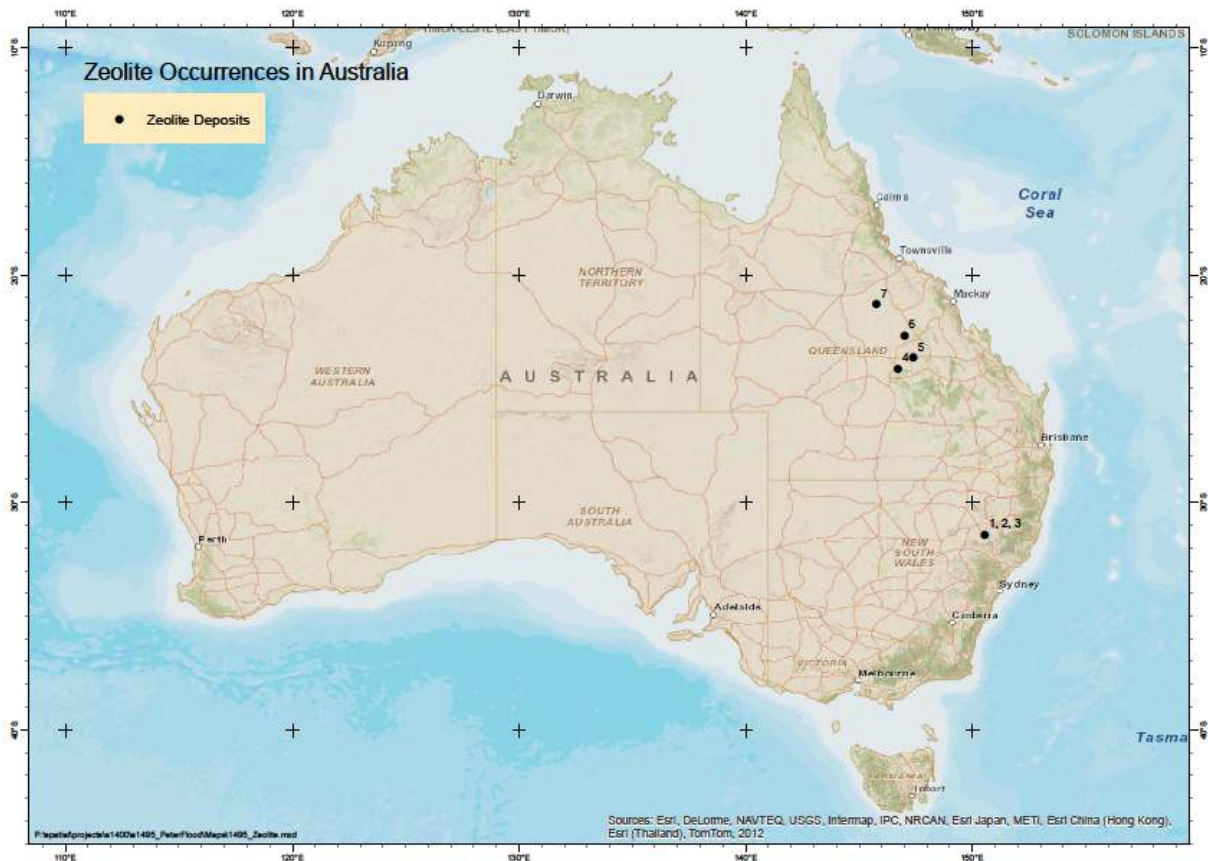


Sedimentary Zeolite Deposits in Australia



Exploited deposit: Points 1, 3, 5 (see map)

Potential resources: Points 2, 4, 6, 7 (see map)

LOCALITY	LATITUDE	LONGITUDE
1. ESCOTT	31° 23' 30"	150° 36' 05"
2. TURILAWA	31° 23' 50"	150° 34' 47"
3. CASTLE MOUNTAIN	31° 31' 57"	150° 42' 37"
4. AVOCA (exploration site)	23° 58' 48"	147° 02' 36"
4. MYERS CREEK	23° 46' 44"	147° 01' 52"
4. MT SURPRISE	24° 04' 48"	146° 51' 06"
4. ECHO HILLS	24° 03' 26"	147° 11' 19"
4. ABERLEIGH	24° 03' 30"	147° 08' 20"
5. WILLOWS	23° 43' 25"	147° 29' 45"
5. SPRINGVALE	23° 40' 36"	147° 27' 54"
6. NARRIEN	22° 48' 01"	146° 55' 25"
7. BLACKWOOD	21° 23' 56"	146° 33' 09"
7. MIRTNA	21° 25' 18"	146° 22' 26"

Zeolite occurrence: Clinoptilolite-rich tuff

Geology: There are two regions of natural zeolite occurrences in eastern Australia (Flood, 1995) which occur in altered Carboniferous volcanoclastics and ash-fall and ash-flow pyroclastics. They are the New England Zeolite Province in New South Wales (deposits 1-3) and the Drummond Zeolite Province in Queensland (deposits 4-7). Both geological settings are closely related (the first in a fore-arc setting and the second in a back-arc setting respectively) to

an ancient Carboniferous “Andean” – margin continental volcanic arc. It appears that the diagenetic-minerogenetic process of zeolitization occurred during or just following deposition of the volcanic glass. There does not appear to have been further post depositional diagenetic alteration for the zeolites in individual layers, only millimeters apart, are of distinctly different chemical composition thereby demonstrating the absence of pervasive circulating fluids. The very old geological age (c. 300 Ma) relative to many other world deposits is worthy of note for it indicates that the deposits have never been subject to significant depths of burial.

The zeolite-bearing tuffs in New South Wales are up to 30 m in thickness whereas those in the Drummond Province are much thinner (up to 3 m thick).



Bulldozer pushing up zeolite rock fragments at Avoca (point 4 of the map)



Escott West Wall (point 1 of the map)

Mineralogy:

The New South Wales natural zeolite is predominantly clinoptilolite (Ca-rich) up to 60 weight percent association with minor mordenite, both as a result of silica glass alteration (Flood and Taylor, 1991). Usually the clinoptilolite is blocky whilst the habit of some of the mordenite is fibrous.

Probe analyses reveal that the zeolite replaced glass shards are zoned as follows:

RIMS	$\text{Ca}_{2.38} \text{Na}_{0.05} \text{K}_{0.23} \text{Mg}_{0.93} \text{Fe}_{0.89} \text{Al}_{7.55} \text{Si}_{28.14} \text{O}_{72} \cdot 24\text{H}_2\text{O}$
INTERIORS	$\text{Ca}_{2.46} \text{Na}_{0.08} \text{K}_{0.22} \text{Mg}_{0.74} \text{Fe}_{0.66} \text{Al}_{7.30} \text{Si}_{28.40} \text{O}_{72} \cdot 24\text{H}_2\text{O}$
GROUNDMASS	$\text{Ca}_{1.50} \text{Na}_{0.11} \text{K}_{0.93} \text{Mg}_{0.76} \text{Fe}_{0.40} \text{Al}_{6.11} \text{Si}_{29.91} \text{O}_{72} \cdot 24\text{H}_2\text{O}$

Additional titrimetric analyses of the Fe content of the red and green layers has shown that the red layers are more oxidized. FeO/Fe₂O₃ ratios of the red layers are half that of the green layers. This is indicative of a chemical gradient across each of the mm to cm laminae.

A typical XRD scan of the Escott zeolite deposit sample provided the following mineralogical composition (Flood and Taylor, 1991):

Phase	%
Ca-Clinoptilolite	53
Quartz	30
Mordenite	5
Albite	6
Sanidine	4

Chemistry:

The composition (major element oxides) of Ca-Clinoptilolite-bearing tuffs (after Flood, 1995) is shown in the following Table.

Major-element oxide analysis (wt. %) of clinoptilolite-rich tuff, Eastern Australia, NSW zeolite province, (Werris Creek) Escott mine and QLD zeolite province Willows (after Flood, 1995).

Oxide	ESCOTT	WILLOWS
SiO ₂	69.99	66.71
TiO ₂	0.21	0.21
Al ₂ O ₃	11.80	16.24
FeO ¹	0.92	0.78
MnO	0.02	0.12
MgO	0.97	0.81
CaO	2.99	4.47
Na ₂ O	0.82	1.21
K ₂ O	1.56	0.24
LOI	10.60	9.95

¹ Reported as ferrous iron, although titrimetric analysis suggests that iron is present as ferric.

The cation exchange capacity of representative samples from the Escott zeolite deposit, determined using the NH₄⁺ exchange method (Fredrickson, 1987), is in the order of 120 meq/100 g. Individual exchangeable cation concentrations, expressed as meq/100 g, are as follows: Ca 85, Na 12, K 4, Mg 18.

Physical and mechanical properties:

Appearance (colour)	light pink to red
Slurry pH	7.6
Particle diameter	>85% minus 65µm
Bulk Density power product	1.6 g/cm ³
Bulk density rock	2.0 – 2.2 g/cm ³
Hardness*	6.0 – 6.5 Mohs Scale
Rock porosity	ca 10%

* Characterized by sharp breaking pattern and dark red colour

Reserves and production: Estimated New England Province reserves are in the order of 20,000,000 tons. Estimated Drummond Province reserves are in the order of 20,000,000 tons, but could be one or more order of magnitude larger. Annual production is approximately 10,000 tons in New England and less than 4,000 tons in the Drummond Province, respectively.

Main applications: The main uses of the zeolite products are:

- (a) *Agriculture* Soil additive (potting mix);
Component of feed for animals.
- (b) *Water* Wastewater and sewage treatment (enhancing biological efficiency and ammonia-N removal) (ZELFLOCC registered product)
Swimming pool filters (ZELBRITE registered product).

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