**Contents**

1  Introduction to the Oil Industry and Oil Show Evaluation:  
   A Personal Retrospective ........................................................................ 1  
   1.1 Introduction and Vocabulary of Oil and Gas ........................................ 2  
   1.2 The Art of Exploration ........................................................................ 7  
      1.2.1 A History of Drilling and Exploration ........................................... 8  
      1.2.2 Generational Challenges and Evolving Technology ....................... 10  
      1.2.3 Some Personal Experiences in Learning About Seals and Shows .......... 11  
      1.2.4 The Art of Exploration: Plays Versus Prospects and Getting Proper Experience Early ................................................. 14  
      1.2.5 Creaming Curves and New Plays Versus Prospects: Challenging the ‘Peak oil’ Paradigm ...................................................... 15  
      1.2.6 Looking at Rocks, Dealing with People and Your Learning Curve .......... 18  
      1.2.7 Break from Paradigms: Believe in Yourself and Your Data .................... 20  
      1.2.8 Pay Attention to the Fluids and the Key Well Concept ......................... 21  
      1.2.9 The Value of Teams, Peer Assists and Risk Assessment ............... 23  
      1.2.10 The Need to Get It Right Needs to Be Balanced by a Need for Speed .................................................... 24  
      1.2.11 Looking for the NULF (Nasty, Ugly, Little Fact) to Break Paradigms ............................................................... 24  
      1.2.12 Pay Attention to Tight Rocks with Oil and Gas Shows ....................... 26  
      1.2.13 You Never Have Enough Data, But Perseverance Pays Off .................... 27  
   1.3 Some Background on Seismic ............................................................ 28  
   1.4 New Tools: Advances in Migration Modeling and Shows Calibration ................... 35  
      1.4.1 Spider Maps to 3D Models ............................................................. 36  
      1.4.2 Some Examples of Model Development and Visualization .................. 38
1.5 Summary .................................................................................................................. 42
References ...................................................................................................................... 42

2 The Basics of Traps, Seals, Reservoirs and Shows ...................................................... 47
   2.1 The Petroleum System: Primary, Secondary Migration, and ‘Unconventional’ Exploration ................................................................. 48
   2.2 Traps, Porosity, Spill Points and Seals ................................................................. 49
      2.2.1 You Don’t Need to Know Why a Trap Exists If You Can Figure Out Where It Is from the Test and Show Data .................. 57
   2.3 Assessing Risk: Thinking About Seals, Structure and Reservoir Quality ......................................................................................... 60
      2.3.1 Making the Right Maps .............................................................................. 63
      2.3.2 Some Thoughts on Stratigraphic Traps ....................................................... 66
   2.4 The Basics of Rock Properties, Free Water Levels, Buoyancy Pressure and Hydrocarbon Shows ......................................................... 71
      2.4.1 Porosity ......................................................................................................... 71
      2.4.2 Buoyancy Pressure (Pb), Pressure vs. Depth Plots, Free Water Levels and Water Saturation .......................................................... 74
      2.4.3 Water and Hydrocarbon Satuations and Height Above Free Water Plots .................................................................................... 76
      2.4.4 Oil-Water Contacts, Top of Transition Zones vs. FWL and Relative Permeability ................................................................. 77
      2.4.5 Permeability .................................................................................................. 80
      2.4.6 Waste Zones .................................................................................................. 80
      2.4.7 Oil Show Types ............................................................................................. 82
      2.4.8 Kerogen-Rich Source Rocks ........................................................................ 85
      2.4.9 Thinking Like a Molecule .............................................................................. 86
   2.5 Summary .................................................................................................................. 86
References ....................................................................................................................... 87

3 Drilling, Mud-Logging, Wireline Logs and Cores ....................................................... 91
   3.1 Historical Context Around Understanding Shows and Drilling Wells ................................................................................................. 92
      3.1.1 Horizontal Wells and Multi-Stage Fracturing ................................................. 94
      3.1.2 East vs. West: Evolution of Different Evaluation Techniques .................. 95
      3.1.3 Seeps .............................................................................................................. 97
      3.1.4 Drilling with Mud ........................................................................................... 98
      3.1.5 Wellbore Design, Pressures and Rig Safety ............................................... 99
      3.1.6 Background on Muds, Mud-Weights and Circulation Time ....................... 100
   3.2 Mud Logs, Gasses and Cuttings Descriptions ..................................................... 101
      3.2.1 The Mud Log ............................................................................................... 101
      3.2.2 Analyzing Mud Gasses: Wet to Light Gas Ratio Analysis ......................... 103
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.3.1</td>
<td>The Basics of Pressure-Depth Plots and Recognition of Hydrodynamic Flow</td>
<td>181</td>
</tr>
<tr>
<td>4.3.2</td>
<td>Making Potentiometric Surface Maps and Modeling Hydrodynamic Entrapment</td>
<td>187</td>
</tr>
<tr>
<td>4.3.3</td>
<td>Modeling Hydrodynamic Tilt and Migration Using Potentiometric Surface Maps</td>
<td>189</td>
</tr>
<tr>
<td>4.3.4</td>
<td>A Practical Example of Hydrodynamic Tilting Using Trinity Software</td>
<td>191</td>
</tr>
<tr>
<td>4.3.5</td>
<td>Example of Tilted Contacts in an Overpressured Environment</td>
<td>192</td>
</tr>
<tr>
<td>4.3.6</td>
<td>Building Your Own Hydrodynamic Maps: A Bit More Theory Behind Migration and Hydrodynamics: The U-V-Z Method</td>
<td>194</td>
</tr>
<tr>
<td>4.3.7</td>
<td>Perched Water—Another Problem That Can Look Hydrodynamic</td>
<td>197</td>
</tr>
<tr>
<td>4.4</td>
<td>High Pressure Systems, Pressure Regressions and Fracture Seal Breaching</td>
<td>203</td>
</tr>
<tr>
<td>4.4.1</td>
<td>Maps of Over Pressure</td>
<td>204</td>
</tr>
<tr>
<td>4.4.2</td>
<td>Deep Overpressure and Log and Seismic Methods of Prediction</td>
<td>206</td>
</tr>
<tr>
<td>4.4.3</td>
<td>Pressure Regressions and Fracture Gradients- Casing Design, Room for Accumulations and Enhanced Seal Capacity</td>
<td>210</td>
</tr>
<tr>
<td>4.4.4</td>
<td>Bigger Isn’t Always Better—the Role of Pressures and Centroids in Fracture Seal Breach and Exploration Failure</td>
<td>215</td>
</tr>
<tr>
<td>4.4.5</td>
<td>Summary of Part IV</td>
<td>218</td>
</tr>
<tr>
<td>4.5</td>
<td>Case Histories</td>
<td>219</td>
</tr>
<tr>
<td>4.5.1</td>
<td>Temsah Field: 25 Years to Recognition of a Tilted Gas-Water Contact</td>
<td>221</td>
</tr>
<tr>
<td>4.5.2</td>
<td>Deep Nile Delta Play Opener: Pressures and Shows Identified the Play</td>
<td>224</td>
</tr>
<tr>
<td>4.6</td>
<td>Summary</td>
<td>227</td>
</tr>
<tr>
<td>5</td>
<td>Quantifying Seals and Saturations: Capillary Pressure, Pseudo-capillary Pressure and Quantitative Show Assessment</td>
<td>233</td>
</tr>
<tr>
<td>5.1</td>
<td>The Fundamentals of Capillary Pressure</td>
<td>234</td>
</tr>
<tr>
<td>5.1.1</td>
<td>The Importance of Understanding Capillary Pressure</td>
<td>234</td>
</tr>
<tr>
<td>5.1.2</td>
<td>Fluid Potential (Entrapment) Maps Using Capillary Pressure Seals</td>
<td>235</td>
</tr>
<tr>
<td>5.1.3</td>
<td>Capillary Pressure</td>
<td>236</td>
</tr>
<tr>
<td>5.1.4</td>
<td>Estimating Height Above Free Water from Capillary Pressure Data</td>
<td>245</td>
</tr>
</tbody>
</table>
7 Using Fluid Inclusion Data in Exploration .................................................. 349
  7.1 Introduction and Overview of Fluid Inclusions ........................................ 350
    7.1.1 The Reality of Migration: It Is Complicated! ............................ 352
  7.2 Conventional Fluid Inclusion Analysis ............................................. 353
    7.2.1 Using Microthermometry Data and Identifying Hydrocarbon Types and Salinities ............................................. 355
  7.3 Bulk Fluid Inclusion Analysis with FIS ............................................ 361
    7.3.1 Proximity to Pay ................................................................. 365
    7.3.2 Bacterial and Thermal Alteration ......................................... 368
    7.3.3 A Note on Drill Bit Metamorphism (DBM) .......................... 370
  7.4 FIS Interpretation Examples .............................................................. 372
    7.4.1 Northwest Coast of Australia ................................................. 373
    7.4.2 Prospect Ranking .................................................................... 374
    7.4.3 Barents Sea ............................................................................. 374
    7.4.4 Sogn Graben ........................................................................... 375
    7.4.5 Unconventional Well Performance-Mancos Shale, Utah........... 377
    7.4.6 Example of Detecting Oil Shows Missed on Mud Logs: Barmer Basin, India .......................................................... 379
  7.5 Summary ............................................................................................ 381
References ................................................................................................... 381

8 Shows and Geochemistry: Extracting More Information from Source Rocks and Hydrocarbons ................................................... 385
  8.1 Introduction ..................................................................................... 386
  8.2 Source Rock Quality and Maturation ................................................ 387
    8.2.1 The Language of Source Rocks ............................................. 387
    8.2.2 Rock Eval Pyrolysis ............................................................... 388
    8.2.3 Source Rock Quality .............................................................. 389
    8.2.4 Maturation and Source Rock Type ......................................... 392
    8.2.5 Building Maturation Models and Understanding Heat Flow ................................. 404
    8.2.6 Summary: Source Rock Quality and Maturation ................... 418
  8.3 Rig Data Collection: Headspace gas and mud Isotubes ..................... 419
    8.3.1 Summary ................................................................................ 427
  8.4 Some Source Rock Play Screening Criteria ....................................... 428
    8.4.1 Sweet Spots............................................................................ 431
  8.5 Oil to Source Correlations ................................................................. 434
    8.5.1 Examples of Utility of Understanding Basic Oil and Rock Geochemistry Correlations ................................. 435
    8.5.2 A Case History of Migration Modeling from Oil to Source Correlations: Cutbank Field, Montana .................. 440
  8.6 Summary............................................................................................ 443
References................................................................................................... 443
9 Building and Testing Migration Models ................................................................. 451
  9.1 The Scale Challenge in Migration Modelling ....................................................... 452
  9.2 Some Migration Concepts .................................................................................. 453
  9.3 Long Range Migration ...................................................................................... 455
  9.4 Building Migration Models and Recognizing Limits with Risk Maps ................. 458
  9.5 Making Migration Risk Index Maps .................................................................. 461
  9.6 Summary ........................................................................................................... 462
References ................................................................................................................. 463

Appendix A Common Conversion Equations and Fluid Classifications ..................... 465
Appendix B Constructing Winland Pore Throat Graphs in Excel................................. 469
Appendix C Equations in Excel to Convert Mercury-Injection Capillary Pressure Data to Height Above Free Water .............. 473
Appendix D Equations in Excel to Make Pseudo-Capillary Pressure Curves ............... 477
Appendix E Converting Paleogeographic Maps or Shapefiles in ARCGIS to Grids ........ 483
Understanding Oil and Gas Shows and Seals in the Search for Hydrocarbons
Dolson, J.
2016, XIX, 486 p. 341 illus., 315 illus. in color., Hardcover
ISBN: 978-3-319-29708-8