

Ian M. Power

Position/Department/Division/Institution/Organization

Assistant Professor, Trent School of the Environment, Trent University

Country

Canada

Career history

I am an environmental geochemist and geobiologist whose research focuses on carbon dioxide removal from the atmosphere. My research program aims to better understand fundamental geochemical, mineralogical, and geobiological processes that may be applied towards addressing environmental challenges including carbon management and sequestration, an emerging field in geosciences that is ripe for scientific inquiry and technological advances. My research employs fieldwork, laboratory and field experiments, and geochemical analyses to better understand mineral-water-gas interactions in natural and mining environments.

2017–present	Canada Research Chair in Environmental Geoscience (Tier 2)
2017–present	Assistant Professor, Trent School of the Environment, Trent University
2013–17	Research Associate, Mineral Deposit Research Unit, The University of British Columbia
2010–13	Postdoctoral Fellow, Geochemistry Laboratory, The University of British Columbia

Awards/Publications

Research awards

Trent University Merit Award for Research 2020

Articles published or accepted in refereed journals

(Invited publications and those featured on covers are noted; indicates HQP supervised)

41. Power, I.M., Paulo, C., Long, H., Lockhart, J.A., Stubbs, A.R., French, D. and Caldwell, R. (2021) Carbonation, cementation, and stabilization of ultramafic mine tailings.

Environmental Science & Technology, 55:10056–10066.

40. Mavromatis, V., Power, I.M., Harrison, A.L., Beinlich, A., Dipple, G.M., and Bénézech, P. (2021) Mechanisms controlling the Mg isotope composition of hydromagnesite magnesite

playas near Atlin, British Columbia, Canada. *Chemical Geology*, 579:120325. (Invited)

39. Paulo, C., Power, I.M., Stubbs, A.R., Wang, B., Zeyen, N., and Wilson, S.A. (2021) Evaluating feedstocks for carbon dioxide removal for enhanced rock weathering and CO₂ mineralization. *Applied Geochemistry*, 129:104955.

38. Richards-Thomas, T., McKenna-Neuman, C., and Power, I.M. (2021) Particle-scale characterization of Icelandic dust sources: volcanic ash & glaciogenic sediments. *Sedimentology*, 68:1137–1158.

37. Power, I.M., Dipple, G.M., Bradshaw, P., and Harrison, A.L. (2020) Prospects for CO₂ mineralization and enhanced weathering of ultramafic mine tailings from the Baptiste nickel deposit in British Columbia, Canada. *International Journal of Greenhouse Gas Control*, 102895.

36. Lin, Y., Zheng, M., Ye, C., and Power, I.M. (2019) Trace and rare earth element geochemistry of Holocene hydromagnesite from Dujiali Lake, central Qinghai-Tibetan Plateau, China. *Carbonates and Evaporites*, 34:1265–1279.

35. Lin, Y., Zheng, M., Ye, C., and Power, I.M. (2019) Rare earth element and strontium isotope geochemistry in Dujiali Lake, central Qinghai-Tibet Plateau, China: Implications for the origin of hydromagnesite deposits. *Chemie der Erde – Geochemistry*, 79:337–346.

34. Power, I.M., Harrison, A.L., Dipple, G.M., Wilson, S.A., Barker, S.L.L., Fallon, S.J. (2019) Magnesite formation in playa environments near Atlin, British Columbia, Canada. *Geochimica et Cosmochimica Acta*, 255:1–24.

33. McCutcheon, J., Power, I.M., Shuster J., Harrison, A.L., Dipple, G.M., and Southam, G. (2019) Carbon sequestration in biogenic magnesite and other magnesium carbonate minerals. *Environmental Science & Technology*, 53:3225–3237.

32. Mervine, E.M., Wilson, S.A., Power, I.M., Dipple, G.M., Turvey, C.C., Hamilton, J.L., Vanderzee, S., Raudsepp, M., Southam, C., Matter, J.M., Kelemen, P.B., Stiefenhofer, J., Miya, Z., and Southam, G. (2018) Potential for offsetting diamond mine carbon

- emissions through mineral carbonation of processed kimberlite: an assessment of De Beers mine sites in South Africa and Canada. *Mineralogy and Petrology*, 112(Suppl 2):S755–S765.
31. Lin, Y., Zheng, M., Ye, C., and Power, I.M. (2018) Thermogravimetric analysis–mass spectrometry (TGA–MS) of hydromagnesite from Dujiali Lake in Tibet, China. *Journal of Thermal Analysis and Calorimetry*, 133:1429–1437.
30. Ye, C., Mao, J., Ren, Y., Li, Y., Lin, Y., Power, I.M., and Luo, Y. (2018) Salt crystallization sequences of nonmarine brine and their application for the formation of potassium deposits. *Aquatic Geochemistry*, 24:209–229.
29. Blackmore, S., Vriens, B., Sorensen, M., Power, I.M., Smith, L., Hallam, S.J., Mayer, K.U., and Beckie, R.D. (2018) Microbial and geochemical controls on waste rock weathering and drainage quality. *Science of the Total Environment*, 640–641:1004–1014.
28. Li, J., Hitch, M., Power, I.M., Yueyi, P. (2018) Integrated Mineral Carbonation of Ultramafic Mine Deposits – A Review. *Minerals*, 8, 147, 18 p.
27. Power, I.M., Kenward, K.A., Dipple, G.M., and Raudsepp, M. (2017) Room temperature magnesite precipitation. *Crystal Growth & Design*, 17:5652–5659.
26. Harrison, A.L., Dipple, G.M., Song, W., Power, I.M., Mayer, K.U., Beinlich, A., and Sinton, D. (2017) Changes in mineral reactivity driven by pore fluid mobility in partially wetted porous media. *Chemical Geology*, 463:1–11.
25. Power, I.M., Dipple, G.M., and Francis P.S. (2017) Assessing the carbon sequestration potential of magnesium oxychloride cement building materials. *Cement and Concrete Composites*, 78:97–107.
24. Power, I.M., Harrison, A.L., and Dipple, G.M. (2016) Accelerating mineral carbonation using carbonic anhydrase. *Environmental Science & Technology*, 50:2610–2618.
23. Harrison, A.L., Dipple, G.M., Power, I.M., and Mayer, K.U. (2016) The impact of evolving mineral-water-gas interfacial areas on mineral-fluid reaction rates in

unsaturated porous media. *Chemical Geology*, 421:65–80.

22. White, R.A. III, Power, I.M., Dipple, G.M., Southam, G., and Suttle, C.A. (2015) Metagenomic analysis reveals that modern microbialites and polar microbial mats have similar taxonomic and functional potential. *Frontiers in Microbiology*, 6 (966):1–14.

21. Harrison, A.L., Dipple, G.M., Power, I.M., and Mayer, K.U. (2015) Influence of surface passivation and water content on mineral carbonation rates: Implications for CO₂ sequestration in mine tailings. *Geochimica et Cosmochimica Acta*, 148:477–495.

20. McCutcheon, J., Power, I.M., Harrison, A.L., Dipple, G.M., and Southam, G. (2014) A greenhouse-scale photosynthetic microbial bioreactor for carbon sequestration in magnesium carbonate minerals. *Environmental Science & Technology*, 48:9142–9151.

19. Power, I.M., Wilson, S.A., Harrison, A.L., Dipple, G.M., McCutcheon, J., Southam, G., and Kenward P. (2014) A depositional model for hydromagnesite-magnesite playas near Atlin, British Columbia, Canada. *Sedimentology*, 61:1701–1733. (Featured on cover)

18. Wilson, S.A., Harrison, A.L., Dipple, G.M., Power, I.M., Barker, S.L., Mayer, U.K., Fallon, S.J., Raudsepp, M., and Southam G. (2014) Offsetting of CO₂ emissions by air capture in mine tailings at the Mount Keith Nickel Mine, Western Australia: Rates, controls and prospects for carbon neutral mining. *International Journal of Greenhouse Gas Control*, 25:121–140.

17. Power, I.M., McCutcheon, J., Harrison, A.L., Wilson, S.A., Dipple, G.M., Kelly, S., Southam, C., and Southam, G. (2014) Strategizing carbon-neutral mines: A case for pilot projects. *Minerals*, 4:399–436. (Invited)

16. Thom, J.G.M., Dipple, G.M., Power, I.M., and Harrison, A.L. (2013) Chrysotile dissolution rates: Implications for carbon sequestration. *Applied Geochemistry*, 35:244–254.

15. Power, I.M., Harrison, A.L., Dipple, G.M., and Southam, G. (2013) Carbon sequestration via carbonic anhydrase facilitated magnesium carbonate precipitation. *International Journal of Greenhouse Gas Control*, 16:145–155.

14. Power, I.M., Wilson, S.A., and Dipple, G.M. (2013) Serpentinite carbonation for CO₂ sequestration. *Elements*, 9:115–121. (Invited)
13. Harrison, A.L., Power, I.M., and Dipple, G.M. (2013) Accelerated carbonation of brucite in mine tailings for carbon sequestration. *Environmental Science & Technology*, 47:126–134.
12. Bea, S.A., Wilson, S.A., Mayer, K.U., Dipple, G.M., Power, I.M., and Gamazo, P. (2012) Reactive transport modeling of natural carbon sequestration in ultramafic mine tailings. *Vadose Zone Journal*, 11 (2).
11. Chalmers, G.R., Bustin, R.M., and Power, I.M. (2012) Characterisation of gas shale pore systems by porosimetry, pycnometry, surface area and FE-SEM/TEM image analyses: Examples from the Barnett, Woodford, Haynesville, Marcellus and Doig Formations. *American Association of Petroleum Geologists Bulletin*, 96:1099–1119.
10. Angiboust, S., Fayek, M., Power, I.M., Camacho, A., Calas, G., and Southam, G. (2012) Structural and biological control of the Cenozoic epithermal uranium concentrations from the Sierra Peña Blanca, Mexico. *Mineralium Deposita*, 47:859–874.
9. Power, I.M., Wilson, S.A., Small, D.P., Dipple, G.M., Wan W., and Southam, G. (2011) Microbially mediated mineral carbonation: Roles of phototrophy and heterotrophy. *Environmental Science & Technology*, 45:9061–9068.
8. Wilson, S.A., Dipple, G.M., Power, I.M., Barker, S.L.L., Fallon, S.J., and Southam, G. (2011) Subarctic weathering of mineral wastes provides a sink for atmospheric CO₂. *Environmental Science & Technology*, 45:7727–7736.
7. Schuiling, R., Wilson, S.A., and Power, I.M. (2011) Enhanced silicate weathering is not limited by silicic acid saturation. *Proceedings of the National Academy of Sciences*, 108:E41.
6. Power, I.M., Wilson, S.A., Dipple, G.M., and Southam, G. (2011) Modern carbonate microbialites from an asbestos open pit pond, Yukon, Canada. *Geobiology*, 9:180–195.
5. Sherar, B.W.A., Power, I.M., Keech, P.G., Mitlin, S., Southam, G., and Shoesmith, D.W.

(2011) Characterizing the effect of carbon steel exposure in sulfide containing solutions to microbially induced corrosion. *Corrosion Science*, 53:955–960.

4. Power, I.M., Dipple, G.M., and Southam, G. (2010) Bioleaching of ultramafic tailings by *Acidithiobacillus* spp. for CO₂ sequestration. *Environmental Science & Technology*, 44:456–462.

3. Wilson, S.A., Dipple, G.M., Power, I.M., Thom, J.M., Anderson, R.G., Raudsepp, M., Gabites, J.E., Southam, G. (2009) Carbon dioxide fixation within mine wastes of ultramafic-hosted ore deposits: Examples from the Clinton Creek and Cassiar chrysotile deposits, Canada. *Economic Geology*, 104:95–112.

2. Power, I.M., Wilson, S.A., Thom, J.M., Dipple, G.M., Gabites, J.E., and Southam, G. (2009) The hydromagnesite playas of Atlin, British Columbia, Canada: A biogeochemical model for CO₂ sequestration. *Chemical Geology*, 260:286–300.

1. Power, I.M., Wilson, S.A., Thom, J.M., Dipple, G.M., and Southam, G. (2007) Biologically induced mineralization of dypingite by cyanobacteria from an alkaline wetland near Atlin, British Columbia, Canada. *Geochemical Transactions*, 8:13.

Articles submitted to refereed journals

Stubbs, A.R., Paulo, C., Power, I.M., Wang, B., Zeyen, N., and Wilson, S.A. (submitted) Direct measurement of CO₂ fluxes into kimberlite residues and powdered rocks: Implications for enhanced rock weathering. *International Journal of Greenhouse Gas Control*.

Rausis, K., Stubbs, A.R., Power, I.M., and Paulo, C. (submitted) CO₂ removal rates using magnesium oxide powder during the first 5 months. *Environmental Science & Technology*.

Book chapters (refereed)

Wilson, S.A., Zeyen, N., Hamilton, J., Paulo, C. and Power, I.M. (in preparation) CO₂ sequestration within mine wastes. In *Advances in Mine Waste Characterisation, Engineering and Management: A sustainable approach towards mine closure and rehabilitation*; Parbhakar-Fox, A., Lindsay, M., Moncur, M., Eds. (Invited)

Power, I.M., Harrison, A.L., Dipple, G.M., Wilson, S.A., Kelemen, P.B., Hitch, M., and Southam, G. Carbon mineralization: From natural analogues to engineered systems. In *Geochemistry of Geologic CO₂ Sequestration*; DePaolo, D.J.; Cole, D.R.; Navrotsky, A.; Bourg, I.C., Eds.; The Mineralogical Society of America: Chantilly, Virginia, U.S.A., 2013; Vol. 77:305–360. (Invited)

Articles in conference proceedings (refereed)

Paulo, C., Power, I.M., Stubbs, A.R., Zeyen, N., and Wilson, S.A. (2020) An analytical tool to assess the carbonation potential of mineral deposits and mining wastes. Conference of Metallurgists, Toronto, Canada. 9 p.

Vanderzee, S., Dipple, G.M., and Power, I.M. (2019) Carbon sequestration in ultramafic mine waste: Potential for carbon neutral mining. Society for Geology Applied to Mineral Deposits, Glasgow, United Kingdom. 4 p.

Mervine, E.M., Dipple, G.M., Power, I.M., Wilson, S.A., Southam, G., Southam, C., Matter, J.M., Kelemen, P.B., Stiefenhofer, J. and Miya, Z. (2017) Potential for offsetting diamond mine carbon emissions through mineral carbonation of processed kimberlite. International Kimberlite Conference, Gaborone, Botswana. 3 p.

Harrison, A.L., Power, I.M., and Dipple, G.M. (2013) Strategies for enhancing carbon sequestration in Mg-rich mine tailings. In: Reliable Mine Water Technology (Eds. Wolkersdorfer, Brown, and Figueroa). International Mine Water Association, Golden, Colorado, USA. pp. 15–20.

Dipple, G., Wilson, S., Barker, S., Thom, J., Raudsepp, M., Power, I., Southam, G., and Fallon, S. (2009). Carbon sequestration in ultramafic mine tailings. In: P. J. Williams, & et al (Eds.), Proceedings of the 10th Biennial SGA meeting of the Society for Geology Applied to Mineral Deposits. Economic Geology Research Unit, James Cook University. pp. 762–764.

Dipple, G.M., Wilson, S.A., Power, I.M., Thom, J.M., Raudsepp, M., and Southam, G. (2008) Passive mineral carbonation in mine tailings. In: 2nd International Conference on Accelerated Carbonation for Environmental and Materials Engineering (Eds. Baciocchi, Costa, Poletti, and Pomi). Rome, Italy. pp. 119–122.

Industry and technical reports (non-refereed)

Paulo, C., Power, I.M., Stubbs, A.R., McDonald, D.T.E., and Rausis, K. (2019–) De Beers Project CarbonVault - monthly progress report of research activities. De Beers Group Services Propriety Limited, 24 reports, 24 p.

Power, I.M. and Brohart, B. (2014) Determining the relative abundances of pennate diatoms using light and electron microscopy. DE Labs. 14 p.

CarbonVault University Research Team. Wynands, E., Vanderzee, S., Lu, X., Baidya, D., Turvey, C., Dipple, G., Ghoreishi-Madiseh, S.A., Wilson, S., Zeyen, N., Wang, B., Power, I., Paulo, C., Stubbs, A., McDonald, D., Jones, T., Poitras, J., Gagen, E., Southam G. (equal contributions amongst universities; 2021) Project CarbonVault 2020 Annual Research Report.

- Dipple, G., Baidya, D., Lu, X., Madiseh, A., Turvey, C., Vanderzee, S., Wynands, E., Wilson, S., Zeyen, N., Wang, B., Power, I., Paulo, C., Stubbs, A., Southam, G., Shaw, A., and Dockery, J. (equal contributions amongst universities; 2020) Project CarbonVault 2019 Annual Research Report. 198 p.
- Vanderzee, S.S.S., Power, I.M., Dipple, G.M., and Bradshaw, P.M.D. (2018) Carbon mineralization in ultramafic tailings, central British Columbia: A prospect for stabilizing mine waste and reducing greenhouse gas emissions. Geoscience BC Summary of Activities 2017, Geoscience BC, Report 2018-1.
- Wilson, S.A., Dipple, G.M., Vanderzee, S., Carroll, K., Power, I.M., Turvey, C., Hamilton, J., Southam, G., and Southam, C. (2018) Carbon mineralization in processed kimberlite – Venetia: 2017 Report of Activities, Project Minera. 24 p.
- Power, I.M., Dipple, G.M., Vanderzee, S., Carroll, K., Wilson, S.A., Turvey, C., Hamilton, J., Southam, G., and Southam, C. (2018) Carbon mineralization in processed kimberlite – Gahcho Kué: 2017 Report of Activities, Project Minera. 11 p.
- Dipple, G.M., Hitch, M., Mayer, K.U., Southam, G., Wen, J., Thomson, M., Wilson, S.A., and Power, I.M. (2014) Accelerating carbon mineralization in mine waste: Progress report, Year 2. Carbon Management Canada Inc. 13 p.
- Power, I.M. and Raudsepp, M. (2014) Particle size reduction of diatomaceous earth. JP Textiles and Murray Isman. 12 p.
- Dipple, G.M., Hitch, M., Mayer, K.U., Southam, G., Wen, J., Thomson, M., Wilson, S.A., and Power, I.M. (2014) Accelerating carbon mineralization in mine waste: Progress report, Year 1. Carbon Management Canada Inc. 11 p.
- Power, I.M. and Raudsepp, M. (2013) The Rietveld method and X-ray powder diffraction data, particle size analysis, and scanning electron microscopy of diatomaceous earth. JP Textiles and Murray Isman. 11 p.
- Raudsepp, M. and Power, I.M. (2012) Scanning electron microscope images of diatomaceous earth. Murray Isman and JP Textiles. 7 p.
- Raudsepp, M. and Power, I.M. (2012) Quantitative phase analysis of diatomaceous earth using the Rietveld method and X-ray powder diffraction data – Scanning electron microscope images of diatomaceous earth. Murray Isman and JP Textiles. 9 p.
- Raudsepp, M. and Power, I.M. (2012) Quantitative phase analysis of diatomaceous earth using the Rietveld method and X-ray powder diffraction data – Scanning electron microscope images of diatomaceous earth. Murray Isman and JP Textiles. 10 p.
- Dipple, G.M., Harrison, A.L., Power, I.M., Mayer, K.U., Lytle, M., Hitch, M., McCutcheon, J.M., and Southam, G. (2011) Carbon mineralization in mine waste: Progress report, Year 1. Carbon Management Canada Inc. 7 p.

Dipple, G., Wilson, S., Barker, S., Thom, J., Raudsepp, M., Power, I., Southam, G., and Fallon, S. (2008) Carbon sequestration in Mount Keith tailings: Progress report: October 2008. BHP Billiton. 10 p.

Dipple, G., Wilson, S., Thom, J., Southam, G., Power, I., and Grguric, B. (2007) Carbon sequestration in mine tailings: Year 2 Report of Activities. BHP Billiton. 116 p.

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Wilson, S., Power, I., Thom, J., Dipple G., and Southam, G. (2006) Carbon sequestration in mine tailings: Report on Activities Year 2. Diavik Diamond Mines Inc. 36 p.

Power, I., Southam, G., Wilson, S., Thom, J., Woodhouse, J., and Dipple G. (2006) Carbon sequestration in mine tailings: Year 2 Interim Report. Diavik Diamond Mines Inc. 10 p.

Dipple, G., Southam, G., Wilson, S., Thom, J., Power, I. (2005) Carbon sequestration in mine tailings: Year 1 Report of Activities. Diavik Diamond Mines Inc. 12 p.

Power, I., and Southam, G. (2004) An investigation of bacteriological contributions to the formation of SGH signatures associated with different styles of alteration and mineralization. An analytical method for absorbed soil gas hydrocarbons (SGH) to depict anomaly patterns over various types of deeply buried mineral deposits. Camiro. 8 p.

Areas of expertise

CO₂ sequestration using mine wastes, Mine tailings cementation & utilization, Enhanced rock weathering, Natural analogues for carbon storage