

ULEXITE

This dossier on ulexite presents the most critical studies pertinent to the risk assessment of ulexite in its use in coal seam gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch *et al.*, 1997).

Screening Assessment Conclusion – Ulexite is classified as a **tier 1** chemical and requires a hazard assessment only.

1 BACKGROUND

Ulexite is a sodium-calcium-hydroborate and, like other borates, is a structurally complex mineral. It is composed of hydrogen (3.98 %), sodium (5.67 %), calcium (9.89 %), boron (13.34 %), and oxygen (67.12 %), alternatively expressed as Na₂O (7.65 %), CaO (13.84 %), H₂O (35.57 %), and B₂O₃ (42.95 %) (Gulensoy & Kocakerim, 1977; Webmineral).

The boron concentration of ulexite is commercially significant because boron compounds are used in producing materials for many branches of industry. Boron is primarily used in the manufacturing of fiberglass along with heat resistant borosilicate glasses such as traditional Pyrex, car headlights, and laboratory glassware. Boron and its compounds are also common ingredients in soaps, detergents, and bleaches, which contributes to the softening of hard water by attracting the calcium ions.

In coal seam gas applications, the hydraulic fracturing fluid primarily consists of sand, water and guar gum. Boric acid or borates are commonly added to this guar gum slurry to increase its viscosity and provide stability (Stringfellow *et al.* 2014).

Boron is an inorganic, elemental compound and can therefore not be biodegraded by micro-organisms or other biotic-related processes. It does not bioaccumulate in the aquatic environment. Boron is of a low toxicity concern to aquatic organisms. Although boron is required by plants at low concentrations, at high concentrations it is toxic. In Australia, it is generally accepted that boron toxicity will pose a risk to terrestrial plants when soil concentrations exceed 15 mg/kg of extractable boron. The phytotoxicity of boron is dependent on the plant species and soil type (DoEE, 2017).

2 CHEMICAL NAME AND IDENTIFICATION

Chemical Name: Sodium-calcium pentaborate octahydrate

CAS RN: 1319-33-1

Molecular formula: (NaCaB₅O₆(OH)₆·5H₂O)

Molecular weight: 405 g/mol

Synonyms: Ulexite; sodium-calcium pentaborate octahydrate

3 PHYSICO-CHEMICAL PROPERTIES

Key physical and chemical properties for the substance are shown in Table 1.

Table 1: Overview of the Physico-chemical Properties of Commercially Available Ulexite

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	White, granular, ground, or powder form	4	Etimine USA, Inc. (2016)
Melting Point	870°C	4	Etimine USA, Inc. (2016)
Boiling Point	Not Applicable	-	-
Bulk Density	1,410 to 1,500 kg/m ³	4	Etimine USA, Inc. (2016)
Water solubility	26.67% as dissolved Ulexite @ 25°C by weight of solution	4	American Borate Company (2016)

Ulexite is a naturally-occurring mineral that is slightly soluble in water. Limited measured data are available for ulexite. In a study investigating the relative rates of boron from soluble and controlled-release boron fertilizers, ulexite showed releases of boron of 20% in just under 10 weeks; 40% in approximately 25 weeks; 60% by 40 weeks; and 80% by 60 weeks (Broschat, 2008). In the environment, borates will dissociate and/or hydrolyse to release boron as boric acid [B(OH)₃] (also formulated as H₃BO₃) and/or borate anions. Therefore, the information presented within this dossier is for boron (CAS No. 7440-42-8).

4 DOMESTIC AND INTERNATIONAL REGULATORY INFORMATION

A review of international and national environmental regulatory information was undertaken (Table 2). This chemical is listed on the Australian Inventory of Chemical Substances – AICS (Inventory). No conditions for its use were identified. No specific environmental regulatory controls or concerns were identified within Australia and internationally for ulexite.

NICNAS has assessed ulexite in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment¹.

Table 2 Existing International Controls

Convention, Protocol or other international control	Listed Yes or No?
Montreal Protocol	No
Synthetic Greenhouse Gases (SGG)	No
Rotterdam Convention	No
Stockholm Convention	No
REACH (Substances of Very High Concern)	No
United States Endocrine Disrupter Screening Program	No
European Commission Endocrine Disruptors Strategy	No

¹ <https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=1319-33-1%2C+>

5 ENVIRONMENTAL FATE SUMMARY

Boron is found almost exclusively in the environment in the form of boron-oxygen compounds, which are often referred to as borates. In the environment, borates and compounds of boric acid will dissociate and/or hydrolyse to form the same boron species. For example, when borax dissolves in dilute solutions, it dissociates into Na^+ ions and the tetraborate anion ($\text{B}_4\text{O}_5(\text{OH})_4^{2-}$). Boric acid ($\text{B}(\text{OH})_3$) is formed following acid catalysed hydrolysis of the tetraborate anion. Under alkaline conditions, dilute solutions of the tetraborate anion depolymerise rapidly to the mononuclear borate anion ($\text{B}(\text{OH})_4^-$) (DoEE, 2017).

Boron is an inorganic, elemental compound and can therefore not be biodegraded by micro-organisms or other biotic-related processes (ECHA).

The WHO (1998) review of boron noted that highly water soluble materials are unlikely to bioaccumulate to any significant degree and that borate species are all present essentially as undissociated and highly soluble boric acid at neutral pH. The available data indicate that both experimental data and field observations support the interpretation that borates are not significantly bioaccumulated (ECHA).

Bioconcentration factors of <0.1 to 10.5 L/kg have been reported from laboratory tests of fish and oysters (Thompson et al. 1976). Saiki et al. (1993) measured boron levels in aquatic food chains and observed the highest concentrations of boron in detritus and filamentous algae. Invertebrates and fish had lower concentrations, indicating that bioaccumulation was not occurring. Based on these data, boron does not bioaccumulate in the aquatic environment (ECHA).

6 ENVIRONMENTAL EFFECTS SUMMARY

A. Summary

There are no mammalian or aquatic toxicity studies on ulexite. Toxicity for boron is provided within this section.

Boron is of a low toxicity concern to aquatic organisms. Although boron is required by plants at low concentrations, at high concentrations it is toxic. In Australia, it is generally accepted that boron toxicity will pose a risk to terrestrial plants when soil concentrations exceed 15 mg/kg of extractable boron. The phytotoxicity of boron is dependent on the plant species and soil type (DoEE, 2017).

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies on boron.

Table 3 Acute Aquatic Toxicity Studies on boron¹

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
<i>P. promelas</i>	4 day LC_{50}	79.7 mg B/L	2	ECHA

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
<i>Freshwater invertebrates</i>	48-hr LC ₅₀	64 to >544 mg/B/L	2	ECHA
<i>Pseudokirchneriella subcapitata</i>	72-hr EC ₅₀	52.4 mg/B/L	2	ECHA

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Chronic Studies

Table 4 lists the results of chronic aquatic toxicity studies on boron.

Table 4 Chronic Aquatic Toxicity Studies on boron¹

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
<i>Micropterus salmoides</i>	4d-EC10	36.8 mg B/L	2	ECHA
<i>Oncorhynchus mykiss</i>	long term NOEC-LOEC	19.2. mg/B/L	2	ECHA
<i>Brachydanio rerio</i>	long term NOEC-LOEC	36.mg/B/L	2	ECHA
<i>Pimephales promelas</i>	long term NOEC-LOEC	21.3 mg/B/L	2	ECHA
<i>Daphnia magna</i>	NOEC	13.9 mg/B/L	<u>2</u>	<u>ECHA</u>
<i>Hyalella azteca</i>	NOEC	6.3 mg/B/L	<u>2</u>	<u>ECHA</u>
<i>Chironomus riparius</i>	NOEC	20.1 mg/B/L	<u>2</u>	<u>ECHA</u>
<i>Brachionus calyciflorus</i>	NOEC	24.6 mg/B/L	<u>2</u>	<u>ECHA</u>
<i>Lampsilis siliquoides</i>	NOEC	30 mg/B/L	<u>2</u>	<u>ECHA</u>

1/ CAS No. 7440-42- 8 for boron

ANZG has developed a water quality guideline for boron (ANZG, 2021). Very high reliability default guideline values (DGVs) for (dissolved) boron in freshwater were derived from 22 chronic (long-term) toxicity data, comprising eight fish, two amphibians, three crustaceans, one bivalve, three macrophytes, one green microalga, three diatoms and one blue-green alga. The DGVs for 99, 95, 90 and 80% species protection are 340 µg/L, 940 µg/L, 1,500 µg/L and 2,500 µg/L, respectively. The 95% species protection level for boron in freshwater (940 µg/L) is recommended for adoption in the assessment of slightly-to-moderately disturbed ecosystems.

C. Terrestrial Toxicity

Relevant and reliable chronic no-effects values were identified for thirty-nine terrestrial species or microbial processes. No-effect levels for dissolved boron ranged between 7.2 mg B/kg soil dw and 86.7 mg B/kg soil dw. The plant *Zea mays* was the most sensitive trophic level. The least sensitive species was the nematode *C.elegans*. A Species Sensitivity Distribution (SSD) has been developed for

the assessment of boron in the terrestrial compartment, using the reliable species-specific chronic toxicity effect levels that have been generated in various research studies. (ECHA)[KI Score = 2].

7 CATEGORISATION AND OTHER CHARACTERISTICS OF CONCERN

A. PBT Categorisation

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

Ulexite is a naturally-occurring mineral. For the purposes of this PBT assessment, the persistence criteria is not considered applicable to this inorganic substance.

Bioaccumulation is not applicable to naturally-occurring minerals, such as ulexite. Although boron is slowly released from ulexite, limited data indicate that bioaccumulation is not significant in aquatic and terrestrial food chains. Thus, it does not meet the criteria for bioaccumulation.

There are no mammalian or aquatic toxicity studies on ulexite. Ulexite, being a slightly water-soluble mineral, is not expected to be bioavailable. The lowest chronic toxicity value for boron is >0.1 mg/L. The acute E(L)C₅₀ values for boron is >1 mg/L. Thus, based on boron, ulexite does not meet the criteria for toxicity.

Therefore, ulexite is not a PBT substance.

B. Other Characteristics of Concern

No other characteristics of concern were identified for ulexite.

8 SCREENING ASSESSMENT

Chemical Name	CAS No.	Overall PBT Assessment ¹	Chemical Databases of Concern Assessment Step		Persistence Assessment Step		Bioaccumulative Assessment Step	Toxicity Assessment Step			Risk Assessment Actions Required ³
			Listed as a COC on relevant databases?	Identified as Polymer of Low Concern	P criteria fulfilled?	Other P Concerns	B criteria fulfilled?	T criteria fulfilled?	Acute Toxicity ²	Chronic Toxicity ²	
Ulexite	1319-33-1	Not a PBT	No	No	NA	No	No	No	1	1	1

Footnotes:

1 - PBT Assessment based on PBT Framework.

2 - Acute and chronic aquatic toxicity evaluated consistent with assessment criteria (see Framework).

3 – Tier 1 – Hazard Assessment only.

Notes:

NA = not applicable

PBT = Persistent, Bioaccumulative and Toxic

B = bioaccumulative

P = persistent

T = toxic

9 REFERENCES, ABBREVIATIONS AND ACRONYMS

A. References

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B. Abbreviations and Acronyms

°C	degrees Celsius
AICS	Australian Inventory of Chemical Substances
ANZG	Australian and New Zealand Guidelines
COC	constituent of concern
DEWHA	Department of the Environment, Water, Heritage and the Arts
ECHA	European Chemicals Agency
EU	European Union
IUPAC	International Union of Pure and Applied Chemistry
kg/m ³	kilograms per cubic metre
kPa	kilopascal
LC	lethal concentration
LOEC	lowest observed effect concentration
mg/B/L	milligram boron per litre
NOEC	no observed effect concentration
PBT	Persistent Bioaccumulative Toxic
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SGG	Synthetic Greenhouse Gases