FAST TIMES

SEISMOELECTRIC & MICROGRAVITY

Message from the new EEGS President

EEGS/GEONICS EARLY CAREER AWARD

Remembering Dr. George V. Keller

EEGS-SEG-NSG Cooperation

Upcoming Events & Conferences

[JUNE 2012] [VOL. 17, NO. 2] [WWW.EEGS.ORG]

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This issue features the application of seismoelectric and microgravity techniques to near surface investigations.

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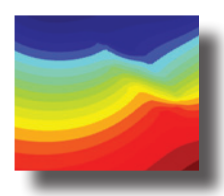

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FAST TIMES

FastTIMES (ISSN 1943-6505) is published by the Environmental and Engineering Geophysical Society (EEGS). It is available electronically (as a pdf document) from the EEGS website (www.eegs.org).

ABOUT EEGS

The Environmental and Engineering Geophysical Society (EEGS) is an applied scientific organization founded in 1992. Our mission:

"To promote the science of geophysics especially as it is applied to environmental and engineering problems; to foster common scientific interests of geophysicists and their colleagues in other related sciences and engineering; to maintain a high professional standing among its members; and to promote fellowship and cooperation among persons interested in the science."

We strive to accomplish our mission in many ways, including (1) holding the annual Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP); (2) publishing the Journal of Environmental & Engineering Geophysics (JEEG), a peer-reviewed journal devoted to near-surface geophysics; (3) publishing FastTIMES, a magazine for the near-surface community, and (4) maintaining relationships with other professional societies relevant to near-surface geophysics.

JOINING EEGS

EEGS welcomes membership applications from individuals (including students) and businesses. Annual dues are $90 for an individual membership, $50 for a retired member, $20 for a student membership, $50 developing world membership, and $650 to $4000 for various levels of corporate membership. All membership categories include free online access to JEEG. The membership application is available at the back of this issue, or online at www.eegs.org.

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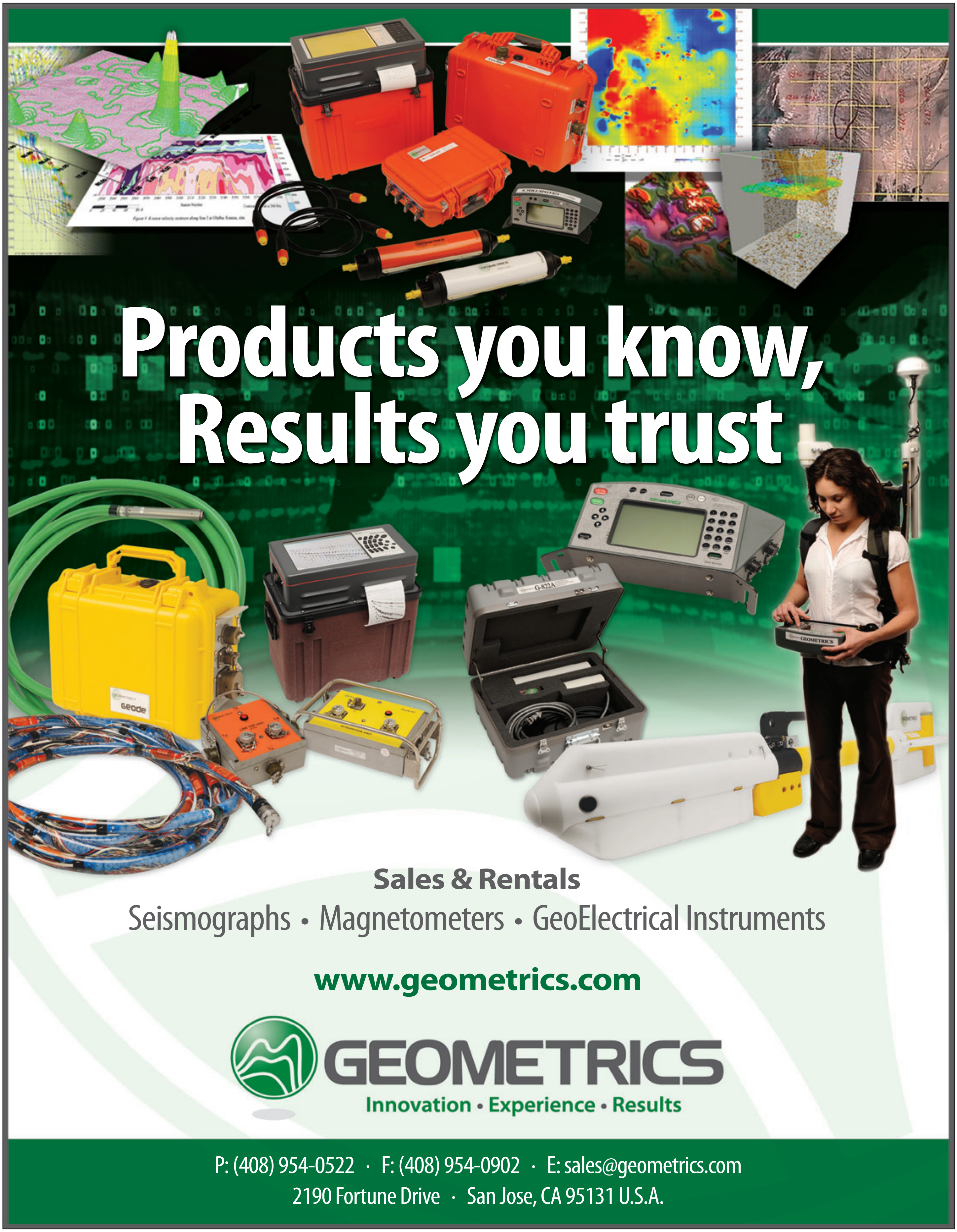
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CALENDAR

2012

June 15-18	5th International Conference on Environmental and Engineering Geophysics, Changsha, China Near-surface Geophysics and Environment Protection Campus of the Central South University, Changsha http://www.iceeg.cn/
August 21	Deadline for submission of articles, advertisements, and contributions to the September issue of FastTIMES
September 19-21	KSEG International Symposium on Geophysics for Discovery and Exploration ICC, Jeiu, Republic of Korea http://2012symp.seg.or.kr
September 23-26	First EAGE Workshop on Dead Sea Sinkholes: Causes, Effects and Solutions Hydrogeological Workshop on Dead Sea Sinkholes, Amman, Jordan
November 21	Deadline for submission of articles, advertisements, and contributions to the December issue of FastTIMES]

2013

March 4-7	73rd Annual Meeting of the German Geophysical Society Leipzig, Germany www.ufz.de/dgg-2013
March 17-21	SAGEEP 2013 Denver, Colorado USA www.eegs.org/SAGEEP 2013
May 6-10	Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst Carlsbad, New Mexico USA
May 26-29	3rd Global Workshop on Proximal Soil Sensing Potsdam, Germany

Please send event listings, corrections or omitted events
to any member of the FastTIMES editorial team.

NOTES FROM EEGS

PRESIDENT'S MESSAGE

Douglas Layman, President
(doug.laymon@tetratech.com)

HAPPY ANNIVERSARY!

This has been a year of anniversaries. We have just celebrated the 25th anniversary of the Symposium on the Application of Geophysics to Engineering & Environmental Problems (SAGEEP) in Tucson Arizona at the Hilton Tucson El Conquistador. Not only was this the 25th SAGEEP but EEGS is celebrating our 20th anniversary as EEGS began in 1992 at the 5th annual SAGEEP held in Oak Brook, Illinois. Also, notably two of EEGS's corporate members (Zonge and Geonics) are celebrating their 40th and 50th anniversaries and many of you helped them celebrate their longevity and success at the Tucson meeting.

Looking back, early in my career I was privileged to attend the first SAGEEP which was held in Golden Colorado on the Colorado School of Mines campus. It was a pivotal time in my life and greatly reinforced my desire to pursue near surface geophysics as a career. The early meetings, although smaller had all of the components of today's meetings that so many of you enjoy. These meetings included technical presentation, publications, equipment demonstrations, vendor booths, networking, and continuing education. In addition, the early SAGEEP meetings were a mix of academia, consultants, equipment manufacturers, government, and students much like the current SAGEEP meetings. There were also nights of food and drink where friendships were forged and business was accomplished. While each venue and city has been unique, the traditions started twenty five years ago in Golden Colorado were the beginnings of where SAGEEP and EEGS are today.

The 25th annual SAGEEP in Tucson carried on the traditions started in Golden. Sorry to say but if you weren't in Tucson this past March - you missed it. This was one of my favorite SAGEEPs and I have been to many of them. The meeting was well attended with over 320 people present. The El Conquistador was a wonderful venue set in the beautiful Arizona desert. The 25th SAGEEP meeting was packed full with an ice breaker, guest speakers, an excellent technical program, short courses, workshops, field trips, equipment demonstrations, a full exhibit hall, luncheons, and the western style conference evening. That being said, we have already moved on to planning next year's SAGEEP meeting. The 2013 SAGEEP will be held on March 17 through March 21 in Denver at the Denver Marriott Tech Center. As many of you know, we return to the Denver area every couple of years for SAGEEP. This will be a great meeting so plan to attend the 2013 meeting in Denver. See our web page (www.eegs.org) for additional details.

One last thought. It occurred to me in Tucson that some things certainly have changed over the last 25 years. EEGS is no longer a struggling fledgling society. EEGS has grown up and we are a leading society for applied near surface geophysics. The growth and success has been a culmination of all the effort, service, and commitment, by you the membership past and present. On behalf of the society I would like to thank each one of you for your commitment and many contributions and congratulate you on a "Happy Anniversary". See you in Denver!

EEGS Foundation makes great strides in its first years.

Since the launch of the EEGS Foundation, there are numerous accomplishments for which we can all be proud: Establishing and organizing a structure that serves the needs of EEGS; underwriting the legal process, achieving tax-exempt status; and soliciting and receiving support for SAGEEP. In addition, the Foundation helped underwrite the SAGEEP conference held this spring in Keystone.

These are only a few of the tangible results your donations to the Foundation have enabled. We would therefore like to recognize and gratefully thank the following individuals and companies for their generous contributions:

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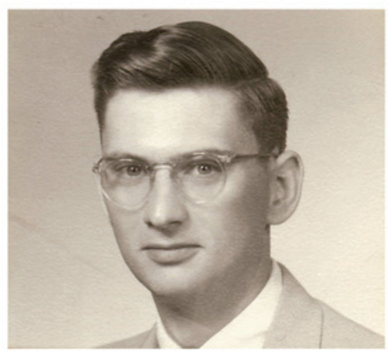
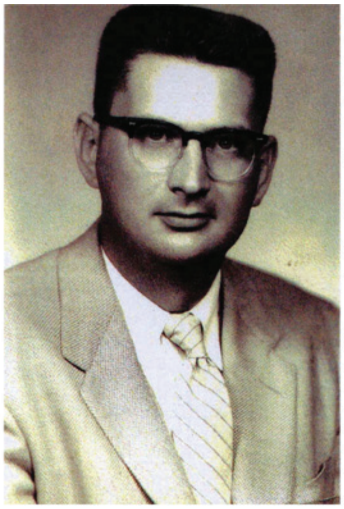
"Guiding Technologies Today -Preparing for a World of Needs Tomorrow"

In Memory of
Dr. George V. Keller
1927-2012

George Vernon Keller was born in New Kensington PA on December 16, 1927 and passed away on April 17th 2012 in Evergreen CO. He married his childhood sweetheart Amber in 1945; she passed away in 1995. He married Liudvika in 1997. George is survived by his wife Liudvika, son George Stephen and wife ,Chong, grandson Justin, and daughter, Susan Diane.





Dr. George V. Keller received his Bachelor of Science (1949) and Master of Science (1952) degrees in Geophysics and his Doctorate (1954) in Geophysics and Mathematics from Pennsylvania State University. From 1945-46, he served in the U. S. Navy as a Seaman First Class. During his career he was employed by the U.S. Geological Survey (1952-1963) and by the Colorado School of Mines (1964 to 1993).

While with the USGS, Dr. Keller's assignments included management of studies of geophysical aspects of nuclear weapons testing for tests carried out within ConUS, impact of earth properties on Command and Control Communications (C31), surveys of the Arctic Ocean during the International Geophysical Year from Drifting Station Bravo (T3), and participation in the early USGS planning team for Deep Sea Drilling (AMSOC).

At the Colorado School of Mines, Dr. Keller's principal areas of interest were in development and applications of electrical geophysical methods to exploration for mineral and energy resources. He served as Head, Department of Geophysics, from 1974 to 1983. He retired from teaching May 1, 1993.

He received a distinguished service award from the U.S. Department of Interior in

1959, was awarded the first Halliburton Award for outstanding professional achievement in 1979, served as a senior Fulbright scholar at Moscow University in 1979, was invited on a distinguished lecture tour by the Japan Association for Advancement of Education during the summer of 1986, and served as a Senior NATO Scholar at the University of Pisa in 1991. He has served as a consultant to many companies and government agencies involved in the earth sciences. Most important among the government assignments were as a member of President Johnson's Blue Ribbon Committee on Mine Safety, as a member of President Carter's energy Research Advisory Board, subcommittee on Geothermal Energy, and as a member of and chairman of the Committee Advisory to the Los Alamos Scientific Laboratory on the Hot Dry Rock (HDR) Project. In 1996, he was named a Centennial Fellow of the College of Earth and Mineral Sciences at Pennsylvania State University.

Dr. Keller (second from left) and students inspect the caldera of Mauna Kea on the island of Hawaii.

Geothermal Class Takes Field Trip to Hawaii

Dr. Keller formed Group Seven, Inc. in 1970 to provide electrical geophysical services to the energy industries. During the 1970s, Group Seven grew to a company with about 60 employees and carried out geophysical surveys for a large number of energy companies and government agencies, includ-

ing Exxon, Chevron, Union Oil, Phillips Oil, Gulf Oil, the Governments of Indonesia and Nicaragua through the U.S. Agency for International Development, the Government of Kenya through the U.N. Development Program, the U.S. Geological Survey, the U.S. Department of Reclamation, the U.S. Navy and the U.S. Department of energy. Group Seven was integrated into United Syscoe Mines (Canada) in 1981.

In the Fall of 2004, he joined a floating campus for the Semester-at-Sea program. He taught three earth science classes to students from throughout the U. S. as the ship sailed around the world.

Dr. Keller has published extensively, including more than 200 technical papers in his own name, more than 2000

pages of translations of technical articles which originally appeared in the Russian literature, and 8 books and texts on the electrical methods of geophysical prospecting. He served as translation editor of the journal "Soviet Mining Science," published by Plenum Press from its inception in 1965 until 1994.During that period, he was responsible for supervisory editing of some 15,000 pages of technical articles originally published in Russian.

Most important among Prof. Keller's publications are 7 books dealing with the electrical geophysical methods.

One of these books became a classic reference and is regularly cited to this day. The book, first published in 1966, was co-authored with his colleague and friend from the USGS, Frank Frischknecht, and was titled "Electrical Methods in Geophysical Prospecting." Its popularity is emphasized by the fact that a second edition was published in 1982.

In 1994, Dr. Keller began research on the detection and identification of hand guns. This research led to the award of U.S. Patent 5552705 on September 3, 1996.

Dr. Keller's last position was president and chief scientist at StrataSearch Corp.

The last picture shows Dr. Keller with former grad students and friends at his 80th birthday party in 2007.

Pictures by HT Andersen, Steve Keller, KM Strack and CH Stoyer. Contributions by Steve Keller and CK Skokan. Editing and layout by CH Stoyer

Renew your EEGS Membership for 2012

Be sure to renew your EEGS membership for 2012! In addition to the more tangible member benefits (including the option of receiving a print or electronic subscription to JEEG, FastTIMES delivered to your email box quarterly, discounts on EEGS publications and SAGEEP registration, and benefits from associated societies), your dues help support EEGS's major initiatives such as producing our annual meeting (SAGEEP), publishing JEEG, making our publications available electronically, expanding the awareness of near-surface geophysics outside our discipline, and enhancing our web site to enable desired capabilities such as membership services, publication ordering, and search and delivery of SAGEEP papers. New this year is an opportunity to donate to the EEGS Foundation during the renewal process. Members can renew by mail, fax, or online at www.eegs.org.

Sponsorship opportunities

There are always sponsorship opportunities available for government agencies, corporations, and individuals who wish to help support EEGS's activities. Specific opportunities include development and maintenance of an online system for accessing SAGEEP papers from the EEGS web site and support for our next SAGEEP conference, to be held in Denver Colorado in 2013.

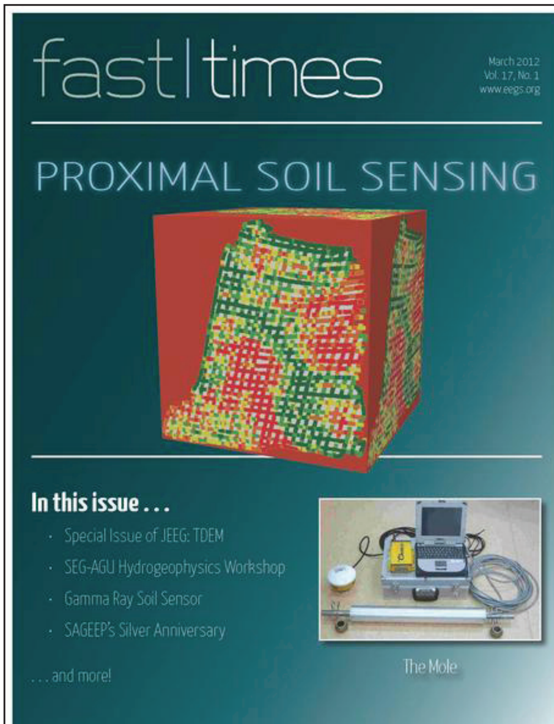
Make this the year your company gets involved! Contact Doug Laymon (doug.laymon@tetratech.com) for more information.

FROM THE FASTTIMES EDITORIAL TEAM

FastTIMES is distributed as an electronic document (pdf) to all EEGS members, sent by web link to several related professional societies, and is available to all for download from the EEGS web site at http://www.eegs.org/PublicationsMerchandise/FASTTIMES.aspx. Our most recent issue has been downloaded more than 11,000 times as of May 2012, and past issues of FastTIMES continually rank among the top downloads from the EEGS web site. Your articles, advertisements, and announcements receive a wide audience, both within and outside the geophysics community.

To keep the content of FastTIMES fresh, the editorial team strongly encourages submissions from researchers, instrument makers, software designers, practitioners, researchers, and consumers of geophysics—in short, everyone with an interest in near-surface geophysics, whether you are an EEGS member or not. We welcome short research articles or descriptions of geophysical successes and challenges, summaries of recent conferences, notices of upcoming events, descriptions of new hardware or software developments, professional opportunities, problems needing solutions, and advertisements for hardware, software, or staff positions.

The FastTIMES presence on the EEGS web site has been redesigned. At http://www.eegs.org/PublicationsMerchandise/FASTTIMES.aspx, you'll now find calls for articles, author guidelines, current and past issues, and advertising information.



Submissions

The FastTIMES editorial team welcomes contributions of any subject touching upon geophysics. The theme for our next issue will be the development and application of geophysical techniques for proximal soil sensing. FastTIMES also accepts photographs and brief non-commercial descriptions of new instruments with possible environmental or engineering applications, news from geophysical or earth-science societies, conference notices, and brief reports from recent conferences. Please submit your items to a member of the FastTIMES editorial team by August 21 to ensure inclusion in the next issue. We look forward to seeing your work in our pages.

JEEG NEWS AND INFO

The Journal of Environmental & Engineering Geophysics (JEEG), published four times each year, is the EEGS peer-reviewed and Science Citation Index (SCI®)-listed journal dedicated to near-surface geophysics. It is available in print by subscription, and is one of a select group of journals available through GeoScienceWorld (www.geoscienceworld.org). JEEG is one of the major benefits of an EEGS membership. Information regarding preparing and submitting JEEG articles is available at http://jeeg.allentrack.net.


Journal of Environmental & Engineering Geophysics

June 2012 Volume 17 Issue 2

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The Environmental and Engineering Geophysical Society

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Editor's Scratch

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The Journal of Environmental and Engineering Geophysics (JEEG) is the flagship publication of the Environmental and Engineering Geophysical Society (EEGS). All topics related to geophysics are viable candidates for publication in JEEG, although its primary emphasis is on the theory and application of geophysical techniques for environmental, engineering, and mining applications. There is no page limit, and no page charges for the first ten journal pages of an article. The review process is relatively quick; articles are often published within a year of submission. Articles published in JEEG are available electronically through GeoScienceWorld and the SEG's Digital Library in the EEGS Research Collection. Manuscripts can be submitted online at www.eegs.org/jeeg/index.html.

EAGE's Near Surface Geophysics Journal, June 2012

As a courtesy to the European Association of Geoscientists and Engineers (EAGE) and the readers of FastTIMES, we reproduce the table of contents from the December issue of EAGE's Near Surface Geophysics journal.

EAGE
EUROPEAN ASSOCIATION OF GEOSCIENTISTS & ENGINEERS

Near Surface Geophysics

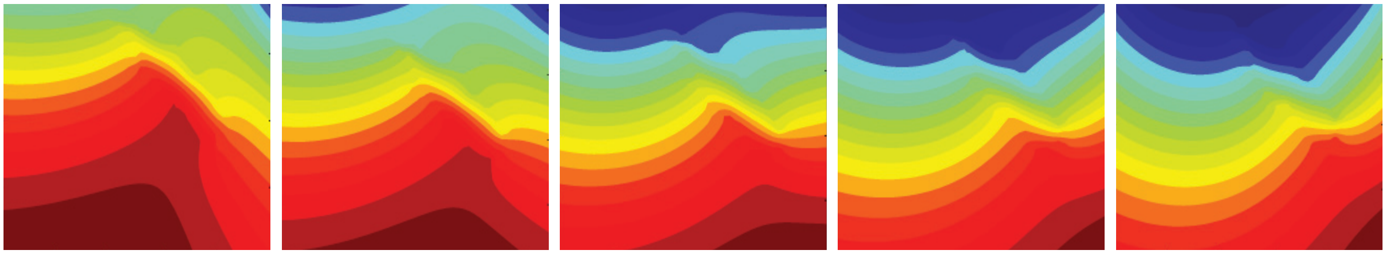
Volume 10 · Number 3 · June 2012

Content

www.nearsurfacegeophysics.org

SUCCESS WITH GEOPHYSICS

FastTIMES welcomes short articles on applications of geophysics to the near surface in many disciplines, including engineering and environmental problems, geology, soil science, hydrology, archaeology, and astronomy. In the articles that follow, the authors present examples of electrical techniques to near surface investigations.



TIME-LAPSE CROSS-WELL SEISMOELECTRIC TOMOGRAPHY

M. KARAOULIS (1), A. REVIL (1, 2), A. JARDANI (3)

Cross-hole seismoelectric measurements consist in triggering seismic sources in one borehole sequentially and measuring the electrical and seismic response in another borehole or in a set of boreholes. For each shot, in the seismoelectric time-window comprised between the time of the shot and the time of the first arrival of the seismic waves, the seismoelectric signals correspond only to seismoelectric conversions at local heterogeneity of the properties of the porous material located between the wells. These electrical anomalies can be inverted to detect the location of the heterogeneities using a focusing method for the source current density combined with an Active Time Constraint (ATC) approach. This time-lapse compact source inversion in 2.5 D is applied here for the first time to a sequence of synthetic shots and the source current density stacked in order to image the seismoelectric conversions occurring between the wells. Applications would concern dynamic imaging between two wells during remediation or the production of oil and gas reservoirs..

(1) Colorado School of Mines, Dept. of Geophysics, Golden, CO, USA.
(2) ISTerre, CNRS, UMR 5559, Université de Savoie, Equipe Volcan, Le Bourget du Lac, France.
(3) Université de Rouen, M2C, UMR 6143, CNRS, Morphodynamique Continentale et Côtière, Mt Saint Aignan, France.

INTRODUCTION

Seismoelectric measurements has been shown to be an effective method to detect heterogeneities between boreholes [Zhu and Toksöz, 1998; Mikhailov et al., 2000; Zhu and Toksöz, 2003; Hu et al., 2007; Dupuis et al., 2009] but no algorithm is presently available to perform the inverse problem. The seismoelectric method consists of measuring two types of electrical fields associated with the propagation of seismic waves through a porous material: One of these fields is related to the conversion of mechanical-to-electromagnetic energy at heterogeneity characterized by gradients or drops in the mechanical or electrical properties. The resulting field is called the seismoelectric field or the interfacial electrical field response. The second type of electrical disturbance corresponds to the co-seismic electrical field traveling at the same speed than the seismic P, slow P and S-waves.

We propose an algorithm to perform the inversion of seismoelectric conversion when a set of seismic sources detonated successively in one well and the electrical field is recorded in a second well (or a set of wells) before the arrival of the seismic waves. The shape reconstruction of heterogeneity between two wells may be possible through the seismic method alone in the case where the heterogeneities are due to the contrasts in the seismic velocity. That said, the seismoelectric method is sensitive to heterogeneities in both seismic and electrical parameters of the porous medium.

In the present paper, we consider the case of a single heterogeneity located between two wells. We use the time-lapse seismoelectric field for a set of seismic sources to reconstruct the shape of this heterogeneity between the two wells and we discuss the result.

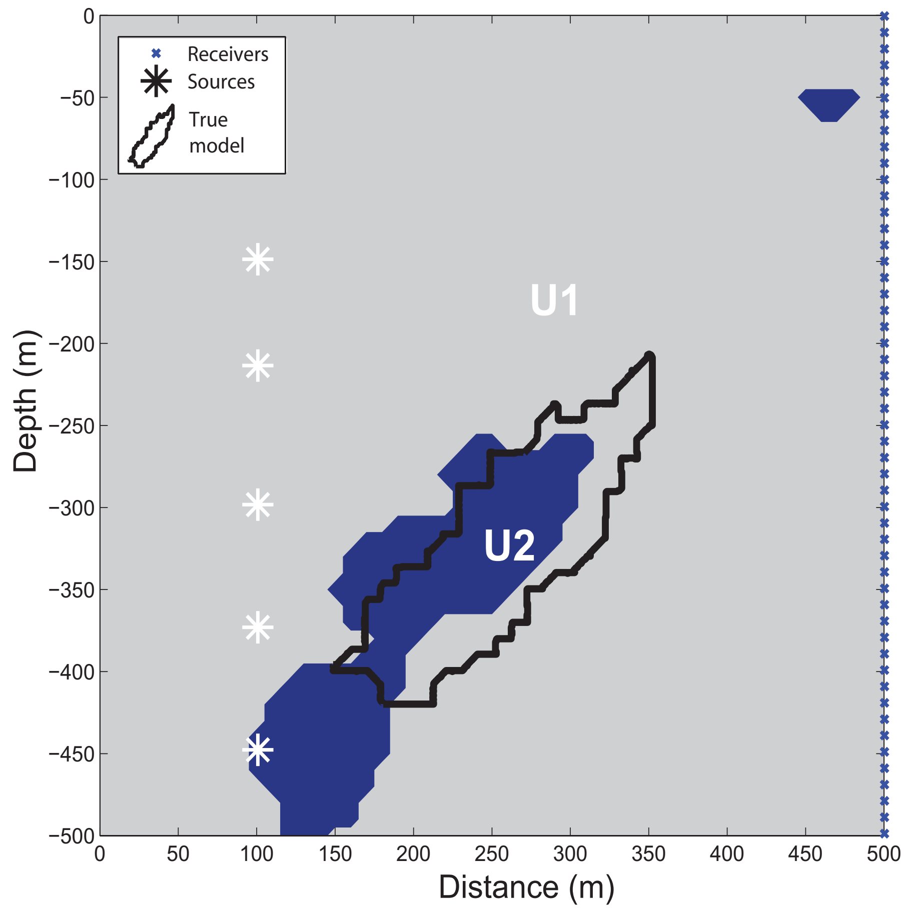


Figure 1. Domain of 500m x 500m. On each side, an extra layer of 50m (not shown in figure) is considered with PML boundary conditions (absorbing the seismic wave). Borehole #1 is located at x=100m, and 5 seismic sources are considered. Borehole #2 is placed on x=500m, and 50 receivers (electrodes and geophones are considered), placed every 10m. Geometry properties for the two units are provided in Table 1. The true position of the heterogenity U2 is shown by the thick black line. The aggregated source localization in shown in blue using the combined information from the six time lapse compact inversion.

THEORY

The isotropic and isothermal poroelastic problem can be expressed in term of the displacement of the solid phase $\mathbf{u}$ and in terms of the fluid pressure p [Jardani et al., 2010]:

$$-\omega^2\rho_\omega^s\mathbf{u}+\theta_\omega\nabla p=\nabla\cdot\hat{\mathbf{T}}+\mathbf{F} \quad (1)$$

$$\hat{\mathbf{T}}=\lambda(\nabla\cdot\mathbf{u})\mathbf{I}+G[\nabla\mathbf{u}+\nabla\mathbf{u}^T] \quad (2)$$

$$\mathbf{T}=\hat{\mathbf{T}}-\alpha p\mathbf{I} \quad (3)$$

$$\frac{1}{M}p+\nabla\cdot\{k_\omega[\nabla p-\omega^2\rho_f\mathbf{u}]\}=\alpha\nabla\cdot\mathbf{u} \quad (4)$$

where $j^2 = -1$ (j represents the pure imaginary number), $\omega = 2\pi f$ is the angular frequency in $\mathrm{rad.s^{-1}}$ (f is the frequency in Hertz), $\mathbf{F}$ is the body force on the elastic solid phase (in N), $\mathbf{T}$ is the stress tensor (in Pa), λ denotes the drained Lamé modulus of the porous material (in Pa), ρ^s_ω corresponds to the apparent mass density of the solid phase at a given angular frequency ω (in kg m^{-3}), and M is one of Biot's moduli (in Pa). The stress tensor in Equation (2) corresponds to the stress tensor with the porous material placed in vacuum, while Equation (3) describes the relationship between the total stress tensor and the effective stress tensor. The material properties are given by $k_w=(w^2\tilde{\rho}_f+jwb)^{-1}$, $b=\eta_f/k_0$, $\tilde{\rho}_f=\rho_f/F$, and $\lambda=K-(2/3)G$, where K denotes the bulk (drained) mudulus) and G the shear mudulus of the porous material, $\alpha=1-K_{fr}/K_s$, $\rho_\omega^s=\rho-w^2\rho_f^2k_w,\theta_w=\alpha-\omega^2\rho_fk_w,\rho=\phi\rho_f+(1-\phi)\rho_s$and $M=K_fK_s[K_f(1-\phi-K_{fr}/K_s)+\phi K_s]^{-1}$, where k_ω is a frequency-dependent transfer function, η_f denotes the dynamic viscosity of the pore fluid (in Pa s), k_0 denotes the DC-permeability (in m^2), ϕ denotes the connected porosity, K_{fr} represents the bulk modulus of the dry porous frame (in Pa), K_f is bulk modulus of the pore fluid (in Pa), K_s denotes the bulk modulus of the solid phase (in Pa), ρ represents the mass density of the saturated porous medium (in kg m^{-3}), ρ_f and ρ_s denotes fluid mass density and the solid mass density respectively (in kg m^{-3}), $\tilde{\rho}_f$ is an effective fluid density, F is the electrical formation factor, and ρ^s_ω corresponds to the apparent mass density of the solid phase at a given frequency ω (in kg m^{-3}). To compute the value of F, we use Archie's law $F = \phi^{-m}$, with m, the cementation exponent, taken equal to 2 by default.

The exact form of the partial differential equations resulting from Eqs. (1) to (4) to solve numerically with finite element approach for two unknown fields $\mathbf{u}$ and p in the water saturated case can be found in Jardani et al. [2010] and will not be repeated here. These boundary conditions express the continuity in the solid displacement, the pore fluid pressure, the fluid displacement, the momentum flux, and the tangential components of the electrical field across an interface. The poroelastic seismic forward modeling code based on the previous equations has been benchmarked by Jardani et al. [2010].

The mechanical-to-electromagnetic conversion is based on the electrokinetic theory developed by Revil and Linde [2006] and used for the seismoelectric problem by Jardani et al. [2010] and Revil and Jardani [2010]. We also assume that the electromagnetic diffusion can be neglected and we treat the electrical problem as quasistatic, an approximation that is perfectly justified for cross-well problems as discussed in Jardani et al. [2010]. With these assumptions, the electrical potential ψ is governed by a Poisson equation:

$$\nabla\cdot(\sigma\nabla\psi)=\mathfrak{F} \quad (5)$$

where $\Im(\mathbf{r},w)=\nabla\cdot\mathbf{j}_s(\mathbf{r},w)$ is a volumetric source term and the source current density (in A m^{-2}) resulting from the mechanical-to-electric conversion is given by:

$$\mathbf{j}_s=\overline{Q_v}\dot{\mathbf{w}}=-jw\overline{Q_v}k_w(\nabla p-w^2\rho_f\mathbf{u}) \quad (6)$$

where $\mathbf{E}=-\nabla\psi$ denotes the (quasi-static) electrical field (in V m^{-1}), σ represents the electrostatic potential (in V), ψ represents the electrical conductivity of the porous rock (in S m^{-1}), and $\overline{Q}_V$ (in C m^{-3}) denotes the excess of electrical charges in the pore space of the porous material.

FORWARD MODELING

We consider the case of an heterogenous inclusion located between two wells as shown in Figure 1. The forward seismoelectric problem is performed with the finite-element package COMSOL Multi-physics 3.5a. The problem specification in COMSOL comprises the following steps: (1) formulating the semi-coupled field equations describing the dynamic poroelastic problem and the associated electric disturbances, (2) defining the geometry of the model, (3) specifying the model parameters, (4) designing the rectangular mesh, (5) selecting the parameters of the boundary layer conditions (we use Perfected Matched Layer PML as boundary conditions, see Jardani et al. [2010] for further details), and (6) solving the partial differential field equations. The problem is solved in 2.5 D.

We use the stationary parametric solver PARDISO (http://www.pardiso-project.org/) to solve the poroelastic wave propagation problem in the frequency domain. This solver is used to determine the distribution of u_x, u_z, p as a function of space and stored in time domain after inverse Fourier transform. Then we compute the quasi-static scalar potential ψ by solving the Poisson equation coupled to the solution of u_x, u_z, p by its source term. The solution in the time domain is computed using an inverse-Fourier transform. In the frequency domain, we solve the partial differential equations from 1 to 100 Hz with a step of 1 Hz. The six seismic sources shown in Figure 1 are detonated sequentially in Borehole #1. Meanwhile, seismic and electrical data are recorded for each individual seismic shot. Table 1 represents the material properties of media U1 and U2 used in the model.

Figure 2 shows some snapshots of the seismic waves, the associated electrical current density and the resulting voltage at Electrode #25 in Borehole #2. A movie showing the wave propagation and the generation of the electrical signals is provided at the end of the article.

Parameter	Description	Unit U1	Unit U2
σ	Conductivity of the medium	0.1 S m^{-1}	0.001 S m^{-1}
$\bar{Q}_V$	Excess of charge per unit pore volume	3090 C m^{-3}	1585 C m^{-3}
ρ_s	Bulk density of the solid phase	2650 kg m^{-3}	2650 kg m^{-3}
ρ_f	Bulk density of the fluid phase	1000 kg m^{-3}	983 kg m^{-3}
ϕ	Porosity	0.10	0.33
K_s	Bulk modulus of the solid phase	6.9x10^9 Pa	37x10^9 Pa
K_f	Bulk modulus of the fluid phase	0.25 x10^9 Pa	2.40 x10^9 Pa
G	Shear modulus of the frame	3.57x10^9 Pa	5x10^9 Pa
K_{fr}	Bulk modulus of the frame	6.89x10^9 Pa	9.60x10^9 Pa
k_0	DC permeability	10^{-16} m^2	10^{-11} m^2
η_f	Dynamic viscosity of the pore fluid	10^{-3} Pa s	10^{-1} Pa s

Table 1. Material properties for the numerical simulation corresponding to the case study (U2 denotes the inclusion and U1 the homogeneous background).

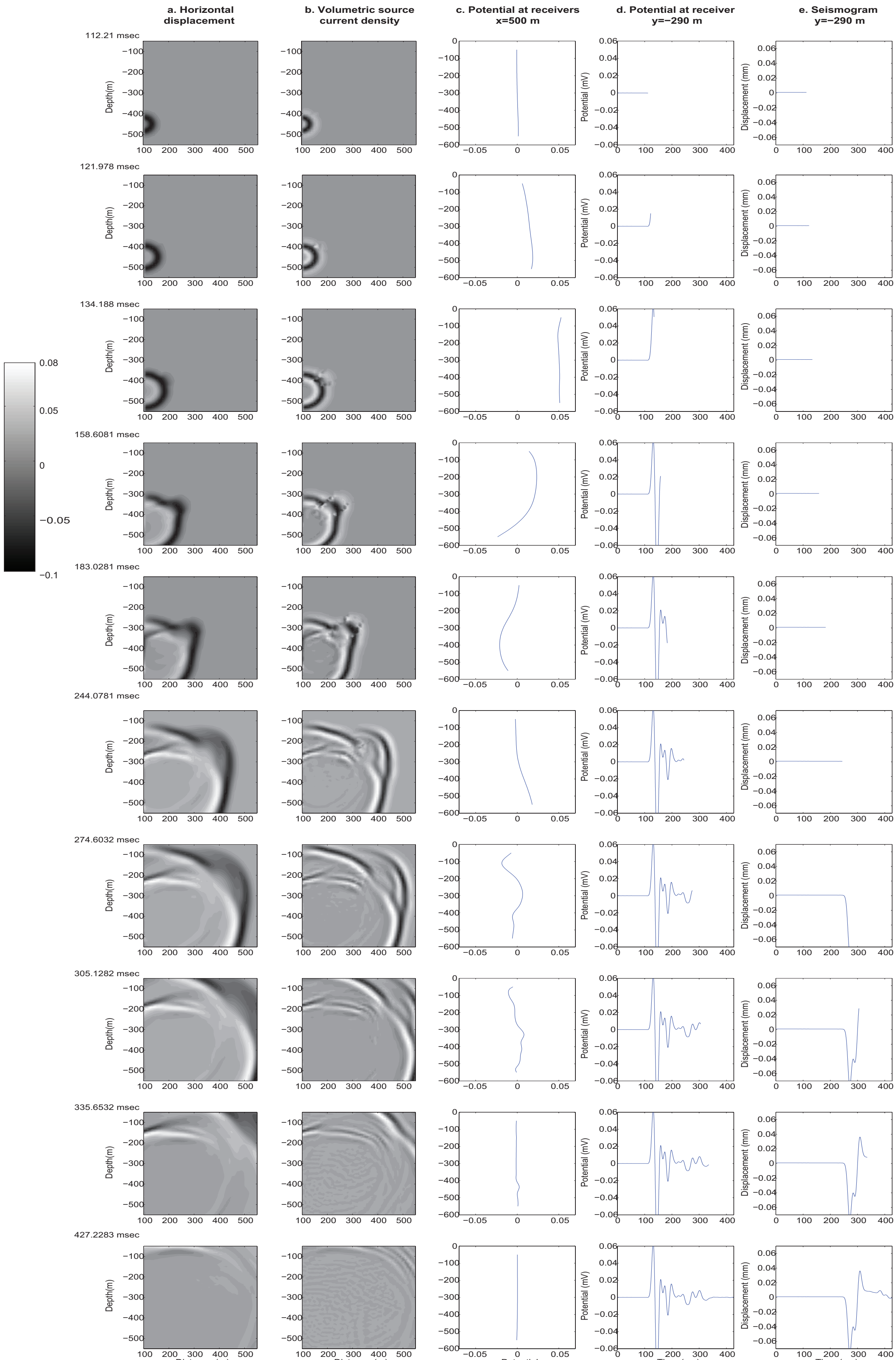


Figure 2. Snapshots of the seismic wave propagating to the medium (a) and the coresponding volumetric current density (b). Potentials recodered at all receivers placed at x=500 meters (c). Response of a receiver (x=0, y=-290m) that records potentials (d) and the coresponding response of the geophone on tha same location (e).

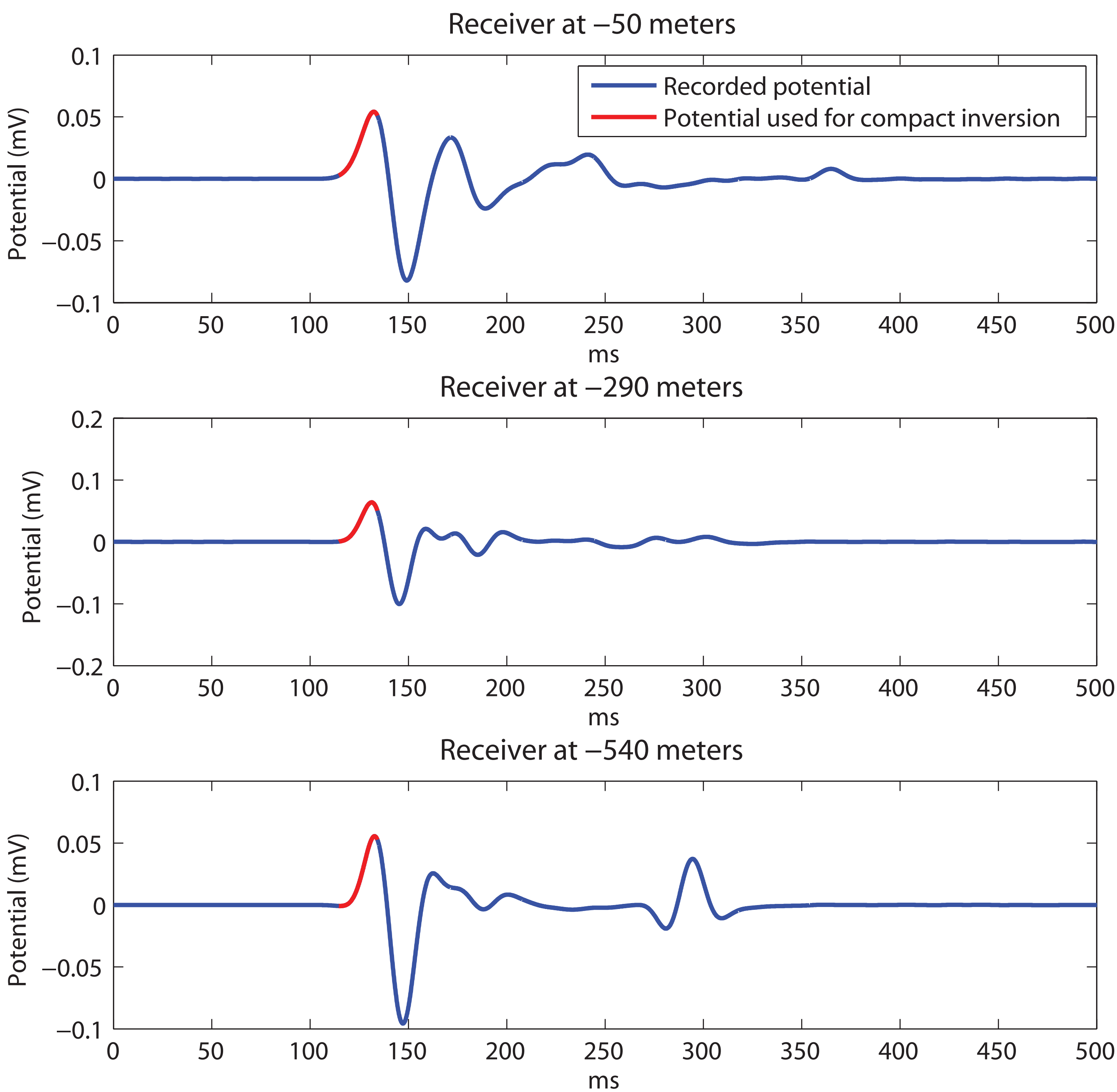
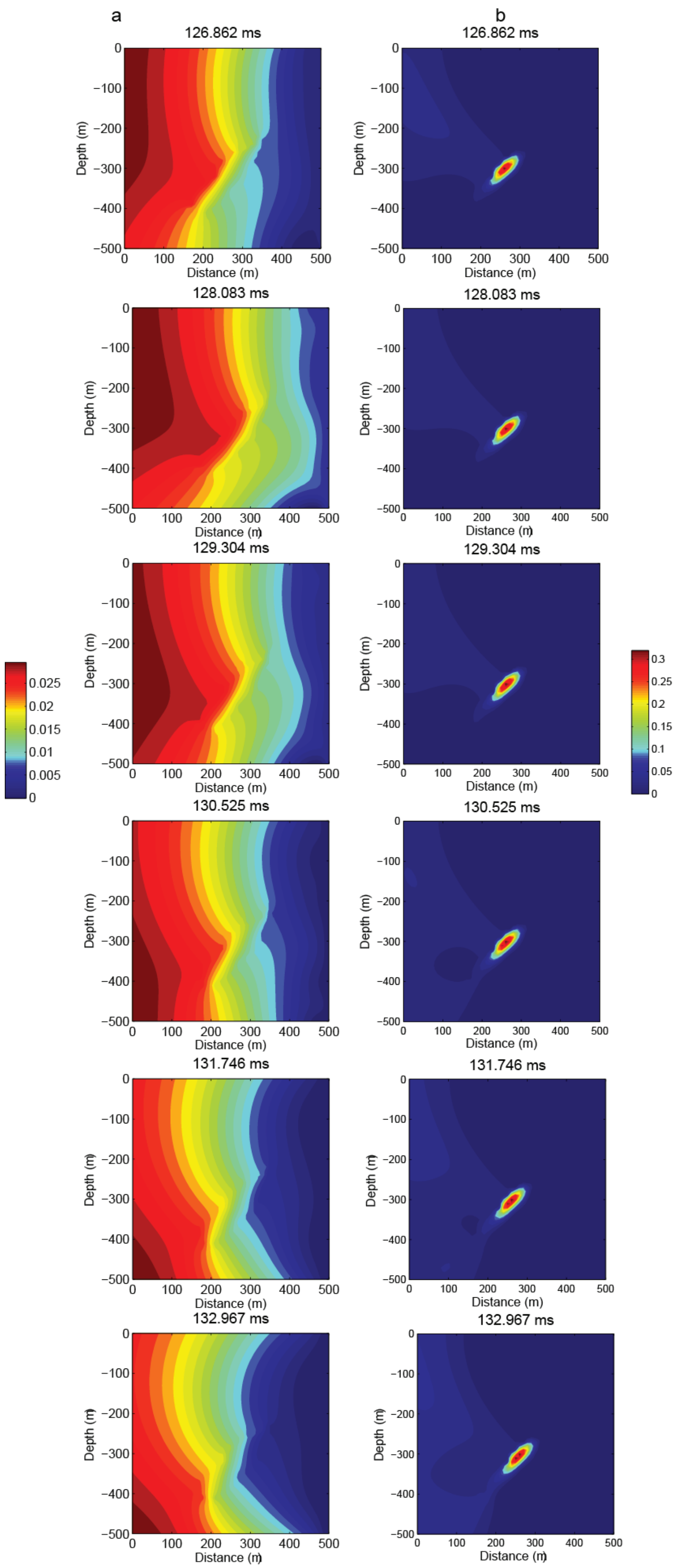


Figure 3. Recorded potential at three receivers (blue line), and potentials used for time lapse compact inversion (red line). The choice is based on the first time the seismic wave is hitting the inclusion.



INVERSE MODELING

At each time in the SC-time window and for each shot, we use the electrical potential distribution recorded on the array of electrodes located in the second well in order to find the position of the current source generated through the seismoelectric conversions between the two wells. Our goal is to develop an algorithm to invert these voltages to recover the position $\mathbf{r}$ and the amplitude of volumetric current source $\Im(\mathbf{r}, t)$. At each time step, the seismic waves impinging on the interface are responsible for the source current density, which has compact support (i.e., the spatial distribution of sources at any given time is very sparse). Therefore, the algorithm we use below is based on compactness as a regularization tool as developed for the self-potential source inversion problem by Minsley et al. [2007a, b]. The governing equation of the forward electrical model can be written at each time step as,

$$\mathbf{K}\varphi(r,t) = s(r,t) \quad (7)$$

where $\mathbf{K}$ is the sensitivity matrix depends on the distance source-receiver and the distribution of the electrical resistivity, **s (r,t)** is a vector containing the M source current density terms $\Im(\mathbf{x}, t)$, and $\varphi(\mathbf{r,t})$ is the vector of electric potential observations at the N receivers locations and in time t. The sources, **s (r,t)**, can be theoretically be calculated if $\varphi(\mathbf{r,t})$ is known completely, but the data are only sampled at a set of receiver locations. The number of receiver locations is much less than source density terms *(N<<M)*, therefore only a subset of rows $\mathbf{K}$ is used, selected by the N by M matrix operator $\mathbf{P}$. The matrix $\mathbf{P}$ is a selector matrix (see Minsley et al [2007]), and therefore the new sensitivity matrix for the electrical potential inverse problem is described as $PK^{\blacklozenge}$, where $K^{\blacklozenge}$ denotes the matrix K^{-1}.

As the seismic wave propagates in the medium

Figure 4. a. Time-lapse inversion of initial solution (diffusive solution). b. Time lapse inversion if compact source location. Since only the first arrivals is used, the compact source inversion shows current density sources belonging to the the inclusion body in the areas first impacted by the seismic wave. It is important to notice, that due the Fresnel zone, an interface is acting as a distributed current source rather than just as a single point source.

and hits the interface of the heterogeneity at different positions generating source current densities, which in turn generate measurable electrical potential fluctuations at the receivers. Therefore in our approach, we define the source locations as a function of space and time, and the inversion algorithm is able to adopt two regularizations, one in space and one time. The time lapse model and the data are described as $\hat{s} = [s_1, s_2, \cdots, s_t]^T$ and $\varphi_d = [\varphi_1, \varphi_2, \cdots, \varphi_t]^T$, respectively, t being the number of time steps for one seismic shot and comprised inside the STW. The kernel matrix is written as,

$$\mathbf{PK}^{\blacklozenge} = \mathrm{diag}[\mathbf{PK}_1^{\blacklozenge}, \mathbf{PK}_2^{\blacklozenge}, \cdots, \mathbf{PK}_t^{\blacklozenge}] \tag{8}$$

where $\mathbf{PK}_i^{\blacklozenge}$ is the sensitivity matrix for time-step i, as described previously. The predicted data are written as $\varphi_p = \mathbf{PK}^{\blacklozenge} * \mathbf{S}$. The error vector is written as $e = \varphi_d - \varphi_p$. The cost function G to minimize is written as (Zhang et al., 2005; Kim et al., 2009),

$$G = \left\| e^T e \right\|^2 + \lambda \Psi + \alpha \Gamma \tag{9}$$

where Ψ is and Γ are the spatial and temporal regularizations, and λ and α the corresponding Lagrange values. Ψ and Γ defined as,

$$\Psi = \mathrm{diag}[\Psi_1, \Psi_2, \cdots, \Psi_t] \tag{10}$$

$$\Psi_i = \lambda \sum_{k=1}^{2} \frac{S_k^2}{S_k^2 + \beta^2} \tag{11}$$

$$\Gamma = \sum_{i=1}^{t-1} \left\| S_{i+1} - S_i \right\|^2 \tag{12}$$

where s_k an element of vector S_i, β is a compact parameter, M is the number of possible source location, within one time step. Minimizing G with respect to the model vector yields the following equations,

$$\begin{aligned}(\Omega_{j-1}^{-1}\mathbf{PK}^{\blacklozenge T}\mathbf{W}_d^T\mathbf{W}_d\mathbf{PK}^{\blacklozenge}\Omega_{j-1}^{-1} + \lambda\mathbf{I} + \alpha\mathbf{M}^T\mathbf{M})\mathbf{S}_{w,j} \\ = \Omega_{j-1}^{-1}\mathbf{PK}^{\blacklozenge T}\mathbf{W}_d^T\mathbf{W}_d\varphi_d - \alpha\mathbf{M}^T\mathbf{M}\mathbf{S}_{w,j-1}\end{aligned} \tag{13}$$

$$\mathbf{S}_j = \Omega^{-1}\mathbf{S}_{w,j} \tag{14}$$

where j is the compact inversion iteration number (we found that for point sources j = 7 iterations provides always a suitable result in terms of source convergence), $\mathbf{M}$ is a square matrix where one diagonal and one sub-diagonal have values 1 and -1 accordingly, $\mathbf{W}_d$ denotes the data weighting matrix (determined according to the standard deviation on the data), $\Omega = \mathrm{diag}[\Omega_1, \Omega_2, \cdots, \Omega_t]$ is a matrix containing the sensitivity scaling and minimum support regularization, and is expressed as,

$$\Omega_i = \mathrm{diag}\left\{ \frac{\Lambda_{kk}^2}{S_{k_{(j-1)}}^2 + \beta^2} \right\} \tag{15}$$

$$\Lambda = \mathrm{diag}\sqrt{\sum_{j-1}^{N} PK_{tkj}^{*T2}} \tag{16}$$

The vector Λ represents an inverse-sensitivity weighting function that accounts for distance from the receivers as well as the resistivity structure. In the following, we consider $\mathbf{W}_d$ to be diagonal with each element on the diagonal being the inverse of the estimated variance of the measurement errors. A sensitivity analysis of the problem is shown here. The electrical potential data are contaminated by a Gaussian noise with a standard deviation of 5% of the computed data mean. We consider 5 snapshots comprised into the seismoelectric time window to perform the inversion for each seismic source. The value of β is 10^{-7} (compact solution), the time-regularization parameter is $\alpha = 10^{-2}$ and the Lagrange parameter is found using the L-curve method. The most important parameter in the inversion is the β-parameter that controls the compactness of the source. It is advisable to start with a small number, based on analysis of the diffusive solution, and increase the number of compact source iterations. The parameter λ controls the stability of the inversion, and it is strongly depended on the noise of the data . We use the L-curve to estimate an optimum value of λ. The parameter α is an extra regularization in the inverse problem, It is on the same order of magnitude with λ parameter.

Figure 3 shows the recorder potential for three characteristic receivers (up, middle, and down), when the source is located at a depth of 370 m. In this approached, we used only the first arrivals of the potential to the self-potential inversion. Figure 4a shows the inverted source location before the compact source localization, while Figure 4b shows the compact solution after 7 iterations. Since only the first arrivals is used, the source is localized on the surface of inclusive body.

The result of the inversion is shown in Figure 1 (blue color). An aggregated solution is chosen, by keeping all source location above that threshold.

CONCLUSIONS

We have developed the first inversion algorithm to perform cross-hole seismoelectric inversion. The algorithm is tested on a numerical case consisting of an inclusion embedded into an homogeneous material. Using only the electrical field in the second borehole, we are able to find the shape of the heterogeneity. The next step will be to perform a joint inversion of the resistivity, seismic, and seismoelectric data and to combine the deterministic inversion proposed in the present paper with the stochastic inversion proposed in Jardani et al. [2010].

ACKNOWLEDGEMENTS

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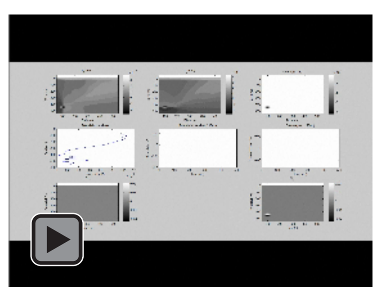
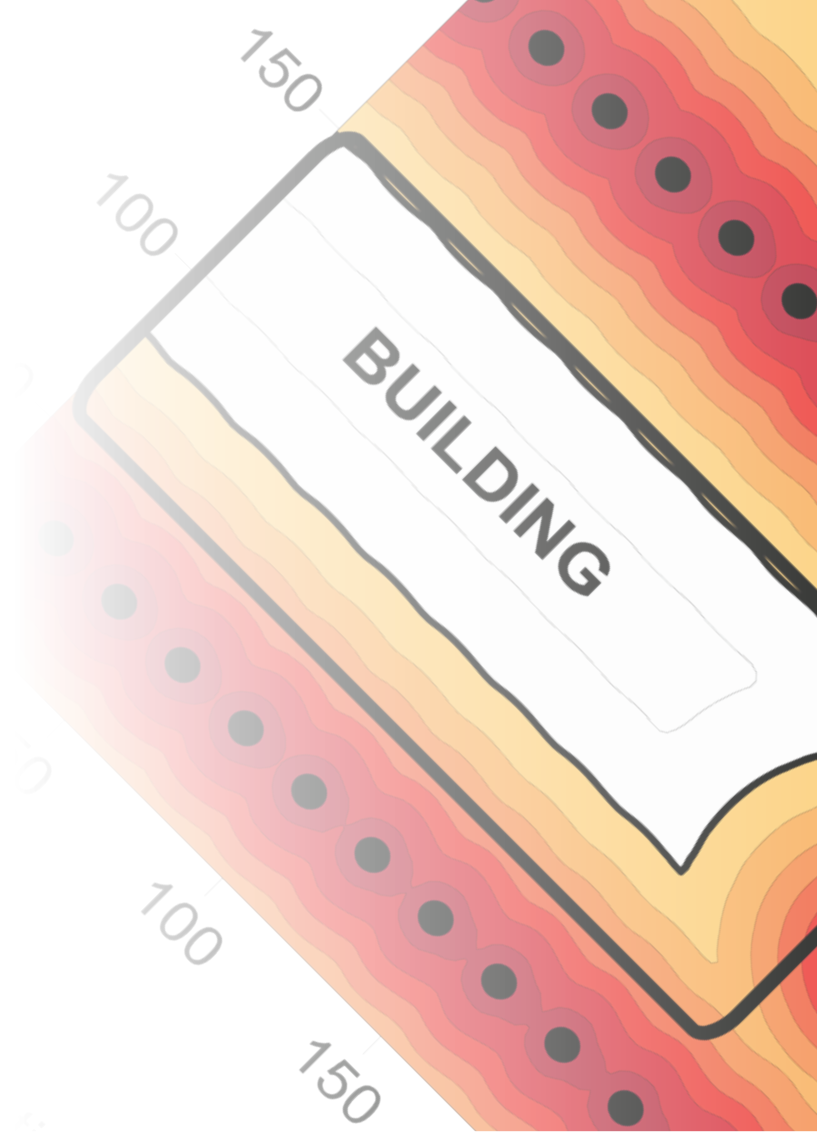


Wave Propagation and Electric Field Generation (right-click to view in full-screen)



A SIMPLE APPROACH TO ASSESS THE SPATIAL COVERAGE OF A MICROGRAVITY SURVEY

RONALD D. KAUFMANN[1] AND DWAIN K. BUTLER[2]

When presenting the results of a microgravity survey to an engineering client or other end-user of the data, we are often asked about the spatial coverage of the survey. What percentage of the site is adequately sampled by the survey? How far out do you see from the gravity meter? After explaining that the answers to those questions depend on many factors such as depth of burial, density contrast, target size, target geometry, etc., the client is either confused or asleep. In order to better answer these questions, we present a simple graphical approach in defining the spatial coverage of a microgravity survey. We use microgravity data as an example, but the same approach could be applied to magnetic or other potential field data.

The spatial sampling and survey design for a microgravity survey are generally described in ASTM 6430-99 (ASTM, 2005). Factors such as the expected gravity response to targets of interest and the need for data at a given location are considered when planning a microgravity survey. Optimally, a grid of microgravity stations would equally cover the site with a sampling interval that is adequate to define the shallowest of targets. In reality, project budgets and surface obstructions limit the number of gravity stations and their placement within the site. Therefore, there is a need to assess the spatial coverage of the site, given the limited number of gravity stations and the targets of interest for the survey.

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TARGET RESPONSE

The gravitational response (or anomaly) to a given target can be modeled using well-known equations developed for three-dimensional shapes that simulate the target (Telford et al., 1976). Typical targets for a microgravity survey include features such as isolated cavities, horizontal karst conduits, and vertically-weathered fracture zones. When appropriate shapes such as spheres, cylinders, and planar sheets are modeled to simulate these features, the anomaly magnitude and width can be calculated for various depths and locations beneath the survey area.

In this example, we examine the response of an air-filled spherical void in rock. The gravity response (vertical component) due to the void depends on its density contrast, size, depth, and the measurement distance from the void as shown in the equation below:

g_z=8.5 ((σa^3))/(z^2 σ(1+x^2/z^2) σ^(3/2))

Where, g_z is the gravity response in μ Gals, σ is the density contrast in g/cm^3, α is the radius of the sphere, z is the depth to the center of the sphere and x is the lateral distance from the center of the sphere. Distances are in units of feet.

Figure 1 shows the response of an air-filled spherical void centered at depths of 20, 30, and 40 feet. The void has a density contrast of σ2.4 g/cm^3 (simulating an air-filled cavity in limestone) and a diameter of 20 feet. Based on this model and our minimum depth of interest, we decide that a 20-foot station spacing will adequately sample the target along our survey lines.

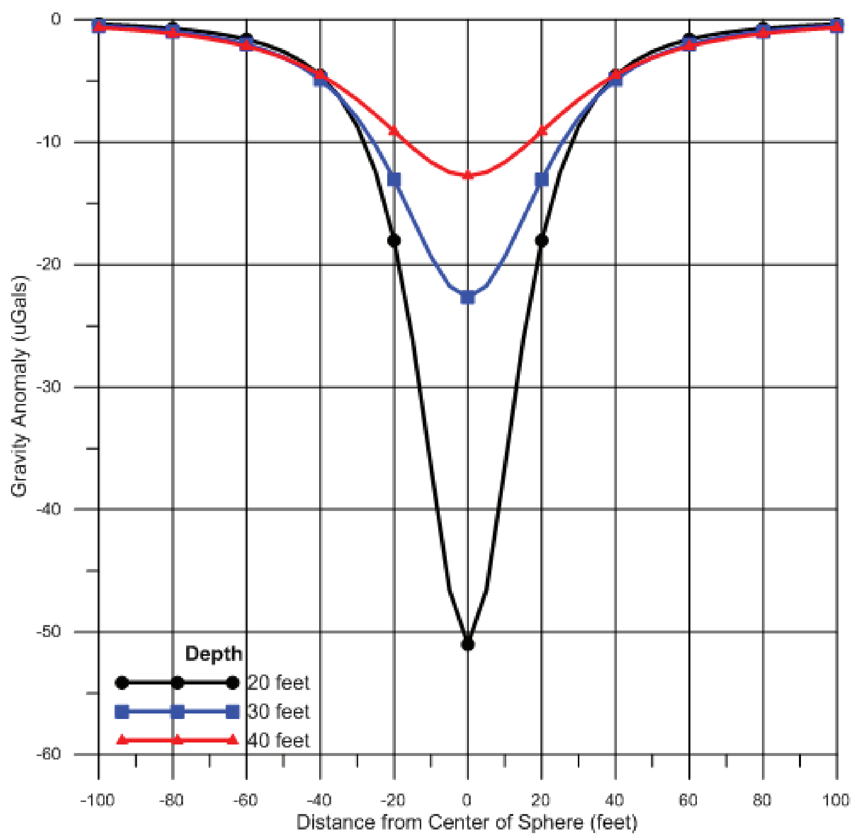

Figure 1. Gravity anomaly due to 20-ft diameter spherical void at various depths.

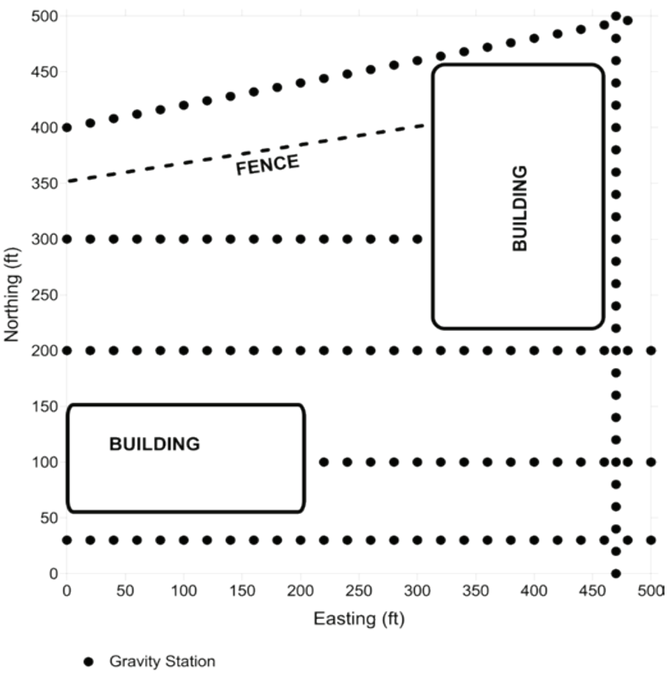

Figure 2. Microgravity survey line layout.

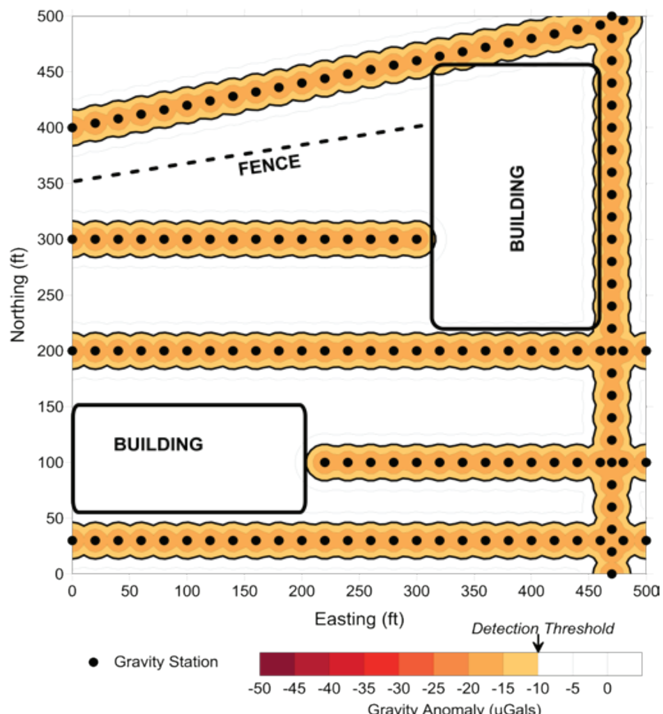

Figure 3. Maximum gravity anomaly for a 15-foot diameter spherical void at a depth of 20 feet.

SPATIAL COVERAGE

Based on the initial modeling, we would like to cover the site with a 20 x 20-foot survey grid for our gravity measurements. However, the site has some surface obstructions that will limit the placement of the survey lines and our budget restricts us to less than 150 stations. Therefore, we position survey lines in accessible areas of the site as shown in Figure 2.

The spatial coverage and detectability of targets within the survey area will be highly biased towards locations directly beneath the survey lines. What if our target lies between the survey lines? What portion of the survey area is adequately sampled for a given target? In order to help visualize the answers to these questions, we calculate the maximum magnitude of the anomaly if a given target is located at any position within the survey area and observed at the gravity stations as shown in Figure 2.

Figure 3 shows the maximum magnitude of a 15-foot diameter spherical void at a depth of 20 feet. The magnitude of the anomaly falls below the detection threshold (conservatively set at 10 QGals) at distances of approximately 17 feet from the gravity stations. Figure 4 shows the maximum magnitude of a larger 30-foot diameter spherical void at a depth of 40 feet. The magnitude of the anomaly falls below the detection threshold at a much greater distance of approximately 50 feet from the gravity stations.

APPLICATIONS

The plan-view representation of the maximum magnitude anomaly for a given target is a simple graphical means to assess the spatial coverage for the survey. It is a useful method to describe the spatial coverage to end-users of the data without over-complicating the issue. The method can also be used in the pre-planning stages of the survey to aid in survey line placement.

Figure 4 illustrates some important concepts in microgravimetry. Note that the 10-μGal detection threshold area extends significantly away from the survey lines and beneath the buildings. For very good site conditions coupled with very exacting microgravity survey procedures, the detection threshold can sometimes be lowered to 5 μGals, which for this case would extend the detection coverage to most of the areas covered by the buildings. Also, if the interiors of the buildings are accessible, microgravity measurements can easily be made within buildings, where other surface geophysical methods would be limited.

We note that this method is not entirely complete and neglects the spatial wavelength of the anomalies, which would have to be addressed separately as in Figure 1. Similar, but more complex, plan-view maps could be developed for features that extend along one axis such as a cave or tunnel. The method is certainly not a substitute for more complete forward and inverse models of subsurface conditions, but is meant to be a quick way to illustrate the answer to a complex question. Also, the method does not explicitly consider terrain corrections and corrections for manmade surface structures.

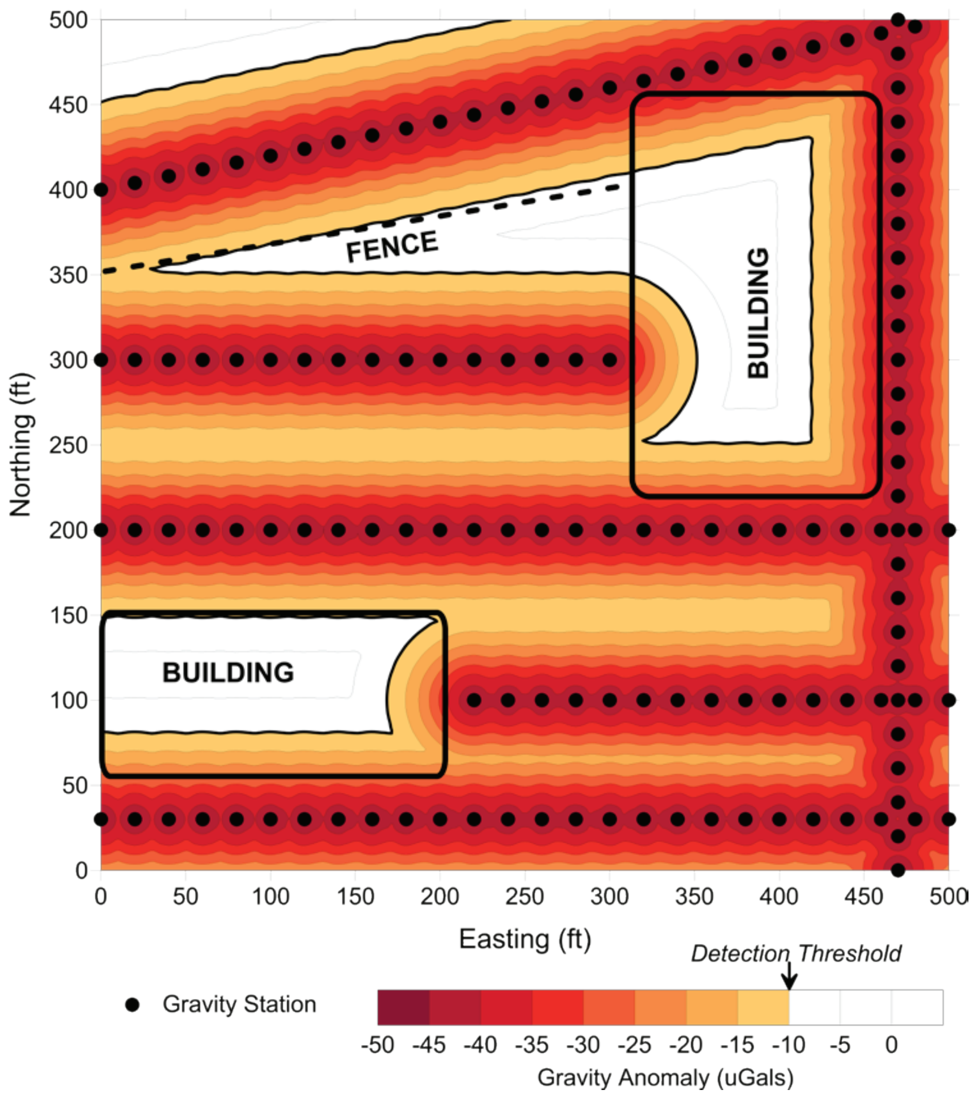

Figure 4. Maximum gravity anomaly for a 30-foot diameter spherical void at a depth of 40 feet.

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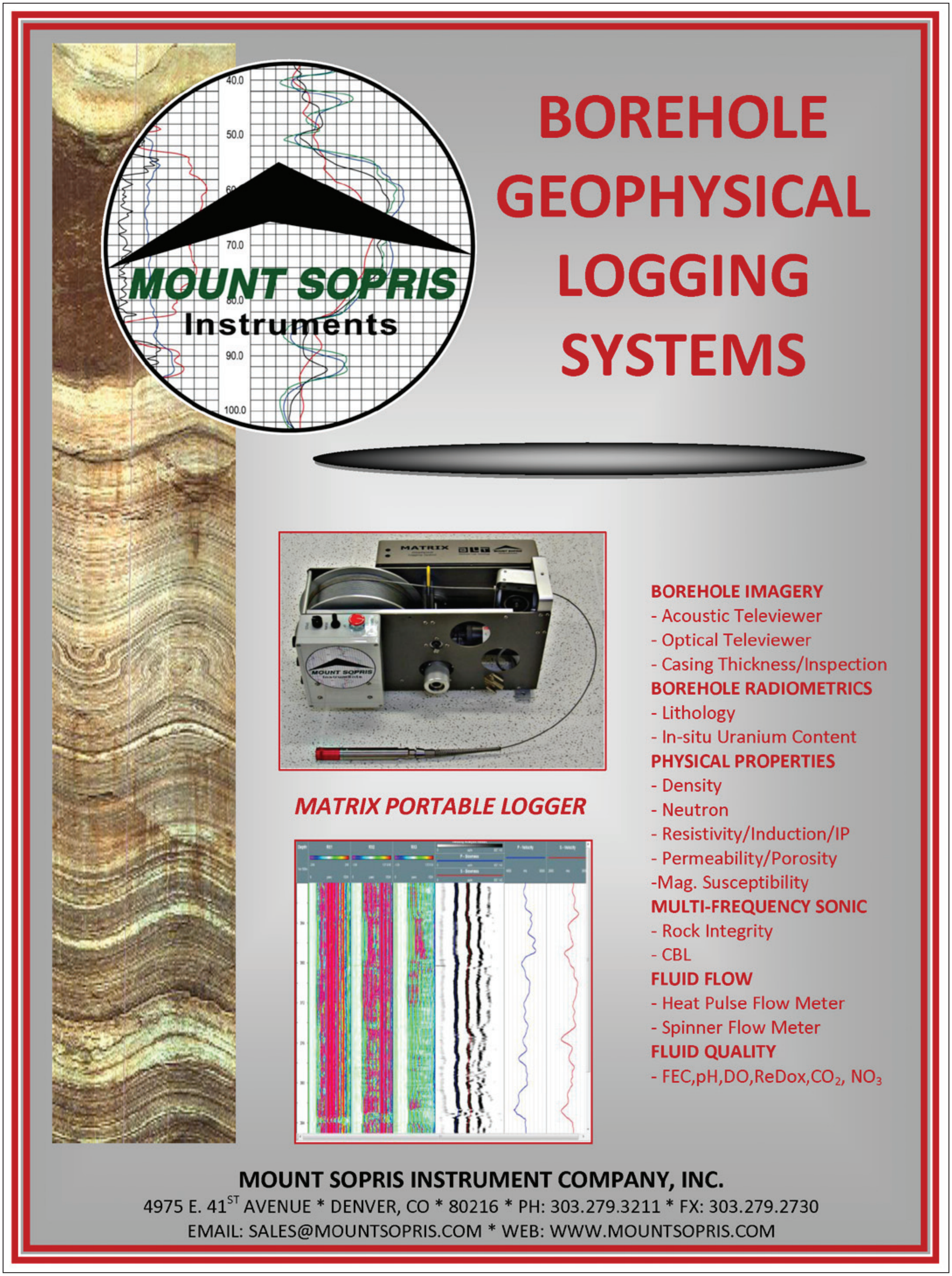
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EEGS and SEG/NSG Discuss Increased Cooperation

The spring of 2012 will mark the 25th anniversary of the SAGEEP conference and the 20th year of existence for EEGS. Both EEGS and the Near Surface Geophysics (NSG) Section of SEG have served the near surface geophysics community during a period of significant growth and technological advancements. These two organizations have had significant overlap in membership and mission. In recent years, these two organizations have worked together for the benefit of the discipline and their members. Examples include:

- Joint publication of at least two significant resources, the 2005 Near Surface Geophysics volumes and the recent "Advances in Near-Surface Seismology and Ground-Penetrating Radar" volume
- Online release of current and past issues of the Journal of Environmental and Engineering Geophysics and SAGEEP proceedings, through the EEGS Research Collection of the SEG Digital Library
- Board-level support ("Level 3") from SEG for special joint sessions at the 2011 and 2012 SAGEEP conferences
- EEGS Foundation's support of the SEG Foundation's Geoscientists Without Borders® program through a special luncheon at SAGEEP and other promotional activities.

Over the years, there have been numerous discussions between the two organizations about how to best serve the needs of the near-surface geophysical community. Recently, EEGS and the SEG have jointly created a task force to formally consider how the two organizations might better accomplish this. The committee has begun meeting and will make recommendations to their respective society board of directors and members. The committee members have been selected and sanctioned by the leaderships of both organizations. They are:

Peter Annan, Sensors & Software

John Bradford, Boise State University

William Doll, Battelle

Mark Dunscomb, Schnabel Engineering

Doug Laymon, Tetra-Tech

Rick Miller, Kansas Geological Survey

John Nicholl, URS

Peter Pangman, SEG

Bruce Smith, USGS

John Stowell, Mount Sopris

The committee has agreed that the first priority must always be to make recommendations that are in the best interest of the members and near surface geophysical community, as opposed to prioritizing organizational interests. As such, they will initially consider several key aspects of what makes an excellent near-surface organization, and review how these can best be addressed for the furtherance of the overall near surface geophysics community. These aspects include governance, publications, meetings/conferences, membership, student services, professional development, management, and finances. Several possible recommendations to members might result from the committee's assessment, for example: 1) no change from current level of interaction; 2) identification of new joint initiatives between the two organizations; 3) sharing responsibility for existing publications or meetings; 4) greater use of SEG by EEGS for publications or management; 5) formal reorganization of the relationship between EEGS and SEG/NSG, perhaps including some form of "merger". Each of these possible outcomes carries potential benefits and compromises that must be weighed carefully by the committee and by the members of each organization.

The committee has had short meetings at SAGEEP 2011 in Charleston and at the 2011 SEG Annual Meeting in San Antonio and has held several conference calls. A weekend meeting is scheduled for December 3-4 in Denver. We encourage members of both organizations to contact any of the committee members listed above to voice their opinions and offer suggestions to the committee.

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The Geophysicist responsibilities include:

Acquisition, processing, and analysis of precision ground and airborne magnetic and electromagnetic data

- Report writing and data archiving
- Field work in both domestic and foreign locations
- Support to new and ongoing geophysical research in sensor, systems, and algorithm development
- Participation in proposal writing, marketing, business development, and development/submission of technical publications and journal articles

THE FOLLOWING REQUIREMENTS MUST BE MET TO BE CONSIDERED FOR THIS POSITION:

- BS or MS in geophysics, engineering, earth science, or related discipline with a strong computational background
- Coursework with a record of solid academic performance in geophysics, earth science, physical science, and computational methods
- Coursework incorporating geophysical data processing, mathematical modeling, and computer language(s)/programming is preferred
- 1-5 years of relevant experience in geophysical surveying systems and methods, with magnetic and electromagnetic systems surveying preferred

- Willingness to travel up to 50% and support project field work in both domestic and foreign locations. Experience in providing support to U.S. Department of Defense (DoD) clients, including DoD's Military Munitions Response Program (MMRP), is preferred
- Demonstrated competence in Microsoft Office. Experience with geophysical/technical software packages including Geosoft Oasis montaj, Matlab, ArcGIS, and related utilities/scripts is preferred
- Ability to successfully pass medical screening, including the ability to lift up to 50 lbs
- Ability to pass Commercial Motor Vehicle training and associated medical exam
- Ability to pass HAZWOPER safety training and maintain HAZWOPER certification
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The EEGS / Geonics Early Career Award

Nomination Deadline: November 30, 2012

The Environmental and Engineering Geophysical Society and Geonics Limited are pleased to announce that nominations are now open for the 2013 EEGS / Geonics Early Career Award, which acknowledges academic excellence and encourages research in near-surface geophysics. The award is presented annually at SAGEEP to a full-time university faculty member who by the nomination deadline is:

- fewer than five years beyond the starting date of his or her current academic appointment;
- within ten years post-completion of his or her PhD.

The award acknowledges significant and ongoing contributions to the discipline of environmental and engineering geophysics. The recipient may have any specialty that is recognized as part of the environmental and engineering geophysics discipline. This specialty is not restricted to departments, colleges, or geographic regions (international applicants are welcome). A committee of four or five members (two or three university faculty, one corporate or consulting representative, and one government laboratory representative), appointed by the EEGS Board, is responsible for selecting the awardee.

The award carries the following benefits:

- Free registration to the SAGEEP conference at which the award will be presented
- A plaque, suitable for display
- A $1000 cash award
- A 30-minute time slot to present the awardee's research and vision at SAGEEP
- The citation and, if available, the awardee's presentation published in FastTIMES and distributed to cooperating societies

The awardee is expected to be present during the EEGS Luncheon at SAGEEP 2013 in Denver, Colorado. Nominations should be sent electronically to:

Dr. Jonathan Nyquist, Chair of the Early Career Award Committee
Temple University
1901 N 13th Street, Philadelphia, PA 19122-6081
Phone: 215-204-7484
nyq@temple.edu

Nomination packages must include:

- A comprehensive vitae for the candidate
- A letter of recommendation outlining the candidate's qualifications for the award
- Copies or PDF files of three representative publications

COMING EVENTS

FastTIMES highlights upcoming events of interest to the near-surface community.
Send your submissions to the editors for possible inclusion in the next issue.

SAGEEP 2013
General Chair
Michael H. Powers
mhpowers@usgs.gov

SAGEEP 2013
Technical Chair
Bruce D. Smith
bsmith@usgs.gov

Symposium Venue
Denver Marriott Tech Center
Denver Technological Center
Denver, Colorado USA

www.EEGS.org

Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP)

This year, SAGEEP will be held in Denver, Colorado during prime Rocky Mountain ski season from March 17-21. Our venue, at the Marriott Denver Tech Center in the business district south of downtown, is an excellent fit for all of our activities. Bruce Smith's enthusiastic technical program committee is building an interesting and unique program you will not want to miss. We look forward to a spacious, modern, and fully utilized exhibit hall, and plenty of comfortable places for two or twenty people to have a private conversation. Expect the schedule of activities to include the ice breaker, keynote and young scientist presentations, luncheons, conference dinner event, outdoor demos, workshops, and short courses.

Session proposals are now being accepted for SAGEEP 2013 (go to www.eegs.org and click on Annual Meeting/SAGEEP 2013). The deadline for all session proposals is Monday, September 10, 2012. Proposals will be reviewed by the Technical Program Committee on a rolling basis. A list of accepted sessions will be maintained at the SAGEEP 2013 web page (www.eegs.org/SAGEEP 2013). The number of sessions is limited so early submission is encouraged.

Save the Date!

"New Views of the Earth"
www.EEGS.org/SAGEEP 2013

Call for Session Proposals - Deadline September 10, 2012

Members of the near-surface geophysics community are invited to propose and chair a session for the 2013 Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP) to be held in Denver, Colorado, USA, March 17-21, 2013. Session proposals must focus on scientific results and/or their applications. The Program Committee will decline proposals that are considered to be too commercial, or have a focus other than scientific results. Each session must have two chairs. For proposed sessions that have only one chair, a slot will be left open for co-chair applications. Session chairs may be contacted by the Technical Program Committee with a request to edit, modify, or combine session content depending on the nature and number of submitted presentations. The Technical Program Committee will consider proposals on a rolling basis, so conveners will be notified of the status shortly after submission. Note: Session proposers may request poster or oral formats. The Technical Program Committee will attempt to honor all requests, but may not be able to honor all requests for oral sessions. Approved sessions will be published on the EEGS Web site (SAGEEP 2013-Sessions/Abstracts) and will appear on the list of sessions to which an author may submit an abstract. Each session will be allowed one invited presentation which may be allocated additional program time. The minimum number of papers (20 min.) in a session is 4.

Guidelines for Proposing a Session

Online Submission: Submit the proposal online to one primary discipline category (listed online). You may also identify secondary discipline categories. These will be used by the organizing committee to help promote your session and to help avoid conflicts during the development of the technical program schedule.

Title and Description: The Session Title should be presented in upper and lower case letters; e,g, Mark the Dates of the Meeting on Your Calendar. The Session Description will be published and used to promote participation. The description may be edited by conference organizers before publication. Session Descriptions are limited to 300 words. Please identify the primary and secondary discipline categories to help the organizing committee avoid conflicts during the development of the technical program, e.g., Applications, Methods, and Tools/Components/Other.

Proposal Information: Each proposal must have at least two chairs but not more than four. E-mail, telephone, and a complete mailing address must be provided for each convener. Individuals listed as conveners must have agreed to be listed as a convener.

Author Invitations: Please do not extend presentation invitations (formal or informal) until after you receive notification that the proposal has been approved. Each session will then be allowed one formally-acknowledged Invited Author, who may be allowed an extended presentation time period at the beginning of your session. When considering to whom you should extend invitations to participate in your session, please be clear to explain the difference between a formal "Invited Presentation" and a broad invitation for others to participate in your session. Note: Session chairs may NOT be first author (first author, presenting author, or otherwise) of invited presentations.

Session Approval: The Technical Program Committee will review all session proposals on an individual basis as they are received. Accepted sessions will be posted on the EEGS Web site (as an addition to the table of sessions).

For more information or to secure your exhibit space at SAGEEP 2013 contact:

EEGS Environmental and Engineering Geophysical Society

Micki Allen, Exhibit Manager SAGEEP 2013
Marac Enterprises
101-345 Renfrew Drive
Markham, Ontario, L3R 9S9, Canada
Phone: 905.474.9118
Fax: 905.474.1968

E-mail: mickiallen@marac.com

Carlsbad, New Mexico • May 6-10, 2013

The Thirteenth Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst™

National Cave and Karst Research Institute

PELA

Barton Springs Edwards Aquifer Conservation District

ILLINOIS STATE GEOLOGICAL SURVEY
PRAIRIE RESEARCH INSTITUTE

CONFERENCE HIGHLIGHTS

- Our 2013 conference opens with a welcoming reception in the Exhibit Hall on Sunday evening.
- Technical papers will be presented in plenary session Wedneday through Friday morning, anchored by two keynote speakers.
- The Exhibit Hall will feature posters, the welcoming reception, breaks, and luncheons. There will be a special Poster Viewing Session on Monday night.
- Spend Monday or Thursday visiting the Waste Isolation Pilot Plant.
- Field trips to Evaporite Karst site Lower Pecos Valley on Tuesday and Carlsbad Caverns Friday afternoon
- The Conference Banquet will be held Tuesday evening, May 9th.
- The conference also features four short courses on geotechnical and geophysical methods.
- A full proceedings volume (in digital form) will be distributed to all Full Conference Registrants.

Membership Renewal

Environmental and Engineering Geophysical Society
1720 South Bellaire Street | Suite 110 | Denver, CO 80222-4303
(p) 011.1.303.531.7517 | (f) 011.1.303.820.3844 | staff@eegs.org | www.eegs.org

Contact Information

Salutation | First Name | Middle Initial | Last Name | Nickname

Company/Organization | Title

Street Address | City & State | Zip | Country

Direct Phone | Mobile Phone | Fax

Email | Website

About Me: Interests & Expertise

In order to identify your areas of specific interest and expertise, please check those that apply:

Classify Association

- ☐ Consultant
- ☐ User of Geophysical Services
- ☐ Student
- ☐ Geophysical Contractor
- ☐ Equiment Manufacturer
- ☐ Software Manufacturer
- ☐ Research/Academia
- ☐ Government Agency
- ☐ Other ______

Classify Interest or Focus

- ☐ Archaeology
- ☐ Engineering
- ☐ Environmental
- ☐ Geotechnical
- ☐ Geotechnical Infrastructure
- ☐ Groundwater
- ☐ Hazardous Waste
- ☐ Humanitarian Geophysics
- ☐ Mining
- ☐ Shallow oil & Gas
- ☐ UXO
- ☐ Other ______

Specific Areas Involved

- ☐ Borehole Geophysical Logging
- ☐ Electrical Methods
- ☐ Electromagnetics
- ☐ Gravity
- ☐ Ground Penetrating Radar
- ☐ Magnetics
- ☐ Seismic
- ☐ Other ______

Professional/Scientific Societies

- ☐ AAPG
- ☐ AEG
- ☐ ASCE
- ☐ AWWA
- ☐ AGU
- ☐ EAGE
- ☐ EER1
- ☐ GeoInstitute
- ☐ GSA
- ☐ MGLS
- ☐ NGWA
- ☐ NSG
- ☐ SEG
- ☐ SSA
- ☐ SPWLA
- ☐ Other ______

Interested in Participating on Standing Committees?

- ☐ Government Affairs
- ☐ Research
- ☐ Publications
- ☐ Awards
- ☐ Corporate Affairs
- ☐ Web Page
- ☐ Student

Membership Categories

Circle the desired Membership Category amount.

	Standard (I prefer to access JEEG online and do not wish to receive a printed issue)	**Printed** (I prefer to receive a printed JEEG)
Individual*	$90	$100
NEW **Retired**	$50	N/A
Student	$20	$60
Corporate Donor	$650	$660
Corporate Associate	$2,400	$2,410
Corporate Benefactor	$4,000	$4,010

To view the qualification for the New Developing World categories, please access http://www.eegs.org and click on Membership	**Standard** (I prefer to access JEEG online and do not wish to receive a printed issue)	**Printed** (I prefer to receive a printed JEEG)
NEW **Developing World Category***	$50	$100

Category Descriptions and Newly Expanded Benefits

Individual and Developing World Category Memberships:

- Access to the **online EEGS Research Collection** resource—online access to the complete *Journal of Environmental and Engineering Geophysics* (*JEEG*) and proceedings archives of the Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP)
- The option of receiving a printed *JEEG* or accessing an electronic issue
- Subscription to the ***FastTIMES*** Newsletter
- **Preferential** registration **fees** for **SAGEEP**
- **Networking** and continued **communication** on issues of interest to the organization

Retired Membership:

- Includes all the benefits of the Individual Membership category. Applicants must approved by the EEGS Board of Directors. Please submit a written request for the Retired Category, which will be reviewed by the Board of Directors.

Note: This category does not include the option for a printed JEEG - if you wish to receive a printed JEEG, please sign up under Individual Membership Printed

Student Membership:

- Includes all the benefits of the Individual Membership category
- Submission must include current student ID or documentation of graduation date (applies to recent graduates for two years after graduation)

Corporate Donor Membership:

- Includes all the benefits of the Individual Membership
- Full conference registration for the Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP)
- A link on the EEGS Website
- Listing with corporate information in *FastTIMES*
- 10% discount on advertising in the *JEEG* and *FastTIMES*

Corporate Associate Membership:

- Includes all the benefits of the Individual Membership for two (2) people
- An exhibit booth at the Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP)
- Ability to insert marketing materials in the SAGEEP delegate packets
- A link on the EEGS website
- Listing with corporate information in *FastTIMES*
- 10% discount on advertising in the *JEEG* and *FastTIMES*

Corporate Benefactor Membership:

- Includes all the benefits of Individual membership in EEGS for two (2) people
- Two exhibit booths at the Symposium on the Applications of Geophysics to Engineering and Environmental Problems (SAGEEP)
- Ability to insert marketing materials in the SAGEEP delegate packets
- A link on the EEGS website
- Listing with corporate information in *FastTIMES*
- 10% discount on advertising in the *JEEG* and *FastTIMES*

Foundation Contributions

Founders Fund

The Founders Fund has been established to support costs associated with the establishment and maintenance of the EEGS Foundation as we solicit support from larger sponsors. These will support business office expenses, necessary travel, and similar expenses. It is expected that the operating capital for the Foundation will eventually be derived from outside sources, but the Founder's Fund will provide an operation budget to "jump start" the work. Donations of $50.00 or more are greatly apreciated. For additional information about the EEGS Foundation (an IRS status 501 (c)(3) tax exempt public charity), visit the website http://www.eegs.org and click on Membership, then "Foundation information". You may also access the EEGS Foundation at http://www.eegsfoundation.org.

Foundation Fund Total: ____________________

Student Support Endowment

This endowed fund will be used to support travel and reduced membership fees so that we can attract greater involvement from our student members. Student members are the lifeblood of our Society, and our support can lead to a lfetime of involvement and leadership in the near surface geophysics community. Donations of $50.00 or more are greatly apreciated. For additional information about the EEGS Foundation (a tax exempt public charity), visit our website at www.eegs.org and click on Membership, then "Foundation information". You may also access the EEGS Foundation at http://www.eegsfoundation.org.

Student Support Endowment Total: ____________________

Corporate Contributions

The EEGS Foundation is designed to solicit support from indivudals and corporate entities that are not currently Corporate Members (as listed above). We recognize that most of our Corporate Members are small businesses with limited resources, and that their contributions to professional societies are distributed among several organizations. The Corporate Founder's Fund has been developed to allow our Corporate Members to support the establishment of the Foundation as we solicit support from new contributors. As such, Corpoate Founders received special recognition for donations exceeding $2500 made before May 31, 2010. These sponsors will be ackowledged in a form that may be posted at their SAGEEP booth for years to come, so that individual members can express their gratitude for the support.

Corporate Contribution Total: $ ____________________

Foundation Total: $ ____________________

Payment Information

Subtotals:

Membership: $ ____________________

Foundation Contributions: $ ____________________

Grand Total: $ ____________________

☐ Check/Money Order ☐ Visa ☐ MasterCard ☐ Amex ☐ Discover

Card Number ____________________ Exp. Date ____________________

Name on Card ____________________

Signature ____________________

Make your check or money order in **US Dollars** payable to: EEGS. Checks from canadian bank accounts must be drawn on banks with US affiliations (Example: checks from Canadian Credit Suisse banks are payable through Credit Suisse new york, USA). **Checks must be drawn on US Banks.**

Payments are not tax deductible as charitable contributions although they may be deductible as a business expense. Consult your tax advisor.

Return this form with payment to: EEGS, 1720 South Bellaire Street, Suite 110, Denver, CO 80222 USA

Credit Card Payments can be faxed to EEGS at 011.1.303.820.3844

Corporate dues payments, once paid, are non-refundable. Individual dues are non-refundable except in cases of extreme hardship and will be

Environmental and Engineering Geophysical Society

1720 South Bellaire Street | Suite 110 | Denver, CO 80222-4303
(p) 011.1.303.531.7517 | (f) 011.1.303.820.3844 | staff@eegs.org | www.eegs.org

Membership Renewal
Developing World Category Qualification

If you reside in one of the countries listed below, you are eligible for EEGS's Developing World membership category rate of $50.00 (or $100.00 if you would like the printed, quarterly *Journal of Environmental & Engineering Geophysics* mailed to you—to receive a printed *JEEG* as a benefit of membership, select the Developing World Printed membership category on the membership application form):

Afghanistan
Albania
Algeria
Angola
Armenia
Azerbaijan
Bangladesh
Belize
Benin
Bhutan
Bolivia
Burkina Faso
Burundi
Cambodia
Cameroon
Cape Verde
Central African Republic
Chad
China
Comoros
Congo, Dem. Rep.
Congo, Rep.
Djibouti
Ecuador
Egypt
El Salvador
Eritrea
Ethiopia
Gambia
Georgia
Ghana
Guatemala
Guinea
Guinea-Bissau
Guyana
Haiti
Honduras
India
Indonesia
Iran
Iraq
Ivory Coast
Jordan
Kenya
Kiribati
Kosovo
Kyrgyz Republic
Lao PDR
Lesotho
Liberia
Madagascar
Malawi
Maldives
Mali
Marshall Islands
Mauritania
Micronesia
Moldova
Mongolia
Morocco
Mozambique
Myanmar
Nepal
Nicaragua
Niger
Nigeria
North Korea
Pakistan
Papua New Guinea
Paraguay
Philippines
Rwanda
Samoa
Sao Tome and Principe
Senegal
Sierra Leone
Solomon Islands
Somalia
Sri Lanka
Sudan
Suriname
Swaziland
Syria
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Thailand
Timor-Leste
Togo
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Vanuatu
Vietnam
West Bank and Gaza
Yemen
Zambia
Zimbabwe

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Intelligent Resources, Inc.
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Northwest Geophysics
www.northwestgeophysics.com

Spotlight Geophysical Services
www.spotlightgeo.com

EEGS STORE

Environmental and Engineering Geophysical Society

2012 Publications Order Form

ALL ORDERS ARE PREPAY

1720 S. Bellaire Street, Suite 110
Denver, CO 80222-4303
Phone: 303.531.7517; Fax: 303.820.3844
E-mail: staff@eegs.org; Web Site: www.eegs.org

Sold To:
Name: ____________________
Company: ____________________
Address: ____________________
City/State/Zip: ____________________
Country: ____________ Phone: ____________
E-mail: ____________ Fax: ____________

Ship To (If different from "Sold To":
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Company: ____________________
Address: ____________________
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Country: ____________ Phone: ____________
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Instructions: Please complete both pages of this order form and fax or mail the form to the EEGS office listed above. Payment must accompany the form or materials will not be shipped. Faxing a copy of a check does not constitute payment and the order will be held until payment is received. Purchase orders will be held until payment is received. If you have questions regarding any of the items, please contact the EEGS Office. Thank you for your order!

SAGEEP PROCEEDINGS

Member/Non-Member

	0029	2010 (CD-ROM) **NEW**	$75	$100
	0026	2009 (CD-ROM)	$75	$100
	0025	2008 (CD-ROM)	$75	$100
	0023	2007 (CD-ROM)	$75	$100
	0020	2006 (CD-ROM)	$75	$100
	0018	2005 (CD-ROM)	$75	$100

	0016	2004 (CD-ROM)	$75	$100
	0015	2003 (CD-ROM)	$75	$100
	0014	2002 (CD-ROM)	$75	$100
	0013	2001 (CD-ROM)	$75	$100
	0012	1988-2000 (CD-ROM)	$150	$225
		SUBTOTAL—PROCEEDINGS ORDERED:		

SAGEEP Short Course Handbooks

	0027	Principles and Applications of Seismic Refraction Tomography (Printed Course Notes & CD-ROM) - William Doll	$125	$150
	0028	Principles and Applications of Seismic Refraction Tomography (CD-ROM including PDF format Course Notes) - William Doll	$70	$90
	0007	2002 - UXO 101 - An Introduction to Unexploded Ordnance - (Dwain Butler, Roger Young, William Veith)	$15	$25
	0009	2001 - Applications of Geophysics in Geotechnical and Environmental Engineering (HANDBOOK ONLY) - John Greenhouse	$25	$35
	0011	2001 - Applications of Geophysics in Environmental Investigations (CD-ROM ONLY) - John Greenhouse	$80	$105
	0010	2001- Applications of Geophysics in Geotechnical and Environmental Engineering (HANDBOOK) & Applications of Geophysics in Environmental Investigations (CD-ROM) - John Greenhouse	$100	$125
	0004	1998 - Global Positioning System (GPS): Theory and Practice - John D. Bossler & Dorota A. Brzezinska	$10	$15
	0003	1998 - Introduction to Environmental & Engineering Geophysics - Roelof Versteeg	$10	$15
	0002	1998 - Near Surface Seismology - Don Steeples	$10	$15
	0001	1998 - Nondestructive Testing (NDT) - Larry Olson	$10	$15
	0005	1997 - An Introduction to Near-Surface and Environmental Geophysical Methods and Applications - Roelof Versteeg	$10	$15
	0006	1996 - Introduction to Geophysical Techniques and their Applications for Engineers and Project Managers - Richard Benson & Lynn Yuhr	$10	$15

Miscellaneous Items

	0021	Geophysics Applied to Contaminant Studies: Papers Presented at SAGEEP from 1988-2006 (CD-ROM)	$50	$75
	0022	Application of Geophysical Methods to Engineering and Environmental Problems - Produced by SEGJ	$35	$45
	0019	Near Surface Geophysics - 2005 Dwain K. Butler, Ed.; Hardcover Special student rate - 71.20	$89	$139
	0024	Ultimate Periodic Chart - Produced by Mineral Information Institute	$20	$25
	0008	MATLAB Made Easy - Limited Availability	$70	$95
		EEGS T-shirt (X-Large) Please circle: white/gray	$10	$10
		EEGS Lapel Pin	$3	$3
		SUBTOTAL—SHORT COURSE/MISC. ORDERED ITEMS:		

Publications Order Form (Page Two)

Journal of Environmental and Engineering Geophysics **(JEEG) Back Issue Order Information:**

Member Rate: $15

Non-Member Rate: $25

Qt.	Year	Issue	Qt.	Year	Issue	Qt.	Year	Issue
	1995			**2001**			**2006**	
		JEEG 0/1 - July			JEEG 6/1 - March			JEEG 11/1 - March
	1996				JEEG 6/3 - September			JEEG 11/2 - June
		JEEG 0/2 - January			JEEG 6/4 - December			JEEG 11/3 - September
		JEEG 1/1 - April		**2003**				JEEG 11/4 - December
		JEEG 1/2 - August			JEEG 8/1- March		**2007**	
		JEEG 1/3 - December			JEEG 8/2 - June			JEEG 12/1 - March
	1998				JEEG 8/3 - September			JEEG 12/2 - June
		JEEG 3/2 - June			JEEG 8/4 - December			JEEG 12/3 - September
		JEEG 3/3 - September		**2004**				JEEG 12/4 - December
		JEEG 3/4 - December			JEEG 9/1- March		**2008**	
	1999				JEEG 9/2 - June			JEEG 13/1 - March
		JEEG 4/1 – March			JEEG 9/3 - September			JEEG 13/2 - June
		JEEG 4/2 - June			JEEG 9/4 - December			JEEG 13/3 - September
		JEEG 4/3 - September		**2005**				JEEG 13/4 - December
		JEEG 4/4 - December			JEEG 10/1 - March		**2009**	
	2000				JEEG 10/2 - June			JEEG 14/1 - March
		JEEG 5/3 - September			JEEG 10/3 - September			JEEG 14/2 - Available June
		JEEG 5/4 - December			JEEG 10/4 - December			JEEG 14/3 - Available September
								JEEG 14/4 - Available December

SUBTOTAL—JEEG ISSUES ORDERED	

SUBTOTAL - SAGEEP PROCEEDINGS ORDERED	
SUBTOTAL - SHORT COURSE / MISCELLANEOUS ITEMS ORDERED	
SUBTOTAL - JEEG ISSUES ORDERED	
CITY SALES TAX (If order will be delivered in the City of Denver—add an additional 3.5%)	
STATE SALES TAX (If order will be delivered in Colorado—add an additional 3.7%)	
SHIPPING & HANDLING (US—$10; Canada/Mexico—$20; All other countries: $45)	
GRAND TOTAL:	

Order Return Policy: Returns for credit must be accompanied by invoice or invoice information (invoice number, date, and purchase price). Materials must be in saleable condition. Out-of-print titles are not accepted 180 days after order. No returns will be accepted for credit that were not purchased directly from EEGS. Return shipment costs will be borne by the shipper. Returned orders carry a 10% restocking fee to cover administrative costs unless waived by EEGS.

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Environmental and Engineering Geophysical Society

1720 S. Bellaire Street, Suite 110
Denver, CO 80222-4303
Phone: 303.531.7517
Fax: 303.820.3844
E-mail: staff@eegs.org
Web Site: www.eegs.org

2012 Merchandise Order Form

ALL ORDERS ARE PREPAY

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Name: ______________________________
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City/State/Zip: ______________________________
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E-mail: ________________ Fax: ____________

Ship To (If different from "Sold To")**:**

Name: ______________________________
Company: ______________________________
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Instructions: Please complete this order form and fax or mail the form to the EEGS office listed above. Payment must accompany the form or materials will not be shipped. Faxing a copy of a check does not constitute payment and the order will be held until payment is received. Purchase orders will be held until payment is received. If you have questions regarding any of the items, please contact the EEGS Office. Thank you for your order!

Merchandise Order Information:

ITEM DESCRIPTION	QTY	T-SHIRT COLOR WHITE/GRAY	MEMBER RATE	NON-MEMBER RATE	TOTAL
EEGS Mug			$10	$10	Sold Out
T-shirt (Medium)			$10	$10	Sold Out
T-shirt (Large)			$10	$10	Sold Out
T-shirt (X-Large)			$10	$10	
T-shirt (XX-Large)			$10	$10	Sold Out
EEGS Lapel Pin			$3	$3	
SUBTOTAL – MERCHANDISE ORDERED:					

TOTAL ORDER:

SUBTOTAL – Merchandise Ordered:	
STATE SALES TAX: (If order will be delivered in Colorado – add 3.7000%):	
CITY SALES TAX: (If order will be delivered in the City of Denver – add an additional 3.5000%):	
SHIPPING AND HANDLING (US - $7; Canada/Mexico - $15; All other countries - $40):	
GRAND TOTAL:	

Payment Information:

☐ Check #: ________________ (Payable to EEGS)

☐ Purchase Order: ________________
(Shipment will be made upon receipt of payment.)

☐ Visa ☐ MasterCard ☐ AMEX ☐ Discover

Card Number: ________________ Cardholder Name (Print): ________________

Exp. Date: ________________ Signature: ________________

Three easy ways to order:
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