From Exploration to Extraction: The consequences of resource morphology for mining operations on the Chatham Rise

AusIMM 2013 – Nelson
Campbell McKenzie – Kenex Ltd
Background

- Discovered in the 1950’s investigated in 1960/70’s
- Extensively studied by NZ- and German surveys in 1978 and 1981
- Average phosphate content of nodules 21.5% $P_2O_5$
- Phosphate about 15% of the sand/silt layer in which it is found
- Concentration variable on scale of 10’s of metres (0-350 kg/m$^2$)
- Resource estimate 25 million tonnes in situ
- CRP licence area 4726 km$^2$, water depth 350-450m
- Mining licence application area 820 km$^2$
Geology and seabed characterisation

- **in situ**
  - Host sand/silt layer
    - (35 cm avg thickness, avg 15% phosphate, 1-150 mm)
  - Ooze (sticky, clayey chalk)
    - NOT to be mined

- **grab sample**

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Chatham Rock Phosphate Ltd

Kenex: Creating opportunities in the spatial world
Local Geology and Morphology

- Significant influence by glacio-tectonic processes
- Furrows and Pits
- High variability of sand thickness and phosphorite coverage
- Repetition during main Pleistocene glacial periods

sea floor slope
Morphology of Furrows

- Prominent features identified in the Chatham Rise bathymetry
- Widths – 1m – 240m
- Mainly a NW-SE to NE-SW orientation
- Traceable for up to 25km
Morphology of Furrows
Morphology of Pits

- Range of diameters (few metres - several hundred metres)
- Smaller pits (up to 50m) frequently round
- Larger pits (several hundred metres) – triangular/lenticular or subrounded
CRP Exploration

- Prior knowledge of deposit variability
- Additional information required to support assumptions and provide sample.
- Total of 6 exploration cruises, varying purposes (geological, geotechnical, environmental, engineering)
Cruise 1 & Cruise 2

- **Purpose:**
  - Deploy subsea current meter and turbidity sensor
  - Collection of sample for analysis, aid mining system design.
  - ~50 samples collected (Van Veen grab)
Cruise 3

- **Purpose:**
  - Obtaining a better understanding of seafloor morphology.

- 715km² multibeam swath bathymetry

- 199km² sidescan sonar

- 236km of seismic and magnetic reflection
Cruise 4

- **Purpose:**
  - Improve knowledge of phosphate nodule distribution, deposit morphology

- 50 large grab samples
  - 32 tonnes of sample material
  - 172 subsamples (500kg)

- 3 ROV dives

- Seafloor photos

- Additional bathymetry
Cruise 5

- **Purpose:**
  - Collection of environmental information (benthic ecology)

- Survey carried out on 42 lines/13 blocks

- ROV surveys to acquire still and video images.

- Samples collected by box corer
Cruise 6

- **Purpose:**
  - Collecting sample and data to aid in mining tool design.
- **Sampling – box corer/vibrocorer**
- **Cone penetration testing (CPT)**
- **Jetting tests (ROV)**
Interpretation of the exploration data

- Points of note from exploration to date:
  - Sand cover thickness variable both globally across projects area and locally between adjacent test sites;
  - Nodule concentration and coverage highly variable.
  - Where highly localised variability is found, it appears consistent with sand filling in relict iceberg scars;
  - Strength of the top of the chalk is extremely variable (soft to hard);
  - Likely localised zones of very weak materials within wider zones of relatively strong material.
Mining considerations

○ Variable water depth and morphology
○ Variable layer thickness and composition
○ Variable resource concentration
○ Impact on benthic and pelagic environment
○ Economics (Capital and operating expenses, expected market)
Next Steps......