

# Nautilus Minerals Solwara Project – Environmental Studies Completed

## 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

### 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

### 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

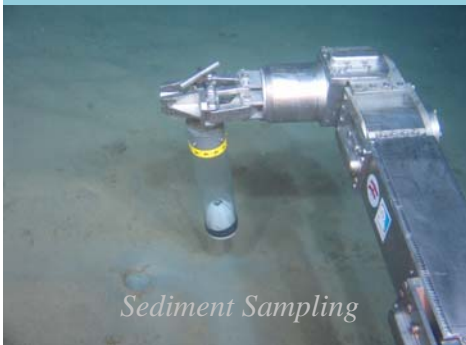
### Existing Resource Utilisation

#### 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 community consultation. Consultation with National Fisheries Authority and other experts with relevant in-country experience



*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

*ROV Operations*



### Hydrodynamic Modelling – Dewatering Process

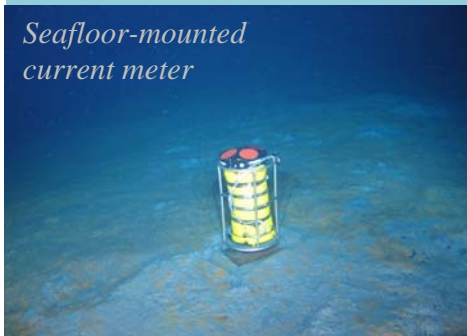
#### Objectives

- 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

*Seafloor-mounted current meter*



### 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

### Macrofauna

#### Objectives

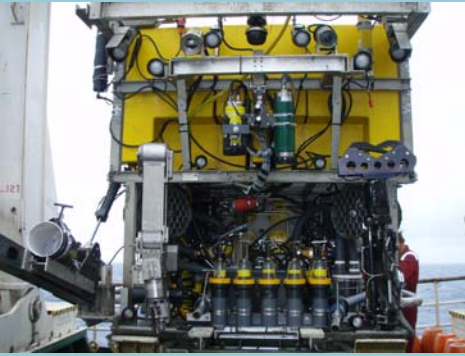
- Determine species present at Solwara 1 and the taxonomic and genetic similarities with species
- Determination of species present at a reference site

#### Approach

- Species identification and DNA investigations on samples collected
- Compare Solwara 1 with the reference site (South Su) and other regional data

*Deep Sea Sediment Trap*





### Meteorology

#### Objectives

- To gather all available meteorological and oceanographic data on the Bismarck Sea
- Use collected data and researched data to model currents within 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

### Oceanography

#### Objectives

- To obtain 12 months of full water column current profiles at Solwara 1
- 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

### Noise, Light, Vibrations

#### 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)
- Underwater acoustic modelling
- Local consultation

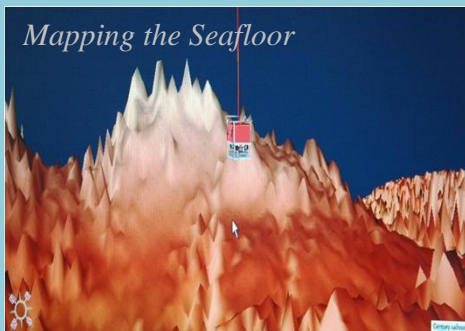
### Sediment Rates – Deep Sea

#### Objectives

- To determine the rate of sediment/particulate matter deposition over Solwara 1 and the reference site (South Su) - data collected over 18 months

#### Approach

- Install deep sea sediment traps (x12) around Solwara 1 and South Su





### 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

### 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

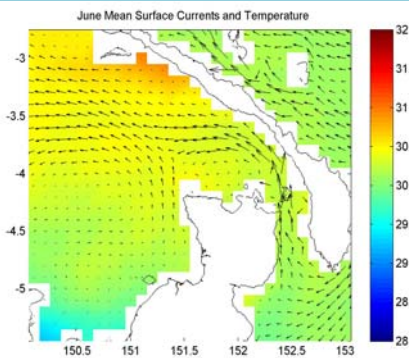
### Video documentation

#### 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



### 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])

### Water Quality

#### Objectives

- To determine the baseline water quality at and above Solwara 1 and South Su

#### Approach

- Water samples taken using ROV- deployed Niskin bottles (water sampling bottles)

