Powerful Reservoir History Matching Helps Large Energy Company Improve Productivity

"AspenTech® Subsurface Science & Engineering helps us optimize gas production by supplying solutions and technology that provide a good understanding of reservoirs and associated uncertainties, identify optimal well locations and predict future production more confidently."

—Staff Reservoir Engineer

CHALLENGE

Gain a better understanding of a reservoir to support business-related decisions such as production optimization, production forecasting and the location of new wells

Create a model of the reservoir, integrating multidisciplinary data to help analyze possible scenarios under various reservoir uncertainties

SOLUTION

The assisted history matching solution of Aspen Tempest™ ENABLE was used to calibrate the reservoir model and quantify its uncertainties. A unique proxy-model technique enabled the system to intelligently drive the reservoir simulator through thousands of realizations.

VALUE CREATED

- AspenTech solutions provided the asset team with a better understanding of important reservoir uncertainties and their impact on fluid flow and field production.

- The ability of Aspen Tempest ENABLE to intelligently drive the reservoir simulator through thousands of realizations freed up time and allowed the team to work on other projects concurrently.

- By reducing uncertainties, Aspen Tempest ENABLE helped the company avoid expensive additional data acquisition.

Overview

A large North American energy company was looking to expand a field that had been in production for several years. The asset team needed to gain a better understanding of the reservoir to support various business-related decisions such as production optimization, production forecasting and the location of new wells. This required the integration of various pieces of multidisciplinary data to build and utilize a model of the reservoir, in order to help analyze different possible scenarios under various reservoir uncertainties. In this context, it appeared necessary to build and calibrate (or history match) the reservoir model to production data, to enhance confidence in the modeling results.

Build and History Match a Reservoir Model under a High Degree of Uncertainty to Support Reservoir Management

A geologic model of the reservoir was built by the company's G&G team using Aspen SKUA™. The reservoir engineering team then built the reservoir simulation model. To calibrate the model, the team began a manual history-matching process based on trial and error. They had to manually change different parameters for which uncertainties existed. The degree of uncertainty regarding the geology and reservoir simulation input parameters was high, making the process tedious and very time-consuming. After weeks of work, it was impossible to achieve a history match, as too many realizations were needed to sample the uncertainty space.

To achieve reliable and calibrated results in a timely manner, it was obvious that an assisted history matching solution was needed to optimize and quantify various uncertainties in the reservoir model.

The company is a long-time user of AspenTech Subsurface Science & Engineering applications, including for seismic processing and imaging, seismic interpretation, formation evaluation, geologic modeling and reservoir simulation. When it was time to tackle the challenge of history matching the dynamic reservoir model, Aspen Tempest ENABLE was the natural choice.

Aspen Tempest ENABLE has highly advanced uncertainty analysis and history matching capabilities. Its unique proxy-model technique enables the system to intelligently drive the reservoir simulator through hundreds of realizations, rather than the few allowed manually, drastically reducing the time needed to history match a model.

Results Deliver Significant Insights

The team was able to set up the full range of uncertain reservoir parameters (e.g., permeability, net-to-gross, gas-water contact depth, relative permeability curves, connectivity and transmissibility) and their distribution. Thousands of cases representing various scenarios and combinations of uncertainties were easily analyzed. Despite the large number of cases, some wells' simulated response still could not match the observed historical production data. This led to a suspicion that the underlying geologic assumptions might be wrong, and eventually pointed to the existence of natural fractures or some sort of high-transmissibility corridors.
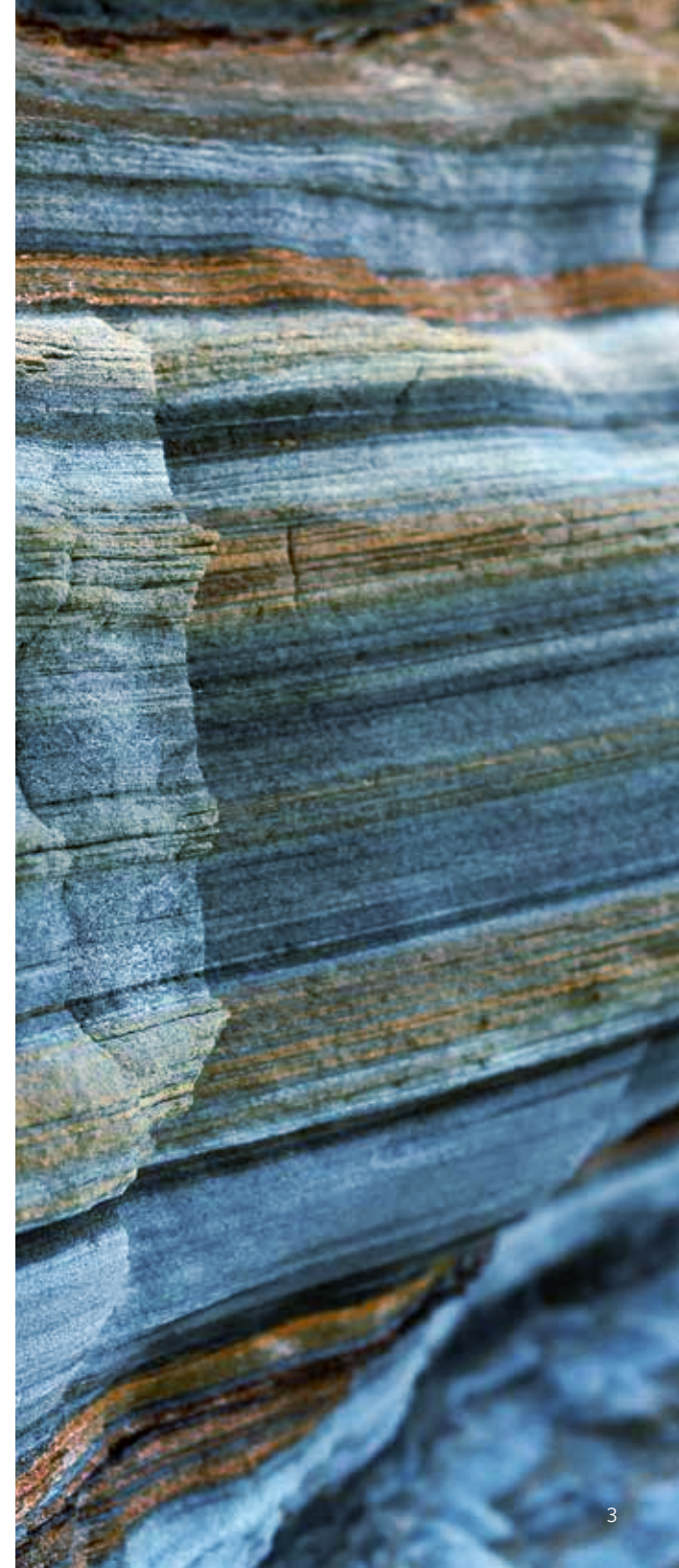
Higher Accuracy and Better Understanding of the Reservoir Architecture and Dynamics

The findings were reported to the asset team, so that they could go back and review all available data in-depth and investigate the possibility of natural fracturing in the reservoir. The team's geophysicist reviewed the seismic interpretations and generated a Seismic Curvature attribute. This showed that the wells which could not be history matched were indeed in areas with high curvature response, suggesting that they were in naturally fractured areas. The Aspen SeisEarth™ Seismic Curvature attribute was then used to analyze the reservoir fracturing. Once the reservoir engineer integrated fracture permeability into relevant areas of the reservoir model, a history-matched model was obtained within days.

This was a remarkable achievement, as the natural fractures could not be easily identified without Aspen Tempest ENABLE. Through the use of AspenTech's solutions, the asset team obtained a better understanding of important reservoir uncertainties and their impact on fluid flow and field production.

Reducing Uncertainties Saves Data Acquisition Costs

As a result of the history matching process and with the assistance of Aspen Tempest ENABLE, an ensemble of simulation cases was generated, with each case representing a scenario and combination of uncertainty parameters. A number of the simulation cases matched the observed data within a given tolerance interval. The ensemble of history matched cases reduced the reservoir uncertainties, narrowing, among other parameters, the range of relative permeability curves. This helped the company avoid the need for expensive Special Core Analysis (SCAL) to measure such data.

Greatly Increased Productivity through the Assisted History Matching Power of Aspen Tempest ENABLE

Aspen Tempest ENABLE's ability to intelligently drive the reservoir simulator through hundreds of realizations significantly freed up time and allowed the team to work on other projects while the product was running days, nights and weekends.

The team programmed Aspen Tempest ENABLE to do all the heavy lifting and they were able to manage and analyze around 2,500 cases (representing various scenarios and combinations of reservoir uncertainties) to ensure all possible uncertainties were considered. The team history-matched the model in a few weeks, as opposed to several years if done manually.

"Aspen Tempest ENABLE makes multitasking projects a breeze."

—Staff Reservoir Engineer

Looking to the Future

The reservoir model is now being updated on a regular basis with new production data as they become available to forecast production for budgeting purposes and plan new wells when needed. Due to the time saved in history matching the reservoir model and the added value it brought to understanding the reservoir architecture and dynamics, the company decided to expand its use of Aspen Tempest ENABLE to other fields. AspenTech solutions and technology are now being used frequently in other oil & gas assets operated by the company to optimize and increase production.

About Aspen Technology

Aspen Technology, Inc. (NASDAQ: AZPN) is a global software leader helping industries at the forefront of the world's dual challenge meet the increasing demand for resources from a rapidly growing population in a profitable and sustainable manner. AspenTech solutions address complex environments where it is critical to optimize the asset design, operation and maintenance life-cycle. Through our unique combination of deep domain expertise and innovation, customers in asset-intensive industries can run their assets safer, greener, longer and faster to improve their operational excellence.

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