GEO-Meß-Systeme GmbH

MESY GmbH · Meesmannstraße 49 · D-44807 Bochum · FRG

BOREHOLE TESTING
HYDROFRACTURING
STRESS MEASUREMENTS
System Design · Planning
Lab + Field Measurements

CBM - Project Sigillaria License Area

CASED - HOLE PERMEABILITY AND STRESS MEASUREMENTS IN BOREHOLE RIETH-1

Operation Report

Client:	CONOCO Mineralöl GmbH, Essen
Contract:	GCBM-04-95, Variation Order No. 001 dated 09.05.1995
MeSy-Quotation:	113.05.95 dated 04.05.1995
MeSy-Reporter:	Dipl.-Geophys. G.Klee
Date:	07.06.1995

Amtsgericht Bochum 14 HRB 2572
Geschäftsführer: Prof. Dr. F. Rummel

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Project:	CBM project Sigillaria License Area
Location:	about 4 km SW of Drensteinfurt, NRW, Germany
Borehole:	Rieth-1
Purpose:	cased-hole permeability and stress measurements
Test-Period:	25.05. - 04.06.1995
Participants:	Mr. K. Thomas (Conoco Essen) Mr. S. Strauss (Conoco Houston) Dipl. Ing. P.Hegemann (MeSy) cand. geophys. T.Hettkamp (MeSy) Dipl. Geophys. G. Klee (MeSy) Dipl. Geophys. T. Przybilla (MeSy) Dipl. Ing. H.Vogt (MeSy) Dipl. Geophys. U.Weber (MeSy)

TIME TABLE OF TESTING

date	time	event
24.05.95	14.00-17.00	discussion at well-site (L. van Zanten, T.Schwarz, P.Hegemann)
25.05.95	08.00/09.30	arrival of P.Hegemann, T.Przybilla, H.Vogt
	09.30-10.30	movement of winch-container
	10.30-15.00	set-up of surface and downhole equipment
	15.00-16.25	tool at wellhead, set zero-mark at middle of injection interval, venting of the hydraulic system
	16.25	start tripping into hole
	16.30-16.50	test of tool at 20 m [1] *file: 0020CH01.DAT*
	20.45	tool at 1570.0 m
	20.53	**START OF CASED - HOLE TEST 1 AT 1570.0 m**
	20.53	start data recording *file: 1570CH01.DAT*
	20.54-21.00	set packers to 10 MPa surface pressure
	21.15-21.25	injection-rate calibration
	21.25	**start initial injection-test**

[1] all depth marks were measured from rig-floor and corresponds to the middle of the 8.7 m long test-interval

date	time	event
25.05.95	**21.35**	**end of initial injection**
		total injected volume: 1.7 l
		injection duration: 10 min
		mean injection-rate: 0.17 l/min
	21.35	**start initial fall-off test**
	22.35	**end of initial fall-off test**, end of data recording
		fall-off duration: 60 min
	22.40-23.05	problems to start data-acquisition with a sample-frequency of 30 sec *(loss of file 1570CH02.DAT)*
	23.08	start data recording *file: 1570CH03.DAT*
	23.10	**start main injection-test**
26.05.95	01.00	departure of P.Hegemann and H.Vogt
	03.31	fill of stand-pipe (47.1 l)
	08.57	fill of stand-pipe (46.6 l)
	11.45	end of data recording
	12.08	start data recording *file: 1570CH04.DAT*
	12.15	arrival of P.Hegemann
	12.40	fill of stand-pipe (50.4 l)
	12.45	departure of T.Przybilla
	17.21	fill of stand-pipe (50.1 l)
	18.12	reset packers from 6.5 to 7.5 MPa surface pressure
	22.05	fill of stand-pipe (50.2 l)
	23.44	end of data recording
	23.45	arrival of H.Vogt
	23.50	start data recording *file: 1570CH05.DAT*
27.05.95	00.45	departure of P.Hegemann
	02.41	fill of stand-pipe (50.1 l)
	06.07	reset packers from 5.5 to 6.0 MPa surface pressure
	07.24	fill of stand-pipe (50.3 l)
	10.34	reset packers from 5.5 to 6.1 MPa surface pressure
	11.10	end of data recording
	11.18	start data recording *file: 1570CH06.DAT*
	11.39	fill of stand-pipe (45.3 l)
	12.10	arrival of T.Przybilla
	12.25	departure of H.Vogt
	14.00	reset packers from 5.5 to 6.6 MPa surface pressure

date	time	event
27.05.95	**14.10**	**end of main injection**
		total injected volume: 416.7 l
		injection duration: 2330 min
		mean injection-rate: 0.179 l/min
	14.10	**start main fall-off test**
	18.04	reset packers from 5.5 to 6.2 MPa surface pressure
	19.14	end of data recording
	19.17	start data recording *file: 1570CH07.DAT*
	20.56	reset packers from 5.3 to 6.2 MPa surface pressure
28.05.95	00.07	reset packers from 5.2 to 6.0 MPa surface pressure
	02.37	reset packers from 5.1 to 6.1 MPa surface pressure
	05.12	reset packers from 5.2 to 6.2 MPa surface pressure
	06.40	end of data recording
	06.44	start data recording *file: 1570CH08.DAT*
	06.55	arrival of H.Vogt
	07.20	departure of T.Przybilla
	07.55	reset packers from 5.4 to 6.3 MPa surface pressure
	11.30	reset packers from 5.4 to 6.2 MPa surface pressure
	14.28	reset packers from 5.2 to 6.1 MPa surface pressure
	15.59	reset packers from 5.4 to 6.3 MPa surface pressure
	18.30	reset packers from 5.4 to 6.3 MPa surface pressure
	18.33	end data recording
	18.40	start data recording *file: 1570CH09.DAT*
	20.45	reset packers from 5.4 to 6.2 MPa surface pressure
	23.00	reset packers from 5.3 to 6.2 MPa surface pressure
29.05.95	01.40	reset packers from 5.3 to 6.2 MPa surface pressure
	03.55	reset packers from 5.4 to 6.2 MPa surface pressure
	06.30	reset packers from 5.4 to 6.1 MPa surface pressure
	06.38	end of data recording
	06.41	start data recording *file: 1570CH10.DAT*
	09.33	reset packers from 5.3 to 6.1 MPa surface pressure
	11.00	arrival of T.Przybilla and U.Weber
	11.15	departure of H.Vogt
	12.30	arrival of G.Klee
	13.05	**end of main fall-off test**, end of data recording
		fall-off duration: 2813 min

date	time	event
29.05.95	13.05-13.35	preparation of frac / step-rate test
	13.42-15.56	**frac / step-rate test** *file: 1570.DAT*
		reset packers to 10 MPa surface pressure, conduction of frac-cycle with 1.5 l/min and step-rate test with 3, 4, 5, 6, 7 and 7.3 l/min., maximum injection pressure: 23.09 MPa, shut-in pressure: 22.5 MPa
	15.56	**END OF CASED - HOLE TEST 1**
	15.56-16.30	deflation of packer elements
	16.47	tool at 1438.4 m
	17.07	**START CASED - HOLE TEST 2 AT 1438.4 m**
	17.07	start data recording *file: 1438CH01.DAT*
	17.07-17.14	set packers to 10 MPa surface pressure
	17.15-17.43	injection-rate calibration
	17.43	**start initial injection-test**
	17.58	**end of initial injection**
		total injected volume: 2.5 l
		injection duration: 15 min
		mean injection-rate: 0.167 l/min
	17.58	**start initial fall-off test**
	18.54	end of data recording
	18.56	start data recording *file: 1438CH02.DAT*
	18.58	**end of initial fall-off test**
		fall-off duration: 60 min
	18.58	**start main injection-test**
	20.00	departure of T.Przybilla and U.Weber
	23.13	fill of stand-pipe (45.8 l)
30.05.95	00.00	end of data recording
	00.01	start data recording *file: 1438CH03.DAT*
	00.26	reset packers from 7.5 to 9.0 MPa surface pressure
	04.12	fill of stand-pipe (51.6 l)
	04.20	reset packers from 7.3 to 9.0 MPa surface pressure
	08.33	fill of stand-pipe (44.5 l)
	08.40	end of data recording
	08.42	start data recording *file: 1438CH04.DAT*
	09.13	reset packers from 7.4 to 8.6 MPa surface pressure

date	time	event
30.05.95	09.55	arrival of T.Przybilla
	10.30	departure of G.Klee
	12.00	end of data recording
	12.02	start data recording *file: 1438CH05.DAT*
	12.26	reset packers from 7.5 to 8.7 MPa surface pressure
	12.34	fill of stand-pipe (40.7 l)
	13.28	reset packers from 8.0 to 9.2 MPa surface pressure
	13.30	**end of main injection**
		total injected volume: 190.1 l
		injection duration: 1112 min
		mean injection-rate: 0.171 l/min
	13.30	**start main fall-off test**
	16.58	end of data recording
	17.01	start data recording *file: 1438CH06.DAT*
	20.41	reset packers from 6.0 to 7.4 MPa surface pressure
	20.59	end of data recording
	21.01	start data recording *file: 1438CH07.DAT*
31.05.95	00.54	reset packers from 5.8 to 7.1 MPa surface pressure
	02.56	reset packers from 6.4 to 7.2 MPa surface pressure
	07.15	reset packers from 5.8 to 7.2 MPa surface pressure
	07.50	arrival of H.Vogt and U.Weber
	08.08	end of data recording
	08.10	start data recording *file: 1438CH08.DAT*
	08.20-08.30	preparation of frac / step-rate test
	09.55	arrival of G.Klee
	09.55	**end of main fall-off test**, end of data recording
		fall-off duration: 1225 min
	09.58-12.45	**frac / step-rate test** *file: 1438.DAT*
		reset packers to 10 MPa surface pressure, conduction of frac-cycle with 1.5 l/min and step-rate test with 3, 4, 5, 6, 7 and 7.9 l/min., maximum injection pressure: 26.10 MPa, shut-in pressure: 25.7 MPa
	10.10	departure of T.Przybilla
	12.45	**END OF CASED - HOLE TEST 2**
	12.49-13.00	deflation of packer elements

date	time	event
31.05.95	13.00-15.05	tripping out of hole
	15.05-15.45	tool out of hole, rig-down of downhole equipment for further perforations
	16.30	departure from site
01.06.95	00.00	arrival of G.Klee, H.Vogt and U.Weber
	00.00-01.53	set-up of downhole equipment, venting of the hydraulic system
	01.55	start tripping into hole
	02.00-02.20	test of tool at 20 m *file: 0020CH02.DAT*
	05.15	tool at 1580.7 m
	05.24	**START CASED - HOLE TEST 3 AT 1580.7 m**
	05.24	start data recording *file: 1580CH01.DAT*
	05.24-05.32	set packers to 10 MPa surface pressure
	05.32-05.52	injection-rate calibration
	05.55	**start main injection-test**
	07.00	departure of H.Vogt
	09.27	end of data recording
	09.29	start data recording *file: 1580CH02.DAT*
	09.30	**end of main injection**
		total injected volume: 35.7 l
		injection duration: 215 min
		mean injection-rate: 0.166 l/min
	09.30	**start main fall-off test**
	15.00	arrival of T.Przybilla
	17.26	**end of main fall-off test**, end of data recording
		fall-off duration: 476 min
	17.33-19.08	**frac / step-rate test** *file: 1580.DAT*
		reset packers to 10 MPa surface pressure, conduction of frac-cycle with 1.5 l/min and step-rate test with 3, 4, 5, 6 and 7 l/min., maximum injection pressure: 25.14 MPa, sudden packer-pressure drop at 28.18 MPa downhole
	19.08	**END OF CASED - HOLE TEST 3**
	19.10-19.16	unsuccessful attempt to inflate the packer elements *file: 1580PAC.DAT*
	19.17-19.45	deflation of packer elements

date	time	event
01.06.95	19.45-23.00	tripping out of hole
	23.00	tool out of hole
	23.00-23.10	repair of tubing connector-lines
	23.16-23.30	unsuccessful test of tool at 20 m *file: 0020CH03.DAT*
02.06.95	23.30-01.30	replacement of both packer elements
	01.47-01.59	test of tool at 20 m *file: 0020CH04.DAT*
	02.10	tool out of hole
	02.30	departure of G.Klee, T.Przybilla and U.Weber from site
	11.00	arrival of G.Klee, T.Przybilla and U.Weber at site
	11.00-12.00	set-up of downhole equipment, venting of the hydraulic system
	12.00	start tripping into hole
	14.21	tool at 1481.5 m
	14.26-14.36	determination of the flow-resistance of the system *file: 1481FLOW.DAT*
	14.42	**START CASED - HOLE TEST 4 AT 1481.5 m**
	14.42	start data recording *file: 1481CH01.DAT*
	14.42-14.52	set packers to 10 MPa surface pressure
	14.52-15.03	injection-rate calibration
	15.05	**start main injection-test**
	17.45	departure of G.Klee and U.Weber
	19.48	fill of stand-pipe (46.1 l)
	22.17	reset packers from 8.4 to 10.1 MPa surface pressure
	22.25	end of data recording
	22.27	start data recording *file: 1481CH02.DAT*
	22.35	**end of main injection**
		total injected volume: 74.3 l
		injection duration: 450 min
		mean injection-rate: 0.165 l/min
	22.35	**start main fall-off test**
03.06.95	06.26	end of data recording due to a power-cut (93 min. without data-recording)
	07.59	start data recording *file: 1481CH03.DAT*

date	time	event
03.06.95	08.00	arrival of T.Hettkamp and G.Klee
	08.42	**end of main fall-off test**, end of data recording fall-off duration: 607 min
	08.55-10.24	**frac / step-rate test** *file: 1481.DAT* reset packers to 10 MPa surface pressure, conduction of frac-cycle with 1.5 l/min, injection-cycle with 3 l/min and step-rate test with 4 and 5 l/min., maximum injection pressure: 22.1 MPa, shut-in pressure: 21.5 MPa
	10.24	**END OF CASED - HOLE TEST 4**
	10.26-10.46	deflation of packer elements
	10.58	tool at 1400.5 m
	11.00-11.05	fill of injection line
	11.08	**START CASED - HOLE TEST 5 AT 1400.5 m**
	11.08	start data recording *file: 1400CH01.DAT*
	11.09-11.16	set packers to 9.7 MPa surface pressure
	11.16-11.24	injection-rate calibration
	11.25	**start main injection-test**
	12.45	departure of T.Hettkamp and T.Przybilla
	15.35	fill of stand-pipe (43.7 l)
	19.49	fill of stand-pipe (43.7 l)
	21.27	end of data recording
	21.28	start data recording *file: 1400CH02.DAT*
	22.00	end of data recording
	22.01	start data recording *file: 1400CH03.DAT*
	22.03	**end of main injection** total injected volume: 110.1 l injection duration: 638 min mean injection-rate: 0.172 l/min
	22.03	**start main fall-off test**
04.06.95	08.50	arrival of T.Hettkamp and T.Przybilla
	09.55	**end of main fall-off test**, end of data recording fall-off duration: 712 min

date	time	event
04.06.95	**10.06-12.14**	**frac / step-rate test** *file: 1400.DAT* reset packers to 10 MPa surface pressure, conduction of frac-cycle with 1.5 l/min, step-rate test with 3, 4, 5, 6 and 7 l/min., maximum injection pressure: 24.7 MPa, shut-in pressure: 24.0 MPa
	12.14	**END OF CASED - HOLE TEST 5**
	12.15-12.30	deflation of packer elements
	12.30-15.50	tripping out of hole
	12.30	arrival of U.Weber
	13.00	departure of G.Klee
	15.50-19.15	tool out of hole, rig-down of downhole and surface equipment, dismantling of the equipment
	19.22	departure from site
06.06.95		maintenance of the equipment, demobilization of MKW-5000 winch-system

APPENDIX A

Overview - Plots of

Injection - and Fall - Off - Tests

remarks: data were not corrected with respect to power supply induced noise

uphole pressure curves:
solid line: interval pressure
broken line: packer pressure

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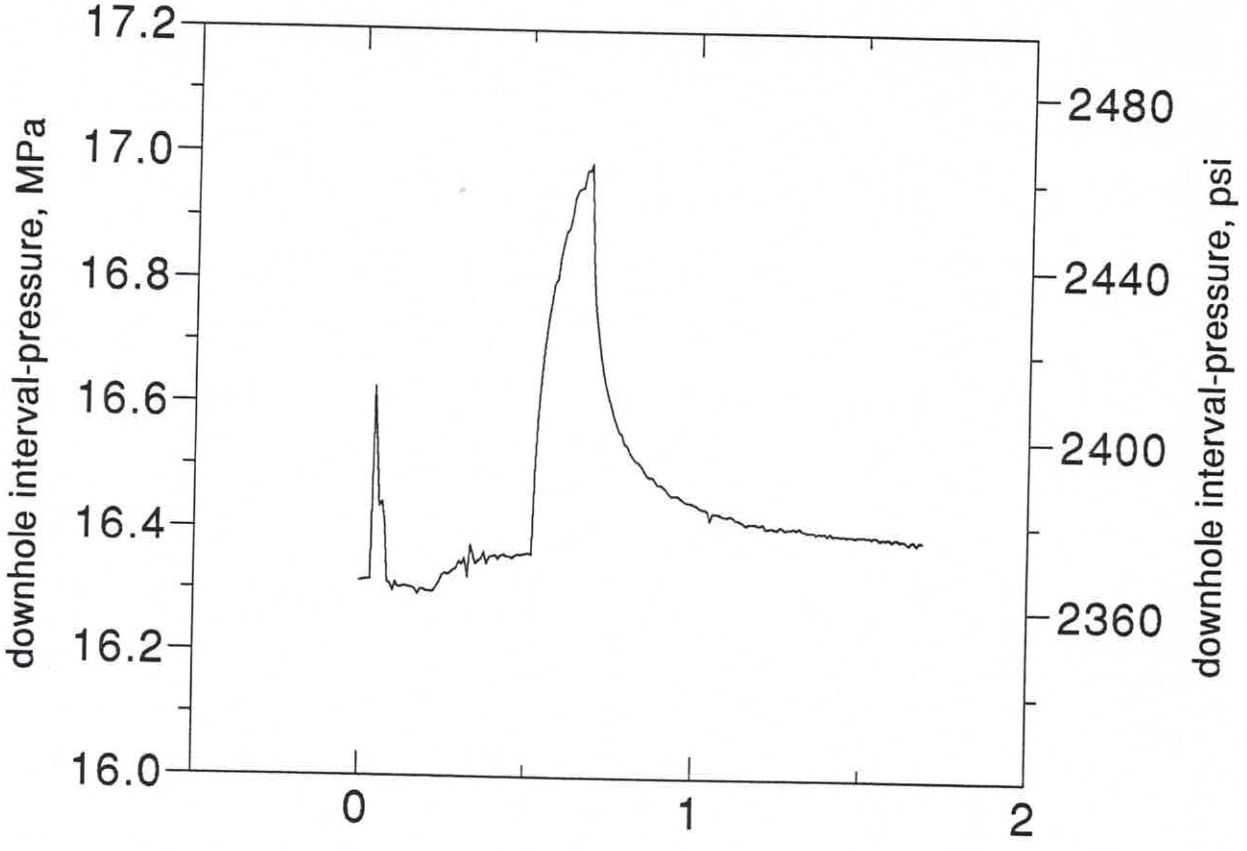
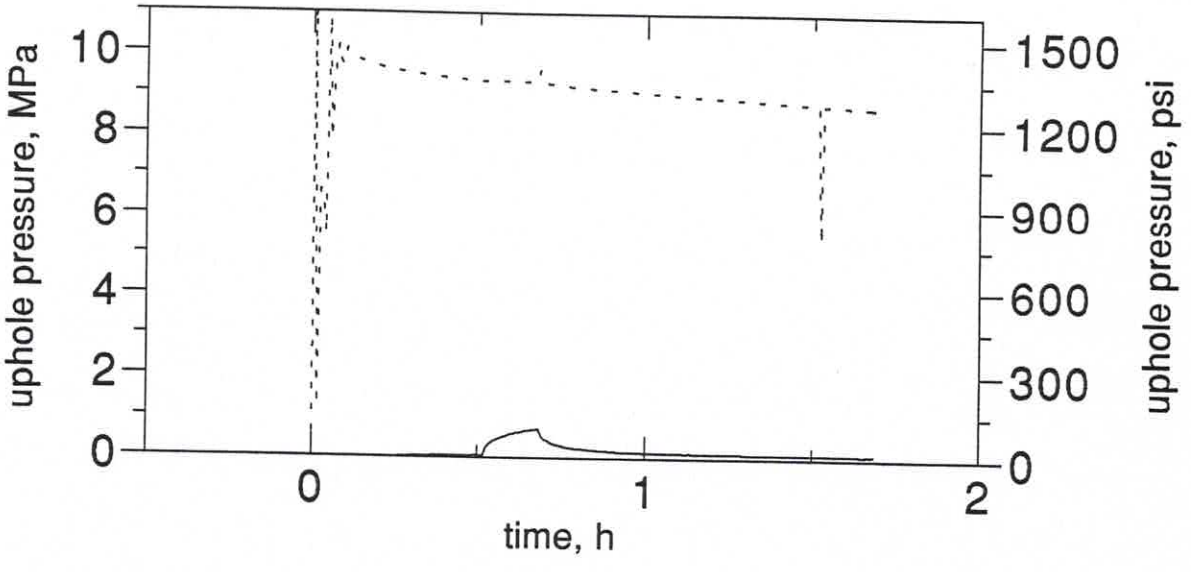
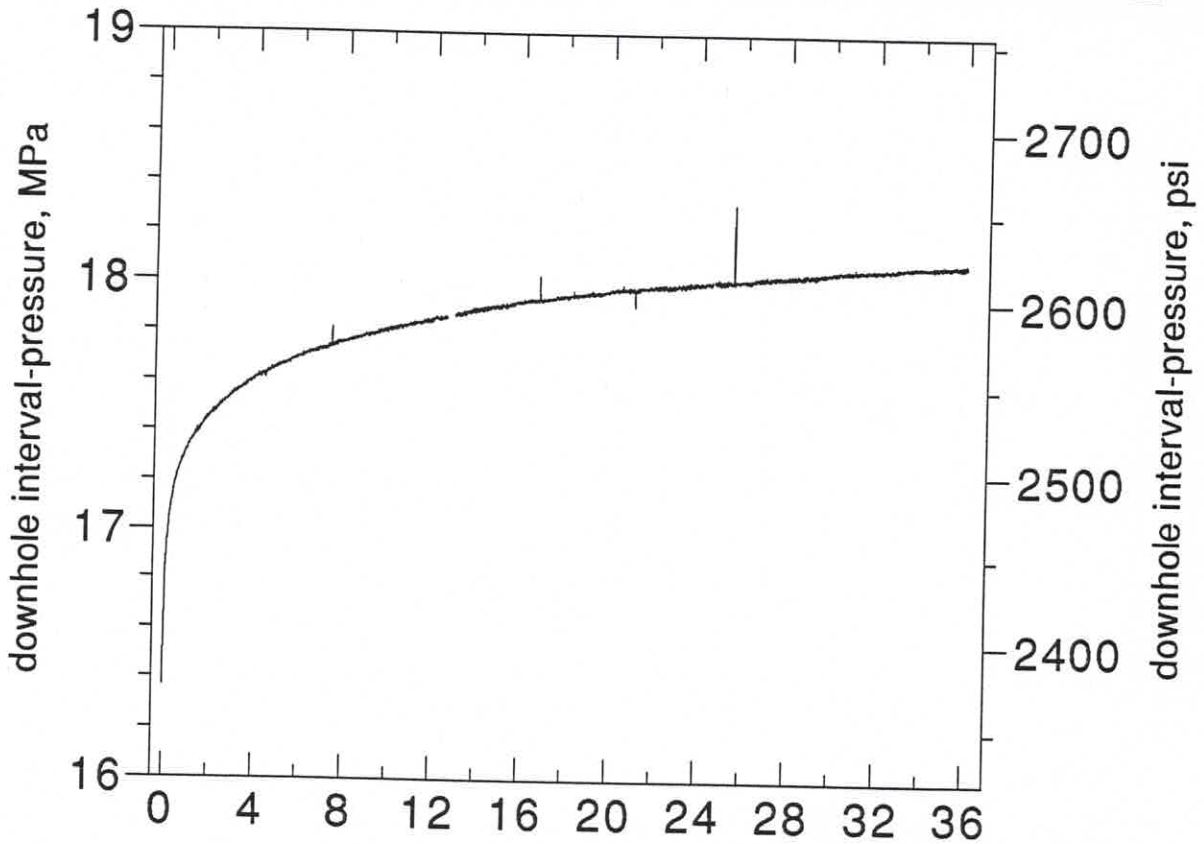
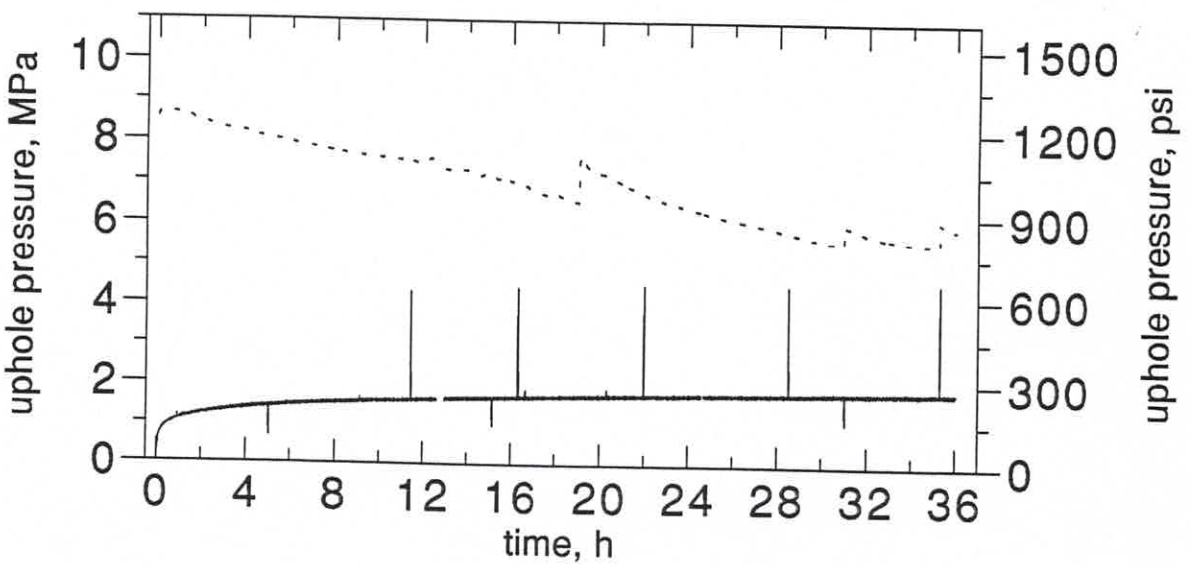
CASED - HOLE TEST 1 AT 1570.0 m
initial injection / fall-off test
file: 1570CH01.DAT
start: 25.05.1995, 20.53 end: 25.05.1995, 22.35





CASED - HOLE TEST 1 AT 1570.0 m
main injection test
files: 1570CH03.DAT, 1570CH04.DAT
1570CH05.DAT
start: 25.05.1995, 23.08 end: 27.05.1995, 11.10





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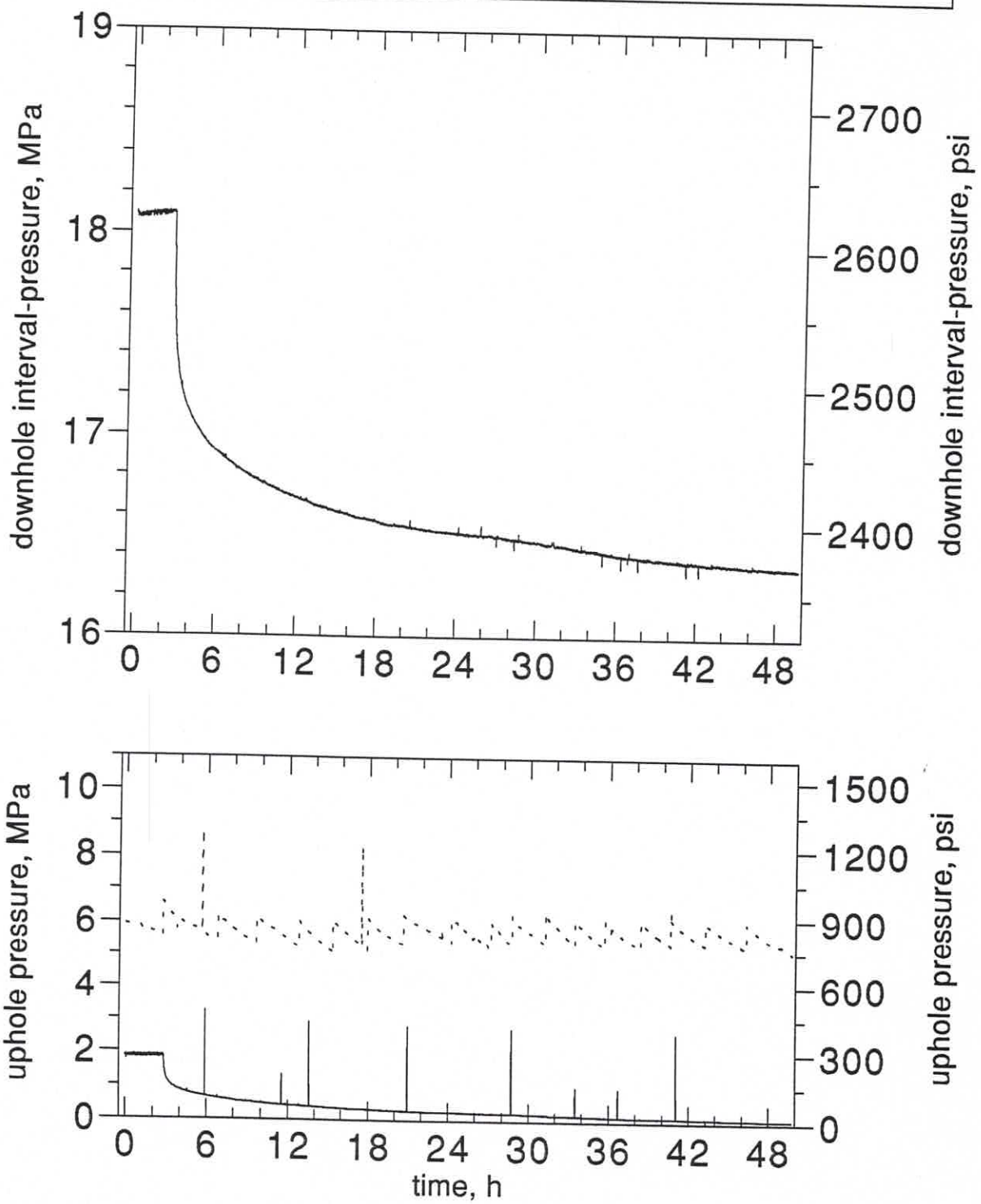
CASED - HOLE TEST 1 AT 1570.0 m
main fall-off test
files: 1570CH06.DAT, 1570CH07.DAT
1570CH08.DAT, 1570CH09.DAT
1570CH10.DAT
start: 27.05.1995, 11.18 end: 29.05.1995, 13.05



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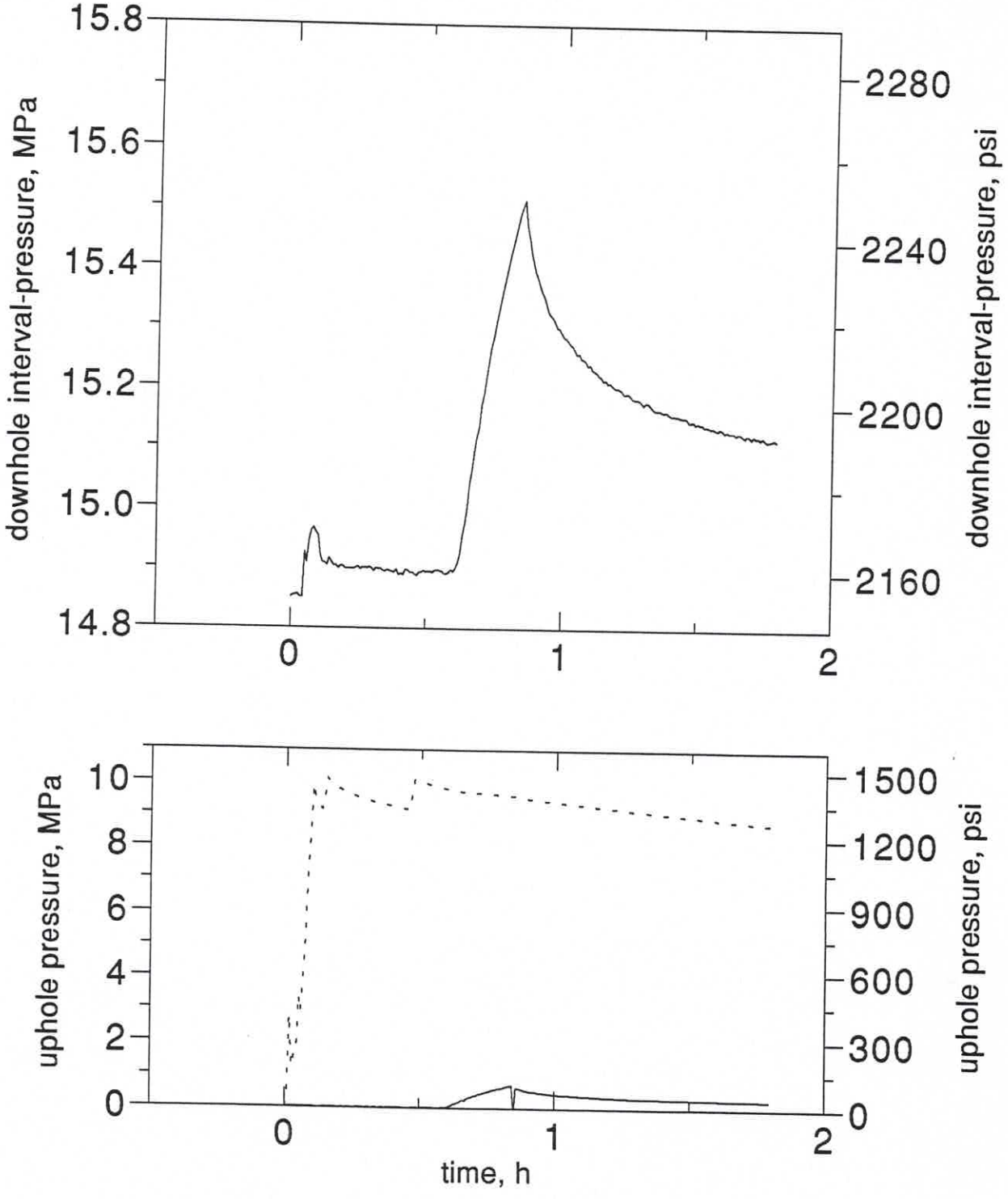
CASED - HOLE TEST 2 AT 1438.4 m
initial injection / fall-off test
file: 1438CH01.DAT
start: 29.05.1995, 17.07 end: 29.05.1995, 18.54



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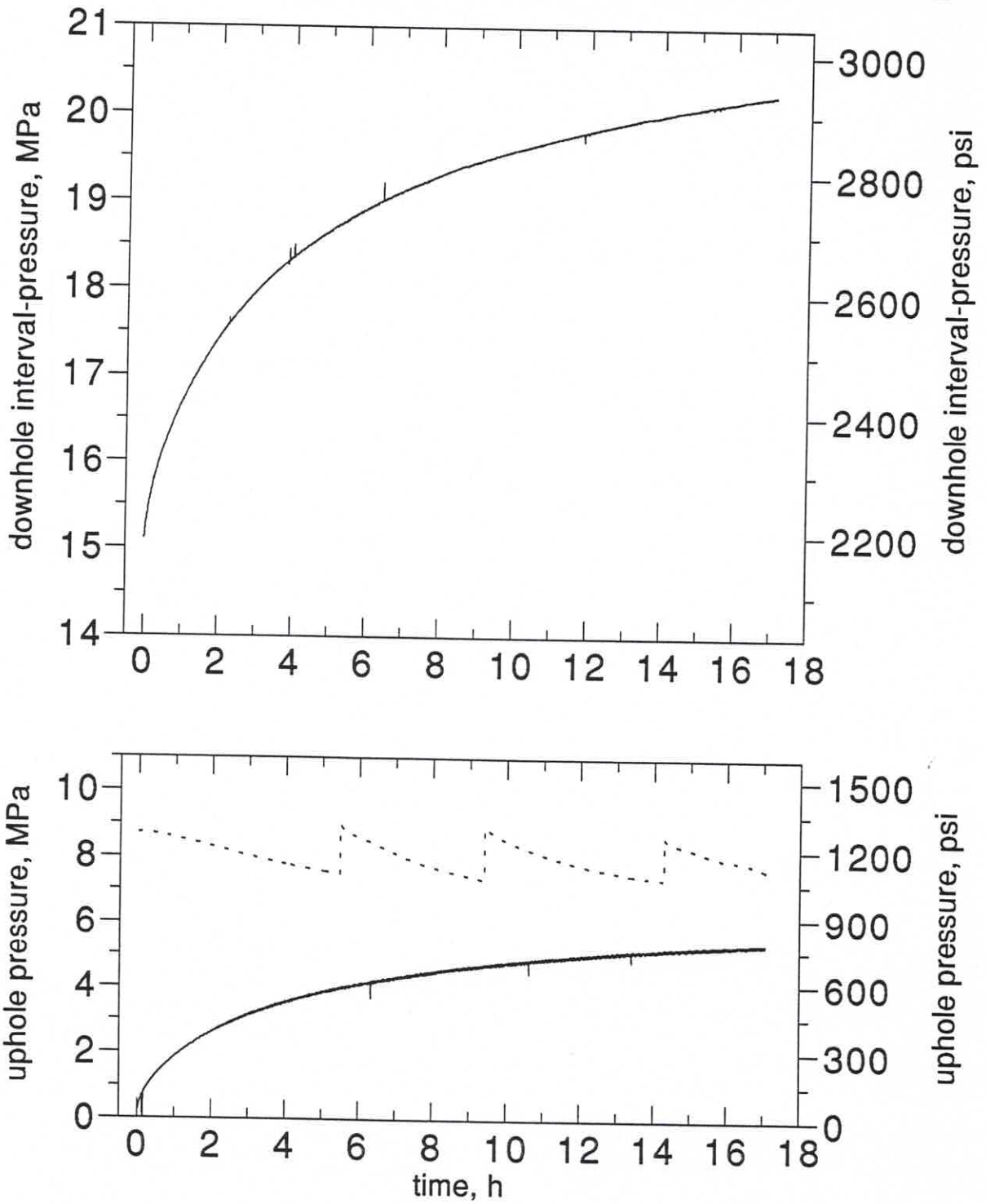
CASED - HOLE TEST 2 AT 1438.4 m
main injection test
files: 1438CH02.DAT, 1438CH03.DAT
1438CH04.DAT
start: 29.05.1995, 18.56 end: 30.05.1995, 12.00



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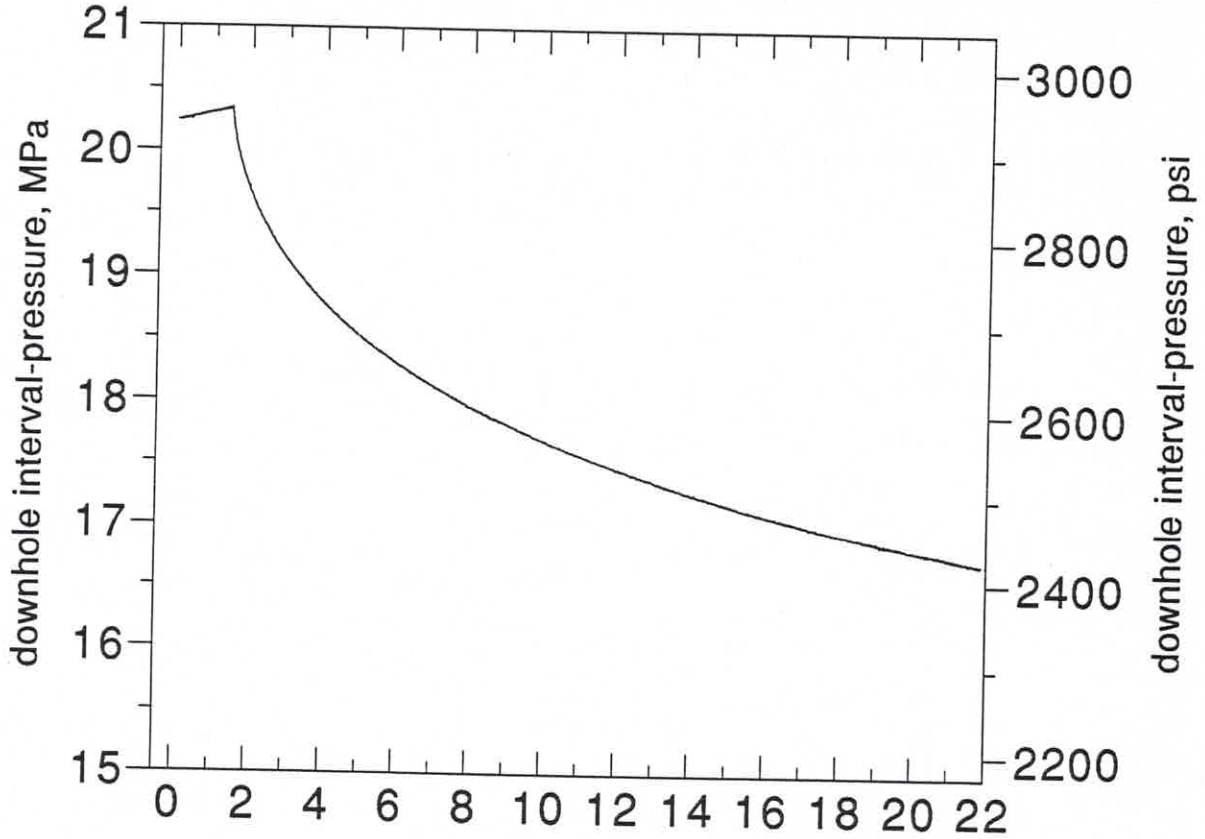
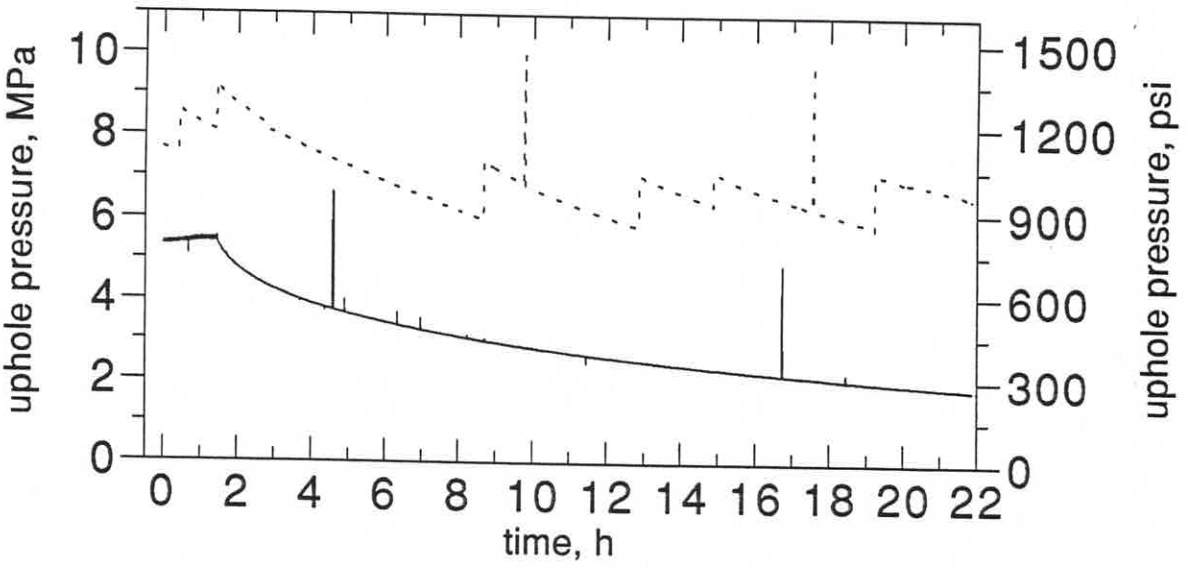
CASED - HOLE TEST 2 AT 1438.4 m
main fall-off test
files: 1438CH05.DAT, 1438CH06.DAT
1438CH07.DAT, 1438CH08.DAT
start: 30.05.1995, 12.02 end: 31.05.1995, 09.55





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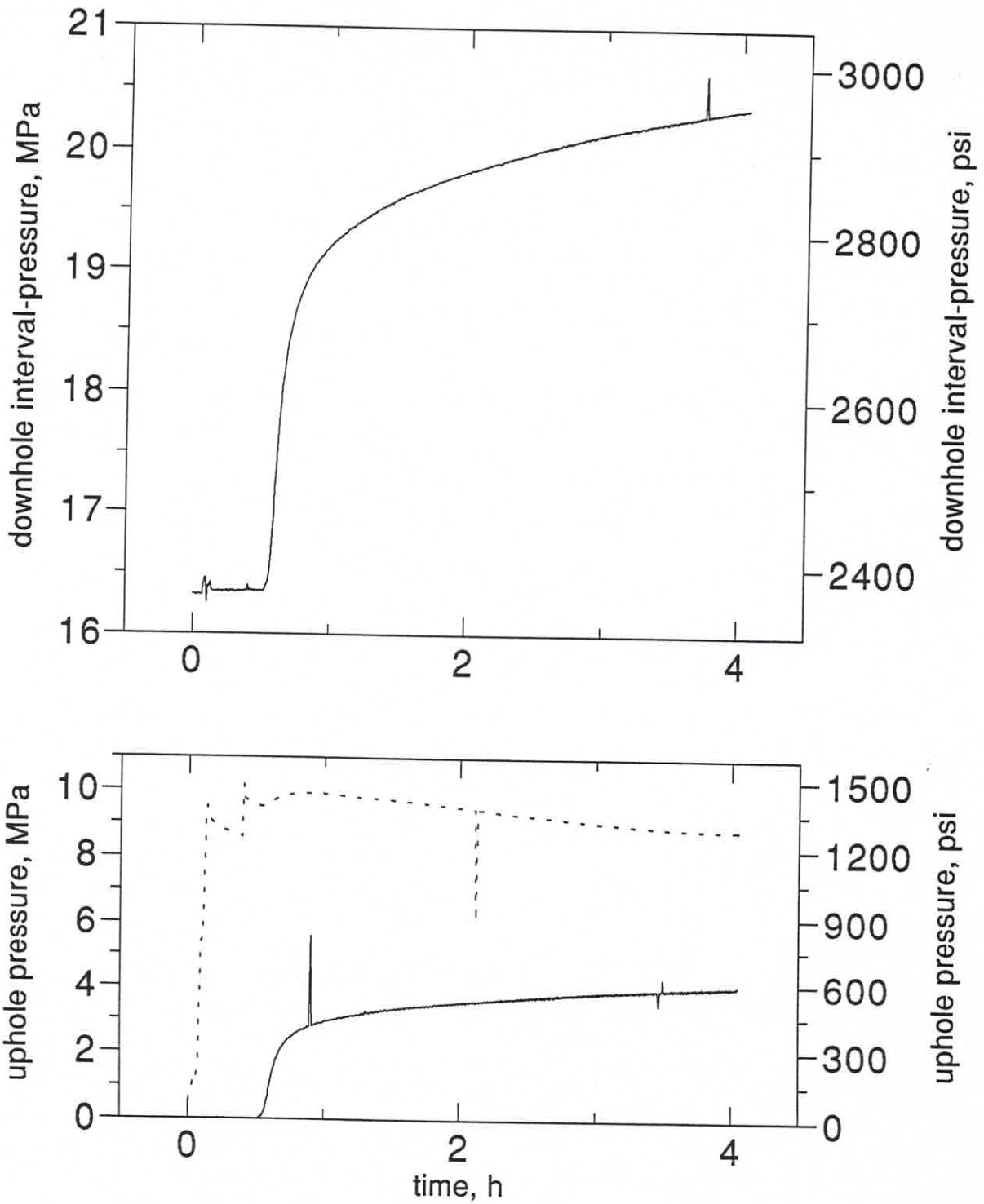
CASED - HOLE TEST 3 AT 1580.7 m
main injection test
file: 1580CH01.DAT
start: 01.06.1995, 05.24 end: 01.06.1995, 09.27



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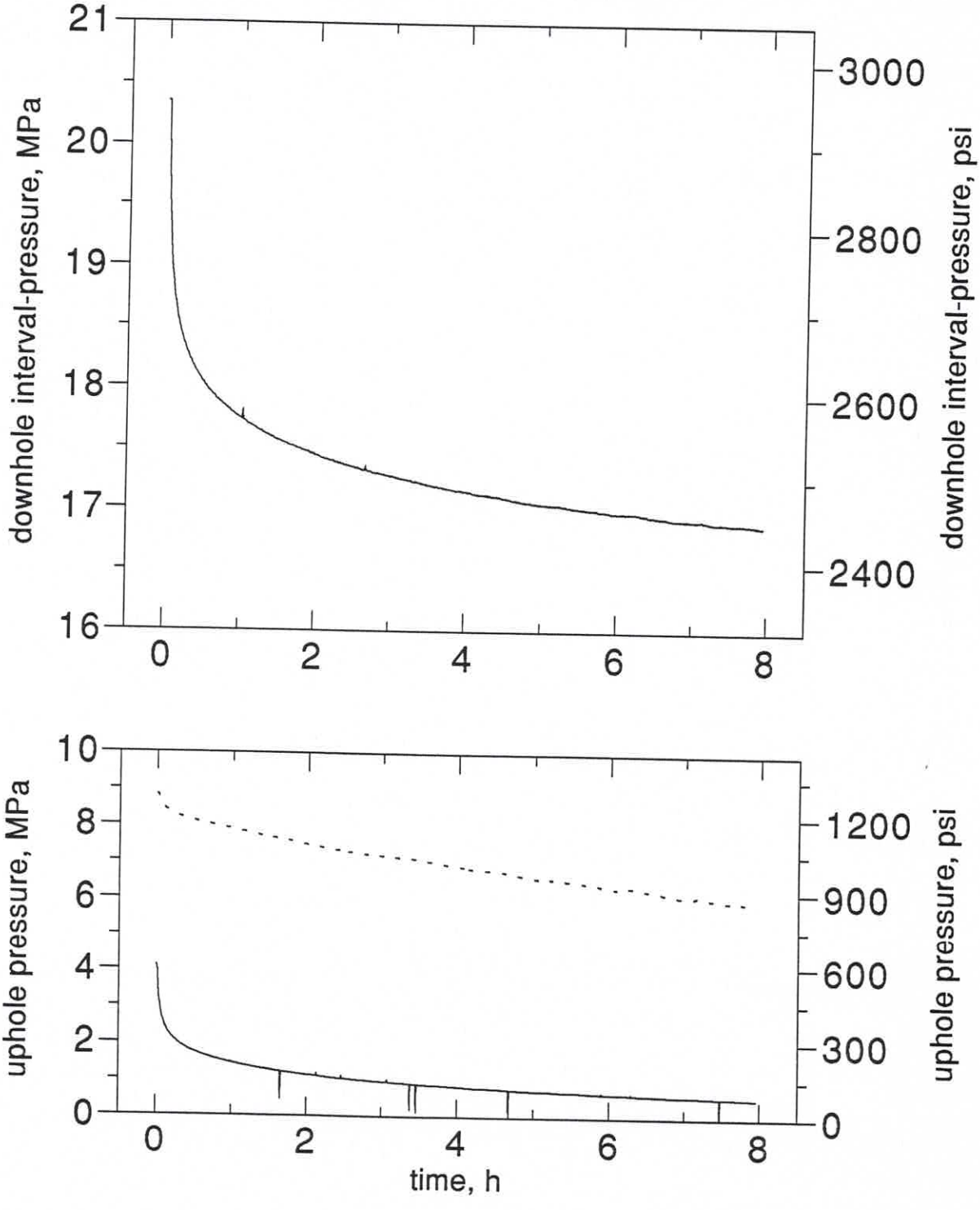
CASED - HOLE TEST 3 AT 1580.7 m
main fall-off test
file: 1580CH02.DAT
start: 01.06.1995, 09.29 end: 01.06.1995, 17.26



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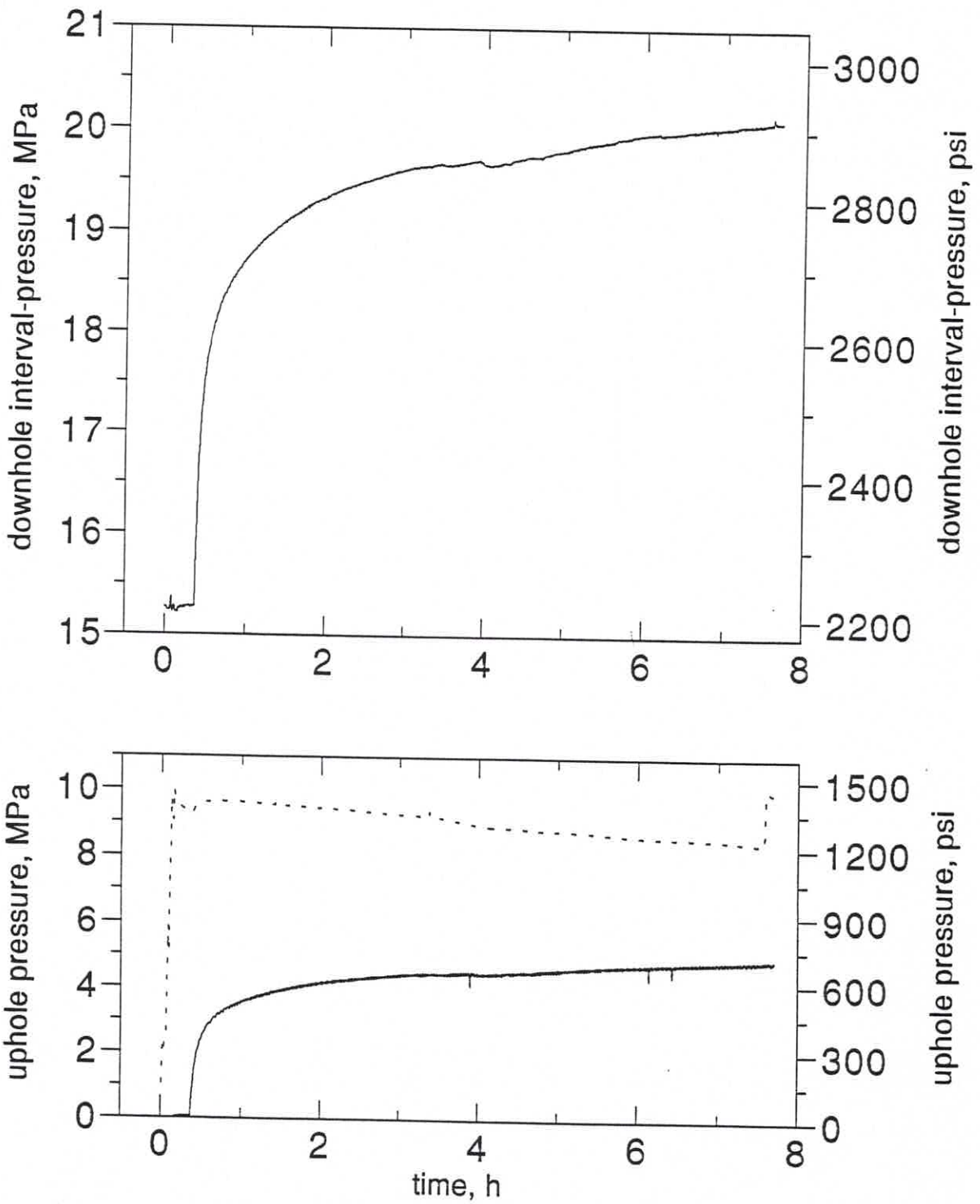
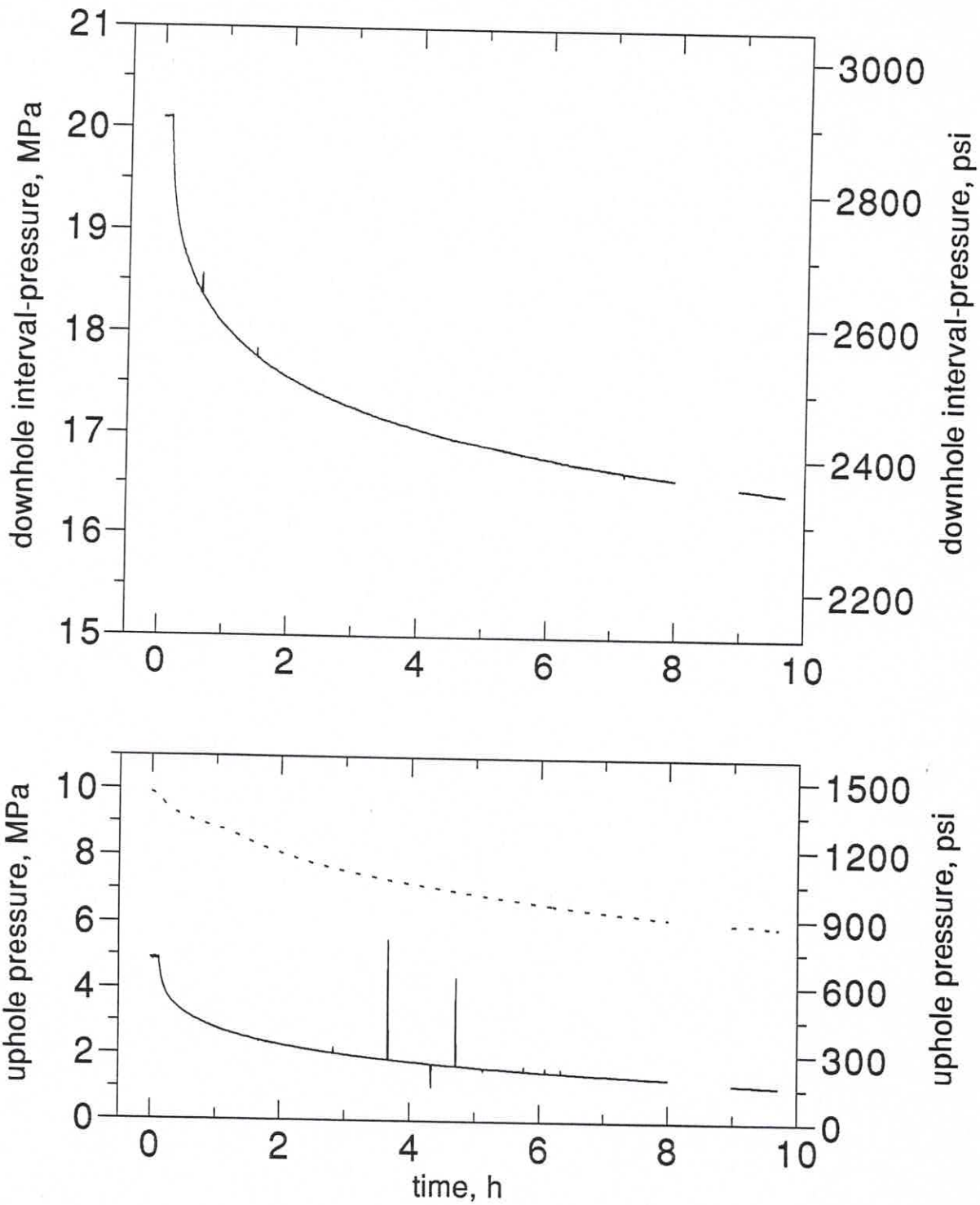
CASED - HOLE TEST 4 AT 1481.5 m
main injection test
file: 1481CH01.DAT
start: 02.06.1995, 14.42 end: 02.06.1995, 22.25



MeSy GEO-Meß-Systeme GmbH

CASED - HOLE TEST 4 AT 1481.5 m
main fall-off test
files: 1481CH02.DAT, 1481CH03.DAT
start: 02.06.1995, 22.27 end: 03.06.1995, 08.42



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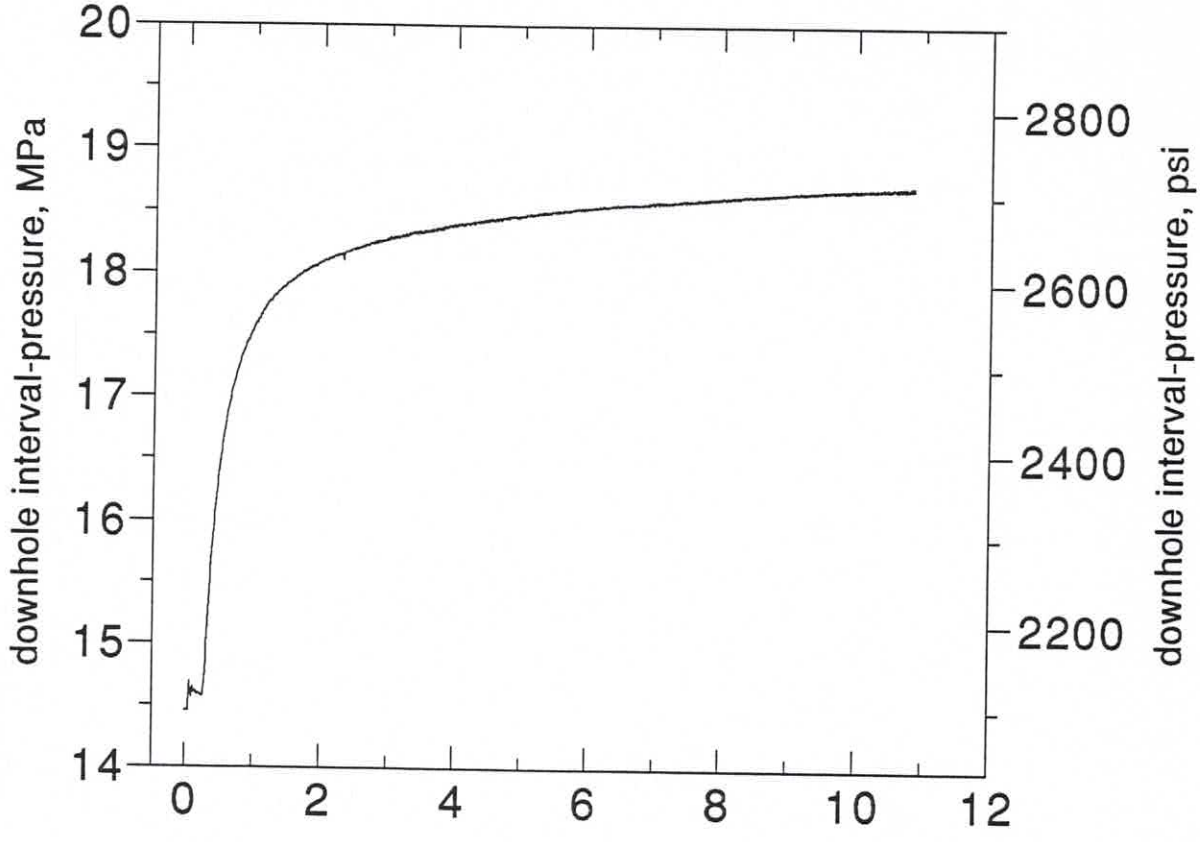
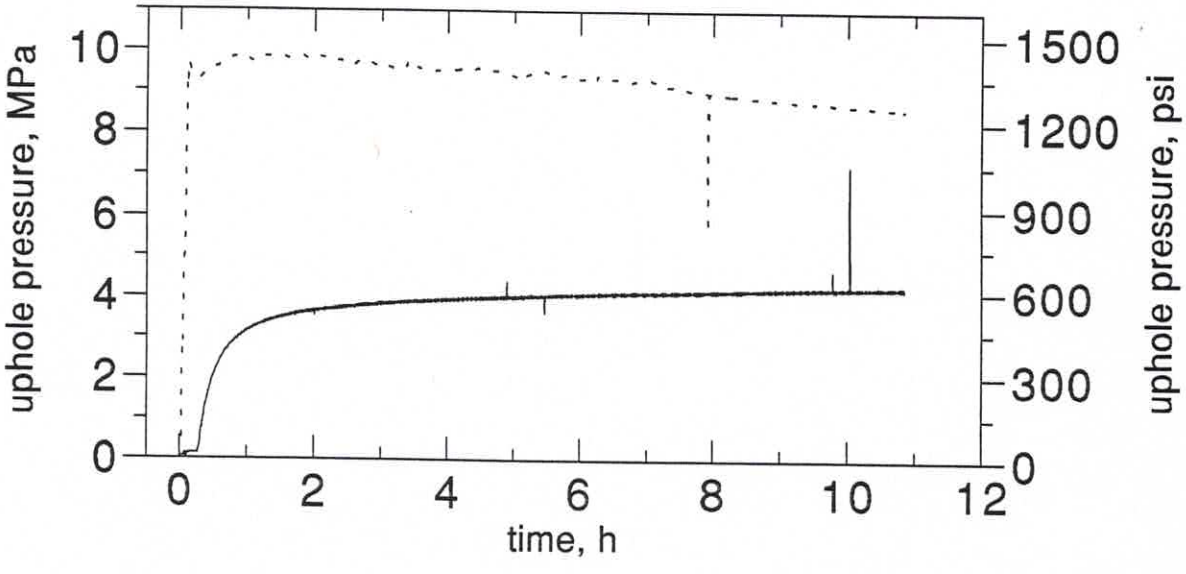
CASED - HOLE TEST 5 AT 1400.5 m
main injection test
files: 1400CH01.DAT, 1400CH02.DAT
start: 03.06.1995, 11.08 end: 03.06.1995, 22.03





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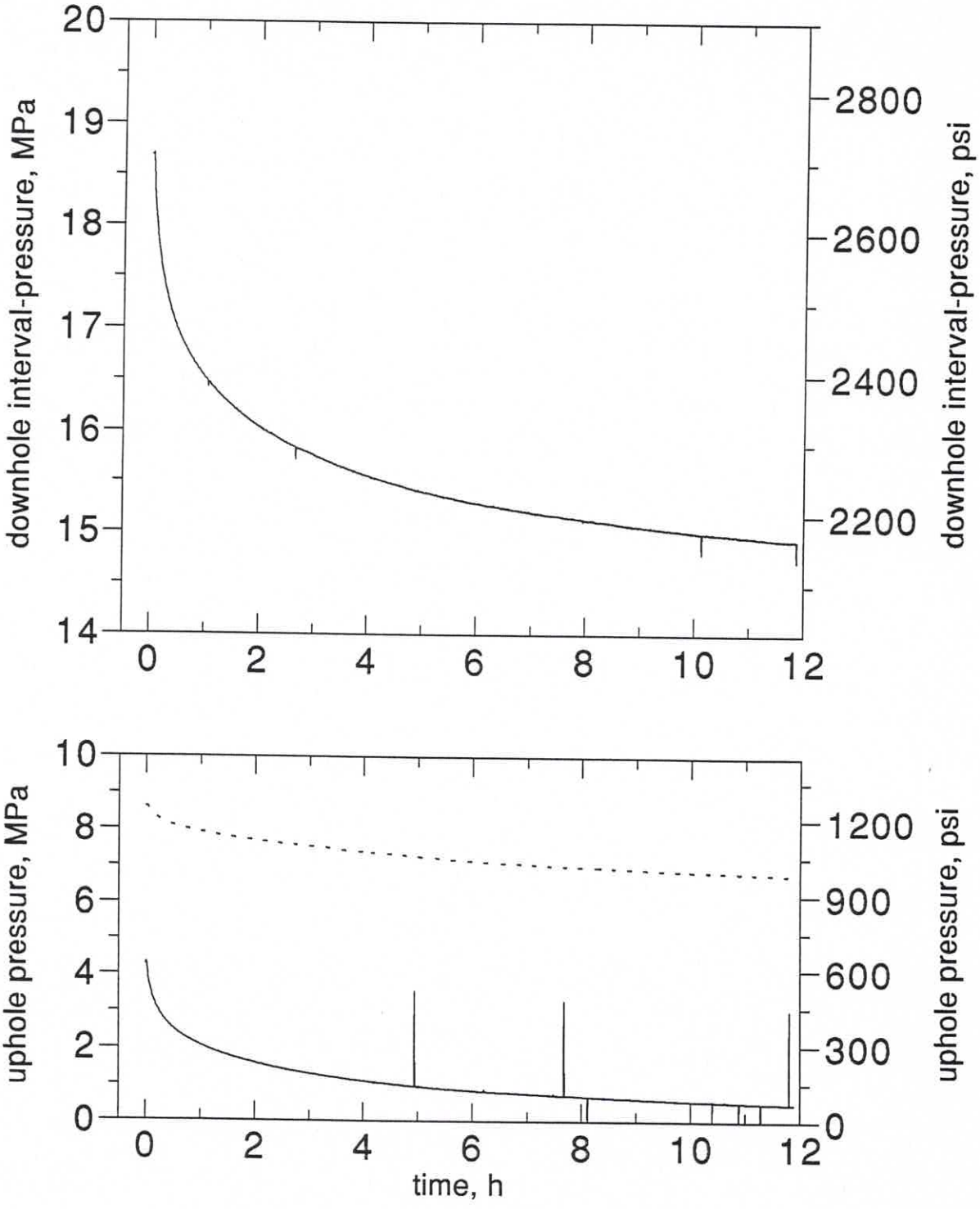
CASED - HOLE TEST 5 AT 1400.5 m
main fall-off test
file: 1400CH03.DAT
start: 03.06.1995, 22.03 end: 04.06.1995, 09.55



APPENDIX B

Overview - Plots of

Frac / Step - Rate - Tests

remarks: data were not corrected with respect to power supply induced noise

downhole pressure curves:
lower curve: interval pressure
upper curve: packer pressure

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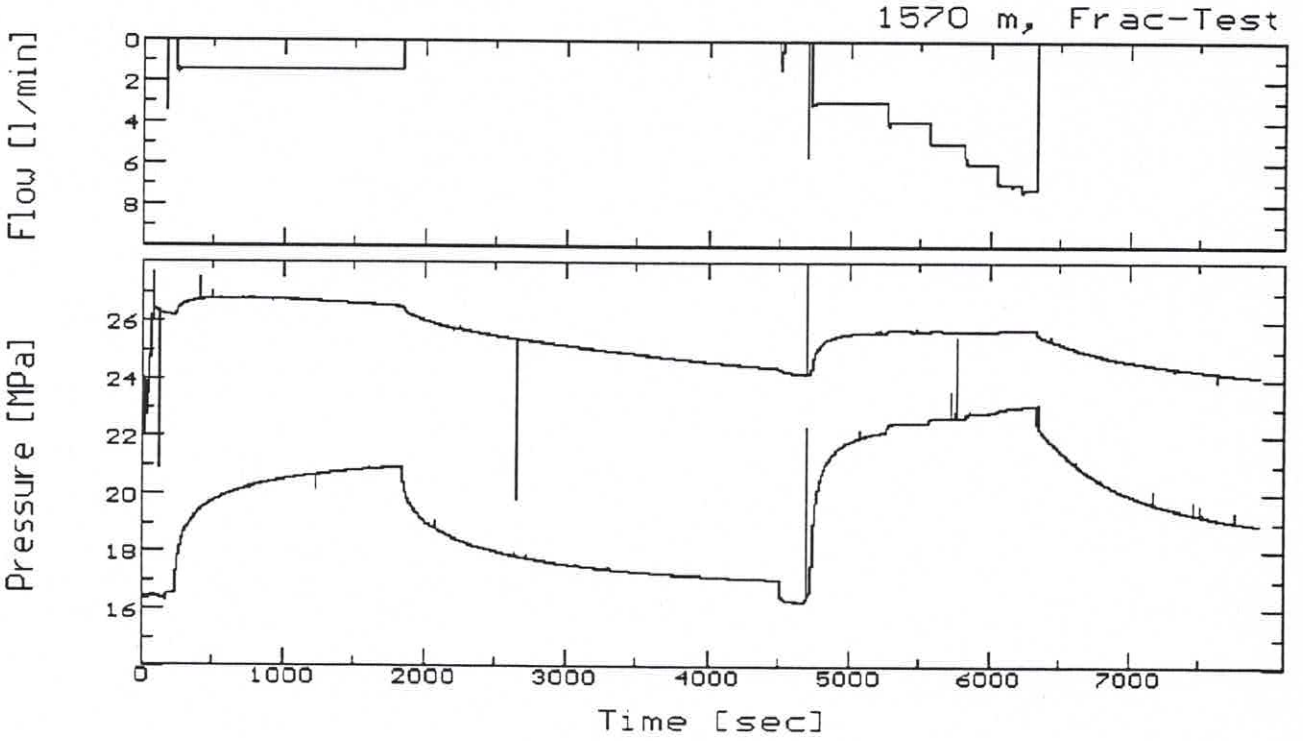
CASED - HOLE TEST 1 AT 1570.0 m

Frac / Step - Rate Test

file: 1570.DAT



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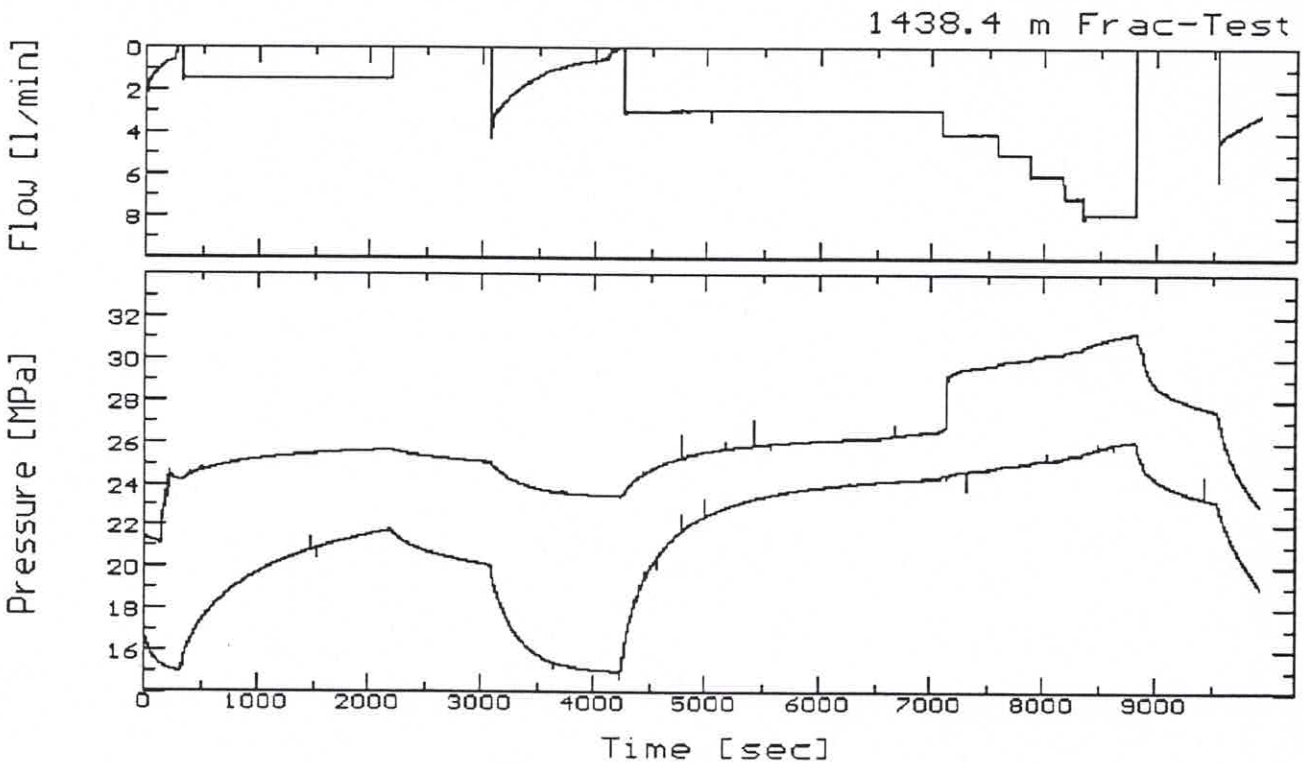
CASED - HOLE TEST 2 AT 1438.4 m

Frac / Step - Rate Test

file: 1438.DAT



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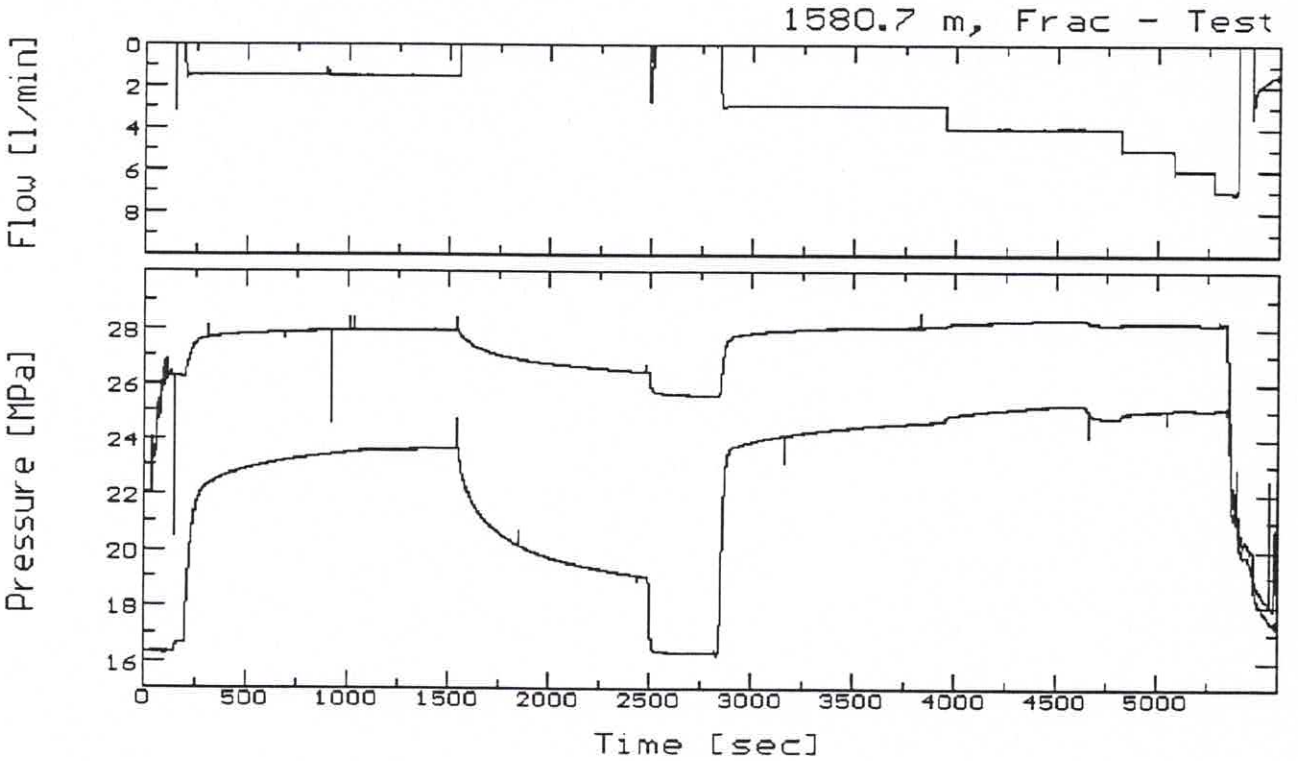
CASED - HOLE TEST 3 AT 1580.7 m

Frac / Step - Rate Test

file: 1580.DAT



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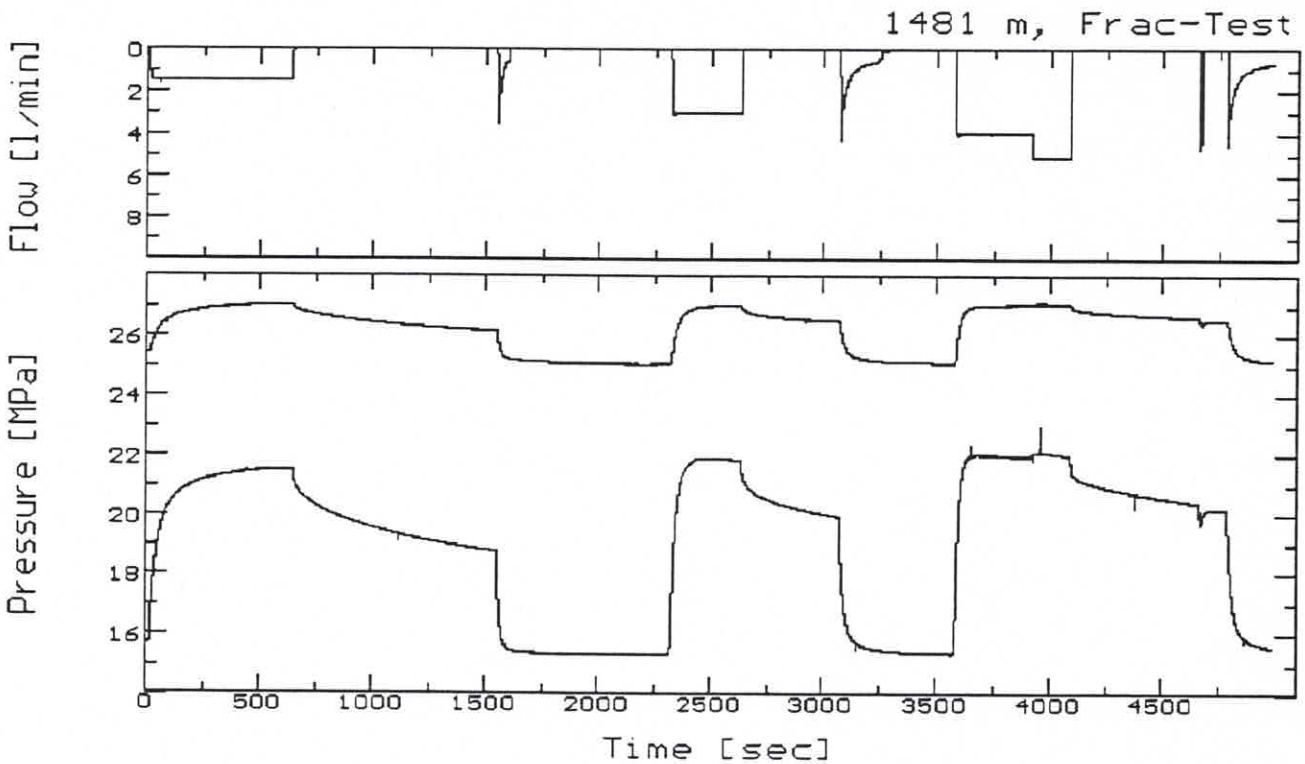
CASED - HOLE TEST 4 AT 1481.5 m

Frac / Step - Rate Test

file: 1481.DAT



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CASED - HOLE TEST 5 AT 1400.5 m

Frac / Step - Rate Test

file: 1400.DAT