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What is a GeoHazard ?

A drilling perspective

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Geological Hazard's

What is a Geo Hazard and when is it most critical?

- ✓Environmental
  - Safe Rig Installation for Jack-Up rig's
- ✓Shallow Geo Hazard's
  - No well control equipment installed
  - Impact on casing design for deep wells
- ✓Intermediate Geo Hazard's
  - Well control equipment installed
  - Impact on casing design
- ✓Deep / HPHT Geo Hazard's
  - Well control equipment installed
  - Impact on hole size and Formation Evaluation

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Consequences to Geological Hazard's

- ✓Environmental
  - Personnel & Rig Safety
  - High Cost
- ✓Shallow Geo Hazard's
  - Personnel & Rig Safety
  - Time delay & Cost
- ✓Intermediate Geo Hazard's
  - Time delay & Cost
  - Commit to use contingency liner's early
- ✓Deep / HPHT Geo Hazard's
  - Time delay & Cost
  - Potential to not meet well objectives

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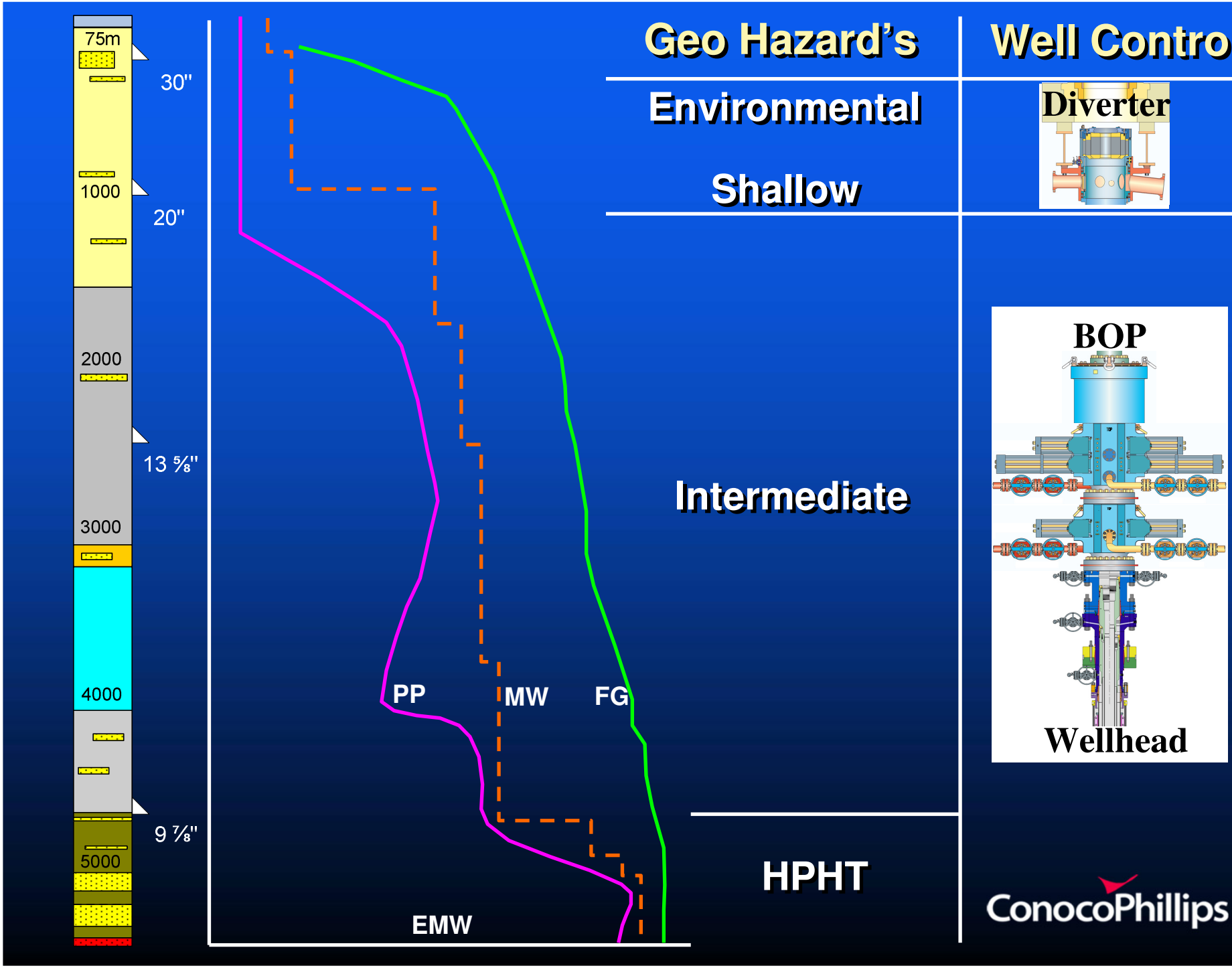
75m
30"
1000
20"
2000
13 5/8"
3000
4000
9 7/8"
5000
PP
MW
FG
EMW
Geo Hazard's
Well Control
Environmental
Shallow
Diverter
Intermediate
BOP
Wellhead
HPHT
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General Environmental Hazard's

- ✓Seabed Debris / Pipelines
  - Safe Rig Installation
  - Spud Location
  - Relief Well Planning
- ✓Soil Conditions
  - Leg Punch Through for Jack-Up rig's
- ✓Prevailing Wind Directions
  - Rig Heading
  - Relief Well Location
- ✓Metocean Data
  - Rig Preload
  - Conductor Analysis

→ Safe Rig Installation

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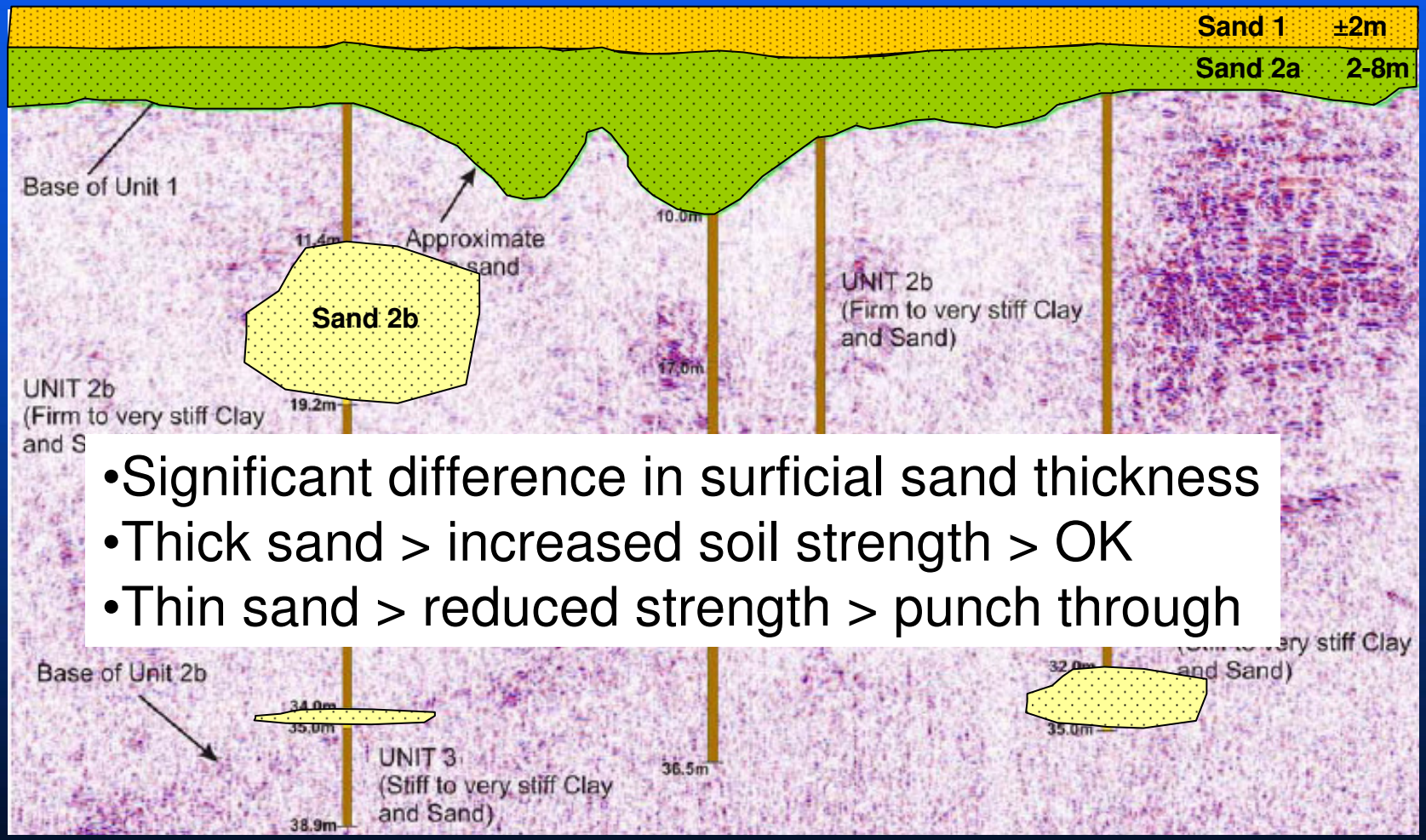
Environmental Geo Hazard's

< 40 meters below mudline



From Hi-Res survey and Geotechnical boreholes

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Environmental Geo Hazard's

Consequence:

Leg Punch Through

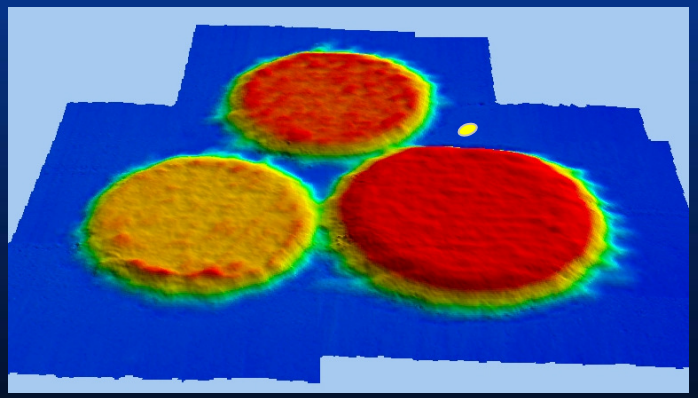
Requirements:

3x Geotechnical Boreholes

< 35 meters

HPHT Well:

- ✓ Shallow Gas Anomalies
- ✓ Soft soil
- ✓ 17x Geotechnical boreholes
- ✓ 3x Gravel Pads 48,000 tons
- ✓ Hi-Res survey
- ✓ Relief well location's



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Shallow Gas Hazard

What is it that drilling needs to know?

1. Any anomalies at drilling location?
2. Any anomalies within 50 meters from location?
3. Is the anomaly down or up-dip?
4. Is there gas present in the anomaly?
5. If gas present – any over-pressure?
6. Would it affect the drilling operation?

- Often told chance of gas being present
- Usually no answer to last question
- Can normally solve the first 3 questions

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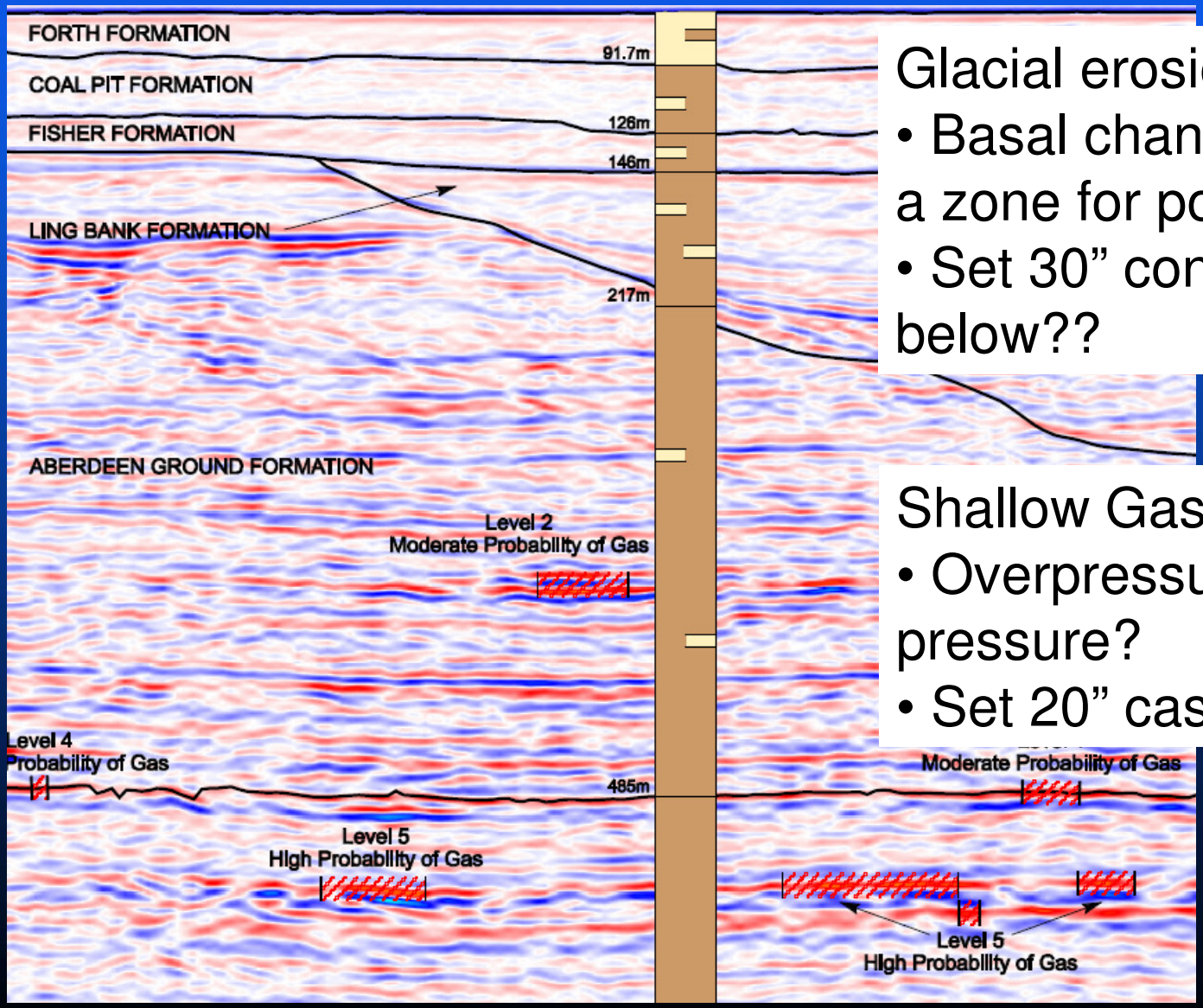
Shallow Hazard's



Glacial erosion channels

- Basal channel fill could be a zone for potential losses
- Set 30" conductor above or below??

Shallow Gas

- Overpressure or normal pressure?
- Set 20" casing above??

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Shallow Hazard's

- ✓No well control equipment installed
  - Can only divert flow overboard – Environmental spill
- ✓Formation fluid influx
  - ✓ Water influx
  - ✓ Gas Influx
  - ✓ Influx during cementing
- ✓Boulders
  - ✓ HSE – Vibration – Falling Objects
  - ✓ Kick off wellbore – re-spud?
- ✓Conductor support
  - ✓ Sufficient soil strength & cementing
- ✓Surface casing seat
  - ✓ Sufficient formation integrity
  - ✓ Avoid pressure ramp

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Conclusions

- Need close dialogue between the drilling department, the site survey contractor and the sub-surface well team
- Make sure that everybody understands the key concerns and nature of any potential hazards and how they would impact the well
- The site survey & geotechnical borehole program must be executed early in the planning face to allow for remedial work

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