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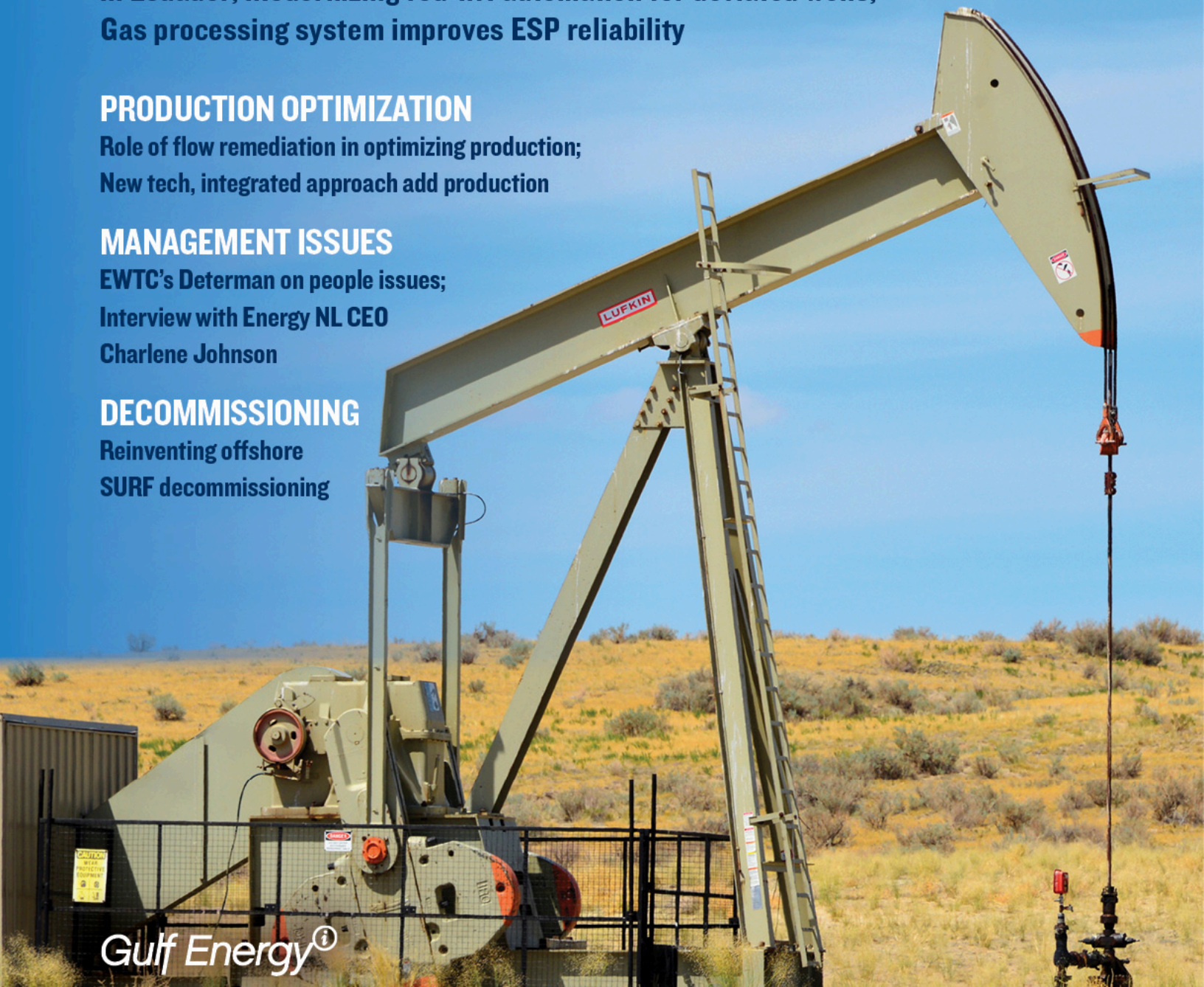
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Cost-effective bottomhole flow diagnostics in mature PDP assets using nanoparticle tracers: A case study from East Texas

Petralis Energy Resources deploys low-cost, advanced nanoparticle tracer technology to optimize decision-making for its mature assets in Anderson County, Texas. The simple, non-intrusive solution enabled precise, targeted remediation strategies, enhancing production efficiency and extending asset lifespan.

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Fig. 1. Anderson, Texas, legacy wells.

Managing mature wells under a Proved Developed Producing (PDP) investment model demands accurate, low-cost diagnostics to inform intervention decisions. Petralis, operating in the Tennessee Colony field of East Texas, deployed QuantumPro Inc.'s OmniTrac™ universal wellbore flow tracer—a nanoparticle-based diagnostic technology—to evaluate bottomhole flow in legacy vertical wells.

The case study of the Flockhart #1 well demonstrates OmniTrac's ability to deliver actionable, high-resolution flow data with minimal disruption, at a fraction of the cost of traditional methods. Tracer data confirmed restored production flow from targeted intervals following acid stimulation, validating the workover and aligning with Petralis' cost-sensitive strategy. OmniTrac offers scalable diagnostics for vertical and horizontal wells alike, presenting a breakthrough solution for operators, balancing operational performance with economic discipline in mature fields.

EAST TEXAS LEGACY WELLS: CHALLENGING ECONOMICS FOR TRADITIONAL DIAGNOSTICS

Located in Anderson County, East Texas, the Tennessee Colony field is a mature oil and gas area known for its conventional carbonate reservoirs, exploited primarily through legacy vertical wells. The field's wells, often decades old, produce oil, dry gas and natural gas liquids (NGLs) from formations like the Pettet and Rodessa. Low decline rates characterize these wells, making them attractive for operators such as Petralis, which employs a Proved Developed Producing (PDP) investment model to develop and maintain their assets.

THE PDP MODEL: COST-CONSCIOUS STRATEGY MAXIMIZES LEGACY WELL INVESTMENT RETURN

The PDP model focuses on actively producing wells with existing infrastructure, offering operators lower-risk assets with established, predictable cash flow. This model reduces uncertainty by emphasizing mature fields with proven reserves, such as those in the Tennessee Colony field. Petralis's approach prioritizes low-capital, high-impact interventions like targeted workovers and restimulation efforts, which aim to boost production while keeping operating costs in check. Managing the natural production decline of these wells is key to extending their economic life and maintaining investor returns.

THE CHALLENGE: DIAGNOSING COMPLEX LEGACY WELLS ECONOMICALLY

The region's geological complexity, including faults and preferred fracture planes, combined with the age of the wells, presents operational challenges, such as blockages and underperforming intervals. This makes bottomhole flow diagnostics highly desirable, to guide workovers with greater confidence and inform broader field development strategies. However, within the tight budget constraints common in mature PDP operations, the high costs of traditional technologies—such as production logging tools, downhole cameras and fiber optic systems—render these traditional technologies unsustainable. These costly methods often exceed the financial thresholds acceptable for most legacy assets, leaving operators with limited viable options for acquiring essential bottomhole flow data and highly-desired diagnostic capabilities—until now.

A NOVEL SOLUTION: OMNITRAC™ UNIVERSAL WELLBORE FLOW TRACER FOR BOTTOMHOLE FLOW DIAGNOSTICS

Petralis Energy Resources is a small, privately funded operator based in Texas, specializing in acquiring and revitalizing mature assets under the PDP model. In 2019, Petralis acquired 2,680 net acres (4.2 mi²) in Tennessee Colony field, including eight legacy wells producing oil, gas and NGLs. The company's strategy focuses on enhancing production through workovers, restimulation and optimized field development, with the aim of increasing production rates while minimizing capital expenditure. Petralis' lean operational model emphasizes cost-effective technologies to maximize asset value and inform decisions.

Having previously collaborated with QuantumPro Inc. on a horizontal well completions flow diagnostics project, using a related nanoparticle tracer product, Petralis Managing Director David Peña recognized the broader potential of QuantumPro's tracer technology platform. Drawing on this foundation, Peña identified QuantumPro's OmniTrac™ universal wellbore flow tracer as a promising solution for a new and distinct application: assessing bottomhole production flow in legacy vertical wells within a highly cost-sensitive environment.

This nanoparticle tracer was selected for its non-intrusive, cost-effective bottomhole production flow diagnostics and simple, unobtrusive deployment. The technology aligns seamlessly with Petralis' PDP

model, delivering critical bottomhole flow data to inform workover strategies. This novel application provides the essential bottomhole flow data needed for precise, data-driven interventions and more informed workover decisions, ultimately enhancing production efficiency and helping Petralis maximize asset value in the Tennessee Colony field, while staying aligned with their cost-conscious approach, **Fig. 1.**

NANOPARTICLE TRACER TECHNOLOGY DELIVERS COST-EFFECTIVE BOTTOMHOLE PRODUCTION DIAGNOSTICS, EVEN IN LEGACY WELLS WITH NARROW MARGINS

QuantumPro's universal wellbore flow tracer is a next-generation diagnostic tool, engineered to quantify production flow from the toe, or bottom, of both horizontal and vertical wells, whether newly completed, legacy, offshore or onshore. The flow tracer employs a dissolvable alloy ball (available in 2.5-in, 3.5-in, or 4.5-in OD) filled with FloTrac™ ultrahigh-resolution nanoparticle tracers. These non-radioactive, non-hazardous tracers, designed for sub-atomic detection accuracy, are stable in temperatures up to 2,000°F and pressures up to 10,000 psi, offering broad utility across diverse well conditions.

The OmniTrac alloy ball functions similarly to a gelatin medicine capsule; only, in this case, it is a precision-machined, highly engineered dissolvable metal shell. This "capsule" is easily dropped or pumped to the bottom of a vertical well or the toe of an extended-reach horizontal section for deployment.

SIMPLE DEPLOYMENT, RAPID RESULTS AND SIGNIFICANT COST SAVINGS

Upon contact with freshwater, brine or production fluids, the hollow alloy ball dissolves within 72 hrs, releasing the uniquely tagged nanoparticle tracer payload. The tracers travel with the production flowback to the surface, where on-site sampling and proprietary lab analysis detect their signature within days. With a 1 µm particle size and dual compatibility with oil and water phases, the need for multiple tracer types is eliminated, reducing complexity and cost compared to traditional chemical tracers.

The flow tracer delivers high-resolution flow diagnostics at a fraction of the cost of alternatives, like retrievable fiber optics or downhole cameras. Its non-intrusive deployment requires no special tools, handling or well modifications, minimizing operational disruption and environmental impact. The resulting data enable operators to confirm flow, identify obstructions, and fine-tune workovers, supporting data-driven remediation strategies and long-term asset value optimization, **Fig. 2.**



Fig. 2. OmniTrac ball.

PETRALIS ENERGY RESOURCES' FLOCKHART #1 WELL SELECTED FOR WORKOVER AND OMNITRAC DEPLOYMENT

Petalis selected their East Texas Flockhart #1 vertical well in Tennessee Colony field for the OmniTrac™ universal wellbore flow tracer introduction. In this case, it involved dropping two separate balls down the well, as a means of ensuring sufficient detectable nanoparticles during well sampling.

The Flockhart #1 well was perforated at 8,940 to 8,950 ft, 8,997 to 9,010 ft and 9,180 to 9,200 ft in the Pettet formation. It was selected for a workover in February 2024, to address potential production issues and enhance output. As part of the workover process, Petralis determined to evaluate bottomhole production flow using the OmniTrac solution. The well's history suggested possible blockages or underperforming intervals, necessitating confirmation of flow from the bottomhole at 9,278 ft. The workover involved:

- **Tubing and rod removal:** Pulling production tubing and rods.
- **Wellbore clean-up:** Running a 4-3/4-in. rock bit to tag the bottom and circulating KCL water to clean the wellbore.
- **Acid stimulation:** Setting a packer at 9,050 ft and pumping 25 bbls of 15% NEFE acid, to clean perforations and near-wellbore zones
- **OmniTrac deployment:** Dropping two OmniTrac™ universal wellbore flow tracer balls to release nanoparticle tracers near the bottomhole of the well.
- **Recommissioning:** Reinstalling the completion assembly and returning the well to production.

Surface sampling to detect the OmniTrac nanoparticle tracers began in March 2024, with daily flowline samples collected for 10 days and analyzed at QuantumPro's lab, to detect tracer concentrations in parts per billion (ppb), **Table 1**.

WELL BORE INFORMATION



COMPANY			CASING	LINER	PROD TUBING	LOWER TUBING
Petalis Energy Resources		SIZE	5.1/2	No	2.7/8	No
WELL NAME & NUMBER		WEIGHT	17#		6.5	
Flockhart #1		GRADE	N-80		N-80	
FIELD		THREAD	?		8Rd	
		DEPTH	?		9,278	
COUNTY		COMPANY REP:				
Anderson		David Pena				
STATE		PREPARED BY:				
Texas		Daniel Mobley Rig # 104				
DATE :	NEW W.O.	OFFICE:				
10/11/22	Workover	MKS				
PREPARED FOR:		PHONE :				
Well Files		903-922-0746				
ITEM	DESCRIPTION		MAX O.D. INCHES	MIN. I.D. INCHES	LENGTH FEET	DEPTH FEET
	Rod & Pump Detail and Description					
	K.B.					
	22' x 1.1/2" Polish Rod		1.250		22.00	22.00
	2' + 4' + 6'+ 8'+ 8' x 7/8" Rod Pony		0.875		28.00	50.00
	98- 7/8" Rods		0.875		2450.00	2500.00
	258- 3/4" Rods		0.750		6450.00	8950.00
	10- 7/8" Rods		1.250		250.00	9200.00
	Right Hand Release On/Off Tool		1.620		1.00	9220.00
	RHBC 2.1/2" x 1.1/4" x 12' x 16' x 20'		2.000		20.00	9240.00
	3 Cups B/Hold D W/10'x 1' Gas Anchor					
	EOR					9240.00
	Spaced @ 20" off Bottom					
	Down Stroke 45"					
	Tubing Detail and Description					
	K.B.		?			15.00
1	222 jts- 2.7/8" 6.5# N-80 EUE 8rd Tbg.		2.875	2.441	6954.04	6969.04
2	5.1/2" x 2.7/8" TAC (30K Shear)		5.500	2.441	2.67	6971.71
3	74 jts- 2.7/8" 6.5# N-80 EUE 8rd Tbg.		2.875	2.441	2270.03	9241.74
4	Stand/Seat Nipple		2.875	1.781	1.25	9242.99
5	4' x 2.7/8" Perf Subs		2.875	2.441	4.13	9247.12
6	1- 2.7/8" Mud jt		2.875	2.441	30.54	9277.66
7	Bull Plug		2.875	0.000	0.65	9278.31
	EOT					9278.31
Note	Well Head 3K Screw On Flange					
	Tubing Anchor Set W / 12K Tension					

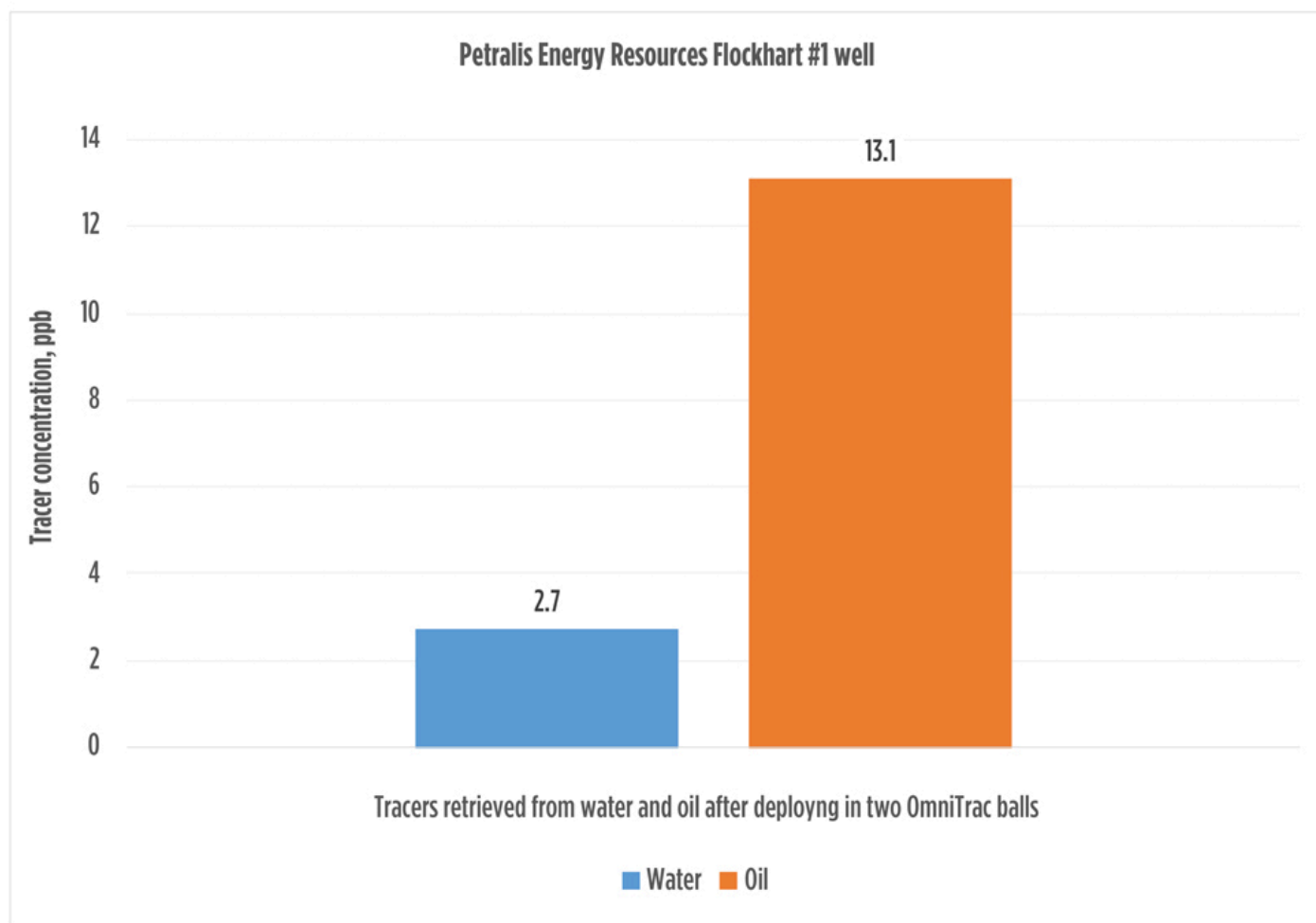


Fig. 3. Pilot results – 05.05.2024.

These results validated the workover’s effectiveness, provided insights into reservoir performance and supported Petralis’ strategy to optimize production, utilizing a highly cost-effective bottomhole production flow diagnostic technology, as exhibited by the OmniTrac™ universal wellbore flow tracers. The data also reinforced the value of OmniTrac in delivering high-resolution diagnostics for legacy assets.

According to David Peña, Managing Director of Petralis, deploying the OmniTrac™ tracer solution effectively gathered essential downhole flow mapping data, enabling Petralis to assess their recompletion campaign's efficiency and performance.

Broad utility across legacy and emerging assets. The successful deployment of OmniTrac™ in the Flockhart #1 well highlights its transformative value for operators working in mature fields. While legacy wells, like those in Tennessee Colony field, are a natural fit, OmniTrac’s versatility extends far beyond them and offers a scalable and robust diagnostics solution across a wide range of well types and energy sectors.

Versatility across well types and conditions. Thanks to its universal design, OmniTrac can be applied in oil, gas, geothermal and water-producing wells—whether they are newly completed, refractured,

or long-producing assets. It is equally effective in vertical and horizontal wellbores, onshore and offshore settings, and in both fractured and non-fractured wells. Its durable construction, capable of withstanding pressures up to 7,500 psi and temperatures up to 500°F, ensures reliable performance in challenging environments including ultra-high-temperature geothermal systems and complex offshore trajectories.

High-resolution diagnostics without disruption. One of OmniTrac's most valuable features is its ability to provide high-resolution flow data from the end of each wellbore without requiring intrusive modifications. Operators can identify flow restrictions, underperforming zones, or production blockages with minimal operational disruption. In horizontal wells, OmniTrac can be pumped to the toe of extended-reach laterals, delivering insights from hard-to-access areas that are critical to overall production. In legacy wells, its non-intrusive delivery method supports diagnostics without downtime—ideal for cost-sensitive operations.

Flexible deployment options for strategic insight. OmniTrac supports both single and multiple-ball deployments, allowing operators to tailor diagnostics to specific operational objectives. Monthly deployments, for instance, can track changes in flow behavior over time, offering a longitudinal view of well performance. In multi-zone wells, the flow tracer can determine whether production originates from specific intervals, eliminating the need for expensive interventions, like coiled tubing runs or production logging tools.

Environmental and operational efficiency. In addition to operational benefits, the flow tracer also supports environmental sustainability goals. Its non-hazardous, non-radioactive tracer materials require no special handling and contribute to a reduced environmental footprint, compared to traditional diagnostic tools. This makes it an ideal choice for operators aligning with ESG principles while maintaining productivity.

Visual insights that drive action. Data gathered through OmniTrac are transformed into high-resolution visual representations of wellbore flow, allowing for targeted remediation strategies—such as reperforation, wellbore cleanup or stimulation design adjustments. Its adaptability also extends to geothermal wells, where it can diagnose steam flow restrictions, and to water injection operations where it identifies inefficiencies—expanding its relevance across sectors.

A cost-effective diagnostic benchmark. The flow tracer provides a low-cost alternative to traditional diagnostics, filling a critical gap for operators like Petralis, who work under a PDP (Proved Developed Producing) model and prioritize cost control. By delivering actionable, timely data without the need for complex infrastructure or long analysis cycles, the technology empowers rapid, informed decision-making that boosts production efficiency and extends asset life.

SUMMARY

The Flockhart #1 deployment demonstrated the real-world impact of OmniTrac. It enabled Petralis to validate bottomhole production, optimize workover decisions and drive greater field value with minimal expense or disruption. As the energy sector continues to emphasize sustainability and efficiency,

OmniTrac stands out as a data-driven diagnostic platform tailored for cost-conscious, performance-focused operators, across a broad range of production environments. **WO**



DAVID PEÑA is a seasoned energy executive and strategic thinker, with over two decades of upstream oil and gas leadership. As managing director of Petralis, an E&P company, he is adept at driving deals from initial prospecting through pitch decks and financial modeling. His ability to oversee asset acquisition, development and performance optimization demonstrates his strategic skills. As a Rice University MBA candidate specializing in strategic marketing and operations, Mr. Peña excels at blending technical rigor (QA/QC, reservoir engineering) with clear, persuasive communication, whether negotiating with ExxonMobil, refining stock-repurchase analyses or coaching youth baseball.



TALGAT SHOKANOV is CEO of QuantumPro, Inc., which he founded in 2017, following a 15-year career at SLB, where he held a variety of international and technology development assignments. He previously spearheaded SLB's cuttings re-injection via hydraulic fracturing business line, including subsurface engineering, disposal domain mapping and pressure diagnostics analysis. He holds numerous patents and has authored over 50 technical papers in complex fracturing and injection. He holds bachelor's and master's degrees in petroleum engineering, from Satbayev University in Kazakhstan.



JOHN OLIVER is a business strategy advisor to QuantumPro, Inc. He has over 40 years of experience in the oil and gas industry, including a number of senior executive positions with M-I SWACO, an SLB company. He managed all the segments in the South American business unit as Senior VP and served as Global Marketing Manager. Mr. Oliver went on to lead Prince Energy, a division of Prince International, from which he retired in July 2018. He currently serves on a number of boards and is an advisor to several companies, as well as energy private equity investment firms. He holds a bachelor's degree with honors in biochemistry from University of St Andrews in Scotland.



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