**Update from the GAP (Groundwater Architecture Project):**

**Advancing the Use of Airborne Electromagnetic Data for Groundwater Management**

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Effective groundwater management requires a 3D hydrostratigraphic model of the subsurface that captures the spatial heterogeneity of the subsurface at the level needed as the input for flow modeling. Many agencies, however, lack sufficient information about the subsurface to develop such a detailed model with an acceptable level of uncertainty. The currently deployed, traditional methods of characterizing aquifers through the drilling of wells with testing and logging are slow, expensive and insufficient in terms of data coverage. The widespread adoption of a well-established geophysical method, the airborne electromagnetic (AEM) method, could significantly advance the quality and availability of subsurface data.

Through a partnership between academia, the private sector and local water agencies, we are completing, over a two-year period, three pilot studies in Butte County, Indian Wells Valley (IWV), and San Luis Obispo County (SLO). This project, the Groundwater Architecture Project (GAP), is supported with funding from the local agencies, the California Department of Water Resources (DWR), and the Ministry of Environment and Food of Denmark's Environmental Technology Development Program (MUDP). Our goal: to develop a template for the optimal workflow in using AEM data as the foundation for the development of the hydrogeologic conceptual model throughout California. This workflow includes not only the acquisition of AEM data, but also designing the supporting computational infrastructure for data analysis, interpretation, and archiving.

We have made progress in all components of the workflow. In each study area, we require at least two wells per section for which we have high quality lithology data and accurate well locations. We have faced considerable challenges in working with available well completion reports and are actively developing approaches to efficiently locate wells, digitize lithology logs and rate quality. A 3D modeling capability has been developed that allows us to assess the information content in the AEM data in terms of spatial resolution and the depth of investigation; this modeling allows us to locate flight lines along which data will be acquired. Data acquisition has been completed in Indian Wells Valley and Butte County. The quality of the data is outstanding, with the data now processed and inverted to obtain models of the electrical resistivity of the subsurface. We are developing a new approach to transform resistivity to lithology, using a methodology that allows us to map the location of the water table. A 3D hydrostratigraphic model has been developed for IWV and Butte County through the integration of the AEM data with all other available data. Our GAP results to date indicate that the acquisition of AEM data throughout California can play a central role in providing critical information to support effective groundwater management.

Rosemary Knight is the George L. Harrington Professor in the Department of Geophysics at Stanford and affiliated faculty with the Water in the West Program. She is the founding director of the Center for Groundwater Evaluation and Management, a research initiative to advance the use of geophysical methods for groundwater applications.

Jared Abraham is a principal Geophysicist/Geologist with Aqua Geo Frameworks. He specializes in the application of geophysics to hydrogeological problems, and has a Master’s degree from Colorado School of Mines. He was with the USGS and USDOE for 20 combined years prior to moving to private industry in 2012.

Dr. Ted Asch is currently a Research Geophysicist with Aqua Geo Frameworks specializing in airborne geophysics for geologic mapping and development of groundwater frameworks. Prior employment included the USGS, Denver and USACE, Sacramento District. Dr. Asch has conducted electrical, electromagnetic, magnetotelluric, and marine geophysical surveys all over the world.

Esben Auken is Professor at the Department of Geoscience at Aarhus University, Denmark. He is heading the HydroGeophysics Group, well known for its research into innovative groundbased and airborne geophysical methods for subsurface imaging with focus on hydrological problems.

Ahmad A. Behroozmand is a research scientist in the Department of Geophysics at Stanford University. He has a PhD degree in Geophysics from University of Aarhus, Denmark. His research activities have focused on the development and application of geophysical methods for subsurface imaging, with a focus on groundwater reservoirs.

Christina Buck, Assistant Director for Butte County Water and Resource Conservation, leads projects to support SGMA implementation and development of data and tools to better understand and manage groundwater within Butte County.  She has a Masters and PhD from UC Davis in Hydrologic Sciences.

James Cannia is the principal geologist for Aqua Geo Frameworks LLC. He Specializes in groundwater -Surface water relationships and hydrogeologic frame works. He has 30 years of groundwater management experience using applied science as basis for management decisions. He has worked in both public and private industry.

Noah Dewar is a 2nd year PhD student in the Department of Geophysics at Stanford University. Noah's thesis research is focused on the application of airborne electromagnetic methods to the issues of aquifer characterization and sustainable groundwater management in the Central Valley of California.

Paul Gosselin is the Butte County Director of Water and Resource Conservation. Previously, Paul served as Chief Deputy Director, California Department of Pesticide Regulation and Director of Regulatory Programs, Massachusetts Department of Food and Agriculture. Paul holds a Bachelors’ degree in biochemistry and a Masters’ degree in chemistry.

Dr. Todd Greene is a professor at California State University, Chico, in the Department of Geological and Environmental Sciences. He specializes in working with core, outcrop, shallow 3-D seismic data, and modern analogs to piece together depositional facies models for volcanic-derived deposits, shallow marine clastic sequences, as well as deep-water sediment gravity flows.

Max Halkjaer has a Master’s degree in geology and geophysics from the University of Aarhus. He has 24 years of experience in groundwater management and especially application of geophysical methods. Since 2013 he has been a Senior Hydrogeophysicist and Market Manager for Ramboll Water with a focus on California.

Niels-Peter Jensen is CEO at I•GIS and holds a Master’s degree geophysics. He has been in charge of building software and services related to building hydrogeological models and has more than 25 years of knowledge within the fields of software, geology and geophysics for use in groundwater.

Casper Mejer, International Project and Market Manager at I•GIS which will design and develop computational infrastructure for data analysis, interpretation, and archiving in the pilot studies. Casper is a professional geologist with 10+ years of experience within mineral and a history within the Danish EPA groundwater mapping campaign.

Tim Parker, a technical consultant for +30 years providing SGMA groundwater management services to public and private sector clients, serves as Director on GRA, International Association of Hydrogeologists, and National Groundwater Association. He co-authored *Sustainability from the Ground Up, Groundwater Management in California* (ACWA 2011), and *California Groundwater Management* (GRA 2005).

Jacob Vind is a Danish Consul General and the Head of the Danish Water Technology Alliance in the US. Jacob is responsible for strengthening ties between the US and Danish water sectors through knowledge sharing and collaboration activities.

Don Zdeba is currently General Manager of Indian Wells Valley Water District. Don has more than 35 years of management experience including employment as Mine Geologist at a uranium mine in Church Rock, New Mexico and Manager of Mining for a solution mining operation in Trona, California producing borates, soda ash and sodium sulfate.