Curriculum vitae

Eric Stephen Boyd

Assistant Professor
Department of Microbiology and Immunology
Montana State University
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Employment

2014-present	Assistant Professor, Department of Microbiology and Immunology, Montana State University, Bozeman, MT
2012-present	NASA Early Career Fellow
2011-2013	Assistant Research Professor, Department of Chemistry and Biochemistry, Montana State University, Bozeman, MT
2009-2011	NASA Astrobiology Institute Postdoctoral Research Fellow, Department of Chemistry and Biochemistry, Montana State University, Bozeman, MT; advisor: John Peters
2007-2009	Postdoctoral Research Fellow, Department of Chemistry and Biochemistry, Montana State University, Bozeman, MT; advisor: John Peters
2002-2003	Laboratory Technician, Department of Microbiology, Iowa State University, Ames, IA; advisor: Alan DiSpirito

Education

2003-2007	Ph.D., microbiology, Montana State University, Bozeman, MT; advisor: Gill Geesey
1998-2002	B.S., biology, Iowa State University, Ames, IA; advisor: Alan DiSpirito

Honors and Service

2013-present	Guest Review Editor, Frontiers in Extreme Microbiology
2013-present	Editorial Board, Geobiology
2013-present	Editorial Board, Geomicrobiology Journal
2012-present	NASA Early Career Fellow

2012-present	Member of the National Association of Biological Teachers Committee on Global Perspectives
2012	Guest Review Editor, Frontiers in Terrestrial Microbiology
2012-present	Editorial Board, Scientifica
2011-present	Editorial Board, Frontiers in Microbiological Chemistry
2011-present	Editorial Board, Frontiers in Terrestrial Microbiology
2011	Montana State University Vice President for Research Postdoctoral Scholar Excellence Award
2009-2011	NASA Astrobiology Institute Postdoctoral Fellowship
2006-2007	Montana University System Water Center Fellowship for outstanding research directed at water resource issues in the state or region
2006-2007	Department of Microbiology Fergusson Graduate Fellowship for outstanding contributions both in research and in teaching
2004-2006	Inland Northwest Research Alliance Graduate Fellowship for exceptional research in the area of subsurface microbiology
2005	International Society for Subsurface Microbiology Travel Award

Peer Reviewed Publications or Book Chapters (In Press/Submitted): Total Citations = 1473, H index = 21

Boyd, E.S., A.M. Garcia Costas, F. Mus, T.L. Hamilton, and J.W. Peters. Evolution of molybdenum nitrogenase during the transition from anaerobic to aerobic metabolism. *In review.*

Hindshaw, R. S., T.H.E. Hinton, **E.S. Boyd**, M. Lindsay, and E.T. Tipper. Influence of glaciation on mechanisms of mineral weathering in two high Arctic catchments. *In review.*

Boyd, E.S., T.L. Hamilton, K.D. Swanson, A.E. Howells, B.K. Baxter, M.C. Posewitz, and J.W. Peters. Distribution, abundance, and diversity of [FeFe]-hydrogenases along a vertical redox gradient in Great Salt Lake, USA. *In review*.

Peters, J.W., G.J. Schut, **E.S. Boyd**, D.W. Mulder, E.S. Shepard, J.B. Broderick, P.W. King, M.W.W. Adams. [FeFe]- and [NiFe]-hydrogenase diversity, mechanism, and maturation. *In review*.

Urschel, M., E. Koonce, M. Kubo, T. Hoehler, J.W. Peters, and **E.S. Boyd**. Carbon transformations in high temperature terrestrial geothermal spring communities. *In review*.

64. **Boyd*, E.S**., T.L. Hamilton, J.R. Havig, R.K. Lange, J.W. Peters, M.L. Skidmore and E.L. Shock. 2014. Chemolithotrophic primary production in a subglacial ecosystem. Appl. Environ. Microbiol. 80: 6146–6153. doi: 10.1128/AEM.01956-14. *Corresponding author. Cover Image.

63. **Boyd, E.S.**, K. Thomas, Y. Dai, J.M. Boyd, and F.W. Outten. 2014. The interplay between oxygen and Fe-S cluster biogenesis: Insights from the Suf pathway. Biochem. 53: 5834–5847. 10.1021/bi500488r.

62. Amenabar, M., M.R. Urschel, and **E.S. Boyd***. 2014. Metabolic and taxonomic diversification in continental magmatic hydrothermal systems. *In* Microbial Evolution under Extreme Conditions ed. Corien Bakermans, De Gruyter. *In press*. *Corresponding author

61. **Boyd*, E.S.**, G. Schut, M.W.W. Adams, and J.W. Peters. 2014. Hydrogen metabolism and the

evolution of respiration. Microbe. 9:361-367. *Corresponding author.

60. Jia, J., C.L. Zhang, W. Xie, F. Li, J. Wang, S. Wang, H. Dong, W. Li, and **E.S. Boyd*.** 2014. Differential temperature and pH controls on the abundance and composition of H-GDGTs in terrestrial hot springs. Org. Geochem. 75: 109–121. doi: 10.1016/j.orggeochem.2014.06.009. *co-corresponding author.

59. Alsop, E.A., **E.S. Boyd**, and J.A. Raymond. 2014. Geochemical constraints on biological evolution: Merging metagenomics and geochemistry to understand how environment shapes biodiversity. BMC Ecology. 14:16. doi:10.1186/1472-6785-14-16.

58. Gammons, C.H., W. Henne, S.R. Poulson, S.R. Parker, T.B. Johnston, J.E. Dore, and **E.S. Boyd**. 2014. Stable isotopes of dissolved oxygen and dissolved inorganic carbon track biogeochemical processes under ice cover in a shallow, eutrophic lake. Biogeochem. 120:359–379. doi: 10.1007/s10533-014-0005-z.

57. **Boyd, E.S.**, G.J. Schut, J.B. Broderick, M.W.W. Adams, and J.W. Peters. 2014. Origin and evolution of Fe-S proteins and enzymes. *In* Iron-Sulfur Clusters in Chemistry and Biology. ed. Tracey Rouault, De Gruyter. ISBN: 978-3-11-030842-6

56. Hamilton, T.L., E. Koonce, A. Howells, J.R. Havig, J.W. Peters, and **E.S. Boyd***. 2014. Competition for ammonia influences the structure of chemotrophic communities in geothermal springs. Appl. Environ. Microbiol. 80 (2):653-661. doi:10.1128/AEM.02577-13
*Corresponding Author. Chosen as a "Spotlight" article by Journal Editors.

55. Peters, J.W. and **E.S Boyd**. 2014. Exploring alternative paths for the evolution of biological nitrogen fixation. *In* Biological Nitrogen Fixation. ed. Frans J. de Bruijn, John Wiley & Sons, Inc. ISBN: *In press*.

54. Reardon, C.L., T.S. Magnuson, **E.S. Boyd**, W.D. Leavitt, D.W. Reed, and G.G Geesey. 2014. Hydrogenase activity of mineral-associated and suspended populations of *Desulfovibrio desulfuricans* Essex 6. Microb. Ecol. 67:318–326. doi 10.1007/s00248-013-0308-y.

53. Møller, A.K., T. Barkay, M.A. Hansen, A. Norman, L.H. Hansen, S.J. Sørensen, **E.S. Boyd,** and N. Kroer. 2014. Novel bacterial mercuric reductase genes (*merA*) and mercury resistance plasmids in high Arctic snow, freshwater and sea-ice brine. FEMS Microbiol. Ecol. 87:52-63. doi: 10.1111/1574-6941.12189.

52 D'Adamo, S., R.E. Jinkerson, **E.S. Boyd**, S. Brown, B. Baxter, J.W. Peters, and M.C. Posewitz. 2014. Evolutionary and biotechnological implications of robust hydrogenase activity in a halophilic species of *Tetraselmis* from Great Salt Lake. PLoS One. 9:e85812. doi: 10.1371/journal.pone.0085812

51. Liu, Z., J. Müller, T. Li, R.M. Alvey, K. Vogl, N.-U. Frigaard, N.C. Rockwell, **E.S. Boyd**, L.P. Tomsho, S.C. Schuster, P. Henke, M. Rohde, J. Overmann, and D.A. Bryant. 2013. Genomic analysis reveals key aspects of prokaryotic symbiosis in the phototrophic consortium "*Chlorochromatium aggregatum*". Gen. Biol. 14**:**R127. doi:10.1186/gb-2013-14-11-r127.

50. Mitchell, A.C., M. Lafreniere, M.L. Skidmore, and **E.S. Boyd**. 2013. Influence of bedrock mineral composition on microbial diversity in a subglacial environment. Geology. 41:855-858. doi: 10.1130/G34194.1.

49. **Boyd, E.S.** and J.W. Peters. 2013. New insights into the evolutionary history of biological nitrogen fixation. Front. Microbiol. 4**:**201. doi: 10.3389/fmicb.2013.00201.

48. Inskeep, W.P., Z. Jay, M. Herrgard, M. A. Kozubal, D. B. Rusch, S.G. Tringe, R. E. Macur, R. dem Jennings, **E.S. Boyd**, J. Spear, F. Roberto and M. Young. 2013. Phylogenetic and functional analysis of metagenome sequence from high-temperature archaeal habitats demonstrate linkages between metabolic potential and geochemistry. Front. Microbiol. 4:95. doi: 10.3389/fmicb.2013.00095

47. **Boyd, E.S.***, T.L. Hamilton, J. Wang, L. He, and C.L. Zhang. 2013. The role of tetraether lipid composition in the adaptation of thermophilic archaea to acidity. Front. Microbiol. 4:62. *Corresponding Author. doi: 10.3389/fmicb.2013.00062

46. Hamilton, T.L., J.W. Peters, M.L. Skidmore, and **E.S. Boyd***. 2013. Molecular evidence for an active endogenous microbiome beneath glacial ice. ISME J. 7:1402-4012. doi: 10.1038/ismej.2013.31. *Corresponding Author.

45. **Boyd, E.S*** and G.K. Druschel. 2013. The role of intermediate sulfur compounds during the reduction of elemental sulfur under acidic, hydrothermal conditions. Appl. Environ. Microbiol. 79(6):2061-2068. *Corresponding author. doi: 10.1128/AEM.03160-12.

44. Meuser, J.E., B.K. Baxter, J.R. Spear, J.W. Peters, M.C. Posewitz, and **E.S. Boyd***. 2013. Contrasting patterns of community assembly in the stratified water column of Great Salt Lake, Utah. Microb. Ecol. 66(2):268-280. doi: 10.1007/s00248-013-0180-9.
*Corresponding author.

43. Shepard, E.M., A.S. Byer, E.S. Boyd, K.D. Swanson, J.W. Peters and J.B. Broderick. 2013. [FeFe]-hydrogenase cofactor assembly. *In*: Encyclopedia of Inorganic and Bioinorganic Chemistry. Robert A. Scott (Ed.), John Wiley & Sons, Ltd. doi: 10.1002/9781119951438.eibc2153.

42. Peters, J.W., **E.S. Boyd**, S. D'Adamo, D.W. Mulder, J. Therien, and M.C. Posewitz. 2013. Hydrogenases, nitrogenases, anoxia, and H_2 production in water-oxidizing phototrophs. In: Algal Biofuels. Michael Borowitzka (Ed.), Elsevier. Pages 59-99. doi: 10.1007/978-94-007-5479-9_3.

41. Schut, G.J., **E.S. Boyd**, J.W. Peters, and Michael W. W. Adams. 2013. The modular respiratory complexes involved in hydrogen and sulfur metabolism by heterotrophic hyperthermophilic Archaea and their evolutionary implications. FEMS Microbiol. Rev. 37(2):182-203. doi: 10.1111/j.1574-6976.2012.00346.x.

40. McGlynn, S.E., **E.S. Boyd**, J.W. Peters, and V.J. Orphan. 2012. Classifying the metal dependence of uncharacterized nitrogenases. Front. Microbiol. 3: 419. doi: 10.3389/fmicb.2012.00419.

39. **Boyd, E.S.***, and T. Barkay. 2012. The mercury resistance operon: From an origin in a geothermal environment to an efficient detoxification machine. Front. Microbiol. 3:349. doi: 10.3389/fmicb.2012.00349.

*Corresponding author.

38. **Boyd, E.S.***, K.M. Fecteau, J.R. Havig, E.L. Shock, and J.W. Peters. 2012. Modeling the habitat range of phototrophic microorganisms in Yellowstone National Park: Toward the development of a comprehensive fitness landscape. Front. Microbiol. 3**:**221. doi: 10.3389/fmicb.2012.00221
*Corresponding author.

37. Duffus, B., E.M. Shepard, **E.S. Boyd**, T.L. Hamilton, J.W. Peters, and J.B. Broderick. 2012. Radical AdoMet enzymes in complex inorganic metallocluster biosynthesis. Biochim. Biophys. Acta. 1824. 1254-1263. doi: 10.1016/j.bbapap.2012.01.002.

36. Hamilton, T.L., K. Vogl, D.A. Bryant, **E.S. Boyd***, and J.W. Peters. 2012. Environmental constraints defining the distribution, composition, and evolution of chlorophototrophs in thermal features of Yellowstone National Park. Geobiology. 10. 236-249. doi: 10.1111/j.1472-4669.2011.00296.x.
*Co-corresponding author

35. Wang, Y., **E.S. Boyd**, S. Crane, P. Lu-Irving, D. Krabbenhoft, S. King, J. Dighton, G. Geesey, and T. Barkay. 2011. Environmental conditions constrain the distribution and diversity of archaeal *merA* in Yellowstone National Park, Wyoming, U.S.A. Microb. Ecol. 62(4): 739-752. doi: 10.1007/s00248-011-9890-z

34. Meuser, J.E., **E.S Boyd**, G. Ananyev, D. Karns, *N.U.M.* Murthy, R. Radakovits, M.L. Ghirardi, G.C. Dismukes, J.W. Peters, and M.C. Posewitz. 2011. Evolutionary significance of an algal gene encoding an [FeFe]-hydrogenase with F-domain homology and hydrogenase activity in *Chlorella variabilis* NC64A. Planta. 234(4):829-43. doi: 10.1007/s00425-011-1431-y.

33. **Boyd, E.S.**, T.L. Hamilton, and J.W. Peters. 2011. An alternative path for the evolution of biological nitrogen fixation. Front. Microbiol. **2:**205. doi: 10.3389/fmicb.2011.00205.

32. Hamilton, T.L., M. Ludwig, R. Dixon, **E.S. Boyd**, P. Dos Santos, J.C.C. Setubal, D.A. Bryant, D.R. Dean, and J.W. Peters. 2011**.** Differential accumulation of *nif* structural gene mRNA in *Azotobacter vinelandii.* J. Bact. 193: 4534–4536. doi: 10.1128/JB.05100-11.

31. Hamilton, T.L., M. Ludwig, R. Dixon, **E.S. Boyd**, P. Dos Santos, J.C.C. Setubal, D.A. Bryant, D.R. Dean, and J.W. Peters. 2011. Transcriptional profiling of nitrogen fixation in *Azotobacter vinelandii*. J. Bact. 193: 4477–4486. doi: 10.1128/JB.05099-11.

30. Hamilton, T.L., R.K. Lange, **E.S. Boyd***, and J.W. Peters. 2011. Biological nitrogen fixation in acidic high temperature geothermal springs in Yellowstone National Park, Wyoming. Environ. Microbiol. 13: 2204-2215. doi: 10.1111/j.1462-2920.2011.02475.x
*Co-corresponding author

29. Arslan, B., **E.S. Boyd**, W. Dolci, E. Dodson, M. Boldt, and C. Pilcher. 2011. Workshop without walls: Broadening access to science around the world. PLoS Biol. 9: e1001118. doi: 10.1371/journal.pbio.1001118

28. **Boyd, E.S.***, R.K. Lange, A.C. Mitchell, J.R. Havig, M.J. Lafrenière, T.L. Hamilton, E.L. Shock, J.W. Peters, and M. Skidmore. 2011. Diversity, abundance, and potential activity of nitrifying and nitrate-reducing

microbial assemblages in a subglacial ecosystem. Appl. Environ. Microbiol. 77: 4778-4787. doi: 10.1128/AEM.00376-11. *Corresponding author

27. Peters, J.W., **E.S. Boyd**, T.L. Hamilton, and L.M. Rubio. 2011. Biochemistry of Mo-Nitrogenase. *In* Nitrogen Cycling in Bacteria: Molecular Analysis. Edited by James W. B. Moir. Caister Academic Press. ISBN: 978-1-904455-86-8.

26. Hamilton, T.L., **E.S. Boyd***, and J.W. Peters. 2011. Environmental constraints underpin the distribution and phylogenetic diversity of *nifH* in the Yellowstone geothermal complex. Microbiol. Ecol. 61:860–870. doi: 10.1007/s00248-011-9824-9.
*Co-corresponding author.

25. **Boyd, E.S.**, A.D. Anbar, S.R. Miller, T.L. Hamilton, M. Lavin, and J.W. Peters. 2011. A late methanogen origin for the molybdenum-dependent nitrogenase. Geobiology. 9(3):221-232. doi: 10.1111/j.1472-4669.2011.00278.x.
*Featured as an Editor's Choice article: Science. 332:896.
http://www.sciencemag.org/content/332/6032/twil.full

24. Shepard, E.M., **E.S. Boyd**, J.B. Broderick, and J.W. Peters. 2011. Biosynthesis of complex iron-sulfur enzymes. Curr. Opin. Chem. Biol. 15(2):319-27. doi: 10.1016/j.cbpa.2011.02.012.

23. **Boyd, E.S**.*, A. Pearson, Y. Pi, W.-J. Li, Y.G. Zhang, L. He, C.L. Zhang, and G.G. Geesey. 2011. Physicochemical influences on glycerol dialkyl glycerol tetraether lipid composition in the crenarchaeote *Acidilobus sulfurireducens*. Extremophiles. 15(1):59–65. doi: 10.1007/s00792-010-0339-y.
*Corresponding author

22. Brown, I.I., D.A. Bryant, D. Casamatta, K.L. Thomas-Keprta, S.A. Sarkisova, G. Shen, J.E. Graham, **E.S. Boyd**, J.W. Peters, D.H. Garrison, and D.S. McKay. 2010. Polyphasic characterization of a thermotolerant siderophilic filamentous cyanobacterium that produces intracellular iron deposits. Appl. Environ. Microbiol. 76(19):6664-72. doi: 10.1128/AEM.00662-10.

21. **Boyd, E.S**., T.L. Hamilton, J.R. Spear, M. Lavin, and J.W. Peters. 2010. [FeFe]-hydrogenase in Yellowstone National Park: evidence of dispersal limitation and phylogenetic niche conservatism. ISME J. 4:1485–1495. doi: 10.1038/ismej.2010.76.

20. Barkay, T., K. Kritee*, **E.S. Boyd***, and G.G. Geesey. 2010. A thermophilic bacterial origin and subsequent constraints by redox, light, and salinity on the evolution of the microbial mercuric reductase. Environ. Microbiol. 12(11):2904-2917. doi: 10.1111/j.1462-2920.2010.02260.x.
*Contributed equally to this work

19. Mulder, D.M., **E.S. Boyd**, R. Sarma, J.A. Endrizzi, R. Lange, J.B. Broderick and J.W. Peters. 2010. Stepwise [FeFe]-hydrogenase H-cluster assembly revealed in the structure of HydA(ΔEFG). Nature. 465: 248-252. doi: 10.1038/nature08993.

18. **Boyd, E.S**.*, M. Skidmore, A.C. Mitchell, C. Bakermans, and J.W. Peters. 2010. Methanogenesis in subglacial sediments. Environ. Microbiol. Reports. 2(5):685-692.
*Corresponding author. doi:10.1111/j.1758-2229.2010.00162.x

17. Soboh, B.*, **E.S. Boyd***, D. Zhao, J.W. Peters, and L.M. Rubio. 2010. Substrate specificity and evolutionary implications of a NifDK enzyme carrying NifB-co at its active site. FEBS Lett. 584(8): 1487-1492. doi:10.1016/j.febslet.2010.02.064.
*Contributed equally to this work

16. Driesener, R.C., M.R. Challand, S.E. McGlynn, E.M. Sheppard, **E.S. Boyd**, J.B. Broderick, J.W. Peters and P.L. Roach. 2010. [FeFe]-hydrogenase cyanide ligands derived from S-adeosylmethionine dependant cleavage of tyrosine. Angewandte Chemie. 49(9):1687-1690. doi: 10.1002/anie.200907047.

15. Inskeep, W.P., D. Rusch, Z. Jay, M. Herrgard, M. Kozubal, T. Richardson, R. Macur, N. Hamamura, B. Fouke, A-L. Reysenbach , M. Young, M. Bateson, F. Roberto, R. Jennings, S. Korf, **E.S Boyd**, J. Badger, G. Geesey, E. Mathur and M. Frazier. 2010. Metagenomes from high-temperature chemotrophic systems reveal geochemical controls on microbial community structure and function. PLoS Biol. 5 (3): e9773. doi: 10.1371/journal.pone.0009773.

14. Zadvornyy, O.A., M. Allen, S.K. Brumfield, Z. Varpness, **E.S. Boyd**, N.A. Zorin, L. Serebriakova, T. Douglas, and J.W. Peters. 2010. Hydrogen enhances nickel tolerance in the purple sulfur bacterium *Thiocapsa roseopersicina*. Environ. Sci. Tech. 44 (2): 834–840. doi: 10.1021/es901580n.

13. McGlynn, S.E., **E.S. Boyd**, E.M. Shepard, R. Lange, R. Gerlach, J.B. Broderick, and J.W. Peters. 2010. Identification and characterization of a novel member of the radical AdoMet enzyme superfamily and implications for the biosynthesis of the Hmd hydrogenase active site cofactor. J. Bact. 192 (2): 595-598. doi: 10.1128/JB.01125-09.

12. Beer, L.L., **E.S. Boyd**, J.W. Peters, and M.C. Posewitz. 2009. Engineering algae for biohydrogen and biofuel production. Curr. Opin. Biotech. 20 (2): 264-271. doi: 10.1016/j.copbio.2009.06.002.

11. **Boyd, E.S**., J.R. Spear, and J.W. Peters. 2009. [FeFe] hydrogenase genetic diversity provides insight into molecular adaptation in a saline microbial mat community. Appl. Environ. Microbiol.75 (13): 4620–4623. doi: 10.1128/AEM.00582-09.

10. **Boyd, E.S**., W.D. Leavitt, and G.G. Geesey. 2009. CO_2 uptake and fixation by a thermoacidophilic microbial community attached to sulfur flocs in a geothermal spring. Appl. Environ. Microbiol. 75 (13): 4289-4296. doi: 10.1128/AEM.02751-08.

9. **Boyd, E.S**., S. King, J.K. Tomberlin, K. Nordstrom, D.P. Krabbenhof, T. Barkay, G.G. Geesey. 2009. Methylmercury enters an aquatic food web through acidophilic microbial mats in Yellowstone National Park, Wyoming. Environ. Microbiol. 11 (4): 950–959. doi: 10.1111/j.1462-2920.2008.01820.x.

8. Krishnakumar, A.M., D. Sliwa, J.A. Endrizzi, **E.S. Boyd**, S.A. Ensign, and J.W. Peters. 2008. Getting a handle on the role of Coenzyme M in alkene metabolism. Microbiol. Mol. Biol. Rev. 72 (3): 445–456. doi: 10.1128/MMBR.00005-08.

7. **Boyd, E. S.***, R.A. Jackson, G. Encarnacion, J.A. Zahn, T. Beard, W.D. Leavitt, Y. Pi, C.L. Zhang, A. Pearson, and G.G. Geesey. 2007. Isolation, characterization, and ecology of sulfur-respiring Crenarchaea inhabiting acid-sulfate-chloride geothermal springs in Yellowstone National Park. Appl. Environ. Microbiol. 73 (20): 6669-6677. doi: 10.1128/AEM.01321-07.

* Corresponding author.

6. **Boyd, E.S.**, D.C. Cummings, and G.G. Geesey. 2007. Mineralogy influences structure and diversity of bacterial communities associated with geological substrata in a pristine aquifer. Microb. Ecol. 54 (1): 170-182. doi: 10.1007/s00248-006-9187-9.

5. Choi, D.W, Y.S. Do, C.J. Zea, M.T. McEllistrem, S-W. Lee, J.D. Semrau, N.L. Pohl, C.J. Kisting, **E.S. Boyd**, G.G. Gessey, T.P. Riedel, P.H. Shafe, K.A. Kranski, J.R. Tritsch, W.E. Antholine, and A.A. DiSpirito. 2006. Spectral and thermodynamic properties of Ag(I), Au(III), Cd(II), Co(II), Fe(III), Hg(II), Mn(II), Ni(II), Pb(II), U(IV), and Zn(II) binding by Methanobactin from *Methylosinus trichosporium* OB3b. J. Inorg. Biochem. 100 (12): 2150-2161. doi: 10.1016/j.jinorgbio.2006.08.017

4. Choi, D.-W., C.J. Zea, Y.S. Do, J.D. Semrau, W.E. Antholine, C.J. Kisting, M.S. Hargrove, N.L. Pohl, **E.S. Boyd**, G.G. Geesey, D. Campbell, V. Rao, S.C. Hartsel, M.T. McEllistrem, A.M. de la Mora, and A.A. DiSpirito. 2005. Spectral, kinetic, and thermodynamic properties of Cu(I)- and Cu(II)-binding by methanobactin from *Methylosinus trichosporium* OB3b. Biochem. 45 (5): 1442-1453. doi: 10.1021/bi051815t.

3. Do, Y.S., T.M. Schmidt, J.A. Zahn, **E.S. Boyd**, and A.A. DiSpirito. 2003. Role of *Rhodobacter* sp. PS9, a purple non-sulfur photosynthetic bacterium isolated from an anaerobic swine waste lagoon involved in odor remediation. Appl. Environ. Microbiol. 69 (3): 1710-1720. doi: 10.1128/AEM.69.3.1710-1720.2003.

2. Choi, D.-W., R.C. Kunz, **E.S. Boyd**, J.D. Semrau, W.E. Antholine, J.-I. Han, J.A. Zahn, J.M. Boyd, A.M. de la Mora, and A.A. DiSpirito. 2003. Isolation of the membrane-associated methane monooxygenase and the NADH:quinone oxidoreductase complex from *Methylococcus capsulatus* Bath. J. Bacteriol. 185 (19): 5755-5764. doi: 10.1128/JB.185.19.5755-5764.2003.

1. Zahn, J.A., J. Anhalt, and **E.S. Boyd**. 2001. Evidence for transfer of tylosin and tylosin-resistant bacteria in air from swine production facilities using sub-therapeutic concentrations of tylan in feed. J. Anim. Sci. 79:189.

Invited Conference Presentations

Boyd, E.S. Coupled iron and sulfur transformations in hydrothermal springs. American Geophysical Union. December, 2014.

Boyd, E.S. On the origin and evolution of acidiphily. NASA Astrobiology Institute Executive Council. October, 2013.

Boyd, E.S. Mineralogical controls on subglacial microbiome assembly. Center for Dark Energy Biosphere Investigations workshop on Biogenergetics and Subsurface Metabolisms. April, 2014.

Boyd, E.S. The assembly of a subglacial microbiome. University of Hawaii Astrobiology Winter School. January, 2014.

Boyd, E.S. Microbial Diversity of Hot Springs. University of Hawaii Astrobiology Winter School. January, 2014.

Boyd, E.S. *Keynote*: Hot Spring Environments as Accessible Portals into the Metabolic Underpinnings of the Deep Hot Biosphere. Goldschmidt Conference. Florence, Italy. August, 2013.

Boyd, E.S. *Young Investigator invited oral presentation*. Phylogenetic Evidence for H_2 Based Electron Bifurcation in Early Life. American Society for Microbiology General Conference. Denver, Colorado. May, 2013.

Boyd, E.S. Integrating Geochemistry and (Meta)Genomics in Geothermal Springs in Yellowstone National Park: Mapping the Functional Limits of Life in Early Earth Analog Environments. NASA Astrobiology Institute Virtual Seminar Series. October, 2011.

Boyd, E.S. Distribution, Diversity, and Activity of Biological Nitrogen Fixation in the Yellowstone Geothermal Complex, Wyoming, USA. The First International Conference on Geomicrobial Ecotoxicology. Wuhan, China. May, 2011.

Boyd, E.S. Nitrogenase Evolution. A Workshop Without Walls on Molecular Paleontology and Resurrection: Rewinding the Tape of Life. NASA Astrobiology Institute Virtual Seminar Series. November, 2010.

Boyd, E.S. Integrating Geochemistry, Phylogenetics, and Ecological Theory Toward a Predictive Framework Encompassing the Reciprocal Interactions Between Living Organisms and Their Geological Milieu. NSF Workshop on Low Temperature Geobiology and Geochemistry. Washington, D.C., August, 2010.

Boyd, E.S. An Early Origin for Molybdenum-Nitrogenase. American Geophysical Union. San Francisco, CA., December, 2009.

Boyd, E.S. Origin of Biological Nitrogen Fixation. National Academy of Sciences subcommittee on the origin and Evolution of Life (EOL) meeting. Big Sky, MT, September, 2009.

Boyd, E.S. Origin and Evolution of Molybdenum-Dependent Nitrogenase. International Congress on Nitrogen Fixation. Big Sky, MT, June, 2009.

Boyd, E.S.. Bioprospecting for Hydrogenase and Hydrogen-Producing Organisms in Yellowstone National Park. Joint Air Force Office of Scientific Research/National Renewable Energy Laboratory Biofuels Conference. January, 2009.

Invited Institutional Presentations

Montana State University. Between a Rock and a Cold, Dark, Icy Place: Mineralogical Controls on the Assembly of a Subglacial Microbiome. March, 2014.

Arizona State University. Carbon Transformations in Terrestrial Hydrothermal Ecosystems. March, 2014.

Pennsylvania State University-Lehigh Valley. Yellowstone Through Space and Time: A Guided Tour Through the Evolution of Life. March, 2013.

Arizona State University. The Role of Intermediate Sulfur Species in the Reduction of Elemental Sulfur Under Acidic Hydrothermal Conditions. February, 2013.

Westminster Collage. Identifying Populations Putatively Involved in Hg Biogeochemical Cycling. October, 2012

Arizona State University. Assessing the Relative Importance of Autotrophic and Heterotrophic Metabolisms in High Temperature Ecosystems. February, 2012

Rutgers University. Pattern and Prediction: Integrating Geochemistry and (Meta)genomics in the Geothermal Springs of Yellowstone National Park. December, 2011.

Yunnan University. Examining Microorganisms and Microbial Processes Within a Geochemical Matrix. June, 2011.

Arizona State University. Ecology of Chlorophototrophs in Yellowstone National Park, Wyoming. February, 2011.

University of Free State. Environmental Constraints on Hydrogen (H_2)-Based Metabolisms in Geothermal Springs in Yellowstone National Park (YNP), Wyoming, USA. January, 2011.

Arizona State University. Merging Geochemistry and Phylogenetics Across the Yellowstone Geothermal Complex. Arizona State University School of Earth and Space Exploration. February, 2010.

Montana State University. Subglacial Methanogenesis. January, 2010.

Montana State University. An Early Origin for Molybdenum-Nitrogenase. October, 2009.

East Carolina University. An Early Origin for Molybdenum-Nitrogenase and Implications for Biospheric Redox Evolution. October, 2009.

Arizona State University. Evolutionary Origin and History of the Mo-Dependent Nitrogenase. January, 2009.

Research Grants

Pending Awards

Searching for icy ecosystems on Mars: Linking microbes and minerals in glacial environments. NASA PSTAR. Co-I: Eric Boyd, PI: Briony Horgan. $1,425,425. 04/01/16 to 03/31/19

Defining the habitability and evolution of microbial perchlorate metabolism. NASA Exobiology and Evolutionary Biology. Co-I: Eric Boyd, PI: Jennifer Dubois. $610,795. 01/01/15 - 01/01/18

RUI: Collaborative Research: Redox chemistry and the development of microbial community structure in a seasonally ice-covered eutrophic lake (PI, Steve Parker). NSF Division of Earth Sciences (EAR) Low Temperature Geobiology and Geochemistry. Co-I: Eric Boyd, PI: Steve Parker. $400,385 in total funding. 9/1/14-8/31/16.

NASA Early Career Fellowship. PI: Eric Boyd, $100,000 in total funding.

Current Awards

Rock-Powered Life. NASA Astrobiology Institute. 2014-2019. Co-I: Eric Boyd, PI: Alexis Templeton. $6,952,420 in total funding.

Microbial Mercury Methylation in Great Salt Lake Stromatolites. Utah Division of Forestry, Fire and State Lands. 2014-2015. Co-PI: Eric Boyd, PI: Bonnie Baxter. $24,860 in total funding.

Biological Electron Transfer and Catalysis (BETCY) Energy Frontier Research Center (EFRC). DOE Basic Energy Sciences (BES). 2014-2018. Co-PI: Eric Boyd, PI: John Peters. $10,000,000 in total funding.

Mechanistic basis for biological polymer stability, electron transfer and molecular sensing in extreme environments. Air Force Office of Scientific Research. 2014-2016. CoI: Eric Boyd, PI: Matthew Posewitz. $1,500,000 in total funding

Biogeochemical and physical processes controlling mercury methylation and bioaccumulation in Lake Powell, Glen Canyon National Recreation Area, Utah. NPS/USGS Water Quality Partnership Program. 2013-2015. Co-PI: Eric Boyd, PI: David Naftz. $300,000 in total funding.

Subsurface Exploration of the Heterotrophic Underpinnings in Yellowstone Hot springs. NSF Center for Dark Energy Biosphere Investigations at University of Southern California. 2013-2014. Co-I: Eric Boyd; PI: John Spear. $50,000 in total funding.

Linking Bioenergetics and Physicochemical Environment with the Distribution and Diversity of Hydrogenases in Microbial Communities Supported by Geothermally-Sourced Hydrogen. NASA Exobiology and Evolutionary Biology (NNX13AI11G). 2013-2016. PI: Boyd, Co-I: Tori Hoehler. $610,695 in total funding.

Habitability, Life Detection, and the Signatures of Life on the Terrestrial Planets. NASA Astrobiology Institute (NNA13AA94A). 2012-2017. Co-I: Eric Boyd, PI-Clark Johnson. $9,013,828 in total funding.

NEEM basal ice, assessing the attributes of a cold, deep, dark ecosystem. NSF Office of Polar Programs Arctic Natural Sciences. ARC – 1204223. 11/01/12-10/31/14. Co-PI: Eric Boyd; PI-Mark Skidmore, $333,341 in total funding.

Collaborative Research: Combining Methods from Geochemistry and Molecular Biology to Predict the Functions of Microbial Communities. NSF Low Temperature Geobiology and Geochemistry. EAR – 1123689. 2011-2014: PI: Eric Boyd, Co-PI: Everett Shock. $554,815 in total funding.

Methane Cycling in Subglacial Sediments. NASA Exobiology and Evolutionary Biology Award# NNX10AT31G. 2010-2014. Co-I: Eric Boyd, PI-Mark Skidmore. $598,000 in total funding.

Toward a Holistic and Global Understanding of Hot Spring Ecosystems: A US-China Based International Collaboration. NSF Partnerships in International Research and Education Award# PIRE-0968421. 2010-2015. Named Postdoc: Eric Boyd; PI-Brian Hedlund, $3,750,000 in total funding.

Past Awards

ETBC: Lipid Biomarkers of Archaea in Great Basin Hot Springs: Environmental and Genetic Controls and Implications for Microbial Functions. NSF Low Temperature Geobiology and Geochemistry Award# EAR – 1024614. 2010-2013. Co-PI: Eric Boyd; PI-Chuanlun Zhang. $300,667 in total funding.

Mercury Biogeochemistry in Great Salt Lake: The Role of Microorganisms in Methylation. Utah Department of Natural Resources: Forestry, Fire, and State Lands. 2011-2012. Co-I: Eric Boyd, PI-Bonnie Baxter, $32,832 in total funding.

The Evolution of Biological Metal Utilization: Integration of Genomic and Geologic Knowledge. NASA Astrobiology Institute Director's Discretionary Fund. 2010-2011: Co-I: Eric Boyd, PI: Chris Dupont. $40,000 in total funding.

Methanogenic Activity in Subglacial Ecosystems: Molecular Insight into Life-Sustaining Processes in Extraterrestrial Environments. NASA Astrobiology Institute Postdoctoral Fellowship. 2009-2010: PI: Eric Boyd. $130,000 in total funding.

Methanogenesis in Subglacial Environments – Biosignatures of Extraterrestrial Life. NASA Montana Space Grant Consortium. 2007-2008. Named Postdoc: Eric Boyd, PI - A. Mitchell. $46,000 in total funding.

Journal Manuscript Reviews

Applied and Environmental Microbiology, Biogeochemistry, Biogeosciences, Bioresource Technology, Chemical Geology, Chemosphere, Environmental Microbiology, Environmental Research Letters, Environmental Science and Technology, Extremophiles, FEMS Microbiology Letters, Folia Microbiologica, Frontiers in Microbiology, Geobiology, Geochemica Cosmochemica Acta, Journal of Biophysical Research – Biosciences, Journal of Cytometry, Journal of Glaciology, International Society for Microbial Ecology Journal, Microbial Ecology, Molecular Ecology, Nature Geoscience, Organic Geochemistry, Polar Research, PLoS One, PLoS Genetics, Proceedings of the National Academy of Sciences, Science, Scientifica

Grant Reviews

Czech Science Foundation, French National Research Agency, Icelandic Research Fund, National Science Foundation, NASA Exobiology and Evolutionary Biology Program, NASA Planetary Protection Program, Netherlands Space Office, New Zealand Ministry of Business, Innovation & Employment, Norwegian Research Council

Graduate Students and Postdoctoral Scientists Supervised/Mentored

Trinity Hamilton (Ph.D)	NASA Postdoctoral Fellow at Pennsylvania State University
Mary Burgess (M.S.)	Staff Scientist at Centers for Disease Control
Matthew Urschel (current)	Ph.D Student at Montana State University
Maximiliano Amenabar (current)	Ph.D Student at Montana State University
Melody Lindsay (current)	Ph.D Student at Montana State University
Nathan Fortney (current)	Ph.D Student at University of Wisconsin-Madison
Scott Montross (former)	Research Associate at Montana State University
Shaomei He (current)	Postdoc at University of Wisconsin-Madison
Zoë Harold (current)	Postdoc at Montana State University

Undergraduate/High School Student Researchers Supervised/Mentored

William Leavitt	NSF Graduate Fellow at Harvard University
Trevor Beard	M.S. Chemistry and Biochemistry, 2011, Montana State University
Rachel Lange	NSF Graduate Fellow at University of Washington
Alta Howells	Ph.D. Student at Arizona State University
Laura Bueter	Undergraduate at University of Wyoming
Ambrien Rising Sun	High school student from Northern Cheyenne Reservation
Jade Carter	M.S. student at the University of Great Falls
Emma Murter	Presidential Scholar at Montana State University
Jayme-Fehyl Buska (current)	Presidential Scholar at Montana State University
Joshua Thiel (current)	B.S. student at Westminster University
Heather Rosler (current)	High school student from Flathead Reservation
Cade Comstock (current)	B.S. student at Montana State University
Kirina Amada (current)	B.S. student at Montana State University
Jacob Sax (current)	B.S. student at Montana State University

Teaching Experience

General Microbiology (BIOM 360). Course lecturer. Montana State University. August-December 2014. 97 students.

Astrobiology Winter School. Course lecturer. University of Hawaii. January 2014. 20 students

International Geobiology Course. Course lecturer. University of Southern California/California Institute of Technology. June 2013. 16 students.

Chemistry 350 (Astrobiology), course lecturer. Montana State University, Bozeman, Montana. August 2013-December 2013. 16 students. Overall Teaching Evaluation: *TBD*.

Chemistry 121 (Introductory), course lecturer. Montana State University, Bozeman, Montana. January 2012-May 2012. 292 students. Overall Teaching Evaluation: 3.67/5.00.

Microbiology 101 (Introductory), laboratory teaching assistant. Montana State University, Bozeman, Montana. January 2014-May 2004. 120 students.

Microbiology 320 (Microbial Physiology and Genetics), teaching assistant. Iowa State University, Ames, Iowa. January2003-May 2003. 20 students.

Community Education and Outreach (Laboratory or Field-Based)

2012-present	Ecology Project International Field Science Program. Contact: Erin Clark
2012-present	Pennsylvania State University CHANCE Conservation and Education Program. Contact: Dr. Jacqueline McLaughlin
2011-present	Headwaters Academy. Contacts: Amy Williams, Sam Francis
2011-present	Boy Scouts of America. Contact: Stanley Bates
2011-present	University of Michigan Summer Geobiology Course. Contact: Dr. Greg Dick
2010-present	NASA Astrobiology Institute Executive Council. Contact: Dr. Carl Pilcher
2010-present	Princeton University Fall Geobiology Course. Contact: Dr. Tullis Onstott
2009	Clemson University Yellowstone Ecology Course. Contact: Dr. Tamara Mcnealy
2006-present	Montana Science Teachers Association. Contact: Monica Brelsford.

2004-present Montana Outdoor Science School. Contact: Joshua Theurer
2004 Teton Outdoor Science School. Out of Business

Professional Development

Conference Co-organizer. NASA Astrobiology Science Conference, June, 2015.

Participant. NSF C-DEBI Limits to Life Workshop. Redondo Beach, Ca. April, 2014.

Participant. NSF C-DEBI Bioenergetics and Subsurface Metabolism. University of Southern California, Los Angeles, Ca. April, 2014**.**

Participant. Astrobiology Roadmap Meeting of Experts. Wallops Island, VA. June, 2013.

Participant. Future Directions in Low Temperature Geobiology and Geochemistry Workshop. Carnegie Institution of Washington. Washington, D.C. August, 2010.

Participant. Future Directions of NASA Astrobiology Institute Research. Tempe, AZ. May, 2008.

Conference Co-organizer. NASA Astrobiology Institute Workshop without Walls on Molecular Paleontology and Resurrection: Rewinding the Tape of Life. Virtual. November, 2010.

Participant. NSF C-DEBI Limits to Life Workshop. Redondo Beach, Ca. May, 2011.

Conference Co-organizer. Thermophiles. Big Sky, MT. September, 2011.

Conference Session Co-organizer. American Geophysical Union. (Bio)geochemical cycling within and beyond the limits of life (San Francisco, California, USA. December, 2014

Conference Session Co-organizer. American Geophysical Union. Windows Into to the Deep Subsurface Biosphere: Coupled Geochemical and Biological Investigations of Terrestrial Hot Spring Ecosystems (San Francisco, California, USA. December, 2013.

Conference Session Co-organizer. American Geophysical Union. Integrating geochemical and biological datasets to predict the response of microbial communities to a changing environment (San Francisco, California, USA. December, 2012.

Conference Session Co-organizer. NASA Astrobiology Science Conference. Signatures of Earth's geologic history in the genomic record: are they there? Houston, Texas, USA. April, 2010.

Conference Session Co-organizer. AbSciCon. Pattern and Prediction: Integrating energetics, geochemistry, and genetics in the investigation of early Earth and extraterrestrial analog environments Atlanta, GA, USA. April, 2012.

Professional Affiliations

2003-present American Society of Microbiology
2005-present Union of Concerned Scientists
2009-present American Geophysical Union

2010-present NASA Astrobiology Institute's Origin of Life Focus Group
2012-present National Association of Biological Teachers
2013-present Geological Society of America