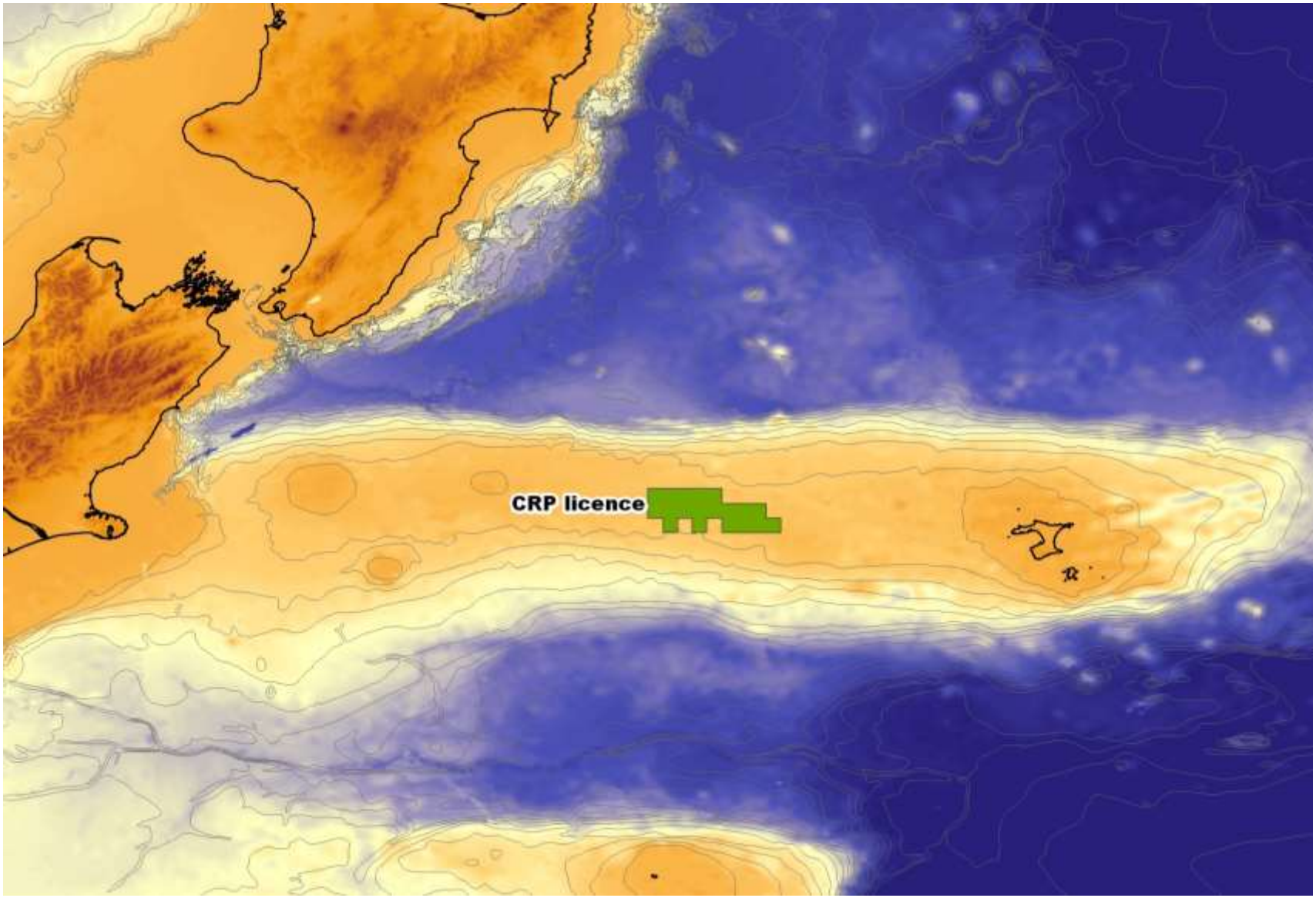
From Exploration to Extraction: The consequences of resource morphology for mining operations on the Chatham Rise

AusIMM 2013 – Nelson

Campbell McKenzie – Kenex Ltd

Chatham Rock Phosphate Ltd

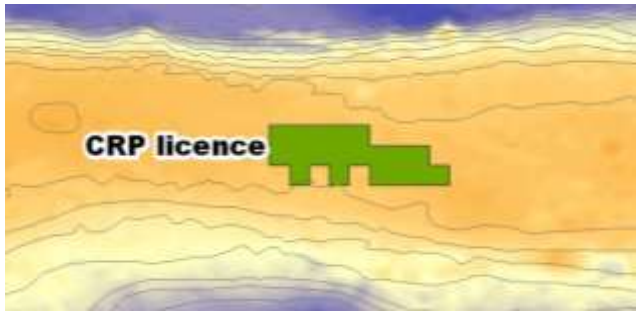
Kenex
Creating opportunities in the spatial world



Chatham Rock Phosphate Ltd

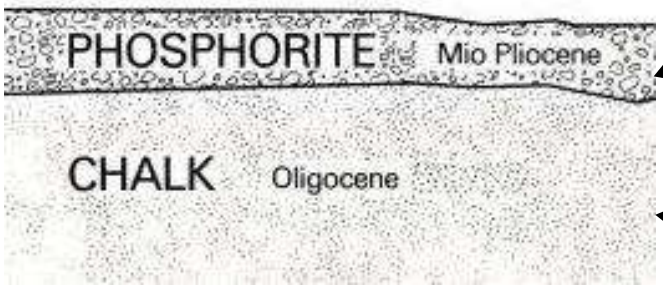
Kenex
Creating opportunities in the spatial world

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

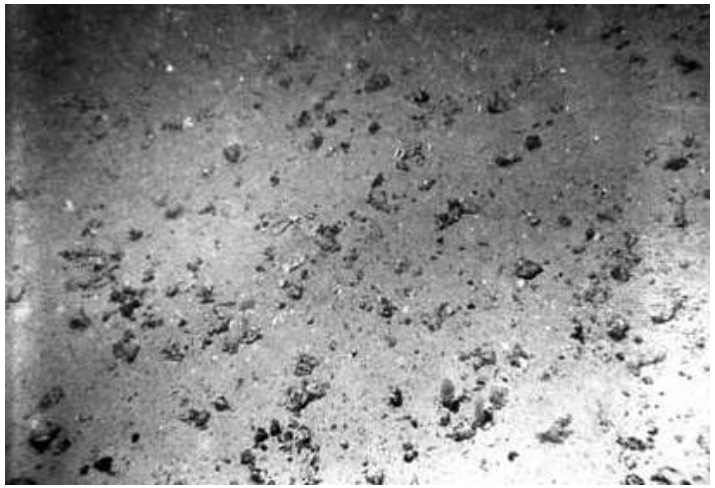
Geology and seabed characterisation



host sand/silt layer (35 cm avg thickness, avg 15% phosphate, 1-150 mm)

ooze (sticky, clayey chalk) NOT to be mined

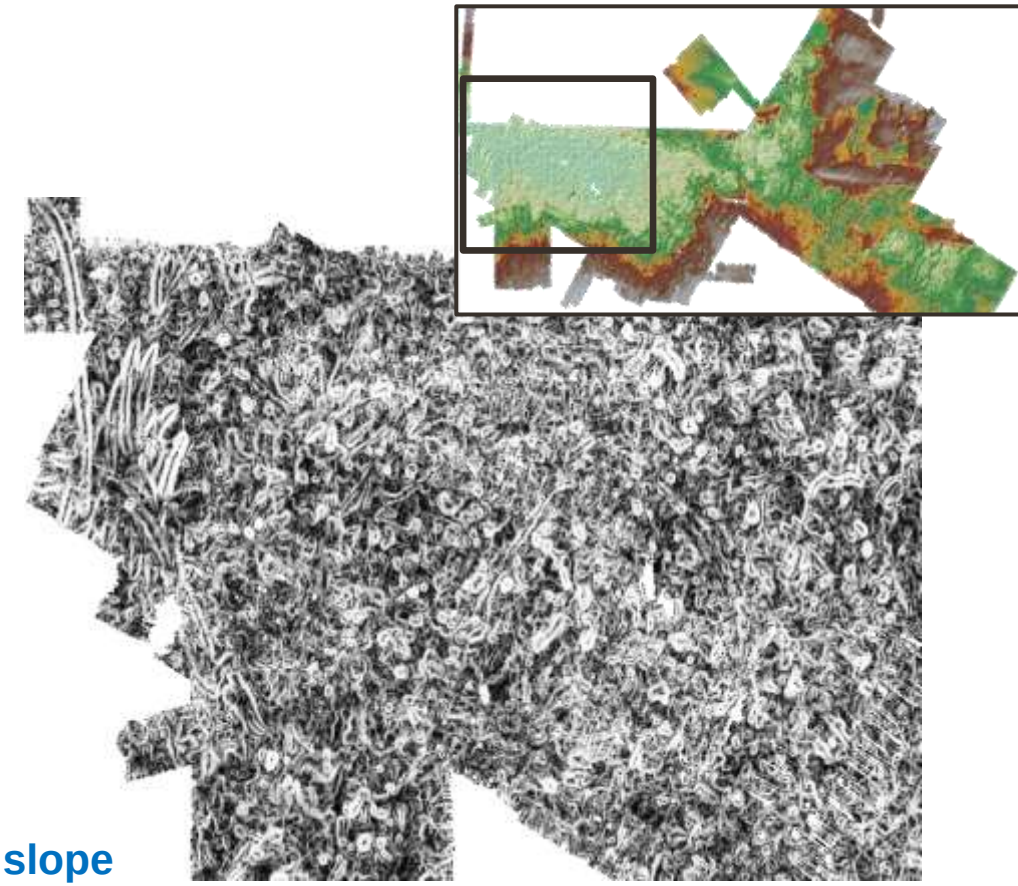
in situ



grab sample

Local Geology and Morphology

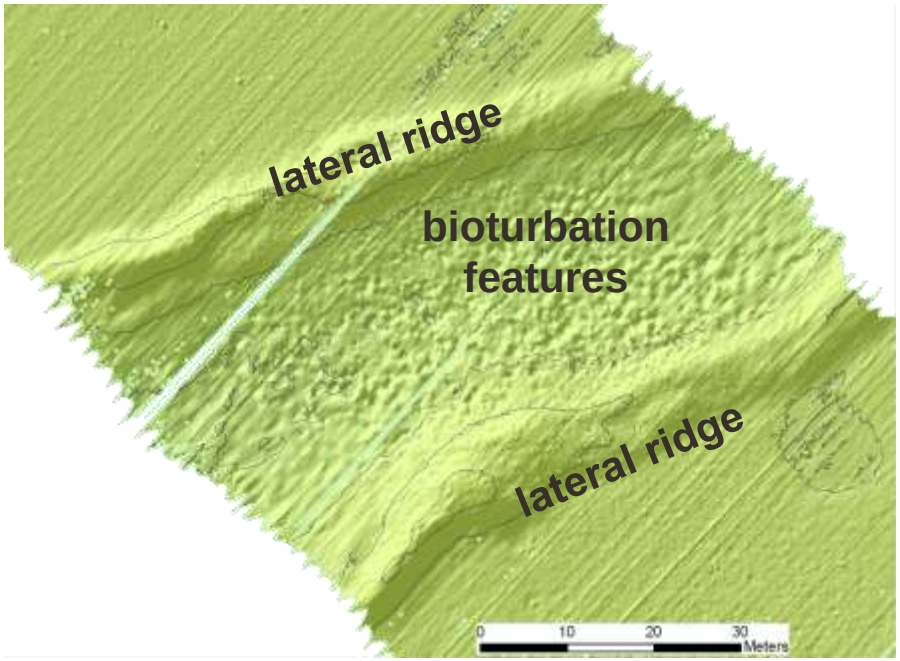
- Significant influence by glacio-tectonic processes
- Furrows and Pits
- High variability of sand thickness and phosphorite coverage
- Repetition during main Pleistocene glacial periods



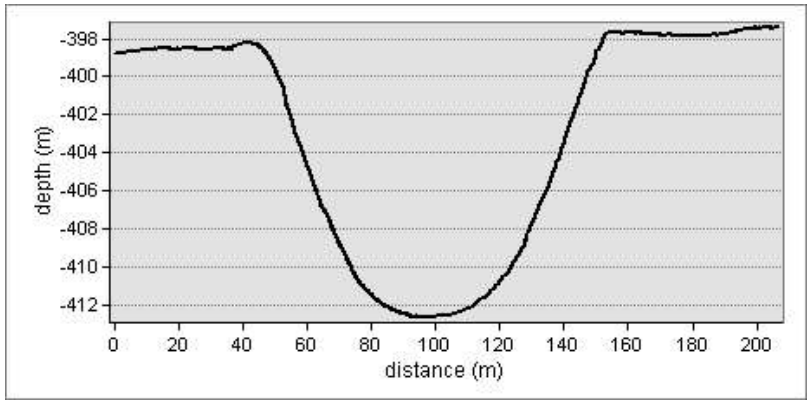
sea floor slope

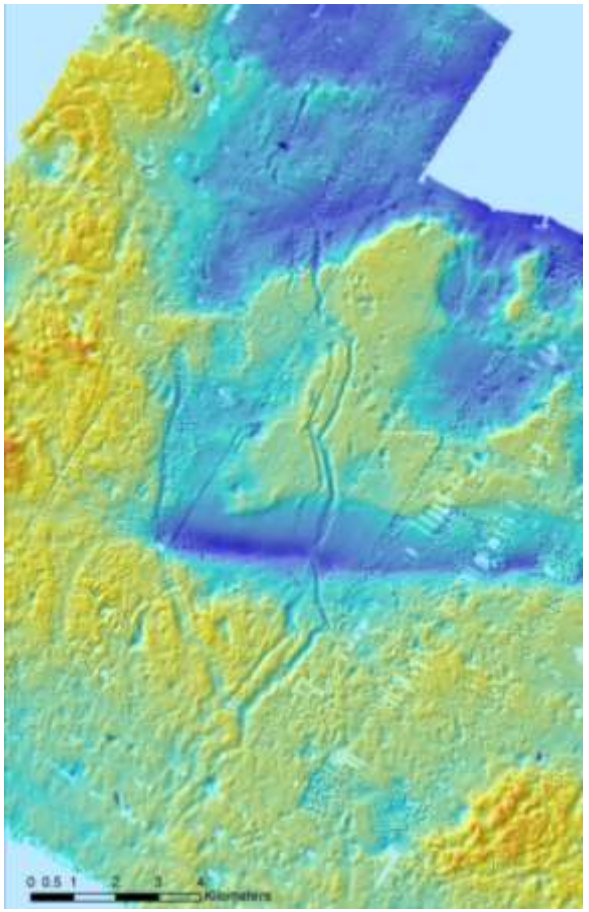
Morphology of Furrows

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



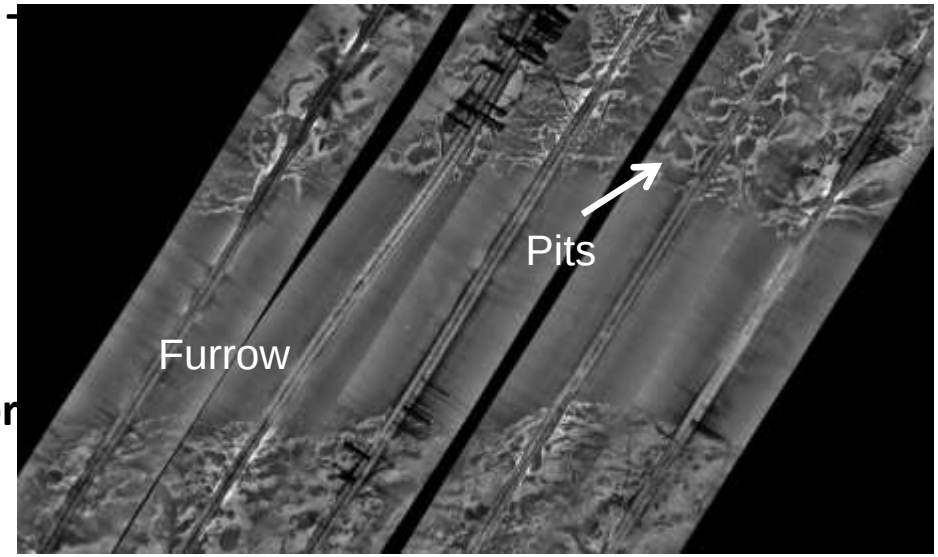
Morphology of Furrows





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**

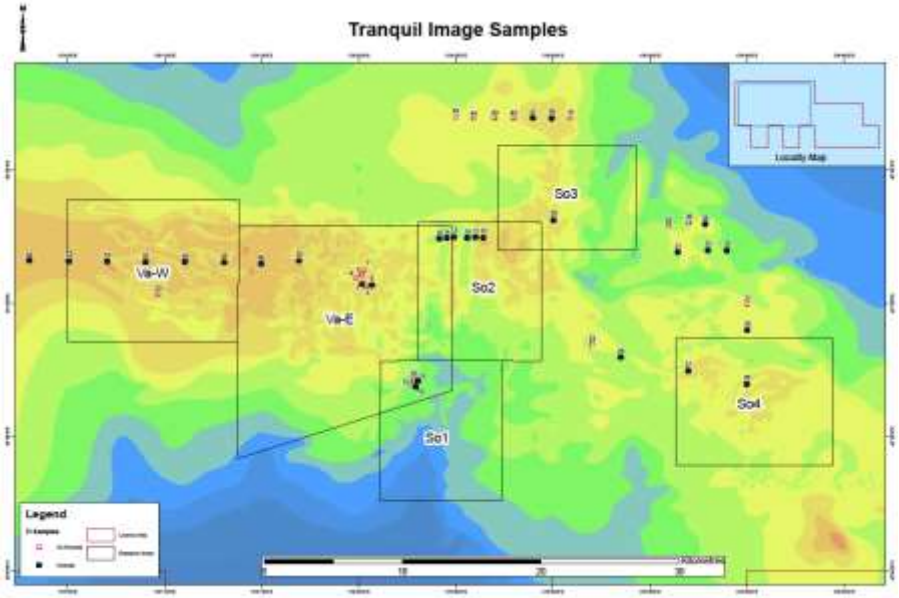


CRP Exploration

- 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)

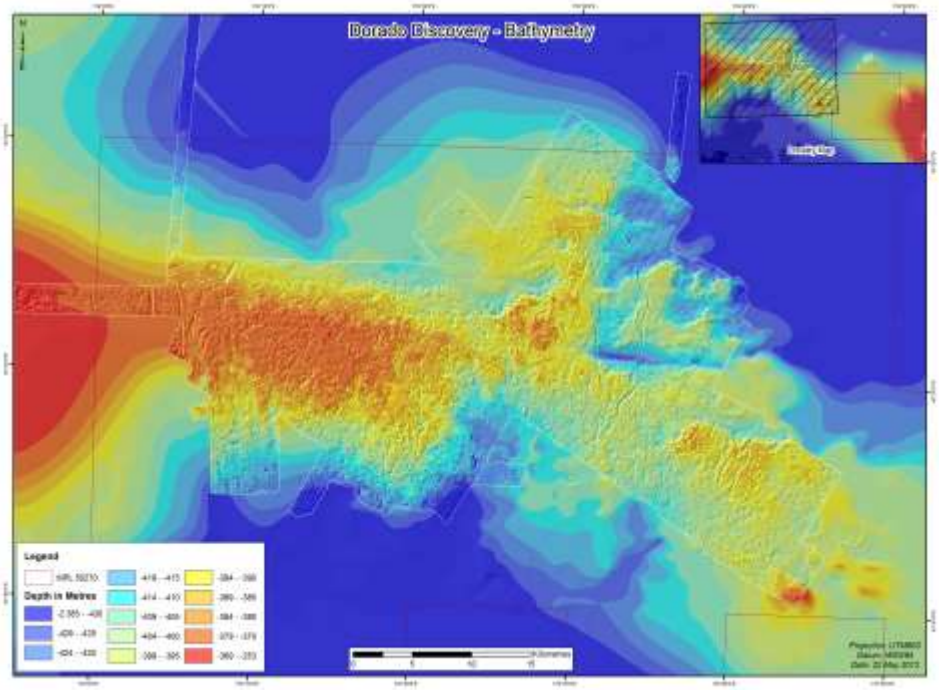
Cruise 1 & Cruise 2

- **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**

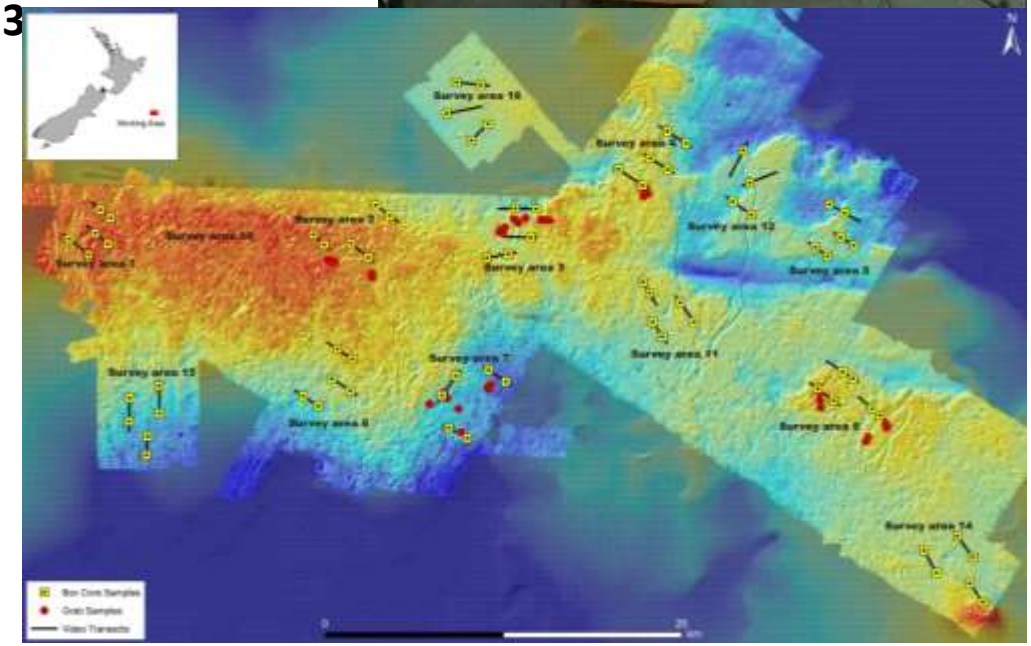


Cruise 4

- **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**

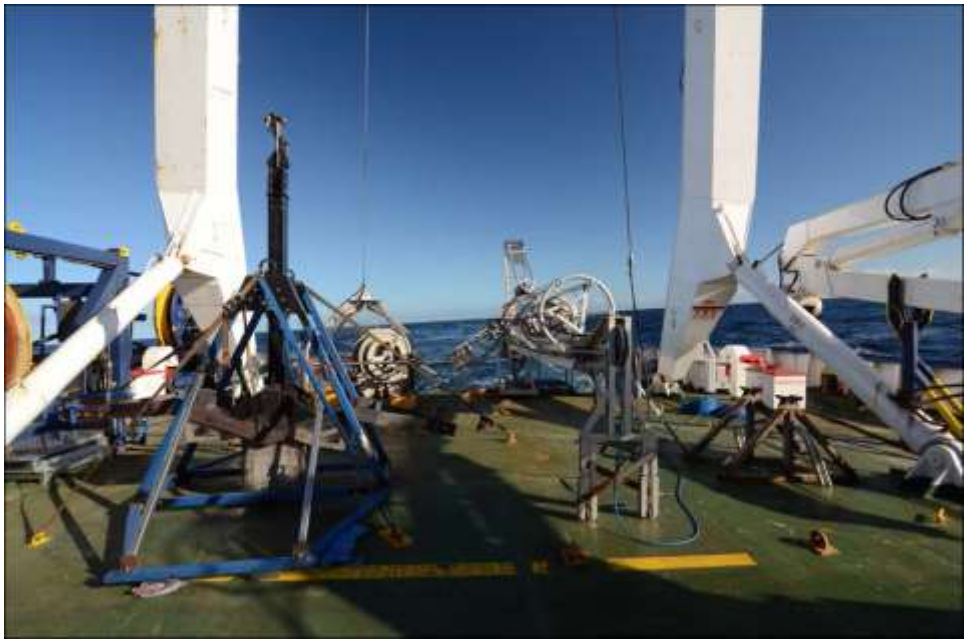
Cruise 5

- **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……