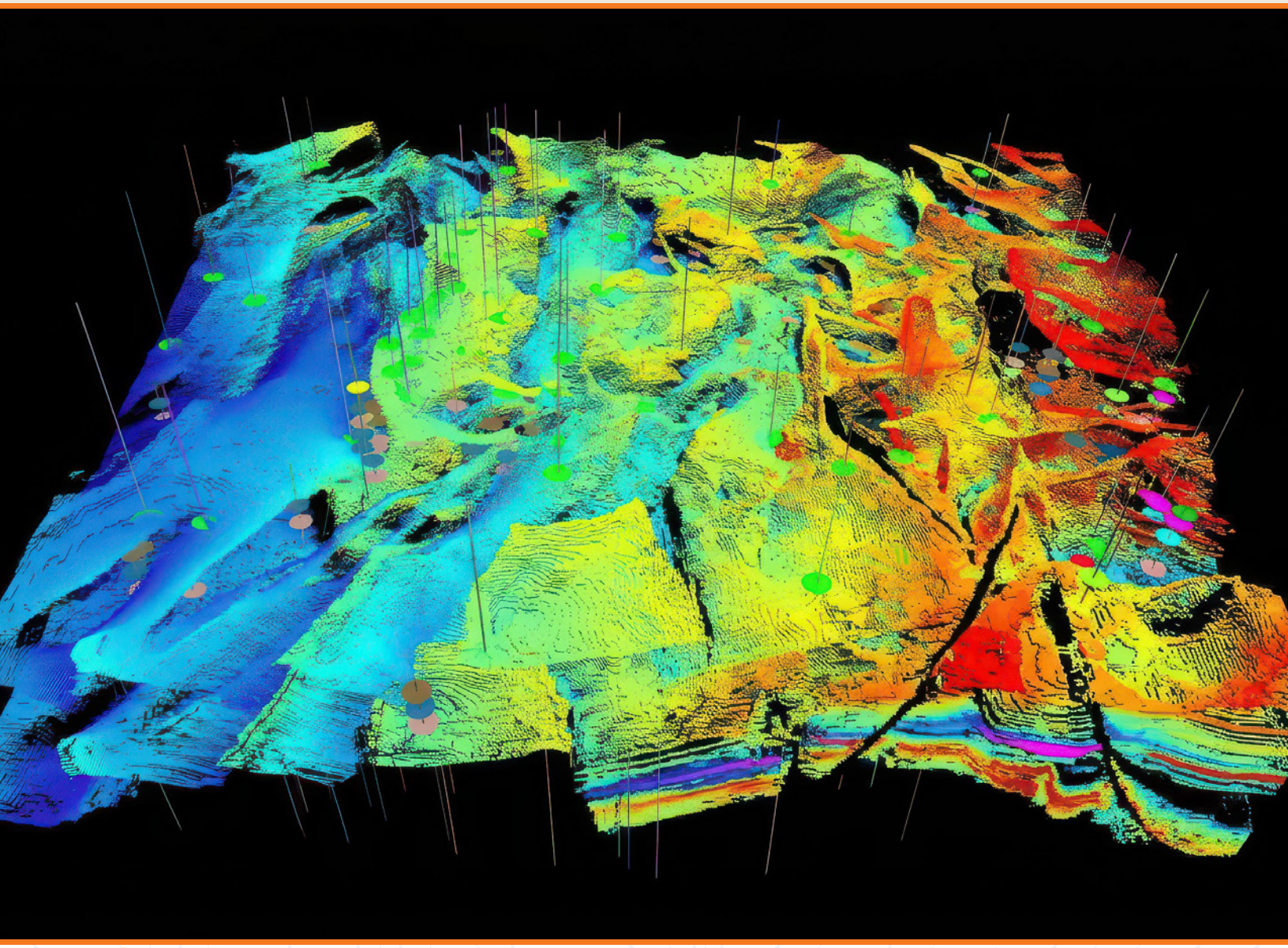
AAPG®

Subsurface AI

Special Report



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Introduction

Artificial intelligence is transforming the energy industry by accelerating exploration, optimizing production, solving complex subsurface challenges, and enabling smarter grid management. AI-driven tools are reducing costs, improving safety, and helping the industry meet growing energy demand while leaders navigate a lower-carbon future. Arguably even more impactful, AI is guiding and upskilling the next generation of the upstream workforce.

Subsurface AI is an exciting area that is rapidly and continuously evolving, but the advanced applications occurring within the upstream sector didn't develop overnight. It has been a 50-year climb from simple neural networks to today's powerful generative AI tools, chips, and data centers.

During the past decade in particular, large language models and generative AI have become operational —not just experimental. Companies have jumped in, deploying various workflows integrated with AI tools. In the upstream sector, applications of AI span seismic surveying and reservoir evaluation, data validation, production strategies and optimization, multidisciplinary collaboration, predictive maintenance, and drilling optimization. Why the rapid adoption? AI can minimize uncertainty, increase efficiency, reduce costs, and upskill and guide workers.

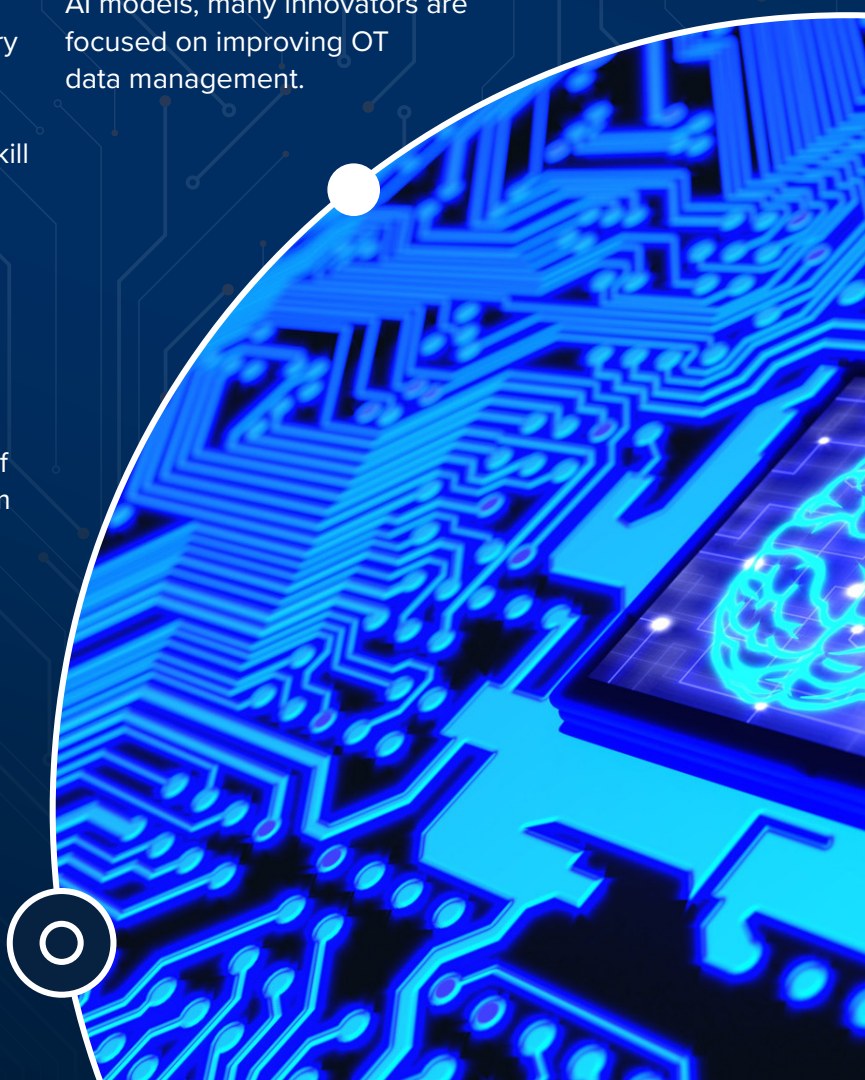
Two big examples are generative AI and digital twins. Generative AI creates an output for the user. Often, within oil and gas, this output is a model that allows companies to analyze various outcomes within well planning or asset maintenance.

Many types of digital twins —real-time digital models of an asset —also use AI to predict maintenance or inform decisions around well-planning and production. For example, YPFB built a country-wide digital twin for its gas production and delivery system. The digital twin spans from the subsurface to the surface and represents the entire network of assets. It allows the company to test different production strategies before making changes. So far, it has increased gas production field-wide by 5 percent. ADNOC also incorporated a digital twin of its utility and water model. It has reduced energy use field-wide for the Shah Gas Field.

While AI has created positive progress in many parts of the industry, it has revealed challenges in other areas, such as scaling AI within upstream use cases that are asset-wide and of enterprise scope. What has held back the scaling attempts is the ability to mobilize all the company's data. AI matured faster than expected, and upstream organizations do not yet have platforms to deliver validated, harmonized, and/or standardized data that fit in the platforms.

This has created data siloes and stranded digital assets. Many operators have decades of data spread across many individual databases, data management systems, service providers, joint venture partners, and storage and contextualization platforms and methods.

Data is also often multi-modal, spanning formats including 3D seismic models, well logs, production data, 2D and 3D geological maps, and time series. Typically, IT data has been given priority over geological, geophysical, engineering, and production data. Now, instead of focusing on developing AI models, many innovators are focused on improving OT data management.



Trends in Subsurface AI in 2026

As technology continues to rapidly evolve, four key themes emerge as trends within subsurface AI applications for 2026.

1. Simplifying Vendor Portfolios

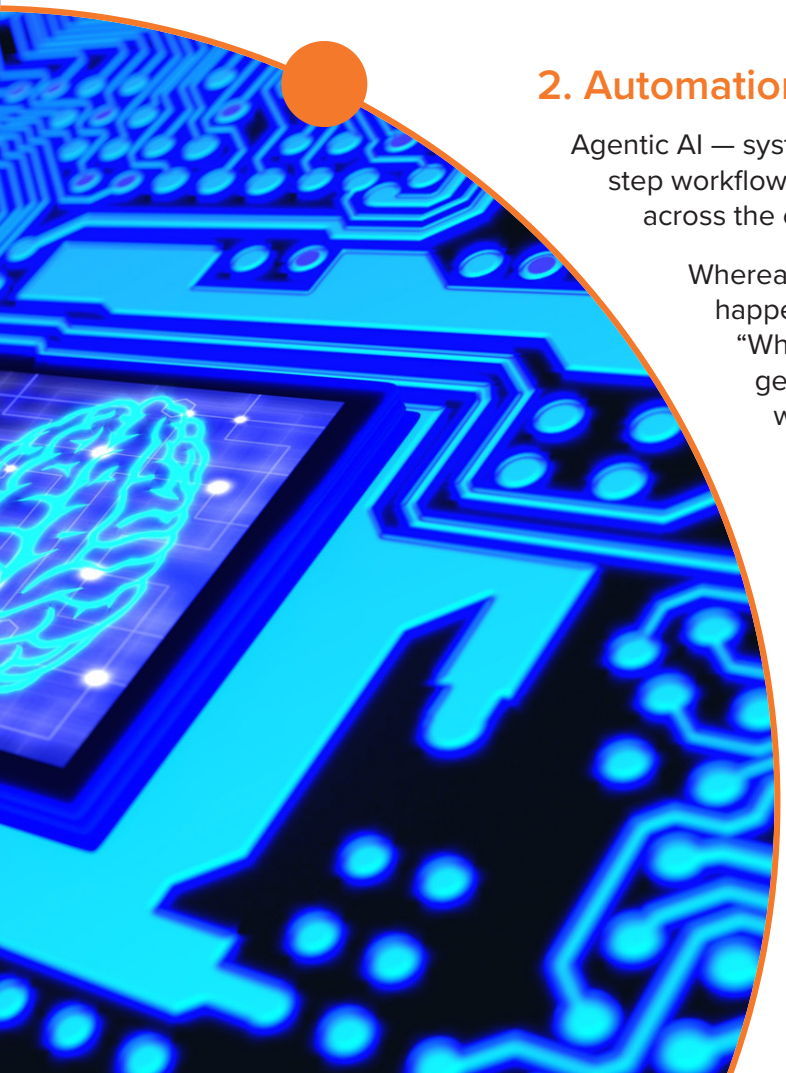
Many companies are addressing the data management bottleneck in two main ways: Better connecting data sets and analysis platforms or acquiring cleaner data.

AI-propelled software is enabling companies to use a single platform to work with multimodal data. Data analytics software company Databricks' Data Intelligence Platform bridges data warehouses (where structured data informs decisions, but raw data is often problematic) with data lakes (repositories for raw data).

"Leveraging Databricks, companies standardize schemas, manage quality, and keep datasets in sync as new sources come online," says Enterprise Solutions Specialist at DataBricks, Reagan Kennedy. "With that data they can apply AI/ML capabilities, build out analytics, and expose the data via APIs and applications so existing tools can read/write against the same data instead of maintaining their own silos."

As part of better connecting datasets and optimizing analyses, AI is acting like an API, bridging the many platforms used to fuel oil and gas workflows. More technical and specialized data management is being optimized by software such as AspenTech Subsurface Intelligence, which brings together domain-specific agents (for geophysics, formation evaluation, petrophysics, geomodelling and reservoir engineering) using AI capabilities.

"What agentic AI needs to solve complex upstream challenges is the domain (science and engineering) context. We have solved that challenge by taking the 'gems' of forty years of capturing scientific principles and industry best practices in domain software (such as the Aspen SSE desktop portfolio) and turning them into dozens of software 'agents.' A generative AI application can deploy these agents as an automated workflow to apply to the contextualized data and answer questions like 'where is the best place to drill?'" says AspenTech Vice President of Products Aymen Haouesse.



2. Automation of Upstream Workflows with Agentic AI

Agentic AI — systems that autonomously act, decide, and orchestrate multi-step workflows — is moving from pilot project to operational backbone across the energy value chain.

Whereas generative AI addresses the question of "What could happen?" with a model, agentic AI addresses the question "What should a company do?" and then does it. For example, generative AI might suggest a reservoir model to help with well planning. Agentic AI would use automation to rapidly create the model and then query asset-wide data to understand where the next best places to drill are or to predict the outcomes of different development strategies.

Operators are beginning to use Agentic AI systems extensively within exploration and production. Applications include autonomously ingesting seismic datasets, running fault interpretation, generating prospect maps, and flagging anomalies. These tasks that once required weeks of geoscientists' time are now compressed into hours with the use of agentic AI. "The operators who invest in meaning and machine-scale access will have agents. The ones still polishing clean data alone won't," said Patrick Kelly, OSDU forum chair at Chevron, at AAPG's AI and Machine Learning Workshop in June.

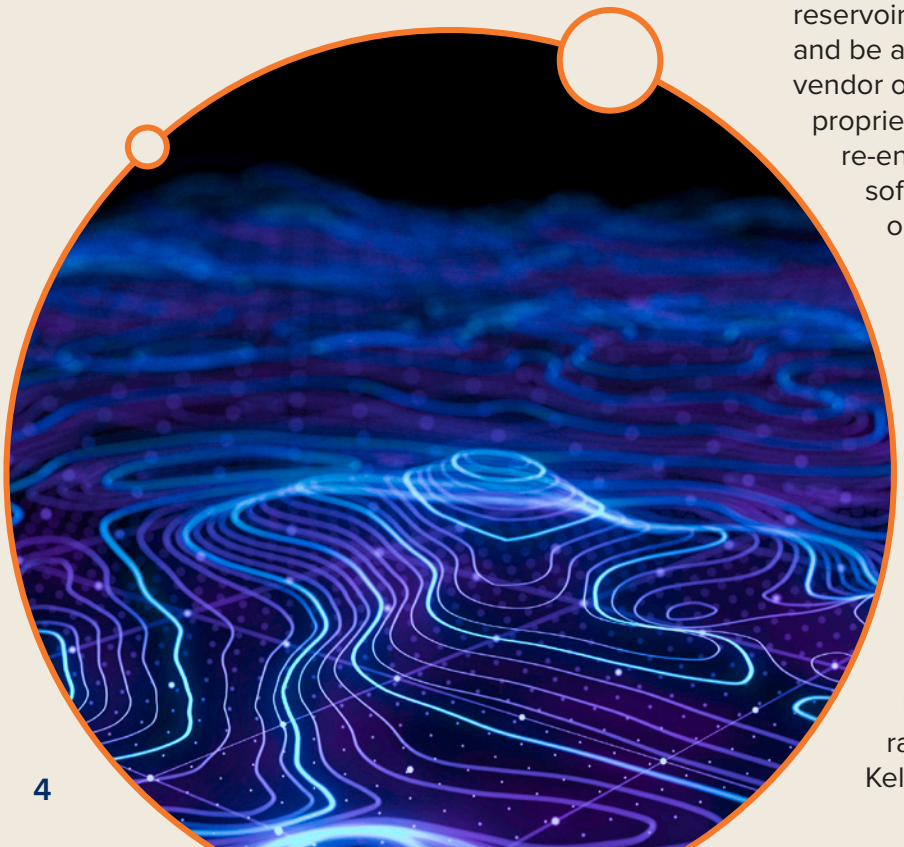
Additionally, multi-agent frameworks can coordinate across subsurface disciplines simultaneously: One agent interprets stratigraphy, another models pore pressure, a third cross-references offset well data — all reconciling outputs without human handholding. Furthermore, automated basin screening agents scan public and proprietary datasets to rank exploration opportunities by risk and resource potential, feeding decision-ready outputs directly to asset teams.

But there are still some challenges. “Formats and platforms decide whether agents can actually operate at the scale the work demands,” said Kelly. Agents trained on one basin’s geology can confidently misread another. Thus, location- and domain-specific validation remains non-negotiable.

“A group of upstream companies are currently advising us on the use cases which create the strongest business value when applying agentic AI,” said Ron Beck, director of product marketing at AspenTech. “Use cases such as capital spending prioritization among owned assets fundamentally involve interdisciplinary teams and a lot of data and uncertainty analysis; Therefore, the opportunity to save up to **80 percent of time** and have a much better handle on uncertainty is huge.”

3. The Open Subsurface Data Universe Launches

Born in 2018 as a consortium-driven initiative led by major energy companies and cloud providers, the Open Subsurface Data Universe (OSDU) set out to do what the oil and gas industry had never achieved — agree on a common language for subsurface data.



Among the founding entities were Anadarko, BP, Chevron, ConocoPhillips, Devon, Equinor, Exxon, Shell, and TotalEnergies.

At its outset, the project hoped to create a single, open, cloud-native data platform where seismic, well log, reservoir, and production data could live, communicate, and be accessed by any application, regardless of vendor or operator. Its goal was to end the era of siloed, proprietary data formats that forced companies to re-engineer integrations every time they changed software vendors. Standardization across operators promised massive cost savings and faster time-to-insight across exploration and production workflows.

But implementation has proven far harder than design: Data governance, legacy system migration, and inconsistent metadata standards created gridlock. Operators discovered that “open” didn’t mean “easy”: Onboarding real-world, messy data into OSDU schemas was expensive and time-consuming. Additionally, vendor adoption was uneven, and some companies quietly built proprietary layers on top, undermining interoperability. “Data quality has been the rallying cry for AI readiness, and rightly so,” said Kelly. “But quality alone stopped being enough.”

Now, project momentum is real but selective. AI integration is becoming the strongest use case; Clean OSDU-formatted data is proving its value as a training and inference layer for geoscience models. Also, cloud providers (Microsoft Azure, AWS, Google) have committed OSDU-native services, giving it an infrastructure backbone. “For us, a strong commitment to OSDU across all of our solutions is fundamental,” said AspenTech’s OSDU czar, Dani Alsaab. “The future is multi-vendor collaboration in the upstream ecosystem, and we see ironclad commitment to OSDU as a differentiator for the future.”

OSDU remains the best framework the industry has produced for subsurface data standardization, but it is a marathon dressed up as a revolution, and the gap between its vision and operational reality is still wide.

Adoption remains uneven; Smaller independents and national oil companies lag significantly, and the governance model makes development progress slow. “OSDU-compliant” is not a guarantee of true interoperability. Vendor interpretations still vary, and without sustained executive commitment and dedicated data engineering resources, OSDU projects stall.

4. Using AI to Train the Next Generation of Workers

The next realm AI is breaking into within oil and gas is professional development. Companies have begun using AI to train employees to nimbly utilize key software tools and problem-solve in real time.

For example, a company might load a software tool’s user manual and its own documented best practices into an AI platform. When an employee has a question while using that software tool, they can type it into the AI platform and receive an answer immediately. This answers many of the “how do I’” and “what is the best way to” questions that arise for new employees and the next generation of oil and gas professionals.

This new way of training could potentially reshape the way oil and gas companies hire and operate, creating new methods for onboarding, troubleshooting, and shifting required skillsets for new workers. “GenAI with domain guardrails is the way to transfer technical knowledge and experience to the next generation of workers,” said AspenTech’s AI CTO Heiko Claussen. “We see this as a way to give our four decades of technology leadership that has been built into our domain-specific software a new lease on life: It is an evergreen way to make future workers experts. It empowers us to add value to industry in new ways. There will be plenty of jobs, but the core skills will be how knowledge workers best leverage, interpret, and take advantage of these new AI tools.”

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SCAN ME

HELLO!

I'm AVA, an AI-powered agent in AspenTech Subsurface Intelligence™ (ASI), helping exploration and production teams accelerate analysis, uncover insights faster and make more confident decisions.

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