

Contents

CHAPTER 1 INTRODUCTION	1
Background	1
Categories of Cased Hole Logs	2
Purpose of This Book	3
CHAPTER 2 THE CASED HOLE LOGGING JOB	5
The Well	5
The Logging Job	7
Rigging Up for the Job—Naturally Producing Wells	8
Rigging Up—Pumping Wells	10
Rigging Up—High Deviation Angle and Horizontal Wells	11
Points to Remember	14
References	15
CHAPTER 3 LOGGING TOOLS AND THE CASED HOLE ENVIRONMENT	17
The Cased Hole Environment	17
Factors Affecting Log Response	19
Typical Production Problems	22
Points to Remember	25
References	25
CHAPTER 4 FORMATION EVALUATION: NATURAL GAMMA RAY LOGGING	27
Conventional Gamma Ray Logging	27
Applications of the Gamma Ray Measurement	28
Natural Gamma Ray Spectrometry Measurements	32
Applications of Spectral Gamma Ray Measurements	34
Points to Remember	40
References	42
CHAPTER 5 FORMATION EVALUATION: PULSED NEUTRON CAPTURE LOGS	43
Equipment and Applications	43
Principle of Operation	44
Formation Model and Log Response	46
Measurement Technique	51
Chronological Development of Tools and Log Presentations	52
Factors Influencing the Sigma Measurement	61
Interpretation Techniques	64
Applications Arising from Time-Lapse PNC Log Runs	69
Points to Remember	79
References	80
Other Suggested Reading	81

CHAPTER 6 FORMATION EVALUATION: NEUTRON LOGGING	83
Neutron Logging Overview	83
Single Detector Neutron Tools	83
Compensated Dual Detector Neutron Logs	85
Environmental Effects	88
Pulsed Source Neutron Tools	91
Application Examples of Dual Detector Neutron Logs	92
Points to Remember	95
References	96
CHAPTER 7 FORMATION EVALUATION: CARBON/OXYGEN LOGGING	97
Typical Applications of Carbon/Oxygen Logging	97
Methods of Operation to get Carbon/Oxygen Ratio	99
Interpretation and Presentation of Carbon/Oxygen Logs	104
Through Tubing Carbon/Oxygen Logging	109
Examples of Carbon/Oxygen Log Applications	115
Points to Remember	121
References	122
Other Suggested Reading	123
CHAPTER 8 FORMATION EVALUATION: SONIC AND ACOUSTIC TECHNIQUES	125
Sonic Overview	125
Basic Principles	125
Applications of Sonic Measurements	128
Sonic Equipment	129
Measurement Technique and Requirements	132
Acoustic Logs Through Casing—Application Examples	133
Points to Remember	138
References	138
CHAPTER 9 FORMATION EVALUATION: OTHER SERVICES	141
Introduction	141
Borehole Gravity Survey	141
Points to Remember	146
Density Log	146
Formation Resistivity Through Casing	147
Points to Remember	152
Chlorine Log	152
Cased Hole Wireline Formation Tester	153
Points to Remember	160
References	160
CHAPTER 10 WELL INTEGRITY: ACOUSTIC CEMENT EVALUATION SURVEYS	161
Overview	161
Cement Bond Log (CBL) Tool Configuration and Operation	162
The Received Signal and Logs Presented	162
CBL Log Presentation	166
Factors Affecting Tool Performance	167
Quantitative Cement Bond Log Evaluation	176

Special and Non-Standard CBL Examples	181
Borehole Compensated Cement Bond Logs	183
Pad Type CBL, The Segmented Bond Tool (SBT)	187
Bond Logs with Directional Receivers	189
Points to Remember	189
References	190
Other Suggested Reading	191
CHAPTER 11 WELL INTEGRITY: ULTRASONIC PULSE ECHO CEMENT EVALUATION	193
Overview	193
Fixed Transducer Pulse Echo Tool Configuration and Operation— The Schlumberger CET	194
The Halliburton PET	201
Miscellaneous Factors	202
CBL/Pulse Echo Comparison	205
The Mobil/Goodwin Technique	207
The Schlumberger Ultrasonic Imaging Tool (USI)	209
Points to Remember	212
References	213
CHAPTER 12 WELL INTEGRITY: DOWNHOLE CASING INSPECTION	215
Overview	215
Mechanical Calipers	216
Electromagnetic Casing Inspection Tools	217
Acoustic Casing Inspection Tools	224
Borehole Videos	227
Casing Potential Surveys for Cathodic Protection	229
Points to Remember	233
References	233
CHAPTER 13 FLUID MOVEMENT: TEMPERATURE SURVEYS	235
Temperature Logging Overview	235
Single Well Temperature Logs	236
Time Lapse Temperature Logging Techniques	242
Locating Fractured and Acidized Zones	244
Other Temperature Log Applications	246
Radial Differential Temperature (RDT) Logging	247
Log Examples	249
Points to Remember	252
References	252
CHAPTER 14 FLUID MOVEMENT: NOISE LOGGING	255
Noise and Fluid Movement Downhole	255
Noise Amplitude and Spectrum	256
Noise Log Presentation and Response	257
Quantitative Considerations in Noise Logging	261
Other Noise Logging Techniques	263
Noise Log Examples	264
Points to Remember	267
References	268

CHAPTER 15 FLUID MOVEMENT: RADIOACTIVE TRACER LOGGING	269
Introduction to Radioactive Tracer Logging	269
Radioactive Tracer Tools and Isotopes	270
Calculating Flow Rates with Tracers	274
RA Tracer Techniques for Fluid Movement	276
Tagging Materials Downhole, Multiple Tracers, RotaScan	284
Tracer Log Examples	287
Points to Remember	292
References	292
CHAPTER 16 FLUID MOVEMENT: OXYGEN ACTIVATION AND OTHER PULSED NEUTRON APPLICATIONS	295
Overview	295
Water Movement Detection Using Oxygen Activation	295
Identification of Borehole Fluids	302
Special PNC Applications for Fluid Movement	306
Points to Remember	309
References	309
CHAPTER 17 FLUID MOVEMENT: BULK FLOW RATE MEASUREMENT	311
Types of Flowmeters	311
Spinner Response	313
Computing Downhole Flow Velocity from Log Data	316
Computation of Bulk Flow Rate from the Spinner Velocity	320
Spinner Logging in Multiphase Inclined Flow	321
Other Flowmeter Techniques	324
Log Examples	325
Points to Remember	328
References	328
CHAPTER 18 FLUID MOVEMENT: FLUID IDENTIFICATION AND MULTIPHASE FLOW	331
Downhole Flow Conditions	331
Phase Holdup and Cut	332
Fluid Identification Devices	335
Computing Two-Phase Holdup, Slip, and Flow Rates	340
Three-Phase Flow	343
Examples of Multiphase Logs	344
Points to Remember	347
References	348
CHAPTER 19 FLUID MOVEMENT: PRODUCTION LOGGING IN HORIZONTAL WELLS	349
The Tools and Equipment of Horizontal Wells	349
Configuration of a Horizontal Well	349
Production Logging Tool Response in Horizontal Flows	353
Conclusion	357
Points to Remember	359
References	359