Fast-Track FDP of a Complex Gas Condensate Field Using Cloud Technology – A Case Study from Saudi Arabia

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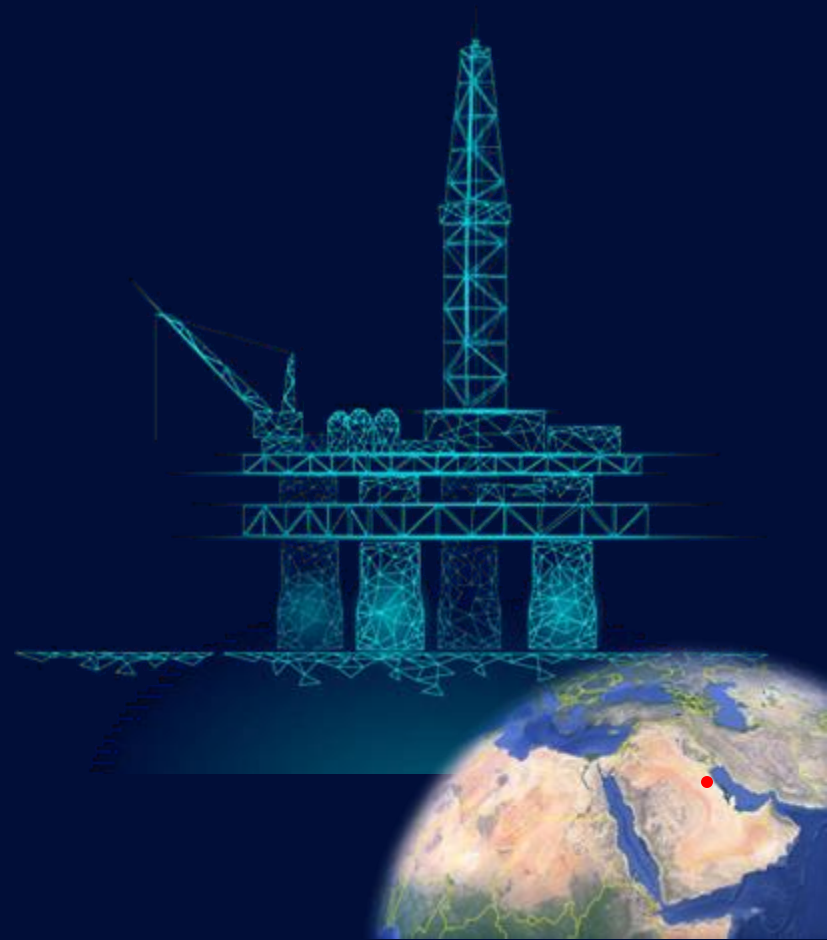
الشركة الكويتية لنفط الخليج
KUWAIT GULF OIL COMPANY
KJO
أرامكو لاعمال الخليج
Aramco Gulf Operations
AL KHAFJI JOINT OPERATIONS عمليات الخفجي المشتركة

Simulating the largest dynamic model on the cloud

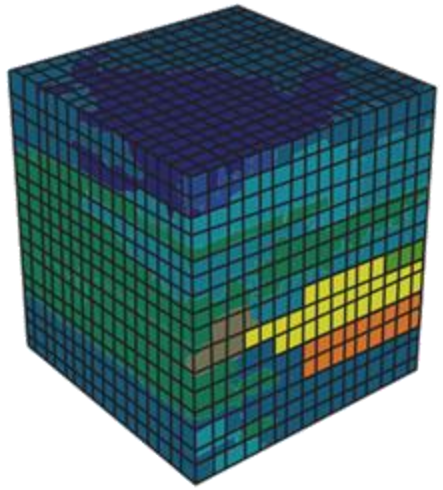
A New World Record

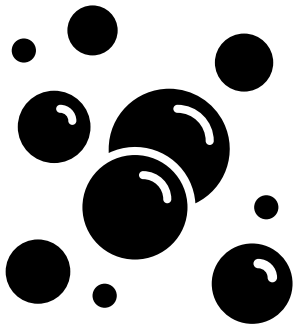


Introduction

- KJO Joint venture
- Located at a remote area (N-E)
- KJO office at Khafji.

Objectives

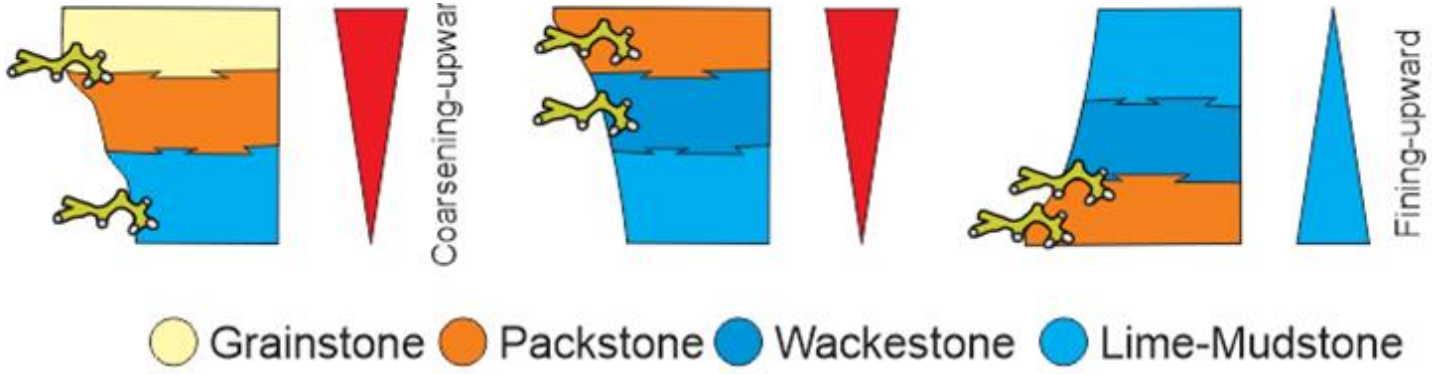




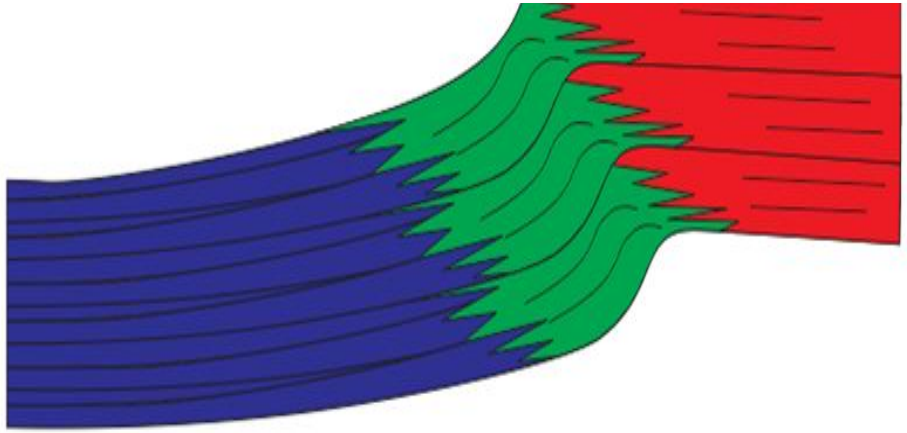
- To develop a full field 3D static model that can address the **reservoir geological complexities,**
- Develop a dynamic simulation model that can capture the effects of **Gas Condensate Dropout**
- All this work, needed to be done **in-house at the remote location in Khafji**

Reservoir Heterogeneity Complexity

To be able to characterize a complex carbonate heterogeneities reservoir the pre-existing 3D static model needed to be upgraded. Such reservoir can represent a significant challenge for reservoir modeling.



Selected Formation depositional cycles in the Field, showing shoaling and deepening sequences.

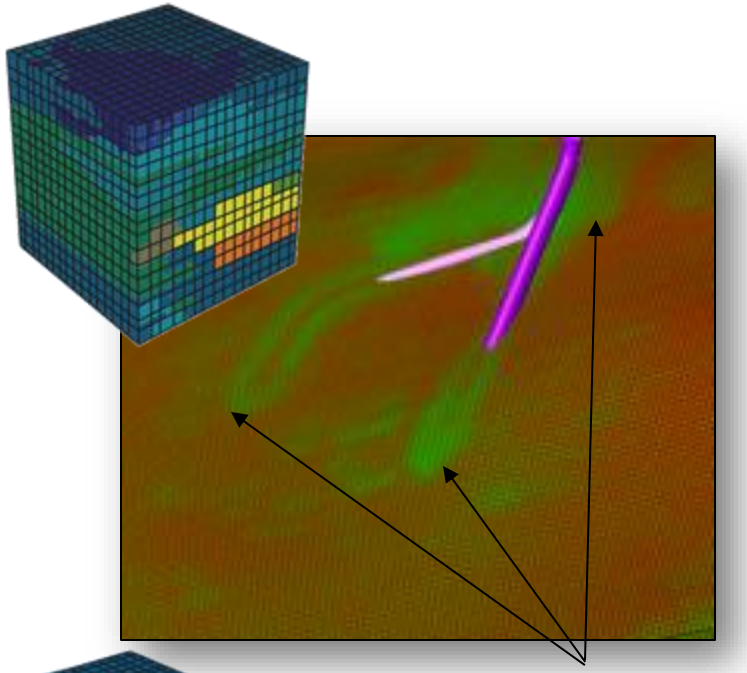


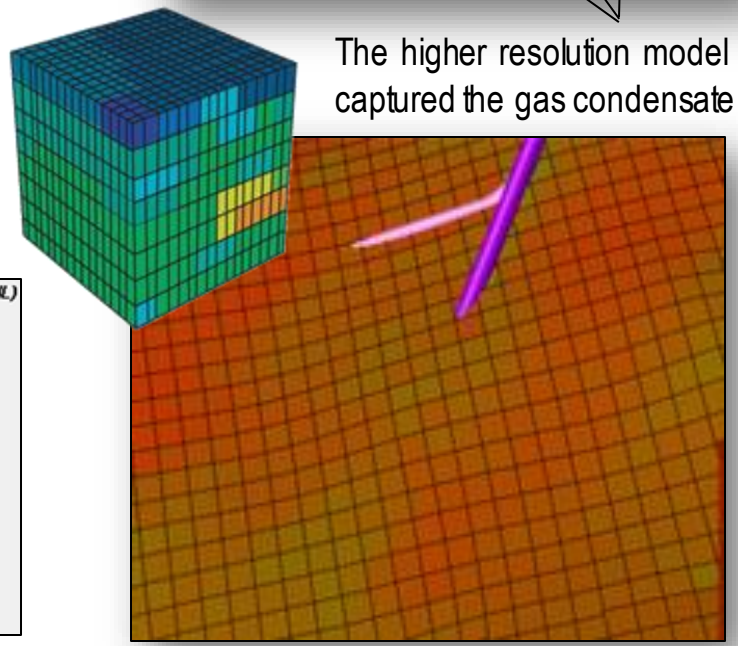
Progradational Carbonate Platform Margin

Gas Condensate Dropout

- Fluid PVT analysis indicated that the reservoir fluid is gas condensate. As a result of the reservoir fluid property, gas condensate dropout can represent a challenge that will impact the production rates.
- To come over this challenge, the **Saudi Aramco Simulation Team** requested to increase the model resolution to 5X5m cell model to be able to capture the gas condensate dropout effect.

KJO, Aramco SLB integrated peer review team



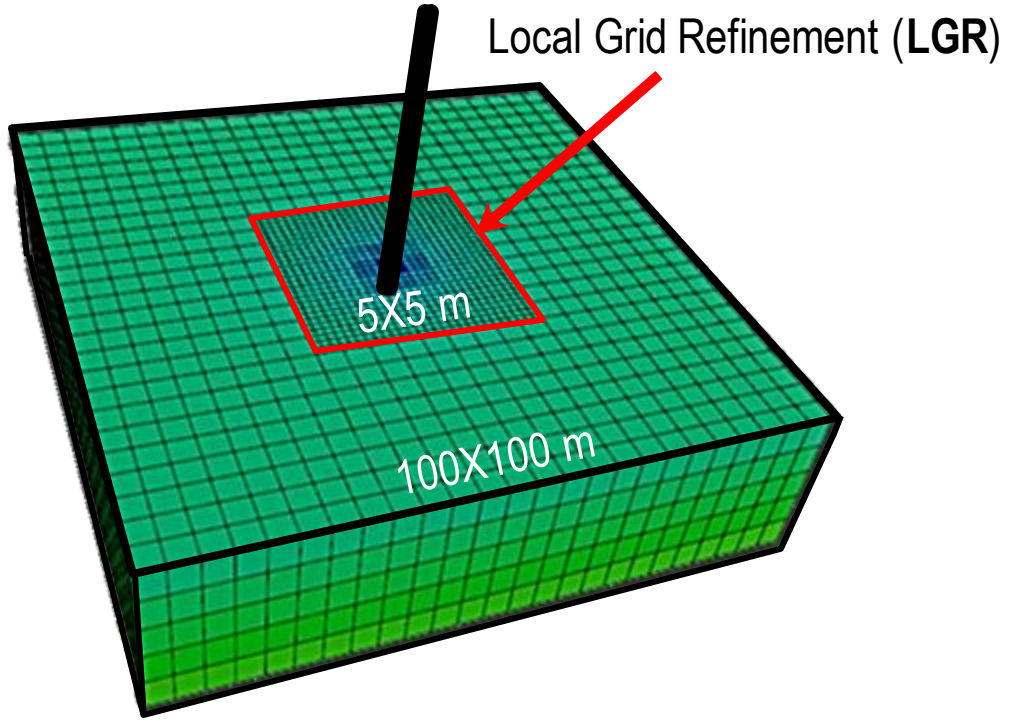


The higher resolution model successfully captured the gas condensate dropout.

Gas Condensate Dropout Traditional Workflow

- The traditional method to address the challenge of capturing the gas condensate dropout is to build a model with LGR around wells.

- Such approach may capture the effect around the wells, but it does not capture the gas condensate dropout over the whole field.

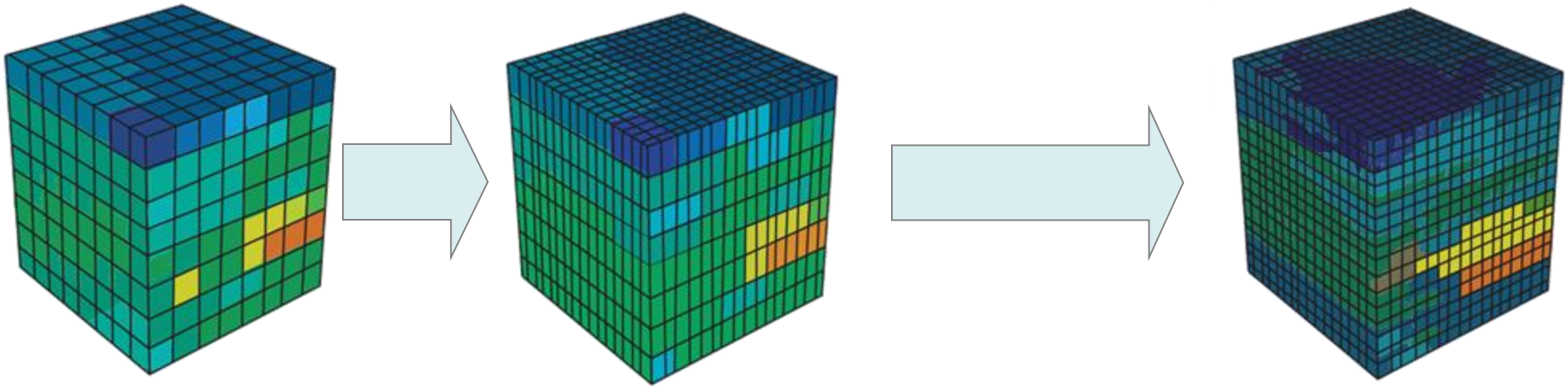


Handling Big Data

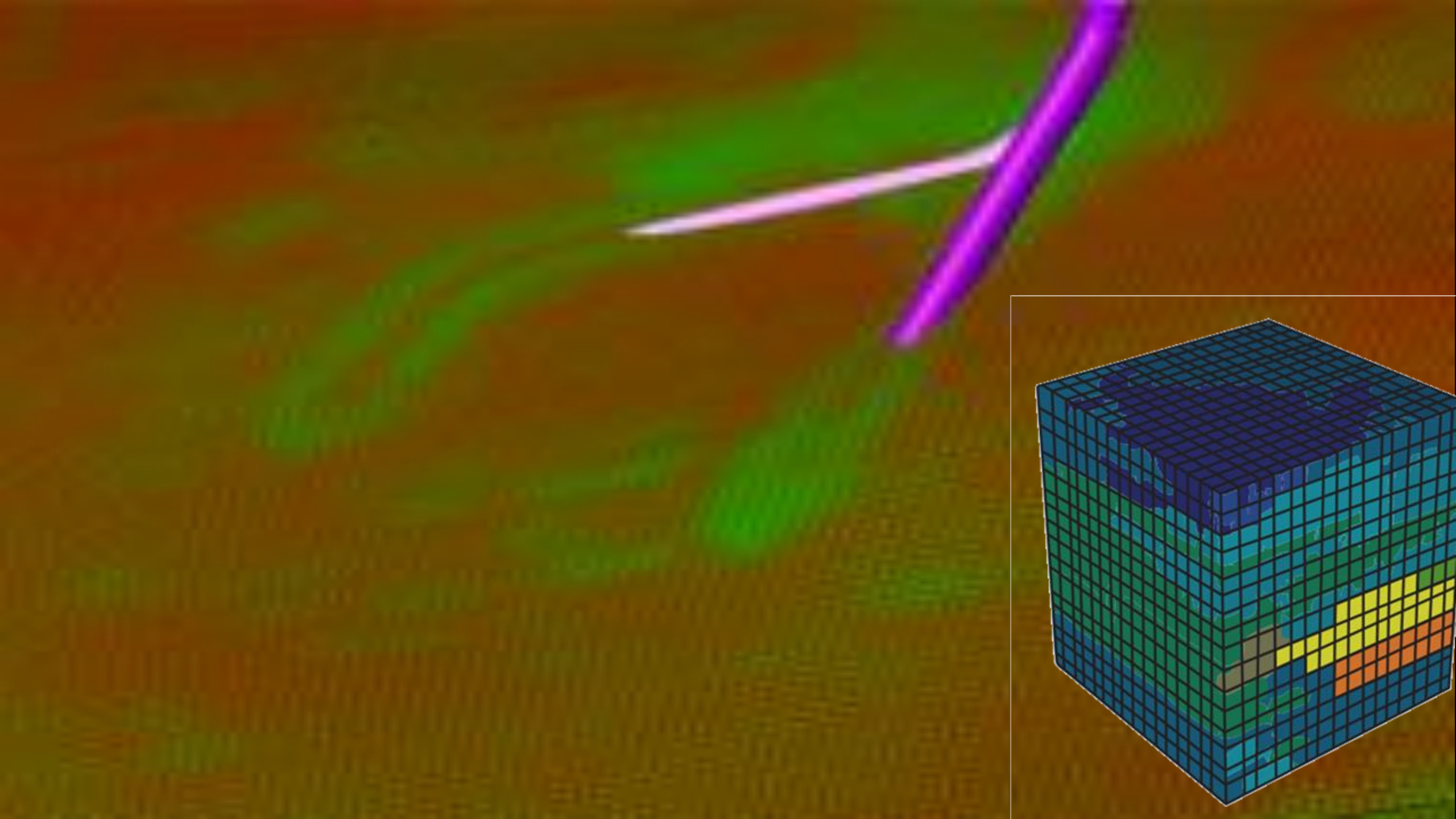
Moving from the traditional 200X200 or 100X100 to a 5X5m cell size, would suggest the increase in the model size from 5, 21, and finally to 521 Million cells, respectively.

Simulating such volume, was not attempted before and will represent a challenge for any operating company, especially at a remote location.

5 Million Cells Model **21 Million Cells Model** **521 Million Cells Model**

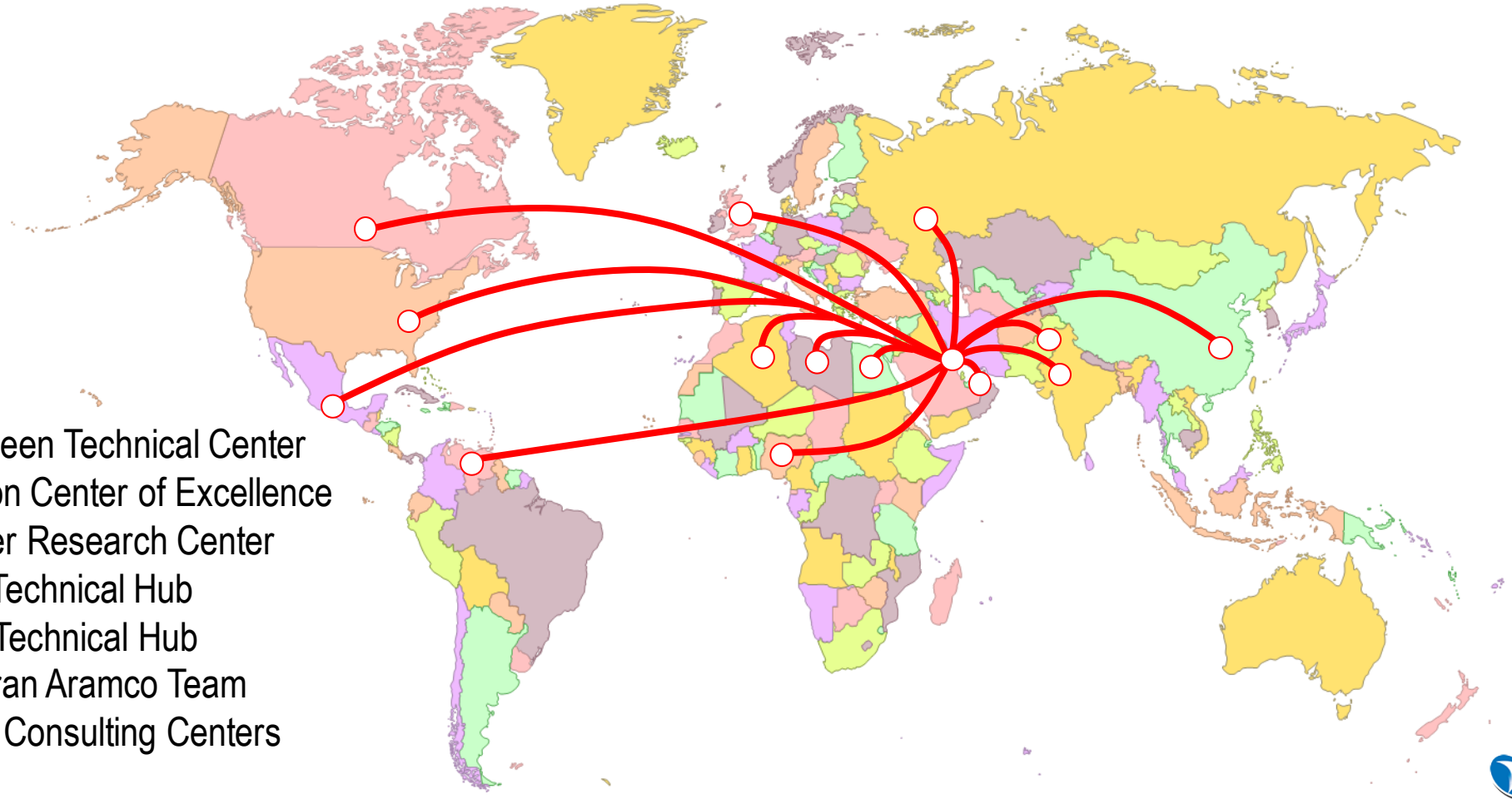


Current industry standard **New standard**



Multinational Taskforce

This challenge was accepted by the technical team despite its magnitude and a taskforce was put in place from different research centers to address this requirement.



- Aberdeen Technical Center
- London Center of Excellence
- Denver Research Center
- UAE Technical Hub
- India Technical Hub
- Dhahran Aramco Team
- Other Consulting Centers

Team Dynamics

Workshop in London

Khafji in-house discussions

Conference in Saudi Arabia

Workshop in Abu Dhabi

Resolving the Challenges

The multinational team collaboration resulted in **upgrading** the current software capabilities

Third-party **Cloud services** had to be changed from one large service provider to another in order to optimize the simulation runs.

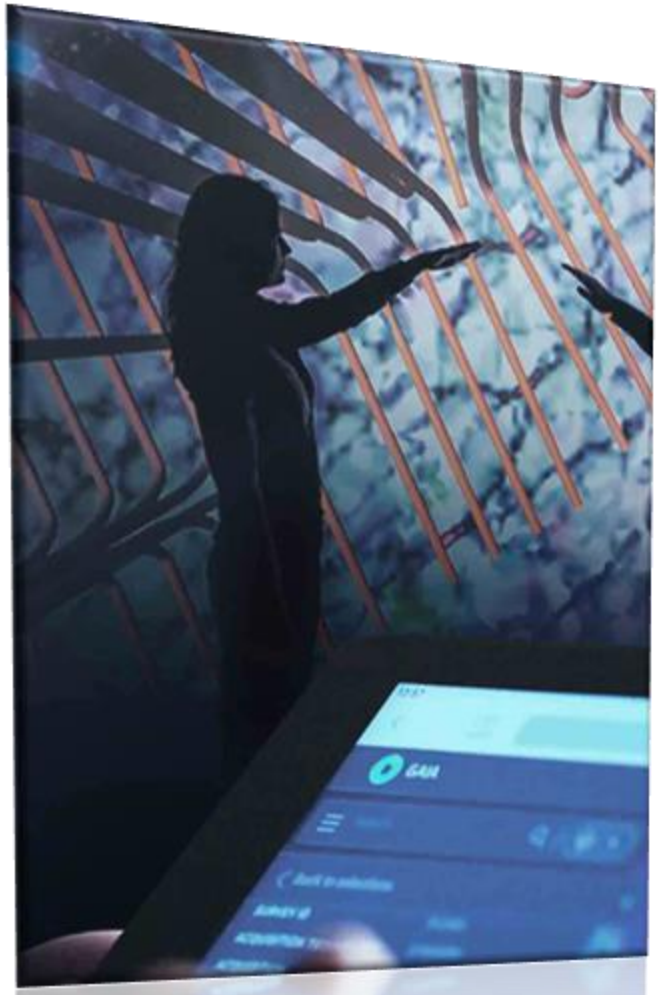
Several new equations have been developed to provide **fit-for-purpose solutions**

Several running parameters have been modified and adjusted to accommodate **Big Data** runs

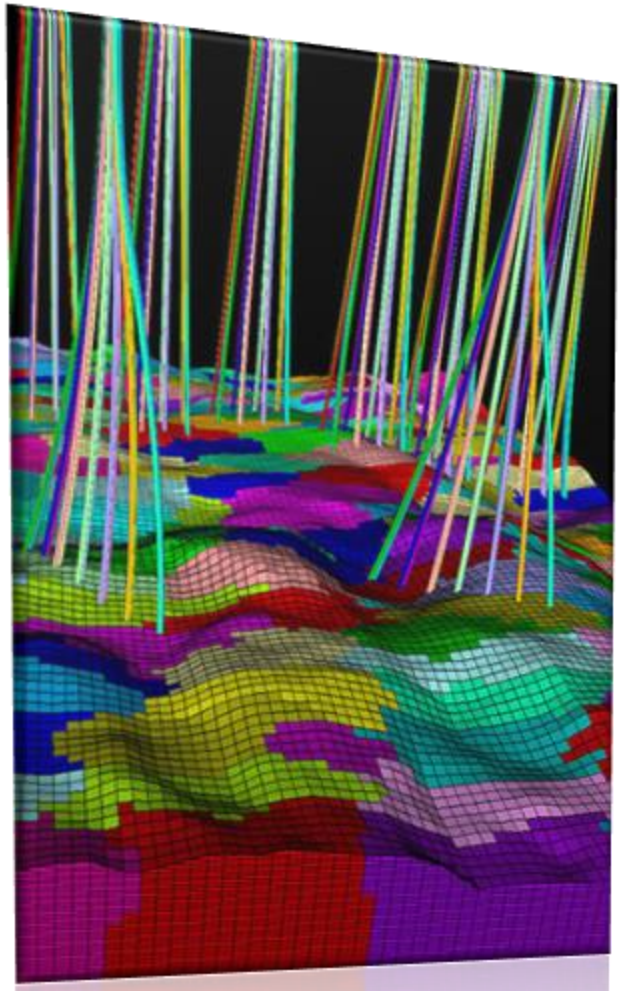
Remote area connectivity have been resolved and upgrading the project network infrastructure

Integrated Effort

Design a Digital Al Field



Cloud Enabled Simulation



Optimum Well Trajectory Design

Conclusions

- We successfully completed a **Mega Project in the remote area** in-house at Khafji
- All KJO stakeholders (Saudi Arabia & Kuwait) and Aramco **acknowledged KJO achievement**
- KJO & SLB jointly developed a leading technology that currently is capable to perform **Big Data** projects simulation through cloud.
- Similar projects with Big Data can be performed in any location **around the world**
- Although we reached this level, there is room for improvement, and we will **continue improving** to reach new standards


Thank you

Welcome to Khafji