SHRIMP U–Pb zircon geochronology from *NDI Carrara 1*

Implications for regional stratigraphic correlations, resource potential and geological evolution of the Carrara Sub-basin

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The Carrara Sub-basin and NDI Carrara 1

- Carrara Sub-basin discovered during EFTF 1 South Nicholson Seismic Survey in 2017
- NDI Carrara 1 located on western flank of Carrara Sub-basin
- Drilling of NDI Carrara 1 completed in Dec 2020
- EOH 1751 m
- 630 m of Cambrian Georgina Basin
- 1121 m of Proterozoic sediments
PreSTM 17GA-SN1 and 06GA-M2

- 17GA-SN1 links with legacy line 06GA-M2
- Important for geological control, well-studied outcrop
- Extrapolation into the concealed Carrara Sub-basin

See also:
Frogtech SEEBASE 2017
Gibson et al., 2017, 2016
Carr et al., 2019
Key outstanding but related questions

- Confirmation of the stratigraphy within Carrara 1
- Age of sedimentation
- Regional stratigraphic correlations with adjacent prospective regions

Targeted glauconitic tuff intervals

- Abundant in NDI Carrara 1
- Dating of interbedded volcanics the ‘gold standard’ of determining absolute age of sedimentation

Over 20+ tuffs identified over this interval

Depth (m) | SHRIMP Geochronology (sample no) | Stratigraphy | Lithofacies | Mineralisation/ Hydrocarbon shows | Ethane | Methane
--- | --- | --- | --- | --- | --- | ---
7533587 | Georgina Basin | Pyrite | 1,000 ppm 18,000 ppm
7533592 | | Pyrite
7533652 | | Bitumen
7533699 | Proterozoic Carrara Sub-basin | Pyrite
7533699 | | Oil bleeds associated with veins
7533699 | | Sphalerite
7533699 | | Sphalerite/ pyrite
7533699 | | Chalcopyrite
7533699 | | 1,000 ppm 18,000 ppm
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7533699 | | Sphalerite
SHRIMP Geochronology of NDI Carrara 1

Sample 2021330162 @1012.21-1012.24 m shelf carbonates

Sample 2021330404 @1611.05-1611.20 m Shallow water siliciclastics
Volcanic textures preserved

- Glass bubble wall fragments
- Delicate shards and needles
- Bundles of ‘tube-pumice’
- Devitrified fiamme
- ‘Subaqueous non-welded pyroclastic deposit’ (McPhie pers comm)
- ‘Exceptional preservation of textures’ (McPhie pers comm)
- Geochem suggests ‘A-type volcanism’ (Champion pers comm)
SHRIMP U-Pb geochronology results

- Zircons pristine, clean euhedral crystals, no evidence of rounding or abrasion due to fluvial transport
- Unimodal $^{207}/^{206}$Pb ages, no inheritance, convincing magmatic population
- Max Dep age (1595 Ma) at 706 m – scattered zircon ages suggest reworking of underlying zircon populations

**Max Dep 1595 Ma**

- 1588 Ma
- 1601 Ma

5 tuff samples - combined mean age of 1611 Ma (statistically identical at 95 c.l.)
SHRIMP U-Pb geochronology results

- Much of the Proterozoic intersected in NDI Carrara 1 deposited between ~1611 Ma and ~1588 Ma
- Confirms stratigraphy to mid to upper Lawn Hill Frm
- Section between 1000 m and base of Georgina Basin remains ambiguous, Paleo, Meso or Neoproterozoic?
- Voluminous volcanism at ~1611 Ma
- Averaged compacted sedimentation rate ca. 33 m/Ma

*Altermann and Nelson 1998*
Regional correlations

- These results permit robust correlation with existing data and units from the Lawn Hill Platform
- The abundant ca. 1611 Ma tuffs at the base of Carrara 1 correlate with Lawn Hill Formation:
  - Pₘₕ₂ (Sweet & Hutton 1982)
  - Term-Lawn boundary of NABRE
  - 1611 Ma tuffs (Page et al., 2000)
  - Underlies Century Pb-Zn Mine
- The 1588 Ma tuff correlates with:
  - Pₘₕ₄ (Sweet & Hutton 1982)
  - Wide 1-2 of NABRE
  - Tuff @ 1595 ± 6 Ma (Page & Sweet 1998)
  - Hanging wall of Century Pb-Zn Mine
Regional correlations

- The maximum deposition age of ca. 1595 Ma at 706 m allows several possibilities:
  - Preferred possibility is that the remaining Proterozoic in NDI Carrara 1 is uppermost Lawn Hill Formation
  - or Mesoproterozoic South Nicholson Group
  - or Neoproterozoic sediments?
  - Further geochron work needed to resolve
Resource implications

- Correlates to host units of the world-class Century Mine (100 km to E)
- Sediment-hosted base metal potential of the Carrara Sub-basin
- Gas discovery in carbonaceous shales on the LHP, Lawn 4 supersequence (P$_{m4}$ Egilabria 2)
- Widespread occurrence of organic rich shales elsewhere in Lawn 4 supersequence
- Unconventional hydrocarbon play (Lawn Petroleum Supersystem, e.g. Jarrett and Munson 2022) exists in the Carrara Sub-basin
- Other prospective formations of the McNamara Group lie below NDI Carrara 1 EOH
- e.g. HYC, Mount Isa, Lady Loretta and McArthur Petroleum Supersystem
*Take home message*

Century Mine – upper Lawn Hill Formation

- Chronostratigraphic correlation with NDI Carrara 1 and host rocks at Century
- Base metal and energy potential of Carrara Sub-basin
A 1611 Ma volcanic complex?

- Circular deep gravity low
- Imaged during South Nicholson Seismic Survey (SN1)
- Truncates half-graben bounding faults
- Potential field modelling (Southby unpub.) = igneous body
- 1640 Ma River extension, overlain by Mesoprot (MDA 1586 Ma)
- Source of regional 1611 tuffaceous horizons (Lawn Hill Platform and southern McArthur Basin)
Conclusions

• Volcanism and coincident sedimentation in NDI Carrara 1 = 1611-1588 Ma
• Middle to upper Lawn Hill Formation (McNamara Group), units $P_{mh2}$ to $P_{mh4}$
• Much, if not all, of Proterozoic in NDI Carrara is **Lawn Hill Formation**
• NDI Carrara 1 contains stratigraphic equivalents of host rocks of Century Pb-Zn mine and to rocks identified on the Lawn Hill Platform as prospective for unconventional hydrocarbons (Lawn 4, *Lawn Petroleum Supersystem*)
• Further highlights the resource potential of Carrara Sub-basin
• Permits speculation of a large Paleoproterozoic igneous complex at 1611 Ma
Further information

• NDI Carrara 1 Borehole Completion Report