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IOGP guidance on PPFG Analysis (Report 608)

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7 September 2022

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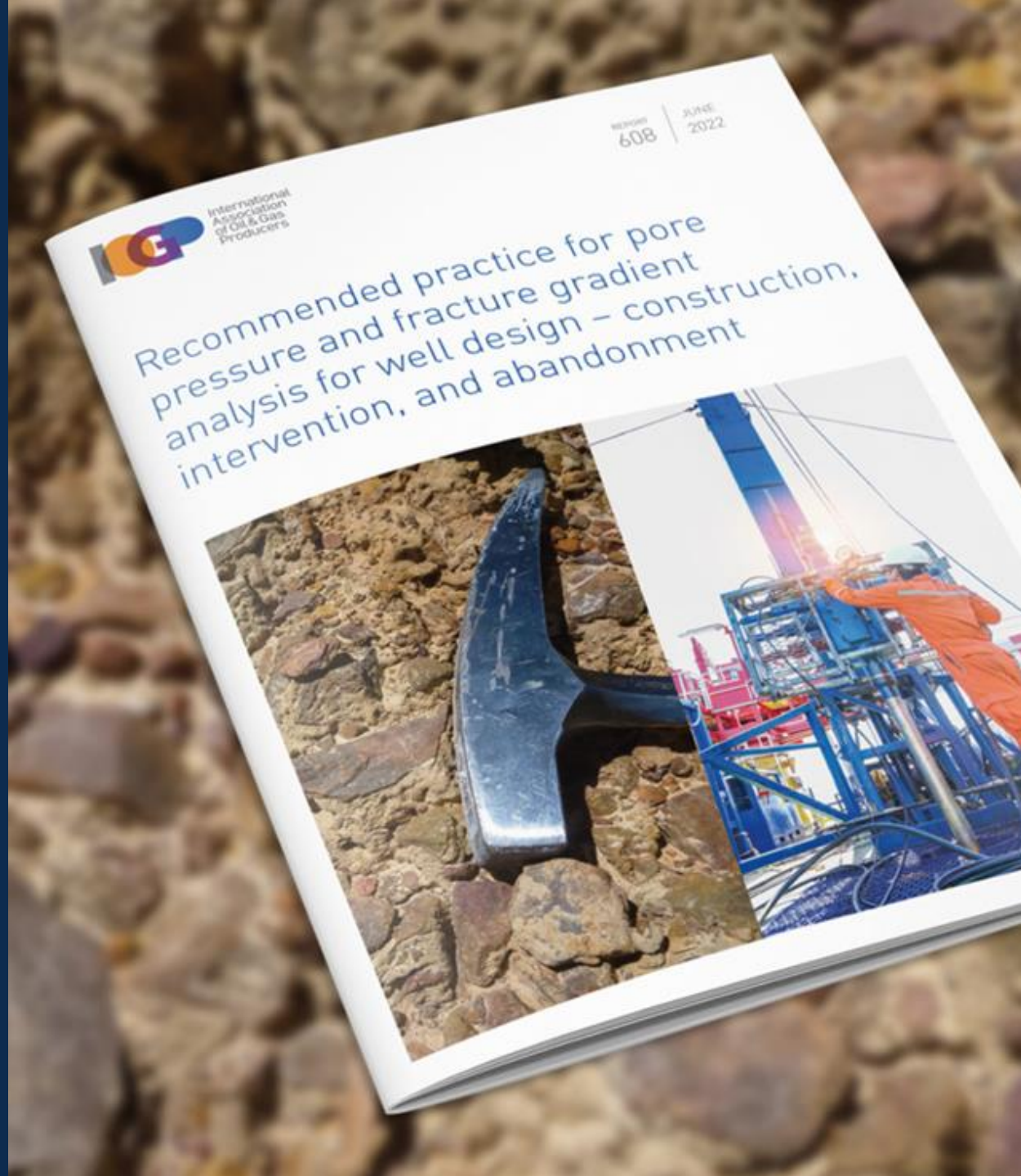

Outline

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What

is PPFG analysis and the purpose of the guidance?

Who

prepared the guidance?

Why

Has the guidance been written?

What

is included in the guidance?

How

will the guidance be used?

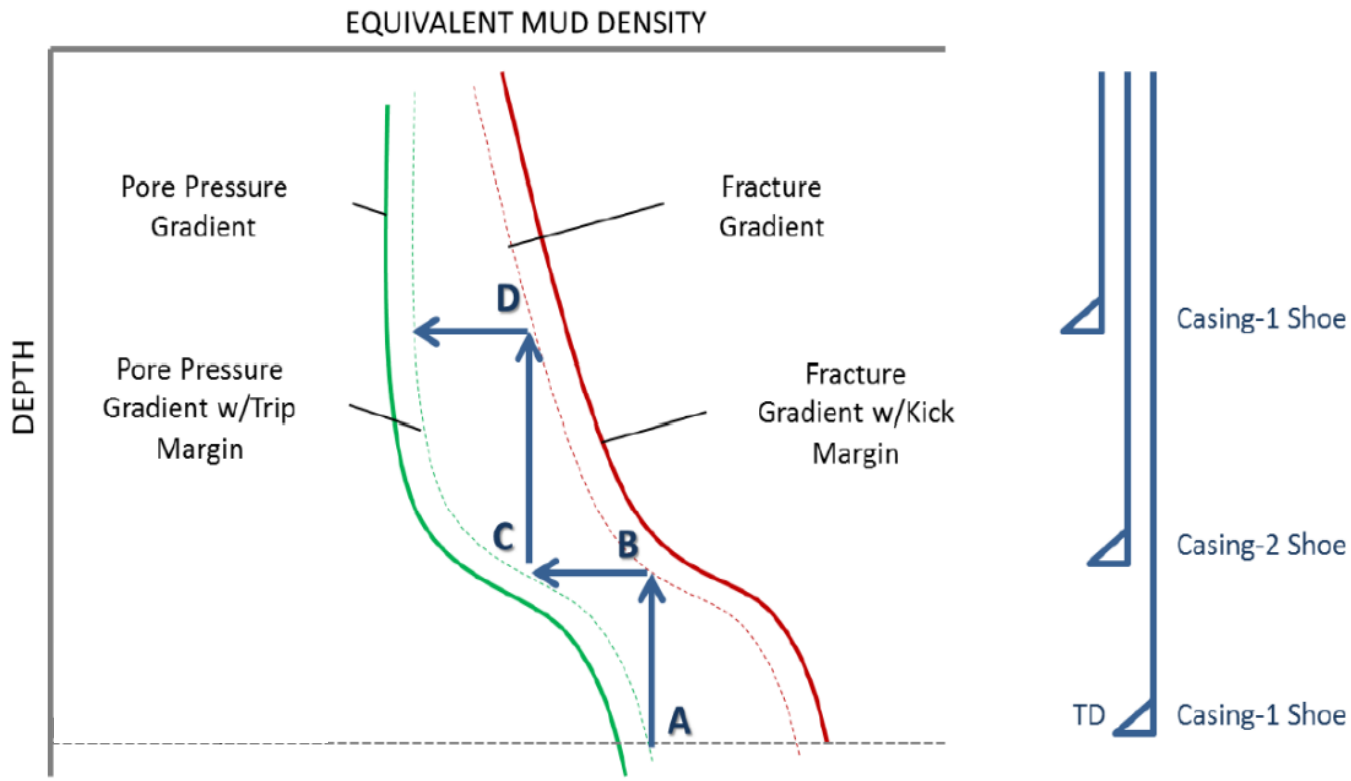
What's PPFG analysis?

Pore pressure (PP) analysis

- The study of how pressure in rock pores varies with depth

Fracture gradient (FG) analysis

- Prediction of the pressures required to fracture the formation



What's the purpose of the guidance?

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Summary of methods and good practices for PPFG analysis and real time PP monitoring

A tool to help teams involved in generating and using PPFG predictions:

- Ensure a rigorous approach
- Improve understanding and communication

Who's prepared the guidance?

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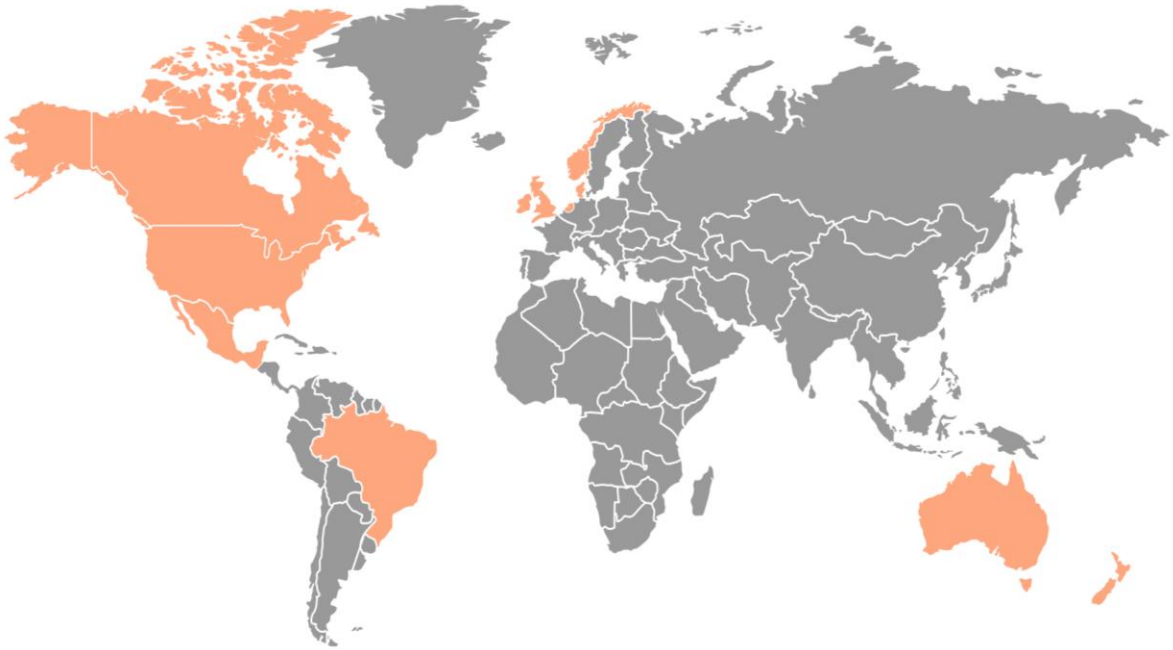

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Why was the guidance written?

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2017  IRF / NOPSEMA identified a gap in international guidance on PPFG prediction

2018  Incident data gathering

2019  IRF drafted problem statement with input from IOGP

2020-21  IOGP PPFG taskforce formed to develop PPFG industry guidance

2022  IOGP PPFG guidance published

Summary of problem statement: More emphasis needed on PPFG prediction and its application

Why was the guidance written? (2)

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Numerous global events with similar root causes:

1. Overconfidence in pre-drill prognosis
2. Actual PP >> pre-drill prediction
3. Early signs of underbalance missed or inadequately actioned

IOGP Well Control Incidents - Causes

Poor communication between subsurface and drilling on log trends

Poor kick detection

Influx misdiagnosed as ballooning

Influx masked by mud treatment

Failed to detect influxes at connections

Gas readings misinterpreted. Driller not empowered to shut the well in.

Gas sampling system malfunctioned

Low vigilance. Mudlogger & geologist didn't interpret gas & log trends correctly.

IOGP Well Control Incidents - Outcomes

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1. Poor comms between G&G and drilling on log trends → 80bbl kick & tertiary WC operations
2. Actual PP>>prediction; poor kick detection (gaps related to sensors, pit discipline & interpretation of gas levels) → ~100bbl kick
3. Actual PP>prediction; kick misdiagnosed as ballooning → Failure to achieve well objectives
4. Actual PP>>prediction (2ppg kick intensity); ~100bbl kick approaching TD (masked by mud treatment) → Gas in riser
5. Actual PP> prediction. Failed to detect influxes at connections → ~60bbl kick and difficult WC operations.
6. Poor well monitoring. Gas readings misinterpreted. Driller not empowered to shut the well in without authorization→ ~50bbl kick and difficult WC operations
7. Actual PP> prediction. Mudlogger gas sampling system malfunctioned → 14bbl kick, and complicated WC operations due to wrong MGS lineup
8. Low vigilance at wellsite. Mud loggers and geologist did not correctly interpret the gas levels and log trends → 6bbl kick & difficult WC operations

Case Study

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What happened

- Gas kick → underground flow
- ~40 days to P&A well
- Cost ~A$110M

Root causes related to pre-drill prediction

- Underestimation of PP and uncertainty level
  →Well design inadequate for PP reality
- Gaps in PP prediction capability, not sufficiently multi-disciplinary
- Learnings from previous well not fed in

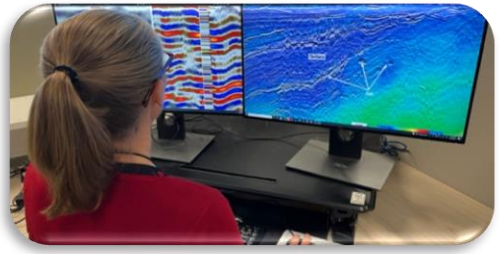
Contributing factors during drilling

- Mud losses not identified as indicator of ↓ FG and lower kick tolerance
- Delayed kick detection due to issues with RT monitoring and well control protocols

What's included in the guidance?

Definitions

- Stress terms
- Pore pressure terms
- Fracture pressure
- Drilling terms



Pre-drill PPFG prediction

- Methods
- Components
- Uncertainty
- Pre-drill assurance

Real-time PP monitoring

- Planning
- PPFG monitoring while drilling
- Post-well review

How will the guidance be used?

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Industry is encouraged to review the guidance and look for potential improvements in their own practices

IOGP welcomes feedback on their reports: publications@iogp.org

Questions?

National Offshore Petroleum Safety and Environmental Management Authority

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