

CURRICULUM VITA (April 2014)

1. Name:

Malcolm J. Rutherford
Professor of Research, Department of Geological Sciences

2. Address.

165 Fifth Street
Providence, RI 02906

3. Education:

B.Sc.Engineering, University of Saskatchewan, 1961
M.Sc. University of Saskatchewan, 1963
Dissertation: Liquid Inclusions in Quartz Veins: Geothermometry
Ph.D. The Johns Hopkins University, 1968
Dissertation: Experimental Studies of Biotite Stability in Igneous
and Metamorphic Rocks

4. Professional Appointments:

1968-69 Postdoctoral Fellow, Univ. of California, Los Angeles
1969-70 Acting Asst. Professor, Univ. of California, Los Angeles
1970-76 Assistant. Professor, Brown University, Providence, RI
1975-85 Associate. Professor, Brown University, Providence, RI
1985- Professor, Brown University, Providence, RI
Department Chairman 1986-1991

5. Completed research:

c. Refereed journal articles: 1993- present

- Rutherford, M.J., and Hill, P.M., 1993, Magma ascent rates from amphibole breakdown: An experimental study applied to the 1980-86 Mount St. Helens eruptions. *J.G.R.* 98, 19667-19686.
- Finnila, A.B., Hess, P.C., and Rutherford, M.J., (1994). Assimilation by lunar mare basalts: melting of crustal material and dissolution of anorthite. *JGR*, 99, 14,677-14690.
- Johnson, MC, Anderson AT, and Rutherford MJ, (1994) Pre-eruptive volatile contents of magmas *in* *Reviews in Mineralogy; Volatiles in Magmas*, Eds J. Hollaway and M. Carroll, Mineral. Society of America, p 289-330.
- Gardner, J.E., Rutherford, MJ, Carey, S, and H Sigurdsson (1995) Experimental Constraints on Preeruptive water contents and changing magma storage prior to explosive eruptions of Mount St. Helens. *Bull Volcan* 57, p 1-17.
- Geschwind, C-H., and Rutherford, M.J., 1995, Crystallization of microlites during magma ascent: the fluid mechanics of 1980-86 eruptions at Mount St. Helens. *Bull Volc.* 57, 356-370.
- Fogel, R.A. and Rutherford, M.J., (1995) Magmatic volatiles in primitive lunar glasses: FTIR and EMPA analyses of Apollo 15 green and yellow glasses and revision of the

- volatile assisted fire-fountaining theory. *Geochem Cosmochemica Acta* 59, 201-215.
- Gardner, J.E., S. Carey, M. Rutherford, and H. Sigurdsson, (1995) Petrologic diversity in Mount St. Helens dacites during the last 4,000 years: implications for magma mixing, *Contrib. Mineral. Petrol.*, 119, 224-238.
- Devine, J.D., J.E. Gardner, H.P. Brack, G.D. Layne, and M.J. Rutherford, (1995) Comparison of microanalytical methods for estimation of H₂O contents of silicic volcanic glasses, *Am. Mineral.*, 80, p 319-328.
- Gardner, J.E., S. Carey, M.J. Rutherford, and H. Sigurdsson, (1995) Influence of magma mixing on the eruptive activity of Mount St. Helens, *Geology*, p. 523-526.
- Baker L, and Rutherford, MJ (1995) The diffusion of S in high Silica magmas. *Contributions Mineral and Petrology* , 123, 335-344.
- Geschwind CHG and Rutherford MJ (1995) Crystallization of microlites during magma ascent: The fluid mechanics of 1980-86 eruptions at Mount St. Helens. *Bull Volc.*57, 356-370.
- Baker LL and Rutherford, MJ (1995) The effect of dissolved water on the oxidation state of silicic melts. *Geochemica Cosmochemica Acta*, 66, 2179-2187.
- Baker LL and Rutherford, MJ (1996) The crystallization of anhydrite bearing magmas. *Proc of the Third Hutton Granite Conference, Trans Royal Society of Edinburgh* 87, 243-250.
- Weitz, C. M., M. J. Rutherford, and J. W. Head, (1997) Oxidation states during ascent and eruption of the volcanic glasses as inferred from metal-melt equilibria in the 74001/2 core. *Geochemica Cosmochim Acta*. 61, p. 2765-2775.
- Rutherford, M.J., and Devine, J.D., (1996) Pre-eruption P-T conditions and volatiles in the 1991 Pinatubo magma, p 751-766, in Newhall and Punongbayan eds, *Fire and Mud: Eruptions and Lahars at Mt Pinatubo*, 1126 p.
- Venezky, D and Rutherford, MJ (1997) Pre-eruption conditions and timing of magma mixing in the 2.2 ka C-layer, Mount Rainier. *Journ Geophys Res*,102, 20,069-20,086.
- Metrich, N, and Rutherford, MJ (1998) Crystallization paths of H₂O saturated melts at low pressures. Implications for open-degassing volcanic systems. *GCA*, 62, 1195-1205.
- Rutherford, MJ, Devine, JD, and Barclay, J, (1998) Changing magma conditions and ascent rates during the Soufriere Hills eruption on Montserrat. *GSA-Today*, 8, 1-7.
- Barclay, J, Rutherford, MJ, Carroll, MR, Murphy, MD, Devine, JD, Gardner, J, and Sparks, RSJ (1998) Experimental phase equilibria constraints on pre-eruptive conditions of the Soufriere Hills magma. *GRL*, 25, 18, 3437-3440.
- Devine, JD, Murphy, MD, Rutherford, MJ, Barclay, J, Sparks, RSJ, Carroll, MR, and Gardner, JE, (1998) Petrological evidence for preeruptive P-T conditions, and recent reheating of andesitic magma erupting at S.H., Montserrat. *GRL* 25, 3669-3672.
- Devine, JD, Rutherford, MJ, and Gardner, JE (1998) Petrologic determination of ascent rates for the 1995-97 Soufriere Hills andesitic magma. *GRL* 25, 19, 3673-3676.
- Cottrell, E, Gardner, JE, and Rutherford, MJ (1999) Petrologic and experimental evidence for the movement and heating of the pre-eruptive Minoan rhyodacite (Santorini, Greece). *Contrib Mineral Petrol.* 135, 315-331.
- Rutherford, M.J., and Gardner, J.E., (1999) Chpt.12 : Rates of Magma Ascent, in Sigurdsson et al., eds, *Volcanoes*. Academic Press.

- Venezky D., and Rutherford, M.J. (1999) Petrology and Fe-Ti oxide reequilibration of the 1991 Mount Unzen mixed magma. *Journ Volc and Geotherm Res.*, 89, 213-230.
- Weitz, C. M., M. J. Rutherford, and J. W. Head III, and McKay, David, S. (1999) Ascent and eruption of a lunar high-Ti magma as inferred from the petrology of the 74001/2 drill core. *Meteoritics and Planet Sci.*, 34, 527-40.
- Minitti, M.E., and Rutherford, M.J. (2000) Genesis of the Pathfinder "sulfur-free" rock from SNC parental liquids. *GCA*, 64, 2535-2547.
- Coombs, M.L. Eichelberger, J.C., and Rutherford, M.J. (2000) Magma storage and mixing conditions for the 1953-68 eruption of Southwest Trident volcano, Katmai National Park, Ak. *EPSL*, 140, 99-118.
- Gardner, JE, Rutherford, MJ, and Hort, Matthias, (2001) Cl degassing of magma during ascent and eruption: Implications for volcano Gas Studies and Atmosphere Effects. *Bull Volc.* 63, 479-492.
- Gardner, JE, Layer, PE, and Rutherford, MJ, 2002, Phenocrysts vs. Xenocrysts in the Youngest Toba Tuff: Implications for the Petrogenesis of 2800 km³ of magma; *Geology*, 30, 347-350.
- Hammer J.E., and Rutherford, MJ, (2002) Kinetics of decompression-induced crystallization in Silicic melt: I. An experimental Study. *JGR*, 107, ECV8, 1-24.
- Mandeville CW, Webster, JD, Rutherford, MJ, Taylor, BE, Timbal, A, and Faure, K, (2002) Determination of Molar absorptivities for Infrared absorption Bands of H₂O in andesitic glasses. *Am Mineral.*, 87, 813-821.
- Minitti, M.E., Mustard, J.F. and Rutherford, MJ, (2002) The effects of Glass Content and Oxidation on the spectra of SNC-like basalts: Applications to Mars Remote Sensing. *JGR*. 107, E5, 6-1-16.
- Hammer, JE., Rutherford, MJ, and Hildreth, Wes, (2002) Magma Storage prior to the 1912 eruption at Novarupta, Alaska.. *Contributions Mineral and Petrol.* 144, 144-162.
- Coombs, M.L., Eichelberger, JC, and Rutherford, MJ, (2003) Experimental and Textural constraints on Mafic Enclave formation in volcanic Rocks. *J. Volc Geothermal Res.*, 119, 125-145.
- Hammer, JE and Rutherford, MJ (2003) Glass Composition geobarometry: a petrologic indicator of pre-eruption Pinatubo dacite magma dynamics. *Geology* 31, 79-82.
- Rutherford, MJ and Devine, JD, (2003) Magmatic Conditions and Magma Ascent as indicated by Hornblende Phase Equilibria and Reactions in the 1995-2001 Soufriere Hills Magma. *Journ Petrol.* 44, 1433-1454.
- Devine JD, Rutherford, MJ, Norton, GE, and Young, SR, (2003) Magma storage zone processes inferred from geochemistry of Fe-Ti oxides in andesitic magma, Soufriere hills volcano, Montserrat. *Journal Petrol.*, 44, 1375-1400.
- McCanta M.C., Rutherford M.J., and Jones J.H. (2004) An experimental study of rare earth element partitioning between a shergottite melt and pigeonite: implications for the oxygen fugacity of the Martian interior. *Geochim. Cosmochim. Acta.*, 68, 1943-52.
- McCanta M.C., Rutherford M.J., Dyar M.D., and Delaney J.S. (2004) Iron partitioning between basalt and clinpyroxene as a function of oxygen fugacity. *American Mineral.* 1685-1693.
- Nicholis, M.G., and Rutherford, M.J. (2004) 32 Experimental Constraints on magma ascent rate for the Crater flat volcanic zone Hawaiiite. *Geology*, 32, 489-492.

- Gardner, J. E, Burgeisser, A., Hort, M., and Rutherford, M.J. (2006). Experimental and Model Constraints on Degassing of Magma during Ascent and Eruption. In Seibe, C., Macies, J.L., and Aquirre-Davis, G.J., Neogene-Quaternary continental volcanism: A perspective from Mexico. GSA Special Paper 402, 99-114.
- McCanta, M.C., Hammer, J.E., and Rutherford, M.J., (2007). Pre-eruptive and syn-eruptive conditions in the Black Butte, CA dacite: Insight into crystallization kinetics in a silicic magma system. *Jour of Volcanology and Geothermal Res*, 160, 263-284.
- Rutherford MJ, and Devine J (2008) Magmatic conditions and processes in the Storage Zone of the 2004-06 Mount St. Helens Eruption: The record in Amphibole and Plagioclase phenocrysts. *In A volcano rekindled: the first year of renewed eruption at Mount St. Helens, 2004-2006*. Sherrod, DR, Scott WE, Stauffer PH (ed) US Geol Survey Prof Pap 1750, chpt 31.
- Saal, A, Hauri, E., LoCasio, M., Van Orman J., Rutherford, M., and Cooper R., (2008). The volatile content of lunar volcanic glasses: Evidence for the presence of water in the lunar interior. *Nature*,
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- Rutherford, M.J. (2008) Magma ascent Rates. In *Minerals, Inclusions and volcanic Processes: Reviews in Mineralogy Vol. 69 Chapter 7*. Eds: Putirka, K. and Tepley F., p 241-271.
- Calvin, C and Rutherford M.J. (2008) The parental melt of Lherzolitic shergottite ALH 77005: a study of rehomogenized melt inclusions. *American Mineralogist*, 93, 1886-1898.
- McCanta M.C., Rutherford M.J., and L. Elkins-Tanton. (2009) Expanding the Application of the Eu-oxybarometer to the lherzolitic shergottites and Nakhilites: Implications for the oxidation state heterogeneity of the Martian Interior. *Met. Planet. Sci.* 44, 725-745
- Rutherford, M.J. and Papale, P. (2009). Origin of Basalt Fire fountain eruptions on the Earth vs: the Moon. *Geology*, 37, 219-222.
- E. H. Hauri¹, T. Weinreich², A. E. Saal², M. C. Rutherford², and J. A. Van Orman². (2011) Evidence for high volatile abundances in Lunar melt inclusions. L.P.I. Wet vs. Dry Moon Workshop June 13-15, 2011. Abst # 6036
- Rutherford, M.J., Wetzel, D., Hauri, E.H., and Saal, A.E., (2011) Origin and composition of Lunar volcanic Gas: The picritic Glass Model. L.P.I. Wet vs. Dry Moon Workshop June 13-15, 2011. Abst # 6010.
- Hauri, Eric, Weinrich, Thomas, Saal, Alberto, Rutherford, Malcolm, and Van Orman, James, (2011). High Pre-eruptive water contents preserved in Lunar Melt inclusions. *Science-express*, 1/10.1126/science. 1204626.
- D. T. Wetzel, M. J. Rutherford, S. D. Jacobsen, E. H. Hauri, A. E. Saal, Degassing of reduced carbon from planetary basalts, *Proc. Natl. Acad. Sci.* **110**, 8010–8013 (2013).
- A. E. Saal, E. H. Hauri, J. A. V. Orman, M. J. Rutherford, Hydrogen isotopes in lunar volcanic glasses and melt inclusions reveal a carbonaceous chondrite heritage, *Science* **340**, 1317–1320 (2013).
- Devine, J. D. & Rutherford, M. J. 2014. Magma storage region processes of the Soufrière Hills Volcano, Montserrat. In: Wadge, G., Robertson, R. E. A. & Voight, B. (eds) *The Eruption of Soufrière Hills Volcano, Montserrat from 2000 to 2010*. Geological Society, London, *Memoirs*, 39, 359–379, <http://dx.doi.org/10.1144/M39.19>
- Hauri, E.H., Saal, A.E., Rutherford, M.J., and Van Orman, J.A., (2015) Water in the Moon's

Interior, Earth and Planet Sci Letters **409**, 252-264.

6. Service

(i) University:

- Chairman of Department, 1983-1989
- ACUP, 1992-1995
- Undergraduate Advising -Advisor in both Freshman and sophomore advisory programs in 1999 through 2004.
- Chair of the Faculty awards and Benefits committee, 1999-2001.
- Member of the Graduate Council 2004-07

(ii) Professional:

NASA Proposal Review Panel, 1980-1983

Appointed Fellow of the American Mineralogical Society in 1983.

Associate Editor, Journal of Geological Research, 1980-1983

Geology Editorial Board, 1989-1992

Appointed to NASA Proposal Review Panel, 1989-1993

Appointed member of NASA Planetary Materials Program Advisory Group, 1990-96

Appointed to membership on the University Space Research Council LPI Science Council for the period 2007-2010.

NASA Mars Fundamental Analysis Program: Chair of Peer Review Panel.

Member NASA Captem (Committee on Allocation of Extra Terrestrial Materials) 2005-present.

Professor Emeritus and Research beginning June 2007.

7. Academic Honors

Research Grants (last two years)

- One research grant is currently funded for a term of 3 Years by the NASA LASER program. This funding began in 2011 and continues for 3 years.

1. NASA

a. Studies of magmatic processes on the moon and other terrestrial type planetary bodies continue to be carried out with NASA support. During the past year, volcanic processes on the moon were the focus of two studies carried out by the P.I., co-investigators Hauri, and Saal, and a graduate student (Diane Wetzel) as part of her thesis work. This research focuses of the nature and role of volatiles in lunar magmas. The research involves the analysis of natural lunar glasses and the experimental study of volatile solubility and speciation in lunar magmas, particularly the well-known picritic glass magmas. One paper (Hauri et al., 2011) was published, and four talks were presented at NASA meetings. Funding of this project continued until at Oct. of 2013. A new proposal is being prepared.

Professional:

Appointed Fellow of the American Mineralogical Society in 1983.
Associate Editor, Journal of Geological Research, 1980-1983
Geology Editorial Board, 1989-1992
Appointed to NASA Proposal Review Panel, 1989-1993
Appointed member of NASA Planetary Materials Program Advisory Group, 1990-93
NASA Cosmochemistry Planetary Science Proposal Review panel 2000; chair in 2001.
Member AGU Executive Committee for VGP, and chair of the Bowen Award Committee 2002 -3.
Chair of the Mars Fundamental Analysis Program Peer review panel. 2004
Member of the University Space research Foundation Council, 2002-present.
Member of NASA Cosmochemistry Peer review Panel August 2008.
Editor; Journal of Volcanology and Geothermal Research 2009-2012

8. Graduate student advising

MSc THESES SUPERVISED

- | | |
|--------------------------------------|--|
| 15. Leslie Baker, MSc 1992 (C.F.) | Experimental Study of ferrous/ferric ratios in hydrous silicic magmas |
| 16. Danielle Ford, MSc 1993 (C.F.) | Crystallization conditions in the SNC meteorite parent body. |
| 17. Dina Venzky, MSc 1994 (C.F.) | Petrology of explosive eruptions at Mount Rainier over the past 6000 years. |
| 18. Michelle Minitti MSc 1997 (C.F.) | Hydrogen loss and D/H fractionation in Mars (SNC) meteorites: an experimental study. |
| 19. Brett Conaway Msc 1998 (C.M.) | Phase equilibria of the 1831 Vesuvius eruption products. |
| 20. Molly McCanta Msc 2000 | Phase equilibria and magma transport for eruptions at Black Butte and Shastina, CA |
| 21. Sargon DeJesus MSc. 2008 | Role of F in silicic magmas: the Mount St. Helens Example. |
| 22. Diane Wetzel, MSc expected 2010 | Lunar Volcanic degassing |

RECENT PhD. THESES SUPERVISED

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|--------------------------------|---|
| Marie Johnson Ph.D 1990 (C.F.) | An experimental study of hornblendes in Igneous Rocks (5 years to completion). |
| Leslie Baker Ph.D 1995 (C.F.) | H-O-S Volatiles, Oxidation state, and Phase equilibria in silicic magmas. |
| Dina Venezky Ph.D.1997 (C.F.) | Magma Mixing, Storage, and ascent over the last 6.5 ka of volcanic history at Mount Rainier Wa. |

Michelle Minitti Ph.D 2000	Role of Water in igneous and volcanic processes on Mars.
Molly McCanta PhD.2004	Volcanic processes in the Mount Shasta area and on Mars
Angela Roach PhD 2005	Processes and conditions in the Phlegrean Fields volcanic system, Italy.
Mike Nicholis PhD 2006	The composition and role of volatiles in Terrestrial and lunar basaltic volcanism
Christine Calvin PhD 2008	Stability and composition of phosphates in Extraterrestrial basaltic magmas.
Diane Wetzel PhD 2014 Exptd	Experimental and Analytical study of C-O-H-S Volatiles in lunar picritic magmas

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