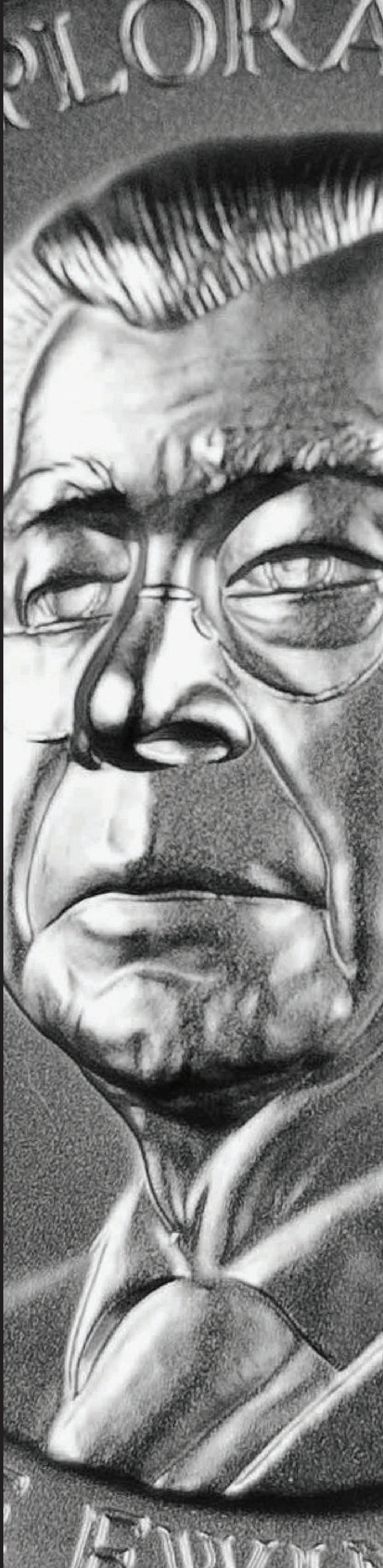
MAURICE EWING MEDAL

To honor the memory of Maurice Ewing and his enormous contributions to geophysics, this award was established for presentation for the first time in 1978 as the highest honor given by SEG. The Maurice Ewing Medal shall be awarded from time to time to a person who, by a unanimous vote of both the Honors and Awards Committee and of the Board of Directors, is deserving of special recognition through having made major contributions to the advancement of the science and profession of exploration geophysics. The award of the Maurice Ewing Medal shall confer Honorary Membership on its recipients.



Recipients of the Maurice Ewing Medal

2019 Robert H. Stolt
2018 Albert Tarantola
2017 Samuel Gray
2016 Arthur Benjamin Weglein
2015 Manik Talwani
2014 Norman Bleistein
2013 Peter Hubral
2012 George A. McMechan
2011 Amos M. Nur
2010 Anthony R. Barringer
M. Nafi Toksöz
2009 David W. Strangway
2008 John W. C. Sherwood
2007 Roy Oliver Lindseth
2006 Fred Hilterman
2005 Robert J. Graebner
2004 Vlastislav Cerveny
2003 A. J. Berkhout
2002 Gordon F. West
2001 Enders A. Robinson
2000 Stanley H. Ward
1999 Gerald H. F. Gardner
1998 Robert E. Sheriff
1997 Thomas R. LaFehr
1996 Kenneth L. Larner
1995 Harold O. Seigel
1993 M. Turhan Taner
1992 Jon F. Claerbout
1991 Theodor C. Krey
1990 Milo M. Backus
1989 Sven Treitel
1988 Franklyn K. Levin
1987 Arthur A. Brant
1986 J. E. White
1985 N. A. Anstey
1984 L. L. Nettleton
1983 W. Harry Mayne
1982 Frank Press
1981 J. Tuzo Wilson
1979 C. Hewitt Dix
1978 Cecil H. Green

Robert H. Stolt

Robert Stolt was awarded the Reginald Fessenden Award for his pioneering landmark contribution to seismic migration in the Fourier domain. One of his subsequent major contributions was the extension of his original f-k migration algorithm to provide the only comprehensive, inclusive and effective method for imaging and inverting specular and non-specular reflectors. He has been and remains the epitome, the lodestone, and the main engine of direct seismic migration and inversion methods that are based on well-founded physics with clear derivations that make both the strengths and the limitations and assumptions behind his new methods and algorithms transparent and abundantly clear. He has been a leader in extending and merging two previously disjointed and unconnected activities into one framework with migration-inversion.

by Arthur B. Weglein

Robert H. Stolt earned his PhD in physics at the University of Colorado, in the research area of parastatistics, mentored by professor John Taylor, followed by a postdoctoral fellowship with professor Wes Britain in many-body theory. Bob entered the petroleum industry and joined Conoco Research in Ponca City, Oklahoma, in 1971. At Conoco, Bob flourished in a positive and enlightened Conoco research culture, moving to a technical leadership position and inheriting the mantle of preeminent researchers like Pierre Goupillaud and Jerry Ware.

In 1980, Bob received the SEG Reginald Fessenden Award for his pioneering work on *f-k* migration. His contribution is known worldwide as Stolt *f-k* migration. In 1998, Bob received the SEG Honorary Membership Award, recognizing his landmark contributions to seismic migration and inversion.

In this citation, I will describe Bob's substantive and impactful contribution since 1998 that goes far beyond his earlier landmark contribution to *f-k* migration.

Wave theory methods for migration were introduced in the 1970s. These migration methods consisted of two ingredients — a wave propagation model and an imaging principle — and three distinct imaging principles were introduced. The imaging principle behind *f-k* migration involved using surface-recorded reflection data to predict a source and receiver reflection experiment at a coincident point in the subsurface and asking for the time-equals-zero value of that experiment. That imaging principle has tremendous conceptual and practical advantages in terms of clarity, meaning, and physical interpretability when compared to the other two original imaging principles.

Bob made two major conceptual and practical extensions to the most effective of the original imaging principles that resides behind *f-k* migration. The *f-k* migration result outputs a data-like scalar point function, a structure map, and image. Bob realized that to output more than a number at each point on the structure map — to provide, for example, an angle-dependent function (for amplitude analysis) at every point on the structure — the original and at that time most effective imaging principle behind *f-k* migration was too rigid and restrictive. He recognized that the original *f-k* migration result produced a highly localized band-limited singular function at every point on the structure, and within the character of that singular function resided information on the angle-dependent information needed to go beyond a structure map to amplitude analysis. Bob responded to that challenge and introduced a new imaging principle, by relaxing the coincident source and receiver condition of the original *f-k* migration. He examined the resulting offset dependence of the original *f-k* migration imaging principle in the Fourier conjugate to offset domain. The latter dependence provided angle-dependent amplitude information, and subsequent analysis, at every point on the structure map. Bob's advance from migration to migration-inversion can be viewed as a (naturally and much more complicated) multidimensional extension and generalization of the earlier one-dimensional NMO-stack evolving to NMO-AVO. The second part of his new and extended imaging principle introduces the concept of a point reflectivity that automatically accommodates specular and non-specular reflectors. To realize those advances, Bob connected with and extended linear inverse scattering methods to prestack seismic data and multiparameter acoustic and elastic 2D and 3D earth models. That allowed the original wave theoretic migration and imaging principle behind Bob's *f-k* migration to provide a fundamentally new and quantitatively interpretable imaging principle for migration. Rather than seen as the end product, this new migration is now a preprocessing intermediate step and stage for first locating where any subsurface physical property changed (a reflector) and then to determine what specifically has changed and by what amount. Migration evolved into migration-inversion, determining first *where* something changed (migration) before using that new extended form of *f-k* migration to determine *what* specifically changed and by what amount (inversion). That contribution provided a new framework that superseded the conventional view that these were two (i.e., migration and inversion) entirely unrelated topics. Prior to Bob's advancement, those who practiced migration and those who practiced amplitude analysis (for example, trace integration, model-matching and AVO) basically ignored each other (at best) and their inconsistent and contrary views of the world. Bob extended the imaging principle to allow for both structure and amplitude analysis in a multidimensional subsurface, that with one algorithm automatically accommodates planar, curved, undulating, and diffractive reflectors and pinch-outs. At that time, the seismic world was separated into two camps: migration and amplitude analysis. The migration community cared about "where" in a multidimensional subsurface, but didn't care about "what" changed, while the amplitude analysis people assumed a one-dimensional subsurface and cared about what changed but didn't care about where. In many research labs, these two groups were kept physically separated and often were located on different floors.

As with all major new ideas in the history of science, Bob's idea of "where before what," or migration-inversion in a multidimensional subsurface, faced tremendous headwinds and resistance from both the migration and the AVO communities and practitioners. Bob and his colleagues held steady, kept moving forward, and eventually persevered.

Bob was the concept and idea generator, the point man and driving force in the development of migration-inversion, a major advance in seismic data processing.

That development was inspired and influenced by scattering theory concepts. Bob's extended source and receiver experiment at depth imaging principle was the most comprehensive, capable, and interpretable imaging theory for migration at that time, and remains that today. The M-OSRP group at the University of Houston has recently advanced Bob's extension of his original *f-k* migration method to allow for discontinuous rapidly varying and smoothly varying heterogeneous media, producing the first migration method for a heterogeneous subsurface that avoids high frequency approximations, in both the imaging condition and the wave propagation model. That migration is equally effective for all frequencies at the target, with practical advantages for structural resolution, illumination, and target identification.

Bob's contribution to the theory of migration ultimately entered inverse scattering series (ISS) multiple removal methods that he helped pioneer and collaborated on, producing methods that allowed multiples to be removed that were generated by specular or nonspecular reflections, without needing to know, estimate, or ever determine anything about the subsurface or the reflectors that generated the multiples.

Those multiple removal methods are the most capable methods available today and are offered by all the major oil service companies, (among them PGS, Western-Geco Schlumberger, BGP, CGG, and TGS) with innumerable published references from both industry and academia that document the worldwide usage and impact on both offshore and onshore plays. In addition to being the only methods for free surface and internal multiple removal that require no subsurface information, another reason the ISS internal multiple attenuation and elimination algorithms are so effective is the ISS internal multiple algorithms incorporate the prestack form of extended *f-k* migration that Bob pioneered and delivered, the only form of migration (the most capable and effective migration method at that earlier time, and currently) that within the context of multiple prediction automatically accommodates both specular and nonspecular multiple generators, including pinch-out generators and head-waves as subevents of the multiple to be removed. The most popular form of migration today, reverse time migration, in all its various extensions and incarnations, derives from a separate and intrinsically less capable choice among the three original imaging principles, and they are unable to match that set of standalone imaging, resolution, illumination, and inversion strengths and capabilities.

Over the years, the direct inversion methods that were derived as distinct isolated task inverse scattering subseries (for free surface and internal multiple removal, depth imaging, parameter estimation, and Q compensation, each without any subsurface information known, estimated or determined) would run into either theoretical, practical, or political obstacles with no shortage of naysayers at every step of the way. Bob was the one individual in our leadership team always ready with a positive word of optimism, encouragement, and support, and always available at a darkest moment when needed most. Bob has played and continues to play a key role in that success and continuing campaign and delivery. I will always remember and will forever be grateful and appreciative.

During the 1980s, Bob was developing computer processing algorithms for dip moveout and amplitude-preserving prestack cascading time migration. Bob's work in migration and inversion culminated in coauthorship (with Al Benson) of a classic migration textbook published in 1986.

In 2012, Bob and I published the first of a two-volume graduate text for Cambridge University Press, *Seismic Imaging and Inversion: Application of Linear Inverse Theory*. The second volume, *Seismic Imaging and Inversion: Application of Direct Non-Linear Inverse Theory*, is currently underway and being written. Volume two provides a first single comprehensive framework and platform that derives both the direct linear seismic methods for imaging and inversion that require a velocity model (volume one) and the direct non-linear methods for all seismic processing objectives that do not require or need a velocity model or any subsurface information (volume two) with the former derived as a special and limiting case of the latter. Those two volumes describe what Bob, his coauthor, their colleagues, and their students have pioneered, developed, and continue to deliver, along with open issues.

During 1979–1980, Bob served as a consulting professor and acting director of the Stanford Exploration Project. He helped that prestigious group in developing breakthroughs in inversion and multiple attenuation. Bob has served SEG in a number of capacities including as associate editor and then editor of GEOPHYSICS, Chairman of the Publications Committee, Technical Program Chairman of the 1994 Annual Meeting, and as a member of the Research Committee since 1991. He is an Honorary Member of the Geophysical Society of Tulsa.

Bob was selected to receive the DuPont Lavoisier Medal, an award recognizing great technical and creative accomplishments and contributions over many years that resulted in a measurable business impact of enduring significance. The winners represent the best scientists and engineers in DuPont's history, and Bob is one of the few recipients who was an active employee at the time of his award. In 2017, Bob was inducted into the Offshore Energy Center Hall of Fame.

Bob was the highest-ranking technical person in Conoco. In his role as senior research fellow, he made tremendous advances in imaging and in multiple attenuation. He continues to be extremely active and productive since his retirement from ConocoPhillips.

Bob is devoted and dedicated to his wife Donna, his family, and his community. He is a role model of quiet confidence, competence, and integrity.

It has been my great good fortune to work with many brilliant, creative, and prolific scientists, and it is not the slightest exaggeration to say that Bob is in a separate highest tier and category by himself. It is my honor, privilege and pleasure to write this citation for the 2019 SEG Maurice Ewing Award for Robert H. Stolt.