Charles P. Oden

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Objective

Research and development of cutting-edge geophysical instrumentation, survey methods, and analysis techniques to solve practical problems. Teaching people to use science and technology for the benefit of us all.

Professional Experience

Director of Research and Development

2006 - Present Earth Science Systems, LLC Wheat Ridge, CO

- Exploiting nano-technology to create the next generation of acoustic, electromagnetic, and electric instrument arrays.
- Leveraging recent development in portable computing to develop real-time data integration, processing, and interpretation for multi-sensor data sets.
- Direct a multi-disciplinary engineering team.
- Reference: Robert Sander, phone 303-800-2000 x03

Graduate Student Appointment

2003 - 2006 U.S. Geological Survey Denver, CO

- Investigated custom ground penetrating radar antennas to compensate for variable near field coupling with changing earth properties. Research and development of algorithms to compensate for variable antenna coupling with the ground and to migrate radar data from dispersive media.
- Reference: Dr. David Wright, phone 303-236-1381

Proprietor

2001 - Present Mercury Geophysics Denver, CO

- Authored processing software for borehole geophysical data. Software contains common log analysis algorithms and advanced modeling features. Specialties include acoustic, nuclear, and hydrogeological measurements.

Engineering Manager

1991 - 2003 Mount Sopris Instrument Co., Inc. Golden, CO

- Over twelve years experience in all aspects of borehole geophysical instrument design and fabrication. Designed measurements based on electrical, nuclear, acoustic, and electromagnetic principles. In-depth knowledge of associated sensor technologies.
- Intimately involved with analog and digital circuit design, prototyping, and fabrication.
- Creation of software for data acquisition and processing. Authored software to correct for environmental effects and calculate derived properties.

- Experience managing complex projects involving internal and external resources.
- Reference: John Stowell, phone 303-279-3211

Engineer
1985 - 1991 Nebraska Radio Telephone Systems Lincoln, NE
- Maintained and repaired radio paging networks. Made custom modifications to telephone switching equipment to automatically provide verbal instructions to callers and dispatch messages. Planed, built, and maintained multi-transmitter broadcast systems. Made applications to FCC (part 21 and part 90) for new transmitter locations.

Education

Ph.D. Geophysical Engineering
2002 - 2006 Colorado School of Mines Golden, CO

B.S. Electrical Engineering
1989 - 1990 University of Nebraska Lincoln, NE
- Special projects in geophysical instrumentation.

B.S. Geology
1984 - 1989 University of Nebraska Lincoln, NE
- Minors in mathematics and physics.
- Field camp in northern Wyoming
- Two years of German language

Professional Memberships

Society of Exploration Geophysicists, Environmental and Engineering Geophysical Society, Institute of Electrical and Electronics Engineers, Denver Well Logging Society, Society of Professional Well Log Analysts, European Association of Geoscientists and Engineers.

Certifications and Training

Registered professional electrical engineer, Colorado, 1996; Competent toastmaster, 2001; Training for handling radioactive materials.

Interests and Activities

Family, reading about new concepts in physics and mathematics, travel, skiing, mountain biking, and mountaineering.

Summary of Key Accomplishments — Charles P. Oden

Team Leadership

- Have lead small (~5 member) teams.
- Provided technical guidance for team projects.
- Promoted and facilitated learning of new skills by team members.
- Managed complex projects with internal and external resources, including work from other countries.
- Tailored projects to capitalize on team strengths, and avoid pitfalls.
- Promoted accurate resource allocation and reporting to facilitate project accounting.

Teaching Experience

- Classroom Taught portions of courses on linear systems (GP302), dynamic fields (GP322), and electromagnetic methods (GP422) in the geophysics department at Colorado School of Mines.
- Customer Training Taught small classes on how to process geophysical data to answer their real word questions (e.g. where is the water?, what is the ore grade?, are contaminants a problem?). Taught the theory behind the measurements and processing techniques.
- Workplace Taught basic analytical skills and trouble shooting techniques to staff members.

Service to Science and Industry

- Meeting Organization Co-chaired a special SAGEEP session on "the future of geophysical technology".
- Journal Reviews
  - Progress in Electromagnetic Research
    - Imaging objects through lossy layers
  - J. Environmental and Engineering Geophysics
    - Monitoring a DNAPL spill using a dielectric logging probe
  - Applied Radiation and Isotopes
    - A neutron activation probe for measuring copper ore grade
    - Candidate reactions for measuring mercury emissions from coal fired power plants
- Internal Reviews
  - USGS: several papers on electromagnetic methods
  - Mt. Sopris Instruments: symposium papers on new well logging technology

Funded Proposals

- Neutron Activation Modeling Study Played a major role in securing $100,000 in private funding to conduct a feasibility study of a neutron activation logging probe.
- Pulsed Neutron Activation Well Logging Probe Played a major role in securing $250,000 in private funding for the development of a neutron activation probe for measuring nickel and copper ore grade.

Summary of Key Accomplishments — Charles P. Oden

Cross Disciplinary Knowledge Base

Education in geology, electrical engineering, geophysics, and extensive programming experience facilitate innovative solutions to real world problems. Can create and explain how complete solutions are created. This involves understanding the real-world problem, instrument design, survey design, processing software design, and tailoring results for the end user.

Software Development Have written a large number of programs for geophysical data processing, analysis, and acquisition. Created software to explain concepts and aid scientists and engineers in solving real world problems. The help systems in my software packages are used as tutorials. Programming languages: C++, assembly, Pascal, and FORTRAN. Have written DOS and Windows based programs. Examples include:

- Inversion Algorithm for UXO Discrimination Algorithm estimates depth, attitude, and aspect ratio for conductive and magnetic targets using ALLTEM tensor electromagnetic induction data.
- Inversion Algorithm to Estimate Soil Properties Algorithm estimates soil properties directly beneath ground penetrating radar antennas. Inversion is based on complex shape of early arriving waveforms.
- Enhanced Radar Imaging in Lossy Media Dispersive migration algorithm improves ground penetrating radar image resolution in lossy media.
- Inversion Algorithm for Crosshole EM Induction Surveys Algorithm inverts simulated crosshole EM data to provide a 2D image of conductivity.
- Advanced Ground Penetrating Radar Processing Windows based package.
  - Standard temporal and spatial filtering, and gridding routines. Section view (2D data) and time slice views (3D data). Various migration routines.
  - Extensive wave and signal processing including filtering, convolution, deconvolution, and multiple signal comparison. Wave field propagators. Many instrument calibration routines.
- Advanced Well Log Processing Windows based log analysis package.
  - Sonic log processing: Automated and interactive velocity analysis and picking algorithms for compressional, shear, and Stoneley waves. Inverse modeling of Stoneley wave to determine shear velocity. Cement bond log processing.
  - Spectral gamma log processing: Compensation for borehole diameter. Elemental concentration from spectral stripping or basis spectra methods.
  - Formation evaluation: Various cross plots. Calculate volumetric fractions, borehole corrections. Principal component analysis.
  - Flowmeter interpretation software to aid in pump and slug tests. Transmissivity, storage, and head can be estimated for each flow unit intersected by borehole.
- Density Probe Compensation Algorithm Borehole compensation algorithms for dual detector density probes based on experiments with physical models.
- Data Acquisition Software and Firmware Authored several generations of well log data acquisition and display systems. Wrote many embedded software programs for well logging probes and acquisition hardware.

Summary of Key Accomplishments — Charles P. Oden

Numerical Simulations Have performed geophysical modeling to estimate the response of proposed and existing instruments. Examples include:

- Cross Hole EM Simulation Wrote software to make low contrast response models of cross hole electromagnetic induction tomography surveys. Resulting models used to estimate performance of simulated equipment.
- Finite Difference Time Domain Electromagnetic Simulations Tailored simulations to determine ground penetrating radar antenna response when loaded by soils with widely varying properties. Careful measurement and specification of antenna components facilitated high accuracy. Made an extensive library of simulations for wide range of soil properties.
- Monte Carlo Simulations of Neutron Spectroscopy Probes Monte Carlo models to simulate the response of various neutron-gamma spectroscopy probes. These probes use nuclear geophysics to identify and quantify the presence of specific elements such as carbon, oxygen, iron, nickel, copper, and trace elements such as arsenic. Several different classes nuclear reactions were modeled.

Hardware Design Have intimate knowledge of electrical, electromagnetic, acoustic, and nuclear geophysical instrumentation. Designed and built many downhole and surface based geophysical instruments using these measurements. Examples include:

- Wireless Sensor Motes Designed miniature inexpensive geophysical sensor packages that do not require batteries and wirelessly transmit data to a data logger. Designed motes for many geophysical measurements including seismic, magnetic, EM induction, and ground penetrating radar.
- Ground Penetrating Radar Designed antenna systems and receiver circuitry. Optical circuits were used when necessary so that noise and interference due to metallic cabling was avoided.
- Variable Frequency Sonic Probe By varying the frequency, the probe can be tuned for optimal operation based on borehole diameter, and rock velocities, and desired modal excitation.
- Multi-Detector Density Probe for Low Activity Radioactive Sources The source to detector offsets can be selected based on the source activity. Probe can also make spectral density measurements.
- Temperature Compensated Spectral Gamma Probe Temperature compensation is made by automatically calibrating the multi-channel analyzer (pulse height analyzer) to account for changes in the detector response with temperature.
- Resistivity Probe on Mono-Conductor Cable A unique implementation of normal resistivity logging probe that operates on single conductor logging cable without the use of batteries.
- Low Power Button Guard Resistivity Probe A low power design using very large guard electrodes (> 1m). Vertical resolution is ~ 1cm.
- EM Induction Probe Determined problems with existing induction conductivity probes and recommended design changes to fix problems.

Publications Charles P. Oden

Peer Reviewed

Oden, C. P., Olhoeft, G. R., Wright, D. L., and Powers, M. H., 2007, Measuring the Electrical Properties of Soil using a Calibrated Ground-Coupled GPR System, Vadose Zone Journal, Special Issue on the Application of GPR in Hydrogeophysics, v. 7, n.1, p. 171-183.

Oden, C. P., Wright, D. L., Powers, M. H., and Olhoeft, G. R. 2006, Improving GPR Image Resolution in Lossy Ground using Dispersive Migration, IEEE Trans. Geoscience and Remote Sensing, v. 45, n. 8, p. 2492-2500.

Oden, C. P., 2006, Calibration and Data Processing Techniques for Ground Penetrating Radar Systems with Applications in Dispersive Ground, Ph.D. Dissertation, Dept. Geophysics, Colorado School of Mines, Golden, CO, USA.

Oden, C. P. Schweitzer, J. S., and McDowell, G. M., 2006, The Feasibility of Well-Logging Measurements of Arsenic Levels using Neutron-Activation Analysis, Applied Radiation and Isotopes, v. 64, n. 9, p. 1074-1081.

Conference Papers and Other Publications

Oden, C. P., Olhoeft, G. R., Jones, D. P., and Smith, S. S., 2008, Wireless Sensor Networks in Geophysics, *in* Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems, Philadelphia, PA, Environmental and Engineering Geophysical Society, Denver, CO.

Oden, C. P., and Moulton, C. W., 2007, GP Workbench Manual: Technical Manual, User's Guide, and Software Guide, USGS Open File Report 2006-1365, 81 p, http://pubs.usgs.gov/of/2006/1365/.

Wright, D. L., Mouton, C. W., Asch, T. H., Brown, P. H., Nabighian, M. N., Li, Y., and Oden, C. P., 2007, ALLTEM UXO Detection Sensitivity and Inversions for Target Parameters from Yuma Proving Ground Test Data, *in* Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems, Denver, CO, Environmental and Engineering Geophysical Society, Denver, CO.

Oden, C. P., Wright, D. L., Powers, M. H., and Olhoeft, G. R., Rittgers, J. B., Irons, T., and Meininger, A. J., 2006, Estimating Soil Properties under Ground-Coupled GPR Antennas, *in* Eleventh International Conference on Ground Penetrating Radar, Columbus, Ohio, USA, Agrigeophysics and Production GPR.

Wright, D. L., Oden, C. P., Powers, M. H., Moulton, C. W., Hutton, S. R., and Kibler, J. D., 2005, A Ground Penetrating Radar System for High Loss Environments, *in* Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems, Atlanta, GA, Environmental and Engineering Geophysical Society, Denver, CO, paper 84.

Oden, C. P., Wright, D. L., Powers, M. H., and Olhoeft, G. R., 2005, Ground Penetrating Radar Antenna System Analysis for Prediction of Earth Material Properties, *in* IEEE Antennas and Propagation Society International Symposium, Proceedings, Washington, DC.

Powers, M. H., and Oden, C. P., 2004, Migration of Dispersive GPR Data, *in* Tenth International Conference on Ground Penetrating Radar, Delft, The Netherlands.

Oden, C. P., 2004, An Automated Transmissivity Modeling Method for Use with Borehole Flowmeter Data, *in* Symposium on the Application of Geophysics to Engineering and Environmental Problems, Colorado Springs, Colorado, 2004 Proceedings, Environmental and Engineering Geophysical Society, Denver, Colorado, p. 234-241.

Oden, C. P., and LoCoco, J. J., 2002, Sonic Logging Case Histories Using Advanced Equipment and Data Processing Techniques, *in* International Symposium on Borehole Geophysics for Minerals, Geotechnical, and Groundwater Applications, 7th, Toronto, Ontario., 2002 Proceedings, Houston, Texas, The Minerals and Geotechnical Logging Society, A Chapter at Large of the Society of Professional Well Log Analysts, and Canadian Exploration Geophysics Society, A Chapter of the Society of Exploration Geophysicists, Tulsa, Oklahoma, Paper 13.

LoCoco, J. J., and Oden, C. P., 2002, A New Slimline Temperature-Compensated 1024 Channel Spectral Gamma Logging Tool, *in* International Symposium on Borehole Geophysics for Minerals, Geotechnical, and Groundwater Applications, 8th, Toronto, Ontario, 2002 Proceedings, Minerals and Geotechnical Logging Society, A Chapter at Large of the Society of Professional Well Log Analysts, Houston, Texas, and Canadian Exploration Geophysics Society, A Chapter of the Society of Exploration Geophysicists, Tulsa, Oklahoma, Paper 11.

Oden, C. P., and LoCoco, J. J., 2000, Variable Frequency Monopole-dipole Sonic Logging for Mechanical and Hydrogeologic Properties, *in* Symposium on the Application of Geophysics to Engineering and Environmental Problems, Arlington, Virginia, 2000 Proceedings, Environmental and Engineering Geophysical Society, Denver, Colorado, p. 493-498.

Oden, C.P., Stowell, J.R., and LoCoco, J.J., 2000, Variable Frequency Monopole-Dipole Sonic Logging for Shear Velocity--Applications and Test Results, *in* International Symposium on Borehole Geophysics for Minerals, Geotechnical, and Groundwater Applications, 7th, Denver, Colorado, 2000 Proceedings, Minerals and Geotechnical Logging Society, A Chapter at Large of the Society of Professional Well Log Analysts, Houston, Texas, p. 71-76.

Oden, C. P., and LoCoco, J. J., 1999, Variable Frequency Monopole-Dipole Sonic Logging for Mechanical and Hydrogeologic Properties, *in* Meeting of the Environmental and Engineering Geophysical Society, European Section, 5th, Budapest, Hungary, 1999 Proceedings, Environmental and Engineering Geophysical Society, Lausanne, Switzerland, Paper W16.

Oden, C. P., 1997, Advances in Instrumentation and Data Processing for Multi Spaced Resistivity Measurements – Hydrogeologic Parameters and Lithostratigraphic Delineation, *in* Symposium on the Application of Geophysics to Engineering and Environmental Problems, Reno, Nevada, 1997 Proceedings, Environmental and Engineering Geophysical Society, Denver, Colorado, p. 223-229.