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MERCURY IN NATURAL GAS

Delivering Accurate Reservoir Sampling and Analysis

Janelle Lawer | 18th May 2023 | APPEA

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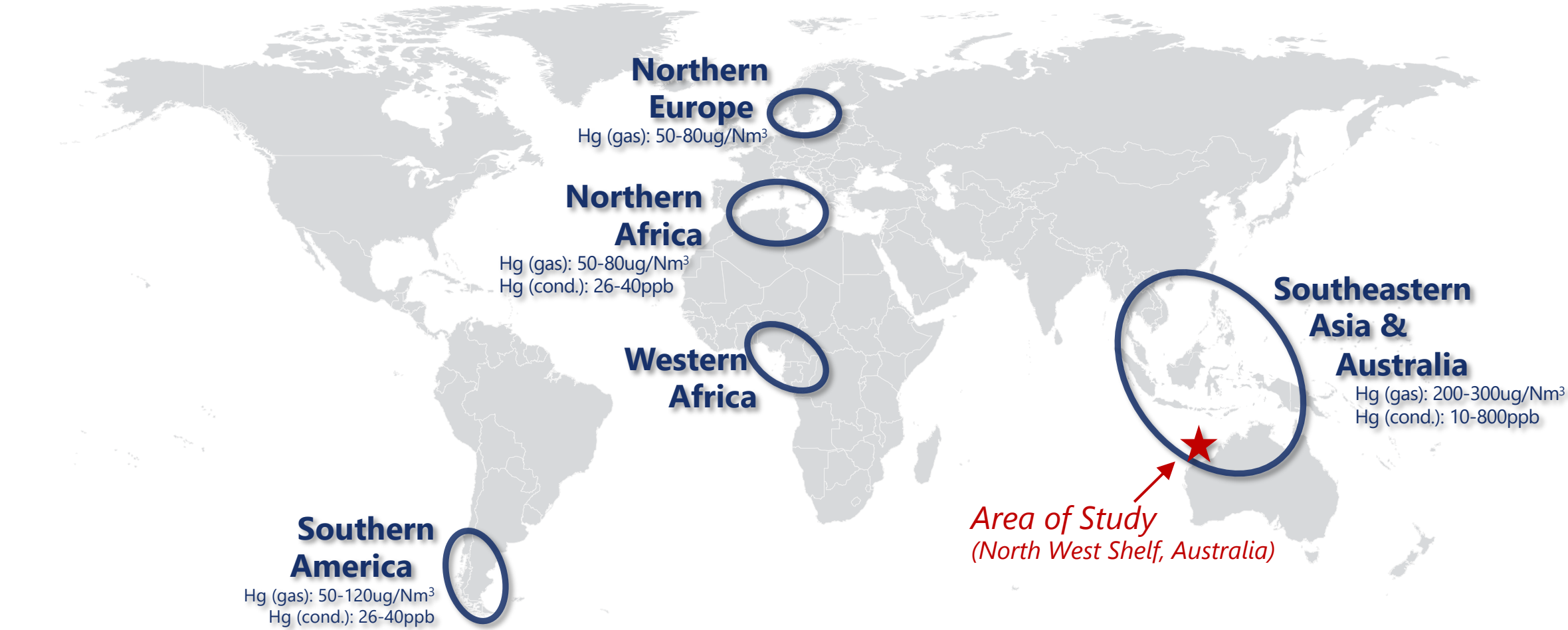
Mercury in Hydrocarbons – Global Presence



Global Mercury in Gas

Adapted from: Row, V.A., 2012. Desulphurization and mercury removal from natural gases. In: Presentation at the GasTech Centre of Technical Excellence. London, United Kingdom.

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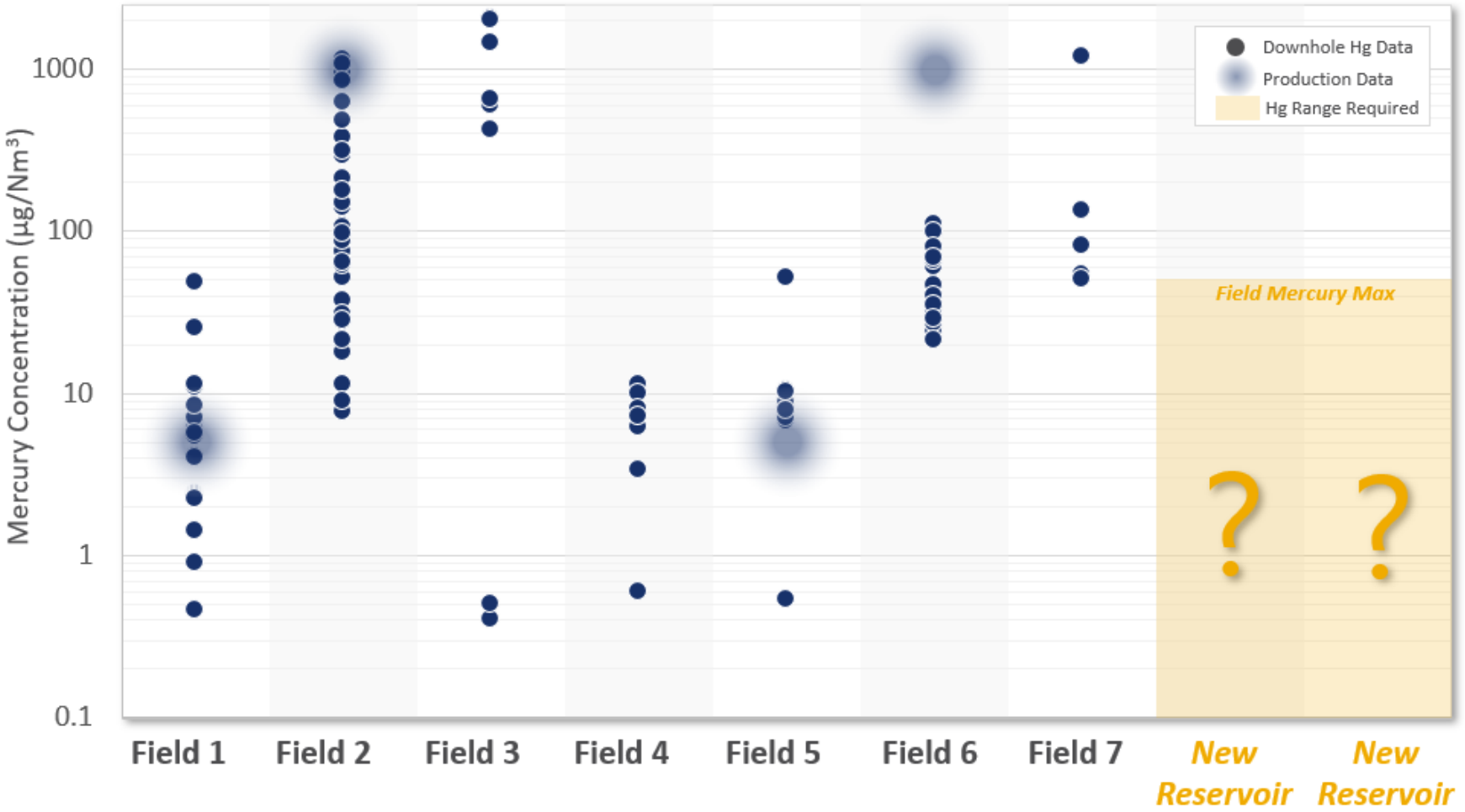
INTRODUCTION

Regional Uncertainty – Study Area



Uncertainty

- Downhole sample range: 1 to 3 orders of magnitude
- Production correlation: Mid? Max? 10x?
- Significant uncertainty for future fields
- Significant uncertainty in development planning

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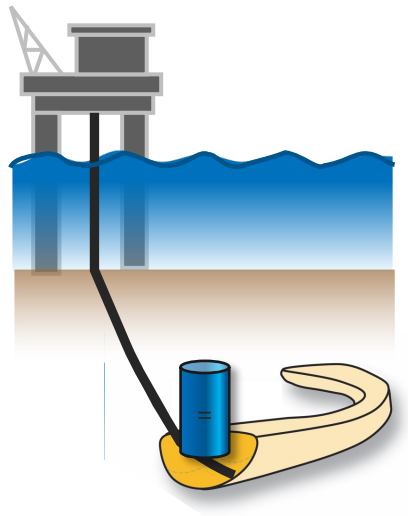
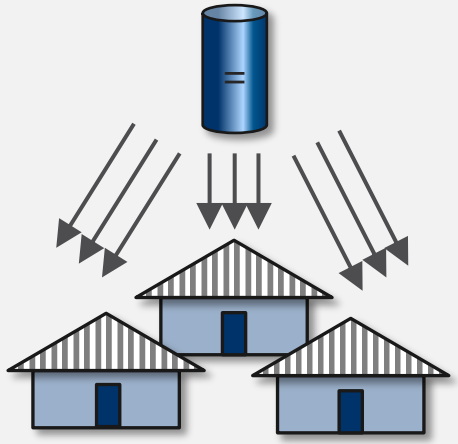
MEASURE

Analysis Repeatability

Reservoir Sampling

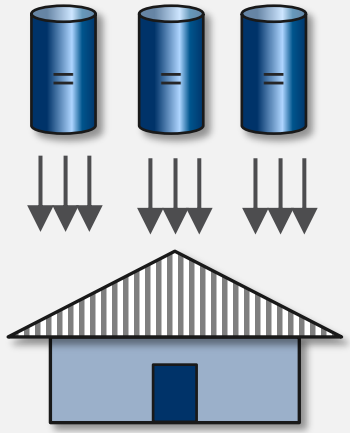


Repeatable Laboratory Analysis?



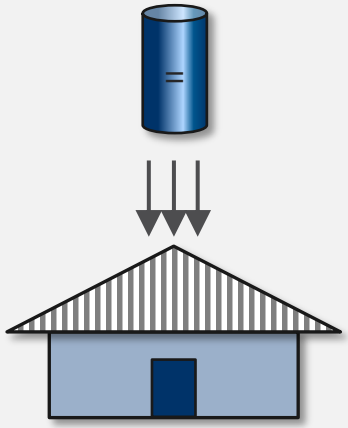
Single chamber
Multiple laboratories

FAIL



Multiple chambers
Single laboratory

FAIL



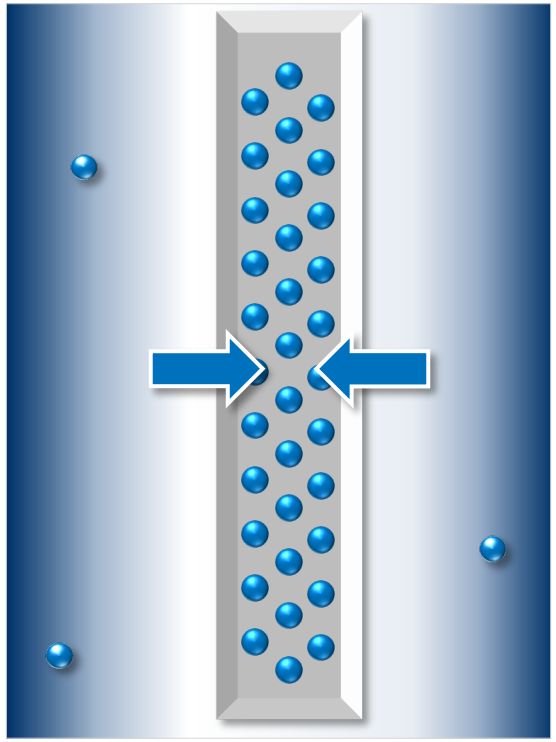
Single chamber
Single laboratory

FAIL

MEASURE

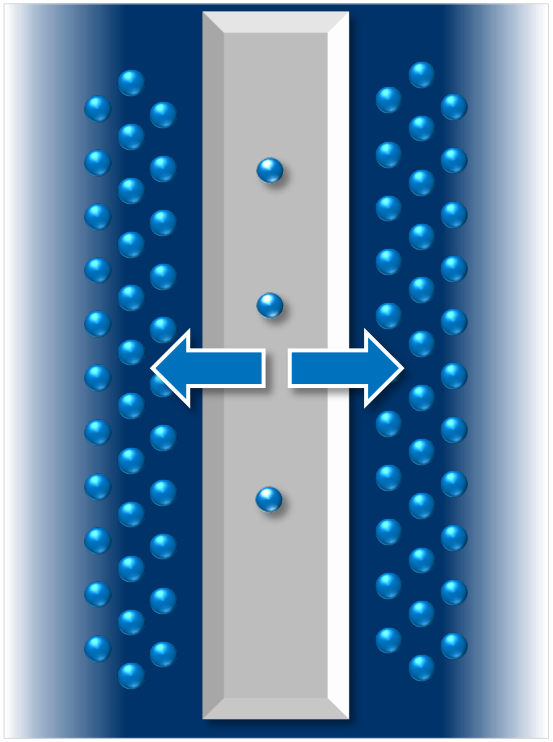
Contamination and Scavenging

Adsorption Process



‘Mercury Scavenged Gas’

Desorption Process

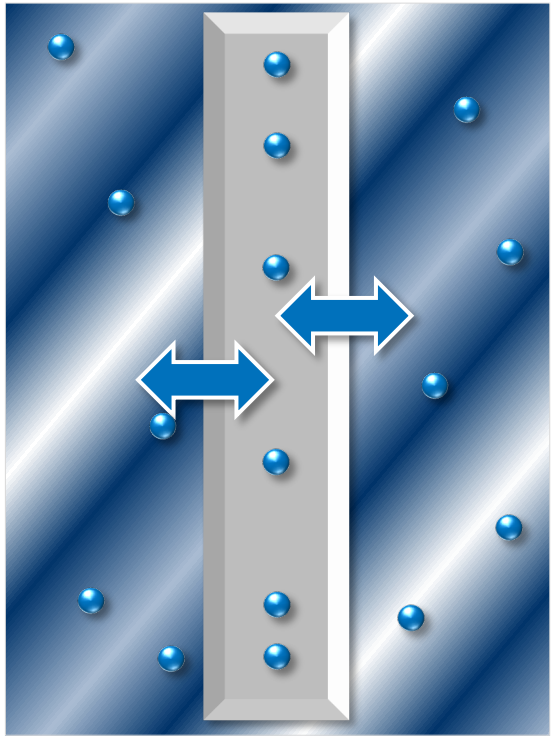


‘Mercury Contaminated Gas’

Potential Variables Include:

- Chamber history
- Pump type & history
- Seals & O-ring history
- Mechanical lubricants
- Cleaning solvents
- Mud type & invasion
- Filtrate contamination %

Combination of Processes



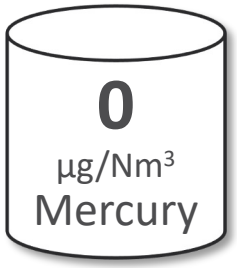
Low Analysis Repeatability

MEASURE

Development of Mercury-In-Gas Laboratory Standards

1. Background Checking Standard

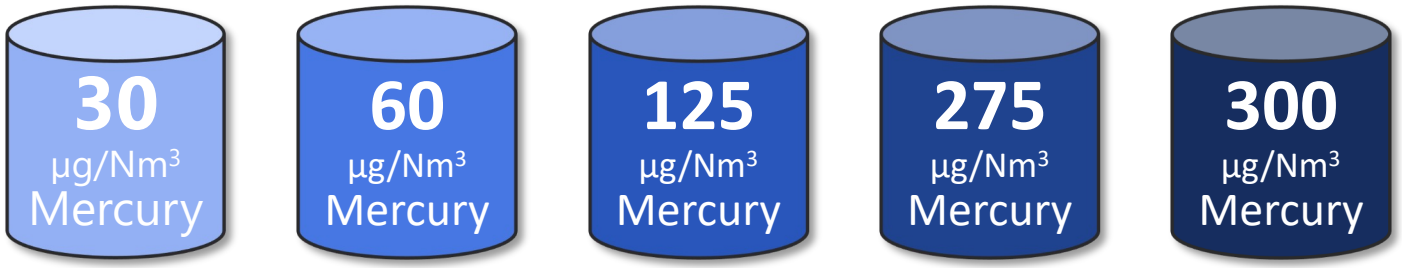
- Mercury-free Methane (CH_4)



Are chambers clean?

2. Analysis Quality Control Standards

- Mercury-doped Methane (CH_4)



Test impact of transit time, temperature, pressure, wash fluids, mercury partitioning etc.

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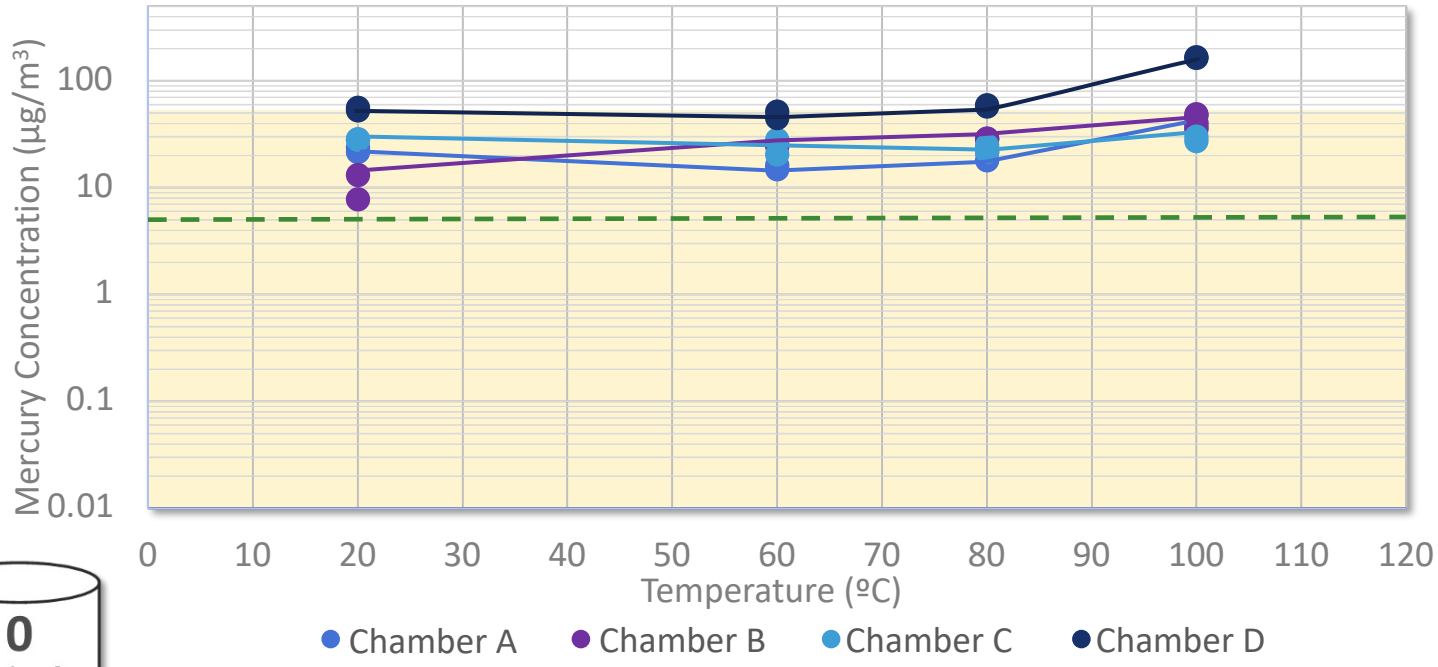
MEASURE

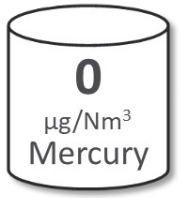
Background Checking

Commercially Available ‘Clean’ Chambers:

- Fill clean chambers with mercury-free methane (CH_4) and analyse
- Result: All chambers contained > 5 µg/m³* background or residual mercury

**Pass/Fail Threshold used throughout this study*





FAIL

‘Clean’ Threshold <5µg/Nm³

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OPTIMISE

New: Thermal Desorption Chamber Cleaning Technique

1. **Quality Control**
   - Fresh-coated inert linings
   - Disassembly & inspection
2. **Thermal Desorption Cleaning**
   - Bake in ventilated ovens for 24 hrs (e.g. 175 °C)
   - Methane-soak for 24 hrs (e.g. up to 7,500 psi & 140°C)
3. **Background Checking**
   - Analyse clean methane in sample chamber (Pass/Fail)

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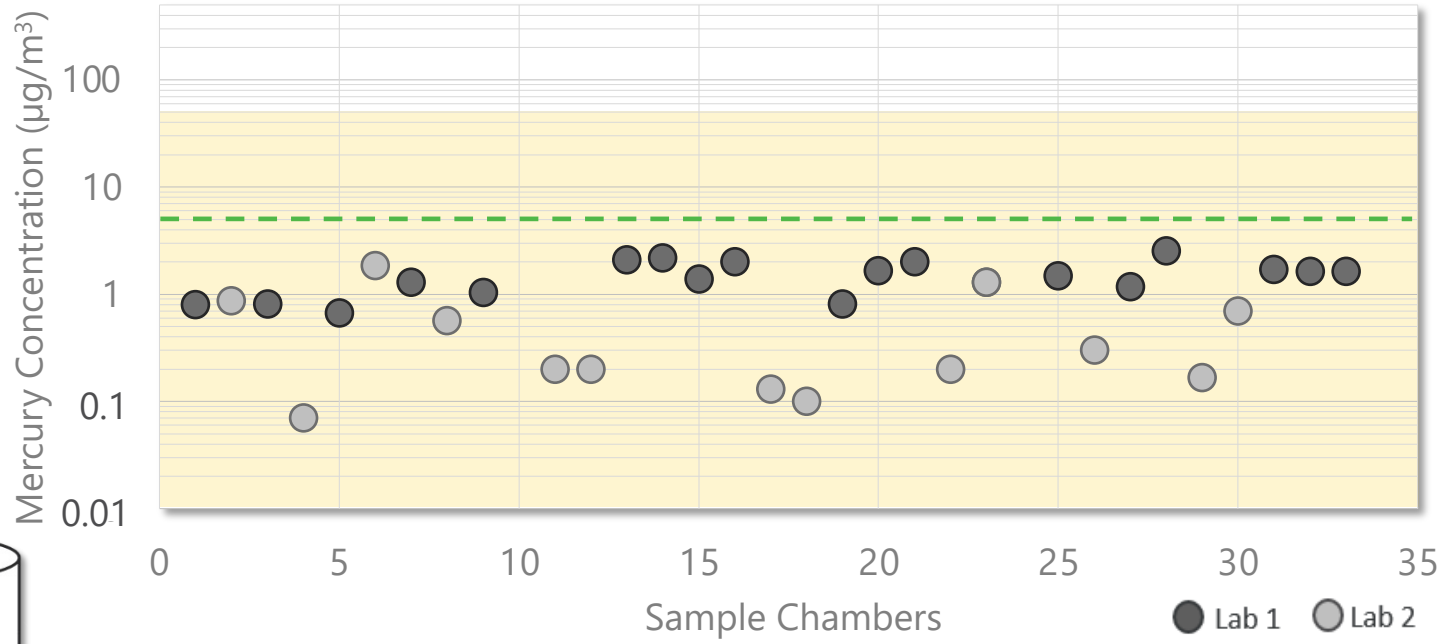
EXECUTE

Case Study: Clean Downhole Sample Chambers

Pre-Campaign Preparations:

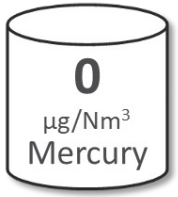
- All operations sample chambers optimally cleaned prior to mobilisation offshore
- Result: All chambers contained < 5 µg/m³* residual mercury (µ = 1)

**Pass/Fail Threshold used throughout this study*



✓PASS

'Clean' Threshold <5µg/m³*



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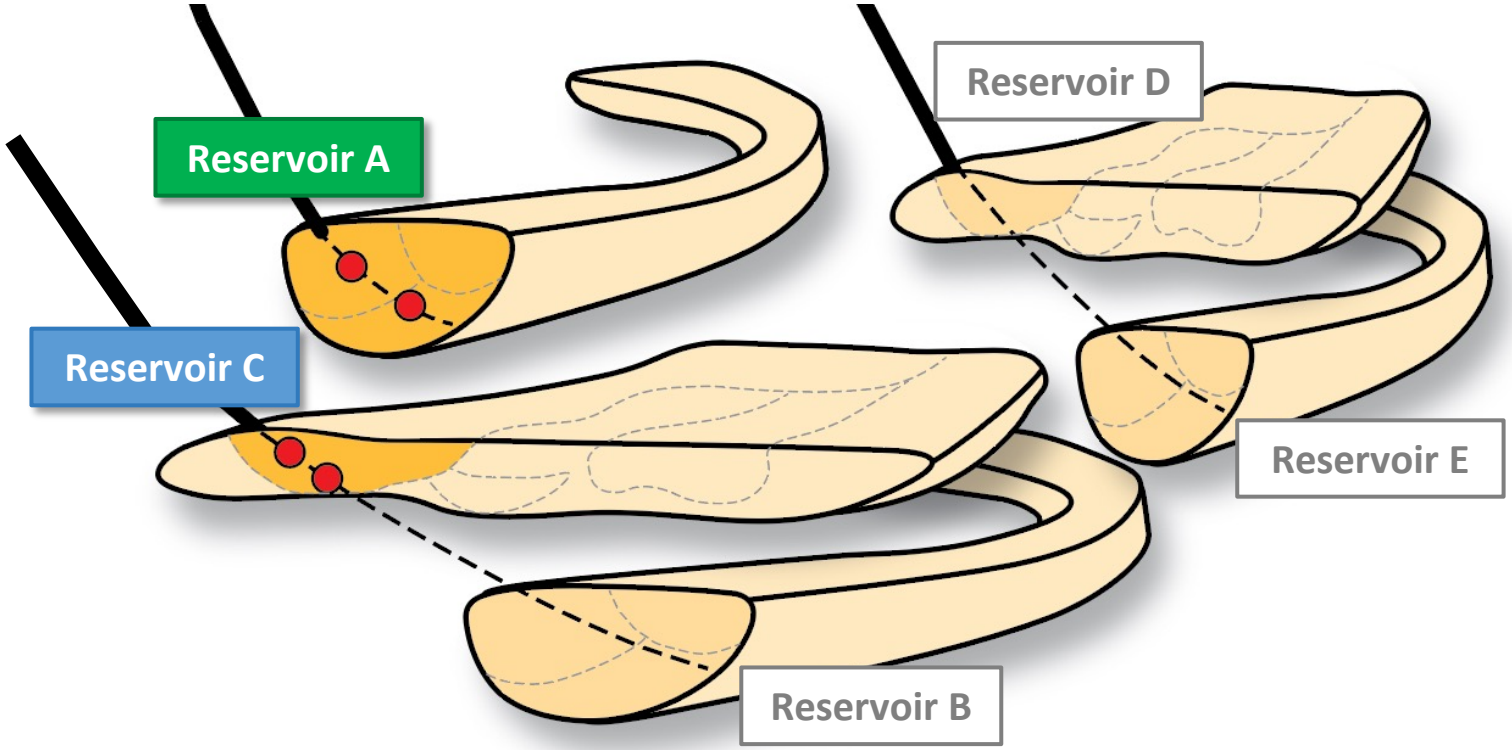
Case Study: Julimar Field, North-Western Australia

Mercury in Gas Sampling Campaign Objective:

Accurate, precise and repeatable mercury in gas analysis results to inform development decisions



Stylised diagrams. Not to scale.

Sampling Campaign

Two reservoirs sampled with techniques to minimise Hg contamination and scavenging:

- Water based mud
- Low drilling overbalance
- Focused sampling / low filtrate contamination
- Minimum flow path to chamber

Multiple sample stations in each zone:

- Identify fluid segregation (if present)

31 chambers and ~15L of gas:

- Volume for QC, repeatability & repeat testing at laboratories

Fast-track (~28hrs to lab) & regular transit:

- Demonstrate transit time impact can be eliminated with recommended procedures

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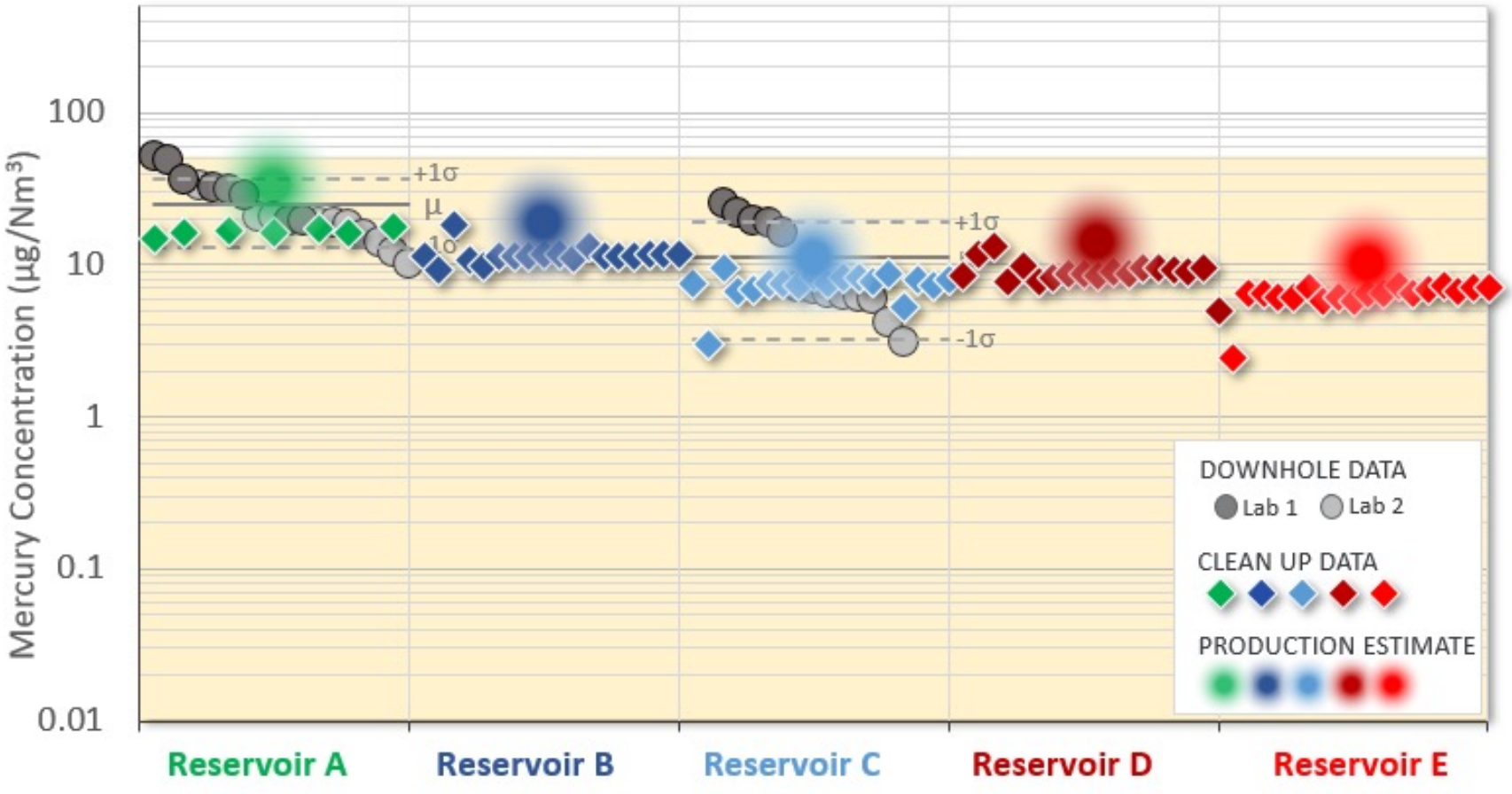
Case Study: Results



Downhole Results (2020)

Repeatable analysis across:

- Multiple sample stations
- Multiple chambers
- Multiple laboratories
- Fast-track & regular transit

Clean Up Results (2021)

Repeatable analysis across:

- 603 platform cleanup samples
- Third independent lab
- ~5 days sampling per zone
- Mean within 10 µg/m³ of downhole mean

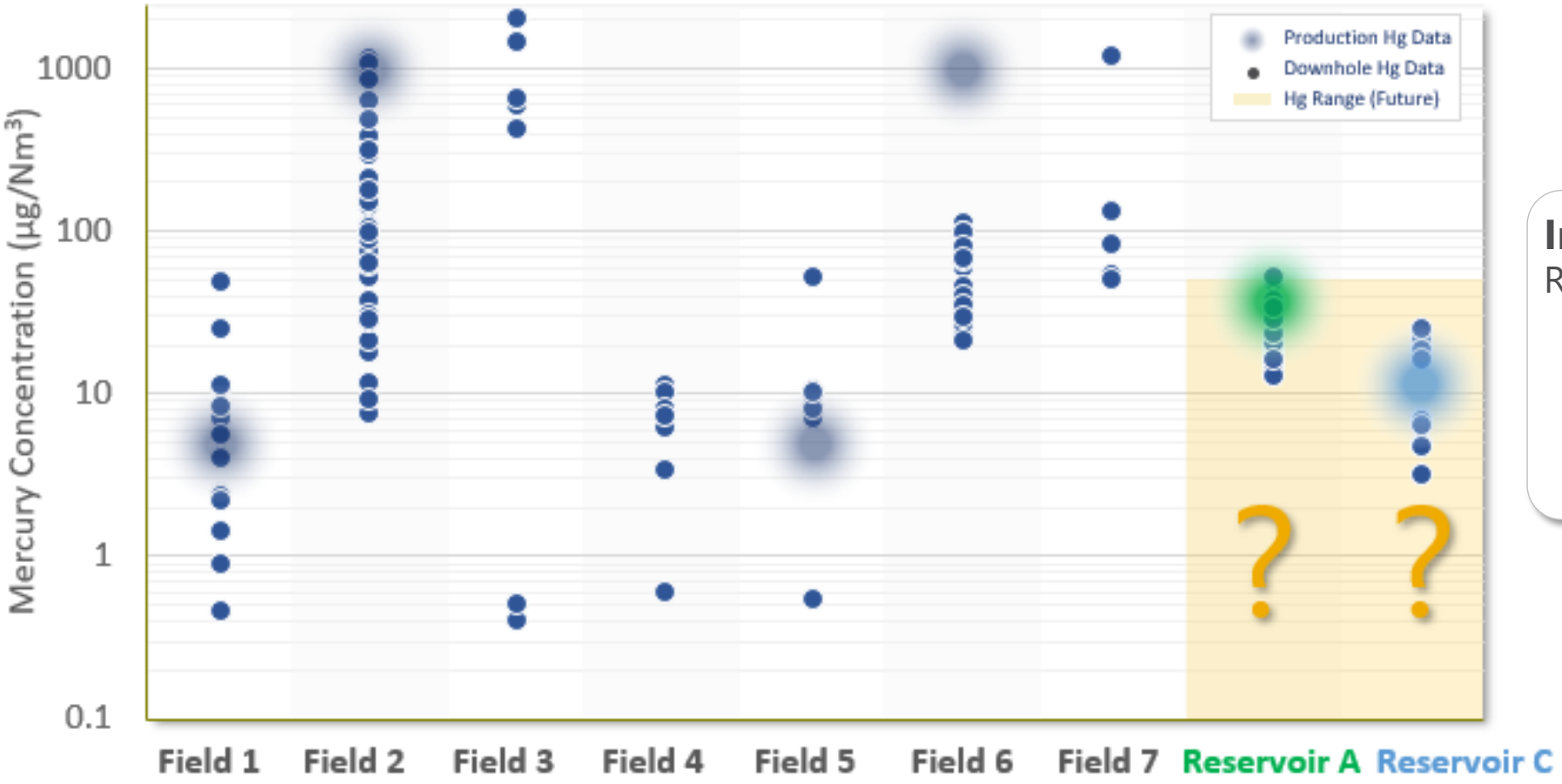
Production Results (2022+)

Repeatable analysis across:

- Blended production streams
- Mean within 10 µg/m³ of downhole mean

EXECUTE

Case Study: Regional Uncertainty



Improved Accuracy

Repeatable analysis:

- Downhole sample range: <1 order of magnitude
- Reduced uncertainty in development planning decisions

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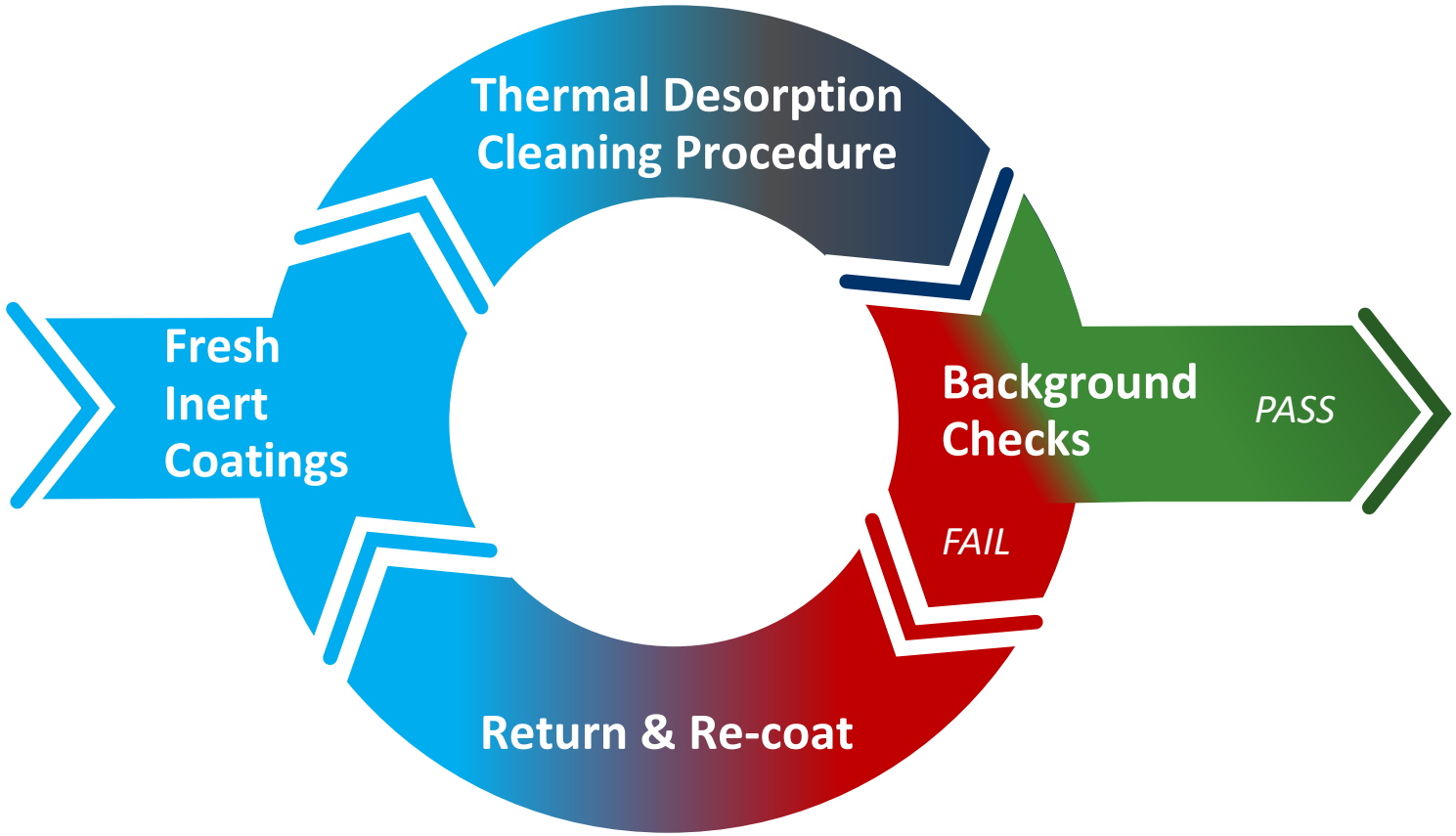
SHARE

Recommendations

Chamber Preparation & Quality Control



Execute

- Water based mud
- Minimal Invasion
- Focused Sampling
- Minimum flow path to chamber
- Sample Volume (repeat analysis)

Lab Analysis

- Validate Clean Equipment
- Validate Sample Pressure
- Use Solvent Washes
- Mass Balance (fluids & wash)
- Repeat Analysis and QC

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Acknowledgments

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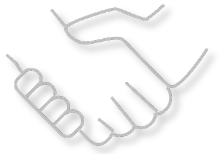
Jack Harfoushian, Brian Toole, Damien Gerard, Mark Anderson



Supported by Joint Venture Partner
Kuwait Foreign Petroleum Exploration Company

Technical insights from
Chevron Corporation

Further Information

Mercury in Natural Gas: Delivering Accurate Reservoir Sampling and Analysis,
Lawer J et al. (2023), The APPEA Journal, doi:10.1071/AJ22270 (available 15 May 2023)

[Title, tbc]
Babadimas J et al. (2023), SPE-215405-MS (available October 2023)

Head Office:
Woodside Energy
Mia Yellagonga
11 Mount Street
Perth WA 6000
Australia

Postal Address:
GPO Box D188
Perth WA 6840
Australia
T: +61 8 9348 4000
F: +61 8 9214 2777
E: companyinfo@woodside.com

Woodside Energy Group Ltd
ABN 55 004 898 962

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