



Australian Resource Reviews

Graphite 2018

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Resource figures are current as at 31 December 2017.

Graphite is a soft, black, lustrous mineral composed of carbon in a hexagonal crystalline structure. It is found in three different forms: in high-grade metamorphic rocks as disseminated crystal flakes; in veins or fractures as vein graphite; and in thermally metamorphosed coal deposits as amorphous graphite.

Graphite is a good electrical conductor and has a high fusion point and good lubricating properties. It is used as an anode in batteries, as a refractory material in industries producing molten metal for crucibles and blast furnace linings, and to replace asbestos in brake shoes for heavier vehicles. Graphite is also used in pencils.

JORC Reserves

Ore Reserves of graphite amounted to 1.05 Mt in 2017 (Table 1) and are attributable to the McIntosh project in Western Australia and the Uley and Kookaburra Gully projects in South Australia.

Table 1. Australia’s Ore Reserves of graphite as at December 2017.

Ore Reserves (Mt)		
Proved	Probable	Total
0.06	0.99	1.05

Mt = million tonnes.

Identified Resources

Australia’s Economic Demonstrated Resources (EDR) of graphite were estimated to be 7.14 Mt in 2017, a 636% increase on the 0.97 Mt last reported in 2013 (Table 2). Australia’s EDR of graphite occur across three states (Table 3): South Australia (4.72 Mt), Queensland (1.32 Mt) and Western Australia (1.10 Mt). Graphite deposits with reported EDR include Uley, Oakdale, Siviour, Kookaburra Gully and Campoona, all in South Australia; Mount Dromedary in Queensland; and Longtom, Munglinup, Wahoo and Emperor, all in Western Australia.

Inferred Resources of graphite have significantly increased by 460% from 1.08 Mt in 2013 to approximately 6.05 Mt in 2017 (Table 2). Deposits with Inferred Resources include those listed above, with the exception of Munglinup; Koppio and Wilclo South, both in South Australia; Burke in Queensland; and Barracuda and Yalbra, both in Western Australia.

Accessible EDR

Some mineral resources are inaccessible for mining because of environmental restrictions, government policies or because they occur within military lands or national parks. All of Australia’s EDR of graphite are considered to be accessible.

Table 2. Australia's identified resources of graphite 2013 and 2017.

Year	Australia					World		
	Demonstrated Resources (Mt)			Inferred Resources ² (Mt)	AEDR ³ (Mt)	Mine Production (Mt)	Economic Resources ⁴ (Mt)	Mine Production ⁴ (Mt)
	EDR ¹	Paramarginal	Submarginal					
2017	7.14	0.06	0	6.05	7.14	0	270	1.20
2013	0.97	0	0	1.08	0.97	0	130	1.11

Mt = million tonnes.

1. Economic Demonstrated Resources (EDR) predominantly comprise Ore Reserves and most Measured and Indicated Mineral Resources that have been reported in compliance with the Joint Ore Reserves Committee (JORC) Code to the Australian Securities Exchange (ASX). In addition, some reserves and resources have been reported using other reporting codes to foreign stock exchanges and Geoscience Australia may hold confidential data for some commodities.
2. Total Inferred Resources in economic, subeconomic and undifferentiated categories.
3. Accessible Economic Demonstrated Resources (AEDR) is the portion of total EDR that is accessible for mining. AEDR does not include resources that are inaccessible for mining because of environmental restrictions, government policies or military lands. All graphite EDR is accessible.
4. Source: United States Geological Survey (Mineral Commodity Summaries)¹.

Table 3. Identified resources of graphite in Australian jurisdictions as at December 2017.

Jurisdiction	Demonstrated Resources (Mt)			Inferred (Mt)
	Economic	Paramarginal	Submarginal	
Queensland	1.32	0	0	1.61
South Australia	4.72	0	0	3.43
Western Australia	1.10	0.06	0	1.01
Total Australia	7.14	0.06	0	6.05

Mt = million tonnes.

Exploration

Future demand for graphite is projected to be high as interest in battery-storage technology rises. This is evident by the increase in exploration activities over recent years that has resulted in a 636% increase in national EDR since 2013. Increased reports of project technical studies being underway also indicates advances in development activities. Examples include:

- the completion of a prefeasibility study in early 2018 for Siviour;
- the granting of mining tenements for the Campoona Shaft graphite project;
- the successful completion of a scoping study for Munglinup in late 2017 and the subsequent prefeasibility study reported in May 2018; and
- the successful completion of an exploration programme at the Burke Graphite Project in Queensland, including nine reverse circulation holes and a diamond core hole totalling 735 m.

¹ <https://minerals.usgs.gov/minerals/pubs/commodity/graphite/index.html#mcs>

Production

Soon after receiving state regulatory approval in 2014, the Uley mine restarted graphite production with its first shipment of approximately 20 t of flake graphite from Port Lincoln in South Australia. However, operations at the mine were short lived with the then operator (Quantum Graphite Ltd) reporting their suspension in December 2015 due to processing and bottleneck issues at the processing plant. The operation remains on care and maintenance.

World Ranking

According to the United States Geological Survey, world production of natural graphite in 2017 was 1.200 Mt (Table 4). The major producers were China (0.780 Mt of graphite), India (0.150 Mt), Brazil (0.095 Mt), Canada (0.030 Mt) and Mozambique (0.023 Mt). The largest economic resources of graphite are located in Turkey (90 Mt), followed by Brazil (70 Mt) and China (55 Mt). Australia ranks seventh in the world for economic resources of natural graphite (Table 5).

Table 4. World production of graphite (natural) 2017.

Rank	Country	Graphite (Mt)	Percentage of world total
1	China	0.780	67%
2	India	0.150	13%
3	Brazil	0.095	8%
4	Canada	0.030	3%
5	Mozambique	0.023	2%
6	Russia	0.019	2%
7	Ukraine	0.015	1%
8	Pakistan	0.014	1%
	Others	0.046	<4%
	Total	1.200	

Notes

Mt = million tonnes.

Source: United States Geological Survey². National figures other than Australia are rounded, as is the final total. Percentages are also rounded and might not add up to 100% exactly.

Table 4. World economic resources of graphite (natural) 2017.

Rank	Country	Graphite (Mt)	Percentage of world total
1	Turkey	90.0	33%
2	Brazil	70.0	26%
3	China	55.0	20%
4	Mozambique	17.0	6%
5	Tanzania	17.0	6%
6	India	8.0	3%
7	Australia	7.1	3%
8	Mexico	3.1	1%
9	Madagascar	1.6	1%
	Total	270	

Notes

Mt = million tonnes.

Source: United States Geological Survey². National figures other than Australia are rounded, as is the final total. Percentages are also rounded and might not add up to 100% exactly.

² <https://minerals.usgs.gov/minerals/pubs/commodity/graphite/index.html#mcs>

Industry Developments

Queensland

Burke: In the last quarter of 2017, Strike Resources Ltd reported a maiden JORC Inferred Resource estimate of 6.3 Mt at 16% TGC, resulting from its exploration drilling programme at its Burke graphite project. Burke is located at Mount Dromedary in the Cloncurry region of north Queensland. As mapped by the Queensland Department of Natural Resources and Mines, Burke graphite mineralisation is hosted by graphitic schist as a sub-unit of the Corella Formation within the Mary Kathleen Group and is of Proterozoic age. The company report states that the graphitic schists within the Burke tenement are intruded by the Black Mountain gabbro and sills (1685-1640 Ma) with subsequent metamorphism to amphibolite grade during the Isan Orogeny (1600-1580 Ma). Similarly, the project's Corella tenement also covers a sequence of mapped graphitic schists within the Corella Formation which have been intruded by gabbro dykes and sills and with subsequent metamorphism to amphibolite grade during the Isan Orogeny.

South Australia

Campoona: Archer Exploration Ltd has advanced the development of its Campoona graphite deposits on the Eyre Peninsula in South Australia since the completion of a 2016 scoping study. The study was based on mining and production of graphite mainly from the Campoona Shaft and Campoona Central deposits at a projected capacity rate of 3312 tonnes per annum (tpa) of graphite concentrate in the first three years of operation. Highlights during 2017 included favourable technical studies of product suitability in battery technology and the granting of mining lease approval by the South Australia government in late 2017.

The project is located near the township of Cleve, which is approximately 120 km southeast of Whyalla, South Australia. The

Campoona graphite mineralisation occurs within the graphitic schist unit of the Hutchison Group sequence on the eastern Eyre Peninsula in South Australia.

Kookaburra Gully: In late 2017, Lincoln Minerals Ltd announced a positive economic outcome for its feasibility study into its Kookaburra Gully graphite project. The study was based on an ore capacity rate of 250 000 tpa to produce approximately 35 000 tpa of flake graphite concentrate. The study estimated the project's JORC Probable Ore Reserve at 1.34 Mt at 14.6 % TGC. The mining lease granted for the project enables the company to commence production in 2019. The Kookaburra Gully graphite deposit is located 35 km north of Port Lincoln and occurs within the Palaeoproterozoic Hutchinson Group metasediments on the eastern Eyre Peninsula of South Australia.

Siviour: Renascence Resources Ltd reported in March 2018 the completion of the Siviour graphite project's pre-feasibility study and its maiden JORC Ore Reserves of approximately 45.2 Mt at 7.9% TGC. The company stated that the study results offered numerous development options, including an immediate large-scale production or a low start-up capital two-staged development approach with a small-scale operation for three years prior to transitioning to a large-scale production. These options are available to the company for consideration as the project proceeds to the definitive feasibility study stage. The study's large-scale option was for 142 000 tpa of graphite concentrate production with a 30-year mine life.

The Siviour graphite project is located on South Australia's Eyre Peninsula, approximately 15 km west of the coastal township of Arno Bay, 120 km northeast of Port Lincoln and 150 km southwest of Whyalla. Pelitic schists within the Mesoproterozoic sediments of the Hutchinson group host Siviour's graphite mineralisation.

Western Australia

McIntosh: Hexagon Resources Ltd reported the completion of its McIntosh flake graphite project's pre-feasibility study, which confirmed the project's technical and financial viability. As part of this study, the company reported maiden JORC Probable Ore Reserve of approximately 11.9 Mt at 4.3% total graphite content (TGC) for 0.512 Mt of contained graphite. In May 2017, the company reported McIntosh project's total JORC Mineral Resources amounted to approximately 21.3 Mt at 4.5% TGC for 0.959 Mt of contained graphite.

The McIntosh graphite project is approximately 100 km north of Halls Creek in the East Kimberley region of Western Australia. The project comprises the **Emperor, Longtom, Wahoo** and **Barracuda** deposits which occur in the Paleoproterozoic Lamboo Province of the Halls Creek Orogen. The graphite mineralisation is stratigraphically hosted by the Tickalara Metamorphic, which extends for approximately 130 km along the western side of the major Halls Creek Fault.

Munglinup: Mineral Commodities Ltd reported the Munglinup graphite project's pre-feasibility study results proved the technical and economic viability of the project, giving weight to the company proceeding to the next phase. The development will occur at the project's five mineral deposits, namely **Halberts Main, Halberts South, Harris, McCarthy East** and **McCarthy West**. The study was based on a production capacity rate of approximately 54 800 tpa of graphite concentrate. Initial JORC Reserves of approximately 3.44 Mt at 15% TGC was estimated as the premise of the study.

The project is located 105 km from Esperance in Western Australia. The company notes that the Munglinup area comprises Archean to Paleoproterozoic, metamorphosed granitic and other metamorphic rocks of the Albany–Fraser Orogen, typically hornblende (\pm garnet) gneiss and migmatite. Within the gneissic rock mass, rocks containing the Munglinup graphite deposits consist of a succession of tightly folded metasedimentary rocks with a consistent dip to the southeast.

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