Seogi Kang

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RESEARCH INTERESTS

My research uses computational methods in geophysical inversion and data science to advance the use of applied geophysics in geoscience applications including groundwater, environmental, geotechnical, and minerals. Problems in these applications are multi-disciplinary requiring effective mechanisms such as open-source tools to communicate across disciplinary lines. Such tools are important to me, as I want to interact with people from both academia and industry to help solve these problems. I bring computational expertise as well as experience related to field acquisition particularly in electromagnetics (EM) and induced polarization (IP), but also I have a background in potential field methods such as gravity and magnetics. I am a developer of open-source computational tools (e.g. SimPEG — open-source geophysical software) and want to promote the growth of those open source tools as well as use them.

Current projects
- Large-scale AEM inversion to image a 3D sediment type model of the subsurface
- Modeling to assist survey design for obtaining high-quality AEM data
- Data integration to understand/estimate spatial and temporal changes of water storage
- Joint and cooperative inversion of geophysical and geological/hydrogeological data
- Extracting chargeability information from EM data
- Numerical methods for simulation and inversion in geophysics
- Problem-focused uncertainty quantification

EDUCATION

University of British Columbia, Vancouver, Canada   **June 3rd 2018**
Ph.D. in Geophysics
Thesis: "On recovering induced polarization information from time-domain electromagnetic data"
Advisor: Douglas W. Oldenburg

Hanyang University, Seoul, Korea   **February 17th 2012**
M.Sc. in Applied Geophysics
Thesis: "A feasibility study of marine controlled-source electromagnetic method for CO_2 sequestration monitoring at a deep brine aquifer in a shallow sea"
Advisors: Joongmoo Byun and Soo Jee Seol

Hanyang University, Seoul, Korea (2010)   **February 19th 2010**
B.S. Natural Resources and Geoenvironmental Engineering

RESECARCH APPOINTMENTS

Groundwater Architecture Project, Stanford University

Postdoctoral researcher   **January 8th 2019 to present**
- Principal Investigator: Prof. Rosemary J. Knight
- Developed a numerical workflow to build a three-dimensional sediment texture model of the subsurface from the AEM and water well data collected in California, U.S.A. Constructing this subsurface model is required by state-wide legislation called Sustainable Groundwater Management Act providing a high level of engagement from the local water agencies and stakeholders.
- Developed a simulation methodology to quantify impact of noise sources related to man-made structures (e.g. power lines) to provide useful information when designing AEM surveys.
- Quantified the uncertainty associated with the derived sediment texture model.
- Interacted with, and facilitated discussions among, partners of the project (universities and companies) and local professionals (e.g. water managers, engineers, hydrogeologists) to meet the needs for answering hydrogeologic questions (e.g. estimating subsidence risk).

GIFtools II Project, University of British Columbia

Postdoctoral researcher   **April 4th 2018 to December 31st 2018**
- Principal Investigator: Prof. Douglas W. Oldenburg
- Developed geophysical 1D spatially-constrained inversion algorithm that can invert large-scale AEM data.
- Integrated developed simulation and inversion software into a commercial framework (called GIFtools) such that sponsors of the project (mining companies) can use the developed code for their own work.
- Facilitated technology transfer to industry sponsors: Teck, Barrick, RioTinto, Anglo American, BHP, Glencore and Vale through courses and tutorials.

TEACHING EXPERIENCE

Undergraduate

EOSC 350: Environmental, Geotechnical and Exploration Geophysics
Co-instructor (with Douglas Oldenburg)   **2018**
- Grade level: 3rd or 4th year undergraduate students
- Number of students: 80
- Contribution: deliver lectures for half of the course, create teaching materials including interactive geophysics apps

EOSC 350: Environmental, Geotechnical and Exploration Geophysics
Teaching assistant   **2013 to 2016**
Instructor: Douglas Oldenburg

- Contribution: running the lab part of the course, developing lab materials developing interactive apps for use in the course and the labs, grading assignments and labs

Workshops & Short Courses

Inverse theory: deterministic approach
Co-presenter (with Douglas Oldenburg)   **April 2019**
- Part of LAPIS 2019 "Inverse Methods in Geophysics"
- Number of participants: ~50
- Contribution: creating course materials and interactive apps that illustrate linear and non-linear inverse problems.
- Webpage: https://courses.geosci.xyz/lapis2019

EM methods in exploration
Co-presenter (with Douglas Oldenburg and Lindsey Heagy)   **July 2018**
- Part of University of Houston Petroleum Geophysics - Summer 2018 Short Courses
- Number of participants: ~30
- Contribution: creating course materials and interactive app illustrate physics of EM method
- Webpage: https://courses.geosci.xyz/houston2018

3D EM Modelling and Inversion with Open Source Resources
Co-presenter (with Douglas Oldenburg and Lindsey Heagy)   **June 2018**
- Part of the 7th Airborne ElectroMagnetics conference 2018 Short Course
- Number of participants: ~30
- Contribution: creating course materials which included running AEM simulations and inversions)
- Webpage: https://courses.geosci.xyz/aem2018

Geophysical Electromagnetics: Fundamentals and Applications
Co-presenter (with Douglas Oldenburg and Lindsey Heagy)   **2017**
- The Society of Exploration Geophysicists 2017 Distinguished Instructor Short Course
- 2 day course per each location (Day1: course, Day2: lab)
- Number of participants: ~40 per location
- Contribution: creating course materials, interactive app for EM fundamentals and applications, and running the lab part (2nd day) of the course
- Webpage: http://disc2017.geosci.xyz/
- Blog: https://medium.com/disc2017
- Locations
    - Denver, USA (January 30-31, 2017)
    - Singapore (February 13-14, 2017)
    - Kuala Lumpur, Malaysia (February 16-17, 2017)
    - Bandung, Indonesia (February 20-24, 2017)
    - Hyderabad, India (February 27-March 3, 2017)
    - National Central University, Taiwan (June 14-15, 2017)
    - KIGAM, Korea (June 19-20, 2017)
    - Kyoto, Japan (June 22-23, 2017)
    - Tokyo, Japan (June 26-27, 2017)
    - Calgary, Canada (December 5-6, 2017)
    - Vancouver, Canada (December 12-13, 2017)

Graduate Student Mentoring/Advising

While at Stanford, I have had the opportunity to work closely with the graduate students in the Environmental Geophysics Group. This includes supporting the following projects, assisting students with various aspects of modeling geophysical data:

- Design of an AEM survey along the Sierra foothills (lead – Alex Miltenberger (PhD student) and postdoctoral fellow Klara Steklova): assisting with the forward modeling to select the appropriate AEM system.
- Use of AEM data to improve the modeling of InSAR data (lead – Ph.D. student Matt Lees)
- Integration of AEM data into the modeling of saltwater intrusion (lead – Ph.D. student Ian Gottschalk)
- Use of the Eikonal solver to assess connected pathways in the subsurface (lead - Ph.D. student Karissa Pepin): assisting with the implementation of Eikonal solver, and consultation of the inversion uncertainty.
- Lab-scale physical modeling of the seawater intrusion, and imaging of the the seawater intrusion interface using ERT method (lead - postdoctoral fellow Meredith Goebel): assisting with the use of 3D ERT simulation, and developing the parametric inversion algorithm for imaging seawater intrusion interface.

Beyond the Stanford border, I am also mentoring a MSc. student, Deniz Dönmez, from the Geophysics Department of Colorado School of Mines. I am providing a full time-domain IP modeling code that I have developed to Deniz; assisting the use of code and the analysis of the numerical results.

GRANTS

Geoscience Without Borders (50K USD; accepted and finished)
Senior Personnel   **2019**
- Title: Improving water security in Mon State, Myanmar via geophysical capacity building
- Principal Geoscientists: Douglas Oldenurg, Kevin Fan, Michael Maxwell, Lindsey Heagy and Seogi Kang
- My role: supporting the software component of the project to provide an efficient and effective interpretation tool allowing local engineers and students to interpret field direct current (DC) resistivity data.

AWARDS

IDEA Innovation Award, University of British Columbia library 2016: *"Open source geophysics project, SimPEG"* (with Rowan Cockett and Lindsey Heagy)   **February 2016**

Outstanding Student Paper Award (Near Surface Geophysics), American Geophysical Union 2015 annual meeting: "Revisiting the time domain induced   **March 2015**

polarization technique, from linearization to inversion"

Best student oral presentation (Minerals), Australian Society of Exploration Geophysics 2015 annual meeting: "Restoration of distributed IP information in airborne-time domain electromagnetic data"	**February 2015**

Five hour wonders, The hackathon in SEG meeting at Denver: "Interactive   **October 2015**
DC app" with Rowan Cockett
- One award annually
- DC app is an interactive app that can emulate physics of direct current (DC) resistivity survey

Four Year Fellowship (FYF) for PhD Students. Selection based on academic   **2012-2016**
excellence, upon the recommendation of the graduate program at UBC
($18, 000 × 4)

PUBLICATIONS

Peer Reviewed Publications

Kang S., Knight R., Greene T., Buck C., Fogg G. (2021), Exploring the model space of airborne electromagnetic data to delineate large-scale structure and heterogeneity within an aquifer system, Water Resources Research (in revision): Link for preprint

Goebel M., Knight R., and **Kang S.** (2021), Enhancing the Resolving Ability of ERT for Imaging Saltwater Intrusion through Improvements in Inversion Methods: A Laboratory and Numerical Study, Geophysics, 1-65: Link.

Kang S., Dewar N., and Knight R. J. (2020), The effect of water wells on time-domain airborne electromagnetic data, Geophysics, 86 (2), E123-141: Link

Kang S. Heagy L. J., and Oldenburg W. D. (2019), Detecting induced polarization effects in time-domain data: a modeling study using stretched exponentials, Exploration Geophysics: Link

Kang S. and Oldenburg W. D. (2019), Inversions of time-domain spectral induced polarization data using stretched exponential, Geophysical Journal International: Link

Heagy L. J., **Kang, S.**, Cockett R, and Oldenburg, W. D. (2019), Open-source software for simulations and inversions of airborne electromagnetic data, Exploration Geophysics, 1-7: Link

Oldenburg, W. D., Heagy L. J. , **Kang, S.**, Cockett R. (2019), 3D electromagnetic modelling and inversion: a case for open source, Exploration Geophysics, 1-13: Link

Miller, C. A., **Kang, S.,** Fournier, D., Hill, G., (2018), Distribution of vapour and condensate in a hydrothermal system: Insights from self‑potential inversion at Mount Tongariro, New Zealand, Geophysical

Research Letters: Link

Yang, D., Fournier, D., **Kang, S.**, and Oldenburg D. W. (2018), Deep mineral exploration using multi-scale electromagnetic geophysics: the Lalor massive sulphide deposit case study, Canadian Journal of Earth Sciences 56 (5), 544-555: Link

Kang, S. and Oldenburg W. D. (2017), Time domain electromagnetic‑induced polarisation: extracting more induced polarisation information from grounded source time domain electromagnetic data, Geophysical Prospecting: Link

Heagy, L. J, Cockett, R., **Kang, S.**, Rosenkjaer, G. K., Oldenburg, D. W., A framework for simulation and inversion in electromagnetics, 2017, Computers & Geosciences, 107, 1-19: Link

Kang, S., Fournier D., and Oldenburg W. D. (2017), Inversion of airborne geophysics over the DO-27/18 kimberlites, Part III: Induced Polarization, Interpretation: Link

Fournier, D., **Kang, S.**, McMillan S. M., and Oldenburg W. D. (2017), Inversion of airborne geophysics over the DO-27/18 kimberlites, Part II: Electromagnetics, Interpretation: Link

Kang, S. and Oldenburg, D. W. (2016) On recovering distributed IP information from inductive source time domain electromagnetic data, Geophysical Journal International, 207 (1), 174-196: Link

Cockett, R., **Kang, S.**, Heagy, L. J., Pidlisecky, A., & Oldenburg, D. W. (2015) SimPEG: An open source framework for simulation and gradient based parameter estimation in geophysical applications, Computers and geoscience, 85 (A), 142–154: Link

Kang, S., Seol, S., and Byun, J. (2014) mCSEM inversion for CO2 sequestration monitoring, Exploration Geophysics, 46 (3), 236-252: Link

Kang, S., Seol, S., Chung, Y., and Kwon, H. (2013) Pitfalls of 1D inversion of small-loop electromagnetic data for detecting man-made objects, Journal of Applied Geophysics, 90, 96-109: Link

Kang, S., Seol, S., and Byun, J. (2012) A feasibility study of CO2 sequestration monitoring using the mCSEM method at a deep brine aquifer in a shallow sea, Geophysics, 77 (2), E117-E126: Link

Non Peer Reviewed Publications

Kang, S., Heagy, L. J., Cockett, R., and Oldenburg D. W., Exploring nonlinear inversions: A 1D magnetotelluric example, The Leading Edge 36 (8), 696-699: Link

Oldenburg D. W., Heagy, L. J., and **Kang, S.**, (2021) Geophysical electromagnetics: A retrospective, DISC 2017, and a look forward, The Leading Edge 40 (2), 140-148: Link

PRESENTATIONS

(*: award, † : invited)

Knight R., Auken E., Buck C., Cannia J., Dewar N., Gosselin P., Halkjær M., Jensen N., **Kang S.**, Martin C., Bjergsted Pedersen J., Zdeba D. (2020), The Stanford Groundwater Architecture Project: Utilizing Advanced Geophysical and Computational Methods for the Development of Hydrogeologic Conceptual Models, GRA 3rd Annual workshop.

Kang, S., Goebel M., Knight J. R.(2020) Targeted inversion of airborne electromagnetic data to inform the development of a groundwater model: Example from the Kaweah Subbasin, California, AGU Fall meeting 2020.

 † **Kang, S.**, Knight J. R., Greene T. (2020) Interrogating the model space of airborne electromagnetic inversion to answer a hydrogeologic question, SEG Technical Program Expanded Abstracts 2020: Link.

Kang, S., Capriotti, J., Oldenburg W. D., Heagy J. L., Cowan D. (2020) Open-source geophysical software development for groundwater applications, SEG Technical Program Expanded Abstracts 2020: Link.

Kang, S., Knight J. R., Greene T. (2019) Interrogating the model space of airborne electromagnetic inversion to answer hydrogeologic questions, AGU Fall meeting : Link

Knight, R. J., Jared, A., Ryan Alward, Asch, Auken, E., Behroozmand, A., Brown, B., Buck, C., Cannia, J., Dewar, N., Dienzo, R., Gosselin, P., Greene, T., Halkjær, M., Howard, C., Jensen, N., **Kang, S.** (2019), Update from the GAP (Groundwater Architecture Project): advancing the use of airborne electromagnetic data for groundwater management, GRA 2nd Annual workshop.

Dewar, N**, Kang, S.**, Knight J. R. (2019), Estimating the Depth to the Saturated Zone from Airborne Electromagnetic Data, AGU-SEG Airborne Geophysics Workshop.

Kang, S., Kuttai, J., and Oldenburg, D. W. (2019), Inversions of time-domain spectral induced polarization data for mineral discrimination, IUGG conference.

Kang, S., Fournier, D., Werthmuller, D, and Oldenburg, D. W. (2018), SimPEG-EM1D: Gradient-Based 1D Inversion Software for Large-Scale Airborne Electromagnetic Data, AGU Fall meeting.

Kang, S., Lauer, R. M., Smerdon, B., and Oldenburg, D. W. (2018), Inversions of airborne and ground-based electromagnetic data sets at Sylvan lake, AGU Fall Meeting: Link

 † **Kang, S.**, Cockett, R., Heagy, J. L., and Oldenburg, D.W. (2018), Expanding the scope of open source software from research to geophysics education, SAGEEP conference.

Kang, S., Oldenburg, W. D., and Heagy, J. L. (2018), Feasibility of induced polarization effects in time-domain airborne EM data, 7th AEM conference: Link

Marchant, D., **Kang, S.**, McMillian M., and Haber E. (2018), Modelling IP effects in airborne time domain electromagnetics, ASEG Extended Abstracts, 1 - 6: Link

Yang, D, Fournier, D., **Kang, S.**, and Oldenburg, D. W. (2018), Recovery of compact conductors in 3D voxel inversion of time-domain EM data, SEG Technical Program Expanded Abstracts 2018, 1873-1877: Link

✝ Oldenburg, W. D. and **Kang, S.** (2017), All charged up: Advances and applications for IP surveys, GeoEM workshop 2017: Link

Kang S. (2016), Inversion of airborne geophysics over the Tli Kwi Cho Kimberlite Complex, BCGS 2016 Fall Symposium: Link

✝ Oldenburg W. D. and **Kang, S.** (2016), Airborne IP for Kimberlite Exploration, IP workshop 2016: Link

Kang, S. and Oldenburg, W. D. (2016), 3D TEM-IP inversion workflow for galvanic source TEM data, IP workshop 2016: Link

Kang, S. and Oldenburg, W. D. (2016), On recovering IP information from time domain EM data, Airborne IP workshop in SEG fall meeting 2016: Link

Kang, S., Lim S., and Oldenburg, W. D. (2016), Development of an SP simulation package for understanding fundamentals of self-potential responses at an earth dam, AGU fall meeting 2016.

Lim S., **Kang, S.**, Song S. H., and Oldenburg, W. D. (2016), Geoelectrical Methods and Monitoring for Dam Safety Assessment, Republic of Korea, AGU fall meeting 2016: Link

Kang, S., Cockett, R., Heagy L. J., and Oldenburg, D. W. (2016), Practices to enable the geophysical research spectrum: from fundamentals to applications, AGU Fall Meeting: Link

*Kang S., and Oldenburg D. W. (2015), Revisiting the time domain induced polarization technique, from linearization to inversion, AGU Fall Meeting Abstracts

Kang, S., Oldenburg W. D. and Michael, S. M. (2015), 3D IP Inversion of Airborne EM data at Tli Kwi Cho, ASEG-PESA 2015: Link

*Kang, S. and Oldenburg, W. D (2015), Restoration of distributed IP information in airborne-time domain electromagnetic data, ASEG-PESA 2015: Link

Kang, S., Cockett, R., Heagy, L. and Oldenburg W. D (2015), Moving between dimensions in electromagnetic inversions, SEG Technical Program Expanded Abstracts 2015: Link

✝ Oldenburg, D. W., **Kang, S.**, and Marchant, D., Inversion of time domain IP data from inductive sources, International Workshop and Gravity, Electrical & Magnetic Methods and their Applications: Link

Kang, S., Cockett, R., and Heagy, L. (2014) Moving between dimensions in electromagnetic inversions with a consistent framework, AGU fall meeting.

Kang, S., Oldenburg, W. D., Yang, D. and Marchant, D. (2014), On recovering induced polarization information from airborne time domain EM data, SEG Technical Program Expanded Abstracts 2014: Link

Kang, S., Oldenburg, W. D. and Marchant, D. (2013), Recovering Complex Conductivity from Frequency and Time Domain Geophysical Surveys, AGU fall meeting 2013.

Kang, S., Seol, S., and Byun, J. (2011), A feasibility study of CO_2 sequestration monitoring using the

mCSEM method at a deep brine aquifer in a shallow sea, SEG Technical Program Expanded Abstracts 2011: pp. 687-692: Link

Kang, S., Seol, S., and Byun, J. (2012), mCSEM inversion for CO_2 sequestration monitoring at a deep brine aquifer in a shallow sea, SEG Technical Program Expanded Abstracts 2012: pp. 1-5: Link

SOFTWARE AND OPEN SCIENCE

I am committed to the development of open-source software projects in geophysics, all of which are accessible through my GitHub profile (https://github.com/sgkang). Some of major projects include:

SimPEG: open-source geophysical simulation and parameter estimation package
Co-creator (with Rowan Cockett and Lindsey Heagy)   **2014 to present**
- **SimPEG** project develops a framework for open-source geophysics simulation and inversion for various geophysical surveys (e.g. magnetics, gravity, DC resistivity, and electromagnetics)
- Webpage: https://www.simpeg.xyz
- GitHub repository: https://github.com/simpeg/simpeg
- **Used in at least 9 different institutions:**
  - Colorado School of Mines
  - DIAS geophysical
  - Geological Survey of New Zealand
  - Rural Research Institute, Korea
  - Stanford University
  - Lawrence Berkeley National Laboratory
  - University of British Columbia
  - University of California, Berkeley
  - University of Houston

GeoSci.xyz
Core contributor   **2014 to present**
- **GeoSci.xyz** project develops an online interactive textbook for geophysics, which includes three main resources:
  - **Geophysics for Practicing Geoscientists**: an introductory resource on applied geophysics (http://gpg.geosci.xyz)
    - **90,000 users and 660,000 page-views (since April 2016)**
  - **Electromagnetic Geophysics**: a graduate level resource on the theory and application of electromagnetic geophysical methods (http://em.geosci.xyz)
    - **350,000 users and 840,000 page-views**
  - **GeoSci Labs**: a collection of Jupyter notebooks for exploring concepts in geophysics (https://github.com/geoscixyz/geosci-labs)
- Webpage: https://www.geosci.xyz

RELATED PROFESSIONAL EXPERIENCE

3D spectral IP inversion of large-scale DC/IP data acquired by DIAS

Collaboration with a geophysical data acquisition company, DIAS   **2018 to present**
- Transferred open-source software developed to process time-domain IP data to extract spectral information to DIAS
- Working on 3D spectral IP inversion of field DC/IP data to prove capability of spectral IP inversion for mineral discrimination

GIFtools training at Teck

Instructor for training   **November 28th-29th 2017**
- With Dominique Fournier and Devin Cowan
- Explained fundamental workflow of geophysical inversion in GIFtools

Testing coincident loop TEM system for detecting seafloor massive sulfide deposit

Research cruise in the Okinawa area (Waseda Univ., Japan)   **November 22th-29th 2016**
- Duration: 8 days
- Vessel: Shinsei Maru
- Consulted software implementation of testing system response and calibration procedure of the TEM system.

Developing a graphic user interface for a rock physics lab with the Geological Survey of Canada

Collaboration with Dr. Randy Enkin   **December 2015**
- Visited Randy's rock physics laboratory for a week
- Developed graphic user interface for fitting spectral IP curves

SERVICE

Conferences

Session Chair: 27th IUGG General Assembly (Mining Geophysics Session)   **2019**
(with Richard Smith)

Session Chair: 7th International Workshop On Airborne Electromagnetics   **2018**
(with Hongzui Cai)

Reviewer for the following peer-reviewed journals

Exploration Geophysics
Geophysical Journal International
Geophysics
Journal of Applied Geophysics

Contact information of references

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