To the Hohmann Trustees;

We are very pleased to nominate Professor Emeritus H. Frank Morrison for the 2017 Gerald W. Hohmann Award in Electromagnetic Geophysics. Frank strongly exemplifies the 2017 topic of the award, namely a ”Lifetime of Achievements”, as we will document below.

Frank received a B.Sc. in physics and geology in 1959 and a M.Sc. in geology at McGill University in 1961. He then began a Ph.D. program with the nascent Engineering Geoscience group formed by Stan Ward at the University of California, Berkeley. In addition to Frank, the fledgling geophysicists in Stan's group included Doug O'Brien, Anders Jepsen, Roger Phillips, Norm Goldstein, and Doug Fraser. This close-knit grad student group had the sense of doing pioneering work in electromagnetic geophysics, believed that Stratton's *Electromagnetic Theory* was the finest book ever written, and due to his friendly personality, intelligence, and insight, held Frank as their natural leader. For his own work, Frank's initial intention was to work on the induced polarization method, but he soon turned his attention to the newly emerging magnetotelluric (MT) technique. This ultimately led to a life-long passion to understand the basic physics and mathematics of the random process that underlies MT. The research included many collaborations with students and others which produced measurement, processing, modeling, and interpretation schemes that helped advance MT to the world-wide stature it has today. During the time when Frank was finishing his Ph.D. he shared ideas with fellow Engineering Geoscience student Jerry Hohmann.

After he finished his Ph.D. degree in 1967 with a dissertation entitled “A Magnetotelluric Profile Across the State of California”, Frank accepted an offer to stay on as an Assistant Professor at Berkeley where he spent the rest of his influential and productive career. Because Stan left Berkeley to start a program similar to Engineering Geoscience at the University of Utah, Frank became the professor that ultimately signed off on Jerry Hohmann's Ph.D. thesis in 1970. Between that time, and when he retired from Cal in 2010, Frank mentored every graduate student in the group who emphasized electromagnetics (EM), held the Plato Malozemoff Chair in Mineral Engineering, served as Chairman of the Department of Material Science and Mineral Engineering, and became a Faculty Senior Scientist at Lawrence Berkeley National Laboratory. With students Ugo Conti and Edward Nichols, he co-founded Electromagnetic Instruments (EMI) Inc., a company devoted to developing new, improved EM equipment. EMI was ultimately purchased by Schlumberger. For Frank's accomplishments and for his role in transferring many of the research projects to practical methods for the exploration industry, he was elected an Honorary Member of the Society of Exploration Geophysicists in 1999. Frank continues to be active in

research being involved in projects at Lawrence Berkeley National Lab as well as with his consulting company Berkeley Geophysics Associates. He is currently Professor Emeritus in two departments at Berkeley, the Department of Earth and Planetary Science and in the Department of Civil and Environmental Engineering, and holds the Plato Malozemoff Professor Emeritus of Mineral Engineering.

Frank's impact in geophysics reaches across the entire spectrum of electrical and electromagnetic methods with scales ranging from deep crustal sounding techniques to near-surface investigations such as developing a new approach in detection and characterization of unexploded ordnance (UXO) for which he received numerous awards. Attached Appendix A covers the major EM activities where Frank, with his students and others, has made significant impacts. Appendix B contains a bibliography of archival journal publications that document some of these results. However, we acknowledge that there is no way that simple lists can convey the true impact that Frank has had on electromagnetic geophysics.

Frank's legacy is forever imprinted on the 34 Ph.D. and 25 M.S. students that he supervised during over four decades at Berkeley. Many ascended to leadership positions nationally and internationally in careers ranging from private to public, energy to environmental, applied to academic. And Frank's lifelong passion and commitment to teaching and mentoring is not limited to UC Berkeley. His outreach to the global geophysical community is demonstrated by an open-access web-based "The Berkeley Course in Applied Geophysics" that he has been developing since 1999. The text and interactive models are derived from course notes and programs developed by Frank, Alex Becker, and former students in the Engineering Geoscience (later Applied Geophysics) group at Berkeley.

Testimonies to Frank's lifelong influence would require volumes. Here we include a few examples from former students to highlight this aspect of his character:

- "I directly experienced how Frank masterfully handled the balance between being a good professor and a good friend and I've strived to achieve his way with my own students."
- "In addition with the friendship he developed with each of his students, a major aspect that stuck with me regarding Frank and his professorial style was his humbleness and humility he exhibited around his and his students' research. He always gave credit to the students where credit was due."
- "Frank's office door was always open to discuss research ideas and make valuable suggestions. And he welcomed everyone to continue the conversation over a cup of cappuccino at the Mediterranean Caffe".
- "Frank always had the knack for making others around him feel comfortable and included, and melding the social life with the technical side for his department was one of Frank's significant

accomplishments. It wasn't very long before our department felt more like a family than a collection of students."

- "He is a stellar professor, researcher, and friend, who creates scientific excitement and interest for all of us that have had the pleasure of interacting with him."

We have documented the remarkably full range of Frank Morrison's contributions to virtually every aspect of electrical and electromagnetic geophysics. Therefore, we highly recommend him for the 2017 Gerald W. Hohmann Award in Electromagnetic Geophysics and we hope the Hohmann trustees will agree with us.

Sincerely,

David Alumbaugh, NEOS
Ted Asch, AquaGeo Frameworks
Alex Becker, Professor Emeritus of Civil and Environmental Engineering, University of California Berkeley
John Henry Beyer, Retired-Lawrence Berkeley National Laboratory
Roger Borcherdt, Retired-U. S. Geological Survey
Craig Beasley, NEOS
Dimitri Bevc, Chevron
Ugo Conti, CTO Marine Advanced Research
Nestor Cuevas, Schlumberger
Erika Gasperikova, Lawrence Berkeley National Laboratory
Norm Goldstein, Retired-Lawrence Berkeley National Laboratory
Mike Hoversten, Chevron
George Jiracek, Professor Emeritus of Geological Sciences, San Diego State University
Karl Kappler, QuakeFinder
Ki Ha Lee, MinTech, Retired-Lawrence Berkeley National Laboratory
Ernie Majer, Lawrence Berkeley National Laboratory
Misac Nabighian, Retired Newmont Mining, Distinguished Senior Scientist, Colorado School of Mines
Ed Nichols, Lawrence Berkeley National Laboratory
Doug Oldenburg, Professor of Earth and Ocean Sciences, University of British Columbia
Roger Phillips, Professor Emeritus of Earth and Planetary Sciences, Washington University
Carlos Torres-Verdin, Professor, The University of Texas at Austin
Mike Wilt, Lawrence Berkeley National Laboratory and GroundMetrics
Glenn Wilson, Halliburton

APPENDIX A: Selected Achievements

- Development and analysis of numerical modeling algorithms for electrical and electromagnetic geophysical methods, including:
    - Semi-analytic techniques for the calculation of the electromagnetic fields generated by various types of EM sources over a layered 1D half-space.
    - 2.5D and 3D DC resistivity modeling algorithms, including induced polarization effects.
    - 2D, 2.5D and 3D electromagnetic modeling algorithms using plane wave and dipole sources, and both in the frequency and time domain.
- Field studies analyzing the possibility of using subsurface resistivity changes, variations in earth self-potentials, and/or temporal fluctuations of atmospheric electromagnetic fields for earthquake prediction.
- Studies to promote and improve the use of magnetotelluric techniques including:
    - Evaluation, analysis, and use of the ElectroMagnetic Array Profiling (EMAP) acquisition and processing technology.
    - Subsurface induced polarization mapping using natural fields.
    - Comparing different types of magnetometers and electrodes in the measurement of naturally occurring EM fields.
    - Analyzing the use of land MT for geothermal, mineral, and sub-basalt oil exploration, and the use of marine MT for sub-salt and tectonic mapping.
    - Investigations of the AFMAG technique for mapping subsurface resistivity variations.
- Investigating of the use of Super Conducting Quantum Interference Devices, or SQUIDS, for magnetic field measurements with geophysical applications. Studies include:
    - The use of SQUIDS for MT measurements.
    - The design, development, and testing of the 'UNICOIL' system.
- Modeling and field studies investigating the use of cross-well, and surface-to-borehole (or borehole-to-surface) DC and EM configurations for mapping subsurface resistivity variations, and mapping temporal resistivity changes due to fluid injection.
- Modeling and field studies to analyze the possibility of making measurements in, and to mitigate the effects of, steel casing. Particular configurations of interest included:
    - Through casing DC resistivity and EM logging tools.
    - Cross-well DC and EM measurements for imaging the region between well bores.

- Development and testing of techniques to detect and estimate the amount of corrosion of rebar embedded in concrete.
- Development of a complete measurement, processing, detection, and classification scheme for finding metallic unexploded ordnance.
- Co-development of on-line “The Berkeley Course in Applied Geophysics”: http://appliedgeophysics.berkeley.edu/.
- Honorary Membership bestowed by Society of Exploration Geophysicists to H. Frank Morrison “for his major contributions as an educator and for his role in transferring electromagnetic concepts to industry”, 1999.
- R & D100 Award for Berkeley UXO Discriminator (BUD) from R & D100 Magazine in 2007.

APPENDIX B: Publications in Refereed Journals

Bhattacharyya, B. K. and Morrison, H. F., 1963, Some theoretical aspects of electrode polarization in rocks: Geophysical Prospecting, 11, no. 2, 176-196.

Morrison, H. F., Wombwell, E., and Ward, S. H., 1968, Analysis of earth Impedances using magnetotelluric fields: Journal of Geophysical Research, 73, no. 8, 2769-2778.

Ralph, E. K., Morrison, H. F., and O'Brien, D. P., 1968, Archeological Surveying utilizing a high sensitivity difference magnetometer: Geoexploration, 6, 109-122.

Bodmer, R., Ward, S. H., and Morrison, H. F., 1968, On induced electrical polarization and ground-water: Geophysics, 33, no. 5, 805-821.

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Morrison, H. F., Phillips, R. J., and O'Brien, D. P., 1969, Quantitative interpretation of transient electromagnetic fields over a layered half-space: Geophysical Prospecting, 17, no. 1, 82-101.

Morrison, H. F., Benavente, J., Clewlow, Jr. C. W., and Heizer, F. F., 1970, Magnetometer Evidence of a structure within the La Venta Pyramid: Science, 167, 3924, 1488-1490.

Coggon, J. H. and Morrison, H. F., 1970, Electromagnetic investigation of the sea floor: Geophysics, 35, no. 3, 476-489.

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Ryu, J., Morrison, H. F., and Ward, S. H., 1972, Electromagnetic depth sounding experiment across Santa Clara Valley: Geophysics, 37, no. 2, 351-374.

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Wang, C. H., Goodman R. E., Sundaram, P. N., and Morrison, H. F., 1975, Electrical resistivity of granite in frictional sliding: applications to earthquake prediction: Geophysical Research Letters, vol. 2, no. 12, 525-528.

Morrison, H. F., Dolan, W. M., and Dey, A., 1976, Earth conductivity determinations employing a single superconducting coil: Geophysics, 41, no. 5, 1184-1206.

Morrison, H. F., Corwin, R. F., and Chang, M., 1977, High accuracy determination of temporal variations of crustal resistivity: American Geophysical Union Monograph 20, 593-614.

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Dey, A. and Morrison, H. F., 1977, An Analysis of the bipole-dipole method of resistivity surveying: Geothermics, vol. 6, no. 3.

Morrison, H. F., Corwin, R.F., and Fernandez, R., 1979, Earth resistivity, self potential variations, and earthquakes: A negative result for M=4.0: Geophysical Research Letters , vol. 6, no.3.

Dey, A. and Morrison, H. F., 1979, Resistivity modelling for arbitrarily shaped two-dimensional structures: Geophysical Prospecting, 27, no. 1, 106-136.

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Asch, T. and Morrison, H. F., 1989, Mapping and monitoring electrical resistivity with surface and subsurface electrode arrays: Geophysics, 54, no. 2, 235-244.

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Moore, J. R., Glaser, S. D., Morrison, H. F., and Hoversten, G. M., 2004, The streaming potential of liquid carbon dioxide in Berea sandstone: Geophysical Research Letters, 31, L17610.

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