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Conventional and Unconventional Developments Part I: What Applies, Where and Why ?

M. Rylance, IXL Oilfield Consulting, M. Pearson, Liberty Resources and G. Fowler and M. McClure ResFrac Corporation

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References

- Abou-Sayed, I.S., Schueler, S., Ehrl, E. and W. Hendricks. (1996) "Multiple Hydraulic Fracture Stimulation in a Deep Horizontal Tight Gas Well." *J Pet Technology* 48 (1996): 163–168. <https://doi.org/10.2118/30532-JPT>.
- Almasoodi, M., Andrews, T., Johnston, C., Singh, A. and M.M. McClure. (2023). "A new method for interpreting well-to-well interference tests and quantifying the magnitude of production impact: Theory and applications in a multi-basin case study". 24 Feb. 2023, <https://doi.org/10.21203/rs.3.rs-2566368/v1>
- Astafyev, V., Samoilov, M., Fayzullin, I., Kuvshinov, I., Mitin, A., Fedorov, G., Gaponov, M., Ovchinnikov, K., Khusainov, R., Fedorov, E. and M. Lushev. (2020) "A Decade of Multi-Zone Fracturing Treatments in Russia." Paper presented at the SPE Symposium: Hydraulic Fracturing in Russia. Experience and Prospects, Virtual, September 2020. <https://doi.org/10.2118/203883-MS>.
- Al-Rashdi, K. A. and D. Spain.(2015) "Barik Reservoir Description- An Evolving Concept." SPE Middle East Unconventional Resources Conference and Exhibition, Muscat, Oman, January 2015. <https://doi.org/10.2118/SPE-172912-MS>.
- Al-Rashdi, K. A., Wells, M. and N. Clark.(2021) "Prediction of Reservoir Quality & Deliverability of the Tight Barik Formation in Khazzan Field, Oman." ADIPEC, Abu Dhabi, UAE, November 2021. <https://doi.org/10.2118/208132-MS>.
- Al-Shamma, B., Nicole, H., Nurafza, P. R. and W. C. Feng. (2014) "Evaluation of Multi-Fractured Horizontal Well Performance: Babbage Field Case Study. (2014) "Paper presented at the SPE Hydraulic Fracturing Technology Conference, The Woodlands, Texas, USA, February <https://doi.org/10.2118/168623-MS>.
- Al Shueili, A., Jaboo, M. and H. Al Salmi. (2022) "Connecting the Dots: Multistage Fracturing in Horizontal Wells with Multilayered Reservoirs - Lessons Learned." Paper presented at the SPE International Hydraulic Fracturing Technology Conference & Exhibition, Muscat, Oman, January 2022. <https://doi.org/10.2118/205302-MS>.
- API RP 19D, Recommended Practice for Measuring Conductivity of Proppants, second edition, November 2021.
- Baumgartner, W. E., Shlyapobersky, J., Abou Sayed, I. S. and R. C. Jacquier.(1993) "Fracture Stimulation of a Horizontal Well in a Deep, Tight Gas Reservoir: A Case History From Offshore The Netherlands." Paper presented at the SPE Offshore Europe, Aberdeen, United Kingdom, September <https://doi.org/10.2118/26795-MS>.
- Britt, L. K., Smith, M. B., Haddad, Z., Lawrence, P., Chipperfield, S., and T. Hellman. "Water-Fracs: We Do Need Proppant After All." Paper presented at the SPE ATCE, San Antonio, Texas, USA, September 2006. <https://doi.org/10.2118/102227-MS>.
- Brovchuk, A. V., Diyashev, I., Lipyanin, A. V., Grant, D., Oussoltsev, D., and K. K. Butula.(2006) "Fracturing Treatments of Open-hole Horizontal Wells in Western Siberia." Paper presented at the SPE Russian Oil and Gas Technical Conference and Exhibition, Moscow, Russia, October 2006. <https://doi.org/10.2118/102417-MS>.
- Butter, M., East, L. and I. Kuvshinov. (2006) "The Potential of Multiple Fractured Horizontal Wells in Layered Reservoirs." Paper presented at SPE Russian Oil and Gas Technical Conference and Exhibition, Moscow, Russia, October 2006. <https://doi.org/10.2118/102633-MS>.
- Cander, H. (2012). Sweet Spots in Shale Gas and Liquids Plays: Prediction of Fluid Composition and Reservoir Pressure. AAPG Search and Discovery Article, 40936, 29 May 2012. https://www.searchanddiscovery.com/documents/2012/80217cander/ndx_cander.pdf.
- Cander, H., (2013) Finding Sweet Spots in Shale Liquids and Gas Plays: (with Lessons from the Eagle Ford Shale. AAPG Search and Discovery Article, 41093, 13 May 2013. https://www.searchanddiscovery.com/documents/2013/41093cander/ndx_cander.pdf.
- Casero, A. and Rylance, M. (2015, February) Unconventional Technology: The Difference Between Successful Application and Unsuccessful Application (North America and Overseas)." SPE Hydraulic Fracturing Technology Conference, The Woodlands, Texas, USA <https://doi.org/10.2118/SPE-173375-MS>.
- Casero, A., Nicolaysen, A., Rylance, M., Clifton, J. and B. Fears. (2017a) "The Importance of Being Well Connected - High Rate Fracs in Horizontals." Paper presented at the SPE Hydraulic Fracturing Technology Conference and Exhibition, The Woodlands, Texas, USA, January 2017. <https://doi.org/10.2118/184813-MS>.
- Casero, A., Rylance, M., Al Shueili, A., Ishteiwy, O., White, D., Al Manji, A., Dawson, W., dwi Kurniadi, S. and E. Bruseth. (2017b) "Stress Management: First Openhole Multistage Ball Drop in Khazzan." Paper presented at the SPE Annual Technical Conference and Exhibition, San Antonio, Texas, USA, October 2017. <https://doi.org/10.2118/187368-MS>.

- Chambers, M. R., Mueller, M. W. and A. Grossmann. (1995) "Well Completion Design and Operations for a Deep Horizontal Well with Multiple Fractures." Paper presented at the SPE Offshore Europe, Aberdeen, United Kingdom, September 1995. <https://doi.org/10.2118/30417-MS>.
- Ciezobka, J. and S. Reeves. (2020) "Overview of Hydraulic Fracturing Test Sites (HFTS) in the Permian Basin and Summary of Selected Results (HFTS-I in Midland and HFTS-II in Delaware)." Paper presented at the SPE/AAPG/SEG Latin America Unconventional Resources Technology Conference, Virtual, November 2020. <https://doi.org/10.15530/urtec-2020-1544>.
- Cinco-Ley, H. and Samaniego-V., F. (1980) "Transient Pressure Analysis for Fractured Wells." *J Pet Technology* 33: 1749–1766. <https://doi.org/10.2118/7490-PA>.
- Cipolla, C.L., Jensen, L., Ginty, W. and C.J. de Pater. (2000) "Complex Hydraulic Fracture Behaviour in Horizontal Wells, South Arne Field, Danish North Sea." Paper presented at the SPE ATCE, Dallas, Texas, October 2000. <https://doi.org/10.2118/62888-MS>.
- Clark, J.B. (1949) "A Hydraulic Process for Increasing the Productivity of Wells." *Journal of Petroleum Technology* 1: 1–8. <https://doi.org/10.2118/949001-G>.
- Clark, R. A., Al-Busafi, B., Adil, I., Al-Lawati, H., Huggins, P. and S. Rainey. (2011) "A Comprehensive Approach to Surveillance in Appraisal of a Tight Gas Project in Central Oman." SPE Middle East Unconventional Gas Conference and Exhibition, Muscat, Oman, January 2011. <https://doi.org/10.2118/142754-MS>.
- Clark, R. A., Mullen, K. and K. Stevanus. (2013) "Adopting North American, Multi-stage Fracturing and Horizontal Completion Technologies Starts to Unlock the Amin Tight Gas Formation in the Sultanate of Oman." Paper presented at the SPE Unconventional Gas Conference and Exhibition, Muscat, Oman, January 2013. <https://doi.org/10.2118/164008-MS>.
- Cleary, M. P., Johnson, D. E., Kogsbøll, H.-H., Owens, K. A., Perry, K. F., de Pater, C. J., Stachel, A., Schmidt, H., and M. Tambini. (1993) "Field Implementation of Proppant Slugs to Avoid Premature Screen-Out of Hydraulic Fractures with Adequate Proppant Concentration." Paper presented at Low Perm. Reservoirs Symp., Denver, Colorado, April 1993. <https://doi.org/10.2118/25892-MS>.
- Coulter, G. R., Benton, E. G., and C. L. Thomson. (2004) "Water Fractions and Sand Quantity: A Barnett Shale Example." Paper presented at the SPE Annual Technical Conference and Exhibition, Houston, Texas, September 2004. <https://doi.org/10.2118/90891-MS>.
- Damgaard, A.P., Bangert, D.S., Murray, D.J., Rubbo, R P., and G.W. Stout.(1992) "A Unique Method for Perforating, Fracturing, and Completing Horizontal Wells." *SPE Prod Eng* 7 (1992): 61–69. <https://doi.org/10.2118/19282-PA>.
- Diyashev, I. R., Sayapov, E. I., and A. Brovchuk.(2009) "Application of Horizontal Wells with Multiple Hydraulic Fractures for the Development of Low Permeability Oil Reservoir in Western Siberia." Paper presented at the International Petroleum Technology Conference, Doha, Qatar, December 2009. <https://doi.org/10.2523/IPTC-13395-MS>.
- Ehrl, E. and S. K. Schueler. (2000) "Simulation of a Tight Gas Reservoir with Horizontal Multi-fractured Wells." Paper presented at the SPE European Petroleum Conference, Paris, France, October 2000. <https://doi.org/10.2118/65108-MS>.
- Elliott, D. and S. Al Abri. (2015) "Completion Advancements in the Khulud Unconventional Gas Project." Paper presented at the SPE Middle East Unconventional Resources Conference and Exhibition, Muscat, Oman, January 2015. <https://doi.org/10.2118/SPE-172938-MS>.
- Fisher, M. K., Heinze, J. R., Harris, C. D., Davidson, B. M., Wright, C. A., and K. P. Dunn. (2004) "Optimizing Horizontal Completion Techniques in the Barnett Shale Using Micro seismic Fracture Mapping." Paper presented at the SPE Annual Technical Conference and Exhibition, Houston, Texas, September 2004. <https://doi.org/10.2118/90051-MS>.
- Hannah, R.R., Park, E.I., Porter, D.A., and Black, J.W. (1994) Combination Fracturing/Gravel-Packing Completion Technique on the Amberjack, Mississippi Canyon 109 Field. *SPE Prod & Fac* 9 262–266. <https://doi.org/10.2118/26562-PA>.
- Hallam, S.D., and N.C. Last. (1991) "Geometry of Hydraulic Fractures From Modestly Deviated Wellbores." *J. Pet. Technol.* 43 (1991): 742–748. <https://doi.org/10.2118/20656-PA>.
- Heward, A., Morton, M. and Kindi, M. (2024). The Search for Petroleum in The Sultanate of Oman – The First 120 Years. Geological Society, London, Special Publications. [550. 10.1144/SP550-2023-220](https://doi.org/10.1144/SP550-2023-220).
- Isaev, V., Ivanov, M., Kuznetsov, D. et al. 2017a. On Modeling of Particles Settling in Hele-Shaw Flows of Non-Newtonian Fluids. Presented at the 14th US National Congress on Computational Dynamics, Montreal, Quebec, Canada, 17–20 July.
- Isaev, V., Velikanov, I., Kuznetsov, D. et al. 2017b. Benchmark Solutions for Models of Solids Transport in Hele-Shaw Cell. Presented at the 14th US National Congress on Computational Dynamics, Montreal, Quebec, Canada, 17–20 July.
- Isaev, V., Velikanov, I., Kuznetsov, D. et al. 2017c. High-Performance Computing in the Modeling of Hydraulic Fracturing. Presented at the 14th US National Congress on Computational Dynamics, Montreal, Quebec, Canada, 17–20 July.
- Ishteiwy, O. A., Casero, A., Al-Shueili, A., Turk, G., Roy, A., Al Manji, A., Dawson, W., White, D. and S. D. Kurniadi. (2017) "Advancing the Understanding of Openhole MultiStage Completion Systems in Khazzan—Hydraulic Fracturing Execution and Analysis." Paper presented at the Abu Dhabi International Petroleum Exhibition & Conference, Abu Dhabi, UAE, November 2017. <https://doi.org/10.2118/188376-MS>.
- Ishteiwy, O. A., Dawson, W., Al Shidhani, R., and B.. Al Busafi (2018) "Fracture Design and Placement and Its Application and Influence on Amin Performance." Paper presented at the SPE International Hydraulic Fracturing Technology Conference and Exhibition, Muscat, Oman, October 2018. <https://doi.org/10.2118/191430-18IHFT-MS>.
- Jacobs, T. (2019) "Shale's Big Sand Switch Is Delivering Dollars, But Not Eroding All Concerns" *J Pet. Technol.* 71 (2019): 28–33. <https://doi.org/10.2118/0219-0028-JPT>
- Kudrya, S., Baydyukov, K. and M. Samoilov. (2016) "Experience of 20 Plus Stage Fracture Stimulation in Samotlorskoye Field." Paper presented at SPE Russian Petroleum Technology Conf. and Exh., Moscow, Russia, Oct 2016. <https://doi.org/10.2118/182038-MS>.
- Langford, M., Westera, D., Holland, B., Bocaneala, B. and M. Norris. (2014) "Development of a Stranded Tight Gas Field in the UK Southern North Sea Using Hydraulic Fracturing Within a Subsea Horizontal Well: A Case Study." Paper presented at the SPE Annual Technical Conference and Exhibition, Amsterdam, The Netherlands, October 2014. <https://doi.org/10.2118/170852-MS>.
- Li, Y, Song, J., Shu, W, Qianyou, J. and F. Zhang. (2020) "Influence of Gas and Oil State on Oil Mobility and Sweet-Spot Distribution in Tight Oil Reservoirs from Perspective of Capillary Force". *SPE Res Eval & Eng* 23: 0824–0842 <https://doi.org/10.2118/198888-PA>.
- Loznyuk, O., Surtaev, V., Sakhan, A., Murtazin, R., Latkin, K., Sitdikov, S., Pestrikov, A., Gusakov, V., Politov, M., Yudin, A., Vernigora, D., Olenkikova, O. and M. Bulova. (2015) "A Multistage Stimulation Operation to Unlock the Gas Potential of the Turonian Siltstone Formation in Western Siberia." Paper presented at the SPE RPTC, Moscow, Russia, October 2015. <https://doi.org/10.2118/176706-MS>.
- Martin, A.N. and Eid, R. (2011). "The Potential Pitfalls of Using North American Tight and Shale Gas Development Techniques in the North African and Middle Eastern Environments" SPE Middle East O&G Conf., Manama, Bahrain. <https://doi.org/10.2118/141104-MS>.

- Martins, J. P., Leung, K. H., Jackson, M. R., Stewart, D. R., and A. H. Carr. (1992) "Tip Screenout Fracturing Applied to the Ravenspurn South Gas Field Development." *SPE Prod Eng* 7 (1989): 252–258. <https://doi.org/10.2118/19766-PA>
- Masood, N., Ishteiwy, O., Dawson, W., Kurniadi, S., Rylance, M., Al Harrasi, S. and D. White. (2019) "Making the Connection Between Conventional and Unconventional." Paper presented at the SPE/AAPG/SEG Unconventional Resources Technology Conference, Denver, Colorado, USA, July 2019. <https://doi.org/10.15530/urtec-2019-13>.
- Mayerhofer, M.J., Richardson, M.F., Walker, R.N., Meehan, D.N., Oehler, M.W. and R.R. Browning. (1997) "Proppants? We Don't Need No Proppants." Paper presented at the SPE ATCE and Exh., San Antonio, Texas, October 1997. <https://doi.org/10.2118/38611-MS>.
- McClure, M., Picone, M., Fowler, G., Ratcliff, D., Kang, C., Medam, S. and J. Frantz. (2020) "Nuances and Frequently Asked Questions in Field-Scale Hydraulic Fracture Modeling." Paper presented at the SPE Hydraulic Fracturing Technology Conference, The Woodlands, TX, USA, February 2020. <https://doi.org/10.2118/199726-MS>.
- Meckel, L.D. and Thomasson, M.R. (2008). Pervasive tight-gas sandstone reservoirs: An overview. AAPG, Vol 3, pp 13-17, 01 Jan 2012.
- Miskimins, J.L. (2019). "Hydraulic Fracturing: Fundamentals and Advancements" SPE ISBN (print): 978-1-61399-719-2 <https://doi.org/10.2118/9781613997192>.
- Nicolaysen, A., Casero, A., Roy, A., Rylance, M., Kurniadi, S., and T.. Batmaz. (2016) "The Good, the Bad and the Ugly: A Case History of a Multi Stage Hydraulic Fracturing Horizontal Well Tight-Gas Development in Oman." Paper presented at the SPE Hydraulic Fracturing Technology Conference, The Woodlands, Texas, USA, February 2016. <https://doi.org/10.2118/179142-MS>.
- Nolte, K. G. (1988) "Principles for Fracture Design Based on Pressure Analysis." *SPE Production Engineering* Vol. 3 (1988): 22–30. <https://doi.org/10.2118/10911-PA>.
- Norris, M., Langford, M., Giraud, C., Stanley, R. and S. Ball. (2022) "Hydraulic Fracturing to Successfully Exploit Depleted Gas Reserves: A Case History from the North Sea." Paper presented at the SPE International Hydraulic Fracturing Technology Conference & Exhibition, Muscat, Oman, January 2022. <https://doi.org/10.2118/205335-MS>.
- Olson, K.E., Olsen, E., Haidar, S., Boulatsel, A. and K. Brekke. (2003) "Valhall Field: Horizontal Well Stimulation "Acid vs. Proppant" and Best Practices for Fracture Optimization." Presented at SPE ATCE, Denver, Colorado, Oct. 2003. <https://doi.org/10.2118/84392-MS>.
- Overin, A., Samoilov, M., Kudrya, S. and K. Baidyukov. (2019) "Multistage Stimulation: Fracturing Optimization at Samotlorskoe Field." Paper presented at SPE Russian Petroleum Technology Conf., Moscow, Russia, October 2019. <https://doi.org/10.2118/196961-MS>.
- Owens, K.A., Pitts, M.J., Klampferer, H.J. and S.B. Krueger. (1992) "Practical Considerations of Horizontal Well Fracturing in the "Danish Chalk"." Paper presented at the European Petroleum Conference, Cannes, France, November <https://doi.org/10.2118/25058-MS>.
- Pearson, M., Fowler, G., McClure, M. and Rylance, M. (2025) "Conventional and Unconventional Development Part II: Extrapolation of Unconventional Horizontal Development to Low Permeability Reservoirs" Paper presented at the SPE Hydraulic Fracturing Technology Conference, The Woodlands, Texas, USA, February 2025 <https://doi.org/10.2118/223562-MS>.
- Pearson, C.M., Rondon, J., Strickland, S., Griffin, L., Ratcliff, D. and G. Fowler. (2024) "A Case Study of Bakken Development Optimization with Complex Constraints." Paper presented at the SPE/AAPG/SEG Unconventional Resources Technology Conference, Houston, Texas, USA, June 2024. <https://doi.org/10.15530/urtec-2024-4043244>.
- Pearson, C.M., Green, C.A., McGill, M. and D. Milton-Taylor. (2022) "Extended-Time Conductivity Testing of Proppants Used for Multi-Stage Horizontal Completions." Paper presented at the SPE International Hydraulic Fracturing Technology Conference & Exhibition, Muscat, Oman, January 2022. <https://doi.org/10.2118/205272-MS>.
- Pearson, C. M., Griffin, L., Wright, C. and L. Weijers. (2013) "Breaking Up is Hard to Do: Creating Hydraulic Fracture Complexity in the Bakken Central Basin." Paper presented at the SPE Hydraulic Fracturing Technology Conference, The Woodlands, Texas, USA, February 2013 <https://doi.org/10.2118/163827-MS>.
- Roy, A., Casero, A., Nicolaysen, A., Al Alawi, K., Al Shabibi, M., Albrecht, K. and W.. Dawson. (2016) "Design and Execution of BP's First 15K Open Hole Multi Stage Completion System in the Sultanate of Oman." Paper presented at the Abu Dhabi International Petroleum Exhibition & Conference, Abu Dhabi, UAE, November 2016. <https://doi.org/10.2118/183247-MS>.
- Rylance, M., Judd, T. and A. Makmun. (2011a) "After Closure Analysis an Underutilized and Undervalued Approach to Understanding kh" SPE Middle East Oil and Gas Show and Conference, Manama, Bahrain, September 2011. <https://doi.org/10.2118/141681-MS>.
- Rylance, M., Nicolaysen, A., Ishteiwy, O., Judd, T., Huey, T. and W. Giffin. (2011b) "Hydraulic Fracturing: Key to Effective Khazzan-Makarem Tight Gas Appraisal." SPE Middle East Unconventional Gas Conference and Exhibition, Muscat, Oman, January 2011.
- Rylance, M. (2024) "Overflush and Hydraulic Fracturing: Playing Poker with Your Completion." *SPE J.* 29 (2024): 371–385. <https://doi.org/10.2118/212342-PA>.
- Rylance, M.. (2022) "Optimist, Pessimist or Engineer - Conductivity Based on Need Not Fashion." Paper presented at the SPE International Hydraulic Fracturing Technology Conference & Exhibition, Muscat, Oman, January 2022. <https://doi.org/10.2118/205286-MS>.
- Shaoul, J., Park, J., Bakhtiyarov, A., Fekkai, S., Jeffs, P. and D. Mandiwall. (2013) "Clipper South Field: Fracturing Operations and Production Matching in a Low Permeability, Sandstone Gas Reservoir in the North Sea." Paper presented at the EAGE Annual Conference & Exhibition incorporating SPE Europe, London, UK, June 2013. <https://doi.org/10.2118/164826-MS>.
- Shaoul, J.R., Park, J., Boucher, A., Tkachuk, I., Veeken, C., Salmi, S., Bahri, K., Rashdi, M. and D. Nazaruk. (2022) "Evaluating the Performance of Horizontal Multi-Frac Wells in a Depleted Gas Condensate Reservoir in Sultanate of Oman." Paper presented at the SPE International Hydraulic Fracturing Technology Conf. & Exh., Muscat, Oman, Jan. 2022. <https://doi.org/10.2118/205328-MS>.
- Schrama, E., Naughton-Rumbo, R., van der Bas, F., Norris, M. and J. Shaoul. (2011) "First True Tight Gas (<0.1 mD) Horizontal Multiple Fractured Well in the North Sea." Paper presented at the SPE European Formation Damage Conference, Noordwijk, The Netherlands, June 2011. <https://doi.org/10.2118/143166-MS> <https://doi.org/10.2118/142783-MS>.
- Smith, M. B., Miller, W. K., and J. Haga. (1987) "Tip Screen-out Fracturing: A Technique for Soft, Unstable Formations." *SPE Prod Eng* 2 (1987): 95–103. <https://doi.org/10.2118/13273-PA>.
- Spain, D. R., Merletti, G. D. and W. Dawson. (2015) "Beyond Volumetrics: Unconventional Petrophysics for Efficient Resource Appraisal (Example from the Khazzan Field, Sultanate of Oman)." SPE Middle East Unconventional Resources Conference and Exhibition, Muscat, Oman, January 2015. <https://doi.org/10.2118/SPE-172920-MS>.
- Sun, H., Zhou, J., Cutler, J., Royce, T., Nelson, S and Q. Qu. (2013) "Field Case Histories of a Non-Damaging Guar Alternative for Linear Gel Application in Slickwater Fracturing." Paper presented at the SPE European Formation Damage Conference & Exhibition, Noordwijk, The Netherlands, June 2013. <https://doi.org/10.2118/165130-MS>.

- Thomas RJ, Ellison RA, Goodenough KM, Roberts NMW, Allen P (2015) A. Salt domes of the UAE and Oman: probing eastern Arabia. *Precambr Res* 256:1–16 <https://doi.org/10.1016/j.precamres.2014.10.011>.
- Velikanov, I., Isaev, V., Bannikov, D., Tikhonov, A., Semin, L., Belyakova, L. and D. Kuznetsov. (2018) "New Fracture Hydrodynamics and In-Situ Kinetics Model Supports Comprehensive Hydraulic Fracture Simulation." Paper presented at the SPE Europec featured at 80th EAGE Conference and Exhibition, Copenhagen, Denmark, June 2018. <https://doi.org/10.2118/190760-MS>
- Walker, R.N., Hunter, J.L., Brake, A.C., Fagin, P.A. and N. Steinsberger. (1998) "Proppants, We Still Don't Need No Proppants - A Perspective of Several Operators." Presented at SPE ATCE & Exh., New Orleans, LA, Sep. 1998. <https://doi.org/10.2118/49106-MS>.
- Weijers, L., (2024) "Making Unconventionals Competitive—Minimizing the Cost per Barrel", SPE Distinguished Lecturer, 2024-25.
- Weijers, L., de Pater, C. J., Owens, K. A., and H. H. Kogsbøll. (1994) "Geometry of Hydraulic Fractures Induced From Horizontal Wellbores. " *SPE Prod & Fac* 9 (1994): 87–92. <https://doi.org/10.2118/25049-PA>.
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Conventional and Unconventional Development Part II: Extrapolation of Unconventional Horizontal Development to Low Permeability Reservoirs

C. M. Pearson, Liberty Resources, G. Fowler and M. McClure, ResFrac Corporation and M. Rylance, IXL Oilfield Consulting

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References

- Abou-Sayed, I.S., Schueler, S., Ehrl, E., and W. Hendricks. (1995) "Multiple Hydraulic Fracture Stimulation in a Deep Horizontal Tight Gas Well." *J Pet Technol* 48 (1996): 163–168. <https://doi.org/10.2118/30532-JPT>.
- Althani, M. (2020) "Development Potential of Non-Source Tight-Oil Formations in the Middle East." Paper presented at SPE/AAPG/SEG Latin America Unconventional Resources Technology Conference, Virtual, November 2020. <https://doi.org/10.15530/urtec-2020-1548>.
- Ba Geri, M, Ellafi, A., Flori, R., Belhajj, A, and Ethar H. A. (2019) "Opportunities and Challenges to Discover and Develop Unconventional Plays in the Middle East and North Africa: Critical Review." Paper presented at the Abu Dhabi International Petroleum Exhibition & Conference, Abu Dhabi, UAE, November 2019. <https://doi.org/10.2118/197271-MS>.
- Cinco-Ley, H. and Samaniego-V., F. (1980) "Transient Pressure Analysis for Fractured Wells." *Jour. Pet. Technology* 33: 1749–1766. <https://doi.org/10.2118/7490-PA>.
- Cipolla, C.L., Jensen, L., Ginty, W. and C.J. de Pater. (2000) "Complex Hydraulic Fracture Behaviour in Horizontal Wells, South Arne Field, Danish North Sea." Paper presented at the SPE ATCE, Dallas, Texas, October 2000. <https://doi.org/10.2118/62888-MS>.
- Coulter, G. R., Benton, E. G., and C. L. Thomson. (2004) "Water Fracs and Sand Quantity: A Barnett Shale Example." Paper presented at the SPE Annual Technical Conference and Exhibition, Houston, Texas, September 2004. <https://doi.org/10.2118/90891-MS>.
- David, F, and. M. Stäuble. (2013) "Developing a Sustainable Unconventional Business in China." Paper presented at the SPE Unconventional Resources Conference and Exhibition-Asia Pacific, Brisbane, Australia, November 2013. <https://doi.org/10.2118/167051-MS>.
- Economides, M. J., and A. N. Martin. (2010). How to Decide Between Horizontal Transverse, Horizontal Longitudinal and Vertical Fracture Completion." Paper presented at the SPE Annual Technical Conference and Exhibition, Florence, Italy, September, 2010.
- Fisher, M. K., Heinze, J. R., Harris, C. D., Davidson, B. M, Wright, C. A., and K. P. Dunn. (2004) "Optimizing Horizontal Completion Techniques in the Barnett Shale Using Micro seismic Fracture Mapping." Paper presented at the SPE Annual Technical Conference and Exhibition, Houston, Texas, September 2004. <https://doi.org/10.2118/90051-MS>.
- Fowler, G., Mark M. and C. Cipolla. (2019). "A Utica Case Study: The Impact of Permeability Estimates on History Matching, Fracture Length, and Well Spacing." Paper presented at the SPE Annual Technical Exhibition and Conference, Houston, Texas, Sep., 2019.
- Martin, A.N. and R. Eid (2011) "The Potential Pitfalls of Using North American Tight and Shale Gas Development Techniques in the North African and Middle Eastern Environments. " *SPE Econ & Mgmt* 4 (2012): 147–157. <https://doi.org/10.2118/141104-PA>.
- Martins, J. P., Leung, K. H., Jackson, M. R., Stewart, D. R., and A. H. Carr. (1992) "Tip Screenout Fracturing Applied to the Ravenspurn South Gas Field Development. " *SPE Prod Eng* 7 (1989): 252–258. <https://doi.org/10.2118/19766-PA>.
- Owens, K.A., Pitts, M.J., Klampferer, H.J. and S.B. Krueger. (1992) "Practical Considerations of Horizontal Well Fracturing in the "Danish Chalk"." Paper presented at the European Petroleum Conference, Cannes, France, November <https://doi.org/10.2118/25058-MS>.
- Pearson, C. M., Griffin, L., Wright, C. and L. Weijers. (2013) "Breaking Up is Hard to Do: Creating Hydraulic Fracture Complexity in the Bakken Central Basin." Paper presented at the SPE Hydraulic Fracturing Technology Conference, The Woodlands, Texas, USA, February 2013 <https://doi.org/10.2118/163827-MS>.
- Pearson, C. M., Rondon, J., Strickland, S., Griffin, L., Ratcliff, D. and G. Fowler. (2024) "A Case Study of Bakken Development Optimization with Complex Constraints." Paper presented at the SPE/AAPG/SEG Unconventional Resources Technology Conference, Houston, Texas, USA, June 2024. <https://doi.org/10.15530/urtec-2024-4043244>.
- Rylance, M., Pearson, M., Fowler, G. and McClure, M. (2025) "Conventional and Unconventional Developments Part I: What Applies, Where and Why ?" Paper presented at the SPE Hydraulic Fracturing Technology Conference, The Woodlands, Texas, USA, February 2025 <https://doi.org/10.2118/223561-MS>.
- Rylance, M. (2022) "Optimist, Pessimist or Engineer - Conductivity Based on Need Not Fashion." Paper presented at the SPE International Hydraulic Fracturing Technology Conference & Exhibition, Muscat, Oman, January 2022. <https://doi.org/10.2118/205286-MS>.
- Settari, A., (1985). A new general model of fluid loss in hydraulic fracturing, *Soc. Petrol. Eng. J.*, 25, 491–501
- Steward, D. B. (2013) "George P. Mitchell and the Barnett Shale. " *J Pet Technol* 65 (2013): 58–68. <https://doi.org/10.2118/1113-0058-JPT>.

Weijers, L., Wright, C., Mayerhofer, M., Pearson, C.M., Griffin, L. and Paul Weddle. (2019) "Trends in the North American Frac Industry: Invention through the Shale Revolution." Paper presented at the SPE Hydraulic Fracturing Technology Conference and Exhibition, The Woodlands, Texas, USA, February 2019. <https://doi.org/10.2118/194345-MS>.



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Conventional and Unconventional Development Part III: Extrapolation of Conventional Horizontal Fractured Well Development to Lower Permeability Reservoirs

C. M. Pearson, Liberty Resources, G. Fowler and M. McClure, ResFrac Corporation and M. Rylance, IXL Oilfield Consulting

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References

- Abdulkadir, R., Al-Lawati, H., Al-Sulaimi, S., Zhan, L., Hilling, S. and C. O'Brien. "Successful Design and Execution of First Multi-Stage-Fractured Horizontal Pilot Well in Low Permeability Reservoir in Oman." Paper presented at the SPE International Hydraulic Fracturing Technology Conference and Exhibition, Muscat, Sultanate of Oman, September 2023. <https://doi.org/10.2118/215642-MS>
- Abou-Sayed, I.S., Schueller, S., Ehrl, E., and W. Hendricks. (1996) "Multiple Hydraulic Fracture Stimulation in a Deep Horizontal Tight Gas Well." *J Pet Technol* 48 (1996): 163–168. <https://doi.org/10.2118/30532-JPT>
- Al-Shamma, B., Nicole, H., Nurafza, P. R. and W. C. Feng. (2014) "Evaluation of Multi-Fractured Horizontal Well Performance: Babbage Field Case Study. (2014) "Paper presented at the SPE Hydraulic Fracturing Technology Conference, The Woodlands, Texas, USA, February <https://doi.org/10.2118/168623-MS>.
- Al Shueili, A., Jaboob, M. and H. Al Salmi. (2022) "Connecting the Dots: Multistage Fracturing in Horizontal Wells with Multilayered Reservoirs - Lessons Learned." Paper presented at the SPE International Hydraulic Fracturing Technology Conference & Exhibition, Muscat, Oman, January 2022. <https://doi.org/10.2118/205302-MS>.
- Allan, Malcolm E., Gold, David K., and Dyke W. Reese. (2010) "Development of the Belridge Field's Diatomite Reservoirs with Hydraulically Fractured Horizontal Wells: From First Attempts to Current Ultra-Tight Spacing." Paper presented at the SPE Annual Technical Conference and Exhibition, Florence, Italy, September 2010. <https://doi.org/10.2118/133511-MS>
- Baumgartner, W. E., Shlyapobersky, J., Abou Sayed, I. S. and R. C. Jacquier.(1993) "Fracture Stimulation of a Horizontal Well in a Deep, Tight Gas Reservoir: A Case History From Offshore The Netherlands." Paper presented at the SPE Offshore Europe, Aberdeen, United Kingdom, September <https://doi.org/10.2118/26795-MS>.
- Bird, A., Lumsden, J., Paterson, J., Marshall, E., Sibbett, S., Hoad, J., Stanley, R. and M. Norris. (2023) "Case Study: First Multistage Fracturing SIMOPs with Concurrent Drilling Operations in Clair Ridge Field, North Sea." Paper presented at the SPE IHFTC, Muscat, Sultanate of Oman, September 2023. <https://doi.org/10.2118/215632-MS>
- Bond, A., Jasser, R., Johnson, V., Morgan, M., Martin, M., Palisch, T., and Williams, B. (2015) "Completion Optimization Provides Step Changes in Horizontal Well Performance in the Nuiqsut Formation – An Oooguruk Field (Alaska) Case History." Paper presented at the SPE Annual Technical Conference and Exhibition, Houston, USA, September 2015. <https://doi.org/10.2118/174743-MS>
- Brekke, K. J, Johansen, T.E. and R. Olufsen. (1993) "A New Modular Approach to Comprehensive Simulation of Horizontal Wells." Paper presented at the SPE Annual Technical Conference and Exhibition, Houston, Texas, October 1993. <https://doi.org/10.2118/26518-MS>
- Briner, A., Moiseenkov, A., Nadezhdin, S., Al-Zeidi, O. and T. Batmaz. (2015) "Successfully Planning Horizontal Well Completions Using Advanced Workflows in a Tight Gas Reservoir in the Sultanate of Oman." Paper presented at the SPE Production and Operations Symposium, Oklahoma City, Oklahoma, USA, March 2015. <https://doi.org/10.2118/173611-MS>
- Cander, H. (2012). Sweet Spots in Shale Gas and Liquids Plays: Prediction of Fluid Composition and Reservoir Pressure. AAPG Search and Discovery Article, 40936, 29 May 2012. https://www.searchanddiscovery.com/documents/2012/80217cander/ndx_cander.pdf
- Chambers, M. R., Mueller, M. W., and A. Grossmann. (1995) "Well Completion Design and Operations for a Deep Horizontal Well with Multiple Fractures." Paper presented at the SPE Offshore Europe, Aberdeen, United Kingdom, September 1995. <https://doi.org/10.2118/30417-MS>
- Clark, R. A., Mullen, K. and K. Stevanus. (2013) "Adopting North American, Multi-stage Fracturing and Horizontal Completion Technologies Starts to Unlock the Amin Tight Gas Formation in the Sultanate of Oman." Paper presented at the SPE Unconventional Gas Conference and Exhibition, Muscat, Oman, January 2013. <https://doi.org/10.2118/164008-MS>.

- Dedurin, A. V., Majar, V. A., Voronkov, A. A., Zagurenko, A. G., Zakharov, A. Y., Palisch, T. and M. C. Vincent. (2006) "Designing Hydraulic Fractures in Russian Oil and Gas Fields to Accommodate Non-Darcy and Multiphase Flow-Theory and Field Examples." Paper presented at the SPE Russian Oil and Gas Technical Conference and Exhibition, Moscow, Russia, October 2006. <https://doi.org/10.2118/101821-MS>
- Ehrl, E. and S. K. Schueler. (2000) "Simulation of a Tight Gas Reservoir with Horizontal Multi-fractured Wells." Paper presented at the SPE European Petroleum Conference, Paris, France, October 2000. <https://doi.org/10.2118/65108-MS>.
- Elliott, D. and S. Al Abri. (2015) "Completion Advancements in the Khulud Unconventional Gas Project." Paper presented at the SPE Middle East Unconventional Resources Conference and Exhibition, Muscat, Oman, January 2015. <https://doi.org/10.2118/SPE-172938-MS>.
- Heward, A., Morton, M. and Kindi, M. (2024). The Search for Petroleum in The Sultanate of Oman – The First 120 Years. Geological Society, London, Special Publications. [550. 10.1144/SP550-2023-220](https://doi.org/10.1144/SP550-2023-220).
- Hoq, A., Caline, Y., Jakobsen, E., Wood, N., Stolpman, R., Thirion, A. and W. Giffin. (2022) "Enhancements in Fracturing Fluid Engineering Reawakens a North Sea Giant." Paper presented at the SPE IHTC, Muscat, Oman, January 2022. <https://doi.org/10.2118/205256-MS>
- Ishteiwy, O. A., Casero, A., Al-Shueili, A., Turk, G., Roy, A., Al Manji, A., Dawson, W., White, D. and S. D. Kurniadi. (2017) "Advancing the Understanding of Openhole MultiStage Completion Systems in Khazzan—Hydraulic Fracturing Execution and Analysis." Paper presented at the Abu Dhabi International Petroleum Exhibition & Conference, Abu Dhabi, UAE, November 2017. <https://doi.org/10.2118/188376-MS>
- Ishteiwy, O. A., Dawson, W., Al Shidhani, R., and B.. Al Busafi (2018) "Fracture Design and Placement and Its Application and Influence on Amin Performance." Paper presented at the SPE IHTC, Muscat, Oman, October 2018. <https://doi.org/10.2118/191430-18IHT-MS>.
- Jelsma, H. H., Comeaux, B. C. and B. Meyerov. (1993) "Drilling of Horizontal Wells in Western Siberia." Paper presented at the SPE Annual Technical Conference and Exhibition, Houston, Texas, October 1993. <https://doi.org/10.2118/26352-MS>
- Jensen, T. B, Little, L., Melvin, J., Reinbold, E., Jamieson, D. and W. Shi. (2012) "Kuparuk River Unit Field - The First 30 Years." Paper presented at the SPE Annual Technical Conference and Exhibition, San Antonio, Texas, USA, October 2012. <https://doi.org/10.2118/160127-MS>
- Jones, A.T., Al Salhi, M.S., Al Shidl, S.M., England, M., and R. Pongratz. "Multiple Hydraulic Fracturing of Deep Gas-Condensate Wells in Oman." Paper presented at the SPE ATCE, New Orleans, Louisiana, September 1998. <https://doi.org/10.2118/49100-MS>
- Kogsbøll, H.H., Pitts, M.J. and K.A. Owens. (1993) "Effects of Tortuosity in Fracture Stimulation of Horizontal Wells - A Case Study of the Dan Field." Paper presented at the SPE Offshore Europe, Aberdeen, United Kingdom, September 1. <https://doi.org/10.2118/26796-MS>
- Langedijk, R. A., Al-Naabi, S., Al-Lawati, H., Pongratz, R., Elia, M. P. and T. Abdulrab.(2000) "Optimization of Hydraulic Fracturing in a Deep, Multilayered, Gas-Condensate Reservoir." Paper presented at the SPE ATCE, Dallas, Texas, October 2000. <https://doi.org/10.2118/63109-MS>
- Langford, M., Westera, D., Holland, B., Bocaneala, B. and M. Norris. (2014) "Development of a Stranded Tight Gas Field in the UK Southern North Sea Using Hydraulic Fracturing Within a Subsea Horizontal Well: A Case Study." Paper presented at the SPE Annual Technical Conference and Exhibition, Amsterdam, The Netherlands, October 2014. <https://doi.org/10.2118/170852-MS>.
- Lietard, O., Ayoub, J. and A. Pearson. (1996) "Hydraulic Fracturing of Horizontal Wells: An Update of Design and Execution Guidelines." Paper presented at the International Conf. on Horizontal Well Technology, Calgary, Alberta, Canada, November. <https://doi.org/10.2118/37122-MS>
- Luo, S., Neal, L., Arulampalam, P. and Ciosek, J.M.: "Flow Regime Analysis of Multi-stage Hydraulically-fractured Horizontal Wells with Reciprocal Rate Derivative Function: Bakken case Study," Paper CSUG/SPE 137514 presented at the Canadian Unconventional Resources and International Petroleum Conference, Calgary, Alberta, Canada, 19-21 October, 2010.
- Martin, A. N. and M. Rylance. (2010) "Hydraulic Fracturing Makes the Difference: New Life for Old Fields." Paper presented at the North Africa Technical Conference and Exhibition, Cairo, Egypt, February 2010. <https://doi.org/10.2118/127743-MS>
- McKimmy, M., Cipolla, C., Miranda, C., Rudolph, S., Shaarawi, K. and B. Baca. (2025) "Case History of Drainage Mapping and Infill Well Performance in the Bakken." Paper presented at the SPE/AAPG/SEG Unconventional Resources Technology Conference, Houston, Texas, USA, June 2025. <https://doi.org/10.15530/urtec-2025-4244595>
- Meehan, D. N.. "Stimulation Results in the Giddings (Austin Chalk) Field." (1995) *SPE Prod & Fac* 10: 96–102. <https://doi.org/10.2118/24783-PA>
- Nicolaysen, A., Casero, A., Roy, A., Rylance, M., Kurniadi, S., and T.. Batmaz. (2016) "The Good, the Bad and the Ugly: A Case History of a Multi Stage Hydraulic Fracturing Horizontal Well Tight-Gas Development in Oman." Paper presented at the SPE Hydraulic Fracturing Technology Conference, The Woodlands, Texas, USA, February 2016. <https://doi.org/10.2118/179142-MS>.
- Norris, M.R., Berntsen, B.A., Myhre, P. and W.J. Winters.(1996) "Multiple Proppant Fracturing of a Horizontal Wellbore: an integration of two technologies." Paper presented at the European Petroleum Conference, Milan, Italy, October 1996. <https://doi.org/10.2118/36899-MS>
- Norris, M.R., Berntsen, B.A., Skartveit, L., and C. Teesdale. (1998) "Multiple Proppant Fracturing of Horizontal Wellbores in a Chalk Formation: Evolving the Process in the Valhall Field." Paper presented at the European Petroleum Conference, The Hague, Netherlands, October 1998. <https://doi.org/10.2118/50608-MS>
- Norris, M., Langford, M., Giraud, C., Stanley, R. and S. Ball.(2022) "Hydraulic Fracturing to Successfully Exploit Depleted Gas Reserves: A Case History from the North Sea." Paper presented at the SPE International Hydraulic Fracturing Technology Conference & Exhibition, Muscat, Oman, January 2022. <https://doi.org/10.2118/205335-MS>.
- Olson, K.E., Olsen, E., Haidar, S, Boulatsel, A. and K. Brekke. (2003) "Valhall Field: Horizontal Well Stimulation "Acid vs. Proppant" and Best Practices for Fracture Optimization." Presented at SPE ATCE, Denver, Colorado, Oct. 2003. <https://doi.org/10.2118/84392-MS>
- Parada, C., Ligocki, L., Varahanaresh, S., Casero, A., Al Harrasi, M. N. and S. Motealleh. (2023) "Is Single Stage Vertical Well the Only Option for Khazzan/Ghazeer? Hydraulic Fracturing Design Optimization Coupled with Production Simulations Provide Insights on Different Completion Approaches to Maximize Recovery, Production and Economics." Paper presented at the SPE International Hydraulic Fracturing Technology Conference and Exhibition, Muscat, Sultanate of Oman, September 2023. <https://doi.org/10.2118/215655-MS>

- Pearson, C.M., Clonts, M.D. and N.R. Vaughn. (1996) "Use of Longitudinally Fractured Horizontal Wells in a Multi-Zone Sandstone Formation." Paper presented at the SPE Annual Technical Conference and Exhibition, Denver, Colorado, October 1996. <https://doi.org/10.2118/36454-MS>
- Pearson, C. M. (2013) "Hydraulic Fracturing of Horizontal Wells - Realizing the Paradigm Shift that has been 30 years in Development." SPE Distinguished Lecturer Program.
- Pearson, C. M., Fowler, G., McClure, M., and M. Rylance. (2025) "Conventional and Unconventional Development Part II: Extrapolation of Unconventional Horizontal Development to Low Permeability Reservoirs." Paper presented at the SPE Hydraulic Fracturing Technology Conference and Exhibition, The Woodlands, Texas, USA, February 2025. <https://doi.org/10.2118/223562-MS>
- Pongratz, R., Kuvshinov, I. K. and K. E. Latkin. (2008) "Evolution of Hydraulic Fracturing in Russia." Paper presented at the SPE Russian Oil and Gas Technical Conference and Exhibition, Moscow, Russia, October 2008. <https://doi.org/10.2118/114876-MS>
- Rylance, M., Judd, T. and A. Makmun. (2011a) "After Closure Analysis an Underutilized and Undervalued Approach to Understanding kh" SPE Middle East Oil and Gas Show and Conference, Manama, Bahrain, September 2011. <https://doi.org/10.2118/141681-MS>
- Rylance, M., Nicolaysen, A., Ishteiwy, O., Judd, T., Huey, T. and W. Giffin. (2011b) "Hydraulic Fracturing: Key to Effective Khazzan-Makarem Tight Gas Appraisal." SPE Middle East Unconventional Gas Conference and Exhibition, Muscat, Oman, January 2011.
- Rylance, M. (2024) "Overflush and Hydraulic Fracturing: Playing Poker with Your Completion." *SPE J.*29 (2024): 371–385. <https://doi.org/10.2118/212342-PA>.
- Rylance, M., Pearson, M., Fowler, G., and M. McClure. (2025) "Conventional and Unconventional Developments Part I: What Applies, Where and Why ?." Paper presented at the SPE Hydraulic Fracturing Technology Conference and Exhibition, The Woodlands, Texas, USA, February 2025. <https://doi.org/10.2118/223561-MS>
- Schneider, T. S., Uldrich, D., Hodge, R., Barree, B., Martin, M.W. (2007). "Horizontal Fracture Stimulation Success in the Alpine Formation, North Slope, Alaska." Presented at the SPE Hydraulic Fracturing Technology Conference, College Station, TX, January 29-31. <https://doi.org/10.2118/106050-MS>
- Schrama, E., Naughton-Rumbo, R., van der Bas, F., Norris, M. and J. Shaoul. (2011) "First True Tight Gas (<0.1 mD) Horizontal Multiple Fractured Well in the North Sea." Paper presented at the SPE European Formation Damage Conference, Noordwijk, The Netherlands, June 2011. <https://doi.org/10.2118/143166-MS> <https://doi.org/10.2118/142783-MS>.
- Shaoul, J., Park, J., Bakhtiyarov, A., Fekkai, S., Jeffs, P. and D. Mandiwall. (2013) "Clipper South Field: Fracturing Operations and Production Matching in a Low Permeability, Sandstone Gas Reservoir in the North Sea." Paper presented at the EAGE Annual Conference & Exhibition incorporating SPE Europe, London, UK, June 2013. <https://doi.org/10.2118/164826-MS>
- Shaoul, J.R., Park, J., Boucher, A., Tkachuk, I., Veeken, C., Salmi, S., Bahri, K., Rashdi, M. and D. Nazaruk. (2022) "Evaluating the Performance of Horizontal Multi-Frac Wells in a Depleted Gas Condensate Reservoir in Sultanate of Oman." Paper presented at the SPE International Hydraulic Fracturing Technology Conf., Muscat, Oman, Jan. 2022. <https://doi.org/10.2118/205328-MS>.
- Soliman, M. Y., Pongratz, R., Rylance, M. and D. Prather. (2006) "Fracture Treatment Optimization for Horizontal Well Completion." Paper presented at the SPE Russian Oil and Gas Technical Conference and Exhibition, Moscow, Russia, October 2006. <https://doi.org/10.2118/102616-MS>
- Stramp, R.L. (1980). The Use of Horizontal Drainholes in the Empire Abo Unit. Presented at the SPE Annual Technical Conference and Exhibition, Dallas, Texas, 21-24 September 1980. SPE-9221-MS. <http://dx.doi.org/10.2118/9221-MS>
- Tehrani, A. D. H. (1992) "An Overview of Horizontal Well Targets Recently Drilled in Europe." Paper presented at the International Meeting on Petroleum Engineering, Beijing, China, March 1992. <https://doi.org/10.2118/22390-MS>
- Thomas RJ, Ellison RA, Goodenough KM, Roberts NMW, Allen P (2015) A. Salt domes of the UAE and Oman: probing eastern Arabia. *Precambr Res* 256:1–16 <https://doi.org/10.1016/j.precamres.2014.10.011>.
- Thomson, S., Kiyabayev, B., Ritchie, B., Monberg, J., De Heer, M., and S. Skov List. (2022) "Worlds First Offshore Horizontal Well Using Jointed Pipe Cemented Frac Sleeve Technology." Paper presented at the SPE International Hydraulic Fracturing Technology Conference & Exhibition, Muscat, Oman, January 2022. <https://doi.org/10.2118/205331-MS>
- White, C. W. (1989) "Drilling and Completion of a Horizontal Lower Spraberry Well Including Multiple Hydraulic Fracture Treatments." Paper presented at the SPE Annual Technical Conference and Exhibition, San Antonio, Texas, October 1989. <https://doi.org/10.2118/19721-MS>
- Wright, C.A., Minner, W.A., Weijers, L., Davis, E.J., Golich, G.M., and H. Kikuchi. (1997) "Wellbore-to-Fracture Communication Problems Pose Challenges in California Diatomite Horizontal Wells." Paper presented at the SPE Annual Technical Conference and Exhibition, San Antonio, Texas, October 1997. <https://doi.org/10.2118/38632-MS>
- Young, D., Koløy, T.R., Keerthivasan, V. and S. Satimov. (2022) "Development and Deployment of a Novel Single-Trip Multistage Proppant Fracturing System in the Norwegian Continental Shelf." Paper presented at the SPE Norway Subsurface Conference, Bergen, Norway, April 2022. <https://doi.org/10.2118/209563-MS>