

1a. Personal details				
Full name	<i>Title</i>	<i>First name</i>	<i>Second name(s)</i>	<i>Family name</i>
	Prof	Russell	David	Frew
Present position	Professor of Chemistry			
Organisation/Employer	University of Otago			
Contact Address	Department of Chemistry			
	University of Otago			
	PO Box 56, Dunedin			Post code
Work telephone	03 479 7913		Mobile	
Email	rfrew@chemistry.otago.ac.nz			

1b. Academic qualifications

1991, PhD, Chemistry, University of Otago
 1988, BSc(HONS) First Class, Chemistry, University of Otago

1c. Professional positions held

2013 – present, Professor of Chemistry, U.Otago,
 2012 – 2015 on secondment to the UN as Food Traceability Specialist, International Atomic Energy Agency (IAEA), Vienna
 2009-2013, Associate Professor of Chemistry, U.Otago
 2004-2007, Isotrace NZ Ltd, Director and Chief Scientist, 0.4 EFTE
 1996-2008, Lecturer/ Senior Lecturer in Chemistry, U.Otago
 1992-1996, Senior Research Fellow, University of East Anglia, England
 1991-1992, Analytical Chemist, Zenith Technology Corporation

1d. Present research/professional speciality

I am an analytical chemist with research interests in applying analytical tools to gain understanding of environmental systems. Recent research has focussed on the interaction of chemistry (nutrients) with biology in controlling primary productivity in the oceans. My other main interest is in applying the analytical tools to determining the origin of natural products such as invasive species (biosecurity) or food commodities. The main tools used in this work are light isotopes using many different preparative techniques including bulk analysis, pyrolysis and compound-specific. Results of this research have been used in policy and the public sector including biosecurity and as forensic evidence in court work. I am particularly interested in the development of novel science into working systems that are useable in industry. This is the main purpose of my work for the International Atomic Energy Agency, i.e. enabling member states to take advantage of the technological developments through training and capability building.

1e. Total years research experience	24 years
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1f. Professional distinctions and memberships (including honours, prizes, scholarships, boards or governance roles, etc)

2014, IAEA/FAO, Merit Award for Outstanding Performance

2012 – 2015 on secondment to the UN as Food Traceability Specialist in a joint International Atomic Energy Agency (IAEA) and Food and Agricultural Organisation (FAO) post in Vienna.

2012, University of Otago Distinguished Research Group Medal,
2011, **Prime Ministers Science Prize**

2009 – 2012, 2015 - Director of Applied Science programme in Forensic Analytical Science,
2008 – 2011, 2014 - Director Oritain Ltd
2004 – 2007 Director Isotracer NZ Ltd

2011 Expert witness in the case Ministry of Fisheries vs West Coast Fishing Ltd, Tauranga District Court, September 2011.

2011 Commissioned by Inspector John Walker (NZ Police) to investigate the use of chemical incinerated bone to aid the identification of severely burnt victims of the Christchurch earthquake. Provided advice to the Chief coroner.

2009 Expert witness in the case Crown vs Mr King, Nelson district court.

2005 – 2007 Scientific advisor for the Cross Departmental Research Pool project on the development of isotopic tools for biosecurity, conservation management and police enforcement. This project is supported by Biosecurity NZ, MAF, DoC, NZ Food Safety Authority, Wildlife Enforcement Group, NZ Customs Service, Ministry of Fisheries, Ministry of Health, NZ Police, Dept of PM & Cabinet, Fish & Game NZ.

2011-2014, PI, Marsden: Does bioaccumulation of iron by seabirds enhance productivity around sub-Antarctic Islands?

2010-2013, AI, Marsden: Solving the mystery of sustained ocean fertility at the Subantarctic Front using Seismic oceanography.

2007-2010, PI, Marsden: Southern Ocean Biogeochemistry: Calibrating the Cd paleoproxy.

2006, PI, Biosecurity NZ: Effect of Geographic Origin on Isotopic signature of the light brown apple moth.

2006, PI, Biosecurity NZ (Funded from Treasury): Isotopic mapping of NZ precipitation.

2004-2007, AI, Marsden: Food web connectivity in the Fiordland ecosystem: an investigation of trophic links across ecotone boundaries.

2005, PI, Animal Health Board: Investigation of animal movement utilizing isotope ratio mass spectrometry, 2005.

2001-2004, PI, Marsden: Gaia at sea: Phytoplankton, feedback and global climate

1g. Total number of <i>peer reviewed</i> publications and patents	Journal articles	Books, book chapters, books edited	Conference proceedings	Patents
	80	6	3	0

PART 2

2a. Research publications and dissemination

Peer-reviewed journal articles

- Muhammad S, Hayman A., and R. Frew. Compound-Specific Isotope Analysis of Diesel Fuels in a Forensic Investigation. *Frontiers in Chemistry*, 3:12, doi: [10.3389/fchem.2015.00012](https://doi.org/10.3389/fchem.2015.00012), 2015
- Nielsen, J.A., **R.D. Frew**, P.A. Whigam, R.M. Callaway and K.J.M. Dickinson. Thyme and space invasion; *Thymus vulgaris* decreases exotic plant species diversity in Central Otago, New Zealand. *Biological Invasions*, BINV-D-14-00146R2, 2015
- Ehtesham E., Hayman, A., Van Hale, R., and **R. Frew**. Influence of feed and water on the stable isotopic composition of dairy milk. *International Dairy Journal*, <http://dx.doi.org/10.1016/j.idairyj.2015.02.008>, 2015
- Jandrić, Z., Haughey, S.A., **Frew, R.D.**, McComb, K., Galvin-King, P., Elliott, C.T., Cannavan, A., Discrimination of honey of different floral origins by a combination of various chemical parameters, *Food Chemistry*, doi: <http://dx.doi.org/10.1016/j.foodchem.2014.11.165>, 2015
- Holder P.W., **R.D. Frew** and R. Van Hale. The geographic origin of an intercepted biosecurity pest beetle assigned using hydrogen stable isotopes. *Journal of Economic Entomology*, doi: 10.1093/jee/tou097, 2015.
- Nielsen, J.A., **R.D. Frew**, P.A. Whigam, R.M. Callaway and K.J.M. Dickinson. Germination and growth responses of co-occurring grass species to soil from under invasive *Thymus vulgaris*. *Allelopathy Journal*, 35(1), 139-152, 2015
- Muhammad, S.A., **Frew R.D.**, Van Hale R., Hayman A.R. Assessing carbon and hydrogen isotopic fractionation of diesel fuel *n*-alkanes during progressive evaporation. *Journal of Forensic Sciences*, 60 Suppl. 1, S56-65, doi: 10.1111/1556-4029.12551, 2015.
- Nielsen, J.A., **R.D. Frew**, P.A. Whigam, R.M. Callaway and K.J.M. Dickinson., Thyme Invasion and Soil Properties in the Central Otago Region of New Zealand. *Geoderma Regional*, doi: 10.1016/j.geodrs.2014.08.002, 2014
- Holder, P.W., Armstrong, K., Van Hale, R., Millet, M., **Frew, R.D.**, Clough, T. J., Baker, J.A. Isotopes and Trace Elements as Natal Origin Markers of *Helicoverpa armigera* – An Experimental Model for Biosecurity Pests. PLoS ONE 9(3): e92384. doi:10.1371/journal.pone.0092384, March 2014
- Nielsen, J.A., Whigham, P.A., **Frew, R.D.**, Callaway, R.M. and K.J.M. Dickinson. Invasion essentials: does secondary chemistry plasticity contribute to the invasiveness of *Thymus vulgaris* L.? *Chemoecology*, 24(1) 15-27, doi 10.1007/s00049-013-0142-1, 2014
- Sander, SG, T. Feng, EB Ibisani, K Currie, KA Hunter and **RD Frew**. Spatial and Seasonal Variation of the Iron Speciation in Surface Waters of the Subantarctic Front and the Otago Continental Shelf. *Marine Chemistry*, accepted July 2014
- Wing S.R., L. Jack, O Shatova, J.J. Leichter, D. Barr and **R.D. Frew**. Seabirds and marine mammals redistribute bioavailable iron in the Southern Ocean. *Marine Ecology Progress Series*, www.doi.org/10.3354/meps10923, 2014
- Ehteshamrad E., Hayman A.R., McComb, K., Van Hale, R. and **Frew R.D.** Correlation of geographical location with the stable isotope values of hydrogen and carbon of the fatty acids from New Zealand milk and bulk milk powder. *J.Agricultural and Food Chemistry*, <http://dx.doi.org/10.1021/jf4024883> 2013
- McLeod R., Garland M., Van Hale, R., Steiman S. and **Frew R.** Determining the most effective combination of chemical parameters for differentiating the geographic origin of food products: an example using coffee beans. *J. Food Chemistry and Nutrition*, 1, 49-61, 2013
- Muhammad S.A., **R.D. Frew**, A.R. Hayman., Forensic differentiation of diesel fuels using hydrocarbon isotope fingerprints, *Central European Geology*, 56(1), 19-37, doi: 10.1556/CEuGeol.56.2013.1.3, 2013.
- Frew, R.**, K. McComb, L. Croud, D.Clark and R. Van Hale. Modified sugar adulteration test applied to

New Zealand honey. *Food Chemistry*, 141, 4127-4131,
<http://dx.doi.org/10.1016/j.foodchem.2013.06.124>, 2013

Benbow, T., A.R. Hayman and **R.D. Frew**. A rapid method to prepare aqueous fatty acids for hydrogen and carbon compound specific stable isotope analysis. *Marine and Freshwater Research*. 64, 294-302, <http://dx.doi.org/10.1071/MF12192>, 2013

Ehteshamrad E., Baisden W.T., Keller E.D., Hayman A.R., Van Hale R. and **Frew R.D.** Correlation between precipitation and geographical location on the $\delta^2\text{H}$ values of the fatty acids from milk and bulk milk powder. *Geochimica et Cosmochimica Acta*, 111, 105-116, 2012 (IF 4.3)

Gault-Ringold, M., T. Adu, C. Stirling, **R. Frew** and K. Hunter. Anomalous biogeochemical behavior of cadmium in subantarctic surface waters: Mechanistic constraints from cadmium isotopes. *Earth Planet. Sci. Lett*, 341-344, 94-103, 2012

Wing, S., R. McLeod, J.J. Leichter, **R.D. Frew**, G. Fennell and M.D. Lamare Sea ice microbial production supports Ross Sea benthic communities: influence of a small but stable subsidy, *Ecology*, doi: <http://dx.doi.org/10.1890/11-0996.1>, 2012

Thomas, Daniel B., McGoverin, Cushla M., Fordyce, R. Ewan, **Frew, R.D.**, Gordon, K.C., Raman spectroscopy of fossil bioapatite - a proxy for diagenetic alteration of the oxygen isotope composition, *Palaeogeography, Palaeoclimatology, Palaeoecology*, doi: [10.1016/j.palaeo.2011.06.016](http://dx.doi.org/10.1016/j.palaeo.2011.06.016). 2011 (IF 3.2)

David, G.E., **R.D. Frew**, A.R. Hayman. Isotope fractionation during precipitation of methamphetamine HCl and discrimination of seized forensic samples. *Forensic Science International*, 200, 123-139, 2010

Benbow T.J., **R.D. Frew** and A.R. Hayman. Validation of a rapid and simple method for the preparation of aqueous organic compounds prior to compound specific isotope analysis. *Organic Geochemistry*, 39, 1(12), 1690-1702, 2008

Frew R.D., D.A. Hutchins, S. Nodder, S. Sanudo-Wilhelmy, A. Tovar-Sanchez, P.W.Boyd. Particulate iron dynamics during FeCycle in subantarctic waters SE of New Zealand. *Global Biogeochemical Cycles*, 20, GB4S22, doi:10.1029/2005GB002558, 2006

Frew, R., A.Bowie, P. Croot and S. Pickmere. Macronutrient and trace-metal geochemistry of an *in situ* iron-induced Southern Ocean bloom. *Deep-Sea Research II*. 48, 2467-2482, 2001.

Frew, R.D. Dennis, P.F., Heywood, K.J, Meredith, M.M and S. Boswell. The oxygen isotope composition of water masses in the north-eastern North Atlantic. *Deep Sea Research*, 47(12), 2265-2286, 2000.

Boyd, P.W., A. Watson, C.S. Law, E. Abraham, T. Trull, R. Murdoch, D.C.E. Bakker, A.R. Bowie, M. Charette, P. Croot, K. Downing, **R. Frew**, et al. Mesoscale iron fertilisation elevates phytoplankton stocks in the polar Southern Ocean. *Nature*, 407(6805), 695-702, 2000.

Frew, R.D. and Hunter, K.A. Influence of Southern Ocean waters on the cadmium-phosphate properties of the global ocean. *Nature*, 360:144-146, 1992.

Peer reviewed books, book chapters, books edited

McComb, Kiri and **Russell Frew**. Using new analytical approaches to verify the origin of honey. In: *New analytical approaches for verifying the origin of food*. Paul Brereton Editor, Woodhouse Publishing. ISBN-13: 978 0 85709 274 8, 2013.

Sander, S., K. Hunter and **R. Frew**. Trace Element Analysis. In: Sampling and Measurement of Trace Metals in Seawater. *Practical Guidelines for the Analysis of Seawater*. Oliver Wurl, editor. CRC Press. ISBN: 978-1-4200-7306-5, 2009

Refereed conference proceedings

Muhammad, S. Akmal, **R.D. Frew** and A.R. Hayman. Compound-Specific Isotope Analysis of Diesel Fuels in a Forensic Investigation. DOI: 10.1007/978-981-4560-70-2_26. Pages 137-142. In: *From Sources to Solution*. Aris, A.Z, Tengku Ismail, T.H., Harun, R., Abdullah, A.M and M.Y. Ishak, Editors. Springer Singapore, ISBN 978-981-4560-69-6, 2014

Other forms of dissemination (reports for clients, technical reports, popular press, etc)

Frew Russell. Report on the Trace Element Analysis of Paint Flakes. Report for Ministry of Fisheries for the case MFish vs West Coast Fishing Ltd, 12 pp, 2011

Frew Russell, Robert Van Hale. A stable isotope rainfall map for the protection of New Zealand's biological and environmental resources. Report to Biosecurity New Zealand, January 2011, 34 pp

Muhammad, Syahidah, Alan Hayman, **Russell Frew, Robert van Hale.** Report on the Compound-Specific Isotopic Analysis of Blenheim diesel samples. Report to New Zealand Police, July 2009, 19 pp
Beavan Athfield, N., Claymore, V., Phillips A., **Frew R.,** 2009. A "Country of Origin" identification tool for the deer velvet industry: Complete Isotopic Report for New Zealand and Foreign Velvets including Oxygen and Deuterium Analysis. *GNS Science Consultancy Report 2009/34*, 15pp

Frew R.D. Effect of geographic origin on the isotopic composition of the Light Brown Apple Moth. Report to Biosecurity NZ, June 2006, 14 pp.

Frew R.D., R. van Hale and T. Husheer. Investigation of animal movement utilizing IRMS. Report to the Animal Health Board, April 2006, 30 pp

2b. Previous research work

Research title: Isotopic tools for determining origin of invasive insects

Principal outcome: Method developed and used in case work

Principal end-user and contact: Biosecurity NZ, Ian Gear

Research title: Food web connectivity in the Fiordland ecosystem: an investigation of trophic links across ecotone boundaries

Principal outcome: Research papers and reports that informed establishment of Fiordland marine reserve

Principal end-user and contact: Local and National Gov't, Researchers

Research title: Developing isotopic tools for point of origin of flora and fauna.

Principal outcome: Map of isotopic variability across NZ and tools for using this to verify origin of NZ natural products.

Principal end-user and contact: George Gill, MAF NZ

2c. Describe the commercial, social or environmental impact of your previous research work

Research on stable isotope and trace element profiling led to founding of commercial company (Oritain see www.oritain.com) as a commercial provider of these services. I was a founding Director of this company.

Stable isotope profiling used in forensic context and several court cases including

1. Crown vs Mr King (2009) stolen diesel
2. Ministry of Fisheries vs West Coast Fishing Ltd (2011)

2d. Demonstration of relationships with end-users

I have delivered invited lectures on stable isotope traceability to 4 NZ Food Safety Authority conferences and 2 National Beekeeper conferences.

I have provided reports for producers from numerous industries on traceability of products including; pip fruit, lamb, wine, honey, saffron, dairy, goat milk.