

Richard L. Hervig

PROFESSIONAL PREPARATION

University of Iowa, Iowa City, IA Geology B.S., 1975
University of Chicago, Chicago, IL Geophysical Sci. Ph.D., 1979

APPOINTMENTS

2006- School of Earth and Space Exploration, Professor
2004-2005 Department of Geological Sciences, Professor
1996-2003 Center for Solid State Science, Arizona State University, Sr. Research Scientist
1992-2003 Dept. of Geological Sciences, Arizona State University, Affiliated Professor
1990-1996 CSSS, Arizona State University, Associate Research Scientist.
1987-1990 CSSS, Arizona State University, Assistant Research Scientist.
1984-1987 Dept of Chemistry, Arizona State University, Research Specialist
1981-1984 Dept. of Chemistry, Arizona State University, Postdoctoral Research Associate
1980-1981 Basalt Waste Isolation Project, Rockwell Hanford, Richland, WA, Adv. Scientist.
1979-1980 Geophysical Sciences, University of Chicago, Postdoctoral Research Associate

PROFESSIONAL ORGANIZATIONS:

Mineralogical Society of America (Fellow)
American Geophysical Union
Kaiserlich Konigliche Böhmisches Physikalische Gesellschaft (elected May, 1993)

SYNERGISTIC ACTIVITIES

Dr. Hervig has developed new analytical techniques in secondary ion mass spectrometry (SIMS) and has made significant improvements in instrument performance through implementation of novel designs. He has contributed four chapters to Reviews in Mineralogy volumes concerning the applications of SIMS to Earth Science problems. Hervig's collaborative research with electrical engineers has presented new ways of applying SIMS to problems in earth science. Besides training researchers in the use of SIMS, he also teaches classes in petrology, geochemistry, nuclear forensics, and analytical instrumentation to chemistry, engineering, and geology students.

Richard L. Hervig

LIST OF PUBLICATIONS

1. Dawson, J. B., Smith, J. V. and Hervig, R. L. (1977) Late-stage diopside in kimberlite groundmass. *N. Jb. Miner. Mh.* 12, 529-543.
2. Smith, J. V., Hervig, R. L., Ackermann, D. and Dawson, J. B. (1979) K, Rb and Ba in micas from kimberlite and peridotitic xenoliths, and implications for origin of basaltic rocks. In, Kimberlites, Diatremes and Diamonds: Their Geology, Petrology and Geochemistry. Proceedings of the Second International Kimberlite Conference 1, 241-251.
3. Smith, J. V. and Hervig, R. L. (1979) Shergotty meteorite: mineralogy, petrology and minor elements. *Meteoritics* 14, 121-142.

4. Dawson, J. B., Smith, J. V. and Hervig, R. L. (1980) Heterogeneity in upper mantle lherzolites and harzburgites. *Proc. Roy. Soc. Lond. Ser. A.* 297, 323-331.
5. Hervig, R. L. and Smith, J. V. (1980) Sodium thermometer for pyroxenes in garnet and spinel lherzolites. *Jour. Geol.* 88, 337-342.
6. Hervig, R. L., Smith, J. V., Steele, I. M., Gurney, J. J., Meyer, H. O. A. and Harris, J. W. (1980) Diamonds: minor elements in silicate inclusions; pressure-temperature implications. *Jour. Geophys. Res.* 65, 6919-6929.
7. Hervig, R. L., Smith, J. V., Steele, I. M. and Dawson, J. B. (1981) Fertile and barren Al-Cr-spinel harzburgites from the upper mantle: ion and electron probe analyses of trace elements in olivine and orthopyroxene: relation to lherzolites. *Earth Planet. Sci. Lett.* 50, 41-58.
8. Hervig, R. L. and Smith, J. V. (1981) Dolomite-apatite inclusion in chrome-diopside crystal, Bellsbank kimberlite, South Africa. *American Mineralogist* 66, 346-349.
9. Steele, I. M., Hervig, R. L., Hutcheon, I. D. and Smith, J. V. (1981) Ion microprobe techniques and analyses of olivine and low-Ca pyroxene. *American Mineralogist* 66, 526-546.
10. Smith, J. V., Delaney, J. S., Hervig, R. L. and Dawson, J. B. (1981) Storage of F and Cl in the upper mantle: geochemical implications. *Lithos* 14, 133-147.
11. Woodley, R. E., Wilson, C. N. and Hervig, R. L. (1981) The chemical and physical properties of spent light water reactor fuel and a method for simulation of a nonradioactive analog. RHO-BWI-C-114, Rockwell Hanford Operations, Richland WA 99352.
12. Dawson, J. B., Hervig, R. L. and Smith, J. V. (1981) Fertile iron-rich dunite xenoliths from the Bultfontein kimberlite, South Africa. *Fortschr. Miner.* 59, 303-324.
13. Exley, R. A., Smith, J. V. and Hervig, R. L. (1982) Cr-rich spinel and garnet in two peridotite xenoliths from the Frank Smith mine, South Africa. *Mineral Mag.* 45, 129-134.
14. Hervig, R. L. and Smith, J. V. (1982) Temperature-dependent distribution of Cr between olivine and pyroxenes in lherzolite xenoliths. *Contributions to Mineralogy and Petrology* 81, 184-189.
15. Navrotsky, A., Zimmermann, H. D. and Hervig, R. L. (1983) Thermochemical study of glasses in the system $\text{CaMgSi}_2\text{O}_6 - \text{CaAl}_2\text{SiO}_6$. *Geochimica et Cosmochimica Acta* 47, 1535-1538.
16. Hervig, R. L. and Navrotsky, A. (1984) Thermochemical study of glasses in the system $\text{NaAlSi}_3\text{O}_8 - \text{KAlSi}_3\text{O}_8 - \text{Si}_4\text{O}_8$ and the join $\text{Na}_{1.6}\text{Al}_{1.6}\text{Si}_{2.4}\text{O}_8 - \text{K}_{1.6}\text{Al}_{1.6}\text{Si}_{2.4}\text{O}_8$. *Geochimica et Cosmochimica Acta* 48, 513-522.
17. Navrotsky, A., Hervig, R. L., Roy, B. and Huffman, M. (1985) Thermochemical studies of silicate, aluminosilicate and borosilicate glass. *High Temp. Science* 19, 133-150.
18. Hervig, R. L. and Navrotsky, A. (1985) Thermochemistry of sodium borosilicate glasses. *Jour. Amer. Ceram. Soc.* 68, 314-319.
19. Hervig, R. L., Scott, D. and Navrotsky, A. (1985) Thermochemistry of glasses along joins of pyroxene stoichiometry in the system $\text{Ca}_2\text{Si}_2\text{O}_6 - \text{Mg}_2\text{Si}_2\text{O}_6 - \text{Al}_4\text{O}_6$. *Geochim. Cosmochim. Acta* 49, 1497-1501.

20. Hervig, R. L. and Williams, P. (1986) Non-oxygen negative ion beams for oxygen isotopic analysis in insulators. In Secondary Ion Mass Spectrometry, SIMS V, eds. A. Benninghoven, R. J. Colton, D. S. Simons and H. W. Werner. Springer-Verlag Series in Chemical Physics 44, 152-154.
21. Alexander, R. W. S., Dawson, J. B., Patterson, E. M. and Hervig, R. L. (1986) The megacryst and inclusion assemblage from the Black Rock vent, Ayrshire. *Scott. Jour. Geol.* 22, 203-212.
22. Streit, L. A., Hervig, R. L. and Williams, P. (1986) Quantitative SIMS microanalysis of trace elements in geological samples using *in situ* ion-implanted standards. In Microbeam Analysis-1986 eds. A. D. Romig Jr. and W. F. Chambers, pp. 91-94.
23. Hervig, R. L., Smith, J. V. and Dawson, J. B. (1986) Lherzolite xenoliths in kimberlites and basalts: petrogenetic and crystallochemical significance of some minor and trace elements in olivine, pyroxenes, garnet and spinel. *Transactions Roy. Soc. Edinburgh, Earth Sciences* 77, 181-201.
24. Hervig, R. L., Kortemeier, W. T. and Burt, D. (1987) Ion microprobe analyses of Li and B in topaz from different environments. *American Mineralogist*, 72, 392-396.
25. Webster, J. D., Holloway, J. R. and Hervig, R. L. (1987) Phase equilibria of a Be, U, and F-enriched vitrophyre from Spor Mountain, Utah. *Geochim. Cosmochim. Acta*, 51, 389-402.
26. Oestrike, R., Yang, W.-H., Kirkpatrick, R. J., Hervig, R. L., Navrotsky, A. and Montez, B. (1987) High-resolution ^{23}Na , ^{27}Al and ^{29}Si NMR spectroscopy of framework aluminosilicate glasses. *Geochim. Cosmochim. Acta*, 51, 2199-2209.
27. Jackman, J. A., Hunt, P. A., van Breemen, O. and Hervig, R. L. (1987) Preliminary investigation on spatial distributions of elements in zircon grains by secondary ion mass spectrometry. In "Radiogenic Age and Isotopic Studies". Geological Survey of Canada Paper 87-2, pp. 9-12.
28. Hervig, R. L. and Williams, P. (1988) SIMS microanalysis of minerals and glasses for H and D. In, "Secondary Ion Mass Spectrometry, SIMS VI". Eds., A. Benninghoven, A. M. Huber and H. W. Werner, John Wiley & Sons, pp. 961-964.
29. London, D., Hervig, R. L. and Morgan, G. B., VI (1988) Melt-vapor solubility and elemental partitioning in peraluminous granite-pegmatite systems: Experimental results with Macusani glass at 200 MPa. *Contributions to Mineralogy and Petrology*, 99, 360-373.
30. Kovalenko, V. I., Hervig, R. L. and Sheridan, M. F. (1988) Ion microprobe analyses of trace elements in anorthoclase, hedenbergite, aenigmatite, quartz, apatite and glass in pantellerite: Evidence for high water contents in pantellerite melts. *American Mineralogist*, 73, 1038-1045.
31. Hervig, R. L., Dunbar, N., Westrich, H. R. and Kyle, P. (1989) Pre-eruptive water content of rhyolitic magmas as determined by ion microprobe analyses of melt inclusions in phenocrysts. *Journal of Volcanology and Geothermal Research*, 36, 293-302.
32. Kovalenko, V. I., Hervig, R. L., Naumov, V. B., Solovova, I. P., Sheridan, M. F. (1989) Using ion probe for analysis of rare elements and water in pantellerites of Pantelleria Island, Italy. *Geokhimiya*, 9, 1307-1319.

33. Webster, J. D., Holloway, J. R. and Hervig, R. L. (1989) Partitioning of lithophile trace elements between H₂O and H₂O + CO₂ fluids and topaz rhyolite melt. *Economic Geology*, 84, 116-134.
34. Dunbar, N. W., Hervig, R. L. and Kyle, P. R. (1989) Determination of pre-eruptive H₂O, F and Cl contents of silicic magmas using melt inclusions, Taupo volcanic center, New Zealand. *Bulletin of Volcanology*, 51, 177-184.
35. Hervig, R. L., Thomas, R. M. and Williams, P. (1989) Charge neutralization and oxygen isotope analysis of insulators using the ion microprobe. In, "New frontiers in stable isotopic research: laser probes, ion probes, and small-sample analysis. W.C. Shanks and R.E. Criss, eds. United States Geological Survey Bulletin, 1890, 137-143.
36. London, D., Morgan, G. B., VI and Hervig, R. L. (1989) Vapor-undersaturated experiments in the system macusanite-H₂O at 200 MPa, and the internal differentiation of rare element pegmatites. *Contributions to Mineralogy and Petrology*, 102, 1-17.
37. Hervig, R. L. and Peacock, S. M. (1989) Implications of trace element zoning in deformed quartz from the Santa Catalina mylonite zone. *Journal of Geology*, 89, 343-350.
38. Rovetta, M., Blacic, J. D., Hervig, R. L. and Holloway, J. R. (1989) An experimental study of hydroxyl in quartz using infrared spectroscopy and ion microprobe techniques. *Journal of Geophysical Research*, 94, 5840-5850.
39. Hervig, R. L. (1989) Comment on "Metasomatic origin for Fe-Ti-rich multiphase inclusions in olivine from kimberlite xenoliths". *Geology*, 17, 675-677.
40. Kovalenko, V.I., Hervig, R.L., Solovova, I. and Naumov, V.B. (1990) Ion microprobe analysis for rare elements and water in pantellerites from Pantelleria, Italy. *Geochemistry International*, 27, 80-91.
41. Pan, V., Holloway, J. R. and Hervig, R. L. (1991) The pressure and temperature dependence of carbon dioxide solubility in tholeiitic basalt melts. *Geochimica et Cosmochimica Acta*, 55, 1587-1595.
42. Westrich, H. R., Eichelberger, J. C., and Hervig, R. L. (1991) Degassing of the 1912 Katmai magmas. *Geophysical Research Lett.*, 18, 1561-1564.
43. George, R. D., McMillan, P. F., Burrows, V. A., and Hervig, R. (1991) Structure and composition of thin films of peripherally unsubstituted phthalocyanine deposited using the Langmuir-Blodgett technique. *Thin Solid Films*, 203, 303-316.
44. Hervig, R. L. and Dunbar, N. W. (1992) Cause of chemical zoning in the Bishop (California) and Bandelier (New Mexico) magma chambers. *Earth Planet. Sci. Lett.*, 111, 97-108.
45. Hervig, R. L. (1992) Oxygen isotope analysis using extreme energy filtering. *Proceedings of the Ion Microprobe Stable Isotope Workshop*, Ed., R. W. Hinton, Chemical Geology, Isotope Geosciences Section, 101, 185-186.
46. Hervig, R. L., Williams, P., Thomas, R. M., Schauer, S. N., and Steele, I. M. (1992) Microanalyses of oxygen isotopes in insulators by secondary ion mass spectrometry. *Int. Jour. Mass Spec. Ion Proc.*, 120, 45-63.

47. Dunbar, N. W. and Hervig, R. L. (1992) Petrogenesis and volatile stratigraphy of the Bishop Tuff: evidence from melt inclusion analysis. *Jour. Geophys. Res.*, 97, 15, 129-15,150.
48. Dunbar, N. W. and Hervig, R. L. (1992) Volatile and trace element composition of melt inclusions from the Lower Bandelier Tuff: Implications for magma chamber processes and eruptive style. *Jour. Geophys. Res.*, 97, 15, 151-15,170.
49. Lowenstern, J. B., Mahood, G. A., Hervig, R. L., and Sparks, J. (1993) The occurrence and distribution of Mo and molybdenite in unaltered peralkaline rhyolites from Pantelleria, Italy. *Contrib. Mineral. Petrol.*, 114, 119-125.
50. Domanik, K. J., Hervig, R. L., and Peacock, S. M. (1993) Beryllium and boron in subduction zone minerals: an ion microprobe study. *Geochim. Cosmochim. Acta*, 56, 4997-5010.
51. Capobianco, C. J., Drake, M. J., and Hervig, R. L. (1994) Experiments on crystal/liquid partitioning of Ru, Rh, and Pd for magnetite and hematite solid solutions crystallized from silicate melt. *Chemical Geology*, 113, 23-43.
52. Jamtveit, B. and Hervig, R. L. (1994) Mass transport and chemical reaction kinetics in hydrothermal systems recorded by intracrystalline mineral zonation. *Science*, 263, 505-508.
53. Williams, P., Pecore, J. A., and Hervig, R. L. (1994) Isotope ratio measurements on microscopic samples at Arizona State University. In, *Secondary Ion Mass Spectrometry, SIMS IX*. Eds. A. Benninghoven, Y. Nihei, R. Shimizu, H. W. Werner. J. Wiley & Sons, Chichester, pp.839-843.
54. Schauer, S. N., Lareau, R. T., Hervig, R. L., and Williams, P. (1994) Energy-dependent mass fractionation of ions during sputtering. In, *Secondary Ion Mass Spectrometry, SIMS IX*. Eds. A. Benninghoven, Y. Nihei, R. Shimizu, H. W. Werner. J. Wiley & Sons, Chichester, pp. 68-71.
55. Lowenstern, J. B., Bacon, C. R., Calk, L. C., Hervig, R. L., and Aines, R. D. (1994) Major-element, trace element, and volatile concentrations in silicate melt inclusions from the tuff of Pine Grove, Wah Wah Mountains, Utah. U.S. Geological Survey Open-File Report 94-242: 20 p.
56. Atzmon, Z., Bair, A. E., Jaquez, E. J., Mayer, J. W., Chandrasekhar, D., Smith, D. J., Hervig, R. L., Robinson, McD. (1994) Chemical vapor deposition of heteroepitaxial Si_{1-x}Ge_xCy films on (100)Si substrates. *Applied Physics Letters* 65, 2559-2561.
57. Ihinger, P. D., Hervig, R. L., McMillan, P. M. (1994) Analytical methods for volatiles in glasses. In, M. Carroll and J. R. Holloway, editors, "Volatiles in Magmas", *Reviews in Mineralogy*, v. 30, pp. 67-121.
58. Kovalenko, V. I., Naumov, V. B., Solovova, I. P., Girmis, A. V., Hervig, R. L., and Boriani, A. (1994) Volatile components, composition, and crystallization conditions of the Pantelleria basalt-pantellerite association magmas, inferred from the melt and fluid inclusion data. *Petrology*, 2, 19-34.
59. Brabander, D. J., Hervig, R. L., and Jenkins, D. M. (1995) Experimental determination of F-OH interdiffusion in tremolite and significance to fluorine-zoned amphiboles. *Geochim. Cosmochim. Acta* 59, 3549-3560.

60. Kovalenko, V. I., Tsaryeva, G. M., Goreglyad, A. V., Yarmolyuk, V. V., Troitsky, V. A., Hervig, R. L., and Farmer, G. L. (1995) The peralkaline granites-related Khaldzan-Buregtey rare element (Zr, Nb, REE) deposit, Western Mongolia. *Econ. Geology*, 90, 530-547.
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62. LaTourrette, T., Hervig, R.L., and Holloway, J. R. (1995) Trace element partitioning between amphibole, phlogopite, and hydrous basanite melt. *Earth and Planetary Science Letters*, 135, 13-30.
63. Kawamoto, T. Leinenweber, K., Hervig, R. L., and Holloway, J. R. (1995) Stability of hydrous minerals in H₂O-saturated KLB-1 peridotite up to 15 GPa. In, *Volatiles in the Earth and Solar System*, K. A. Farley (ed), American Institute of Physics, 229-239.
64. Leshner, C. E., Hervig, R. L., and Tinker, D. (1996) Self diffusion of network formers (Si and O) in naturally occurring aluminosilicate liquids. *Geochimica Cosmochimica Acta*, 60, 405-413.
65. Kovalenko, V. I., Tsaryeva, G. M., Naumov, V. B., Hervig, R. L., and Newman, S. (1996) Magma of pegmatites from Volhynia: Composition and crystallization parameters determined by magmatic inclusion studies. *Petrology*, 4, 277-290.
66. Grzechnik, A., Zimmermann, H.D., Hervig, R.L., King, P.L., and McMillan, P.F. (1996) FTIR micro-reflectance measurements of the CO₃²⁻ ion content in basanite and leucitite glasses. *Contributions to Mineralogy and Petrology*, 125, 311-318.
67. Hervig, R. L. (1996) Analyses of geological materials for boron by secondary ion mass spectrometry. In, E. S. Grew and L. M. Anovitz, editors, "Boron: mineralogy, petrology, and geochemistry in the Earth's crust", *Reviews in Mineralogy*, v. 33, 789-803.
68. Kawamoto, T., Hervig, R. L., and Holloway, J. R. (1996) Experimental evidence for a hydrous transition zone in the early Earth's mantle. *Earth and Planetary Science Letters*, 142, 587-592.
69. Smyth, J. R., Kawamoto, T., Jacobsen, S. D., Swope, R. J., Hervig, R. L., and Holloway, J. R. (1997) Crystal structure of monoclinic hydrous wadsleyite [b-(Mg,Fe)₂SiO₄]. *American Mineralogist*, 82, 270-275.
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76. Brooker, R., Holloway, J. R. and Hervig, R. L. (1998) Reduction in piston-cylinder experiments: The detection of carbon infiltration into platinum capsules. *American Mineralogist*, 83, 985-994.
77. Peacock, S. M. and Hervig, R. L. (1999) Boron isotopic composition of subduction-zone metamorphic rocks. *Chemical Geology*, 160, 281-290.
78. King, P. L., Hervig, R. L., Holloway, J. R., Vennemann, T. W., and Righter, K. (1999) Oxy-substitution in mantle-derived amphibole megacrysts. *Geochimica et Cosmochimica Acta*, 63, 3635-3651.
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80. Williams, P., Abdulkawi, H., and Hervig, R. L. (2000) Breaking the rules of ion source design: On-axis negative ion extraction and ion sources fabricated from insulators. In, *Secondary Ion Mass Spectrometry, SIMS XII*. Eds. A. Benninghoven, P. Bertrand, H. N. Migeon, H. W. Werner. Elsevier, Amsterdam, pp. 241-244.
81. Williams, P. and Hervig, R. L. (2000) Associative detachment reactions in oxygen-sputtered uranium. In, *Secondary Ion Mass Spectrometry, SIMS XII*. Eds. A. Benninghoven, P. Bertrand, H. N. Migeon, H. W. Werner. Elsevier, Amsterdam, pp. 139-142.
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- 88 Laursen, T., Chandrasekhar, D., Hervig, R. L., Mayer, J. W. and Smith, D. J. (2001) Fabrication and characterization of C implantation standards for Si_{1-x-y}Ge_xC_y alloys. *J. Vac. Sci. Tech A*, 19, 2879-2883.
- 89 Dyar, M. D., Wiedenbeck, M., Robertson, D., Cross, L. R., Delaney, J. S., Ferguson, K., Francis, C. A., Grew, E. S., Guidotti, C. V., Hervig, R. L., Hughes, J. M., Husler, J., Leeman, W., McGuire, A. V., Rhede, D., Rothe, H., Paul, R. L., Richard, I., Yates, M. (2001) Reference minerals for microanalysis of light elements. *Geostandards Newsletter* 25, 441-463.
- 90 Righter, K., Dyar, M. D., Delaney, J. S., Vennemann, T. W., Hervig, R. L. (2002) Distribution of OH⁻, O²⁻, Cl⁻, and F⁻ in biotite from volcanic rocks and correlations with octahedral cations. *American Mineralogist*, 87, 142-153.
- 91 Williams, L. B. and Hervig, R. L. (2002) Exploring intracrystalline boron isotope variations in mixed-layer illite/smectite. *American Mineralogist*, 87, 1564-1570.
- 92 King, P. L., Vennemann, T. W., Holloway, J. R., Hervig, R. L., Lowenstern, J. B., Forneris, J. F. (2002) Analytical techniques for volatiles: A case study using intermediate (andesitic) glasses. *American Mineralogist*, 87, 1077-1089.
- 93 Hervig, R. L., Moore, G. M., Williams, L. B., Peacock, S. M., Holloway, J. R., and Roggensack, K. (2002) Isotopic and elemental partitioning of boron between hydrous fluid and melt. *American Mineralogist* 87, 769-774.
- 94 Hervig, R. L. (2002) Beryllium analyses by secondary ion mass spectrometry. In, E. S. Grew, editor, "Beryllium: mineralogy, petrology, and geochemistry in the Earth's crust", *Reviews in Mineralogy*, v. 50, 319-332.
- 95 Hervig, R. L. (2002) Anomalous fractionation of sulfur isotopes during sputtering. *Rapid Commun. Mass Spec.*, 16, 1774-1778.
- 96 Matthews, A., Putlitz, B., Hamiel, Y., and Hervig, R. L. (2003) Volatile transport during the crystallization of anatectic melts: oxygen, boron and hydrogen stable isotope study on the metamorphic complex of Naxos, Greece. *Geochimica et Cosmochimica Acta* 67, 3145-3163.
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