Uley graphite deposit

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Introduction

The Uley Mine, which is sited in the very large Mikkira graphite resource, has been developed in a high-grade flake graphite occurrence 22 km southwest of Port Lincoln on southern Eyre Peninsula in the Gawler Craton. The Uley deposit occurs in Precambrian schist and gneiss; the best developed mineralisation occurs in conjunction with pegmatites and folding.

Eagle Bay Resources NL now holds a 100% interest in the Mikkira resource, which includes the prospects shown on Figure 1, and owns the 20 000 t/year treatment plant at the mine site. The mine and plant are currently non-operational and under care and maintenance.

History of mining

Between its discovery in the late 19th century and the late 1950s, production from the deposit was by spasmodic underground mining, principally during the war years. CRAE explored the Mikkira resource and discovered significant quantities of flake graphite (385–400 Mt at 6–7% fixed carbon (FC)) in 1981 but deemed it to be uneconomic to develop at the time. In 1988, Solution Mining Pty Ltd, later a wholly owned subsidiary of Eagle Bay Resources NL, acquired the project from CRAE for 5% royalty and a cash payment of $3 million. By 1990, the company had established an on site pilot ore treatment plant, mined ore from an open cut for three months, then produced ~160 t of +194 grade graphite over eight weeks at the plant.

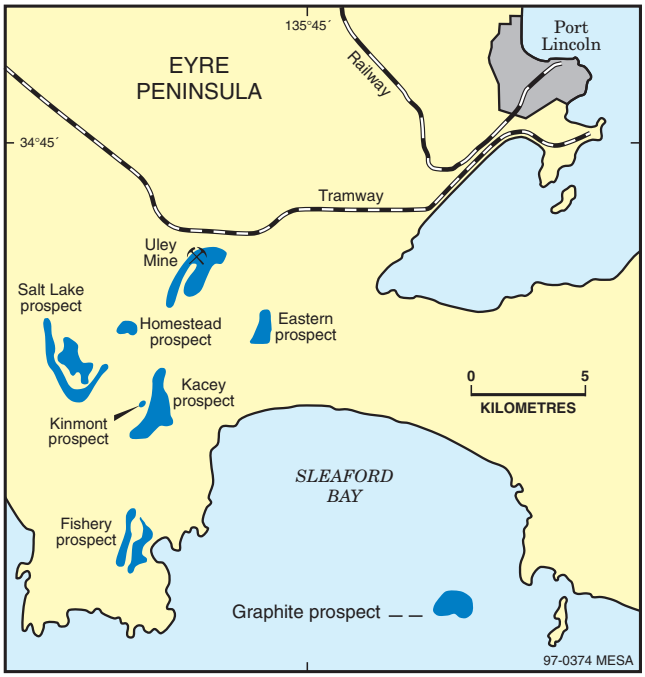


Fig. 1 *Location of the Uley Mine and other prospects in the Mikkira graphite resource, southern Eyre Peninsula.*

There followed a JV agreement between Eagle Bay and Pittston Mineral Ventures (Aust.) Pty Ltd to upgrade the mine and treatment plant to facilitate production of 14 000 t/year of processed flake graphite. Break even for the operation was considered ~4000 t/year of graphite sales, depending on grade and quality. Sales commenced in November 1992. The product gained accreditation as a result of end user quality testing, and sales were made to BHP Newcastle in Australia and to markets in Japan, Europe and USA. By December 1994, Pittston had invested ~$14 million in the JV and had established a high-grade area, sufficient for 10 years production, with a measured and indicated *in situ* resource of 2.87 Mt at 13.4% FC including 1.49 Mt at 15.3% FC (Rowe, 1993).

In September 1996, Pittston commenced negotiations which ultimately led to the entire project being returned to Eagle Bay Resources. It was agreed that Eagle Bay would acquire freehold title to the property, the ore treatment plant and all mineral leases free of debt and encumbrances.

Open cut at the Uley graphite mine. (Photo 44428)

Uley graphite treatment plant. (Photo 44427)

Ore treatment

During production, Uley graphite was open-cut mined and treated in the plant near the mine site. The ore was crushed, ground, screened and classified through a cyclone. A primary stage rod mill was used in open circuit during the process.

Flotation beneficiation of coarse and fine grades preceded drying, bagging and storage. A range of flake sizes with purities up to 95% FC were produced; fine flake (<100 mesh or 125 µm) was consigned to a tailings dam.

Pittston commissioned NGS Naturgraphit GmbH in December 1993 to prepare a 'Report on examinations of Uley flake graphite soft and hard ore samples'; Eagle Bay Resources commissioned a 'Secondary beneficiation and chemical purification of Uley graphite' study that was completed by Darragh (1993) in Western Australia. The latter produced 99.93% pure graphite in a single step process.

Data from the NGS report show that product moisture, volatile matter and ash content were low, constant and therefore favourable. The treated ore did contain low quartz and feldspar grain impurities and inter-lamina iron oxide (predominantly goethite) contaminant. There was also a high lime content associated with much of the ore mined and typical flake contains ~2% calcium carbonate. Tables 1 and 2 indicate the treated ore product grades and average composition of impurities in the highest grade product.

Table 1 *Uley graphite product description and price (1993).*

Grade	A$/t	Grade	A$/t
+594	1554	+193	824
+592	1351	+192	703
+590	1216	+190	649
+585	1162	+185	541
+894	1081	+15090	527
+893	946	+12087	477
+892	878	-195	642
+890	811	-193	554
+885	608	-190	426
+195	1014	-185	405
+194	946		

Example: +594 grade describes product with 80% of flake particle size greater than 250 µm (50 mesh) and containing a minimum of 94% FC.

Table 2 *Typical averaged analytical results describing fixed carbon component and product residue of +594 grade Uley product.*

	% from	% to
Carbon	95.6	97.8
	Residue	
Ash	4.59	
Volatiles	1.50	
S	0.18	0.11
SiO_2	47.65	50.88
Al_2O_3	27.15	27.30
Fe_2O_3	14.96	15.23
TiO_2	0.98	1.03
P_2O_5	0.35	0.42
CaO	1.32	1.98
MgO	1.95	3.36
Na_2O	0.50	0.85
K_2O	1.52	1.89
SO_3	0.16	0.54
MnO_2	Tr	

Properties of graphite

Graphite, coal and diamond are three naturally occurring forms of carbon. While graphite occurs naturally in amorphous (microcrystalline) and crystalline forms, properties of the more commonly occurring amorphous graphite are such that it is less useful for a wide range of industrial purposes than is the crystalline product. Crystalline graphite occurs as vein, flake or powder deposits.

Large flake exhibits a range of chemical properties which makes it a versatile commodity. Its high temperature strength and resistance to thermal shock make it useful for the manufacture of refractory bricks used in steel production, while properties of high conductivity and a low coefficient of friction are utilised in the manufacture of electrical products and lubricants.

Markets

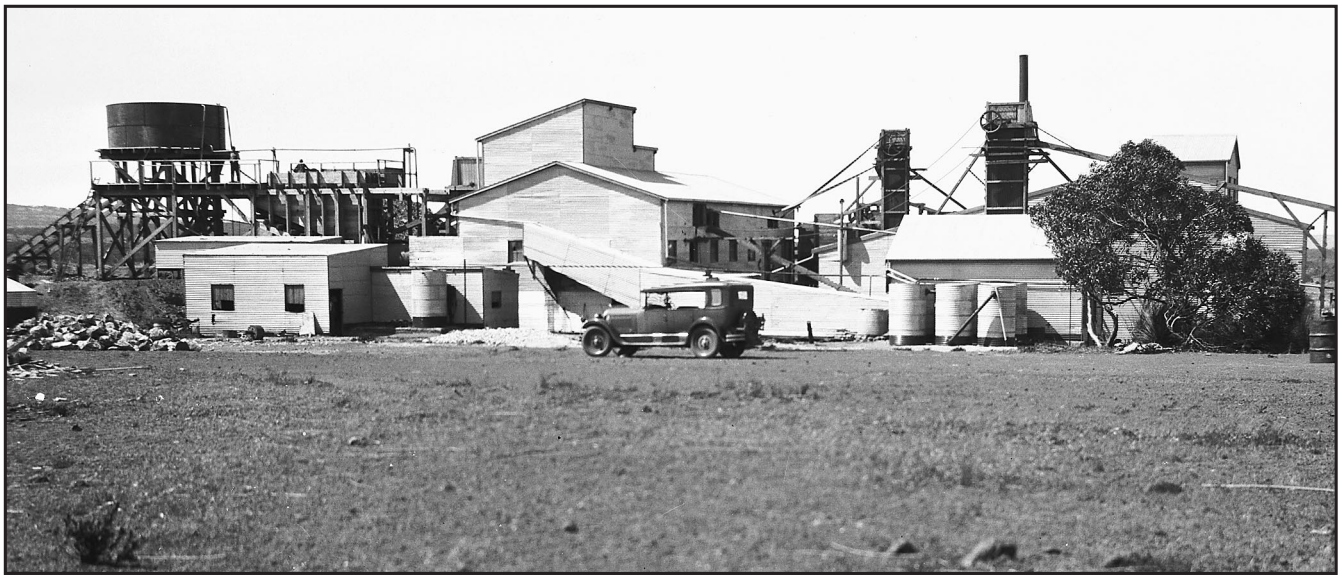
The world's major supplier of graphite is China, where non-mechanical mining and processing has created end user resistance due to problems in final product grading and purity. World coarse flake graphite consumption currently fluctuates at ~220 000 t/year, with the price ranging from $400/t for 94% purity flake to $3700/t for ultra high purity flake used in anode production.

With the Pittston JV, Eagle Bay had the association of a company with financial capacity to successfully conduct the project and who were also a major USA supplier of metallurgical grade coal to the steel industry, the prominent graphite consumer. In the period following 1993, which ushered in depressed world prices for graphite, difficulties were encountered in developing markets sufficient to sustain production from Uley at a level considered viable by Pittston, given their large capital investment. While in production however, they established markets with BHP Newcastle and obtained product accreditation and sales in Japan, Europe and USA.

Product potential and opportunities for value adding

Natural graphite has traditionally been used in:

- Refractories industries — steel furnaces
- Crucibles — foundry steel production



Uley graphite mill and refinery in 1928. (Photo n1640)

- Anodes — electric arc steel furnaces
- Recarburisation and hot topping — steel production
- Non-ferrous industries foundries — glass
- Powder metallurgy
- Pharmaceuticals and explosives
- Artificial diamond production
- Carbon brush and bearing manufacture
- Paints — industrial paints and pigments
- Batteries
- Lubricants
- Friction materials — disc brakes
- Pencils and art supplies
- Expanded graphite foil for gaskets
- Composite graphite epoxy.

Carbon anodes

Australia is currently the world's largest exporter of bauxite, and consumes 500 000 t/year of high-quality anode carbon in the aluminium refining process. The aluminium industry in the Eastern States is currently sponsoring CSIRO research to develop the technology for production of anodes using ultra clean coal.

Carbon, semi-graphite and graphite electrodes are also used to produce steel from scrap iron using the increasingly popular electric arc furnace methods. A major component of these anodes is imported petroleum-derived coke, and the annual consumption of ~800 000 t of graphitised electrodes is valued at A$3000–5000/t.

As natural graphite has a number of properties desirable for anode production which are not duplicated to the same extent in artificially produced graphite from either petroleum coke or ultra clean coal, it is possible that ultra pure graphite from Uley may be used in this role. Were the technology developed to produce superior anodes using 100% or a blend of high purity graphite, then a substantial new local market for natural graphite would be available.

Current developments

A low level of activity initially followed the return of the Uley project to Eagle Bay Resources but its management were always optimistic for a revival of production at the site. While it was conceded any rapid or short-term development would depend on increased demand and firmer world prices for graphite, it was also considered necessary to continue efforts to establish markets that would sustain a viable level of mining and ore treatment.

Operations at Uley are presently at a low level but have included the review completed in May 1993 for $3 million of expenditure to optimise the open-cut mining operation. Eagle Bay is also considering further research initiatives using CSIRO Coal and Energy Division's research group on coal and carbon products at North Ryde in NSW. The Division has previously expressed interest in researching product development for Uley graphite.

Negotiations are underway to supply some previously established clients and enquiries have been initiated to supply a number of new overseas markets. Recent developments include negotiations with a Japanese company that has expressed interest in financing the recommissioning of the mine and treatment plant under a JV agreement.

Acknowledgement

This paper has been prepared with permission of Eagle Bay Resources NL.

For further information contact Tony Rechner, Eagle Bay Resources NL (ph. 09 481 3322).

References

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