of P_2O_5, CaO, K_2O, Fe_2O_3 and Al_2O_3 plotted against for the number of samples in each of the respective composition ranges for the 2–8 mm and >8 mm size fraction for the *Sonne* samples (Johnston, 2013).

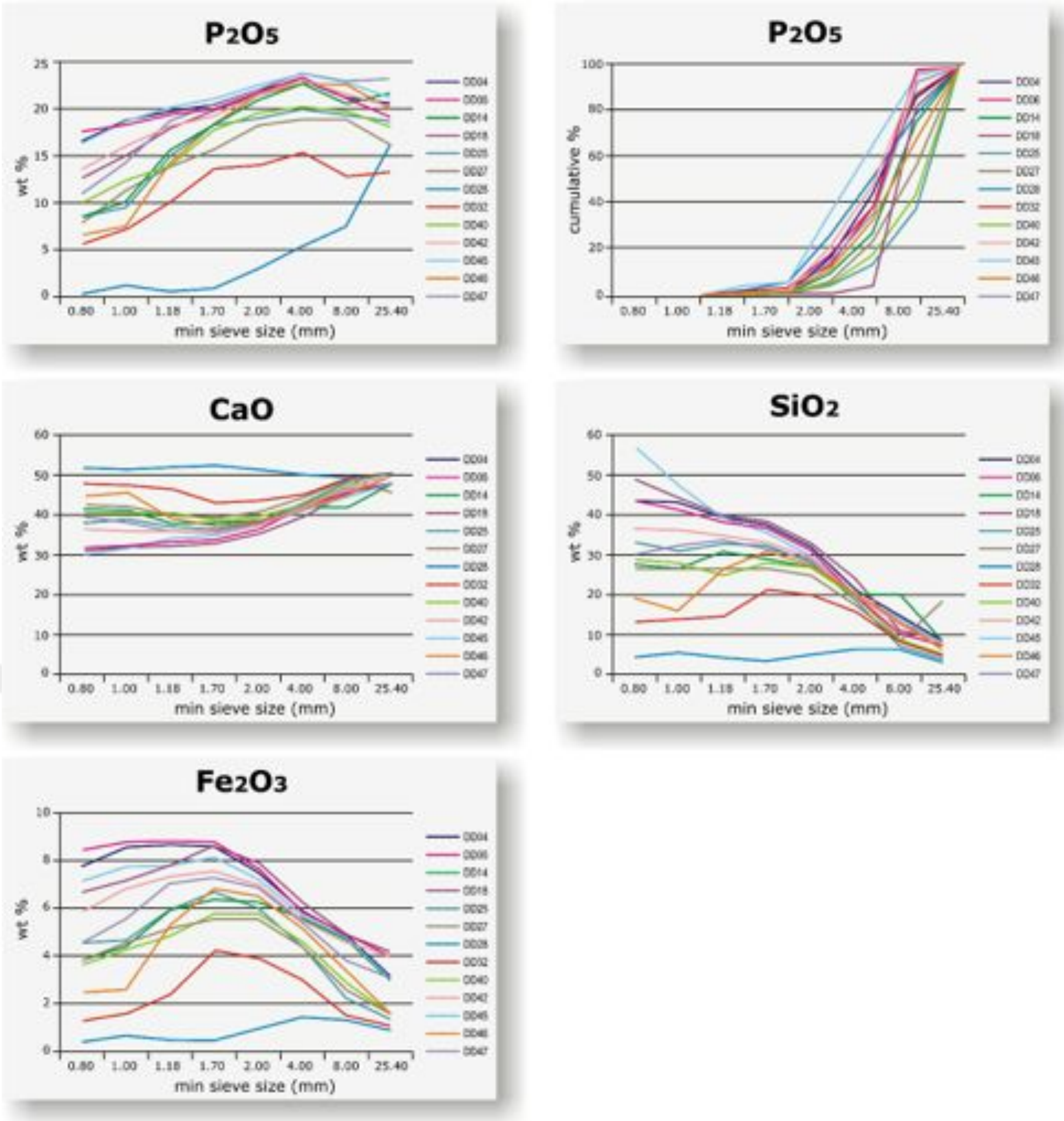

Figure 50: P_2O_5, CaO, SiO_2 and Fe_2O_3 contents of sieved DD samples (Johnston, 2013).

11.4 Trace Elements

Trace-element distributions display similar variation between larger and smaller nodules as seen in the major element geochemistry. Some elements, e.g. Cu, Mo, Ba, Co, and V, are more or less evenly distributed in nodules of all sizes, and are thought to be original constituents of the parent limestone. Sr, Th, and U, on the other hand, tend to occur in higher proportions in nodules 8–64 mm across, and they are presumed to have been introduced during phosphatisation. As, Ni, Pb, Rb, Y, Zn, and Zr all predominate in nodules <8 mm across and their introduction may well have accompanied the late-stage impregnation by glauconite. Uranium concentrations are elevated with an average grade of 216 ppm from the *Sonne* samples, and may even attain ore grade with uranium being extractable during processing that involves solution (Syer *et al.* 1986; Cullen, 1987). However, even if the phosphorite were used as an unprocessed, direct-application fertiliser, studies suggest there is little danger of uranium contaminating livestock or building up in the soil (Cullen, 1987).

Tests by Syers *et al.* (1986) show that the phosphorite from the Chatham Rise is very low in cadmium (2 mg/kg) and arsenic (below level of detection). This was also seen on *Dorado Discovery* samples where thirteen samples assayed on both coarse and fine fractions showed no assays for cadmium above level of detection (<2 ppm). Sayers also noted elevated uranium at 100 mg/kg. RSC notes that it cannot confirm the source of the Chatham Rise phosphorite sample used for this analysis. The analysis of sediment presented in Golder Associates (2013) included the abundance of key environmental trace elements. Elements such as arsenic (about 6 mg/kg in sediment and <4 mg/kg in chalk) and cadmium were low (0.2 mg/kg in surface sediment and 0.3 mg/kg in chalk) even though cadmium is often associated with phosphorites. Mercury abundances were low, about 0.06 mg/kg in surface sediments and about 0.04 mg/kg in chalk samples.

Further work is needed to assess metallurgical variations between geological facies. Deleterious elements are not considered to be an issue; however, RSC recommends that any future test work includes systematic analysis of arsenic, cadmium and uranium.

11.5 Recovery

Boskalis have undertaken studies for providing a separation plant on a ship such as the *Queen of the Netherlands*. The proposed processing plant would contain four parallel processing streams for the coarse fraction (>8 mm) separation and two to four processing streams for the finer (2 to 8 mm) fraction separation. The separation concept is shown in Figure 51.

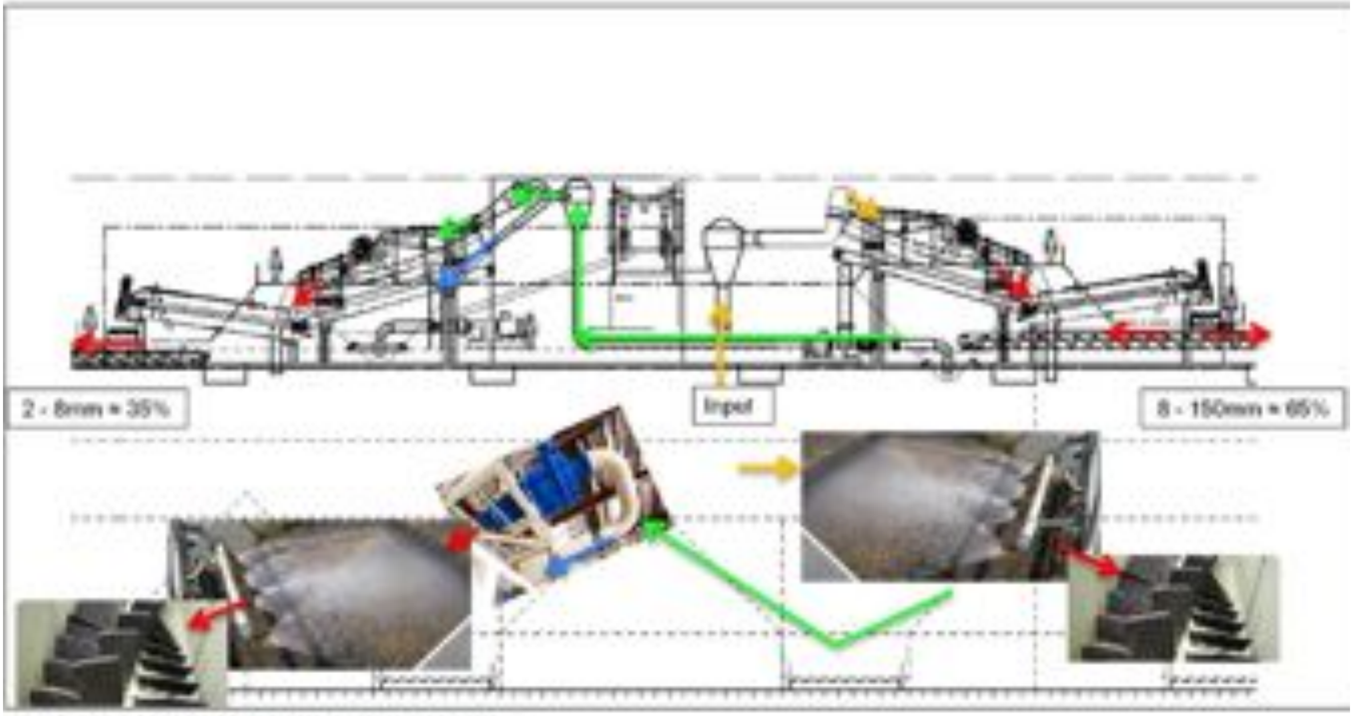

Figure 51: Separation process proposed by Boskalis for the Queen of Netherlands (Boskalis, 2013).

Most of the sampling data that formed part of the Mineral Resource estimate was carried out on fraction size larger than 1 mm, whereas the Boskalis conceptual separation plant studies assume a larger than 2 mm fraction being mined, with the smaller fraction returned to the ocean floor. There will therefore be a small percentage of phosphorite nodules in the 1 to 2 mm fraction that will not be recovered from the Mineral Resource. Limited size fraction analysis (CRL, 2013) shows that this may account for only ~1% loss of recovery of which the P_2O_5 concentration is low as well (Johnston, 2013).

RSC considers the level of test work conducted to assess the metallurgical properties of the Chatham Rise Phosphorite deposit to be suitably supportive for the purpose of an Inferred Mineral Resource classification.

12 Mineral Resource Estimates

12.1 Informing Data

12.1.1 Data Handling

The data on which the Mineral Resource is based is stored in a Microsoft Access database. Because of the simplicity of the data structure (i.e. one single table with two-dimensional points and grade data and no related or inter-dependent tables or other data sheets) this data storage solution is adequate. MS Access database update extracts would be prefixed with a date tag to denote the date of the database (YYMMDD) to allow proper version control, both throughout the CRP exploration programmes as well as the database validation and upgrade process as part of the estimation process. The database was stored on a cloud-based storage system that allows full audit trail and stores a back-up of each new version of the database. Data for estimation was extracted from this database into a single flat Excel table.

During the CRP exploration work, the database was managed and administrated by employees of Wellington-based Kenex Knowledge Systems Ltd (GIS specialists).

12.1.2 Data Validation

A new Mineral Resource has been estimated as part of this Report using mostly historic data validated by RSC. Since the Mineral Resource is based predominantly on historic data, a process was set up to make sure only properly validated data was included in the estimate. Any data that could not be properly validated was flagged or a comment added so that it could be excluded (see Section 10.2 for a more comprehensive discussion).

It is important to note that even though many data issues were resolved through the validation process, it is clear that several issues remain which simply cannot be resolved. Several assumptions were required to calculate final grades for some samples and these samples have been appropriately flagged and downgraded in the database. This has been taken into account in the estimation process where relevant.

12.2 Data Analysis

12.2.1 Geological Interpretation

Wire-frames were created for ten different seismic facies to sub-domain the sample data sensibly and create appropriate domains for grade estimation. However, given the large overall size of the area covered by the sampling campaigns, and the relatively low resolution of the geological data within these large areas, the domains can only be considered applicable to the large-scale variability of the data. Smaller scale features like individual ice-berg furrows are unable to be defined into domains at this stage. Thus, even though geological understanding of the process is considered sound, the resolution of the data does not allow optimum application of this knowledge. This has been taken into account when classifying the Resource.

The specific geological controls on mineralisation have been discussed in Section 7.

12.2.2 Extrapolation

The Mineral Resource was not constrained by estimation domains. Extrapolation of grades into blocks was therefore simply controlled by the size of the search ellipse which was kept at a conservatively short distance based on spatial analysis of the sample data. Extrapolation of data into poorly sampled areas was minimised where relevant, given the various uncertainties involved with the data.

12.2.3 Alternative Interpretations

Given the low resolution of the available wire-frames for geological domains it is possible to generate alternative interpretations for the geology. Given the level of confidence at which the resource is classified (see Section 12.10) it is not expected that alternative interpretations would have a major impact on either resource classification or grade estimation.

12.2.4 Coding and Definition of Domains

Using the seismic facies domains described above, the sample data were coded into the ten different domains defined during the seismic mapping (Figure 27). The data were further coded with a Sample Quality Ranking ("SQR") to investigate the effects of including lower quality data into the resource. Details of the SQR have been discussed in Section 10.2. The SQR attribute has a large impact on the final resource figures. There are many different categories and factors influencing the quality of the sample. An SQR value of 4 was used as a cut-off for the estimation process to ensure that only suitable samples were included in the analysis.

Several checks were carried out to make sure that samples were correctly coded and to determine whether any samples were missed in the coding process.

12.2.5 Sample Support

Sample support varies between the various sampling cruises and is considered a weakness of the available sample data. The sample taken on the *Sonne* cruise was about 8 times larger than on the *Valdivia* and *Tranquil Image* cruises and this means there is relatively large sample variance within these latter datasets, although this is somewhat moderated by the consistency of the mineralisation.

Some of the smaller samples have been allowed into the estimation process, but, they are limited to a SQR of 3–4 and are subsequently also downgraded at the classification stage based on a high required minimum amount of informing samples. In essence, high variance can be combated with an increase in sample numbers to still get a reasonable estimate.

12.3 Estimation Methodology

Estimation was performed using 2D accumulation Ordinary Kriging on the parameters Ph kg/m^2 (i.e. grade x thickness), Depth and SQR. Two-dimensional accumulation estimation is considered appropriate because there is a negative correlation between thickness and grade, and variability in the vertical direction is disregarded as selective mining is not possible (Figure 52). Each of the domains was estimated in isolation, i.e. neighbouring data from other seismic facies domains were excluded from the estimation process. Each block therefore ended up with an estimated value for Ph kg/m^2, Depth and SQR. The grade (Ph kg/m^3) was then calculated by dividing Ph kg/m^2 by the estimated Depth for each block.

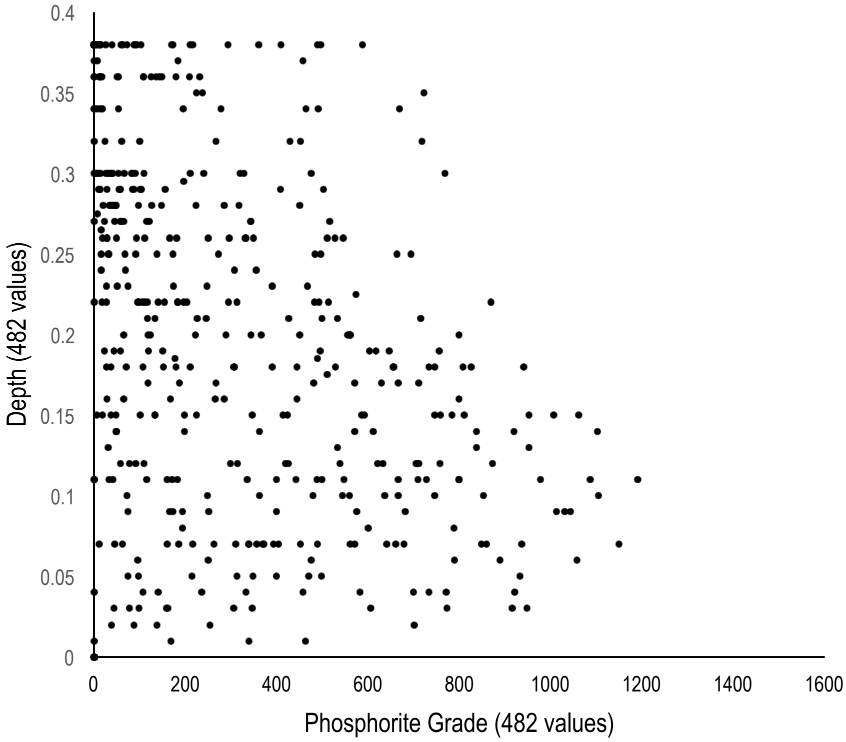

Figure 52: Correlation between depth (m) and grade (Ph kg/m^3) for domain 4 (482 points) shows negative correlation, however, a few of the highest grade samples look to be related to the lesser depths.

12.4 Summary Statistics

Data for each of the ten sub-domains (Figure 27) were statistically analysed. Main points assessed were the number of data points, mean, variance, covariance, histogram, cumulative frequency, and mean/variance vs. top-cut. This was done at an SQR top-cut of 4. These are summarised in Table 19.

Table 19: Basic statistics for sample data for each domain (capped at SQR of 4).

	Samples	Mean Ph kg/m3	CV Ph kg/m3	Mean Depth (m)	Mean SQR
Domain 1	1	13		0.38	4.0
Domain 2	0				
Domain 3	30	197	1.4	0.21	3.3
Domain 4	482	289	1.0	0.21	2.5
Domain 5	12	375	1.4	0.21	3.2
Domain 6	14	50	1.7	0.28	4.0
Domain 7	23	57	1.4	0.29	4.0
Domain 8	6	208	2.1	0.25	4.0
Domain 9	121	239	1.6	0.23	2.2
Domain 10	6	125	0.7	0.14	1.8

Total (Mean)	**695**	**172**	**1.4**	**0.24**	**3.2**

The sample points for the *R.V. Valdivia* and *R.V. Sonne* cruises overlap in the central area and this allows statistical comparison between the datasets in this area. For each sample of the *Valdivia* dataset, any points within the *Sonne* dataset that fell within a radius of 400 m were flagged. For each *Valdivia* point there could be more than one *Sonne* point within the radius, and vice versa. The process was capped at a quality ranking of 4 to only allow relatively good samples to be compared. This resulted in 13 *Valdivia* points and 23 *Sonne* points (green triangles and green circles, respectively in Figure 53) for comparison. The averages for the two datasets are 313 and 298 Ph kg/m^3 for the *Valdivia* and *Sonne* data respectively, which is considered a reasonable result and a positive indication that the *Valdivia* data can be used together with the *Sonne* data in the model.

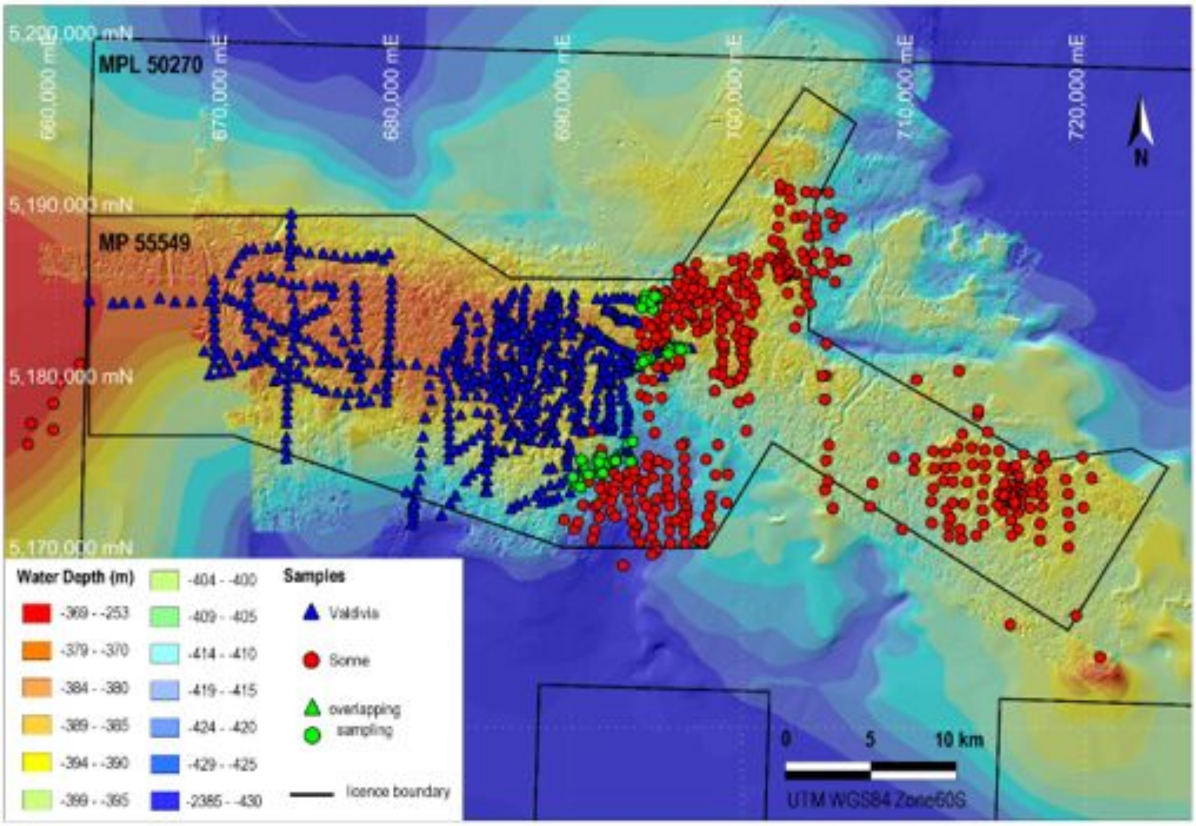

Figure 53: Sample overlap (green) between *Sonne* (red circles) and *Valdivia* (blue triangles) cruises.

12.5 Grade Capping

Investigation of cumulative frequency, histograms, and mean/variance vs. top-cut plots indicated that top-cutting was warranted for the distribution in domain 9. A grade cap of 150 kg/m^2 was chosen which caps two outlier samples to this value and lowers the mean of the domain from 35 to 32 Ph kg/m^2. The depth was not capped as it was limited to the depth of the sampling tool used.

12.6 Spatial Analysis

Geological knowledge is the best guide to define directions of grade continuity. However, for this analysis they cannot be determined. A simple visual thematic representation of the grades within each of the established geological domains in plan view doesn't indicate any consistent or coherent trends or directions. Two-dimensional directional variography confirms this, showing several short-range directions of increased coherence, mixed within each of the ten domains. This may indicate a lack of high resolution geological control on the mineralisation and that further sub-domaining is required. But this is not possible at this stage. This result has been taken into account when classifying the Resource.

For this reason, a circular search is adopted on each domain. An omni-directional normal scores variogram was constructed on facies domains 4 and 9 as well as the entire data set, and capped at a SQR of 4, to investigate the nugget effect and the variogram ranges as input parameters for the 2D Ordinary Kriging estimation process ("OK"). Nested spherical structures were used in normal score transform to deal with the skewed dataset. Data was declustered and top-cut before processing for smoother results. The result is shown in Figure 54.

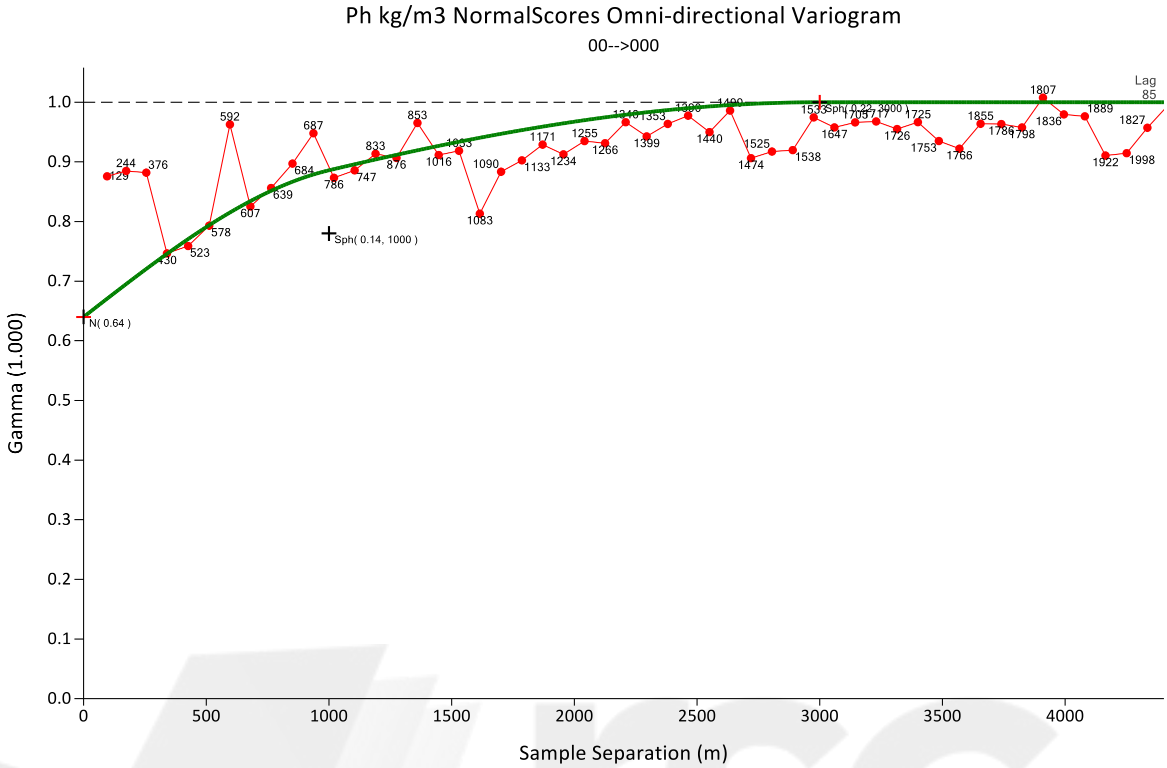

Figure 54: Omni-directional variogram for the entire dataset, capped at a quality ranking of 4 indicates a high nugget of 65%, a short range structure at around 1,000 m and 80% of the variance, with an overall range of around 3,000 m (using a lag of 85 m).

12.7 Resource Estimation

12.7.1 Block Model

A block model was constructed that covers the main sampled area. A block size of 1 km x 1 km x 1 m was chosen, based on the average data spacing in the main sample areas, hereby attempting to maintain a balance between the sparsely sampled and densely sampled areas. The more densely sampled areas may statistically require a smaller block size for optimum estimation parameters but the 1 km^2 was considered applicable given the proposed mining method. The model was brought into two dimensions (only one block in the z-direction) and all the samples given an elevation of 0.5 m RL.

Attributes were assigned for depth, grade, coverage, resource class and SQR.

12.7.2 Search Neighbourhood Parameters

A circular search was applied, with parameters based on the variogram. A maximum 3,000 m search distance was allowed. The total minimum samples were set at 2 to allow sparsely sampled areas to be estimated (to also estimate the exploration potential outside the main Mineral Resource). The maximum of samples was set to 30.

12.8 Validation

The block model was checked for representativeness by comparing the raw data with the block data for each domain (Figure 55). This showed several instances in a densely sampled area, a zero-grade sample surrounded by several high grade samples. This high local variability is also clear from the variogram (Figure 54) and has been included into the blocks.

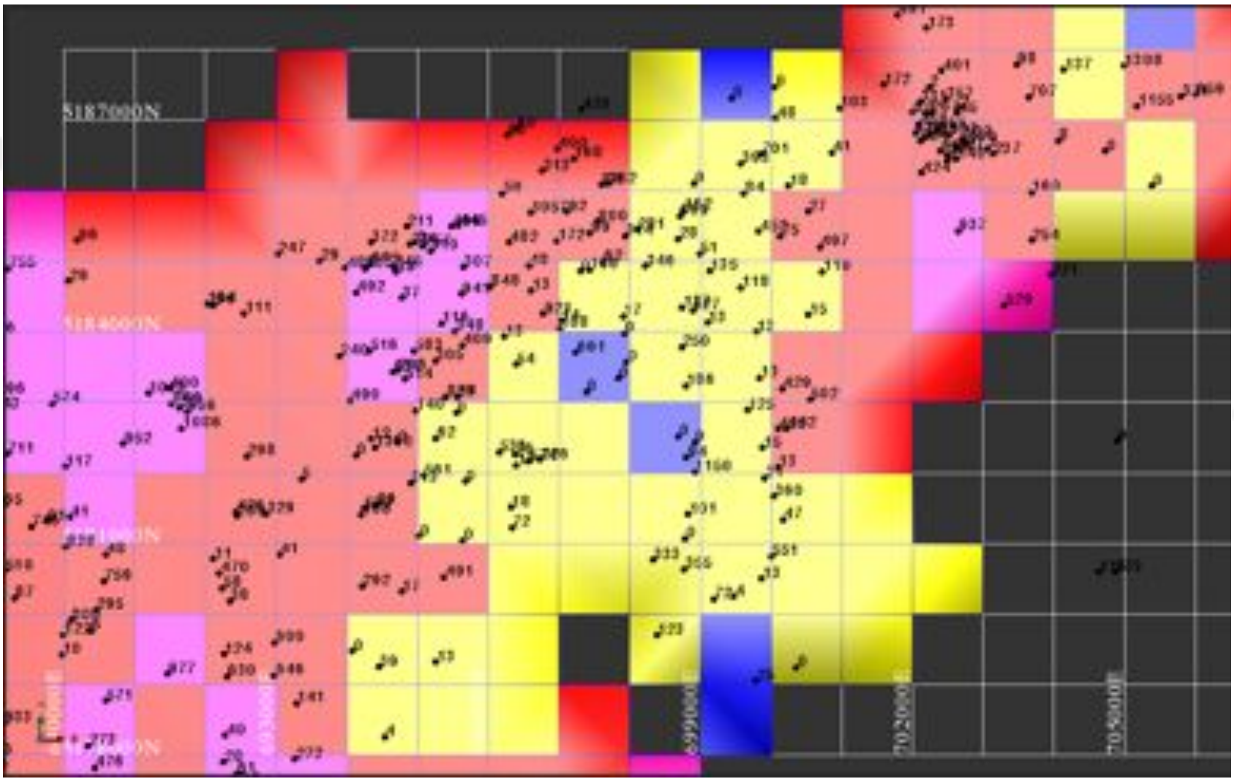

Figure 55: Visual validation of block grades vs. sample grades in kg/m^3. Only blocks considered for the Mineral Resource are shown. Cyan < 50, Blue < 125, Yellow < 250, Red < 500 and Magenta > 500 kg/m^3.

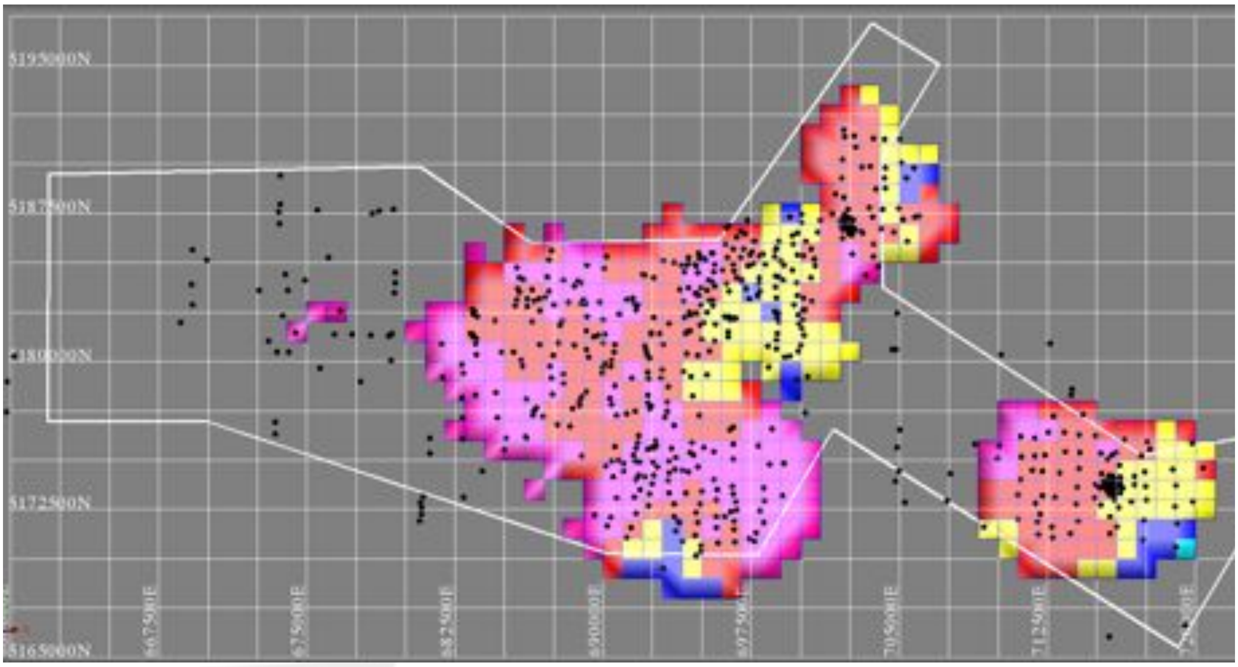

Figure 56: Estimation results showing block grades for Ph kg/m^3. Cyan < 65, Blue < 125, Yellow < 250, Red < 500 and Magenta > 500 kg/m^3. The Mining Lease boundary is shown as white outline.

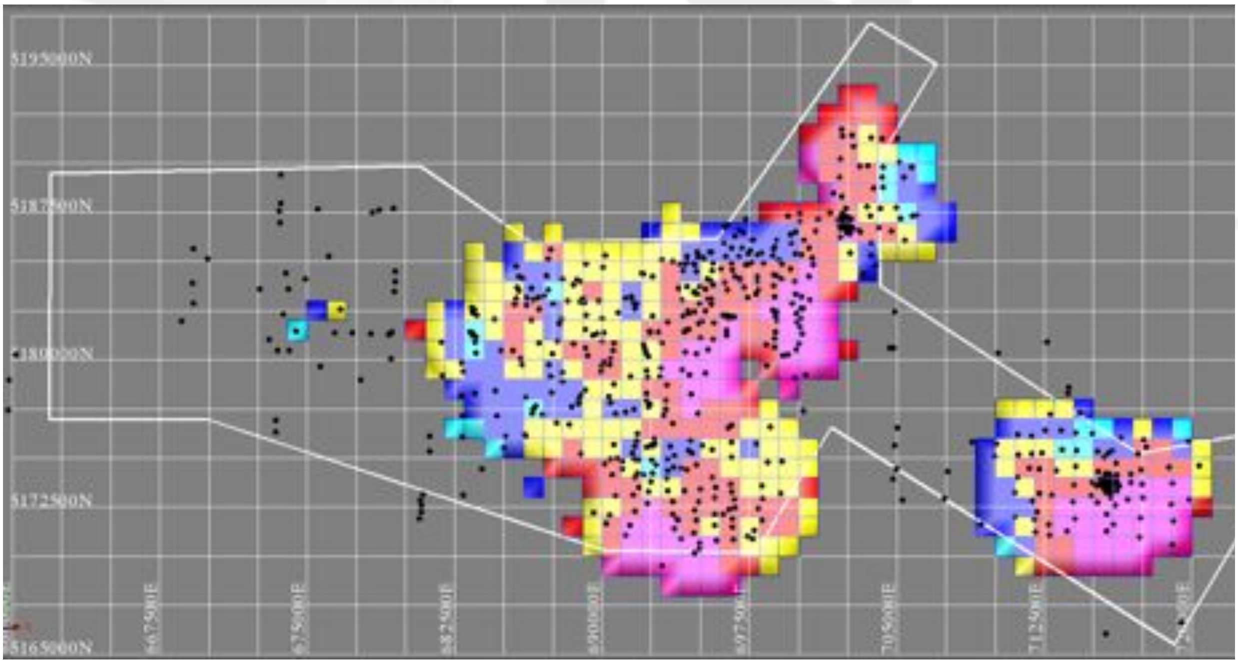

Figure 57: Estimation results showing true depths in cm. Cyan < 15, Blue < 17.5, Yellow < 20, Red < 25 and Magenta > 25 cm. The Mining Lease boundary is shown as white outline.

A trend analysis in east direction plot (Figure 58) shows that the resource blocks represent the sample grades well. Only for the section between 70,4000E and 71,4000E do the samples show a higher average grade than the blocks but this area is poorly informed (low number of samples).

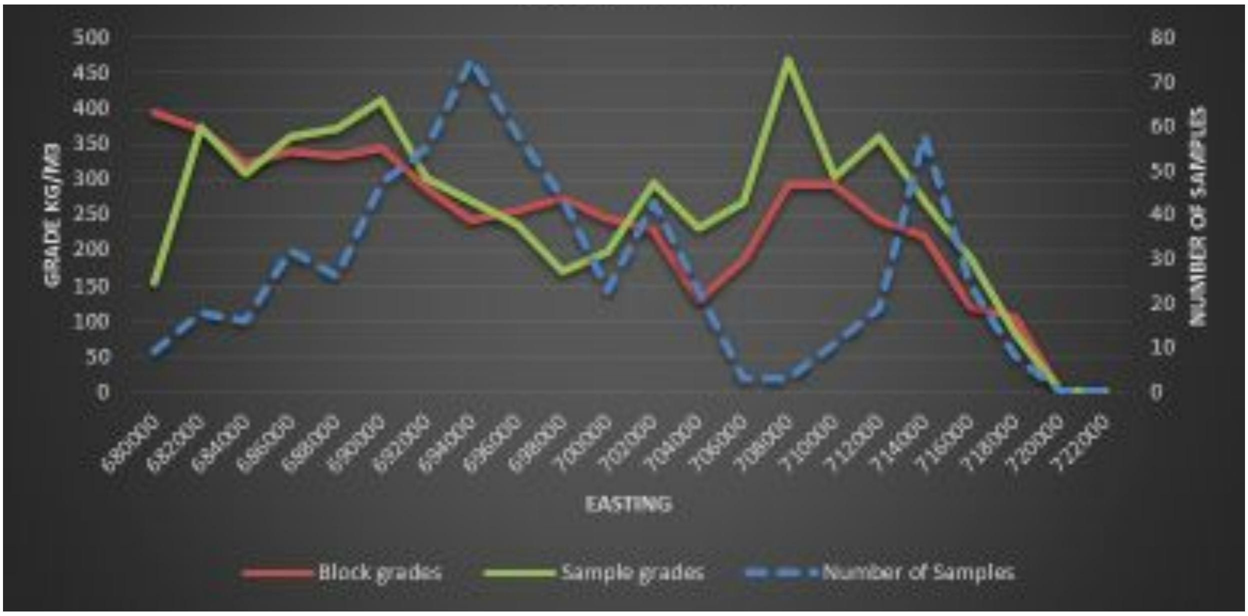

Figure 58: Trend analysis showing validation of block grades versus the input samples from west to east (left to right)

12.9 Consideration for Potential of Economic Extraction

No similar deposits exist that are currently in production from which economic parameters can be derived to evaluate the potential of economic extractability. CRP has assessed several mining, economic and environmental concepts. RSC deems these concepts important to determine whether the Mineral Resource detailed in this report is "potentially economically extractable". However, while the concepts outlined and described below reflect the current status of work completed, it in no way can be considered to represent a preliminary economic assessment (“PEA”) and should not be considered as a reflection of the outcome of a PEA.

Mining operations are proposed to be carried out via a contract mining arrangement, which is expected to be with Boskalis. Boskalis has advised CRP that the estimated operating costs to the Project, payable by CRP to Boskalis (assuming Boskalis were to be appointed mining operator) would be in a range of Euros 62 to 70 (85 to 97 USD) per landed tonne of phosphorite depending on the vessel used. This cost estimate is subject to negotiation and has not been finalised. Boskalis and CRP are still investigating options for unloading at various ports and CRP has estimated a further NZD 10.5 - 14 million (USD 9 - 12 million) of operational expenditure per annum for onshore operations and corporate costs for the Project from the commencement of production.

12.9.1 Mining

In December 2010 CRP invited OceanflORE, Jan de Nul, van Oord and Boskalis to submit independent studies for the design of a system to recover rock phosphate from the seabed of the Chatham Rise. Three of the four companies submitted designs that met the required cost parameters (USD 100/tonne or then Euros 70/tonne) and after a rigorous independent evaluation by CRP, Boskalis was selected by CRP in mid-2011 as its preferred technical partner.

CRP and Boskalis have worked in collaboration to design a mining vessel to meet the specific requirements of the Project (Figure 59). The current design assumes the modification of a dredging vessel. Phosphorite nodules and surrounding material would be retrieved from the seabed using the principles of a conventional trailing suction hopper dredger or drag-head. This material would be brought to the surface via a riser and processed on-board the mining vessel; the phosphorite nodules (>2 mm) being retained and stored on the vessel and the tailings returned to the seabed via a sinker and diffuser (Figure 60). When the vessel's holds are full, the mining vessel would stop mining and proceed to a port where the phosphorite would be unloaded, stored and distributed to the market.

Under this scenario, CRP would mine 1.5 Mt or more of nodules per annum by mining about three 10 km^2 mining blocks. The mine areas would initially target areas of high resource value and therefore will be spaced throughout the Mining Permit area. As mining plans are still conceptual at this point in time, there are no detailed estimates of expected mining recovery, spillage (ore loss) and dilution.

The core elements of the proposed seabed mining activity may include:

- mining to occur in 350 to 450 m of water on the Chatham Rise;
- mining an area of approximately 30 km^2 each year;
- the trailing drag-arm carrying the suction head is suspended from the vessel by wires (dependent on the mining vessel used, this could either be off one side of the vessel or from the centre of the stern);
- the trailing suction drag-head would excavate up to 0.5 m and, on average, the top 0.35 m of seabed;
- pumping of mined sediment through a riser to the surface vessel;
- on-board processing (physical processes only) of the recovered material to separate and retain phosphorite nodules larger than 2 mm in the vessel's hold/s;
- no overflow of sediment/tailings at the sea surface; and
- controlled disposal of unwanted sediment/tailings onto the seabed and within previously mined areas, through a sinker located on the opposite side of the vessel from the drag-arm.

Figure 59: Queen of the Netherlands, example of a Boskalis vessel that could be significantly modified for mining (CRP, 2012).

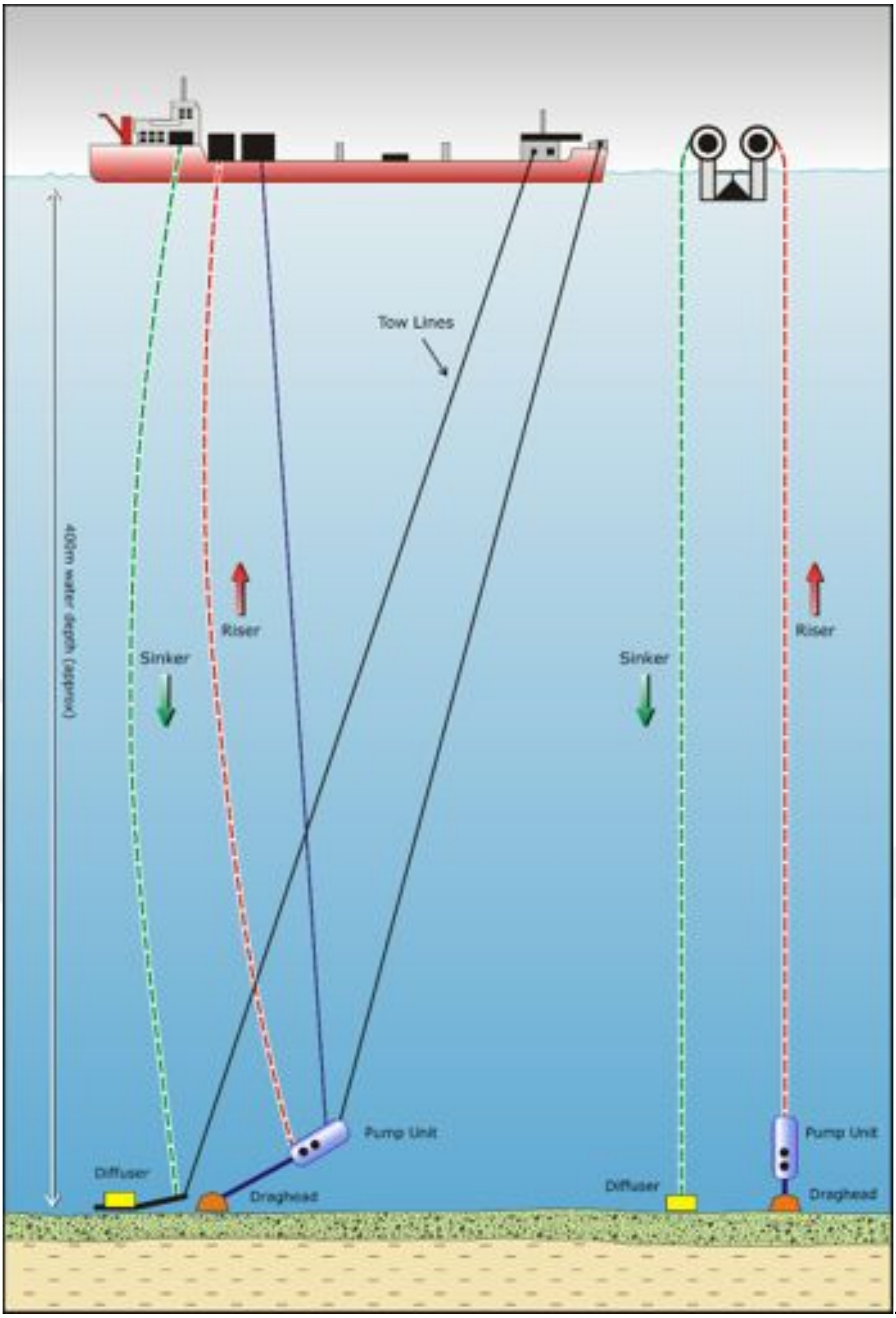

Figure 60: Mining system concept – *Queen of the Netherlands*. The seabed sediment goes up through the drag-head and riser, is processed on the mining vessel, and the non-phosphorite sediments are returned to the seabed through the sinker and diffuser (Boskalis, 2013).

The proposed drag-head is designed to efficiently collect phosphorite nodules from a layer that varies in thickness from 0 to 50 cm, 35 cm in average, and to avoid dredging the underlying chalk/ooze layer. Where the phosphorite-bearing sediment is thicker than 50 cm the drag-head would not be able to mine the entire layer and would therefore leave some of the nodules behind. The drag-head design has been extensively studied by Boskalis (Figure 61) with development and trials still ongoing.

Figure 61: Conventional drag-head concept. The drag-head moves to the right in this illustration. Water jets fluidise the seabed sediment (blue arrows) and pumps lift the sediment and water mixture to the riser and onto the mining vessel (brown arrows, Q riser). Q = water flow rate (Boskalis, 2013).

To optimise the conceptual mining process and use of the mining area, Boskalis have proposed a conceptual mining plan. Key factors influencing the consideration of the seabed mining patterns were the dominant wave direction, width that would be covered with tailings, and the vessel's turning time.

Boskalis used satellite based wave data on the Chatham Rise to model how their vessels would be affected by the wave conditions present at the Chatham Rise using. They determined that certain vessels could mine in swells of up to 4.5 meters, that they could therefore operate approximately 85 per cent of the time, and that the optimal mining orientation was in a north-northeast direction.

With the current foreseen layout of the dredging vessel the material would be loaded on the starboard side and the tailings (sand and fines) would be discharged on the port side. The path of the vessel would likely be a rough oval (Figure 62). A zone of approximately 250 m wide in the centre of each mining block will be un-mined. Of that 250 m zone, 100 m will be covered by tailings from the primary dredge swathes leaving a centre part of each area neither mined nor covered by a thick layer of tailings. It is expected that this central zone may allow benthic organisms to re-populate mined areas rapidly after operations in an area have been completed.

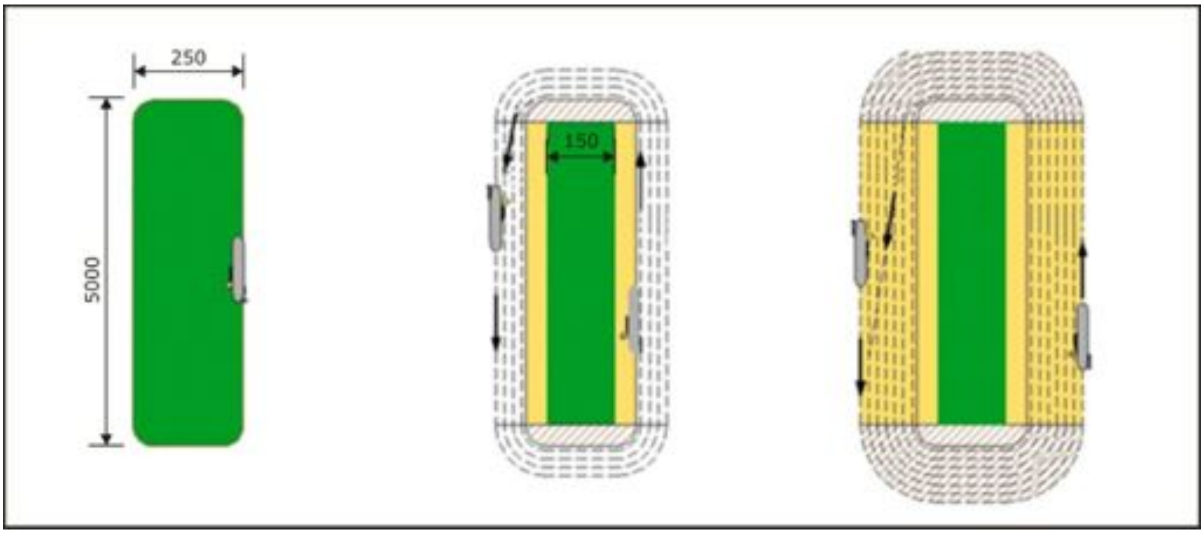

Figure 62: Seabed mining trajectory concept (CRP, 2012).

The current mining concepts anticipate using one vessel with a mining cycle of eight days but allowing up to twelve days to accommodate for weather delays and equipment servicing. Each mining cycle would include approximately one day to reach the proposed mining blocks, three days mining, one day transit to port, and three days unloading. It is therefore anticipated that there will be approximately 30 mining trips per year assuming one vessel is used with a 50,000 tonnes capacity, giving 1.5 million tonnes per annum.

RSC has some concern with regards to the unproven nature of the proposed extraction technique. Trail Suction Hopper Dredging in its proposed form and at these depths is untried and despite extensive work by Boskalis on detailed aspects of the project there are some issues which may require further work. These include movement of the drag-head over the seabed, control on speed of drag-head due to the long tow lines and the accuracy of positioning of the drag-head (which may prove more difficult and less efficient than anticipated by Boskalis). However, in general RSC is of the opinion that the proposed technique appears to be a viable option to mine the deposit, and that with more research the method can be optimised to successfully mine the phosphorite layer in a feasible manner.

12.9.2 Infrastructure

Boskalis is working with CRP to identify a suitable port, where the mining vessel can unload the mined phosphorite, and where the phosphorite can be stored and handled for transfer or export. The main issues that would affect port selection are:

- distance from mining area;
- access for 11 m draft mining vessel and bulk carrier: without dredging;

- method of unloading of the mining vessel: dry (conveyor belt);
- available wharf frontage and storage area: existing, to be modified or to be constructed; and
- environmental criteria (water management) and consenting issues.

There are no other significant infrastructure requirements for the project.

12.9.3 Market Potential

The CRP long term strategic focus is to mine phosphorite from the Chatham Rise in order to supply phosphorite to the fertiliser industry. The phosphorite would be both exported and sold to New Zealand fertiliser manufacturers. CRP commissioned the New Zealand Institute of Economic Research (Schilling, 2013) to conduct an economic assessment of Chatham Rock Phosphate as part of the in-progress EIA requirements. RSC deems this study an important step to assess whether the Mineral Resource is potentially economically extractable. Section 12.9.3.2 is a summary of this report.

12.9.3.1 Fertiliser trials

A number of field trials were conducted in the 1960s and 1970s on the applicability of the Chatham Rise phosphorite as a fertiliser and is summarised by Cullen (1987). RSC is unable to comment on the quality of the work conducted.

One of the primary reasons for the increase in commercial interest in the Chatham Rise deposits in the 1970s and 1980s was the finding that the Chatham Rise phosphorite does not need to be converted to superphosphate as it was an effective fertilizer if just ground, pelletised and applied directly (Falconer, 1989). Pot and field trials have established that, when finely crushed, the phosphorite is suitable for use as a direct-application fertiliser on many New Zealand soil types. It can also still be converted, at increased cost, to superphosphate and triphosphate fertilisers (Cullen, 1987).

Superphosphate is one of the most widely used fertilisers in the world. It was first developed in the 19th Century in England, by mixing sulphuric acid to conventional rock phosphate containing the mineral apatite, a calcium fluoro-phosphate. The resulting water soluble phosphorus was able to significantly improve yields on a variety of crops. Today in countries like New Zealand it is used extensively for livestock and cropping farming.

The agronomic potential of the phosphorite deposits on Chatham Rise was first reported by Norris (1964). However, it was not until 1971 that Buckenham *et al*. reported the results of a comprehensive series of flotation, calcination, slaking (soil breakdown test), and acid-treatment tests to assess the suitability of Chatham Rise phosphorite (CRP) for fertiliser production. The phosphorite was found to have a high reactivity, maintained on heating to at least 850°C, which rendered it fit for the manufacture of superphosphate. On the scale of phosphate reactivity ranges proposed by Hoffman and Breen (1964), CRP compared favourably with Nauru, Christmas Island, Florida, and offshore California phosphorites. Moreover, the high availability and short maturing time of both single and triple superphosphates produced from the Chatham Rise nodules was expected to offset, partly at least, the latter's somewhat lower phosphorus content.

Early pot trials by the N.Z. Fertiliser Manufacturers' Research Association (Roberts & White, 1974), using unprocessed milled Chatham Rise phosphorite, proved encouraging. In the late 1970s the Soil Science Department of Massey University instituted an investigation of the phosphorite as a direct-application fertiliser, using nodules collected by the N.Z. Oceanographic Institute between 1975 and 1978. Unprocessed, ground and pelletised phosphorite was used in both glasshouse and field trials in which perennial ryegrass (Lolium perenne), brown top (Agrostis tenuis), and clovers (Trifolium repens, Trifolium subterraneum), in particular, were grown on a selection of soil types (Mackay *et al*. 1980, 1984a, b, c). Used as a direct application, the Chatham Rise phosphorite compared very favourably with traditional single superphosphate when tested on acid soils with pH values up to about 5.7. Soils of this type cover a high proportion of hill-country farming areas throughout New Zealand. It was found that, after an initial lag because of the lower solubility of Chatham Rise phosphorite, its herbage yield ranged between 85 and 106% of that furnished by superphosphate (Mackay *et al*., 1980), and was mainly in the upper half of this range.

12.9.3.2 Phosphate Future Market Expectations

<u>Domestic Market</u>

The use of phosphate-based fertilisers in New Zealand agriculture is extremely widespread. Super-phosphate accounts for a third of the fertiliser used in New Zealand by tonnage. In total, phosphate-based fertilisers account for over 40% of the fertiliser used in New Zealand (Schilling, 2013).

Production of super-phosphate and other phosphate fertilisers relies largely on imported rock phosphate. Statistics New Zealand's data shows highly volatile import volumes over the last few years, ranging from 320,000 tonnes in 2009 to 890,000 tonnes in 2010 (Schilling, 2013).

<u>Global Market Supply</u>

The drivers for increased fertiliser demand globally are well known and include:

- world population growth combined with greater affluence, particularly China which has 19% of the world's population but only 7% of the arable land;
- greater affluence results in a transfer of consumption from vegetable to meat protein, the latter requiring 10 times more fertiliser to produce;

- reduced arable land availability due to urban encroachment and the degradation of topsoils by erosion and contamination; and
- it has been estimated a 70% increase in food production will be required by 2050.

Globally the phosphate industry has been subject to significant changes in recent decades. In the USA, Florida's rock phosphate reserves have continued to decline, and in the process pushed North American production down to such an extent, that close to 3 million tonnes of rock now need to be imported into the US annually. Chinese production has continued to grow in recent years, raising the country's share of global production to 40% in 2011. The combination of increasing demand for phosphate based fertiliser products, and the overall high rock phosphate prices, has also seen mines being commissioned in South America (Peru) and the Middle East (Saudi Arabia). Further expansions have been proposed for Africa, Europe, South America, the Middle East, the FSU, Asia and Oceania over the medium term (2012 – 2017). Notwithstanding the high overall rock phosphate prices over the last 7 years, a recent (since December 2012) downwards adjustment in rock phosphate prices has resulted in the development of many proposed small onshore mines being put on hold.

Existing operations in Morocco have vast resources but the focus is moving to added value fertiliser products with a USD 15 billion investment in phosphoric acid, and ammonium phosphate manufacturing plants. These expansions require rock phosphate prices to be maintained, particularly as the production costs are also increasing significantly due to various “social investments” encouraged by recent high profit levels. These include substantially increased salaries and social advantages given to the workers which are unlikely to be withdrawn. Elsewhere in the Middle East other rock phosphate competitors such as Syria and Egypt are currently dumping product into the market but they face political problems that are likely to have a major impact on their production and export volumes. Algeria has recently commissioned a new phosphoric acid and ammonium phosphate plant and as a result is no longer exporting to the rock phosphate market.

Vietnam, an exporter of low cadmium rock and a direct competitor of CRP, has recently stopped the export of phosphate rock to keep it for domestic phosphoric acid and fertiliser production.

According to commodity market analysts CRU the most important issues facing the phosphates industry today are:

- US rock phosphate production has fallen by a quarter since 2007; several factors have contributed to this trend but it can be largely attributed to the decrease in reserves with many of the easy to access, high grade resources in North America being mined out, resulting in increased production costs; as a consequence, CRU acknowledges ever greater quantities of product will need to be imported from foreign markets;
- increase in rock phosphate production from proposed expansions of Moroccan mining operations; and

- strong domestic demand for rock has seen Chinese rock phosphate production double over the past decade; key challenges for the Chinese are whether this trend can be sustained in an environment of declining run of mine grades and increasing production costs.

The monthly price as at March 2014 for the cost per tonne of phosphate in Morocco is around USD 108 (NZD 125) per tonne (Figure 63), to which a freight cost (currently around USD 70 or NZD 82 per tonne) is added to achieve a landed cost in New Zealand of approximately USD 178 (NZD 208) per tonne. The average selling price over the last twelve months is around USD 150 (NZD 175) per tonne (USD 220or NZD 255 landed in New Zealand).

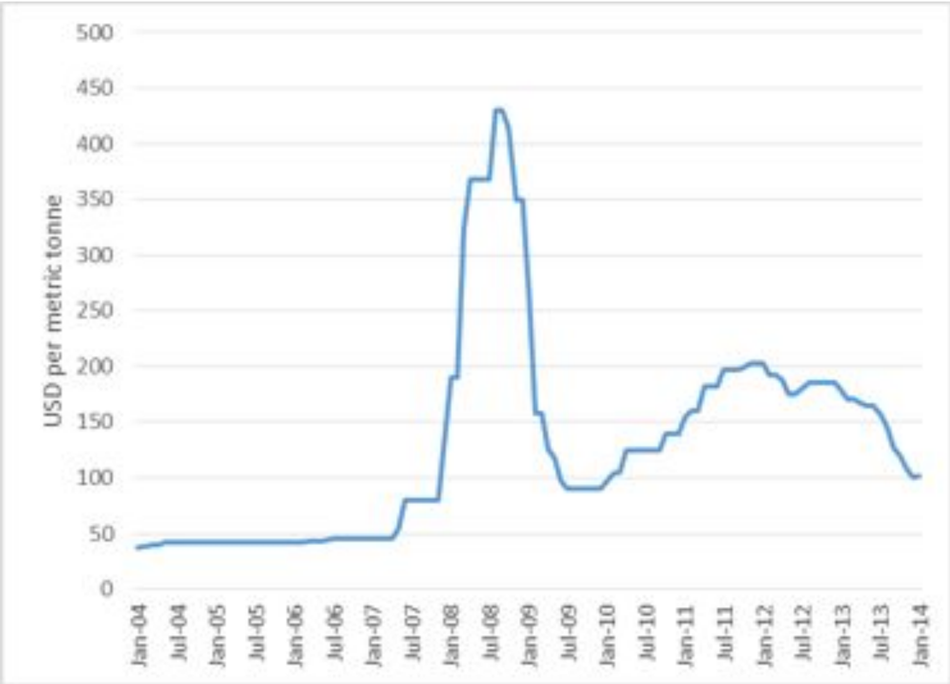

Figure 63: Ten year price range, USD per tonne of phosphate FOB Morocco (source: indexmundi.com/commodities).

Outlooks by the CRU Group and Integer Research over the longer term are more favourable with the expectation of growing consumption and greater need to produce more food production from the same amount of land, especially in regard to Asian countries. Schilling (2013) also notes strong agricultural markets will support significant growth in phosphate demand over the coming years. Heckenmüller et al. (2014) demonstrate that agriculture will always be dependent on phosphorite inputs, and at least in the foreseeable future, it is very likely that the prime source of phosphorite for agriculture will be mineral phosphate fertilisers and therefore, ultimately, phosphate rock (Heckenmüller et al., 2014).

Indicative Pricing of Rock Phosphate

Based on market conditions prevailing in October 2012 the weighted average selling price ("WASP"), net of freight, for Moroccan phosphate was USD 160/tonne. This assumed a range of prices that varied by market and by the intended use of the product.

The extremes of prices in 2008 may not be repeated but CRP is of the opinion that there is little likelihood of prices collapsing from their current levels. Short-term price variations are not likely to have an impact on the Project as no production is likely from the Project before 2017. CRP is confident the predictions of growth in phosphate demand in the next few decades against a background of increasing production costs worldwide, and an unwillingness for the major players in traded rock phosphate, to lower prices will result in continued upward pressure on the cost per tonne of phosphate.

To enter the New Zealand market, the Moroccan phosphate product will also be subjected to an additional USD 70 shipping cost. CRP are confident that due to the Project's close proximity to the New Zealand market, any phosphate product to be delivered by CRP to New Zealand is likely to be landed at a discount to the Moroccan product.

12.9.4 Economic Considerations

Following the granting of the Marine Consent, CRP plans to enter into a contract with a mining operator (assumed, but not guaranteed to be Boskalis) to contract-mine and deliver to a New Zealand port 1.5 million tonnes of dry rock phosphate at an agreed cost per tonne for a period of at least 15 years. The rock will be stored at a rented portside facility before being either exported (about 75% of production) or shipped to New Zealand customers on a FOB basis. CRP has planned key milestones for progressing the Project (Table 20).

Table 20: CRP Project milestones as at March 2014

Milestone	Date
Marine consent application	Q2 2014
Marine consent granted	Q4 2014
Mining contract finalised	Q4 2014
Boskalis vessel engineering initiated	Q4 2014
First production	Q1 2017

12.9.4.1 Operating Expenditure

Mining operations are proposed to be carried out via a contract mining arrangement, which is expected to be with Boskalis.

CRP has estimated that a dredging contractor will seek to charge a fee in the range of Euros 62 to 70 (USD 85 to 97) per landed tonne of phosphorite to cover operating costs, as well as a profit margin. This cost estimate is based on discussions with only one dredge operator and is subject to contractual negotiations that are expected to follow the grant of Marine Consent.

Boskalis and CRP are still investigating options for unloading at various ports and CRP has estimated a further NZD 10.5 - 14 million (USD 9 - 12 million) of operational expenditure per annum for onshore operations and corporate costs for the Project from the commencement of production.

As all portside facilities are expected to be leased by CRP, CRP will need only to finance whatever level of stockpile is necessary to ensure customer demands are not affected by interruptions to the mining schedule.

It is assumed that the mining operator would be responsible for substantially all capital expenditure in relation to the mining vessel used and would be responsible for providing and managing such vessel. Therefore, the only significant assets that CRP expects to hold are the Mining Permit and the Marine Consent.

12.9.4.2 Conceptual Sales Forecasts

Conceptual economic studies by CRP assume a long-term phosphorite sale price of USD 125 per tonne for CRP's product mix. These forecasts assume that the product will be sold for four different uses to a number of identified buyers in eight countries. The assumed uses are as follows:

- to make either medium or high grade super phosphate, direct application, or di-calcic phosphate;
- it can be blended with other high grade super phosphate to reduce higher cadmium found in other rock phosphate;
- it can be used as 100% feedstock (without blending) for medium grade super phosphate; this is a key product for international markets; and
- New Zealand is a key target market for direct application, which is likely to grow due to its lower environmental impact (low cadmium content); this product currently sells at a premium.

12.9.4.3 Royalties

CRP must pay the higher of:

i. an ad valorem royalty of 2% of the net sales revenue of the minerals obtained under the Mining Permit; and

ii. an accounting profits royalty of 10% of the accounting profits, or provisional accounting profits, as the case may be, of the minerals obtained under the Mining Permit.

Conceptual mining costs estimated by CRP for landed phosphorite tonnes are lower than the forecast long term phosphorite price per tonne indicating a likely profit for the Project. Key risk to the Project is the phosphorite commodity sale price and if this drops by more than 32% from forecast then the Project may become unprofitable.

In 2012 the Ministry of Business, Innovation & Employment conducted a review of the royalty regime for minerals, including rock phosphate (section **Error! Reference source not found.**).

12.10 Classification

Given the considerations for potential economic extraction (section 12.9), RSC reports a Mineral Resource of 80,000,000 m^3 at an average grade of 290 kg/m^3, within Mining Permit 55549. The Mineral Resource is classified as an Inferred Mineral Resource at a cut-off grade of 100 kg/m^3 for a total contained 23.4 Mt of phosphorite (see Table 21). The specification of the phosphorite (i.e. the *phosphate* content has been discussed in sections 4.2.2.2, 4.2.2.6, 5.1, 5.4, 11.1, 11.3, 11.5, 12.9.3.1 and even though a representative average grade cannot be determined for the Mineral Resource, the tenor of the specification (in the order of 18-19% P_2O_5 of screened material) is suitable to allow classification into the Inferred Resource category.

There are no resources classified in Indicated or Measured categories. The grade-tonnage relationship is shown in Figure 64.

Table 21 Statement of Mineral Resources (Phosphorite) for Mining Permit 55549, Chatham Rise. Estimates are rounded to reflect the level of confidence in these resources at the present time.

Classification	Volume (m^3)	Thickness (cm)	Ph kg/m^3	Contained Ph Mt
Inferred	80,000,000	20	290	23.4

Notes:

1. *The Mineral Resource is reported in accordance with the JORC Code, 2012 edition*
2. *The Mineral Resource is contained within MP 55549*
3. *All resources have been rounded to the nearest 0.1 million tonnes*
4. *Ph kg/m^3 is the weight of phosphorite per cubic metre*
5. *Contained Ph Mt is contained weight of phosphorite per million tonnes*
6. *Even though a representative average grade for the specification (phosphate grade) cannot be determined for the Mineral Resource, the tenor of the specification (in the order of 18-19% P_2O_5 of screened material) is suitable to allow classification into the Inferred Resource category*

7. *Mineral Resource is reported at 100 kg/m³ cut-off grade*

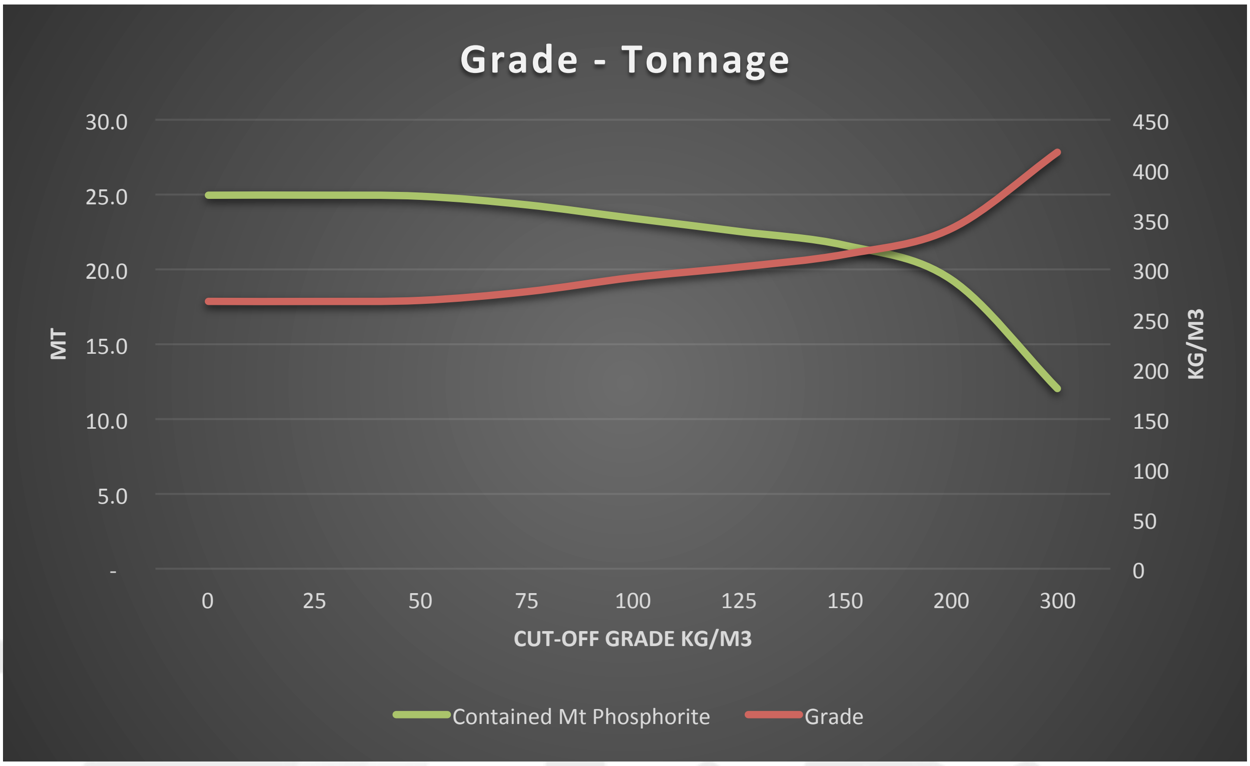

Figure 64: Relationship between cut-off grade (horizontal axis) and contained Phosphorite (left axis) and Resource grade (right axis).

This classification adequately reflects the Competent Person's view of the deposit and is based on several factors, in general order of importance.

1. RSC's analysis to date indicates that a potentially economically extractable phosphorite Mineral Resource exists in the project area. Several high-profile sampling cruises, most independent from each other, have all identified grades of economic interest within the same area. These cruises have been well documented and specific knowledge on sampling systems has been retained and included in this Report with contributions from Dr. Robin Falconer and Dr Hermann Kudrass.
2. The overall amount of sampling within the Mineral Resource area is abundant, and, within each cruise-domain, there are data points for other cruises that, to various degrees of acceptance, confirm the tenor of mineralisation. There may well be comments to add to the quality of some of the sampling, but these two first points warrant a classification of at least a part of the deposit into the Inferred category.

3. Following international guidelines, an Inferred Mineral Resource is that part of a Mineral Resource for which quantity and grade are estimated on the basis of limited geological evidence and sampling. In RSC's opinion this is an adequate description of the Mineral Resource reported in this Report.

In terms of the boundary between the material that can be classified as Exploration Potential and what can be classified as Inferred Mineral Resource, the following is noted:

4. Blocks were classified primarily on the minimum amount of informing samples for each block, which was set to 10 to make sure that there were sufficient samples to inform each block; and
5. Blocks with lower minimum informing samples were allowed into the Inferred classification if the SQR for the block was lower than 3 (indicating good quality samples informed the block) as long as the minimum was still at least 5 informing samples.

In this way, RSC has incorporated the summary of all the issues that negatively affect the sample quality (i.e. sample location, sample size, sample integrity, etc.) into the SQR value for each block.

12.11 Exploration Potential

RSC considers the potential to locate additional areas of economical phosphorite-bearing sand to be significant. In areas immediately adjacent to the Inferred Mineral Resource, sampling indicates exploration targets of 40,000,000 m^3 with a phosphorite grade between 200 and 300 kg/m^3 and a contained phosphorite target of 8 to 12 Mt (refer to the area between the solid white and dotted white lines in Figure 65, Table 22). RSC notes that the existing sampling in these areas is not of good enough quality or high enough density, and therefore recommends follow-up sampling would be required if CRP intends to confirm this potential.

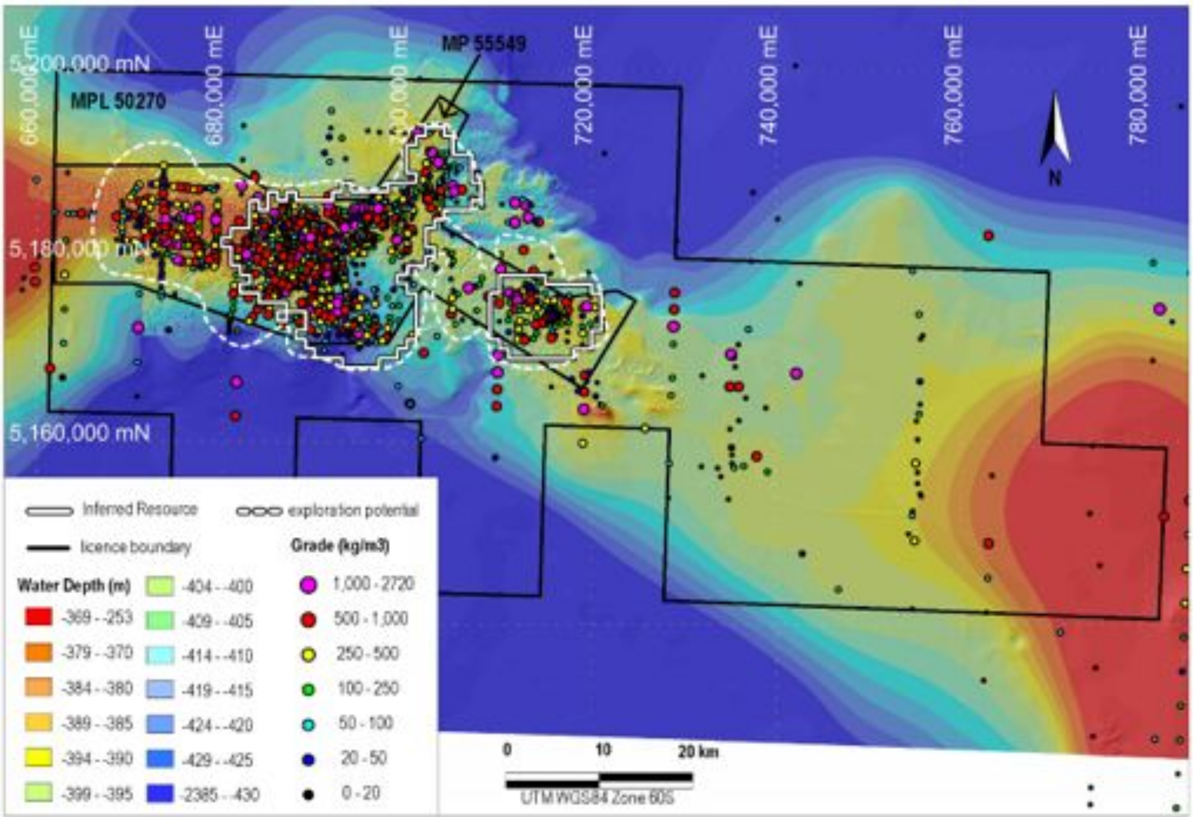

Figure 65: Exploration Potential

Table 22: Exploration potential for Phosphorite within CRP tenements (MP55549, MPL50270)

	Volume m³	Ph kg/m³	Contained Ph Mt
Exploration potential	40,000,000	200 – 300	8 – 12

In addition to this exploration target immediately adjacent to the Mineral Resource, a prospectivity study by Kenex (2014) aimed to identify the areas of highest exploration potential in a wider tenement area, covering MP 55549 as well as MPL 50270 and areas to the east which are currently under application (Kenex, 2014). Kenex used the "mineral system concept" in its study to develop 28 Weights of Evidence and eight Fuzzy Logic predictive maps for use in exploration and to assess the prospectivity of the central Chatham Rise for nodular phosphorite deposition.

The fuzzy logic prospectivity modelling was completed to produce targets based largely on derivatives of bathymetry and geology. The model identified low slope angles, entrainment in the saddle regions, and shallow bathymetry with south-east facing slopes as important parameters for nodule deposition on the Chatham Rise. The most prospective regions are likely to be found in the vicinity of major faults and within the very prospective Early Oligocene chalk facies.

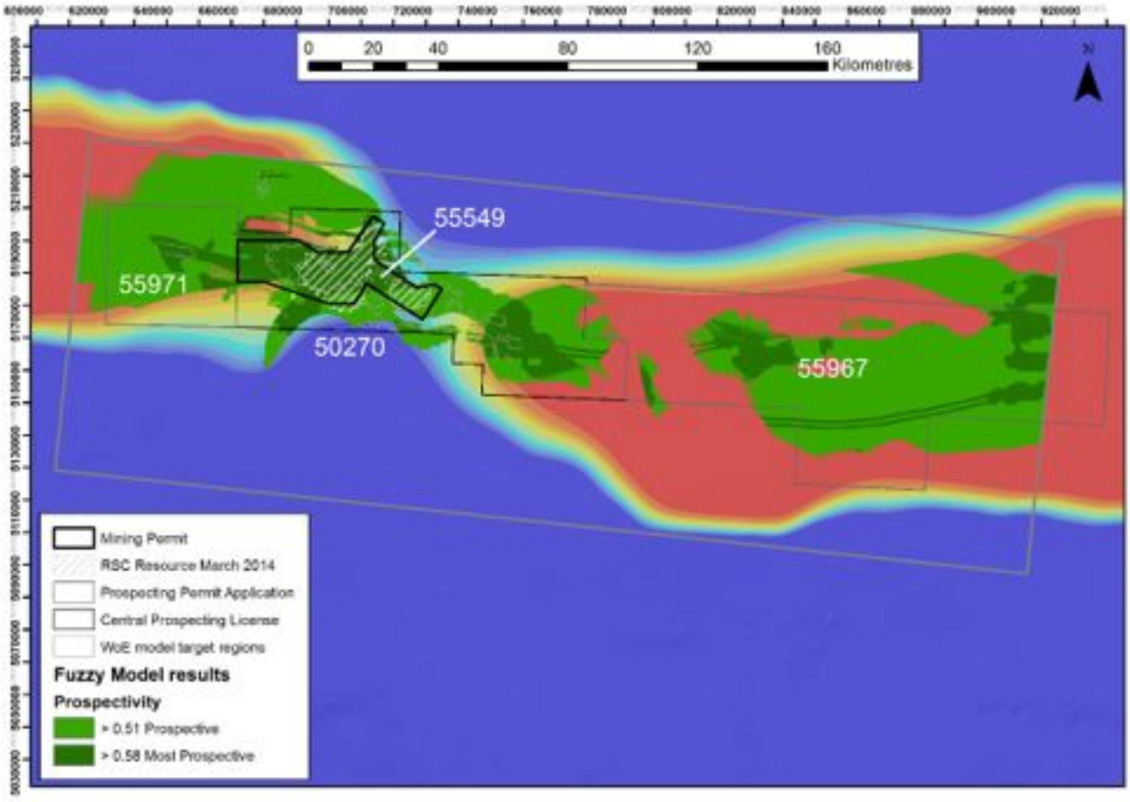

Figure 66: Mineral Prospectivity Map

The model also identified areas where high grade nodules are least likely to be encountered: area containing outcrops of basement and areas with thick covers of Late Neogene, especially Pleistocene, sandy sediments. Prospectivity is also likely to decrease as one searches north or south away from the central crest where slope angles are steeper, young sediment drapes are thicker, and water depth likely to have been too deep to favour extensive phosphatisation in the past.

The Kenex prospectivity model indicates that the overall mineral endowment is likely to extend further along the Chatham Rise and it can be used to maximise and guide exploration efforts.

13 Interpretation and Conclusions

During the last five decades of exploration of the Chatham Rise phosphorite deposit, a variety of sampling techniques and measuring techniques have been used with varying degrees of success. For the purpose of Mineral Resource estimation, both the historic and modern sampling undertaken suffers from a number of issues including large sample location errors, variable sample sizes, lack of documentation of sample procedures, limited quality control, invalid calculation assumptions and visual estimations of phosphorite contents. All of these add errors to the grade estimation process. Most of the work carried out by RSC has focused on a thorough review of all the available data to understand the implication of each of the various errors and assumptions on the quality of the data, and to separate the usable data from the non-usable data. On a small scale, the deposit is also complicated with high local variability caused by the coarse-grained nature of nodules and post-depositional modifications from icebergs.

After reviewing the sample data and procedures RSC has identified the data from the *Sonne* to represent the best data collected for the purpose of Mineral Resource estimation. The locations of *Sonne* data points have been determined using underwater transponders to reduce relative position error. The *Sonne* used a large pneumatic grab that allowed adequate penetration of the sand horizon, and is capable of recovering large samples (0.8 m^3). The *Sonne* sampling process was furthermore very well documented and extensively reported on in post-cruise research studies. RSC has calculated new grade information from the raw datasheets and removed samples that were compromised (i.e. sample washing, etc.).

RSC reviewed the *Valdivia* data, collected using a much smaller Van Veen grab. This grab had a 0.12 m^3 sample and had some difficulty penetrating the nodule-rich sand consistently. The *Valdivia* dataset was carefully analysed for bias and a large number of samples were classified with a low ranking and removed from the Mineral Resource estimate.

The *Sonne* and *Valdivia* datasets are the most important for quantifying grade and volume estimation of the Chatham Rise phosphorite deposit, with other earlier data sets being too widely spaced and later data sets being in small numbers, closer spaced but collected in isolated groups.

RSC's analysis to date indicates that a potentially economically extractable phosphorite Mineral Resource exists in the Project area. Several high-profile sampling cruises, most independent from each other, have all identified grades of economic interest within the same area. These cruises have been well documented and specific knowledge on sampling systems has been retained and included in this Report with contributions from Dr. Robin Falconer and Dr Hermann Kudrass, who were part of the earlier sampling cruises on which most of this Resource is based. Furthermore, CRP has carried out extensive work (conceptual mining studies, market analysis, recovery studies and environmental studies) to further support that the Mineral Resource is potentially economically extractable.

The overall amount of sampling within the Mineral Resource area is abundant, and, within each cruise-domain, there are data points for other cruises that, to various degrees of acceptance, confirm the tenor of mineralisation. There may well be comments to add to the quality of some of the sampling, but these two first points warrant a classification of at least a part of the deposit into the Inferred category.

14 Recommendations

14.1 Work Program

The current Mineral Resource is based on historic data and classified as Inferred because of its relatively low confidence. RSC recommends that further sea floor sampling is undertaken to both increase the confidence in the established Mineral Resource as well as to extend the boundaries of the Resource, predominantly towards the west where currently low-quality *Valdivia* data indicates an exploration target of 8 to 12 Mt phosphorite at grades of 200 to 300 kg/m^3. Increasing the confidence in the current Mineral Resource by additional properly located and documented sampling will give CRP and Boskalis the grade and geological confidence in the phosphorite deposit to allow them to further develop mining plans and economic studies.

RSC recommends that further exploration includes, but is not limited to:

- 400 x 400 m seafloor sampling using a large-sized pneumatic grab;
- a thorough QA/QC programme for future sampling campaigns;
- logging of data indicating depth of mineralised sand layer;
- ROV transects of sample sites to confirm sample quality and depth of sample; and
- detailed bathymetric survey of mining blocks to delineate barren zones from outcrop, icebergs furrows and pits.

Based on previous work programmes, up to 30 samples can be collected each day. More samples can be collected if work can continue through the night. On the 400 x 400 m grid there will be about 9 samples every 1 km^2 of seafloor. The next phase of sampling required to increase the resource to Indicated classification can be staged to reduce exploration expenditure, but will need to deliver enough resources volumes that feasibility studies can utilise and show an economic mine life over a sustainable period. This may require delineating resources over 150 km^2 of seafloor to allow for approximately five years of mining based on current mining concepts. Approximate costs of this programme are shown in Table 23.

Table 23 Sampling required to upgrade the Mineral Resources.

Phase	Number	Ship days	Ship operational cost @ USD 100k per day	Mobilisation, transit @ USD 60k per day
Seafloor sampling	1,350	45 (30 samples per day)	USD 4.5 M	Mob USD? Transit USD 0.36 M

14.2 Seafloor Sampling

Ideally, grab sampling should be conducted on a 400 x 400 m grid in zones identified as high economic potential for mining operations. This distance is regarded as adequate for delineating short-range variability (<1000 m) in the phosphorite deposit shown in Figure 54. The grid dimension may need to be further adjusted depending on local geological conditions and results. Using a grid-based sampling design will reduce the issue of clustered data and efficiently cover a large area.

RSC would recommend undertaking the sampling using a grab of similar capabilities to the *Sonne* grab. A minimum of 0.8 m^3 will reduce the effect of the nuggety nature of the phosphorite, allow meaningful duplicates to be taken, both of the field sample and for sub-sampling, and allow less disturbed samples to be collected of the full sand depth. The jaws need to be hydraulically controlled, preferably from the deck and triggered as the grab hits the seafloor. The sample grab must be fully sealed to protect the sample from washing.

Sample processing can be completed either at sea or on land. However, the whole sample needs to be processed for separation. Data collection prior to processing needs to include:

- Accurate measurement of the sample volume of the whole grab sample;
- Accurate measurement of the sand volume/thickness;
- Detailed descriptive logs of profile and visual estimation of phosphorite content;
- Graphical profile of the grab showing depths of phosphorite occurrences; and
- Collection of photographic record of sample profile.

Sample processing and analysis requires reducing the sample down to one or more fractions over 2 mm. The system needs to use a standardised sieve which can handle the size of sample without overflowing, getting blocked, and can be cleaned between separation runs. Data requirements are:

- accurate measurement of the weight or volumes of sieved fraction(s); and
- estimation of phosphorite content using a standardised abundance reference.

The results will allow for the accurate calculation of phosphorite content of the sand layer (kg/m^3). Grab sample volume would need to be estimated based on the known grab dimensions and height of collected sample in the grab.

14.3 QA/QC

As part of the resource reporting requirements, the sampling programme requires a suitable QA/QC programme to ensure the sample collection is undertaken according to best practice and controlled. RSC proposes using the following practices to meet the appropriate QA/QC requirements:

- clear documentation of sampling and other procedures;
- collection of duplicate grabs from the seafloor (<10 m separation) 5% of the samples;
- photograph of the sample site after collection (ROV or similar, or a video camera mounted on the grab) with scale to determine sample depth, and void shape of the sample on seafloor; and
- full phosphorite separation needs to be conducted on 3% of the samples, where the phosphorite material is separated from the non-phosphorite material in the sieved fractions.

Any further subsampling or reduction of sample size for further analyses needs to be conducted under controlled conditions using proper splitters capable of handling large nodules and sample sizes of several hundred kilograms. Sub samples will be required for additional geochemical analyses and density testing.

RSC recommends routine laboratory analysis on all samples with phosphorite for P_2O_5. The quality of these analyses should be controlled with standards and blanks.

RSC also recommends that the levels of deleterious elements such as As, Cd and U should be analysed.

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Appendix I: Mining Permit 55549 boundary points; MPL 50270 boundary points

Point	South Latitude			Longitude			
	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds	East/West
1	43	25	19	179	14	01	E
2	43	27	13	179	18	16	E
3	43	27	07	179	25	15	E
4	43	20	58	179	30	44	E
5	43	22	02	179	13	18	E
6	43	24	37	179	31	20	E
7	43	28	15	179	31	25	E
8	43	32	30	179	41	23	E
9	43	32	00	179	45	21	E
10	43	32	33	179	46	56	E
11	43	37	46	179	42	52	E
12	43	32	09	179	29	48	E
13	43	35	32	179	27	08	E
14	43	35	39	179	20	53	E
15	43	32	25	179	06	30	E
16	43	32	31	179	00	14	E
17	43	25	36	178	59	60	E

Boundary Coordinates of the MPL 50270

Point	South Latitude			Longitude			
	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds	East/West
1	43	40	0	179	0	0	E
2	43	20	0	179	0	0	E
3	43	20	0	179	50	0	E
4	43	30	0	179	50	0	E
5	43	30	0	179	40	0	W
6	43	40	0	179	40	0	W
7	43	40	0	179	30	0	W
8	43	50	0	179	30	0	E
9	43	50	0	179	50	0	E
10	43	40	0	179	50	0	E
11	43	40	0	179	40	0	E
12	43	50	0	179	40	0	E
13	43	50	0	179	30	0	E
14	43	40	0	179	30	0	E
15	43	40	0	179	20	0	E
16	43	50	0	179	20	0	E
17	43	50	0	179	10	0	E
18	43	40	0	179	10	0	E

Appendix II: Sample Details, SQR 1 to 4

Notes:

1. *Sample details are limited to informing samples used in the Mineral Resource.*
2. *Samples with an SQR 5 to 7 are not shown.*
3. *SQR is sample quality ranking, see Section 10.2.*
4. *Ph Grade kg/m³ is the weight of phosphorite per cubic metre.*

Sample	Easting (UTM)	Northing (UTM)	SQR	Thickness (m)	Ph Grade (kg/m³)
VA004	686775	5180854	4	0.15	346.53
VA013	687498	5182878	2	0.19	489.60
VA020	683382	5182653	4	0.15	810.34
VA021	683513	5182573	4	0.26	49.98
VA023	683418	5181367	2	0.18	654.28
VA024	683300	5181410	4	0.00	0.00
VA025	683421	5181258	4	0.00	0.00
VA026	683584	5181169	4	0.00	0.00
VA027	683598	5180344	4	0.00	0.00
VA032	683556	5178287	3	0.15	952.00
VA033	683533	5180893	3	0.26	249.90
VA041	685862	5180065	4	0.17	118.47
VA045	685934	5179732	4	0.27	58.99
VA048	688713	5184053	3	0.21	499.80
VA051	688538	5180815	2	0.30	35.24
VA054	688462	5177623	3	0.11	114.75
VA061	683418	5182409	2	0.19	44.43
VA062	683602	5182256	2	0.18	70.15
VA069	691662	5182626	3	0.11	1085.99
VA071	689823	5182985	4	0.23	574.13
VA072	688867	5182948	3	0.26	92.99
VA083	686115	5178066	3	0.19	177.71
VA085	686086	5176123	3	0.18	808.42
VA092	691459	5179154	2	0.11	977.39
VA100	685996	5184136	2	0.09	193.80
VA102	685556	5182850	3	0.28	7.71
VA107	685460	5180486	3	0.30	66.64
VA113	686617	5177632	3	0.08	787.56
VA114	686948	5177234	4	0.15	783.36
VA116	687686	5176806	3	0.27	23.45
VA117	688320	5176693	2	0.24	15.30

VA122	687050	5183245	4	0.00	0.00
VA124	687162	5184295	4	0.00	0.00
VA126	687260	5185136	3	0.29	100.95
VA127	687384	5185624	4	0.29	28.71
VA133	687423	5178339	3	0.13	31.47
VA135	687375	5179168	4	0.18	746.37
VA137	687307	5179750	3	0.10	559.78
VA139	687494	5180310	4	0.27	16.15
VA142	687744	5180927	4	0.14	837.76
VA146	687808	5181854	3	0.18	307.81
VA150	688260	5183008	3	0.20	555.33
VA158	690183	5185292	3	0.06	95.67
VA160	690059	5184716	3	0.30	29.32
VA164	690006	5182086	3	0.22	116.62
VA167	690095	5179909	3	0.20	799.68
VA174	689203	5184893	3	0.19	755.25
VA178	689089	5182902	4	0.28	43.07
VA179	689191	5182270	3	0.12	710.83
VA180	689138	5181539	3	0.20	64.60
VA182	689156	5180613	4	0.18	510.43
VA183	689289	5180223	4	0.29	86.98
VA184	687928	5182073	4	0.00	0.00
VA191	690828	5182414	3	0.13	952.00
VA196	690018	5180951	3	0.13	837.76
VA199	689985	5179706	4	0.27	121.60
VA200	689967	5179426	2	0.30	10.36
VA207	689033	5183110	3	0.30	196.41
VA215	687968	5179379	4	0.20	561.18
VA216	687969	5178877	3	0.10	479.81
VA233	686469	5177501	4	0.00	0.00
VA234	686460	5177253	4	0.18	826.34
VA236	684551	5178432	3	0.15	224.40
VA239	684865	5180476	3	0.18	733.04
VA242	684537	5182056	2	0.25	32.64
VA247	685645	5184770	2	0.09	1043.06
VA248	685750	5184228	2	0.19	495.27
VA250	685696	5183685	3	0.27	57.42
VA251	685776	5183503	4	0.14	198.77
VA252	685654	5183117	3	0.20	222.13

VA253	686167	5183166	4	0.14	571.20
VA255	686391	5183657	3	0.16	444.27
VA258	687989	5184129	4	0.13	533.12
VA260	688541	5183820	2	0.16	799.68
VA262	688884	5183971	2	0.23	466.48
VA269	686155	5182791	3	0.25	484.50
VA270	686483	5183031	3	0.29	84.18
VA271	686755	5183158	2	0.29	12.78
VA273	687239	5183549	3	0.09	1029.89
VA274	686791	5182583	4	0.23	74.61
VA275	686411	5182004	4	0.22	184.54
VA276	695372	5180525	4	0.17	490.69
VA283	694241	5181497	4	0.15	592.42
VA286	694898	5181853	4	0.05	312.80
VA287	695084	5181962	3	0.20	561.00
VA293	696151	5182293	2	0.21	533.12
VA294	696375	5182255	3	0.30	25.84
VA295	696565	5182170	3	0.09	574.46
VA296	696731	5182186	3	0.21	225.55
VA299	691187	5183131	3	0.09	1012.93
VA300	691478	5183197	4	0.09	399.84
VA302	691522	5182979	3	0.06	888.53
VA303	691630	5182926	4	0.30	34.99
VA304	691736	5182873	4	0.18	655.82
VA308	692581	5182237	3	0.12	298.42
VA311	693355	5181911	4	0.30	4.58
VA315	692015	5184399	2	0.08	193.80
VA316	692112	5184372	4	0.30	54.40
VA318	692546	5184256	4	0.26	110.74
VA328	693897	5183654	3	0.30	239.90
VA329	692443	5181387	3	0.20	288.77
VA334	692854	5181418	4	0.30	328.87
VA335	692426	5181448	4	0.21	426.36
VA340	690080	5181372	2	0.11	40.80
VA341	689753	5181318	2	0.25	91.20
VA342	689530	5181242	4	0.15	746.37
VA346	688799	5177782	4	0.30	109.95
VA348	688820	5177996	4	0.03	605.82
VA349	688910	5178187	4	0.30	0.72

VA350	689141	5178458	4	0.05	932.96
VA354	691638	5177469	4	0.15	18.79
VA358	692253	5177901	2	0.26	28.44
VA359	692341	5177605	4	0.21	183.63
VA360	692443	5177737	2	0.08	61.20
VA365	692275	5178282	4	0.30	40.37
VA369	692297	5179117	2	0.17	630.05
VA371	692256	5179430	2	0.20	124.16
VA374	692345	5180181	2	0.18	37.59
VA376	692237	5180364	4	0.19	57.86
VA377	692197	5180577	2	0.05	469.82
VA378	692108	5180783	2	0.29	10.51
VA383	693016	5185100	4	0.23	246.96
VA385	693610	5185004	3	0.26	28.71
VA386	693979	5184898	2	0.11	488.07
VA398	682842	5179841	3	0.11	1190.00
VA407	693120	5177194	4	0.30	232.89
VA408	693244	5177492	3	0.09	319.87
VA409	693259	5177944	4	0.25	272.00
VA412	693283	5178737	4	0.25	140.95
VA413	692969	5179132	2	0.13	646.00
VA414	692973	5179592	3	0.08	599.76
VA416	693046	5180849	4	0.28	41.34
VA417	690581	5180848	4	0.28	48.45
VA418	690553	5180468	4	0.15	758.67
VA419	690442	5180061	3	0.22	295.31
VA420	690375	5179764	4	0.30	5.93
VA422	690586	5178774	3	0.17	571.20
VA424	690337	5178133	4	0.25	272.63
VA425	690434	5177821	2	0.06	476.00
VA427	690661	5177267	4	0.28	450.19
VA435	690781	5174984	3	0.30	148.10
VA436	691620	5174936	3	0.30	493.14
VA437	691528	5175237	3	0.11	498.67
VA440	690443	5174959	3	0.17	266.56
VA449	692663	5175969	4	0.28	10.88
VA450	692707	5175738	2	0.29	35.24
VA451	692492	5175641	3	0.21	418.88
VA452	692284	5175573	4	0.22	19.58

VA463	688931	5175205	2	0.19	646.21
VA466	686062	5176177	4	0.30	210.44
VA469	684988	5175503	3	0.12	621.97
VA472	683860	5174439	4	0.11	799.92
VA474	682936	5173134	2	0.30	345.26
VA478	680709	5171921	4	0.20	6.94
VA479	680801	5172278	4	0.30	0.98
VA480	680794	5172609	4	0.30	0.00
VA481	680765	5172861	4	0.20	1.24
VA482	680869	5173170	4	0.30	1.63
VA485	681209	5175354	4	0.15	133.28
VA486	681230	5176128	3	0.15	586.43
VA489	681849	5179174	4	0.29	57.42
VA491	681829	5180917	3	0.19	602.93
VA495	679141	5181280	4	0.28	34.68
VA496	678232	5181328	4	0.30	81.60
VA497	677297	5181358	4	0.10	852.99
VA498	676390	5181353	4	0.21	715.28
VA500	674427	5181438	4	0.12	705.60
VA506	668605	5181982	4	0.30	14.51
VA507	682957	5179409	4	0.29	55.95
VA509	682850	5178156	4	0.17	710.83
VA511	682893	5177139	3	0.09	166.11
VA513	682886	5176076	2	0.12	633.08
VA518	684656	5177157	4	0.24	69.31
VA522	685080	5176122	2	0.11	799.68
VA528	676100	5185269	4	0.28	96.93
VA531	674903	5184131	4	0.28	36.18
VA533	674025	5183612	2	0.11	666.40
VA546	673494	5180479	4	0.17	186.84
VA552	673400	5176927	4	0.29	13.60
VA553	673379	5176338	4	0.27	65.28
VA555	673605	5186968	2	0.17	776.77
VA556	673552	5187599	4	0.29	60.29
VA559	673661	5189431	4	0.33	0.00
VA566	679478	5184505	2	0.10	745.70
VA567	679466	5183993	3	0.20	343.95
VA568	679435	5183478	4	0.26	333.20
VA572	679295	5181411	4	0.22	869.98

VA574	679259	5181351	3	0.30	319.87
VA576	679266	5180029	4	0.17	666.40
VA579	679386	5187708	3	0.18	27.20
VA581	678653	5187624	4	0.12	57.80
VA582	678316	5187488	4	0.15	5.80
VA587	675535	5187680	4	0.13	652.80
VA590	673662	5187969	4	0.10	48.96
VA602	669216	5182873	4	0.23	50.77
VA604	669182	5183899	4	0.10	92.86
VA607	669200	5185666	4	0.22	0.92
VA609	669933	5185152	4	0.22	13.60
VA615	672567	5183581	4	0.17	480.86
VA632	677729	5178993	3	0.23	26.61
VA633	675648	5179675	4	0.10	666.40
VA636	674087	5180485	3	0.16	166.71
VA638	673075	5181019	4	0.15	413.44
VA665	676699	5182564	3	0.14	610.87
VA671	673762	5182312	3	0.09	682.18
VA675	673894	5184414	4	0.16	285.60
SO001	691870	5173502	4	0.37	645.26
SO002	694668	5171192	4	0.15	92.21
SO011	691773	5176235	3	0.37	192.08
SO013	691658	5175577	1	0.09	350.87
SO014	691197	5177343	4	0.01	463.36
SO015	690119	5174700	3	0.37	7.14
SO016	691849	5174920	1	0.11	570.93
SO017	691686	5174013	3	0.23	592.01
SO019	691646	5172316	1	0.07	99.19
SO020	691389	5171596	3	0.37	27.34
SO021	691209	5171043	3	0.37	93.61
SO022	692593	5175637	1	0.14	414.57
SO023	692501	5174918	1	0.06	225.44
SO024	692747	5174638	3	0.33	644.63
SO026	692337	5173298	3	0.37	0.00
SO027	692314	5172699	3	0.37	19.85
SO030	693335	5174963	1	0.07	137.38
SO031	693617	5174544	1	0.15	154.22
SO032	693279	5173956	1	0.06	951.28
SO033	693346	5173336	1	0.06	23.41

SO034	693584	5172779	1	0.11	289.93
SO035	693575	5172144	2	0.36	20.90
SO036	693850	5171827	2	0.36	0.00
SO037	693675	5171424	2	0.36	0.00
SO038	694472	5175887	1	0.04	27.37
SO039	694415	5175376	1	0.12	414.61
SO040	694592	5175254	2	0.14	892.19
SO041	694337	5174421	1	0.34	198.37
SO042	694114	5173948	4	0.37	0.00
SO043	694194	5173324	1	0.27	0.00
SO044	694366	5172973	1	0.02	0.00
SO045	693784	5171926	3	0.37	0.00
SO046	695570	5173440	1	0.29	0.00
SO048	695587	5175408	3	0.37	44.05
SO050	695602	5173998	1	0.24	60.09
SO052	695740	5173007	2	0.36	102.43
SO054	693046	5169520	2	0.36	0.00
SO055	693478	5175580	1	0.07	749.89
SO056	693672	5175109	1	0.25	57.89
SO057	694030	5174506	1	0.27	2.86
SO060	696603	5175801	1	0.14	0.00
SO062	696568	5175054	1	0.08	308.14
SO065	696556	5173673	1	0.32	28.30
SO066	699059	5173184	1	0.21	183.14
SO067	696573	5173274	1	0.07	151.15
SO069	696720	5172899	3	0.37	0.00
SO070	696742	5172486	2	0.18	562.42
SO071	696648	5171899	1	0.35	0.00
SO072	696631	5171492	3	0.38	0.05
SO073	690603	5175686	1	0.11	728.15
SO074	690530	5174122	1	0.25	556.69
SO075	691017	5174833	2	0.36	137.97
SO076	691025	5174431	1	0.03	281.96
SO077	696400	5176551	1	0.22	76.59
SO079	698569	5176566	2	0.37	37.47
SO080	698417	5174804	1	0.24	81.07
SO081	699138	5174849	1	0.22	190.35
SO082	698123	5173575	1	0.07	201.45
SO083	698148	5172936	1	0.33	57.54

SO085	697944	5172416	1	0.07	463.38
SO086	698115	5171816	3	0.38	13.22
SO087	697755	5171334	1	0.08	891.57
SO088	697651	5170896	1	0.10	182.04
SO089	694946	5170673	3	0.38	396.44
SO090	694706	5170180	3	0.38	18.18
SO092	694689	5172366	3	0.26	224.39
SO093	694983	5173420	3	0.20	81.35
SO094	697876	5175722	1	0.03	197.52
SO095	693591	5176754	2	0.37	0.00
SO096	690675	5173063	1	0.25	416.18
SO097	690401	5172079	3	0.22	360.41
SO098	689591	5172202	1	0.04	868.92
SO099	690208	5171656	3	0.11	39.84
SO100	694008	5170899	3	0.38	0.00
SO101	694969	5170369	3	0.38	0.00
SO102	696673	5170840	1	0.13	97.20
SO103	697392	5171017	3	0.18	292.50
SO104	696463	5172407	3	0.18	255.58
SO105	695727	5171568	1	0.06	317.40
SO106	696142	5172128	1	0.04	720.35
SO107	694914	5172759	3	0.38	1.32
SO109	695803	5170818	1	0.14	29.88
SO110	691783	5174229	3	0.06	1135.61
SO111	692085	5174149	1	0.04	2015.82
SO112	692573	5174228	1	0.02	2680.10
SO113	693342	5174343	1	0.11	652.68
SO114	695103	5175636	1	0.07	432.05
SO115	694779	5174664	1	0.15	350.43
SO116	698381	5179702	1	0.08	122.95
SO117	699781	5179052	3	0.38	25.12
SO118	699470	5180246	3	0.36	3.99
SO119	694214	5180395	1	0.14	291.58
SO121	694074	5179476	3	0.38	0.00
SO122	694453	5179253	3	0.38	38.93
SO123	694861	5177268	2	0.36	0.00
SO124	694532	5178261	1	0.32	4.02
SO125	695255	5179320	3	0.38	12.56
SO126	694770	5180320	3	0.28	17.02

SO127	695016	5181104	3	0.38	0.00
SO128	694413	5181550	3	0.38	39.13
SO129	694708	5182441	2	0.32	0.00
SO130	694948	5183730	1	0.04	582.58
SO131	694713	5183454	3	0.26	296.19
SO132	694811	5183324	1	0.22	513.58
SO133	694693	5184840	1	0.02	37.93
SO134	694978	5185264	1	0.27	0.00
SO135	694843	5185492	1	0.18	211.12
SO136	694123	5182249	2	0.34	0.00
SO138	694043	5183023	1	0.07	489.78
SO139	694253	5184890	1	0.18	305.49
SO140	694335	5185263	1	0.07	371.57
SO141	694329	5184967	1	0.25	694.73
SO142	695573	5185502	1	0.18	445.21
SO143	695475	5185487	1	0.25	496.17
SO144	695643	5184916	1	0.24	306.95
SO145	695613	5184533	1	0.18	941.05
SO146	695337	5184121	1	0.27	115.92
SO147	695626	5183813	3	0.38	409.47
SO148	695544	5182845	3	0.38	0.00
SO149	695255	5182486	3	0.38	62.31
SO151	695636	5181038	3	0.38	0.00
SO152	695674	5181876	2	0.04	0.00
SO153	696329	5181224	3	0.38	71.81
SO154	696320	5181510	3	0.26	18.17
SO155	696395	5182106	3	0.36	13.24
SO156	696385	5183537	3	0.34	53.52
SO157	696225	5183928	3	0.36	13.11
SO158	696608	5184581	3	0.38	12.56
SO159	696570	5184931	1	0.28	48.20
SO160	696602	5185686	1	0.06	1056.67
SO161	696762	5186274	1	0.22	313.44
SO162	696380	5186873	1	0.32	60.45
SO163	697239	5183703	1	0.07	661.24
SO165	697298	5184854	3	0.38	0.00
SO166	696972	5185287	1	0.09	172.49
SO167	697113	5185701	1	0.12	91.72
SO168	697206	5186449	1	0.01	168.20

SO169	697315	5187147	1	0.12	419.89
SO170	697385	5183154	2	0.22	0.00
SO171	697021	5184153	3	0.34	13.85
SO172	697428	5184877	1	0.22	196.13
SO173	697435	5185395	1	0.22	98.74
SO174	697540	5185561	2	0.11	799.80
SO175	697695	5186094	1	0.14	361.66
SO176	697837	5183341	3	0.38	0.00
SO177	697956	5183571	3	0.36	0.00
SO178	697906	5184220	3	0.22	17.22
SO179	698225	5184925	1	0.03	346.27
SO181	698800	5182218	3	0.38	93.99
SO182	698686	5182520	3	0.38	0.00
SO183	698788	5183231	1	0.07	186.07
SO184	698736	5183783	1	0.06	249.74
SO185	698743	5184346	3	0.36	136.89
SO187	698710	5185641	1	0.07	369.07
SO188	698909	5186098	3	0.38	0.00
SO189	699664	5182891	3	0.36	125.16
SO190	699837	5183346	3	0.38	12.56
SO191	699785	5183998	3	0.36	13.11
SO192	699572	5184623	1	0.20	117.55
SO193	699825	5185417	1	0.07	451.53
SO195	697918	5183982	1	0.11	0.00
SO196	700356	5179244	1	0.25	0.00
SO197	700220	5177391	1	0.07	194.25
SO198	700003	5180820	3	0.36	550.61
SO199	699868	5180499	3	0.36	13.11
SO200	699910	5181928	1	0.25	30.80
SO201	699883	5182355	3	0.38	15.07
SO202	700216	5182633	1	0.11	442.47
SO203	700170	5181339	3	0.38	47.09
SO204	695397	5183079	1	0.07	858.93
SO205	695568	5183077	3	0.38	12.56
SO206	700035	5181666	3	0.38	360.34
SO207	700094	5182082	3	0.38	12.56
SO208	700101	5182624	1	0.12	425.47
SO209	700152	5183194	2	0.32	429.23
SO210	700546	5183039	2	0.29	502.49

SO211	700526	5184240	3	0.38	15.07
SO212	700692	5185198	3	0.38	496.63
SO213	700726	5184853	1	0.12	109.74
SO214	700516	5185698	1	0.22	26.58
SO215	699858	5186516	1	0.02	701.16
SO217	698755	5185719	1	0.03	162.05
SO218	698687	5185316	3	0.16	28.26
SO219	698988	5185106	3	0.36	50.65
SO220	698887	5184300	2	0.26	526.98
SO221	698771	5180633	1	0.24	355.33
SO222	698785	5181070	3	0.38	0.00
SO223	698826	5181416	1	0.15	100.73
SO224	698917	5182008	1	0.07	1150.23
SO225	698916	5182434	3	0.38	0.00
SO226	694201	5181411	2	0.36	107.90
SO227	694346	5182483	3	0.07	12.14
SO228	694971	5182880	1	0.22	139.93
SO229	694314	5183724	3	0.27	516.03
SO230	694650	5183432	1	0.10	637.13
SO231	695254	5183583	1	0.03	305.46
SO232	695526	5184009	1	0.05	348.12
SO233	694769	5184478	3	0.15	37.06
SO234	694122	5184555	1	0.22	492.18
SO235	694657	5184913	1	0.21	246.33
SO236	695184	5185149	1	0.07	310.40
SO237	695074	5185210	1	0.12	757.35
SO238	694891	5185234	1	0.04	235.55
SO239	696778	5184250	1	0.04	921.40
SO240	696026	5184637	1	0.07	848.27
SO241	697616	5184988	3	0.38	61.87
SO242	696289	5185265	1	0.22	482.10
SO243	696196	5185958	1	0.14	49.73
SO244	696264	5186783	1	0.14	49.73
SO245	696977	5186596	1	0.11	399.71
SO246	697598	5186081	1	0.30	84.45
SO247	700136	5185355	1	0.05	75.25
SO248	699099	5184129	3	0.38	12.56
SO249	698332	5180766	1	0.04	333.23
SO250	699187	5180209	1	0.11	72.28

SO251	704808	5173930	4	0.07	561.67
SO252	704982	5174458	4	0.09	251.62
SO253	705034	5176539	4	0.01	0.00
SO254	704859	5180600	4	0.03	232.50
SO256	704893	5182457	4	0.38	0.00
SO257	704640	5180599	4	0.07	114.91
SO259	702638	5185427	4	0.07	936.72
SO260	701584	5187498	4	0.25	172.29
SO261	704236	5189278	4	0.03	198.83
SO262	702217	5191378	4	0.36	17.56
SO263	704992	5187763	4	0.02	1307.82
SO264	705390	5186064	4	0.38	0.00
SO265	703077	5189832	1	0.32	451.49
SO266	702811	5190869	3	0.38	292.94
SO267	702701	5191448	1	0.10	1105.33
SO268	703945	5184803	2	0.14	920.54
SO269	702104	5187251	2	0.26	330.63
SO270	702198	5188297	3	0.38	172.51
SO271	702071	5189269	1	0.11	546.80
SO272	702120	5190249	2	0.18	390.43
SO273	702202	5191712	3	0.38	0.00
SO274	705795	5187329	1	0.19	371.08
SO275	705179	5187194	2	0.01	1154.82
SO276	704058	5186705	3	0.38	7.53
SO277	703137	5186512	1	0.35	237.10
SO278	702125	5186250	1	0.15	424.00
SO279	700858	5186536	1	0.30	41.11
SO280	700245	5186065	1	0.34	18.29
SO281	704248	5191259	1	0.12	77.35
SO282	704290	5189787	1	0.22	251.76
SO283	704305	5188789	1	0.11	77.91
SO284	700051	5187467	3	0.38	0.00
SO285	700065	5187020	1	0.14	47.67
SO286	699445	5187311	3	0.38	0.00
SO287	699570	5186379	1	0.07	393.49
SO289	702408	5187696	1	0.05	400.56
SO290	703468	5187788	1	0.03	97.97
SO291	704139	5187707	1	0.02	137.17
SO292	705008	5191254	2	0.37	0.00

SO293	705087	5190054	1	0.07	146.96
SO294	705339	5189274	3	0.38	0.00
SO295	704726	5186557	2	0.18	0.00
SO297	703536	5189900	1	0.02	87.28
SO298	703817	5188725	3	0.38	0.00
SO299	703641	5187320	1	0.12	706.56
SO300	703678	5185973	1	0.07	160.38
SO302	703292	5184371	1	0.18	528.56
SO303	705735	5189785	1	0.03	72.42
SO304	706004	5187360	1	0.14	658.67
SO305	719473	5166609	4	0.38	0.00
SO307	715606	5166070	4	0.38	2.51
SO308	715178	5172712	4	0.38	0.00
SO309	715552	5175047	4	0.14	1101.69
SO310	716180	5174139	4	0.38	0.00
SO311	715760	5175262	4	0.27	344.43
SO312	717663	5175571	4	0.34	194.67
SO313	715136	5173608	4	0.26	180.57
SO315	711854	5175225	4	0.16	64.39
SO316	711733	5174467	4	0.26	510.72
SO317	711900	5172804	4	0.03	158.29
SO318	712003	5171870	4	0.28	126.22
SO319	712622	5180885	4	0.11	560.00
SO320	710143	5180360	4	0.03	138.09
SO321	702239	5186785	1	0.16	265.60
SO322	702233	5187466	1	0.30	1.56
SO323	701999	5187105	3	0.34	0.00
SO324	702042	5186819	1	0.12	314.93
SO326	702397	5186558	1	0.34	668.95
SO327	702345	5186863	2	0.34	464.55
SO328	702622	5186442	2	0.36	148.91
SO329	702491	5186418	3	0.38	0.00
SO330	702615	5186585	1	0.04	106.97
SO331	703053	5186589	3	0.38	1.76
SO332	702495	5186510	1	0.34	277.38
SO333	702766	5186674	3	0.38	489.11
SO334	702636	5187091	1	0.07	44.86
SO335	702468	5187295	1	0.07	356.54
SO336	702673	5187178	3	0.38	1.76

SO337	702521	5186791	1	0.25	137.49
SO338	702712	5186749	1	0.11	182.15
SO339	702259	5187096	2	0.32	267.38
SO340	702085	5186924	2	0.37	458.03
SO341	702104	5186700	1	0.35	224.07
SO342	701784	5188490	2	0.34	490.74
SO343	702176	5187097	3	0.38	0.00
SO345	702156	5186739	2	0.29	55.76
SO346	754737	5178645	4	0.32	79.80
SO347	755417	5173869	4	0.28	65.22
SO348	755574	5171243	4	0.36	0.00
SO350	755550	5166625	4	0.34	38.48
SO351	755423	5163135	4	0.26	113.24
SO352	755117	5162322	4	0.32	0.00
SO353	755264	5160325	4	0.32	0.00
SO354	755045	5157756	4	0.18	319.52
SO355	755237	5155566	4	0.32	0.00
SO358	755543	5154423	4	0.11	0.00
SO359	755639	5154229	4	0.11	0.00
SO360	754706	5152628	4	0.37	0.00
SO361	754662	5152084	4	0.27	84.11
SO362	754287	5150074	4	0.32	0.00
SO363	734793	5153866	4	0.21	2.87
SO364	733956	5156318	4	0.38	0.00
SO365	733608	5157245	4	0.38	0.00
SO367	735180	5158652	4	0.38	0.00
SO368	735111	5159458	4	0.32	24.86
SO369	734915	5161463	4	0.38	0.00
SO370	734938	5166050	4	0.03	915.27
SO371	735085	5169538	4	0.01	1004.47
SO372	735413	5169181	4	0.26	0.00
SO373	735829	5170640	4	0.32	0.00
SO374	735534	5168250	4	0.37	0.00
SO375	735895	5166050	4	0.06	789.11
SO376	735920	5162388	4	0.28	19.58
SO378	735400	5157305	4	0.22	95.54
SO379	731825	5157419	4	0.38	0.00
SO380	738988	5156854	4	0.36	209.61
SO381	737880	5158490	4	0.04	733.71

SO382	731972	5167270	4	0.38	0.00
SO383	738805	5163770	4	0.26	0.00
SO387	890890	5157317	4	0.25	84.79
SO388	891230	5156060	4	0.29	254.88
SO389	891476	5153413	4	0.34	52.93
SO390	891808	5151117	4	0.29	65.74
SO391	891570	5159406	4	0.26	0.00
SO392	894599	5155688	4	0.26	0.00
SO393	894111	5154026	4	0.36	0.00
SO394	893849	5152110	4	0.08	32.25
SO395	883528	5161934	4	0.36	25.26
SO396	883072	5158793	4	0.34	0.00
SO397	883148	5156157	4	0.34	0.00
SO398	882834	5152347	4	0.28	0.00
SO399	882674	5149766	4	0.23	183.60
SO400	882815	5145873	4	0.26	0.00
SO401	882620	5142065	4	0.38	0.00
SO402	886831	5145600	4	0.37	2.49
SO403	888498	5155963	4	0.18	127.97
SO404	888990	5158550	4	0.26	43.27
SO405	888237	5154139	4	0.36	0.00
SO406	881124	5150598	4	0.36	0.00
SO407	881136	5149351	4	0.37	0.00
SO408	873862	5153425	4	0.29	0.00
SO409	874052	5152004	4	0.30	110.48
SO410	873879	5150100	4	0.26	2.20
SO411	869690	5154606	4	0.37	0.00
SO412	864880	5156413	4	0.35	126.51
SO413	864006	5154218	4	0.18	12.78
SO414	863658	5156620	4	0.30	204.83
SO415	851543	5160294	4	0.36	3.90
SO416	851455	5161585	4	0.38	0.00
SO417	851360	5165481	4	0.17	297.08
SO418	818042	5151461	4	0.38	0.00
SO419	798509	5172026	4	0.26	0.00
SO420	794767	5169780	4	0.29	41.62
SO421	780743	5179468	4	0.32	103.03
SO422	781477	5174431	4	0.02	1076.13
SO423	780706	5168900	4	0.38	12.62

SO424	717502	5172969	3	0.38	216.86
SO425	717370	5171971	3	0.38	12.56
SO426	717336	5170985	3	0.38	5.02
SO427	714299	5177308	1	0.22	105.37
SO428	714104	5176274	1	0.11	0.00
SO429	714136	5175395	1	0.11	32.76
SO430	714102	5174578	1	0.05	498.44
SO431	714001	5173643	3	0.38	169.73
SO432	713974	5172773	3	0.38	587.19
SO433	714063	5171902	2	0.36	143.13
SO434	713642	5171292	1	0.36	231.61
SO435	712820	5177206	3	0.38	211.04
SO436	712544	5176406	1	0.07	339.24
SO437	712357	5175250	3	0.38	0.00
SO438	712258	5174423	1	0.18	107.30
SO439	712248	5173190	2	0.27	342.67
SO440	712127	5172279	1	0.11	335.42
SO441	712022	5171216	1	0.07	404.53
SO442	716025	5171620	1	0.28	147.96
SO443	716075	5172618	3	0.38	90.42
SO444	716077	5173700	1	0.32	718.67
SO445	715186	5175322	1	0.30	474.99
SO446	716392	5176018	3	0.03	44.52
SO447	717548	5175933	1	0.25	67.78
SO448	719818	5175838	1	0.00	0.00
SO449	714950	5176223	1	0.05	97.46
SO450	715950	5175363	1	0.04	456.86
SO451	717259	5175199	1	0.12	538.82
SO452	717414	5174390	1	0.04	770.77
SO453	717453	5173659	3	0.34	7.26
SO454	718848	5174544	1	0.15	134.09
SO455	718990	5173712	3	0.38	25.12
SO456	718978	5172627	2	0.18	179.32
SO457	719066	5171797	2	0.02	254.31
SO458	718991	5170603	3	0.38	0.00
SO459	715678	5171290	2	0.07	678.90
SO460	715654	5172150	3	0.36	53.34
SO461	715563	5173325	1	0.20	451.03
SO462	715246	5174312	3	0.38	0.00

SO463	713366	5176403	1	0.12	872.66
SO464	713417	5175415	1	0.07	640.77
SO465	713105	5174375	2	0.23	390.20
SO466	712889	5173101	1	0.28	223.72
SO467	712714	5171628	3	0.38	0.00
SO468	712771	5171060	1	0.04	699.35
SO469	711026	5172012	1	0.15	47.65
SO470	711000	5173256	1	0.10	249.03
SO471	711116	5174014	1	0.22	155.00
SO472	711174	5175190	1	0.22	203.29
SO473	711121	5176202	1	0.15	1060.86
SO474	716144	5174762	2	0.21	117.13
SO475	716924	5174192	3	0.38	102.32
SO476	716923	5173752	3	0.38	0.00
SO477	716744	5172904	2	0.29	104.76
SO478	715881	5172987	1	0.28	48.55
SO479	714885	5173054	1	0.11	159.82
SO480	714949	5173739	2	0.05	215.16
SO483	715833	5173811	1	0.23	173.62
SO484	715726	5173790	1	0.15	1006.77
SO485	715901	5173801	1	0.26	545.61
SO486	715731	5173807	2	0.29	408.05
SO487	715977	5173597	3	0.38	87.77
SO488	716183	5173796	1	0.32	100.62
SO490	715814	5173912	1	0.19	22.59
SO491	715928	5173858	1	0.15	197.60
SO492	715937	5174049	1	0.18	151.66
SO493	715746	5174077	3	0.09	75.12
SO494	715770	5174082	1	0.10	543.69
SO495	715845	5173655	1	0.20	366.09
SO496	715522	5173978	1	0.36	179.81
SO497	715804	5174180	2	0.25	662.97
SO498	715571	5174040	3	0.36	12.42
SO499	715386	5173923	3	0.03	772.16
SO500	715437	5173656	1	0.28	285.29
SO501	715477	5173487	2	0.26	165.46
SO502	715580	5173507	1	0.28	316.69
SO503	715746	5173348	1	0.21	133.96
SO504	715641	5173325	1	0.22	110.58

SO505	715758	5173465	1	0.19	616.84
SO506	715833	5173469	1	0.19	149.74
SO507	715314	5173946	3	0.36	107.98
SO508	715491	5173794	3	0.01	339.59
SO509	715479	5173672	3	0.36	0.00
SO510	715470	5173575	2	0.29	155.61
SO511	715677	5173343	3	0.25	15.85
SO512	716179	5174054	1	0.07	216.06
SO513	716166	5173753	1	0.07	61.51
SO514	716208	5173579	1	0.27	44.75
SO515	716179	5173658	3	0.38	0.00
SO516	716190	5173324	3	0.03	948.56
SO517	716289	5173593	2	0.36	13.73
SO518	715619	5174234	2	0.07	337.69
SO519	715897	5173808	3	0.37	183.69
SO520	715757	5173679	1	0.22	183.18
SO521	715681	5173244	1	0.19	119.04
SO522	715221	5173648	2	0.11	709.05
SO523	715414	5173897	1	0.26	349.75
SO524	715528	5173877	1	0.30	90.04
SO525	715648	5173784	1	0.35	722.49
SO526	715902	5173352	1	0.11	171.49
SO527	715867	5173207	3	0.38	0.00
SO528	713709	5178305	1	0.11	0.00
SO529	713749	5178579	2	0.02	780.48
SO531	720357	5174622	2	0.11	499.17
SO532	719872	5172910	3	0.38	58.79
SO534	710054	5175747	4	0.10	361.65
SO535	708818	5175811	4	0.07	570.67
SO536	709995	5175093	4	0.30	768.42
SO537	709291	5171639	4	0.10	71.36
SO538	705276	5172855	4	0.03	77.43
SO539	707567	5174317	4	0.04	141.19
SO540	707424	5172951	4	0.38	0.00
SO541	704889	5175661	4	0.07	262.81
SO543	660163	5180255	4	0.38	0.00
SO544	659816	5178958	4	0.06	661.47
SO545	659785	5177457	4	0.07	640.50
SO546	658518	5177821	4	0.38	0.00

SO547	658337	5176596	4	0.38	0.00

Appendix III: List of Acronyms and Terms

%	percent
BRG	German Federal Institute for Geosciences and Natural Resources
Boskalis	Boskalis Offshore Subsea Contracting B.V.
°C	Degrees celsius
CRP	Chatham Rock Phosphate Ltd
cm	centimetres
CM Act	Crown Minerals Act
CMA ACT	Crown Minerals Amendment Bill
CPT	Cone penetration test
CRL	CRL Energy Ltd
CS Act	Continental Shelf Act
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EPA	Environmental Protection Authority
DD	*Dorado Discovery*
DSIR	New Zealand Department of Scientific and Industrial Research
GM	Global Marine
Golder	Golder Associates Ltd
JBL	JBL Exploration NZ Ltd
Kenex	Kenex Knowledge Systems Ltd
kg	kilograms
kg/m^2	kilograms per square metre
kg/m^3	kilograms per cubic metre
km	Kilometre
MPa	Megapascals
NIWA	National Institute of Water and Atmospheric Research (New Zealand)
NZD	New Zealand Dollar
NZIER	New Zealand Institute of Economic Research
NZOI	New Zealand Oceanographic Institute
NZPM	New Zealand Petroleum and Minerals
m	metres
Ma	million years
mm	millimetres
Mt	million tonnes
SO	*R.V. Sonne*
t	tonnes
TI	*Tranquil Image*
ROV	Remotely operated underwater vehicle
RSC	RSC Mining and Mineral Exploration
USD	United States of America dollar
VA	*R.V. Valdivia*

Major Chemical Elements

Al_2O_3	Aluminium oxide
CaO	Calcium oxide
F	Fluorine

Fe_2O_3	Iron oxide
K_2O	Potassium oxide
MgO	Magnesium oxide
Na_2O	Sodium oxide
P_2O_5	Phosphate pentoxide
SiO_2	Silica dioxide
SO_3	Sulphur trioxide
TiO_2	Titanium oxide

Trace elements

As	Arsenic
Ba	Barium
Cd	Cadmium
Co	Cobalt
Cu	Copper
Mo	Molybdenum
Ni	Nickel
Pb	Lead
Rb	Rubidium
Sr	Strontium
Th	Thorium
U	Uranium
V	Vanadium
Y	Yttrium
Zn	Zinc
Zr	Zircon

Appendix IV: Table 1: JORC Code, 2012 edition

Section 1 Sampling Techniques and Data

(Criteria in this section apply to all succeeding sections.)

Criteria	JORC Code explanation	Commentary
Sampling techniques	• *Nature and quality of sampling (eg cut channels, random chips, or specific specialised industry standard measurement tools appropriate to the minerals under investigation, such as down hole gamma sondes, or handheld XRF instruments, etc). These examples should not be taken as limiting the broad meaning of sampling.* • *Include reference to measures taken to ensure sample representivity and the appropriate calibration of any measurement tools or systems used.* • *Aspects of the determination of mineralisation that are Material to the Public Report.* • *In cases where 'industry standard' work has been done this would be relatively simple (eg 'reverse circulation drilling was used to obtain 1 m samples from which 3 kg was pulverised to produce a 30 g charge for fire assay'). In other cases more explanation may be required, such as where there is coarse gold that has inherent sampling problems. Unusual commodities or mineralisation types (eg submarine nodules) may warrant disclosure of detailed information.*	• The samples were collected on a number cruises using a variety of clam shell grabs, box cores and dredge samples. • Samples were collected by lowering the sampling tool to the sea floor and collecting a sample of the surficial phosphorite deposit. • Sample quality was highly variable and a sample quality ranking (SQR) process was applied to the samples and data collected. The SQR ranked the samples from the highest quality (1) to lowest quality (7). For the purpose of resource modelling only samples with SQR ranking 1 to 4 were used. • Samples with SQR values of 1 to 4 consisted of pneumatic grab samples collected on the Sonne cruise and Van Veen-style grab samples collected on the Valdivia cruise. • Representivity was obtained by taking large grab samples from what is effectively a 2-dimensional sampling situation. Given the large areas covered and the many samples collected, the sampling is considered broadly representative. Deeper sample penetration (more representative) was stimulated by adding extra weights to the grab sampler (Valdivia) or by pneumatic closing of the bucket (Sonne) • Calibration was obtained by detailed measurements of sampling equipment. • Since the work is not "industry standard", the following detailed explanation is provided for each sampling programme: Global Marine (1967 – 1968) • Sampling was conducted using a custom built pipe dredge with a diameter of 45 cm and the dredge was then towed behind the slow moving vessel. • RSC considers the Global Marine data to not be suitable for resource estimation as the error on the location of samples is excessive and the

		sampling is of poor quality. Tangaroa (1975 – 1978) • No information detailing sampling procedures or the raw data collected was available. • RSC notes these grades are considered to be not suitable for estimation purposes as there is insufficient data to reliably calculate phosphorite grade and the sample data is unable to be verified. Valdivia (1978) • The majority of the Valdivia samples were collected using a 0.12 m^3 Van Veen-style grab. The sea floor sample area was between 45 x 45 cm to 66 x 66 cm and sample depths were up to 33 cm. • The Valdivia samples were washed through a 1 mm screen. The >1 mm fraction volume was measured using the water displacement method in graduated cylinders, and its phosphorite concentration estimated as a phosphorite volume percent. • Valdivia samples were given an SQR based on their sample quality and location accuracy and parts of the Mineral Resource are based on this data. Sonne (1981) • The majority of the Sonne samples were collected using a 0.8 m^3 grab. The sea floor sample area was 1.06 x 1.90 m and maximum calculated sample depth of 38 cm. • Small Van Veen grab, vibrocorer, box corer and chain bag dredge were also trailed with limited success and none of this data has been used as they are not considered reliable. • The Sonne samples were processed using a custom-built vibrating sieve device containing an 8 mm and 1 mm screen. Any material observed not to have phosphorite was discarded overboard without being sieved and the sample was recorded as not containing phosphorite. Samples were washed through the sieve, the sieved fractions retained and its phosphorite concentration estimated as a phosphorite volume percent. • Sonne samples were given an SQR based on their sample quality and location accuracy and parts of the Mineral Resource are based on this data.

		Tranquil Image (2011) • The samples were collected using a Van Veen grab sampler provided by NIWA. The Van Veen grab sampler used for this program was small and had a surface area of 0.25 m^2. • The sediment collected was subsampled on the ship and packed for processing onshore. • Tranquil Image samples were given an SQR based on their sample quality and location accuracy. Dorado Discovery (2011 – 2012) • Seafloor sampling was conducted using the large clamshell grab, and box corer. • The sea floor sample area for the large clam shell grab was 2.03 x 1.42 m. • An issue with the clamshell grab as a sampling tool is that it was not fully enclosed, resulting in washing of the contained sediment when the grab was retrieved, particularly at the sea surface where it was exposed to wave action. RSC has concerns that this action has the potential to cause sample bias. • The box corer sea floor sample area was 20 x 30 cm to 50 x 50 cm and sample depths were up to 50 cm. • The Dorado Discovery samples were collected on the boat, subsampled and stored for on shore processing. Samples were separated into three size fractions: >8 mm; 0.8–8 mm and <0.8 mm. The phosphorite content was estimated for the >8 mm and 0.8-8 mm fractions. • Dorado Discovery samples were given an SQR based on their sample quality and location accuracy.
Drilling techniques	• *Drill type (eg core, reverse circulation, open-hole hammer, rotary air blast, auger, Bangka, sonic, etc) and details (eg core diameter, triple or standard tube, depth of diamond tails, face-sampling bit or other type, whether core is oriented and if so, by what method, etc).*	• No drilling has been conducted. • Attempts to core the sediment using vibrocores were attempted on a number of cruises and were generally unsuccessful due to core loss or equipment getting stuck in the underlying ooze.
Drill sample	• *Method of recording and assessing core and chip sample recoveries and results assessed.*	• Sample recovery was noted on the sampling sheets as “washed” or “washed out”. Any sample noted as washed had its SQR downgraded to at

recovery	• *Measures taken to maximise sample recovery and ensure representative nature of the samples.* • *Whether a relationship exists between sample recovery and grade and whether sample bias may have occurred due to preferential loss/gain of fine/coarse material.*	least a ranking of 6 and was not used in the estimation process. This was a significant issue with large grab samples collected on the Dorado Discovery cruise. • Van Veen and the pneumatic grab sampling tools used were designed to be totally enclosed after the sample was collected to minimise sediment loss due to water movement. • Nodules getting caught in the jaws of the Van Veen grab resulted in some washed out samples on the Valdivia cruise. When this occurred it was noted on the sample sheet. • Samples with low recovery (i.e. "washed") often had higher grades and for this reason these have been removed from the estimation process.
Logging	• *Whether core and chip samples have been geologically and geotechnically logged to a level of detail to support appropriate Mineral Resource estimation, mining studies and metallurgical studies.* • *Whether logging is qualitative or quantitative in nature. Core (or costean, channel, etc) photography.* • *The total length and percentage of the relevant intersections logged.*	• Samples were geologically logged for presence of phosphorite nodules, lithic and biological features. Some sieved fractions were further logged visually for percentage phosphorite nodules. • Some samples had geotechnical tests conducted on them including shear vane tests and samples collected for density tests. • Photographs of collected sample were taken on the Tranquil Image and Dorado Discovery cruises, including photos of the sea floor sampling sites using a ROV on the Dorado Discovery cruise. No photographs were retained of the Valdivia and Sonne samples.
Sub-sampling techniques and sample preparation	• *If core, whether cut or sawn and whether quarter, half or all core taken.* • *If non-core, whether riffled, tube sampled, rotary split, etc and whether sampled wet or dry.* • *For all sample types, the nature, quality and appropriateness of the sample preparation technique.* • *Quality control procedures adopted for all sub-sampling stages to maximise representivity of samples.* • *Measures taken to ensure that the sampling is representative of the in situ material collected, including for instance results for field duplicate/second-half sampling.* • *Whether sample sizes are appropriate to the grain size of the material being sampled.*	Valdivia • The majority of samples were sieved in their entirety, however, 37 grab samples had only large (20 – 80 litres) subsamples of their sediment sieved. How these subsamples were extracted from the grab samples is not recorded, an issue which was taken into account when ranking the samples for quality (SQR) and inclusion into the estimation process. • Sampled sediment was washed through a 1 mm screen. The >1 mm fraction volume was measured using the water displacement method in graduated cylinders, and its phosphorite concentration estimated as a phosphorite volume percent. • The sampling technique and size is not considered to be optimal, however considered acceptable for the type and grain size of material being sampled. • Since the sub-sampling was very limited (only 37 samples and one extra

		step in the process, rather than the many sub-samples at conventional laboratory assay techniques), the representivity is not considered affected. • No field duplicate samples were taken and therefore it could not be determined whether the sampling is representative of the in situ material collected. Only three sample pairs were within 70m of each other and could be considered as pairs given the large sampling area. These pairs all had comparably high grades. Sonne • Small subsamples for onshore analyses were taken using a shovel leaving the bulk of the sample for processing. Once logging was completed the entire contents of nodule-bearing grabs was dumped into a hopper. The hopper funnelled the sediment onto a custom-built vibrating sieve device containing an 8 mm and a 1 mm screen. Any material observed not to have phosphorite was discarded overboard without being sieved and the sample was recorded as not containing phosphorite. Samples were washed through the sieve and the >8 mm and 1-8 mm fractions retained; the <1 mm fraction was washed overboard. • Each retained fraction was then weighed, initially using spring weights but this proved difficult to do accurately due to the constant motion of the ship. As such the procedure was adapted and volume-calibrated bins were used to determine the weight of the >8 mm and 1-8 mm fractions. It is not clear when this change in procedure was adopted. Trials were run to determine the graduated weight of different volumes of the separate fractions in bins and thereafter the >8 mm and 1-8 mm fractions were placed in the bins and their weight assigned based on their volume. Unlike the calculation for net sediment weight this process does not use a numeric assumed density, however it does assume that the density of all the >8 mm and 1-8 mm fractions (respectively) were approximately the same. • The weight percent of each fraction relative to the estimated total weight of the sand was calculated from the volume-calibrated kilograms of the >8 mm and 1-8 mm sieved fractions. The percentage of contained phosphorite in each fraction was estimated visually and multiplied by the weight of the fraction in order to calculate the amount of phosphorite (kg) in each fraction. These weights were summed to determine the total amount of phosphorite

		(kg) in each sample. • No field duplicates were taken. However, analysis of 33 sample pairs that are within 100 m of each other shows poor precision, consistent with the nature of the mineralisation. • The sampling technique and size is considered to be good, especially considering practical restrictions and considered acceptable for the type and grain size of material being sampled. • The Sonne samples are regarded as the best quality samples collected on the Chatham Rise and have the highest SQR values. Dorado Discovery: • Box core samples were retrieved, surface characteristics of the sediment were noted and two push cores per box core sample were collected for geotechnical and biological assessment. The remaining sample was processed aboard the Dorado Discovery with the top 15 cm of sediment being washed through a 500 μm sieve and the underlying sediment through a 1,000 μm sieve. Biological specimens were collected and both biological and sediment samples were stored in formaldehyde solution. Remaining sediment was bagged for on-shore geological analysis. • Geological analysis of the >8 mm and 0.8-8 mm fractions was carried out; the <0.8 mm fraction was not studied. The >8 mm sample fractions were processed in detail. The grain lithologies were separated and described and phosphorite nodules were further classified by size. The 0.8 – 8 mm fraction of twelve of the grab samples was submitted to GNS where they were air dried and a subsample of the fraction spread out under a stereoscope and observed under ca. 50x magnification. Grain types were determined and classified using Powers Roundness Scale and ASTM 2488-00 for grain shape; grains were picked at random until a total of at least 200 grains were analysed per sample. • The sampling technique and size is not considered to be optimal, and to err on the side of caution they have been removed from the estimation process. • The smaller samples collected on the Dorado Discovery means they are more likely to be affected by volume-grade variances. • No field duplicates were taken and therefore it cannot be determined if the sampling is representative of the in situ material collected

Quality of assay data and laboratory tests	• *The nature, quality and appropriateness of the assaying and laboratory procedures used and whether the technique is considered partial or total.* • *For geophysical tools, spectrometers, handheld XRF instruments, etc, the parameters used in determining the analysis including instrument make and model, reading times, calibrations factors applied and their derivation, etc.* • *Nature of quality control procedures adopted (eg standards, blanks, duplicates, external laboratory checks) and whether acceptable levels of accuracy (ie lack of bias) and precision have been established.*	• The phosphorite grade estimations (ph kg/m^3) are determined in a field based environment and have not been conducted under laboratory conditions. • Analyses were completed for major element chemistry and trace elements on selected Valdivia, Sonne and Dorado Discovery samples in two size fractions >8 mm and 1-8 mm. These showed some correlation of chemistry with nodule size: Larger nodules had lower P_2O_5 and higher CaO content than the smaller ones. • In 77 analyses from 48 Sonne samples the >8 mm nodules averaged 19.8% P_2O_5 and the 1–8 mm nodules averaged 21.6%. In 63 Valdivia bulk samples the P_2O_5 average was 22.0%. • A detailed particle size and chemical analysis has been carried out on the suite of Dorado Discovery samples by CRP. The process involved a sieve analysis to provide split fractions of the bulk Dorado Discovery samples into the size ranges of the 1.18–1.70, 1.7–2.0, 2.0–4.0, 4.0–8.0, 8.0–25.4 and 25.4–80.0 mm. The chemical composition was determined for each fraction by XRF analysis. • No QC was conducted (standard, blanks or duplicates). Most of the samples were collected during the 1970s and 1980s before the understanding of the significance of sample quality control for sampling. Later sampling by CRP also lacked adequate QC due to supervising staff at the time not understanding the standard QC requirements. • No external laboratory checks have been conducted. Samples from pre-CRP cruises have not been retained and are unable to be reprocessed. CRP samples have been retained but they are no longer representative due to sub-sampling. • For the purpose of classifying the resource in Inferred Mineral Resource category, acceptable levels of accuracy, bias and precision have been established by a thorough review of procedures as well as through a comparison of results the various cruises in the same area and in general. It is clear that all sampling shows poor precision, which is largely due to the style of mineralisation with a large inherent variability in grade. However, poor sampling techniques have had an impact on the precision, which RSC has attempted to remove as much as possible by removing bad data from the estimation process. Accuracy is equally not optimal and some bias has

		occurred by means of the various different sampling techniques. RSC regards this bias, although difficult to quantify, as within acceptable boundaries for the Inferred Mineral Resource classification.
Verification of sampling and assaying	• *The verification of significant intersections by either independent or alternative company personnel.* • *The use of twinned holes.* • *Documentation of primary data, data entry procedures, data verification, data storage (physical and electronic) protocols.* • *Discuss any adjustment to assay data.*	• Specific high grade samples were not individually verified, however some overlap occurs between the various campaigns and these all confirm the general tenor of the phosphorite grades. The campaigns were all independent form each other and this forms a key aspect of the verification of grades and the establishment of the Mineral Resource. • A digital database was supplied to RSC by consultants from Kenex Knowledge Systems Ltd who had been involved with the data management from the start of the Project and data collection for the Dorado Discovery cruise. Compilation of the database was a collaborative effort by Kenex and NIWA. Initially, NIWA compiled the Valdivia and Sonne data from hard copy maps and scanned sample sheets. The Global Marine, Tranquil Image and Dorado Discovery data were later added by Kenex. No data were compiled from the Tangaroa cruise and these have been sourced by RSC from Cullen (1978). Kenex has added some calculation fields from the historic data to further analyse sample grade estimations and prospectivity analyses. • RSC conducted a thorough validation of Valdivia and Sonne data from scanned sample sheets, and a best-possible validation of the Tranquil Image and Dorado Discovery data. A number of errors and inconstancies were noted and corrected. • The data was stored in Microsoft Access tables and exported into flat Microsoft Excel tables to facilitate verification. • As part of the data verification process, the relative and absolute quality of the data was assessed. This is a critical part of the assessment of the data as it depicts what the quality threshold is to either allow or disallow data to enter into the estimation process. Across and even within the various sampling campaigns, different sampling, sub-sampling, logging, volume and depth measurements, grade calculations, and location measurements have occurred and a matrix was constructed to rank the impact of all these factors. • RSC attempted to determine if there is a relationship between the general nodule abundance and the phosphorite grade of the nearest samples, however this could not be demonstrated. ROV images confirm the existence

		of phosphorite nodules at a number of Dorado Discovery sample sites and also show the visual differences between higher and lower grade sites. Also along the ROV sample line transects, the images and nodule counts also confirm the high short-range variability of the sample grades. • RSC also compared sediment depths determined from CPT data and sample depths. The results of the CPT work showed sand depths which were often considerably thicker than the sample depths determined by the seafloor sampling with an average from the CPT showing a sand depth of 0.47 m with a maximum of 2.27 m. This is significantly thicker than the depth of the sediment as indicated by the samples, which averages 0.23 m. • Using the raw sample data collected RSC recalculated the phosphorite grade (ph kg/m^3) and sample depth. The estimation process is not consistent between the cruises due to the variations of sampling tools used and raw data collected. Valdivia • RSC has reviewed the grade calculations and has re-estimated the Valdivia grades. Phosphorite volume percent was calculated by first multiplying the estimated percentage of phosphorite within the >1 mm fraction by the volume of this fraction which yielded the volume of phosphorite in the >1 mm fraction (i.e. excluding shell fragments, etc.). This volume was then divided by the sieved sample volume to give phosphorite nodule volume percent for the sieved sample. Phosphorite grade is then determined by multiplying the calculated phosphorite volume percent by the average density of phosphorite nodules (taken as 2.72 g/cm^3 based on the most recent density data collected by CRP in 2011). • The penetration thickness and/or sand thickness recorded for each sample is assumed to be equal to the true sample/sand depth of the samples, as it is unknown whether grab samples underwent any lateral compression during closure of the grab. Sonne • RSC has reviewed the grade calculations and has re-estimated the Sonne grades using a volume-penetration relationship based on the volume of the grab and penetration depth of the sediment. Based on the grab

		specifications, a detailed 3D model of the closed grab was generated and the volume calculated in 1 cm vertical increments. These were compared to the recorded penetration depths of total sediment and thickness of sand for each sample in order to calculate the volume of sand in each sample. The amount of phosphorite (kg) in each sample was calculated from the estimated percentage of phosphorite and volume-calibrated weight of the 1–8 mm and >8 mm sieved fractions. RSC calculated the phosphorite grade (kg/m^3) by dividing the total calculated phosphorite (kg) by the calculated volume of sand (m^3) in each sample. • Due to the compression of the sampled sediment during grab closure the thickness of the sample in the grab cannot equal the actual sample depth on the sea floor. To calculate this depth, it has been assumed that down to a depth of 38 cm the grab was able to sample 100% of the sediment contained within the 2 m^2 area of its open jaws. By comparing the volume of in-situ sediment in 1 cm increments with the 1 cm incremental cumulative volumes previously determined for the grab it was possible to generate a conversion table for penetration depth to true depth of sediment for the Sonne grab. Dorado Discovery • The supplied data contain the calculated dry weight percentages of these fractions as well as the original sample wet and dry weights. As data from the Dorado Discovery grab samples indicate that >1 mm sieved fractions contain significant constituents other than phosphorite, RSC has factored the dry weight percentages of the >8 mm and 2—8 mm box core fractions down to account for non-phosphorite material in these fractions, using the grab sample sieve data for reference. For the >8 mm fraction of the grab samples the weight percent of phosphorite averaged 91% of the fraction weight, and for the twelve measured 0.8—8 mm grab sample fractions the phosphorite volume percent averaged 74% (excluding outliers). • The box core >8 mm and 2—8 mm sieved fractions were multiplied by these percentages, respectively. RSC notes that applying a volume percent to a weight percent in the case of the 2—8 mm sieved fraction assumes that the density of all constituents is the same, which is not the case. RSC also notes that the difference between the sieved fraction ranges of 0.8—8 mm

		and 2—8 mm for the grab and box core samples, respectively, means that using the volume percent of phosphorite from the grab samples to proportion the weight percent of phosphorite in the box core samples is likely to be inaccurate and lead to an underestimation in grade as it does not take into account the removal of the 1–2 mm sand fraction (assumed to be comparatively phosphorite poor) from the box core sieved fraction. This is in contrast to the overestimation in grade expected if no correction factors are applied. • Summing the factored weight percentages of the sieved fractions and multiplying by dry weight of the sieved sample estimates gives the contained kilograms of phosphorite. Dividing this weight of contained phosphorite by the volume of each sample (estimated from the box area, 0.2 m x 0.3 m, multiplied by the thickness of the sediment in the box) yields sample grade (kg/m^3). • The penetration thickness and/or sand thickness recorded for each sample is assumed to be equal to the true sample/sand depth of the samples, as it is unknown whether box core samples underwent any vertical compression during closure of the grab.
Location of data points	• *Accuracy and quality of surveys used to locate drill holes (collar and down-hole surveys), trenches, mine workings and other locations used in Mineral Resource estimation.* • *Specification of the grid system used.* • *Quality and adequacy of topographic control.*	Valdivia • Sample locations were determined using a combination of satellite navigation (SATNAV) with an integrated Doppler sonar system, and a network of underwater acoustic transponders (ATNAV). Eight transponders were deployed in the east of the sampling area and three transponders were deployed in the west. The ATNAV system was used to determine the location of 647 samples, with the location of the remaining samples determined solely using SATNAV. • As the transponders were located using SATNAV the overall accuracy of sample locations is estimated to be within 0.25 – 0.5 nautical miles (0.5 - 0.9 km), however the precision of applicable sample locations relative to each other is increased by the use of the transponder network reducing the error associated with relative sample locations to approximately 5 – 10 m. Sonne • The Sonne was equipped with a MAGNAVOX satellite navigation system

		coupled to a Doppler sonar to determine its geographic position. Using this system a position accuracy of 200 to 500 m was achieved. To increase the location accuracy of samples an underwater acoustic transponder navigation (ATNAV) system consisting of 6 to 8 transponders was laid 3,000 to 4,000 m apart on the sea floor. Under favourable conditions the system had an accuracy of 30 to 50 m within the central parts of the grid and 100 m near the edges. Dorado Discovery and Tranquil Image • During the cruises sample locations were determined by GPS. The approximate location was established by the navigation equipment installed on the vessel and the actual sample location was recorded using a hand-held GPS at the time the sample was taken on board. GPS is a satellite-based radio-navigation system with precision of 5 m. • Multibeam swath bathymetry data has been collected throughout the licence giving good control of depth to sea floor. A total of 426 km^2 of multibeam swath bathymetry data was collected. The data was gridded at 20 m and 25 m cell sizes. Within the licence area, water depths increase from a minimum of 300 to over 600 m to the south and north. The area of primary interest is on the crest of the rise in water depths of 350 to 450 m, with a saddle depth of 390 m.
Data spacing and distribution	• *Data spacing for reporting of Exploration Results.* • *Whether the data spacing and distribution is sufficient to establish the degree of geological and grade continuity appropriate for the Mineral Resource and Ore Reserve estimation procedure(s) and classifications applied.* • *Whether sample compositing has been applied.*	• The data spacing of samples within the licence area is variable and does not follow a consistent grid. Sample spacing ranges from 100 m to over 1 km. • Data spacing is considered sufficient to imply geological and grade continuity for the type of mineralisation being targeted under the JORC Code, 2012 edition. It is considered suitable data spacing for Inferred Resources. • No sample compositing has been applied as it is not relevant to the type of sampling.
Orientation of data in relation to geological	• *Whether the orientation of sampling achieves unbiased sampling of possible structures and the extent to which this is known, considering the deposit type.* • *If the relationship between the drilling orientation and the orientation of key mineralised structures is considered to have*	• The target zone is a thin horizontal layer of phosphorite that occurs at the sea floor surface. Since this is a 2-dimensional sampling situation, the *orientation* of sampling is not relevant. • Grab sampling tools will not sample equally across the entire sample depth due to the arc-like closing action of the jaws. This means the samples are

structure	*introduced a sampling bias, this should be assessed and reported if material.*	slightly biased towards the material sampled nearer the surface. This effect is limited by the average depth of the samples taken being 0.2 m. The Mineral Resource is only based on that part of the deposit that has been sampled (i.e. if only 20cm sample depth was achieved, the Mineral Resource was limited to this depth, regardless of the mineralised material potentially extending deeper).
Sample security	• *The measures taken to ensure sample security.*	• Sampling was conducted under geological supervision. • No special security measures were taken in regard to the collection and storage of the samples, however as measurements were carried out on board by the supervising staff, security issues are not considered an issue.
Audits or reviews	• *The results of any audits or reviews of sampling techniques and data*	• No audits or reviews of sampling techniques outside the one carried out in the Report by RSC have been completed.

Section 2 Reporting of Exploration Results

(Criteria listed in the preceding section also apply to this section.)

Criteria	**JORC Code explanation**	**Commentary**
Mineral tenement and land tenure status	• *Type, reference name/number, location and ownership including agreements or material issues with third parties such as joint ventures, partnerships, overriding royalties, native title interests, historical sites, wilderness or national park and environmental settings.* • *The security of the tenure held at the time of reporting along with any known impediments to obtaining a licence to operate in the area.*	• CRP holds 100% of Mining Permit 55549 (820 km^2) and the 3,906 km^2 (formerly 4,726 km^2) Continental Shelf Licence MPL 50270. • The Ministry of Business, Innovation and Employment granted Mining Permit 55549 to CRP for the extraction of rock phosphate on the Chatham Rise on the 6th of December 2013. The permit was granted for 20 years. As part of the permit conditions, CRP is required to obtain a marine consent from the Environmental Protection Authority (EPA) before it is able to begin mining. • The MPL 50270 licence was due to expire on the 25th February, 2014. A licence renewal application has been submitted on 20th December, 2013 to the New Zealand Petroleum and Minerals. CRP has been able to refine the area of focus, reducing the footprint of the licence. The licence has been reduced from 4,726 km^2 to 2,887 km^2. This area excludes the removed area which has had the mining permit granted over it. • Boskalis Offshore Subsea Contracting B.V. (Boskalis) is a technical partner

		in the Project and hold a 17.6% shareholding of CRP. • The MPL 50270 licence came with environmental conditions that required the licence owner to comply with environmental guidelines published by the International Marine Minerals Society "Code of Environmental Management of Marine Mining", conduct environmental baseline studies and monitor and report effects of exploration activity on the environment. • The payment of a royalty to the New Zealand Government on production from any future mining operation has been set at the higher rate of 2% of revenue or 10% of pre-tax profits.
Exploration done by other parties	• *Acknowledgment and appraisal of exploration by other parties.*	• Various programmes have been undertaken since the 1950s. Initial reconnaissance surveys were conducted by the New Zealand Geological Survey in 1952 and later Global Marine Inc. in 1967–68. Global Marine Inc. held the first mineral prospecting licence (MPL) over the Chatham Rise extending over 100,000 km^2. These surveys undertook dredge sampling over much of the Chatham Rise, noting the presence/absence of phosphorite nodules, and helped to prioritise areas for later expeditions. • From 1971, JBL Exploration NZ Ltd. (JBL) held a prospecting licence covering a portion of the MPL previously held by Global Marine Inc. • From 1975 – 1978 the New Zealand Oceanographic Institute (NZOI) conducted a more localised survey to determine the distribution and thickness of phosphorite-bearing sediments over an area now covered by MP 55549. • Subsequent to this campaign a collaboration between the West German Government and the New Zealand Department of Scientific and Industrial Research (DSIR) launched two extensive sampling surveys, one in 1978 utilising the R.V. Valdivia, and the second in 1981 utilising the R.V. Sonne. Together the two campaigns collected over 1,100 sediment samples, the vast majority from within the area presently encompassed by MPL 50270. Data from these cruises provides the most comprehensive data for phosphorite grade determination collected to date. The New Zealand company Fletcher Challenge Ltd. was involved in the 1981 work and was granted a prospecting licence for further investigation of the phosphorite deposits, but no further data collection surveys were undertaken and the licence was allowed to lapse in 1984. • No mineral permits were issued over the Chatham Rise until MPL 50270 was

		granted to CRP in 2010.
Geology	• *Deposit type, geological setting and style of mineralisation.*	• The phosphorite deposit occurs as a thin layer of phosphorite-bearing glauconitic sand with an average thickness of 0.2 m, but can reach thicknesses of more than 0.5 m in places. The sand layer consists of mainly silt and sand-sized sediments, with the phosphatised chalk pebbles up to 15 cm in diameter. The layers would have been originally stratified with phosphorite nodule layers representing the periods of erosion and phosphatisation; however, later post-depositional modifications have resulted in these layers becoming disrupted. The underlying chalk layer occurs as a white ooze at the base on the sand. The upper 20-30 cm of this zone can be mixed due to bioturbation and include burrows filled with the overlying sand. The ooze also contains weathered chalk, an important constituent for phosphorite nodule formation. At depth, the ooze grades into an indurated chalk layer. • The present composition of the phosphorite nodules originated during the late Miocene by diagenetic replacement of the chalk pebbles. Apatite based cement replaced pre-existing glauconite suggesting that the main Late Miocene phosphatisation event was followed by minor authigenic phosphatisation which mainly cemented fractures and bore holes. • Analyses by x-ray diffraction show that apatite and calcite are the main mineral constituents. Analyses on separated Sonne samples show apatite contains P_2O_5 up to 30.05%. The apatite mineral is assumed to be francolite (carbonate-fluorite-apatite).
Drill hole *Information*	• *A summary of all information material to the understanding of the exploration results including a tabulation of the following information for all Material drill holes:* ○ *easting and northing of the drill hole collar* ○ *elevation or RL (Reduced Level – elevation above sea level in metres) of the drill hole collar* ○ *dip and azimuth of the hole* ○ *down hole length and interception depth* ○ *hole length.* • *If the exclusion of this information is justified on the basis that the information is not Material and this exclusion does not detract from the understanding of the report, the Competent*	• No drilling has been conducted on the Project. • Sample data used as informing data for the Mineral Resource is detailed in Appendix II.

	Person should clearly explain why this is the case.	
Data aggregation methods	• *In reporting Exploration Results, weighting averaging techniques, maximum and/or minimum grade truncations (eg cutting of high grades) and cut-off grades are usually Material and should be stated.* • *Where aggregate intercepts incorporate short lengths of high grade results and longer lengths of low grade results, the procedure used for such aggregation should be stated and some typical examples of such aggregations should be shown in detail.* • *The assumptions used for any reporting of metal equivalent values should be clearly stated.*	• No data aggregation has been conducted. • No high grade cut-off has been applied. • Sample locations consist of a single grade and a sample depth. • Metal equivalents have not been reported as they are not relevant for the commodity reported.
Relationship between mineralisation widths and intercept lengths	• *These relationships are particularly important in the reporting of Exploration Results.* • *If the geometry of the mineralisation with respect to the drill hole angle is known, its nature should be reported.* • *If it is not known and only the down hole lengths are reported, there should be a clear statement to this effect (eg 'down hole length, true width not known').*	• The geometry of the phosphorite deposit is essentially a thin (<1 m) horizontal unit at the sea floor. It extends laterally for tens of kilometres. • The sampling is conducted perpendicular to the mineralisation so the sample depths noted are true depths. • In places the mineralisation extends below the sample depth. This was not always sampled due to the depth limitation of the sampling methods. The Mineral Resource is only based on that part of the deposit that has been sampled (i.e. if only 20cm sample depth was achieved, the Mineral Resource was limited to this depth, regardless of the mineralised material potentially extending deeper). • No grade has been estimated beyond the sample depth.
Diagrams	• *Appropriate maps and sections (with scales) and tabulations of intercepts should be included for any significant discovery being reported These should include, but not be limited to a plan view of drill hole collar locations and appropriate sectional views.*	• See Figures above for plan view of sample locations. • No sections are shown as the deposit is essentially two dimensional. A schematic section is shown above.
Balanced reporting	• *Where comprehensive reporting of all Exploration Results is not practicable, representative reporting of both low and high grades and/or widths should be practiced to avoid misleading reporting of Exploration Results.*	• All sample details including grades and depths used in the resource estimation are shown in Appendix II.
Other substantive exploration data	• *Other exploration data, if meaningful and material, should be reported including (but not limited to): geological observations; geophysical survey results; geochemical survey results; bulk*	• A significant amount of data has been collect by previous government sponsored surveys and more recently by CRP. These include: • underwater photography and video data;

	samples – size and method of treatment; metallurgical test results; bulk density, groundwater, geotechnical and rock characteristics; potential deleterious or contaminating substances.	• sidescan sonar surveys data; • seismic survey data; • multibeam bathymetric surveys; • oceanographic monitoring data; • environmental monitoring data; • geotechnical investigations including particle size analyses, density testwork, moisture contents, CPT and strength tests; • K-Ar dating; • XRD analysis; and • ROV dives and seabed mapping;
Further work	• *The nature and scale of planned further work (eg tests for lateral extensions or depth extensions or large-scale step-out drilling).* • *Diagrams clearly highlighting the areas of possible extensions, including the main geological interpretations and future drilling areas, provided this information is not commercially sensitive.*	• CRP is continuing to assess the Chatham Rise Phosphorite deposit. This work may include collection of infill samples for grade analysis, environmental studies, and mining studies.

Section 3: Estimation and Reporting of Mineral Resources

(Criteria listed in section 1, and where relevant in section 2, also apply to this section.)

Criteria	JORC Code explanation	Commentary
Database integrity	• *Measures taken to ensure that data has not been corrupted by, for example, transcription or keying errors, between its initial collection and its use for Mineral Resource estimation purposes.* • *Data validation procedures used.*	• RSC conducted a thorough validation of Valdivia and Sonne data from scanned sample sheets, and a best-possible validation of the Tranquil Image and Dorado Discovery data. All possible care has been exercised to remove errors from legacy data. • A number of transcription errors, minor calculation errors, and rounding errors were noted in the Valdivia and Sonne data. All inconsistencies have been either fixed or the ranking of the sample quality appropriately downgraded where fixing was not possible. • Dorado Discovery and Tranquil Image have had 10% of the data validated with no significant issues noted. Data from the Global Marine and Tangaroa work have been accepted at face value as original data was not available. • As part of the data verification process, the relative and absolute quality of

		the data was assessed in as much detail as practically possible. This is a critical part of the assessment of the data as it depicts what the quality threshold is to either allow or disallow data to enter into the estimation process. Across and even within the various sampling campaigns, different sampling, sub-sampling, logging, volume and depth measurements, grade calculations, and location measurements have occurred and a matrix was constructed to rank the impact of all these factors. • Samples with SQR values of 1 to 4 were used for resource estimation, this resulted in only Sonne and Valdivia samples being used.
Site visits	• *Comment on any site visits undertaken by the Competent Person and the outcome of those visits.* • *If no site visits have been undertaken indicate why this is the case.*	• None of the Competent Persons have visited the Project as the mineralisation is 400 m below the sea surface. • For site-specific information, RSC relies on the experience of people who were directly involved with sampling and estimating phosphorite grade (Dr. Falconer, Dr. Kudrass, Dr. Nielsen). Mr. Sterk has visited CRP's sub-sampling site in Wellington in January 2014. • Dr. Robin Falconer, a chief scientist with CRP, a professional marine scientist and seabed phosphorite mineralisation expert. Dr. Falconer has visited the site, aboard the first and third legs of R.V. Sonne, during the 1981 sampling campaigns. At the time of the cruise he was a consultant to Fletcher-Challenge Corporation Ltd and held the position of geophysicist. He was involved with the sediment sampling, bulk sample processing and phosphorite analyses conducted on the cruise. Since July 2010, Dr. Falconer has worked as a chief scientist for CRP and has been directly involved with the planning and execution of the 2011 and 2012 sampling programmes conducted by the Dorado Discovery and Tranquil Image. He has recently also joined the board of CRP. • Dr. Hermann Kudrass, a former director of the German Federal Institute for Geosciences and Natural Resources and a seabed phosphorite mineralisation expert. Dr. Hermann Kudrass first visited the Project site in 1978 aboard the R.V. Valdivia working under a joint West German-New Zealand Agreement for Scientific and Technological co-operation and was involved with both legs of the cruise. At the time of the cruise he was a marine geologist working with the BGR. Dr. Kudrass was involved with all aspects of the development of sample procedures, sampling, and grade analyses conducted on the cruise. Dr. Kudrass was also a marine geologist

		working with the BGR on the R.V. Sonne cruise leg 2 where he was involved in all aspects of sampling. He has published a number of scientific papers detailing the work conducted on the R.V. Valdivia and R.V. Sonne cruises including previous resource estimations of the deposit. Dr. Kudrass also visited the Project aboard the Dorado Discovery for approximately 12 days during the April 2012 geotechnical survey. • Dr. Simon Nielsen, a Senior Geologist with Kenex Knowledge Systems Ltd visited the Project three times aboard the Dorado Discovery in 2012. He has spent approximately 5 weeks on site. Dr. Nielsen was closely involved with collecting geological samples on the Dorado Discovery, logging the samples and onshore separation analyses of the samples.
Geological interpretation	• *Confidence in (or conversely, the uncertainty of) the geological interpretation of the mineral deposit.* • *Nature of the data used and of any assumptions made.* • *The effect, if any, of alternative interpretations on Mineral Resource estimation.* • *The use of geology in guiding and controlling Mineral Resource estimation.* • *The factors affecting continuity both of grade and geology.*	• Geological wire-frames were created for ten different seismic facies delineated during the Sonne cruise to sub-domain the sample data sensibly and create appropriate domains for grade estimation. However, given the large overall size of the area covered by the sampling campaigns, and the relatively low resolution of the geological data within these large areas, the domains can only be considered applicable to the large-scale variability of the data. Smaller scale features like individual ice-berg furrows are unable to be defined into domains at this stage. • Though geological understanding of the process is considered sound, the resolution of the data does not allow optimum application of this knowledge. This has been taken into account when classifying the Resource. • Given the low resolution of the available wire-frames for geological domains it is possible to generate alternative interpretations for the geology. Given the level of confidence at which the Resource is classified it is not expected that alternative interpretations would have a major impact on either resource classification or grade estimation. • Marine phosphorite deposits typically occur as laterally extensive units with multi-kilometre scale geology and grade continuity. Post-depositional factors like ice bergs gouging through the deposit create short range (tens of metres scale) variability in the grade and geology.
Dimensions	• *The extent and variability of the Mineral Resource expressed as length (along strike or otherwise), plan width, and depth below surface to the upper and lower limits of the Mineral Resource.*	• The Resource has an east-west extent of 60 km and north-south extent of 10 to 30 km. • The Resource depth extends from the sea floor surface to an average of 0.2

		m below the existing sea floor. This depth is constrained by sample depths and it is likely the average depth of the phosphorite extends beyond this.
Estimation and modelling techniques	• *The nature and appropriateness of the estimation technique(s) applied and key assumptions, including treatment of extreme grade values, domaining, interpolation parameters and maximum distance of extrapolation from data points. If a computer assisted estimation method was chosen include a description of computer software and parameters used.* • *The availability of check estimates, previous estimates and/or mine production records and whether the Mineral Resource estimate takes appropriate account of such data.* • *The assumptions made regarding recovery of by-products.* • *Estimation of deleterious elements or other non-grade variables of economic significance (eg sulphur for acid mine drainage characterisation).* • *In the case of block model interpolation, the block size in relation to the average sample spacing and the search employed.* • *Any assumptions behind modelling of selective mining units.* • *Any assumptions about correlation between variables.* • *Description of how the geological interpretation was used to control the resource estimates.* • *Discussion of basis for using or not using grade cutting or capping.* • *The process of validation, the checking process used, the comparison of model data to drill hole data, and use of reconciliation data if available.*	• Estimation was performed using 2D accumulation Ordinary Kriging on the parameters Ph kg/m^2 (i.e. grade x thickness), Depth and SQR. The grade (Ph kg/m^3) was then calculated by dividing Ph kg/m^2 by the estimated Depth for each block. Two-dimensional accumulation estimation is considered appropriate because there is a negative correlation between thickness and grade, and variability in the vertical direction is disregarded as selective mining is not possible. • Modelling was undertaken in Surpac. • A block model was constructed that covers the main sampled area. A block size of 1 km x 1 km (XY) was chosen, based on the average data spacing in the main sample areas, hereby attempting to maintain a balance between the sparsely sampled and densely sampled areas. The more densely sampled areas may statistically require a smaller block size for optimum estimation parameters but the 1 km^2 was considered applicable given the proposed mining method. The model was brought into two dimensions (only one block in the z-direction) and all the samples given an elevation of 0.5 m RL. • A circular search was applied, with search distance based on the ranges from the variograms constructed in Snowdon's Supervisor v8.2 software. A maximum 3,000 m search distance was determined. • Each of the domains was estimated in isolation, i.e. neighbouring data from other seismic facies domains were excluded from the estimation process. • Investigation of cumulative frequency, histograms, and mean/variance vs. top-cut plots indicated that top-cutting was warranted for the distribution in domain 9. A grade cap of 150 kg/m^2 was chosen which caps two outlier samples to this value and lowers the mean of the domain from 35 to 32 Ph kg/m^2. The depth was not capped as it was limited to the depth of the sampling tool used. • The Mineral Resource estimate was not constrained by estimation domains. Extrapolation of grades into blocks was therefore simply controlled by the size of the search ellipse which was kept at a conservatively short distance based on spatial analysis of the sample data. Extrapolation of data into

		poorly sampled areas was minimised where relevant, given the various uncertainties involved with the data. • The Mineral Resource estimate is the first JORC compliant Resource constructed on the Chatham Rise so it cannot be compared to earlier JORC compliant resources, however, it compares well to historic estimates that were not compliant with the guidelines as set out by the JORC Code, 2012 edition. • No previous production has occurred on the Project to allow comparisons with the Resource. • The estimation does not include any by-products as not enough relevant information is available to make estimations. • No deleterious elements such as cadmium have been modelled as not enough relevant information is available to make estimations. • Cadmium is regarded as a key deleterious element for phosphate products. Testwork to date show that cadmium levels are generally below the level of detection. • The model is considered appropriate for the potential mining options where a drag head dredge is pulled along the sea floor, and the phosphorite layer is broken up and then pumped to the ship where it is processed. The optimal mining depth is 35 cm from the sea floor surface. The method will essentially be non-selective as the dredge will drag in an oblique path in a 5 by 2 km mining block. • The model did not include any assumptions between variables. • Each of the domains was estimated in isolation, i.e. neighbouring data from other seismic facies domains were excluded from the estimation process. Each block therefore ended up with an estimated value for Ph kg/m^2, Depth and SQR. • Investigation of cumulative frequency, histograms, and mean/variance vs. top-cut plots indicated that top-cutting was warranted for the distribution in domain 9. A grade cap of 150 kg/m^2 was chosen which caps two outlier samples to this value and lowers the mean of the domain from 35 to 32 Ph kg/m^2. The depth was not capped as it was limited to the depth of the sampling tool used. • The model was checked for representativeness by comparing the raw data

		with the block data for each domain. This showed several instances in a densely sampled area, a zero-grade sample surrounded by several high grade samples. This high local variability is also clear from the variogram and has been included into the blocks.
Moisture	• *Whether the tonnages are estimated on a dry basis or with natural moisture, and the method of determination of the moisture content.*	• Tonnages are estimated on a wet tonnage basis and no estimation of moisture content has been included.
Cut-off parameters	• *The basis of the adopted cut-off grade(s) or quality parameters applied.*	• A cut-off grade of 100 kg/m^3 was used in the classification of the Resource. This is based on conceptual revenue from forward sales of phosphorite per tonne (USD 125) and mining operating costs per phosphorite landed tonne (USD 85 to 97) presented by CRP.
Mining factors or assumptions	• *Assumptions made regarding possible mining methods, minimum mining dimensions and internal (or, if applicable, external) mining dilution. It is always necessary as part of the process of determining reasonable prospects for eventual economic extraction to consider potential mining methods, but the assumptions made regarding mining methods and parameters when estimating Mineral Resources may not always be rigorous. Where this is the case, this should be reported with an explanation of the basis of the mining assumptions made.*	• CRP and their partner Boskalis propose using a mining vessel built or modified to meet the specific requirements of the Project. The phosphorite layer would be retrieved from the seabed using the principles of a conventional trailing suction hopper dredger or drag-head. This material would be brought to the surface via a riser and processed on-board the mining vessel; the phosphorite nodules (>2 mm) being retained and stored on the vessel and the tailings returned to the seabed via a sinker and diffuser. When the vessel's holds are full, the mining vessel would stop mining and proceed to a port where the phosphorite would be unloaded, stored and distributed to the market. • The proposed 4.5 m wide drag-head is designed to efficiently collect phosphorite nodules from a layer that varies in thickness from 0 to 50 cm, 35 cm in average, and to avoid dredging the underlying chalk/ooze layer. Where the phosphorite-bearing sediment is thicker than 50 cm the drag-head would not be able to mine the entire layer and would therefore leave some of the nodules behind.
Metallurgical factors or assumptions	• *The basis for assumptions or predictions regarding metallurgical amenability. It is always necessary as part of the process of determining reasonable prospects for eventual economic extraction to consider potential metallurgical methods, but the assumptions regarding metallurgical treatment processes and parameters made when reporting Mineral Resources may not*	• It is proposed that the phosphorite material to be mined from the Chatham Rise is a bulk product that will be sold to customers in its recovered raw state. All material received at the ship will be processed through a separation plant, with the >2 mm fraction retained and stored in the ship's hold. • Boskalis investigated the implications of minimum grain separation

	always be rigorous. Where this is the case, this should be reported with an explanation of the basis of the metallurgical assumptions made.	scenarios with separation at 2 mm being regarded as the most optimal. • Analyses were completed for major element chemistry and trace elements on both Valdivia (>1mm) and Sonne samples (>8 mm and 1-8 mm). Larger nodules had lower P_2O_5 and higher CaO content than the smaller ones. In 77 analyses from 48 Sonne samples the >8 mm nodules averaged 19.8% P_2O_5 and the 1–8 mm nodules averaged 21.6%. In 63 Valdivia >1mm samples the P_2O_5 average was 22.0%.
Environmental factors or assumptions	• *Assumptions made regarding possible waste and process residue disposal options. It is always necessary as part of the process of determining reasonable prospects for eventual economic extraction to consider the potential environmental impacts of the mining and processing operation. While at this stage the determination of potential environmental impacts, particularly for a greenfields project, may not always be well advanced, the status of early consideration of these potential environmental impacts should be reported. Where these aspects have not been considered this should be reported with an explanation of the environmental assumptions made.*	• CRP conceptual tailings proposal has sediment less than 2 mm in size returned to the seabed via a flexible sinker hose and a diffuser that will release the material within 10m of the sea floor. Boskalis are working on design concepts that ensure the tailings are deposited back to the sea floor with minimum sediment dispersion by reducing the high-flow velocity of the sinker and increasing the dispersers on the lower part of the sinker. • CRP has collected a variety of marine information to develop an informed assessment of the marine environment and the potential impacts that exploration and extraction may have on this environment. • CRP has undertaken a comprehensive literature review of the occurrence of spawning and juvenile-rearing areas of commercially-significant deep-water fish species in and around the CRP licence area, to assess possible sensitivities to mining. • CRP has commissioned Golders Associates Ltd to undertake a Marine Consent Application and Environmental Impact Assessment (EIA) for the Chatham Rise Project. The purpose of the report is an EIA in support of the application by CRP for a marine consent. This EIA has been prepared in accordance with the framework outlined in the Exclusive Economic Zone Act. This report will be structured to cover all environmental and social impacts that could potentially arise from the Chatham Rise Project.
Bulk density	• *Whether assumed or determined. If assumed, the basis for the assumptions. If determined, the method used, whether wet or dry, the frequency of the measurements, the nature, size and representativeness of the samples.* • *The bulk density for bulk material must have been measured by methods that adequately account for void spaces (vugs,*	• Density measurements were taken on the Valdivia, Sonne, Tranquil Image and Dorado Discovery cruises. Tests included bulk density of phosphorite bearing sands, ooze below the sand, phosphorite nodules. • Density measurements were not systematically applied to all samples and were conducted on selected samples. • All samples have an assumed density.

	porosity, etc), moisture and differences between rock and alteration zones within the deposit. • *Discuss assumptions for bulk density estimates used in the evaluation process of the different materials.*	• Sample phosphorite grade is determined by multiplying the calculated phosphorite volume percent by the 2.72 g/cm^3 (average wet density of phosphorite nodules collected by CRP) • Ten samples collected by CRP from the Tranquil Image cruise made up of composited material from 1 to 4 samples each were submitted to Boskalis Dolman Laboratory for Environmental and Geotechnical Research, to test nodule density and water absorption. One to six nodules from each composite were tested, totalling 36 analyses. Sample density was determined using the weight in water and weight in air method. Samples were dried at 110ºC for an unspecified length of time to determine their dry density. The samples' dry weights ranged from 1.9 to 69.8 g. When two outliers are excluded the samples yielded an average dry density of phosphorite nodules of 2.65 g/cm^3, an average wet density of 2.72 g/cm^3, and average water absorption of 2.8%.
Classification	• *The basis for the classification of the Mineral Resources into varying confidence categories.* • *Whether appropriate account has been taken of all relevant factors (ie relative confidence in tonnage/grade estimations, reliability of input data, confidence in continuity of geology and metal values, quality, quantity and distribution of the data).* • *Whether the result appropriately reflects the Competent Person's view of the deposit.*	• The Mineral Resource has been reported as an Inferred Mineral Resource under the JORC code, 2012 edition. • Geological evidence from geophysical surveys, video mapping and sampling is sufficient to imply geological and grade continuity over tens of kilometres. • The Mineral Resource is based on exploration, sampling gathered using appropriate sampling techniques that have been ranked for quality. • Samples have been taken from insitu outcrop on the sea floor. • Extrapolation of the resource up to 3,000 m from known sample points is valid based on the size of the deposit and variogram modelling. • The resource classification accounts for all relevant factors. • The result of the Mineral Resource estimate adequately reflects the Competent Person's view of the deposit.
Audits or reviews	• *The results of any audits or reviews of Mineral Resource estimates.*	• The Resource has not been independently reviewed.
Discussion of relative accuracy/	• *Where appropriate a statement of the relative accuracy and confidence level in the Mineral Resource estimate using an approach or procedure deemed appropriate by the Competent Person. For example, the application of statistical or*	• Confidence in the relative accuracy of the estimates is reflected by the classification of estimate as Inferred.

confidence	*geostatistical procedures to quantify the relative accuracy of the resource within stated confidence limits, or, if such an approach is not deemed appropriate, a qualitative discussion of the factors that could affect the relative accuracy and confidence of the estimate.* • *The statement should specify whether it relates to global or local estimates, and, if local, state the relevant tonnages, which should be relevant to technical and economic evaluation. Documentation should include assumptions made and the procedures used.* • *These statements of relative accuracy and confidence of the estimate should be compared with production data, where available.*	