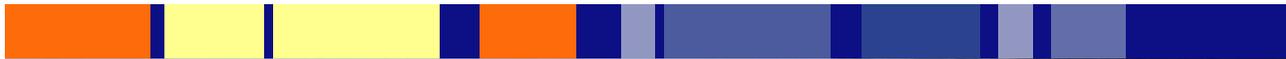


Gulf of Mexico Oil Spill

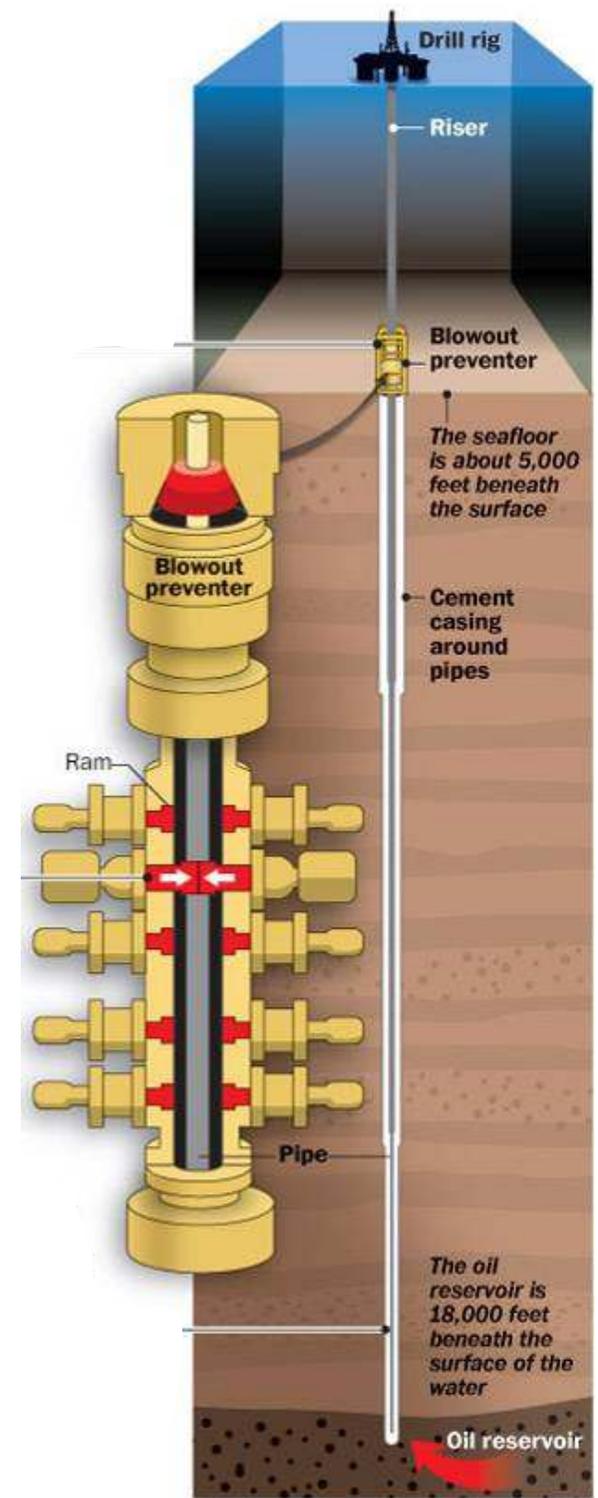
What happened and what is being done to solve the problems?



This presentation is based on information available from BP and testimonies in the initial US hearings. It may not be definitive.

Subsea drilling

- Drill string from platform to bottom of hole
 - Rotated from the top to drill
- Mud is crucial to the process:
 - Pumped down drill string, up around outside annulus
 - Lubricates the bit, removes cuttings
 - Large hydrostatic head prevents inflow of reservoir fluids while drilling: delicate balance!
- If gas enters the wellbore, a blow-out can result
 - BOP is last barrier of defence
- A BOP can close the well in three ways:
 - Closing a seal around the drill string (annular ram)
 - Closing a seal in an empty pipe (blind ram)
 - Cutting the drill string and closing the pipe (shear ram)

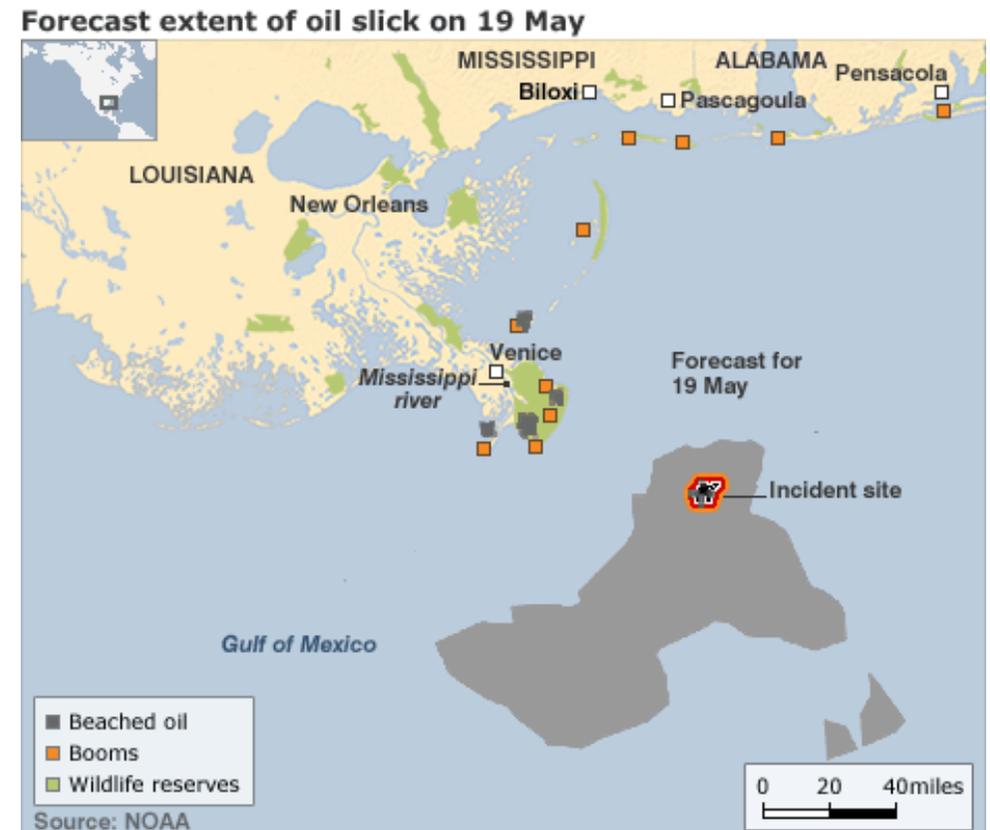


What were they planning to do?

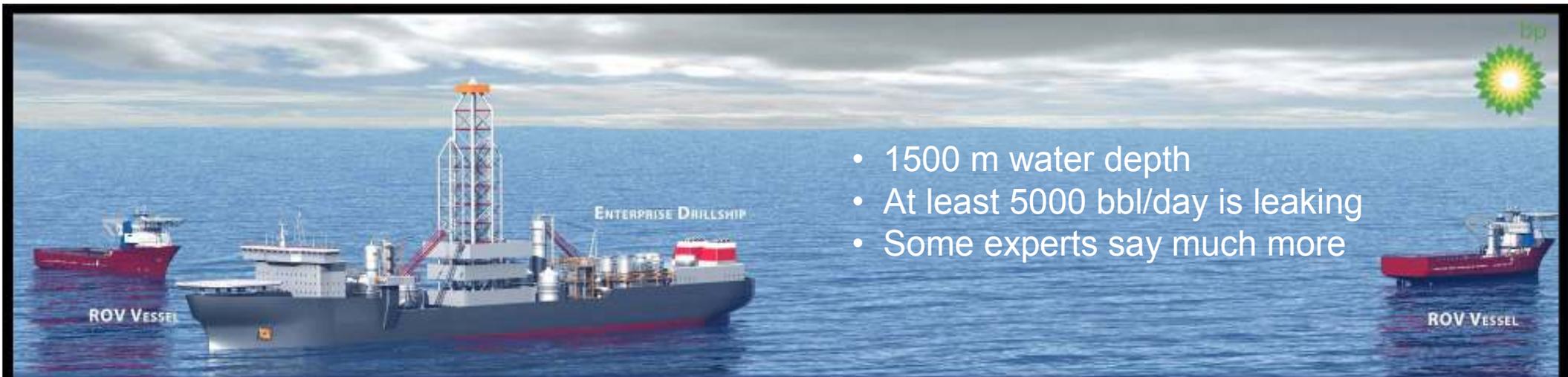
- Drilling had been completed
- Different casing strings were all cemented
- Well was not yet perforated
 - No fluids should be able to enter wellbore
- BP was to leave the well, to be produced later
 - Set final cement plug at top of wellbore
 - Remove riser
 - Remove BOP
- A production rig would then at a later time:
 - Remove the cement plug
 - Insert production tubing
 - Perforate the well
 - Oil would then be produced

What went wrong?

- The mud was removed from the riser and replaced with water
 - Done *before* final cement plug was set, for unknown reasons
 - Much lower density → bottomhole pressure decreased
- Gas then entered the wellbore
 - Should have been impossible due to cement layer
 - Gas rapidly expands, forming bubbles
 - Resulting in ever lighter column → blow-out!
- BOP was activated but did not close fully
- Uncontrolled gas production
 - Gas ignited
- Rig sank after burning for several days
 - Riser containing drill pipe still attached
- Massive oil spill was formed
 - Leak of at least 5000 bbl/day



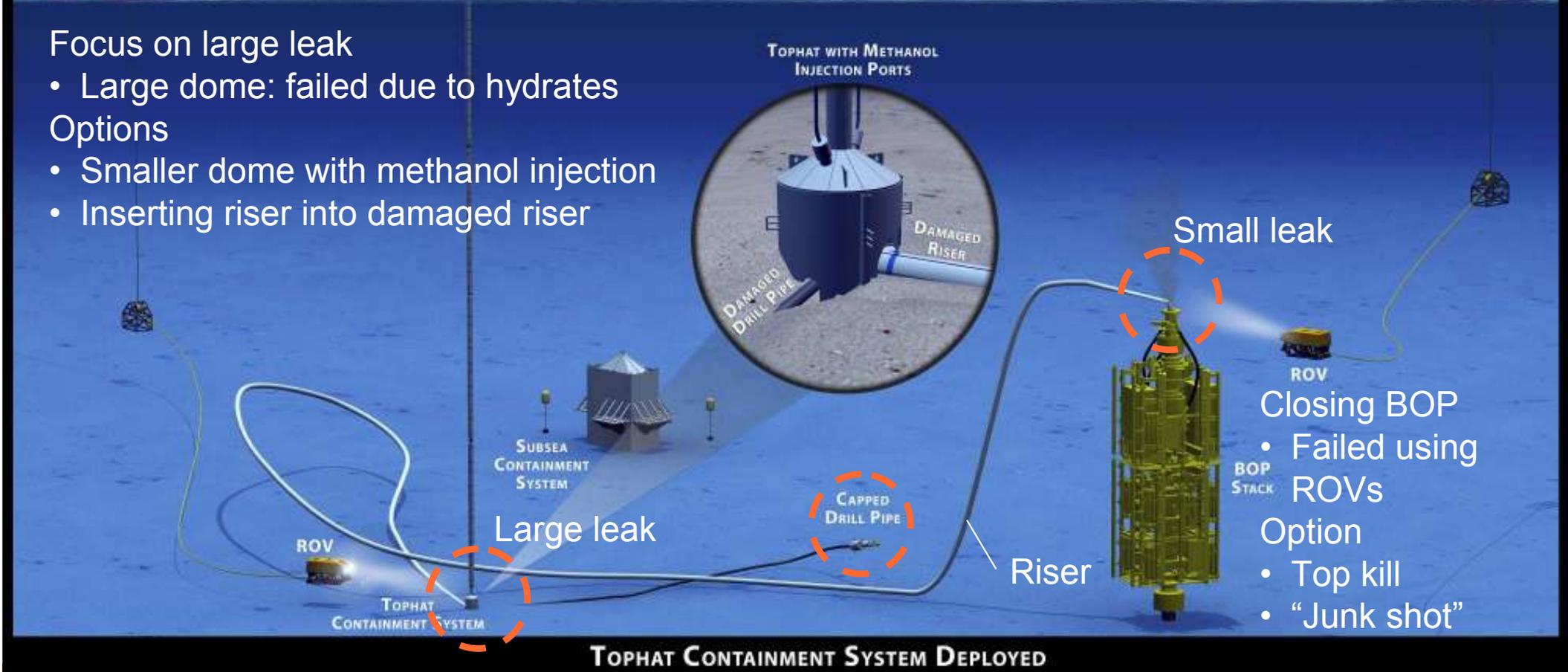
Situation on the sea bed



- 1500 m water depth
- At least 5000 bbl/day is leaking
- Some experts say much more

Focus on large leak

- Large dome: failed due to hydrates
- ### Options
- Smaller dome with methanol injection
 - Inserting riser into damaged riser



Small leak

- Closing BOP
 - Failed using ROVs
- ### Option
- Top kill
 - "Junk shot"

TOPHAT CONTAINMENT SYSTEM DEPLOYED

Riser insertion tube

DISCOVERER ENTERPRISE
DRILLSHIP



RISER INSERTION TUBE

"SPEARING" THE RISER



1 Insertion tube is guided into riser.



2 Rubber diaphragms conform around drill pipe to plug riser as much as possible.



3 Hydrocarbons are then flowed to the drillship.

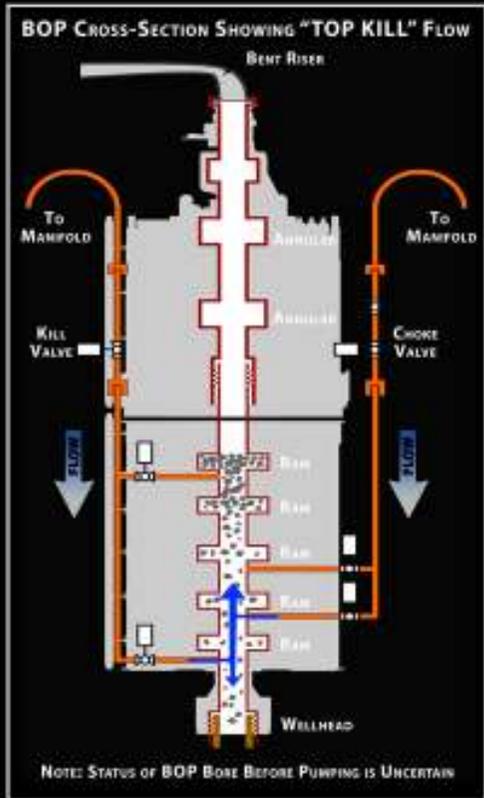


1000 bbl/day oil to surface

- Increase is hoped for
- Perfect seal is difficult: much still leaking

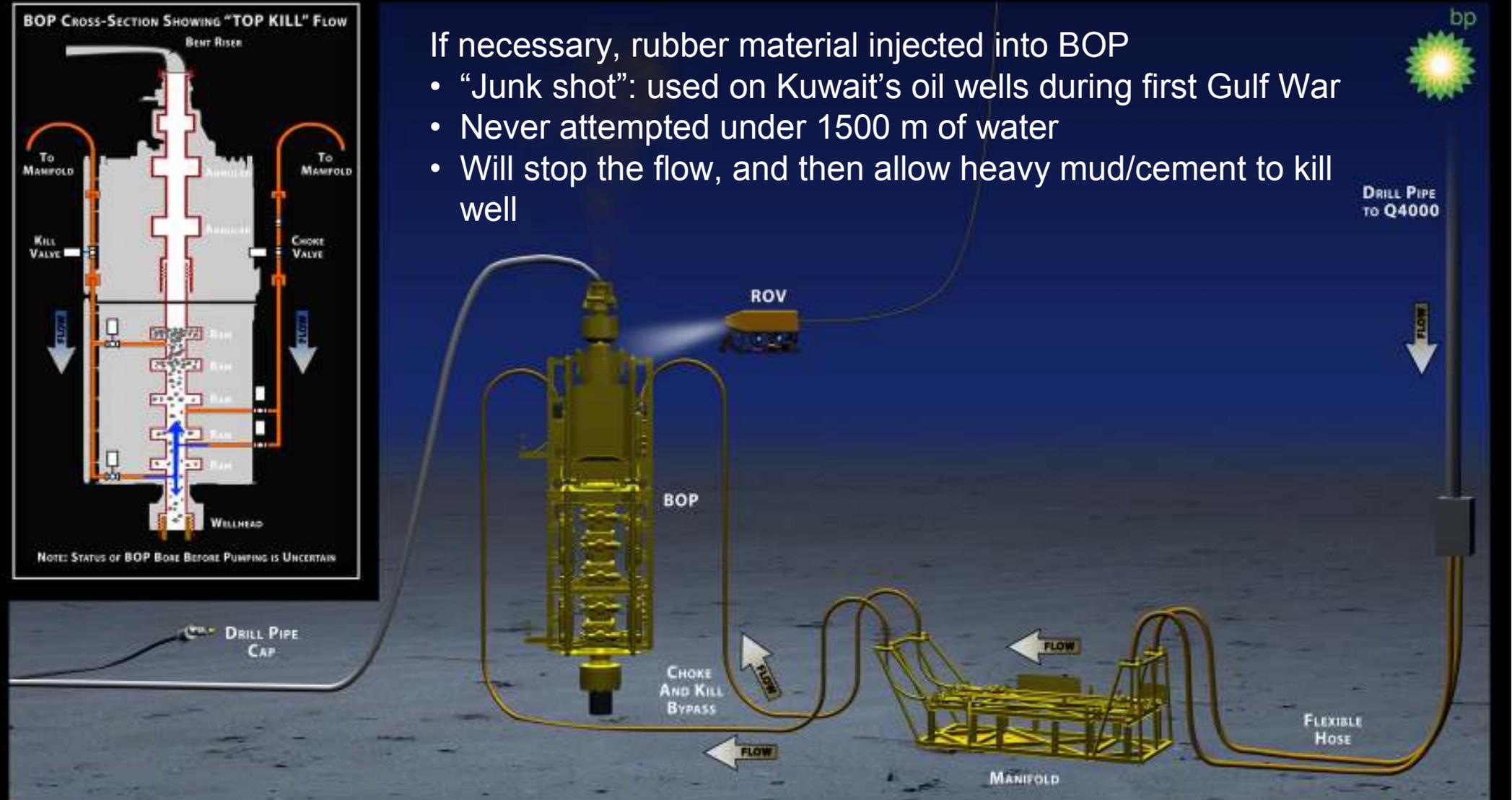
Top kill possibly with “junk shot”

- Closing BOP will stop the leak: ROVs were unsuccessful
- Top kill: injecting kill fluid (heavy mud) to stop flow
- May only be possible by first plugging BOP: “junk shot”



If necessary, rubber material injected into BOP

- “Junk shot”: used on Kuwait’s oil wells during first Gulf War
- Never attempted under 1500 m of water
- Will stop the flow, and then allow heavy mud/cement to kill well



TOP KILL

Best solution: relief wells

Two wells are drilled

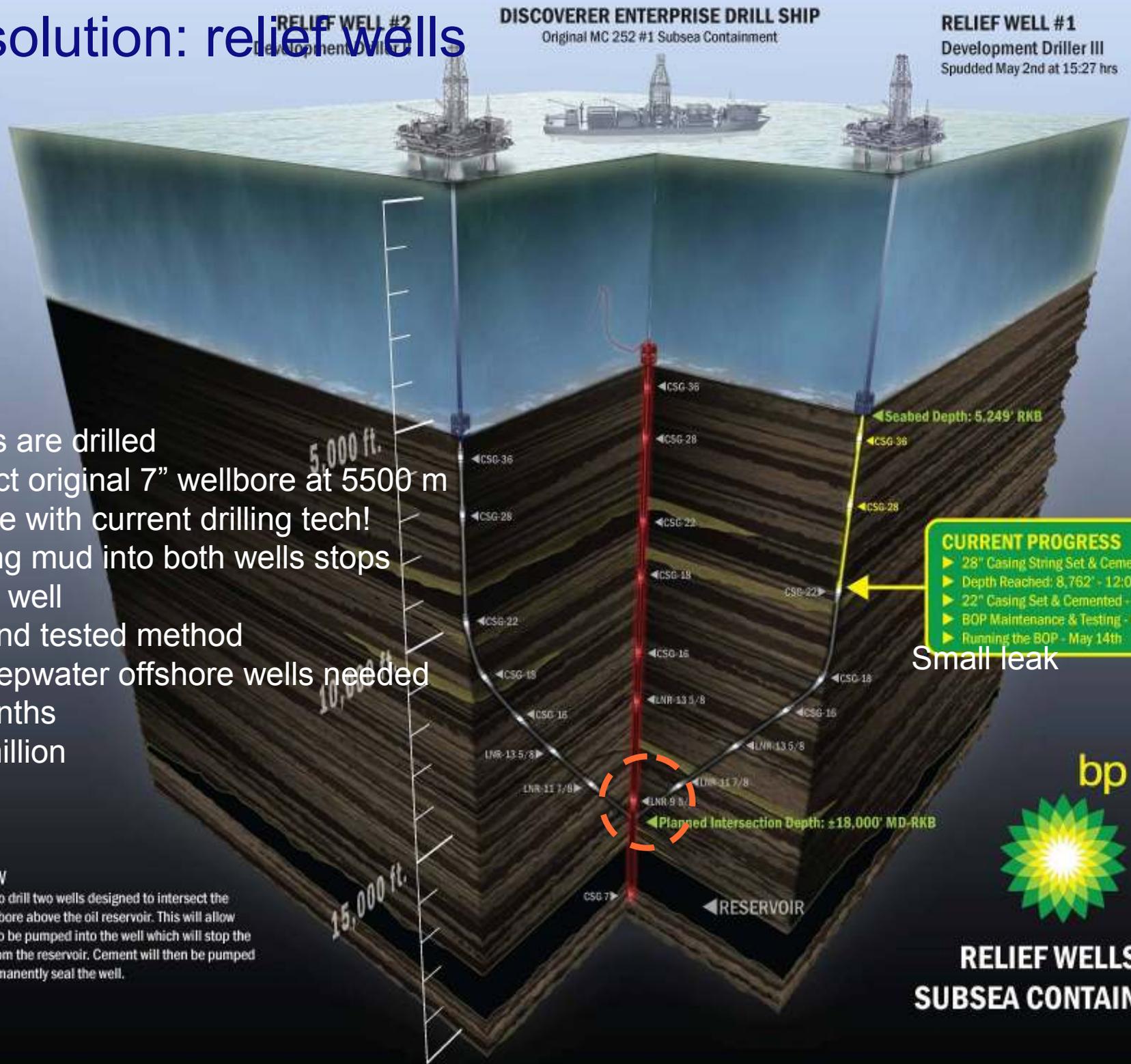
- Intersect original 7" wellbore at 5500 m
- Possible with current drilling tech!
- Pumping mud into both wells stops original well
- Tried and tested method

But: 2 deepwater offshore wells needed

- 2-3 months
- \$300 million

OVERVIEW

BP intends to drill two wells designed to intersect the original wellbore above the oil reservoir. This will allow heavy fluid to be pumped into the well which will stop the flow of oil from the reservoir. Cement will then be pumped down to permanently seal the well.



Investigation: how could this have happened?

- Three systems should have prevented a blow-out
 - Cement seal around the casing
 - Correct mud weight in the well and riser
 - Last resort: BOP should have closed
- However, many errors were found...
- Cement seal failed important pressure tests before the blow-out
 - Halliburton say they pointed this out, but no action was taken
- BP decided to remove mud from riser *before* setting last cement plug
- BOP (supplied by Cameron):
 - Hydraulic system operating the shear ram contained a leak
 - One of the controllers had a dead battery
 - Uncertainty whether shear ram is able to cut through thick deepsea drill string
 - Some rams were replaced by non-functioning test rams
 - Schematics did not match actual device
- Transocean did the drilling itself and owned the rig and BOP
- BP is responsible overall
- Blame game, all sides blaming the other