

# **Ex. PGS 1026**



*Honors & Awards Program  
and Presidential Session*



75TH ANNIVERSARY

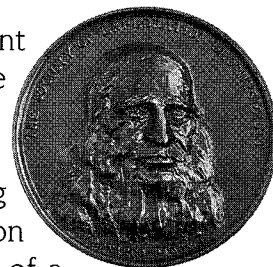
SOCIETY OF EXPLORATION GEOPHYSICISTS  
1930 – 2005

GEORGE R. BROWN CONVENTION CENTER • HOUSTON, TEXAS  
4 P.M., SUNDAY • 6 NOVEMBER 2005



# Virgil Kauffman Gold Medal

A fund has been established by Virgil Kauffman, former president of Aero Service Corporation, to encourage improvement in the science of geophysical exploration. The Kauffman Gold Medal is awarded to a person who, in the unanimous opinion of the Honors and Awards Committee and the Executive Committee, has made an outstanding contribution to the advancement of the science of geophysical exploration as manifested during the previous five years. The contribution may be of a technical or a professional nature.



## Recipients of the Virgil Kauffman Gold Medal

2005	Robert J. Greaves Terry Fulp	1991	Oz Yilmaz	1977	M. B. Widess
2004	N. Ross Hill	1990	Richard A. (Rusty) Alford	1976	Peter R. Vail
2003	Gregory A. Partyka	1989	Ira David Hale	1975	Stephen Chelminski
2002	Michael Batzle Zhijing (Zee) Wang	1988	Stuart Crampin	1974	David W. Strangway
2001	Patrick Connolly	1986	John W. C. Sherwood	1973	Samuel J. Allen
1999	Eivind W. Berg James E. Martin Bjørnar A. Svenning	1985	William J. Ostrander	1972	Nigel A. Anstey
1998	Michael S. Bahorich	1984	Fred J. Hilterman	1971	Joseph Zemanek
1997	George A. McMechan	1983	Sidney Kaufman Jack E. Oliver	1970	Roy O. Lindseth
1996	Ilya Tsvankin	1982	J. T. Cherry Kenneth H. Waters	1969	Robert E. Sheriff
1995	Fred J. Barr Jr. Joe I. Sanders	1981	S. Norman Domenico	1968	Howard A. Slack
1994	Davis W. Ratcliff	1980	A. R. Barringer	1967	Lucien J. B. LaCoste
		1979	Carl H. Savit	1966	Cecil H. Green
		1978	William J. Zwart		



Robert Greaves and Terry Fulp are receiving the Virgil Kauffman Gold Medal for their pioneering work in 4D or time-lapse seismic to monitor the fluid movement within a producing hydrocarbon reservoir. Their efforts, done while working at ARCO in 1982-83, were the first successfully repeated 3D (actually three 3Ds over a one-year period) that not only monitored the fluid movement in the reservoir, but also tied the seismic changes to the rock and fluid properties. In fact, it was in the latter part of the decade that 4D really began to attract the attention of the industry. Greaves and Fulp presented their work at the SEG Annual Meeting in 1983 and published their results in 1987 (for which they received a Best Paper in GEOPHYSICS Award). Even though Bob and Terry left the industry to pursue other earth science careers, they were recommended for this award because 4D has now become mainstream commercial technology. One 4D expert recently said, "The work done by Greaves and Fulp was way ahead of its time."



## Virgil Kauffman Gold Medal for Robert J. Greaves

by Arthur B. Weglein

It is a distinct and special pleasure to write this citation for Robert J. Greaves. This award recognizes both his leadership of a visionary 4D project and the first, and pioneering, conceptual development and practical contribution to the field of 4D seismology.

Bob Greaves received a bachelor's degree with distinction in physics, magna cum laude, from Boston University, and went on to earn a master's in exploration geophysics from Stanford University and then a PhD from MIT/WHOI in marine geology and geophysics, under the mentorship of Ralph A. Stephen at WHOI and M. Nafi Toksoz at MIT.

His career in exploration geophysics began with Gulf Oil in 1977, and he moved to ARCO in 1980. At ARCO Bob was promoted from research scientist to senior research scientist and then technical coordinator/senior research scientist. Bob led the historic seismic time-lapse experiment in the Holt Sand In-Situ Combustion reservoir engineering project. The purpose was to determine the efficiency of oxygen-fed in-situ combustion as a thermal tertiary EOR process. The 3D seismic surveys, repeated three times between 1982 and 1983, determined preburn, midburn and postburn reservoir conditions; it was the first ever such 4D field test, and it was onshore. That first 4D experiment was a success, demonstrating the usefulness of time-lapse for monitoring changes to a reservoir caused by production operations.

That forefront research effort was way out ahead of industry practice at the time. The subsequent history of 4D speaks volumes to the early vision and contribution of Greaves and Fulp. That 4D effort at ARCO depended on a supportive management and technical infrastructure that made such advanced research possible. Among those deserving recognition are Eddie Neitzel, Jim Gant and Jamie Robertson, who provided both technical review and enthusiastic management support throughout the life of the project.

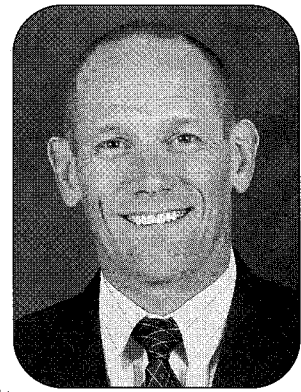
As with many petroleum companies, ARCO went through phases of great and less-than-great support for fundamental high-impact research. On its best days ARCO was able to rise to great heights and scale great technical challenges, well before the rest of the industry, and was visionary and peerless in areas where it decided to excel and lead. The "roll your own" ARCO ambience prevented a dominant and sometimes stifling technical corporate culture and inertia and, hence, could allow an inventive spirit to flourish.

The 4D fundamental research effort of Robert J. Greaves, and his colleagues, represented one of the high-water marks of that ARCO golden era. In a broader sense it is representative of the best thinking, sharpest and most effective management and scientific and technical impulses and instincts that reside within our industry.

I have known Bob Greaves since we worked together at ARCO some 20 years ago. Bob has an amazing sense of data, and an almost instinctual, intuitive grasp and understanding of what data communicates that represents a unique talent and gift. He has a beguiling, low-key and unassuming understated manner, and a dry sense of humor that, in fact, covers an amazing breadth and depth of understanding of seismic acquisition, seismic processing theory and practice, and data interpretation. Bob Greaves is an absolutely first-class, high-impact, leading-edge geoscientist; he is direct, plain spoken, clear, impeccably honest, and a model and lodestone of professional and personal integrity. Bob Greaves produces world class quality contributions in every endeavor he pursues—and he has produced several including contributions in wave-field modeling of seafloor scattering, cross-well seismic imaging, and ground-penetrating radar.

While we recognize and celebrate the accomplishments leading to this award, we fully anticipate and look forward to further visionary breakthroughs and contributions from Bob Greaves.

Robert Greaves and Terry Fulp are receiving the Virgil Kauffman Gold Medal for their pioneering work in 4D or time-lapse seismic to monitor the fluid movement within a producing hydrocarbon reservoir. Their efforts, done while working at ARCO in 1982-83, were the first successfully repeated 3D (actually three 3Ds over a one-year period) that not only monitored the fluid movement in the reservoir, but also tied the seismic changes to the rock and fluid properties. In fact, it was in the latter part of the decade that 4D really began to attract the attention of the industry. Greaves and Fulp presented their work at the SEG Annual Meeting in 1983 and published their results in 1987 (for which they received a Best Paper in GEOPHYSICS Award). Even though Bob and Terry left the industry to pursue other earth science careers, they were recommended for this award because 4D has now become mainstream commercial technology. One 4D expert recently said, "The work done by Greaves and Fulp was way ahead of its time."



## Virgil Kauffman Gold Medal for Terry Fulp

by Walt Lynn

It is very fitting, and arguably late, to honor Terry Fulp and Robert Greaves for their pioneering work in time-lapse seismology. Time-lapse, or 4D, seismic is often mentioned and considered in today's industry; but it is remarkable that one of the most sophisticated and comprehensive 4D experiments was done in the early 1980s under conditions that even today are considered formidable. It is still considered one of the "textbook" cases, even though more than two decades have passed.

Terry Fulp received his bachelor's degree in earth sciences at the University of Tulsa in 1975, his master's in geophysics at Stanford University in 1977 (where I first met Terry and Bob Greaves), his master's in civil engineering at the University of Colorado in 1988 and his PhD in mathematical and computer sciences at the Colorado School of Mines in 1996. It was during his tenure at ARCO, 1977-1986, that Terry, Bob, and colleagues designed, implemented, and successfully interpreted the first time-lapse series of 3D surveys over a producing field. It is also a tribute to the forward thinking of ARCO's R&D management to fund and proceed with this project.

To truly appreciate the sophistication of the ARCO time-lapse experiment, I asked Jamie Robertson (then director of ARCO's Development Geophysics Group) to provide his recollections. I preface his kind response with the note that the Holt Sand time-lapse project was a true team effort and many people were involved, including previous Kauffman Gold Medalist Mike Batzle. However, Bob and Terry were the key people to work through and integrate the entire project.

"The Holt Sand project was a reservoir engineering experiment to determine whether oxygen in-situ combustion was superior to air-driven in-situ combustion as a thermal tertiary EOR process," Robertson said. The engineers drilled two five-well patterns (one injector surrounded by four production wells) plus a number of boreholes that were instrumented to monitor the fireflood. Air was injected in one pattern and oxygen in the other, so there was a side-by-side comparison. Preburn drilling and coring were conducted in late 1981 to early 1982, and the patterns were ignited in March/April 1982. The air pattern was terminated in August 1982 owing to poor performance. The oxygen pattern continued until December 1982, and postburn coring in the oxygen pattern was conducted from December 1982 to February 1983.

"The EOR activity in the oxygen pattern was monitored by three 3D seismic surveys spaced over a year or so that were compared to each other in a time-lapse fashion (what is now called 4D, although ARCO never used this term). The baseline survey was acquired about January 1982, the midburn survey about August 1982 and the postburn survey about February 1983. Time-lapse data were not collected on the air pattern owing to its early termination. The receivers were single, buried, cemented geophones at about 6-m spacing; the sources were dynamite shots. Since the reservoir was at a depth of less than 2000 ft, the reservoir reflection had a center frequency of about 100 Hz. The oxygen injection plus gaseous combustion products plus thermal alteration of the reservoir rock produced an artificial bright spot at Holt Sand level that was easily detected and mapped by the midburn and postburn 3D surveys as the bright spot spread out from the injection well. The flow of the gaseous fluids was not circular around the injection well but appeared to follow paths of better porosity and to be blocked by barriers like faults as one might expect. There was a strong limestone reflector immediately below the Holt Sand. This reflector dimmed underneath the gas stream as the gas propagated outward from the injection well, so the activity in the reservoir was also mapped by this dimming at a deeper reflector. All in all, the experiment was very successful at demonstrating the usefulness of time-lapse seismic for monitoring changes to a reservoir caused by production operations."

Considering the complexities, which include land reservoir, oxygen injection and ignition, the state of 3D, let alone 4D, processing and interpretation in the early 1980s and seismic linkage to rock properties, the Holt Sand time-lapse remains one of the most comprehensive and sophisticated 4Ds to this day.

Like many geophysicists in our industry, Terry left the oil and gas industry in the late 1980s. He is now area manager, Boulder Canyon Operations Office at Hoover Dam. I have known Terry for 30 years and can personally attest to his integrity, work ethic, determination, geophysical and hydrological knowledge and insights and most important of all, his kindness, fairness and respect for his colleagues and friends. I am very proud and honored to write this citation for an incredible individual.