Building on our strengths: adding value to our mineral resources

Australians have long lamented the fact that much of our vast mineral wealth is exported, unprocessed, only for us to buy back the much higher valued finished goods. A priority for CSIRO has been to help Australia capture more of the true value of our resources by processing them here.

CSIRO found a kindred spirit in the founder of Queensland Metals Corporation, Mr Ian Howard-Smith. Mr Howard-Smith had discovered the world's largest deposit of magnesite near Rockhampton. Magnesite is an ore of magnesium, a metal with great potential for the production of light weight alloys for the automotive and aerospace industries. Mr Howard-Smith wanted to process the metal in Australia, which would increase the value of the ore up to ten-fold.

CSIRO has worked with QMC to develop a cost effective processing technology for the magnesite ores in this deposit, using electrolysis. The ore is cleaned and dissolved in hydrochloric acid to produce magnesium chloride, which is then purified, dehydrated and electrolysed. The magnesium and chlorine separate, leaving hot magnesium metal and chlorine gas. The research has focused on optimising the production processes of the magnesium chloride feedstock, on the dehydration processes and on the efficiency of the electrolytic cell. The process developed is very low cost compared to other available technology and the electrolytic cell is the most powerful magnesium cell available.

CSIRO also wants to go one step further and start fabricating magnesium alloy parts for both the aerospace and automotive industries in Australia, adding even further value to this resource. A great deal of research is going into the diecasting and performance of such alloys to give us an edge in this field. CSIRO is supplying eight magnesium alloy parts for the engine bay of Ford's new PT2000 demonstration car, including the engine mounts. The PT2000 project aims to cut car weight by 40%, without reducing performance. A lighter car means better fuel efficiency and both economic and environmental gains. Ford's recent entry into the project also positions Australia well to win future supply contracts to the company.

Magnesium Metal Project: never losing sight of the project vision

The Magnesium Metal Project (Magmetal) was founded on a dynamic business plan which clearly defined both the commercial and technological vision of the Project. By holding on to this vision, the project movers had kept the Project on track despite some of the traumas arising from building an entire new industry for Australia.

During the 11 years since CSIRO and the Queensland Metals Corporation (QMC) initiated collaborative R&D to establish a new magnesium metal industry in

Australia, the Project experienced the sudden withdrawal of major commercial partners, and some unexpected technical problems.

Patience and persistence have now taken them very close to the ultimate goal of building Australia's first magnesium smelter. Construction of a demonstration plant began in mid-1997, and a full commercial plant costing $700 million is scheduled for construction starting in early 1999. The first batch of 'hot metal' is expected to roll out of that plant in 2002. Plans are also under way to investigate further value-adding activities through the manufacture of magnesium alloy automotive parts.

The business plan

CSIRO's Julian Land, who has been involved with the Project since the early negotiations with QMC, says the business plan was, and still is, progressively refined to adapt to changing market conditions. "The plan presented a persuasive case for the Project and helped clinch agreement from both governments and companies to put in money during the crucial research stage," says Land.

The plan has three basic ingredients:

- Research program – this essentially set out the technology vision, and defined CSIRO's strategic role in developing a cost-effective process of converting magnesite to magnesium metal. After 10 years of intensive R&D that cost the partners $38 million, the Project has patented the innovative Australian Magnesium Process (AM Process), which is expected to make the Australian plant the lowest-cost magnesium producer in the world.

- Marketing plan – this laid out the Project's market potential, and set out the commercial strategies and targets that would underpin its continued viability.

- Working relationships – this set out the respective roles of the collaborators, effectively defining the strategies and outcomes for all those involved in the Project. Each partner's work was placed in perspective of the overall vision, enabling them to keep within sight of the 'big picture' when difficulties arose.

According to Land, the importance of project management procedures, where roles and objectives are well understood, cannot be under-estimated in a long-term project that involves organisations with different structures and interests. "Members of the Magmetal Project team have developed a level of trust that enabled them to bring out, and deal with, troubles as soon as they arose."

"Relationships built up to an extent that people from diverse groups were passionately committed to the Project Team. There's an art to doing this. A person from one company reports to his corporate base, but is actually spending a lot of time and effort on the Project so in practice, he's reporting more to the Team. Care had to be taken to balancing the needs of all parties, and to ensuring that the priorities of all involved are kept aligned," adds Land.

Project origins

The Magmetal Project began in 1986, shortly after QMC discovered the largest deposit in the world of cryptocrystalline magnesite– the purest and most reactive form of natural magnesite – at Kunwarara, Queensland. Recognising the emerging market for light metals particularly in the automotive market, QMC decided from the start to process the magnesite in Australia, instead of exporting the unprocessed mineral. Having chosen the value-adding path, the company approached CSIRO for its leading edge expertise in mineral processing.

The Magmetal Project is just one part of the collaborative arrangement, in which CSIRO conducts a wide range of magnesite-related R&D for QMC. Land says that the magnesite deposit is large enough to support a number of different value-adding projects. These include the production of dead-burned magnesia for use in making refractory bricks; the use of calcined magnesia and magnesium hydroxide for environmental control applications; the development of a low-smoke flame-retardant filler in plastics; and the development of magnesium cements that are light, water-resistant and can bind low-cost waste products.

Among the different projects, magnesium metal had the most exciting potential. Developed countries have begun mandating fuel economy targets for motor vehicles, and light metals, mainly aluminium and magnesium, will play a significant role in meeting the more stringent targets. Lighter-weight automobiles can achieve higher fuel economies, and as a result, aluminium and magnesium alloys are increasingly replacing steel in the manufacture of cars. According to Land, the market for magnesium automotive parts has been growing by up to 20% per year since 1994.

Land: "When the Project first started, we were aiming at establishing a parallel industry to that of the aluminium industry. Today, we believe that we can do better than that. The aluminium sector converts 25% of the metal into products within Australia. The rest is exported as aluminium metal. We should be able to locally process a higher proportion of our metal into car parts. And when the smelter is finally built, we'd be looking at opportunities to convert the metal into other products."

Early problems and opportunities

The ultimate viability of the Project depends on the team being able to build a magnesium smelter of a size that can process the Kunwarara magnesite deposit, economically.

According to Land, this meant that QMC and CSIRO team had to develop a smelting technology to be 'bankable', whereby it would withstand the scrutiny of financiers who are extremely cautious about ground-breaking projects such as this. "To secure a bankable technology, we had two options: we could obtain a license to an established technology, which would readily satisfy financiers because of the blue-chip name behind the technology; or we could develop a new technology from scratch and prove its workability," he says.

Land adds that the magnesium metal industry is relatively small, compared to the aluminium industry, so it was considered that it may be more economic to obtain an existing technology and modify it to Australia's requirements. This meant that while CSIRO was conducting the early technical work on magnesite processing, QMC was simultaneously holding commercial discussions with potential overseas partners who would provide the technology.

Two companies who had the appropriate technology were approached: Norway's Norsk Hydro and Dow Chemical of the US. Project representatives spent a few years talking to both companies, but none came into fruition. Discussions with Dow Chemical went a long way, with a management structure for the proposed enterprise mooted.

Land: "It could have been a very good structure, but Dow decided not to go ahead as it wasn't entirely convinced of the market. A Japanese company, Ube Industries, subsequently showed a lot of interest but it appeared to want a dominant role in the venture. Such a dominance wouldn't give the outcomes that the Project managers had envisaged."

By late 1990, it was obvious that acquiring an established technology was not an option. The Project would have to develop the technology itself. "The problem was that QMC was an SME (small-to-medium sized enterprise) and did not have the financial wherewithal to shoulder the project on its own. It proved difficult to persuade other big companies to support the project. At the same time, we did not wish the Project to be dominated by the Japanese interest who was willing to come in."

Instead, the team decided to approach the Federal Government for R&D funding assistance, through CSIRO. In early 1991, QMC and CSIRO presented the business plan to the Government. They made a case for the potential new industry in Australia; the only barrier was the lack of suitable technology. It was a persuasive plan, and was buttressed by the increasingly clear picture of the emerging market for magnesium metal.

In November 1991, both the Federal and Queensland State Governments agreed to put in a combined $25 million, on a 50-50 funding basis with industry partners, to develop a new, bankable technology. This meant that the Project had to find industry participants to match the $25 million for the R&D effort.

Land: "During our discussions with the governments, we were rather surprised to discover their scepticism about how well CSIRO relates to industry. We were surprised by the attitude; we thought we were accustomed to working with industry, particularly the mining and minerals sector. Our close working relationship with QMC was therefore seen as a plus."

Search for commercial partners

While the governments were considering support for the Project, negotiations were launched with potential industry partners to raise the counterpart funding. Talks were

resumed with Ube Industries, which had maintained its interest in the Project. MIM Holdings also expressed interest, seeing the Project as an opportunity to enter the light metals industry. MIM had missed out on this sector, being the only one of the major mining companies not involved in the aluminium industry.

In June 1992, the deal was sealed for the $50 million total funding to come from the Federal and Queensland governments, Ube and MIM. The $25 million government contribution was channeled through CSIRO, to develop an innovative technology to produce magnesium metal.

Commercial and technical problems

From June 1992, work proceeded well. Land says that a new Project Team was formed, composed of people from the four partners: QMC, CSIRO, MIM and Ube. CSIRO's Malcolm Frost headed the research program, parceling out R&D contracts as technical issues emerged. Several CSIRO Divisions were involved in contract research, including the Divisions of Minerals, Mineral and Process Engineering; Manufacturing Technology; Mathematics and Statistics; Coal and Energy Technology; and Building, Construction and Engineering.

Land, who looked after the commercial side of the Project for CSIRO and was involved in negotiations with the governments and commercial partners, also kept a close link with the Project Team by serving on its management committee.

Then in 1994, both Ube and MIM suddenly withdrew from the Project. Both were going through strategic changes in their operations and were selling off non-core businesses. "It was sad, disappointing and traumatic," recalls Land. "We agreed to part company, but QMC and CSIRO were committed to see the Project through. Looking back, it was the most difficult period in the Project. But in the end, the withdrawal was smooth. In fact it was one of the toughest but most successful negotiations I've been involved with – it's usually easier to enter into a marriage than to get divorced."

Ube's and MIM's departures left a gaping hole in the Project's funding program, delaying the planning for a demonstration plant. Each of the departing companies had disbursed only $4 million on the Project, out of their commitment of $12 million.

At the same time that the commercial difficulties arose, some technical problems were also encountered. For example, more work than expected had to done on understanding the properties and behaviour of magnesium chloride, which is produced when magnesite is dissolved in hydrochloric acid. It had turned out that there were major gaps in the literature about magnesium chloride. Other steps in processing, such as dehydration, were also more complex than originally thought.

As a result, the research phase took longer than planned. The combination of technical and funding problems had caused a delay in the planned start-up of commercial production from 1998 to 2002.

Land emphasises that at this difficult period. The Project Team's morale was boosted by support and encouragement from the highest echelons in QMC and CSIRO, as well as from the governments. The CSIRO Team members received continued encouragement from its Chief Executive and the Director of the Institute of Minerals, Energy and Construction Dr Alan Reid, who also chaired the Project Management Committee.

Finding new partners

QMC and CSIRO spent the next two-and- a-half years looking for new commercial partners. "I remember a list of around 30 companies on the board, followed by numerous presentations that took us to the US and Europe. As the biggest potential market is the automotive industry, a lot of the discussions were made with car producers" says Land.

The pieces fell into place in 1997, when the Ford Motor Company and Normandy Mining announced they would participate in the Project, and immediately invested in the pre-commercial phase, estimated to cost around $73 million. The pre-commercial phase involves the construction of a $40 million demonstration plant, and the preparation of a feasibility study for the actual commercial plant.

Ford came in because of its need for a long term supply of magnesium for automotive parts. Ford committed $40 million directly in the project and will enter into a multi-billion dollar contract to purchase up to 45,000 tonnes of magnesium for up to 10 years for its automotive operations around the world – around 47 per cent of the Gladstone's plant expected metal production. Land says that their involvement positions Australia well for the eventual manufacture of these parts, and is another step towards realising the vision of capturing the maximum possible value of the resource in Australia. Normandy Mining's entry brought in much needed mining expertise and experience to replace MIM.

According to Land, CSIRO did not hesitate putting money into the pre-commercial phase. "We had $7.8 million left from the $25 million funding from the Federal and Queensland governments, so we were able to put in the whole amount. However, we reaffirmed the earlier decisions not to take equity in Australian Magnesium Corporation Pty Ltd (AMC), the company established to hold the magnesite resource, the technology and the licences. The CSIRO Board has agreed that to take equity in a joint venture, CSIRO must have qualified and experienced management people spending a lot of time and effort on the Project. Running commercial ventures is not CSIRO's strength. Research is."

Instead, CSIRO has taken a royalty interest. It will receive a production royalty for the first 20 years of the commercial plant's life, in repayment for the total $25 million contribution.

The new structure

The $73 million pre-commercial phase is being funded by Ford ($40 million), Normandy ($20 million), CSIRO ($7.8 million) and QMC ($5 million). AMC, which

will operate the commercial plant, is a 50-50 joint venture between QMC and Normandy, through its subsidiary, Commercial Minerals Ltd. CSIRO has a royalty interest, while Ford has a long-term agreement to purchase nearly half the commercial plant's expected annual production, worth up to $2 billion.

Fluor Daniel, one of the world's largest engineering companies, is also contributing to the Project, in the form of its services. It will act as design and construction engineers for both the pilot and commercial plant. In exchange for its service contribution during the pre-commercial phase, it will gain 10% equity in AMC, which will dilute the interests of QMC and Normandy.

The demonstration plant, expected to be completed in mid-1998, has a rated capacity of 1,000 tonnes per annum (tpa), and will establish the feasibility of a commercial smelter capable of producing 90,000 tpa of magnesium metal. The commercial plant, expected to cost $700 million, is scheduled for construction in mid-1999, with production due to start in late 2002 and full capacity reached in 2004.