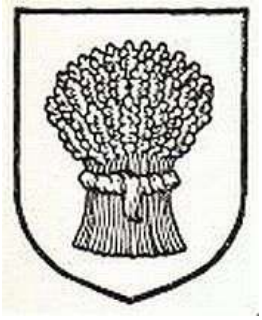
Wednesday, October 23, 2024



HALLGARTEN + COMPANY

Initiation of Coverage

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5E Advanced Materials

(NASDAQ: FEAM | ASX: 5EA)

Strategy: NEUTRAL

Key Metrics

	USD	AUD
Price	0.53	0.09
12-Month Target Price	0.40	0.065
Upside to Target	-25%	-28%
12mth high -low	$0.4038 to $2.66	$.063 to $0.41
Market Cap ($ mns)	36.47	61.938
Shares Outstanding (mns)	68.8	688.2
Fully diluted	138.6	1,385.7

Wednesday, October 23, 2024

5E Advanced Materials

The Wilderness Years

- ➕ The company's Fort Cady "mine" is aspiring to be a producer in the borates space with its small-scale facility having started operations early this year after many travails
- ➕ The deposit is located in the Mojave Desert, somewhat proximate to the second largest Borates mines in the world, which is operated by RTZ
- ➕ Boron has an enormous range of uses, from high-tech to the mundane, with one of the most talked about being Neodymium-Iron-Boron permanent magnets in EV motors
- ➕ Boron´s main sources of production, in Turkey and the US, mean that it is not regarded as being under Chinese control, and thus it is not really a critical metal
- ➕ Demand for the mineral is strong and growing with CAGR exceeding most forecasts of just a few years ago
- ✖ Management has been a revolving door over the last 18 months
- ✖ Financial and building travails have required a scaling back in ambitions and curtailment in its timetable for the various planned phases
- ✖ Boron is on the EU Critical Minerals List, but not on those of other countries
- ✖ Insidious manouevrings by short sellers, related to the company's inclusion, then deletion, from the Russell 2000 Index, have been less than helpful
- ✖ The environment for funding new mining projects remains tough with many investors not acquainted with the mineral, therefore lacking understanding of its dynamics

The Voice that Cryeth in the Wilderness

In our Boron Sector roundup, earlier this year, investors perceived a decidedly jaded view of 5E. The company had been subject to a massive pumping which pushed it to a $2bn market cap, before the inevitable dumping of the stock left those inclined to believe in the story, with egg of their faces and large holes in their pockets.

The transmogrification of 5E Advanced Materials from a potential Lithium play to the new entrant into the rather exclusive club of borates producers has been a rough ride for the company and its shareholders. In the space of the year the company has got its project back on track, its finances in order and provided proof of concept by lifting its first material and processing it to a state where offtakers can start to commit to the finished project as the demonstration plant ramps up production.

In this Initiation of Coverage, we shall look at the company's aspirations to become a producer, its current status and its financial travails.

Borates Go Sexy

It might be stating the obvious, but Neodymium Iron Boron magnets contain Boron. The chemical symbol is the giveaway here…. $Nd_2Fe_{14}B$. Technically this makes Boron (and Iron), the forgotten magnet metal.

The global borates market, according to ETI Maden's 2022 Sector Report, is over 4.3 million tonnes of B_2O_3 equivalent per annum with a myriad of uses ranging from the prosaic to high-tech. Some common applications of Boron include: fibreglass, glass production, insulation, fertilizer, silicon, metallurgy, LCD screens, stealth technology, sports equipment, nuclear reactors and waste storage, lithium batteries, computers, heat shields and medicines.

The Back Story

In April of 2022, American Pacific Borates Limited (ASX:ABR) rebranded, with a new name and parent company in 5E Advanced Materials (ASX:5EA). On the 15th of March of 2022, the company listed on the NASDAQ in the US.

The company asserts that its mining asset, the Fort Cady mine, is the largest-known new conventional (colemanite) Boron deposit globally. It has tilted its promotion towards being perceived more as a chemical company, preferring to not be branded a miner, particularly in California. This is consistent with the approach taken by lithium players, Albemarle and (in the past) by Livent.

The company's lofty goal is to be "positioned to become a vertically-integrated global leader in boron advanced materials with a focus on enabling decarbonization and re-shoring critical materials. Boron products target critical, high value applications within electric transportation, clean energy, food and domestic security".

It also claims that 5E's resource quality, domestic supply source, and future downstream processing capabilities provide a competitive advantage given customer product specifications, scarcity of resource, and reliance on unstable, international supply.

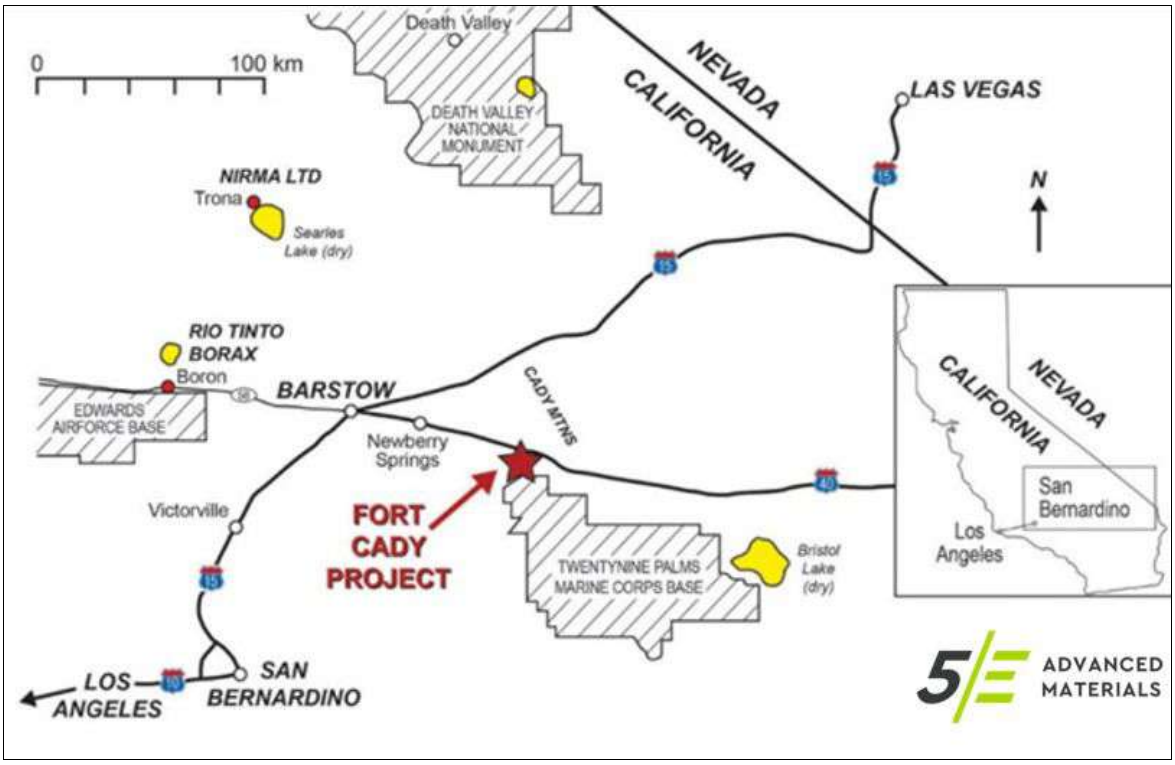
On the US Government's Radar

In February of 2022, the Fort Cady Integrated Boron Facility was designated as Critical Infrastructure by the Cybersecurity and Infrastructure Security Agency (CISA) with letters of support from members of the U.S. Congress and California State Legislature. CISA, as a U.S. federal agency and operational component under the Department of Homeland Security, is tasked with understanding, managing, and reducing risk to the nation's cyber and physical infrastructure. In this function, CISA, in cooperation with other government and industry partners, is responsible for protecting and strengthening the nation's Critical Infrastructure against current and future threats in the interest of national security, including supply chains of strategic and critical materials and their respective projects.

The Fort Cady Mine

The 5E Boron Americas Complex is located at Fort Cady in the Mojave Desert region of San Bernardino County, California, approximately 200km north-east of Los Angeles (and around 80kms from RTZ's operations). The site encompasses an area of 1.39km² and is situated approximately 50km east of Barstow and shown on the map on the following page.

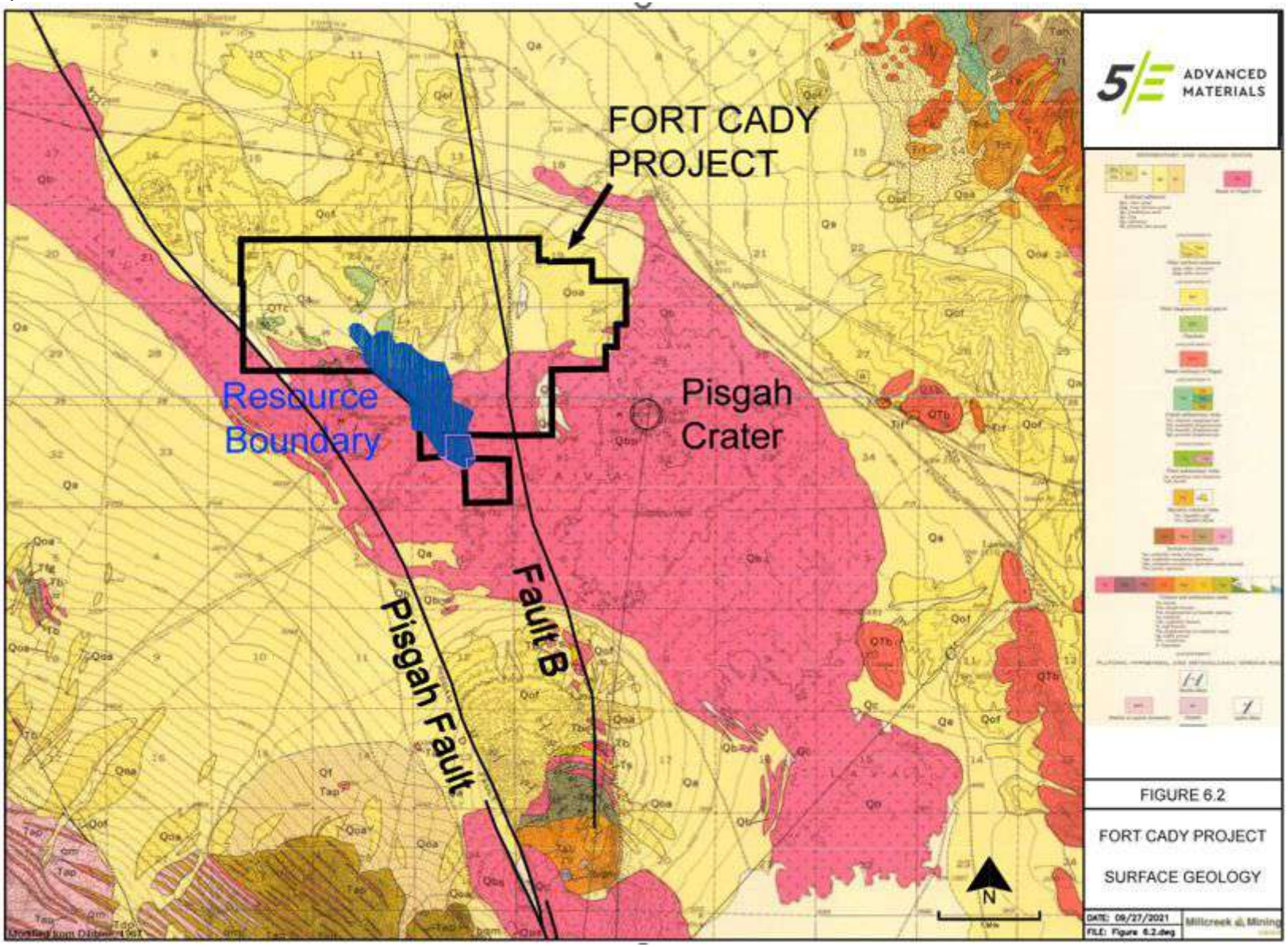
Solid progress has been made in in early 2024 as the project transitioned into a producing mine, kickstarting a new phase for the company. This is a boric acid project that has been described as being "largest-known new conventional (colemanite) Boron deposit globally. with an estimated mineral resource of 120.4 mn tonnes".



The project area includes private land owned by 5E, with an electrical transmission corridor running through the project where Southern California Edison has surface and subsurface control to a depth of 500 ft. While this limits surface access to the area within the right-of-way, mineral rights are owned by 5E, and mineralization remains accessible as the ore body occurs at depths more than 1,000 ft.

The project also includes two unpatented lode claims, and 117 unpatented placer claims from the Bureau of Land Management within the U.S. Department of the Interior. On the southwestern side of the Project, 5E owns the surface area and the State of California owns the mineral rights.

Other areas surrounding the project area include patented and unpatented lands of the Elementis Hectorite Mine directly west of the project and unclaimed public lands managed by the Bureau of Land Management (BLM) to the north and east. While land south of the project area is part of the U.S. Marine Corps Twentynine Palms Base.


FORT CADY
PROJECT
Resource
Boundary
Pisgah
Crater
Pisgah Fault
Fault B
N
5E ADVANCED MATERIALS
FIGURE 6.2
FORT CADY PROJECT
SURFACE GEOLOGY
DATE: 09/27/2021
FILE: Figure 6.2.dwg
Millcreek Mining

The Pisgah Crater

The Pisgah Crater is a young volcanic cinder cone rising above a lava plain in the Mojave Desert. The volcanic peak is around 4 kms south of U.S. Route 66 and of Interstate 40, and west of the town of Ludlow. The volcano had a historic elevation of 2,638 feet (804 m) but has been reduced to 2,545 feet (776 m) due to mining.

The Mount Pisgah Volcanic Cinders Mine was a quarry that produced pumice for commercial use, the primary end-product being railroad ballast for the Santa Fe Railroad. In the process of mining the top of the mountain has been removed. The mountain is still occasionally quarried for various cinder products.

Above can be seen an aerial view of site and works, with the Pisgah Crater in the background top right

Regional Geology

The project is located in the western Mojave Desert in a region is characterized by narrow faulted mountain ranges and flat valleys and basins, the result of tectonic extension that began approximate 17 million years ago.

The project lies within the Hector Basin of the Barstow Trough and is bounded on the southwest by the San Andreas fault zone and the Transverse Ranges, on the north by the Garlock fault zone, and on the east by the Death Valley and Granite Mountain faults. Numerous faults of various orientations are found within

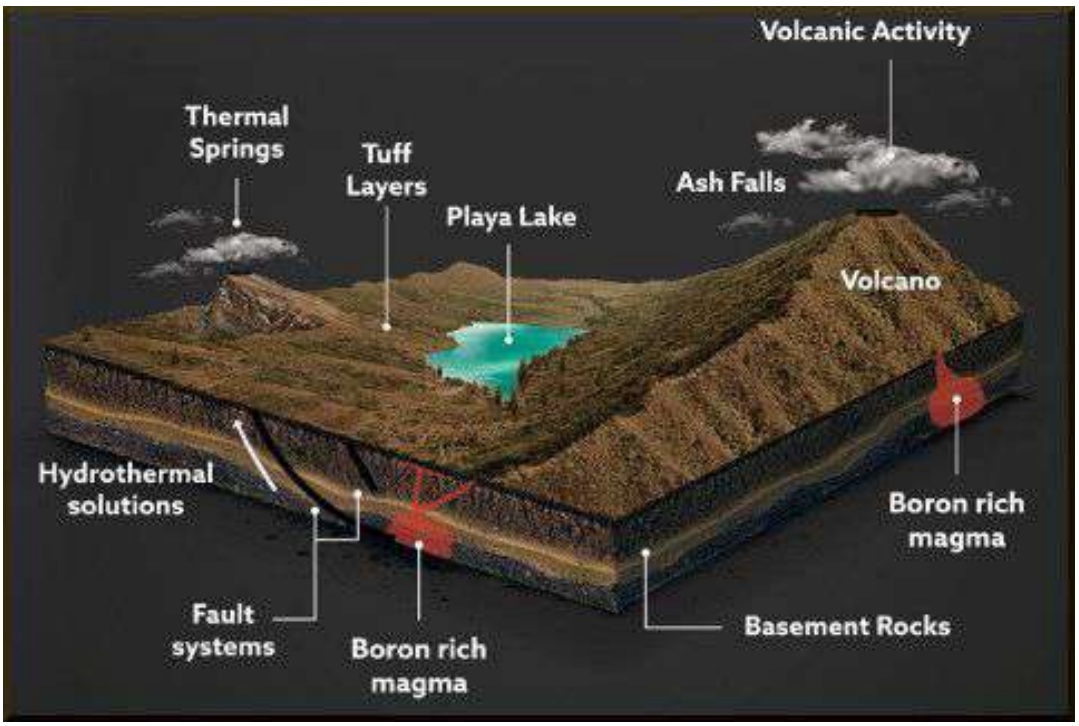
the area with various orientations though the predominant trend is to the northwest.

The Barstow Trough is a structural depression, which extends northwesterly from Barstow toward Randsburg and in an east-southeast trend toward Bristol. It is characterized by thick successions of Cenozoic sediments, including borate-bearing lacustrine deposits, with abundant volcanism along the trough flanks. The northwest-southeast trending trough initially formed during Oligocene through Miocene times. As the basin was filled with sediments and the adjacent highland areas were reduced by erosion, the areas receiving sediments expanded, and playa lakes, characterized by fine-grained clastic and evaporitic chemical deposition, formed in the low areas at the center of the basins.

Project geology

As mentioned, the Fort Cady deposit lies in the Hector Basin in the central Mojave region.

Boron at Fort Cady is believed to have been sourced from thermal waters that flowed from hot springs in the region during times of active volcanism. These hot springs vented into the Hector Basin that contained a large desert lake. The graphic below shows the conjunction of geological and climatic factors that are most propitious for the formation of borate deposits.



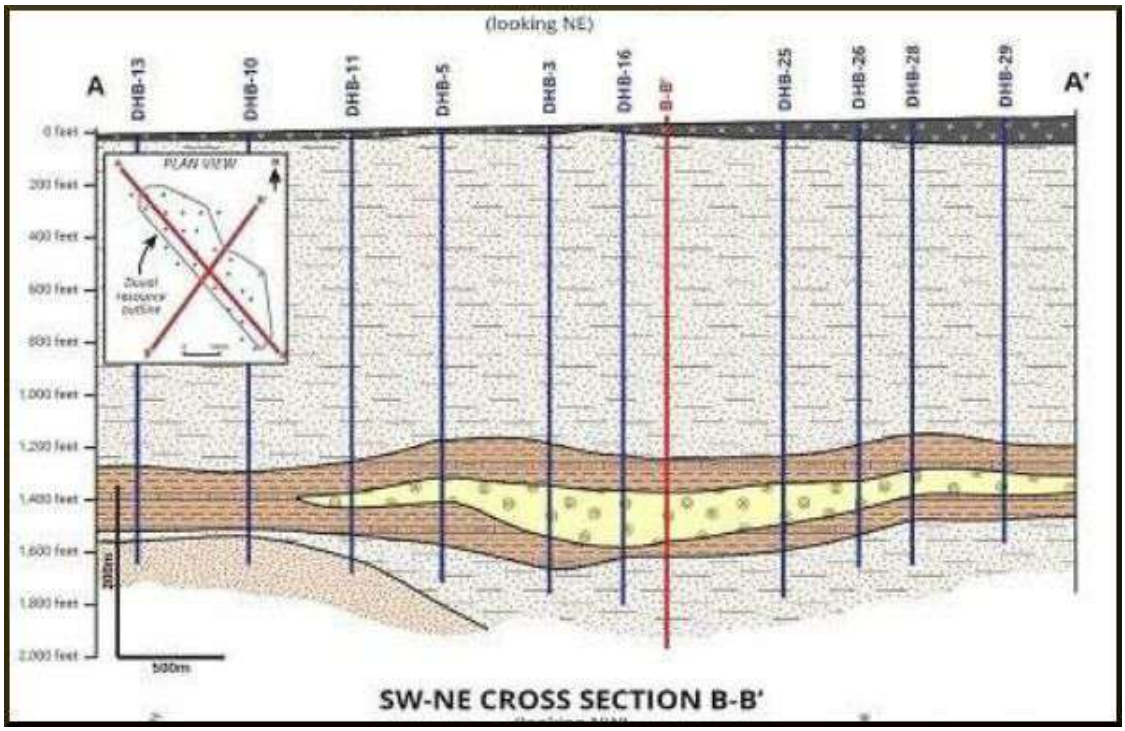
Borates were precipitated as the thermal waters entered the lake and cooled or as the lake waters evaporated and became saturated with boron. Colemanite, the least soluble mineral, would evaporate on

the receding margins of the lake. The evaporite-rich sequence forms a consistent zone in which the borate-rich colemanite zone transgresses higher in the section relative to stratigraphic marker beds.

The project area has uniform exposures of fine-grained lacustrine sediments and tuffs, possibly Pliocene in age, are found throughout the project area. Younger alluvium occurs in washes and overlying the older lacustrine sediments. Much of the project area is covered by recent basalt flows from Pisgah Crater. Thick fine-grained, predominantly lacustrine mudstones appear to have been uplifted, forming a block of lacustrine sediments interpreted to be floored by an andesitic lava flow.

Mineralization occurs in the subsurface in a sequence of lacustrine sediments ranging in depths from 1,135 to 1,872 ft. below the surface. The mineralization is hosted by a sequence of mudstones (thinly laminated silt, clay, and gypsum beds) and tuffs, consisting of variable amounts of colemanite, a calcium borate, which is the target mineral for this deposit and is found in evaporite deposits of alkaline lacustrine environments.

The entire mineralised zone, irrespective of grade cut-off and minor barren interbeds, ranges up to 130m in thickness. The deposit is elongated in shape and trends northwesterly, extending over an area of about 606 acres at an average depth of approximately 1,150 ft to 1,312 ft. below surface. A long section of the deposit looks like:



When looking at the cross-section of the deposit, the concentration of boron-rich evaporites is roughly ellipsoidal. Beds within the colemanite deposit strike roughly N45°W and dip about 10° or less to the

southwest. Using an isoline of 5% B2O3, mineralization has an approximate width of 2,800 ft. and a length of 11,150 ft. with thickness ranging from 70 to 262 ft. (exclusive of barren interbeds).

The Resource

In 2021, an SEC-compliant, the original S-K 1300 Mineral Resource Estimate (MRE) was published to coincide with the US listing. This was prepared by Steven Kerr, CPG, Principal Geologist of consultants, Millcreek Mining Group, and was based on an existing geologic model used in 2018 JORC compliant MRE.

After 2021, an additional 13 wells were drilled as part of a monitoring well and testing program.

In April 2023 a new MRE for the Fort Cady project was published. This was prepared by Louis Fourie, P. Geo., of Terra Modeling Services. It is shown below:

Measured Resource	Tonnage (MST)	B_2O_3 (wt%)	H_3BO_3 (wt%)	Lithium (ppm)	B_2O_3 (MST)	H_3BO_3 (MST)	LCE (MST)
Total Measured Resource	30.95	4.81	8.55	357	1.49	2.65	0.059
Total Indicated Resource	43.35	4.09	7.27	355	1.77	3.15	0.082
Total Measured & Indicated Resource	**74.31**	**4.15**	**7.37**	**356**	**3.26**	**5.80**	**0.141**
Total Inferred Resource	96.90	4.75	8.43	321	4.60	8.17	0.166

*Using a 2% B_2O_3 cut-off grade and no Lithium cut-off grade.

The contained minerals in the resource are:

	Contained Tons	
	B2O3 (MST)	LCE (MST)[3]
Measured	2,646,840	58,901
Indicated	3,151,461	81,854
Inferred	8,172,461	165,752
Total	13,970,761	306,508

As part of the 2021 MRE, there was also a resource target prepared in August 2021 which was believed to have the potential to further extend mine life or scale or both. The Exploration Target was:

Area	Thickness metres	Tonnage Range MMt	Grade Range		Boric Acid Range MMt
			B_2O_3 %	H_3BO_3 %	
Land Parcel A	20.39 - 28.91	5.97 - 35.39	5.53 - 7.15	9.84 - 12.73	0.59 - 4.50
Land Parcel B	29.05 - 38.08	3.32 - 13.06	5.08 - 7.15	9.04 - 12.73	0.30 - 1.66
Land Parcel C	27.94 - 31.48	6.41 - 21.66	4.93 - 7.15	8.78 - 12.73	0.56 - 2.76
Land Parcel D	24.00 - 30.57	4.94 - 18.88	5.72 - 7.22	10.18 - 12.85	0.50 - 2.43
Total		**20.64 - 88.99**	**5.32 - 7.17**	**9.47 - 12.76**	**1.95 - 10.08**

Previous Studies

In 2017 the company engaged Minneapolis based engineering and environmental consulting company Barr Engineering Co. and mineral processing expert consultant Mike Rockandel to manage its mineral processing program. Both Barr and Rockandel have extensive experience in process testwork, pilot plants, process design and engineering in commodities such as borates, soda ash and trona. Work to date has utilised 33 historic drill holes, 17 production wells, pilot plant operations, laboratory-derived data and previous feasibility and engineering studies to evaluate commercial processing of colemanite ore with the goal of providing a process concept.

That Scoping Study was based on feasibility studies and operational parameters used by previous owners to gain the permits. As part of the work program, Barr and Mike Rockandel delivered flow sheets, mass balances, reagent consumption estimates, process plant operational cost estimates and capital expenditure estimates.

The consultants were also tasked with evaluating a potential scaling-up the production rate to be more in line with the perceived potential that the project held. The initial boric acid Scoping Study did not consider adding a lithium circuit, given time constraints with respect to lithium test works, and the management's desire to release some financial metrics on the project. The results of the lithium test works were expected to be included into an optimisation study.

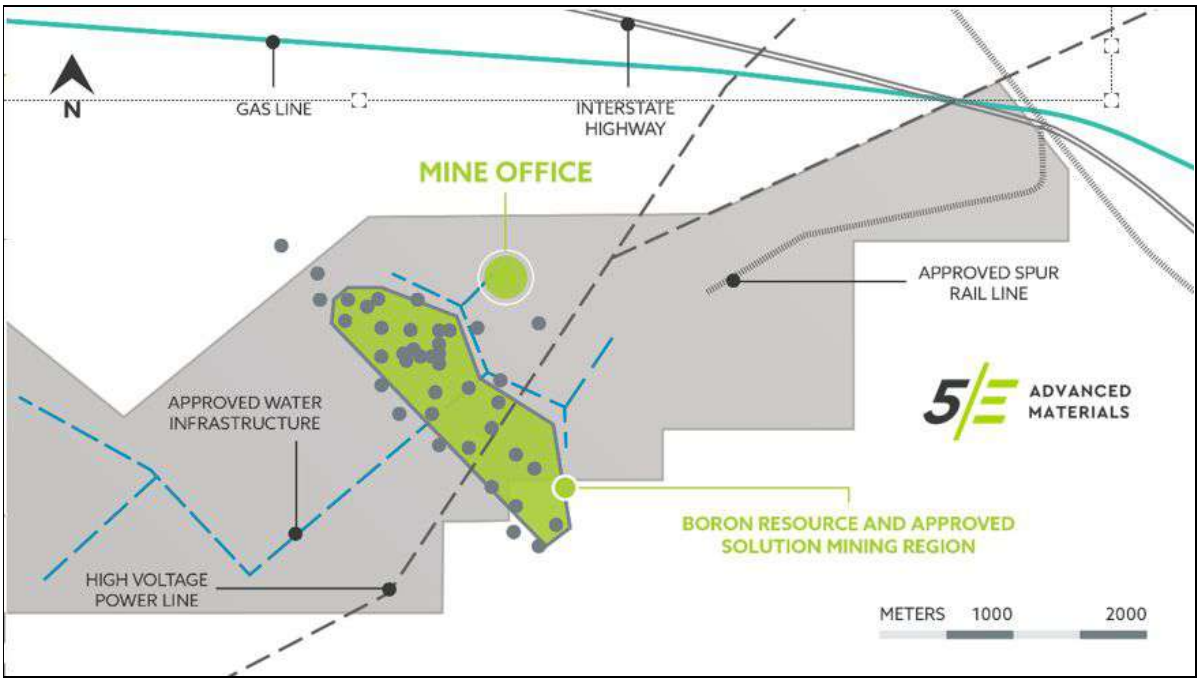
Mining & Processing

The project, as mooted in 2019, was to be developed in three phases with an estimated investment of US$526mn. Phase One was expected to be operational by 4Q20 (but this clearly did not happen), while phases two and three were expected to be operational by 2Q23 and 2Q25, respectively.

The project employs *in situ* solution mining method for recovering boric acid. A push-and-pull method will be employed initially until the wells naturally connect, after which separate injection and recovery wells will be used.

A diluted hydrochloric acid solution will be injected into the ore body, 425m below the surface through

the wells. The solution will leach the colemanite ore to form a pregnant leach solution (PLS), which will be extracted through reverse pumping.



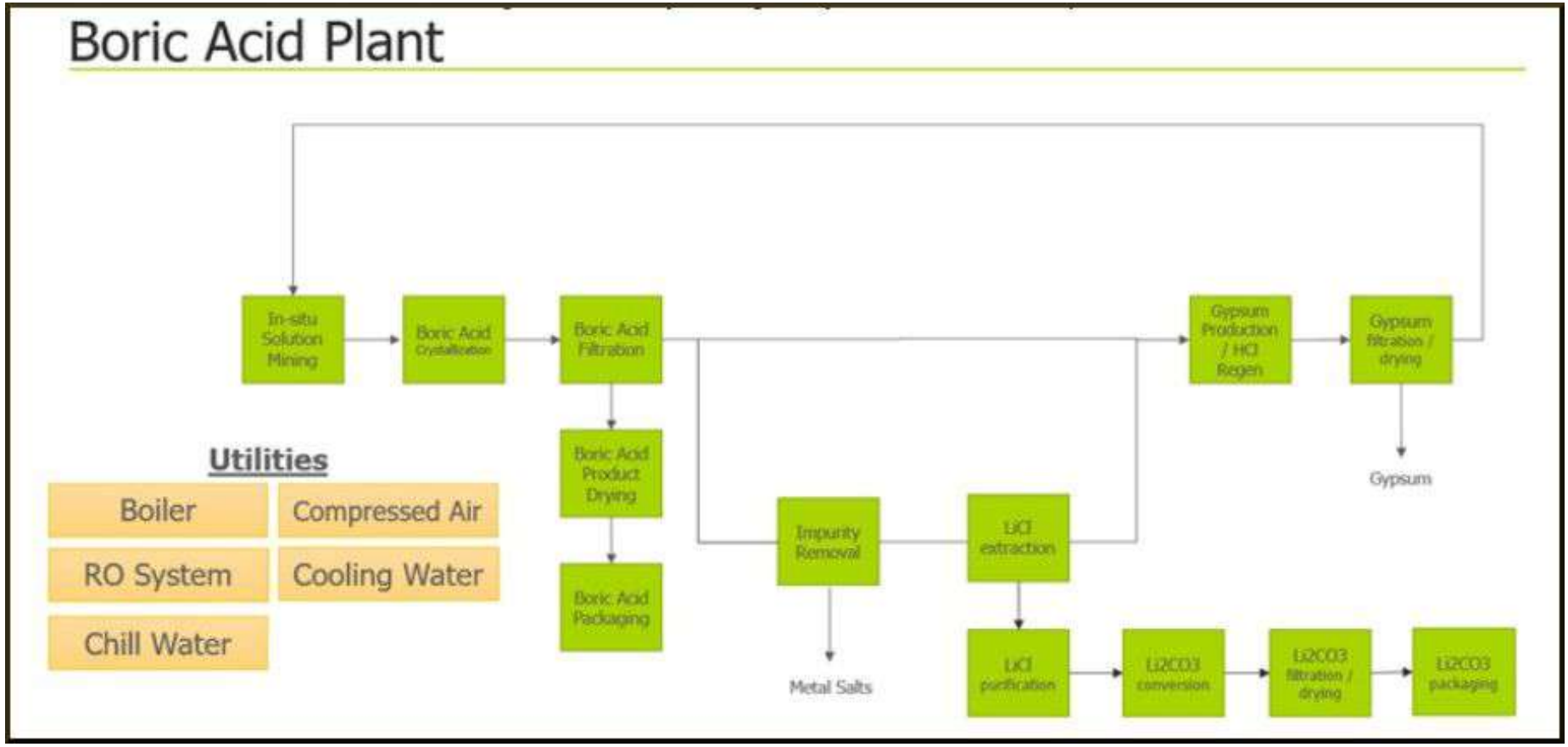
Above Ground Processing

The management at 5E has selected crystallization as the method for recovering H_3BO_3 as it is an established process for purification of other industrial materials, can be operated on a continuous basis reducing equipment size, is based on fundamental physical properties such as relative solubility, and doesn't require the use of flammable solvents.

PLS that enters the plant will contain water, approximately 7% H_3BO_3, as well as calcium chloride ($CaCl_2$), trace metal salts, and any unreacted amount of HCl from the mining operation. The solubility of H_3BO_3 is such that it will precipitate first when concentrated. A crystallization process is utilized to perform this concentration.

At this point the water is recovered, as is the HCl mixture, which is recycled for reuse in the mine.

After crystallization, the resulting boric acid slurry contains 28% liquid boric acid by weight, $CaCl_2$, trace metal salts, and trace hydrochloric acid. This slurry is concentrated, filtered and then moisture is removed in a dryer and then the end-product is loaded into customer-specific packaging.


Boric Acid Plant
In-situ Solution Mining
Boric Acid Crystallization
Boric Acid Filtration
Boric Acid Product Drying
Boric Acid Packaging
Impurity Removal
Metal Salts
LiCl extraction
LiCl purification
Li2CO3 conversion
Li2CO3 filtration / drying
Li2CO3 packaging
Gypsum Production / HCl Regen
Gypsum filtration / drying
Gypsum
Utilities
Boiler
Compressed Air
RO System
Cooling Water
Chill Water

The flowsheet is shown on the preceding page and can be summarized as:

- Acid in-situ solution mining using heated (58°C) weakly acidic solution (4% HCl)
- Cooling to produce crude boric acid crystals
- Collection, de-watering and re-dissolution of the crude crystals to produce a concentrated boric acid solution
- Cooling recrystallisation of pure boric acid
- Crystal de-watering and drying
- Solvent extraction (SX) to recover soluble boric acid from the crude crystallisation step
- Regeneration of the injection solution by sulphuric acid acidification of the SX reject solution (raffinate)
- De-watering and disposal of the gypsum stream

The Commercial Phase 1 processing plant is designed to operate continuously based on up-time of 87%. To produce 90,000 tpa of boric acid, the plant will require 640 - 650 gal/min of PLS from the mine on a continuous basis. Other inputs for the process based on a production rate of 90 k tpa are 102 k tpa of 97% sulfuric acid H2SO4, 13 ktons/yr of 35% HCl, 340 gal/min of water, 15 MW of power, and 300 MM BTU/hr of natural gas.

The plant will employ approximately 133 people at these production rates.

Infrastructure details

The site is accessible from the I-40 Hector turn-off and Route 66. A pipeline will be constructed to connect the processing plant to the existing Pacific Gas & Electric Company (PG&E) mainline for supplying natural gas for the project.

Power will be sourced from an 8MW steam turbine generator, while water will be supplied from two existing water wells in the area. Four new wells are proposed to supply 100 gallons per minute of process water required for the operations.

Capex

In the May 2023 study, the capital cost expectations were determined to be US$373mn for the first stage, 90k tpa boric acid plant (inclusive of co-product processing) based on thorough review of multiple third-party EPC firm estimates. This estimate includes a 25% contingency.

Later expansion phases have been scaled from this figure. Operating costs are built upon detailed process material balances and escalated recent historical pricing of raw materials and utilities.

Price Assumptions

The pricing assumptions for the economics of the project were:

Year	2026	2030	2040	2055
Boric acid price per short ton	$1,726	$ 2,130	$ 3,010	$ 4,620
CAGR (1)		5.40%	4.05%	3.45%

As can be noted there is an aggressive price growth factored in.

	Life of Mine Price Assumptions (1)			
	Measured and Indicated		Measured, Indicated and Inferred	
	Average	Range	Average	Range
Boric acid price per short ton	$ 2,401	$1,685 - $3,054	$ 3,120	$1,685 - $4,759

Misstep with Contractor

In April 2022, the company signed a contract with Matrix Service Inc. to lead the construction efforts in building the Small-Scale Boron Facility (SSBF) in Newberry Springs, California. As part of the contract to fulfill its scope of work, Matrix agreed to provide all construction project management, procurement services, and construction work through mechanical completion. After repeated cost escalation and schedule misses, 5E determined that Matrix could no longer deliver on the agreed-upon scopes of work as defined by the contract, and thus 5E made the decision to demobilize Matrix from the project site.

Then in mid-July, 5E filed a complaint with the United States District Court for the Central District of California against Matrix alleging numerous breaches of its contractual obligations to 5E, which lead to cost and schedule overruns.

Kickstarting Operations – Many a Slip

After the travails of 2023, 5E launched itself into 2024 with an announcement on the first business day of the year that it had officially begun mining operations at the company's "mine" with the startup of the wellfield injection process. Under its EPA UIC permit it could begin extracting minerals at Fort Cady.

The company announced that it expected to begin lab production in the short-term and production of boric acid and lithium carbonate from the small-scale facility by the end of the 1Q24. This initial production will be used for customer qualification as the 5E seeks to obtain bankable offtake agreements and future sales to support FEL 2 engineering as the focuses on moving to commercial scale operations.

Then a couple of weeks later the company announced the selection of Fluor Corporation as its engineering, procurement, and construction (EPC) services provider. The initial scope of Fluor will be to lead FEL-2 which will directly feed into the upgrading of the extant S-K 1300 technical document into a

Pre-Feasibility Study upon completion.

In late October of 2024 the company confessed that it had to remove metal salts and produce gypsum, in the near term, as calcium levels and metal salts have lagged boric acid leach rates. Calcium content has now increased to greater than 20,000 ppm, necessitating the production of a calcium-based by-product.

Customer Qualification

At the end of June, the company commenced its customer qualification program after producing commercial grade boric acid. Over a period of several days, some 2,800 pounds of boric acid were produced, and the immediate target for production rates is three tons per day.

To clear customer qualification, boric acid requires little to no moisture and impurities, as well as a specific particle size. Once initial production was achieved, the following 60 days were dedicated to refining the process to meet these customer specifications. After successful bench trials, the technical and operations team made the necessary plant modifications to achieve commercial grade product. With confidence that the facility produces quality boric acid, initial samples were shipped.

The next phase of customer qualification will require significantly more (up to 100 tons) boric acid for testing in a live manufacturing environment, and the next phase of customer qualification is targeted for Fall of 2024.

Next Step – Optimisation

Optimisation studies/reviews are a new trend to be welcomed. We have seen them increasingly used by managements to correct or resize previous detailed studies that may have been made upon premises that have subsequently changed.

In 5E´s case the company has used a combination of sources of industry contracts, industry reports and data sources, the focus is the boron market (pricing, markets, offtake agreements). On the operations side the priorities have changed to a systematic approach to commercial production without having to undertake the type of expenditure that a full rewrite would involve. Particularly in the case of 5E, now that the “proof of concept” of In-Situ mining colemanite is complete there is no need to reinvent the wheel at great cost, rather it is preferable to readjust the direction of its travel.

In late July of 2024, the company released its initial thoughts on CAPEX and OPEX optimization opportunities at the project now that it has digested its lessons from the first six months of operations at the small-scale plant. The optimization exercise progress will feed into the FEL2 engineering program. The principal findings are:

- That an opportunity to reduce wellfield sustaining CAPEX has been identified and quantified
- Consistent head grade of 5.5% to 6.0% can and has been achieved
- Higher mining temperature provides an OPEX optimization opportunity

These findings came as the company reported continued progress towards steady state production, and while the operations team ramps towards its next target of three short tons per day. The engineering team continues to optimize CAPEX and OPEX, focusing on the mine plan, process, and biproduct mix.

Optimising Wells & Head Grades

The most current technical report summary calls for a mine plan with 841 vertical wells. Initial recovery data and mine planning indicates that utilizing horizontal wells can increase solution flow rates, resource contact, and reduce the quantity of wells by a factor of up to ten which could meaningfully reduce CAPEX. For 5E, head grade equates to the quantity of boron in solution that is fed into the processing facility for crystallization.

Based on historical reports from operations in the 1980's, the company's predecessor parent company, American Pacific Borates, estimated head grade of 3.7%. Through the first six months of operation, actual head grade has consistently ranged between 5.5% and 6.0%, with an average of 9,822ppm boron. The outperformance of head grade is attributed to mining solution entering the deposit at 140 degrees Fahrenheit where higher temperature drives a better head grade.

The most recent technical report summary assumes a head grade of 7% and the company remains on track to achieve this level or better. After processing boric acid, the remaining solution includes deleterious elements, calcium, water, and 1.5% HCl. Through recirculation of the remaining solution, the 7% head grade or higher is expected to be achieved. As head grade increases, the process requires less energy for crystallization which would reduce OPEX costs. The technical team is assessing the impact of increasing the temperature above 140 degrees such that OPEX is further reduced with less energy consumption.

By-Products – Icing on the Cake?

Colemanite is a calcium-based deposit, and as boron is extracted, the process results in a calcium by-product. The current technical report summary anticipates a gypsum by-product which is not expected to add meaningful value. Other value-added by-products, such as calcium chloride and magnesium hydroxide, are currently being assessed. Magnesium is classified as a critical mineral according to the United States Geological Survey and production of magnesium hydroxide is expected to be accretive to cash costs and further reduce OPEX.

In addition to H_3BO_3, and the above-mentioned chemicals there are Lithium carbonate and gypsum could

be produced as production volumes of H_3BO_3 increase.

FEL2

With production rates expected to ramp, line of sight on the next phase of customer qualification, and the optimization work currently in process near completion, 5E's management is prioritizing the FEL2 engineering program with targeted completion in early 2025. Included in the scope of the FEL2 program is a capital estimate of +/- 25% for the 90,000 short ton per annum facility.

This, in turn, will drive an updated technical report summary and pre-feasibility report.

Permitting

As far back as late 2017, the Fort Cady Project had in hand the two key Land Use Permits and an Environmental Impact Statement / Environmental Impact Report to produce 90,000 tons per annum of boric acid.

The Lithium "Potential"

As previously noted, the project passed through a phase where the previous management chose to promote the development as a lithium project, firstly, and the borates being of secondary interest. Borates won that battle, but the potential still exists for Lithium output from the project. It is well-known from *salares* in Latin America that those deposits hold both Lithium and Boron (which are only separated by Beryllium in the Periodic Table).

Financial Travails?

On the 9th of November of 2023 the company announced that it was advancing discussions with its main lender and other parties to achieve a funding solution for its debt burden. In order to restructure its convertible note and strengthen its balance sheet, the company entered into a standstill agreement with BEP Special Situations IV, LLC, its primary lender and the holder of the senior secured convertible notes.

This situation dated back to August 2022, when 5E secured a US$60mn private placement of senior secured notes convertible into common stock of 5E from US-based institutional investment manager, Bluescape Energy Partners. Under the terms of the private placement, 5E was to maintain a minimum cash balance of US$10mn. With respect to its ongoing financing and commercial initiatives, the company signalled to the market that it required a time extension to achieve an appropriate funding solution.

In early November of 2023, 5E announced its fiscal first quarter 2024 financial results (10Q for September quarter) and a cash balance of US$11.8mn. In February of 2024, it announced in its 10Q filing that its cash balance at the end of December of 2023 was $2.045mn (down from $20mn a year before).

The standstill agreement provided 5E with a time extension to advance discussions with several parties to achieve funding for its next phase of growth as it works judiciously to finalize its permit obligations. Under the standstill agreement, 5E was allowed to go below its current cash covenant until the 1st of December 2023, but then on December 3rd, it was announced that the standstill agreement had been extended.

Finally, on the 6th of December, 5E agreed a funding package with its main lender and a group of new investors for:

- New investors committing up to US$25mn under the transaction and the terms of the 5E's existing senior secured convertible notes which were to be amended to reduce the conversion rate, extend the maturity date by one year and increase the paid-in-kind interest rate to 10%
- Bluescape Special Situations IV, LLC provided an option to invest an additional US$10mn under the transaction
- The new investors would acquire 50% of the outstanding principal amount of the convertible notes from the lender
- The lender agreed to reduce the minimum required cash covenant in the notes to zero until the 28th of June 2024. The upon the closing of the transaction, the notes would be amended to provide for a minimum required cash covenant of US$7.5mn beginning from the 28th of June 2024

Financing

At the very end of January 2024, the company announced that it had closed its previously announced second tranche of equity financing. The second closing included US$7.75mn in new equity capital from 5ECAP, LLC. The company had previously closed on US$10mn on January 18th. That tranche was split equally between Ascend Global Investment Fund SPC and 5ECAP, LLC. At the time, the company did not announce the price at which the shares were issued.

Funds raised from these transactions were to be deployed to continue initial production of boric acid and lithium carbonate and to complete the final stages of the processing plant.

Then in June of 2024, the company announced the issue of US$6mn in additional senior secured convertible notes. These were taken up by Bluescape Energy Partners and Ascend Global Investment Fund SPC that each purchased US$3mn in the notes, that will be initially convertible into common stock at $1.53 per share, with an August 2028 maturity, paying interest in-kind at 10%.

In late August of 2024, it was announced that 5E had entered into a securities purchase agreement with a single institutional investor to purchase 5,333,333 shares of common stock in a registered direct offering at a price of $0.75 per share, along with Series A warrants to purchase up to an aggregate of 5,333,333 shares of common stock (and the same number of Series B warrants to purchase up to an aggregate of

5,333,333 shares of common stock in a concurrent private placement). Each of the Series A warrants and Series B warrants will have an exercise price of $0.7981 and will be exercisable six months from the date of issuance. The Series A warrants will expire on the five and one half-year anniversary from the date of issuance, and the Series B warrants will expire on the two and one half-year anniversary from the date of issuance.

The gross proceeds from the registered direct offering and concurrent private placement of warrants were estimated to be approximately US$4mn before deducting the placement agent's fees and other estimated offering expenses.

The Balance Sheet

Instead of getting better the debt situation at the company has got worse, as can be seen from the balance sheet on the following page:

5E Advanced Materials - Balance Sheet

US$mns

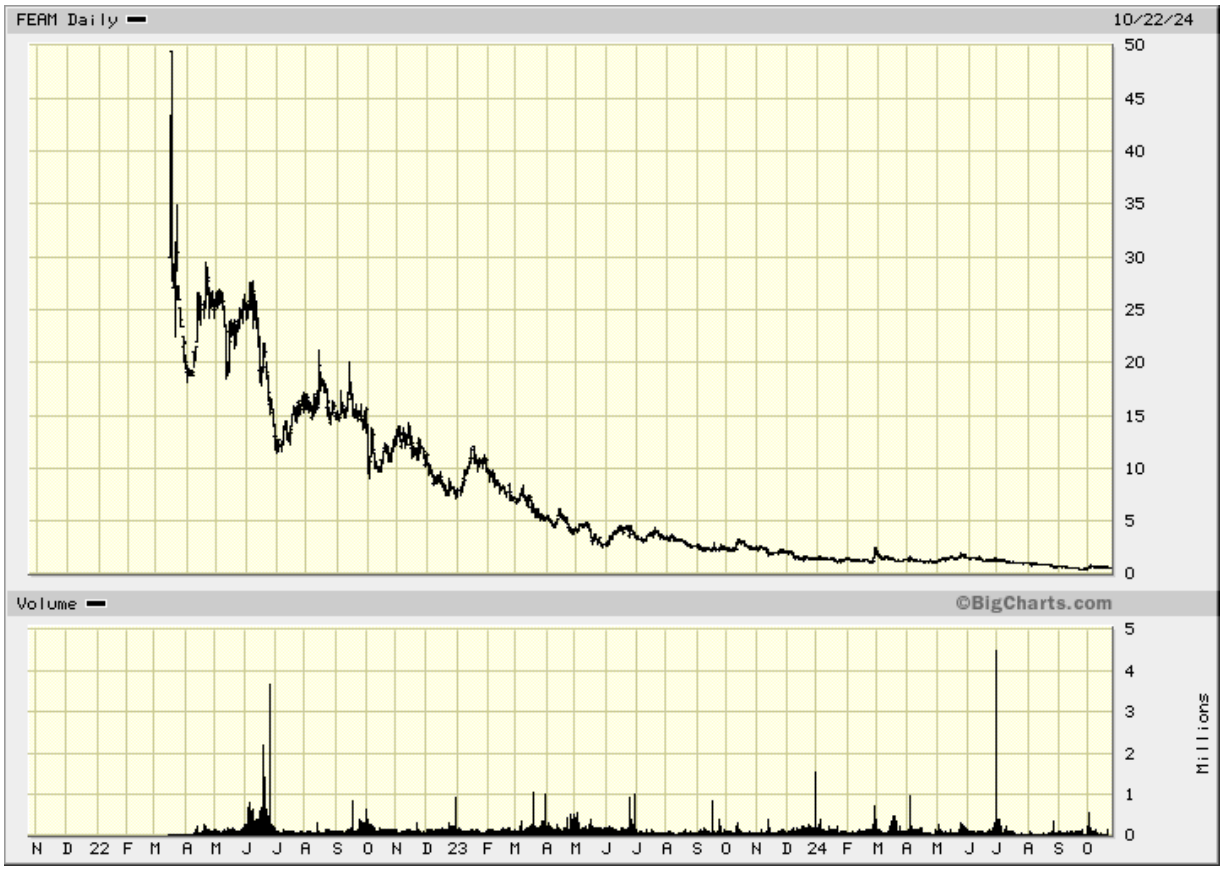
	30-Jun-24	30-Jun-23
Current assets:		
Cash and cash equivalents	4,896	20,323
Prepaid expenses and other current assets	1,913	1,808
Total current assets	6,809	22,131
Mineral rights and properties, net	7,616	7,637
Construction in progress	608	67,553
Properties, plant and equipment, net	73,872	3,056
Reclamation bond deposit	311	309
Right of use asset	282	207
Other assets	6	6
Total assets	89,504	100,899
LIABILITIES AND STOCKHOLDERS' EQUITY		
Current liabilities:		
Accounts payable and accrued liabilities	9,567	8,728
Lease liabilities, current	141	136
Total current liabilities	9,708	8,864
Long-term debt, net	64,831	37,671
Convertible note derivative liability	3,315	—
Lease liabilities	149	74
Asset retirement obligations	795	724
Total liabilities	78,798	47,333
Stockholders' equity:		
Common stock outstanding	633	441
Additional paid-in capital	210,074	191,113
Retained earnings (accumulated deficit)	(200,001	(137,988
Total stockholders' equity	10,706	53,566
Total liabilities and stockholders' equity	89,504	100,89

Directors & Management

The board and management at the company experienced a major overhaul at the beginning of June 2024 and more heads have rolled in recent times. It seems clear that there is a high degree of organizational disfunction.

Price Moves - A Rough Ride for Investors

The price of 5E Advanced Materials, Inc. (Nasdaq: FEAM | ASX:5EA) has been absolutely crushed over the last 18 months, despite being potentially both a Boron producer and a Lithium producer. From a debut price on the NASDAQ around $50 per share it has slid, almost unremittingly, down to a current level below $1 per share. To put that in perspective, it was at a market capitalisation of ~ US$2bn and is down to around $60mn.



The low current share price flies in the face of the developments of the company since the start of 2024. However, part of the problem can be attributed to “index malaise”. FEAM was added to the Russell 2000 Index in mid-June of 2022 and then dropped on July 1st of 2024.

The inclusion in the Index was a case of “it’s all downhill from here” as the company immediately became the victim of a massive short interest. Institutions were lending out shares and covering for synthetic shorts.

The short interest peaked in size at the very end of 2023, and has been declining steadily since. It currently stands at less than half its peak level.

Risks

The risks for 5E might be summarized as:

- A weak Boron price
- The advent of competing new projects
- Weakened global industrial demand that would soften price & volumes
- A tough financing market for developers

As is the case for every company in the metals and minerals spaces the onset of weak pricing can be the undoing of the best laid plans. Hitherto the Boron space has been a fairly well-disciplined space. The Lithium sector shows how this can come undone with the market disciplining effect of a few big players. We were however dismayed to have one of the company’s (now departed) executives claim that weaker Boron prices were not a risk. Famous last words (literally).

New competing projects are what upset the Lithium space, with uncontrolled new entrants not working in concert. At the moment, 5E is the most likely new entrant to commercial production with the Serbian players hot on their tail. The Turkish major is unlikely to engage in price spoiling activities by adding significantly to supply.

Past recessions have not dealt a blow to Boron consumption, and it appears to be relatively inelastic to consumer downturns due to the fundamental nature of its applications.

Tough financing conditions are a constant in mining and 5E has had its own experiences of the vagaries of this. While 5E has seemingly made the move out of developer to producer, the issue remains as to the appetite of the equities markets for supporting a new Boron production buildout particularly in light of its relative novelty to equity investors. This does not exclude the possibility that the next phases of the buildout may be expedited by strategic (or trade) investors. But will the company actually survive long enough to make it to these mooted sunny uplands?

Conclusion

5E may now be coming out the other side of a very long and dark tunnel, but with its ambitions (and market cap) severely cut down to size. Maybe not a bad thing. But will it survive?

The wild gyrations in the management team have scarcely helped project a stable image to investors or the financial markets. Meanwhile, the balance sheet makes disturbing reading with sizeable debt, much diminished shareholders' funds and the earnings statement haemorrhaging money.

The price went into a severe decline in 2021 after studies showed the financial metrics on the three-stage rollout of the Fort Cady mine project were in fact marginal, with a meaningful EBITDA only delivered on the completion of phase 1C.

This triggered a meltdown, which in turn led to a financial crisis, and then to development delays and ultimately a whole rethink, with the project finally getting on the road in a much reduced (or dare we say, diminished) form. The background music to this was the Short interest related to the company's inclusion then deletion from the Russell 2000. He who lives by the index status, dies by it, as we have often said.

This reality check left the company scrambling to reposition itself with a universe of investors that can stomach the much smaller market cap of current times. US investors that had bought into a billion-dollar market cap now found themselves in a much smaller investment, while Australian investors (who had been overlooked in the rush into US equity markets) might be viewed as more tolerant of a smaller entity with a now more conventional growth and price evolution trajectory. Meanwhile, investors both small and large are jamming the exits like third-class passengers on the Titanic. Its not a good look.

We are Initiating 5E Advanced Materials with a **NEUTRAL** rating and a twelve-month target price of US$0.40 or AUD$0.065.

Boron

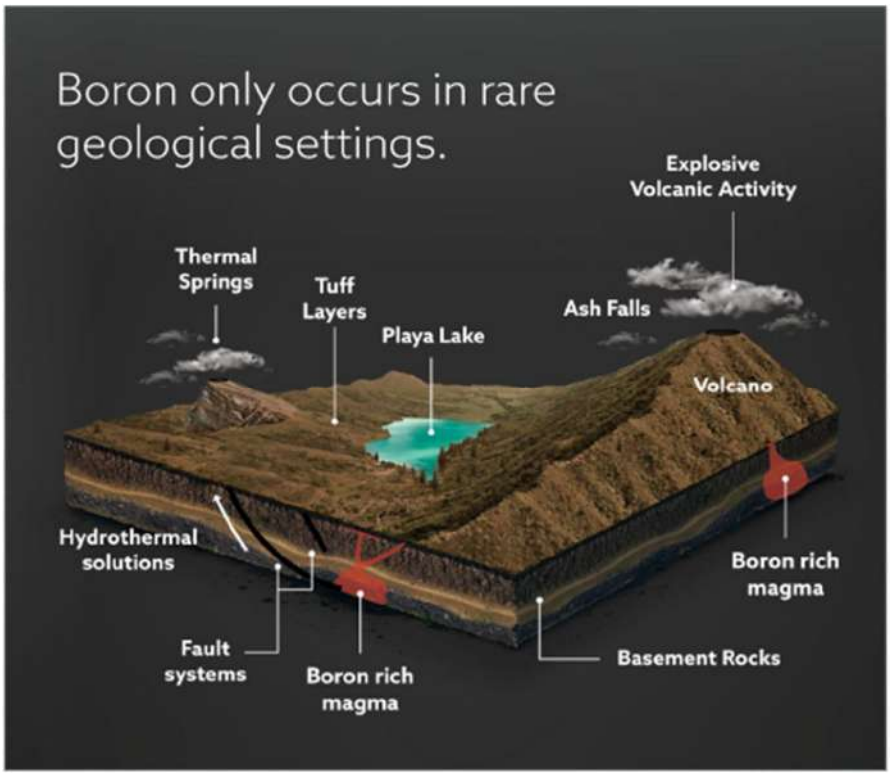
The Low-Flying Tech Mineral

The Element and Its Geology

Boron is ubiquitous in the environment, occurring naturally in over 80 minerals and constitutes 0.001% of the Earth's crust. The chemical symbol for Boron is B with an atomic weight of 10.81. Boron is not found as a free element in nature.

The highest concentrations of boron are found in sediments and sedimentary rock, particularly in clay-rich marine sediments. The high boron concentration in seawater (4.5 mg B L-1), ensures that marine clays are rich in boron relative to other rock types.

Boron occurs as an orthoboric acid in some volcanic spring waters, and as borates in the minerals, borax and colemanite.



Source: 5E Advanced Materials

Extensive borax deposits are found in Turkey. It is also present in lithium *salares* in the Argentine *altiplano* (e.g. Salta). However, by far the most important source of Boron is rasorite. This is found in the Mojave Desert in California, USA.

Processing

Boric acid is mainly prepared from borates and minerals and is produced by reacting sodium borax with an inorganic acid such as sulfuric acid or hydrochloric acid.

To produce boric acid using sulfuric acid, sodium borohydride is first poured into the reaction tank, and then the dilute sulfuric acid is slowly added until the solution is highly acidified and the pH approaches zero. Then a saturated solution of borax or ortho-borate forms. The hot solution then crystallizes and cools in a vacuum. Boric acid crystals will then be formed. Separate the crystals from the solution and cool the remaining solution until sodium sulfate is obtained as a secondary and secondary product. In the next step, boric acid is recovered by hot water, purified boric acid, ready to be packed and sold.

Boric acid production leads to either calcium or sodium salts by-products depending on acid utilised, the Boron mineral, and Boron mineral impurities. The use of strong acids in production processes is not preferred due to economic considerations, waste-water problems, and shortened equipment lifetimes (especially for the reactor vessel). Some have posited utilizing CO_2 as a leaching agent and as a plausible alternative to use of acids in boric acid production from minerals.

Applications

The main application of Borates is in glass production and insulation. Borates increase the mechanical strength of glass, as well as their resistance to thermal shock, chemicals and water. Glass manufacturing is a key market for borates accounting for more than 50% of global consumption, predominantly comprised of fibreglass (both insulation and electronics) and borosilicate glasses.

The other headline usage is in fertilizers with agricultural markets accounting for a significant share (~15%) of the total global consumption. At the cellular level, Boron is integral to a plant's reproductive cycle.

Boron controls flowering, pollen production, germination, and seed and fruit development. As a non-substitutable micronutrient, Boron also acts as a plant's fuel pump, helping move sugars from older leaves to new growth areas and root systems.

Other technology usages are in silicon, metallurgy, LCD screens, stealth technology, sports equipment, nuclear reactors and waste storage, Lithium batteries, computers, heat shields and medicines, Boron can also be found in automotive products like motor oil, brake fluid, steering fluid and antifreeze.

Boron is found in the ceramic floor tiles and porcelain enamel on sinks, refrigerators, pots and pans. Boron is also in heat resistant cookware, crystal glass and dishwasher detergent. These are not new as borates have been an essential ingredient in ceramic and enamel glazes for centuries, integral to affixing glazes or enamels, and enhancing their durability. Borates continue to gain acceptance as an essential ingredient in ceramic tile bodies, allowing manufacturers to use a wider range of clays, heightening productivity and decreasing energy usage during production.

Boron's other applications in the construction industry include uses in roofing materials, wallboard, paint, fibreglass & cellulose insulation. It is also used as a treatment for construction materials such as wood, plastic, bricks, pipes and wires, helping to protect these products from mold, fungus and insects.

Boron is also found in soap, shampoo, creams, lotions, makeup, shaving cream, lens solution, hair products (dye, straighteners, perms etc.) and even dental/denture products. Sheets, bed coverings and clothing contain Boron that improves fibre performance. Boron is also used in detergents, laundry boosters and bleaches.

The Magnet Trade

Neodymium magnets, with an important Boron component, are the most widely used type of Rare-Earth magnet. A Neodymium magnet (also known as NdFeB, NIB or Neo magnet) is a permanent magnet made from an alloy of Neodymium, iron, and Boron to form the $Nd_2Fe_{14}B$ tetragonal crystalline structure.

Fastmarkets made an interesting observation that their sources often refer to boron as a sort of shadow critical mineral because it is tied to a lot of applications in energy transition trends – solar panels, wind turbines, magnets in EV engines, thin-film transistor displays and even batteries, though it is not discussed or covered as much as lithium, nickel or copper, for example.

NdFeB magnets can be classified as sintered or bonded, depending on the manufacturing process used. This technology was developed independently in 1984 by both General Motors and Sumitomo Special Metals.

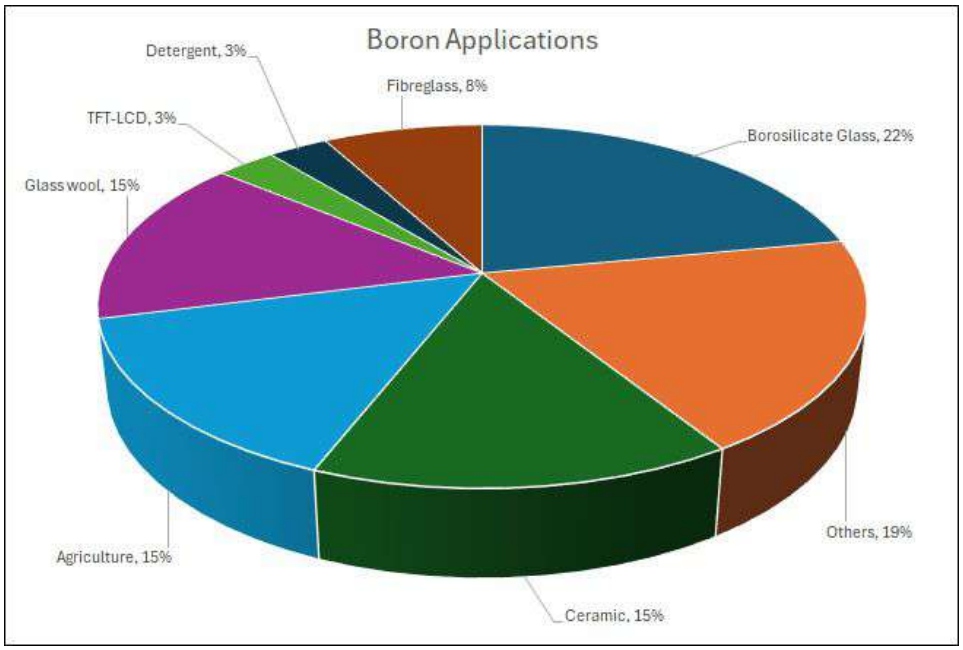
Neodymium magnets are the strongest type of permanent magnet available commercially and have come

into wider discussion now that they are perceived to be a key input in the EV industry. They have replaced other types of magnets in many applications in modern products that require strong permanent magnets, such as electric motors in cordless tools, hard disk drives, magnetic fasteners and the motors of EVs.

Fastmarkets have noted on neodymium-iron-boron (NdFeB) magnets that they require higher boron content used to make ferroalloys, technical-grade granular material is sometimes seen as a reference.

But there is only a fraction of boron used in those applications. Boron content in NdFeB magnets, wind turbines and blades, and photovoltaic panels, for example, is around 1-5%. It's worth noting that Boron priced inside of a permanent magnet is around 150th the price of the Rare Earths that go into it.

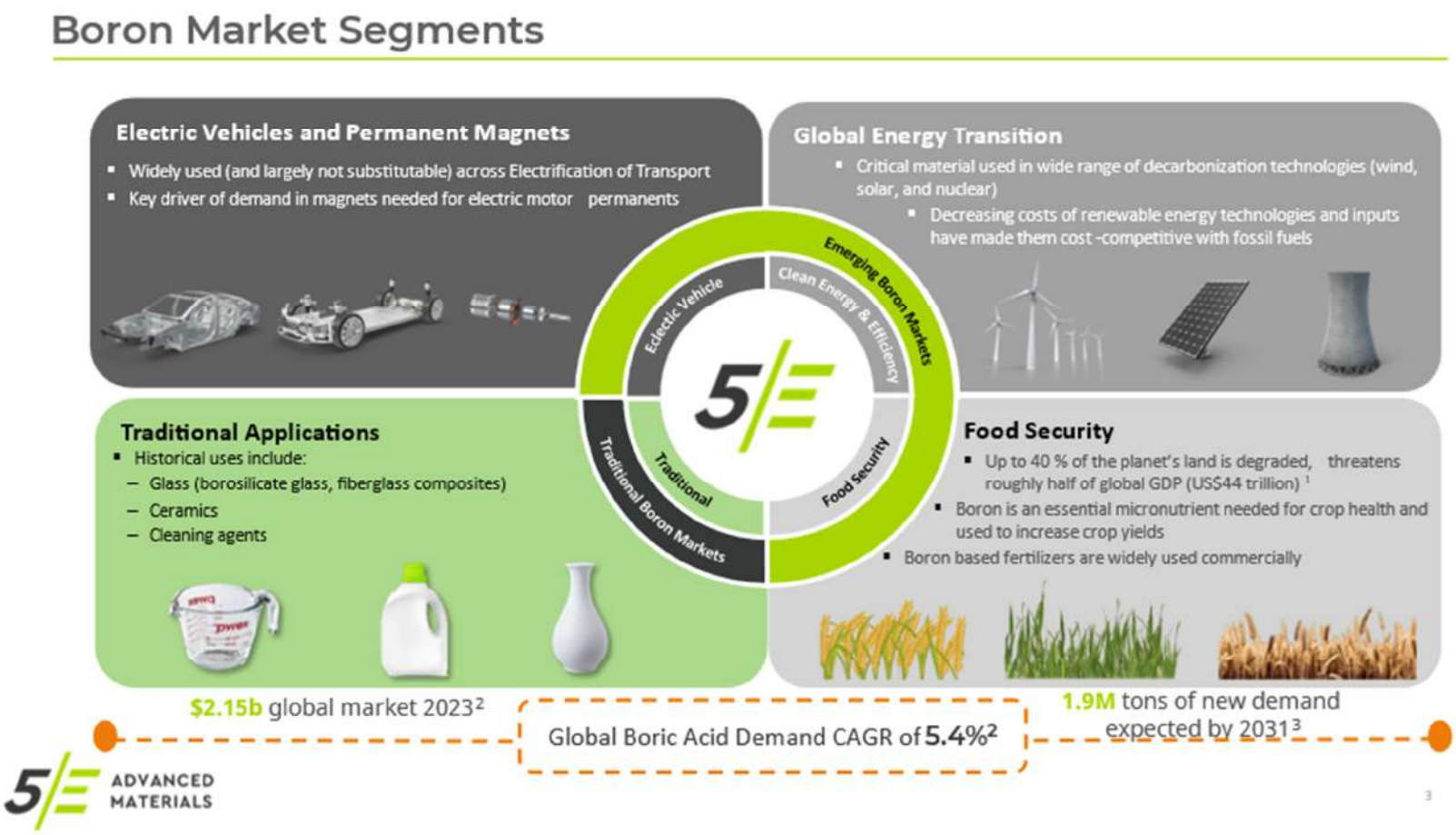
Despite the eye-catching nature of REE magnets they are mainly a rounding error in global Boron consumption (figuring in the *Others* category in the pie chart below).



Demand Outlook

The major demand drivers in the borates market are growth in urbanisation (global housing market), global population, sustainable food supply and energy production.

The chart below, showing supply/demand balance (excerpted from 5E's presentation), posits a fairly rapid widening of the gap between supply and demand.

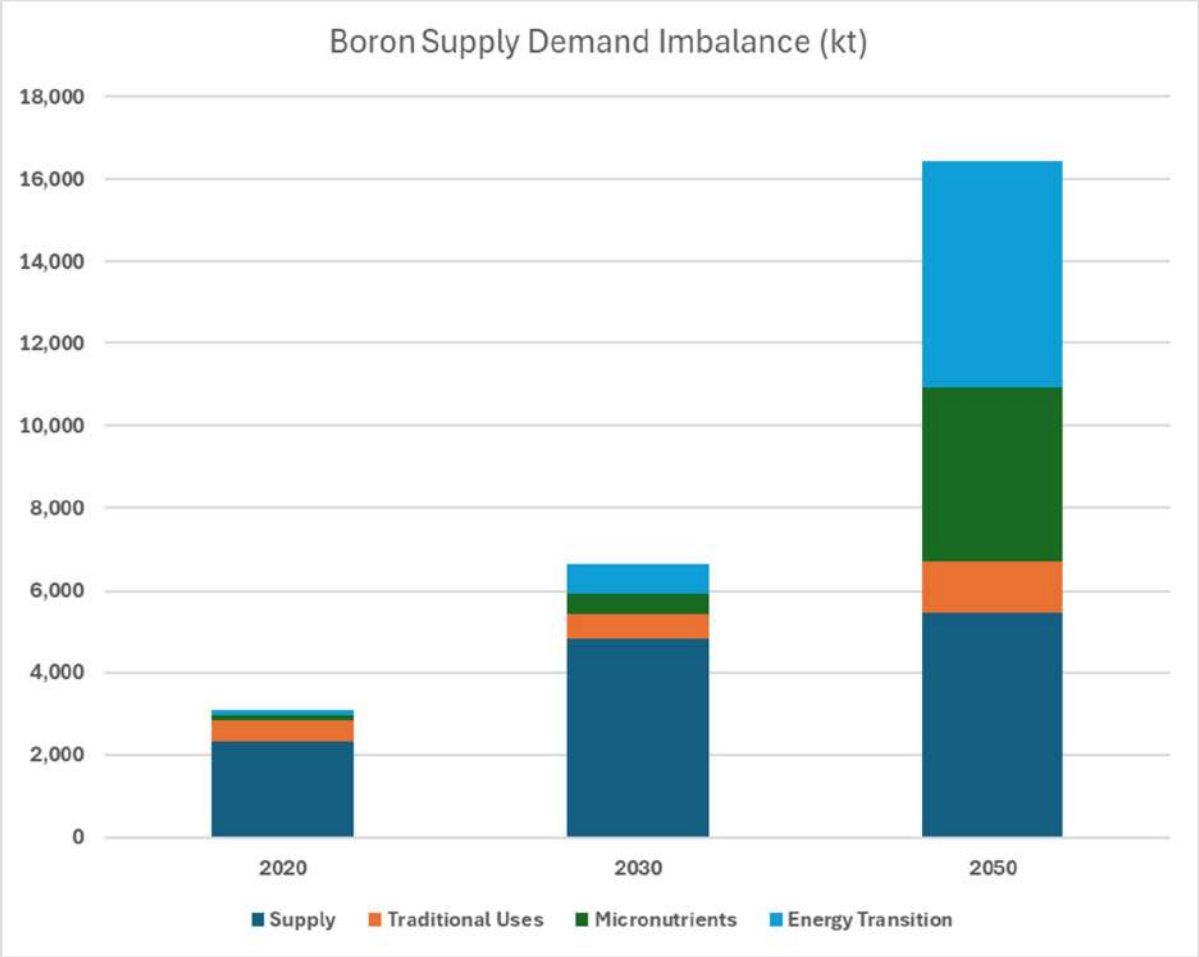


Sources: Chronic land degradation: UN offers stark warnings and practical remedies in Global Land Outlook & Global Market Insights, Boron Market – Industry Analysis & Forecast (2024-2030) - Kline Market Report

	2020	2024	Chg.	2026	Chg.	2031	Chg.
Global BA Demand, KT	1,096	1,273	16%	1,441	13%	1,977	37%
Change: 2020-2031	80%						
Source: Kline Report							

According to the most recent Kline Report on Global Supply/Demand of Boric Acid the overall CAGR from 2020-2031 is 4.6%. This equates to a change of +16% percent in the period from 2020-2024, from 2024-2026, another change of +16% and from 2025-2031 this demand increases by another +37%.

The total additional demand in the forecasted period is an increase of +80% from 2020-2031.



Source: 5E Advanced Materials

Pricing

In a recent market summary published by the commodity pricing service, Fastmarkets, they noted that consumers were trying to secure more volumes earlier than usual, signaling a potential market upside.

At the beginning of August, Fastmarket's price assessment for boric acid, technical grade, granular, fca US West Coast was $1,100-1,250 per tonne, while its price assessment for boric acid, technical grade, granular, ddp Europe was $1,000-1,200 per tonne. It also assessed the price for boric acid, technical grade, granular, cif China at $900-1,050 per tonne, and assessed the price for boric acid, technical grade, cif Brazil at $950-1,050 per tonne.

The pricing service reported its sources had spoken of a gradual increase in prices in the second half of the year, especially amid tougher negotiations with Turkey. Other "positive" factors included the conflicts in the Red Sea area, which have sent freight rates soaring and made boric acid imports more expensive, especially in 2Q24. Some shipments were being delayed by 20-40 days with a few consumers in Asia reported that supply was insufficient at times.

At the current time there appears to be no amelioration of the shipping attacks in the Red Sea, indeed, tensions across the wider Middle East are on the rise, advantaging US West Coast sources, and reinforcing the thesis that 5E is arriving at the market at a propitious moment.

Boron Producers

The largest market participant by far, is Turkish state-owned company Eti Maden, accounting for 60% of global supply The second largest producer in the is Rio Tinto with ~20% share of production. The remaining 15-20% of global boron production is sourced from smaller operations, such as Searles Valley Minerals (also in California), Quiborax in Chile and Minera Santa Rita in Argentina.

Asia maintains its position as the largest regional consumer of borates, accounting for more than 50% of total global consumption.

EtiMaden's operations are primarily three mines, while Rio Tinto now has one mine that is located in California. RTZ used to own several mines in Argentina, which it sold to Orocobre.

Turkey holds pole position in Borates both in reserves and production with 73% of world boron reserves; Eskişehir province– the Kırka mine, Kütahya province – the Emet mine and in Balıkesir province – the Bandırma & Bigadiç mines.

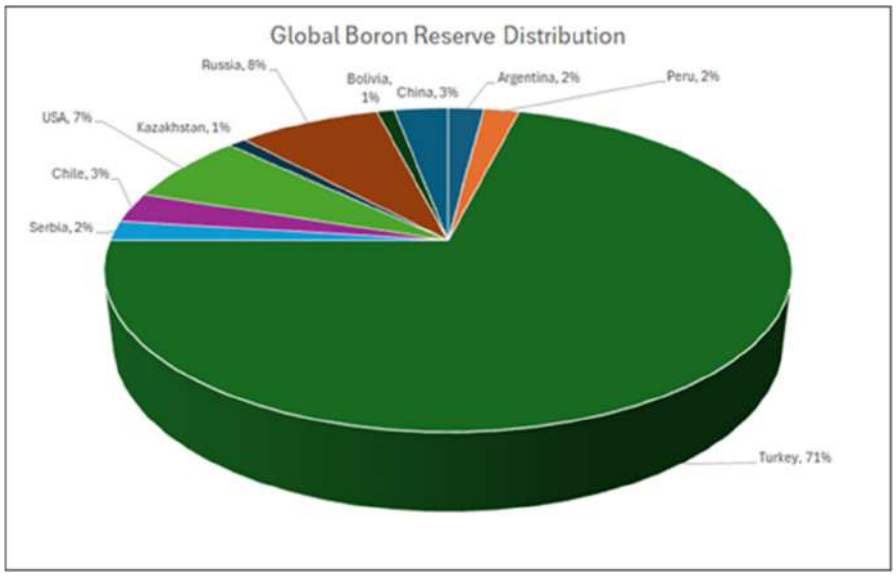
The most abundant borate minerals in Turkey in terms of reserves are tincal and colemanite. Tincal reserves are located in Eskişehir - Kırka, colemanite reserves are located in Kütahya – Emet, Balıkesir – Bigadiç and Bursa – Kestelek. In addition, there is an ulexite reserve in Balıkesir – Bigadiç as well and Ulexite is extracted as a by-product in Bursa – Kestelek from time to time.

Rio Tinto's mine is located at the appropriately named, Boron, where mining began in 1927. Today, the mine (pictured on the following page) produces one million tonnes of refined borates every year and is the largest in the world.

Above can be seen Rio Tinto's US Borax mine.

In 2023 we had the opportunity to visit a real producing facility in the form of Borax Argentina's long-standing plant in the Altiplano of Salta province in Argentina. This had been in public ownership (Orocobre, and before that RTZ) but has passed back to the private sphere when sold to a company, Minera Santa Rita, owned by local Salteño entrepreneurs.

The pie chart at the right shows the global borate reserves. This, unsurprisingly, shows Turkey with a dominant share.



However, we would note that the Turkish state miner has put in the most effort towards defining reserves of the mineral as it makes the most out of it. We suspect that reserves in

Chile and most particularly Argentina and Bolivia could prove to be massively larger than currently assessed due to the relatively unexplored/unquantified nature of borates in the myriad *salares* in the Andes. The Lithium Triangle is thus also the Borates Triangle. Do not be surprised if Ganfeng suddenly pops up as a leading producer in coming years.

Additionally, Serbia is only just appearing on the radar, though it has been a producer in the past. The Jadar Valley project controversy continues. A move towards construction was announced in mid-June that the Serbian Government was going to let Rio Tinto resume the project.

If **Ioneer** gets across the line into Lithium production, its borates sideline could be substantial, and this could also move the dial for some of the Clayton Valley lithium wannabes.

Market "Discipline"

As largely a duopoly the Boric Acid market is fairly well-disciplined. Both major parties know what is needed to keep prices in order as they both have their fingers on the pulse of the demand situation, and they are, essentially, the supply side of the market. Smaller players are along for the ride. However, with Fastmarkets now covering Boric Acid pricing, there seems to be enough demand to bring transparency to this critical material.

Thus, prices and supply are fairly evenly balanced and if anything looks certain it is that they wish to see gradualist price moves, without any spikes or plunges. This is essentially how cartels work, though we would not call two participants that think alike to necessarily be a cartel.

It is poignant that the Lithium market went totally haywire when the old Lithium "Cartel" broke down in its discipline in 2022-23, due to the entry of a large number of undisciplined players.

Over and beyond the supply/demand balance we wonder whether the potential new players will "follow the lead" of Rio Tinto and EtiMaden on maintaining price discipline, or not, should they get into production.

The Listed Companies

Since Borax Argentina exited Orocobre/Allkem's grasp back into private ownership, the universe of listed Boron producers has been reduced to 5E Advanced and the behemoth diversified miner, RTZ.

There are a number of other wannabes in the Boron space. Boron One, snapped out of a multidecade somnolence and lifted its game at its Piskanje project in Serbia. Then there is **Euro Lithium**, a privately-owned Canadian company, not to be confused with European Lithium, has the Valjevo project (in close proximity to Belgrade, the capital of Serbia). This was halted by local resident actions in late 2021.

Ioneer (ASX: INR | NASD: IONR) that has the Rhyolite Ridge project in Nevada has a resource showing

some 14mn tonnes of contained Boric Acid and it has an ambitious timeline showing production by 2026. The Boron component of its deposit grades at 0.685%. This is dramatically less than the grades of the two companies we focus on in this note. Its progress towards production is predicated by Lithium factors rather than a boron-focus. It also needs to pass various permitting hurdles.

Balkan Mining & Metals (BMM.ax) might have merited greater coverage here but it has become distracted with Ontario & Quebec lithium projects, provinces where we have often signalled our scepticism on the Lithium (production) potential. The eponymous asset of BMM is in Serbia but has seemingly been relegated to the backburner. The Rekovac project area is located 110 km away from Belgrade, in the south of the country. The project is comprised of three separate licences (Rekovac, Ursule and Sikovac) with an aggregate land area of 273km^2 and is located within the Vardar Zone.

Important disclosures

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