Research Collaboration

COLLABORATIVE LINKAGES WITH EXTERNAL RESEARCHERS

Collaborative Australian Linkages	Activities
ARC Centre of Excellence in Ore Deposits (CODES), the University of Tasmania	Discussions to scope a proposed HydroGeM module within the AMIRA P843 "Geometallurgical Mapping and Mine Modelling (GeM)" project. The Parker Centre, CODES, the Julius Kruttschnitt Mineral Research Centre (JKMRC) and AMIRA are collaborating to develop this module which will focus on the identification of the leaching characteristics of ores in ore deposits
Australian Nuclear Science and Technology Organisation (ANSTO)	Memorandum of Understanding with the Centre for a closer research relationship, especially related to research for the uranium industry and biohydrometallurgy
Biz AnyWare	Software support for the AMIRA P420C "Gold Processing Technology" project and the "Modelling/Simulation of Gold Recovery Processes" project
CRC for Plant Biosecurity	The Parker Centre and the CRC for Plant Biosecurity combined resources in November 2007 to run a professional development course, "Networking – Make It Work For You", for staff and students from both CRCs
CRC for Sustainable Resource Processing (CSRP)	Parker Centre project leader Dr Jim Avraamides is a member of CSRP's Executive and Technical Advisory Panel Working Group A joint article on the Quantitative Sustainability Assessment Tool for bauxite residue management developed through the collaborative research in the AMIRA P772 "Bauxite Residue: Sustainability Measures of Improvement" project was published in the April 2008 issue of *Light Metal Age* Discussions on potential research interaction related to recycling of printed circuit boards
CSIRO's Minerals Down Under (MDU) National Research Flagship	Collaborative links with the "Biohydrometallurgy of Sulfides" project (Base Metals Market)
CSIRO Land & Water	Collaborative research with the "Bayer Environmental Issues" project (Alumina Market) associated with bauxite residue and collaborative relationship between the "Biohydrometallurgy of Sulfides" project (Base Metals Market) and Land & Water's Minerals Bioprocessing team
CSIRO Marine and Atmospheric Research	Planning of collaborative work with the "Impurities Issues" project (Alumina Market) on volatile organic compounds produced under wet oxidation and other process conditions
CSIRO Materials Science & Engineering	Collaborative research in the "Solid-Liquid Handling" project (Alumina Market), the AMIRA P266E "Improving Thickener Technology" project and an Australian Research Council Linkage project on optimising dewatering in thickeners
CSIRO Mathematical & Information Sciences	Research collaboration with the "Solid-Liquid Handling" project (Alumina Market) and the AMIRA P266E "Improving Thickener Technology" project
CSIRO Minerals' CFD (Computational Fluid Dynamics) Group	Collaborative research with the "Bayer Red-Side Technology" project (Alumina Market) related to Bayer process digestion and collaboration with the AMIRA P705A "Electrowinning of Base Metals" project Collaboration with the Centre's Solvent Extraction (SX) team on the new "Solvent Extraction Technology" project to improve SX contactor efficiency

Collaborative Australian Linkages	Activities
CSIRO Minerals' Materials Characterisation Group	Linkages with the "Processes for Low-Grade Nickel Ores" project (Base Metals Market), which has enabled the project team to now have access to the new Australian Synchrotron for specialised analyses
CSIRO Minerals' High-Temperature Processing Group	A joint paper, "Treatment of Salt Cakes by Aqueous Leaching and Bayer-Type Digestion", based on collaborative research with the "Bayer Red-Side Technology" project (Alumina Market) was accepted and is in press in the journal *Minerals Engineering*
Curtin University's Department of Applied Geology	Informal collaboration with the "Processes for Low-Grade Nickel Ores" project: the relationship will be formalised in the new "The Impacts of Mineralogy on Hydrometallurgy" project, one of the Parker Centre's Tranche 2 Core Capability projects
Curtin University's Department of Imaging and Applied Physics	Informal collaboration with the "Processes for Low-Grade Nickel Ores" project (Base Metals Market): the relationship will be formalised in the new "The Impacts of Mineralogy on Hydrometallurgy" project, one of the Parker Centre's Tranche 2 Core Capability projects
Curtin Water Quality Research Centre (CWQRC), Curtin University	Collaboration with the "Impurities Issues" project (Alumina Market) on a CSIRO Light Metals Flagship Collaboration Fund project: CWQRC researchers will develop analytical methods for Bayer organics to support the "Impurities Issues" project's wet oxidation work
Griffith University	Collaborative research between the Gold Market's "Non-cyanide Leaching and Recovery of Gold" project and Professor Greg Hope (Griffith University), involving on-going surface studies of gold during leaching in thiosulfate solutions
Julius Kruttschnitt Mineral Research Centre (JKMRC), the University of Queensland	Discussions to scope a proposed HydroGeM module within the AMIRA P843 "Geometallurgical Mapping and Mine Modelling (GeM)" project. The Parker Centre, the JKMRC, CODES and AMIRA are collaborating to develop this module which will focus on the identification of the leaching characteristics of ores in ore deposits
Monash University (Department of Chemical Engineering)	Collaboration with the "Solid-Liquid Handling" project (Alumina Market), related to electrical resistance tomography and non-invasive profiling during sedimentation in a continuous tall column
Murdoch University's School of Electrical, Energy and Process Engineering (Physics)	Collaborative research with the "Impurity Issues" project (Alumina Market) on scale growth
Particulate Fluids Processing Centre (University of Melbourne)	Collaborative research in the "Solid-Liquid Handling" project (Alumina Market), the AMIRA P266E "Improving Thickener Technology" project and an Australian Research Council Linkage project on optimising dewatering in thickeners
RMIT University	Collaborative projects with the "Impurity Issues" project (Alumina Market) on co-oxidation of model Bayer organics
University of Western Australia (UWA)	Memorandum of Understanding with the Centre to build collaboration within the Perth research community
WA Centre of Excellence in Industrial Optimisation (WACEIO), Curtin University	Collaborative research between the "Bayer White-side Technology" project (Alumina Market) and Associate Professor Vilker Rehbock (WACEIO) that developed a mathematical tool which optimises gibbsite crystallisation was published in a joint paper in the *Journal of Industrial and Management Optimization* in August 2007

Collaborative International Linkages	Activities
Advanced Mineral Technology Laboratory (AMTEL), Canada	Collaboration involving AMTEL's Dr Stephen Chryssoulis and the Gold Market's "Improving the Treatment of Preg-robbing Ores" and "Processing Copper-Gold Ores" projects
Bangor University (Wales, UK)	Collaboration between the Bangor University Biodiversity group headed by Dr Barrie Johnson and the "Biohydrometallurgy of Sulfides" project (Base Metals Market)
Cape Peninsula University of Technology, South Africa (Gravity Research Unit)	Collaborative research as part of the AMIRA P420C "Gold Processing Technology" project
Central South University, China (Metallurgical Separation Science and Engineering Laboratory, School of Metallurgical Science and Engineering)	Collaboration between Dr Chu Yong Cheng, project leader of the "Solvent Extraction Technology" project (Base Metals Market) and Dr Qixiu Zhang (Central South University) in the supervision of PhD student Mr Li Zeng who is undertaking his PhD studies in the Parker Centre on the development of SX processes to separate and recover vanadium and molybdenum from spent catalysts used in the chemical/petroleum industries
École Polytechnique Fédérale de Lausanne, Switzerland (Powder Technology Laboratory)	A joint paper with Centre crystallisation researchers at Curtin University was published in the *Journal of Crystal Growth* in February 2008. The paper, "Growth Modification of Hematite by Phosphonate Additives", described the use of a computational approach to predict the morphologies (shapes) of crystals grown in the presence of additives.
GTT-Technologies (Germany)	Collaboration between Dr Gunnar Eriksson (Managing Director, GTT-Technologies) and the Centre's Chemical Speciation group (Murdoch University) on thermodynamic model development for hydrometallurgical processes, particularly in the "New Bauxite Processes" component of the "Bayer Red-side Technology" project (Alumina Market). Dr Eriksson and the Centre's Dr Erich Koenigsberger had an invited, joint paper, "FactSage and ChemApp: Two Tools for the Prediction of Multiphase Chemical Equilibria in Solutions", published in the journal *Pure and Applied Chemistry* in June 2008.
Hahn-Meitner Institut (Germany)	On-going collaboration between the "Biohydrometallurgy of Sulfides" project (Base Metals Market) and Professor Helmut Tributsch (Director, Solar Energy Department, Hahn-Meitner-Institut), with joint interests in sulfide interfaces and the bioleaching of complex sulfide systems and complementary skills and capabilities
Mr Takuo Harato (recently retired from the Sumitomo Chemical Company, Japan)	Collaboration between the "Bayer Red-side Technology" project (Alumina Market) and Mr Takuo Harato (inventor of the Sumitomo process for high silica bauxites) began with a short visit by Mr Harato in November 2007. Mr Harato will return to the Centre in January 2009 for at least 12 months to pursue joint work on improving ways to process high silica bauxite ores.
Dr Bryn Harris (NeoFerric Technologies, Canada)	Collaboration on three papers between Parker Centre researchers in the Chemical Speciation group (Murdoch University) and Dr Bryn Harris, a world expert in aqueous chloride chemistry for recovery of base metals and magnesium. The three papers on work on properties of electrolyte solutions relevant to high concentration chloride leaching were published in the journal *Hydrometallurgy* in February 2008.
Institute of Chemical Technology (Czech Republic)	Collaboration with the AMIRA P507C "Thermodynamic Characterisation of Organics in Bayer Liquors" project team

Collaborative International Linkages	Activities
Korea Institute of Geoscience and Mineral Resources (KIGAM), Daejeon, South Korea	A Memorandum of Understanding (MOU) between KIGAM and the Parker Centre for collaborative research and staff and student exchanges was signed in 2002. A four-year extension of the MOU was signed in 2007. A number of mutually beneficial projects were undertaken in the past year, including two projects (one on bioleaching of spent vanadium catalyst and one on bioleaching of a complex gold ore containing copper and silver) that further extended the strong links between the Centre's Dr David Ralph (Murdoch University) and KIGAM's Dr Dong-Jin Kim. Collaborative research involving Dr Ralph and Dr Kim generated three journal papers and a full conference proceedings paper during 2007-2008. The project on the complex gold ore is being extended to investigate an alternative processing route (under the supervision of the Centre's Dr Jim Avraamides at Murdoch University). A formal collaborative arrangement, the Global Partnership Program (GPP), was signed between CSIRO and KIGAM on 22 August 2007: the Parker Centre is involved in hydrometallurgical activities as a consequence of CSIRO being a Centre Research Participant. The Centre received GPP funds for two small collaborative projects, one based at Murdoch University related to leaching of dry cell batteries (involving the "Reductive Leaching of Metal Oxides" project) and one at CSIRO Minerals (the recovery of metal values from spent battery leach solutions by solvent extraction). The staff exchanges also continued with three KIGAM researchers spending time at the Centre and three Centre members visiting KIGAM: ▼ Dr Soo-Kyung Kim (KIGAM) – see page 87 ▼ Dr Jin-Young Lee (KIGAM) – see page 87 ▼ Dr Shun-Myung Shin (KIGAM) – see page 89 ▼ Dr Jim Avraamides (Parker Centre) visited KIGAM in August 2007 to attend the GPP signing and for discussions. ▼ Dr David Muir (Parker Centre) was invited to spend a week at KIGAM. During his GPP-funded visit to South Korea from 10-19 November 2007, he discussed collaborative research, presented three research-based seminars and also visited two industry operations (Korea Zinc's Onsan refinery and the LS-Nikko Copper Onsan refinery) and the Research Institute of Industrial Science and Technology. ▼ Dr Gamini Senayake (Parker Centre) had a week-long visit to KIGAM in January 2008. His trip was funded through the GPP. Whilst at KIGAM Dr Senanayake gave several seminars and lectures on aspects of hydrometallurgy and discussed future work on recovering valuable metals from spent dry cell batteries.
Lappeenranta University of Technology (LUT), Finland	The collaboration between LUT's Vice Rector (Research) Professor Erkki Paatero (Department of Chemical Technology) and the "Electrostatic Solvent Extraction" project (Base Metals Market) was strengthened by a visit by two members of the project team – Associate Professor Don Ibana (project leader) and PhD student Mr Marc Steffens – to Professor Paatero on 14-15 August 2007 to discuss research collaboration as well as student exchange arrangements
Max-Planck Institute for Colloids and Interfacial Science (Germany)	Cooperative links with the scale research component of the "Impurity Issues" project (Alumina Market)
Mokpo National University, South Korea (Department of Advanced Materials Science & Engineering)	Professor Man-Seung Lee, a Visiting Research Fellow from Mokpo National University, completed his sabbatical with Professor Mike Nicol (Murdoch University) in August 2007. He worked on the "Electrochemical Investigations of the Leaching of Sulfide Minerals" project (Base Metals Market) and other Centre projects. The collaborative research generated two papers in the 2007-2008 period: i) "Ionic Equilibria in Mixed Solutions of Cuprous and Cupric Chloride", published in the *Journal of the Korean Institute of Metals & Materials* in 2008 and ii) "Cathodic Processes in the Leaching and Electrochemistry of Covellite in Mixed Sulfate-Chloride Media", published in the *Journal of Applied Electrochemistry* in March 2008.

Collaborative International Linkages	Activities
State Secretariat of Science, Technology and Higher Education of Minas Gerais, Brazil	A Memorandum of Understanding (MOU) with the Parker Centre for cooperation in joint hydrometallurgy research projects, scientific exchanges of staff and information and joint educational activities was signed on 25 June 2008. Discussions on collaborative research opportunities have already commenced. The MOU will involve seven research providers in the State of Minas Gerais that belong to the Mineral & Metallurgic Pole of Excellence, a government program led by the State Secretariat of Science, Technology and Higher Education of Minas Gerais. One of the Brazilian research providers is the Universidade Federal de Minas Gerais (UFMG), which has had an MOU with the Parker Centre since 2005.
Technical University of Dresden (Germany)	Collaborative research with the Centre's Chemical Speciation group (Murdoch University): during the past year a joint paper authored by Dr Wolfram Rudolph and Dr Gert Irmer (Technical University of Dresden) and the Centre's Dr Erich Koenigsberger, "Speciation Studies in Aqueous HCO_3^--CO_3^{2-} Solutions. A Combined Raman Spectroscopic and Thermodynamic Study", was published in the journal *Dalton Transactions* in 2008
Universidade Federal de Minas Gerais (UFMG), Brazil	Memorandum of Understanding with the Centre for collaboration, with a focus on research collaboration in the base metals and gold areas. Activities in the past year included i) the participation of two undergraduate UFMG students in the Centre's Student-Industry Research Program (one from January-August 2007 and the second from December 2007-February 2008) and ii) the attendance of UFMG's Professor Virginia Ciminelli at the 2008 Parker Centre Hydrometallurgy Conference: New Directions in Leaching – Science & Technology, and her subsequent involvement in discussions at the Centre about collaborative research opportunities.
Université Blaise Pascal (France)	Collaboration with the AMIRA P507C "Thermodynamic Characterisation of Organics in Bayer Liquors" project team
University of British Columbia (UBC), Canada (Hydrometallurgy Group, Department of Materials Engineering)	UBC's Professor David Dixon (a long-term collaborator with the Centre in the area of heap bioleaching) attended the 2008 Parker Centre Hydrometallurgy Conference: New Directions in Leaching - Science & Technology Collaborative relationship between Centre Base Metals Market researchers and UBC's Professor David Dreisinger
University of Cape Town (UCT), South Africa	Memorandum of Understanding with the Centre to accelerate the rate of development of collaborative research relationships: activities in the past year included the participation for the fourth year in a row of two UCT undergraduate chemical engineering students in the Centre's Student-Industry Research Program
University of Limerick (Ireland)	Memorandum of Understanding with the Centre for research collaboration and exchange of personnel
Universität Regensburg, Germany (Institute for Physical & Theoretical Chemistry)	Collaboration with the AMIRA P507C "Thermodynamic Characterisation of Organics in Bayer Liquors" project team and the Centre's Chemical Speciation group at Murdoch University. Professor Richard Buchner from the Universität Regensburg was a Visiting Research Fellow at the Centre for three months from July 2007 (he was hosted by Associate Professor Glenn Hefter of the Chemical Speciation group). During his visit, Professor Buchner delivered the Keynote Lecture in the "Chemical Speciation" session at the 30th International Conference on Solution Chemistry, held on 16-20 July 2007 in Perth.
University of Toronto (U of T), Canada (Aqueous Process Engineering and Chemistry Group)	Collaborative relationship between Centre Base Metals Market researchers and Professor Vladimiros Papangelakis (U of T)
Ural State Technical University, Russia	Following a visit to the Parker Centre by a group of Russian scientists from the Ural State Technical University on 12-13 December 2007, a Memorandum of Understanding with the Centre was signed in January 2008. The Centre and the Ural State Technical University agreed to work to develop a mutually beneficial cooperative relationship in a number of areas, including collaborative hydrometallurgy research on non-ferrous and rare metals and exchange of researchers/students.

Dr Kyung-Ho Park from the Korean Institute for Geoscience and Minerals (KIGAM) presenting the Parker Centre's Dr Jim Avraamides (right) with a plaque acknowledging his contributions to developing scientific collaborations between Korean and Australian researchers. The presentation took place in June 2008 at the 2nd Korea-Australia Joint Symposium on the Technology for Sustainable Development of Mineral and Energy Resources. Dr Avraamides and the Centre's Dr Chu Yong Cheng delivered presentations at the symposium on collaborative research with KIGAM. (Photo courtesy of Dr Dong-Jin Kim, KIGAM).

Dr David Muir (Parker Centre) in the waste recycling demonstration laboratory at the Korean Institute for Geoscience and Minerals (KIGAM) during his invited week-long visit to KIGAM in November 2007 as part of the Memorandum of Understanding between KIGAM and the Parker Centre.

COLLABORATIVE LINKAGES WITHIN THE PARKER CENTRE

Three of the six CRC-funded research projects (Tranche 1) in the Centre's Alumina Market involved collaboration between multiple Research Participants in the Centre. The project teams for two of these collaborative projects comprised researchers from two different Research Participants, while the third project team included researchers from three different Research Participants.

Three of the eight Gold Market CRC-funded projects (Tranche 1) involved researchers drawn from two of the Centre's Research Participants, while a fourth collaborative project had a team comprising researchers from three of the Centre's Research Participants. The Centre's research in the AMIRA P420C "Gold Processing Technology" project involved researchers from two of the Centre's Research Participants, namely Murdoch University and Curtin University.

The "Biohydrometallurgy of Sulfides" project was the only project among the Base Metals Market CRC-funded projects (Tranche 1) to involve work by multiple Research Participants.

However, the process for the development of the Tranche 2 portfolio of the Centre's CRC-funded projects that began in October 2007 involved a considerable collaborative effort to scope and define the projects by the Centre's Executive, the three Industry Technical Panels, the Market Leaders and consortia of Centre researchers from the Research Participants.

The Centre's Board formally approved the new portfolio in June 2008. The 12 projects in Tranche 2 will run from 1 July 2008 to June 2011. The research in these projects will be high quality science that is relevant to the minerals industry; that will be, or is highly likely to be, valued by industry and that will, in all but one project, involve collaboration between Centre researchers at two or more of the Centre's Research Participants.

The Tranche 2 projects will consolidate the research activities in the Centre's CRC-funded projects into fewer, but more collaborative, projects. The new projects will be the principal driver for collaboration between the Centre's Research Participants. The projects will place the Centre at the forefront of the particular areas of research and will significantly increase the collaboration between the Centre's Research Participants in all three of the Centre's research Markets.

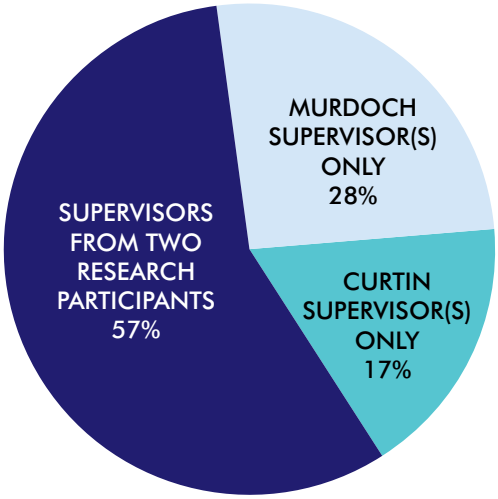
Tranche 2 will comprise five Alumina Market projects (three involving collaboration between two Research Participants and one involving collaboration between three Research Participants), four Base Metals Market projects (two involving collaboration between two Research Participants and two involving collaboration between three Research Participants) and three Gold Market projects (two involving collaboration between two Research Participants and one involving collaboration between three Research Participants).

There is also sometimes collaboration between Parker Centre researchers in different Market research areas. For example, during the past year Dr Ricardo Pascual (the flowsheeting engineer from the "Flowsheeting and Process Modelling" project team in the Centre's Gold Market) also spent time working with Centre Alumina Market researchers to adapt their crystallisation model into a stand-alone application.

In addition, collaborative linkages within the Centre exist in other areas of activity. CSIRO Minerals, one of the Centre's Research Participants, introduced a new seminar series in early 2007. The seminars in the new Spotlight-on-Science seminar series are held every fortnight and are open to all Parker Centre staff and students. The speakers are mainly drawn from Centre staff at CSIRO Minerals' Waterford site, but the series will also feature visitors and other external speakers, including collaborating researchers from other Centre Research Participants.

The pie chart below shows the significant percentage of the Centre's PhD students with supervisors from two of the Research Participants in the Centre.

COOPERATION IN PHD STUDENT SUPERVISION



Researchers from three of the Parker Centre's four Research Participants contributed to the Centre's Student-Industry Research Program over the 2007-2008 Australian summer university vacation, with Centre staff supervising employed undergraduate students at CSIRO Minerals (seven students), Curtin University of Technology (two students) and Murdoch University (two students). One of the students had supervisors from both CSIRO Minerals and Curtin University.

Together the Centre's Research Participants make a significant in-kind contribution to the Centre, which totalled A$7.17 million in 2007-2008. This contribution is predominantly staff in-kind but also non-staff in-kind such as provision of the offices for the Centre's Headquarters at Murdoch University until March 2008 when the Centre's Headquarters moved to the Australian Minerals Research Centre.

The Centre also promoted collaborative linkages within the Centre during 2007-2008 through the following activities:

- The establishment of an annual Parker Centre Award for Research Collaboration for the most effective demonstrated collaboration within the Centre in a CRC-funded research project during the preceding two years.

  The inaugural award, the 2007 Parker Centre Award for Research Collaboration, was presented to the multidisciplinary "Biohydrometallurgy of Sulfides" project team at the 2007 Parker Centre Science Day on 14 November 2007. The award came with a A$5000 prize to be shared equally between all the members of the team.

The members of the "Biohydrometallurgy of Sulfides" project team who were present at the 2007 Parker Centre Science Day on 14 November 2007 to hear their team announced as the winner of the Centre's inaugural Award for Research Collaboration.

The "Biohydrometallurgy of Sulfides" project concluded on 30 June 2008. The project, led by Dr Helen Watling (CSIRO Minerals), incorporated the collaborative activities of Parker Centre researchers from Curtin University of Technology's School of Biomedical Sciences (led by Dr Elizabeth Watkin and also including Dr Lesley Mutch, two PhD students and an Honours student) with those of a group of Centre researchers based at CSIRO Minerals (led by Dr Watling).

The team's submission for the award said that the collaboration had brought together complementary skills in leaching and leaching mechanisms, microbiology and bioleaching, and laboratory and pilot scale test work, with expertise in complex molecular biology methods adapted for use within biomining environments. "The combination of leaching, environmental microbiology and molecular biology gives added substance to the team's research," the submission said.

At the time of their submission, CSIRO Minerals and Curtin University researchers from the Biohydrometallurgy team had also jointly supervised two Honours students; were co-supervising two PhD students; had published four journal papers together (with another two in preparation) and had jointly contributed to technology transfer activities.

Following the award, the project's effective internal collaboration was strengthened by Curtin University's Dr Elizabeth Watkin spending her research sabbatical leave with the CSIRO Minerals' researchers from January to July 2008.

- The Parker Centre Science Conversations seminar series: organised by Dr Jane Rosser, the Centre's Education Program Manager, the Science Conversations are a new series of *ad hoc* presentations by eminent local and visiting scientists on topics considered to be of interest to Centre staff and students. Other interested researchers and industry employees are also welcome to attend. The series has several aims, including increasing the communication of relevant science and encouraging networking between attendees. A further four Parker Centre Science Conversations (Science Conversations 4-7) were held in the past year.

"Biohydrometallurgy of Sulfides" project team members Dr Suzy Rea (CSIRO Minerals) and Dr Elizabeth Watkin (Curtin University) looking at a bacterial culture of *Acidithiobacillus ferrooxidans* growing on Fe_2SO_4. Dr Watkin (right) undertook her research sabbatical with the project's CSIRO Minerals researchers between January-July 2008.