Lessons from a Decade of Discovery Thinking*

Charles A. Sternbach1

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Abstract

AAPG/DPA Discovery Thinking Forums began in 2007. This initiative of the 100th Anniversary committee featured discoverers telling stories about new field or new play discoveries at invited Forums at AAPG Annual Meetings. These immediately became a popular and integral part of the ACE Technical Program. Global interest required that Discovery Thinking forums should also become a part of the ICE Technical program, which they did in 2012.

In the decade since inception, 18 Discovery Thinking Forums have been hosted at both ACE and ICE events. More than 100 speakers and their co-authors have presented discoveries they know well commonly to standing room only audiences. We owe these “100 who made a difference” heartfelt gratitude as we celebrate the AAPG Centenary. They have generously gifted us with hard won and costly insights leading to significant discoveries. They offer analogs for technical and business success. Their greatest lesson to us? As Michel T. Halbouty said of pioneering wildcatters: “If they could do it, why can’t we?” During the two Discovery Thinking Forums planned for the Houston ACE 2017, we pay tribute to the 115 men and women who have participated in these forums. We will feature several brief representative vignettes of previous presentations spotlighting valuable exploration lessons. These will be distributed throughout a lively program of 8 new significant discoveries in a morning and afternoon forum.

Resources hosted on the AAPG Search and Discovery website (Special Collections, Discovery Thinking) form an enduring heritage to modern and future explorers. Multimedia presentations of previous Discovery Thinking talks have been viewed more than 40,000 times (as of this writing). In addition, AAPG/DPA has launched Playmaker Forums, 1-day stand-alone events on Discoveries. Playmakers also offer a collection of multimedia presentations. Thanks to all the presenters. We celebrate their success and thank them for leaving their heritage better than they found it. May they inspire us to continuously make new discoveries.

Discovery Thinking

Houston ACE April 3, 2017 Morning,
Charles Sternbach and Paul Weimer
Today’s Programs

#17,18 ACE Houston, 2017

Discovery Thinking Forum, Houston ACE April 3, 2017 (#17)
Chair: Charles Sternbach and Paul Weimer
(WORKING LIST) WESTERN HEMISPHERE and GOM SESSION

- “Lessons in Exploration Creativity from a Decade of Discovery Thinking Forums”, Charles Sternbach, President-elect AAPG
- “Discovery of a Bolivian Foothills Giant Gas Field: Incahuasi”, Philippe Mallard, Total, SA.
- “Discovery of the Utica Shale—Update on an evolving giant”, Bill Zagorski, Chief Geologist, and Taylor McClain, Senior Geologist, Range Resources
- “A Fresh Look to Exploration and Discoveries in Mississippi Canyon, Northern Gulf of Mexico”, Eric Zimmermann, Vice President – Geology, LLOG

Discovery Thinking Forum, Houston ACE April (#18)
Chair: Charles Sternbach and Paul Weimer
(WORKING LIST) GLOBAL SESSION

- “The Future of Exploration- the next decade” Bob Fryklund IHS, Chief Strategist- Upstream and Pete Stark
- “Opening new oil basins: a pattern of discoveries”, Angus McCoss, Exploration Director, Tullow, “The Greater Gorgon Area, Northwest Australia: Exploration to Production” Mike McLerie, Geophysical Advisor, Chevron Eurasia Business Unit
Discovery Thinking Vignettes
Chaired by: C. Sternbach and P. Weimer

- Morning Break
  - Orion Skinner
  - Dick Stoneburner
  - James Cearley

- Afternoon Break
  - Hans Ronnevik
  - Ed LoCricchio
  - Greg Jewell
Tribute to Past Speakers, organizers, and lessons for today

- Fulfilled Decade long promise to Recognize “100 who made a difference” (with 115+)
- Speakers include: 2 Sidney Powers, 6 Halbouty and 9 Outstanding Explorer awardees
- If you like Discovery Thinking forums, there are also Playmaker Programs
- Video Resources for Explorers on Search And Discovery, Special Collections
Where and When have they spoken?

- ACE San Antonio, 2008
- ACE Denver, 2009
- ACE New Orleans, 2010
- ACE Houston, 2011
- ACE Long Beach, 2012
- ICE Singapore, 2012
- ACE Pittsburgh, 2013
- ICE Cartagena, 2013
- ACE Houston, 2014
- ICE Istanbul, 2014
- ACE Denver, 2015
- ICE Melbourne, 2015
- ACE Calgary, 2016
- ICE Cancun, 2016
- ACE Houston, 2017

Upcoming events (red)
Thank you to Co-Organizers

**Discovery Thinking**
- Charles Sternbach (18)
- Ed Dolly (8)
- Paul Weimer (8)
- Ted Beaumont (1)
- Gabor Tari (1)
- Peter Baille (1)
- Mike Canich (1)
- John Hogg (1)
- Victor Vega (1)
- John Kaldi (1)
- Jonathan Craig (1)
- Chandler Wilhelm (1)

**Playmakers**
- **Mike Party**
- **David Entzminger**
- **Rick Fritz**
- **David Cook**
- **Marty Hewitt**
- **David Dolph**
- **Bill Haskett**
- **Dan Billman**
- **Steve Sonnenberg**
- **Kurt Neher**
- **Greg Gordon**
- **Vaughn Thompson**
- **David Curtiss**
- **Susan Nash**
- **Amy Mahan**

Thanks to Linda Sternbach for her pioneering work in multimedia.
Thank you to 115 previous Discovery Thinking speakers and their co-authors.
A Special Thank You to the Following Speakers and Co-authors
Thank You
Discovery Thinking
Chaired by: C. Sternbach and P. Weimer

Discovery Thinking Forum, Houston ACE April 3, 2017 (#17)
Chairs: Charles Sternbach and Paul Weimer

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Lessons from a Decade of Discovery Thinking

Charles A. Sternbach
Lessons from a Decade Of Discovery Thinking

- Short vignettes from the video collection throughout the talks today
- Exciting Decade with many technological innovations
- Conceptual contexts for the Discoveries
- Technology Transfer, AAPG plays a key role
- Geoscience adds critical incremental value
Lessons from a Decade Of Discovery Thinking

- “Geology is a Science, Exploration is a Business”
- “History is valuable; additive to personal experience”
- Focus Efforts On Following Oil From Source To Trap…
- Think Like Oil!

-- Marlan Downey

DT #1, ACE San Antonio 2008
Sidney Powers Medalist
Lessons from a Decade Of Discovery Thinking

- Technology Transfer around the globe.
- AAPG and other professional societies help transfer oil finding “know how”

Everette Lee DeGolyer
Max Steineke
US Dominated Exploration 1856 – 1925

From Merrill and Sternbach, 2017 “The AAPG Century–Giant Fields through the decades”
Global Expansion 1926 – 1945

From Merrill and Sternbach, 2017 “The AAPG Century—Giant Fields through the decades”
Post WWII Growth 1946 - 1970

Giant Fields of the World
Post-WWII Growth
1946-1970

From Merrill and Sternbach, 2017 “The AAPG Century—Giant Fields through the decades”
OPEC & Nationalization 1971 – 1987

From Merrill and Sternbach, 2017 “The AAPG Century—Giant Fields through the decades”
Globalization & Mergers 1988 – 2005

From Merrill and Sternbach, 2017 “The AAPG Century—Giant Fields through the decades”
Emerging Countries 2006 – Present

From Merrill and Sternbach, 2017 “The AAPG Century–Giant Fields through the decades”
Lessons from a Decade Of Discovery Thinking

• Multimedia: increases broadband
• Learning on demand
• Team learning
• Building on our Heritage
Legacy of Discovery: Resources for Explorers

Charles A. Sternbach
Lessons from a Decade Of Discovery Thinking

• Discovery Thinking Forums allow people to tell of their success, their discoveries, their proudest and happiest of times.

• Their gift in return enables us to share in their glory, and perhaps to inspire us to our own great moments.

• “If they could do it, why can’t we?”
  – Michel T. Halbouty
Lessons from a Decade Of Discovery Thinking

- Exploration is based on analogs
- Lateral Thinking
- Geology Makes the Incremental Difference
- Vignettes:
  - John Amoruso Cotton Valley, East Texas
  - Jim Henry, Wolfcamp, Permian Basin
John Amoruso, Outstanding Explorer
DT #3, ACE San Antonio 2010

Bossier E. and Cotton Valley, East Texas
Discovery of Amoruso Field, A new East Texas giant

John Amoruso, Outstanding Explorer
DT #3, ACE San Antonio 2010
Wolfcamp Geology – Midland Basin

West

Coarse Grained

High Stand - Sea Level

Fine-Grained

Central Basin Platform

Areas 2 & 3
Sweetie Peck Chickadee

Slope

Proximal Debris Apron

Distal Debris Apron

Area 1 ARCO + CMS

East
Wolfcamp/Wolfberry/Wolfbone Play, lessons

• Geology impacts completion strategy
• Thin beds require Hydraulic Fracturing
• Share the wealth with employees
• Advice to Young Professionals: Come to Midland!
Lessons from a Decade Of Discovery Thinking

- Vignettes from video collection throughout talks today
- Exciting Decade with many technological innovations
- Conceptual contexts for the Discoveries
- Technology Transfer, AAPG plays a key role
- Geoscience adds critical incremental value
- AAPG future focus on petroleum
- Global population and energy demand grows!
- “100 years of science fueling 100 years of prosperity”
Discovery Thinking Vignettes
Chaired by: C. Sternbach and P. Weimer

• Morning Break
  – Orion Skinner
  – Dick Stoneburner
  – James Cearley

• Afternoon Break
  – Hans Ronnevik
  – Ed LoCricchio
  – Greg Jewell
Bakken, Williston Basin

Orion Skinner, Outstanding Explorer
DT #5, ACE Long Beach 2012
Bakken, lessons

• Open minded to sweet spots factors
• Many benches mean multiple play targets
• Hydraulic Fracturing of Horizontal wells
• Use SEM and core analysis on site
• Lag deposits define key horizons
• Core control key aspect

Orion Skinner, Outstanding Explorer
DT #5, ACE Long Beach 2012
Eagle Ford, GOM onshore,

Prospect Identification: Unconventional Analogy

- Eagle Ford Shale Prospect
- Known regional source rock across large petroliferous basin
- Reservoir quality and geochemical attributes poorly understood
- The area was >10 MM acres with high side resource potential of >10 BBOE

Dick Stoneburner, Outstanding Explorer
DT #8, ICE Cartagena, Colombia 2013
Eagle Ford, GOM onshore,

A Key Aspect of Quality Shale Reservoirs: Vertical Heterogeneity

Dick Stoneburner, Outstanding Explorer
DT #8, ICE Cartagena, Colombia 2013
Eagle Ford, GOM onshore,

**Unconventional Exploration: A Different Way of Thinking**

<table>
<thead>
<tr>
<th>Conventional</th>
<th>Unconventional</th>
</tr>
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<tbody>
<tr>
<td>• Project identification focuses “outside in”</td>
<td>• Project identification focuses “inside out”</td>
</tr>
<tr>
<td>• Seismic control works “outside in”</td>
<td>• Seismic control works “inside out”</td>
</tr>
<tr>
<td>• Stratigraphic support eventually focuses on the facies analysis local to the prospect</td>
<td>• Stratigraphic support focuses on analysis of the entire basin</td>
</tr>
<tr>
<td>• Reservoir quality issues are relegated to the area of the prospect</td>
<td>• Reservoir quality analysis is required over a very broad area of the basin</td>
</tr>
</tbody>
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Dick Stoneburner, Outstanding Explorer
DT #8, ICE Cartagena, Colombia 2013
Deepwater GOM

Geographic & Geologic Provinces of the Gulf of Mexico Basin

- Texas
- Louisiana
- New Orleans
- Houston
- Shelf
- Deepwater
- Salt Dome Province
- Salt Ridge Province
- Salt Canopy Province
- Miocene Trend
- Lower Tertiary (Wilcox) Trend

James Cearley
DT #4, ACE Houston 2011
Deepwater GOM

Deepwater Gulf of Mexico
Evolution of Play Types and Salt Tectonics

Gulf of Mexico Deepwater Exploration
1,300' – 10,000' water depth

Welded Salt Canopies
Inflated Salt Canopies

Norphlet Trend
Miocene Trend
Wilcox Trend

Salt Rollers
Salt Domes
Inverted Basins
3-way Closures
3-way Closures
Salt-cored Folds

Plio-Pleistocene
Lower Tertiary
Mesozoic

Thunder Horse
Tahiti
Kaskida
Tucker
St Malo
Das Bump

Geologic architecture controlled by salt
Thick Jurassic salt loaded by sediment
Salt displaced vertically and laterally

James Cearley
DT #4, ACE Houston 2011
Wilcoxon Deepwater GOM, Lessons

- Bet on Technology
- Integrate Technical information
- Exploration requires long term commitment
- Look for oil in place, you will find a way to produce
- Constantly test paradigms like:
  - “there is no sand basinward of shelf edge” (1983)
  - All salt is rooted (1984)
  - Why do you want to lease subsalt when you can’t see? (1990)
  - Porosity/Permeability can’t survive 28,000 drill depth (2000)

James Cearley
DT #4, ACE Houston 2011
Discovery Thinking
Chaired by: C. Sternbach and P. Weimer

• Morning Break
  – Orion Skinner
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  – James Cearley

• Afternoon Break
  – Hans Ronnevik
  – Ed LoCricchid
  – Greg Jewell
Norwegian North Sea

Without core no discovery of the Edvard Grieg Field

Logs read 40% shale in 100% sand

Chalk

Reservoir

This is the gamma log from core no 1.

This is how it looks like

Hans Ronnevik, Outstanding Explorer
DT #9, ACE Houston 2014
Norwegian North Sea

Reality is more diverse than the models

Hypothesis: Saturated system with 40-50 m oil leg

Results: Undersaturated and saturated oil

Hans Ronnevik, Outstanding Explorer
DT #9, ACE Houston 2014
Norwegian North Sea, Lessons

- Exploration is continuous unfolding reality
- Basement high tested early had no reservoir
- Flanking grabens were later seen to contain great thickness of sediments with improved seismic
- Logs indicated high GR sandstones with Darcy quality rock which would not have been completed without core
- Success involves will and skill

Hans Ronnevik, Outstanding Explorer
DT #9, ACE Houston 2014
Anadarko Basin, Texas Oklahoma

Discovery Thinking Forum, ACE 2012 Long Beach

Granite Wash Vertical & Horizontal Completions

Ed LoCriccio
DT #5, ACE Long Beach, 2012
Anadarko Basin, Texas Oklahoma

Ed LoCriccio
DT #5, ACE Long Beach, 2012
Anadarko Basin, TX OK Lessons

- Desmoinesian Granite Wash Play 2.5 million acres
- Multi-stacked resource play concentrates value
- Siliclastics shed from Wichita Mountains
- Geologic correlations key to steering
- Minimum of fifteen separate reservoirs
- Advent of horizontal drilling technology and isolated multi-stage fracture stimulation has revolutionized play in a “mature basin”
- Total Recoverable resources potential of 500 TCFE, (114 BBOE including NGL’s)

Ed LoCriccio
DT #5, ACE Long Beach, 2012
Conjugate margins, W Africa

Turonian (91 Million Years Ago)

Foundation of Source and Sediment System for Cretaceous Fan Play

Gregg Jewell
DT #4, ACE Houston 2011
Conjugate margins, W Africa

Gregg Jewell
DT #4, ACE Houston 2011
Conjugate margins, W Africa lessons

- Conventional wisdom questioned maturity on oceanic crust and if rift basins had source rock
- Team asked “What if?” “Why not”
- Found good hydrocarbon indications
- Regional evaluation of tacked turbidites of Turonian age
- Willingness to drill if it can open new plays
- 25 exploration wells between Sierra Leone-Ghana

Gregg Jewell
DT #4, ACE Houston 2011
The Energy Challenge

There is more demand for energy globally as the world’s population and living standards increase.

Growing population
Global population is expected to increase from around 7 billion today to nearly 10 billion by 2050, with 67% living in cities.

Rising demand
Global energy demand will likely be almost 60% higher in 2060 than today, with 2 billion vehicles on the road (800 million today).

Ongoing supply
Renewable energy could triple by 2050, but we will still need large amounts of oil and gas to provide the full range of energy products that the world needs.

Decarbonization
Declining carbon intensity of the energy system is already happening; the future pace will be driven by market forces and policy choices.
In Summary and Conclusion

• Geoscience plays a key role
• Oil reserves are grand, perhaps grander than we had dared to imagine
• AAPG and professional societies play a key role to play in technology transfer
• Population and Demand are growing.
• We will be focused on Discovery Thinking for a very long time to come!
Thank You