



20 March 2013

UPDATED NI 43-101 TECHNICAL REPORT Clarion-Clipperton Zone Project, Pacific Ocean

NI 43-101 Technical Report

Clarion-Clipperton Zone Project, Pacific Ocean

Qualified Person:

Matthew Nimmo, MAIG, Principal Geologist, Golder Associates Pty Ltd

Effective Date of Technical Report: 20 March 2013.

Submitted to:

John Parianos
Tonga Offshore Mining Limited

REPORT

Report Number. 127631013-003-R-Rev1





Important Information

Golder Associates Pty. Ltd. (Golder) has prepared this document in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this document. No warranty, express or implied, is made beyond the application of the foregoing care and skill.

This document, including all text, data, tables, plans, figures, drawings and other documents contained herein, has been prepared by Golder for Tonga Offshore Mining Limited (TOML), as well as for public disclosure by TOML's parent, Nautilus Minerals Inc. It represents Golder's professional judgement based on the knowledge and information available at the time of completion. Golder is not responsible for any unauthorized use or modification of this document.

The factual data, interpretations, suggestions, recommendations and opinions expressed in this document pertain to the specific project, site conditions, design objective, development and purpose described to Golder by TOML, and are not applicable to any other project or site location. In order to properly understand the factual data, interpretations, suggestions, recommendations and opinions expressed in this document, reference must be made to the entire document.

This document, including all text, data, tables, plans, figures, drawings and other documents contained herein, as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder. Nautilus Minerals Inc. may publish this document with relevant securities commissions, any stock exchange and other regulatory authorities as may be required, including general publication in hardcopy and electronic formats in its company files or on company websites, to shareholders and to the public. Electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore readers are responsible for ensuring they are reviewing an electronic version that is obtained from a reliable source and viewing it with compatible technology.



Table of Contents

ITEM 1.	SUMMARY	1
ITEM 2.	INTRODUCTION	5
2.1	Report Distribution	5
2.2	Terms of Reference	5
2.3	Purpose of the Technical Report	5
2.4	Current Personal Inspection	5
2.5	Personnel	6
ITEM 3.	RELIANCE ON OTHER EXPERTS	7
3.1	International Seabed Authority data.....	7
3.2	Other information	7
ITEM 4.	PROPERTY DESCRIPTION AND LOCATION	8
4.1	Tenement and Permitting	8
4.1.1	United Nations Convention of the Law of the Sea.....	9
4.1.2	International Seabed Authority.....	9
4.1.3	Reserved Areas and the Enterprise	10
4.2	TOML Obligations.....	10
4.2.1	Work Programme	10
4.2.2	Royalties and Taxes.....	11
ITEM 5.	ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY	12
5.1	Accessibility and Infrastructure	12
ITEM 6.	HISTORY	14
6.1	Overview.....	14
6.2	The Historic Commercial Consortia	16
6.2.1	Kennecott Consortium (KCON).....	16
6.2.2	Ocean Mining Associates (OMA)	16
6.2.3	Ocean Mining INC. (OMI).....	17
6.2.4	Ocean Minerals Company (OMCO)	18
ITEM 7.	GEOLOGICAL SETTING AND MINERALISATION	20
7.1	Global Distribution of Nodules	20
7.2	Tectonic Setting and Topographic features within the CCZ.....	20
7.2.1	Tectonic Elements.....	20
7.2.2	Seafloor Topography.....	21



7.2.3	Currently Proposed Formation Mechanisms	25
7.2.4	Role of Sediment and the Carbonate Compensation Depth	25
7.3	Mineralisation.....	27
7.3.1	Variation in Nodule Grades	27
7.3.2	Grades of Other Metals.....	29
7.3.3	Nodule Abundance.....	30
ITEM 8.	DEPOSIT TYPES	33
8.1	Polymetallic Seafloor Nodules	33
8.1.1	Nodule distribution	33
8.1.2	Nodule morphology and formation	34
ITEM 9.	EXPLORATION.....	38
9.1	Nodule Sample Data Supplied to TOML.....	38
9.2	Sampling Method.....	44
ITEM 10.	DRILLING.....	46
ITEM 11.	PREPARATION, ANALYSES AND SECURITY	47
11.1	Sample Preparation	47
11.1.1	OMCO Procedures.....	47
11.1.2	Yuzhmorgeologiya Procedures	48
11.1.3	DORD Procedures	50
11.1.4	BGR Procedures.....	50
11.2	Quality Assurance and Quality Control Procedures.....	50
11.3	Adequacy of Sample preparation, Security and Analytical Procedures	51
ITEM 12.	DATA VERIFICATION	52
12.1	Data Independence	52
12.2	Physical Evidence of Nodules.....	52
12.2.1	Photographic Evidence	52
12.3	Data Integrity	53
12.4	Data Comparisons for the Entire Reserved Areas.....	53
12.6	Comparison with non-ISA Sourced Data	55
12.7	Adequacy of Data	55
ITEM 13.	MINERAL PROCESSING AND METALLURGICAL TESTING.....	57
ITEM 14.	MINERAL RESOURCE ESTIMATES.....	59
14.1	Resource Domains	59
14.1.1	Domain Statistics	59



14.2	Data Preparation.....	62
14.2.1	Declustering.....	64
14.2.2	Top Cutting.....	65
14.3	Variography.....	65
14.3.1	Representativeness of Sampling.....	70
14.4	Geological Block Model.....	70
14.5	Grade Estimation.....	71
14.6	Estimation Results.....	71
14.7	Model Validation.....	78
14.8	Comparison with ISA Regional Assessment for Abundance.....	80
14.9	Mineral Resource Classification.....	82
14.10	Mineral Resource Statement.....	82
ITEM 15.	MINERAL RESERVE ESTIMATES.....	85
ITEM 16.	MINING METHODS.....	85
ITEM 17.	RECOVERY METHODS.....	86
ITEM 18.	PROJECT INFRASTRUCTURE.....	86
ITEM 19.	MARKET STUDIES AND CONTRACTS.....	87
ITEM 20.	ENVIRONMENTAL STUDIES, PERMITTING AND SOCIAL OR COMMUNITY IMPACT.....	87
ITEM 21.	CAPITAL AND OPERATING COSTS.....	87
ITEM 22.	ECONOMIC ANALYSIS.....	87
ITEM 23.	ADJACENT PROPERTIES.....	88
ITEM 24.	OTHER RELEVANT DATA AND INFORMATION.....	90
24.1	Potential Additional Mineralisation.....	90
24.2	Seafloor Mining Systems.....	90
24.3	Other Obligations.....	92
24.4	Prior Mineral Resource Estimates.....	92
24.5	Areas of Particular Environmental Interest.....	93
ITEM 25.	INTERPRETATION AND CONCLUSIONS.....	94
ITEM 26.	RECOMMENDATIONS.....	95
ITEM 27.	REFERENCES.....	96
DATE	101	
SIGNATURE	101	



TABLES

Table 1-1: Inferred Mineral Resource Estimate for the TOML Exploration Areas A-D within the CCZ at a series of Nodule Abundance cut-offs 3

Table 2-1: Current Personal Inspection Details – Davey Banning..... 6

Table 4-1: TOML Exploration Area in the CCZ..... 9

Table 7-1: Summary of Global Nodule Grades (McKelvey et al., 1983)..... 20

Table 9-1: Summary of Historic Grab Samples Area A 39

Table 9-2: Summary of Historic Grab Samples Area B 40

Table 9-3: Summary of Historic Grab Samples Area C 40

Table 9-4: Summary of Historic Grab Samples Area D 40

Table 9-5: Historic Grab Samples Area E (four samples only; ex-KORDI)..... 40

Table 9-6: Historic Grab Samples Area F (two samples only; ex-BGR/OMI) 41

Table 9-7: Summary of Historic Samples from the Reserved Areas outside the TOML Exploration Area 41

Table 12-1: Mean Grades of the CCZ Nodules from Various Sources..... 55

Table 14-1: Summary Statistics of Samples within the TOML Exploration Area 61

Table 14-2: Minimum and Maximum UTM Coordinates for each TOML Exploration Area..... 63

Table 14-3: Declustered Statistics..... 65

Table 14-4: Global Top Cuts 65

Table 14-5: Variogram Models 66

Table 14-6: Block Model Framework (overlain UTM coordinates)..... 70

Table 14-7: Model Variables 71

Table 14-8: Global Mean and Variance Comparison 80

Table 14-9: Estimated Tonnage of Nodules in TOML Exploration Areas A, B, C, and D (Derived from ISA, 2010 Estimate Contour map, Figure 14-21). 82

Table 14-10: Inferred Mineral Resource Estimate for the TOML Exploration Area within the CCZ at a Series of Nodule Abundance Cut-offs. 83

Table 24-1: Tonnage and Grade of Nodules (ISA, 2010)..... 93



FIGURES

Figure 1-1: Location of the Clarion-Clipperton Zone (TOML, 2012). 1

Figure 4-1: Location of the Clarion-Clipperton Zone (TOML, 2012). 8

Figure 5-1: Mean Diagnostic Surface Current Velocity Relative to the 30 m Depth Surface Layer and Drifter Velocity (15 m sub-surface) for the Central Pacific (Modified from Bonjean and Lagerloef, 2002)..... 12

Figure 5-2: Wave Height Probabilities around the CCZ (Metocean, 2012 internal report submitted to TOML). 13

Figure 5-3: Ship Movements Through the Pacific Coloured on Journeys per Annum (Modified from Kaluza et al., 2010). 13

Figure 6-1: Photos of Nodules from the Clipperton Zone, Nodules are 1 to 10 cm in Diameter (Mero, 1965)..... 14

Figure 6-2: Lockheed and Kennecott Trial Miners and Lift Systems (Morgan, 2011). 17

Figure 6-3: Trial Mining of Nodules by the OMI Consortium (Brockett et al., 2008). 18

Figure 6-4: 100 ton Lockheed Martin Trial Miner on the Glomar Explorer in 1978 (Source Spickerman, 2012)..... 19

Figure 7-1: Regional Seafloor Structure, Sediment Type and Degree of Nodule Cover as of 1976 (Margolis et al., 1976). 20

Figure 7-2: Ocean Floor Age and Motion (ISA, 2003). 21

Figure 7-3: Bathymetric Regimes in the CCZ (modified from ISA, 2010). 21

Figure 7-4: Semi-Detailed Bathymetry for the Yuzhmorgeologiya (Melnik and Lygina, 2010) and COMRA East Block (COMRA, 2010), (ISA, 2010) with Single Track Surveys for Comparison. The TOML Exploration Areas D and E are on a Smith and Sandwell Product (ISA, 2010) but the Track Surveys Suggest a Commonly Crenulated Topography (TOML, 2012). 22

Figure 7-5: Example detailed Bathymetry for the Three Boxes within the Yuzhmorgeologiya Area in Figure 7-4 (scale of view as per Figure 7-4 (Melnik and Lygina, 2010). 23

Figure 7-6: GEBCO Bathymetry Showing the Extent of Seamount Chains Relative to Abyssal Hill Province 24

Figure 7-7: GEBCO Bathymetry Showing Areas with Bathymetry Slopes Greater than 13° in Blue 24

Figure 7-8: Formation Model for Polymetallic Seafloor Nodules (ISA, 2010). 25

Figure 7-9: Global (Futterer, 2006; Mukhopadhyay et al., 2008) and Regional (ISA, 2010) Seafloor Sediment Maps. 26

Figure 7-10: Schematic of Vertical Distribution of Sediment Types Within the IOM Exploration Area (Kotlinski and Stoyanova, 2006). 27

Figure 7-11: Modelled Mn and Cu Grades in Nodules across the CCZ (Morgan, 2009), point data attributed to OMI. 28

Figure 7-12: Modelled Ni and Co Grades in Nodules across the CCZ (Morgan, 2009), point data attributed to OMI. 29

Figure 7-13: Modelled Nodule Abundance across the CCZ (Morgan, 2009), point data are attributed to OMI. 31

Figure 7-14: OMCO and Yuzhmorgeologiya Abundance Models across the Central CCZ (modified from ISA, 2003). 32

Figure 8-1: Nodule Pavement at Depth Within or Near the CCZ the Nodules Shown are Typically 5-10 cm in Diameter (photo A from Brockett et al., 2008; photos B-D from Beaulie, 2012). 33

Figure 8-2: Undisturbed Nodule-sediment SYMPAS Box Core Sample (MNHN, 2006)..... 34

Figure 8-3: Polymetallic Nodule Types (ISA, 2010)..... 35

Figure 8-4: Polymetallic Nodule Growth Processes (Koschinsky, 2008)..... 36

Figure 8-5: Sections Through a S-type Nodule (L) and a R-type Nodule with a S-type core (von Stackelberg and Beiersdorf, 1991). 36



Figure 8-6: Nodule Densities of Samples from the Central North Pacific 36

Figure 9-1: Total Number of Samples by Pioneer Contractor..... 39

Figure 9-2: Total Number of Samples by TOML Exploration Areas. 39

Figure 9-3: Samples coloured by Pioneer Contractor (within the Reserved Areas; ISA, 2012a)..... 42

Figure 9-4: Box Plots Showing Range of Sample Grades within the TOML Exploration Areas Compared with all Other Data from the Reserved Blocks in the CCZ..... 43

Figure 9-5: Box Plots Comparing the 6 Pioneer Contractor Reserved Area Data Sets across the entire CCZ 43

Figure 9-6: Log Probability Plots Comparing the 6 Pioneer Contractor Data Sets 44

Figure 9-7: Cartoon Showing the Recovery Process of Nodules Using Free Fall Grab (Lee et al., 2008). 45

Figure 9-8: Cartoon Showing the Recovery Process of Nodules Using Box Corer (Lee et al., 2008). 45

Figure 9-9: Comparison of Returned Abundances from BC and FFG at Test Stations within the KORDI Exploration area (Lee et al., 2008). 46

Figure 11-1: Ocean-0.25 Grab Sampler (Yubko, 2012). 48

Figure 11-2: Recovery of Ocean-0.25 Grab Sampler (Yubko, 2012). 49

Figure 11-3: Mn-nodules Inside Grab Sampler (left) and Outside Grab Sample (right) (Yubko, 2012). 50

Figure 12-1: Quantile-Quantile (QQ) Plots Comparing the Distribution of TOML Samples with all Other Samples from the Reserved Blocks in the CCZ. 54

Figure 12-2: CCZ Showing Boundary used to Clip the SIO Polymetallic Nodules Dataset 56

Figure 13-1: Potential Process Flow-sheets for Seafloor Nodules. 58

Figure 14-1: Global Grade Distribution for Ni, Co, Cu, Mn and Abundance. 60

Figure 14-2: Grade Distribution for Ni, Co, Cu, Mn and Abundance within Each of the TOML Exploration Areas. 61

Figure 14-3: Box Plots of Ni, Co, Cu, Mn and Abundance by TOML Exploration Area. 62

Figure 14-4: Location of Sample Data Supplied Provided by ISA to Golder (TOML Exploration Areas A to D were Included in the Inferred Mineral Resource) 63

Figure 14-4: TOML Exploration Area sub-areas and Samples in overlain UTM zones. 64

Figure 14-5: Location of Close Spaced Sampling in TOML Exploration Area C (TOML, 2012). 67

Figure 14-6: Abundance Variogram Using Short Range Data..... 67

Figure 14-7: Semi-Variogram Maps for Ni, Co, Cu and Mn and Abundance..... 68

Figure 14-8: Major and Semi-Major Semi-Variograms for Ni, Co, Cu and Mn..... 69

Figure 14-9: Experimental Semi-Variograms for Nodule Abundance (annotated with number of samples)..... 70

Figure 14-10: Nodule Abundance – Tonnage Curve (only includes blocks A to D)..... 72

Figure 14-11: Map Showing Block Model and Sample Distribution of Ni in TOML Exploration Areas A-D..... 73

Figure 14-12: Map Showing Block Model and Sample Distribution of Cu in TOML Exploration Areas A-D. 74

Figure 14-13: Map Showing Block Model and Sample Distribution of Co in TOML Exploration Areas A-D. 75

Figure 14-14: Map Showing Block Model and Sample Distribution of Mn in TOML Exploration Areas A-D..... 76

Figure 14-15: Map Showing Block Model and Sample Distribution of Abundance in TOML Exploration Areas A-D..... 77

Figure 14-16 SWATH Plots for Ni in the Easting and Northing Directions..... 78

Figure 14-17 Swath Plots for Co in the Easting and Northing Directions. 78



Figure 14-18 Swath Plots for Cu in the Easting and Northing Directions. 79

Figure 14-19 Swath Plots for Mn in the Easting and Northing Directions. 79

Figure 14-20 Swath Plots for Abundance in the Easting and Northing Directions. 79

Figure 14-21 ISA Inferred Abundance in TOML Exploration Areas (by Dr Charles Morgan, 2012). 81

Figure 24-1: Two Alternative Deep Sea Mining Systems (Handschuh et al., 2001). 91

Figure 24-2: Commercial Scale Hydraulic Lifter and Transport System Based on a Towed Sled (Brockett et al., 2008). 91

Figure 24-3: Sample Data and Blocks Used for the CCZ-Wide Mineral Resource Estimate by ISA (ISA, 2010). 93

Figure 25-1: Nodule Abundance – Tonnage Curve (only includes TOML Exploration Areas A to D). 94



List of Acronyms and Terms

AAS	– Atomic Absorption Spectroscopy
Abundance	– See definition in section 7.3.3
AFERNOD	– Association Française pour l'Étude et la Recherche des Nodules
AMR	– Arbeitsgemeinschaft Meerestechnisch Gewinnbare Rohstoffe
BC	– Box Corer
BGR	– German Consortium
CAPEX	– Capital Expenditure
CCD	– Calcite Compensation Depth
CCZ	– Clarion-Clipperton Zone
CIM	– Canadian Institute of Mining, Metallurgy and Petroleum
COMRA	– China Ocean Mineral Resources Research and Development Association (Chinese Consortium)
DOMCO	– Deep Ocean Mining Co.
DORD	– Deep Ocean Resources Development Company (Japanese Consortium)
Enterprise	– See definition in section 4.1.3
EPR	– East Pacific Rise
FFG	– Free-Fall Grab samplers
FIGNR	– Federal Institute for Geosciences and Natural Resources (German Consortium)
GEBCO	– General Bathymetric Chart of the Oceans (www.gebco.net)
HPAL	– High temperature and high pressure sulfuric acid leach process
IDOE	– International Decade of Ocean Exploration
IDW	– Inverse Distance Weighting estimation method
IFREMER	– Institut Français de Recherché pour l'Exploitation de la Mer (French Research Institute for Exploitation of the Sea) (French Consortium)
INCO	– International Nickel Corporation
IOM	– Interoceanmetal Joint Organization (Bulgaria, Cuba, Czech Republic, Poland, Russian Federation and Slovakia Consortium)
ISA	– International Seabed Authority
JORC	– Joint Ore Reserves Committee
KADOM	– Korean Association of Deep-Ocean Mineral Development
KCON	– Kennecott Consortium
KORDI	– Korean Ocean Research and Development Institute (now known as KIOST; Korean Institute of Ocean Science and Technology)
LMS	– Lockheed Martin Systems
LTC	– Legal and Technical Commission of the ISA
NI 43-101	– Canadian National Instrument 43-101
NIOT	– National Institute of Ocean Technology
NOAA	– National Oceanic and Atmospheric Administration
NORI	– Nauru Ocean Resources Inc
NN	– Nearest Neighbour estimation method
OK	– Ordinary Kriging estimation method
OMA	– Ocean Mining Associates
OMI	– Ocean Mining Incorporated
OMCO	– Ocean Minerals Co. (US Consortium)
OPEX	– Operating Expenditure
IOM	– Interoceanmetal Joint Organisation
ITLOS	– International Tribunal for the Law of the Sea
QAQC	– Quality Assurance and Quality Control
QP	– Qualified Person
R-type	– Rough type nodules



ROV	– Remotely Operated Vehicle
SA-SSS	– Synthetic aperture side scan sonar
SIO	– Scripps Institution of Oceanography
S-R-type	– Smooth-rough type nodules
SSS	– Sidescan sonar
S-type	– Smooth type nodules
TOML	– Tonga Offshore Mining Limited
UNCLOS	– United Nations Convention on the Law of the Sea 1982
UTM	– Universal Transverse Mercator Cartesian coordinate system
Yuzhmorgeologiya	– State Enterprise Yuzhmorgeologiya (Russian Federation Consortium)

Elements

Al	– Aluminium
As	– Arsenic
Ba	– Barium
Ca	– Calcium
Ce	– Cerium
Cl	– Chlorine
Co	– Cobalt
Cu	– Copper
F	– Fluorine
Fe	– Iron
La	– Lanthanum
Mg	– Magnesium
Mn	– Manganese
Mo	– Molybdenum
Nd	– Niobium
Ni	– Nickel
Pb	– Lead
PGM	– Platinum Group Minerals
Pt	– Platinum
REE	– Rare Earth Elements
S	– Sulphur
Si	– Silicon
Sr	– Strontium
Te	– Tellurium
Ti	– Titanium
Zn	– Zinc
Zr	– Zirconium
Y	– Yttrium



Direction – Azimuth Abbreviations

N	– North
E	– East
S	– South
W	– West
NNE	– North North East
NE	– North East
ENE	– East North East
ESE	– East South East
SE	– South East
SSE	– South South East
SSW	– South South West
SW	– South West
WSW	– West South West
WNW	– West North West
NW	– North West
NNW	– North North West

Symbols

°	– degree
°C	– degrees centigrade
µm	– micrometre
cm	– centimetre
g/t	– grams per tonne
kg	– kilogram
kg/m ²	– kilograms per square kilometre (surface abundance)
km ²	– square kilometres
kWh/t	– kilowatt hour per tonne
m	– metre
m/s	– metres per second
m ³	– cubic metre
mbsl	– metres below sea level
mm	– millimetre
Mwt	– million tonnes (wet)
nmi	– nautical mile
ppb	– parts per billion
ppm	– parts per million
s	– second
t/m ³	– tonnes per cubic metre



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

ITEM 1. SUMMARY

The Clarion-Clipperton Zone (CCZ) is a large, extensive deposit of polymetallic nodules in the tropical north Pacific. The nodules are located on the seafloor at depths of 4 000 to 6 000 m and have significant grades of Mn, Ni, Cu, and Co as well as lower grades of a range of other metals of interest.

Since the CCZ deposit is situated within international waters, exploration and development of the deposit is regulated by the International Seabed Authority (ISA). The ISA is an autonomous international organization established under the 1982 United Nations Convention on the Law of the Sea and the 1994 Agreement relating to the implementation of Part XI of the United Nations Convention on the Law of the Sea.

Exploration and development efforts in the CCZ started in the 1960s by state sponsored groups from Russia, France, Japan, Eastern Europe, China, Korea and Germany. Several commercial consortia also explored between the 1960s and the 1980s and in some instances their descendants are still involved to the present day. No commercial operations have yet been established in the CCZ. However, a variety of collectors, pickup systems, and metallurgical processing flow sheets were tested, and an integrated “demonstration scale” system operated in the CCZ for several months in the late 1970s.

The Law of the Sea and ISA regulations require “pioneer contractors” to return 50% of their initial Exploration Areas (of equal value) along with key exploration data to become part of the “reserved blocks”. A developing nation or their sponsored companies may then apply for an “Exploration Area” from these “reserved blocks” (up to 75 000 km²). Tonga Offshore Mining Ltd (TOML), a 100% owned subsidiary of Nautilus Minerals Inc., is sponsored by the Kingdom of Tonga and has obtained an Exploration Area under a “contract for exploration of polymetallic nodules” (74 713 km²; executed 11th of January 2012). The Exploration Area consists of six separate areas (termed Areas A to F) scattered across the CCZ (Figure 1-1).

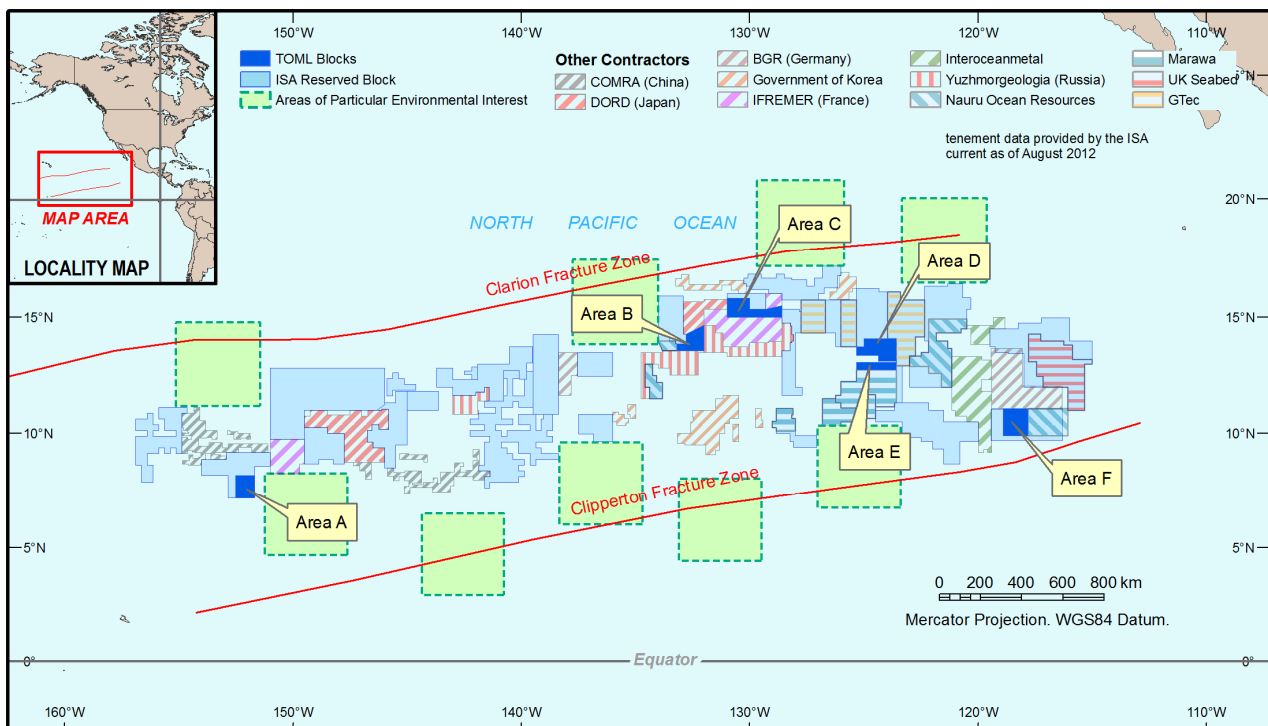


Figure 1-1: Location of the Clarion-Clipperton Zone (TOML, 2012).



Sea state is an important consideration in the location of the deposit. The climate is largely warm, and equatorial surface currents vary by season but are not very strong. Wave-heights and frequencies are often moderate (for the open ocean). Storms are significant for part of the year as a major tropical cyclone belt covers the southern side of the CCZ. The deposit is away from major existing sea routes used by commercial transport vessels.

The worldwide nature of polymetallic nodules has been known since the late 1800s. They form by the precipitation of metals either directly from ocean waters or via decomposing microorganisms and/or their waste matter in the benthic sediments. The specific conditions of the CCZ (water depth, latitude and seafloor sediment type) are the key controls on the formation of what is believed to be the largest and highest Ni-Cu-Co grade nodules deposit in the world. Nodules grow on 0.1 to 1 cm 'seeds' (e.g. shark's teeth, pieces of pumice and older broken nodules) and are typically 4 to 6 cm and up to 10 cm in diameter.

Unlike most land deposits, exploration groups working within the CCZ term the quantity of nodules at a given sampling station as "abundance" measured in units of wet kg/m². This is because both the primary exploration method (surface sampling) and likely recovery method (surface collectors or rakes) are unlikely to work at any significant depth below the seafloor (i.e. 0 to 30 cm). Abundances are typically reported as wet weights due to the practicalities of handling the nodule samples, the wet density of studied nodules is around 2 g/cm³ irrespective of the nodule size. Studies show nodules to contain around 15% free water and 25% water of crystallisation (incorporated into the complex manganese and iron oxy-hydroxide minerals of formation).

Some of the exploration data from the pioneer contractors is of sufficient quality to allow Golder to estimate an Inferred Mineral Resource for Areas A to D, 4 of the 6 areas that comprise the TOML Exploration Area. Within these areas the data were collected by pioneer contractors representing Japan, Russia and France. The data were obtained directly from the ISA and were not supplied with quality assurance or quality control data. However, verification is possible by cross comparison between all of the six pioneer contractors (also Korea, Germany and an eastern European consortium) who have so far supplied the ISA with data across what is effectively a single large deposit. The TOML Mineral Resource estimate also compares very well with a subset of an ISA sponsored integrated Mineral Resource estimate that uses a much larger multisource database from across the entire CCZ.

The key data behind the Mineral Resource estimate are surface samples obtained by free-fall grab samplers, although a few results from box corers were also included. Free-fall grab samplers are believed to underestimate the actual abundance, as smaller nodules may escape some grabs during ascent and larger nodules around the edge of the sampler may be knocked or fall out during the sampling process. Despite this, they are the standard sampling method as they are the most productive and proven tool available, because several can be deployed at any one time independently of the survey vessel (from deployment to recovery is several hours).

Many of the sampling procedures used by the pioneer contractors were not available to the Qualified Persons, but it is likely that all of the pioneer contractors followed similar procedures. Nodule abundance (wet kg/m²) is derived by dividing the weight of recovered nodules by the surface area covered by the open jaws of the sampler or corer (typically 0.25 to 0.5 m²). A split of the nodules was dried, crushed and ground to enable grade determination via standard analytical methods (typically atomic absorption spectrometry and X-ray fluorescence) either on the vessel or back on shore. Specific nodule chemical standards, provided by the U.S. Geological Survey were used for instrument calibration.

Analysis of the data reveals that, as a consequence of their origin, nodule grades vary only slightly across the CCZ, with spatial continuity of the Ni, Co and Cu grades often ranging up to the order of several tens of kilometres. Nodule abundance is less continuous, with ranges up to the order of several kilometres, as they are also subject to local changes in net sedimentation (a consequence of seafloor slope, slumping, erosion and local currents).

Estimation of tonnage and grade for the TOML Exploration Area within the CCZ was undertaken using only sample data within the TOML Exploration Area. Datamine Studio mining software version 3.20.6140.0 was used for the modelling. The modelling methodology used for estimating the Mineral Resource was



determined through careful consideration of the scale of deposit, mechanism of nodule formation, geological controls and nature of the sampling method. The approach involved estimating nodule abundance and grades into a two-dimensional block model with abundance in kg/m² used for calculating tonnage. Grades were estimated using Ordinary Kriging (OK) and Inverse Distance Weighting (IDW) while abundance was only estimated using IDW. The modelling methodology is similar to the method applied by the ISA (2010) for their global estimate (not NI 43-101 compliant) which was produced by a multi-disciplinary effort that involved several world authorities.

The occurrence of manganese nodules within the CCZ is controlled by two large scale geological features: the boundary of the CCZ deposit and the presence of sea mounts.

The boundary limits of the CCZ defining the region where nodules have been found to occur is on a continental scale bracketed by the Clarion and Clipperton Fracture Zones to the north and south respectively. The deposit extends to the west and east in a channel between the two fracture zones. The limits to the CCZ occur well outside the boundaries of the TOML Exploration Area. Consequently, 100% of the TOML Exploration Area falls within the CCZ deposit. Internally within the CCZ deposit the continuity of the distribution of nodules can be reasonably assumed since the mechanism for the formation of nodules is continental in scale.

Bathymetric features are likely to play a role in local distribution of nodules through variations in net sedimentation rates via erosion and deposition. There are principally two bathymetric domains:

- Sea mount ranges
- Abyssal hill province.

Based on interpretation of GEBCO bathymetry data, less than 2% of the TOML Exploration Area contains isolated sea mounts. Essentially, the entire TOML Exploration Area falls within the abyssal hill domain.

The Inferred Mineral Resource estimate was made using a 2D model and ordinary kriging estimation for grade and inverse distance estimation for abundance, and is summarised at a range of cut-offs in Table 1-1. The Mineral Resource estimate at an abundance cut-off of 4 wet kg/m² is the selected base case scenario considering a non-selective bulk mining operation.

Table 1-1: Inferred Mineral Resource Estimate for the TOML Exploration Areas A-D within the CCZ at a series of Nodule Abundance cut-offs.

Abundance Cut-off (wet kg/m ²)	Abundance (wet kg/m ²)	Ni (%)	Co (%)	Cu (%)	Mn (%)	Polymetallic Nodules (x10 ⁶ wet t)
4	8.9	1.2	0.24	1.1	26.9	440
5	9.1	1.2	0.24	1.1	26.9	420
6	9.4	1.2	0.24	1.1	26.9	410
7	9.8	1.2	0.24	1.1	26.8	370
8	10.4	1.2	0.24	1.0	26.7	310

The available information regarding mining and processing of the manganese nodules has been assessed and there are reasonable prospects for economic extraction.

This Mineral Resource estimate is based upon and accurately reflects data compiled or supervised by Mr. Matthew Nimmo, Principal Geologist, who is a Member of the Australian Institute of Geoscientists and a full time employee of Golder Associates Pty Ltd. Mr. Nimmo has sufficient experience in resource estimation to qualify as a Qualified Person under NI43-101 He is the lead author of this report.

Dr Charles Morgan, Member of the Australian Institute of Geoscientists and Registered Member of the Society for Mining, Metallurgy, and Exploration, a full-time employee of Planning Solutions Inc., is a



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

Professional Marine Scientist and the Qualified Person responsible for Items 6, 9, 10, 11 and 12 of this report. He has visited the CCZ as part of a regional study by an independent multinational consortium called Ocean Minerals Company. Dr Morgan has been intermittently involved with evaluation of nodule resources over the past 30 years, and has produced various geological summaries and statements for the International Seabed Authority and other parties.

Davey Banning, Member of the Australian Institute of Geoscientists and consultant to Golder, is an independent consultant and the Qualified Person responsible for Items 7 and 8 of this report. He visited the site as part of the last (1980s) exploration cruises known over the TOML Exploration Area with Ocean Minerals Company.

Exploration information (samples collected by the Korean and German state-supported pioneer contractors) indicates nodule potential additional to the Inferred Mineral Resource in TOML Exploration Areas E and F, which comprise approximately 30% of the total TOML Exploration Area and for which no resource estimate has been completed. Also some or all of the nodules may contain elevated levels of rare-earth elements based on results released by an adjacent licence claimant.

TOML has not yet done any detailed recovery planning or equipment design for the nodule project, but a large and growing body of work, by a variety of organisations over the past 30 plus years, indicates that recovery of the nodules is possible. TOML's parent Nautilus Minerals is currently building the world's first deep seafloor resource production system for its Solwara 1 massive sulphide deposit.

TOML has not done any mineral processing or metallurgical test-work on the seafloor nodules from the TOML licences. However, considerable historical work has been done at both laboratory scale and pilot plant scale that indicates that processing of the nodules is technically feasible.

Recommended future work on the TOML Exploration Area focuses on determining an Inferred Mineral Resource estimate for Areas E and F and increasing the resource classification for parts of the other areas to Indicated or Measured Mineral Resource. Additionally, key modifying factors will be constrained to a point where a Mineral Reserve may potentially be estimated. Recommendations for future work also includes: detailed bathymetric and sonar surveys; additional sampling with assaying of all samples collected for additional elements; density and moisture studies; environmental, engineering and metallurgical studies and design work; and preliminary economic and commercial studies.



ITEM 2. INTRODUCTION

A large deposit of polymetallic nodules is located in the northern central Pacific (the Clarion-Clipperton Zone or CCZ). Despite the nodules being located at great depths (4 000 to 6 000 m), they were explored with considerable success between the mid-1960s to the present day using a variety of deep sea technologies. In early 2012, Tonga Offshore Mining Limited (TOML), a 100% owned subsidiary of Nautilus Minerals Inc. acquired an Exploration Area for 74 713 km² of the CCZ. In line with the requirements of the relevant oversight body (International Seabed Authority or ISA) TOML is sponsored by the government of the Kingdom of Tonga. The contract for exploration of polymetallic nodules was approved in July 2011, and then formalised on 11 January 2012.

In June 2012, TOML commissioned Golder Associates Pty Ltd (Golder) to complete an independent Mineral Resource estimate and prepare a Technical Report in accordance with the Canadian National Instrument 43-101 reporting standards (NI43-101) and Form 43-101F1. The Mineral Resource statement was prepared in accordance with the CIM “Estimation of Mineral Resources and Mineral Reserves Best Practice Guidelines” and the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (JORC Code, 2004).

The International Seabed Authority (ISA) provided the exploration sample data on 22 of June 2012 to Golder for the Mineral Resource estimate reported herein. All of the exploration sample data is historical information, supplied to the ISA by pioneer contractors under the principles of the United Nations Convention on the Law of the Sea.

This technical report summarises the current information available for the TOML CCZ property.

2.1 Report Distribution

This report is intended to be used by TOML and Nautilus subject to the terms and conditions of its contract with Golder. That contract permits TOML and Nautilus to file this report as a Technical Report with Canadian Securities Regulatory Authorities pursuant to provincial securities legislation. Except for the purposes legislated under provincial securities laws, any other use of this report by any third party is at that party's sole risk.

2.2 Terms of Reference

Golder was commissioned by TOML to:

- Compile and report on the technical aspects of the deposit including setting, geology and exploration history in line with the structure and requirements of NI43-101 in the format of NI43-101F1.
- Complete for the TOML Exploration Area an independent Mineral Resource estimate compliant with Canadian NI43-101 in the format of NI43-101F1.

2.3 Purpose of the Technical Report

To present TOML's current state of knowledge of the geology, prospectivity and mineral resource potential for its Exploration Area covering parts of the polymetallic seafloor nodule deposit in the CCZ.

2.4 Current Personal Inspection

Mr Davey Banning visited the CCZ in the early 1980s while on board the ship M/V Governor Ray. He has spent approximately ten months within the CCZ while on-board a number of voyages that intersected the TOML Exploration Areas. He was involved with regional sampling of the CCZ polymetallic nodule deposit by Lockheed Missiles and Space Company (a participant in the Ocean Minerals Company deep seabed mining consortium). Mr Banning participated in the collection, inspection and analysis of nodule samples, photographs and video coverage including OMCO cruises to the TOML Exploration Area (Table 2-1).



Table 2-1: Current Personal Inspection Details – Davey Banning

TOML Exploration Area	Dates of cruise	Cruise	Pioneer Contractor Exploration (sample data used in this report)
B	10/05/78 – 28/06/78	OMCO 7802	Yuzhmorgeologiya (early 1970s)
C	27/09/78 – 05/11/78	OMCO 7804	AFERNOD 1976 (Hoffert, 2008)
	21/06/79 – 09/08/79	OMCO 7903	
	29/08/80 – 17/10/80	OMCO 8004	
D	27/09/78 – 15/11/78	OMCO 7804	DORD
	01/02/81 – 22/03/81	OMCO 8101	

Golder considers that the personal inspections that Davey Banning undertook in the 1970s and 1980s are current, because there has been no material change to the property since the samples were collected in the TOML Exploration Area since his visit. Nodule formation is measured on the scale of millions of years and sedimentation rates on the scale of thousands of years. No additional sampling of the licences of any type is known since the work of the pioneer contractors in the 1970s and 1980s. No mining has taken place on the TOML Exploration Area and no other material disturbance to the site is possible due to the accessibility of the area without specialised deep sea equipment.

2.5 Personnel

This Technical Report is based on information supplied to Golder by TOML. The work completed by Golder that is the subject of this NI43-101 compliant Technical Report was carried out primarily by the following persons:

Matthew Nimmo, Member of the Australian Institute of Geoscientists, a full-time employee of Golder, is a Principal Geologist and the Qualified Person with overall responsibility for the Technical Report.

Dr Charles Morgan, Registered Member of the Society for Mining, Metallurgy, and Exploration and Member of the Australian Institute of Geoscientists, a full-time employee of Planning Solutions Inc., is a Professional Marine Scientist and the Qualified Person responsible for Items 6, 9, 10, 11 and 12.

Davey Banning, Member of the Australian Institute of Geoscientists and consultant to Golder, is an independent consultant and the Qualified Person responsible for Items 7 and 8 of this report.



ITEM 3. RELIANCE ON OTHER EXPERTS

3.1 International Seabed Authority data

The sample data used as the basis for the Mineral Resource estimate in this report were obtained by Golder directly from the ISA (see also section 4.1.2).

Under the principles of the Law of Sea (Item 4), pioneer contractors explore then relinquish or return 50% of their initial Exploration Area to the ISA (see also section 4.1.3). As part of the relinquishment process the ISA requires each pioneer contractor to provide all sample data to a robust centrally managed database within the ISA. The contractor suggests how the initial Exploration Area might be split evenly and may or may not suggest which portion they would prefer to retain.

The ISA analyse these data to verify that the two split areas are of equal economic value. The analysis and acceptance, or otherwise, of the data by the ISA indicates a degree of verification and validation of these data.

The ISA also supplied Golder with other data in numerous reports (referenced accordingly in the text) and the Mining Code administered by the ISA. These reports as well as structure and authorities of the ISA are publicly available from the ISA website (<http://www.isa.org.jm/en/home>).

The authors of this report neither supervised or were involved with the preparation, compilation and management of data supplied by the ISA. The ISA compiled these data from multiple and independent pioneer contractors. These data can be relied upon for the following reasons:

- The ISA has an imperative to manage these data properly and fairly in order to maintain credibility and minimise disputes amongst its many stakeholders (the nations of the world) and to date Golder is unaware of any such disputes being raised in the context of data quality and management;
- The ISA operates independently of any particular government or commercial stakeholder;
- These data have been used as part of a CCZ wide study and mineral inventory estimation exercise (ISA, 2010) which involved experts not employed by the ISA, including QP Dr Charles Morgan and these data were deemed to be of suitable reliability for this exercise,

3.2 Other information

Outside of referenced public documents, this Technical Report includes statements on the property tenure, location and ownership and accessibility as presented in Items 4 and 5 and elsewhere in this report. These were provided by John Parianos, Chief Geologist of TOML. Golder has not undertaken an independent review of the tenure held by TOML and relies on the expertise and experience in international tenure provided by TOML in this regard.

Information supporting Item 16 Mining Methods was provided by John Parianos, Chief Geologist of TOML. Golder has reviewed the information on mining for the purpose of assessing the potential prospects of economic extraction of the nodules from the TOML Exploration Area. The assessment is conceptual in nature and is not supported by a preliminary economic assessment (PEA).



ITEM 4. PROPERTY DESCRIPTION AND LOCATION

The TOML exploration rights are located within the Clarion-Clipperton Zone (CCZ) located in the Pacific Ocean (Figure 4-1). The western end of the CCZ is approximately 500 km ENE of Kiribati and approximately 1000 km south of the Hawaiian island group. The CCZ extends over 4500 km ENE, in an approximate 750 km broad trend with the eastern limits located approximately 2000 km west of southern Mexico.

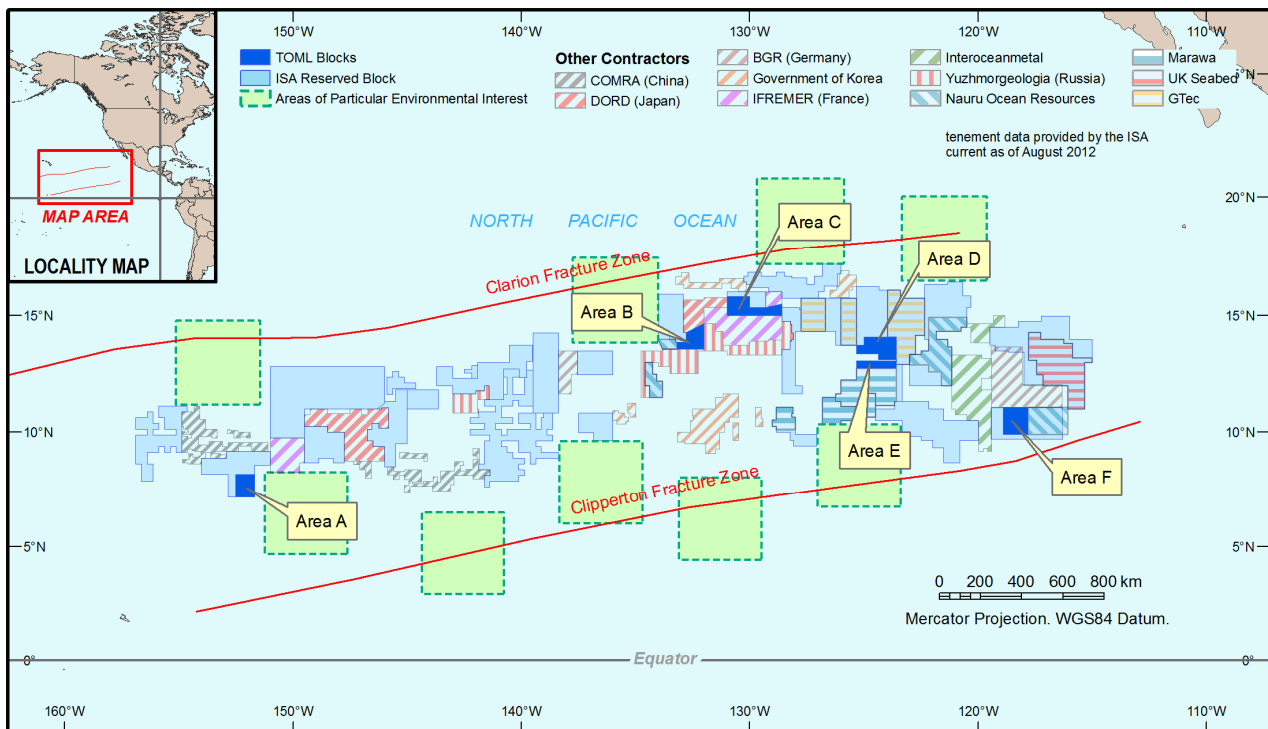


Figure 4-1: Location of the Clarion-Clipperton Zone (TOML, 2012).

4.1 Tenement and Permitting

Tonga Offshore Mining Ltd (TOML), a 100% owned subsidiary of Nautilus Minerals Inc., has been sponsored by the Government of the Kingdom of Tonga in its application for approval of a “plan of work for exploration for polymetallic nodules” by the International Seabed Authority (ISA) under the terms of the United Nations Convention on the Law of the Sea 1982 (UNCLOS) and the Mining Code of the ISA (specifically the Regulations for Prospecting and Exploration of Polymetallic Nodules).

The ISA approved the plan of work in July 2011 and this led to signing of a “contract for exploration for polymetallic nodules” by the ISA and TOML on 11 January 2012, that formalises an “Exploration Area” (tenement or licence; Figure 4-1, Table 4-1), a term of 15 years for the contract, and a programme of activities for the first 5-year period. The contract also formalises the rights of TOML around security of tenure leading to a “contract for exploitation”. The contract does not cover commodities other than polymetallic nodules but in this context the ISA is obligated to ensure that no other entity operates in a manner that might unreasonably interfere with TOML.

The contract of exploration was signed on the 11 of January 2012, and at that date was the only contract of exploration of its type held by a publically listed company within the CCZ.



Table 4-1: TOML Exploration Area in the CCZ

Exploration Area “Areas”	Reserved Block	Area (km²)
Area A	Block 2	10 281
Area B	Block 15	9 966
Area C	Block 16	15 763
Area D	Block 20	15 881
Area E	Block 21	7 002
Area F	Block 25	15 820
Total		74 713

4.1.1 United Nations Convention of the Law of the Sea

UNCLOS (also known as the Law of Sea) was drafted in 1982 replacing earlier United Nations led conventions on the sea as well as the “freedom of the seas concept”. As of 15 May 2011 it had been signed by 162 parties (mostly independent states and the European Union; ISA, 2012c). The law is overviewed by The Division for Ocean Affairs and the Law of the Sea within the United Nations. It deals with navigational rights, territorial sea limits, economic jurisdiction, legal status of resources on the seabed beyond the limits of national jurisdiction, passage of ships through narrow straits, conservation and management of living marine resources, protection of the marine environment, and marine research. Major issues, amendments and disputes are dealt with by the International Tribunal for the Law of the Sea (ITLOS).

The most notable non-signatory to the Law of the Sea is the United States of America which maintains its own deep seabed exploration and mining regulations.

Part XI of UNCLOS, and its subsequent Implementation Agreement of 1994, deals with mining of minerals from the seafloor outside of nationally regulated areas. The agreements provide a framework for countries and companies (with country sponsorship) to obtain legal title to areas of the seafloor from the International Seabed Authority (ISA) for the purpose of exploration and eventually exploitation of resources. The agreements also recognise the rights of the first pioneer contractors (Historic Consortia), those companies and countries that had invested significantly in deep ocean mining prior to the adoption of UNCLOS and the Implementation Agreement.

In the 1960s to 1980s and prior to the implementation of UNCLOS and formation of the ISA, explorers applied for and were granted exploration rights within their own country (state). The states then tried to minimise overlapping licences through a process of negotiation (e.g. between the United States, Belgium, Canada, the Federal Republic of Germany, Italy, the Netherlands, the United Kingdom and the USSR; NOAA, 1987).

4.1.2 International Seabed Authority

The ISA is an autonomous international organization established under UNCLOS and the 1994 Implementation Agreement. The ISA is the organization through which parties to the Law of the Sea shall, in accordance with the regime for the seabed and ocean floor and subsoil thereof beyond the limits of national jurisdiction established in Part XI, organise and control activities beyond the limits of national jurisdiction, particularly with a view to administering their resources.

The ISA, which has its headquarters in Kingston, Jamaica, came into existence on 16 November 1994, upon the entry into force of the 1982 Convention. The ISA became operational as an autonomous international organization in June 1996. Currently, the ISA has 162 signatories of UNCLOS as members and the United States of America has “observer” status. Legal recourse with the Law of the Sea by association the ISA is handled by the International Tribunal for the Law of the Sea in Hamburg (<http://www.itlos.org>).



Within the ISA is a function called the Central Data Repository (Kodagali, 2009). This function collects and stores data on marine deposits of all types within international waters. Much of the data is publically available, but other data is kept confidentially. This includes data supplied to the ISA by pioneer contractors under the 1994 implementation agreement and their respective exploration contracts, for the purposes of meeting various requirements, including those around the evaluation of the value of tenements for the purposes of returning ground to the reserved areas (section 4.1.3).

4.1.3 Reserved Areas and the Enterprise

A key principle of the Law of the Sea is that *“the seabed and ocean floor and the subsoil thereof beyond the limits of national jurisdiction, as well as its resources, are the common heritage of mankind, the exploration and exploitation of which shall be carried out for the benefit of mankind as a whole”*.

With this intent the ISA has issued regulations on Prospecting and Exploration for Polymetallic Nodules (adopted 13 July 2000), and Prospecting and Exploration for Polymetallic Sulfides (adopted 7 May 2010). Regulations for Prospecting and Exploration of Cobalt-Rich Crusts” are in draft.

Contracts of exploration for polymetallic nodules are granted for 15 years, and provide the Contractor with exclusive title and security of tenure in moving to a contract of exploitation. Regulations regarding the exploitation of polymetallic nodules have not yet been drafted, but it is noted that these will need to be consistent with the Law of the Sea.

The regulations allow for “pioneer” contract areas that initially comprise 150 000 km². Designation of pioneer contractor status is flexible in that prior rights are recognised to organisations descended from major explorers in the region that predate the formation of the ISA. Pioneer contractors are required to return 50% of their 150 000 km² of Exploration Area to the ISA to be administered by the authority as part of the Reserved Areas. The area returned must be of at least equal value to the area retained, based on assessment by the ISA.

The Reserved Areas exist to allow developing nations (or their sponsored companies) to apply for ground and to benefit also from the deep sea resource inventory. The ISA may also elect to manage the ground through its own mining organisation termed the Enterprise.

As detailed in Item 23, to date 12 contractors have been granted either Pioneer or Reserved Contracts of exploration for polymetallic nodules within the CCZ. One other consortium is recognised by the ISA to have historic rights.

4.2 TOML Obligations

The contract for exploration for polymetallic nodules conditions cover such areas as obligations of the sponsoring state, environmental obligations, marine scientific research, fees, and work programs.

4.2.1 Work Programme

A five year programme of activities is part of the contract for exploration for polymetallic nodules between the ISA and TOML:

- Year 1 involves compilation and review work.
- Years 2 and 3 involves cruises to evaluate the mineral resources to a higher standard and address the key modifying factors of environment, mining and other engineering, metallurgy and economics to complete a prefeasibility study.
- Years 4 and 5 a feasibility study.

TOML also has commitments to provide bursaries and scholarships and capacity building and training to Tongan nationals, nationals from other developing nations and ISA personnel.



4.2.2 Royalties and Taxes

Royalties and taxes payable on any future production from the property will only be finalised once the ISA has developed an 'exploitation code'. This was formally proposed as a project by the Secretary General of the ISA and endorsed at the 17th Annual Session of the ISA. Any code will need to include the key principles of UNCLOS.

TOML has agreed to a royalty with the Tongan government of US\$1.25 per dry ton of nodules for the first 3 million dry tons of nodules mined in any one year and US\$0.75 per dry ton for all dry tons mined thereafter in that same year.



ITEM 5. ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

5.1 Accessibility and Infrastructure

Access to the CCZ is essentially only achieved by medium to large ocean going vessels.

Climate in the region of the CCZ is largely warm equatorial, moving northwards into lower temperate zones. An environmental review for the OMCO historic consortia (NOAA, 1984) indicates that:

- Prevailing winds are easterly all year round
- Predominant swell direction is from the east to northeast due to trade-wind influences, wave height and period probability are shown in (Figure 5-2)
- Tropical cyclone season is generally from May to October with peak frequency from July to September.

Prevailing currents change seasonally and with El Nino-La Nina events but generally are gentle (Figure 5-1).

The CCZ is outside major shipping lanes as shown in Figure 5-3.

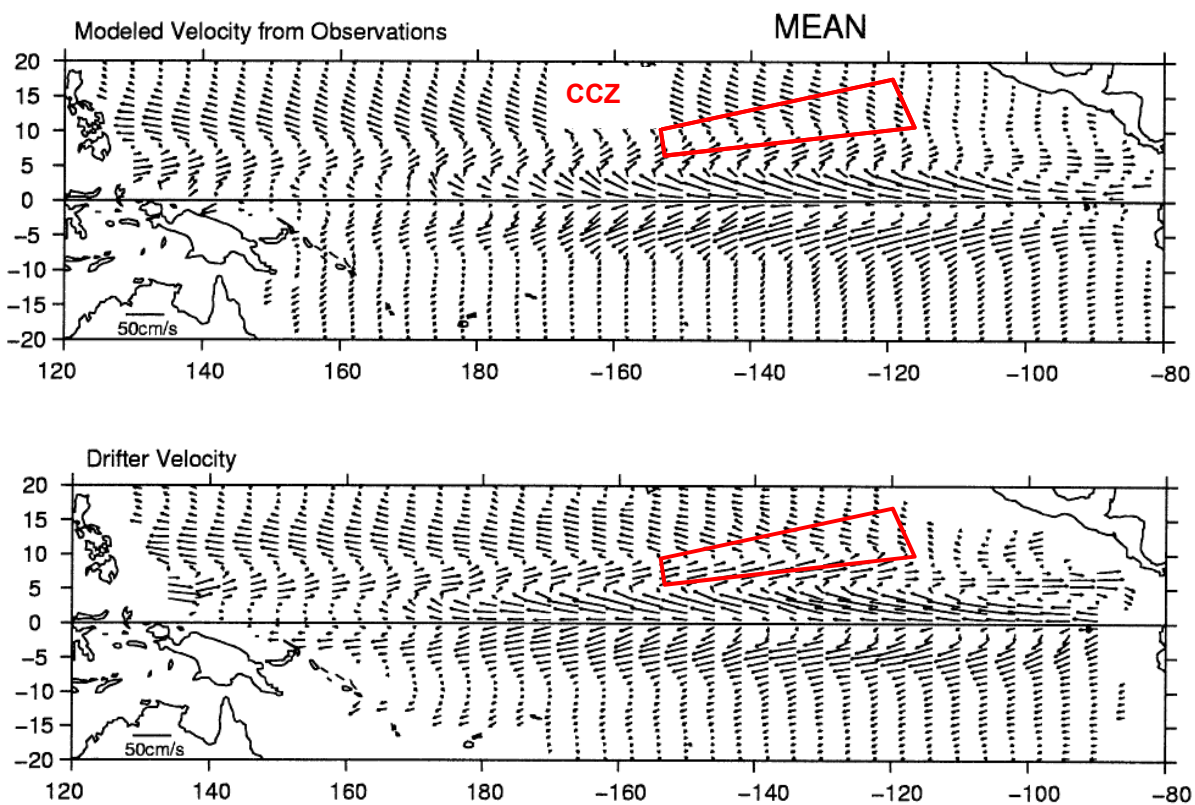


Figure 5-1: Mean Diagnostic Surface Current Velocity Relative to the 30 m Depth Surface Layer and Drifter Velocity (15 m sub-surface) for the Central Pacific (Modified from Bonjean and Lagerloef, 2002).



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

Per 100000 waves source: Global Wave Statistics (Area 45) compiled by Metocean for TOML

Sig Hgt (m)	569	12956	83278	208476	269367	216911	123904	55020	20289	6521	1894	1000000
> 14							1	1	2	2	1	
13 to 14							1	1	1	1	1	6
12 to 13						1	2	2	2	2	1	11
11 to 12						1	3	4	4	3	2	18
10 to 11					1	3	6	8	7	5	3	32
9 to 10					2	7	13	15	13	8	5	63
8 to 9				1	7	21	36	39	30	18	9	162
7 to 8				6	35	94	140	137	97	54	25	590
6 to 7			3	44	220	503	659	571	363	182	76	2622
5 to 6			29	342	1405	2721	3060	2307	1290	576	216	11947
4 to 5		6	270	2482	8126	12851	12036	7684	3690	1432	473	49050
3 to 4		77	2248	14994	36987	45414	33875	17593	7002	2289	646	161125
2 to 3	5	811	14312	62200	105325	92690	51355	20410	6381	1675	387	355549
1 to 2	89	5696	47330	109935	109092	60473	22327	6190	1399	273	48	362852
0 to 1	475	6365	19086	18471	8166	2131	391	57	7	1		55148
	< 4	4 ~ 5	5 ~ 6	6 ~ 7	7 ~ 8	8 ~ 9	9 ~ 10	10 ~ 11	11 ~ 12	12 ~ 13	> 13	
	Zero Crossing Period (s)											

Figure 5-2: Wave Height Probabilities around the CCZ (Metocean, 2012 internal report submitted to TOML).

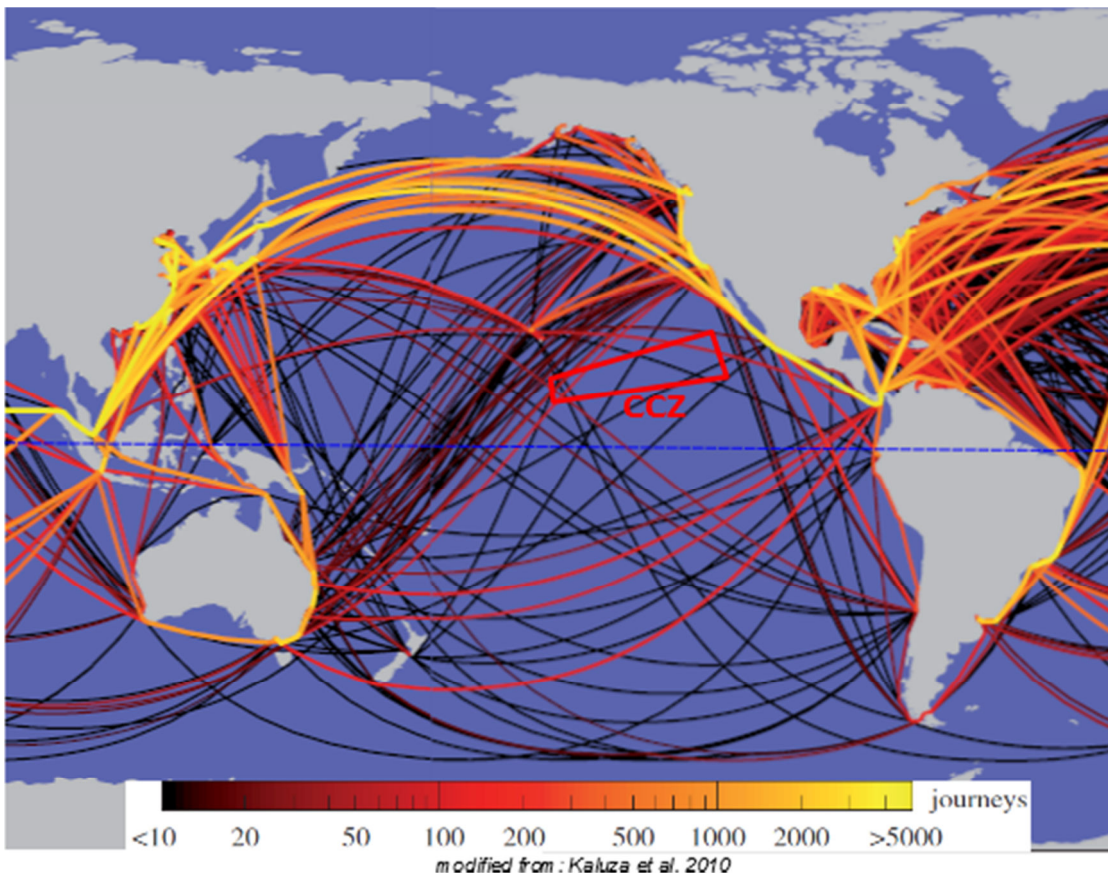


Figure 5-3: Ship Movements Through the Pacific Coloured on Journeys per Annum (Modified from Kaluza et al., 2010).

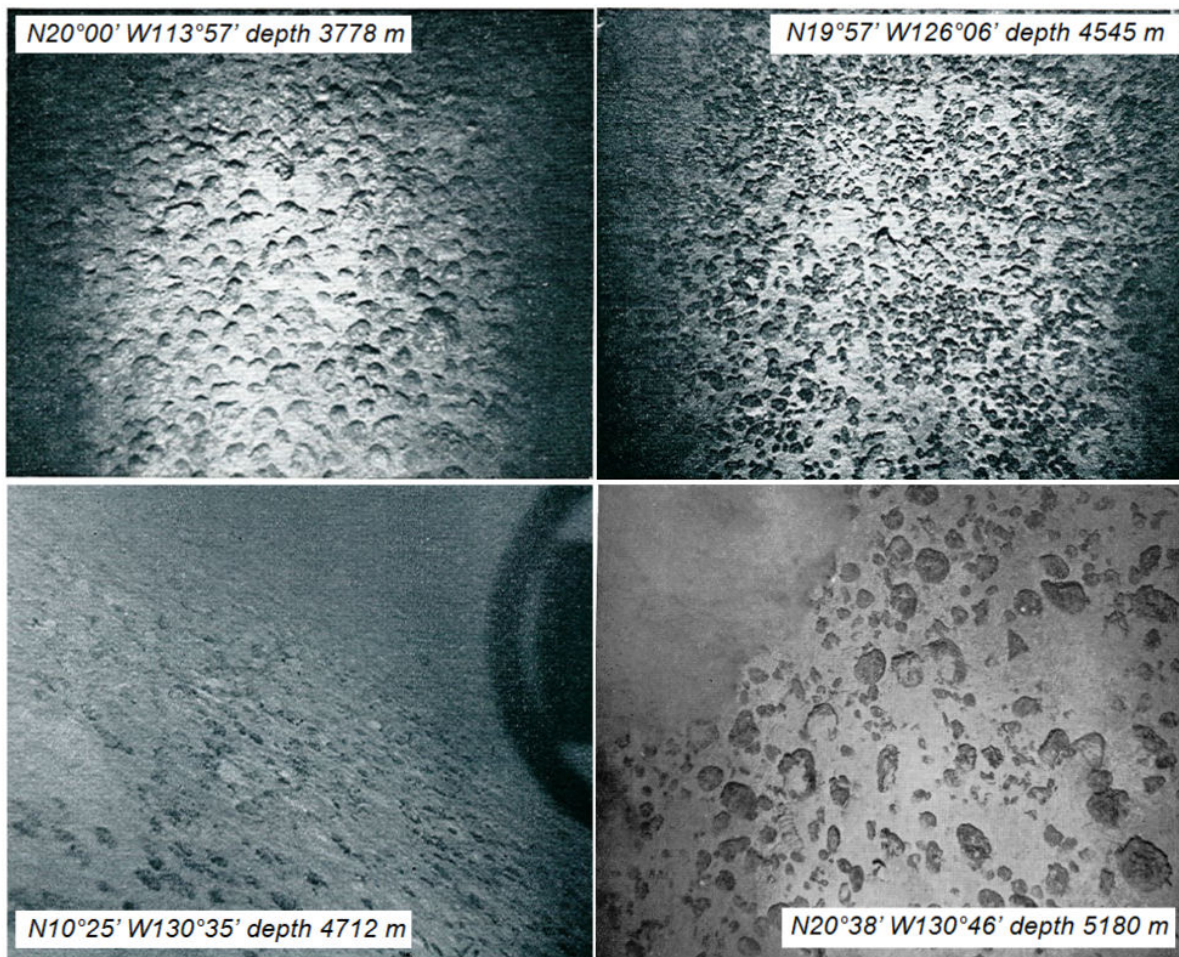


ITEM 6. HISTORY

6.1 Overview

Polymetallic nodules were first discovered in the deep sea by the British *HMS Challenger* expedition in February 1873 in the Atlantic Ocean off the Canary Islands. The expedition recovered nodule samples in 50 of the 343 seabed sample stations surveyed by the ship, located in the South and North Atlantic and Pacific Oceans and in the Southern Indian Ocean and the China Sea (Murray and Renard 1891). This clearly established the widespread nature of these deposits on the deep ocean floor.

The first commercial interest in deep seabed polymetallic nodules was sparked by a book titled “Mineral Resources of the Sea” that included the first spectacular photos of nodules from around the world (Mero, 1965; Figure 6-1). Based on less than 100 samples collected from the CCZ, Mero predicted the occurrence of many millions of tons of deposits with nickel and copper concentrations each greater than 1% and manganese and cobalt concentrations, respectively, greater than 30% and 0.25%.



source Mero (1965)

Figure 6-1: Photos of Nodules from the Clipperton Zone, Nodules are 1 to 10 cm in Diameter (Mero, 1965).

Based partially on Mero’s predictions, and also on the consistent rates of increase in metal market prices between 1926 and 1970 (e.g. for nickel, \$41 per metric ton (t) per year, constant 1998 US dollars), several private industry and government-sponsored efforts to develop these resources were undertaken in the 1970s to 1990s. Many hundreds of millions of dollars (1970s US dollars) were committed by several parties to development ventures.



These efforts successfully tested several small-scale mining systems in the CCZ. These system tests evaluated the performance of several towed and self-propelled collection and mining devices, along with air-lift technology for lifting the nodules from the deep ocean floor to the test support vessel. Hundreds of tons of polymetallic nodules were recovered in these tests.

Participation in these early ventures is the way most of today's pioneer contractors qualify in terms of expenditure and survey area commitments. Somewhat independently, the Government of India undertook nodule exploration in the area within the central Indian Ocean, and was granted an exploration contract by the ISA in 2002.

Between 1976 and 1986 the market value of nickel plunged from \$14 200/t to \$5 770/t (1998 constant US dollars), shattering the economic models and business plans for the development of these seabed resources (e.g. Hoagland, 1993). From establishment of the ISA in 1994 until 2006, the active pioneer contractors, were all state supported and maintained their ISA rights but did not commit to aggressive development programs.

On 19 July 2006 the Federal Institute for Geosciences and Natural Resources (BGR) of the Federal Republic of Germany signed a contract with the ISA, since then five new exploration contracts have been granted to state trusts or commercial companies with state sponsorship (Nauru, Tonga, UK, Kirabati and Belgium).

A chronological summary of the history of discovery and exploration of the CCZ includes:

1868-76	Seafloor polymetallic nodules discovered in the Kara Sea by the Swedish expedition <i>Sofia</i> (Ingri, 1985) and off the Canary Islands by the British expedition of the <i>HMS Challenger</i> (Seibold, 1978).
1891	"Dredgings" by the <i>Challenger</i> between Tahiti and Valparaiso discover "most interesting" polymetallic nodules (Murray and Renard, 1891). This was confirmed by the 2 nd American <i>Albatross</i> expedition of 1899/1900 (Hoffert, 2008; Margolis and Burns, 1976).
1947/48	Swedish expedition of the <i>Albatross</i> reportedly recovers nodules (UNOETO, 1979).
Late 1950s-1960s	Interest in the exploration and potential exploitation of the nodules grows e.g. Mero (1965)
1970	United Nations Assembly declares the bed and ocean floor beyond the limits of national jurisdiction to be the common heritage of mankind.
1970s early 1980s	Several mining consortia were formed (and reformed) at various times during this period (more details in the section below on the Historic Consortia) This activity culminated in the trial mining or bulk sampling of nodules by two of these consortia in the mid to late 1970s.
1972-82	The United States led International Decade of Ocean Exploration (IDOE) from 1972 to 1982. During this period some 30 to 40 US, 26 German, and 42 French cruises as well as Soviet and Japanese programs were completed.
1973	Deep Sea Drilling Project produce first surface sediment map of the CCZ illustrating WSW to ENE strike of key sediment types i.e. from north to south: red clay, argillaceous-siliceous and siliceous-argillaceous oozes (that form nodules), calcareous ooze (ISA, 2010).
1982	UNCLOS (United Nations Convention on the Law of the Sea) is signed. Refer to Item 4.
Mid 1980s	Activities stop or slow due to a combination of low metal prices and critical gaps in technology Johnson and Otto (1986), Hoagland (1993).



1987-1993	Seven state sponsored entities register for Pioneer Exploration Contracts (refer Item 23). They all start exploration and environmental baseline work.
1994	United Nations Convention on the Law of the Sea is implemented establishing the International Seabed Authority (ISA) to manage international waters. The ISA starts operating autonomously 2 years later.
2001-2005	The pioneer contractors relinquish 50% of their holdings into the ISA reserved areas. United States of America registered pioneer contractor Exploration Areas remain within the Enterprise, pending resolution of status.
2000-2010	With input from the historical consortia and pioneer contractors, the ISA publishes a series of technical reports on the geology, prospectivity and environmental aspects of the CCZ
2006-2012	Other entities (including TOML) begin applying for exploration contracts with five granted to date (Item 23).

6.2 The Historic Commercial Consortia

Unless indicated otherwise, this section is summarised from Hoffert (2008) and NOAA (1987). In addition to these commercial consortia, the Soviets and the French are known to have done CCZ wide nodule exploration in the 1970s.

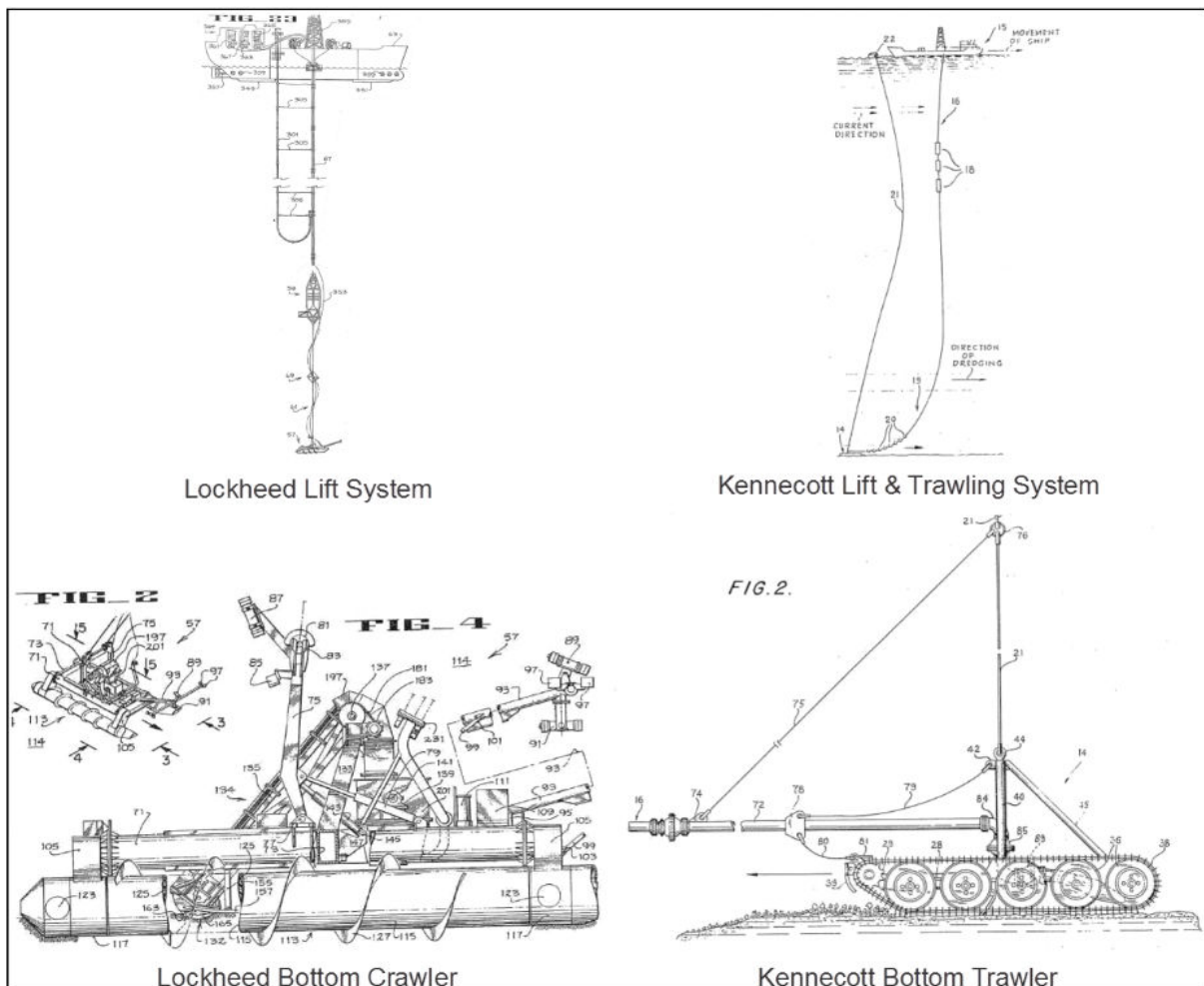
6.2.1 Kennecott Consortium (KCON)

KCON was formed in January 1974 by Kennecott, Noranda, Consolidated Gold Fields and Mitsubishi, subsequently RTZ. BP Petroleum Development Ltd. subsequently also joined the consortium. In 1993, KCON abandoned exploration licences which had been granted by the UK and U.S. governments and the consortium was dissolved.

This consortium tested various components of a commercial mining system within the CCZ, including a towed nodule pick-up system (Figure 6-2; Morgan, 2011), a hydraulic lift system, and various transport and metallurgical processing systems.

6.2.2 Ocean Mining Associates (OMA)

OMA was formed in October 1974 by subsidiaries of Tenneco, U.S. Steel, ENI and Union Minière. Its principal exploration group was Deepsea Ventures, Inc., which operated out of Virginia, USA. OMA tested an integrated mining system that was monitored for environmental impact assessment by the US Government National Oceanographic and Atmospheric Administration. They succeeded in recovering a few hundred tons of nodules with parts of their test system.



source Morgan (2011)

Clockwise from top left: hydraulic collector (8 final models underwent sea-trials); Sedco 445 vessel (with gyro-stabilised “Hydra-Rig” derrick); overflow of nodules from conveyors; schematic of system. Source Brockett et al. (2008)

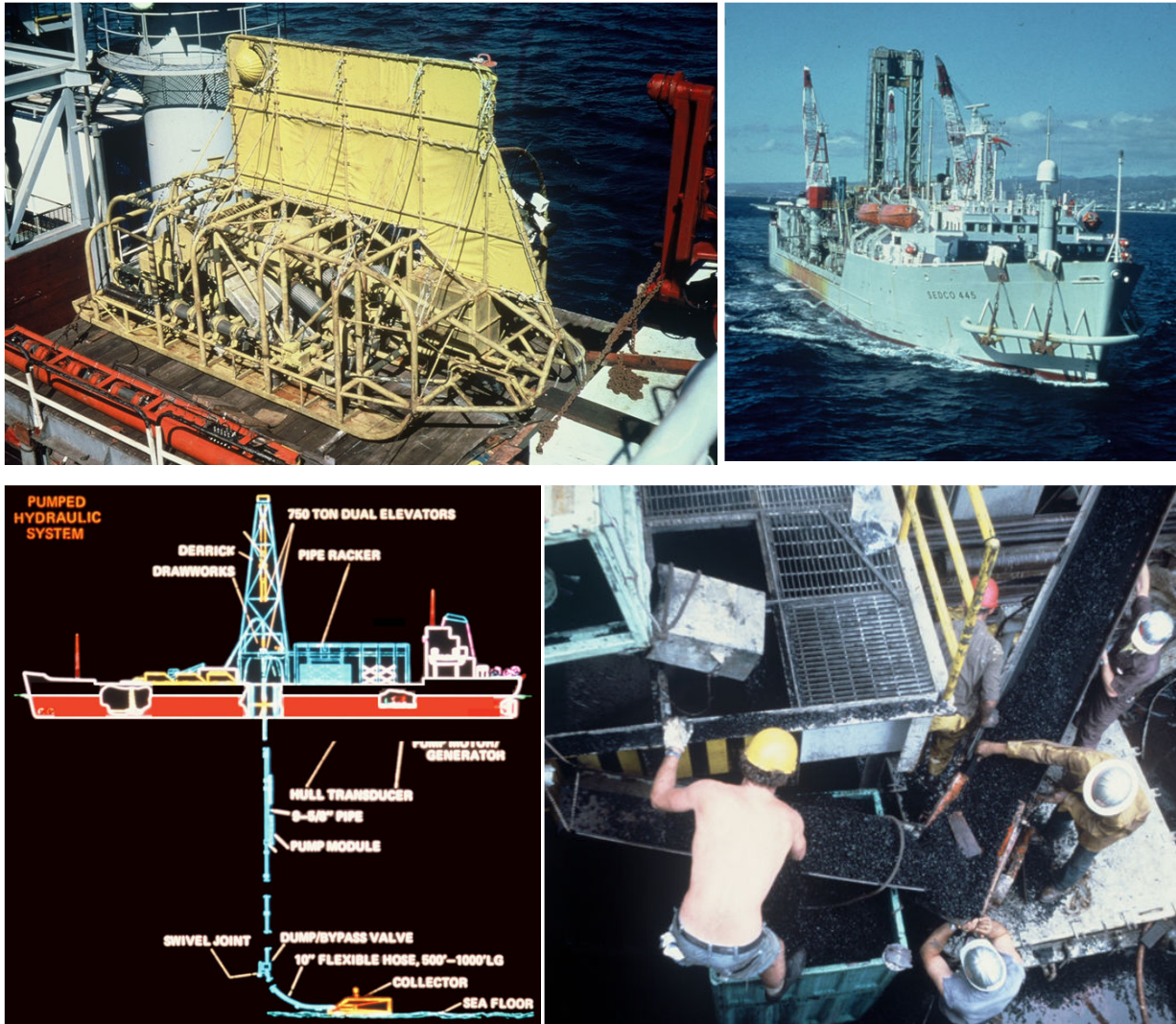
Figure 6-2: Lockheed and Kennecott Trial Miners and Lift Systems (Morgan, 2011).

6.2.3 Ocean Mining INC. (OMI)

OMI was formed in May 1975 by roughly equal partners:

- AMR (Arbeitsgemeinschaft Meerestechnisch Gewinnbare Rohstoffe: comprising Metallgesellschaft AG, Preussag AG and Salzgitter AG),
- INCO (Inco Limited),
- DOMCO (Deep Ocean Mining CO, Ltd. Itself a venture of some 20 Japanese companies including Sumitomo); and
- Schlumberger Technology Corporation.

This consortium trial mined 800 t of nodules from a depth of approximately 5 500 mbsl in 1978 (Figure 6-3) the only known successful fully integrated trial. Nickel, copper and cobalt were extracted in both pyrometallurgical and hydrometallurgical trials.



Clockwise from top left: hydraulic collector (8 final models underwent sea-trials); Sedco 445 vessel (with gyro-stabilised “Hydra-Rig” derrick); overflow of nodules from conveyors; schematic of system.

Figure 6-3: Trial Mining of Nodules by the OMI Consortium (Brockett et al., 2008).

6.2.4 Ocean Minerals Company (OMCO)

From origins within Howard Hughes Summa Corporation in the late 1960s and early 1970s, OMCO was formed in November 1977 by Lockheed Missiles and Space Company, Royal Dutch Shell, Amoco (Standard Oil), Billiton and Bos Kalis. In 1986 Cyprus Minerals Co. assumed Amoco’s interest in the venture. Late in 1995 Lockheed took over the other interests and effectively replaced OMCO.

Lockheed Martin still holds exploration and mining rights under US law, the only notable exception to the ISA. Their original rights were added to when they acquired the rights abandoned by KCON in 1993 (Item 23). Lockheed Martin has also acquired an Exploration Area (located north of TOML Exploration Area F) from the ISA.

The OMCO consortium collected thousands of free-fall grab and box core samples of nodules from their claim area (Spickermann, 2012), culminating in a trial mining exercise in 1978. Lockheed’s design efforts resulted in over eighty patents, a seafloor production system that consists of a collector (Figure 6-2 and Figure 6-4) and crusher, a seafloor to surface slurry riser system, the first industrial scale dynamic positioning system for a vessel and a metallurgical processing plant (Spickermann, 2012).

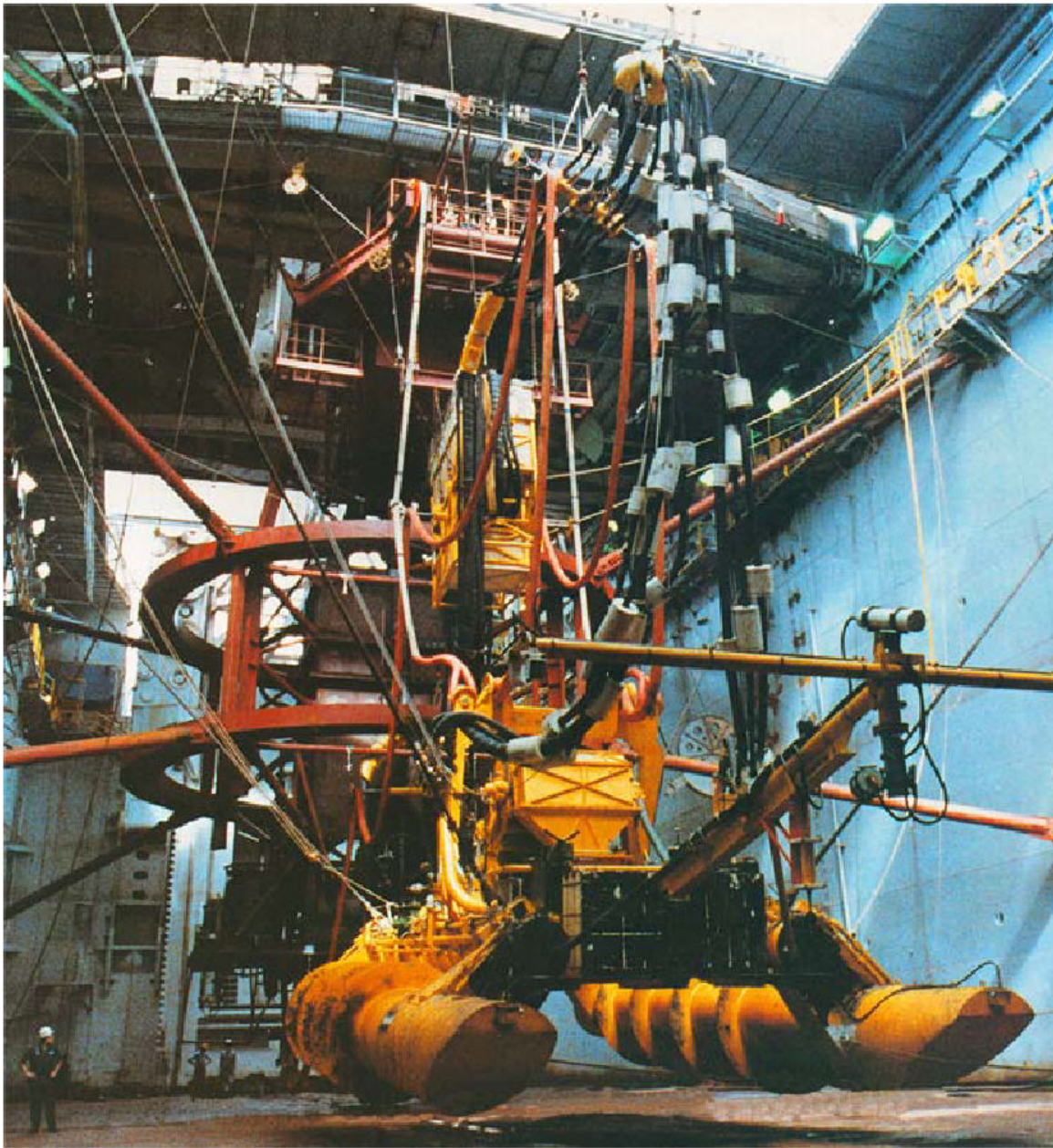


Figure 6-4: 100 ton Lockheed Martin Trial Miner on the Glomar Explorer in 1978 (Source Spickerman, 2012).



ITEM 7. GEOLOGICAL SETTING AND MINERALISATION

7.1 Global Distribution of Nodules

Polymetallic nodules with various grades of base metals are found in distinct zones in submarine settings worldwide (ISA, 2000). The geology of formation likely varies as the settings vary widely, e.g. from about 4 000 to 6 000 m depth in the mid Pacific to about 200 m depth in the Gulf of Bothnia (Bostrom, Wiborg and Ingri, 1982) and these variances are reflected in part in nodule chemistry (e.g. Fe:Mn ratio). The consistently highest base-metal grades and often highest abundance of nodules are found in the CCZ (Table 7-1).

Table 7-1: Summary of Global Nodule Grades (McKelvey et al., 1983)

Element	All Pacific	Pacific outside CCZ	CCZ	Atlantic	Indian
Mn wt%	20.1	18.8	26.3	13.3	15.3
Fe wt%	11.4	12.8	6.6	17.0	14.2
Ni wt%	0.76	0.63	1.20	0.32	0.43
Cu wt%	0.54	0.41	0.98	0.13	0.25
Co wt%	0.27	0.29	0.20	0.27	0.21

7.2 Tectonic Setting and Topographic features within the CCZ

7.2.1 Tectonic Elements

The CCZ is defined by two major WSW-ENE trending fracture zones, the Clipperton to the south and the Clarion to the north. There are at least three similarly oriented fracture zones further north in the Pacific (Figure 7-1), as well as the internally located (and much less well expressed in the bathymetry) Mahi-Mahi fracture Zone (ISA, 2010). The eastern and western limits can be defined by the Mathematician Seamounts or Ridge in the east (a fossil spreading centre west of the east pacific rise), and the Republic of Kiribati or Line Islands in the west (a line of seamounts along a fracture zone highly oblique to the Clarion and Clipperton Fracture zones).

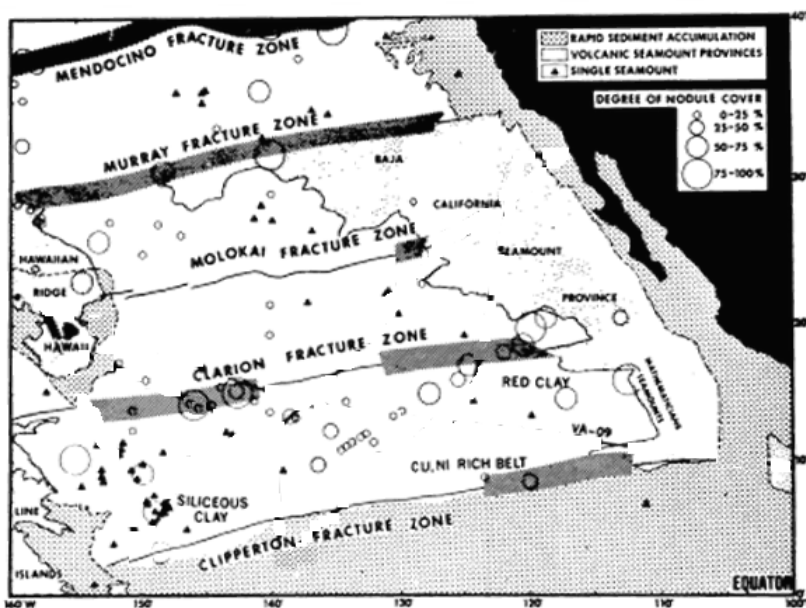


Figure 7-1: Regional Seafloor Structure, Sediment Type and Degree of Nodule Cover as of 1976 (Margolis et al., 1976).



The ocean floor within the CCZ ranges in age from 10 to 100 million years younging from west to east (Figure 7-2), with growth from the east Pacific rise to the WSW but current plate motion to the WNW.

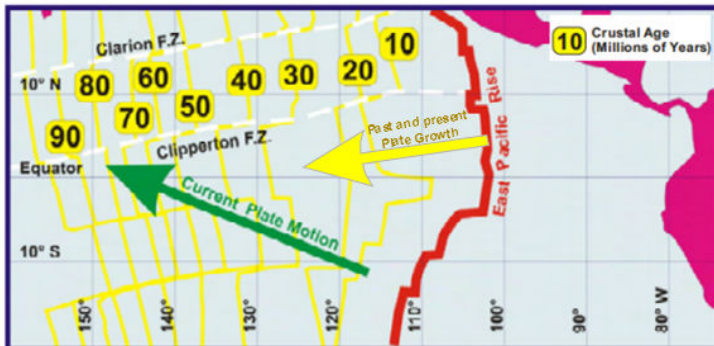


Figure 7-2: Ocean Floor Age and Motion (ISA, 2003).

Volcanic seamount distribution in the CCZ in some locations at least is clearly controlled by fracture zones.

7.2.2 Seafloor Topography

Definition of the topography is important as it likely will help constrain abundance of nodules on the regional scale as well as the style of mining that needs to be employed (i.e. through slope angles and swath width and length). There is a close relationship between topography and tectonics within the CCZ.

Within the CCZ there is a gradual increase in water depth to the seafloor from the east (approximately 4 200 m) to west (approximately 5 000 m). This change is a consequence of the sinking of older and cooler oceanic crust in the west.

A series of “Bathymetric Regimes” can also be defined as shown in Figure 7-3, of which the “Abyssal Hill Province” contains the largest concentration of nodules. Within each regime, publically available detailed bathymetric coverage of the CCZ is patchy (TOML do not have any detailed bathymetry for its Exploration Area), and there appears to be a variety of geomorphological forms for the seafloor but the most common form is of gently crenulated ridges (Abyssal Hills).

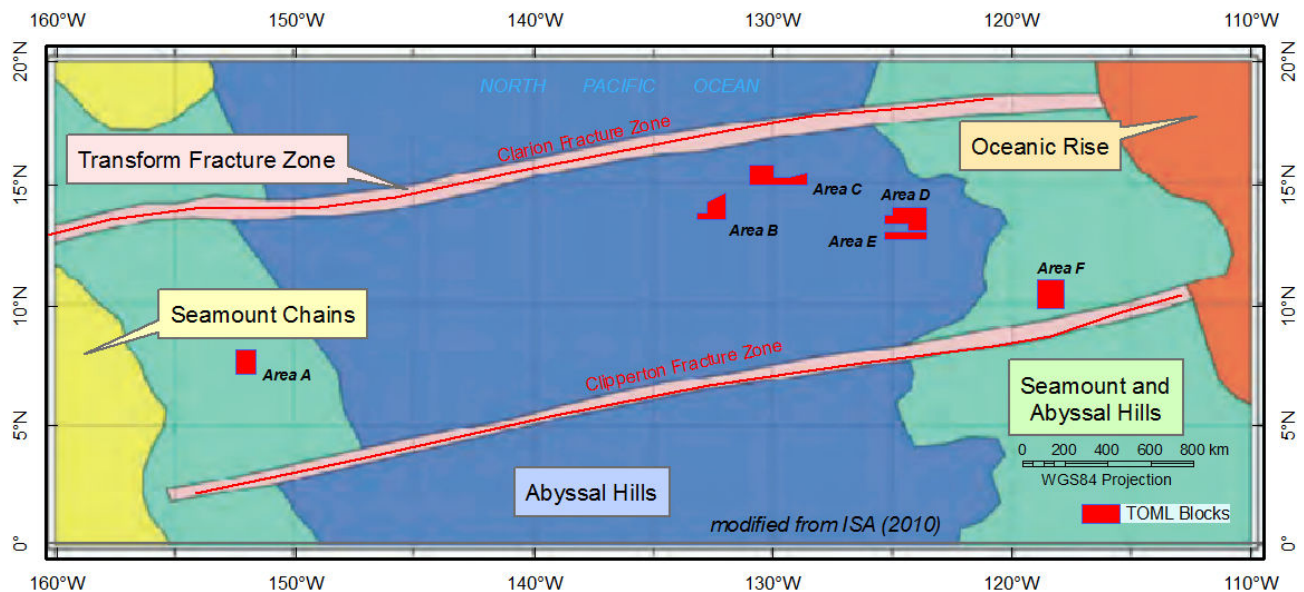


Figure 7-3: Bathymetric Regimes in the CCZ (modified from ISA, 2010).



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

The crenulated ridges are believed to have formed from the process of seafloor spreading, having slight variations in spreading rate (and associated pressure fronts), magma effusion and cooling related subsidence. Within the central CCZ they are typically oriented parallel to the plate segments; i.e. the ridges obvious in Figure 7-4 and the segments in Figure 7-2. Orientation is NNW-SSE (locally $\pm 20^\circ$) with amplitude of 50 to 300 m (maximum 1000 m; Hoffert, 2008) and wavelength of 1 to 10 km (detailed examples outside of the TOML Exploration Areas in Figure 7-4, Figure 7-5). A simple relationship between topography and surface abundance on nodules has not been established, probably because of other overriding factors (e.g. net sedimentation as a result of currents and earthquake related slumping). However, volcanic seamounts and ridges and fault escarpments are much less prospective for consistently abundant nodule occurrence (COMRA, 2010). Nodules are also found on the flanks of seamounts; these are commonly smaller with higher Fe and lower Mn, Cu and Ni due to proportionally more active hydrogenetic processes (section 8.1.2; Figure 8-4).

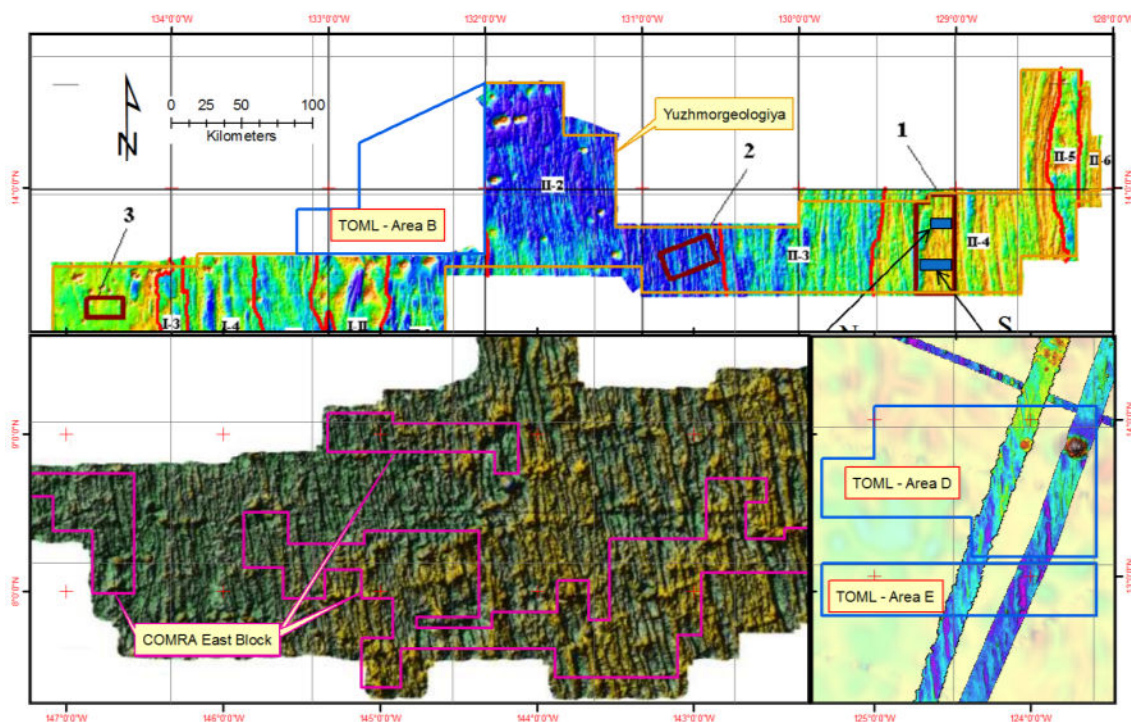


Figure 7-4: Semi-Detailed Bathymetry for the Yuzhmorgeologiya (Melnik and Lygina, 2010) and COMRA East Block (COMRA, 2010), (ISA, 2010) with Single Track Surveys for Comparison. The TOML Exploration Areas D and E are on a Smith and Sandwell Product (ISA, 2010) but the Track Surveys Suggest a Commonly Crenulated Topography (TOML, 2012).

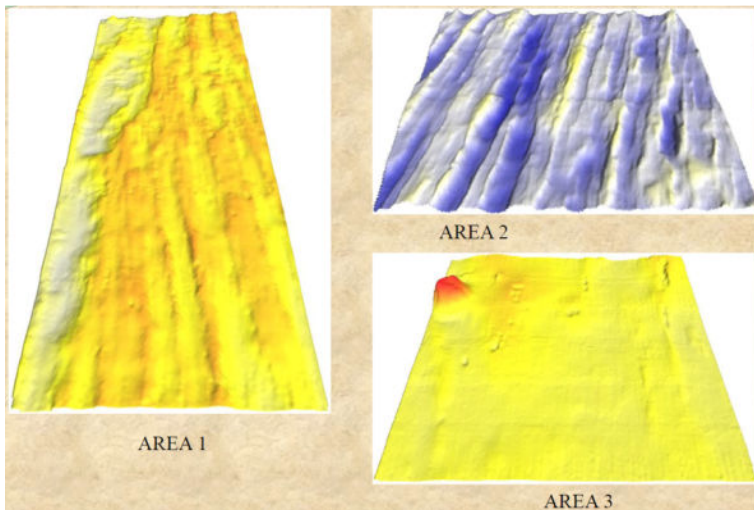


Figure 7-5: Example detailed Bathymetry for the Three Boxes within the Yuzhmorgeologiya Area in Figure 7-4 (scale of view as per Figure 7-4 (Melnik and Lygina, 2010).

Other geomorphological forms include plains, sea-mounts (Figure 7-4, Figure 7-5) and in some places E-W volcanic ridges that might be 'seams' along fault systems in parallel to the main Clarion and Clipperton fracture zones. Sub vertical fault scarps of up to 70 m have also been reported parallel to the crenulated ridges (Melnik and Lygina, 2010; Hoffert 2008).

Two topographic domain can be defined in the CCZ:

- *Abyssal hill province* characterizes most of the CCZ and these areas are expected to have relatively continuous nodule abundances.
- *Sea mount ranges* are interspersed (Figure 7-6) and these areas are expected to have relatively variable nodule abundance due to erratic sedimentation on and near the sea mounts due to steep slopes coupled with higher local currents (Kuhn et al. 2011, Ruhlemann et al. 2011). Some nodules in these areas will also have a higher hydrogenetic component

Based on GEBCO bathymetry (ISA 2010), all of the TOML Exploration Area is interpreted to be abyssal hill province as shown in Figure 7-6, There are individual seamounts but these are isolated and comprise approximately 2% of the total area (Figure 7-7).

Within the abyssal hill province there is no evidence to suggest that local topography plays a material role in global nodule abundance. There are three lines of evidence for this:

- The slope of the hills (<20%) is typically insufficient to affect sediment and nodule repose
- A geostatistical simulation study by Chautru et al (1987) included topography and very detailed sampling failed to show any strong correlation
- In the experience of the QP (Davey Banning) basalt and sediment escarpments are rare and any effect would be small (typically on the scale of 2-4 m).



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

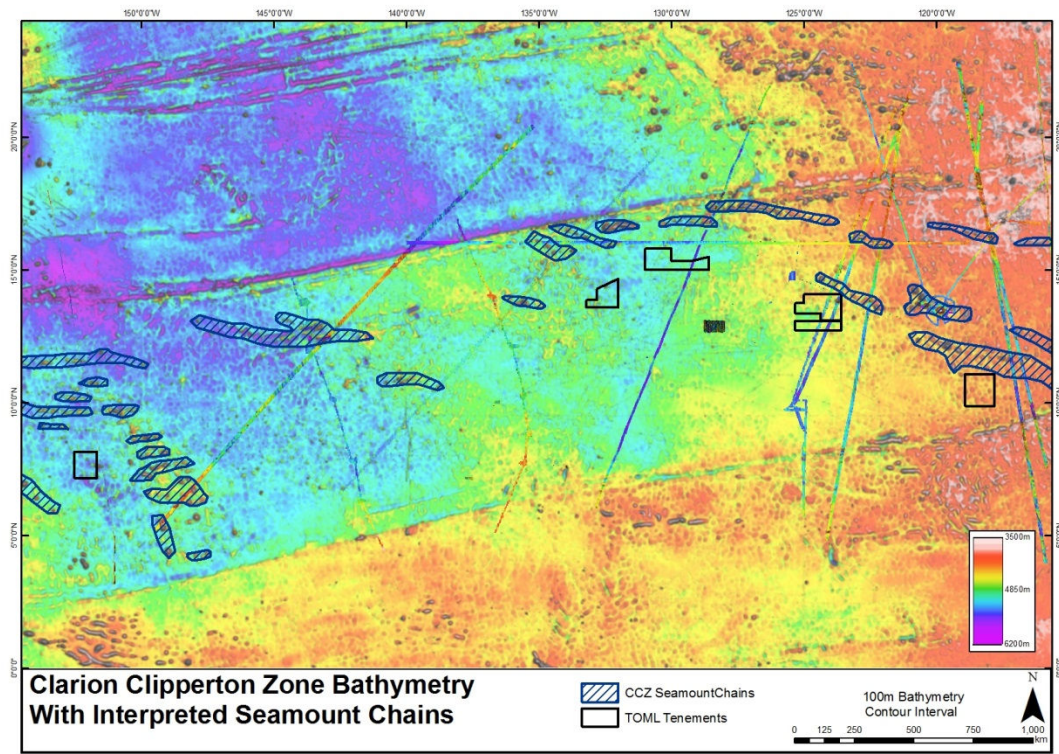


Figure 7-6: GEBCO Bathymetry Showing the Extent of Seamount Chains Relative to Abyssal Hill Province

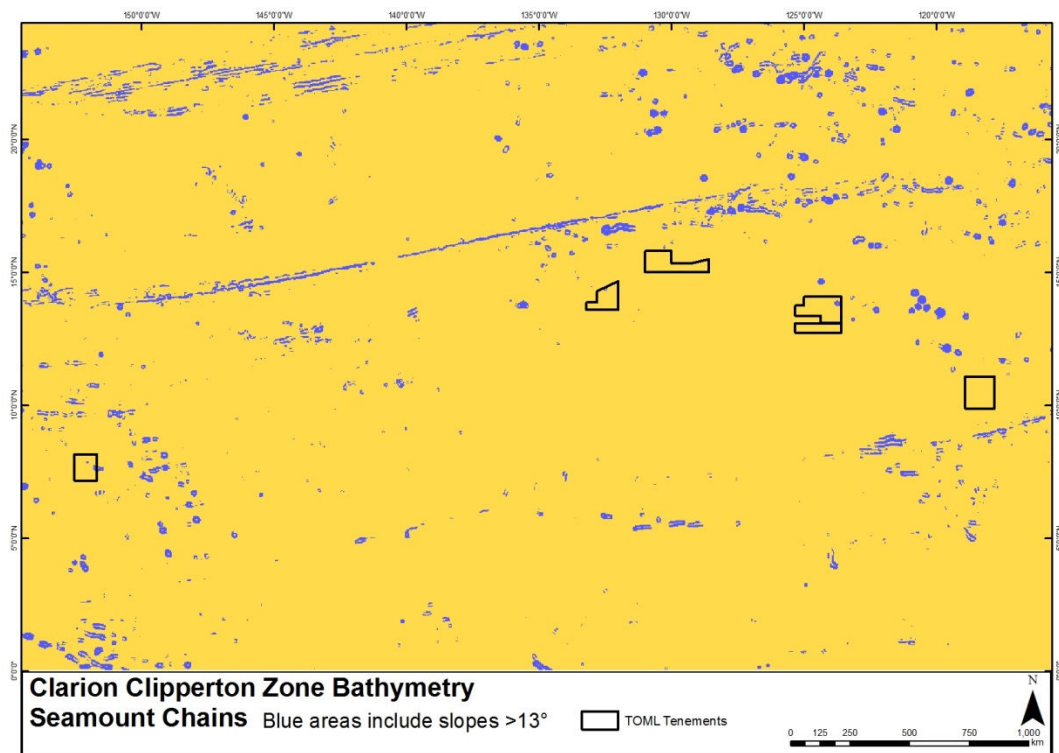


Figure 7-7: GEBCO Bathymetry Showing Areas with Bathymetry Slopes Greater than 13° in Blue



7.2.3 Currently Proposed Formation Mechanisms

Formation of the very high grade and relatively high abundance of nodules in the CCZ results from a complex interplay of factors as discussed in this and subsequent sections.

Attempts by McKelvey et al. (1983) to correlate on a global basis metals such as Ni, Cu and Co with Mn, Fe, water depth and latitude had only very limited success, suggesting that either long-lived local metal sources and/or clay minerals in the host sediments (that 'compete' for the metals) are the key influence(s).

Transport of the metals to the seafloor is illustrated in Figure 7-8. In the case of the CCZ the California and Humboldt (Peru) currents are thought to transport plankton to the north equatorial and equatorial currents that in turn carry them to the CCZ (refer also Item 7). Details of the chemical and bio-chemical processes that lead to metal transfer is not discussed. However, the processes are interpreted to involve:

- Precipitation of metals from seawater
- Remobilization of manganese in the water column
- Derivation of metals from hot springs associated with volcanic activity
- Decomposition of basaltic debris by seawater
- Precipitation of metal hydroxides through the activity of micro-organisms.

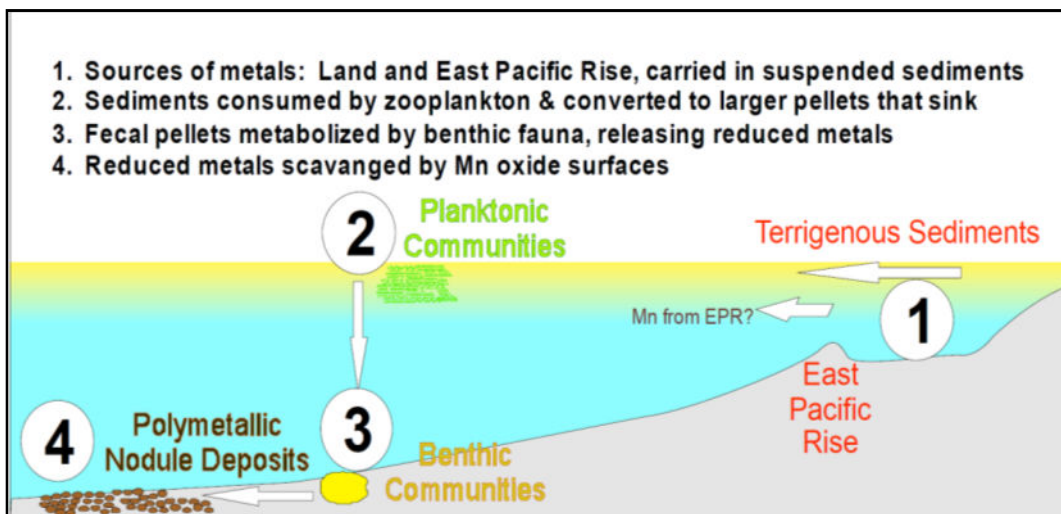


Figure 7-8: Formation Model for Polymetallic Seafloor Nodules (ISA, 2010).

7.2.4 Role of Sediment and the Carbonate Compensation Depth

The CCZ covers a major regional transition in sediment type (e.g. Kotlinski and Stoyanova, 2006; Hoffert, 2008; ISA, 2010; Ju et al., 2010). This is the transition between the red pelagic seafloor clays of the northern Pacific (sourced largely from windblown dust from central Asia; Futterer, 2006) and the carbonate sediments of the central and southern Pacific (Figure 7-9).



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

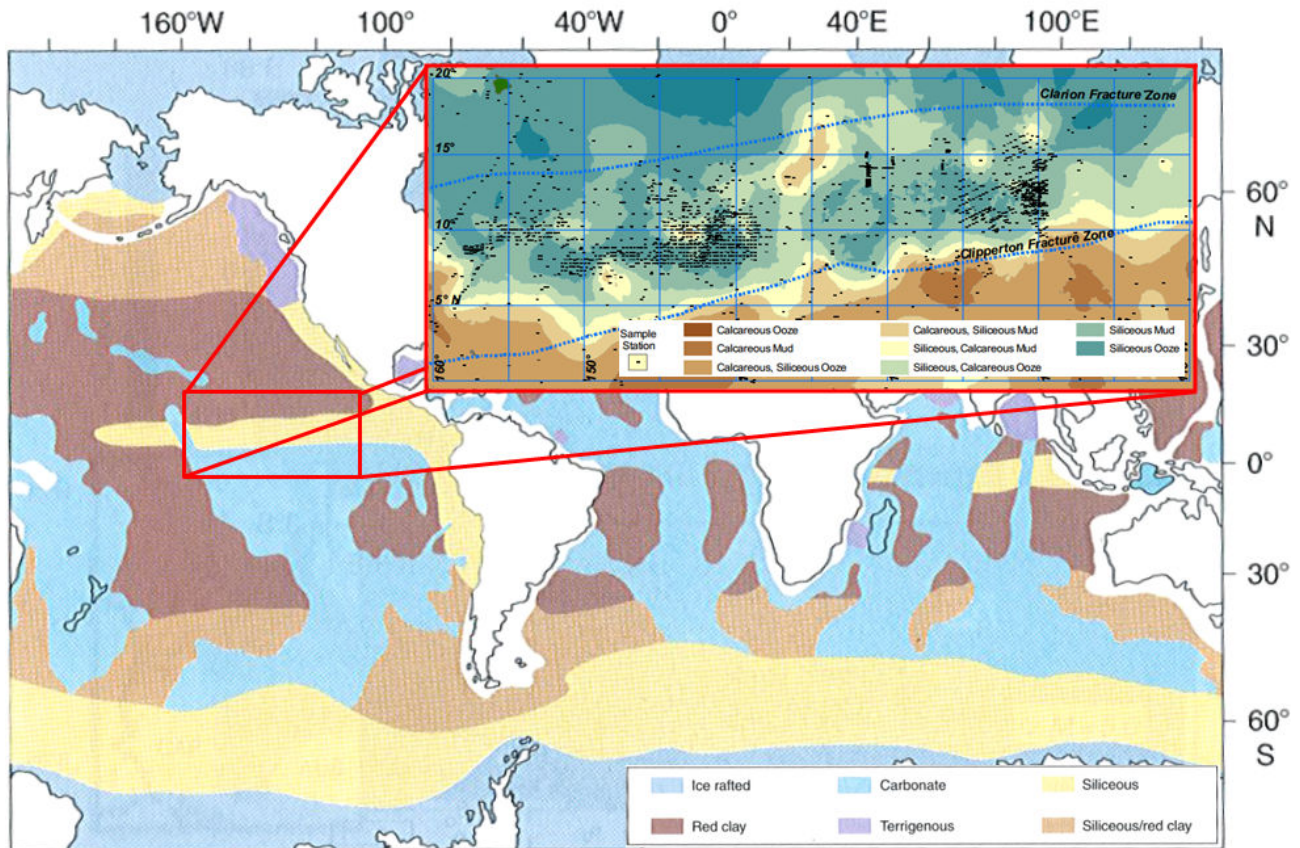


Figure 7-9: Global (Futterer, 2006; Mukhopadhyay et al., 2008) and Regional (ISA, 2010) Seafloor Sediment Maps.

This transition appears to be primarily a function of latitude and water depth (ISA, 2010), with the elevated and effectively acidic CO_2 content of deeper waters overwhelming declining carbonate production with the increase in latitude from the equator and defining the effective southern limit of the Carbonate Compensation Depth (CCD); or in quantitative terms effectively <20% calcareous sediments.

The results of sediment coring by a number of parties indicate that the transition zone has vertical variability as the position of the CCD has not remained constant over time (e.g. Kotlinski and Stoyanova, 2006; presented in Figure 7-10).

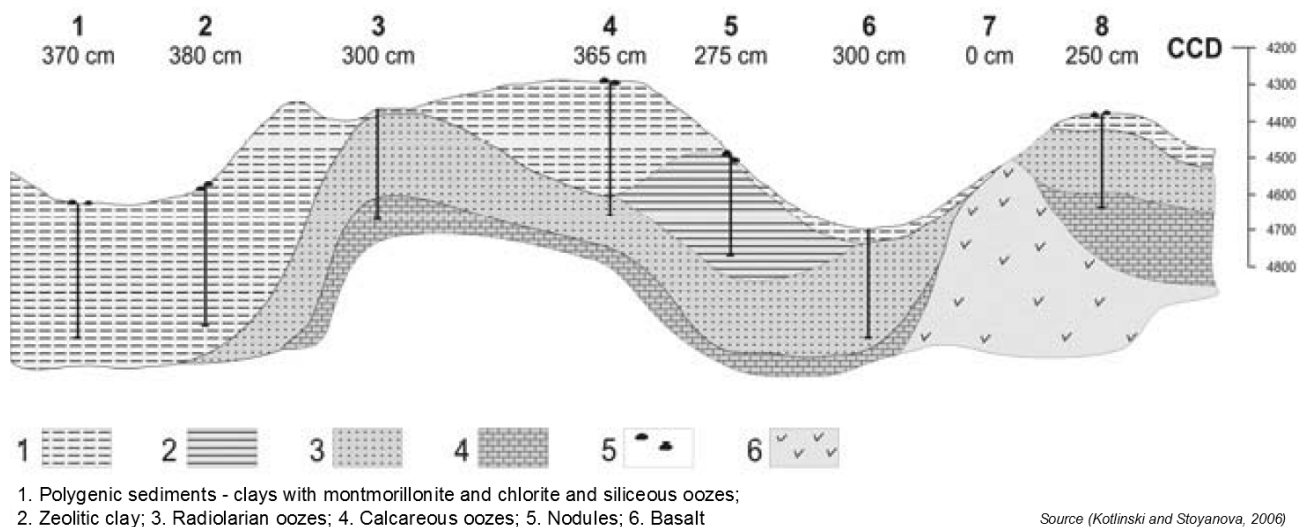


Figure 7-10: Schematic of Vertical Distribution of Sediment Types Within the IOM Exploration Area (Kotlinski and Stoyanova, 2006).

A general increase from east to west in depth of the contact between overlying siliceous ooze and carbonates is thought to reflect ocean floor growth over geological time (Sclater, Anderson, and Bell 1971). Another distinctive feature is a basin wide mid Miocene disconformity (ISA, 2010) that may reflect the Langhian Middle Miocene Disruption and glacial event perhaps in association with closure and opening of the Drake Passage (von Stackelberg and Beiersdorf, 1991).

A simple relationship between sediment composition and nodule abundance does not appear to exist. The highest abundance of nodules occur in partly siliceous sediments and not in the calcareous sediments. However, siliceous-calcareous muds host higher abundances (Figure 7-9) than purely siliceous oozes (ISA, 2010). There is some evidence that the majority of nodule formation commences during local hiatuses in carbonate formation (von Stackelberg and Beiersdorf, 1991) although the nodules can survive and even grow during carbonate forming periods (some nodules containing distinct layers of carbonate and siliceous microfossils).

7.3 Mineralisation

Data on the mineralisation within the TOML Exploration Area is restricted to widely spaced FFG (free-fall grab sampler) and BC (box core) data supplied by the ISA at the time of application (see below and Item 14). There are more useful data on a regional basis assembled by the ISA as part of their Geological Model Project compiled over 2008 to 2010 (ISA, 2010). For some reason, this model was not built using data supplied to the ISA in 2005 by the German government (ex-OMI member Preussag) as part of a registered pioneer contractor application. This additional data includes significant coverage over the eastern side of the CCZ near TOML Exploration Area F and indicate good grades and at least locally high abundance of nodules in this region.

7.3.1 Variation in Nodule Grades

Within the CCZ nodule field chemistry varies only slightly compared to mean nodule grades from other basins elsewhere in the world (Table 7-1). The strongest trend is observed for Mn and Cu, which both increase towards the SE (Kazmin in ISA, 2003; ISA 2010; Morgan 2009; see Figure 7-11). The reason for this is not clear but may relate to proximity to metal sources from the East Pacific Rise or the American continents.



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

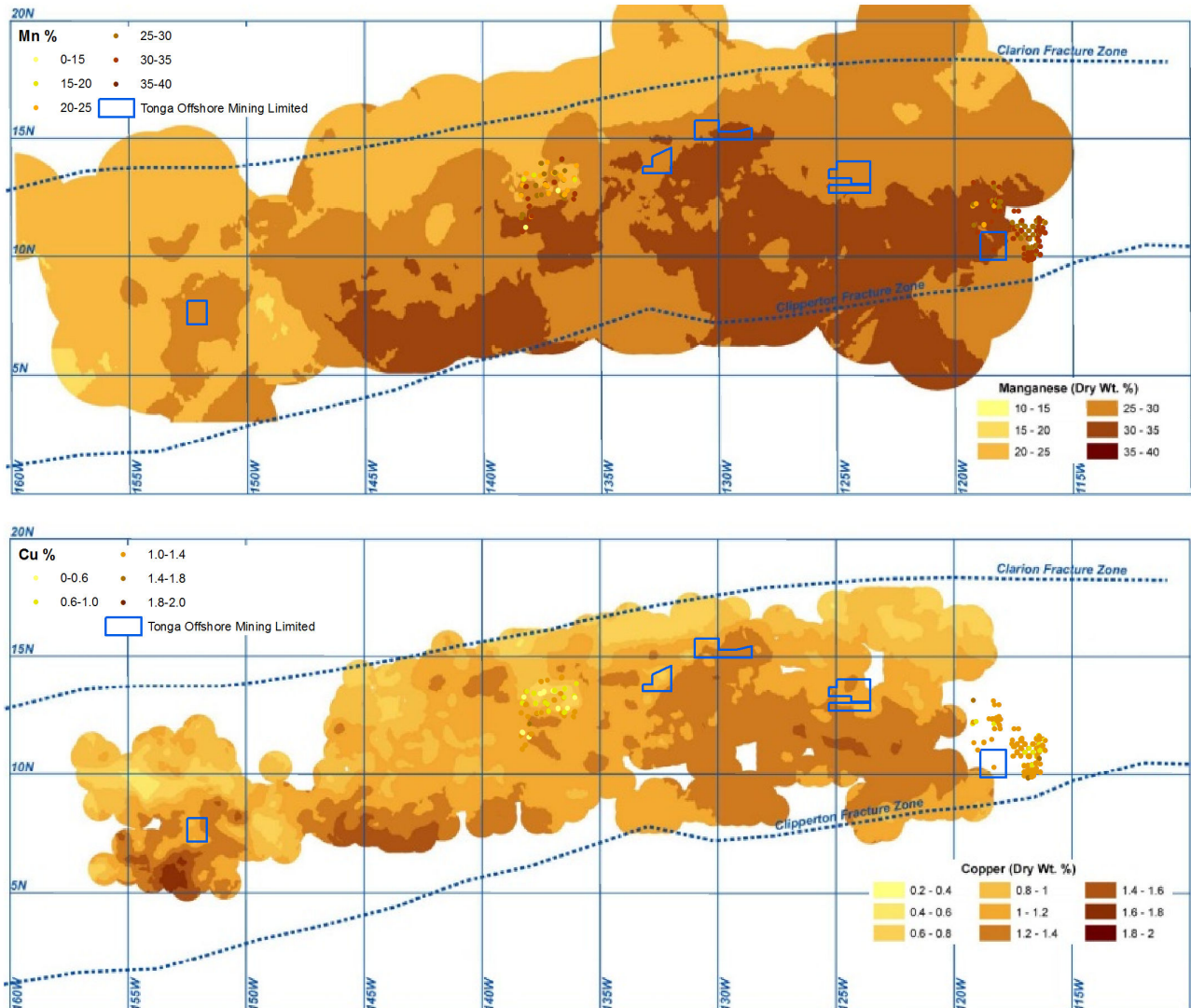


Figure 7-11: Modelled Mn and Cu Grades in Nodules across the CCZ (Morgan, 2009), point data attributed to OMI.

In contrast, Ni and Co partly correlate along the central axis of the CCZ (Figure 7-12), with the Co appearing to be offset to the north from the Ni. The reason for the distribution of these metals is unknown, but may relate to a lack of competition for the metals in the sediments, which have both lower chlorite and lower smectite in this region (Futterer, 2006).

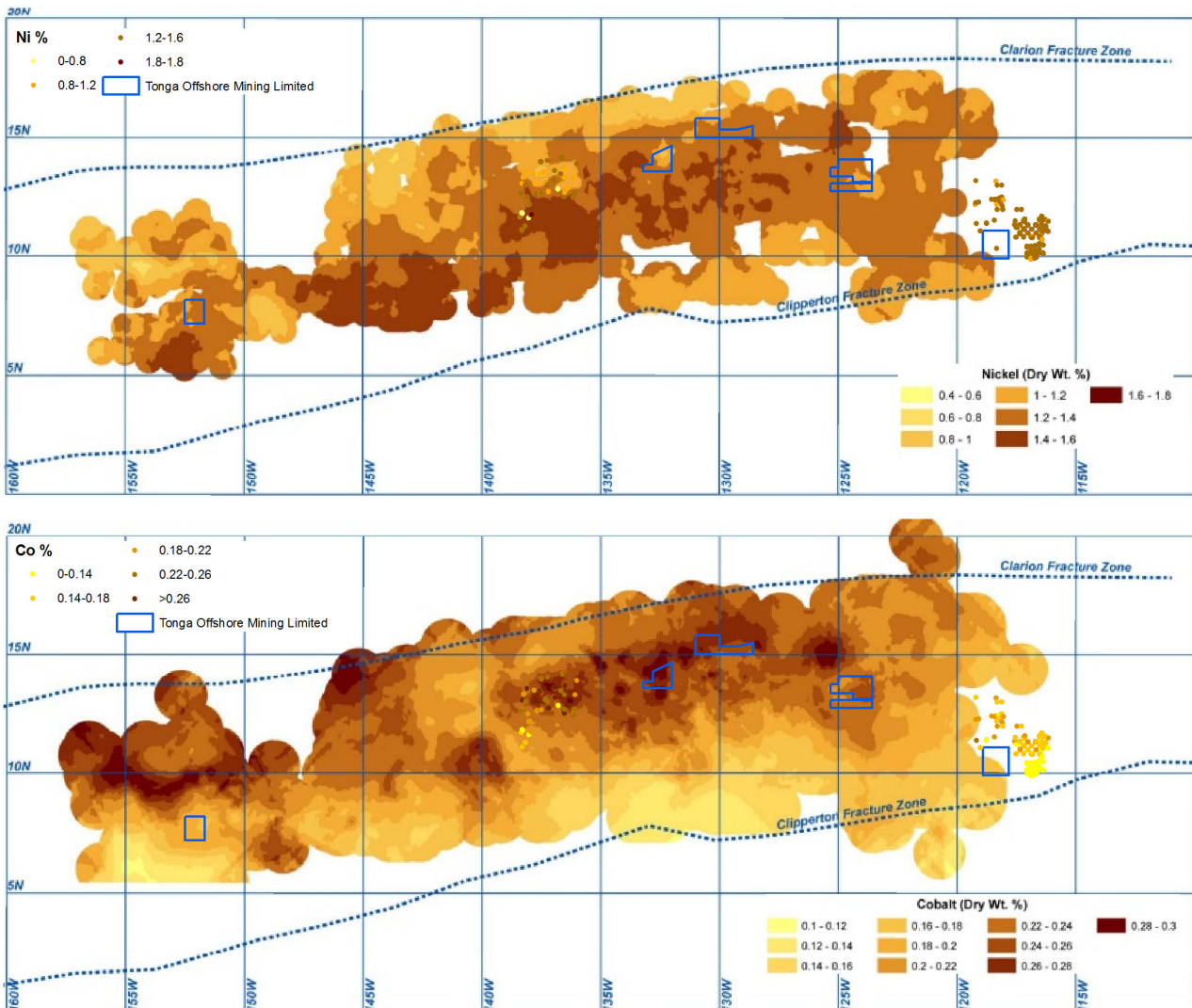


Figure 7-12: Modelled Ni and Co Grades in Nodules across the CCZ (Morgan, 2009), point data attributed to OMI.

The nodule grades of Ni, Cu, Co and Mn in the data supplied to Golder from the ISA pertaining to the TOML Exploration Area compare closely to the nodule grades illustrated above for the greater CCZ deposit. The grades also compare closely with mean grades published by a range of other independent parties as shown in Table 12-1.

7.3.2 Grades of Other Metals

Grades for elements other than Mn, Ni, Cu and Co are not available for any of the nodule sample results from within the TOML Exploration Area. However, it is likely that grades of other elements are broadly similar to those reported from elsewhere in the CCZ. A study by McKelvey, Wright and Bowen (1983), does not separate out grade from the CCZ but presents average grades for nodules with Ni+Cu >1.8%, the bulk of which come from the CCZ. These can be summarised as:

- Other base or alloy metals such as Zn (0.14%), Mo (0.039%), Ti (0.58%) and Pb (0.071%)
- Rare earth and other transition metals such as Sr (0.077%), Y (0.012%), Zr (0.050%), Te (0.021%), La (0.019%), Ce (0.066%) and Nd (0.023%)



- Possible deleterious elements or reagent consumers and enhancers such as F (3%), Mg (1.57%), Al (2.96%), Si (8.26%), S (0.319%), Cl (0.860%), Ca (1.73%), As (0.012%), and Ba (0.224%)

These levels of metals are supported in some cases (Zn, Mo) by data presented by Haynes et al. (1985), who also report very limited data on Au and PGMs (all at the ppb level except Pt which averaged 0.1 ppm from 5 samples).

The Rare Earth Element (REE) contents of nodules within the historic Lockheed Martin Exploration Area were recently determined (Spickermann, 2012). This area is adjacent to TOML Exploration Areas B, D, and E. Total REE are about 0.08% with a median of 617 ppm light REE (La-Eu) and 788 ppm heavy REE (Gd-Y). If similar REE grades occur within the TOML Exploration Area, then at current market prices, the value of the REE, if extractable, could be of an equivalent level to the Ni+Cu+Co. Further work is recommended to determine the quantity and recoverability of additional metals.

7.3.3 Nodule Abundance

A key feature in the vertical distribution of nodules in the CCZ is that the majority appear to be located either on the seafloor or immediately below it (<30 cm from the surface; Item 8). This feature means that effectively estimating nodule abundance and nodule mining (or collecting) is a two dimensional problem. To date this is how all of the workers in the CCZ have worked on the question of nodule abundance.

Nodule abundance is estimated either by:

- Taking a sample from the seafloor and dividing the weight of nodules by the area of the primary sampler (Item 9.2); or
- Using a sonar or photographic method to estimate percentage coverage of the seafloor by nodules and converting this to abundance using calibration factors (e.g. as used by COMRA; ISA, 2010). Ruhlemann *et al.* (2011) discuss some of the issues with this approach for example the interplay between nodule size, nodule abundance and response to acoustic surveys (e.g. backscatter).

All of the nodule miners/collectors known to have been designed to date (Items 6 and 24) also follow similar principles by scraping, sucking, plucking or jetting nodules off the seafloor (\pm semi-liquid layer; Figure 8-3).

In theory, an alternative method more commonly used in land based deposits is to derive a three dimensional model involving volume and density. This has a number of inherent problems:

- Depth of penetration of the samplers is usually not measured, and the relative depth of the semi-liquid layer versus the clay layer is usually not measured. Thus these would have to be estimated or assumed to a low degree of certainty.
- The order of the depth is trivial i.e. approximately 1×10^{-5} that of the inter-sample distance that is (i.e. 0.1 to 0.3 m against 10 to 30 km spacing).
- Densities of the sediment would need to be estimated or assumed, again to a low degree of certainty.
- It is unlikely that the proportion of sediment is critical in any mining/collection operation, as the nodules would be screened from any adhering sediment on the seafloor and the sediment returned immediately, while the nodules were lifted to the surface. Speed over ground for the collector, nodule size and wet density of the nodules are the factors that most likely would drive the fundamentals of a collection and transportation system (Items 6 and 24).

Nodule abundance is typically reported in wet kg/m^2 for similar reasons.

- Wet weights are the most relevant in any collecting and transport operation.



- Often the nodule samples had multiple uses, some were for assay, others for metallurgical test work and some for reference (the latter being a requirement in the ISA polymetallic nodule exploration contract regulations).
- Weighing of the samples at surface is the simplest and most effective way to measure and compare nodule abundances between different cruises and between the different contractors (given variations in processing and equipment; Item 9). Conversely there is very likely to be limited variation in wet density of nodules (Figure 8-6).

As also discussed in Item 9 samples were dried, crushed and pulverised before assaying. Using “dry” weight percent assays on “wet” weight inventories is a commonly accepted practice for similar bulk commodities (e.g. iron ore or Ni-Co laterite).

Data analysis in Item 9 shows that nodule abundance variability is significantly higher than metal grades, suggesting that abundance estimation will be the key variable of uncertainty in mineral resource estimation. Figure 7-13 shows evidence of this compared to Figure 7-11 and Figure 7-12. However at a large scale, regional variations in abundance are consistently estimated by independent sources, for example as shown in Figure 7-14.

There is little data on local-scale variability from the CCZ and even less from the TOML Exploration Area (Figure 14-5 and Figure 14-6) but continuity can be assumed. Much more work will be required to define any high confidence (Indicated or Measured) mineral resource estimate, and will be required for detailed mine planning. The key control is likely to be local net sedimentation rates (via erosion and deposition due to the interplay of topography, earthquake, benthic currents, and related slumping; Item 7.2.4).

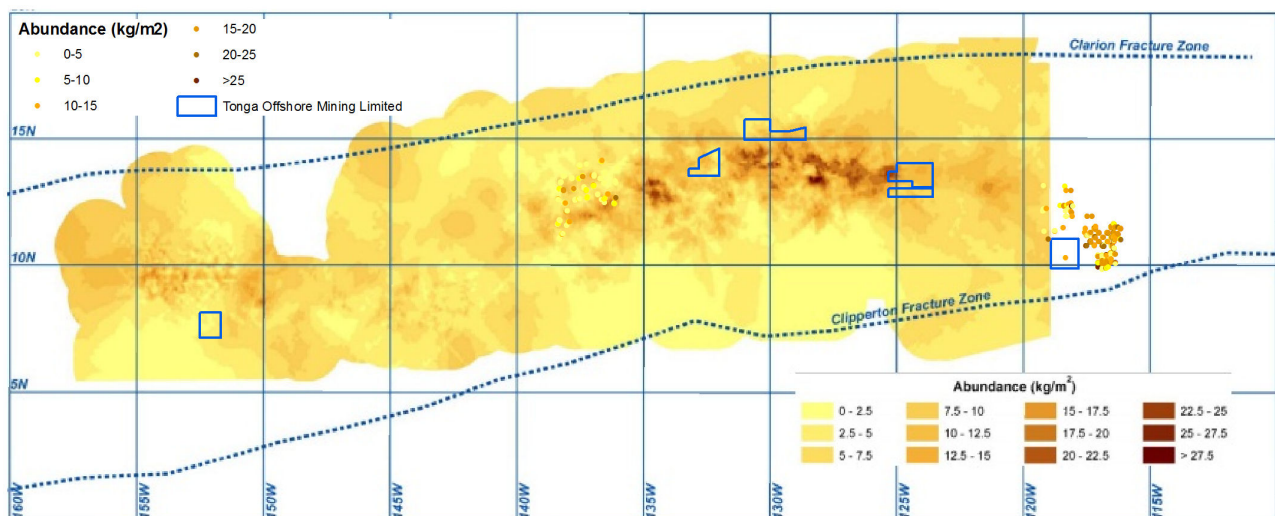


Figure 7-13: Modelled Nodule Abundance across the CCZ (Morgan, 2009), point data are attributed to OMI.

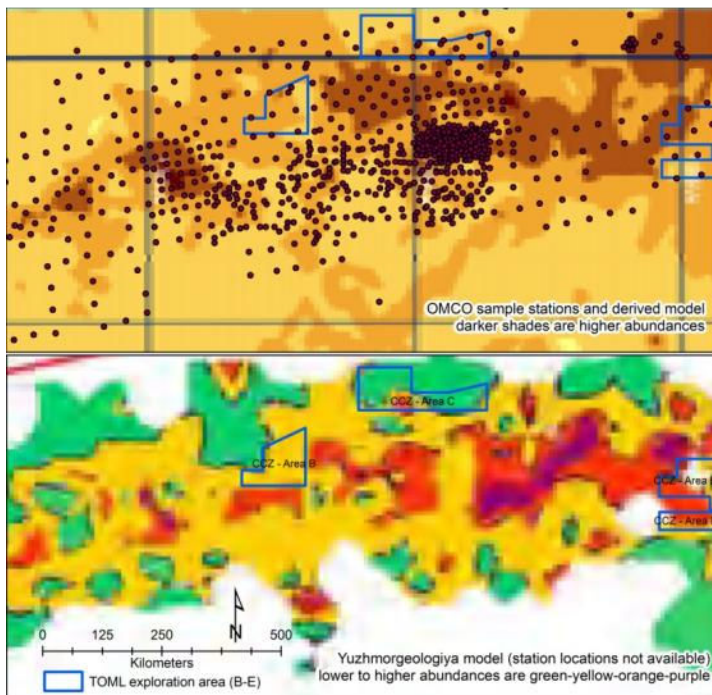


Figure 7-14: OMCO and Yuzhmorgeologiya Abundance Models across the Central CCZ (modified from ISA, 2003).



ITEM 8. DEPOSIT TYPES

Surface and near surface polymetallic seafloor nodules are the only deposit type considered in this report. Other types of mineralisation possible within the “greater” CCZ include:

- Nodules buried at depths greater than 0.3 m (effective limit of samplers used to date in the CCZ; Lee et al, 2008).
- Co rich crusts (are located on seamounts in the CCZ as found over extensive areas in the western Pacific; von Stackelberg and Beiersdorf, 1991).
- Seafloor Massive Sulphide (SMS) deposits (are possible along fracture zones and seamounts and are widespread along the Eastern Pacific Rise located several hundred km to the east and SE of the CCZ).

8.1 Polymetallic Seafloor Nodules

8.1.1 Nodule distribution

Nodules lie on the seafloor sediment, often partly or in some instances completely buried (Figure 8-1 and Figure 8-3). They vary greatly in abundance, in some cases touching one another and covering more than 70% of the seafloor. They can occur at any depth, but the highest concentrations have been found on abyssal plains between 4 000 and 6 000 mbsl.

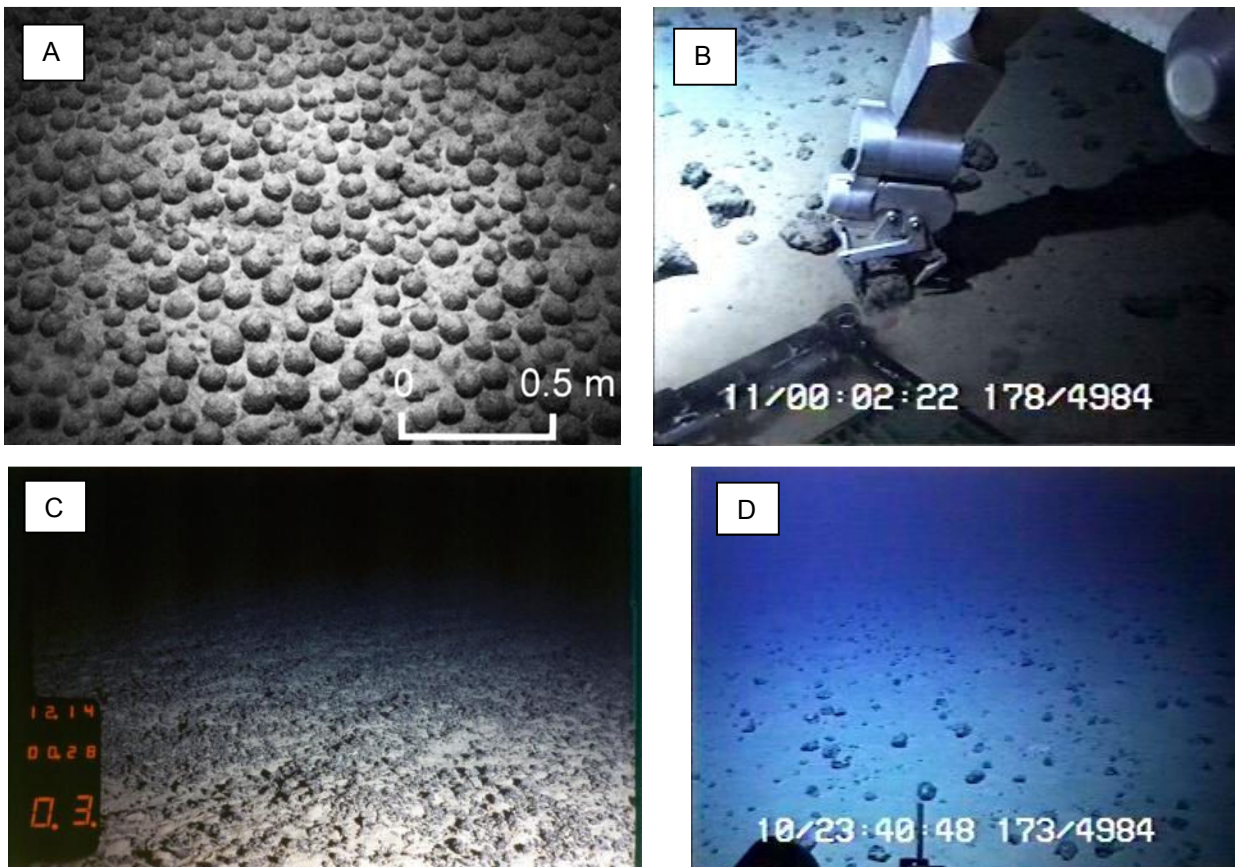


Figure 8-1: Nodule Pavement at Depth Within or Near the CCZ the Nodules Shown are Typically 5-10 cm in Diameter (photo A from Brockett et al., 2008; photos B-D from Beaulie, 2012).



Some nodules are buried although the frequencies of such subsurface occurrences are very poorly defined. (Kotlinski and Stoyanova, 2006) document up to five discrete layers of buried nodules, although all were within 45 cm of the surface despite using sediment cores of 250 to 380 cm depth; i.e. all of these nodules are 'near surface'. Other images of box corers (e.g. Figure 8-2) also suggest that all or most of the nodules are at the surface.



Figure 8-2: Undisturbed Nodule-sediment SYMPAS Box Core Sample (MNHN, 2006).

8.1.2 Nodule morphology and formation

A variety of nodule classification systems are known to have been used (e.g. von Stackelberg and Beiersdorf, 1991; Haynes et al., 1985) but the three class system of (ISA, 2010) prevails today (Figure 8-3). According to their texture they are:

- S-type (smooth type)
- R-type (rough type)
- S-R-type (smooth-rough mixed type)

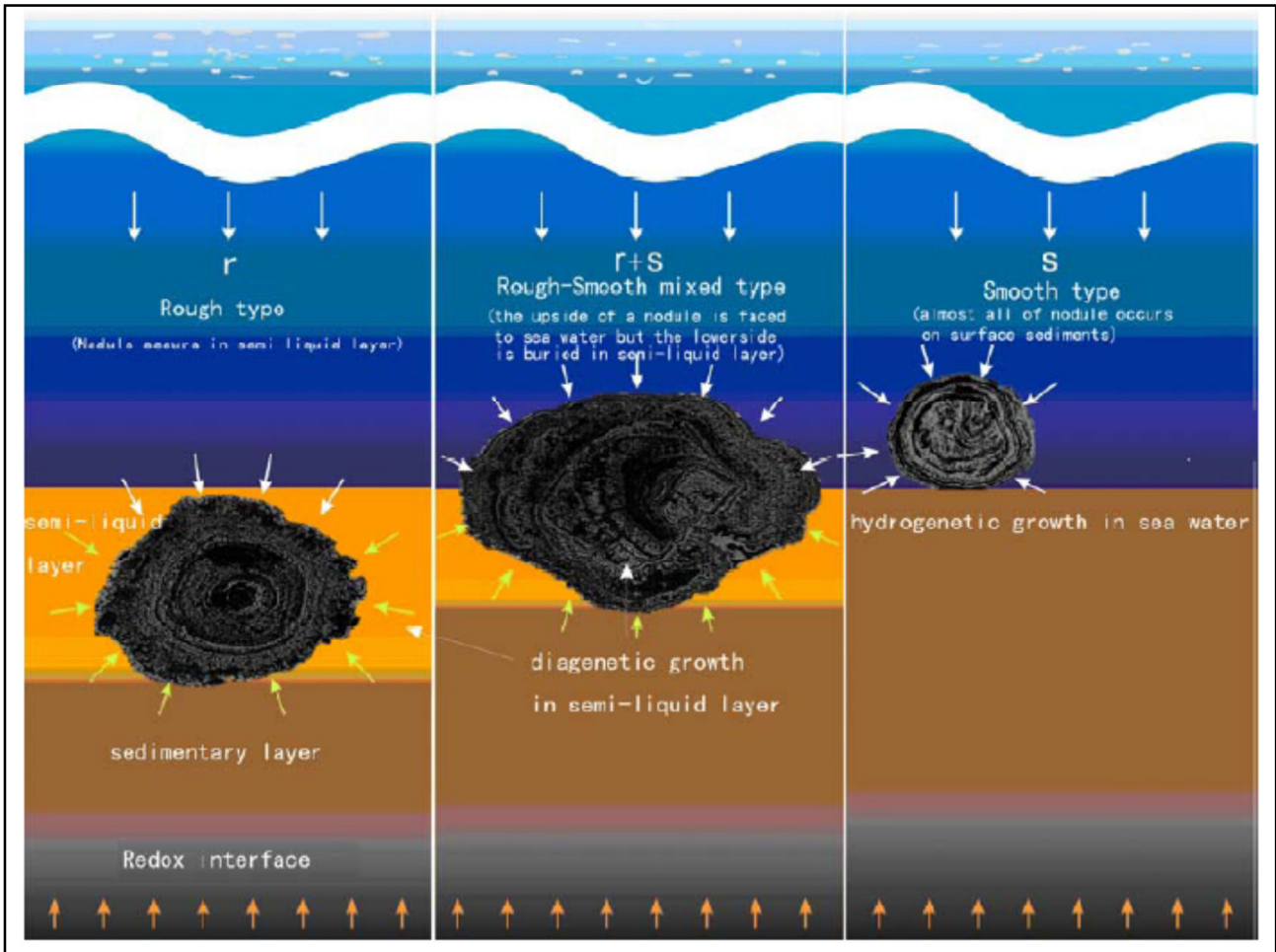


Figure 8-3: Polymetallic Nodule Types (ISA, 2010).

The mineralogical features and genetic implications are discussed by Koschinsky (2008) and Haynes et al. (1985) and are illustrated in Figure 8-4. The S (smooth) type nodules are believed to be hydrogenetic, adsorbing Mn and other metals from the ocean. The main Mn-minerals are Fe-bearing vernadite (δ - MnO_2) intergrown with an X-ray amorphous Fe oxyhydroxide phase. R (rough) type nodules are believed to be mostly diagenetic in origin, taking Mn and other metals from sediment pore water, which may be frequently replenished by water flow and bioturbation. The main Mn minerals are 10Å todorokite and 7Å birnessite. However, McKelvey, Wright and Bowen (1983) found that nodules recovered from deeper waters worldwide tend to have more todorokite and less vernadite and Haynes et al. (1985) suggest that this may be a feature of post deposition recrystallisation.

Many nodules show features of S and R type nodules, suggesting that they have formed under partly buried conditions. These are termed S-R type (Figure 8-3). Both S and R type nodules can have fragments of nodules as seed cores e.g. Figure 8-5. Compared to polymetallic nodules globally, the CCZ nodules are predominantly diagenetic in nature Glasby (2006).

Based on a limited suite of five samples, Fuerstenau et al. (1973) show that nodules have very high porosities (52 to 61%) and specific types of surface area (rough or smooth) with apparent densities of 1.36 to 1.54 t/m³ (dry basis after heating to 110°C). Most pores are 0.1 microns or less in size. After air drying, about 10 to 17% by mass of water was removed at 110°C (adsorbed) and a further 19 to 26% at 400°C (crystallisation from the iron and manganese oxides). Hessler and Jumars (1974) present wet density data from two sites north of the CCZ (approximately 10 nmi apart) that show wet densities on the order of 2 g/cm³ (Figure 8-6), a value also mentioned by Hoffert (2008) for the CCZ nodules.



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

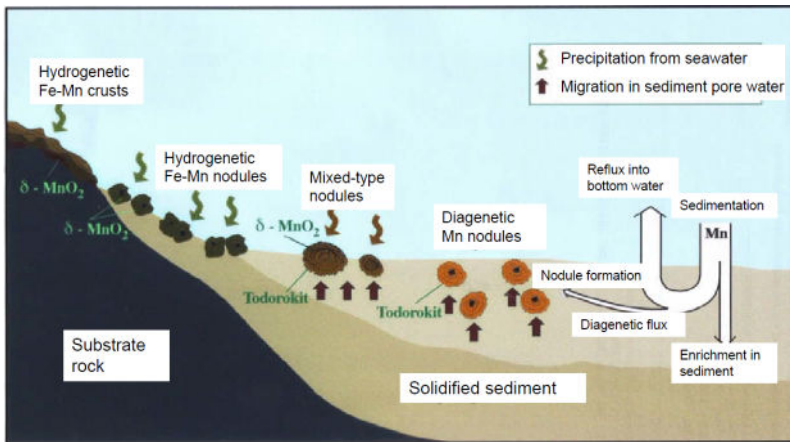


Figure 8-4: Polymetallic Nodule Growth Processes (Koschinsky, 2008).



Figure 8-5: Sections Through a S-type Nodule (L) and a R-type Nodule with a S-type core (von Stackelberg and Beiersdorf, 1991).

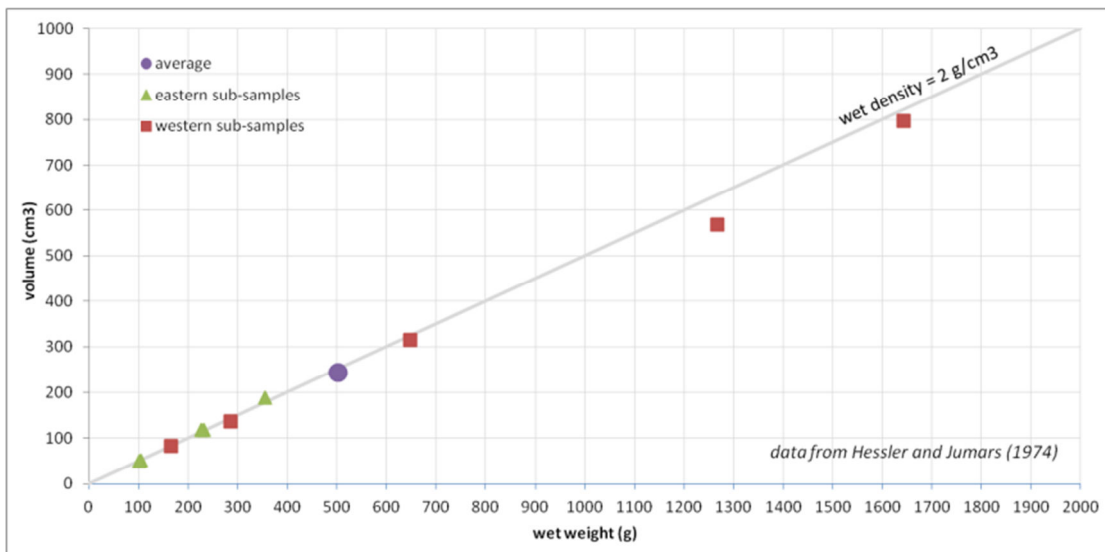


Figure 8-6: Nodule Densities of Samples from the Central North Pacific.



A total of 15 discrete manganese minerals and nine iron oxide minerals in Pacific nodules are identified by Haynes et al. (1985) although most of these only occur in minor or trace amounts.

Nodule growth is a relatively slow geological process, at rates of only several mm per million years (Krishnaswami et al., 1982). In contrast, sedimentation within the CCZ is much faster, although still very slow, at rates of 1 to 10 mm per thousand years (Piper and Fowler, 1980).

The concept of biogenic 'lifting' is supported by von Stackelberg and Beiersdorf (1991), and Heath (1979) but is difficult to explain in detail as dating from nodules indicates that they are turned only every few hundred thousand years. It is likely that winnowing of sediments by near seafloor currents is an active mechanism, although the ultimate deposition sites of this very significant volume of sediment are yet to be demarcated. An alternative, suggested by Piper and Fowler (1980) is that burrowing fauna transport sediment from the surface by compacting it within the burrows. The role of burial or exposure by erosion and sediment slumping is more likely to be localised due to rare occurrence of obvious fault movements (Hoffert, 2008) and the relatively low seismicity of the inner Pacific basin (Piper and Fowler, 1980).



ITEM 9. EXPLORATION

TOML has not yet conducted a field based exploration program on its Exploration Area within the CCZ.

Six exploration groups are known to have surveyed areas within the TOML Exploration Area and collected samples of polymetallic nodules. Much of this work overlapped as it predates the signing of the Law of the Sea. These include the Japanese consortium (DORD), the South Korean Consortium (KORDI), the Russian Federation consortium (Yuzhmorgeologiya), the French consortium (IFREMER), the German consortium (FIGNR or BGR), and the US consortium, Ocean Minerals Company (OMCO). The timing (Item 2) and location (ISA, 2003) of the OMCO sampling is known but the results are not available outside of ISA published contour maps (e.g. Item 14.8).

Virtually all the samples in the TOML Exploration Area were obtained by free-fall grab samplers although a few results from box corers were also included. As detailed in Item 7.3.3, nodule abundance (wet kg/m²) is derived by dividing the weight of recovered nodules by the surface area covered by the open jaws of the sampler or corer (typically 0.25 to 0.5 m² but in some cases as much as 1 m²). Assays were done on dried sample splits by commonly used spectrometric methods (AAS and XRF).

9.1 Nodule Sample Data Supplied to TOML

The TOML Exploration Area was a Reserved Area and as such was sampled by pioneer contractors (4.1.3). The pioneer contractors defined two areas of equal value, and then returned one to the ISA for use by the Enterprise for developing nations (such as Tonga). These sample data provide the basis of a database held by the ISA, and were used initially to define the areas of the TOML application, and then to estimate a mineral resource for the part of the TOML Exploration Area.

The sites shown have been sampled by a combination of grab samplers and box corers of different sizes and designs, with the details of most being unavailable. As a result, sample quality, spacing, and assay reliability vary from sample to sample and block to block. However, any net biases are reduced (Figure 9-5, Figure 9-6). Average sample spacing (based on the data supplied by the ISA) varies across the CCZ ranging between 10 km to 30 km and averaging approximately 20 km within the TOML Exploration Area. Some close spaced data (<5 km) exists within Area C (ex-IFREMER). The DORD sample stations are typically an average of three samples (Item 11.1.3).

Bar plots showing the total number of samples by the pioneer contractor that collected the samples and within the TOML Exploration Area are presented in Figure 9-1 and Figure 9-2. A plan of the sample locations is presented in Figure 9-3. The statistics for the samples that contain both abundance and grade data inside the TOML Exploration Area are tabulated in Table 9-1 to Table 9-6 and illustrated in Figure 9-3. Samples in the CCZ but outside the TOML Exploration Area are presented in Table 9-7.



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

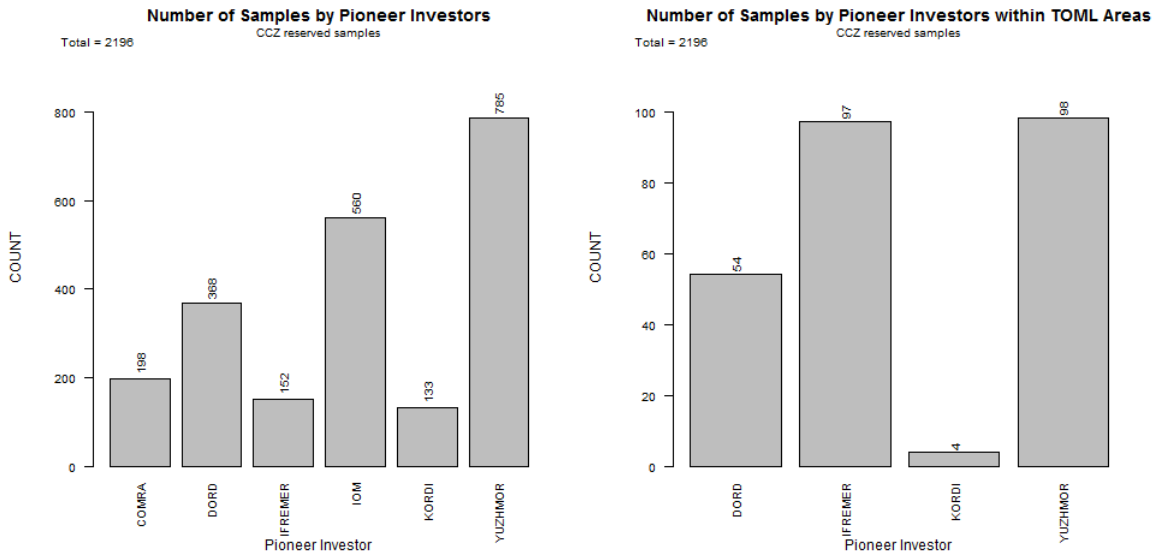


Figure 9-1: Total Number of Samples by Pioneer Contractor.

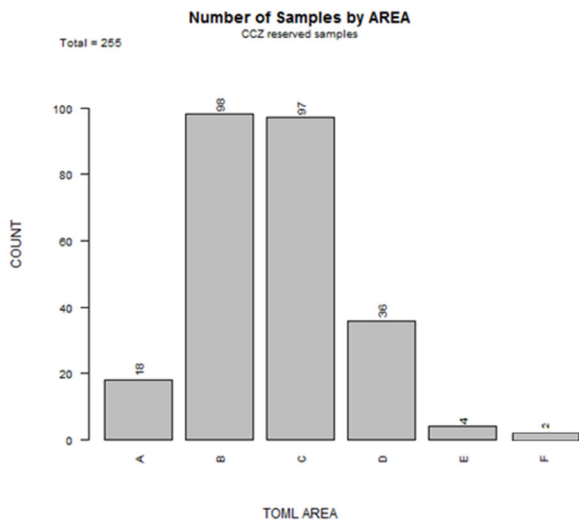


Figure 9-2: Total Number of Samples by TOML Exploration Areas.

Table 9-1: Summary of Historic Grab Samples Area A

(all ex-DORD)	Mn (%)	Co (%)	Ni (%)	Cu (%)	Abundance (wet kg/m ²)
Count	18	18	18	18	18
Minimum	21.46	0.15	0.71	0.46	2.68
Maximum	30.05	0.30	1.47	1.51	17.93
Mean	25.40	0.22	1.14	1.00	10.12
Median	25.50	0.21	1.15	1.02	9.19
Standard Deviation	2.44	0.04	0.24	0.35	5.08
Coefficient of Variation	0.10	0.18	0.21	0.35	0.50



Table 9-2: Summary of Historic Grab Samples Area B

(all ex-Yuzhmorgeologiya)	Mn (%)	Co (%)	Ni (%)	Cu (%)	Abundance (wet kg/m ²)
Count	88	88	88	88	88
Minimum	10.30	0.02	0.53	0.40	0.03
Maximum	31.20	0.35	1.51	1.40	26.00
Mean	25.40	0.25	1.16	0.94	8.82
Median	26.55	0.25	1.23	1.02	8.09
Standard Deviation	4.19	0.06	0.23	0.26	5.87
Coefficient of Variation	0.16	0.22	0.20	0.27	0.67

Table 9-3: Summary of Historic Grab Samples Area C

(all ex-IFREMER)	Mn (%)	Co (%)	Ni (%)	Cu (%)	Abundance (wet kg/m ²)
Count	78	78	78	78	78
Minimum	22.01	0.14	0.93	0.71	1.35
Maximum	30.90	0.32	1.42	1.44	21.25
Mean	27.91	0.25	1.27	1.15	9.98
Median	28.55	0.25	1.29	1.19	9.17
Standard Deviation	2.13	0.03	0.10	0.15	4.20
Coefficient of Variation	0.08	0.13	0.08	0.13	0.42

Table 9-4: Summary of Historic Grab Samples Area D

(all ex-DORD)	Mn (%)	Co (%)	Ni (%)	Cu (%)	Abundance (wet kg/m ²)
Count	42	42	42	42	42
Minimum	22.79	0.19	1.09	0.79	0.12
Maximum	30.45	0.30	1.44	1.36	16.37
Mean	28.52	0.22	1.31	1.16	7.68
Median	28.76	0.22	1.32	1.17	7.78
Standard Deviation	1.47	0.02	0.08	0.10	4.09
Coefficient of Variation	0.05	0.10	0.06	0.08	0.53

Table 9-5: Historic Grab Samples Area E (four samples only; ex-KORDI)

Longitude	Latitude	Water depth (m)	Mn (%)	Co (%)	Ni (%)	Cu (%)	Abundance (wet kg/m ²)
-124.162	12.8331	4542	26.83	0.16	1.11	1.14	18.18
-123.669	12.8293	4497	24.04	0.21	1.01	0.88	6.73
-124.667	12.8284	4851	25.64	0.18	1.21	1.04	9.24
-125.163	12.8328	4577	27.5	0.16	1.29	1.13	9.2



Table 9-6: Historic Grab Samples Area F (two samples only; ex-BGR/OMI)

Longitude	Latitude	Water depth (m)	Mn (%)	Co (%)	Ni (%)	Cu (%)	Abundance (wet kg/m ²)
-118.33	10.35	4073	32.4	0.17	1.33	1.31	9.3
-118.33	10.35	4073	32.4	0.16	1.27	1.29	13.7

Table 9-7: Summary of Historic Samples from the Reserved Areas outside the TOML Exploration Area

	Mn (%)	Co (%)	Ni (%)	Cu (%)	Abundance (wet kg/m ²)
Count	2188	2188	2188	2188	2188
Minimum	4.14	0.05	0.15	0.12	0.01
Maximum	35.62	3.23	1.75	1.62	52.20
Mean	27.47	0.21	1.25	1.04	8.21
Median	28.47	0.21	1.30	1.09	7.10
Standard Deviation	4.06	0.08	0.20	0.24	6.06
Coefficient of Variation	0.15	0.40	0.16	0.24	0.74

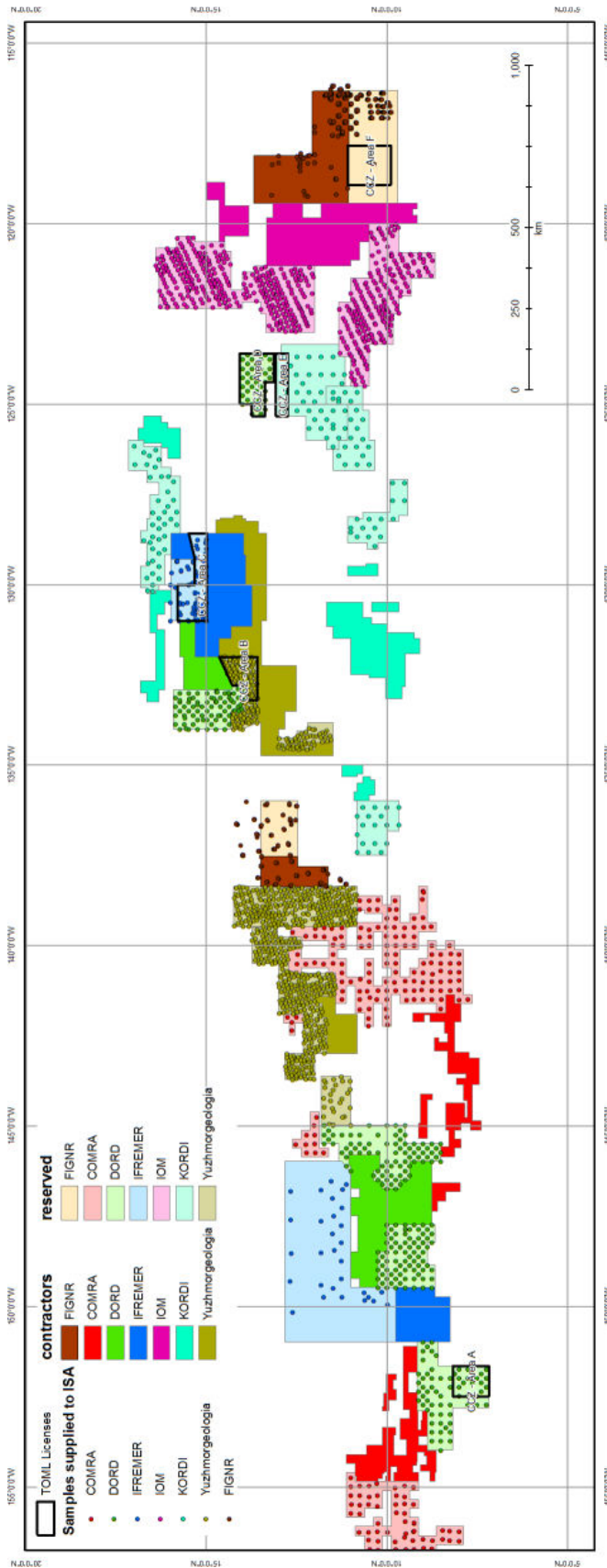
The above tables and Figure 9-4 indicate that all of the TOML Exploration Areas have similar ranges of grade and abundance to the rest of the CCZ deposit. Grades typically vary by one order of magnitude less than the mean. The coefficient of variation is low compared to most terrestrial mineral resources. Abundance values vary more widely, making abundance estimates the key variable of uncertainty in mineral resource estimation.

Buried abundances are very poorly constrained at this time, and are likely to be subordinate to surface abundances. Thus they are not included in exploration information or mineral resource estimates.

The sample spacing is predominately wide (10 to 30 km). However there are a number of closely spaced samples (500 m to <10 km) but these are insufficient to constrain the short range controls on grade and abundance within the TOML Exploration Areas.



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

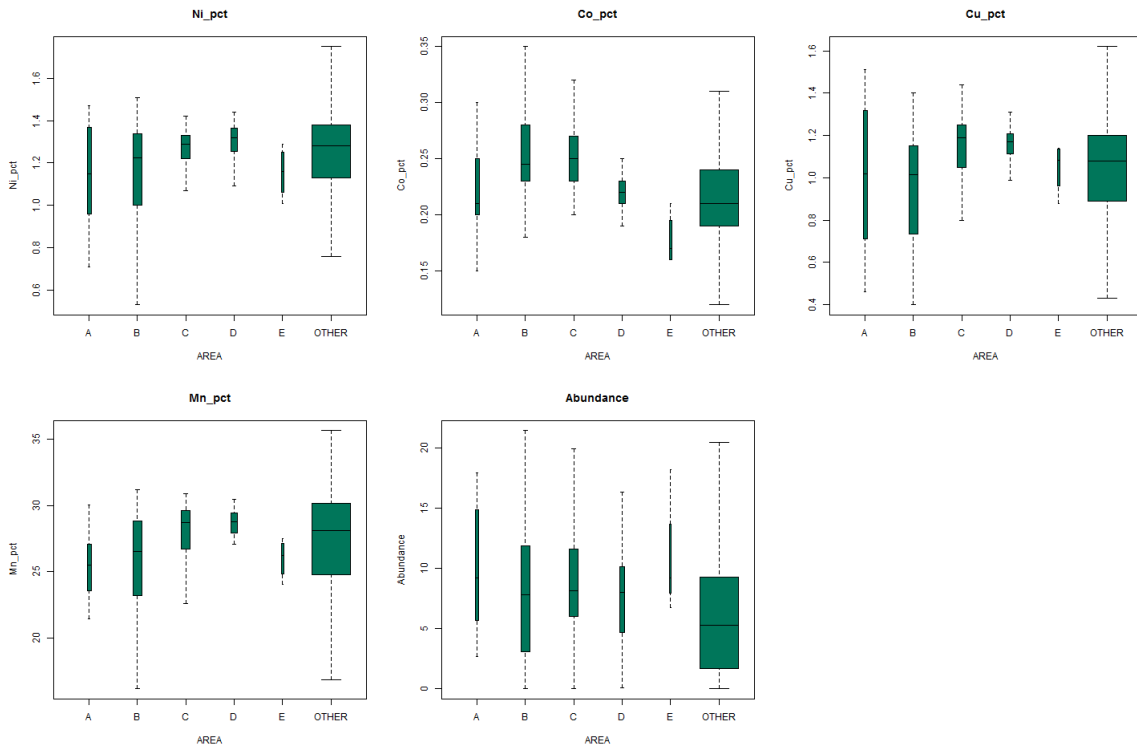


TOML Exploration Area	Pioneer Contractor
A	DORD
B	Yuzhmorgeologiya
C	IFREMER
D	DORD
E	KORDI
F	OMI-BGR/FIGNR

Figure 9-3: Samples coloured by Pioneer Contractor (within the Reserved Areas; ISA, 2012a).



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN



Box size represents 1st and 3rd quartiles centred on the median and box width reflects number of samples

Figure 9-4: Box Plots Showing Range of Sample Grades within the TOML Exploration Areas Compared with all Other Data from the Reserved Blocks in the CCZ.

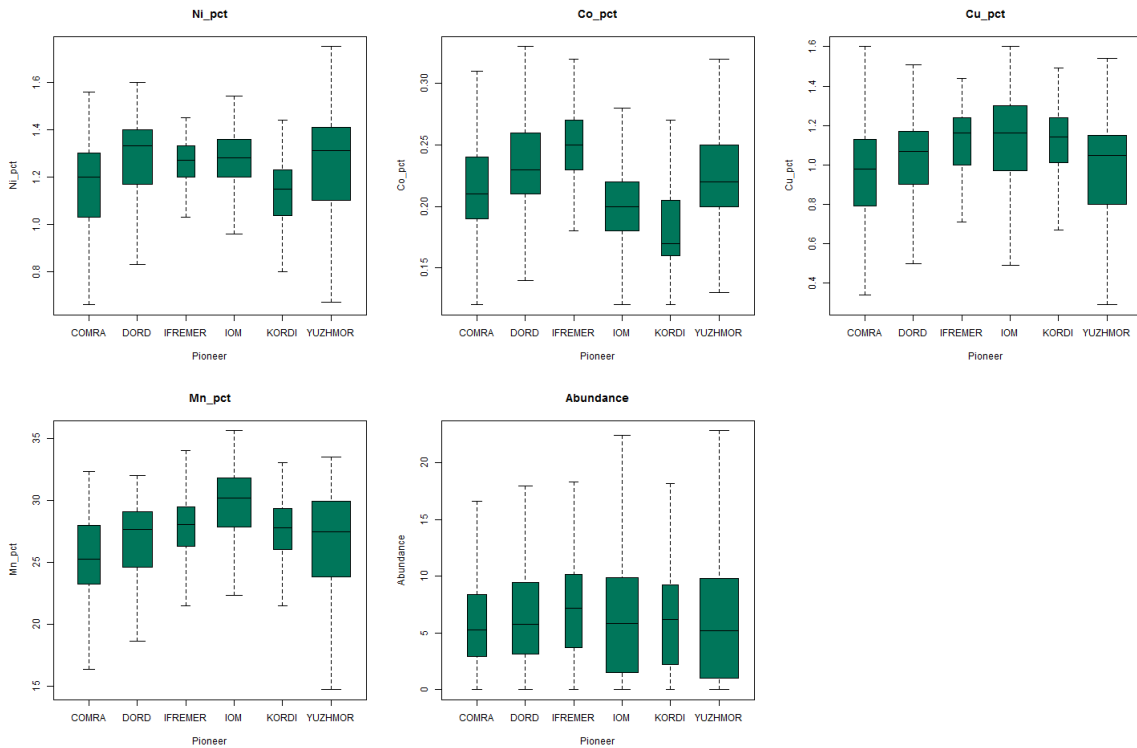


Figure 9-5: Box Plots Comparing the 6 Pioneer Contractor Reserved Area Data Sets across the entire CCZ.

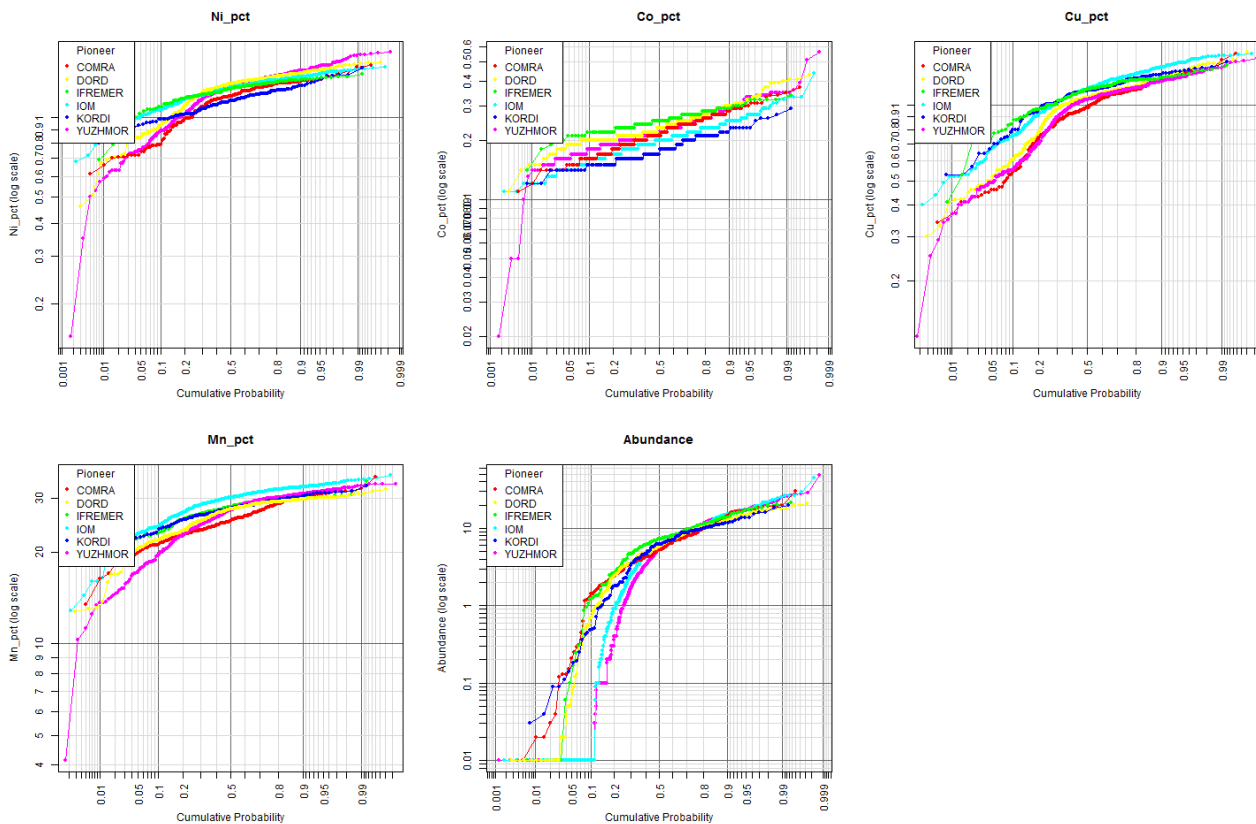


Figure 9-6: Log Probability Plots Comparing the 6 Pioneer Contractor Data Sets.

9.2 Sampling Method

Virtually all the samples used in the TOML Mineral Resource estimate were obtained by FFG samplers plus a few by BC samplers. Free-fall grab samplers consistently underestimate the actual abundance (Hennigar, Dick and Foell, 1986), but even today they are the most productive and proven tool available for the assessment of nodule abundance. This is because a number of them can be deployed at any one time from the survey vessel allowing an order of magnitude increase in collection efficiency i.e. approximately 10 to 20 samples per day for a FFG versus 2 to 3 samples per day for a BC that is winched to and from the seafloor.

Due to limited penetration into the sediment, these sampling methods do not provide any information on the subsurface nodule occurrence and there are limited data available throughout the CCZ on the occurrence of nodules below surface. Penetration is typically 10 to 30 cm with only the biggest and very rarely used box corers reaching 0.5 m. Effective subsurface sampling data are very limited and indicate that nodules continue with depth but tend to be much lower in abundance (Heath, 1979). Von Stackelberg and Marchig (1987) note that FFG's sometimes fail to return nodules when abundances are very high due to a nodule 'pavement' that could not be penetrated by the grab.

Lee et al. (2008) examined correction factors between FFG and BC in some detail. They found a wide range but consistent differences with FFG under-reporting compared to BC (Figure 9-9). They also illustrate why BC results should be much more accurate than FFG results based on mechanical effectiveness (Figure 9-7, Figure 9-8). They then recommend an overall correction factor of 1.4 to convert a FFG abundance to a BC abundance. However, they acknowledge that any simple factor lacks precision. Dr Charles Morgan has extensive experience with the FFG to BC conversion 'problem' and one key issue is the size of the FFG or BC (area covered) versus the nodule diameter. Free-fall grab samplers have been demonstrated to



underestimate the actual abundance as smaller nodules may escape some grabs during ascent and larger nodules around the edge of the sampler may be knocked out or fall out during the sampling process.

No conversion has been applied to the TOML nodule abundance because:

- sample collection type is not clearly specified (i.e. proportion and identity of BC versus FFG samples is unknown (although most are likely to be FFG).
- the size of collector and nodule sizes are unknown.

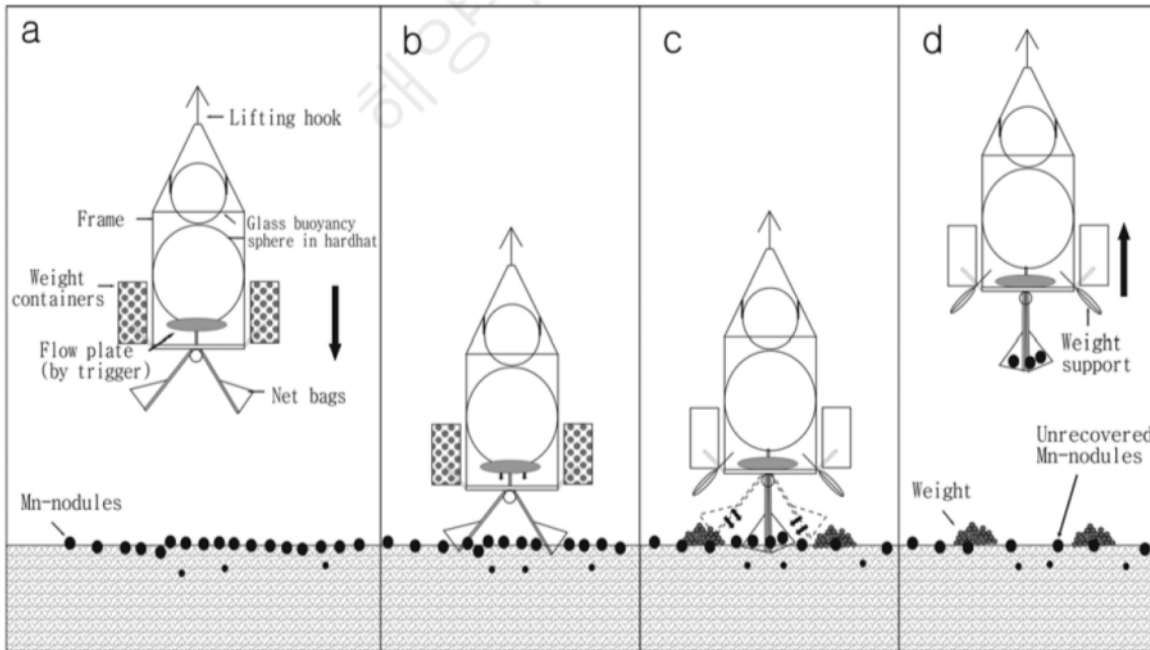


Figure 9-7: Cartoon Showing the Recovery Process of Nodules Using Free Fall Grab (Lee et al., 2008).

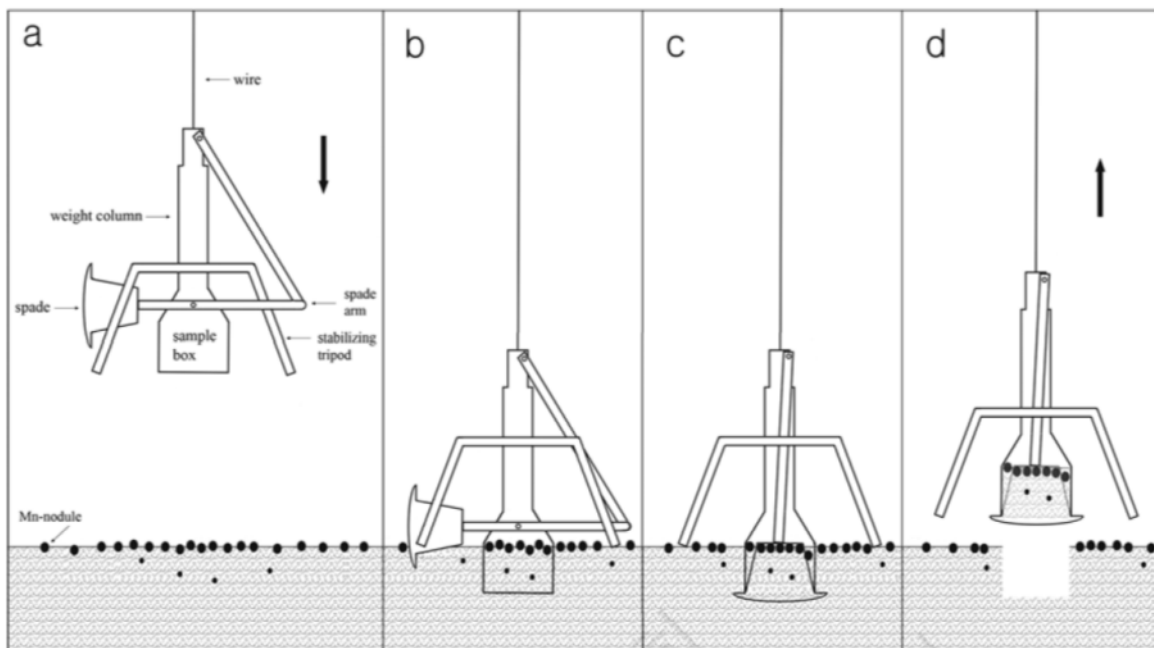


Figure 9-8: Cartoon Showing the Recovery Process of Nodules Using Box Corer (Lee et al., 2008).

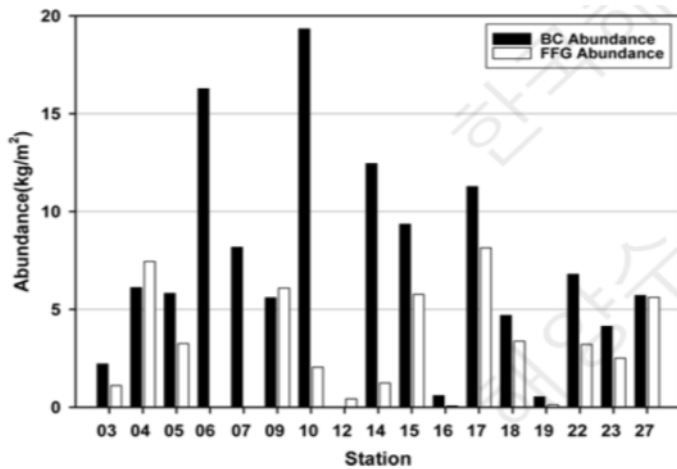


Figure 9-9: Comparison of Returned Abundances from BC and FFG at Test Stations within the KORDI Exploration area (Lee et al., 2008).

Therefore, the estimates of nodule abundance is likely to be conservative.

Metal content in the samples collected was determined by a variety of standard analytical methods, including atomic absorption and X-ray fluorescence. Limited information is available on sample preparation and analytical methods (11.1.2, 11.1.3). The various consortia reportedly used polymetallic nodule Certified Reference Materials (e.g. NOD-P-1; Flanagan and Gottfried, 1980) for QAQC, however details of the Certified Reference Materials and analytical results were not included in the dataset supplied by the ISA to TOML and Golder.

ITEM 10. DRILLING

TOML has not yet conducted any drilling on its Exploration Area within the CCZ. All known past exploration for polymetallic seafloor nodules within the CCZ involved surface sampling (refer Item 9) rather than drilling.

Surface sampling is sufficient to define the mineral resource given that intrinsic value exists for just the polymetallic nodules found at the surface of the seafloor.

Given the size of the nodules and the soft nature of the sediment in which they lie, any drilling would need to be of an exceptionally large diameter to avoid significant negative sample bias.

Some sediment cores have also been collected to study the sediment composition, but none are specifically known to be from the TOML Exploration Area.



ITEM 11. PREPARATION, ANALYSES AND SECURITY

11.1 Sample Preparation

The sampling programs undertaken by previous explorers in the area of the application, which comprise the primary data set used here for resource estimation, include Japanese, French, and Russian data sets (Figure 9-3). Golder sent requests to the agencies responsible for each of these data sets but only received partial responses from Yuzhmorgeologiya (Russia; TOML Exploration Area B) and DORD (Japan; TOML Exploration Areas A and D) which are included below.

The author (Dr Charles Morgan) was directly involved with one of the US exploration programs (OMCO) that was carried out during the same period as these other programs, working as a Senior Scientist for Lockheed. This work included direct participation in resource assessment survey expeditions to the CCZ and development and implementation of sample preparation and analysis procedures. The description of sample preparation and analysis methods provided below is based on this experience.

Prior to establishment of the ISA, explorers working under different jurisdictions settled claim boundary overlaps through a process of negotiation and data exchange (e.g. NOAA, 1987; Item 4.1.1). Though data were generally not exchanged until after negotiations related to exploration claim boundaries were completed, the author conferred with representatives of these consortia at several formal professional meetings and informal settings, comparing methods and procedures used for sample collection, analysis, and quality control. Many aspects of the OMCO procedures were used by the other explorers.

As described below, documentation of sample treatment methods has been provided by Professor Valeriy Yubko, Deputy Director of the Russian oceanographic institution Yuzhmorgeologiya, based in Gelendzhik, Russia and operating under the jurisdiction of the Russian Federal Agency of Natural Resources. Professor Yubko was a senior member of the Russian team that explored for polymetallic nodule deposits in the CCZ and delineated the Yuzhmorgeologiya exploration claim under the ISA. As shown in the following sections, the Russian methodology was very similar to the methodology practiced by the Lockheed group. The Russian data covers TOML Exploration Area B which has the highest density of sampling and represents the majority of samples for the TOML Exploration Area. Some details have also been provided by Dr Okazaki on the DORD sampling and analytical procedures. Dr Okazaki is current exploration manager for the CCZ nodule field for DORD. Ongoing use of determining wet weights for abundance by the BGR is also explained below.

11.1.1 OMCO Procedures

Polymetallic nodule samples collected with FFG samplers were transferred directly from the sampler into individual plastic bins and carried below deck to the geochemical laboratory. In the laboratory they were laid out separately on a white surface marked with a scaled grid and photographed to permit determination of nodule size distribution. They were then sealed in labelled fibreglass-reinforced collection bags and stored in the ship's hold for the balance of the exploration cruise.

The bins and lay-out surface were cleaned between samples using filtered seawater and dry paper towels. No cleaning of the nodules was usually necessary, since any mud adhering to them would be swept off the nodule surface through the open mesh of the sampler collection net during the ~4 500 m ascent from the seafloor. Samples collected with box corers were processed in a similar manner, except that the adhering mud had to be rinsed off each nodule as it was removed from the box corer.

The collected sample bags were transported from the ship that almost always docked at a pier in San Diego Bay, to the Lockheed Ocean Laboratory, which was also located on the Bay at Harbor Island. Transfer of the samples from the ship to the secured laboratory storage facility was the first priority when the ship came to port and was always handled personally by the expedition crew and other Lockheed employees.

Prior to weighing, the samples were removed from the sample bags and placed in a single layer in labelled, open trays on tables in the air-conditioned laboratory for at least 12 hours to ensure a uniform degree of air drying. The samples were then weighed using a high-capacity laboratory scale and divided into two



subsamples of approximately equal weight. As a portion of the nodules was to be kept uncrushed, the technicians were instructed to ensure as much as possible that both subsamples contained similar nodule size distributions to the original samples. One subsample was placed in a labelled jar and kept as a permanent archive. The second subsample was prepared for Atomic Absorption Spectrographic (AAS) analysis, as described below. This is a potential source of sample bias but OMCO minimised this by randomly selecting which sample was used for archive.

The second subsample was crushed using a jaw crusher (similar to the Retsch™ BB51 currently available; see Retsch, 2012) to produce a product with a maximum size of less than about 1 mm. The crushed sample was then mixed using a 3-axis shaker to achieve uniform mixing and to preclude any separation of the less dense detrital (siliceous) component from the more dense metal oxide component of the sample. The mixed sample was passed through a laboratory sample splitter as required to produce a 5 to 10 g subsample for AAS analysis. The remainder of the sample was then stored as a second, crushed archive sample. The subsample was further ground to a fine powder using a laboratory ball mill prior to assaying.

The powdered subsample was placed in a 110° C drying oven for at least 6 hours to remove adsorbed water. It was then immediately transferred to a sealed desiccator to cool to ambient temperature. Cooled samples were weighed using a Mettler™ analytical balance and then transferred to Parr™ Teflon-lined high pressure digestion vessel. Reagent grade hydrofluoric, boric, and hydrochloric acids were introduced to the vessel, which was then sealed and heated for several hours to complete the digestion. The digested samples were then diluted as necessary with filtered, distilled water for AAS analysis using a Hewlett-Packard instrument. Standard analysis included determination of Mn, Fe, Co, Ni, Cu, Zn, Si, Ca and Mg.

Analytical accuracy was confirmed by periodic introduction of standards made from crushed, mixed, and powdered bulk nodule samples that had also been sent to three independent commercial laboratories for determination of these metal contents. Additional confirmation was achieved using standards formulated by the U.S. Geological Survey (A-1 and P-1; see Flanagan and Gottfried, 1980). These standards were subjected to the entire preparation procedure to ensure that no significant contamination was occurring and that no systematic analytical errors were being included in the process.

11.1.2 Yuzhmorgeologiya Procedures

The measurement of abundance of nodules at the sample site was carried out using an 'enclosed' Ocean-0.25 grab sampler (Figure 11-1, Figure 11-2) with a 0.25 m² gripped surface and a depth of sampling of approximately 30 cm. The grab sampler was combined with GFU-6-8 photography unit. This device takes ocean bottom photos at the sampling point.



Figure 11-1: Ocean-0.25 Grab Sampler (Yubko, 2012).

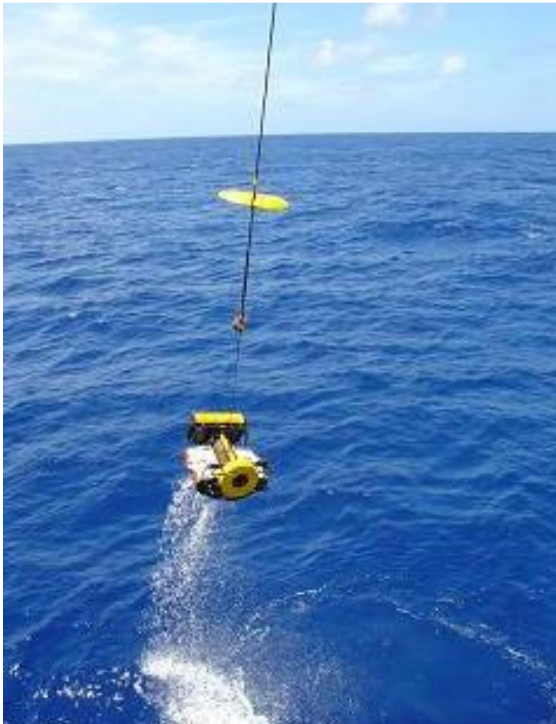


Figure 11-2: Recovery of Ocean-0.25 Grab Sampler (Yubko, 2012).

The procedure for sub-sampling was:

- 1) Extraction of all nodules from the grab sampler (Figure 11-3)
- 2) Crushing of all nodules to a maximum particle size of up to 10 mm
- 3) Drying (approximately 24 hours) of all samples at 105° C until constant weight was achieved
- 4) Crushing of all samples to 1 to 2 mm particle size and splitting of 400 to 500 g using a splitting device
- 5) Pulverizing of the split sample (not less than 400 g) was carried out in the vibrating grinder up to 100 mesh particle size (0.074 mm)
- 6) Formation of analytical sample (200 g) and its duplicate (200 g).

Chemical analyses were carried out on sub-samples with an approximate weight of 0.5 g, selected from the analytical sample. Determination of Ni, Cu, Co and Fe content was carried out by AAS and the content of Mn by a method of photometric (electrometric) titration.

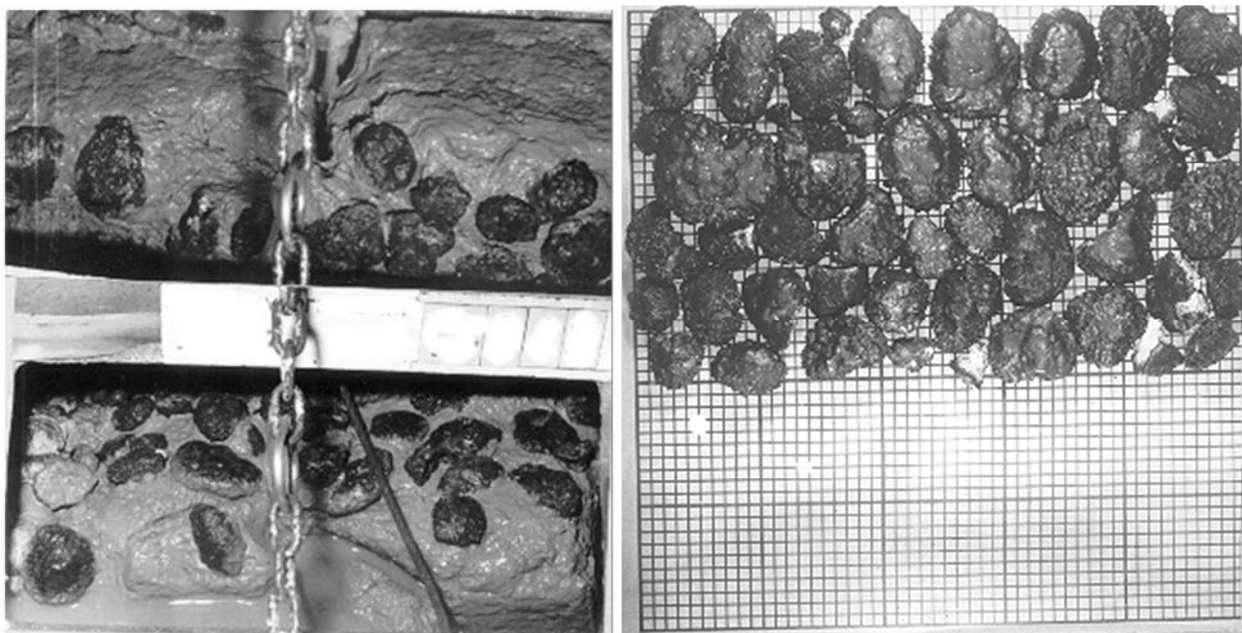


Figure 11-3: Mn-nodules Inside Grab Sampler (left) and Outside Grab Sample (right) (Yubko, 2012).

11.1.3 DORD Procedures

DORD's procedure for sampling (Okazaki, 2012) is understood to include:

- Each sample station is a combination of three sub-sampling points which effectively form an isosceles triangle with lengths of sides 1.4 nmi, 1.4 nmi and 2.0 nmi.
- Collection was mostly by free-fall grab, but at occasional stations a box corer was used at one of the three sub-sample points
- In later cruises at least (which may not include the TOML Exploration Area) a ship-borne X-ray fluorescence analyzer was used for the chemical analysis with some representative samples being assayed at an on-land laboratory to assess precision and accuracy.

11.1.4 BGR Procedures

Ruhlemann *et al.* (2011) describe the sediment and nodule sampling process used by the BGR in recent times (2006) which is largely not relevant to the pioneer contractor data from the TOML Exploration Area. One exception however is their citing the ongoing use of a BGR procedure in the 1980s of washing sediment from collected nodules with specially cleaned seawater before determining their wet weight and converting this to a dry weight by means of a simple 30% reduction factor.

11.2 Quality Assurance and Quality Control Procedures

No systematic QAQC information is available as this information was not provided to the ISA. QAQC was known to be undertaken at the time of sampling as part of the scientific process used by each consortia (country). Golder have assured the quality of the data using comparative measures between the different datasets (Item 9.1) to prove that the samples within the TOML Exploration Area are not statistical outliers, this level of quality assurance is deemed suitable for a mineral resource at an inferred level of confidence.

As part of the requirements by ISA, the pioneer contractors were required to relinquish half of their claim to the ISA as reserved blocks. During this process the ISA reviewed the sampling data to ensure that the splitting of the claim was even with equal abundance and grade occurring in the retained portion of the claim



and the parts being relinquished. As such, the ISA has accepted the data (and quality) supplied by the pioneer contractors.

11.3 Adequacy of Sample preparation, Security and Analytical Procedures

Free-fall grab samplers consistently underestimate the actual abundance but provide samples that can be used to determine adequate estimates of the grade of the surface nodules (Hennigar, Dick and Foell, 1986). Even today they are the standard and most effective proven tool available for sampling the nodules at the seafloor. This is because a number of them can be deployed at any one time from the survey vessel allowing an order of magnitude greater speed in collection i.e. approximately 10 to 20 samples per day for a FFG versus 2 to 3 samples per day for a BC that is winched to and from the seafloor.

Comparison of nodule abundance and grade between the pioneer contractors (Figure 9-6), which used different methods for sampling and assaying and unknown sample security protocols, show that the various sampling and assaying methods produced very similar results. For abundance above approximately 4 kg/m² sampling results by all pioneer contractors are similar. While below approximately 4 kg/m² there appear to be two populations of data consisting of 1) COMRA, DORD, IFREMER and KORDI sampling and 2) IOM and Yuzhmorgeologia. This also occurs for Ni and Cu assays where the two populations are: 1) COMRA, DORD and Yuzhmorgeologiya sampling and 2) IFREMER, KORDI and IOM sampling. The populations appear to divide at approximately 1% Ni and 1% Cu. It is noted that these differences can be explained by either a difference in the relative populations of hydrogenetic and (less) diagenetic nodules (Item 8.1.2) or possibly by low order sampling biases either at the sampler or in splitting.

As in many cases it is unknown exactly when the nodule weights have been taken by the pioneer contractors. It has been assumed that the samples were weighed shortly after recovery on board the exploration vessels (or back at base) and usually before any splitting or crushing. This partial assumption is more conservative in any tonnage estimate than the alternative that the abundance weights are for dried nodules. It also fits well with Dr Charles Morgan's experience with sampling in the CCZ and the process description provided by Yuzhmorgeologia.

Overall, the comparison of the sampling and assaying between the pioneer contractors show that the data are adequate for geological modelling and are reliable for a mineral resource estimation at an inferred level of confidence.



ITEM 12. DATA VERIFICATION

All of the available sampling data are historic and were collected by six pioneer contractors during the 1970s to 2000s. As part of the ISA requirements to relinquish half of the registered pioneer contractor's claims, the data for the relinquished portions were made available to the ISA where they were archived. This entire data set was first provided to TOML in a comma delimited format, and then independently to Charles Morgan and thence to Golder in an excel spreadsheet (ISA, 2012a).

The database provided by the ISA contains multiple independent datasets that were independently collected and sampled using similar methods (FFG or BC sampling) but with slightly different equipment and were assayed by different laboratories. Because the database contains multiple datasets the datasets can be compared with each other for the purpose of validating the internal consistency of the data. Additionally, there are a number of published summaries of data that have not been provided to the ISA but show similar mean grades to the data within the TOML Exploration Area (Table 12-1).

The Author Dr Charles Morgan is familiar with the procedures and processes that were used in collecting and assaying the samples. He has also been involved with collection, inspection and analysis of samples, photographs and video coverage of the polymetallic nodule deposits for Lockheed Martin while on board the exploration ship *MV Governor Ray*. Dr Morgan has also been involved with reviewing the pioneer contractors work and results, through his role on the ISA Legal and Technical Commission (ISA LTC), and in the compilation of ISA Technical Bulletin No. 6.

The sample data are supported by independent third party data, have been reviewed by the ISA LTC during the process of granting licences to the pioneer contractors, and are maintained by the independent ISA. We believe these data are suitable for Inferred Mineral Resource estimation purposes.

12.1 Data Independence

Golder received the available data collected from within the CCZ and the TOML Exploration Area directly from the ISA. The data set was received on June 22 2012 from Dr Vijay Kodagali, Senior Scientific Officer of the International Seabed Authority (Email: vkodagali@isa.org.jm) who sent the data by email in Microsoft Excel format.

This data set is identical to the one used for the resource assessment provided by TOML, verifying the source of the sample data.

The database includes all data submitted to the ISA by Exploration Contract Applicants that were collected in the Reserved Areas of the CCZ. The data were collected by parties completely independent of TOML or Nautilus Minerals and retained exclusively in the custody of the ISA prior to their transfer: firstly to TOML to facilitate its efforts to obtain an ISA exploration contract in 2008; and secondly to Golder in June 2012 for use in estimating the mineral resource for TOML Exploration Area of the CCZ. The data sets were also subject to third party review by the ISA's LTC, as part of the process of granting pioneer contractors Exploration Areas.

12.2 Physical Evidence of Nodules

12.2.1 Photographic Evidence

As part of their sample collection process both Yuzhmorgeologiya and OMCO took photographs of the seafloor at representative sample locations. Example photos from other locations and sources are provided in Figure 6-1 and Figure 8-1. The photographs show the occurrence of nodules on the seafloor within the CCZ deposit. These photos encompass much of the range of nodule occurrences seen by the author within the CCZ. Photographs for specific samples within the TOML Exploration Area are not available to TOML or Golder.

Figure 6-3, Figure 8-2, Figure 11-3 provide further examples of photographs of the polymetallic nodules from the CCZ.



12.3 Data Integrity

Neither Golder nor Nautilus has had access to the original assay sheets for the individual samples within the TOML Exploration Area nor the quality control procedures used by the laboratories and the ISA. Golder believes it is reasonable to infer that the data is of sufficient quality for an Inferred Resource estimate because:

- The ISA is an independent agency with significant accountability under the Law of the Sea. Part of its mandate is the receipt and storage of sea floor sampling data suitable for the estimation of nodule resources and the legally binding award of licenses. It is reasonable to assume that a reasonable level of care was applied by the ISA.
- Comparison of the six independent data sets from the CCZ shows a high level of consistency in abundance and grade and, conversely, provides no evidence of bias or systematic error in the TOML data

12.4 Data Comparisons for the Entire Reserved Areas

The Quality Assurance/Quality Control (QAQC) data for the historic samples are not available. Some QAQC is known to have been completed at the time, but there was no requirement to submit the results to the ISA. All the pioneer contractors collected samples by slightly different methods and assayed using different laboratories from what is effectively a single deposit. Due to the vast size and relative consistency of grade of the deposit the comparison between the data sets can be used as a proxy for QAQC.

Data covering the reserved blocks of ISA contained only a small number of anomalous values that may be suspected to be erroneous (four out of 2212 data points). These included:

- A Co value of 3.23% (next largest is 0.56% Co)
- Two Cu values of 157.0% and 66.0% (probably 1.57% and 0.66% respectively) (next largest is 1.62% Cu)
- A Mn value of 288.0% (probably 28.8%) (next largest is 35.62% Mn)

All these anomalous values are likely data entry errors and are contained within one contractor dataset (Yuzhmorgeologiya) and do not occur within the TOML Exploration Area, these data points were not used in any way for the resource estimate.

The box plots (Figure 9-5) and log-probability plots (Figure 9-6) comparing the data sets show that the distributions for Ni, Co, Cu, Mn and abundance are very similar between the different data sets, and across the CCZ. Variations between the data sets are attributed to both spatial variability and minor differences in sampling and assaying methods.

Quantile-Quantile (QQ) plots comparing the assay distributions of the samples within the TOML Exploration Area with all other available data from the reserved blocks are presented in Figure 12-1. These plots show that Ni, Cu and Mn compare well but with divergence at the tails of the distributions, while Co and nodule abundance tend to be biased slightly lower for the TOML data.

The samples within the TOML Exploration Area used for the Mineral Resource estimate were collected by Yuzhmorgeologiya, DORD and IFREMER. These three data sets show no significant differences.

Overall the results confirm the consistency of the mineralisation across the entire CCZ and the TOML Exploration Area which form a small part of the CCZ.



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

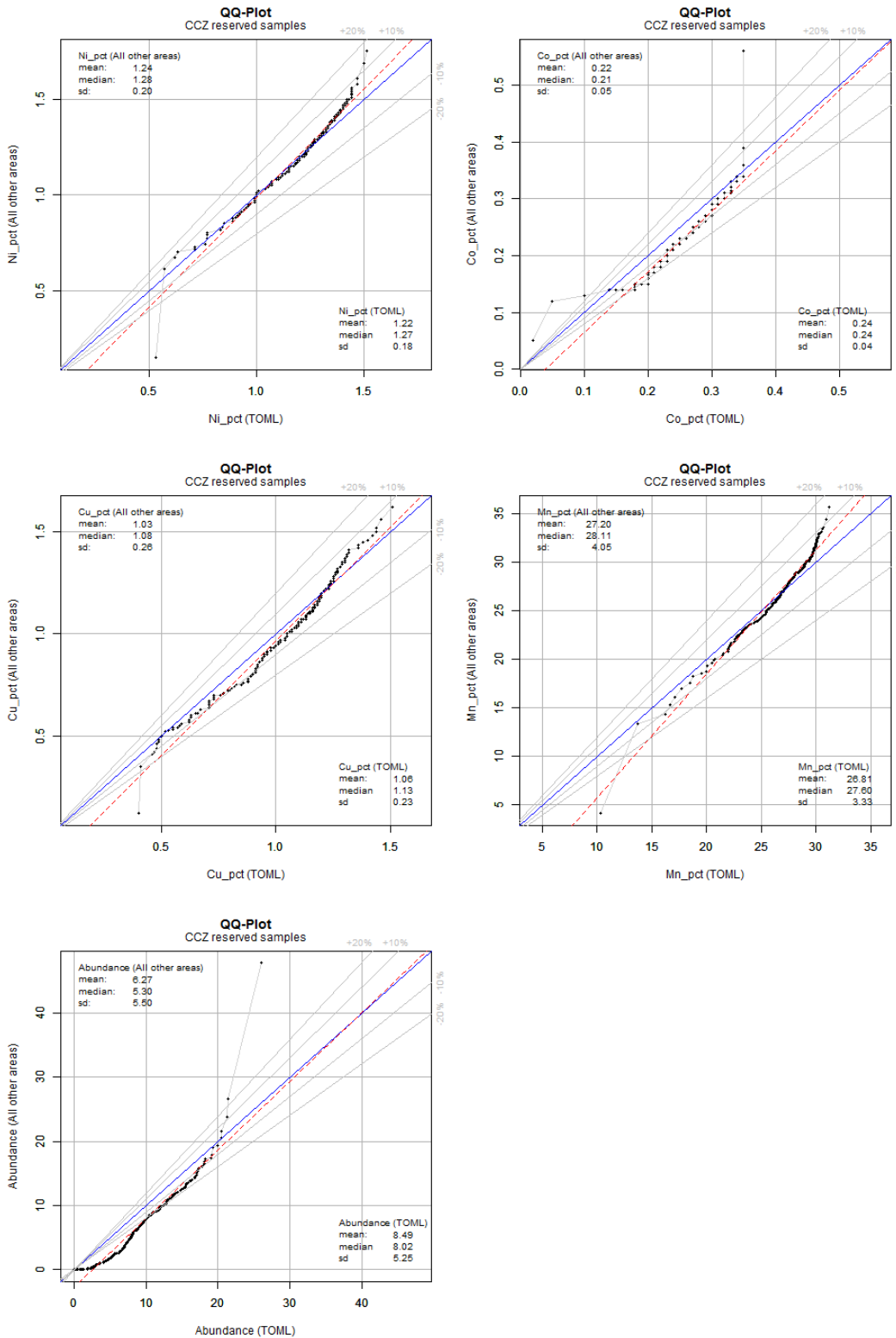


Figure 12-1: Quantile-Quantile (QQ) Plots Comparing the Distribution of TOML Samples with all Other Samples from the Reserved Blocks in the CCZ.



12.6 Comparison with non-ISA Sourced Data

Table 12-1 lists the mean grades of the nodules from different parts of the CCZ that were based on data that is not included in the data obtained from the ISA. These mean grades are very consistent with each other and with the mean grades of the data that falls within the TOML Exploration Area.

One example is from the Scripps Institution of Oceanography (SIO) which compiled a database of polymetallic nodules information from numerous sources (referenced in the database), last updated in 1981 (NOAA, 2013 a). As a comparison exercise, this dataset has been clipped to the CCZ and analysed for comparison with the available ISA database. Note that as the vast majority of these samples were collected by dredging and coring, abundances have not been estimated or recorded, and therefore only grade analysis is possible.

The dataset is available at <http://www.ngdc.noaa.gov/mgg/geology/sionar.html> and was downloaded and imported into Microsoft Access, with some minor format alteration in the process. This database was then saved and accessed directly from ArcGIS.

A polygon representing the boundaries of the CCZ (Figure 12-2) was used to query the database, and create a subset containing only samples within this zone. The mean values are included in the table below.

Table 12-1: Mean Grades of the CCZ Nodules from Various Sources

Ni (%)	Cu (%)	Co (%)	Mn (%)	Abundance (wet kg/m ²)	Number of Samples	Source
1.24	1.03	0.22	27.2	6.5	2196	Data supplied by ISA (All CCZ)
1.22	1.06	0.24	26.9	8.5	255	Data supplied by ISA (TOML Exploration Area)
1.20	0.98	0.20	26.3	-	-	McKelvey et al., 1983
1.22	0.97	0.16	24.5	-	160	SIO (NOAA, 2013a)
1.29	1.19	0.23	29.1	-	-	Friedrich et al 1983
1.28	1.16	0.23	24.6	-	-	Mielke (1975)
1.3	1.0	0.23	24.6	17	141	Ruhlemann et al.(2011) west area
1.3	1.1	0.17	24.6	10	237	Ruhlemann et al.(2011) east area

12.7 Adequacy of Data

Golder considers the sampling data is suitably supported and maintained by ISA for the purpose of estimating resources to an Inferred level of confidence.



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

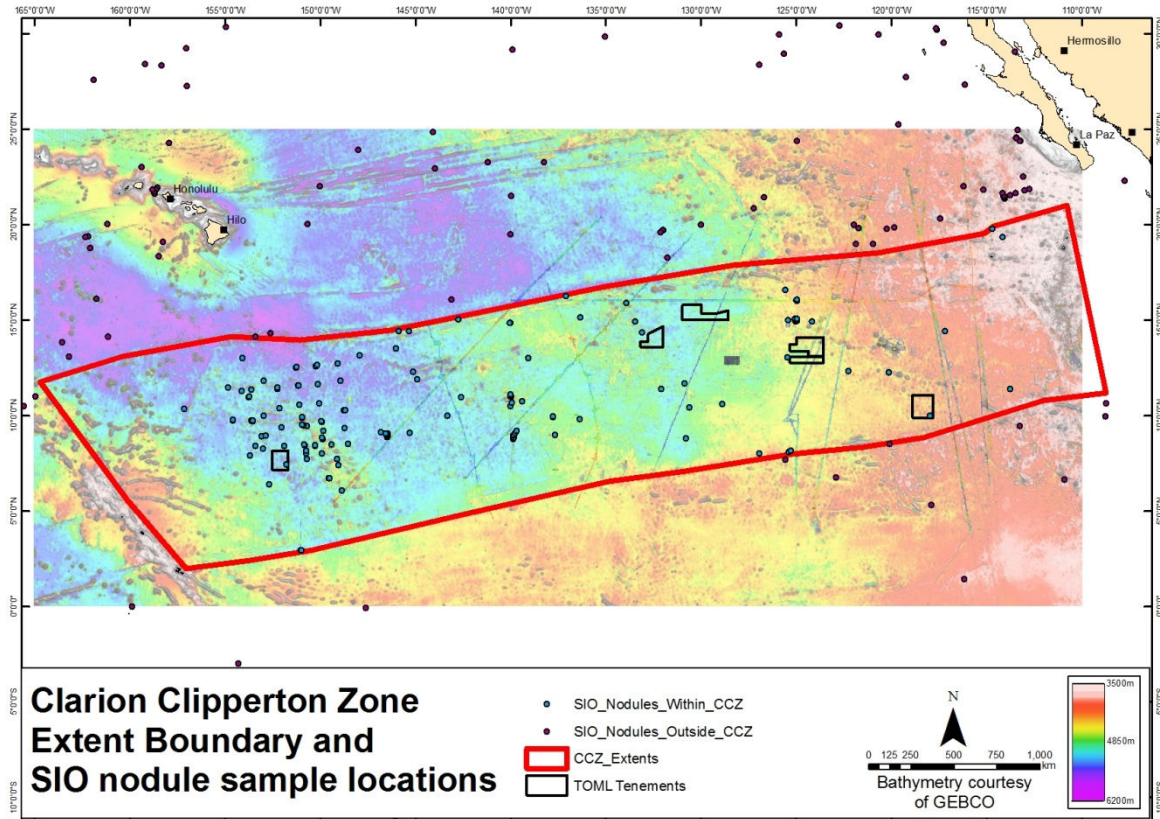


Figure 12-2: CCZ Showing Boundary used to Clip the SIO Polymetallic Nodules Dataset



ITEM 13. MINERAL PROCESSING AND METALLURGICAL TESTING

TOML has not done any mineral processing or metallurgical test-work on the seafloor nodules from the TOML Exploration Area. Such test work will be incorporated into a prefeasibility study planned for 2013-2014.

However, considerable historical work has been done, predominately at a laboratory scale, with some test work at a pilot plant scale (Sen, 2010), which indicates that processing of the nodules is technically feasible. To maximise recoveries of valuable metals the high valence Mn lattice in nodules has to be broken down either through pyrometallurgical or hydrometallurgical/biohydrometallurgical reduction.

Haynes et al (1985), in a NOAA funded US Bureau of Mines managed study, examined in detail the chemistry, morphology, and mineralogy of the nodules as well as five discrete processing routes. The processing routes are either solely hydrometallurgical or combinations of pyrometallurgical and hydrometallurgical processes, and were investigated at the bench top scale with nodule feed with a specific focus on tailing and slag composition (Haynes et al, 1985). The potential process routes (Figure 13-1) include:

- Gas reduction and ammoniacal leach process (Caron process)
- Cuprion ammoniacal leach process (as developed by Kennecott in their nodule studies in 1970s and 80s)
- High temperature and high pressure sulfuric acid leach process (HPAL)
- Reduction and hydrochloric acid leach process
- Smelting and sulfuric acid leach process

These processes use either an acid or ammoniacal leach followed by solvent extraction and electro-winning for the selective recovery of copper, nickel and cobalt metals. The first three processes are three-metal recovery systems with manganese reporting to a waste stream, with the last two also recovering manganese. The cuprion process operates at atmospheric pressure and temperature and flotation of the tailings can produce commercial grade manganese concentrates (NIOT, 2008).

Additional process routes, including biohydrometallurgy and alternative reducing agents, have been studied, e.g. Wang et al (2005, Figure 13-1) and general reviews by Mukherjee et al. (2008) and Sen (2010).

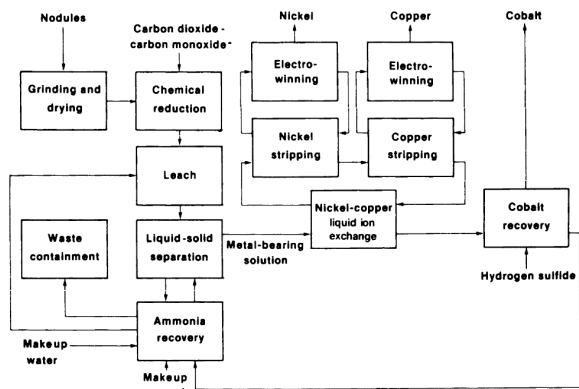
Haynes et al (1985) and Wang et al. (2005) both conclude that the studied flow sheets for nodules are technically feasible. At the laboratory (bench top) scale Ni, Cu and Co recoveries vary but for the processes not using ammonia leach generally exceeded 90%. For the ammonia leach type processes recoveries vary with Haynes et al (1985) achieving greater than 90% for Ni and less for Co and Cu and Wang et al.(2005) achieving 95% for Cu, 65% for Co and 84% for Ni.

Neither Haynes et al (1985) nor Wang et al. (2005) reported Mn or REE recovery, although the smelting process produced Mn rich tailings and a ferro-manganese product, and the hydrochloric acid leach process could also produce manganese. Sen (2010) reports process options with manganese recoveries of 85%. In NIOT (2008) COMRA reports that pilot tests on 'smelting – oxidative leaching-SX' returned metal recoveries of Ni, Cu and Fe of greater than 90%, Co of 89%, and Mn of 82%, while IOM, who studied both hydro and pyrometallurgical process routes, report extraction efficiencies via sulphur-dioxide leaching of greater than 98% for Ni and Mn and greater than 90% for Co.

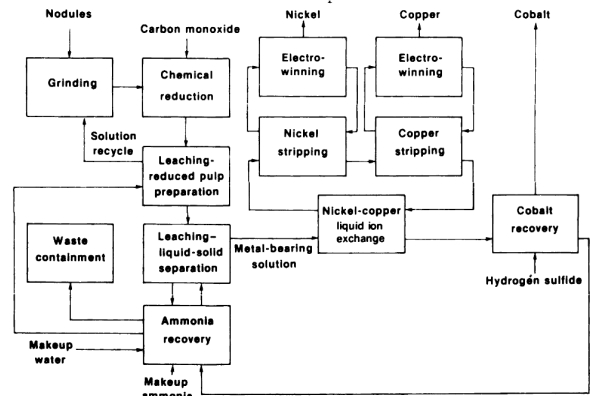
Spickermann (2012) does not look at how REE could be extracted, but notes that any hydrometallurgical process that extracts all of the Mn, Ni, Co and Cu (without REE losses or reagent additions) would effectively create a tail with over 3 times the original REE grade. This could be very competitive compared to other REE sources, with substantially lower environmental risks due to the negligible uranium and low thorium contents of nodules.



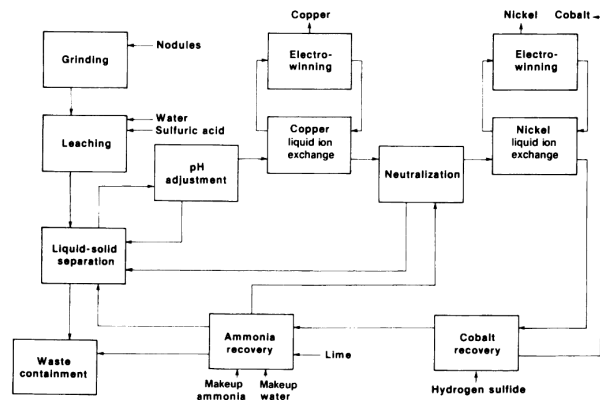
TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN



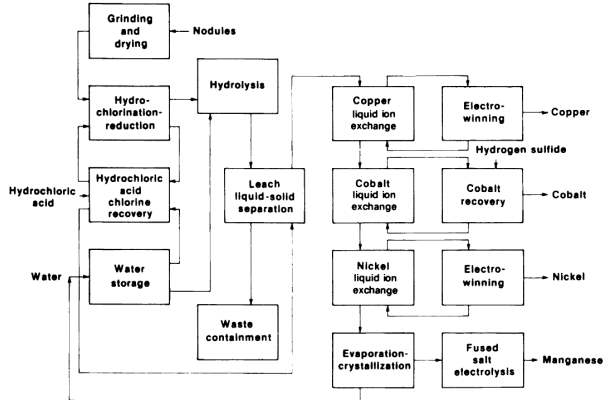
1. Gas reduction and ammoniacal leach



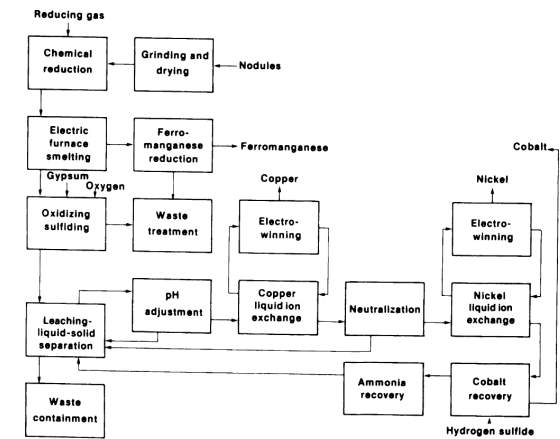
2. Cuprion ammoniacal leach



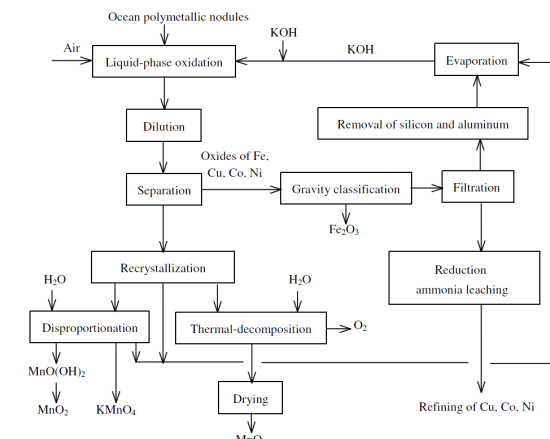
3. High temperature/pressure sulfuric acid leach



4. Reduction and hydrochloric acid leach



5. Smelting and sulfuric acid leach



6. Potassium hydroxide oxidation ammonia leach

1-5 studied by Haynes et al. (1985) and 6 by Wang et al. (2005)

Figure 13-1: Potential Process Flow-sheets for Seafloor Nodules.



ITEM 14. MINERAL RESOURCE ESTIMATES

Estimation of tonnage and grade for part of the TOML Exploration Area within the CCZ was undertaken using only sample data within the TOML Exploration Area. Datamine Studio mining software version 3.20.6140.0 was used for the modelling. The modelling methodology used for estimating the Mineral Resource was determined through careful consideration of the scale of deposit, geological mechanism and controls behind nodule formation and nature of the sampling method (refer also to section 7.3.3). The approach involved estimating nodule abundance and grades into a two-dimensional block model with abundance in wet kg/m² used for calculating tonnage. Grades were estimated using Ordinary Kriging (OK) and, as an interim step, Inverse Distance Weighting (IDW) while abundance was only estimated using IDW. The modelling methodology is similar to the method applied by the ISA (2010) for their global estimate (not NI 43-101 compliant) which was produced after a multi-disciplinary effort that involved several world authorities (ISA, 2010).

Golder has assessed the available information regarding mining and processing of the manganese nodules and concluded that there are reasonable prospects of economic extraction; refer to Item 16 for further details.

14.1 Resource Domains

The occurrence of manganese nodules within the CCZ is controlled by two large scale features: the boundary of the CCZ deposit and the presence of seamounts.

The boundary limits of the CCZ defining the region where nodules have been found to occur is bracketed by the Clarion and Clipperton Fracture Zones to the north and south respectively. The deposit extends to the west and east in a channel between the two fracture zones. The limits to the CCZ occur well outside the boundaries of the TOML Exploration Area. Accordingly, 100% of the TOML Exploration Area falls within the CCZ deposit. Internally within the CCZ deposit the continuity of the distribution of nodules can be reasonably assumed, for the purposes of an inferred mineral resource (section 14.3.1), since the mechanism for the formation of nodules is continental in scale.

Bathymetric features are only likely to play a role in distribution of nodules at a regional scale (Refer to Item 7.2.2). There are principally two regional scale bathymetric domains:

- Sea mount ranges
- Abyssal hill province.

Based on interpretation of the GEBCO bathymetry data from the ISA (Item 7.2.2), less than 2% of the TOML Exploration Area is covered by isolated sea mounts. Effectively, the entire TOML Exploration Area falls within the abyssal hill domain.

Variations in Ni, Cu, Co and Mn grades in nodules may be in part due to varying degrees of diagenetic or hydrogenetic phases of growth, and this may extend to grade variations from the scale of single nodules to several tens of kilometres. However, CCZ nodules are predominantly diagenetic in nature (section 8.1.2) and changes are gradational. Domaining parts of the TOML Exploration Area on the basis of nodule growth type is not possible with the level of data available to this inferred mineral resource estimate and may never prove to be an effective discriminant.

Since the TOML Exploration Area falls within a single bathymetric domain (abyssal hill province) and the CCZ deposit boundary is well outside the areas it was not considered necessary to domain the data .

14.1.1 Domain Statistics

For the 255 sample stations documented within the TOML Exploration Area 229 samples were assayed for Ni, Co, Mn, and Cu. 248 of the 255 sample stations have an effective abundance (wet kg/m²) of greater than 0. Of the 19 samples with missing assays:



- 6 samples fall within area B (Yuzhmorgeologiya) and 3 have very low abundances (≤ 1 wet kg/m^2).
- 13 fall within area C (IFREMER) and all but 1 of these have very low abundances (≤ 1 wet kg/m^2).

Log-probability plots for Ni, Co, Cu, Mn and abundance distributions for all areas are provided in Figure 14-1 and by area in Figure 14-2. Figure 14-2 shows that the distributions for Ni and Cu in TOML Exploration Areas A, B and E are slightly different than Areas C and D. This feature is also present in the full CCZ data set and is attributed to either differences in sampling and assaying and or differences in the relative populations of hydrogenetic and (less) diagenetic nodules (refer to Item 11.3). Box plots provided in Figure 14-3 clarify the differences in assays between areas. Table 14-1 presents the summary statistics for Ni, Co, Cu, Mn and abundance, which shows that the coefficient of variation is very low.

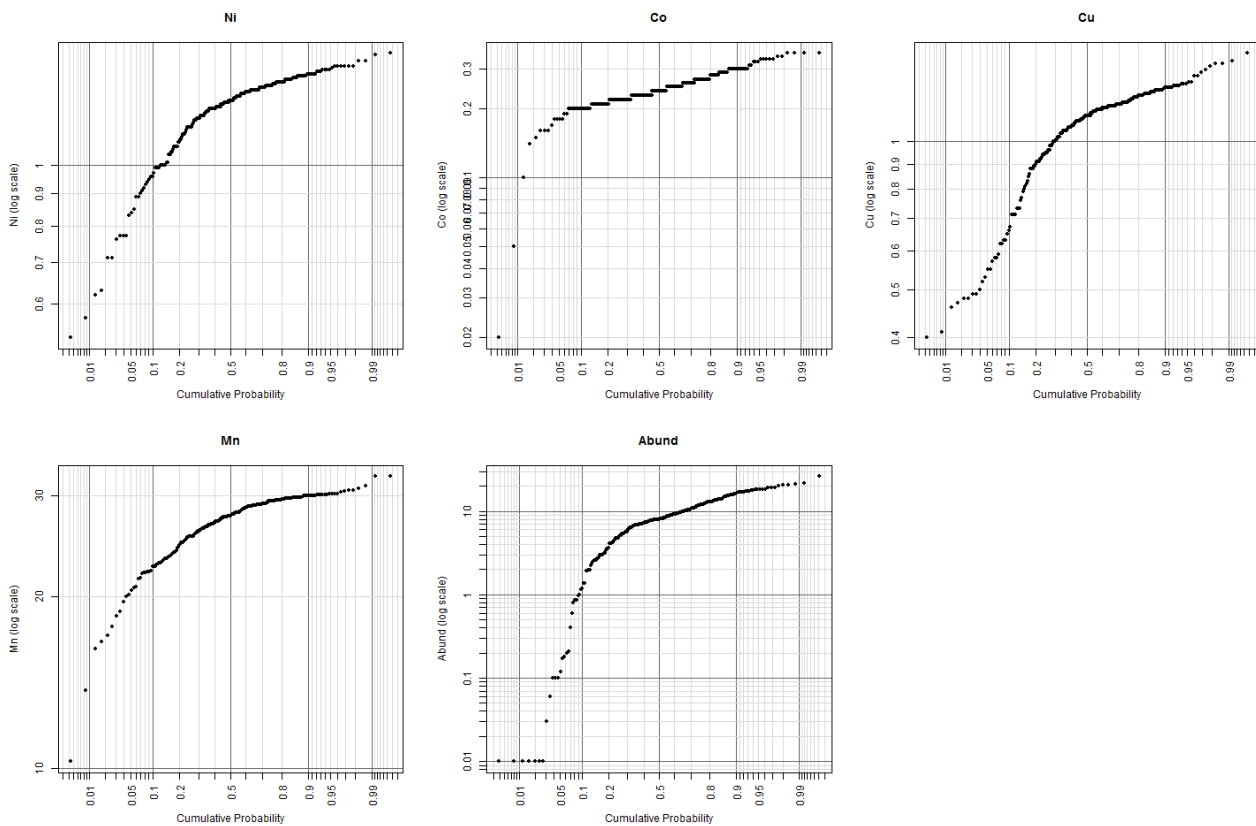


Figure 14-1: Global Grade Distribution for Ni, Co, Cu, Mn and Abundance.



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

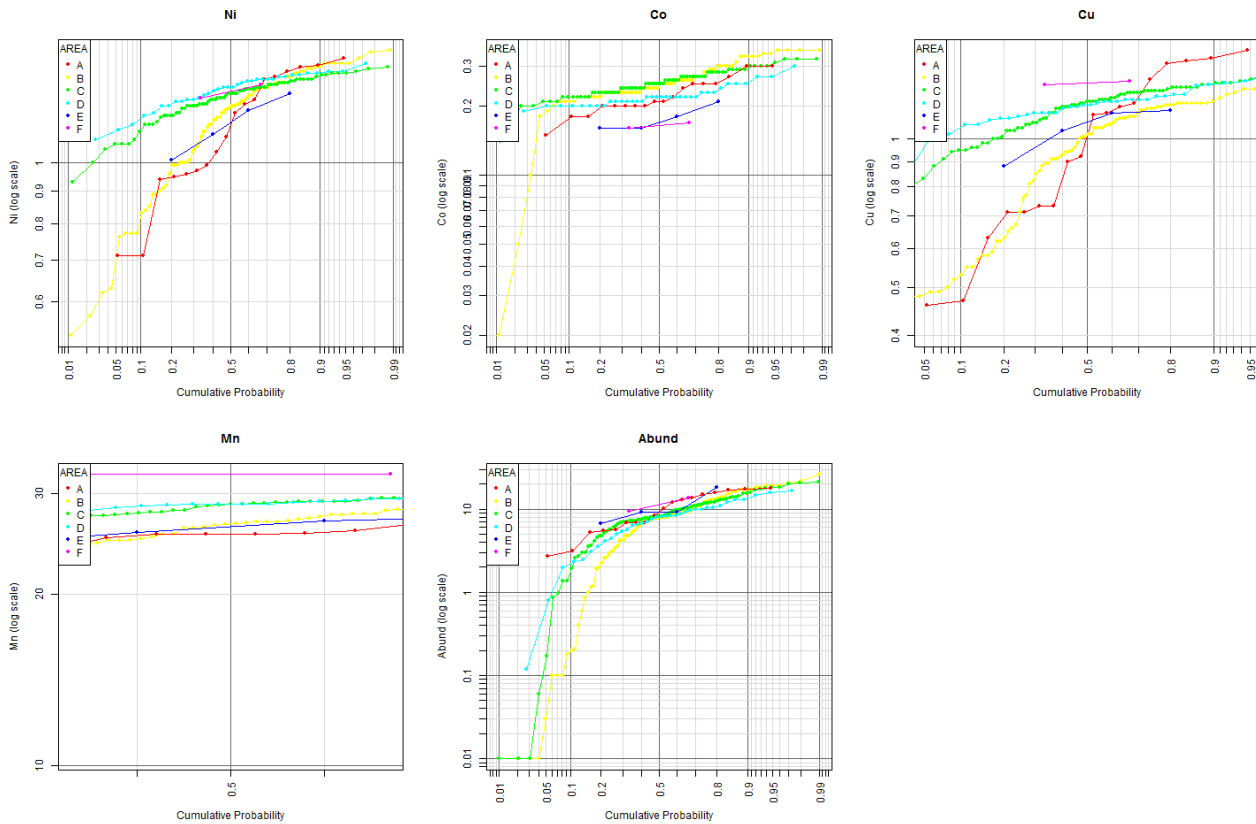


Figure 14-2: Grade Distribution for Ni, Co, Cu, Mn and Abundance within Each of the TOML Exploration Areas.

Table 14-1: Summary Statistics of Samples within the TOML Exploration Area

Variable	Samples	Missing	Min	Max	Mean	Var	CV	Median
Ni	229	26	0.53	1.51	1.22	0.033	0.15	1.27
Co	229	26	0.02	0.35	0.24	0.002	0.18	0.24
Cu	229	26	0.4	1.51	1.06	0.054	0.22	1.13
Mn	229	26	10.3	32.4	26.86	11.236	0.12	27.6
Abundance	255	0	0	26	8.51	27.437	0.62	8.02

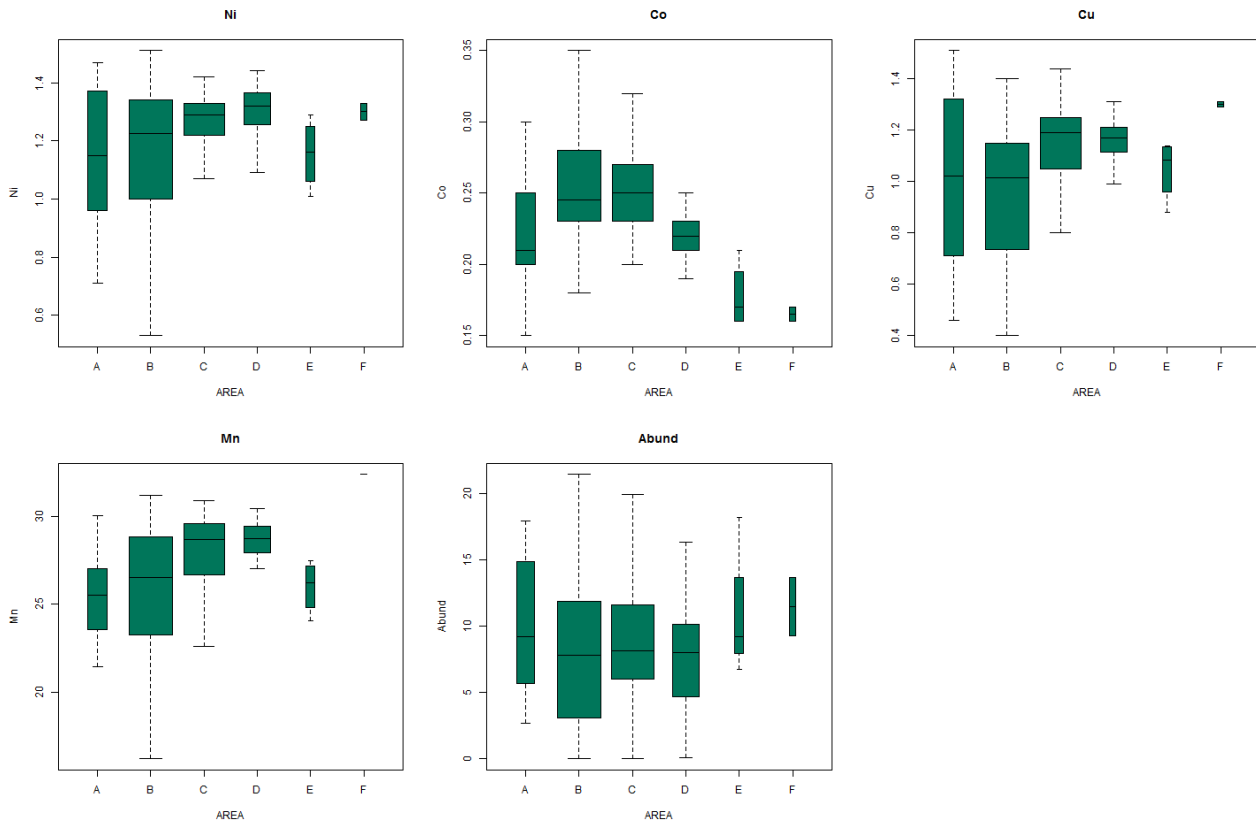


Figure 14-3: Box Plots of Ni, Co, Cu, Mn and Abundance by TOML Exploration Area.

14.2 Data Preparation

The data were briefly validated to check for anomalous or erroneous data. These data were also cross-checked with data supplied directly by ISA.

Data preparation steps included in order:

- Data validation.
- Conversion of latitude/longitude coordinates to UTM coordinates using WGS 84 datum and overlaid onto one coordinate system to facilitate modelling of all areas in one model (Figure 14-4). Table 14-2 lists the minimum and maximum UTM coordinates for each TOML Exploration Area.
- Resetting 0 assay values to missing and 0 abundance values to 0.01 where there are assay values.
- Application of top cuts (see Table 14-4).



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

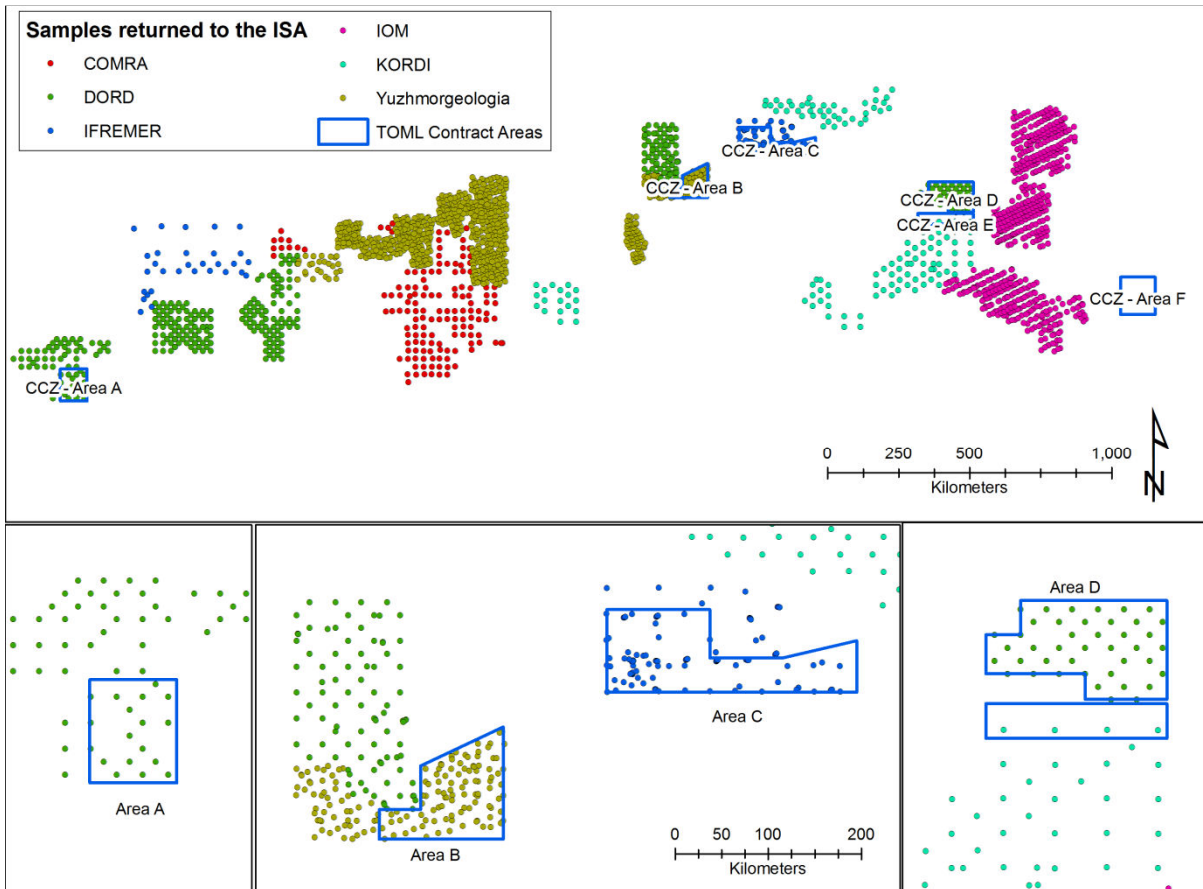


Figure 14-4: Location of Sample Data Supplied Provided by ISA to Golder (TOML Exploration Areas A to D were Included in the Inferred Mineral Resource)

Table 14-2: Minimum and Maximum UTM Coordinates for each TOML Exploration Area

TOML Exploration Area	Easting		Northing		UTM Zone
	Min	Max	Min	Max	
A	553 976.1	647 191.3	792 205.9	902 969.6	5
B	694 523.4	824 684.8	1 502 007	1 623 606	8
C	284 947.0	544 795.5	1 658 368	1 747 831	9
D	247 296.3	437 027.2	1 451 032	1 557 860	10
E	246 691.9	436 798.9	1 409 560	1 447 514	10
F	289 837.4	410 806.1	1 093 913	1 225 830	11

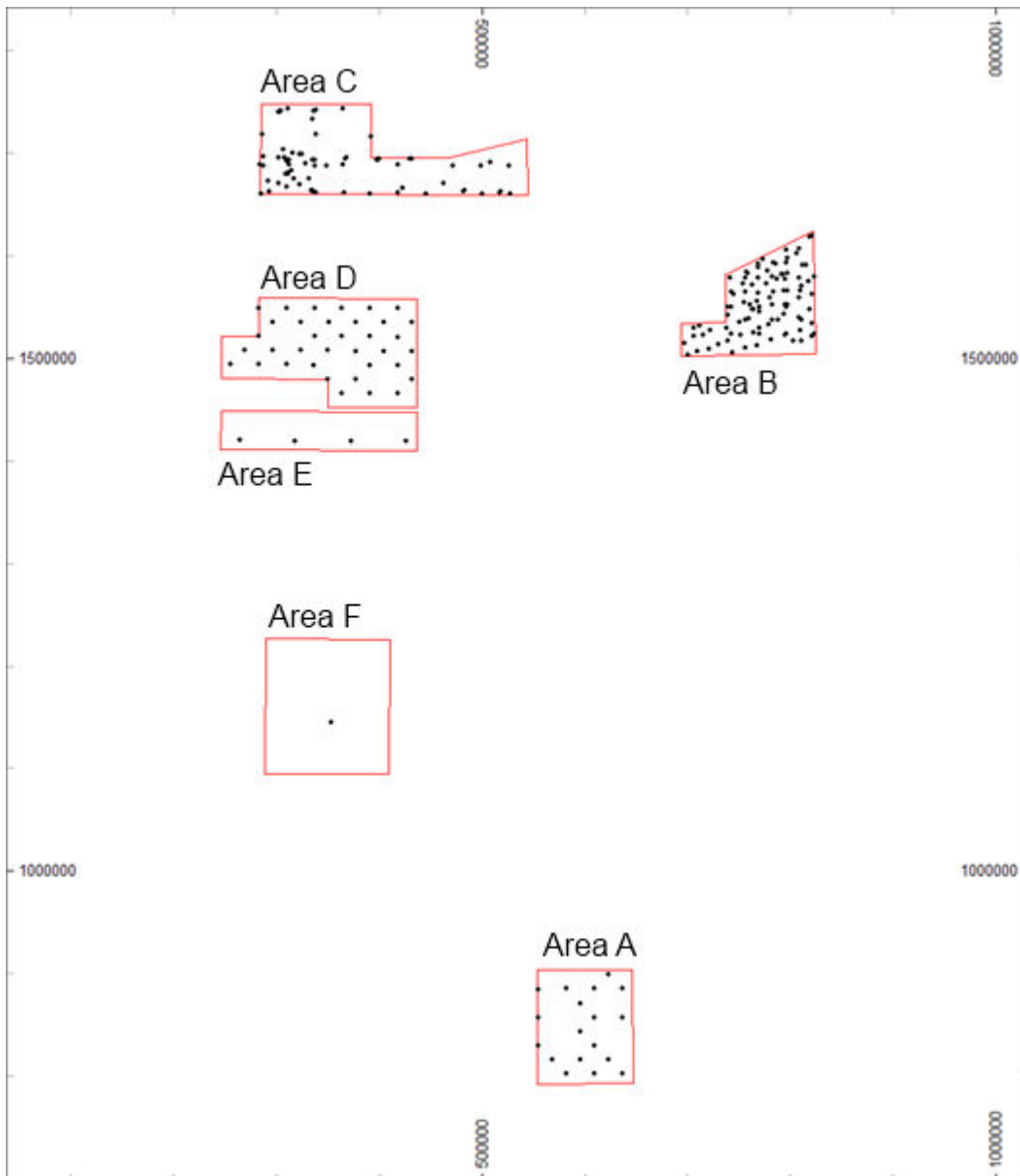


Figure 14-4: TOML Exploration Area sub-areas and Samples in overlain UTM zones.

14.2.1 Declustering

Declustering was used to remove potential biases in statistics that can arise from variable sample spacing. This can arise from the multiple sampling at close locations as the ship undertakes its voyage.

Normal cell declustering without any boundaries can present issues where the edge cells become overweighted as the cell size is increased. A modified cell declustering algorithm was used that weights the cells to the block model volume within each cell. The process provides a declustering weight which is used to weight the univariate statistics (Table 14-3).

For this method the cell size was optimised for a square window size of 30 km and the origin offset 10 times.



Table 14-3: Declustered Statistics

Variable	Samples	Min	Max	Mean	Variance	CV	Median
Ni	229	0.53	1.51	1.23	0.030	0.14	1.27
Co	229	0.02	0.35	0.23	0.002	0.18	0.23
Cu	229	0.40	1.51	1.08	0.052	0.21	1.14
Mn	229	10.3	32.4	27.18	8.517	0.11	27.88
Abundance	255	0.0	26.0	8.76	24.232	0.56	8.16

14.2.2 Top Cutting

The coefficient of variation is very small for Ni, Co, Cu, Mn and nodule abundance suggesting that the application of top-cuts is not necessary. However, due to the wide spacing of samples a top-cut was applied to trim the high (99.5th percentile) values to reduce the likely impact of the high-grade outliers.

The presence of outliers (or 'extreme' values), and the need to apply 'top-cut' values or 'capping', (where samples above a certain threshold are assigned the top-cut value) to sample populations was assessed using a number of techniques:

- Examination of grade distributions using probability plots, see Figure 14-1 and Figure 14-2
- Statistical assessment of the grade distributions, see Table 14-3
- Examination of the spatial locations of identified outlier samples

Top cuts defined in Table 14-4 are roughly equivalent to the 99.5th percentile of the mineralised samples and do not have a significant impact on the average grade. Application of top cuts reduced the mean only for Mn which was reduced by a very low 0.2% of the uncut mean. This is simply because the grades within the CCZ are very consistent due to the deposit's hydrogenetic and diagenetic origin.

Table 14-4: Global Top Cuts

Variable	Top Cut Value
Ni	1.47
Co	0.35
Cu	1.44
Mn	30
Abundance	20

14.3 Variography

The samples with top cuts applied were used for variogram analysis. Traditional semi-variograms show good structure and were used for all variogram modelling. The semi-variograms were scaled to the population variance. Variogram maps (Figure 14-7) were calculated for the purpose of determining direction of greatest continuity.

Semi-variogram models are presented in Table 14-5.



Table 14-5: Variogram Models

Variable	Nugget		Gaussian Structure 1	
	C0	C1	Range H1	
			Along Strike (km)	Cross Strike (km)
Ni	0.2	0.8	30	18
Co	0.2	0.8	18	18
Cu	0.2	0.8	50	35
Mn	0.2	0.8	30	18
Abundance	-	-	-	-

Where possible, variogram model parameters were retained at similar values between orientations, and the different variables, so as not to produce artefacts in the estimations. In particular this was done to ensure element relationships or correlations evident between samples are respected implicitly during estimation and reflected in the resource estimate. Also, the same type of variogram model was fitted to the experimental semi-variograms.

Gaussian variogram models were fitted to the experimental semi-variograms. Typically, spherical models are sufficient for modelling the spatial continuity but in this case the Gaussian model fits the data better. The Gaussian models give greater weight to the very close samples (in the range of 0-5 km) and then rapidly decay to the sill compared with the spherical model. This fits in with the likely short range variability possibly being controlled by ridges in the abyssal hill province which are of the frequency of 3 to 5 km and are oriented approximately north-northwest. TOML Exploration Area C (Figure 14-5) shows the location of strings of closely spaced sampling with a spacing of approximately 500 m.

Spherical models were also fitted (not presented in the report) and used in estimating grades and the results are almost identical to the estimates produced using Gaussian variograms. This is principally due to the very low variance in the assays.

The direction of greatest continuity from the variogram maps is 060° which is roughly parallel to the broad regional trend of the CCZ. Smaller scale local trends oriented parallel with bathymetry ridges are not visible in the wide spaced data.

The long range experimental semi-variograms for abundance are erratic with an almost nugget model (Figure 14-9). Figure 14-6 shows the semi-variogram for abundance using short range data. From the short range data there is some spatial correlation but not visible in directional variograms due to insufficient data.

Additional variogram parameters used in most cases for semi-variogram calculation include:

- One structure Gaussian models with common nugget and incremental sill levels
- Lag distance of 5 km
- Horizontal search angle of 20°
- Vertical search angle of 10°
- Horizontal distance of 10 km



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

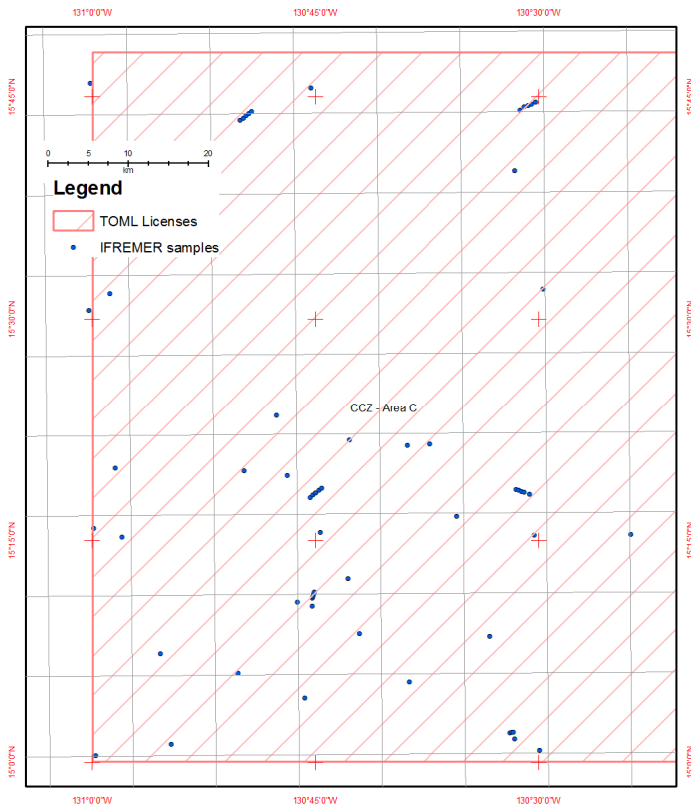


Figure 14-5: Location of Close Spaced Sampling in TOML Exploration Area C (TOML, 2012).

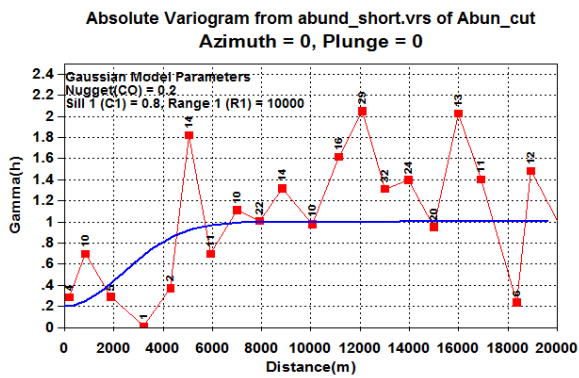


Figure 14-6: Abundance Variogram Using Short Range Data.

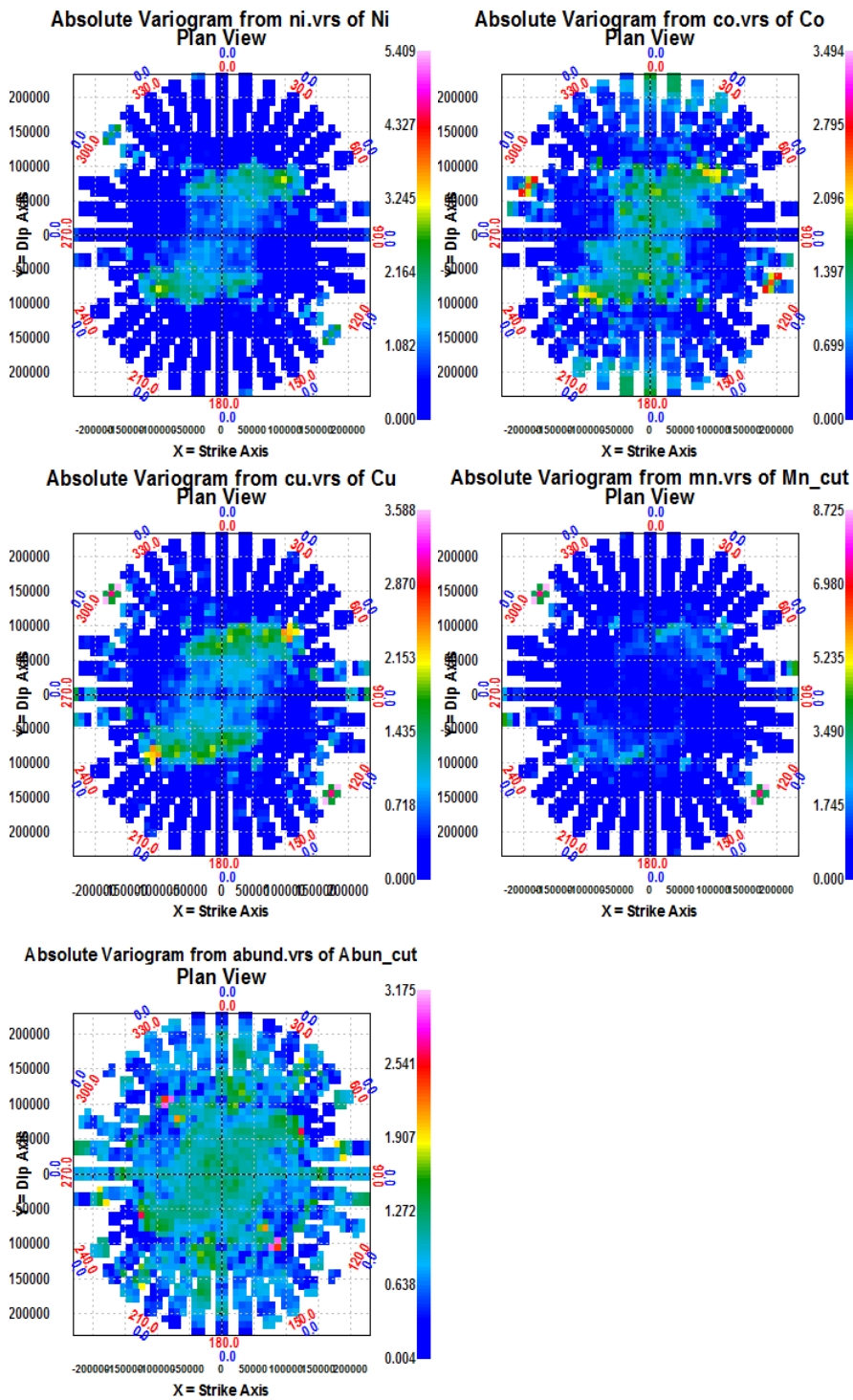


Figure 14-7: Semi-Variogram Maps for Ni, Co, Cu and Mn and Abundance.



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

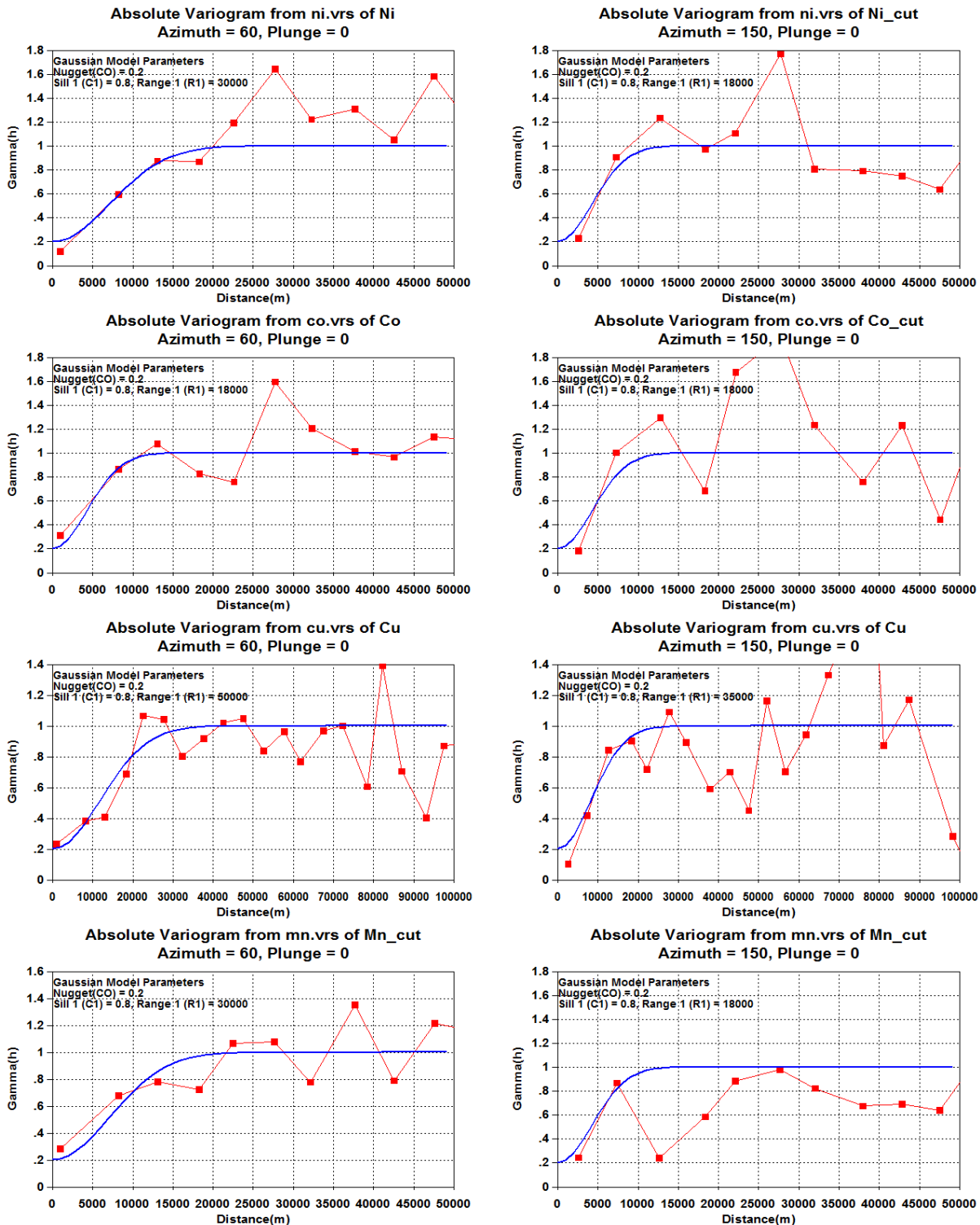


Figure 14-8: Major and Semi-Major Semi-Variograms for Ni, Co, Cu and Mn.

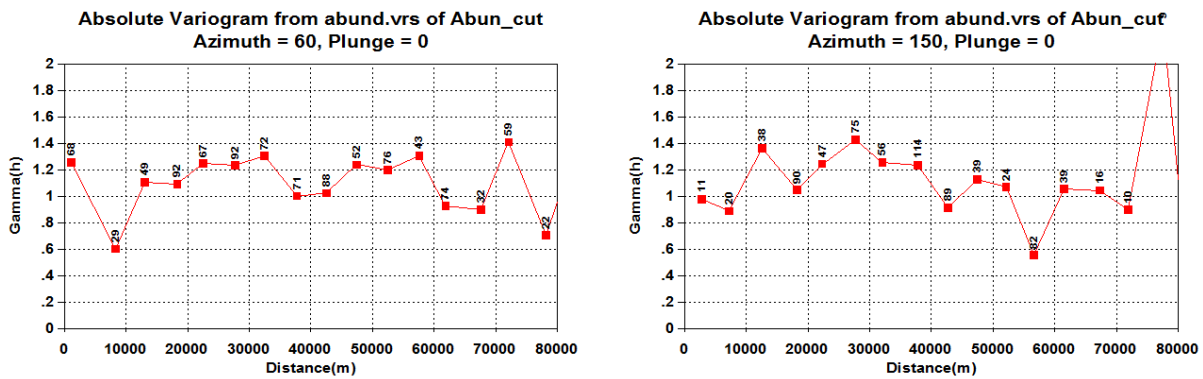


Figure 14-9: Experimental Semi-Variograms for Nodule Abundance (annotated with number of samples).

14.3.1 Representativeness of Sampling

Continuity of grades and abundance between sample points can be reasonably assumed for several reasons. Firstly the continental scale of the deposit and mode of formation leads to the expectation of low variability. Secondly, statistics of the nodule samples within the reserve blocks of the CCZ show very low coefficient of variation which indicates a low risk in estimating and interpolating grades. Thirdly, the variography of the samples within the TOML Exploration Area shows reasonable spatial continuity with ranges greater than the average sample spacing for Ni, Cu, Co and Mn. While abundance has a more erratic variogram with shorter ranges, this is thought to reflect in part the sampling method which results in under-sampling of nodules at some locations (section 9.2). Fourthly, reasonable indications of continuity in nodule abundance can be seen in the sample-block comparison map comprising Figure 14-15.

Golder considers that the sample density and spacing within the TOML Exploration Areas A to D are sufficient to demonstrate continuity of Ni, Cu, Co and Mn while continuity of abundance can be reasonably assumed on the basis of the scale of the deposit and the mechanisms of nodule formation.

14.4 Geological Block Model

The block model contains 1051 blocks representing Ni, Co, Cu, Mn and abundance of polymetallic nodules. The model was built using the model framework defined in Table 14-6 and with additional block attributes listed in Table 14-7. A vertical block size of 1 m was used, essentially creating a two-dimensional model.

Blocks were added to the model using the limits of the TOML Exploration Areas. Parent blocks were split into sub-blocks to ensure reasonable resolution of the boundaries of the Areas.

Table 14-6: Block Model Framework (overlain UTM coordinates)

	Easting	Northing	RL
Model origin	246 690	792 200	-0.5
Model limit	826 690	1 752 200	0.5
Model extent	580 000	960 000	1
Parent block dimensions	10 000	10 000	1
Number of parent blocks	58	96	1
Minimum sub-block size	500	500	1



Table 14-7: Model Variables

Variable	Type	Description
AREA	alphanumeric	Tenement area (A to F)
Ni	numeric	Estimated Ni weight % value
Co	numeric	Estimated Co weight % value
Cu	numeric	Estimated Cu weight % value
Mn	numeric	Estimated Mn weight % value
Abund	numeric	Estimated nodule abundance wet kg/m ²

The total area of the block model is 74 669 km² which is 99.94% of the actual total area of the TOML Licence Areas of 74 713 km². This indicates that the sub-blocks were adequate for estimating the licence boundaries.

14.5 Grade Estimation

Ordinary Kriging (OK) was used to estimate Ni, Co, Cu, Mn into the block model. Inverse Distance (IDW) to the power of 2 was used for nodule abundance due to the erratic semi-variograms for nodule abundance. Grades were estimated on a parent block basis using block discretisation of 3 by 3 by 1. Grades were also estimated using Inverse Distance (IDW) to the power of 2 for validation of the OK estimates.

To ensure that all blocks in the model had values for Ni, Co, Cu, Mn and abundance a three pass elliptical search strategy was used for selecting the neighbouring samples for estimation. Dimensions of the search ellipse radii were based on the ranges of the variogram models and average sample spacing. The search pass ellipse radii that were used are:

- PASS 1: 30 km by 30 km
- PASS 2: 60 km by 60 km (pass 1 expanded by a factor of 2)
- PASS 3: 90 km by 90 km (pass 1 expanded by a factor of 3)

A minimum of 1 and a maximum of 8 samples were allowed per octant for each search pass with a minimum of 4 and maximum of 32 samples per estimate. The required minimum number of samples per estimate was relaxed to 1 sample for the third search pass. The relatively large number of samples used in the estimate will ensure the estimates are smoothed for this early stage of evaluation.

14.6 Estimation Results

To ensure completeness of the block estimates and avoid potential issues for missing grades the third and final search passes used large search radii to ensure most relevant blocks were assigned estimated grades. This ensured that nearly all mineralised blocks were assigned estimates. Any remaining unassigned grades were set to 0.01% for Ni, Co and Cu and 26.86% for Mn.

The nodule abundance and tonnage curves for various nodule abundance cut-offs is presented in Figure 14-10. This includes only the TOML Exploration Areas A to D. The curves indicate rapid reduction in global tonnage between abundance cut-offs of approximately 7 to 11 kg/m², which brackets the mean abundance for those areas.

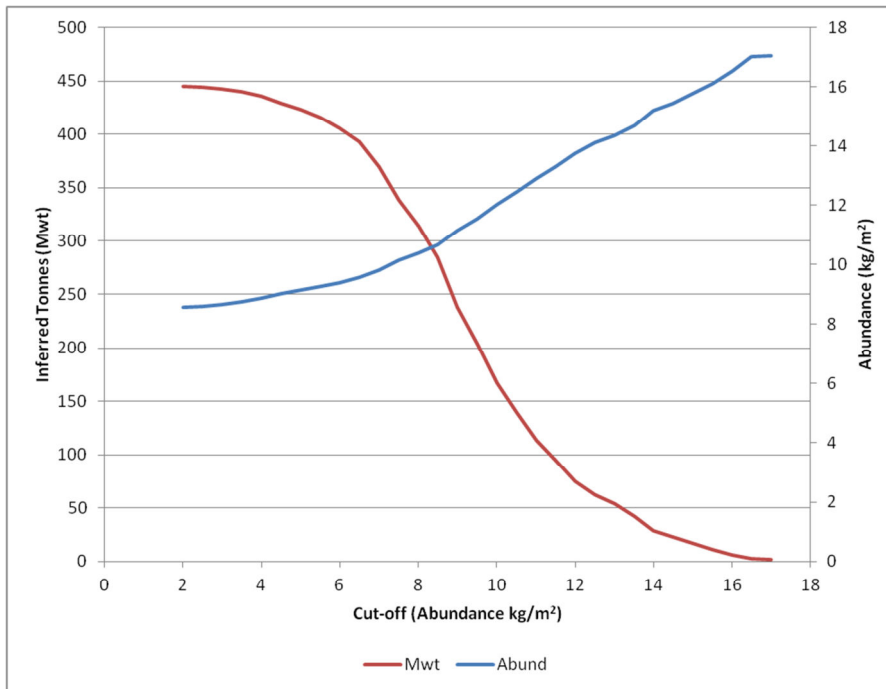


Figure 14-10: Nodule Abundance – Tonnage Curve (only includes blocks A to D).

In the considered opinion of the QP the mineral resource estimate meets the requirement of reasonable prospects for economic extraction (refer also to Item 16). The mineral resource is reported in Table 14-11 at a range of cut-off values to reflect the uncertainty around which effective cut-off will ultimately define the optimum threshold that would be used in eventual economic extraction. With reference to the other relevant items of this report, particular factors of note are:

- Seabed and sea conditions in the TOML Exploration Area are not materially different from other parts of the CCZ;
- Nodules have been successfully extracted in the past and technological advances are likely to make the next attempts much more efficient; today there are twelve other parties considering development; and
- While TOML and Nautilus have not published any economic assessment for mining seafloor nodules in the CCZ, others have (e.g. Yamazaki 2008) and they consider cut-off values in line with those listed in Table 14-11.

Figure 14-11 through to Figure 14-15 compare sample grades with estimated block grades for Ni, Cu, Co, Mn and abundance within the TOML Exploration Areas A to D. TOML Exploration Areas E and F are not shown due to limited data and are not included in the resource estimate. The figures indicate that for Ni, Cu, Co, Mn and abundance there is continuity of grade and abundance at ranges (40 to 80 km) several times greater than the average sample spacing. The patterns in distribution appear consistent between Ni, Cu, Co, and Mn reflecting the homogenous nature of the nodule chemistry across the TOML Exploration Area.



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

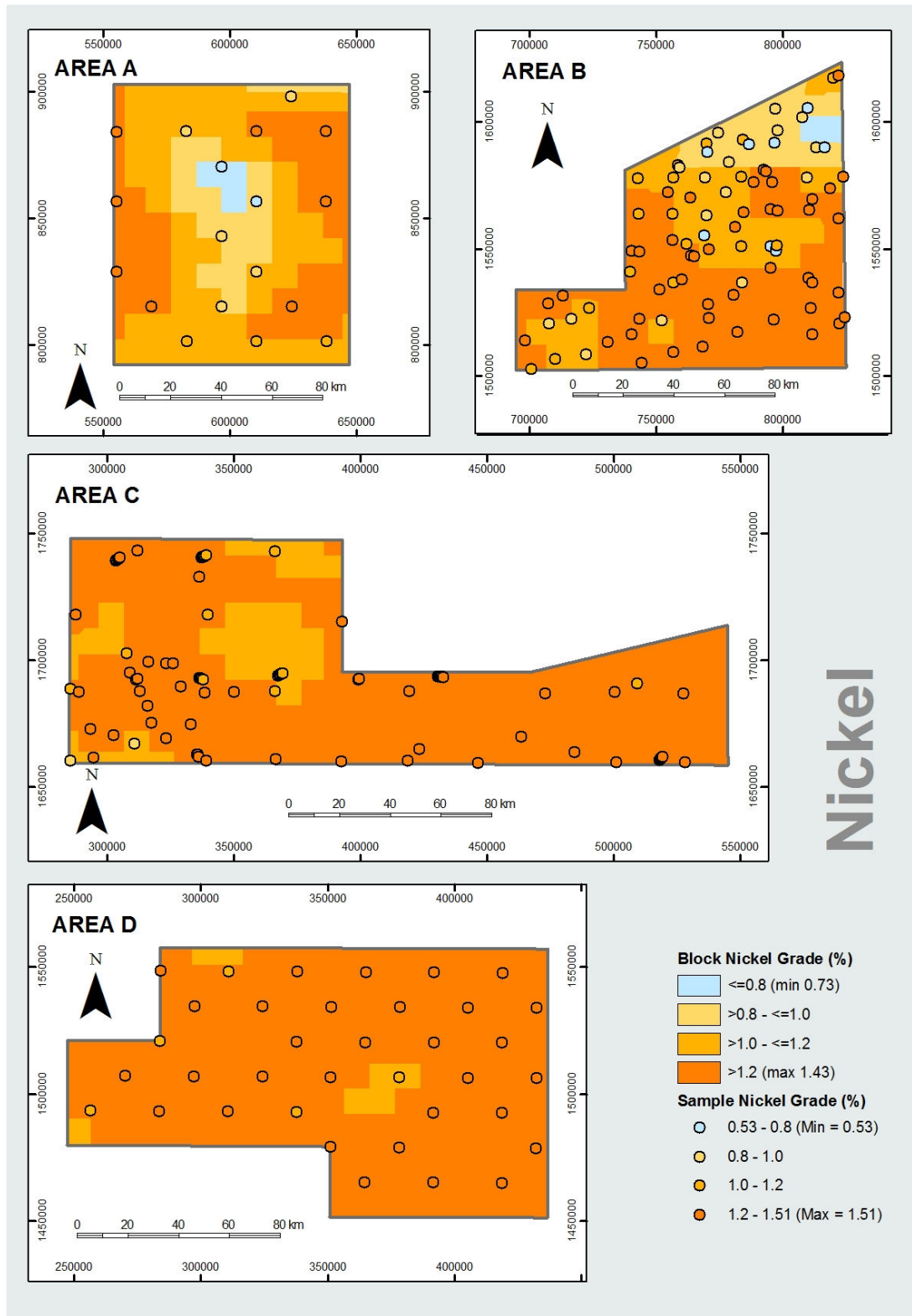


Figure 14-11: Map Showing Block Model and Sample Distribution of Ni in TOML Exploration Areas A-D.



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

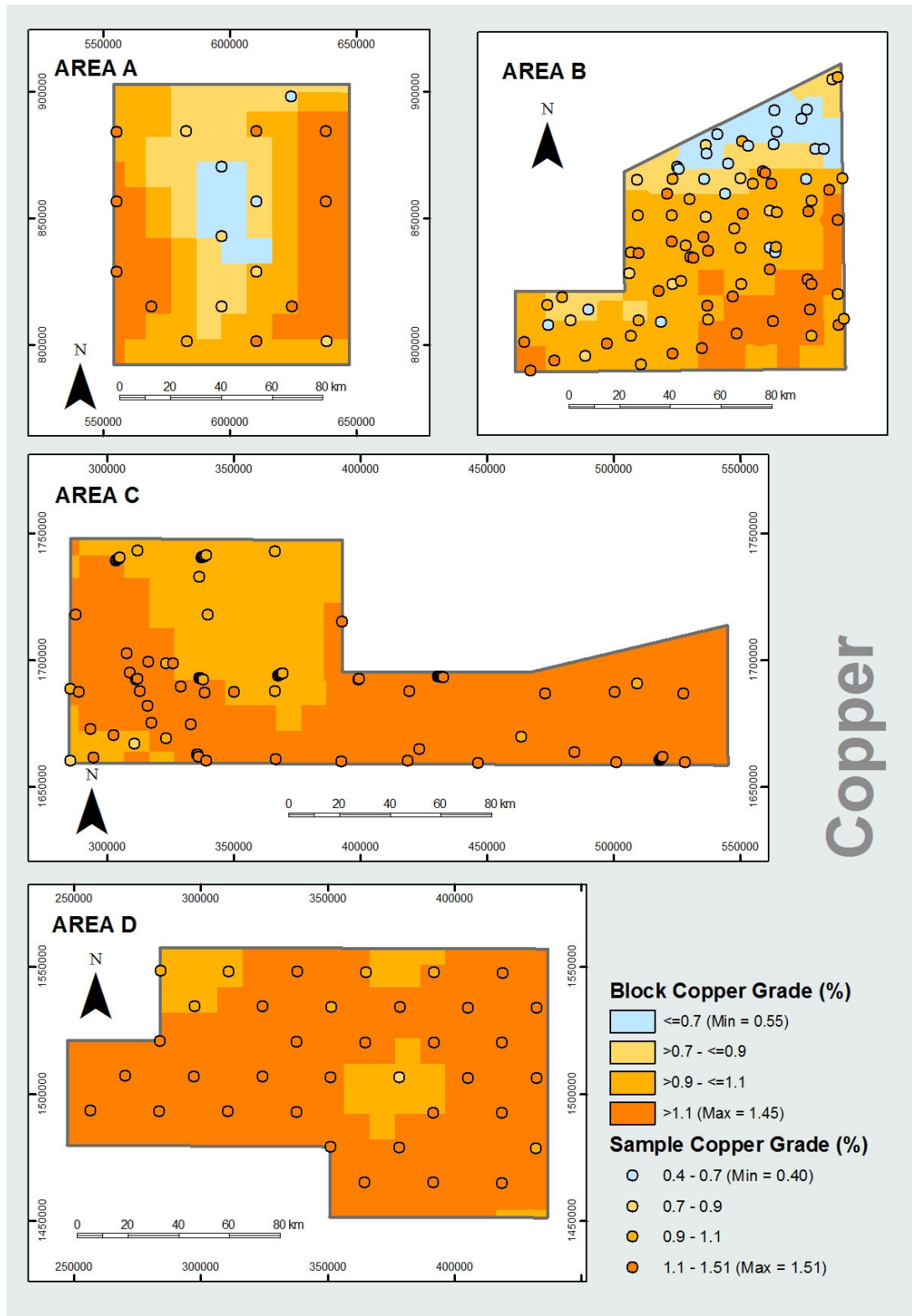
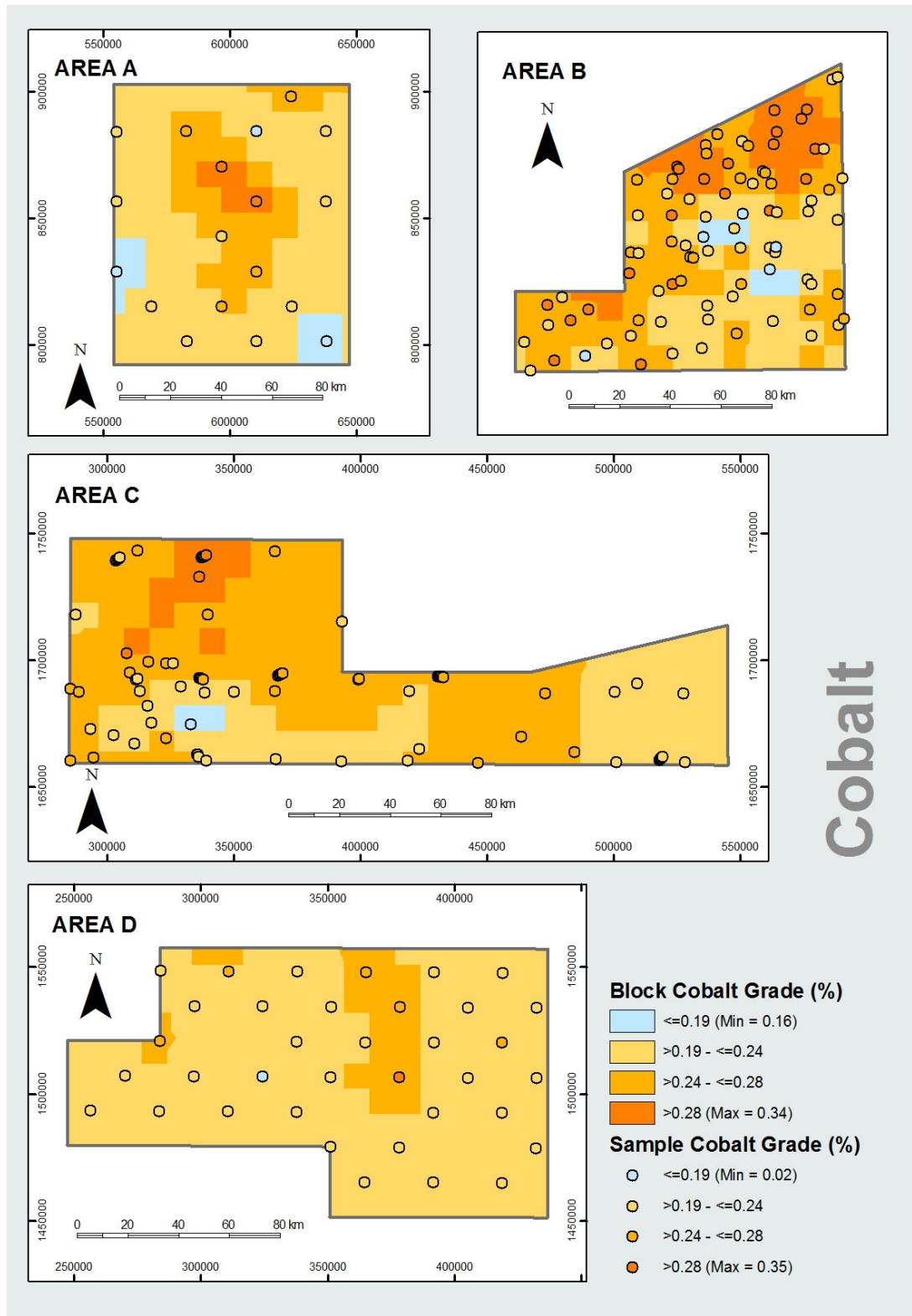


Figure 14-12: Map Showing Block Model and Sample Distribution of Cu in TOML Exploration Areas A-D.



Cobalt

Figure 14-13: Map Showing Block Model and Sample Distribution of Co in TOML Exploration Areas A-D.

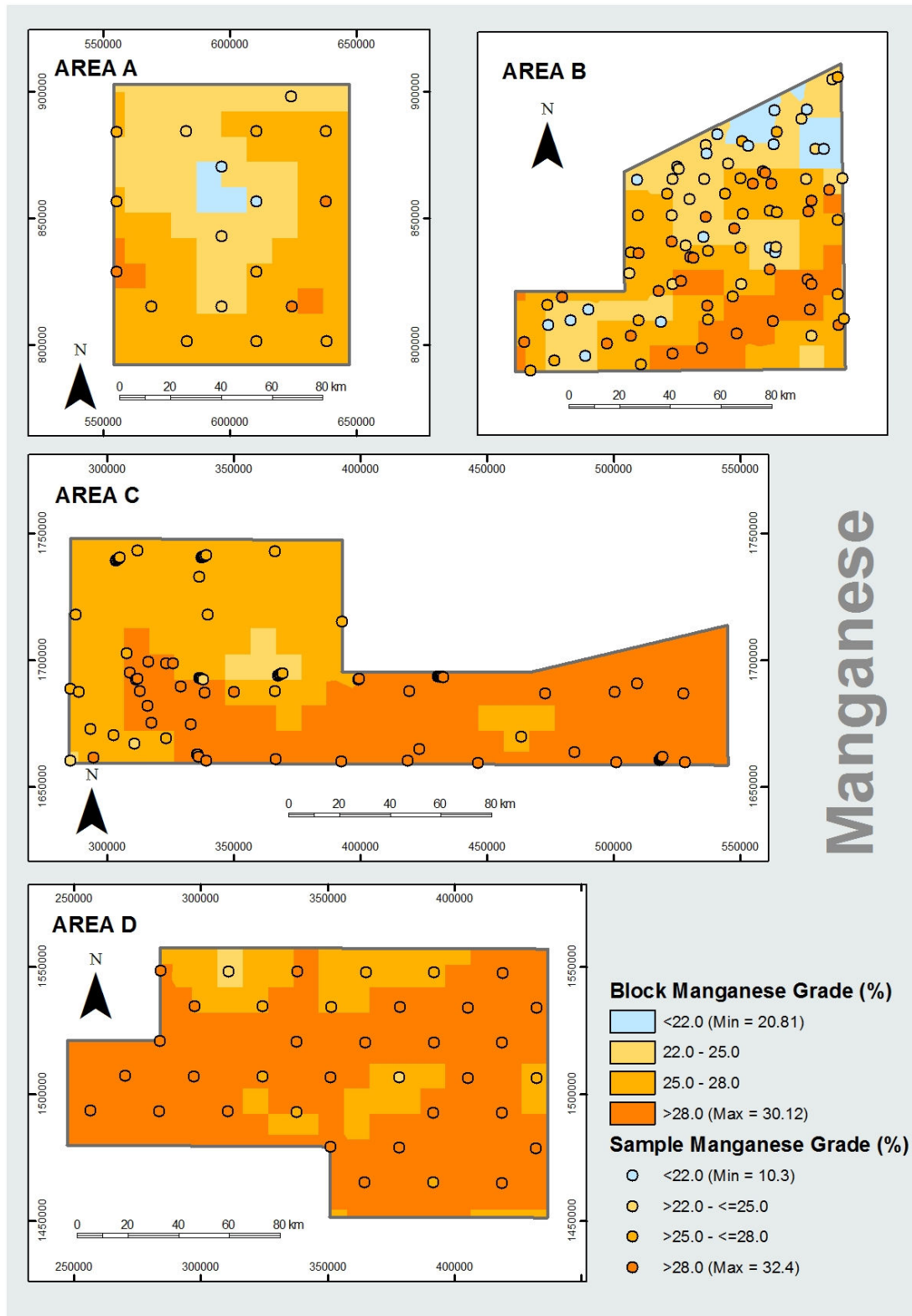


Figure 14-14: Map Showing Block Model and Sample Distribution of Mn in TOML Exploration Areas A-D.



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

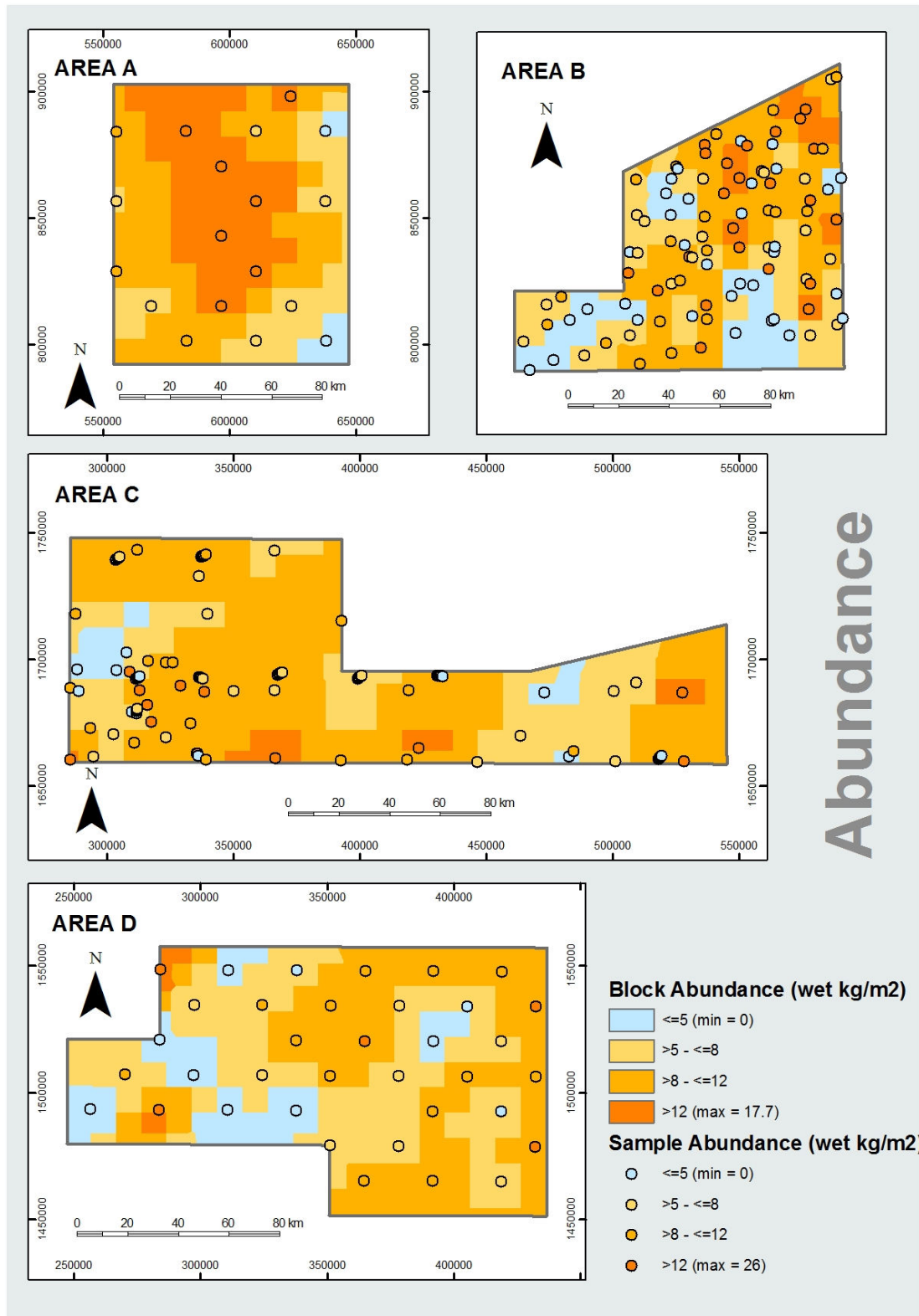


Figure 14-15: Map Showing Block Model and Sample Distribution of Abundance in TOML Exploration Areas A-D.



14.7 Model Validation

Validation of the block model included:

- Visual inspection of the grade estimates
- Global mean and variance comparisons
- SWATH plots (in UTM coordinates) for TOML Exploration Areas A to D (Figure 14-16 to Figure 14-20). TOML Exploration Areas E and F were excluded due to limited sampling. These areas are known to contain nodules, and as they represent on an aerial basis approximately 30% of the total TOML Exploration Area, they present significant upside to the existing resource estimate. The SWATH plots include comparison of block model and declustered composite grade averages for North-South slices

The SWATH plots show good agreement between the average estimated grades compared with the sample average grades by slice.

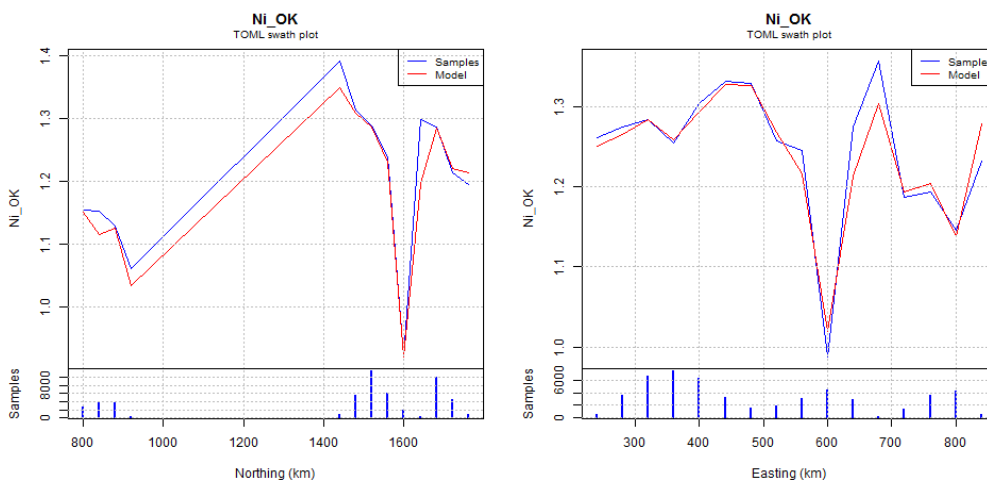


Figure 14-16 SWATH Plots for Ni in the Easting and Northing Directions.

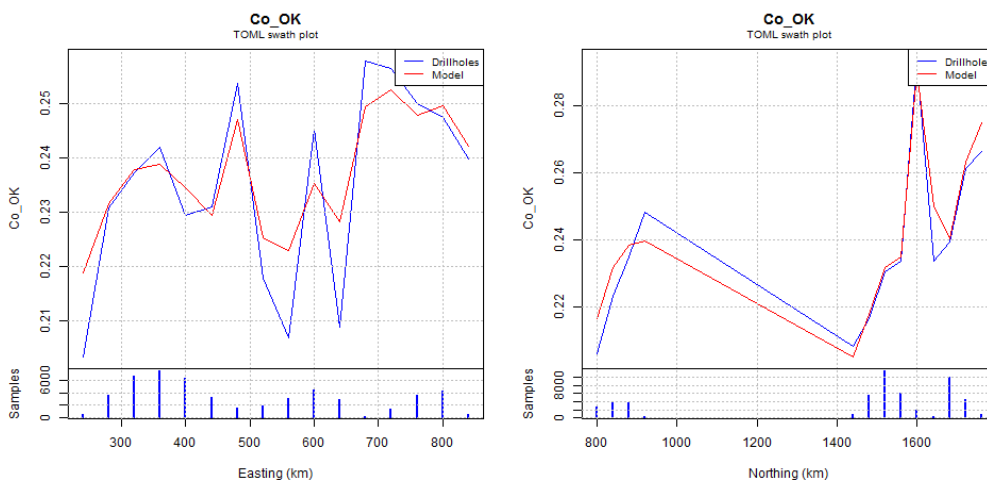


Figure 14-17 Swath Plots for Co in the Easting and Northing Directions.



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

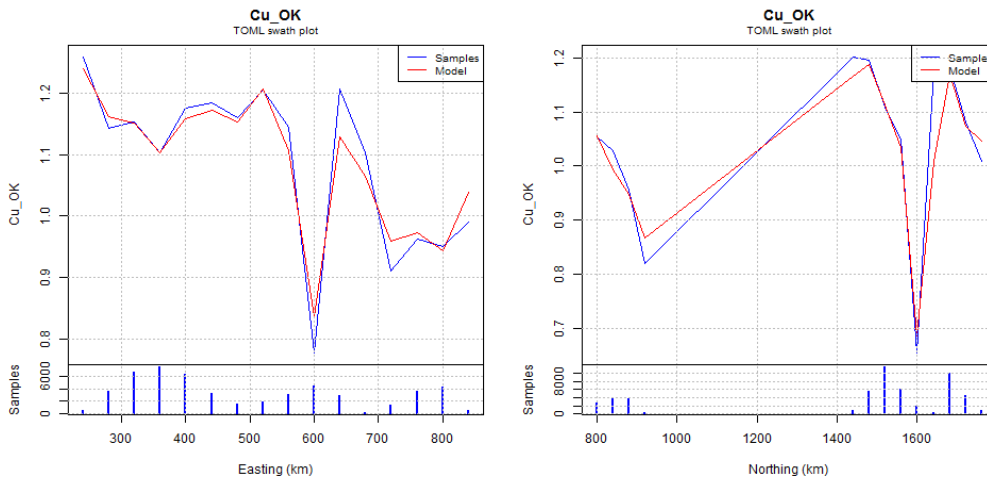


Figure 14-18 Swath Plots for Cu in the Easting and Northing Directions.

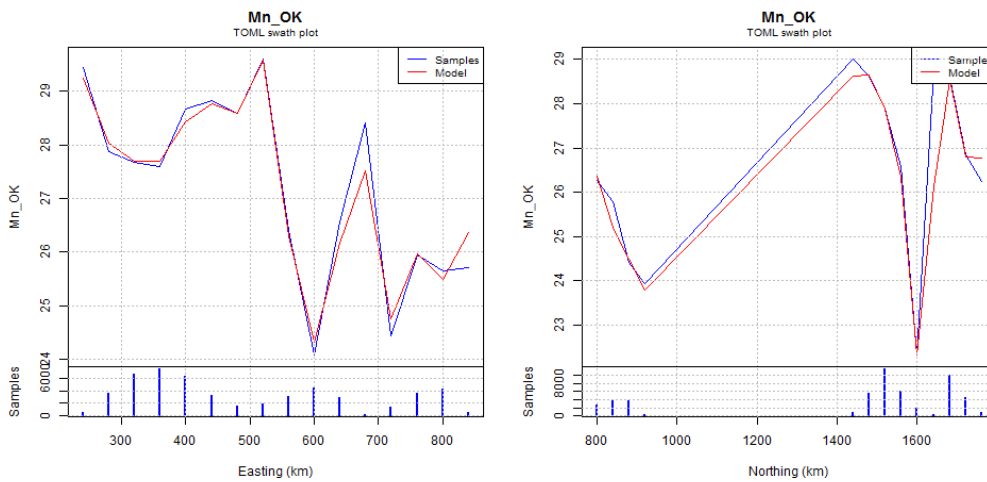


Figure 14-19 Swath Plots for Mn in the Easting and Northing Directions.

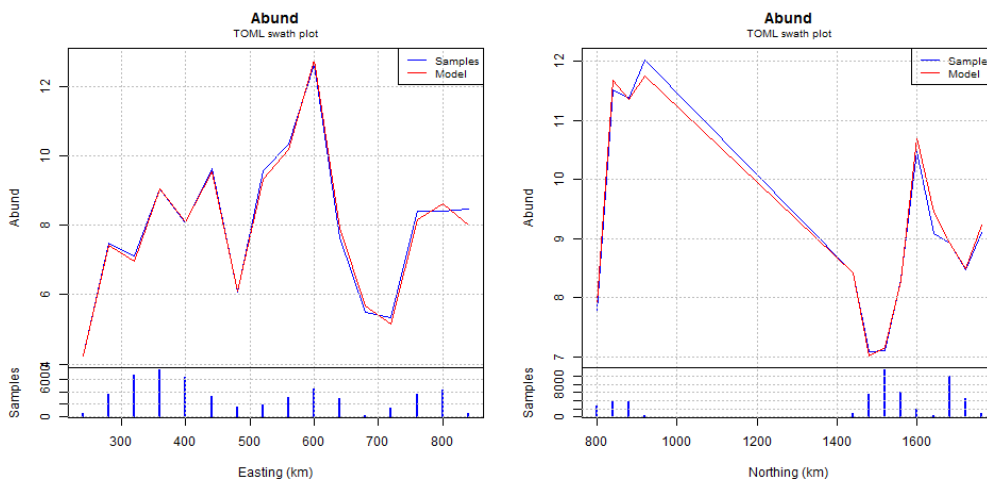


Figure 14-20 Swath Plots for Abundance in the Easting and Northing Directions.



A comparison of the global mean and variance between the declustered composites and the volume weighted block model estimates for each combined domain is provided for Ni, Co, Cu, Mn and Abundance in Table 14-8. The mean grades compare favourably and indicate no significant bias. The comparison of the OK and IDW estimates are globally identical while individual cells show minor variance.

Table 14-8: Global Mean and Variance Comparison

		Samples		Estimates	
		Cut	NN	IDW	OK
Ni	Mean	1.22	1.23	1.21	1.21
	Var	0.03	0.03	0.017	0.018
Co	Mean	0.24	0.23	0.24	0.24
	Var	0.002	0.002	0.001	0.001
Cu	Mean	1.06	1.08	1.05	1.05
	Var	0.053	0.052	0.035	0.032
Mn	Mean	26.86	27.18	26.78	26.76
	Var	11.24	8.52	5.67	5.92
Abundance	Mean	8.48	8.76	8.69	-
	Var	26.40	24.23	7.23	-

14.8 Comparison with ISA Regional Assessment for Abundance

ISA (2010) includes a regional resource assessment for the polymetallic nodule deposit of the CCZ determined from ore grade and nodule abundance data provided by several independent sources and consisting of more than 10 000 individual sample stations. This data set includes the dataset used for the Mineral Resource estimate in this report as well as other major proprietary datasets (e.g. OMCO as referred to in ISA, 2010).

An order of magnitude comparison is possible by simply digitising in the abundance contours Figure 14-21. within the TOML Exploration Areas and multiplying the mid value of the respective contour ranges times the area. The original data values behind the ISA model are not available to TOML or Golder.

This comparison aims only to verify the order of magnitude abundances for the CCZ deposit within the TOML Exploration Areas. It does not aim to produce a more accurate or precise estimate as the scale errors in the exercise are significant (although not biased).



TOML CLARION-CLIPPERTON ZONE PROJECT, PACIFIC OCEAN

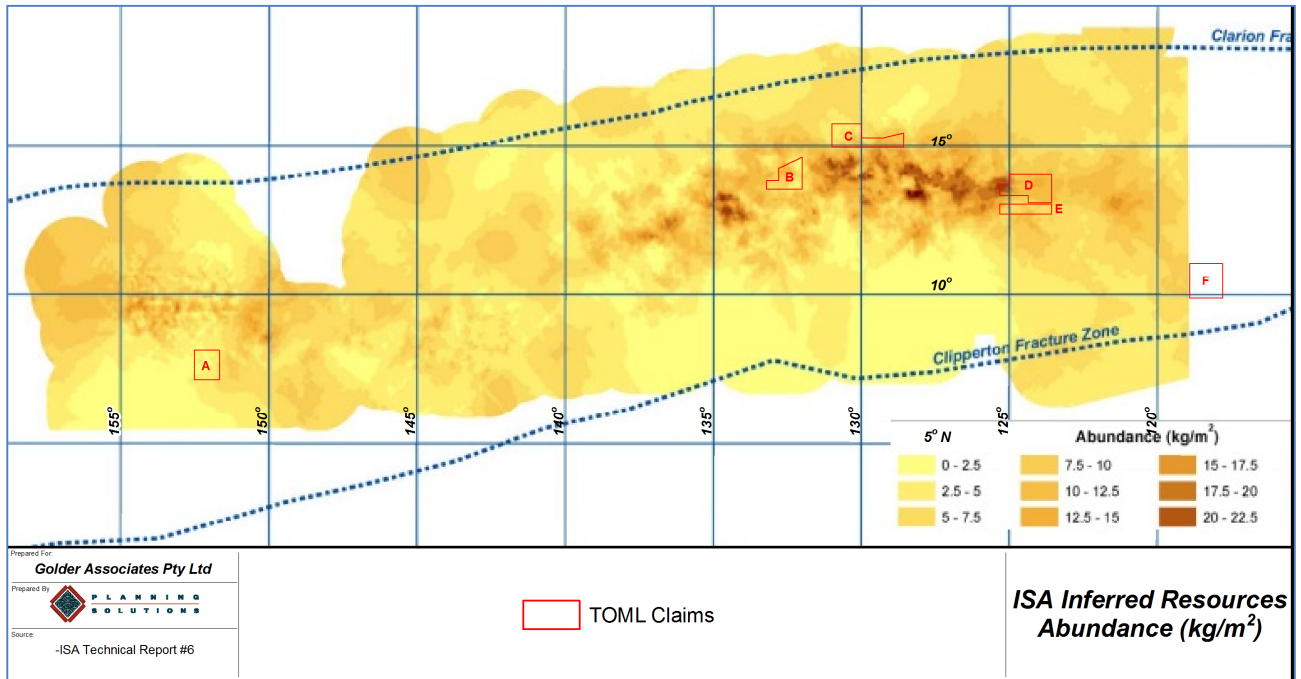


Figure 14-21 ISA Inferred Abundance in TOML Exploration Areas (by Dr Charles Morgan, 2012).

Table 14-9 shows the estimated resource in the TOML Exploration Areas based on this rough method of estimation. It excludes TOML Exploration Area F for which there was no data coverage in the ISA study and TOML Exploration Area E which has insufficient data to be classified as Inferred. Both these areas are however known to contain nodules, and will be assessed as part of TOML exploration. This rough subset of the ISA evaluation indicates similar order of tonnage as estimated by Golder in Table 14-10.



Table 14-9: Estimated Tonnage of Nodules in TOML Exploration Areas A, B, C, and D (Derived from ISA, 2010 Estimate Contour map, Figure 14-21).

TOML Exploration Area	Abundance Range (wet kg/m ²)		Percentage of Area	Area (km ²)	Million Tonnes
	Min	Max			
A	2.5	5.0	100.0%	10 281	39
B	7.5	10.0	43.1%	4 349	38
B	10.0	12.5	56.9%	5 749	64
C	7.5	10.0	33.8%	5 334	47
C	10.0	12.5	55.6%	8 779	99
C	12.5	15.0	10.6%	1 667	23
D	15.0	17.5	73.2%	11 702	189
D	17.5	20.0	19.9%	3 176	59
D	20.0	22.5	4.8%	773	16
D	22.5	25.0	2.1%	339	8
Total Million Tonnes (A, B, C, D)					580

Note this table provides only an interpretation of the ISA estimate which is publically available but does not conform to any international resource reporting code. No qualified person has undertaken sufficient work to classify this work in accordance with NI43-101. It is only presented to support the classified resources estimated by Golder in Figure 14-10, being independently calculated and available on public record.

14.9 Mineral Resource Classification

Golder undertook resource classification on the basis of the quality and uncertainty with the sample data. Accordingly, TOML Exploration Areas A to D are considered to have sufficient continuity to warrant Inferred Mineral Resource classification in accordance with Canadian Institute of Mining, Metallurgy and Petroleum (CIM) definitions. While areas E and F are considered to have insufficient sampling (in the ISA database provided) to be considered for a Mineral Resource estimate and no estimation has been attempted. These two blocks are however known to host nodules, and provide significant exploration upside to the resource calculated above.

14.10 Mineral Resource Statement

The global Inferred Mineral Resource estimate at various nodule abundance cut-offs for the TOML Exploration Area within the CCZ polymetallic nodule deposit is presented in Table 14-10. The Mineral Resource estimate at an abundance cut-off of 4 wet kg/m² is the selected base case scenario considering a non-selective bulk mining operation. The effective date for the estimate is 22 June 2012 (the date when the last of the data used for the resource estimate was received by Golder).

Note that for the Mineral Resource estimate the nodule weight is assumed wet (Item 7.3.3 and 8.1.2).

The QP has assessed the available information regarding mining and processing of the manganese nodules (refer to Item 16) and concluded that there are reasonable prospects for economic extraction.



Table 14-10: Inferred Mineral Resource Estimate for the TOML Exploration Area within the CCZ at a Series of Nodule Abundance Cut-offs.

Abundance Cut-off (wet kg/m ²)	TOML Exploration Area	Abundance (wet kg/m ²)	Ni (%)	Co (%)	Cu (%)	Mn (%)	Polymetallic Nodules (x10 ⁶ wet t)*
4	A	10.8	1.1	0.23	0.9	24.9	110
	B	8.4	1.2	0.25	0.9	25.5	90
	C	8.9	1.3	0.25	1.1	28.0	140
	D	7.9	1.3	0.22	1.2	28.5	110
	Total	8.9	1.2	0.24	1.1	26.9	440
5	A	10.8	1.1	0.23	0.9	24.9	110
	B	9.0	1.2	0.25	0.9	25.4	70
	C	9.1	1.3	0.25	1.1	28.1	140
	D	8.1	1.3	0.22	1.2	28.5	110
	Total	9.1	1.2	0.24	1.1	26.9	420
6	A	11.1	1.1	0.23	0.9	24.8	100
	B	9.2	1.2	0.25	0.9	25.4	70
	C	9.2	1.3	0.25	1.1	28.1	130
	D	8.5	1.3	0.22	1.2	28.5	100
	Total	9.4	1.2	0.24	1.1	26.9	410
7	A	11.5	1.1	0.23	0.9	24.7	100
	B	9.6	1.1	0.25	0.9	25.3	60
	C	9.5	1.3	0.25	1.1	28.1	120
	D	8.9	1.3	0.22	1.2	28.5	90
	Total	9.8	1.2	0.24	1.1	26.8	370
8	A	12.0	1.1	0.24	0.9	24.6	90
	B	10.3	1.1	0.26	0.9	25.4	50
	C	9.9	1.3	0.25	1.1	28.0	100
	D	9.5	1.3	0.22	1.2	28.5	70
	Total	10.4	1.2	0.24	1.0	26.7	310

*Variations in Totals are due to rounding of individual values

Note: TOML Exploration Areas E and F have no estimates attempted, due to a lack of data in the ISA provided database. Both blocks are however known to host nodules, and provide significant upside to the current resource.

This resource was estimated independently by Golder Associates Pty Ltd. A summary of technical items of interest includes:

Tenure

- All resources are held by TOML, a wholly 100% owned subsidiary of Nautilus. TOML is registered in the Kingdom of Tonga and is subject to all appropriate Tongan mining and civil laws and Tongan taxes and royalties.
- The resource falls within four of the six areas within the Contract of Work granted to TOML, which covers the extraction of the polymetallic nodules.



Exploration

- All sampling was collected by pioneer contractors prior to TOML acquiring the property January 2012.

Quality control

- There are no duplicate or blank assay laboratory data available for the sample results supplied to Golder and TOML by the ISA.
- There were six consortia that sampled the CCZ deposit over various parts using different sampling and assaying methods. Comparison of the data between each of the consortia shows that the different sampling achieved similar results over vast areas.

Resource Estimation

- Extensive areas of polymetallic nodules occurrence on the surface of the seafloor at varying abundance.
- Grades are estimated from cut sample assays using parent block ordinary kriging. Elements estimated include Ni, Co, Cu, Mn and nodule abundance.
- Model estimates by ordinary kriging used a parent cell size of 10 km x 10 km. Sub-cells to one 20th (500 m) of the parent cell size were allowed to better represent the area within the TOML Exploration Areas.
- Estimate of tonnage is based on area and nodule abundance (wet kg/m²). Area is used as there is no effective sampling below the immediate seafloor (surface, semi-liquid layer, and weakly consolidated sediment to a maximum of 0.3 m).
- Inferred Mineral Resource classification is based on sampling on a nominal spacing of 20 km, the variation and uncertainty in the sample quality, and the likely presence of short range variation to nodule abundance.
- Estimate of abundance is likely to be biased low based on experience with free-fall grab samples used. Correction factors have not been applied as they cannot be adequately measured at this stage.
- Based on the sampling process it is assumed that the weights in the abundance measurements are wet but there is some uncertainty as it is not clearly specified by each of the pioneer contractors who collected the data or the ISA who supplied it.
- Based on the sampling process the metal grades are reported on a dry weight basis.

Resource Uncertainty

- Uncertainty with local variability of nodule abundance.

Development

- No development of any deep sea resources has been attempted or demonstrated other than some minor trial mining (refer to Item 6 and Item 24).

This Mineral Resource estimate is based upon and accurately reflects data compiled or supervised by Mr Matthew Nimmo, Principal Geologist, who is a Member of the Australian Institute of Geoscientists and a full time employee of Golder Associates Pty Ltd. Mr Nimmo has sufficient experience that is relevant to the style of mineralisation and the type of deposit under consideration and to the activity which he has undertaken to qualify as a Competent Person as defined in the 2004 edition of the 'Australasian Code for the Reporting of Exploration Results, Mineral Resources and Ore Reserves' and as a Qualified Person under NI43-101.



ITEM 15. MINERAL RESERVE ESTIMATES

There are no Mineral Reserve estimates for the TOML Exploration Area of the CCZ and the potential viability of the Mineral Resources has not yet been supported by a preliminary economic assessment, a pre-feasibility study or a feasibility study.

ITEM 16. MINING METHODS

There are no Mineral Reserve estimates for the TOML Exploration Licence Area of the CCZ and the potential viability of the Mineral Resources has not yet been supported by a preliminary economic assessment, a pre-feasibility study or a feasibility study.

In assessing the project for reasonable prospects of economic extraction, the technical delivery and cost effectiveness of a potential mining project have been considered by Nautilus. Although the assessment considers more than just mining methods the explanation is included together here as the mining method is perhaps the most critical part.

The possibility to collect nodules at the great depths (circa 5000 m) is considered reasonable because nodules have been collected in the CCZ by dredges since the 1800's and by trial mining in the early 1980's (Item 6). Technological development over the last three decades has progressed operating depths to up to: 2000 m for rock placement on cables and pipes (Ship Technology, 2012); 2500 m for oil and gas production (Shell Perdido Project, 2013); 3000 m for drilling (Stephan, 2013); 5000 m for cable laying and retrieving (History Magazine, 2013); and 11,000 m for sampling (National Geographic, 2013).

After years of research and development and sea trials of various designs, the mechanism by which nodules could be effectively recovered from the sea floor has been demonstrated by all of the commercial consortia mentioned in section 6.2. The effectiveness of these and any new tools would be improved by recent developments in hydraulics, subsea navigation and communication as shown in the current generation of deep ROVs and AUVs (WHOI, Underwater Vehicles, 2013).

Similarly the mechanism by which nodules could be lifted from the seabed to a surface ship has been demonstrated in the CCZ to be possible in three ways, via:

- Cable as used in dredges and skips (Murray and Renard, 1891; InfoMine, 2013)
- Hydro-hoist slurry riser pipe with intermediate slurry pumps (Van Den Berg, G., Cooke, R. 2004)
- Slurry riser pipe powered by airlift (Saito et al. 1989)

Nautilus Minerals is building a fourth type of system for the Solwara 1 project (1600 m water depth). This is a hydro-hoist slurry riser pipe with single positive displacement pressure exchange pump (Leach et al. 2012).

With regards to the surface vessel, offshore floating production and storage vessels (FPSO's) are routinely used in the offshore oil industry to act as the floating production platform for subsea operations (Oil & Gas Financial Journal, 2012).

Transport of the ore to market for nodules should be straightforward as nodules are oxides like nickel laterite, but unlike laterite not prone to liquefaction (Fabi, 2010). Thus conventional bulk carrier ships, in sizes ranging from 25kt to 90kt, are well suited to performing this role.

Possible metallurgical processing routes for nodules (on-shore) are discussed in Item 13, and three of these processing routes are operating in various plants around the world.

With strong forecast growth in the developing world (Montgomery, 2008), the prospect for the future market for the key economic metals in nodules is encouraging (assumed as a minimum to be Ni, Cu and Co).



The cost effectiveness of a potential mining project is considered reasonable as on the revenue side:

- grades of nickel are 20% higher than recently commissioned Ni-laterite projects (Daigle et al. 2011; Highlands Pacific, 2009);
- there is likely upside in terms of significantly higher Co and substantial Cu grades;
- there is more tentative upside in terms of Mn and other metals not covered by the mineral resource such as Mo and REE (section 7.3.2)

On the cost side:

- the challenges of working over large areas at depth will at least in part be compensated by the lack of any overburden or even digging in the sense normally needed in mines (the nodules can be in effect scooped or harvested from the seafloor mud).
- the vertical transport distance of circa 5000 m will at least in part be compensated by the lack of haul roads or need for horizontal pipelines that can reach 220 km in length (Sherritt International 2008).
- transport distances to markets are comparable with current trade routes in bulk commodities to Asia and Europe (Bockmann, 2010; Ashby, 2012).
- processing costs may be lower than some laterites due to lower Fe grades (Dalvi et al. 2004, Daigle et al. 2011)

In assessing the project for reasonable prospects of economic extraction, the most sensitive variable in the inferred mineral resource that might constrain productivity is nodule abundance. Thus, in context of the relative and conceptual nature of the assessment, the mineral resource is reported at a range of nodule abundance cut-offs (Table 14-10).

Separate to the evaluation above, indirect corroboration of reasonable prospects for economic extraction come from interest in CCZ nodules from other commercially oriented groups. Both UK Seabed Resources and GTec (Item 23) represent large commercial groups making a significant investment in developing the CCZ deposit. There are also recent and publically available financial evaluations on nodule extraction (Kotlinski et al. 2008, Yamazaki, 2008, Agarwal et al. 2012).

ITEM 17. RECOVERY METHODS

There are no Mineral Reserve estimates for the TOML Exploration Area of the CCZ and the potential viability of the Mineral Resources has not yet been supported by a preliminary economic assessment, a pre-feasibility study or a feasibility study.

ITEM 18. PROJECT INFRASTRUCTURE

There are no Mineral Reserve estimates for the TOML Exploration Area of the CCZ and the potential viability of the Mineral Resources has not yet been supported by a preliminary economic assessment, a pre-feasibility study or a feasibility study.



ITEM 19. MARKET STUDIES AND CONTRACTS

There are no Mineral Reserve estimates for the TOML Exploration Area of the CCZ and the potential viability of the Mineral Resources has not yet been supported by a preliminary economic assessment, a pre-feasibility study or a feasibility study.

ITEM 20. ENVIRONMENTAL STUDIES, PERMITTING AND SOCIAL OR COMMUNITY IMPACT

There are no Mineral Reserve estimates for the TOML Exploration Area of the CCZ and the potential viability of the Mineral Resources has not yet been supported by a preliminary economic assessment, a pre-feasibility study or a feasibility study including environmental and social or community studies or impact studies.

ITEM 21. CAPITAL AND OPERATING COSTS

There are no Mineral Reserve estimates for the TOML Exploration Area of the CCZ and the potential viability of the Mineral Resources has not yet been supported by a preliminary economic assessment, a pre-feasibility study or a feasibility study.

ITEM 22. ECONOMIC ANALYSIS

There are no Mineral Reserve estimates for the TOML Exploration Area of the CCZ and the potential viability of the Mineral Resources has not yet been supported by a preliminary economic assessment, a pre-feasibility study or a feasibility study.



ITEM 23. ADJACENT PROPERTIES

Currently twelve contractors hold licence in the CCZ (Figure 4-1):

- Yuzhmorgeologiya (state owned company of the Russian Federation). Pioneer contract for exploration registered December 1987, executed March 2001. Currently they hold about approximately 75 000 km².
- Deep Ocean Resources Development Company (DORD; Japan). Pioneer contract for exploration registered December 1987, executed June 2001. Currently they hold approximately 75 000 km².
- Association Française d'Etude et de Recherche des NODules océaniques (AFERNOD; France). Managed by IFREMER (French Research Institute for Exploitation of the Sea). Pioneer contract for exploration registered December 1987, executed June 2001. Currently they hold approximately 75 000 km².
- China Ocean Minerals Research and Development Association (COMRA). Pioneer contract for exploration registered March 1991, executed May 2001. Currently they hold approximately 75 000 km², the reduced area being approved in November 2011.
- Interoceanmetal Joint Organization (consortium comprising Bulgaria, Cuba, Slovakia, Czech Republic, Poland and the Russian Federation). Pioneer contract for exploration registered August 1991, executed March 2001. Currently they hold approximately 75 000 km².
- Korean Association of Deep-Ocean Mineral Development (KADOM). Pioneer contract for exploration registered August 1994, executed April 2001. Currently they hold approximately 75 000 km².
- The Federal Institute for Geosciences and Natural Resources (BGR or FIGNR; Germany). Licence from the reserved areas of approximately 75 000 km² being approved in November 2005. The application was based on contributions by the German consortium AMR through the historic consortium OMI (refer Item 8).
- Nauru Ocean Resources Inc. (NORI), wholly owned by two Nauruan Foundations the Nauru Education and Training Foundation and the Nauru Health and Environment Foundation,. Licence from the reserved areas of approximately 75 000 km² granted in November 2011.
- Nautilus Minerals' Tongan registered and supported subsidiary, Tonga Offshore Mining Ltd (TOML). Licence from the reserved areas of approximately 75 000 km² granted in January 2012.
- UK Seabed Resources Ltd., a Lockheed Martin company sponsored by the Government of the United Kingdom had an application to convert an old Kennecott licence issued originally by the UK into ISA contract of exploration and reserved areas (each approximately 58 000 km²) approved by the ISA in July 2012.
- G-Tec Sea Minerals Resources NV, a Belgian company sponsored by the Government of Belgium, had an application to convert an old OMA licence issued originally by the USA into an ISA contract of exploration (approximately 75 000 km²) and reserved areas (approximately 85 000 km²) approved by the ISA in July 2012.
- Marawa Research and Exploration Ltd., a state enterprise of the Republic of Kiribati had an application for an approximately 75 000 km² contract of exploration over a reserved area approved by the ISA in July 2012.

Some background on these historic consortia is included in Item 8. Note that India holds a similar contract for the polymetallic nodules in part of the Indian Ocean.



Contractor licences are granted for 15 years. Work programs and progress are reviewed annually by the Legal and Technical Committee of the ISA during its annual meeting. To date, no commercial production has taken place by these adjacent contractors.

Most of the surviving explorers from the 1970s have moved to the current licensing system and are incorporated in some way into the current contractors. However, Lockheed Martin Systems Co (LMS) or Ocean Minerals Company (OMCO; Spickermann, 2012) is recognised to have some type of historic right to areas included within the reserved areas (i.e. as converted by BGR, UK Seabed and G-Tec above).



ITEM 24. OTHER RELEVANT DATA AND INFORMATION

24.1 Potential Additional Mineralisation

TOML Exploration Areas E (9% of the total TOML Exploration Area) and F (21% of the total TOML Exploration Area) have been assessed with very limited sampling. The sampling that does exist indicates the presence of polymetallic nodules enriched in Ni, Co, and Cu at similar grades to the other TOML Exploration Areas and at similar nodule abundance.

24.2 Seafloor Mining Systems

TOML has not done any detailed development or production on the seafloor nodules from the TOML Exploration Area within the CCZ, and no other company has ever produced nodules at a commercial rate from the area.

Several groups have designed mining systems with varying degrees of success and some of these have been trialled. These designs and trials indicate that eventual economic extraction of nodules is reasonable.

Historically, the most successful trial mining exercise by OMI (Brockett et al., 2008) produced 800 t of nodules in 1978 (Figure 24-1) using a towed collector with airlift and hydraulic pumping to the surface. As part of an international effort the French consortia (AFERNOD) tested a Continuous Line Bucket system using two ships in 1970-1972, and later tested an autonomous shuttle system. The OMCO consortia (including Lockheed Martin) tested a more sophisticated self-propelled collector incorporating a crusher, and an airlift system with a buffer in 1976 and 1979. This concept is the basis of most modern proposals for nodules mining systems (Chung, 2009), although it failed to recover significant tonnages of nodules due to crusher problems.

Hydraulic mining systems are typically subdivided into three main components (e.g. Figure 24-1):

1. Collector or miner
2. Raiser-pipe-pump system
3. Surface vessel

The collector can either be passive or active (in which case systems are incorporated to actively separate the nodules from sediments), and is integrated into a mining unit which can either be towed or self-propelled (tracked or Archimedes screw drives).

Specific examples of miner concepts trialled (e.g. NIOT, 2008) include:

- Water jets or blade-scraper configurations into a towed collector (OMI-INCO).
- Tracked drum into a towed trawler (Sheary and Steele, 1969).
- Collectors within or adjacent to Archimedes screw drives (OMC-Lockheed, AFERNOD).
- Suction pumps suspended between towed dredges (DORD).

Designs also exist for self-propelled crawlers (e.g. IKS Germany with India; Handschuh et al., 2001). COMRA are understood to have trialled a similar and well developed system in a lake (NIOT, 2008). KORDI have done advanced trials on a hybrid water jet (hydraulic) and baffle plate collector. Diagrams of how the OMI-INCO collector system could be expanded to a commercial scale (Brockett et al., 2008) is illustrated in Figure 24-2.

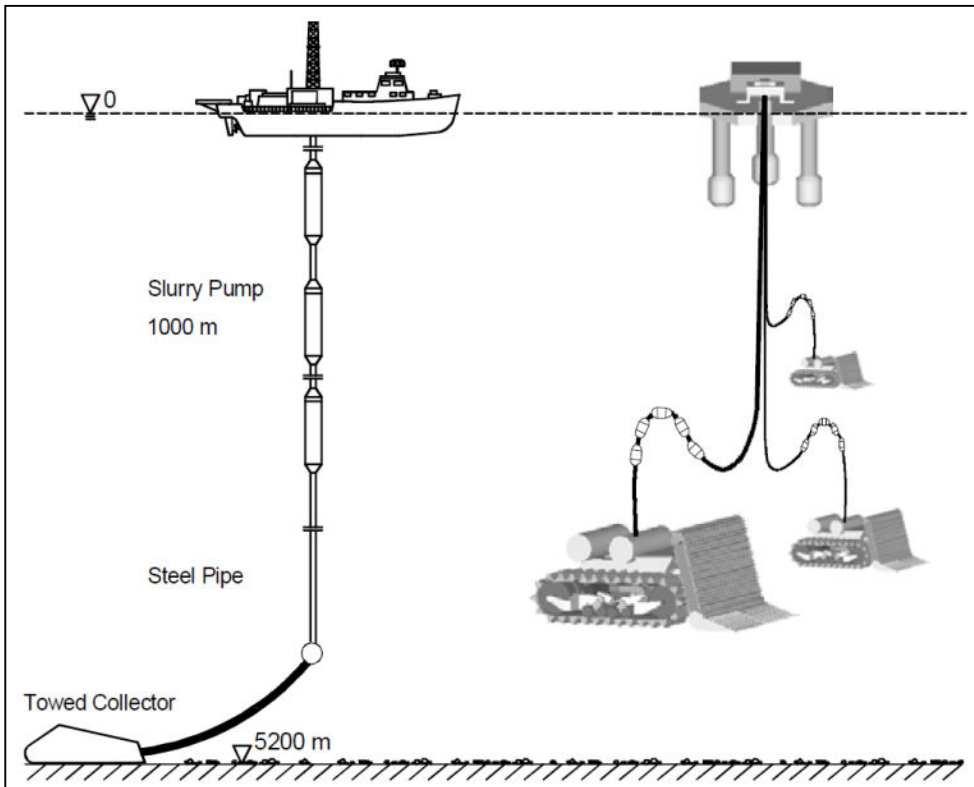


Figure 24-1: Two Alternative Deep Sea Mining Systems (Handschuh et al., 2001).

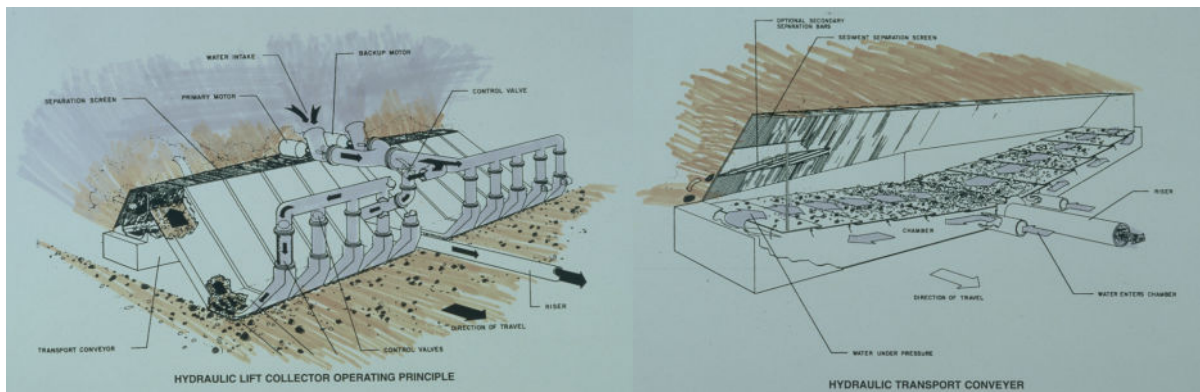


Figure 24-2: Commercial Scale Hydraulic Lifter and Transport System Based on a Towed Sled (Brockett et al., 2008).

Riser systems trialled to date (e.g. NIOT, 2008) include:

- Largely successful airlift systems (nodules are raised under negative pressure in an aerated environment; OMA, OMI, OMCO) and hydraulic lift systems (OMI)
- An unsuccessful continuous line bucket system between two vessels (AFERNOD)
- An unsuccessful free shuttle system using unmanned submersibles (AFERNOD)

Vessels system concepts include gyro-stabilised vessels or vessel derricks and more recently, semi-submersibles that would avoid the worst effects of ocean swell (Figure 24-1).



24.3 Other Obligations

Nautilus and TOML are parties to a contract with Nauru Ocean Resources Inc. (“NORI”) and NORI’s current shareholders, pursuant to which Nautilus increased its indirect ownership interest in TOML from 50% to 100% in exchange for its 50% indirect interest in NORI. That contract provides, among other things, a value normalisation process in respect of the TOML and NORI exploration contracts to explore for polymetallic nodules in the Exploration Area. The process is triggered by TOML and NORI achieving a resource pursuant to NI43-101. NORI has not yet disclosed a resource estimate in respect of its Exploration Area.

24.4 Prior Mineral Resource Estimates

The ISA (2010) published a resource estimate for a large section of the CCZ that includes the TOML Licence Areas. This estimate did not conform to any international resource reporting standards or codes. Though recent it is considered a “historic estimate” under NI43-101. The data used and the calculation and derivation of the estimate cannot be verified by Golder, and the estimate was undertaken prior to TOML acquiring the TOML Exploration Area. The resource estimate is reported here because it is already publically reported and is relevant to the TOML Exploration Area in that it demonstrates the significance of the CCZ mineralisation and summarises the average results across the entire CCZ. There is no classification for the ISA estimate since it does not conform to NI43-101.

The estimate combined five different data sets from within 110° to 160° W and 0° to 20° N:

- All publicly available data in the Authority’s Central Data Repository (CDR; <http://www.isa.org.jm>; Polymetallic Nodules - Major elements)
- A proprietary database used with the permission of the Lockheed-Martin Corporation (Ocean Minerals Company; OMCO)
- Data sets provided by the Government of the Republic of Korea
- Data sets provided by the China Ocean Mineral Resources Research and Development Association (COMRA) of China
- Data sets provided by the Interoceanmetal Joint Organization (IOM), composed of Bulgaria, Cuba, the Czech Republic, Poland, the Russian Federation and Slovakia

The data was modelled in four blocks (Figure 24-3) using a variety of methods including ordinary kriging of gridded data and sequential indicator simulation in ArcGIS.

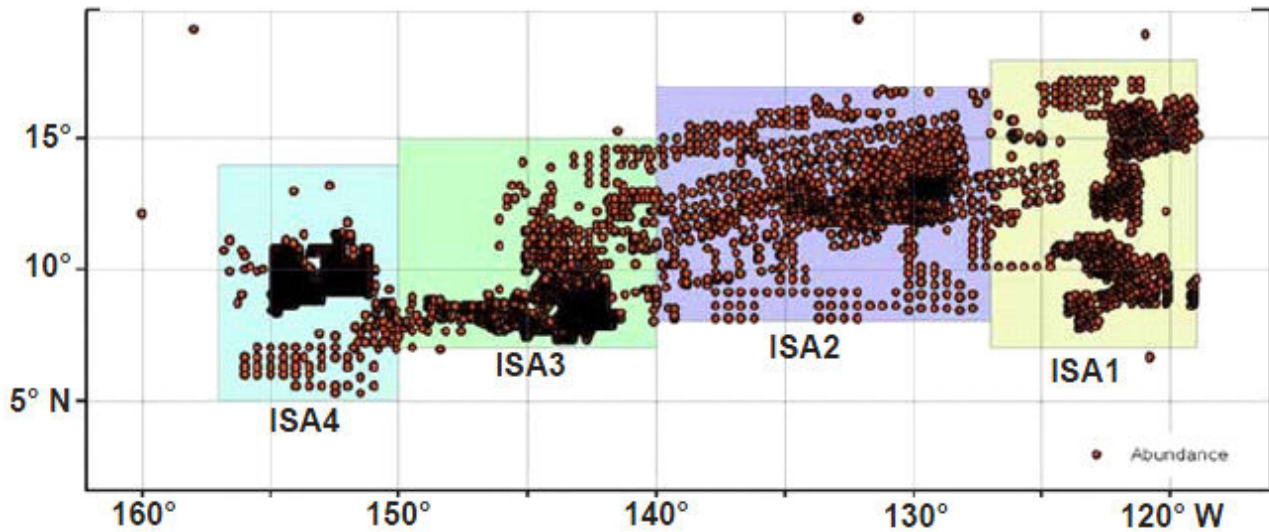


Figure 24-3: Sample Data and Blocks Used for the CCZ-Wide Mineral Resource Estimate by ISA (ISA, 2010).

Estimation results are shown below in Table 24-1. Note that the different OK and SIS (Sequential Indicator Simulation) approaches made by ISA (2010) provided a range of nodule tonnage estimates between 23 100 Mwt and 30 700 Mwt. Tonnages were estimated from nodule abundances over the area that falls within one-half of the variogram range for the available sample data. Within the OMCO dataset box core samples results were adjusted (reduced) to estimated equivalent free fall grab recoveries and other datasets were assumed to all be freefall grabs. No correction was made to account for a believed negative free-fall grab recovery bias.

The ISA estimate of nodule abundance and grade provided in Table 24-1 are not reported under any International code including NI43-101 or JORC requirements. Since it is not compliant to current reporting codes no classifications are provided. The historic resources for the total CCZ is provided only to indicate the size and scale of the nodules in the CCZ and to indicate how the mineralisation was previously defined and supported by an international body providing additional confirmation of the presence of nodules within the CCZ. A qualified person has not done sufficient work to classify this historical estimate as current Mineral Resources or Mineral Reserves and TOML is not treating such estimates as current Mineral Resources or Mineral Reserves.

Table 24-1: Tonnage and Grade of Nodules (ISA, 2010)

Tonnes (Mwt)	Abundance (kg/m ²)	Mn (%)	Co (%)	Ni (%)	Cu (%)
27 100 ± 660	5.58	27.1	0.22	1.25	1.08

24.5 Areas of Particular Environmental Interest

As part of the eighteenth session of the ISA in July 2012, (ISA 2012b). Nine “Areas of Particular Environmental Interest” within the CCZ were designated by the Council of the ISA as part of an environmental management plan. None of the nine areas (Figure 4-1) impact on the TOML Exploration Area.



ITEM 25. INTERPRETATION AND CONCLUSIONS

The global Inferred Mineral Resource estimate at various nodule abundance cut-offs for the part of the TOML Exploration Area modelled within the CCZ polymetallic nodule deposit is presented as grade-tonnage curves in Figure 25-1. Given a non-selective bulk mining operation the selected base case scenario is an abundance cut-off of 4 wet kg/m². The effective date for the estimate is 22 June 2012.

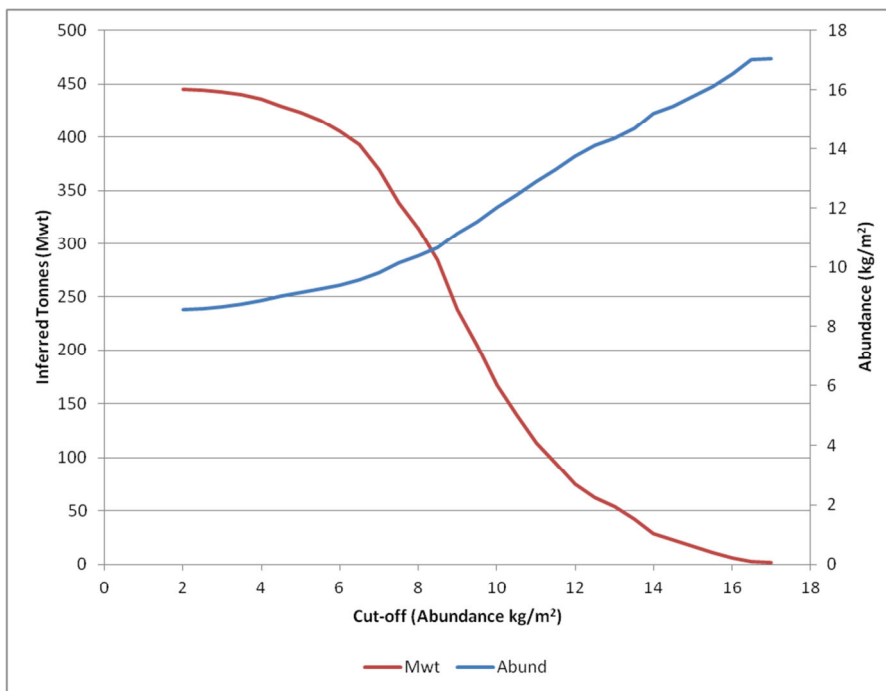


Figure 25-1: Nodule Abundance – Tonnage Curve (only includes TOML Exploration Areas A to D).

TOML holds licences over a significant part (74 713 km²) of the CCZ polymetallic nodule deposit in 6 areas (Areas A through to F). These licences are under a contract for exploration of polymetallic nodules signed with the International Seabed Authority which has its remit from the United Nations Convention on the Law of the Sea.

Historical work over the last four decades has shown the deposit to be widespread and of very consistent grades. Abundances of nodules at or near the seafloor vary more than grades.

The formation and distribution of the nodules is a result of a complex interplay of factors, key being: a) sediment source; b) transport via phytoplankton; c) release of metals below the CCD by benthic fauna; d) suitable redox conditions and e) available metal ratios.

TOML Exploration Areas A to D have sufficient samples of adequate quality and authenticity to define an Inferred Mineral Resource. Other metals of value (e.g. REE) cannot be estimated from the data at hand, but could provide significant upside.

The estimate of abundance and hence tonnage for the TOML Exploration Areas A to D may be biased low due to reliance on free-fall grab samples.

TOML Exploration Area E (9% of the total TOML licence area) and F (21% of the total TOML Exploration Area) lack sufficient data coverage to define a Mineral Resource of any class, but have exploration information that indicates similar nodule abundance and grades as TOML Exploration Areas A to D.



ITEM 26. RECOMMENDATIONS

It is recommended that future work on the TOML Exploration Area focuses on determining an Inferred Mineral Resource estimate for Areas E and F and increase the resource classification for parts of the other areas to Indicated or Measured Mineral Resource. Additionally, key modifying factors will be constrained to a point where a Mineral Reserve may potentially be estimated. It is recommended that future work include:

Exploration Phase

- Exploration surveys for detailed bathymetry.
- Sampling on TOML Exploration Areas E and F to define Inferred Mineral Resources for these areas.
- Sampling at sufficient detail on the best of the defined Inferred Mineral Resources to define short range variability, assay variance and trends, density, and other critical data.
- Assaying of all samples collected for additional elements, including but not limited to REE, potential “contaminants”, and any other elements that may aid economic studies.
- Widespread and detailed study of dry and wet density of the nodules on the TOML Exploration Area including study of free and crystallisation water contents.
- Side scan sonar and/or photographic survey of TOML Exploration Area where appropriate to image nodule occurrence.
- Base line environmental studies.

Study Phase

- Engineering and metallurgical studies and design work for both the onshore and offshore components.
- Preliminary economic and commercial studies to provide scoping estimates for CAPEX and OPEX for mining, transportation and processing options.

Possible budgets required to complete the exploration phase over the next two years may total \$US5 million to \$US10 million.



ITEM 27. REFERENCES

- Agarwal, B., Hu, P., Placidi, M., Santo, H., Zhou, J.J. 2012 Feasibility Study on Manganese Nodules Recovery in the Clarion-Clipperton Zone. The Lloyds Register Education Trust Collegium 2012 Series, Volume 2
- Ashby, I. 2012. BHP Billiton Iron Ore – Growth and Outlook. Presentation at the Global Iron Ore and Steel Conference, Perth, Australia March 20, 2012., accessed March 14 2013 at http://www.bhpbilliton.com/home/investors/reports/Documents/2012/120320_AJMConference.pdf
- Beaulieu, SE, 2012. Photographic Atlas to Megafauna at the Hawaii-2 Observatory Web site on the H2O underwater observatory. URL: http://www.whoi.edu/science/B/people/sbeaulieu/H2O_new/H2O_images/mn_nodule.html
- Bockmann, M.W. 2010. WA iron ore route to China tops 2010 dry bulk flows Lloyds List DCN Awards 9th December 2010., accessed March 14 at <http://www.lloydslistdcnawards.com.au/lldcnnews/december/weekly-edition-9th-december/wa-iron-ore-route-to-china-tops-2010-dry-bulk-flows>
- Bonjean, F. and Lagerloef, G., 2002 Diagnostic model and analysis of the surface currents in the tropical pacific ocean. *Journal of physical oceanography*, Volume 32, pp 2938- 2954
- Bostrom, K., Wiborg, L. And Ingri, J., 1982. Geochemistry and origin of ferromanganese concretions in the Gulf of Bothnia. *Marine Geology*, Vol 50 Issues 1-2 pp 1-24.
- Brockett, F.H., Huizingh, J.P. and McFarlane, J.A.R., 2008. Updated analysis of the capital and operating costs of a manganese nodule deep ocean mining system developed in the 1970s. *Proceedings ISA Workshop*, Chennai, India
- Bruland, K.W., 1983. Trace Elements in Seawater. In: J.P. Riley and R. Chester (Ed.), *Chemical Oceanography*. Academic Press, London, pp. 157-220.
- China Ocean (Mineral Resource R&D Association), 2010. Environmental Work. Presentation given at International Workshop for the Establishment of a Regional Environmental Management Plan for the Clarion-Clipperton Zone in the Central Pacific 8-12 November 2010 Kingston, Jamaica.
- Chautru, J. M., Morel, Y., and Herrouin, G. 1987. Geostatistical Simulation of a Commerical Polymetallic Nodule Mining Site. APCOM 87. *Proceedings of the Twentieth International Symposium on the Application of Computers and Mathematics in the Mineral Industries*. Volume 3: Geostatistics. Johannesburg, SAIMM, 1987. pp. 177 -185.
- Chung, J.S., 2009, Deep-ocean mining technology III: developments, *Proceedings of the 8th (2009) ISOPE Ocean Mining Symposium*, Chennai, India
- Daigle, B., McConaghy, E., Perreault, S. and Mohan Srivastava, R. 2011. NI 43-101 Technical Report on the Ambatovy Nickel Project in Madagascar. Prepared for Sherritt International Corporation., accessed March 13, 2013 on www.sedar.com
- Dalvi, A.D., Bacon, W.G., and Osborn, R.C., 2004, The past and the future of nickel laterites: PDAC 2004 International Convention, Prospectors and Developers Association of Canada, 27 p., accessed April 1, 2010 at <http://www.pdac.ca/pdac/publications/papers/2004/techprgm-dalvi-bacon.pdf>.
- Fabi, R. 2010 Unacceptable danger for Indonesian nickel laterite ship crews - Trade Group. *Mine Web online magazine*. 7/12/2010, accessed March 14, 2013 at <http://www.mineweb.com/mineweb/content/en/mineweb-fast-news?oid=116423&sn=Detail&pid=102055>
- Flanagan, F.J., and Gottfried, D., 1980, USGS Rock Standards, III: Manganese-Nodule Reference Samples USGS-NOD-A-1 and USGS-NOD-P-1: U.S. Geological Survey Professional Paper 1155, 39 p.



- Friedrich, G., Glasby, G.P., Thijssen, T. and Pluger, W.L., 1983. Morphological and geochemical characteristics of manganese nodules collected from three areas on an equatorial Pacific transect by R.V. Sonne. *Marine Mining*, 4, 167-254.
- Fuerstenau, D. W., Herring, A. P., and Hoover, M., 1973. Characterisation and extraction of metals from sea floor Manganese Nodules. *Transactions*, vol 254 Society of Mining Engineers, AIME pp. 205-211
- Futterer, D. K., 2006. The solid phase of marine sediments. In Schulz, H.D. and Zabel, M. 2006. *Marine geochemistry 2nd edition* Springer
- Glasby, G.P. 2006 Manganese: Predominant role of nodules and crusts. In Schulz, H.D. and Zabel, M. 2006. *Marine geochemistry 2nd edition* Springer
- Handsuh, R., Grebe, H., Panthel, J., Schulte, E., Wenzlawski, B., Schwarz, W., Atmanand, MA, Jeyamani, R., Shajahan, MA, Deepak, CR and Ravindran, M (2001) Innovative Deep Ocean Mining Concept based on Flexible Riser and Self-propelled Mining Machines. *Proceedings of the 4th (2001) ISOPE Ocean Mining Symposium*, Szczecin, Poland. pp. 1-9. ISSN 1946-0074
- Haynes, B.W., Law, S.L., Barron, D.C., Kramer, G.W., Maeda, R. And Magyar, M.J., 1985. Pacific manganese nodules: characterisation and processing. *United States Geological Survey Bulletin* 679
- Heath G.R., 1979. Burial Rates, Growth Rates and Size Distributions of Seep-Sea Manganese Nodules. *Science* Vol 205 pp 903-904
- Hennigar, H.F, R.E. Dick and E.J. Foell, 1986, Derivation of Abundance Estimates for Manganese Nodule Deposits: Grab Sampler Recoveries to Ore Reserves, *Offshore Technology Conference*, OTC 5237, May 1986, Houston, TX, 5 p
- Hessler, R.R. and Jumars, P.A., 1974 Abyssal community analysis from replicate box cores in the central North Pacific. *Deep-sea research*, 21 pp185-209
- Highlands Pacific, 2009, Ramu Nickel and Cobalt Project. Fact sheet., accessed March 14, 2013 at http://www.highlandspacific.com/pdf/Ramu_Nickel_Cobalt_Project.pdf
- History Magazine. The Transatlantic Cable. Accessed March 13 at <http://www.history-magazine.com/cable.html>
- Hoagland, P., 1993 Manganese nodule price trends, *Resources Policy* 1993
- Hoffert, M., 2008 Les nodules polymétalliques dans les grands fonds océaniques : Une extraordinaire aventure minière et scientifique sous-marine. Vuibert editions
- InfoMine, "Moab Khotsong mine". Accessed March 13 at <http://www.infomine.com/minesite/minesite.asp?site=moabkhotsong>
- Ingri J., 1985 Geochemistry of ferromanganese concretions in the Barents Sea *Marine Geology*, 67 (1985) 101--119 101
- ISA, 2000. Global non-living resources on the extended continental shelf: Prospects at the year 2000. *ISA Technical Study: No.1*. ISBN 976-610-375-5
- ISA, 2001a. Patents Issued for Technologies for Deep Seabed Polymetallic Nodule Exploration and Mining: 1960-1998; (July 2001) Volumes 1-5; and Volumes 6-10 Volumes 6-10; ISBN 976-610-389-5
- ISA, 2001b, Proposed technologies for mining deep-seabed polymetallic nodules, *Proceedings of the International Seabed Authority's Workshop*, Kingston, Jamaica
- ISA, 2003. Establishment of a geological model of the polymetallic nodule resources in the Clarion-Clipperton Fracture Zone of the Equatorial North Pacific Ocean : *Proceedings of the 13-20 May 2003 International Seabed Authority workshop held in Nadi, Fiji* ISBN: 976-95217-3-6



- ISA, 2010. A Geological Model of Polymetallic Nodule Deposits in the Clarion-Clipperton Fracture Zone and Prospector's Guide for Polymetallic Nodule Deposits in the Clarion-Clipperton Fracture Zone. International Seabed Authority Technical Study: No. 6 ISBN: 978-976-95268-2-2
- ISA, 2012a. RE: Tonga Offshore Mining Exploration Data. Email from Vijay Kodagali to Charles Morgan Thursday 21st June 2012.
- ISA, 2012b. Decision of the Council relating to an environmental management plan for the Clarion-Clipperton Zone. Missive of the ISA Council, 18th Session, 26th July 2012.
- ISA, 2012c. Member States <http://www.isa.org.jm/en/about/members/states> accessed 1 September 2012.
- Johnson, C.J. and Otto, J.M., 1986 Manganese nodule economics, Resources Policy March 1986
- Ju, S-J, Kim, K-H, Chi, S-B, and Yoo, C-M, 2010 The CCFZ Environmental Study carried out by KORDI. Presentation given at International Workshop for the Establishment of a Regional Environmental Management Plan for the Clarion-Clipperton Zone in the Central Pacific 8-12 November 2010 Kingston, Jamaica.
- Kaluza, P. Kolzsch, A., Gastner, M.T. and Blasius, B., 2010. The complex network of global cargo ship movements. Journal of the Royal Society Interface, 7 pp1093-1103
- Kodagali, V. 2009. Review of Data used for the geological model. Workshop on the results of a project to develop a geological model of polymetallic nodule deposits in the Clarion-Clipperton Zone, Kingston Jamaica 14-17 December 2009., accessed March 11, 2013 at <http://www.isa.org.jm/en/scientific/workshops/2009>
- Koschinsky, A., 2008. Ferromanganese Nodule Deposits: Distribution, Composition and Origin. Proceedings Deep-Sea Minerals and Mining 2008, Aachen, Germany. pp 17-20
- Kotlinski, R. and Stoyanova, V., 2006 Buried and surface polymetallic nodule distribution in the eastern Clarion-Clipperton Zone: main distinctions and similarities. Advances in Geosciences Vol. 9: Solid Earth, Ocean Science & Atmospheric Science (2006) Eds. Yun-Tai Chen et al. World Scientific Publishing Company, pp 67-74
- Kotlinski, R., Stoyanova, V., Hamrak, H. and Avramov, A. 2008 An Overview of the Interoceanmetal (IOM) Deep-Sea Technology Development (Mining and Processing). Proceedings ISA Workshop, Chennai, India
- Leach, S., Smith, G., Berndt, R.. SME Special Session: Subsea Slurry Lift Pump Technology – SMS Development. 2012 Offshore Technology Conference, Houston, Texas, USA.
- Lee, G.C, Kim, J., Chi, S.B., Ko, Y.T and Ham, D.J., 2008. Examination for correction factor for manganese nodule abundance using the free fall grab and box corer. The Sea: Journal of the Korean Society of Oceanography, Vol 13, No. 3 pp 280-285
- Margolis, S. V. and Burns, R. G., 1976 Pacific Deep-Sea Manganese Nodules: Their Distribution, Composition, and Origin. Annual Review of Earth and Planetary Sciences, Vol. 4, p.229
- McKelvey, V.E., Wright, N.A. and Bowen, R.W., 1983. Analysis of the World Distribution of Metal-Rich Subsea Manganese Nodules. Geological Survey Circular 886, US Geological Survey.
- Melnik, V. and Lygina, T., 2010. Environmental Research carried out by Yuzhmorgeologiya. Presentation given at International Workshop for the Establishment of a Regional Environmental Management Plan for the Clarion-Clipperton Zone in the Central Pacific 8-12 November 2010 Kingston, Jamaica.
- Mero, J., 1965 The mineral resources of the sea. Volume 1 (Elsevier Oceanography Series)
- Mero J.L., 1977, Economic Aspects of Nodule Mining, Ch 11 of Marine Manganese Deposits, Editor: Glasby, G.P., pg.327-355, Elsevier Oceanography Series Number 15



Mielke, J.E. 1975 Ocean Manganese Nodules. Committee Print US Government 94th Congress 1st session. US Government Printing Office.

Montgomery, M.R., et al. The Urban Transformation of the Developing World. Science Vol 319, pg 761 (2008)

Van Den Berg, G., Cooke, R. Hydraulic hoisting technology for platinum mines, The South African Institute for Mining & Metallurgy, 2004

Morgan, C. L., 2000. Resource estimates of the Clarion-Clipperton manganese nodule deposits. In: Cronan D. S. (ed.) Handbook of Marine Mineral Deposits , CRC press, 145-170, 2000

Morgan, C., 2009. Geological Model Project Implementation. Presentation from the ISA geological model workshop December 2009, Kingston, Jamaica

Morgan C., 2011 Potential Environmental Impact of Seabed Mining – Presentation International Workshop on Environmental Management Needs for Exploration and Exploitation of Deep Seabed Minerals Fiji Islands, 29 November – 3 December 2011

MNHN (Museum National d'Histoire Naturelle), 2006. Box Corer, Department Histoire de la Terre, Geologie collections and databases.
http://www.mnhn.fr/mnhn/geo/Collection_Marine/moyens_mer/Engins_de_prelevements_eng.htm
http://www.mnhn.fr/mnhn/geo/Collection_Marine/moyens_mer/Engins_de_prelevements_eng.htm

Mukhopadhyay, R.Ghosh, A.K. and Iyer, S.D., 2008. The Indian Ocean Nodule Field: Geology and Resource Potential. Handbook of Exploration and Environmental Geochemistry 10 Ed. M. Hale. Elsevier

Murray, J, and Renard, A. F., 1891, Report on Deep-Sea Deposits; Scientific Results Challenger Expedition (1891), pp. 267-276

National Geographic. DEEPSEA CHALLENGE , The Solo Journey to the Deepest Known Point in the Ocean. Accessed March 13 at <http://education.nationalgeographic.com/education/deepsea-challenge/>

NIOT (National Institute of Ocean Technology), 2008. Workshop on polymetallic nodule mining technology – current status and challenges ahead. Background Document.
<http://www.isa.org.jm/files/documents/EN/Workshops/Feb2008/Backgrd.pdf>
<http://www.isa.org.jm/files/documents/EN/Workshops/Feb2008/Backgrd.pdf>

NOAA, 1984 Deep Seabed Mining: Draft environmental impact statement on issuing an exploration license to Ocean Mining Associates. Report by the Office of Ocean and Coastal Resource Management, Ocean Minerals and Energy Division, United States Department of Commerce – National Oceanic and Atmospheric Administration

NOAA, 1987 Deep Seabed Mining: Report to Congress. United States Department of Commerce, National Oceanic and Atmospheric Administration Report.

NOAA, 2013 a Marine Geology Data Scripps Institution of Oceanography Ferromanganese Nodule Analysis File. NGDC Data Set G00128. <http://www.ngdc.noaa.gov/mgg/geology/sionar.html>

NOAA, 2013 b Marine Geology Data "Base de Donnees Geochimiques des Depots Ferromanganesiferes d'Origine Oceanique Lacustre et Fossile" CNEXO Ferromanganese Nodule Analysis File. NGDC Data Set G00251. <http://www.ngdc.noaa.gov/mgg/geology/cnexo.html>

Ocean Currents and Sea Ice from Atlas of World Maps, United States Army Service Forces, Army Specialized Training Division. Army Service Forces Manual M-101 (1943)

Oil & Gas Financial Journal, 2012. Global use of FPSOs is growing. Accessed March 13 at <http://www.ogfj.com/articles/2012/03/global-use-of-fpsos-is-growing.html>

Okazaki, M., 2012 Email “RE:DORD Reserved Area Data” to Charles Morgan 12th July 2012



- Piper, D.Z. and Fowler, B., 1980, New constraint on the maintenance of Mn nodules at the sediment surface. *Letters to Nature* 286, pp 880-883
- Ruhlemann, C., Kuhn, T., Wiedicke, M., Kasten, S., Mewes, K. And Picard, A., 2011 Current status of manganese nodule exploration in the German licence area. *Proceedings of the Ninth (2011) ISOPe Ocean Mining Symposium Maui, Hawaii, USA, June 19-24, 2011* Scanlon, K. And Masson, D. (2000) Fe-Mn Nodule Field Indicated by GLORIA, North of the Puerto Rico Trench, *Geo-Marine Letters*, 1992. v. 12, p. 208-213
- Saito, T., Usami, T., Yamazaki, T., Tomishima, Y., Kiyono, F. Lifting Characteristics of Manganese Nodules By Air-lift-pump On 200m Vertical Test Plant. *Oceans '89 Proceedings*, Vol 1, pg 48-53, (1989)
- Sclater, J.G, R.N. Anderson, and M.L. Bell 1971. Elevation of Ridge and Evolution of the Central Eastern Pacific, *Journal of Geophysical Research*, V 76(32); p 7888-7915.
- Seibold, E., 1978. Deep Sea Manganese Nodules: The Challenge since "Challenger". *Episodes Vol 1 No 4*
- Sen, P.K., 2010. Metals and materials from deep sea nodules: an outlook for the future. *International Materials Reviews* vol 55 no 6, 364-391
- Sheary, G.W. and Steele, J.E., 1969. Mechanical Deep Sea Nodule Harvester, United States Patent 3,480,326
- Shell Perdido Project website on Shell website. See <http://www.shell.com/global/aboutshell/our-strategy/major-projects-2/perdido.html>
- Sherritt International, 2008. Ambatovy Nickel Project: A Progress Report. Presentation at Mine Africa Conference 2008., accessed March 13 at <http://www.sherritt.com/getattachment/fd4e3e6e-d0cc-4167-99fd-e85aadb159dc/Mine-Africa-Presentation>
- Ship Technology, 2012. Simon Stevin Mining and Fallpipe Vessel, Belgium., accessed March 13 at <http://www.ship-technology.com/projects/simon-steving/>
- Spickermann, R., 2012. Rare Earth Content of Manganese Nodules in the Lockheed Martin Clarion-Clipperton Zone Exploration Areas. *Proceedings Offshore Technology Conference, Houston Texas*
- Stephan, D. Process Worldwide. ONGC Sets World Record on Drilling Deepest Water Depth Well. Accessed March 13 at http://www.process-worldwide.com/management/project_management/articles/397703/
- UNOETO, 1979, Manganese Nodules: Dimensions and Perspectives edited by United Nations. Ocean Economics and Technology Office.
- von Stackelberg U. and Beiersdorf H., 1991. The formation of manganese nodules between the Clarion and Clipperton fracture zones southeast of Hawaii. *Marine Geology* 98, pp 411-423
- von Stackelberg U. and Marchig, V., 1987. Manganese nodules from the equatorial North Pacific Ocean. *Geologisches Jahrbuch, Reihe D Heft 87*, pp 123-227
- Retsch, 2012. Laboratory Jaw Crushers. URL: http://search.babylon.com/?q=laboratory+crusher&babsrc=NT_ss&s=web&rlz=0&as=0&ac=0
- Wang, Y., Li, Z. and Li, H., 2005. A new process for leaching metal values from ocean polymetallic nodules. *Minerals Engineering* (18) pp 1093-1098
- Woods Hole Oceanographic Institution, 2013. Underwater Vehicles, accessed March 13 at <http://www.whoi.edu/main/underwater-vehicles>
- Yamazaki, T. (2008) Model mining units of the 20th century and the economies. *Proceedings ISA Workshop, Chennai, India*
- Yubko, V., 2012. Email "RE: Yuzhmorgeologiya Exploration Data in Tongan ISA Contract Area" to Charles Morgan 18th June 2012



DATE

The effective date of this Technical Report is 20 March 2013.

SIGNATURE

GOLDER ASSOCIATES PTY LTD

A handwritten signature in black ink, appearing to read "Matt Nimmo".

Matthew Nimmo
Principal Geologist
MJN/JH/MJN

Dated: 20 March 2013

A.B.N. 64 006 107 857

Golder, Golder Associates and the GA globe design are trademarks of Golder Associates Corporation.

w:\min\2012\127631013_nautilus_ccz\correspondence out\127631013-003-r-rev1_ni43-101_report_nautilus_ccz_signed.docx



CERTIFICATE OF QUALIFIED PERSON

I, Matthew Nimmo, of Brisbane, Australia, do hereby certify that as the author of the "Updated NI 43-101 Technical Report, Clarion-Clipperton Zone Project, Pacific Ocean Technical Report" dated effective 20 March 2013, make the following statements:

1. I am employed as a Principal Geologist with Golder Associates Pty. Ltd. 174 Coronation Drive, Milton, Queensland, 4064, Australia.
2. I graduated with a degree in B Sc (Hons) in geology from the University of Queensland in 1992.
3. I am a Member in good standing of the Australian Institute of Geoscientists (AIG #3606).
4. I have practiced my profession continuously since graduation.
5. I am responsible for all sections of the Technical Report.
6. I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that, by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfil the requirements to be a "qualified person" for the purpose of NI 43-101.
7. My relevant experience with respect to the CCZ Deposit includes 20 years in exploration, mining geology and grade estimation of diverse nickel and copper deposits with over 13 years' experience in resource estimation. This experience includes:
 - a. Resource estimation of the deep-sea Solwara Cu-Au-Ag-Zn-Pb deposits in the Bismark Sea.
 - b. Resource estimation of a number of base metal deposits including: Starra Cu deposits and Lady Annie Cu deposit Queensland, Vulcan and Mt McCabe Cu deposits Queensland, the Boseto Cu deposit Botswana, the Mkushi Cu deposit Zambia. This experience is relevant as the assaying and data analysis (statistics and variography) are the same as for the polymetallic nodule deposits.
 - c. Resource estimation of a number of bulk commodities including: nickel laterite, iron ore and bauxite deposits such as Solomon Ni laterite project Solomon Islands, Sipilou Ni laterite deposit Ivory Coast, Sangaji Ni laterite deposit Indonesia and Onca-Puma nickel laterite deposit Brazil, Marilana Iron Ore deposit Western Australia, Pisolite Hills Bauxite Queensland. This experience is especially relevant as bulk commodity deposits are typically thin and laterally extensive and exhibit similar statistical and geostatistical features as the polymetallic nodule deposits.
 - d. Extensive experience with assay quality control and exploratory data analysis.
8. I have not had prior involvement with the property that is the subject of the Technical Report.
9. I am independent of the Issuer as defined by Section 1.4 of the Instrument. I have read National Instrument 43-101 and the sections for which I am responsible in this Technical Report have been prepared in compliance with National Instrument 43-101 and Form 43-101F1.
10. As of the date of this Certificate, to my knowledge, information and belief, the sections of this Technical Report for which I am responsible contains all scientific and technical information that is required to be disclosed to make the technical report not misleading.

Dated this Day of 20 March 2013 at Brisbane, Australia

Matthew John Nimmo
Principal Geologist



CERTIFICATE of AUTHOR – Dr Charles Morgan

I, Dr Charles Morgan, of Honolulu, United States of America, do hereby certify that as the author of the Technical Report "Updated NI 43-101 Technical Report, Clarion-Cliperton Fracture Zone Project, Pacific Ocean" and dated effective 20 March 2013 make the following statements.

1. I am employed as a Professional Marine Scientist with Planning Solutions Inc., 210 Ward Avenue, Suite 330, Honolulu HI 96814, United States of America.
2. I graduated with a degree in B Sc (Hons) in chemistry with specialty in Earth Sciences from the University of California-San Diego and a PhD in Limnology and Oceanography from the University of Wisconsin- Madison. I have also completed all required coursework at the University of Wisconsin required for a Master's Degree in Geology.
3. I am a Registered Member in good standing of the Society of Mining, Metallurgy, and Exploration (Member #4041112).
4. I have practiced my profession continuously since graduation.
5. I am responsible for Items 6, 9, 10, 11, and 12 of the Technical Report.
6. I have read the definition of "Qualified Person" set out in National Instrument 43-101 (NI 43-101) and certify that, by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purpose of NI 43-101.
7. My relevant experience with respect to Clarion-Cliperton Zone (CCZ) deposit includes 9 years working in resource assessment of the seabed polymetallic nodule deposit in the CCZ for Lockheed Minerals and Space Company (a participant in the Ocean Minerals Company deep seabed mining consortium).
9. I have not had prior involvement with the property that is the subject of the Technical Report. I have had prior involvement with the CCZ deposit prior to Nautilus acquiring the exploration licence sponsored by Tonga government.
10. I am independent of the Issuer as defined by Section 1.4 of the Instrument. I have read National Instrument 43-101 and the sections for which I am responsible in this Technical Report have been prepared in compliance with National Instrument 43-101 and Form 43 101F1.
11. As of the date of this Certificate, to my knowledge, information and belief, the sections of this Technical Report for which I am responsible contains all scientific and technical information that is required to be disclosed to make the technical report not misleading.

Dated this Day of 20 March 2013 at Honolulu, United States of America

Dr Charles Morgan
Professional Marine Scientist

SME
Society for
Mining, Metallurgy
& Exploration
Dr. Charles L. Morgan
SME Registered Member No. 4041112
Signature *Charles L. Morgan*
Date Signed *20 March 2013*
Expiration date *Dec 31, 2013*



CERTIFICATE of AUTHOR – Davey Banning

I, Davey Lee Banning, of West Richland, United States of America, do hereby certify that as the author of the Technical Report "Updated NI 43-101 Technical Report, Clarion-Clipperton Fracture Zone Project, Pacific Ocean" and dated effective 20 March 2013 make the following statements.

1. I consult as a Geologist at 5110 Dove Lane, West Richland, WA 99353, United States of America.
2. I graduated with a degree in BSc in Geology from Washington State University and a MSc in Geology from Washington State University. My MSc thesis deals with the chemistry of polymetallic nodules and I have authored or co-authored several papers on polymetallic nodules.
3. I am a Member in good standing of the Australian Institute of Geoscientists.
4. I have practiced my profession continuously since graduation in 1967.
5. I am responsible for Items 7 and 8 of the Technical Report.
6. I have read the definition of "Qualified Person" set out in National Instrument 43-101 (NI 43-101) and certify that, by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfil the requirements to be a "qualified person" for the purpose of NI 43-101.
7. My relevant experience with respect to Clarion-Clipperton Zone (CCZ) deposit includes 7 years working in the exploration and resource assessment of the seabed polymetallic nodule deposit in the CCZ for INCO United States Inc. and Lockheed Missiles and Space Company (a participant in the Ocean Minerals Company deep seabed mining consortium).
8. I have visited the property on several cruises from 1978 to 1981 on board the M/V Governor Ray for Lockheed Missiles and Space Company.
9. I have not had involvement with the property that is the subject of the Technical Report since TOML acquired the exploration area sponsored by the Kingdom of Tonga.
10. I am independent of the Issuer as defined by Section 1.5 of NI 43-101. I have read NI 43-101 and the sections for which I am responsible in the Technical Report have been prepared in compliance with NI 43-101 and Form 43-101F1.
11. As of the date of this Certificate, to my knowledge, information and belief, the sections of the Technical Report for which I am responsible contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Dated this Day of 20 March 2013 at West Richland, Washington, United States of America


Davey Banning
Geologist

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Pty Ltd
147 Coronation Drive
Milton, Queensland 4064
Australia
T: +61 7 3721 5400

