

Dear Louise,

I would like to nominate Arnold Orange for the **2017 G.W. Hohmann Award for Lifetime Achievement**.

Arnie has had a career in basic and applied geophysics that spans well over half a century, starting with ionospheric phenomena, deep resistivity soundings, electrical properties of rocks under pressure, some of the earliest studies of ice thickness using ground penetrating radar, and moving on to the use of the magnetotelluric (MT) method for exploration. After pioneering the use of the MT method on land, he took the method into the marine environment and then extended his work to include marine controlled-source electromagnetic (CSEM) sounding. His final contributions employ numerical simulations to gain insights into the performance of various EM methods. I submit that this is a truly remarkable lifetime of achievements.

The first decade of Arnie's career was as a research scientist at the Air Force Cambridge Research Laboratories. During this time his profile was that of a highly successful academic, publishing several papers a year in journals such as *Science*, *Nature*, and *Journal of Geophysical Research*. He obtained his Master's degree at MIT, and although he regrets that he did not continue and get a PhD, his academic record from this time is one that many senior professors would be proud of. His work in radio propagation and micro pulsation activity resulted in his early interest in the MT method, and his 1965 paper with Bostick is in the first few dozen papers ever written to use the word *magnetotelluric* in the title. His three papers with Brace on the electrical properties of rocks are classics in the field, and have been cited a total of 471 times to date. The work with Cantwell to use controlled-source methods with huge source-receiver separations to study deep resistivity structure is also well cited, and was the first of its kind.

In 1965 Arnie moved into industry, working with various geophysical companies. He continued to publish, and during this time carried out and reported some of the first measurements of sea ice thickness using ground penetrating radar. During this time he worked with Keeva Vozoff to develop the MT method for exploration in sedimentary environments, and truly was one of the pioneers in the commercial use of MT for exploration. Arnie was instrumental in applying MT to structural imaging in overthrust settings, including North and South America, and led the first such application in Papua New Guinea. MT has now become a method of choice for hydrocarbon exploration there by the majors and independents.

The next stage of Arnie's career was as entrepreneur, founding Emerald Exploration in 1979 and then AOA Geophysics in 1989. AOA Geophysics was a successful consulting shop, and also the company behind the Geotools software package, which was one of the first environments to combine data management with modeling capabilities. Geotools was an early platform for the Occam code, making this program broadly available outside the academic environment. Arnie, and AOA Geophysics, are responsible for my entry into the marine exploration business, when Arnie approached me in 1993 to help a client extend a land survey offshore. AOA Geophysics provided the seed money to make the first offshore tests of an MT system designed to operate at the higher frequencies needed for exploration targets, and taught me how to work with MT data. As we developed the equipment systems, AOA would rent the Scripps MT receivers and carry out proprietary commercial surveys, and Scripps used the rental money to expand the instrument fleet, in a highly symbiotic relationship. Arnie and AOA conducted the first commercial offshore MT surveys in the Gulf of Mexico, North Atlantic, and Mediterranean.

Arnie's support of the early marine MT equipment development, and AOA's pool of trained, ocean-going field hands, were critical to the early commercialization of marine CSEM methods. He sent one of his people out on the first Statoil/Scripps/Southampton trial over the Girassol oilfield in deepwater Angola. With support from ExxonMobil, AOA and Scripps developed the specifications for a next-generation MT/CSEM receiver fleet, which was built by Scripps and then operated by AOA Geophysics, which spun off AOA Geomarine Operations (AGO) in June 2002. AGO carried out many commercial CSEM surveys and was purchased by *Schlumberger*, the giant oilfield services firm, in October 2004. Arnie has always delighted in being in the field, and worked closely on board the vessel with Len Srnka on several of ExxonMobil's marine CSEM surveys.

I worked closely with Arnie to build up AOA's and then AGO's marine EM capabilities, and while this cut into my research productivity somewhat, I found it a thoroughly exhilarating and enjoyable experience, a consequence of

Arnie's wonderful demeanor, sense of humor, strong scientific sense, and all-around nice-guyness. But what I would most like to emphasize about working with Arnie in the business world is that he is scrupulously honest. I never, ever, saw him compromise his principles in order to make more money or succeed in business. He would rather go bankrupt than do anything unethical (and I can tell you, he was tested a few times).

Arnie retired from AGO at the end of 2006 to share his time between AOA Geophysics and the Scripps marine EM group as a volunteer. In July 2011 *Fugro* purchased AOA Geophysics, leaving Arnie's primary affiliation as Scripps, where he became a Research Associate in 2009. Arnie had never stopped publishing while he was working in industry, but now he has returned to his roots as a full-time researcher (give or take spending time with grandchildren). His first paper with his Scripps affiliation, on which he is senior author, has become the benchmark publication on the feasibility of using marine CSEM for reservoir monitoring during production, and has been cited 50 times so far (ISI: 103 if you prefer Google Scholar).

Arnie's publication record, while certainly respectable (until recently he had more *Science/Nature* papers than I did, and even now is equal to me by that metric), will not match those of academics being nominated for this award. But, this must be placed in the context of his founding three companies, one of which achieved the gold standard of being bought by *Schlumberger*, and of being a pioneer in the use of land MT for exploration, *the* pioneer in the use of marine MT for exploration, and a pioneer in the use of marine CSEM for exploration.

Detractors might say that the academic aspect of his career has been carried by teaming up with luminaries such as Bill Brace, Francis Bostick, and, if I may, myself. I would counter this by saying that's just clever, and these people get to choose who they work with – Arnie earns his keep in these collaborations, but, as I found out, he prefers to let others take the senior authorships and the responsibility of dealing with recalcitrant editors and reviewers.

Another thing that makes Arnie exceptional is that he's still very active. There are other, very eminent, people in our field whose lifetime achievements ended a decade ago, many of them younger than Arnie. That he is still doing influential and publishable work into his late seventies/early eighties speaks to an energy and ability that would be the envy of many. It also supports the case that now is the right time to appropriately recognize his continued contributions to the field of Electromagnetic Geophysics with the G.W. Hohmann Award. I think Gerry would approve.



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