



Metallurgy and Mineral Processing

WHAT DOES A METALLURGIST DO?

Within the minerals industry, metallurgists work at mine sites in concentrators and metal recovery operations, in smelters, metal refineries, foundries, and research and development laboratories. They use their knowledge of chemistry and physics, mineralogy, underlying process fundamentals and process engineering to control and improve the processes that separate, concentrate and recover minerals and their valuable metals from the natural ores. Depending on the mineral and metal, the process stages can include mineral processing that upgrades or concentrates the mined ore, and extraction of a metal or intermediate product. This extractive or primary metallurgy can include wet or hydrometallurgical process stages, high-temperature or pyrometallurgical process stages, and electro-metallurgical process stages. Sometimes, crude metals can go through complex refining processes. The metal products can be subject to further processing, termed secondary metallurgy or physical metallurgy, that includes process such as alloying, casting in foundries, rolling, and extrusion.

Some of the many roles that a metallurgist can take are:

- application of physical and chemical methods to concentrate valuable minerals from their ores; processes can involve methods such as magnetic, electrostatic, gravity, and flotation processes;
- application of a combination of processes involving hydrometallurgy, electrometallurgy and pyrometallurgy to produce crude or refined product metal for market;
- management of the technical aspects metallurgical operations using tools such as on-line process monitoring, sampling, chemical analysis, data analysis and process modelling;
- management and supervision of production staff in metallurgical operations;
- design of mineral processing and extractive metallurgical plant;
- study and application of the fundamentals of metallurgical processes to both aid control and improve their physical and economic operation;
- undertake or manage research and development studies to improve existing processes, or to apply existing or possible processes to new ores or concentrates;
- improve environmental performance of metallurgical operations and ensure all environmental standards are met;
- prepare reports on metallurgical operations and projects;
- liaise with a wide variety of people on the job such as operators, maintenance and engineering staff, geologists, mining engineers, and supporting specialists in process control, computing, technology provision and research.

WHAT DOES A MINERAL PROCESS ENGINEER DO?

Minerals process engineers transform the ores found in nature to value-added products. These ores can be high-grade materials taken directly into metal extraction, such as iron ore into production of iron and steel. For most other metals (and for some iron ores) it is necessary to upgrade or concentrate the ore into an intermediate product that is then subject to extractive processes for metal recovery. Further refining of the metal may be necessary. Ores typically contain many waste and undesirable elements, and their treatment can involve surprisingly complex and difficult process technology. The continuing variation in feed requires a high level of metallurgical process understanding and control.

A mineral process engineer may perform the following tasks:

- process design and development;
- process control and management;
- application of chemical, metallurgical and process engineering fundamentals to production processes;
- management of process data collection and analysis;
- metallurgical problem solving with application of modified or addition unit processes;
- application of economic analysis of production processes to effect optimal performance;
- planning of production, budgets, operational and management reporting;
- human resource management of both professional and operational staff.

Metallurgist - Extractive/General

Extractive Metallurgists study and apply metallurgical techniques for extracting and refining metallic materials from their ores or concentrates. They research, develop, control and provide advice on processes used in extracting metals from their ores and the washing, crushing and grading of ore or refining metals. They coordinate the analysis of samples taken from metallurgical process streams to ensure safe and economic operation and they advise operations personnel on process changes required to obtain desired products, processes and quality control.

Mineral Processing Engineer

Minerals process engineers transform low value impure minerals, recycled materials and by-products of other processing operations into commercially valuable products. The main sources of these raw materials are low grade minerals, by-products of other processing operations and recycled materials. Minerals process engineers are employed in all stages of raw materials processing

Hydrometallurgist

Hydrometallurgists are involved in the treatment of ores through low temperature refining and wet processes such as leaching. Hydrometallurgists study the nature and properties of different metals and materials and remove insoluble and toxic materials from metal using water-based solutions to find a more pure form of ore. They may use electrolytic refining and processes.

Pyrometallurgist

Pyrometallurgists design and develop high temperature heat-based processes and equipment to concentrate, extract, refine and process metals and other materials. They extract and obtain pure metals and ore through various extractive processes such as refining, welding, fusing and smelting metals. They control temperature adjustments, change mixtures and other variables in operations such as blast-furnaces and steel-melting furnaces to obtain materials such as pig iron and steel of specified metallurgical characteristics and qualities.

Metallurgy/Mineral Processing - Consulting

Consulting Metallurgists and Mineral Processing Engineers often work on a variety of processes, plants and ores. They will typically be based in coastal cities and fly out to projects as necessary.

Consultants can and do specialise in certain processes or metals/minerals and therefore act to provide certain specific technical information to companies and operations.

Metallurgy/Mineral Processing - Research

Academic and Research metallurgists/mineral processors often work in universities or CRC's (cooperative research centres). Rather than looking primarily at the economic issues of how to extract metals and minerals from ore, they investigate why and how things behave the way they do or are the way they are.

Chemical Engineer

Chemical Engineers design, develop and operate processes for converting and refining raw materials into products. A chemical engineer may improve/develop new processes and materials; design/ improve methods and equipment for extraction, filtration, distillation; prepare reports and detailed costing of changes/improvements; design/operate pilot plants; design plants and specify equipment/processes and layout; test the quality of the process/product; find faults in plant equipment and take corrective action to ensure safe operation.

Materials Engineer

Materials engineers investigate the properties of metals, ceramics, polymers and other materials and develop and assess their commercial and engineering applications. Materials engineers may study the structure and properties of metals and other materials, investigate methods for shaping and fabricating materials, and study methods for joining materials, improving existing materials and evaluating new ones. They participate in the design of products using advanced materials, investigate material failures and study ways to extend the life of materials.

MATHEW REVELL

BEng(Minerals Processing, Hons), Postgraduate Diploma Finance and Investment, MAusIMM Senior Paste Engineer, Revell Resources

What formal qualifications do I have?

I completed a 4 year Minerals Processing Engineering degree at the University of Queensland. I graduated in 1997. I also completed a Postgraduate Diploma in Finance and Investment by correspondence through the Securities Institute. I completed the diploma in 2003.

Why did I choose my particular career(s)?

In the first year at University of Queensland it is a general engineering course. At the end of first year I heard about vacation jobs, that paid good money, were available in the coal mines. I worked for three months at a Bowen Basin coal mine and really enjoyed it. As a result I decided to choose Minerals Processing Engineering.

What have I enjoyed most about my profession(s)?

More than anything I have enjoyed the variety of challenges that the mining industry offers. At most mine sites there is always something going on, and there are more than enough

challenges if you put your hand up. The industry also offers you the chance to travel. Lastly there is also a great variety of characters you meet. It is also a very small industry and you tend to keep in touch with a large range of people.

For someone considering a career in your profession are there any words of wisdom to pass on to them?

I must say that vacation work was a huge bonus for me. I really didn't have any clear idea of what I wanted to do. By doing vacation work you get a clear idea of the industry, the culture and the type of work you will be doing. I also found having mentors in my early years was very important. For my job at Cannington, one of the driving factors for accepting the job was the strong metallurgical team and the experience I could gain from them. Lastly the mining industry is a small industry, so always put in 100% and you may be surprised by the opportunities that arise down the track.

MIRIAM LYONS-STANBOROUGH

BE (Chem, Hons) BA (Hons) MSc (Mineral Economics) MAusIMM MIEAust Clarification Area Supervisor, Pinjarra Refinery, Alcoa of Australia

What formal qualifications do I have?

I initially completed a double degree in Arts and Engineering at Monash University, deferring along the way to complete an honours year in Arts – my major was Japanese language. In 2001 I graduated from WASM with a Masters degree in Mineral Economics – I completed this degree via intensive coursework sessions over two years while working full time for WMC Resources Ltd.

Why did I choose my particular career(s)?

I did well at school and particularly liked Chemistry and Japanese. Not wanting to abandon either field of study, I investigated combined degrees. Initially I was heading towards an Arts/Science degree, but a friend's boyfriend who was studying first year engineering at the time convinced me that, for an extra year of study, I would be more employable with an engineering degree than a science degree upon graduation. So I settled on Engineering/Arts. During Year 11 at school I participated in what was then known as the CRA National Science Summer School in Canberra.



It was a fantastic experience, and after returning the following year as a staff member, I kept up contact with CRA which eventually led to me getting vacation work with one of their subsidiaries, Argyle Diamonds, at the end of first year at uni. And that's when I realised that the mining industry was for me.

What do I enjoy about my role?

The opportunity to work in both technical and line-management roles. All the roles I have performed have required a high level of communication skills. I love working with people, rather than in isolation.

For someone considering a career in your profession are there any words of wisdom to pass on to them?

Find out as much as you can about the profession and industry while you're still studying – vacation work in particular is so valuable. Start your career planning early – I stalled for a few years, waiting for someone to offer me opportunities, until I realised that I had to get out there and tell people where I wanted to go and what I could do.

MEGAN KROPP

BEng (Minerals Process) GAusIMM
Process Engineer, BHP Billiton Mitsubishi
Alliance Central Qld. Office

What formal qualifications do you have?

Minerals Processing Engineering at the University of Queensland, after high school in Mt Isa.

Why did you choose your particular career(s)?

I always enjoyed and excelled in Maths and Science at high school, and when I had to pick what I wanted to do at Uni; Engineering seemed like a natural choice. Despite growing up in Mount Isa I didn't know much (if anything) about careers in the mining industry apart from apprenticeships, but I did know Chemical Engineering could lead into a variety of fields, including mining. As part of preparation for a scholarship interview, I organised to visit a Chemical Engineer working at the Copper Concentrator in Mt Isa and learnt a little about what she did, and what options were generally available for Chemical Engineers. Once at Uni, while completing the generic first year of Eng, I attended all the information sessions held by the different Eng departments to learn a bit more about each field. During these sessions, I became aware of a program to give 1st year Eng students Vacation Work in metallurgical roles. After spending summer at Osborne in NW Qld, learning about the plant, doing surveys and experiencing the FIFO lifestyle, I decided to take the plunge and chose the specialised option of Minerals Processing Engineering (rather than general Chem Eng)

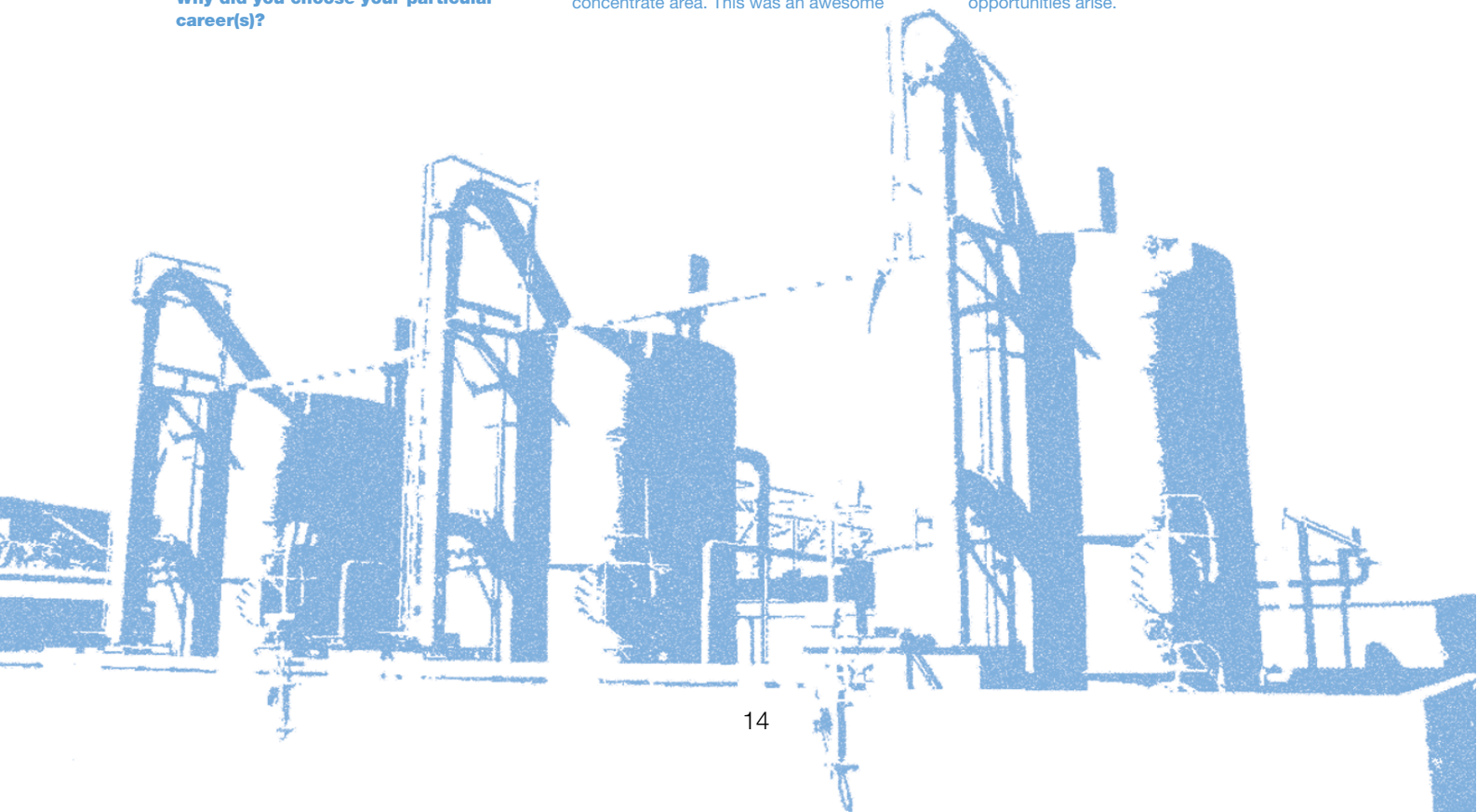
What have you done?

I was very fortunate to have three sets of vacation work while at Uni - Osborne, Mt Gordon and Ernest Henry. The first two were spent working in a metallurgical role, conducting plant surveys at Osborne, and developing lab tests to model the process at Mt Gordon. My vac work working as an operator at Ernest Henry was very interesting, mainly looking after the thickeners and concentrate area. This was an awesome

experience - I believe that to truly understand the process, (esp. as a young engineer) you have to get right into it and the best way to do this is be involved in the operations team. After Uni I was offered a position in the WMC Graduate Program at its Phosphate Hill Operation. I spent 6 months moving around the different plants interacting and being a part of production crews. I also did 6 weeks in Mt Isa at the WMC Acid Plant working on optimising their sampling regime. Phosphate Hill was more a chemical plant than a traditional base metals concentrator, but the plant I started working in as a Process Engineer was basic Minerals Processing with crushing and screening. I was involved in a screen optimisation study and also developing some Metallurgical Accounting systems. As part of the Graduate Program I was offered the opportunity to move to WA and work at WMC's Mt Keith Operations, which is a more complicated Nickel concentrator. I spent time on shift learning the day to day operations of the plant, then acted in the Production Planning Metallurgist role, then spent 12 months as a Plant Metallurgist.

Do you have any regrets about how your career has developed?

My career is still developing; only four years out of Uni and at this stage, everything I do whether right or wrong gets chalked up to experience, and you soon learn not to repeat stupid mistakes. I am still aiming towards a career more in the production, day to day running of the plant, and getting my hands dirty, but will keep an open mind as opportunities arise.



DAVID READETT

BEng(Metallurgical Engineering)
Group Manager Project Development -
Minara Resources Ltd

Why did you choose your particular career(s)?

I was always inclined towards the sciences. I attended a University Careers day and liked what I saw in Metallurgy. I also found out that the entry criteria were less competitive than other engineering based degrees so felt I had a better chance of gaining entry.

What have you done?

I am Chartered Professional Metallurgical Engineer (FAusIMM CPMet) with over 15 years experience in the Mining and Minerals Industry, employed in a variety of professional roles including Group Manager Processing and Engineering with Straits Resources, Technical Services Manager with Cobre Las Cruces (on secondment from Straits Resources), Business Development Manager and Senior Process Engineer with CMPS&F as well as roles with Mount Isa Mines Limited, Pasminco Metals and the South Australian Institute of Technology. I have been involved in test work, process flowsheet development, design, commissioning, optimisation, operation and management of numerous metallurgical projects specialising in base metal hydrometallurgy and biohydrometallurgy, coal and gold. I have been involved with a number of the Australian Copper Leach SX-EW projects and operations and have also had extensive overseas experience in the Americas, Europe and South East Asia.

I have developed an international reputation, in my chosen field of hydrometallurgy, as a result of industrial and consulting experience and extensive publication of technical papers. In 1987 I was the inaugural winner of the AusIMM G.B O'Malley Medal and was also part of the team that was awarded the 1999 AusIMM Mineral Industry Operating Technique Award. I headed the Process/Metallurgical/Engineering team within Straits, a small Australian resource companies, for the past 7 years. During this time I have overseen the development and optimisation of several significant successful projects including Girilambone Copper Operation, Nifty Copper Operation, Browns Creek Gold Operation and Sebuku Coal Mine. I took on site based management roles as well as corporate and operational technical management role. David has also headed the development teams for a number of Feasibility studies including Tritton Copper Project, Whim Creek Copper Project, and Maroochydhore Copper project. I have also headed up Straits

technical Due Diligence teams which has investigated numerous base metal, cobalt/nickel, gold and coal projects/prospects.

Through my career I have been intimately involved in the development and establishment of new technologies including Isa Process, Jameson Cells, heap Bioleaching/aeration and SX coalescing systems as well as being involved in a number of innovative design/engineering developments.

PS and had a lot of fun along the way

Do you have any regrets about how your career has developed?

No, I have worked hard, had fun and achieved beyond what my early goals were.

What have you enjoyed most about your profession(s)?

I have enjoyed the variety of challenges that the mining industry offers along with the chance to travel. It's a small industry which attracts like minded people. Along the way I have made many close enduring friendships.

ADAM LONERGAN

BE (Metallurgical Engineering) (Hons)
BBus (Business Administration), MAusIMM
Metallurgical Engineer, Rio Tinto Technical
Services

Why did you choose your particular career?

Whilst completing high school I was interested in Chemistry and Physics and wanted a career that would combine these disciplines and be "hands on". In addition to 'the sciences' I'd also had an interest in business management (topping my class), so when applying to university I decided to aim for a dual Engineering/Business degree. As nothing like this was available locally I was forced to look to Melbourne, and was offered a place at RMIT to study Metallurgical Engineering and Business Administration concurrently as a double degree. A double degree is more difficult to get into and means an increased workload, but it allowed me to obtain two degrees within five years rather than seven (4 year Engineering, 3 years Business Administration). Doing a double degree has certainly made me more rounded and I am quite sure that it was a strong contributing factor to securing both vacation work every year and my graduate position.

I was lucky enough to also be offered a residential place at Ridley College, which was a great place to live after moving out of home and down to Melbourne.

Living at college is an excellent experience and a great place to meet friends; it's close to campus and most things are taken care of for you so you can concentrate on studying and socialising. If you can justify the costs I recommend it to everybody.

What have you done so far in your career?

At completion of first year university I landed my first vacation job with Newcrest at Cadia (Copper/Gold flotation) in NSW. I was quite 'green' when I commenced shift work as a plant operator that summer, but gained a great deal of knowledge that helped me at university and earned enough money to pay a good portion of my expenses for the following year. Each year afterwards I completed vacation work with a different company in a different commodity (MIM, Mount Isa (Lead/Zinc flotation); AngloGold, Pine Creek (Gold CIL); Rio Tinto, Bundoorra (Iron/Titanium Pyrometallurgy R&D) which gave me a good perspective of the industry and different career options. Rio Tinto then supported my final year research project and paid my expenses (including a trip to Perth to present the findings).

In my final year I successfully applied to Rio Tinto for a graduate position and was interviewed by my research project supervisor and manager. Having over 12 months industry experience and my work being known to them undoubtedly helped my application.

Day one of my full time employment saw me in the Pilbara working at an iron ore mine, where I stayed for 5 months; followed by a 2 month stint in Perth before spending my first day at my desk back in Melbourne (7 months after starting). Since then I've worked at ERA (Ranger, Uranium), a number of Coal operations in Queensland and NSW and nearly a year overseas in Richards Bay, South Africa, but that's another story...I don't know of any other graduates in any industry that have had these kind of opportunities!

What have you enjoyed most about your profession?

I really enjoy the diversity of the work I do as a Metallurgical Engineer. In the past year I've been involved in pilot plant construction, equipment decommissioning, mine site energy reviews, high temperature molten metal test work, numerous plant and laboratory trials, advanced computer modelling and technical desktop studies. I've travelled extensively interstate and worked overseas in a number of different commodities and roles.