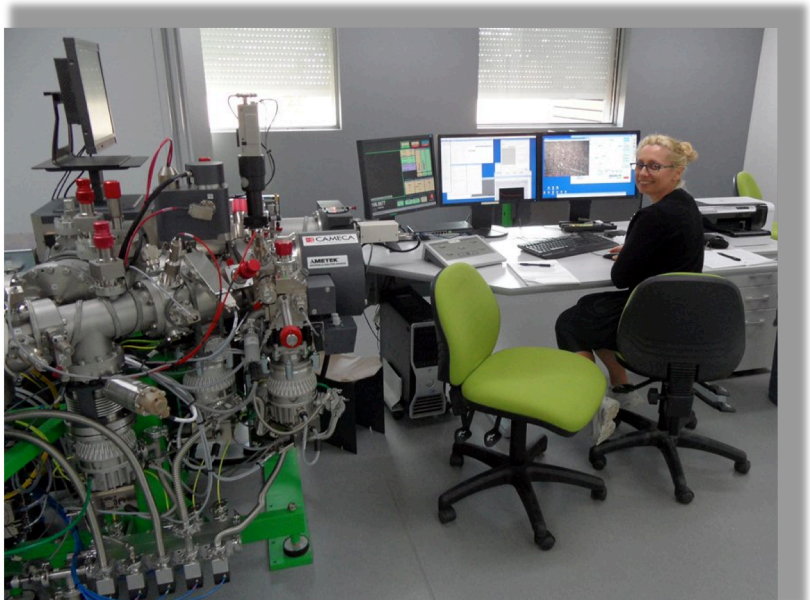
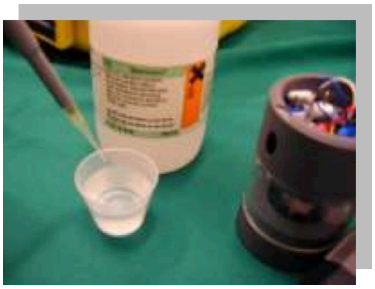
Edith Cowan University
School of Natural Sciences

Dr Magdalena Wajrak
Research Profile

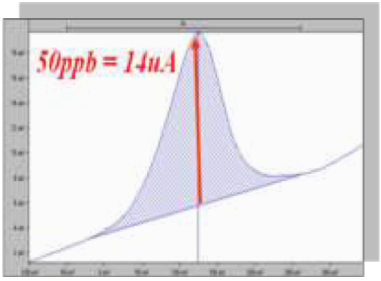


Analysing surface of a gold electrode with electrodeposited arsenic film using Secondary Ion Mass Spectrometer, SIMS, instrument at University of Western Sydney.

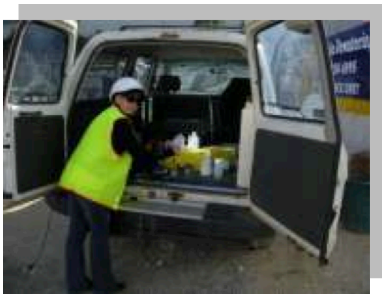
ELECTROCHEMICAL RESEARCH PROJECTS



My main research area is in the field of electrochemistry. I am particularly interested in the development of simple, accurate, reliable and infield detection methods for heavy metals and semi-metals, such as arsenic, lead and cadmium in groundwater using anodic stripping voltammetry, ASV, (first picture on the right – shows sample cell ready for ASV analysis and second picture on the right – is voltammogram showing arsenic peak of concentration of 50ppb). Infield accurate detection of arsenic is currently crucial for people in Bangladesh, where there is a desperate need to continuously monitor groundwater, which is used for drinking, for arsenic levels. Toxic levels (above 50ppb) of arsenic in groundwater have been found all over Bangladesh and millions of people are being poisoned. Not all tube wells used for drinking have toxic levels of arsenic, therefore all wells need to be tested on regular basis to determine which ones are safe to drink from and which are not. This will reduce the severity of contamination.



As part of this research project, I am often asked by environmental companies, shires and the Department of Environment to go onsite and analyse groundwater (third picture on the right – shows me analysing groundwater samples at Perth Arena site), using portable digital voltammeter instrument (PDV6000+), for arsenic, which is also becoming a concern in some areas around Perth due to acid sulphate soils.



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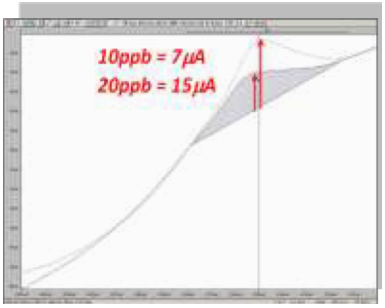
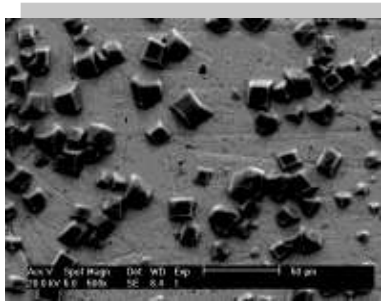
More recently I have also started a project which involves developing a voltametric method for barium detection (first picture on the right – is voltammogram of barium 10ppb and 20ppb standards). In particular, I am interested in being able to detect barium in gunshot residues, GSR (second picture on the right – shows target shooting paper being swabbed for GSR). GSR samples are identified by the presence of barium, lead and antimony (antimony is not always present). Currently the analysis of samples collected at the crime scene for the presence of GSR can only be done off site in a laboratory using scanning electron microscope, SEM, instrument. However, it would be highly beneficial to have an onsite preliminary test to determine whether the collected sample does indeed contain barium and lead, that will reduce the number of samples needed to be analysed using SEM, which is a both time consuming and expensive.

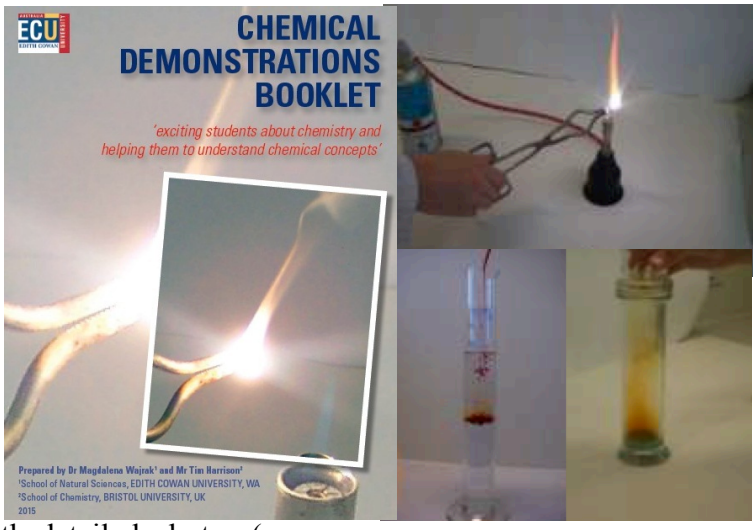




I am also involved in more fundamental electrochemical research, which involves investigation of the surface of the working electrode used in anodic stripping voltammetry, after it has been subjected to electrochemical processes. Understanding what happens at the electrode surface is crucial in being able to improve sensitivity and reliability of the voltametric method for heavy metal detection. This research involves the use of instruments such as scanning electron microscope, SEM (third picture on the right - shows SEM image of the formation of salt crystals on the surface of solid gold working electrode), secondary ion mass spectrometer and synchrotron radiation.

CHEMICAL EDUCATION RESEARCH PROJECTS

My second major area of research is chemical education. I am interested in developing and effectively using latest technologies, such as audience response system, ARS, multimedia and chemical demonstrations (seventh picture on the right – shows some of the chemical demonstrations that are currently being used in first year chemistry lectures) in lectures, to help students understand difficult chemical concepts. Chemistry is a 'visual' subject and its understanding can be greatly enhanced through the use of appropriate images, interactive computer simulations and chemical demonstrations. In 2010, I started a new collaboration with Mr Tim Harrison, ChemLabS Teacher Fellow from Bristol University, UK. Together we have developed a 'Chemical Demonstrations Booklet', which presents 31 chemical demonstrations with detailed photos (some examples are shown on the right), equipment list, chemical concepts being covered in each demonstration, safety notes, disposal of chemicals and useful hints when performing each demonstration.



COLLABORATIONS

- Electrochemistry Research: Prof Fujikawa and Prof Hamasaki, Osaka University, Japan; Modern Water Company, Cambridge, UK; Dr Rob Hart, Curtin University, WA; Dr Alex Lubansky, ECU, WA.
- Chemical Education Research – Prof Roy Tasker, University of Western Sydney, NSW; Dr Danny Bedgood, Charls Sturt University, NSW; Dr Ian Jamie, Macquarie University, NSW.
- Outreach Programs – Assoc Prof Joanne Jamie, Macquarie University, NSW, Mr Tim Harrison, Bristol University, UK; Mr Jason Barrow, ECU, WA.

RESEARCH STUDENT SUPERVISION

- Master of Science (Chemistry), Investigation of Interferences and Development of Pre-treatment Methods for Arsenic Analysis by Anodic Stripping Voltammetry, Mr Paul Lewtas, 2014.
- Honours (Chemistry), Measurement of Nickel and Cobalt in Urine using UV Digestion and Voltammetry, Mr Wade Lonsdale, 2014.
- Honours (Chemistry), Development of an Infield Voltammetric Method for the Determination of Barium, Mrs Samantha Ridgway, 2015.

PUBLICATIONS

1. Chandler, G.S., Jayatilaka, D. and **Wajrak, M.**, (1995). *A study of the cyclic isomers of N_2S_4*, Chemical Physics, 198, 169-181.
2. **M. Wajrak** and J. Rummey, (2003). *Determination of silver by differential pulse anodic stripping voltammetry*, Aust. J. Ed. Chem., Issue 63, 26-30.
3. Hinwood, L.A., Horwitz, P., Barton, C. and **Wajrak**, **M.**, (2005). *Acid sulphate soil disturbance and heavy metals in ground water: implications for human exposure - a pilot study*. Environmental Pollution 143(100).
4. **Wajrak, M.** and Boyce, M., (2005). *The development of best separation conditions for a mixture of preservatives: methyl-, ethyl-, propyl- parabens, sorbic and benzoic acid*. Australian Journal of Education in Chemistry, 65.
5. **Wajrak, M.**, (2009). *Infield Detection of Arsenic using Portable Digital Voltammeter, Natural Arsenic in Groundwaters of Latin America - Occurrence, Health Impact, Remediation and Management*, Eds. J. Bundschuh, M.A. Armienta, P. Bhattacharya. & J. Matschullat, London: CRC Press.

6. **Wajrak, M.**, (2010) *Investigating the surface of solid gold electrode to improve the sensitivity of anodic stripping voltammetry for arsenic detection*, Arsenic in Geosphere and Human Diseases; Arsenic 2010: Proceedings of the Third International Congress on Arsenic in the Environment, Eds. Jiin-Shuh Jean, Jochen Bundschuh and Prosun Bhattacharya, USA: CRC Press.

7. **Wajrak**, **M.**, R. Hart and K. Prince, *Investigation of the surface of solid gold electrode subjected to electrochemical processes using SIMS, SEM and Synchrotron,* NCTA 2009, Sydney, Australia **http://www.ainse.edu.au/ainse/events/peer-reviewed_abstracts/ncta_2009.html**

8. **Wajrak, M.** and Perkins, T., (2010). *'Authentic Assessment - Mission Possible or Mission Impossible?, Enhancing Teaching and Learning through Assessment: Emerging Ideas*, S. Frankland (Ed.) Assessment Series, Volume 4, Hong Kong: Assessment Resource Centre, The Hong Kong Polytechnic University.

9. Braungardt, C.B., Buttertfield, M. and **Wajrak, M.**, (2010) *On-site mine water analysis: Application Note for the PDV6000+*, IMWA2010, Nova Scotia: CBU Press (ISBN 978-1-897009-47-5).

10. **Wajrak, M.,** *Arsenic in drinking water – the silent killer*, SSR, 93(343), (2011).

11. Ahmed, M.S., Munroe, P., Jiang, Z., Zhao, X., **Wajrak, M.**, Guo, H., Rickard, W. and Xie, Z., *Corrosion- and Damage-Resistant Nitride Coatings for Steel*, J. Am. Ceram. Soc., Issue 95 [9], (2012), 2997–3004.

12. **Wajrak, M.** and McCafferty, P., *Validation of a Portable Digital Voltammeter, PDV6000+, Instrument for Detection of Lead in Rain Water Samples in Esperance*, Western Australia Heavy Metals in the Environment: Selected Papers from the ICHMET-15 Conference, Edited by J. Nriagu, P. Szefer, J. Pacyna, B. Markert and S. Wünschmann, (2012), pp. 271-288, (ISBN 978-94-90970-00-0).

13. Lewtas, P., **Wajrak, M.**, (2012), Improved rinsing procedure for samples containing sulfide and organic interferences in determination of arsenic by voltammetry. *Understanding the Geological and Medical Interface of Arsenic, As 2012 - Proceedings of the 4th International Congress on Arsenic in the Environment*, 400-401.

14. **Wajrak, M.**, McCafferty, P., Ramalingam, M., Kittappa, S., (2014), Water and Wastewater: The Malaysian Experience. *Journal of the Australian Water Association*, 41(1), 28-29, Australia.

15. Chandler, G., **Wajrak, M**. and Khan, N., (2015), Neutron Diffraction Structures of Water in Crystalline Hydrates of Metal Salts. *Acta Crystallographica Section B*, 71(3).