Doing it all — a career in electromagnetic methods

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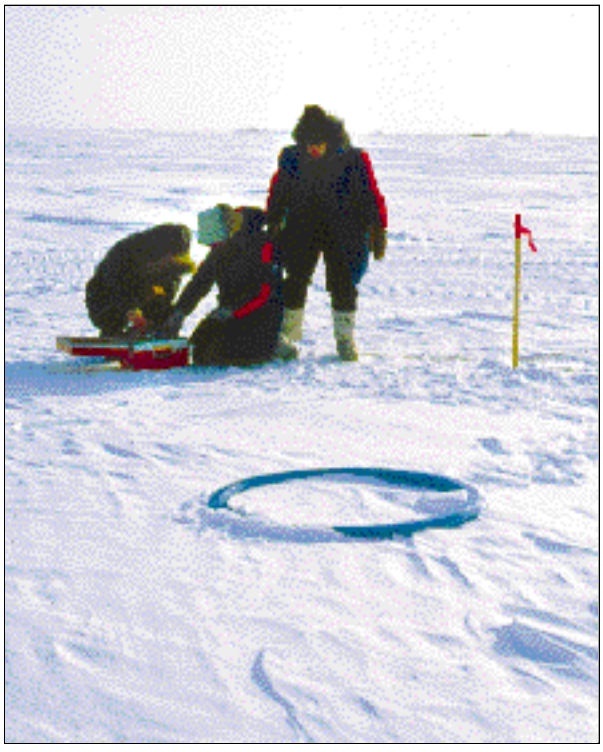
Are you the type of person who would be interested — from a scientific or business perspective, or just because you want a career that isn't virtually identical to that of your colleagues — in looking for gold in Peru, mapping plate boundaries in the Himalayas, finding diamonds in Canada, or exploring for oil in Greenland? Then electrical methods geophysics might be the place for you. EM specialists have done all of the above, and much else, and they might be the only branch of our profession which has.

In other words, if you like a challenge, you will get one in this specialty. That is guaranteed. In fact, it is the only guarantee that you will get. Intrigued or, better yet, challenged? Then read on.

What do EM geophysicists do? EM geophysicists usually participate in more than one phase of the geophysical process. Those involved in exploration (whether for minerals, petroleum, geothermal, water, etc.) help with field planning, may bird-dog a job, often process data, and interpret the data which will involve integrating them with other information (geologic and geophysical). Contractors perform the field acquisition, usually process the data, and may interpret them. They are also involved often in system design or modification and in research. Equipment manufacturers build the gear but may also work as contractors and are continually involved in new design work and research. Those in academic groups (such as universities, geologic surveys, and labs) develop new algorithms for understanding the processes but may also acquire data, build equipment, interpret data, and interface with the above groups.

Thus, a geophysicist working with EM has an opportunity to be talented (a nice way of saying better be, at the very least, somewhat competent) in many fields, and a variety of applications, which is not necessarily true of other geophysical fields. This can include equipment design, data acquisition, data interpretation, data processing, computer development of algorithms or displays, etc. People often work in teams, collaborating on concepts or integrating different types of data in an interpretation.



MT crews in Nicaragua (above) and EM on the North Slope of Alaska.

This is a major reason why some of us think EM is exciting for a geophysicist: You are involved in many of the steps that precede the final product.

Let me reemphasize that many EM geophysicists spend at least some portion of their careers (probably sooner rather than later, and often more rather than less) in the field. If you don't like field work, a career as an EM geophysicist would probably be torture. However, most of us enjoy this aspect of the job and regard it as an opportunity to understand how and why the technique is being used — information that can translate into better equipment design or interpretation.

What are electrical methods? Briefly, electrical and electromagnetic methods geophysics measure either natural or man-made electric and / or magnetic fields. The measured fields are normally time-varying (as opposed to "magnetics" which measures the earth's static magnetic field) but can also be frequency-varying. From these measurements, some parameter of the subsurface is derived. The most used parameter is resistivity (or its inverse, conductivity). These measurements can be taken on land, in the air, at sea, or in a borehole.

Examples of EM methods are magnetotellurics (MT), audio MT (AMT), controlled-source AMT (CSAMT), induced polarization (IP), direct-current resistivity (DC), and electromagnetics (EM). For brevity, I will abbreviate the techniques as EM methods for the remainder of the article, and no distinction will be made between EM and electrical methods.

MT crew in Turkey (above) and Montana.

What are EM methods used for? Major applications of EM geophysics include:

- looking for almost any resource (minerals, oil, gas, groundwater, or geothermal energy)
- environmental and engineering analysis, such as mapping brine contamination in the subsurface, locating archaeological sites or spent ordnance on bombing ranges
- fundamental scientific research like mapping plate boundaries and deep-seated structures

What is the history of EM methods? Electrical methods were first developed and used by the Schlumberger brothers in the early 1900s. Since then, the main developments were made by the Russians, eastern Europeans, and Canadians. Most advancements were encouraged because of EM's obvious "fit" for mineral exploration. It wasn't until the 1960s and 1970s that EM expanded into exploration for other resources and studies.

Recent improvements to EM systems mimicked improvements in seismic and other instrumentation — such as smaller and faster acquisition systems, smaller and faster computers, imaging routines for visualization of data and results, improved algorithms for interpreting and understanding data, and the use of GPS for

data synchronization and location.

What education is required to become an EM geophysicist? A basic geophysics degree, with an advanced degree with EM emphasis is usually required. However, there aren't many universities with classes in EM geophysics. Many students take some electrical engineering or physics classes or work with an advisor on a project where EM is used. A strong computer and math background is a plus, even if you just want to be on the application side of the geophysics, since it's needed to understand the data and concepts. A knowledge of geology is great if you plan on interpreting data and working more with direct application of the techniques.

What kind of companies do EM types work for? Very few oil and gas companies have in-house staff for EM applications. This is usually outsourced to contractors or consultants. A lot of contractors design systems and acquire data, and many of them also process and interpret data. Thus, an EM geophysicist regularly has the chance to "see" a project through from start to finish (acquisition to interpretation).

Some mining, engineering, environmental, and geothermal companies have EM geophysicists on staff. Universities and research groups (including geological surveys and national labs) employ EM geophysicists for research and projects.

EM geophysics is used all over the world and many, if not most, contractors work worldwide. Thus a career in EM can provide opportunity for travel, and it's not idyllic cruises but very exciting — with acquisition being done on volcanoes, mountainous areas, remote regions which are accessed by anything from helicopters to camel to snowmobile.

Where do I get more information? For an idea of some EM applications and developments, search through GEOPHYSICS and *TLE*, SEG *Expanded Abstracts*, as well as EAGE and ASEG publications. There are a few books on the subject (such as SEG's multivolume *Electromagnetic Methods in Applied Geophysics*, and *Geoelectrical Methods in Geophysical Exploration* by Zhdanov and Keller).

A career in EM is not for the faint of heart. We are constantly having to explain what we do, without involving too much math, and have to ride the ups and downs of many resources (oil prices, gold prices, environmental awareness). However, it is challenging and rewarding and can be applied to a great variety of tasks. TLE

Karen Rae Christopherson received a bachelor's degree in geology (1977) and a master's in geophysics (1979) from the University of Colorado. She worked for the U.S. Geological Survey and Standard Oil (now BP America) before founding Chinook Geoconsulting in 1988. She has been involved in all aspects of electrical methods geophysics. Her specialty is magnetotellurics in which she has been active on a worldwide basis for 20 years. She has been active in professional societies and is currently the Second Vice-President on the SEG Executive Committee.

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