

ISCWSA

Well Intercept Subcommittee

Roger B. Goobie

WISC Chairman

2015 - 2017

46th General Meeting
October 12th, 2017
San Antonio Texas, USA

Wellbore Positioning Technical Section



Attendance



Highlights

- 1) Average turn out due to the current state of the industry
- 2) Reduction in participation ~ 40%
- 3) No new members added to the team



S/N	Name	Affiliation
1	Roger Goobie	BP
2	William Allen	BP
3	Mike Long	BHGE
4	Wayne Courville	Boots & Coots
5	John Hatteberg	Boots & Coots
6	Son Pham	Conoco Phillips
7	Avinash Ramjit	Conoco Phillips
8	Heatrher Vannoy	EOG
9	Patrick Knight	Halliburton
10	Pete Schiermeier	Halliburton
11	Robert Estes	Halliburton
12	Patrick Walker	MagVar
13	Benny Poedjono	Schlumberger
14	Chad Hanak	Superior QC

Agenda

- Recap
 - Mission
 - Where are we at?
- Acoustic Ranging (SPE 187313)
 - Presentation by Benny and Bill
- eBook Update
 - Final Edits
- The way forward!
 - New Focus
 - Dissolve Subcommittee
- AOB

3



Mission

“To disseminate knowledge related to ranging technology, techniques and methods that provide value to the industry for relative wellbore positioning.”

With a focus on the following areas:

- Enhance safety and production
- Wellbore avoidance
- Wellbore intervention
- Plug and Abandon operations
- Contingency preparation
- Emergency response

SPE187313 – Active Acoustic Ranging



Active Acoustic Ranging (AAR)

What is it?

Why do we need it?

Summary

- The paper discusses the ranging results obtained from an Access-Independent (AI), AAR system in a salt formation.
- The system was tested to expand the industry's available and reliable ranging options for Contingency Relief Well (CRW) response, specifically in salt formations, for both cased and open hole.
- The results indicate ranging performance for relief well application in salt that is superior to other commonly used commercial ranging systems.
- The results encourage future work to extend the possibility of well-to-well ranging in other than just salt formations.



SPE-187313-MS

Active Acoustic Ranging to Locate Two Nearby Wellbores in Deepwater Gulf of Mexico

Benny Poedjono, Samer Alatrach and Albert Martin, SPE, Schlumberger; and Roger Goobie, William T. Allen, and Eugene Sweeney, SPE, BP

Copyright 2017, Society of Petroleum Engineers

This paper was prepared for presentation at the 2017 SPE Annual Technical Conference and Exhibition held in San Antonio, Texas, 9-11 October 2017. Contents of this paper have not been reviewed by the Society of Petroleum Engineers and are subject to correction by the author(s). This material does not necessarily reflect any position of the Society of Petroleum Engineers, its officers, or members. Electronic reproduction, distribution, or storage of any part of this paper without the written consent of the Society of Petroleum Engineers is prohibited. Permission to reproduce in print is restricted to an abstract of not more than 300 words; illustrations may not be copied. The abstract must contain conspicuous acknowledgment of SPE copyright.

Abstract

Salt drilling in Deepwater Gulf of Mexico (GOM) presents unique challenges. One of these challenges is the effect salt has on ranging technologies used in contingency relief well designs. A new technique called Active Acoustic Ranging (AAR) addresses the challenge of locating and tracking the target wellbore to the interception phase. This case study details the degree of precision that this new technique provided while locating two nearby wellbores within salt. This study is intended to improve industry awareness and understanding of relief well ranging options available to the industry, specifically wellbore ranging activities conducted within a salt formation.

Sonic logging started in the early 1930s to determine rock characteristics by measuring the refracted signals from a combination of transmitters and receivers. The technique evolved by recording acoustic signals beyond the refracted zone, by positioning the transmitters and receivers downhole in the logging tool.

AAR utilizes surface seismic processing methods to determine azimuthal direction and distance of compressional and shear acoustic signals, reflected from around the borehole. After processing the reflected signals, the distance and direction of nearby wellbores can be determined. This can be effective in salt formations, where resistivity inhibits use of active electromagnetic ranging tools.

This case study presents test results conducted in a GOM Deepwater operation to locate two nearby wellbores, a cased hole and an open hole, using AAR. It shows that AAR signals can be successful in locating offset wellbores within salt formations. The acoustic signals, both compressional and shear, were recorded using a stack of 12 receivers. Each stack had 8-sector azimuthal receivers to determine the distance and direction of the corresponding target wellbores.

By utilizing compressional and shear signals generated from the various distances of monopole and dipole transmitters, a redundant process was provided to determine the location of the target wellbores with a high degree of accuracy.



WISC Milestone



SPE WTPS / Halliburton Agreement

Highlights

- 1) Agreement reached between SPE ISCWSA and Halliburton on 27th October 2015.
- 2) To use the Halliburton document “Customer Guide to Relief Well Ranging” without any copyright violation.
- 3) Liability disclaimer wrt the use of the information the SPE produces.
- 4) SPE agree to provide Halliburton with a draft copy of the final document for their approval before publication.

HALLIBURTON

Halliburton Energy Services, Inc.
10200 Bellaire Blvd.
Houston, TX 77072-5206
www.halliburton.com

Halliburton Copyright Permission and License

Date: 27 October 2015

In consideration of the mutual covenants of the Parties, the receipt of which is hereby acknowledged, the Parties agree as follows: Halliburton Energy Services, Inc. (“Halliburton”) grants the Society of Petroleum Engineers (“SPE”) a limited, fully paid up, non-exclusive, non-transferable right and license to use and create derivative works from the Halliburton copyrighted material identified as a document entitled “Introduction To Relief Well Ranging & Interception” (the “Halliburton Document”). The Halliburton Document is intended to be used by SPE for the creation of a document covering the same or a similar subject matter (the “SPE Document”). By signing below, SPE agrees to be bound by the terms of this License.

This license is limited to use as outlined above and does not include any other copyrighted material owned by Halliburton or use of Halliburton’s trademarks. This license is not assignable or transferable in any manner whatsoever.

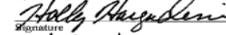
Halliburton disclaims all liability to SPE with respect to any publication or materials produced which include use of the Halliburton Document outlined above. SPE agrees to indemnify Halliburton, its officers, directors, agents, employees, subsidiaries and affiliates against and from all reasonable loss, cost, liability and expense incurred by Halliburton, which may arise out of a claim against SPE or SPE representatives in relation to the SPE Document, except to the extent the claim is based upon the Halliburton Document.

SPE agrees to provide Halliburton with a draft of the SPE Document for Halliburton’s approval. Unless approved by Halliburton, SPE shall not publish or cause to be published the SPE Document. SPE agrees to indicate the proper copyright notice regarding use of the Halliburton Document by giving credit to Halliburton.

This license shall be governed by the laws of the State of Texas, United States of America. Halliburton reserves the right to terminate this license for any reason upon notice to SPE; provided, however, the license shall not terminate as to documents, including the SPE Document, that are published prior to termination. Please acknowledge SPE’s acceptance of the above license terms by having an authorized representative of SPE sign below. The signed form should be returned to the appropriate Halliburton representative with a scanned copy emailed to Holly Soehnge at holly.soehnge@halliburton.com.

Accepted and agreed by SPE this 27 day of October, 2015.

By:



Signature

Holly Hargadine

Name

Assistant Director Technical Activities

Title:

Society of Petroleum Engineers

22 Parkside Creek Dr.
Richardson, TX 75080

972 952 9342

Phone/Fax:

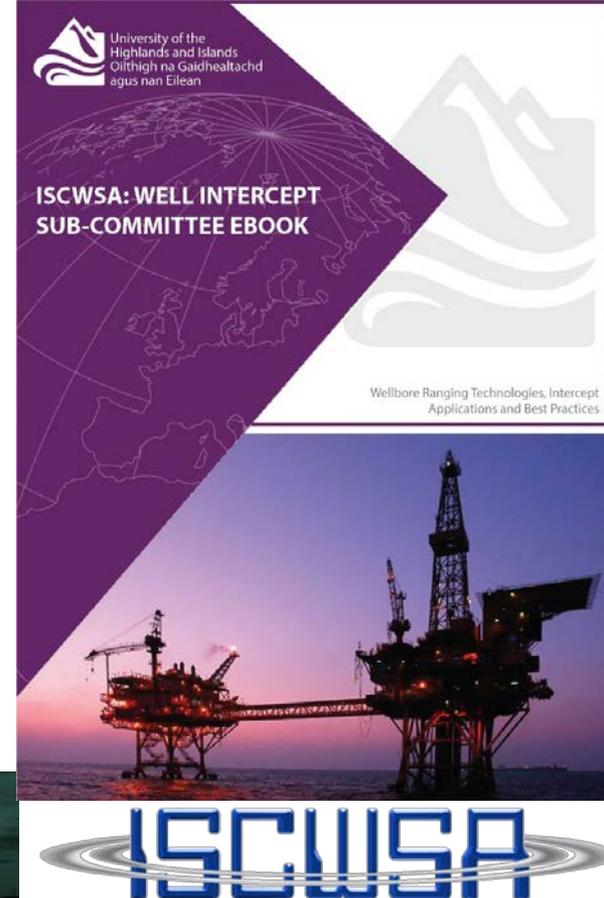
hhargadine@spe.org

Email:

Company/Organization:
Society of Petroleum Engineers

WISC eBook

- Completed
 - Wellbore Ranging Technologies Intercept Application and Best Practices
- Ready for Download
 - <http://www.iscwsa.net/docs-and-publications>
- Current eBook
 - Eight Main Chapters
- Lexicon
 - No Change
- Bibliography
 - Updated with additional publications



WISC eBook TOC



Contents	
COVER	1
Copyright notice	2
Revisions	2
Preface	5
Well Intercept	6
Compiled and co-written by	6
Members of the ISCWSA	6
Well Intercept Sub-Committee	6
Table of figures	10
1. Introduction	12
1.1 History of Ranging	12
1.2 Magnetic Ranging Techniques	14
1.3 Acoustic Ranging Techniques	14
1.4 Well Intercept/Paralleling Technology	15
1.5 Wellbore Intercept Applications	15
1.5.1 Relief wells	15
1.5.2 Intervention Wells	15
1.5.3 U-Tube Wells	17
1.5.4 Conductor Connector Well (CC)	17
1.5.5 Steam Assisted Gravity Drainage wells	18
1.5.6 Well avoidance	18
1.5.7 Subsurface connected wells	18
1.5.8 Horizontal Directional Drilling (HDD)	18
1.5.9 Ranging to Surface	18
2. Passive Magnetic Ranging (PMR)	19
2.1 What is PMR?	19
2.1 Why Use PMR?	20
2.3 Economics	20
2.4 Insensitivity to Formation and Hole Conditions	20
2.5 High Inclination and Incidence Angles	20
2.6 Accuracy and Detection Range	20
2.6.1 Direction Accuracy	21
2.6.2 Distance Accuracy	21
2.6.3 Detection Range	21
2.7 Limitations of PMR	21
2.7.1 Reliability/Repeatability	21
2.7.2 Sensor location	22
2.7.3 Interference from the Casing Shoe in the Drilling Well	22
2.7.4 Multiple Offset Wells	22
2.8 Applications for PMR	22
3. Active Magnetic Ranging	23

ISCWSA WELL INTERCEPT SUB-COMMITTEE EBOOK

	Page 8
3.1 Access Dependent Active Magnetic Ranging	23
3.1.1 Magnetic Solenoid AMR Systems	23
3.1.1 Typical Magnetic Solenoid AMR Systems Protocol	24
3.1.2 Rotating Magnet AMR Systems	24
3.2 Access-Independent Active Magnetic Ranging (AI AMR)	27
3.2.1 Advantages	27
3.2.2 Disadvantages	27
3.2.3 AMR Data Collection	27
3.3.1 Reasons to Select AMR	28
3.3.2 AMR Tool and Wireline Assembly (Bridle)	28
Shipping Details	29
3.3 Detection Range	30
3.3.1 AMR Active Magnetic Ranging (AMR)	30
4. Passive Acoustic Ranging	32
4.1 Introduction	32
4.7 Application	32
5. Active Acoustic Ranging	36
5.1 Introduction	36
5.2 Basic Theory	37
Acoustic Acquisition	37
5.2.1 Fundamental Principle	38
5.2.2 Acoustic Source	38
5.2.3 Acoustic Propagation	39
5.3 Acoustic Distance and Direction	41
5.3.1 Ranging Direction	42
5.4 Application	44
5.5 Modeling	46
6. Ranging Techniques Comparison	48
7. Relief Well Ranging Operations	52
7.1 Relief Well Overview	52
7.2 Ranging Decision Matrix	52
7.3 Categories of Relief Well Designs	53
7.3.1 Simple Intercept	53
7.3.2 Parallel Track	53
7.3.3 Oriented Intercept	53
7.4 Relief Well Phases	53
7.4.1 The Data Gathering (Planning) Phase	55
7.4.2 The Drilling Phase	55
7.4.3 The Locate Phase	55
7.4.4 The Tracking (Follow) Phase	58
7.4.5 The Intercept Phase	59
7.5 Relief Well Survey Management	61
7.6 Relief Well Planning Personnel	61

ISCWSA WELL INTERCEPT SUB-COMMITTEE EBOOK

	Page 9
7.7 Project Communication	62
7.7.1 Overview of the Ranging Plan	62
7.7.2 Overview of the Ranging Report	62
7.8 Summary	63
8. Well Intersection Design Fundamentals	64
8.1 Project Objective(s)	64
8.2 Drilling and Remedial Operations Plan	64
8.3 Intersection Strategy	64
8.4 Ranging Strategy	64
8.5 Directional Trajectory	64
8.6 Intersection Project Complexities	64
8.7 General Planning Process	65
8.7.1 Well Intersection Planning Process	66
8.8 Drilling Intervals of an Intersection Well Project	69
8.8.1 Normal	69
8.8.2 Initial Locating/Ranging	69
8.8.3 Monitor/Parallel	69
8.8.4 Final Alignment & Intersection	69
8.9 Types of Well-to-Well Intersections	72
8.9.1 Direct/Geometric	72
8.9.2 Indirect/Proximity	72
8.10 Establishing Hydraulic Communication	72
8.10.1 Geometric	72
8.10.2 Perforating/Explosive	72
8.10.3 Milling	74
Hydraulic (sand cutting, acid, water, etc.)	75
Typical Equipment and Methods	76
Directional Drilling Equipment	76
Surveying Equipment and Methods	76
Special KIL and Plugging Equipment	76
Operational Information	76
Well Intersection Bibliography	86
VERSION & SUBMISSION INFORMATION	90
Submissions for Assessment	90

CONTENTS

ISCWSA WELL INTERCEPT SUB-COMMITTEE EBOOK



WISC eBook Lexicon and Bibliography



Well Interception Lexicon	
Word/Phrase/Symbol	Definition
Absolute Positional Uncertainty	Three dimensional position uncertainty with respect to a defined local reference point.
Active Acoustic Ranging	A technique that utilizes direct bursts of acoustic energy toward an acoustic reflector generally an open hole or cased hole wellbore. The reflected signal time is measured to determine the distance. The direction of the reflected signal is determined by the reflected azimuth relative to the tool position or the surface seismic source and receiver arrangements.
Active Magnetic Ranging	Any well-to-well ranging technology that requires the induction and detection of a magnetic field between two wellbores.
Allowable Elevation from Plan (ADP)	The maximum distance in 3D space that an as drilled wellbore may deviate from the directional well plan.
Attack Angle	See Angle of Incidence
Angle of Incidence	The relative angle between two wells, expressed in degrees (°), which defines the total angular difference in the well trajectory vectors. Can be expressed as a two or three dimensional difference(s) and having either converging or diverging vectors. Typically used to describe the angle present between the RW and the TW during ranging operations and when attempting to make the final intersection.
Blowout Well	A wellbore that may be completed or is being drilled in which hydraulic control has been lost resulting in a need to kill the well. Also referred as Target Well or Subject Well.
Bay	Magnitude of the magnetic field measured perpendicular to the relief wellbore direction.
Call Box	The distance and direction to a target, projected in the plane normal to the RW or TW on a horizontal (TVD) plane that incorporates best estimates of the ranging result and its uncertainty.
Capping	A surface intervention technique which allows the blow out well to be capped and brought under control without the need to drill a relief well.
Completion Recovery	The use of ranging technology to drill a new wellbore that communicates with a target wellbore for the purpose of gaining further utilization of the completion of the target well (for instance, the fracture job of the target well).
Cone of Uncertainty	A 3 dimensional area of positional uncertainty in the form of a cone where the central axis of the cone aligns with the downhole axis of the wellbore and the base is located at the deepest measured depth of the wellbore. Cones of uncertainty are typically defined by degrees per distance or lateral error per distance.
Contingency Relief Well Plan	A document which describes the plan of implementing a relief well project to solve an uncontrolled blowout well condition.

ISCWSA: WELL INTERCEPT SUB-COMMITTEE EBOOK

Well Interception Bibliography	
Page 186	
SPE 186901; Managing Risks in Relief Well Operations: From Planning to Execution Ferdinando B. SPE, Schlumberger; and Maxwell L. and Sakal A. SPE, PathControl	
SPE 187137; Active Acoustic Ranging to Locate Two Nearby Wellbores in Deepwater Gulf of Mexico Benny Fiedorow, Sameer Alatrach and Albert Martin, SPE, Schlumberger; and Roger B. Goodie, William T. Allen, and Eugene Swerenny, SPE, BP	
SPE 003496; "Magnetostatic Methods for Estimating Distance and Direction from a Relief Well to a Cased Wellbore"; J.D. Robinson, Shell Development Co.; J.P. Vignatiello, Shell Development Co.	
SPE 003531; "A New Approach in Relief Well Drilling"; Bruist, E.H., Shell Oil Co.	
SPE 003963; "Gas Blowout Control by Water Injection Through Relief Wells-A Theoretical Analysis"; F. Lehner, Koninklijke/Shell Exploratie, A.S. Williamson, En Produktie Laboratorium;	
SPE 006781; "A New Method Of Determining Range And Direction From A Relief Well To A Blowout Well"; F.J. Morris, Tensor, Inc.; R.L. Waters, Tensor, Inc.; G.F. Roberts, Tensor, Inc.; E.P. Costa, Houston Oil and Minerals, Research and Development, Inc.	
SPE 010946; "An Electromagnetic Survey Method for Directionally Drilling a Relief Well Into a Blown Out Oil or Gas Well"; Arthur F. Kuckes, Cornell U.; T. Lautzenhiser, Amoco Production CO., A.G. Nekut, Amoco Production CO., R. Sigal, Amoco Production Co.	
SPE 014047; "Useful Interpretation in Blowout Well Location From Relief Wells"; Runge, Richard J., Chevron Oil Field Research Co.	
SPE 014388; "Improved Magnetic Model for Determination of Range and Direction to a Blowout Well"; Douglas L. Jones, * Rice U., Gus I. Hoehn, * Mobil R&D Corp.; Arthur F. Kuckes, Cornell U.	
SPE 016677; "Relief Well Planning and Drilling for SIB-5-4X Blowout, Lake Maracibo, Venezuela"; J.A. Volisin, Lagoven S.A.; G.A. Quiroz, Lagoven S.A., R. Pounds, Eastman Christensen; J. Wright, Eastman Christensen; K. Bierman, Shell Intl. Petroleum Mj. B.V.	
SPE 017255; "Improved Detectability of Blowing Wells"; John I. de Lange and Toby J. Darling, SPE, Koninklijke/Shell E&P Laboratorium	
SPE 017820; "Relief Well Drilling Technology"; Xiu Yu, Dagand Petroleum Admin. Bureau; Jinding lie, Dagand Petroleum Admin. Bureau	
SPE 018059; "Operations at a Deep Relief Well: The TXO Marshall"; by R.D. Grace, GSM & A.W. Kuckes, Vector Magnetix; J. Branton, TXO Production	
SPE 018717; "Enchova Blowout: Record Relief Time"; W.P. Maduro, Petrobras; Jim Reynolds, Smith Intl. Inc.	
SPE 10946; "An Electromagnetic Survey Method for Directionally Drilling a Relief Well Into a Blown Out Oil or Gas Well"; Arthur F. Kuckes, Cornell U.; T. Lautzenhiser, Amoco Production Co.; A.G. Nekut, Amoco Production Co.; R. Sigal, Amoco Production Co.	

ISCWSA: WELL INTERCEPT SUB-COMMITTEE EBOOK



eBook Acknowledgements

This book was compiled by members of the Industry Steering Committee on Wellbore Survey Accuracy (ISCWSA), a Society of Petroleum Engineers (SPE) Technical Section for Wellbore Positioning.

The acknowledgement table captures main authors; some who have contributed to more than one chapter and we sincerely thank them for their commitment, contribution and for sharing their knowledge.

We also thank Halliburton for allowing us to use their “Customer Guide to Relief Well Ranging” without any copyright violation.

<i>Chapter Contributors</i>		
Wellbore Ranging Technologies, Intercept Applications and Best Practices		
<i>Name</i>	<i>Affiliation</i>	<i>Chapters</i>
Roger Goochie	BP	Introduction and Well Intercept History
William Allen	BP	
Shawn DeVerse	Surcon	Passive Magnetic Ranging
Chad Hanak	SuperiorQC	
James Towle	Proximity Drilling Management	
Patrick Walker	Magvar	
Denis Reynaud	PathControl	
Ludovic Macresy	PathControl	
Tyler Milford	Halliburton	Active Magnetic Ranging
Dan Eby	Blowout Engineers	
Alan Gosse	Halliburton	
Ryan Zallas	Halliburton	
Tyler Milford	Halliburton	Acoustic Ranging
Clint Moss	Scientific Drilling	
Benny Poedjono	Schlumberger	
Samir Alatrach	Schlumberger	
Ross Lawdon	Schlumberger	
Phil Harbidge	Schlumberger	Ranging Techniques Comparison
Geir Instanes	ClampOn	
John J. Beauregard	ClampOn	
Anas Sikal	PathControl	Relief Well Ranging Operation
Ludovic Macresy	PathControl	
Tyler Milford	Halliburton	
Pete Schiermeier	Halliburton	
Patrick Knight	Halliburton	Well Intercept Design Considerations
Mike Terpening	Schlumberger	
Tyler Milford	Halliburton	
Jim Woodruff	Wild Well	Reviewers
Mo Amer	Wild Well	
Joe Burke	Wild Well	
Son Pham	Conoco Phillips	
Nestor Sanchez	Conoco Phillips	Technical Writer
Avinash Ramjit	Conoco Phillips	
Michael Long	Baker Hughes Inteq	Lexicon & Bibliography
Heather Vannoy	EOG Resources	
WISC Members	ISCWSA	



What's Next?



The way forward!

- Nominate New Chairman
- New Focus
- Dissolve Subcommittee

12



Thank You!