



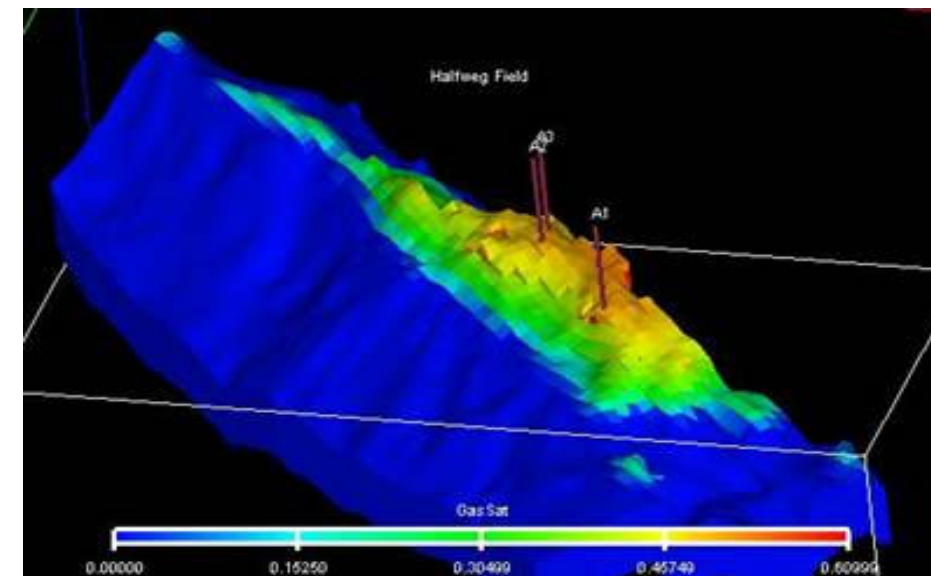
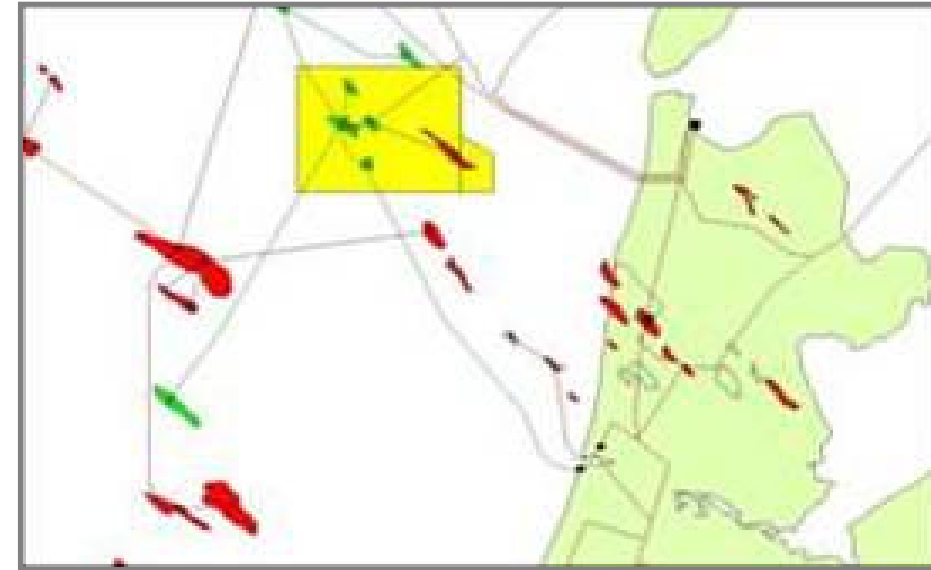
Q/1-Q/2c Halfweg Tight Gas field history case

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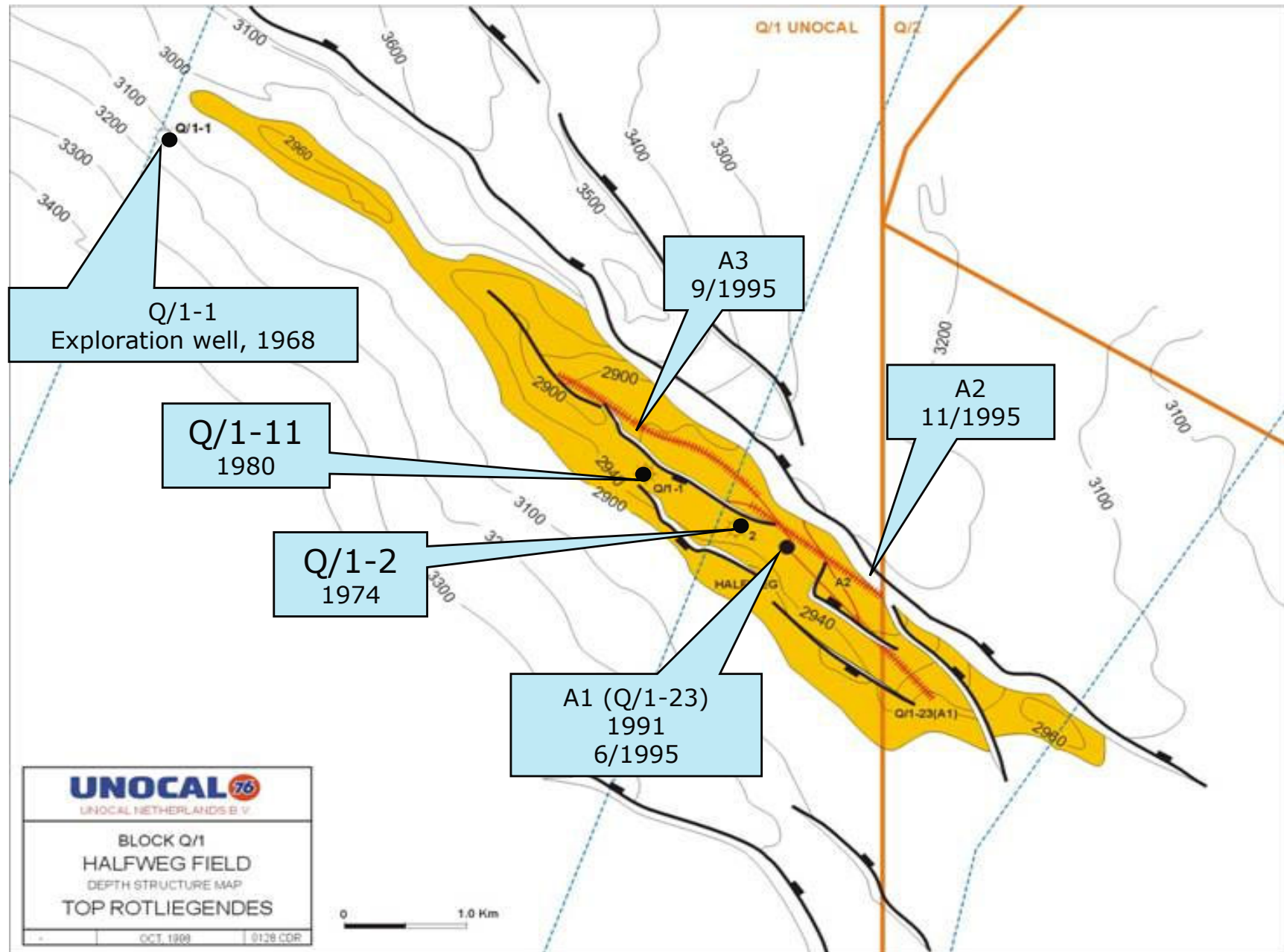
19 September 2006

Halfweg Field data

- Halfweg Gas field located 25 km west of Den Helder on boarder Q/1-Q/2
- Reservoir: Rotliegend Sandstone, southwest dipping fault block, 8 x 1.1 km, bounded by fault to the northeast side. 300 m thick sand. Maximum gas column 200m.
- Sandstone consists of foresets and bottomsets
- Permeability range results from flow tests 0.02 – 0.5 mD
- Three vertical wells and three horizontal wells drilled into the structure



Halfweg Top structure map

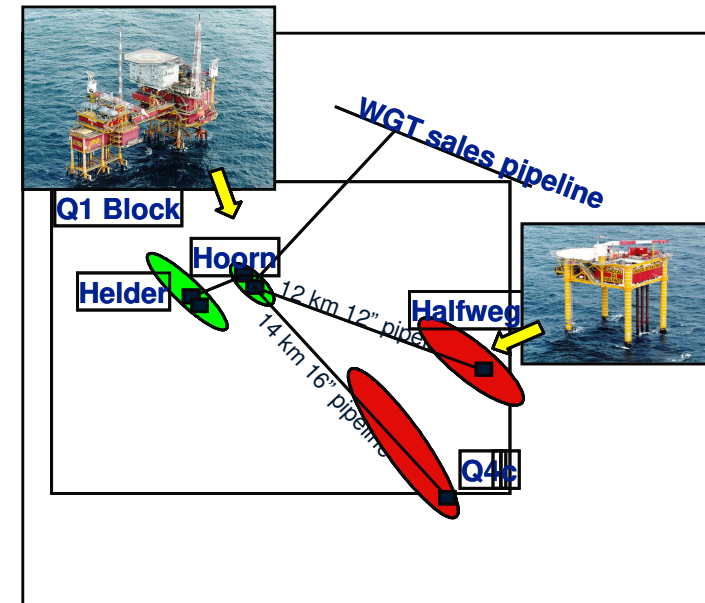


Halfweg Well test data

- Q/1-1 :
 - Welltest showed mainly water with gas shows
 - Based on these results, continued further appraisal
- Q/1-2
 - Welltest rates in the order of 1.9 MMscf/d [52Mm3/d]
 - Permeability in the order of 0.5mD
- Q/1-11
 - Welltest rates in the order of 0.9 MMscf/d [24Mm3/d]
 - Permeability in the order of 0.09mD
- Q/1-23 (A1)
 - Welltest economic rates that triggered the development of Halfweg

Halfweg facility layout

- Halfweg Satellite connect with 12 ¾" pipeline to Hoorn facility
- Water separation and processing takes place on Hoorn facility
- Three Halfweg wells produce via one manifold into pipeline
- Flowmeter and pressure gauge on Xmas tree per well
- Total gas flow metered at Hoorn
- Self installing platform to reduce installation cost



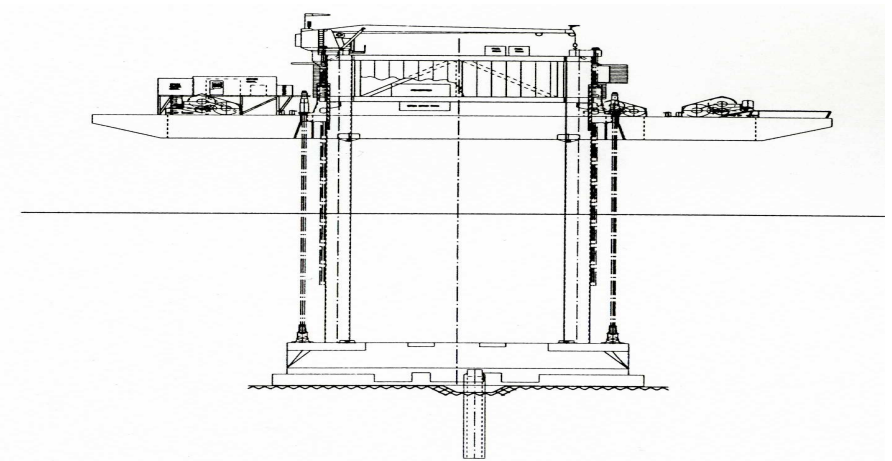
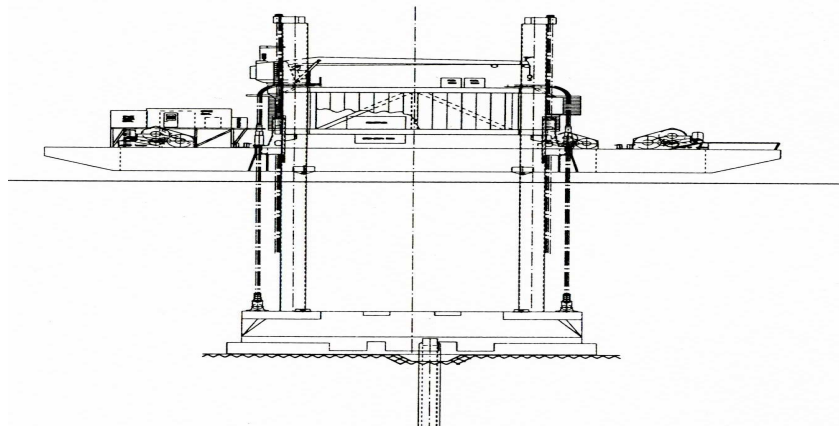
Halfweg facility



4 piles with two decks and concrete base

Towed on location
used barge to install structure

4 winches pulled deck (& barge) in position. Weight of barge was used to set enough load on seabed



Halfweg PVT data

Gas specific gravity = 0.664 (rel.to air)

$B_g = 236 \text{ scf/ft}^3$

Reservoir $P_i = 4549 \text{ psia @ GWC (313 Bara)}$

Reservoir Temp.= $231^{\circ}\text{F (110 }^{\circ}\text{C)}$

Dew point = $2700 \text{ psia (186 Bara)}$

Condensate / Gas ratio = $4.2 \text{ bbl/MMscf (ini.tests)}$
 $(0.025 \text{ m}^3/\text{Mm}^3)$

Formation water SG = 1.06

Halfweg Reservoir: Details

- Three reservoir units A, B, C
- Large transition zone (>150m)
- Interdune beds act as permeability barriers
- Foresets and bottomsets result in low vertical permeability
- Condensate drop out near wellbore

| Unit | A | B | C |
|--------------|----------|----------|-----------------------------|
| Thickness | 18-30m | 60-110m | Remaining, mainly below GWC |
| Porosity | 11% | 15-19% | 14-16% |
| Permeability | <0.5mD | <1mD | 0.5 < K < 5mD |
| Sw | 60% | 45% | 55-100% |

Halfweg Transition zone

Halfweg A unit

Halfweg B unit

Meter above GWC

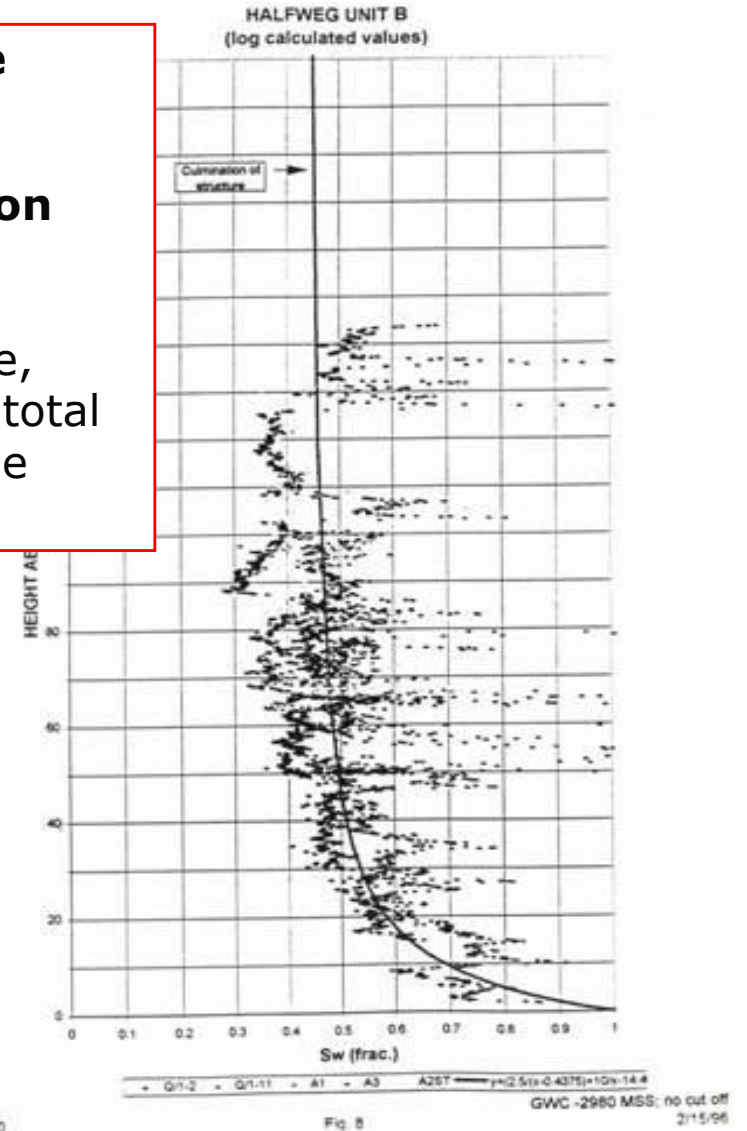
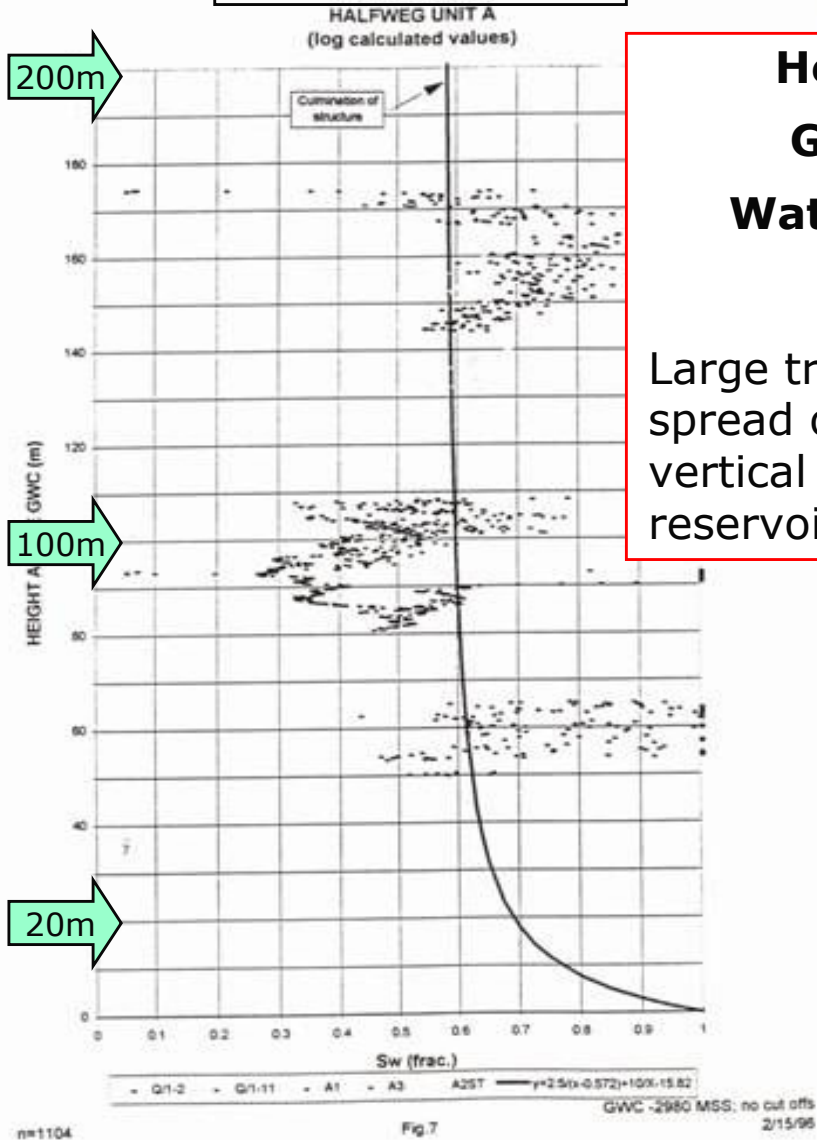
200m

100m

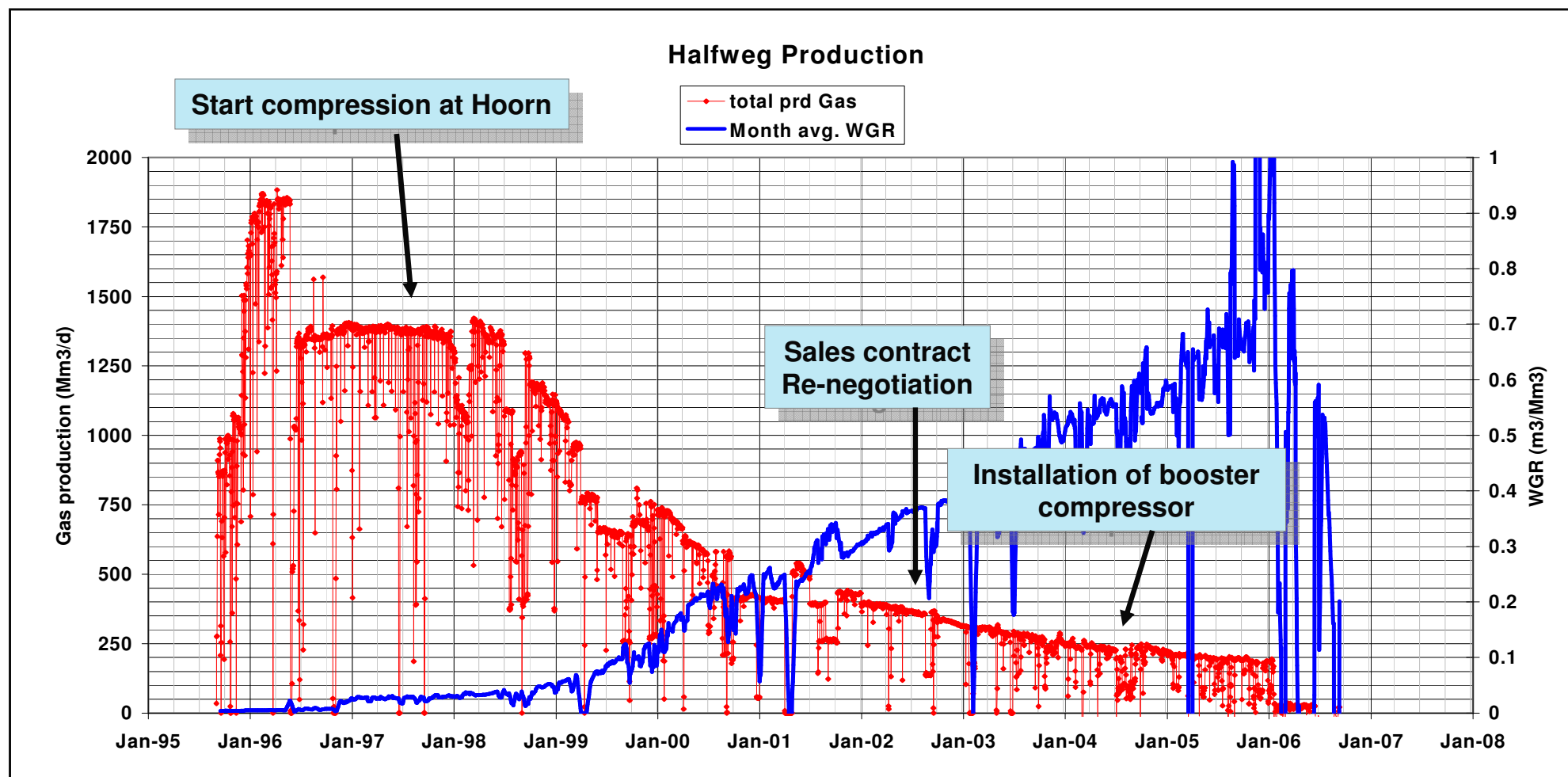
20m

**Height above
GWC versus
Water saturation**

Large transition zone,
spread out over the total
vertical section of the
reservoir.

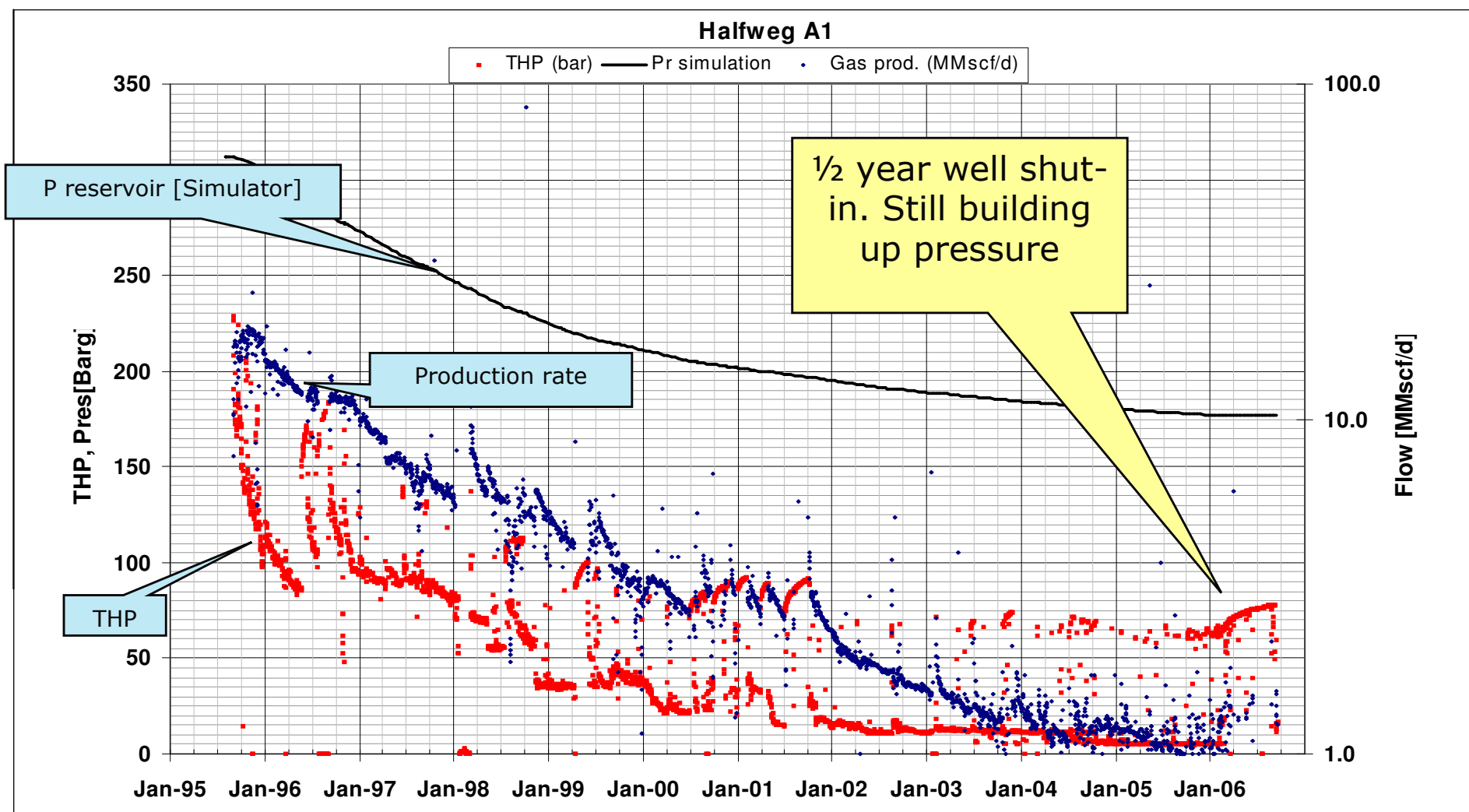


Halfweg production behaviour

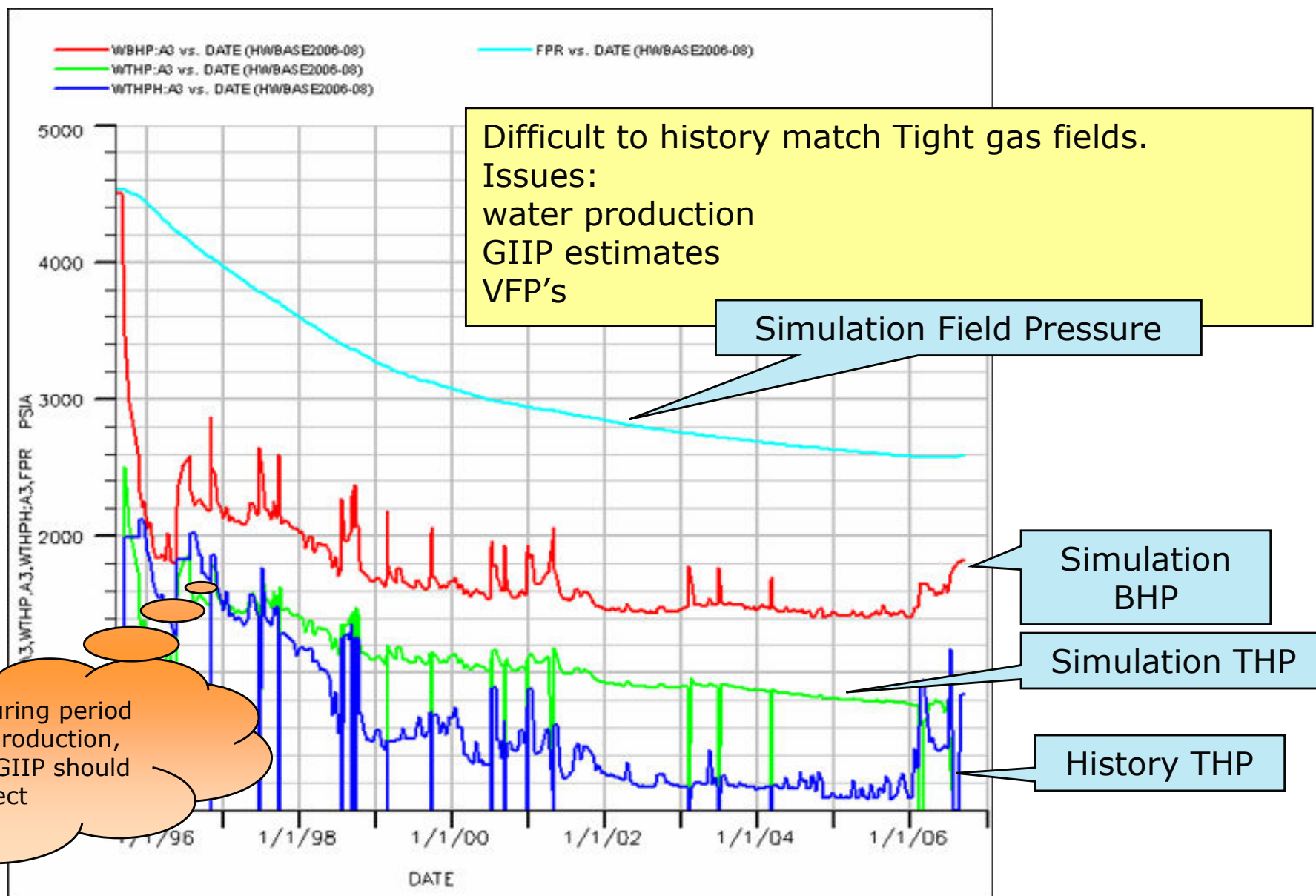


- 1997 Start compressor at Hoorn
- 2002 re-negotiated sales contract
- 2003 Booster compressor at Halfweg

Halfweg Long Pressure build-up



Halfweg simulation work



Success and issues of Halfweg

Success

- Horizontal wells that can produce at economical rates
- Installation of a simple small satellite fit for purpose, to reduce capital cost

Issues

- Difficult to collect reservoir data during production life of the field
 - No downhole pressure data
 - No individual well production test data
- Limit access due to small platform / crane