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BIOGRAPHICAL SKETCH / CV

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Dr. Booth is an environmental biogeochemist with 20 years of professional experience in basic and applied research, teaching and consulting in the fields of coastal and environmental biogeochemistry, radiochemistry applied to particle transport in fluvial systems, applied remote sensing of earth systems, soil and groundwater remediation, and environmental remediation chemistry/technology development and commercialization. Dr. Booth received a Bachelor of Science Degree in Environmental Geosciences/Geology from Southeastern Missouri State University. He received a Master of Science Degree in Aquatic Toxicology/Environmental Geochemistry and a Doctor of Philosophy Degree in Chemical Oceanography/Coastal Biogeochemistry from Louisiana State University.

Dr. Booth was employed as a Physical Scientist in the Earth System Science Office (ESSO), with the National Aeronautics and Space Administration (NASA) during 1997 – 1999; and in 2000, he began working in the environmental remediation/consulting industry. His early involvement was focused on the subsurface biogeochemistry associated with starting up and operating a very large engineered *in-situ* bioremediation system (~ 2000 linear feet of bio-wall) for the destruction of a mixed plume of chlorinated ethene and methane compounds in soil and groundwater beneath an active chemical manufacturing facility. He has been active with a wide range of projects involving governmental entities (e.g. NASA, EPA, NSF, Navy, Air Force), engineers, scientists, academicians, regulators and consultants, on an international scale. Dr. Booth has led efforts for the research and development of environmental remediation technologies and products, as well as, commercialization, manufacturing and site specific implementation guidance for end users. Dr. Booth has been responsible for identifying and assessing technologies and products for further development and/or strategic partner alliances focused on environmental remediation and site assessment.

Dr. Booth is a leader in the commercialization and implementation of the NASA patented Emulsified Zero Valent Iron (EZVI) technology. He has actively worked with the EZVI technology since 2003, for use as an *in-situ* halogenated hydrocarbon DNAPL destruction approach. Dr. Booth has also been actively involved with the development of the NASA environmental remediation technology, Activated Metal Treatment System (AMTS), which is focused on the *in-situ* destruction of PCB's and other more recalcitrant compounds in our environment.

In November 2015, Dr. Booth accepted the position of Senior Vice President with Provectus Environmental Products, Inc. (PEP) to commercialize genuine advances in ISCO and ISCR technologies with a focus on continually evolving remediation chemistries that are safer to implement, provide highly effective results and are cost efficient.

CAREER SUMMARY:

Dr. Booth is an environmental biogeochemist with 20 years of professional experience in basic and applied research, teaching and consulting in the fields of coastal and environmental biogeochemistry, applied remote sensing of earth systems, soil and groundwater remediation, and environmental remediation technology development and commercialization. He has been involved with a wide range of projects, involving governmental entities (e.g. NASA, EPA, NSF, Navy, and Air Force), engineers, scientists, academicians, regulators and consultants, on an international scale. Dr. Booth has led efforts for the research and development of environmental remediation technologies and products, as well as, commercialization, manufacturing and site specific implementation guidance for end users. Dr. Booth has been responsible for identifying and assessing technologies and products for further development and/or strategic partner alliances focused on environmental remediation and site assessment. Dr. Booth is a leader in the commercialization and implementation of the NASA patented Emulsified Zero Valent Iron (EZVI) technology. He has actively worked with the EZVI technology since 2003, for use as a combined abiotic/biotic *in-situ* halogenated hydrocarbon DNAPL destruction approach. Dr. Booth has also been actively involved with the development of the NASA environmental remediation technology called Activated Metal Treatment System (AMTS), which is focused on the *in-situ* destruction of PCB's and other more recalcitrant compounds in our environment.

EDUCATION:

Louisiana State University (LSU)

Ph.D. Department of Oceanography & Coastal Sciences: (1998)
Coastal Biogeochemistry/Chemical Oceanography

M.S. Veterinary Medical School: (1994)
Aquatic Toxicology/Environmental Geochemistry

Southeastern Missouri State University

B.S. Department of Earth Science: (1988)
Environmental Geosciences/Geology

National Aeronautics and Space Administration (NASA):

(Basic and Applied Research and Teaching)

- Awarded NASA Graduate Fellowship for Doctoral studies and research (1994 - 1996)
- Physical Scientist for the National Aeronautics and Space Administration (NASA) (1996 - 2000)
- Facilitated, developed, and field tested technologies for the application of *in-situ* optical measurements to coastal biogeochemical processes and cycling of materials through the use of satellite and airborne remote sensing platforms
- Science Advisory Panel - Served as NASA representative for the EPA Gulf of Mexico Program
- Technical Advisory Panel - NASA Stennis Space Center (SSC)

Dr. Booth was awarded a NASA graduate researcher fellowship (1993 - 1996) to study and conduct research associated with his Doctoral degree, and was subsequently employed as a Physical Scientist by NASA during 1996 - 1999 in the Earth Systems Science Office (ESSO) at the John C. Stennis Space Center (SSC) in southern Mississippi. During his employment with NASA, Dr. Booth worked to advance the state of knowledge regarding material transport and carbon cycling in shallow, highly productive coastal ecosystems. This work involved facilitating and overseeing technology development with regard to *in-situ* optical instrumentation for assessing the propagation of visible and near-IR light within coastal waters. These data were utilized in the development of algorithms for quantifying water parameters using satellite derived images of coastal margin environments. See included manuscript for detailed description of this work.

While working at NASA, Dr. Booth also managed graduate student research work, funded by NASA, at various universities. Dr. Booth also served as the NASA representative to the EPA Gulf of Mexico Science Advisory Panel. Dr. Booth also develop collaborative research opportunities between NASA and the NRL (Naval Research Lab), also located at SSC. Dr. Booth served on the NASA Technical Advisory Committee at SSC.

WORK EXPERIENCE:

Environmental Consulting:

Dr. Booth began his employment in the Environmental Consulting industry beginning in 2000. His early involvement was focused on the biogeochemistry associated with starting up and operating a very large engineered *in-situ* bioremediation system (~ 2000 linear feet of bio-wall) for the destruction of a mixed plume of chlorinated ethene and methane compounds in groundwater beneath an active chemical manufacturing facility on the U.S. west coast. He has continued to primarily focus on the *in-situ* remediation of halogenated hydrocarbons in locations across the U.S. and Canada. Dr. Booth has functioned in a variety of roles in the consulting industry ranging from project management to senior technical advisor and frequently managed communications with clients, regulators and technical implementation contractors.

Fields of Specialization:

- Soil and Groundwater Remediation
    - In-situ DNAPL remediation
    - Bioremediation
    - In-situ chemical reduction (ISCR) remediation approaches
    - In-situ chemical oxidation (ISCO) remediation approaches
    - Combination/synergistic remediation approaches
    - Implementation approaches
    - Communication of results/technical reasoning to regulators
- Research & Development for Environmental Technologies
    - Identification, Evaluation, Development, Commercialization
    - Remediation Chemistry Development/Commercialization
        - Laboratory and bench scale development

- Field pilot design, implementation & monitoring
- Remote sensing technology applications
  - LiDAR - Light Detection and Ranging
  - Engineering precision, surface topography, buildings/structures, etc.
- Thermal imagery
  - Subsurface thermal anomaly detection for moisture trails, contaminant plume, NAPLs, tanks, etc.
  - Remote sensing technologies integrated on an aerial platform through a military grade inertial navigation system, providing high precision geolocation of all imagery
  - Delineation of preferential groundwater movement using applied electrical current and hyper sensitive magnetic field characterization
- Coastal Processes
  - Northern Gulf of Mexico
    - Biogeochemical cycling
      - coupling surface water with bottom sediments
    - Sediment transport and sedimentation in coastal margins
    - Marsh accretion and subsidence
    - Material transport processes in northern Gulf of Mexico coastal margins

EXPERIENCE SUMMARY:

Remediation Work Summary

- *In-situ* DNAPL remediation:

  Implementation design and oversight, product manufacturing of the EZVI technology at numerous active sites, ranging from active DOD facilities to active industrial manufacturing locations. At all of these locations EZVI was injected directly into source areas to destroy the residual product and expedite/augment the biological (microbial) processes that degrade dissolved phase halogenated hydrocarbon contamination.

  Multiple pilot scale DNAPL destruction projects (2003 – 2015)

  Multiple full scale DNAPL destruction projects (2005 -2015)

  Full Scale Source Area Treatment: Commercialized the NASA patented *In-situ* DNAPL technology, EZVI; manufactured and delivered greater than 500,000 pounds of EZVI to an active DoD facility in Central Florida for the largest full scale implementation of the technology to date.

- *In-situ* Dissolved Phase Remediation (ISCR):

  Multiple projects utilizing *in-situ* chemical reductive (ISCR) chemistries for dissolved phase remediation of halogenated hydrocarbon contamination. Dr. Booth has applied a suite

of synergistic chemistries at multiple sites using *in-situ* PRB implementation techniques. This approach takes advantage of both abiotic and biotic reaction processes for the degradation of halogenated compounds.

Dr. Booth also has significant experience operating and monitoring one of the largest engineered *in-situ* bioremediation (EISB) systems ever installed (approximately 2000 linear feet of biowall treating groundwater from ~ 20 – 110 feet bgs).

- PCB remediation in building materials:

  Treatability testing of the NASA patented PCB remediation technology, Activated Metal Treatment System (AMTS). Bench-scale study conducted on painted steel, concrete, soil, sludge and oil obtained from two separate sites in the Northern United States.

  Field pilot testing of the AMTS technology at a manufacturing facility in the southern United States for extraction and destruction of chlorinated compounds from concrete.

- Groundwater Tracer Testing:

  Conducted successful groundwater tracer experiments to better understand subsurface flow in conjunction with an engineered, pumping, in-situ bioremediation system, as well as to assess natural groundwater seeps; developed, tested and implemented field and laboratory methods to obtain statistically significant data; data interpretation, report preparations.

- Remote Sensing Technologies for surface and subsurface assessment:

  Fully integrated LiDAR, thermal imaging and geo-positioning systems for remote subsurface structures and contaminant assessment (e.g. pipelines, pipeline leaks, UST's, groundwater & soil contamination, infrastructure assessment, etc.). Responsible for identifying these technologies and facilitating their integration in order to address issues in the environmental market.

Coastal Project Work Summary

- Sediment and Contaminant Transport:

  Sediment and contaminant transport in coastal environments (e.g. Louisiana, Brazil, Norway and Puerto Rico). Significant experience requiring expertise in the design of field sampling programs; interpretation of complex data sets; management of personnel and tasks in the field and laboratory; the ability to analyze and determine the logistics of working in remote locations and/in foreign countries; preparation of reports and technical manuscripts; oral and written communications.

- Produced Water:

  Produced water discharge effects on the chemical and physical properties of bottom sediments. Two year project focused on the collection and analysis of produced water and sediment samples; interaction with private industry managers and field personnel; data analysis and interpretation.

- Surface Water Quality (remote sensing technologies):

  Determining the Spatial and Temporal Variability of Water Quality in Near-Shore Environments (e.g. Louisiana, Puerto Rico). Significant experience with the application of remote sensing data and bio-optical technologies primarily directed at determining water quality remotely; required technology development and testing involving the federal government and private sector companies.

- Quantification of NORM:

  Quantified NORM levels (e.g. radium) in produced waters and in bottom sediments adjacent to produced water effluents in coastal Louisiana. Significant experience in the design and implementation of field sampling programs and protocols; development of wet chemistry techniques and tools to facilitate sample processing; oral and written interactions with personnel from the private sector, academics, and governmental agencies.

  Conducted bottom sediment surveys in estuarine and continental shelf environments of the Northern Gulf of Mexico, for naturally occurring (e.g. 238U, 234Th, 7Be, 210Pb) and anthropogenic (e.g. 137Cs) radioisotopes. Significant experience requiring management of field and laboratory operations; radiochemical analyses; data interpretation; report preparation.

- Material Flux in Coastal Environments (see manuscript):

  Bottom sediment erosion and accumulation in lakes and bays in coastal Louisiana. 8 years' experience coordinating intensive laboratory and field efforts (i.e. frequent sampling with limited processing time); developed innovative and highly successful techniques to determine particle transport characteristics.

Technical Reports and Presentations (through 2011)

Booth, G., B. Droy, C. Clausen, C. Geiger, and J. Quinn. 2011. Bench Scale Treatability Studies Using Activated Metal Treatment System (AMTS). *International Symposium on Bioremediation and Sustainable Environmental Technologies.* Reno, Nevada, 2011.

Booth, G. 2011. In-Situ DNAPL Remediation Using the Emulsified Zero-Valent Iron (EZVI) Technology. Invited presentation. American Institute of Professional Geologists (AIPG) Georgia

Section. Third Conference: Innovative Environmental Assessment and Remediation Technology. Kennesaw, Georgia.

Geiger, C., C. Clausen, S. Novaes-Card, C. Acevedo-Parra, and G. Booth. 2011. Degrading Aroclor 1248 and 1260 in Wet and Dry Soils from a Contaminated Site. *Sixth International Conference on Remediation of Contaminated Sediments, New Orleans, Louisiana.* February 2011.

Droy, B., G. Booth, R. Musser, J. Barber, and S. Cobert. 2010. *In-Situ* Source Area Remediation with Emulsified Zero-Valent Iron (EZVI). Poster Presentation. *Seventh International Conference on Remediation of Chlorinated and Recalcitrant Compounds.* Monterey, California.

Booth, G. 2010. "Green" DNAPL Remediation using the Emulsified Zero-Valent Iron (EZVI) Technology. Invited Presentation. *Environmental Regulatory Compliance Conference*. September 2010.

Booth, G. 2010. "Green" DNAPL Remediation using the Emulsified Zero-Valent Iron (EZVI) Technology. Invited Presentation. *Louisiana Department of Environmental Quality Green Business Expo*. August 2010.

Faircloth, H, Booth, J.G., Schnell, D., Quinn, J., Johansen, D., Matthews, J. (2006) In-situ DNAPL remediation: Full scale EZVI implementation. *Florida Remediation Conference, Orlando, Florida.* Conf. Proceedings pp. S4-D2 20

Booth, J.G., Jin, P., Droy, B.F., Manale, F., Creber, C., and Klecka, G. (2002) Conservative chemical tracer studies to evaluate a large scale circulating in-situ bioremediation system. *Battelle Conference on the Remediation of Recalcitrant Compounds in Groundwater, Monterey, California.* Conf. Proceedings pp. 2B-38

Jin, P., Droy, B.F., Manale, F., Booth, G., Creber, C., and Klecka, G. (2002) Groundwater biogeochemical study for evaluating feasibility of in-situ anaerobic bioremediation. *Battelle Conference on the Remediation of Recalcitrant Compounds in Groundwater, Monterey, California.* Conf. Proceedings pp. 2B-39

Booth, J.G., McKee, B.A. and Miller, R.L. (1999) Bulk particulate and sedimentary organic carbon transport characteristics in a shallow, wind-driven coastal environment. *Estuarine Research Federation Conference (ERF), New Orleans, LA (Invited Speaker)*.

Booth, J.G., Miller, R.L. and McKee, B.A. (1997) Deposition and burial of organic carbon in estuarine bottom sediments. *Fourth Thematic Conference on Remote Sensing for Marine and Coastal Environments*. Orlando, FL.

Booth, J.G., Miller, R.L. and McKee, B.A. (1997) Deposition and burial of particulate material in a shallow estuary: combining geochemical and remote sensing techniques. *Marine Technology Society (Gulf Coast Section) pp. 158-160*.

Rovansek, R.J., Booth, J.G., Cruise, J.F., McKee, B.A. and Miller, R.L. (1997) Hydrology and sediment flux in Barataria Bay, LA. *Remote Sensing for Marine and Coastal Environments* II: 416.

Miller, R.L., McKee, B.A., Booth, J.G., Cruise, J., and Rouse, L. (1997) Analyzing carbon and sediment flux in Barataria Bay, LA using remote sensing and field observations: An integrated approach. *Fourth Thematic Conference on Remote Sensing for Marine and Coastal Environments*. Orlando, FL.

McKee, B., Booth, G. and Miller, R. (1997) Combining the use of remote sensing and geochemical techniques in coastal margins. *Fourth Thematic Conference on Remote Sensing for Marine and Coastal Environments*. Orlando, FL.

Publications **(Peer Reviewed)**

Booth, J.G., Miller, R.L., McKee, B.A. and Leathers, R.A. (2000) Wind induced sediment resuspension in a microtidal coastal environment. *Continental Shelf Research* 20:785-806.

Swarzenski, P.W., McKee, B.A., Skei, J.M., Booth, J.G. and Todd, J.F. (1999) Uranium across the redox transition zone of a permanently stratified fjord: Framvaren, Norway. *Marine Chemistry*. 67 (3/4): 181-198.

Rovansek, R.J., J.G. Booth, J.F. Cruise, B.A. McKee and R.L. Miller. 1997. Hydrology and sediment flux in Barataria Bay, LA. *Remote Sensing for Marine and Coastal Environments*. Vol. II, p. 416-425.

McKee, B.A., Swarzenski, P.W., and Booth, J.G. (1996) The flux of uranium isotopes from river dominated shelf sediments. In: *Internat'l Symposium on the Geochemistry of the Earth's Surface*. (IAGG) pp. 85-91.

Miller, R.L., M. Giardino, B.A. McKee, J.F. Cruise, G. Booth, R. Rovansek, D. Muirhead, W. Cibula, L. Holladay, R. Pelletier, W. Hudnal, G. Ioup and G. Love. 1996. Processes and fate of sediments and carbon in Barataria Bay, LA. *Remote Sensing for Marine and Coastal Environments*. Vol. II, p. 401 – 423.

Swarzenski, P.W., McKee, B.A., and Booth, J.G. (1995) Uranium geochemistry on the Amazon Shelf: Chemical phase partitioning and cycling across a salinity gradient. *Geochemica et Cosmochimica Acta*, 59: 7-18