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Profile: I am a geologist with interests in the application of mineralogy to the petrology and geochemistry of crustal rocks. I have wide ranging experience in research and teaching and have worked in Europe and North America. My primary research experience covers studying mineral compositions, fabrics and textures in igneous, metamorphic and hydrothermal rocks. The work is based on extensive fieldwork complemented by the application of a broad range of laboratory techniques. The results of research have been published in international peer-reviewed scientific journals. Other public outreach activities include leading fieldtrips and museum tours, and presentations to interested clubs, societies, and associations. I support several professional bodies, and give service as an Associate Editor to *American Mineralogist* and as a reviewer to scientific journals and the U.S. National Science Foundation. I have also sponsored topical sessions at major national and international meetings. I have supervised a number of graduate students, and mentored several under-graduate students in independent research. Research has been supported financially by the National Science Foundations of Switzerland and the United States of America, as well as through internal university sources, trusts and foundations.

Education 1997 – 2001: University of Basel, Basel, Switzerland, (Ph.D. *Magna cum Laude*).

1993 – 1997: University of St. Andrews, United Kingdom. (B.Sc. Geochemistry with *Upper Division Second Class Honours*).

1987 – 1993: Queensferry High School, South Queensferry, United Kingdom (Scottish Examination Board Qualifications).

Experience Sept 2014: Associate Professor (Geosciences) Texas Tech University.

Aug 2008 – 2014: Assistant Professor (Geosciences) Texas Tech University.

2007 – July 2009: Adjunct Assistant Professor (Research), University of Massachusetts, USA

2007 – August 2008: Visiting Researcher, University of Western Ontario, London, Canada.

2006: Lecturer, University of Massachusetts, USA.

2005 – 2006: Senior Post-Doctoral Research Fellow, University of Massachusetts, USA.

2005: Visiting Scientist, Helmholtz *GeoForschungsZentrum*, Potsdam, Germany.

2001 – 2004: Post-Doctoral Research Fellow, Natural History Museums, University of Oslo, Norway.

1997 – 2000: Assistant in the Institute for Mineralogy and Petrology, University of Basel, Switzerland.

1995: Laboratory Assistant (Heavy Metal Geochemistry), International Atomic Energy Agency, Marine Environment Laboratories, Monaco.

Further details of educational and professional achievements are provided in appendices as follows:

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Appendix A

Research Experience

Aug 2008 – present Texas Tech University – Research in Mineral Science with applications to Petrology and Geochemistry.

Topics of research interest:

- Accessory mineral stability and trace element mobility during metamorphism – the role of bulk rock composition, chemistry and fluid-mineral reactivity.
- Rare earth element minerals: occurrence, behaviour and petrographic significance.
- Causes of peraluminous magmatism in the Great Basin Region, western United States – a case study from the Ruby Mountains, Nevada.
- Application of integrated XRF and XRD to sedimentary geochemistry and the prediction of mechanical rock properties.

Feb 2007 – July 2008 University of Western Ontario (Canada): Cathodoluminescence studies of accessory phase minerals and analysis of barium silicates by XRD, FT-IR and MAS-NMR (in collaboration with D.E Moser and R.L. Flemming).

July 2005 – Dec 2006 University of Massachusetts, Amherst: Development and application of the Cameca *SX-Ultrachron* Electron Microprobe for *in situ* total U-Th-Pb geochronology and trace element analysis.

Topics of research interest:

- Application and improvement of trace element electron-probe micro-analysis techniques, with special interest in accessory and exotic mineral phases.
- Dissolution-precipitation reactions in phosphate minerals: Implications for total U-Th-Pb geochronology to dating metamorphic and alteration processes.
- Heavy element minerals and texture development in rare element pegmatites: metamorphism versus magmatism and applications for total U-Th-Pb geochronology.
- Apatite-allanite-monazite associations in carbonatite complexes from south-west Finland: Monitoring fluid flow during continental break-up and mineralization.

Sept – Nov 2005 *GeoForschungsZentrum*, Potsdam (Germany): High pressure-temperature experiments in the [fluid + monazite] and [fluid + xenotime] systems.

Jan – June 2005 University of Western Ontario (Canada): Application of *in situ* μ -X-ray diffractometry to complex pegmatite systems.

2001 – 2004 University of Oslo Natural History Museums (Norway): Post-doctoral research fellow responsible for establishing mineralogically orientated research and upgrading laboratory facilities in the Geological Museum.

Topics of research interest:

- Emplacement of the Seiland Igneous Province, associated metamorphism, and the consequence of younger Caledonian deformation and metamorphism.
- Metamorphism, structural development, and geothermobarometry of the Ardencaple Fjord Region, East Greenland.
- Advanced analytical analysis of bariannite and ganterite: the metamorphic stability of Ba-micas, and their application to understanding diffusion processes.
- Heavy mineral deposits in the Proterozoic sandstones of the Telemark Region.

1997 – 2001 University of Basel (Switzerland): Assistant in the Institute for Mineralogy and Petrology. Duties included: teaching assistant to undergraduate courses in crystal optics, optical microscopy and mineralogy; teaching assistant on fieldtrips;

preparation of graphics for presentation and publication; rock-collection management; and, responsibility for double-polished fluid inclusion thick section preparation.

Summer 1997 Teaching assistant to the University of Basel independent mapping course on the Adamello complex, European Central Alps, Italy.

Field Experience Highlights (* - Fieldwork with Student Participation)

*July 2014 Mapping and sample collection of meta-sedimentary assemblages and cross-cutting igneous relationships with peraluminous granites in the Angel Lake and Lizzies Basin areas of the East Humboldt Range, Nevada.

*June 2014 Mapping and sample collection of calc-silicate assemblages in the thermal aureole of the Ballachulish Igneous Complex, NW Highlands, Scotland.

*June 2012 Sample collection in the meta-sedimentary thermal aureole of the Ballachulish Igneous Complex, NW Highlands, Scotland.

*July 2011 Outcrop mapping and sample collection of complex inter-mingled and cross-cutting granite lithologies, Ruby Mountains, NE Nevada.

*July-August 2010 Field mapping and sample collection of mafic-ultramafic intrusive rocks in the Chetco Complex, Klamath Mountains, California.

*July 2009 Field investigation and sample collection in the Ruby Mountain – East Humboldt Range, metamorphic core complex, NE Nevada.

*July 2005 Field investigation of Archean to Proterozoic lower continental crust and associated granulite facies metamorphic rocks in the East Athabasca Mylonite Triangle, Northern Saskatchewan.

*December 2004 Field investigation and sample collection in the Hydra Anorthosite Complex, Southwest Norway.

*Summer 2004 Field investigation of igneous-rock/host-rock relationships in the ~565 Ma Seiland Igneous Province, Finnmark (Northern Norway): thermal metamorphism, and the effects of younger orogenesis.

September 2003 Sample collection in the Mesoproterozoic supracrustal sediments of the Baltic Shield, Telemark District, Norway for provenance studies

Summer 1998 Sample collection for stratigraphy research in the Cambro-Silurian rocks of the Oslo Region, Norway.

November 1997 Sample collection and underground mapping in the Dalen-Kjørholt limestone mine, Brevik, Norway.

1997 – 2000 Field investigation of Palaeozoic silicate-hosted barium-anomalies in the Berisal Complex, Simplon Region, Switzerland.

Summer 1996 Geological mapping of the Moshaneng Complex, a reversely zoned example of magma-mingling, Kanye District, Botswana.

Short-Course Participation

Fluid inclusions: Analysis and interpretation. CAG-MAG-SEG Joint Meeting, May 2003, Vancouver, Canada.

Thermodynamic Models in Hydrothermal and Environmental Systems (with Gregor M. Anderson, Toronto, Canada). *Cours de 3emè Cycle Commission Romande Des Sciences De La Terre*, May 2000, University of Geneva, Switzerland.

Isotope Systems and the Application of Mass Spectrometry (with Jan Kramers, Igor Villa, Thomas Nägler). May 2000, University of Bern, Switzerland.

Thermobarometry and Applications, (with Frank S. Spear, RPI, New York). *Cours de 3emè Cycle Commission Romande Des Sciences De La Terre*, October 1999, University of Bern, Switzerland.

4th Workshop on Alpine Geological Studies, May 1999, Tübingen, Germany.

Fission Track Dating (with Meinert Rahn and Bernhard Fügenschuh). April 1999, University of Basel, Switzerland.

The Alps and their Variscan Framework. *Cours de 3emè Cycle Commission Romande Des Sciences De La Terre*, October 1998, University of Lausanne, Switzerland.

Professional Development

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| January 2014 | Summit on the Future of Undergraduate Education in the Geosciences (University of Texas, Austin). |
| 15 October, 2012 | Effective Strategies for Working with Students on the Autism Spectrum (TTU Teaching, Learning and Professional Development Center) |
| 16 August, 2012 | Will these be posted online? Note taking in the 21 st Century. Flipping out! Encouraging preparation before class for more discussion during class. <i>TTU Teaching Learning and Professional Development Jumpstart</i> |
| Spring semester 2012 | Semester long evaluation of teaching strategies and performance mentored by Dr. Suzanne Tapp (Director, TTU Teaching, Learning and Professional Development Center) and Dr. Michael Dini (TTU Teaching Academy). |
| 30 November, 2011 | Tuned-in teaching: recognizing and improving classroom dynamics (TTU Teaching, Learning and Professional Development Center) |
| 19 September, 2011 | If they write it, I have to grade it! Evaluating student writing (TTU Teaching, Learning and Professional Development Center) |
| 18 August, 2011 | The Many Hats We Wear (TTU Jumpstart Program) |
| 21 April, 2010 | Building an Exemplary On-Line Course (TTU Teaching, Learning and Technology Center) |
| 14-18 June, 2009 | Early Career Geoscience Faculty: Teaching, Research and Managing Your Career – a NSF/On the Cutting Edge sponsored workshop for aiding the Professional Development of Geoscience Faculty. |
| 2 Febraury, 2009 | Introduction to the Fundamentals of Blackboard (TTU Teaching, Learning and Technology Center) |

Appendix B

Teaching Portfolio

Fall Semesters 2008 – present

Earth Materials (GEOL-2303)/Mineralogy & Petrology (GEOL-3401) – Lecture and laboratory course introducing basic concepts in crystallography, descriptive mineralogy, rock description and identification, and discussing some of the fundamental processes and controls over rock and mineral composition and stability.

Spring Semesters 2011 – present

Introduction to Physical Geology (GEOL-1303) – Traditional lecture based general education course introducing concepts, processes and components of planet Earth.

Alternate Spring Semesters 2012 onwards

GCH 4308/5308 – Techniques and Applications in Mineral Sciences. Cross-listed course that combines theoretical aspects of crystallography and mineral science with the practical techniques applied to constrain and quantify mineral properties.

Alternate Spring Semesters 2011 onwards

Advanced Metamorphic Petrology – Lecture and discussion based course cover topics in metamorphic petrology, with particular focus on thermodynamic modelling, quantification and modeling of tectono-thermal processes, the role of fluids in mediating and promoting metamorphic reactions, and, high-temperature metamorphism, including partial melting and migmatization.

Spring Semesters 2009 – 2010

Special topic graduate courses in Geology and Geochemistry (GCH/GEOL – 5300) including:

- 1) Diagenesis and Low Grade Metamorphism
- 2) Applications of Radiogenic Isotopes

Fall Semester 2006

University of Massachusetts, Amherst: Lecturer of 300-level Mineralogy course for undergraduates. Classic mineralogy course covering basic concepts in crystallography and mineral optics, hand-sample mineral identification and thin section mineral identification and description. Student evaluations ranged from very good to excellent.

Teaching & Research Awards

2011 Outstanding Faculty Mentor Award, Center for Undergraduate Research

Appendix C

Publications (* - Graduate Student Author; † - Undergraduate Student Author)

Izawa, M.R.M., Dynes, J.J., Banerjee, N.R., Flemming, R.L., MacLean, L.C.W., Hetherington, C.J., Matveev, S. and Southam, G. (submitted): Cellular remains within microbial borings in ~120 Ma basaltic glass of the Ontong-Java Plateau. *Geology*.

Banerjee, N.R., Izawa, M.R.M., Flemming, R.L., Hetherington, C.J., Muehlenbachs, K., Shervais, J.C., Schultz, C. and Hanan, B.B. (submitted): Record of microbial activity in Jurassic (164 Ma) volcanic glass, Coast Range Ophiolite, California: linking modern seafloor bioalteration and Archean ichnofossils *Geology*.

Woodard, J. and Hetherington, C.J. (2014): Primary carbonatite in a post-collisional tectonic setting: geochronology and emplacement conditions at Naantali, SW Finland. *Precambrian Geology*, **240**, 97-104.

*Morsy, S., Hetherington, C.J. and Sheng, J.J. (2013): Effect of Low-Concentration HCl on the Mineralogical, Mechanical, and Physical Properties of Shale Rocks. *Journal of the Society of Petroleum Engineers*. SPE 165689-MS.

*Morsy, S., Sheng, J.J., Mohamed S.Y., Hetherington, C.J. and Ezewu, R.O. (2013): Impact of Matrix Acidizing on Shale Formations. *Journal of the Society of Petroleum Engineers*, SPE 167568.

Hetherington, C.J. and Dumond, G. (2013): Versatile monazite: Resolving geological records and solving challenges in materials science. *American Mineralogist*, **98**, 817-818.

Hetherington, C.J., Nakrem, H.A. and Potel, S. (2011): Note on the composition and mineralogy of Wenlock Silurian bentonites from the Ringerike District: Implications for local and regional stratigraphic correlation and sedimentary environments. *Norsk Geologisk Tidsskrift*, **91**, 181-192.

*Oalmann, J.A.G., Barnes, C.G. and Hetherington, C.J. (2011): Geology of the island of Ylvingen, Nordland, Norway and evidence for pre-Scandian (~475 Ma) exhumation in the Helgeland Nappe Complex. *Norsk Geologisk Tidsskrift*, **91**, 77-99.

Harlov, D.E., Wirth, R. and Hetherington, C.J. (2011): Fluid-mediated partial alteration in monazite: the role of coupled dissolution-reprecipitation in element redistribution and mass transfer. *Contributions to Mineralogy and Petrology*. **162**(2), 329–348

Williams, M.L., Jercinovic, M.J., Harlov, D.E., *Budzyń, B. and Hetherington, C.J. (2011) Resetting monazite ages during fluid-related alteration. *Chemical Geology*. **283**(3-4), 218–225

*Budzyń, B., Hetherington, C.J., Williams, M.L., Jercinovic, M.J. and Michalik, M. (2010): Monazite stability in gneiss pebbles from the Silesian Unit (Western Outer Carpathians, Poland). *Mineralogical Magazine*. **74**(4), 659–681

Hetherington, C.J., Harlov, D.E. and *Budzyń, B. (2010): Experimental metasomatism of monazite and xenotime: mineral stability, REE mobility and fluid composition. *Mineralogy and Petrology*. **99**, 165-184.

Harlov, D.E. and Hetherington, C.J. (2010): Metasomatic alteration of monazite: constraints on fluid chemistry and the dating of mass transport. *American Mineralogist*. **95**, 1105-1108.

*Roberts, R.J., Corfu, F., Torsvik, T.H., Hetherington, C.J. and Ashwal, L.D. (2010): Alkaline and carbonatitic magmatism coeval with mafic plutonism in the Seiland Igneous Province, Northern Norway: Age and palaeotectonic significance. *Journal of the Geological Society*. **167**(1), 71-81.

- Hetherington, C.J., Williams, M.L., Jercinovic, M.J. and Mahan, K. (2008): Understanding geologic processes with xenotime: composition, chronology, and a protocol for electron-probe micro-analysis. *Chemical Geology*. **254**, 133-147
- Hetherington, C.J. and Harlov, D.E (2008): Metasomatically induced formation of thorite and uraninite inclusions in xenotime and monazite from granite pegmatites, Hydra anorthosite massif, southwestern Norway: Mechanics and fluid chemistry. *American Mineralogist*. **93**, 806-820
- Hetherington, C.J., Lundmark M., Graeser, S. and Gieré, R. (2008): Late Ordovician magmatism and its role in the evolution of barium anomalies in the Berisal Complex. *International Journal of Earth Sciences*. **97**, 51-69.
- *Budzyń, B., Hetherington, C.J., Williams, M.L., Jercinovic, M.J., *Dumond, G. and Michalik, M. (2008): Application of electron probe micro-analysis U-Th-total Pb geochronology to provenance studies of sedimentary rocks: An example from the Carpathian Flysch. *Chemical Geology*. **254**, 148-163.
- Hetherington, C.J. and Villa, I.M. (2007): Barium silicates of the Berisal Complex: A study in geochronology and rare-gas release systematics. *Geochimica et Cosmochimica Acta*, **71**(13), 3336-3347 (doi:10.1016/j.gca.2007.05.001).
- Ashwal, L.D., Armstrong, R.C., *Roberts, R.J., Schmitz, M.D., Hetherington, C.J., Corfu, F., Burke, K. and *Gerber, M. (2007): Geochronology of large zircons from nepheline syenite gneisses as constraints on tectonic setting: an example from southern Malawi. *Contributions to Mineralogy and Petrology*, **153**(4), 389 - 403.
- Harlov, D.E., Wirth, R. and Hetherington, C.J. (2007): The relative stability of monazite and huttonite at 300 - 900°C and 200 - 1000 MPa: metasomatism and the propagation of metastable mineral phases. *American Mineralogist*, **92**, 1652-1664.
- Williams, M.L., Jercinovic, M.J. and Hetherington, C.J. (2007): The petrological and geochronological frontiers of monazite analysis. *Annual Review of Earth and Planetary Sciences*, **35**, 137-175.
- Hetherington, C.J. and Le Bayon, R. (2005): Bulk rock composition: a key to identifying invisible prograde reactions. *Schweizerische Mineralogische und Petrographische Mitteilungen*. **85**(1), 57-67.
- Hetherington, C.J., Nakrem, H.A. & Batchelor, R.A. (2004): The Bjørntvet Quarry metabentonite: A new Silurian correlation tool for the southwest Oslo Region. *Norsk Geologisk Tidsskrift*. **84**(4), 239-249.
- Hetherington, C.J., Mullis, J., Graeser, S. and Gieré (2003): The formation of armenite in the Berisal Complex, Simplon Region, Switzerland. *Schweizerische Mineralogische und Petrographische Mitteilungen*. **83**(3), 243-259.
- Hetherington, C.J., Gieré, R. and Graeser, S. (2003): Composition of barium-rich white micas from the Berisal Complex, Simplon Region, Switzerland. *The Canadian Mineralogist*. **41**, 1281-1291.
- Graeser, S., Hetherington, C.J. and Gieré, R. (2003): Ganterite, a new barium-dominant analogue of muscovite from the Berisal Complex, Simplon Region, Switzerland. *The Canadian Mineralogist*. **41**, 1271-1280.
- Armbruster, T., Berlepsch, P., Gnos, E. and Hetherington, C.J. (2002) Crystal chemistry and structure refinements of barian muscovites from the Berisal Complex, Simplon region, Switzerland. *Schweizerische Mineralogische und Petrographische Mitteilungen*. **82**(3), 537-548.

Published Abstracts (* - Graduate Student Author; † - Undergraduate Student Author)

†Watkins, T., Hetherington, C.J. and Beane, R.J. (2013): Crystal preferred orientation in quartz from the aureole of the Priest Pluton: distribution of microfabrics and impact on thermal conductivity. *Geological Society of America Abstracts with Programs*, 45(7).

*Olinger, D.A. and Hetherington, C.J. (2013): Quantifying the role of water in the migmatization of metapelitic units of the Ballachulish Igneous-Metamorphic Complex using phase diagrams. *Geological Society of America Abstracts with Programs*, 45(7).

*Hensley, S.A. and Hetherington, C.J. (2013): Lithological correlation with trace element abundances and monazite stability: implications for fluid availability in the metamorphic aureole of the Ballachulish Igneous Complex. *Geological Society of America Abstracts with Programs*, 45(7).

Hetherington, C.J. and Husdal, T. (2013): 400 Ma dates in a rare element NYF-pegmatite from Stetind, Nordland, Norway: Recrystallized Proterozoic assemblages or A-type pegmatite-emplacement in overly-thickened crust at a continental margin? *GAC-MAC Annual Meeting, Winnipeg, Program with Abstracts*, 31, 66-67.

†Berry, R.A., †Dyer, J., *Weiss, R.B., Hetherington, C.J. and Barnes, C.G. (2013): Correlation of the Rogue Volcanic and Chetco Intrusive Complex in the Klamath Mountains, SW Oregon. *Geological Society of America Abstracts with Programs*. 45(3), 79.

†Watkins, T. L., Hetherington, C.J., *Annasiwatta, A.-W. and Berg, J. (2012) Thermal conductivity in deformed quartzites: the role of mineral preferred orientation. *Abstract ED23B-0763 presented at 2012 Fall Meeting, AGU, San Francisco, California*.

*Romanoski, A., Hetherington, C., †Arendale, A. H., Barnes, C. G. and Cottle, J. M. (2012) Isotopic evidence for channel flow driven lower crustal refertilization beneath the Ruby Mountain-East Humboldt Metamorphic core complex. *Geological Society of America Abstracts with Programs*, 44(7), 129.

*Romanoski, A., Coint, N., Cottle J.M., Hetherington, C.J., Barnes C.G. (2011) The impact of chemical abrasion on trace element analysis of zircon by in situ micro-analytical techniques. *Abstract V31C-2532 presented at 2011 Fall Meeting, AGU, San Francisco, California*.

†Arendale, A.H., Hetherington, C.J., Barnes, C.G. and Cottle, J.M. (2011): Constraining the onset of Cretaceous Peraluminous magmatism in the Ruby Mountains, Nevada. *Geological Society of America Abstracts with Programs*, 43(4), 14.

†Ward, C.A. (III) and Hetherington, C.J. (2011): Greenstone rocks in the Mimbres Valley, Central New Mexico: Geologic significance for archaeological provenance. *Geological Society of America Abstracts with Programs*, 43(4), 68.

†Horton, B.A. and Hetherington, C.J. (2011): Quartz preferred orientation and its impact on thermal anisotropy in sandstone and quartzite. *Geological Society of America Abstracts with Programs*, 43(3), 9.

*McLachlin, B.R. and Hetherington, C.J. (2010): Accessory mineral texture development as a function of lithology: a case study from the Ballachulish Igneous Complex metamorphic aureole. *Geological Society of America Abstracts with Programs*, 42(5), 614.

†Werts, K. and Hetherington, C.J. (2010): Field relationships and zircon textures constrain relative timing of peraluminous magmatism in the Ruby Mountains, Nevada. *Geological Society of America Abstracts with Programs*, 42(2), 63.

Harlov, D. E., Williams, M., Jercinovic, M., Budzyn, B. and Hetherington, C.J. (2010): Partial alteration of monazite and xenotime during mineral-fluid interaction: implications for geochronology. *IMA 2010 - 20th General Meeting of the International Mineralogical Association (Budapest, Hungary 2010)*, 447.

Hetherington, C.J. (2009): Zircon, xenotime and monazite stability in evolving pegmatite fluids: implications for geochronometer stability in igneous and metamorphic systems. *Geological Society of America Abstracts with Programs*, 41(7), 113.

*Oalmann, J.A.G., Hetherington, C.J., *Marko, W.T. and Barnes, C.G. (2009): Thermodynamic modeling of metasedimentary rocks and diatexite, Helgeland Nappe Complex, Nordland, Norway. *Geological Society of America Abstracts with Programs*, 41(7), 636.

Hetherington, C.J., *Izawa, M.R.M., Flemming, R.L., and Kirby, C.W. (2008): Structure refinement and spectroscopic analysis of di-octahedral Ba-micas. *Geochimica et Cosmochimica Acta*, **72**(12S), A373.

†Kietäväinen, R., *Woodard, J., Eklund, O., Hetherington, C.J. and Boettcher, I (2008): Apatite as a petrogenetic indicator for lamprophyres and carbonatites. *Geochimica et Cosmochimica Acta*, **72**(12S), A469.

*Woodard, J., Hetherington, C.J. and Huhma, H. (2008): Sr, Sm and Nd isotope geochemistry and U-Th-Pb geochronology of the Naantali carbonatite, SW Finland. *Geochimica et Cosmochimica Acta*, **72**(12S), A469.

*Budzyń, B., Williams, M.L., Jercinovic, M.J., Hetherington, C.J. and *Dumond, G. (2008) Monazite Th-U-total Pb dating using electron microprobe – recent improvements of the method. *Dating of Minerals and Rocks X*. Lublin 23-24 October 2008. pp. 34-35.

Hetherington, C.J., Williams, M.L., Jercinovic, M.J., and Mahan, K. (2007): The mineralogy and petrology of xenotime: a bridge between monazite and zircon. *Mineralogica Polonica*, **30**, p. 74.

Hetherington, C.J. and Moser, D.E. (2007): Application of scanning electron-beam cathodoluminescence imaging and spectroscopy to the accessory minerals. *Mineralogica Polonica*, **30**, p. 26.

Hetherington, C.J., Williams, M.J., and Jercinovic, M.J. (2007): Application of electron microprobe trace element analysis to dating xenotime in high-fluid activity metamorphic rocks. *Frontiers in Mineral Sciences 2007, Cambridge, UK, Programme and Abstracts*, p. 90.

*Budzyń B., Hetherington C.J., Williams M.L., Jercinovic M.J., Dumond G., Michalik M. (2007) Increased precision in microprobe monazite geochronology: Implications for evolution of the crystalline rocks from the Silesian ridge (Western Outer Carpathians, Poland). *Mineralogica Polonica – Special Papers* **31**, 81-84.

*Budzyń B., Hetherington C.J., Williams M.L., Jercinovic M.J., *Dumond G., Michalik M. (2007): Application of electron beam techniques to provenance studies: Textural studies of metamorphic pebbles from the Silesian Unit, Poland. *Mineralogica Polonica – Special Papers* **30**, 22-23.

*Budzyń, B., Hetherington, C.J., Williams, M.L., Jercinovic, M.J., and Michalik, M. (2007): Monazite stability as a function of the silicate mineral assemblage in the presence of fluid. *European Geological Union General Assembly 2007, Geophysical Research Abstracts* **9**.

Williams, M.J., Jercinovic, M.J., *Dumond, G., and Hetherington, C.J. (2007): Monazite petrogenesis and geochronology by electron microprobe: Analytical challenges and applications for dating tectonic processes. *European Geological Union General Assembly 2007, Geophysical Research Abstracts* **9**.

Rehnström, E.F., Andersen, T.H. and Hetherington, C.J. (2007): U-Pb geochronology of the Tysfjord Granite and the Hundholmen Pegmatite: crystallisation, recrystallisation and ages of exotic U-bearing minerals. *NGF Abstracts and Proceedings, No. 1*.

- Williams, M.J., Jercinovic, M.J., *Dumond, G., and Hetherington, C.J. (2007): Microprobe monazite geochronology: Analytical challenges and powerful applications for dating tectonic processes. *Geological Society of America, Abstracts with Programs*, **39**(1).
- Harlov, D.E., Wirth, R. and Hetherington, C.J. (2006): Replacement of monazite by a huttonite component: nature and experiment. *Geochimica et Cosmochimica Acta*, **70**(18S), A231.
- Hetherington, C.J. (2006): Young inclusions in an old host: Dating alteration event through electron-beam techniques. *2006 AGU Joint Assembly, Baltimore, Program with Abstracts*, U41B-07.
- Hetherington, C.J. and Harlov, D.E. (2006): The role of high pH fluids in facilitating dissolution-precipitation reactions in pegmatite xenotime and monazite: Nature and experiment. *GAC-MAC Annual Meeting, Montreal, Program with Abstracts*, **31**, 66-67.
- Williams, M.J., Jercinovic, M.J., *Dumond, G., Mahan, K., and Hetherington, C.J. (2006): Microprobe monazite analysis: Integrating composition, texture, and chronology to characterize host-rock tectonics. *Geological Society of America, Abstracts with Programs*, **38**(7), 49.
- *Woodard, J. and Hetherington, C.J. (2006): The composition of fluorapatite and monazite from the Naantali Carbonatite, southwest Finland: implications for timing and conditions of carbonatite emplacement. *Litosfääri 2006, Espoo, Finland*.
- Hetherington, C.J. (2005): Dissolution-Reprecipitation of Xenotime and Simultaneous Growth of Thorite-Coffinite. *European Geological Union General Assembly 2005, Geophysical Research Abstracts* **7**, EUG05-A-01659.
- Hetherington, C.J. and Villa, I.M. (2004): Barium minerals of the Berisal complex, Switzerland: Age, tectonic implications, rare-gas release systematics and general importance for Ar-Ar geochronology. *GFF*, **126**(1), p. 68-69.
- Hetherington, C.J. (2003): Calcite crystal growth at the Dalen-Kjørholt limestone mine, southwest Oslo Region. *GAC-MAC-SEG Joint Meeting, Vancouver 2003, Abs.* 84.
- Hetherington, C.J., *Davies, N.S., Batchelor, R.A. and Nakrem, H.A. (2003): The Bjørntvet Brudd metabentonite. *NGF Abstracts and Proceedings, No. 1.* p. 41.
- Hetherington, C.J. and *Harstad, A.O. (2002): Calcite crystal growth at the Dalen-Kjørholt limestone mine, Southwest Oslo Region. *International Mineralogical Association, Program with Abstracts.* p. 213.
- Hetherington, C.J., Graeser, S., Schmidt, S. Th. and Gieré, R. (2001): Ganterite: A new barium dominant white-mica. *European Union of Geosciences, Journal of Conference Abstracts.* **6**(1), 551.
- Hetherington, C.J., Mullis, J., Gieré, R. and Graeser, S. (2001): Armenite formation in the Berisal Complex, Simplon, Switzerland. *European Union of Geosciences, Journal of Conference Abstracts.* **6**(1), 575.
- Hetherington, C.J., Gieré, R. and Graeser, S. (2001): Barium anomalies in the Berisal Complex, Simplon Area, Switzerland. *European Union of Geosciences, Journal of Conference Abstracts.* **6**(1), 608.
- Le Bayon, R. and Hetherington, C.J. (2001): Bulk rock chemistry: A key to identifying invisible prograde reactions. *European Union of Geosciences, Journal of Conference Abstracts.* **6**(1), 567.
- Hetherington, C.J., Graeser, S., Schmidt, S. Th. and Gieré, R. (2000): Barium-bearing white mica from the Wasenalp, Simplon, Switzerland, *Bericht der Deutschen Mineralogischen Gesellschaft Beihefte zum European Journal Of Mineralogy* **12**, p80.

Hetherington, C.J., Graeser, S. and Gieré, R. (1999): Armenite in metamorphic rocks from the Simplon area, Switzerland. *Schweizerische Mineralogische und Petrographische Mitteilungen* **79**, 319.

Meeting Abstracts († - Undergraduate Student Author)

†Gonzales, A.E. and Hetherington, C.J. (2013) Quantifying the Mineralogical and Compositional Response of Shale Oil and Gas Rocks to Matrix Acidification. *Poster Presentation at The 2013 AAPG Southwest Section Meeting, Fredericksburg, Texas.*

†Moore, L. M. and Hetherington, C. (2012) Cation charge controls on calcite crystal size and morphology: potential impact on reservoir rock cementation, porosity and permeability. *Poster Presentation at The 2012 AAPG Southwest Section Meeting, Fort Worth, Texas.*

†Watkins, T. L., Hetherington, C.J and Mills, T. (2012) Quartz Preferred Orientation and its Impact on Thermal Anisotropy in Sandstone and Quartzite," Regional. (May 2012). *Poster Presentation at The 2012 AAPG Southwest Section Meeting, Fort Worth, Texas.*

†Horton, B.A. and Hetherington, C.J. (2011): Quartz preferred orientation and its impact on thermal anisotropy in sandstone and quartzite. *National Conference on Undergraduate Research*, April 2011, Ithaca, NY.

Other Publications

Hetherington, C.J. (2006): Magic Mineralogy: Facing the challenges of the future. *Anglo-Norse Review*, Autumn 2006.

Hetherington, C.J. (2005): Magic Mineralogy: Norway's alternative geological economy. *Anglo-Norse Review*, Spring 2005, 48-51.

Graeser, S. and Hetherington, C.J. (2004): Ganterit – ein neues Mineral aus den Walliser Bergen. *Lapis* **29**(2), 37.

Hetherington, C.J. (2004): An ascent of the Bortelhorn, Simplon Region, Switzerland. *The Cairngorm Club Journal*, **21**(107), 112-114.

Hetherington, C.J. (1999): Travels in Southern Africa: A report on field-mapping in Botswana. *The Cairngorm Club Journal*, **20**(105), 358-361.

Hetherington, C.J. (2001): Barium anomalies in the Berisal Complex, Simplon Region, Switzerland (A study in mineralogy, petrology and geochemistry). *Unpublished PhD Thesis, University of Basel.*

Hetherington, C.J. (1997): Mapping and geochemical studies of the Moshaneng Complex, Moshaneng, Botswana. *Unpublished Honours Thesis, University of St. Andrews.*

Appendix D

Invited Talks

Investigating How Composition and Mineralogical Variability May Impact Completion and Production Results (July 2016, Permian Basin Geology and Geophysics Congress 2014, Houston, Texas).

Protracted versus punctuated peraluminous magmatism in metamorphic core complexes (February 2014, Sul Ross State University, Alpine, Texas).

Refining the magmatic history of a metamorphic core complex by chemical abrasion and in situ geochronology of accessory minerals (June 2012, University of St. Andrews, Scotland, United Kingdom)

The multi-stage history of magma production and emplacement in the crustal column beneath the Ruby Mountains-East Humboldt Range metamorphic core complex, Nevada. (March 2012, Tectonics Study Group, University California Santa Barbara, California)

Fluids and their role in accessory mineral texture development (May 2011, The University of Texas El Paso, El Paso, Texas).

From detritus to diagenesis: accessory mineral stability and textures and their role in provenance studies (December 2009, The University of Oklahoma, Norman, Oklahoma)

Monazite and xenotime reactivity in common geological fluids: trace element analysis, geochronology and monitoring geologic processes (April 2008, Miami University, Ohio)

Monazite and xenotime stability in metamorphic fluids: geologic processes, trace element analysis and geochronology (April 2008, Texas Tech University, Texas)

Monazite and xenotime stability in metamorphic fluids: geologic processes, trace element analysis and geochronology (February 2008, University of Western Ontario, Canada).

Trace element analysis by electron microprobe: pitfalls and practical applications (November 2007, Cambridge University, United Kingdom).

The mineralogy and petrology of xenotime: a bridge between monazite and zircon (September 2007, Jagiellonian University, Poland).

Application of scanning electron-beam cathodoluminescence imaging and spectroscopy to accessory phase minerals (September 2007, Jagiellonian University, Poland).

Metasomatic alteration of xenotime: the role of dissolution-reprecipitation in the formation of thorite and uraninite inclusions (October 2005, *GeoForschungs Zentrum*, Potsdam).

Magic Mineralogy: Norway's alternative geological economy (Feb 2005, Anglo-Norsk Society, Oslo).

The mineralogy of provenance studies (February 2005, University of Oslo).

Xenotime: A gem of a mineral (March 2005, University of Basel).

The occurrence of spectacular calcite crystals in southeast Norway, (May 2003, University of Giessen).

Other Presentations

Lubbock Gem and Mineral Society, March 2012
Accessory Minerals are Gems Too!

Contributions to Annual Meetings of the Swiss Society of Mineralogy and Petrology

2001 – Barium minerals from the Berisal Complex: Age, tectonic significance, rare-gas release systematics and general importance for Ar-Ar geochronology

2000 – Fluid evolution during quartz and armenite growth in late-stage Alpine type veins in the Berisal Complex, Simplon Region, Switzerland.

1999 – Barium-bearing white mica from the Wasenalp, Simplon, Switzerland.

University of Massachusetts, Professional Seminar

December 2005: Xenotime – A gem of a mineral!

October 2006: When zircon just doesn't work!

University of Oslo, Natural History Museums (Section for Geology) Winter Seminars

October 2004: Magma Mingling at Moshaneng, Botswana.

March 2004: Is Finnmark a missing piece of the Laurentia jig-saw?

S-AFRIKA Finnmark Project Meeting, July 2004, (Trondheim, Norway).

P-T conditions of Seiland Igneous Province emplacement and later metamorphism: lending support to the geochemical model.

Basel-Fribourg Colloquium 2000, (Basel, Switzerland).

Geochemistry and petrogenesis of barium anomalies in the Berisal Complex, Simplon Region, Switzerland.

Bern-Basel Colloquium 1999, (Bern, Switzerland).

Two barium-bearing white micas from two lithologies in the Berisal Complex.

Appendix E

Research Student Committee Chair and Under-Graduate Mentoring (listed in year of graduation)

Current Mentees: Stephen Nguyen (MS), Ethan Backus (MS), Annie Aaroe (MS), Fortune Usoro (BS)

- 2014 Stanley Hensley (MS) Lithological Correlation with Trace Element Abundances and Monazite Stability: Implications for Fluid Availability in the Metamorphic Aureole of the Ballachulish Igneous Complex.
Trudy Watkins (BS) Quartz preferred orientation and its impact on thermal conductivity in thermal aureoles.
Jacob Cobb (BS) Whole rock geochemical analysis of metapelites in the thermal aureole of the Ballachulish Igneous Complex.
Deborah Drennan (BS)
Alexander Lonzano (BS) X-Ray diffraction based determination of biotite compositions in garnet-absent thermally metamorphosed metapelites.
- 2013 Ryan Berry (BS) Trace element analysis of pyroxene
Jordan Dyer (BS) Major element analysis of volcanic and plutonic rocks
Brian Crass (BS) The mineralogical host of U in black-shales
Alexander Gonzales (BS) Quantifying the Mineralogical and Compositional Response of Shale Oil and Gas Rocks to Matrix Acidification
- 2012 Anthony Romanoski (MS) Geochronology of pegmatitic gneisses in the Ruby Mountains
Laura Moore (BS) Cation charge effect on calcite crystal size and morphology
- 2011 B. Rex McLachlin (MS) Mapping and petrography of the York Butte quadrangle, OR.
J. Walter Dunn (BS) Quartz and zircon textures in the San Angelo Formation
Charles Ward (BS) Composition of “green-stone” rocks in the Mimbres Valley, NM
Avery H. Arendale (BS) Geochronology of banded gneisses, Ruby Mountains, NV
- 2010 Brian Horton (BS) Thermal conductivity studies of quartzites
- 2009 Kevin Werts (BS) Zircon petrography at Liberty Pass, Ruby Mountains, NV
Joseph Yoklavich (BS) Rare element minerals from the Hundholmen pegmatite
- 2007 Junior supervisor to Bartosz Budzyn (Ph.D., Jagiellonian University). *Project:* Accessory mineral reactions and reconstructing the metamorphic evolution of the Western Outer Carpathian basin source rocks.
- Jan. 2006 Committee member for Don Lac (M.Sc., University of Massachusetts). *Project:* Fe²⁺/Fe³⁺ distribution in plagioclase and the correlation with oxygen fugacity in magmas.
- 2004 Junior supervisor to Tor Aas (M.Sc., University of Oslo). *Project:* The micro-structural and metamorphic evolution of the Ardencaple Fjord Region, East Greenland.
- 2003 – 2006 Junior supervisor to R. James Roberts (Ph.D., University of the Witwatersrand). *Project:* U-Pb chronology of the Seiland Igneous Province, Northern Norway.

Graduate Student Committees (students listed in the year of their graduation)

Current Committee Memberships: Jeremy Deans (Ph.D.), Samantha Buck (MS), Hollee Baird (MS), David Brannan (MS)

- 2014 Rachel Weiss (MS), Jennifer Riedel (MS), Jared Stoffel (MS), Samiha Morse (Ph.D., Department of Petroleum Engineering)

2013 Jacob Leader (MS)

2012 Nolwenn Coint (Ph.D.), Danielle Olinger (MS), Brendan Hargrove (MS)

2010 Jian Zhou (MS), Jeremy Deans (MS).

2009 Jeffery Oalman (MS).

Appendix F

Service

Chair, Department of Geosciences Graduate Committee, Texas Tech University (2014 – present).

Member of the Mineralogical Society of America Distinguished Lecture Series Committee (2014-2016).

National Research Foundation South Africa, External Applicant Rating Reviewer (2013).

Convenor of topical session T221: The Development, Application, and Value of Phase Diagrams for Understanding High-Temperature Crustal and Upper Mantle Rocks, 2013 Geological Society of America Annual Meeting.

Convenor of topical session T133: Getting to the Root of It: Metamorphism, Tectonics, and Crustal Evolution at the 2012 Geological Society of America Annual Meeting.

Associate Editor to The American Mineralogist with responsibility for compiling special issue on Monazite entitled “Versatile monazite: Resolving geological records and solving challenges in materials science (Dec 2011 – present)

Panellist: Texas Tech University Tenure Academy – Surviving the 3rd Year Review (16 November, 2011).

Presenter: Communicating with the Net Generation – What is successful mentoring? (20 October, 2011)

Convenor of topical session T31: Monazite: the ultimate geologic record at the 2011 Geological Society of America Annual Meeting.

Member of the Graduate Committee, Department of Geosciences, Texas Tech University (2009 – Present)

Texas Tech University Center for Undergraduate Research Advisory Committee (2010 – 2012)

Member of Texas Tech University Radiation License and Safety Committee (2010 – Present)

Member, Dean's of Engineering and Arts & Sciences, Materials Characterization Task Force (2011 – 2012).

Chair of the TTU Geosciences Research Day organizing committee (2009 – 2014).

Member of Texas Tech Bicycling Co-ordination committee (2009 – Present).

Convenor of topical session T76: Continuous, Discontinuous and Disequilibrium Reactions during the Crystallization of Heavy-Element Enriched Pegmatites at 2009 Geological Society of America Annual Meeting.

Reviewer for American Mineralogist (6), Applied Geochemistry (1) Cambridge University Press (book review – 1), Chemical Geology (1), Computers in Geoscience (1), Contributions to Mineralogy and Petrology (4), Earth and Planetary Science Letters (1), Estonian Journal of Earth Sciences (1), European Journal of Mineralogy (2), Geological Society of America Bulletin (1), Geology (1), GFF (1), Geostandards and Geoanalytical Research (2), Geosphere (1), Lithos (5), Mineralogia (2), Mineralogical Magazine (2), Mineralogy & Petrology (2), Minerals (1), Scanning (3), Terra Nova (1), and the U.S. National Science Foundation (6).

Convener, University of Oslo, Natural History Museums (Section for Geology) Winter Seminar Series (2002-2003, 2003-2004, 2004-2005)

Book prospectus and chapter reviewer for publishing houses that include Cambridge University Press, Oxford University Press, and Waveland Press.

Abstract reviewer: 13th Annual University of Massachusetts Undergraduate Research Conference (2006).

Scientific Advisor: University of Oslo, Natural History Museums, Laboratory Refurbishment program.

- Establishment of a new Scanning Electron Microscopy laboratory, with energy dispersive and cathodoluminescence detectors.
- Restructuring of optical microscopy suite, with responsibility for purchasing new binocular and petrographic microscopes, digital and CCD cameras, monitors, and digital image processing systems.
- Refurbishment of rock-preparation and thin-section workshop.

Professional Affiliations

Fellow of the Geological Society of London

Member of the American Geophysical Union

Member of the Edinburgh Geological Society

Member of the Mineralogical Society of America

Member of the Mineralogical Association of Canada

Member of the Swiss Society of Mineralogy and Petrology

Appendix G

Successful Research Funding and Grants

- 2011 Trace element mobility in the sub-solidus: Accessory mineral stability, fluids and the role of the rock (\$184,159 from NSF-EAS Petrology and Geochemistry).
- 2005 *GeoForschungsZentrum* Research Grant for travel, accommodation and stipend to complete experimental studies on monazite and xenotime.
- 2004 University of Oslo Travel Fund (NOK 9,500) to support travel and attendance of Goldschmidt 2004, Copenhagen.
- 2003 University of Oslo Travel Fund (NOK 17,000) to support travel and attendance of short course (Fluid inclusions: Analysis and Interpretation) and GAC-MAC-AEG 2003 Joint Meeting, Vancouver.
- 2002 International Mineralogical Association Young Scientist Bursary (GBP 325.00) to support attendance of IMA 2002, Edinburgh.
- University of Oslo Travel Fund (NOK 8,000) to support travel and attendance of IMA 2002, Edinburgh.
- 2000 Basel *Freiwillige Akademische Gessellschaft* (CHF 6,000) to support stipend, travel and publication expenses associated with the completion of Ph.D.
- Grant 20-46906.00 (CHF 14,000) from the Swiss National Research Foundation to provide stipend and publication expenses associated with the completion of Ph.D.

Research Funding and Grants (declined)

- 2014 Structural and Tectonothermal Evolution of the Roots of the Nevadaplano: The Wood Hills-East Humboldt Range Crustal Section, NE Nevada (\$235,792 from NSF-EAS Tectonics).
- Tracking Mesozoic Lower Crustal Evolution of the Klamath Mountain Accretionary Province--Testing Relamination (\$379,316.00 from NSF-EAS Petrology and Geochemistry).
- 2013 Rates and timing of magmatism, Ruby Mountains, NV (\$22,300 from TTU Proposal Stimulus Program).
- 2012 Magmatism and deep-crustal flow in the Ruby-East Humboldt-Woods Hill metamorphic core complex (\$220,811 from NSF-EAS Tectonics).
- 2011 Sub-solidus controls on crystal growth (\$81,775.00 requested from Norman Hacker Advanced Research Program).
- Age and Petrogenesis of REE-Bearing Carbonatites, Bear Lodge Complex, NE Wyoming (\$89,725 requested from US Department of the Interior – USGS).
- 2010 Understanding the origins of diverse and protracted granitic magmatism in the Great Basin from detailed accessory phase petrography (\$318,027 requested from NSF-EAS Petrology and Geochemistry).

- 2009 Non-destructive analysis and examination of high-value archaeological material: tracking trade using hafted greenstone axes in the Mogollon cultures of the Mimbres Valley (\$67,843 requested from NSF Division of Behavioral and Cognitive Sciences – Archaeometry).
- Geology and field relations of the Chetco plutonic complex, Klamath Mountains (\$13,365 requested from EDMAP – The Educational Component of the National Cooperative Geologic Mapping Program).
- Understanding the origins of diverse and protracted granitic magmatism in the Great Basin from detailed accessory phase petrography (\$250,084 requested from NSF-EAS Petrology and Geochemistry).
- Acquisition of a scanning micro-X-ray fluorescence spectrometer for compositional and textural analysis of geologic materials (\$256,085 requested from NSF-EAS Instrumentation and Facilities).
- 2008 Geochemical Society award to aid travel and attendance of the Goldschmidt Conference.

Appendix H

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