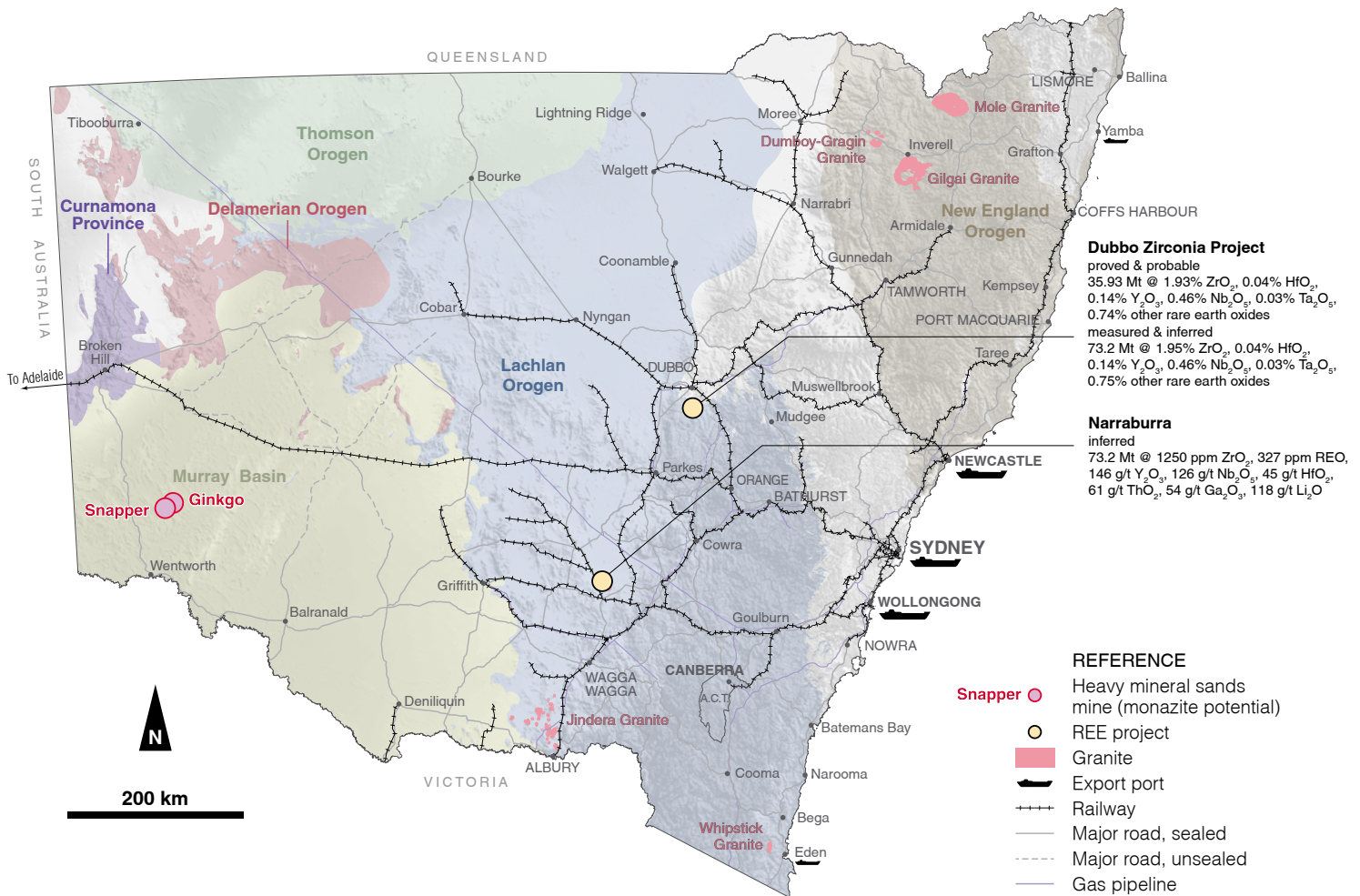


Rare earth elements

Opportunities in New South Wales, Australia

DECEMBER 2021



Overview

- New South Wales (NSW) offers a range of opportunities for discoveries of rare earth elements (REE).
- Rocks known to contain elevated concentrations of rare earth elements in NSW include:
 - Trachytes such as those that host the Dubbo Zirconia Project (Toongi)
 - Nephelinite and carbonatite magmatic rocks
 - Highly fractionated granitoids and pegmatites
 - Pliocene heavy mineral sands deposits that contain monazite (for example the Snapper and Ginkgo mines).
- The potential for rare earth elements in NSW is largely untested.
- Rare earth elements comprise a series of 15 natural metallic elements ranging in atomic number from 57 (lanthanum) to 71 (lutetium). Also generally included for geological purposes are yttrium (which behaves as a rare earth element), scandium and thorium. Compounds of rare earth elements have numerous uses, such as in the production of automotive catalytic converters, optical lenses, lighting and powerful magnets.

Geological setting

Prospective rocks for rare earth elements include:

- Potassic rocks, carbonatite and nephelinite rocks
- Highly fractionated, metaluminous and peralkaline I-type granites that can be enriched in incompatible elements. Hydrothermal activity, commonly involving chlorine and fluorine associated with the intrusions, can concentrate rare earth elements.
- Surficial clays and laterites with elevated concentrations of rare earth elements.

Bastnaesite is the most important mineral as a source of rare earth elements. Other important source or tracer minerals include parisite, monazite and xenotime.

Project highlights

Dubbo Zirconia Project (Toongi), about 275 km northwest of Sydney, is a world-class resource containing zirconium (ZrO_2), hafnium (HfO_2), niobium (Nb_2O_5), tantalum (Ta_2O_5), yttrium (Y_2O_3) and rare earth elements. The deposit is associated with a hydrothermally altered pipe-like alkaline (trachyte) intrusion of Jurassic age.

Narraburra, 375 km west of Sydney, contains zirconium oxide, yttrium oxide, rare earth oxides, niobium oxide, and thorium oxide, hosted by deeply weathered and fresh leucogranite.

Exploration targets

The **Lachlan Orogen**, recognised as a world-class mineral province for metalliferous deposits, also hosts important rare earth element deposits.

Exploration opportunities for rare earth elements include highly fractionated metaluminous and peralkaline I-type granitoids and associated skarns (e.g. at Narraburra, Jindera and Whipstick).

Latite-trachyte intrusions, mainly of Jurassic age, are scattered widely across NSW. These intrusions have potential for Toongi-style deposits. Laterites associated with the intrusions have potential to host elevated concentrations of rare earth elements.

The **New England Orogen** hosts highly fractionated, relatively oxidised and metaluminous I-type granitoids of Permian to Early Triassic age. The Mole Granite, north east of Inverell, is associated with many polymetallic mineral occurrences, some of which contain monazite with elevated rare earth elements and thorium. Other prospective rocks in the area include the Dumboy-Gragin and Gilgai granitoids.

In the Proterozoic **Curnamona Craton**, highly anomalous concentrations of rare earth elements occur in sulfide-bearing deposits including the famous Broken Hill base metal deposit. Granitoids (e.g. Mundi Mundi-type) and associated pegmatites can also be anomalous in rare earth elements.

The **Delamerian Orogen** is a greenfields terrain that offers many opportunities for rare earth elements including oxidised mafic carbonatite and nepheline syenite.

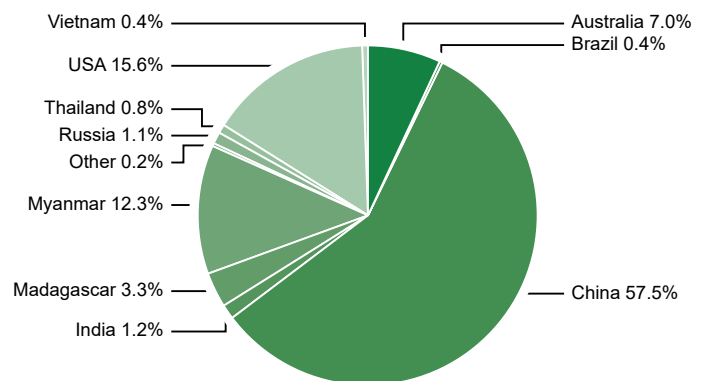
The **Murray Basin** in the southwest of the state is a globally significant heavy mineral sands province, with extensive Pliocene beach placer deposits that contain rare earth element-bearing monazite. The economic potential for monazite associated with heavy mineral sands extraction has not been fully established.

Periodic table



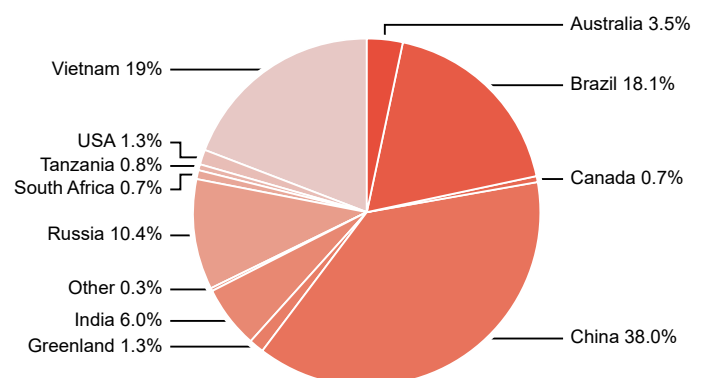
Pegmatite, Triple Chance mine.

Global REE production (2020)



Source: modified from <https://pubs.usgs.gov/periodicals/mcs2021/mcs2021.pdf>

Global REE reserves (2020)



Source: modified from <https://pubs.usgs.gov/periodicals/mcs2021/mcs2021.pdf>

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