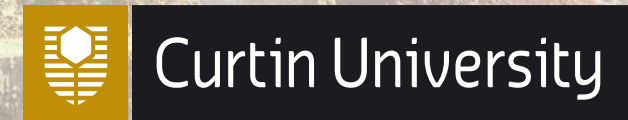


Understanding the Mt Weld Carbonatite mineral system

A Critical Minerals super-resource in Western Australia

MRIWA Project M10422

Arthur Vicentini de Oliveira, Denis Fougereuse, Pete Kinny



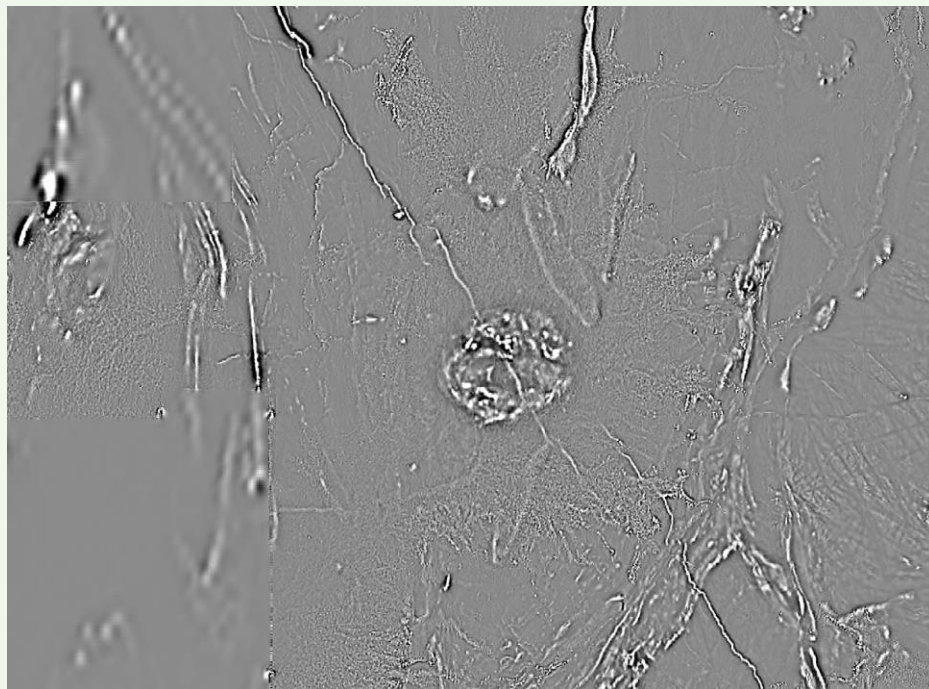
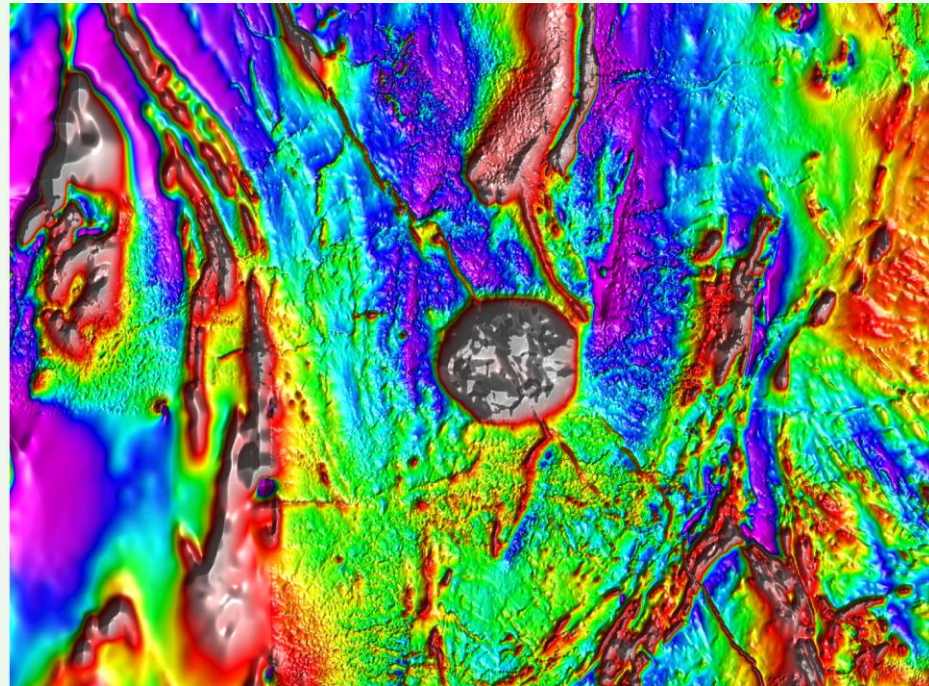
Anderson Santos, Artur Deditius, Hans Oskierski



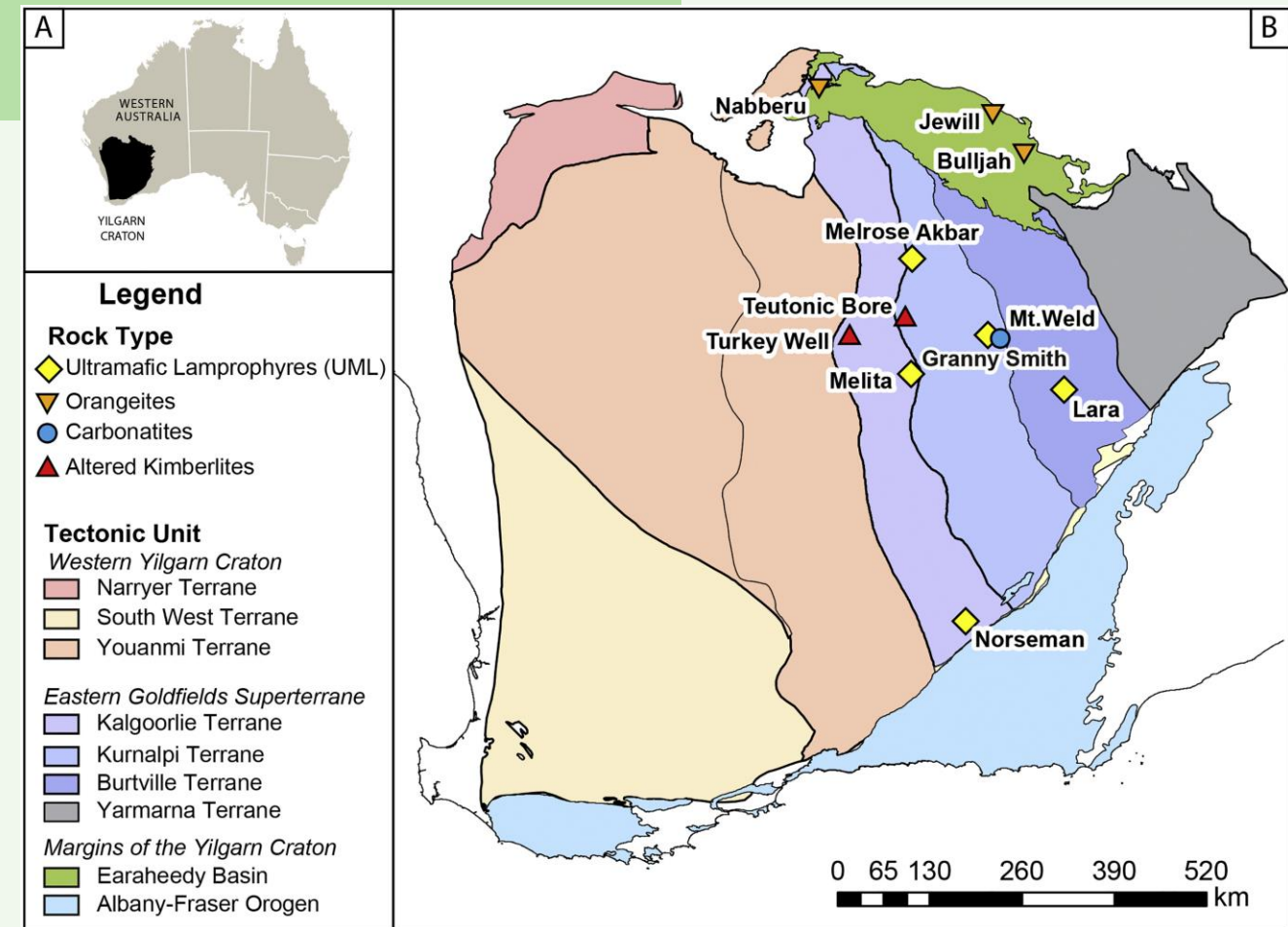
Ganesh Bhat



The Mt Weld Carbonatite



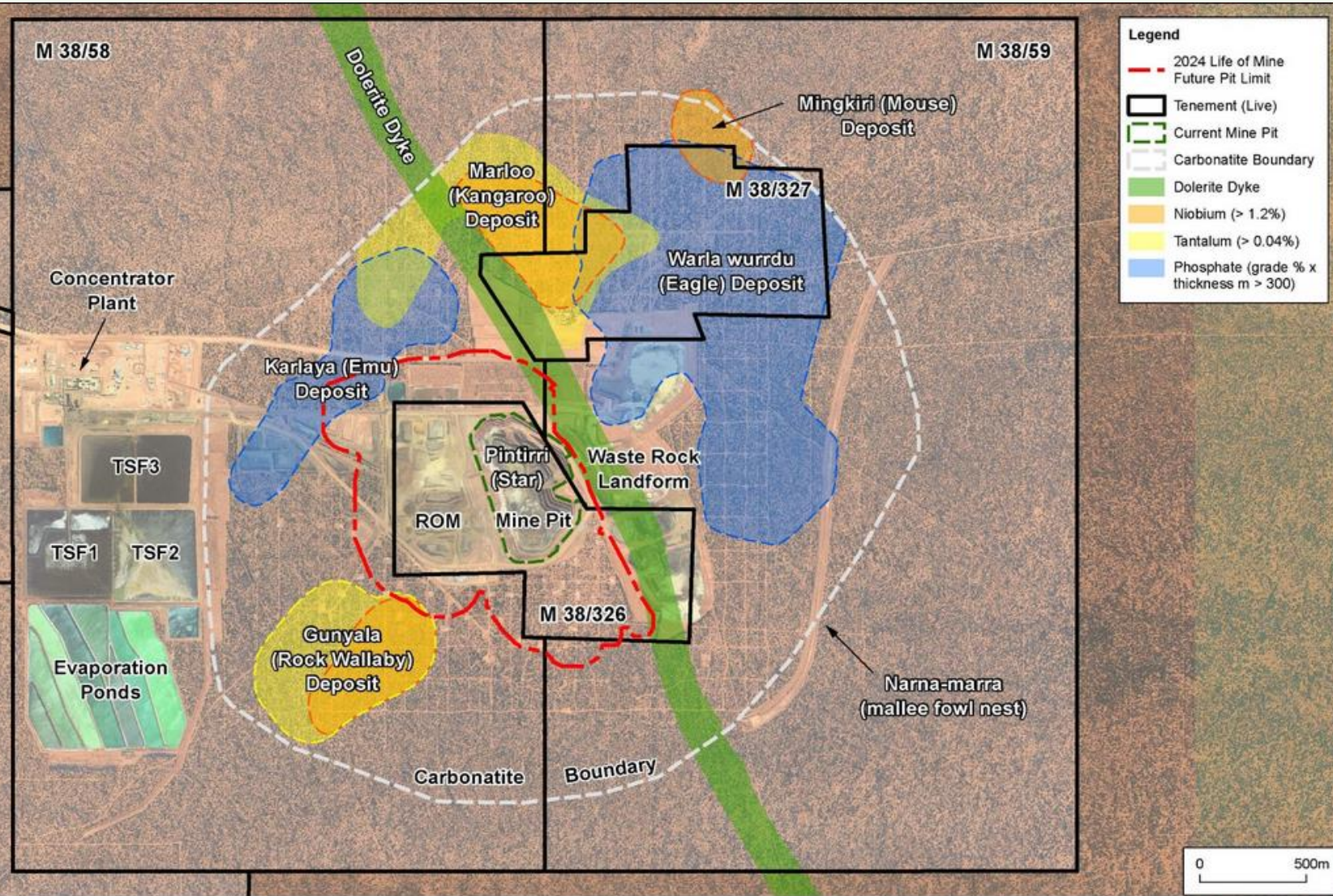
Aerogeophysics of Mt Weld carbonatite, Bureau of Mines and Geology, WA



Schematic map of the Yilgarn Craton, the Mt Weld carbonatite and temporally associated ultramafic alkaline volcanism, Choi et al. (2021)

- Concealed under 25m thick alluvial sediments;
- 1966 Aerial magnetic survey: search for Nickel deposits;
- 1969 drillholes in the Mt Weld anomaly: presence of a carbonatite;
- First a phosphate resource, then a REE resource.

The Mt Weld Deposit



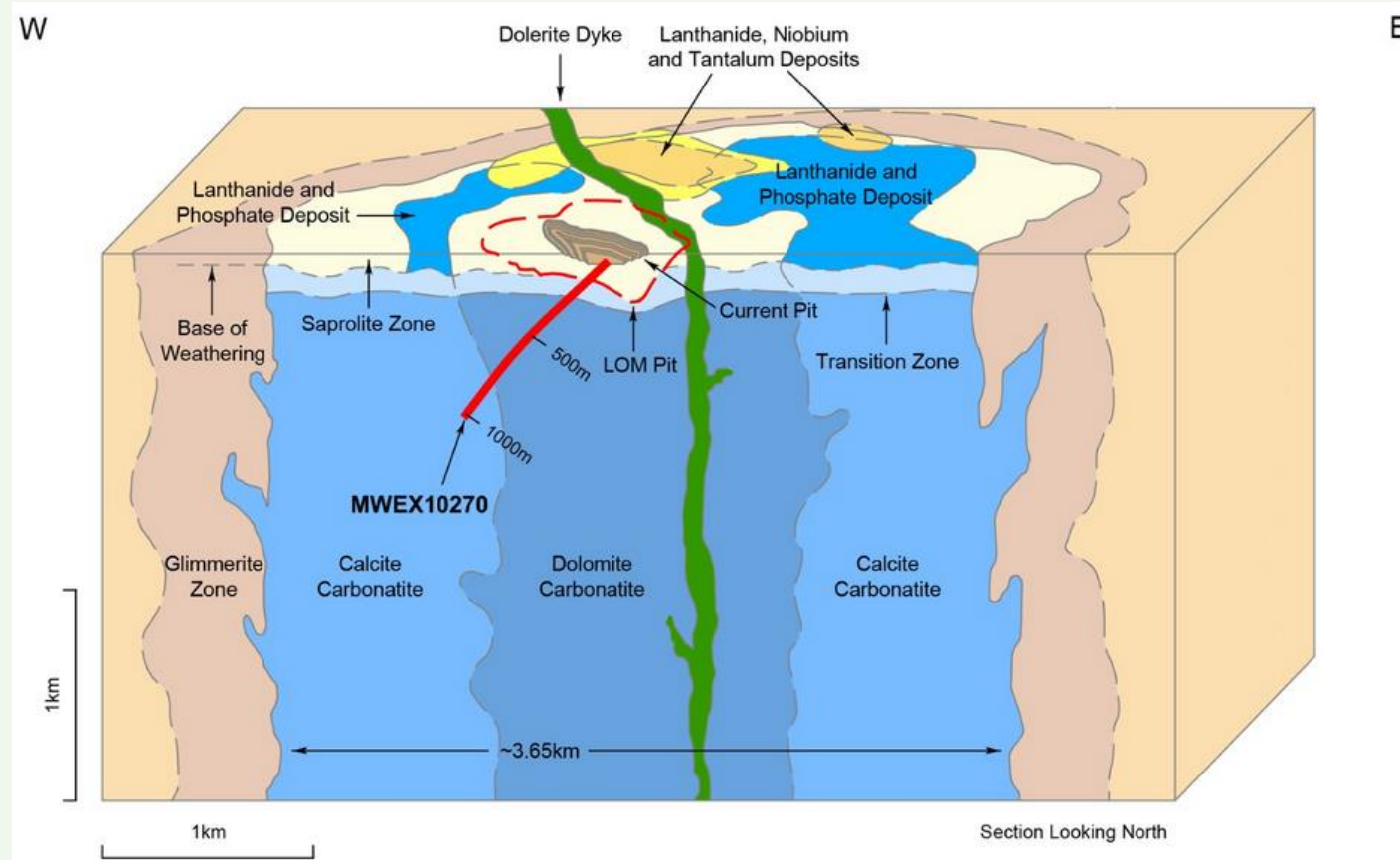
Active mine at the regolith: REE production

Multiple commodities:

- Rare earth elements (Light and Heavy REE);
- Niobium and Tantalum;
- Phosphate

Mt Weld Carbonatite and related mineral deposits. REE mine pit and 2018 mine design of the future pit limit (red outline), Lynas Rare Earths, 2024.

The Mt Weld Carbonatite



Schematic block diagram of the main rock units of the Mt Weld carbonatite. Lynas Rare Earths Ltd, 2024

- Mt Weld is one of the world's oldest carbonatites:
 - Paleoproterozoic – 2.06 Ga (Fiorentini et al., 2020)
- Ferroan Dolomite Carbonatite core and Calcite Carbonatite – Phoscorite annulus;
- Glimmerite/Fenite rim of metasomatized Archean country rock
- Crosscut by a Proterozoic dolerite dyke

First deep drillhole (1020m inclined) into the fresh carbonatite, MWEX10270, drilled in 2021, via the DMIRS Exploration Incentive Scheme

Project objectives

PhD project 1. Secondary REE-Nb mineralisation at Mt Weld and the influence of weathering: Murdoch University

- What are the main controls on REE-Nb enrichment during the weathering of the Mt Weld carbonatite?
- What processes control light and heavy REE distribution in the regolith?
- Characterise the porosity and understand its control on REE enrichment during weathering.
- Dating of the weakly weathered carbonatite and the regolith (Mn oxide layers).
- Does the dolocrete overlying the regolith represents a relic of the dissolved carbonatite?

PhD project 2. Primary REE-Nb mineralisation at Mt Weld: Curtin University

- Define the main rock units and the REE-Nb mineralisation styles and alterations.
- Dating of the different rocks and mineralisation events at Mt Weld.
- Is the mineralisation hydrothermal or there is an important magmatic influence?
- Is there any crustal influence on the REE enrichment of Mt Weld?
- What controls LREE and HREE mobilisation and precipitation?



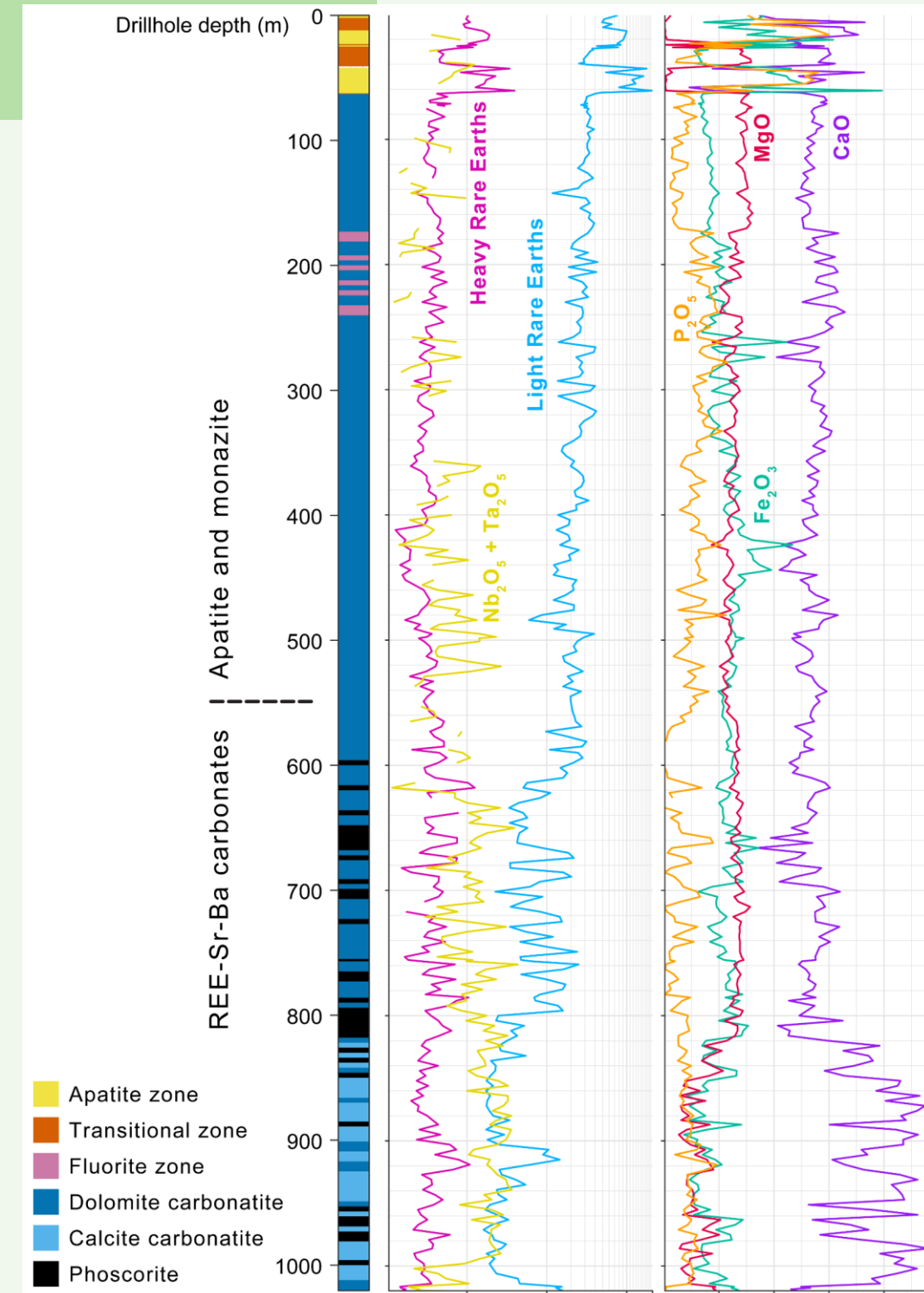
RC drill powders (2023)



Mt Weld open pit view (2023)

Fresh carbonatite — main rock units

- REE mineralisation is associated with Dolomite Carbonatite;
 - REE-Phosphate and REE-Carbonate zones
- Nb mineralisation is associated with Calcite Carbonatite and Phoscorite.



Logging of the MWEX10270 diamond drill core, starting at the open pit floor.

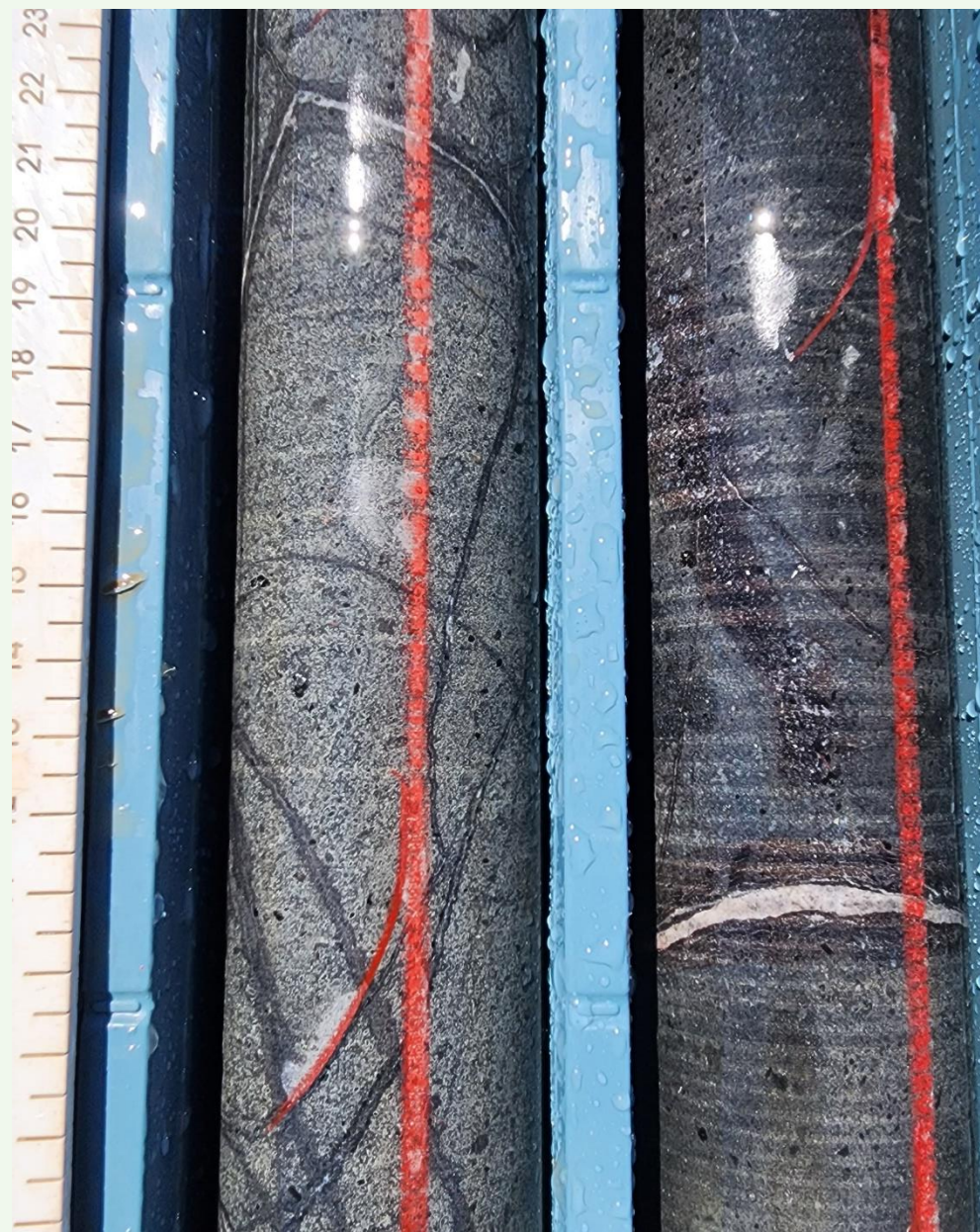
Fresh carbonatite — Nb Mineralisation

Olivine/Biotite + Apatite + Magnetite = Phoscorite

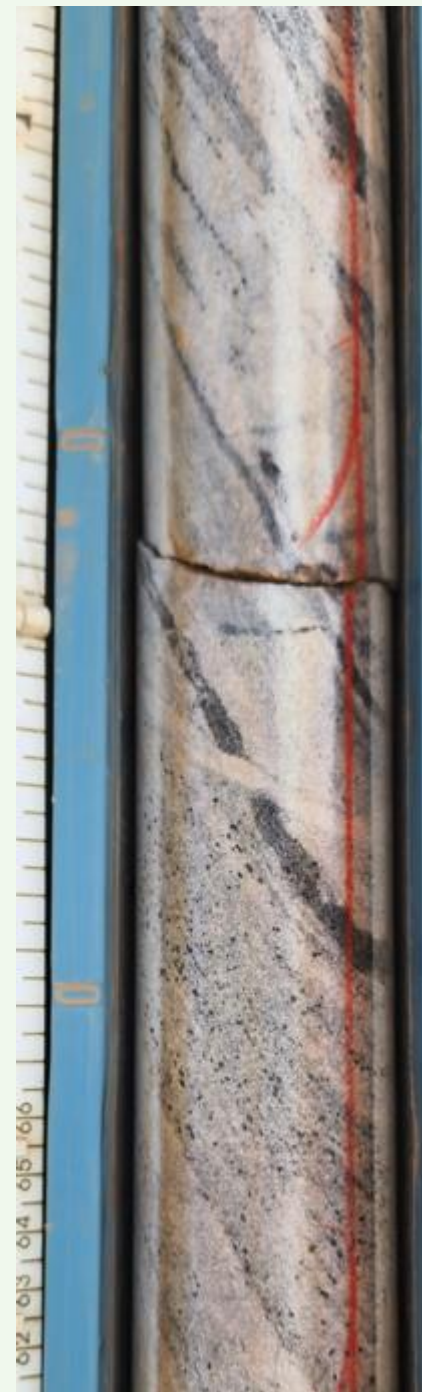
Olivine

Carbonatite influence

Biotite

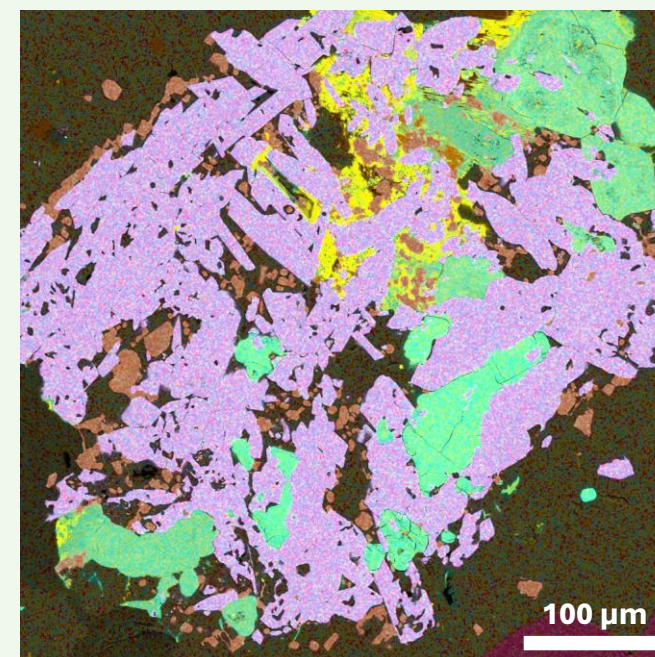


Calcite carbonatite



Olivine Phoscorite metasomatism:

- Olivine > Biotite
- Formation of sulphides
- Baddeleyite > Zircon + **Pyrochlore (Nb ore)**



- Bdy
- Pcl
- Zrn
- RECarb
- Cal

Phoscorite baddeleyite crystal incorporated into calcite carbonatite and altered

Fresh carbonatite — REE Mineralisation

Calcite carbonatite



Carbohydrothermal vein in Calcite carbonatite



Ferroan Dolomite + **REE carbonate** ± Amphibole

Ferroan Dolomite + Amphibole ±
REE carbonate ± Sulphides

Sr-rich calcite carbonatite
(alteration of host rock)

Host rock
Calcite carbonatite

Dolomite intrusion/veining in the calcite carbonatite;

Formation of REE-Sr-Ba carbonates:

- Strontianite (Strontium carbonate)
- Barytocalcite (Barium-calcium carbonate)
- Ancylyte (REE-strontium carbonate)
- Bastnäsite-Synchysite (REE-calcium fluorocarbonate)

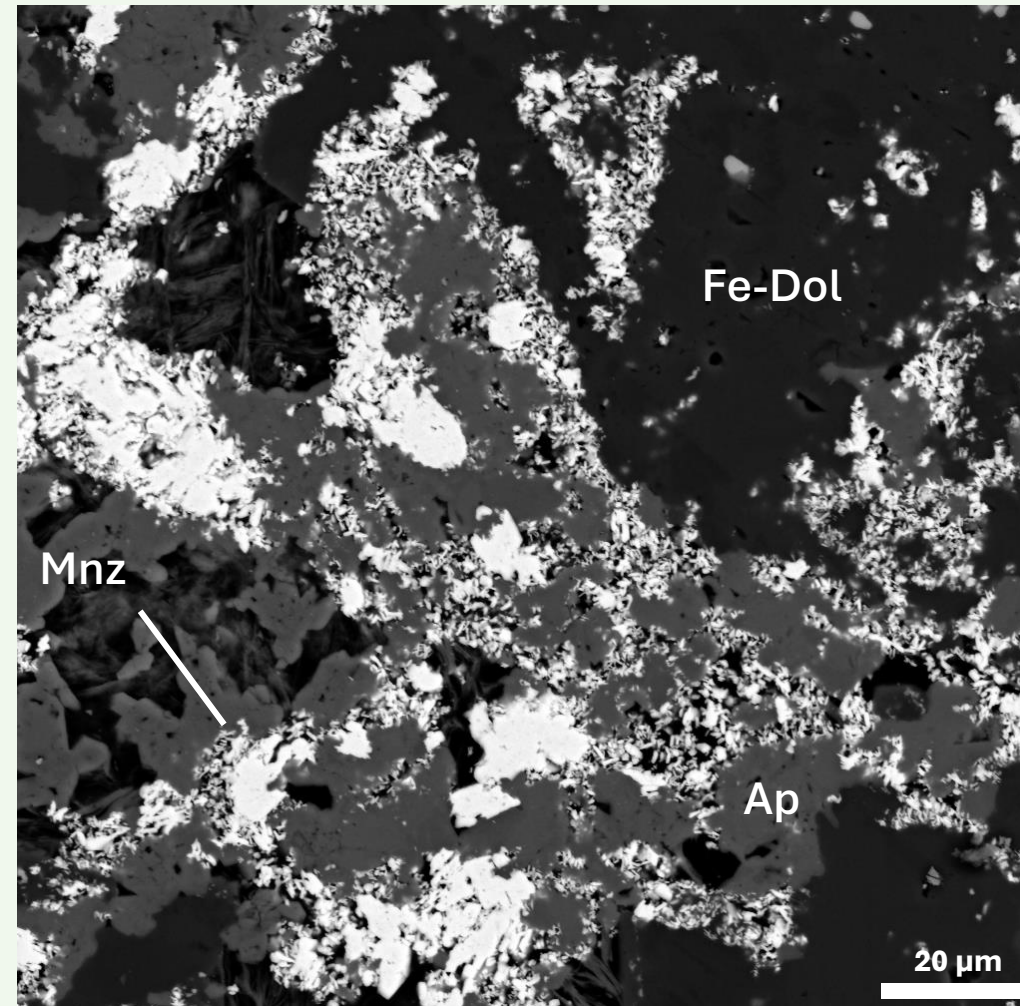
Fresh carbonatite — REE Mineralisation

Ferroan dolomite carbonatite



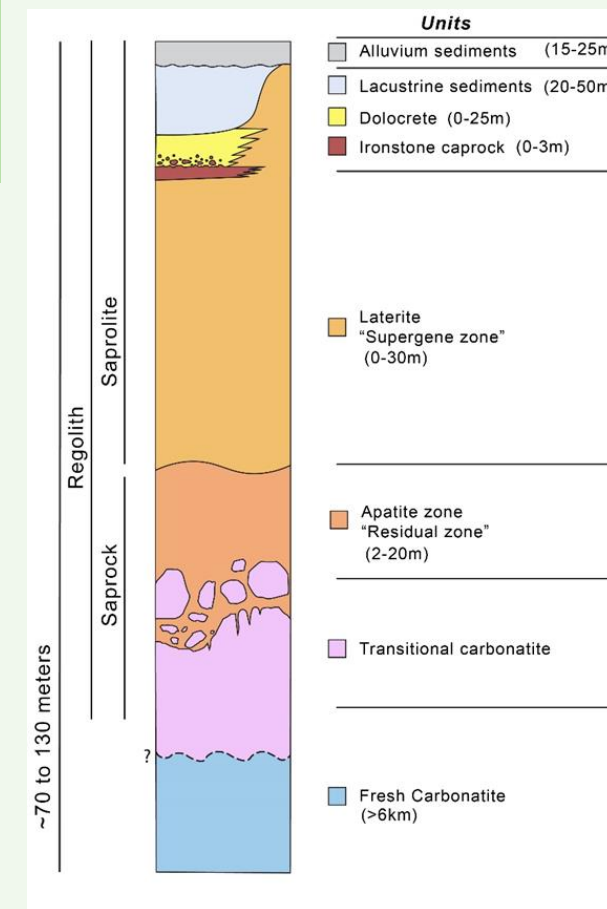
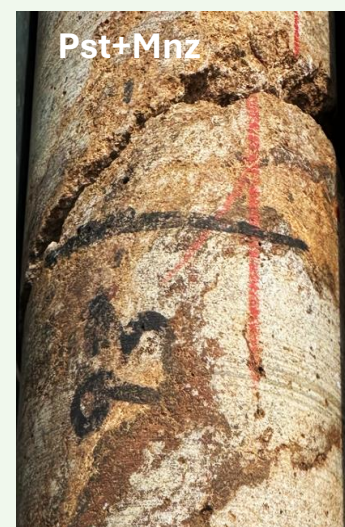
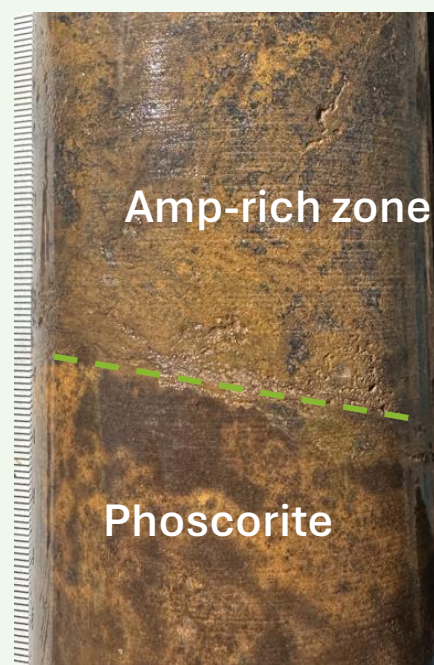
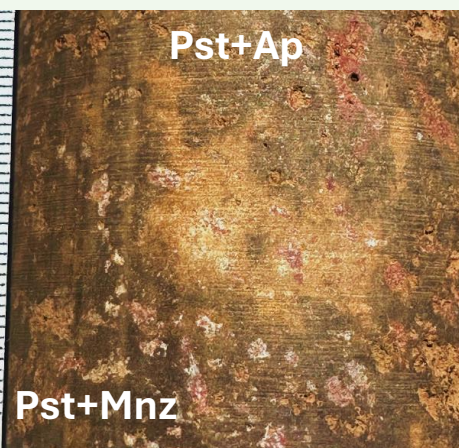
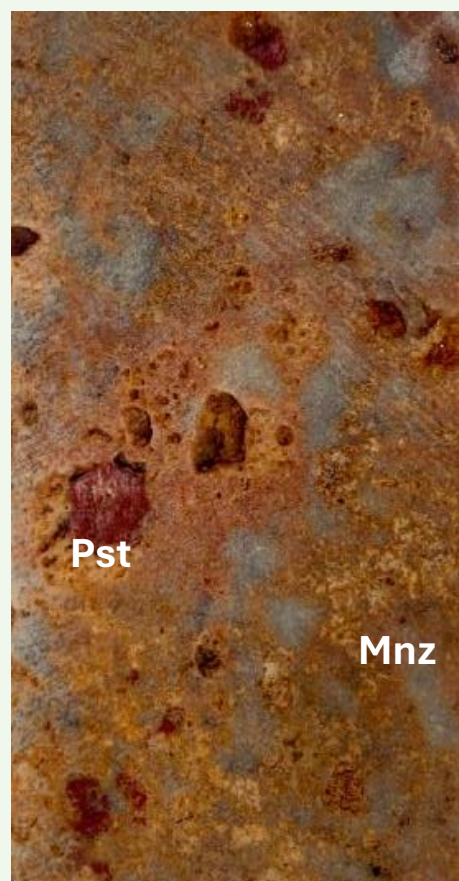
Monazite mineralisation

Monazite precipitates after apatite dissolution



Weakly Weathered Carbonatite — REE Mineralisation

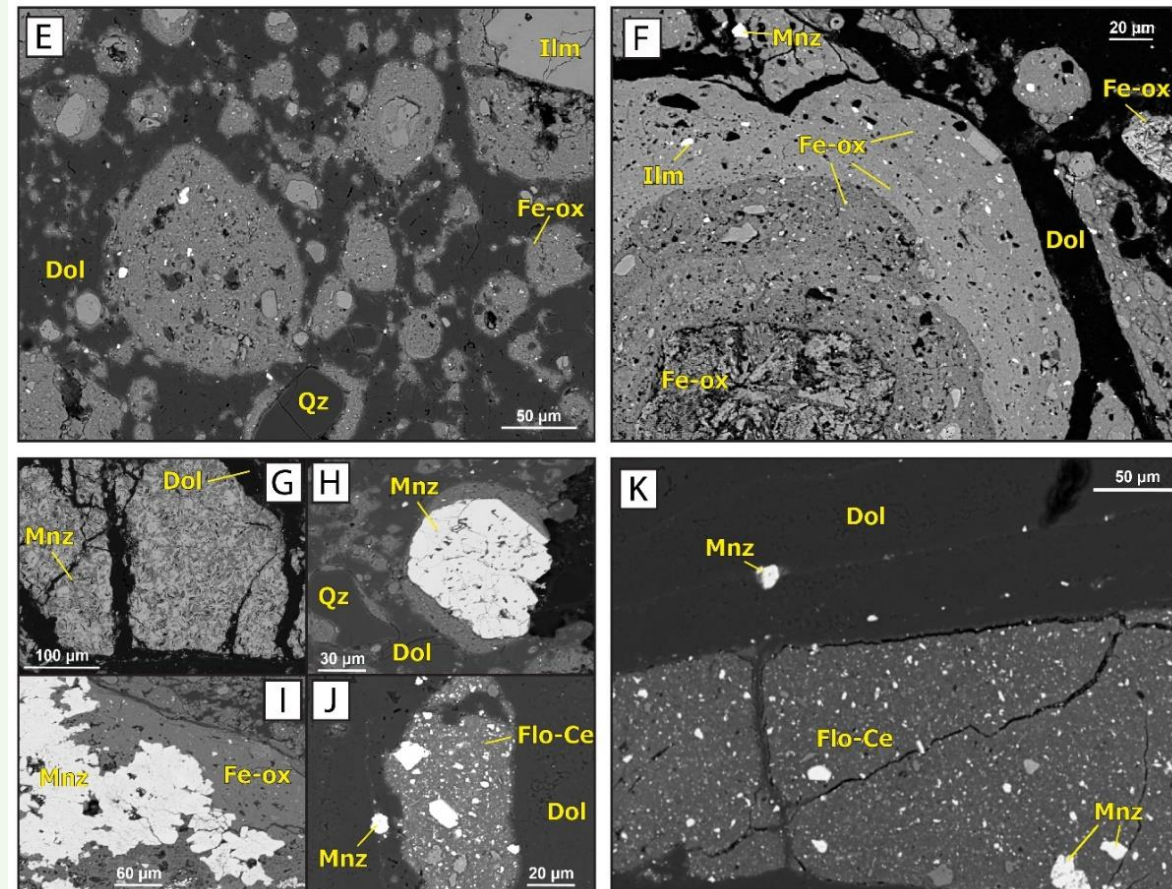
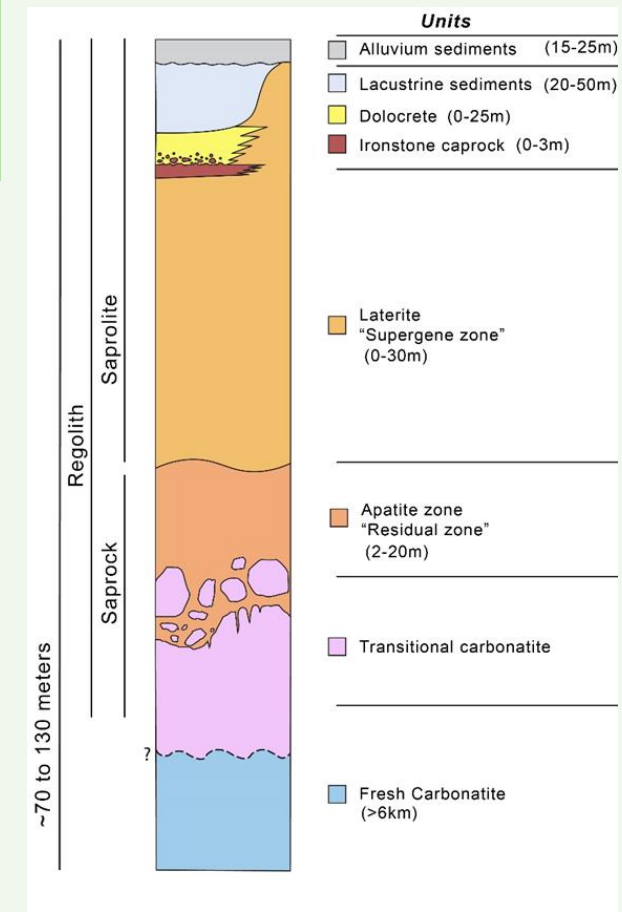
“Transitional” zone



- Mineralisation style largely preserved
- REE ore minerals are Parisite + Monazite
- Strong association with **porosity**
- Sulphide oxidation ('rust stain')
- Incipient carbonate dissolution (Porosity formation?)

Dolocrete — a carbonatite exploration tool

- Dolocrete is the topmost expression of carbonates in the regolith;
- Formed by carbonate-rich groundwater, displacing and replacing the regolith;
- Comprised of precipitated dolomite and 'residual' iron oxides;
- **Nb and REE minerals** characteristic of the underlying regolith and carbonatite are retained.



- Calcrete is common in (semi-)arid regions, especially in Australia;
- Underlying carbonatite promotes the formation of **dolocrete** instead of calcrete;
- Typical Nb and REE minerals are indicators of buried mineralised regolith/carbonatite

Conclusions

- **Phoscorite** (Olivine-Apatite-Magnetite rock) is an important component of the Mt Weld carbonatite complex
- The **heavy REE** are relatively compatible with fluids, escaping from the dolomite carbonatite;
 - in other carbonatites they tend to disperse, but in Mt Weld HREE were partly trapped in metasomatized phoscorite
- This is reflected by higher HREE (e.g. Dy) in areas of the overlying regolith: HREE-bearing Monazite and Churchite;
- Sr and Pb isotopic data indicate there were **no significant crustal fluids** involved in the mobilisation of REE in Mt Weld;
 - REE mobilisation was deuteritic (from the own magmatic fluids)
- **Carbonate dissolution** is the main process that has concentrated REE in the regolith;
 - REE and Nb seem to have moved vertically and don't have a significant horizontal mobilisation vector
- REE and Nb in **dolocrete** reflects the underlying carbonatite: A possible exploration target for carbonatites in Australia

THANK YOU

