

Curriculum Vitae
Geoffrey Hamilton Howarth (Ph.D.)

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1. Academic Qualifications

2010-2012 **Rhodes University, Grahamstown, South Africa**

Degree **Ph.D.: Geology**

- Post-graduate degree by thesis entitled “Petrogenesis of the Panzhihua mafic layered Intrusion, SW China: Implications for Fe-Ti oxide ore forming processes.”
- The work involved radiogenic isotope analysis of the Panzhihua intrusion as well as mineral compositional analysis, whole-rock geochemistry, stable isotope geochemistry, PGE geochemistry along with detailed thermodynamic modeling using the program PELE in order to constrain Fe-Ti oxide ore-forming process at the Panzhihua intrusion.
- Supervisor: Dr. Steve Prevec and Dr. Mei-Fou Zhou (Co-supervisor based in Hong Kong)
- Funded by a South African National Research Foundation (NRF) Scarce Skills scholarship for 2010-2012 (~\$20,000.00).
- Resulted in five peer-reviewed publications (Howarth et al., 2013; Howarth and Prevec, 2013a; Howarth and Prevec, 2013b; Zhou et al., 2013; Ganino et al., 2013 – See publication list).

2008-2009 **Rhodes University, Grahamstown, South Africa**

Degree **Master of Science: Geology**

- Post-graduate degree by thesis entitled “Geology of the Kroonstad Kimberlite Cluster” with emphasis on near surface emplacement (Volcanology) of the Voorspoed and Lace Group II kimberlites.
- Supervisors: Dr. John Moore and Mr. Mike Skinner
- Resulted in three peer-reviewed publications (Howarth et al., 2011; Howarth and Skinner, 2012; Howarth and Skinner, 2013)

2007 **Rhodes University, Grahamstown, South Africa**

Degree **Bachelor of Science (Honours): Geology**

- Post-graduate degree by coursework and thesis in a variety of geological subjects. Thesis entitled “Estimating erosion of Group II kimberlite pipes and palaeo-distribution of the Karoo Supergroup in the Free State province of South Africa, using upper-crustal xenoliths.”
- Supervisor: Dr. John Moore
- Resulted in one peer-reviewed publication (Hanson et al., 2009)

2004-2006 **Rhodes University, Grahamstown, South Africa**

- Degree** **Bachelor of Science**
- Undergraduate degree majoring in Geology and Environmental Science.

2. Work Experience

Accepted position: Assistant Professor in Igneous Petrology
Date: Due to start in January 2018
Department: Department of Geology
Address: Department of Geology, 210 Field Street, University of Georgia, Athens, GA 30602-2501.

Current position: Post-doctoral Research Associate
Date: July 2015 - present
Department: Department of Geological Sciences
University: University of Cape Town (South Africa)
Address: Department of Geological Sciences, University Avenue, Upper Campus. Rondebosch 7701. Cape Town, RSA.

Position: Post-doctoral Research Associate
Date: February 2013 – March 2015
Department: Department of Earth and Planetary Science
University: University of Tennessee, Knoxville
Address: Department of Earth and Planetary Sciences, 1412 Circle Drive, 306 EPS Building. Knoxville, TN, 37996.

3. Publication Record (Google Scholar h-index = 10)

3.1 Peer-reviewed Journal Articles

1. **Howarth, G. H.**, Day, J. M., Pernet-Fisher, J. F., Goodrich, C. A., Pearson, D. G., Luo, Y., Ryabov, V. V., & Taylor, L. A. **2017**. Precious metal enrichment at low-redox in terrestrial native Fe-bearing basalts investigated using laser-ablation ICP-MS. *Geochimica et Cosmochimica Acta*, 203, 343-363.
2. Pernet-Fisher, J. F., Day, J. M., **Howarth, G. H.**, Ryabov, V. V., & Taylor, L. A. **2017**. Atmospheric outgassing and native-iron formation during carbonaceous sediment–basalt melt interactions. *Earth and Planetary Science Letters*, 460, 201-212.
3. Udry, A., **Howarth, G. H.**, Lapen, T. J., & Righter, M. **2017**. Petrogenesis of the NWA 7320 enriched martian gabbroic shergottite: Insight into the martian crust. *Geochimica et Cosmochimica Acta*, 204, 1-18.
4. **Howarth, G.H.** & Udry, A. **2017**. Trace elements and the petrogenesis of the intermediate, olivine-phyric shergottite NWA 10170. *Meteoritics and Planetary Science* DOI: 10.1111/maps.12799.
5. **Howarth, G. H.** & Taylor, L. A. **2016**. Multi-stage kimberlite evolution tracked in zoned olivine from the Benfontein sill, South Africa. *Lithos*, 262, 384-397.
6. Jean, M. M., Taylor, L. A., **Howarth, G. H.**, Peslier, A. H., Fedele, L., Bodnar, R. J., Y Guan, LS Doucet, DA Ionov, AM Logvinova, AV Golovin, & Sobolev, N.V. **2016**. Olivine inclusions in Siberian diamonds and mantle xenoliths: Contrasting water and trace-element contents. *Lithos* 265, 31-41.
7. **Howarth, G. H.**, Liu, Y., Chen, Y., Pernet-Fisher, J. F., & Taylor, L. A. **2016**. Postcrystallization metasomatism in shergottites: Evidence from the paired meteorites

- LAR 06319 and LAR 12011. *Meteoritics & Planetary Science*. DOI: 10.1111/maps.12576
8. Taylor, L. A., Logvinova, A. M., **Howarth, G. H.**, Liu, Y., Peslier, A. H., Rossman, G. R., Guan, Y., Chen, Y., & Sobolev, N. V. **2016**. Low water contents in diamond mineral inclusions: Proto-genetic origin in a dry cratonic lithosphere. *Earth and Planetary Science Letters*, 433, 125-132.
 9. **Howarth, G. H.**, Pernet-Fisher, J. F., Bodnar, R. J., & Taylor, L. A. **2015b**. Evidence for the exsolution of Cl-rich fluids in Martian magmas: Apatite petrogenesis in the enriched lherzolitic shergottite Northwest Africa 7755. *Geochimica et Cosmochimica Acta*, 166, 234-248.
 10. **Howarth, G. H.**, Sobolev, N. V., Pernet-Fisher, J. F., Ketcham, R. A., Maisano, J. A., Pokhilenko, L. N., Taylor, D., & Taylor, L. A. **2015a**. 3-D X-ray tomography of diamondiferous mantle eclogite xenoliths, Siberia: A review. *Journal of Asian Earth Sciences*, 101, 39-67.
 11. Logvinova, A. M., Taylor, L. A., Fedorova, E. N., Yelisseyev, A. P., Wirth, R., **Howarth, G.H.**, Reutsky, V.N., & Sobolev, N. V. **2015**. A unique diamondiferous peridotite xenolith from the Udachnaya kimberlite pipe, Yakutia: role of subduction in diamond formation. *Russian Geology and Geophysics*, 56(1), 306-320.
 12. Pernet-Fisher, J. F., **Howarth, G. H.**, Pearson, D. G., Woodland, S., Barry, P. H., Pokhilenko, N. P., Pokhilenko, L.N. , Agashev, A.M., & Taylor, L. A. **2015**. Plume impingement on the Siberian SCLM: Evidence from Re–Os isotope systematics. *Lithos*, 218, 141-154.
 13. Barry, P. H., Hilton, D. R., Day, J. M., Pernet-Fisher, J. F., Howarth, G. H., Magna, T., & Taylor, L. A. **2015**. Helium isotopic evidence for modification of the cratonic lithosphere during the Permo-Triassic Siberian flood basalt event. *Lithos*, 216, 73-80.
 14. **Howarth, G.H.**, Pernet-Fisher, J.F., Balta, J.B., Barry, P.H., Bodnar, R.J., & Taylor, L.A. **2014c**. Two-stage polybaric formation of the new enriched, pyroxene-oikocrystic, lherzolitic shergottite, NWA 7397. *Meteoritics and Planetary Science*, 49, 1812-1830.
 15. Pernet-Fisher, J.F., **Howarth, G.H.**, Liu, Y., Chen, Y., & Taylor, L.A. **2014**. Estimating the lunar mantle water budget from phosphates: Complications associated with silicate-liquid-immiscibility. *Geochimica et Cosmochimica Acta*, 144, 326-341.
 16. **Howarth, G.H.**, Sobolev, N.V., Pernet-Fisher, J.F., Barry, P.H., Penumadu, D., Puplampu, S., Ketcham, R.A., Maisano, J.A., Taylor, D., & Taylor, L.A. **2014b**. The secondary origin of diamonds: multi-modal radiation tomography of diamondiferous mantle eclogites. *International Geology Reviews*, 56(9), 1172-1180.
 17. Pernet-Fisher, J.F., **Howarth, G.H.**, Liu, Y., Barry, P.H., Carmody, L., Valley, J.W., Bodnar, R.J., Spetsius, Z.V., & Taylor, L.A. **2014**. Komsomolskaya diamondiferous eclogites: Evidence for oceanic crustal protoliths. *Contributions to Mineralogy and Petrology*, 167, 981-998.
 18. **Howarth, G.H.**, Barry, P.H., Pernet-Fisher, J.F., Baziotis, I., Pokhilenko, N.P., Pokhilenko, L.N., Bodnar, R.J., Taylor, L.A., & Agashev, A.V. **2014a**. Superplume metasomatism: Evidence from Siberian mantle xenoliths. *Lithos*, 184-187, 209-224.
 19. **Howarth, G.H.** & Skinner, E.M.W. **2013**. Coherent Kimberlite at the Lace and Voorspoed (Group II) Kimberlite Pipes, Kroonstad Cluster, South Africa: Implications for root zone processes in the development of kimberlite pipes. *Journal of Volcanology and Geothermal Research*, 268, 1-16.
 20. **Howarth, G.H.** & Prevec, S.A. **2013b**. Trace element, PGE, and Sr-Nd isotope geochemistry of the Panzhihua mafic layered intrusion, SW China: Constraints on ore-

- forming processes and evolution of parent magma at depth in a plumbing-system. *Geochimica et Cosmochimica Acta*, 120, 459-478.
21. **Howarth, G.H.**, Prevec, S.A., & Zhou, M-F. **2013**. Timing of Ti-magnetite crystallization and silicate disequilibrium in the Panzhihua mafic layered intrusion: Implications for ore-forming processes. *Lithos*, 170-171, 73-89.
 22. **Howarth, G.H.** & Prevec, S.A. **2013a**. Hydration vs. oxidation: Modelling implications for Fe-Ti oxide crystallization in mafic intrusions, with specific reference to the Panzhihua intrusion, SW China. *Geoscience Frontiers* (Special Edition on the Panzhihua Intrusion), 4, 555-569.
 23. Ganino, C., Harris, C., Arndt, N.T., Prevec, S.A., & **Howarth, G.H.** **2013**. Assimilation of carbonate country rock by the parent magma of the Panzhihua Fe-Ti-V deposit (SW China): Evidence from stable isotopes. *Geoscience Frontiers* (Special Edition on the Panzhihua Intrusion), 4, 547-554.
 24. Zhou, M-F., Chen, W.T., Wang, C.Y., Prevec, S.A., Liu, P.P., & **Howarth, G.H.** **2013**. Two stages of immiscible liquid separation in the formation of Panzhihua-type Fe-Ti-V oxide deposits, SW China. *Geoscience Frontiers* (Special edition on the Panzhihua Intrusion), 4, 481-502.
 25. **Howarth, G.H.** & Skinner, E.M.W. **2012**. The geology and emplacement of the volcanoclastic infill at the Voorspoed Group II kimberlite (orangeite) pipe, Kroonstad cluster, South Africa. *Journal of Volcanology and Geothermal Research*, 231-232, 24-38.
 26. **Howarth, G.H.** & Skinner, E.M.W. **2011**. Petrology of the hypabyssal kimberlite of the Kroonstad Group II kimberlite (orangeite) cluster, South Africa: Evolution of the magma within the cluster. *Lithos*, 125, 795-808.
 27. Hanson, E.K., Moore, J.M., Bordy, E.M. Marsh, J.S., **Howarth, G.**, & Robey, J.V.A. **2009**. Cretaceous erosion in central South Africa: Evidence from upper-crustal xenoliths in kimberlite diatremes. *South African Journal of Geology*, 112, 125-140.

3.2 Invited Talks/Seminars

1. **Howarth, G.H.**, Taylor, L.A., and Harris, C. **2017**. Diamonds, kimberlites, and eclogites from the lithospheric mantle. *Seminar Series 2017: University of Nevada, Las Vegas*.
2. **Howarth, G.H.**, Pernet-Fisher, J.F., Sobolev, N.V., Penumadu, D., Puplampu, S., Ketcham, R.A., Maisano, J., Taylor, D.S., & Taylor, L.A. **2014**. 3D Tomography of diamondiferous xenoliths, Siberia. *Seminar Series 2014: Geophysical Laboratory, Carnegie Institution of Washington*.
3. **Howarth, G.H.**, Skinner, E.M.W., & Taylor, L.A. **2014**. Near-surface kimberlite emplacement in Southern Africa. *Seminar Series 2014: University of Tennessee, Knoxville*.

3.3 First author Conference Oral Presentations

1. **Howarth, G. H.**, & Udry, A. **2017**. Nickel in Olivine and Constraining Mantle Reservoirs for Shergottite Meteorites. *Lunar and Planetary Science Conference (LPSC), Houston, TX*.
2. **Howarth, G.H.**, Pernet-Fisher, J.F., Bodnar, R., & Taylor, L.A. **2015**. Apatite and merrillite petrogenesis in the new enriched lherzolitic shergottite NWA 7755. *Lunar and Planetary Science Conference (LPSC), Houston, TX*.
3. **Howarth, G.H.**, Sobolev, N.V., Pernet-Fisher, J.F., Barry, P., & Taylor, L.A. **2014**. X-ray tomography pseudo thin section textural analysis of diamondiferous mantle eclogites. *International Mineralogical Association (IMA) 2014, Johannesburg*.
4. **Howarth, G.H.**, Pernet-Fisher, J.F., Sobolev, N.V., Penumadu, D., Puplampu, S., Ketcham, R.A., Maisano, J., Taylor, D.S., & Taylor, L.A. **2013**. Tomography of diamondiferous

- xenoliths from Yakutia. *Deep Carbon Observatory-III International Conference: Crystallogenes and Mineralogy, Novosibirsk*.
5. **Howarth, G.H.**, Prevec, S.A. & Zhou, M-F. **2013**. Silicate disequilibrium and the formation of oxide ore layers, Panzhihua intrusion, SW China. Igneous and Metamorphic Studies Group (IMSG). Oral Presentation.
 6. **Howarth, G.H.** & Skinner, E. M. W. **2012**. Sub-volcanic development of embryonic kimberlite pipes: Evidence from the Lace and Voorspoed Group II kimberlites (orangeites), South Africa. 10th International Kimberlite Conference (10IKC), Bangalore. Oral Presentation.
 7. **Howarth, G.H.**, Prevec, S. A. & Zhou, M-F. **2012**. Timing of Ti-magnetite crystallisation at the Panzhihua Intrusion, SW China: Implications for the genesis of massive magnetite layers. Igneous and Metamorphic Studies Group Annual Conference (IMSG). Oral Presentation.
 8. **Howarth, G.H.** & Skinner, E.M.W. **2011**. The geology and emplacement of the volcanoclastic infill at the Voorspoed Group II kimberlite (orangeite) pipe, Kroonstad cluster, South Africa. Igneous and Metamorphic Studies Group Annual Conference (IMSG). Oral Presentation.
 9. **Howarth, G.H.** & Skinner, E.M.W. **2010**. Sub-volcanic development of embryonic kimberlite pipes. Igneous and Metamorphic Studies Group Annual Conference (IMSG). Oral Presentation.

3.4 Conference abstracts

1. **Howarth, G.H.**, Liu, Y., Kohl, I., Pernet-Fisher, J.F., Wetteland, C., Chen, Y., Bodnar, R.J., Young, E.D., & Taylor, L.A. **2015**. Heterogeneous olivine-phyric to pyroxene-phyric textures in the paired shergottites LASR 12095 and LAR 12240. *Lunar and Planetary Science Conference (LPSC), Houston, TX*.
2. **Howarth, G.H.**, Day, J., Goodrich, C., Pernet-Fisher, J.F., Pearson, D.G., & Taylor, L. A. **2014**. PGE abundances and Re-Os isotope systematics of Native-Fe bearing basaltic rocks and their carbonaceous crustal contaminants: Insights into magma plumbing-system dynamics in LIPs. *AGU 2014, San Francisco. V51C-4768*.
3. Taylor, L.A., **Howarth, G.H.**, Logvinova, A., Reutsky, V., Fedorova, E., Ketcham, R., Wirth, R., & Sobolev, N.V. **2014**. X-ray tomography of the most diamondiferous peridotite: A unique xenolith from Udachnaya. *AGU 2014, San Francisco. V13A-4748*.
4. Barry, P., Hilton, D., Day, J., Pernet-Fisher, J.F., **Howarth, G.H.**, & Taylor, L.A. **2014**. Helium isotopes of the Siberian sub-continental lithospheric mantle: Insights from eclogite xenoliths. *AGU 2014, San Francisco. V43C-4889*.
5. **Howarth, G.H.**, Pernet-Fisher, J.F., Barry, P.H., Goodrich, C.A., Pearson, D.G., Day, J.M.D., Ryabov, V.V., & Taylor, L.A. **2014**. PGE enrichments of native-Fe-alloy immiscible liquids in basaltic magmas. *The 24nd V.M.Goldschmidt Conference, Sacramento, 2014*.
6. **Howarth, G.H.**, Pernet-Fisher, J.F., Barry, P.H., Bodnar, R.J., & Taylor, L.A. **2014**. Petrology of the new Martian meteorite NWA 7397: Two stages of formation. *Lunar and Planetary Science Conference (LPSC), Houston, TX*.
7. **Howarth, G.H.**, Pernet-Fisher, J.F., Barry, P.H., Pewitt, M., Bodnar, R.J., McSween, H.Y., & Taylor, L.A. **2014**. Tupelo EL6 chondrite: Lithophile element abundances in sulfides and metals. *Lunar and Planetary Science Conference (LPSC), Houston, TX*.
8. Barry, P.H., Pernet-Fisher, J.F., **Howarth, G.H.**, Day, J.M.D., & Taylor, L.A. **2014**. Highly reduced HSE-rich metallic-Fe deposits in the Siberian trap basalts: An analogy of extraterrestrial conditions? *Lunar and Planetary Science Conference (LPSC), Houston, TX*.
9. Pernet-Fisher, J.F., Liu, Y., Guan, Y., Chen, Y., **Howarth, G.H.**, & Taylor, L.A. **2014**. The significance of OH contents of lunar apatites. *Lunar and Planetary Science Conference Abstract*.

10. Pernet-Fisher, J.F., **Howarth, G.H.**, Barry, P.H., Bodnar, R.J., & Taylor, L.A. **2014**. The extent of aqueous alteration within the Jbilet Winselwan CM2 chondrite. *Lunar and Planetary Science Conference (LPSC), Houston, TX*.
11. **Howarth, G.H.**, Pernet-Fisher, J.F., Sobolev, N.V., Penumadu, D., Puplampu, S., Ketcham, R.A., Maisano, J., Taylor, D.S., & Taylor, L.A. **2013**. 3D neutron and X-ray imaging of diamondiferous eclogites, Siberia: Evidence for the secondary origin of diamonds. *AGU 2013, San Francisco*.
12. Taylor, L.A., **Howarth, G.H.**, Barry, P.H., Pernet-Fisher, J.F., Baziotis, I.P., Pokhilenko, N.P., Pokhilenko, L.N., & Bodnar, R.J. **2013**. Superplume metasomatism: Evidence from Siberian mantle xenoliths. *AGU 2013, San Francisco*.
13. Barry, P.H., Hilton, D.R., **Howarth, G.H.**, Pernet-Fisher, J.F., Day, J.M.D., & Taylor, L.A. **2013** Helium isotope evidence for plume metasomatism of Siberian continental lithosphere. *AGU 2013, San Francisco*.
14. Pernet-Fisher, J.F., Pearson, D.G., Barry, P.H., **Howarth, G.H.**, Pokhilenko, N.P., & Taylor, L.A. **2013**. Re-Os systematics of the Siberian lithosphere: Evidence for melt percolation and lithospheric re-fertilization. *AGU 2013, San Francisco*.
15. Logvinova, A.M., Reutsky, V.N., Fedorova, E.N., Wirth, R., **Howarth, G.H.**, Taylor, L.A., & Sobolev, N. V. **2013**. A unique diamondiferous peridotite xenolith from Udachnaya: Evidence for subduction. *Deep Carbon Observatory-III International Conference: Crystallogenes and Mineralogy, Novosibirsk, Abstract*.
16. **Howarth, G.H.**, Prevec, S.A. & Zhou, M-F. **2012**. Magnetite crystallisation in the Panzhihua Intrusion, SW China: constraints from petrography, geochemistry and H₂O-fO₂ modelling. *The 22nd V.M.Goldschmidt Conference, Montreal. Poster at workshop on "Processes that control the composition of Fe-oxides in ore deposits."*

4. Funding – Received and Pending

4.1 Received

- Claude Leon Foundation Post-doctoral research scholarship 2015-2016.
 - \$34,800.00
- University Research Center (URC) post-doctoral research scholarship from the University of Cape Town 2015-2016
 - \$16,300.00
- South African National Research Foundation (NRF) Scarce Skills post-doctoral research scholarship 2013-2014 (turned down for a post-doc at the University of Tennessee)
 - ~\$32, 600.00

4.2 Pending Research Proposals

- NASA Solar Systems Working grant as Co-PI with PI Dr. Arya Udry
 - Revised version to be submitted for a second time in February 2017.

5. Synergistic Activities

- Reviewer for peer-reviewed journals, including:
 - Lithos, Geochimica et Cosmochimica Acta, Chemical Geology, Journal of Asian Earth Sciences, Ore Geology Reviews.
- Graduate TA manager. Responsible for organizer schedules and grading for TAs during undergraduate laboratories at Rhodes University 2011-2012.

6. Research Experience

6.1 Analytical Experience

- Secondary Ionizing Mass Spectrometry (SIMS) – Collaborator Yang Liu and Yunbin Guan
 - California Institute of Technology (CalTech).
 - SIMS used to analyze the water content of olivine inclusions in diamonds.
- Scripps Isotope Geochemistry Laboratory – Collaborator James Day
 - Thermal ionization mass spectrometry (TIMS) for Os-isotope analysis of native-Fe bearing basaltic rocks from Siberia.
- Laser Ablation Inductively Couple Mass Spectrometry (LA-ICP-MS)
 - Virginia Tech with collaborator Robert Bodnar.
 - University of Cape Town.
- High Resolution X-ray Computed Tomography Laboratory – Collaborator Richard Ketcham
 - University of Texas, Austin, for the analysis of diamondiferous eclogite xenoliths from Siberia.
- Electron Microprobe Analysis
 - University of Cape Town.
 - University of Tennessee.
 - Rhodes University.

7. Teaching and Supervision Experience

7.1 Teaching Experience

- **2016 – MSc Exploration Course Rhodes University – Kimberlite Course.** Course organizer. I taught all sections related to near-surface eruption of kimberlite pipes as well as general kimberlite petrography, including practical lab sessions on kimberlite identification and description using a microscope.
- **2016 – BS Honors students (4th year student) field trip organizer.** Two week field excursion to visit geological sites of interest around South Africa, including visits to active mines.
- **2011 - Igneous Petrology 202 Rhodes University** – Sabbatical replacement lecturing – 7-week undergraduate course in igneous petrology.
- **2009-2012 – MSc Exploration Course Rhodes University– Kimberlite Course** – Guest Lecturer on near-surface emplacement of kimberlite pipes as well as Tutoring the practical sessions associated with the course (Kimberlite Petrography).
- **2007-2012 - Geology Undergraduate Practical Tutor**
 - Tutored one to two 3-hour practical sessions a week at 1st to 3rd year undergraduate level
 - Responsible for marking assignments, teaching the contents of set tutorials and helping out the academic staff when and where needed.

7.2 Supervision Experience

Co-supervisor of Honours (4th year BS Students) level dissertations

- Yugendran, A. 2012. Silicate disequilibrium in Fe-Ti oxide ore layers from the Baima and Taihe mafic layered intrusions, SW China. Honours Thesis.
- Mutele, L. 2011. Petrography and Geochemistry of the Big Hole (Kimberley) Kimberlite pipe. Honours Thesis.
- Hulena, A. 2010. Kimberlites of the Man Craton, West Africa. Honours Thesis.