

## REE, lithium, potash, and phosphate mineralization in Western Australia

by DJ Flint

### Rare earth elements

The not-so-rare rare earth elements (REE) have become strategically important globally — the former Chinese premier, Deng Xiaoping, once said ‘The Middle East has oil. China has rare earths’ (Dowling, 2010). Along with many other uses, REE are components of many modern electronic products including flat-panel displays, hard-disk drives and iPods. China currently supplies 95% of the world’s rare earths, but is restricting supply. New significant resources to supply the rest of the world in the near term are limited, and Western Australia (via the Mount Weld REE–tantalum–niobium–phosphorus project) is positioned to meet the growing demand (and expected supply shortage) for these elements. The Mount Weld REE–Ta–Nb–P carbonatite was discovered in 1988 and partly developed in 2008, but problems with continuity of funding arose during the global economic crisis in early 2009. Control of the project owners — Lynas Corporation Ltd — almost passed to the China Nonferrous Metal Mining Group, but was refused by the Australian Foreign Investment Review Board. The Central Lanthanide deposit at Mount Weld is estimated to contain resources totalling 12.2 Mt at 9.7% REO at a cutoff grade of 2.5% REO, yielding 1.18 Mt of contained REO. The Central Lanthanide deposit contains predominantly light REO from CeO<sub>2</sub> (46.7%), La<sub>2</sub>O<sub>3</sub> (25.5%), Nd<sub>2</sub>O<sub>3</sub> (18.5%), Pr<sub>6</sub>O<sub>11</sub> (5.32%), Sm<sub>2</sub>O<sub>3</sub> (2.27%), to Eu<sub>2</sub>O<sub>3</sub> (0.44%), together with minor proportions of heavy REO: Dy<sub>2</sub>O<sub>3</sub> (0.124%), and Tb<sub>4</sub>O<sub>7</sub> (0.07%) (Lynas Corporation, 2010). Other known REE prospects and their settings include Cummins Range (carbonatite intrusion), Cundelee (alkaline ultramafic intrusion with carbonatitic affinities), Brockman (trachyte and related tuffs), Yangibana (dykes and sills of carbonatite and fenitized rocks, with iron oxide veins containing uranium and REE; Pirajno, in prep.), and John Galt, which is xenotime in lithic quartz sandstone of the Proterozoic Red Rock Formation (Fetherston, 2008).

### Lithium

The light metal lithium is another commodity in high demand in recent times, with interest particularly driven by its use in lithium-ion batteries for electric vehicles (broadly speaking, the mobile energy storage industry). Western Australia has a long history of lithium production from spodumene pegmatites at Greenbushes and Ravensthorpe

(Mount Cattlin). Talison Lithium Ltd, from mining at Greenbushes, is the world’s largest producer of lithium minerals. The Greenbushes pegmatite contains up to 50% spodumene, but averages 3.5%–4.5% Li<sub>2</sub>O. Recent annual production of spodumene concentrate from Greenbushes is at the rate of approximately 200 000 tpa of various grades; low-grade products are of >5.0% and >6.0% Li<sub>2</sub>O, with a high-grade product of >6.4% Li<sub>2</sub>O (Miller, 2009). Much of Western Australia’s past production of spodumene was treated in China to produce lithium carbonate — for feedstock for the chemical industry. This is the same route being taken for the new Mount Cattlin lithium–tantalum mine owned by Galaxy Resources Ltd. The mine, which is under construction, has global resources totalling 14.4 Mt at 1.08% Li<sub>2</sub>O and 153 ppm Ta<sub>2</sub>O<sub>5</sub> (Galaxy Resources, 2010). In late 2009, Haddington Resources Ltd announced the discovery of a lithium–tantalum pegmatite, with rock-chip sampling results up to 5% Li<sub>2</sub>O. The discovery was in the Pilbara at Pilgangoora, in the vicinity of historic tin–tantalum mining (Haddington Resources, 2009). About 80% of the world’s lithium is obtained from continental salt-lake brines in South America, and Australia’s first lithium of this style was found by Reward Minerals Ltd in 2008 at Dumbleyung, extraordinarily while exploring for potash. The brines contain 530 mg/L lithium and 1000 mg/L potassium (Reward Minerals, 2009), with the lithium grade comparable to the average resource grade of the Atacama (Clarke, 2009). Western Australia also has potential for lithium-rich clay (hectorite) in a similar setting as bentonite, that is, as secondary clays in paleodrainage channels and lacustrine environments.

### The fertiliser elements — potassium and phosphorus

Australia currently does not produce potassium minerals and imports about 50 000 t of potassium sulfate annually. Australia moved a big step closer to its first potassium mine after the discovery by Reward Minerals Ltd – Holocene Pty Ltd in 2006 of potassium-rich brine at Lake Disappointment, 300 km east of Newman, with average brine grades of around 3.17% K<sub>2</sub>SO<sub>4</sub> (Fetherston, 2008). However, 2009 was disappointing as agreement could not be reached with the Martu people, the Native Title Tribunal decided against the grant of a mining lease, and an appeal to the Commonwealth Attorney General was unsuccessful (Gregory, 2009).

Potassium is found within evaporitic sequences, either in modern playas such as Lake Disappointment, Lake Auld (450 km east of Newman), and Lake Mackay (bordering the Northern Territory) or in older buried evaporitic sequences, such as the Yaringa Evaporite Member of the Dirk Hartog Formation (Southern Carnarvon Basin). Reward Minerals now has substantial inferred resources at Lake Mackay (20 Mt of contained  $K_2SO_4$ ). Historically, Western Australia has produced potassium from alunite (potassium aluminium sulfate) at Lake Chandler (near Merredin) during the 1940s and the deposit is currently being assessed by ActivEX Ltd.

There are 85 sites of known phosphorus mineralization in Western Australia, in addition to the indurated guano (rock phosphate) of Christmas Island. The geological settings of these sites range from apatite within carbonatite and in overlying regolith (e.g. Mount Weld, Cummins Range), phosphate nodules in marine sediments (e.g. Langey Crossing and Liveringa in the Paleozoic of the Canning Basin; at Cardabia and Wandinny Dam in the Cretaceous of the Carnarvon Basin south of Exmouth; and at Wagon Creek in the Paleozoic Southern Bonaparte Basin), glauconite in marine sandstones near Dandaragan (North Perth Basin), variscite in hydrothermal veins (Mount Deverell in the Edmund Basin), apatite in layered mafic-ultramafic intrusives (Balla Balla in the Pilbara), and recent guano from sea birds, bats, and even wallabies (found in Jingemia Cave and Jurien Bay Cave). All have been variously explored and some are marginally economic. The deposit most likely to be mined first is Balla Balla, where the apatite is a potential by-product to the iron-vanadium-titanium magnetite mineralization.

## References

- Clarke, G 2009, Lithium surveys market horizons: Industrial Minerals, April 2009, p. 42–51.
- Dowling, S 2010, China's rare earth strategy: downloaded 18 January 2010 <<http://stephendowling.wordpress.com/2010/01/03/chinas-rare-earth-strategy/>>.
- Fetherston, JM 2008, Industrial minerals in Western Australia: the situation in 2008: Geological Survey of Western Australia, Record 2008/16, 70p.
- Galaxy Resources Limited, 2010, Galaxy increases Mt Cattlin resource and mine life: Australian Stock Exchange announcement, 20 January 2010, 5p.
- Gregory, M 2008, 'Good faith' negotiations under the 'Native Title Act': A case summary: AMEC Explorer, November 2009, 4p.
- Haddington Resources Ltd 2009, New lithium discovery — Pilbara region, Western Australia: Australian Stock Exchange announcement, 9 October 2009, 6p.
- Lynas Corporation Ltd 2010, Investor Presentation: 21 January 2010, 37p.
- Miller, D 2009, Talison and the role of minerals in the lithium industry: Lithium Supply and Marketing Conference presentation, Santiago, Chile, 26–28 January 2009.
- Pirajno, F in prep., Gifford Creek Carbonatite Complex: Geological Survey of Western Australia, Record.
- Reward Minerals Ltd 2009, Lithium target – tenement application: Australian Stock Exchange announcement, 26 August 2009, 2p.

## What do the changes to the approvals processes mean to the minerals exploration and mining sector?

by

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The State Government has made a commitment to streamline approvals processes in order to put Western Australia on par with leading jurisdictions across the world as a destination of choice for responsible resources exploration and development.

All key approvals agencies have been tasked to translate this commitment into practical improvements to their processes to provide a more efficient and transparent approvals system that is easy to understand and navigate, and provides greater certainty, responsiveness, and coordination.

This brief summarizes the projects and priorities for reform in a number of areas across the Department of Mines and Petroleum (DMP).

The focus has been in four main areas:

- Further development of regulatory tracking systems to identify opportunities for improvement and improve certainty of process for proponents;
- Revision of inter-government agreements with other agencies to ensure a more responsive and coordinated approach across government;
- Improved guidance materials for project proponents; and
- Legislative amendments.

This work has been informed by close consultation with industry, both directly by the Department, and through an Industry Working Group that was established by the Minister for Mines and Petroleum to provide strategic advice on approvals reform. A report by the Industry Working Group was tabled in the Legislative Council in August 2009. Its recommendations have made an important contribution to the decisions that the Government has so far made on approvals reforms.

In October 2009, the Government announced significant reforms including a new lead agency framework, greater independence for the WA Environmental Protection Authority, and a suite of legislative changes to streamline approvals systems. These changes are supported by the work DMP has undertaken to date to improve its processes.

DMP is the designated lead agency for the regulation of mining, petroleum, uranium, geothermal, and carbon capture and storage activities. The lead agency role is to

help the proponent through the approvals processes across government. It is intended to provide a level of service appropriate to the scale and significance of the application or project. The lead agency framework guidelines are available on the DMP website:

[http://www.dmp.wa.gov.au/documents/3Lead\\_Agency\\_Guidance\\_Document.pdf](http://www.dmp.wa.gov.au/documents/3Lead_Agency_Guidance_Document.pdf)

DMP is also participating with the Commonwealth and other jurisdictions in the process to respond to the Productivity Commission Review of the Regulatory Burden on the Upstream Petroleum Sector. It agrees with many of the recommendations of this Review, which mirror the steps already being taken in WA to streamline approvals and improve regulatory practice. However, it does not support the establishment of a new national offshore petroleum regulator in Commonwealth waters off the WA coast, which would remove the State from its current shared regulatory role in relation to this very significant industry.

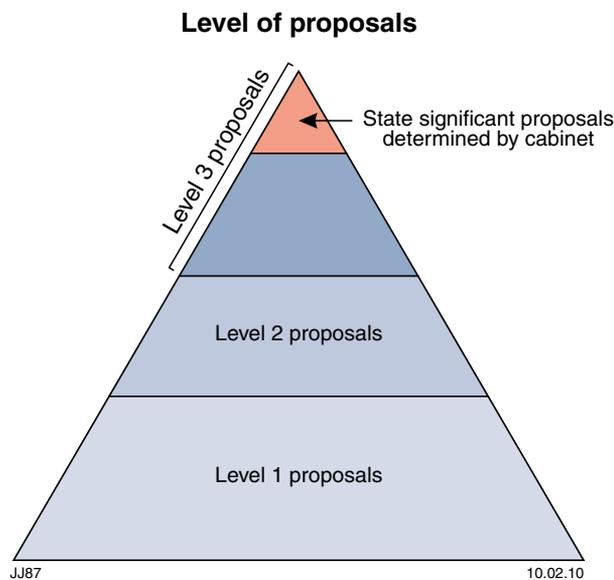
DMP's key projects and priorities for improving its approvals processes are:

### *Regulatory tracking systems*

During 2009, DMP developed and delivered new online systems to provide approval tracking and online lodgement services for the mining industry. Proponents can now access DMP systems through the website. These systems show whether a mining tenement application, exploration or mining activity application is under assessment by DMP or another agency, if it is on hold, and whether it has been approved, rejected, or withdrawn from the process. Proponents can print online reports of their project approval status. DMP has worked closely with proponents in the development of these systems. The feedback from proponents has been positive. DMP will continue to work with industry during 2010 to further enhance the functionality of our online systems. At a whole of Government level, an approval tracking system is being developed to allow approvals to be tracked across government agencies outside of the resource sector.

### *Inter-agency agreements*

DMP is reviewing existing approval arrangements between other key approval agencies to further streamline approval processes. New working arrangements are being developed



*Figure 1. Notional representation of proposals in each level*

between DMP and the Department of Indigenous Affairs, Department of Environment and Conservation, and the Environmental Protection Authority. In June 2009, a new Memorandum of Understanding (MOU) was signed between EPA and DMP. This, together with a revised schedule, provides more recognition of the controls under the Mining and Petroleum Acts for handling resources applications as well as clarity as to what projects will be referred to EPA thereby improving certainty for industry. Industry was consulted in the development of the new MOU.

### **Guidance materials**

DMP has embarked on a series of administrative initiatives to streamline resource sector approval processes including new checklists and guidelines for key approval processes. Clear checklists and guidelines promote quality industry applications. High-quality applications reduce overall approval timelines. Revision of DMP guidelines for key approval processes is ongoing. DMP has also published target timelines and approval performance measures for key mining and petroleum approvals. These performance measures published quarterly show a trend of improved performance across 2009. They are available on the DMP website.

### **Legislative amendments**

A series of legislative amendments to relevant Acts aimed at streamlining approval requirements have been tabled in Parliament. The Approval and Related Reforms No. 1 (Environment) Bill and the Approval and Related Reforms No. 2 (Mining) Bill 2009 provides amendments to remove duplicative and redundant appeal points, clarify the requirements of Section 41 'Implementing a proposal', provide for the lodgement of mineral tenements at any mining registrar within the State, and clarify mine-closure planning requirements. This will further streamline approval processes and add more certainty to the process.

### **Lead agency arrangements**

In implementing the lead agency framework, DMP is offering different levels of service and assistance for proponents depending on the nature and scale of application or applications. Figure 1 represents a notional representation of lead agency service levels. The majority of mining and petroleum tenure and activity applications received by DMP would be characterized by service level one. At this level DMP will ensure clear guidelines and checklists exist, applications are assessed against published target timelines, and proponents have access to online lodgement and approval tracking systems and services. DMP will monitor approval progress and provide pre-proposal consultation advice and support to proponents as required. Where applications cannot be dealt with against published timelines or, for a variety of reasons, where a more urgent assessment is required, a higher level of service will be provided. In addition to normal services, DMP will consult with the proponent and other agencies and may provide a project coordinator to assist with pre-proposal consultation advice, project scoping, issue identification, escalation measures, and resolution strategies. Proposals characterized by applications or proposals that are more complex and require multiple concurrent approvals will be handled with a higher level of service. For example, DMP has assigned a project coordinator to coordinate uranium mining project approval requirements. DMP will, where appropriate, provide a referral and introduction to other relevant departments.