

Nautilus Minerals Solwara 1 Project – Ongoing Environmental Studies

OFFSHORE

Benthic Habitat Assessment

Objectives

- Characterise the seafloor areas adjacent to venting sites

Approach

- Visual assessment from video transects, and sediment samples for faunal characterisation

People Involved

- Scripps Institution of Oceanography, USA

Bioaccumulation

Objectives

- Determine the potential for contaminants to accumulate via the food chain into top-order species such as surface schooling mackerel and tuna

Approach

- Utilise an integrated biophysical model of dispersal and uptake of metals through several trophic levels. Validate the model with tissue (e.g. tuna) samples
- Characterise deep-sea biomass

People Involved

- Hydrobiology, Australia

Bioluminescence

Objectives

- Predict the effect of mining activities on deep-sea species of fish that rely on bioluminescence

Approach

- Undertake a general scientific literature review to determine the likely presence of mid-water and deep-sea bioluminescent species
- Use results of hydrodynamic modelling to assess impacts of increased water turbidity on animals reliant on bioluminescence

People Involved

- Hydrobiology, Australia

Endemicity

Objectives

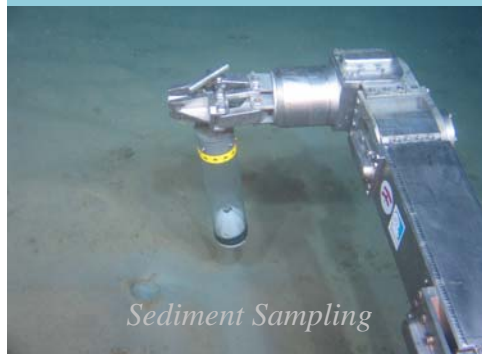
- Determine species present at Solwara 1 and the taxonomic and genetic similarities with species of vent communities at local, regional and global scales (as far as practicable)
- Determination of species present at a reference site

Approach

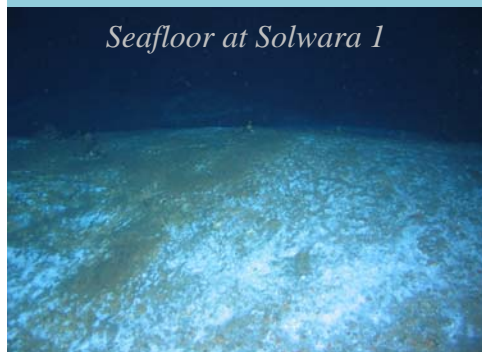
- Species identification and DNA investigations on samples collected on the Luk Luk 07 Campaign
- Compare Solwara 1 with the reference site and other regional data

People/ Institutions Involved

- Duke University, USA
- University of Papua New Guinea, PNG (see Duke Opportunity Bursary at the end of this document)



Sediment Sampling



Seafloor at Solwara 1



Careful sampling of a snail



"Beehive" Vent

Existing Resource Utilisation

Objectives

- Describe the nature of offshore commercial and subsistence fisheries
- Assess the potential impact on these fisheries from the project
- Develop procedures to communicate with fishing vessels during construction and operation
- Describe commercial shipping routes and development measures to manage respective operations

Approach

- Consultations with fishery and shipping agencies in PNG, and local consultation. Consultation with National Fisheries Authority and other experts with relevant in-country experience

People Involved

- Coffey Natural Systems, Australia



Thermal Lance

Hazard and Risk Assessment

Objectives

- Identify and characterise potential hazards and risks associated with construction and operation of the project, including risks to the project area from seismic activity
- Estimate the likelihood of the project activities setting off a hazard event (e.g. earthquake, volcanic eruption, etc.)
- Inform project design and operating procedures so that significant risks are reduced to be as low as is reasonably possible

Approach

- Undertake a workshop to characterise potential hazards posed by the project
- Utilise relevant data and information, including seismic activity and zoning data

People Involved

- Vulcanology Experts, PNG
- Coffey Natural Systems, Australia



ROV Operations

Hydrodynamic Modelling – Dewatering Process

Objectives

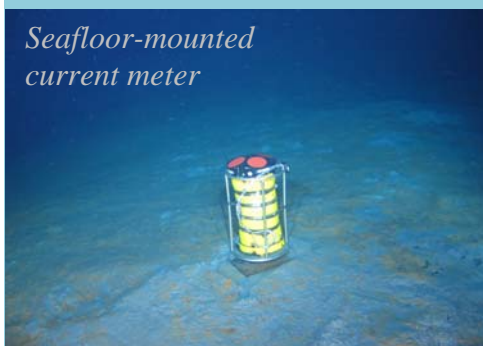
- Determine the composition of the water to be discharged during the dewatering process
- Model the dispersion of discharged water at different depths taking into account density of the discharge water, sediment content, particle size, lateral/vertical ocean currents and the presence of any upwelling
- Determine the most appropriate depth of discharge taking into account factors such as photic and oxygen minimum zones
- Determine the contours of concentrations of contaminants and mixing zone boundaries
- Assess compliance with ambient water quality standards

Approach

- Gather year-round data on local hydrological information such as current direction and speed to use in hydrodynamic modelling

People Involved

- Coffey Natural Systems, Australia
- APASA, Australia



Seafloor-mounted current meter



Subsea scoop sampling of snails

Hydrodynamic Modelling – Seafloor

Objectives

- Determine the potential generation and extent of the formation of plumes caused by the seafloor mining equipment
- Model plume dispersion at the seafloor

Approach

- Hydrodynamic modelling using data obtained at Solwara 1, including oceanographic and bathymetric measurements and investigations

People Involved

- Coffey Natural Systems, Australia
- APASA, Australia

Noise and Light

Objectives

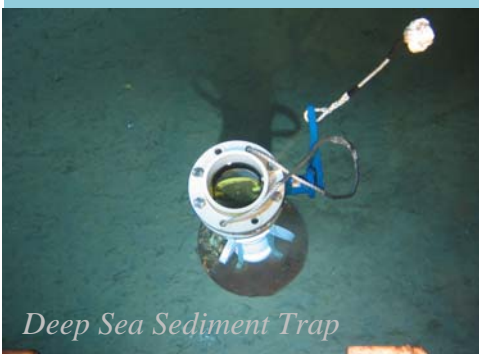
- Determine the underwater noise and likely attenuation characteristics of the project vessels and mining equipment
- Assess the distances from source for noise to attenuate to threshold levels and determine likely impacts on marine life, particularly cetaceans
- Manage potential interactions with cetaceans by application of threshold distances equivalent to those from the extensively researched activities of drilling rigs/tender vessels in major migration routes elsewhere (e.g. Northwest Shelf of Australia)
- Describe likely fish attracting and other physical aspects of the presence of the vessel on surface and near surface swimming animals

Approach

- Desktop study using research findings from offshore oil and gas operations
- Review anecdotal and published accounts of cetacean and turtle activity in the greater project area (including consultation with the DEC and other identified sources of expertise within PNG)
- Local consultation

People Involved

- Coffey Natural Systems, Australia



Deep Sea Sediment Trap

Waste Management

Objectives

- Develop a waste minimisation and management plan for the project

Approach

- The waste minimisation and management plan will meet all relevant PNG and international regulations (e.g. the International Convention for the Prevention of Pollution from Ships [MARPOL])

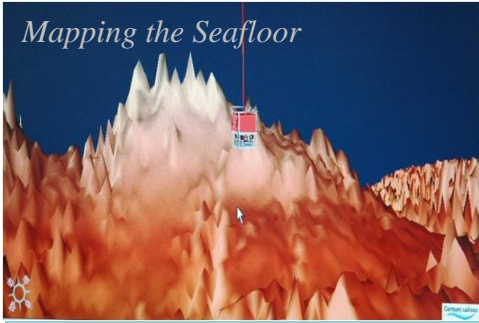
People Involved

- Coffey Natural Systems, Australia



Quadrant used for scale





Visual Observation logging

Objectives

- To record biological, geological, and water observations of the deep seafloor at Solwara 1 and the reference site

Approach

- Using live video feed from the ROV, observations were logged by scientists into a database to characterise the seafloor. Over 8000 observations have been made so far

People Involved

- Nautilus Personnel, Contracted Scientists

Video documentation

Objectives

- To record the benthic environment at Solwara 1

Approach

- The submersed ROV ran transects on and around Solwara 1 and the reference site, as well as capturing footage during scientific sampling and geological tasks. Over 3000 hours of footage has been recorded

People Involved

- Nautilus Personnel

Oceanography

Objectives

- To obtain 12 months of full water column current profiles at Solwara1
- Use collected data and researched data to model currents within The Bismarck Sea

Approach

- Deployment of four Acoustic Doppler Current Profilers at various depths with data downloaded every three months

People Involved

- Coffey Natural Systems, Australia
- APASA, Australia

Sediment Geochemistry

Objectives

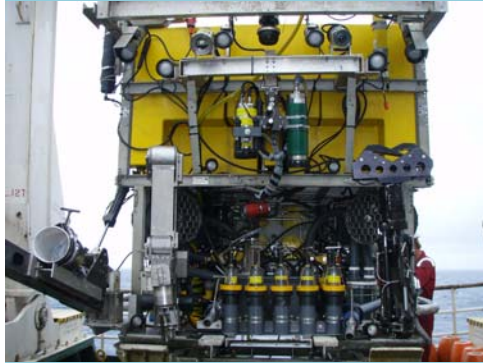
- To determine baseline sediment geochemistry and composition surrounding Solwara 1 and the control site

Approach

- Sediment cores collected by the ROV to be analysed in association with cores taken from previous studies

People Involved

- University of Toronto, Canada



Other Studies Completed to Date – Regional Level

Module 1 Studies

Objectives

- Preliminary scope to determine the breadth of currently available information on the Bismarck Sea

Approach

- Desktop study of current literature and database information

People Involved

- CSIRO, Australia

Module 2 Studies

Objectives

- Conduct a detailed assessment of data and to make recommendations for future work

Approach

- In depth examination of four key areas (animal diversity, CTD-hydrocasts, sediments, dive footage). Collation and gap analysis of data from various institutions.

People Involved

- CSIRO, Australia

Module 3 Studies

Objectives

- To collate a baseline environmental study of the Bismarck Sea.

Approach

- Sediment analysis
- Vent plume mapping
- Water analysis of samples already obtained
- DNA sequencing

People Involved

- CSIRO, Australia

Sources of meteorological and oceanographic data 1

Objectives

- To determine commercially available meteorological and oceanographic data on the Bismarck Sea

Approach

- Desktop study to gather sources of data (wind, wave, current and water level) on the Bismarck Sea from within and external to PNG

People Involved

- Triton Consultants Ltd, Canada

Sources of meteorological and oceanographic data 2

Objectives

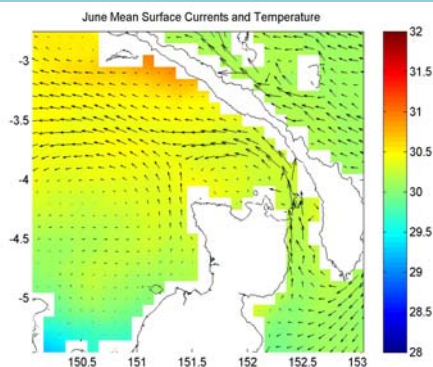
- To conduct a gap analysis of all available meteorological and oceanographic data from the Bismarck Sea

Approach

- Desktop study to gather sources of data (wind, wave, current and water level) on the Bismarck Sea from within and external to PNG

People Involved

- CSIRO, Australia



Other Achievements

Duke Opportunity Bursary

Nautilus offered the opportunity for a student from a tertiary institution in PNG to be trained to help with, and learn about, the analysis of deep sea biological samples from Solwara 1 at Duke University (USA). The winner, Ms. Martha Mungkaje, worked closely with Dr. Cindy Lee Van Dover, a world expert in deep sea biology. During her 5 week internship, Martha learned many cutting edge processes and techniques. Martha thanked Nautilus for the opportunity and wrote:

"I am very grateful for the opportunity given to me by the Nautilus Minerals Niugini Limited to learn more about the deep sea hydrothermal invertebrates at the Duke University Marine lab, North Carolina, USA. I have also learned the PRIMER program which is a very important data analysis tool for solving marine ecology and other multivariate problems. All these things that I have learned will not only benefit me but for many other Papua New Guineans in the long run."

Nautilus will continue to develop and sponsor other such opportunities for PNG.

Workshop to Discuss the Social and Environmental Impacts of Subsea Mineral Extraction

The workshop was convened on 12-13 March 2007 in Port Moresby (PNG) to identify and discuss issues related to the environmental and social aspects of the Solwara 1 project. The workshop provided the opportunity for an open exchange of knowledge and views to enable concerns to be addressed early on in the project, and to help us identify and gain an understanding of stakeholder views and opinions. Direct stakeholders, members of the government of Papua New Guinea, and experts from global and local environmental, social and scientific communities participated.

Science Workshop, Luk Luk 07 Campaign

Before the commencement of the Luk Luk 07 Campaign (Research Cruise), a science workshop was convened to discuss the offshore studies. This workshop provided up-to-date information on the study site for the scientists and gave them a background relevant to their studies. Each study was discussed, and topics covered included: the requirements for each study, time scales and equipment needed, and procedures. This allowed all scientists to be familiar with each others' goals and methods and resulted in a good team approach to the "research cruise". Initial dive plans were also developed.



Ms. Martha Mungkaje, winner of the Nautilus Minerals Duke Opportunity Bursary Award, receives a congratulatory handshake from Mr. Mel Togolo, Nautilus Minerals Niugini Country Manager



Issues Workshop in Port Moresby, PNG