



Seabed Minerals Authority
Runanga Takere Moana
COOK ISLANDS

Diverse marine minerals in a geologically diverse area - the Cook Islands Seabed

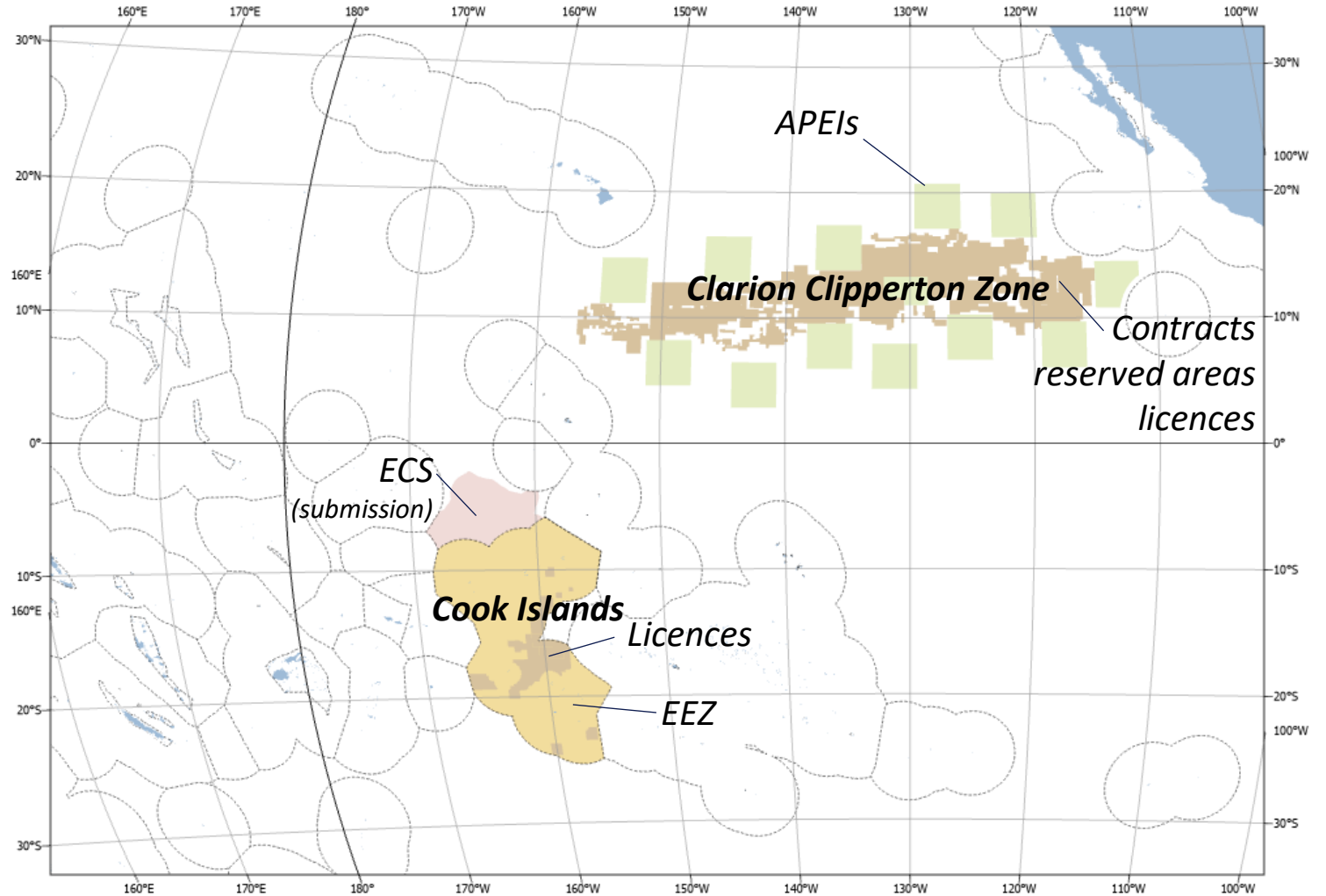
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1. Geology and geomorphology of the Cook Islands Seabed
2. Mineral Occurrence types within the Cook Islands seabed



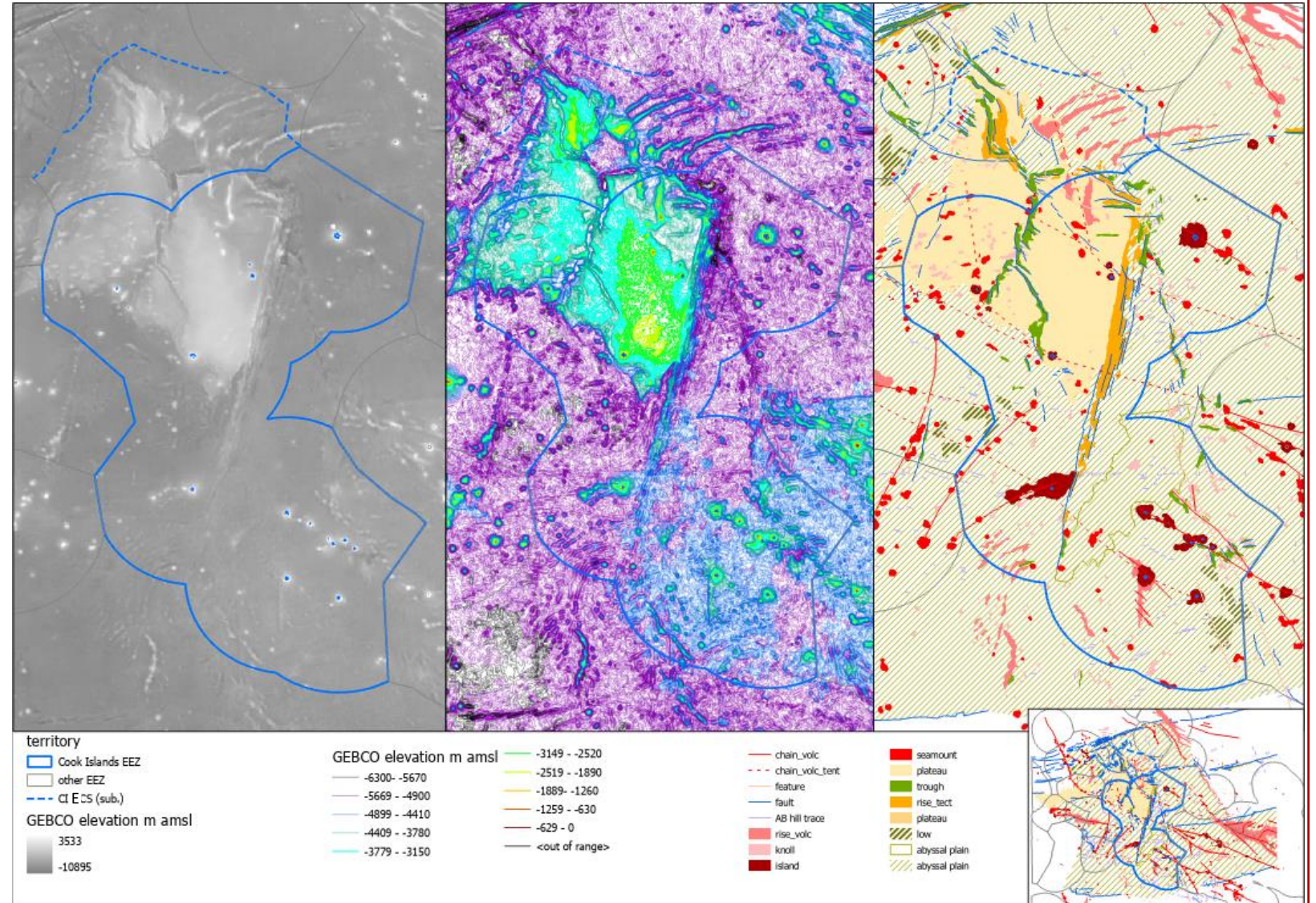


New geomorphological map

- The GEBCO 2021 grid was contoured and carefully colour coded
- Reference was also made to magnetic data
- Manual interpretation of geomorphology

- 1. Abyssal plains and subtypes
- 2. Plateau and associated features
- 3. Knoll-Seamounts and derived chains
- 4. Other tectonic features

- Interpretation covered the region as many features extend beyond our EEZ

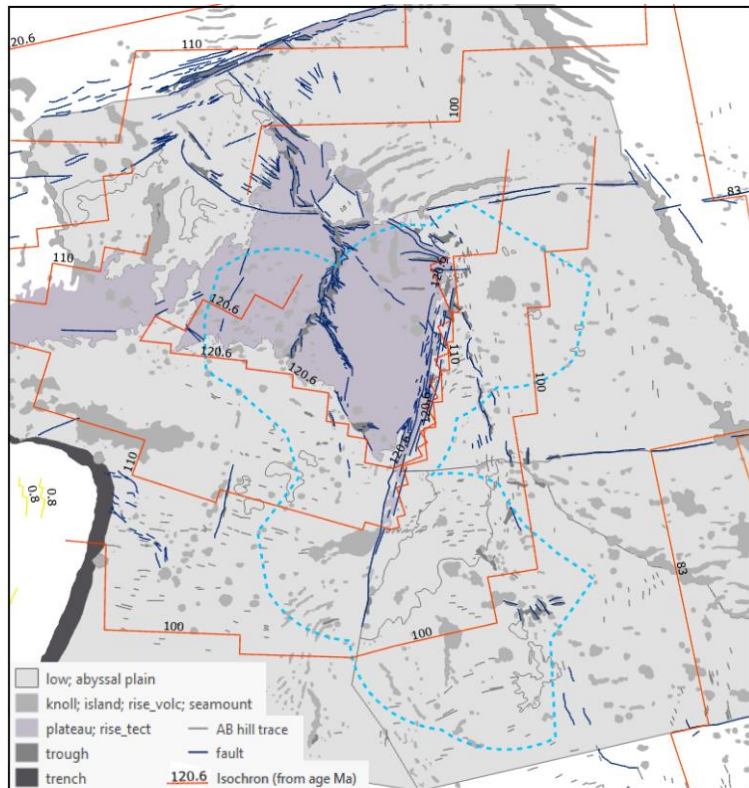




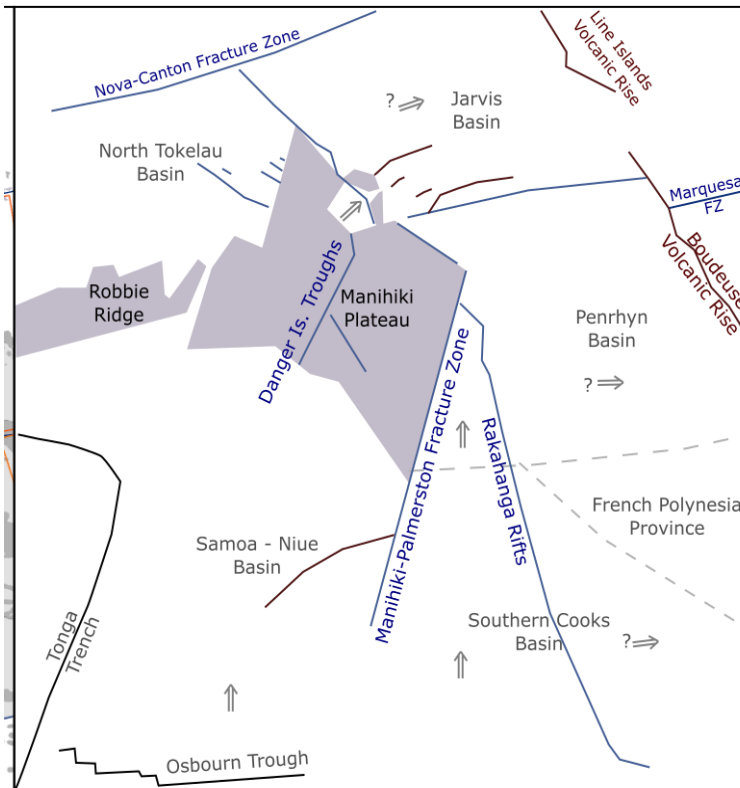
Seabed basement geological history

- Immediately after formation of the Manihiki Plateau circa 120 Ma, seafloor spreading continued to about 100 Ma in multiple locations/orientation
- The plate is then thought traveled over a group of hotspots starting from about 19 Ma

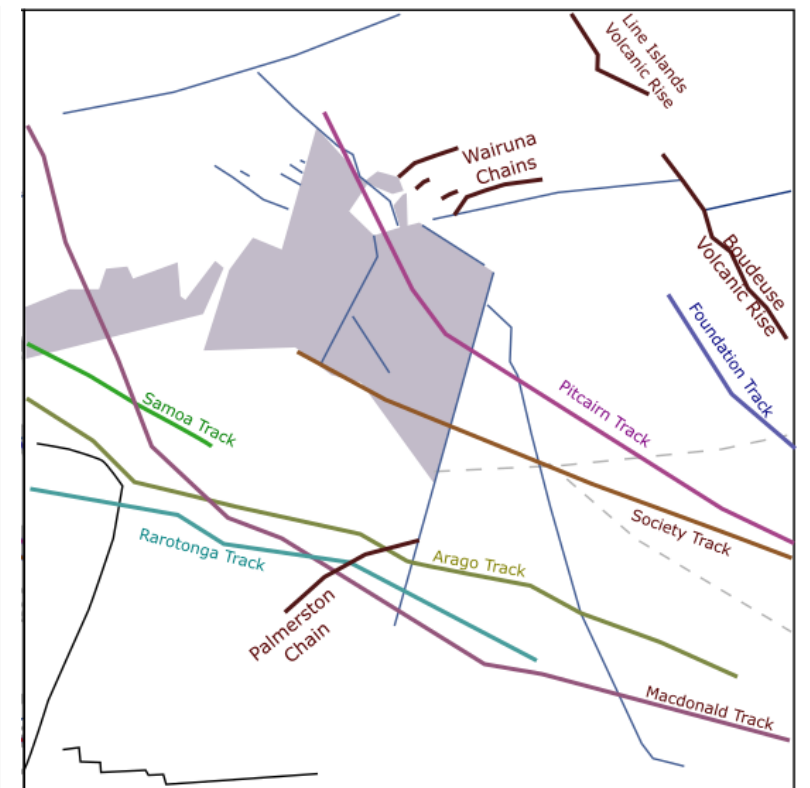
Current Setting



Seafloor Formation

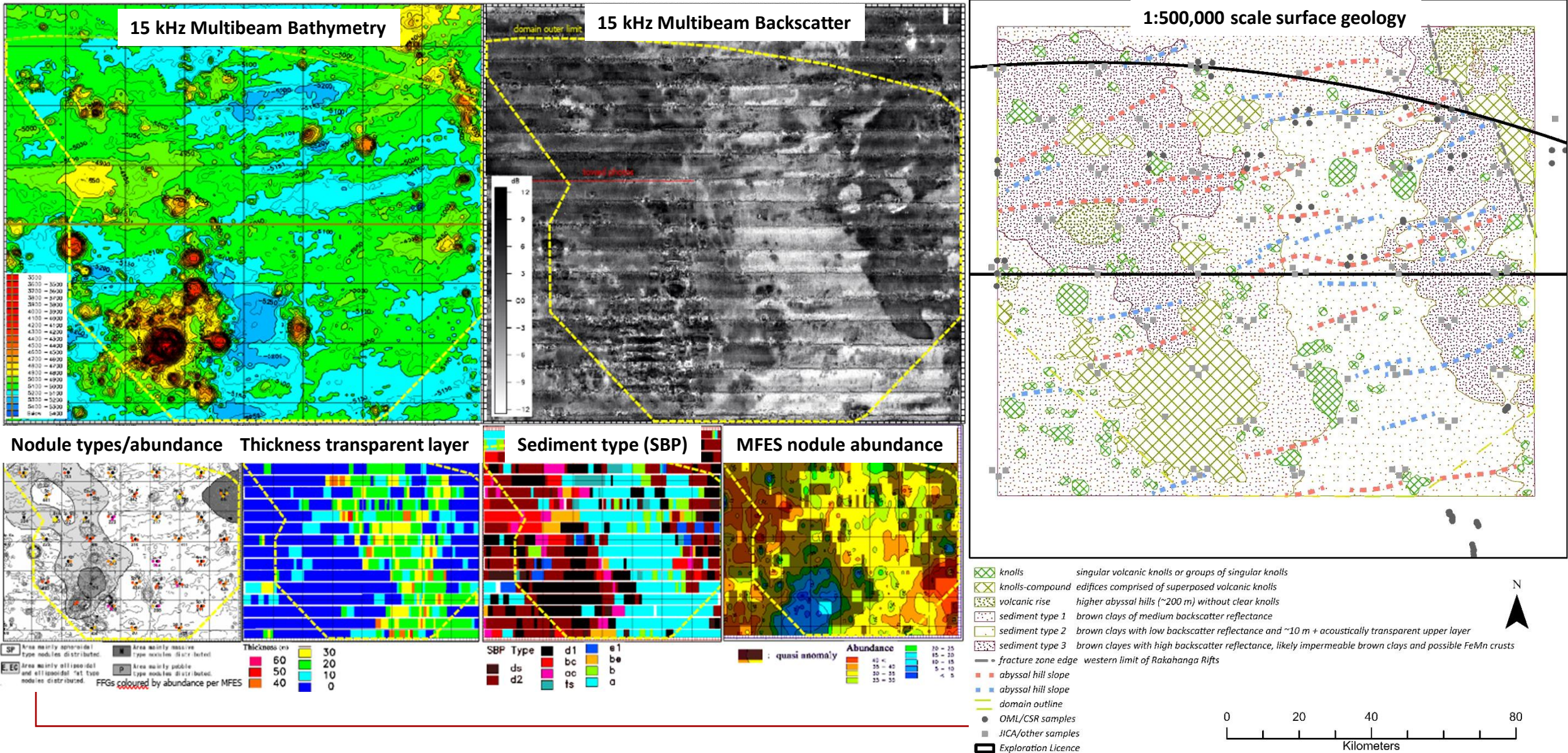


Hotspot Highway





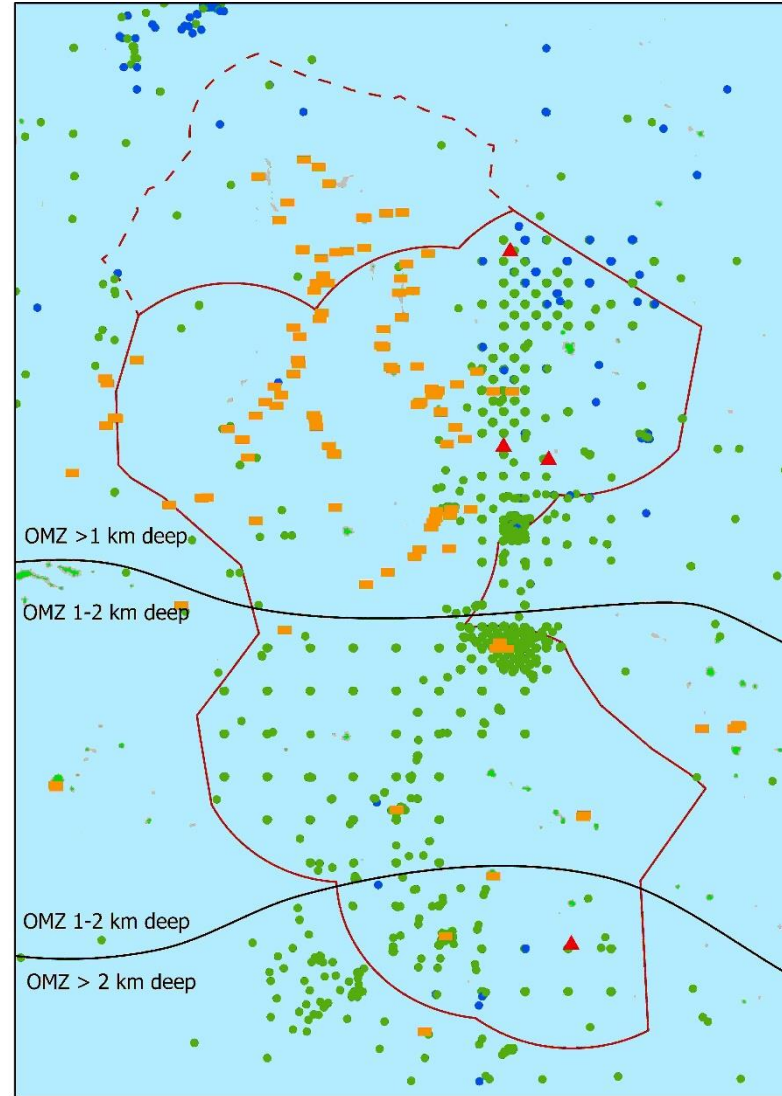
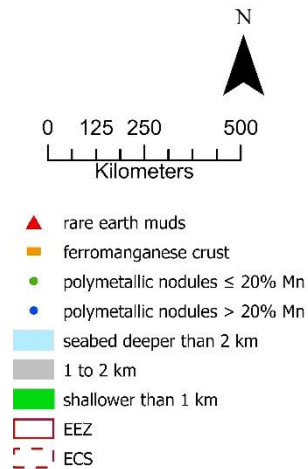
Seabed geology map of part of the Cook Islands nodule field





Overview of mineralization types

- Cook Islands is best known for its nodule deposits
- Different grades of nodules are found in different areas
- Occurrences of Ferro-manganese crusts and REE rich muds have also been found



OMZ is oxygen minimum zone, source World Ocean Atlas 2018



Four chemical classes of nodules

- **Situation 1, high cobalt (Co) nodules (hc):**

up to double the Co of other known occurrences. Very low sedimentation and highly oxygenated bottom water promotes a high proportion of slow hydrogenetic growth.

- **Variant 1, low Co, low nickel nodules (lcln):**

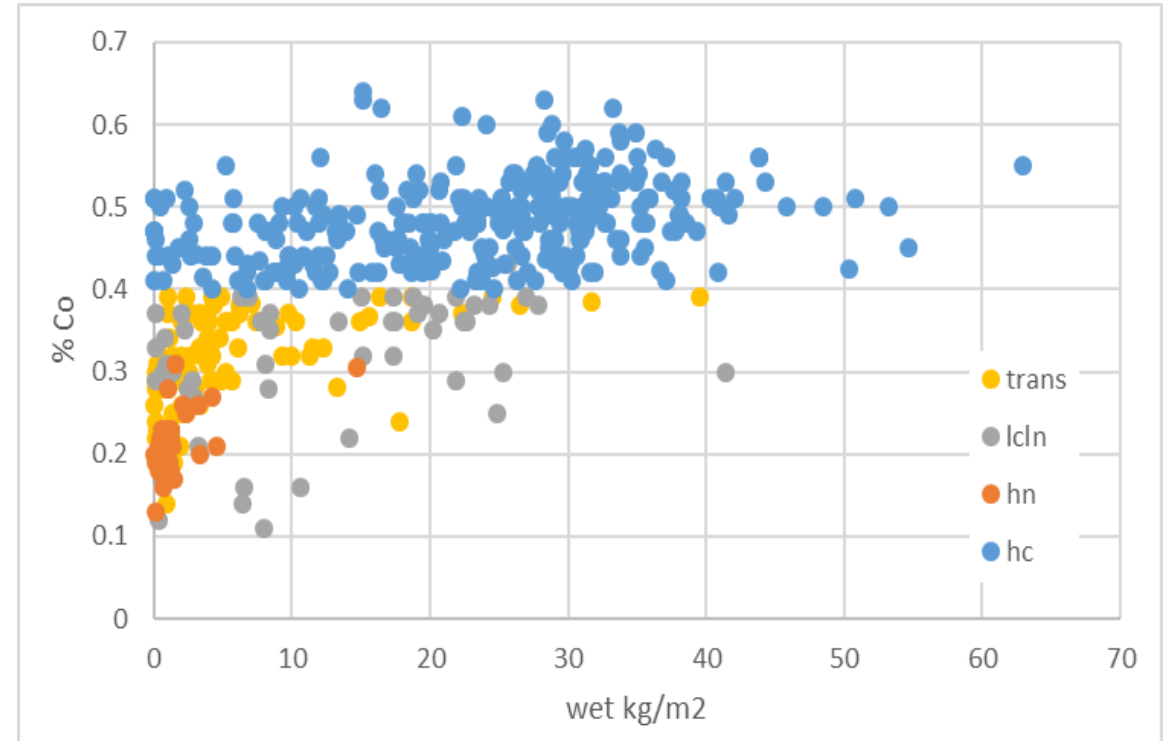
near identical chemistry to the high Co nodules (apart from Co itself). Maybe due to less effective function of the bottom water (above).

- **Situation 2, high nickel nodules (hn):**

in the northern part of EEZ at similar transitional levels of primary productivity to the CCZ.

- **Variant 2, Transitional moderate cobalt moderate nickel nodules (trans):**

may have formed under mixed environments for the high cobalt and high nickel situations above.



Nodule abundance versus cobalt by grade type

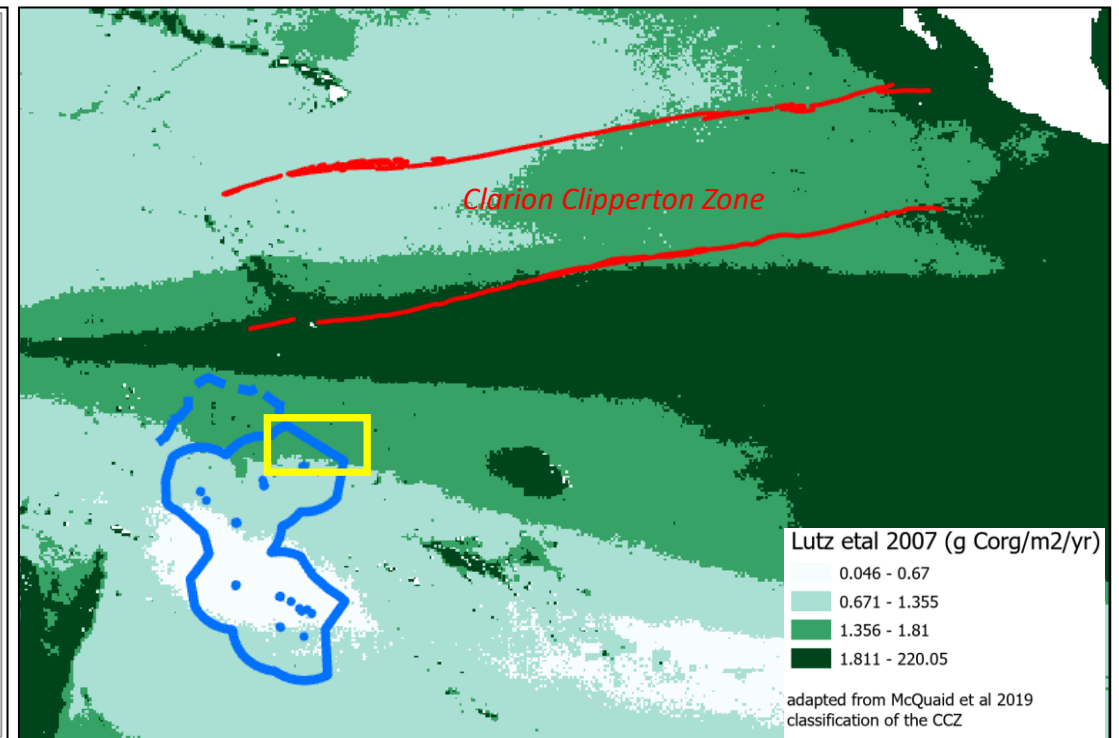
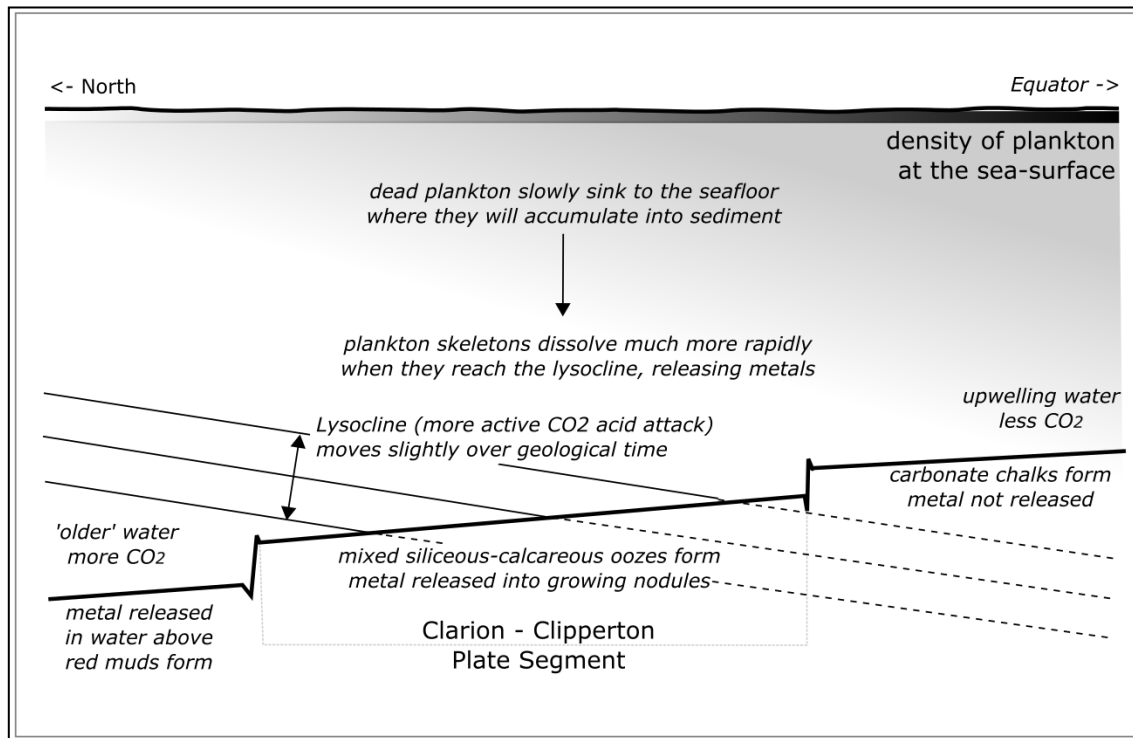
Note that:

1. There is spatial and other grade distinctions between the classes
2. Samples are not de-clustered.



High Ni-Cu nodules – an exploration play

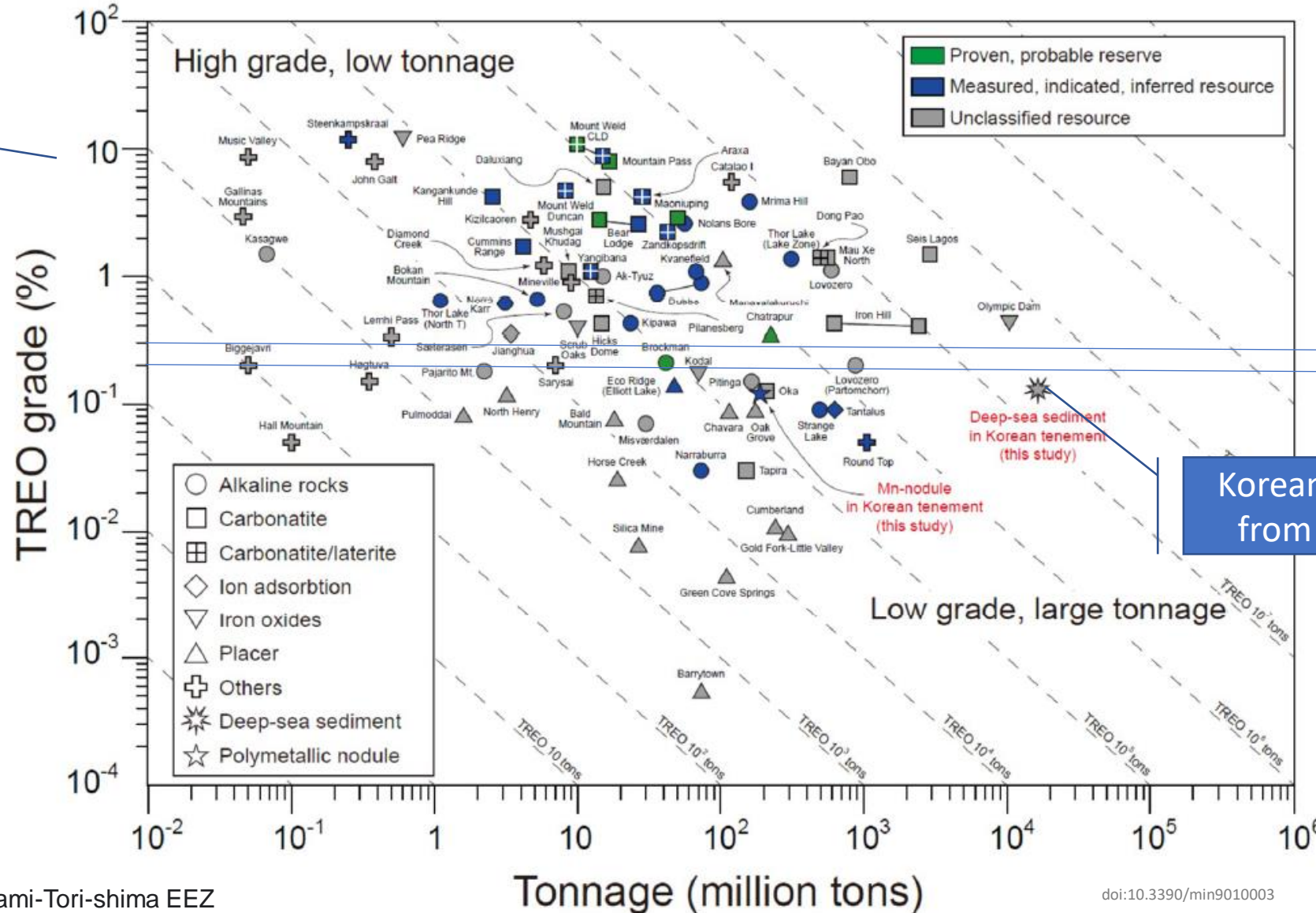
- High Ni-Cu-Mn nodules were sampled by JICA/MMAJ in the northern part of the EEZ in 1985
- Samples at 40-80 km spacing only returned very low abundances (<5 kg/m²)
- Grade and abundance are not related elsewhere – ideal conditions (stability) may be restricted
- The 1985 expedition did not have multibeam technology...





Rare Earth Element muds

Note log scales!



Japan, Cook Islands samples

Korean samples from the CCZ

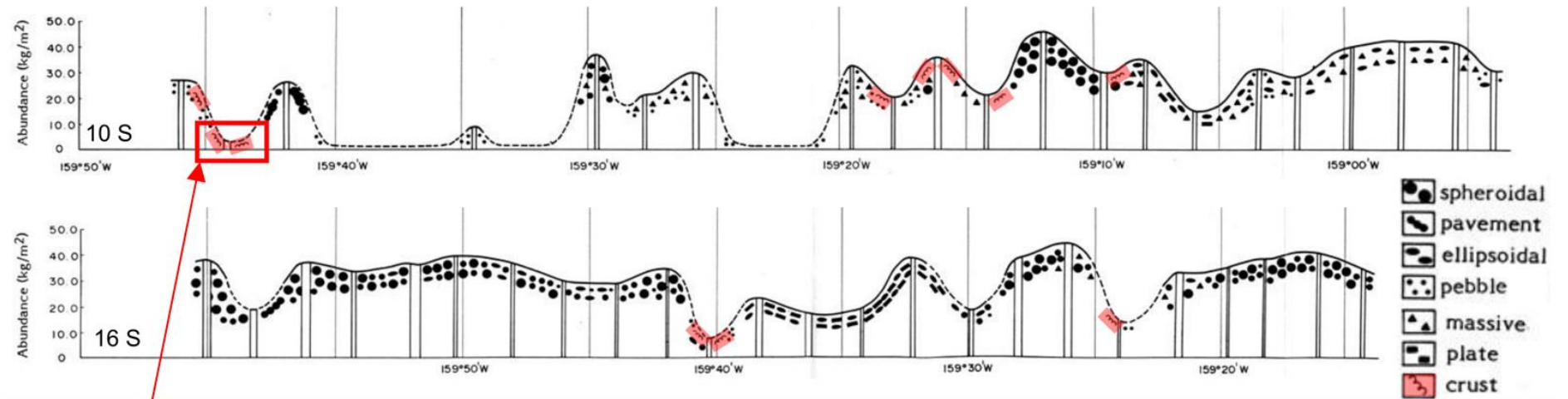
Other benefits:
Readily extracted?
Easier to process?
Little radionuclides
More valuable 'basket'



Cobalt rich crusts

Found in three forms (as seen also in the CCZ)

1. Massive on hard substrate – by far the most common
2. Massive within the sediment
3. Fragments on the sediment



The massive crusts have been noted (never mapped) on the edges of the Manihiki Plateau and amongst the nodules on the abyssal plains.





Status

- At this stage the Cook Islands is only allowing exploration of its marine minerals. Environmental considerations will be foremost before any development is allowed to proceed further.
- While the environmental risk profile for nodules is acceptable to development proponents, a scoping EIA/study might well be required for the other mineral types

