CURRICULUM VITÆ

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Education:

National Research Council Post-Doctoral Fellowship: *1981*, At the U.S. Geological Survey - Office of Marine Geology, Woods Hole, MA. Clay mineralogy of the Amazon River system.

Ph.D., Chemical Oceanography: *1980*, Massachusetts Institute of Technology - Woods Hole Oceanographic Institution Joint Program in Oceanography. Ph.D. thesis entitled "Major Element Geochemistry of the Amazon River System."

B.S., Earth & Planetary Sciences: *1974*, Massachusetts Institute of Technology. Emphasis in Planetary Physics and Chemistry.

Professional Experience:

Research Associate: *2013-present*, The Field Museum, Chicago, Illinois.

Research Scientist: *2004-present*, Smithsonian Tropical Research Institute. *Also,* **Research Associate** *1997-2003*, Smithsonian Tropical Research Institute.

Professor Adjoint: *1998-present*, Institute for Arctic and Alpine Research, University of Colorado. *Also,* **Graduate Faculty / Adjoint Faculty:** *1993-2008.* University of Colorado Department of Geological Sciences and Department of Geography, University of Oregon, Department of Geological Sciences.

Scientist Emeritus (Hydrologist / Biogeochemist): *8/2019-present*. U.S. Geological Survey - Water Resources Mission Area - Ecosystem Processes Division.

Research Hydrologist (Biogeochemist): *10/1987-7/2019*. U.S. Geological Survey - Water Resources Mission Area - Ecosystem Processes Division. Research focused on the effects of land-use change on geomorphic and biogeochemical processes that control the chemistry of solid and dissolved phases in rivers, including interlinked, multidisciplinary studies of weathering, erosion, biogeochemical cycling, atmospheric-gas exchange, and land use.

Assistant Professor (Geology): *7/1981-9/1987*. Princeton University, Department of Geological and Geophysical Sciences. Research involved low-temperature geochemistry, emphasizing relating geomorphic and biologic processes to the chemistry of solid and dissolved phases in rivers and soils. Principal investigator for seven funded projects. Major advisor for seven Ph.D. and seventeen B.A./B.S.E. students.

Research Geologist (Geochemist): *12/1979-6/1983*. U.S. Geological Survey - Geologic Division - Office of Marine Geology, Woods Hole, MA. Post-Doctoral Fellowship, converted to Geologist-WAE (7/81). Examined mineralogy of fine sediment from the Amazon River.

Professional Societies

- American Geophysical Union
- Association for Tropical Biology
- Geological Society of America
- Sigma Xi

Awards and Honors

- Woods Hole Fellowship (1974-75).
- National Science Foundation Graduate Fellowship (1975-78).
- National Research Council Post-Doctoral Fellowship (1979-80).
- Princeton University Dusenbury Preceptorship in Geology (1983-87).
- Invited speaker at the NATO Advanced Research Workshop on the Chemistry of Weathering, Rodez, France (1984).
- Invited Speaker at the NATO Advanced Study Institute, Assois, France (1985).
- Research Fellowship at the Smithsonian Tropical Research Institute, Panama (1986).
- Research Fellowship at the Smithsonian Tropical Research Institute, Panama (1990).
- *Annual Review of Earth and Planetary Sciences*, invited article (1995).
- Performance Award by US Forest Service for work done in studying mercury contamination caused by gold mining in the Caroní River Basin (1995).
- Plenary Speaker, International Association of Geomorphologists, Singapore (1995).
- Meritorious Service Award for the Department of the Interior (2002) "In recognition of his exceptional contributions to the development of new and innovative research programs in the U.S. Geological Survey."
- Secretary's Research Prize of the Smithsonian Institution (2017) "for exemplary scholarship and outstanding contribution towards the increase and diffusion of knowledge" based on research regarding the closure of the Isthmus of Panama.

Professional Activities

Academic Activities, 1970-1981

- Participant in Woods Hole Oceanographic Institution Cruises *R/V Chain* 115 and *R/V Atlantis-II* 78 (1973-1974)
- Participant in United Nations Food and Agricultural Organization geochemical sampling of Lake Tanganyika (1975)
- Participant in *R/V Alpha Helix* Amazon Expedition (1976-1977)
- Organized sampling of rivers in the lowland Amazon and the Peruvian and Bolivian Andes (1976-1978)
- Sampling of Hawaiian rivers (1981)

Princeton University Activities, 1981-1987

- Participant in the U.S. Geological Survey-Venezuelan Ministerio del Ambiente y de los Recursos Naturales Renovables sedimentological/geochemical study of the Orinoco River system (1982-1989).
- Participant in leg I of the T.T.O.-T.A.S. study on the *R/V Knorr*, and *ad hoc* chief scientist for two-day transect of the Amazon River estuary (1982).

- Organized geochemical survey of streams and soils of Barro Colorado Island, Smithsonian Tropical Research Institute, Panama (1984-85).
- Visiting Collaborator at the Instituto Venezolano de Investigaciones Cientificas at the Centro de Ecologia y Ciencias Ambientales with Drs. Rafael Herrera and Jorge Paolini (1986).
- Research Fellowship at the Smithsonian Tropical Research Institute, Panama. Research on geochemical cycles in tropical ecosystems at Barro Colorado Island, Panama, focusing on major elements and nutrients in Island streams (1986).
- Organizer and principal investigator of a systematic study (GOOPS) of gas emissions (CH_4, CO_2, N_2O, H_2O, O_2, ^{222}Ra) from forest, freshwater swamp, and mangrove soils is in Panama, based on Barro Colorado Island at the Smithsonian Tropical Research Institute (1985-1989).
- Participant in expedition to study earthquake-induced landslides that occurred in the Darien region of Panama in July 1976. Organized investigation of the effects of landslides on river geochemistry (1987).

Research Activities, 1987 to present

- Participant in the USGS-WRD Mississippi River Project (1987-1992) utilizing the *R/V Acadiana* to study sediment and pollutant routing on the Mississippi River.
- Visitors Grant ($2,000) at the Smithsonian Tropical Research Institute, Panama. Research on geochemical cycles in tropical ecosystems at Barro Colorado Island, Panama, focusing on major elements and nutrients in Island streams (1990).
- Organizer and principal investigator of a systematic and comprehensive study of weathering, erosion, biogeochemical cycling, and atmospheric-gas exchange on Barro Colorado Island at the Smithsonian Tropical Research Institute (1991-present).
- Organizer and a principal investigator of a systematic and comprehensive study of weathering, erosion, biogeochemical cycling, and atmospheric-gas exchange in the Luquillo Experimental Forest in Puerto Rico, part of the USGS Water, Energy, and Biogeochemical Budgets (WEBB) Program (1991-present).
- Participant in a systematic and comprehensive study of weathering, erosion, and biogeochemical cycling on the basin of South Cascade Glacier, Washington (1992-1993).
- Organized and participated in sampling of the Mississippi River during peak floods (Summer 1993)
- Co-organizer and participant in preliminary studies of the distribution of mercury and sediment in rivers affected by gold mining in the Guayana Shield of Venezuela (1993-1996).
- Established a Geographic Information System (GIS) lab under my project for the study of geomorphic processes and biogeochemical cycling as part of the USGS WEBB program (1994-present).
- Co-organizer and principal investigator in studies of terrestrial sedimentation and carbon and nutrient cycles within the Mississippi River Basin—an integration of historic data and ongoing fieldwork using a GIS-based approach to look at the effects of land-use change in a large, developed, temperate river system (1993-present).
- Co-organizer and principal investigator in studies of the impact of land-use change in the Panama Canal Basin on biogeochemical cycles, weathering, and erosion with the Basin and on the operation of the Canal (1995-1999).

- Initiator and research advisor in studies of fire-flood sequences and post-fire stream chemistry in montane regions of the North American West, with a special focus on the Buffalo Creek Fire / Flood sequence of Spring-Summer, 1996 (1996-present).
- Advisor and investigator in US Army-funded studies of hydrology, biogeochemical cycles, weathering, and erosion of natural landscapes within the Upper Chagres River Basin, Panama (2000-present).
- Organizer of a study of weathering, erosion, and biogeochemical cycling on the basin of Fremont, Bull, and Knifepoint Glaciers, Wyoming (2001-present).
- Contributor to the NSF-sponsored community workshop examining the transport, transformation and fate of carbon in river-dominated ocean margins RiOMar (2001).
- Contributor to and advisor of NSF-funded network studying the tropical amphibian die-off called the Research and Analysis network for Neotropical Amphibians (RANA). (2001-present).
- Contributor to the Department of Interior "white paper" entitled "Carbon Sequestration and the Department of the Interior." (2002).
- Initiator and co-principal investigator on NSF-funded research project entitled "Collaborative Research: Effects of Soil-borne Resources on the Structure and Dynamics of Lowland Tropical Forests" utilizing the forest dynamic plots of the Center for Tropical Forest Science in Panama, Ecuador, Brazil, Colombia, Malaysia, and Thailand. (2002-present).
- Project Scientist for Jason XV Project on research in the tropical rainforests of Barro Colorado Island and the surrounding Panama Canal watershed. (2002-present).
- Advisor and Investigator for design and implementation of the Southwestern Alaska Parks (SWAN) and the Central Alaskan National Parks (CANP) monitoring initiatives of the National Park Service. This project uses state of the art GIS tools to analyze the drainage networks of remote rivers in Alaskan National Parks. (2002-present).
- Contributor to the NSF-sponsored community workshop examining belowground biomass (2003).
- Contributor to the U. S. Army Corps of Engineers System Wide Modeling, Assessment, and Restoration Technology (SMART) Research Program Workshop: Identification of fundamental process knowledge gaps affecting assessment technology needed for sustainable water resources management (2003).
- Contributor to the NSF-sponsored principal-investigators workshop examining the science implementation plan for the North American Carbon Program (NACP) (2003).
- Co-author of the Science Implementation Plan for the Inter-Agency North American Carbon Project (NACP) (2003-2005).
- Contributor to the NSF-sponsored community workshop to develop the Community Surface Dynamics Modeling System (CSDMS) Science Plan (2004).
- I was the first Earth scientist asked to take part in a Rapid Inventory operated by the Field Museum in Chicago. These inventories are done in regions of exceptional biological diversity and remoteness in response to threats immanent destruction or at the request of a group. This inventory was done at the request of the Matsés Tribe, living on the Peru / Brazil frontier (10-11/2004).
- Participant in the NSF-sponsored National Center for Earth-surface Dynamics (NCED) working group on carbon transport and storage in the fluvial environment, called the Carbon in Fluvial Sediment (CFS) Working Group. It focuses on storage in floodplains, lakes, and lowland rivers over annual-to-century time scales (2005).

- Volunteered to write the geologic and hydrologic synthesis for a Rapid Inventory operated by the Field Museum in Chicago. This inventory was done at the request of various conservancy groups, and focused on the Sierra de Divisor Region of Peru. (10-11/2005).
- Worked with Mark Wishnie of STRI PRORENA (Annual Native Species Reforestation Project) to organize a symposium on the 'sponge effect:' "Forests and water: Soil, vegetation and low-flows in the seasonally dry tropics," November 18-20, 2005 Panama City, Panama. This meeting helped gel the concepts in the Agua Salud Project (7-11/2005).
- Worked with the Smithsonian Tropical Research Institute Center for Tropical Forest Science to design and fund a study on the relationships between forests, deforestation, and reforestation and hydrology. This work produced the concept of reforestation of research watersheds (BeyondTimber) that led to the Agua Salud Project (2005-2007).
- Volunteered for a Rapid Inventory operated by the Field Museum in Chicago. This inventory was done at the request of the Regional Government of Loreto. This resulted in the protection of the drinking water supply for the City of Iquitos and the protection of the headwaters of the Nanay, Mazán, and Arabela Rivers. (10-11/2006).
- Co-founded the "Agua Salud Project" in central Panama under the auspices of the Smithsonian Tropical Research Institute Center for Tropical Forest Science, the Panama Canal authority, the National Environmental Authority, and anonymous the relationships between forests, deforestation, and reforestation and hydrology and other ecosystem services, such as biodiversity (2007 to present).
- Volunteered for a Rapid Inventory operated by the Field Museum in Chicago. This inventory was done at the request of the Instituto del Bien Común, representing various tribes. The region studied was the watersheds of the Yaguas and Cotuhé rivers. (10-11/2010).
- Was asked by Jorge A. Espinosa, Chief, Sección de Recursos Hídricos, División de Agua, Autoridad del Canal de Panamá to review the impact of the enormous rainstorms on 7-9 December 2010 that shut down the Canal for 17 hours (2011, ongoing).
- Volunteered for a Rapid Inventory operated by the Field Museum in Chicago. This inventory was done at the request of the Instituto del Bien Común, representing various tribes. The region studied was the Kampankis Mountains. (8-9/2011).
- Volunteered for a Rapid Inventory operated by the Field Museum in Chicago. This inventory was done at the request of the Instituto del Bien Común, representing various tribes. The region studied was the watersheds of the Ere, Campuya and Algodón rivers. (10-11/2012).
- Volunteered for a Rapid Inventory operated by the Field Museum in Chicago. This inventory was done at the request of the Instituto del Bien Común, representing various tribes. The region studied was the Escalera Mountains. (9-10/2013).
- Represented the USGS at meetings with the City of Boulder and Boulder County following the floods of September 2013 (9/2013, ongoing).
- Volunteered for a Rapid Inventory operated by the Field Museum in Chicago. This inventory was done at the request of Centro para el Desarrollo del Indígena Amazónico (CEDIA). The region studied was the divide region between the Tapiche and Blanco rivers. (10-11/2014).
- Participated in the 9th Bienial Rosenberg Internationl Forum on Water Policy, as field presenter and participant. (25-28/1/2016).
- Participated in a Rapid Inventory operated by the Field Museum in Chicago. This inventory was done at the request of the Instituto del Bien Común (IBC), representing various tribes.

The region studied was the divide region between the Medio Putumayo and the Algodón and Mutúm Rivers. (2-3/2016).

- Started work on a Rapid Inventory operated by the Field Museum in Chicago. This inventory is at the request World Wildlife Guyana for the Rupununi Portal. (8/2019).
- Participated in a Rapid Inventory operated by the Field Museum in Chicago. This inventory was done on the Peruvian and Colombian sides of the Lower Putumayo River. (11-12/2019).

Publications:

Published Papers:

1. Boyle, E.A., Collier, R.W., Dengler, A.T., Edmond, J.M., Ng, A.C., and Stallard, R.F., 1974, On the chemical mass-balance in estuaries: Geochimica et Cosmochimica Acta, v. 38, no. 11, p. 1719-1728. [pdf$]
2. Stallard, R.F., Edmond, J.M., and Newell, R.E., 1975, Surface ozone in the South East Atlantic between Dakar and Walvis Bay: Geophysical Research Letters, v. 2, no. 7, p. 289-292. [pdf$]
3. Ceasar, J., Collier, R., W., Edmond, J.M., Frey, F., Matisoff, G., Ng, A.C., and Stallard, R.F., 1976, Chemical dynamics of a polluted watershed, the Merrimack River in northern New England: Environmental Science and Technology, v. 10, no. 7, p. 697-704. [pdf$]
4. Chan, L.-H., Edmond, J.M., Stallard, R.F., Broecker, W.S., Chung, Y.-C., Weiss, R.F., and Ku, T.-L., 1976, Radium and barium at GEOSECS stations in the Atlantic and Pacific: Earth and Planetary Science Letters, v. 32, no. 2, p. 258-267. [pdf$]
5. Richey, J.E., Brock, J.T., Naiman, R.J., Wissmar, R.C., and Stallard, R.F., 1980, Organic carbon: Oxidation and transport in the Amazon River: Science, v. 207, p. 1348-1351. [pdf]
6. Stallard, R.F., 1980, Major element geochemistry of the Amazon River system: Woods Hole, MA, Woods Hole Oceanographic Institution, Ph.D. Dissertation, Massachusetts Institute of Technology / Woods Hole Oceanographic Institution, Joint Program in Oceanography WHOI-80-29, 366 p. [pdf]
7. Wissmar, R.C., Richey, J.E., Stallard, R.F., and Edmond, J.M., 1980, Metabolismo do plâncton e ciclo do carbono no rio Amazonas, seus tributários e águas de várzea, Peru-Brasil, maio-junho: Acta Amazonica, v. 10, no. 4, p. 823-834. [pdf]
8. Edmond, J.M., Boyle, E.A., Grant, B., and Stallard, R.F., 1981, The chemical mass balance in the Amazon plume I: The nutrients: Deep-Sea Research, v. 28A, no. 11, p. 1339-1374. [pdf$]
9. Stallard, R.F., and Edmond, J.M., 1981, Geochemistry of the Amazon 1. Precipitation chemistry and the marine contribution to the dissolved load at the time of peak discharge: Journal of Geophysical Research-Oceans and Atmospheres, v. 86, no. NC10, p. 9844-9858. [pdf$]
10. Wissmar, R.C., Richey, J.E., Stallard, R.F., and Edmond, J.M., 1981, Plankton metabolism and carbon processes in the Amazon River, its tributaries, and floodplain waters, Peru-Brazil, May-June 1977: Ecology, v. 62, no. 6, p. 1622-1633. [pdf]
11. Hu, M.-h., Stallard, R.F., and Edmond, J.M., 1982, Major ion chemistry of some large Chinese rivers: Nature, v. 298, p. 550-553. [pdf$]
12. Stallard, R.F., and Edmond, J.M., 1983, Geochemistry of the Amazon 2. The influence of geology and weathering environment on the dissolved-load: Journal of Geophysical Research-Oceans and Atmospheres, v. 88, no. NC14, p. 9671-9688, microfiche supplement. [pdf$] Supplementary material [pdf tba]
13. Chyi, M.S., Crerar, D.A., Carlson, R.W., and Stallard, R.F., 1984, Hydrothermal Mn-deposits of the Franciscan Assemblage, II. Isotope and trace element geochemistry, and implications for hydrothermal convection at spreading centers: Earth and Planetary Science Letters, v. 71, no. 1, p. 31-45. [pdf$]
14. Key, R.M., Stallard, R.F., Moore, W.S., and Sarmiento, J.L., 1985, Distribution and flux of ^{226}Ra and ^{228}Ra in the Amazon River estuary: Journal of Geophysical Research, v. 90, p. 6995-7004. [pdf$]

15. Manias, W.G., Covey, M., and Stallard, R.F., 1985, The effects of provenance and diagenesis on clay content and crystallinity in Miocene through Pleistocene deposits, southwestern Taiwan: Petroleum Geology of Taiwan, no. 21, p. 173-185. [pdf tba]
16. Stallard, R.F., 1985, River chemistry, geology, geomorphology, and soils in the Amazon and Orinoco basins, *in* Drever, J.I., ed., The Chemistry of Weathering: Dordrecht, Holland, D. Reidel Publishing Co. NATO ASI Series C: Mathematical and Physical Sciences 149, p. 293-316. [pdf$]
17. Brantley, S.L., Crane, S.R., Crerar, D.A., Hellmann, R., and Stallard, R.F., 1986, Dislocation etch pits in quartz, *in* Davis, J.A., and Hayes, K.F., eds., Geochemical Processes at Mineral Surfaces: Washington, D.C., American Chemical Society, p. 635-649. [pdf$]
18. Brantley, S.L., Crane, S.R., Crerar, D.A., Hellmann, R., and Stallard, R.F., 1986, Dissolution at dislocation etch pits in quartz: Geochimica et Cosmochimica Acta, v. 50, no. 10, p. 2349-2361. [pdf]
19. Herbert, T.D., Stallard, R.F., and Fischer, A.G., 1986, Anoxic events, productivity rhythms, and the orbital signature in a mid-Cretaceous deep-sea sequence from central Italy: Paleoceanography, v. 1, no. 4, p. 495-506. [pdf$]
20. D'Hondt, S.L., Keller, G., and Stallard, R.F., 1987, Major element compositional variation within and between different Late Eocene microtektite strewnfields: Meteoritics, v. 22, p. 61-79. [pdf$]
21. Stallard, R.F., 1987, Cross-channel mixing and its effect on sedimentation in the Orinoco River: Water Resources Research, v. 23, no. 10, p. 1977-1986. [pdf$]
22. Stallard, R.F., and Edmond, J.M., 1987, Geochemistry of the Amazon 3. Weathering chemistry and limits to dissolved inputs: Journal of Geophysical Research-Oceans, v. 92, no. C8, p. 8293-8302. [pdf$]
23. Johnsson, M.J., Stallard, R.F., and Meade, R.H., 1988, First-cycle quartz arenites in the Orinoco River Basin, Venezuela and Colombia: Journal of Geology, v. 96, no. 3, p. 263-2771. [pdf$]
24. Koehnken Hernández, L., and Stallard, R.F., 1988, Sediment sampling through ultrafiltration: Journal of Sedimentary Petrology, v. 58, p. 758-759. [pdf$]
25. Murnane, R.J., and Stallard, R.F., 1988, Germanium/silicon fractionation during biogenic opal formation: Paleoceanography, v. 3, no. 4, p. 461-469. [pdf$]
26. Stallard, R.F., 1988, Weathering and erosion in the humid tropics, *in* Lerman, A., and Meybeck, M., eds., Physical and Chemical Weathering in Geochemical Cycles: Dordrecht, Holland, Kluwer Academic Publishers NATO ASI Series C: Mathematical and Physical Sciences 251, p. 225-246. [pdf$]
27. Johnsson, M.J., and Stallard, R.F., 1989, Physiographic controls on the composition of sediments derived from volcanic and sedimentary terrains on Barro Colorado Island, Panama: Journal of Sedimentary Petrology, v. 59, no. 5, p. 768-781. [pdf$]
28. Murnane, R.J., Leslie, B., Hammond, D.E., and Stallard, R.F., 1989, Germanium geochemistry in the Southern California Borderlands: Geochimica et Cosmochimica Acta, v. 53, no. 11, p. 2873-2882. [pdf$]
29. Dickinson, W.R., Ingersoll, R.V., Johnsson, M.J., and Stallard, R.F., 1990, Physiographic controls on the composition of sediments derived from volcanic and sedimentary terrains on Barro Colorado Island, Panama; discussion and reply: Journal of Sedimentary Research, v. 60, no. 5, p. 797-801. [pdf$]
30. Johnsson, M.J., Stallard, R.F., Lundberg, N., DeCelles, P.G., and Hertel, F., 1990, Petrology of fluvial sands from the Amazonian foreland basin, Peru and Bolivia:

Discussion and reply: Geological Society of America Bulletin, v. 102, no. 12, p. 1727-1730. [pdf$]
31. Keller, M., Mitre, M.E., and Stallard, R.F., 1990, Consumption of atmospheric methane in soils of central Panama: Effects of agricultural development: Global Biogeochemical Cycles, v. 4, no. 1, p. 21-27. [pdf$]
32. Maest, A.S., Crerar, D.A., Stallard, R.F., and Ryan, J.N., 1990, Metal and nutrient behavior in the Raritan estuary, New Jersey, U.S.A.: The effect of multiple freshwater and industrial waste inputs: Chemical Geology, v. 81, no. 1-2, p. 133-149. [pdf$]
33. Murnane, R.J., and Stallard, R.F., 1990, Germanium and silicon in rivers of the Orinoco Drainage-Basin: Nature, v. 344, no. 6268, p. 749-752. [pdf$]
34. Stallard, R.F., Koehnken, L., and Johnsson, M.J., 1990, Weathering processes and the composition of inorganic material transported through the Orinoco River system, Venezuela and Colombia, *in* Weibezahn, F.H., Alvarez, H., and Lewis, W.M.J., eds., El Río Orinoco como Ecosistema / The Orinoco River as an Ecosystem: Caracas, Venezuela, Impresos Rubel, p. 81-119. [pdf tba]
35. Yan, L., Stallard, R.F., Key, R.M., and Crerar, D.A., 1990, The chemical behavior of trace metals and ^{226}Rn during estuarine mixing in the Mullica River estuary, New Jersey, U.S.A.: A comparison between field observations and equilibrium calculation: Chemical Geology, v. 85, p. 369-381. [pdf$]
36. Jewell, P.W., and Stallard, R.F., 1991, Geochemistry and paleooceanographic setting of central Nevada bedded barites: Journal of Geology, v. 99, no. 2, p. 151-170. [pdf$]
37. Johnsson, M.J., Stallard, R.F., and Lundberg, N., 1991, Controls on the composition of fluvial sands from a tropical weathering environment: Sands of the Orinoco River drainage basin, Venezuela and Colombia: Geological Society of America Bulletin, v. 103, no. 12, p. 1622-1647. [pdf$]
38. Stallard, R.F., Koehnken, L., and Johnsson, M.J., 1991, Weathering processes and the composition of inorganic material transported through the Orinoco River system, Venezuela and Colombia: Geoderma, v. 51, no. 1-4, p. 133-165. [pdf$]
39. Yan, L., Stallard, R.F., Key, R.M., and Crerar, D.A., 1991, Trace metals and dissolved organic carbon in estuaries and offshore waters of New Jersey, USA: Geochimica et Cosmochimica Acta, v. 55, no. 12, p. 3647-3656. [pdf$]
40. Harden, J.W., Sundquist, E.T., Stallard, R.F., and Mark, R.K., 1992, Dynamics of soil carbon during deglaciation of the Laurentide Ice Sheet: Science, v. 258, no. 5090, p. 1921-1924. [pdf$]
41. Stallard, R.F., 1992, Tectonic Processes, continental freeboard, and the rate-controlling step for continental denudation, *in* Butcher, S.S., Charleson, R.J., Orions, G.H., and Wolfe, G.V., eds., Global Biogeochemical Cycles: San Diego, California, Academic Press 50, p. 93-121. [pdf tba]
42. Yan, L., Stallard, R.F., Crerar, D.A., and Key, R.M., 1992, Experimental evidence on the behavior of metal-bearing colloids in low-salinity estuarine water: Chemical Geology, v. 100, no. 3-4, p. 163-174. [pdf$]
43. Edmond, J.M., Stallard, R.F., Craig, H., Craig, V., and Coulter, G.W., 1993, Nutrient chemistry of the water column of Lake Tanganyika: Limnology and Oceanography, v. 38, no. 4, p. 725-738. [pdf]
44. Jewell, P.W., Stallard, R.F., and Mellor, G.L., 1993, Numerical studies of the bottom shear stress and sediment distribution on the Amazon continental shelf: Journal of Sedimentary Petrology, v. 63, no. 4, p. 734-745. [pdf]

45. Larsen, M.C., Collar, P.D., and Stallard, R.F., 1993, Research plan for the investigation of water, energy, and biogeochemical budgets in the Luquillo Mountains, Puerto Rico: San Juan, Puerto Rico, U.S. Geological Survey, Open-File Report 92-150, 19 p. [pdf]
46. Keller, M., and Stallard, R.F., 1994, Methane emission by bubbling from Gatun Lake, Panama: Journal of Geophysical Research, v. 99, no. D4, p. 8307-8319. [pdf$]
47. Axtmann, E.V., and Stallard, R.F., 1995, Chemical weathering in the South Cascade Glacier basin, comparison of subglacial and extra-glacial weathering, *in* Tonnessen, K.A., Williams, M.W., and Tranter, M., eds., Biogeochemistry of Seasonally Snow-Covered Catchments, Boulder, Colorado, USA, 3-14 July 1995, International Association of Hydrological Sciences, Publication 465, p. 431-439. [pdf tba]
48. Brown, E.T., Stallard, R.F., Larsen, M.C., Raisbeck, G.M., and Yiou, F., 1995, Denudation rates determined from the accumulation of *in situ*-produced ^{10}Be in the Luquillo Experimental Forest, Puerto Rico: Earth and Planetary Science Letters, v. 129, no. 1-4, p. 193-202. [pdf$]
49. Edmond, J.M., Palmer, M.R., Measures, C.I., Grant, B., and Stallard, R.F., 1995, The fluvial geochemistry and denudation rate of the Guayana Shield in Venezuela, Colombia, and Brazil: Geochimica et Cosmochimica Acta, v. 59, no. 16, p. 3301-3325. [pdf$]
50. Stallard, R.F., 1995, Tectonic, environmental, and human aspects of weathering and erosion: A global review using a steady-state perspective: Annual Review of Earth and Planetary Sciences, v. 12, p. 11-39. [pdf]
51. Stallard, R.F., 1995, Relating chemical and physical erosion, *in* White, A.F., and Brantley, S.L., eds., Chemical Weathering Rates of Silicate Minerals: Washington, D.C., Mineralogical Society of America Reviews in Mineralogy 31, p. 543-564. [pdf$]
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12. Murphy, S.F., Scholl, M.A., Stallard, R.F., Gonzalez, G., and A., T.-S., 2017, Windward/leeward rainfall gradients in the Luquillo Mountains, Puerto Rico, and implications for water resources and biogeochemical fluxes, Chapman Conference on Extrmeme Climate Event Impacts on Aquatic Biogeochemical Cycles and Fluxes, San Juan, Puerto Rico, 22-27 January 2017, American Geophysical Union.
13. Birch, A.L., Barnard, H.R., Stallard, R.F., 2018, Differences in Event Water Delivery Thresholds and Hydrologic Flowpaths among Humid Tropical Catchments of Varying Land Cover in Central Panama. American Geophysical Union 2018 Fall Meeting Abstracts, Washington, DC, December 2018, American Geophysical Union.
14. Ogden, F. L., Hall, J. S., Stallard, R. F., and Larsen, M. C., Agua Salud tropical experimental catchments. American Geophysical Union 2019 Fall Meeting.

Professional Interests:

My principal interest is the earth-surface environment and how it changes on human and geologic time scales. Currently, my focus is the study of climate and land-use changes and how these affect processes that control the composition and dispersal of dissolved and solid phases in rivers and trace gases in the atmosphere

Rivers sculpt the landscape, nourish ecosystems and agriculture, and convey erosion products and human wastes to depositional sites or to the ocean. We imperfectly understand how the compositions of river-borne materials are controlled, because this involves a complex ensemble of highly linked chemical, biological, and physical processes. In developed river systems, human activities greatly increase the complexity. Changes in land use are particularly important, because these affect not only the movement of water across the landscape and the composition of river-borne materials, but also the exchange of trace gases with the atmosphere. The problem is to develop comprehensive and integrated descriptions of these processes in a form that is useful to researchers in many disciplines. This work combines both field and theoretical studies using the tools of geology, hydrology, biology, biogeochemistry, and geography.

RESEARCH APPROACH

I am pursuing several areas of investigation: (1) Can we develop general physically and biologically based models of landscapes that predict water transport, the dissolved and particulate load in rivers, and the exchange of gases with the atmosphere? (2) How do various phases chemically partition during transport in rivers and estuaries? (3) What are the dispersal pathways of river-borne substances through rivers and estuaries into the coastal environment? (4) How do human activities, particularly land-use change, affect environments being examined? (5) How do we use rivers to integrate phenomena at local spatial scales up to continental scales? (6) Can we formulate provenance models to reconstruct past geologic environments?

My work on river systems has followed a basic design. I identify key phenomena by combining simple biogeochemical-process models with models of hillslope and fluvial transport. Models are then interpreted considering knowledge of the watershed obtained from diverse sources. For an entire river system I assemble chemical, geological, meteorological, geomorphic, biological, and demographic data. This combines field work with analysis of available maps and public-domain data bases. Phenomena that are especially important in controlling the composition of phases containing the important crustal, nutrient, atmospheric, and indicator elements (Al, B, Be, C, Ca, Cl, F, Fe, Ge, H, K, Mg, Mn, N, Na, O, P, S, Si, Sr, Ti, Zr) are identified to provide the conceptual framework for solving specific research objectives. Solid, dissolved, and gas phases are considered. As part of these investigations, I undertake field surveys, design sampling and analytical procedures, and create computer tools to manipulate and model data. Where necessary, smaller-scale field or laboratory studies are formulated to aid data interpretation.

At the global scale, I examine terrestrial sedimentation and biogeochemical cycles. This involves integration of data from my studies with information from innumerable standard and grey-literature sources. Recent developments in database design—especially Geographic Information Systems (GIS)—and hillslope hydrologic models have increased the sophistication of this endeavor.

CURRENT PROJECTS

My basic research program focuses on the use of natural and altered landscapes to understand the regional effects of land-cover change. Over the years, work has been split among several projects that involve research into near-earth-surface biogeochemical processes on Pleistocene to technological time scales. Since 1990, I have organized and have led two large, interlinked, multidisciplinary studies concerned with the land-use change. One project is part of the USGS Water, Energy, and Biogeochemical Budgets (WEBB) Project in eastern Puerto Rico and parallel work in central Panama funded by the Smithsonian Tropical Research Institute (STRI). The other project was the Inter-Divisional "Carbon Project" which ran from 1993 to 2004 as the "Mississippi Basin Carbon Project" (MBCP). Spread across these projects, I currently work in four broad themes: (A) continental-scale biogeochemistry, (B) nutrient-carbon-cycle research, (C) event-related hydrology and biogeochemistry, and (D) source-region controls on hydrology, biogeochemistry, and vegetation in tropical to glacial landscapes. My most active initiative, the Agua Salud Project (ASP), described next, examines ecosystems services of forests as compared to other land used in the central Panama Canal Watershed, currently funded through STRI,

AGUA SALUD PROJECT

The Agua Salud Project is a basic-science ecosystem-service project focused on the role of different types of reforestation as a means of removing carbon dioxide from the atmosphere. The results will have significant impact on management and conservation in steepland landscapes in the humid seasonal tropics. With proposals to plant of trees to sequester substantial anthropogenic carbon, there is a conflict between water availability and carbon sequestration. According to Jackson et al. (2005, Trading water for carbon with biological sequestration, Science, v. 310, p. 1944-1947), older forests reduce annual runoff by 150-600 mm compared to adjacent lands (for the Agua Salud forests, this is more than 500 mm). Obvious land-cover effects are visible after six years; ten years of data should have unambiguous land-cover-related hydrologic effects. We have more than 10 years of data. The Agua Salud project is attracting research groups that are studying hydrology, carbon and nutrient cycling, biodiversity, microbial biology, and ecosystem-services studies.

Our principal field site includes the Río Agua Salud watershed and the headwaters of several adjacent rivers in the central Isthmus of Panama, east of the Panama Canal. The region encompasses both protected mature forests and a wide variety of land uses that are typical of rural Panama. Reforestation experiments at the scale of entire catchments, ranging from 6 to 180 ha in area, permit complete water and carbon inventories and exchanges for different land uses. There are five experimental treatments: native-species plantation, monoculture teak plantation (supplemented with native species after 7 years), native secondary succession, silvo-pastoral, and deforestation. There are four different control catchments: mature forest, grazed pasture, tropical agricultural mosaic, and a catchment covered by a monoculture of invasive canal grass (*Saccharum spontaneum*). Controls serve to distinguish between effects of tree growth and interannual-climate variation.

Ten water years (May through April) of stream-discharge data have been processed for the nine streams being observed as part of the study of hydrology. Four more streams have shorter records. These data can now be used to research watershed hydrology on time scales from single

storms up to ten years of continuous flow. Much of my current activities focus on the interpretation of these data through statistics and modeling.

CONSERVATION RESEARCH

For the last 20+ years I have used knowledge gained from studies of intensely studied watersheds to develop simple but reliable techniques to rapidly assessment of hydrologic and biogeochemical conditions in remote, pristine ecosystems. My focus has been tropical, and while the initial work was in Panama, since 2004, I have worked with the Science Action for Conservation & Community Program of the Chicago Field Museum, now the Amazon and Andes Program, to rapidly inventory and assess remote landscapes in wester Amazon and Guyana. The purpose of these inventories is to promote conservation, and we apply rigorous biological, social, and now earth-science observations to understand landscapes and to present this knowledge so that it is accessible to non-scientists, including members of indigenous tribes, with whom we are working, local conservationists, and government policy makers. Each inventory is run as a multi-week field campaign to remote and minimally described regions that are of great conservation value and requir characterization to be placed into a protected status.

This work has been remarkably successful; in the ten inventories with which I have been directly involved, 35,128 km^2 of rainforest has been protected, almost four times the area of Yellowstone National Park. Most recently, Yaguas National Park, Peru, created in January 2018, came out of this work; it alone is the size of Yellowstone National Park. Although I work as a volunteer, these campaigns have contributed powerfully to my research interests relating landscape to natural land cover. My last Inventory, completed just before COVID-19 ended such fieldwork, was Rapid Inventory 31 of the lower Putumayo, Yaguas, and Cotuhé Rivers in both Peru and Colombia. I am currently working on developing a study of the Rupununi Portal in Guyana.

LOCAL INVOLVEMENT IN RESEARCH

Both the Agua Salud Project and the Field Museum Rapid Inventories would not be possible without strong and positive engagement with local populations.

For the Agua Salud Project, we relied on the local agriculturists as paid employees in the fieldwork and relied on their knowledge of the landscape to reconstruct land-use histories through time. In turn, we did not experience vandalism of instruments, hunting, or random field burning that have afflicted many field-based studied that treated the local society as a mere backdrop. We also provided instruction as to how to plant native trees for commercial benefit of the small land holders. We also assessed, at the scale of the Canal Basin, whether local land owners would be interested in reforestation.

For the Rapid Inventories, much of the population in the surrounding region is indigenous, and all are quite poor. We had two teams, the field scientists who studied the landscape and a team of sociologists. Most team members were from the host countries. The field scientists relied on paid support from the local population for general support and local knowledge such as organism natural identification and site history. The sociology team interacted with all the surrounding communities to assess their interest in conservation, their understanding and use of the landscape, and also cultural and natural history.

THE BIOGEOCHEMISTRY AND BIOGEOGRAPHY OF SALT – RESTORING A LOST MANUSCRIPT BY DR. STIG RYDÉN

Sodium, & chloride are essential to the functioning of animals such as us. Potassium and a mix of chloride, sulfate, bicarbonate, and organic-acid charge are important in plants. Chloride can be obtained from drinking water & halite, and lacking those, from suitable plant and animal sources. Sodium can be obtained from drinking water & halite, and lacking those, only from hunting. Lack of sodium leads to ineffective sweating and cramps. In salt-deficient landscapes. To avoid sweating, physical activities were confined to night and cool times of the day. The biogeochemistry of sodium and chloride are such that this can become limiting nutrients for animals. Sodium ion (Na^+) has three sources: alumino-silicate weathering, halite weathering, and seasalt blown inland, Na^+ is the most mobile of the major cations and is barely retained in soils, sediments, or plants. Chloride ion (Cl^-) has two sources: halite weathering and seasalt blown inland. Halite is so rare in surficial rocks in the humid tropics, for most landscapes seasalt blown inland is the only significant source of Cl^-. Cl^- is also not retained in soils. Cl^- accumulates in some plants and can be extracted. Na^+ and Cl^- are paired in seawater (molar Na:Cl = 0.8525:1), halite (Na:Cl = 1:1) together referred to salt. Similar proportions are found in blood and sweat. Accordingly, consumption of animals is sometimes the only realistic source of Na^+ and Cl^- (perhaps supplemented by plant ash) for rainforest peoples.

No comprehensive studies of the role of salt in indigenous cultures of Central and South America have ever been published. Dr. Stig Rydén, Director of the Swedish Museum of Ethnology in Stockholm had prepared such a study and was readying it for publication when he died in 1965. The 400-page manuscript, half text, half notes, maps, and inserts, languished in a drawer at the museum until 2014 when a colleague, Dr. Lina Lindell, found it at my behest. With others, I plan to edit and publish the long-lost manuscript on the ethnography of salt use by the indigenous populations of South and Central America and the Caribbean. In parallel articles we plan to update our understanding of salt use in the above populations based on based on the integration of the manuscript data and research undertaken in the 50 years since the death of Dr. Rydén. The Biogeochemical aspect of this work is largely new and unpublished.

Planned Publication of Results:

1. Publication of the Rydén manuscript as an annotated monograph; funding sources to be determined.
2. Two to three scientific publications: e.g., Proceedings of the National Academy of Sciences (U.S.A.) from which we have already received an invitation for submission.
3. Publication in a popular science journal such as the Smithsonian Magazine.
4. Presentations at various institutions.