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Division of Geothermal and Hydropower Technologies
Washington, D.C. 20585

APPENDIX G - Presentation 7

Topic: Hot Dry Rock Technology

Speaker: Bob Potter (LASL)

DISCLAIMER

Workover Operations - Present Status

Fenton Hill 1982
(Phase II)

by

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G-3, 6-4

Introduction

The Los Alamos National Laboratory for the past decade has been investigating methods to obtain high grade thermal energy contained in deep hot impermeable crystalline rock. This program involves the drilling of wellbores into the geothermal resource and then creating the needed heat removal fracture system by means of hydraulic fracturing. An experimental site (Fenton Hill) has been established on the west flank of the dormant Jemez volcanic structure located in New Mexico ∿35 miles to the west of Los Alamos. The initial phase of the program was successful in demonstrating the concept by means of experiments conducted on fracture systems created from two deep wellbores. This initial success has led to a second phase. Two additional wellbores have been drilled at Fenton Hill to greater depths into rock with temperatures greater than 300°C. At the present time we are attempting to create the necessary fracture systems.

Workover Operations

Fenton Hill 1982

(Phase II)

THREE-STAGE DEVELOPMENT PLAN

1. DRILLING OF WELLS EE-2 AND EE-3
2. INTERIM SYSTEM COMPLETION AND OPERATION
3. FINAL SYSTEM COMPLETION AND OPERATION

Workover Goals

Establish an Interim System

Study Various Methods of Fracturing

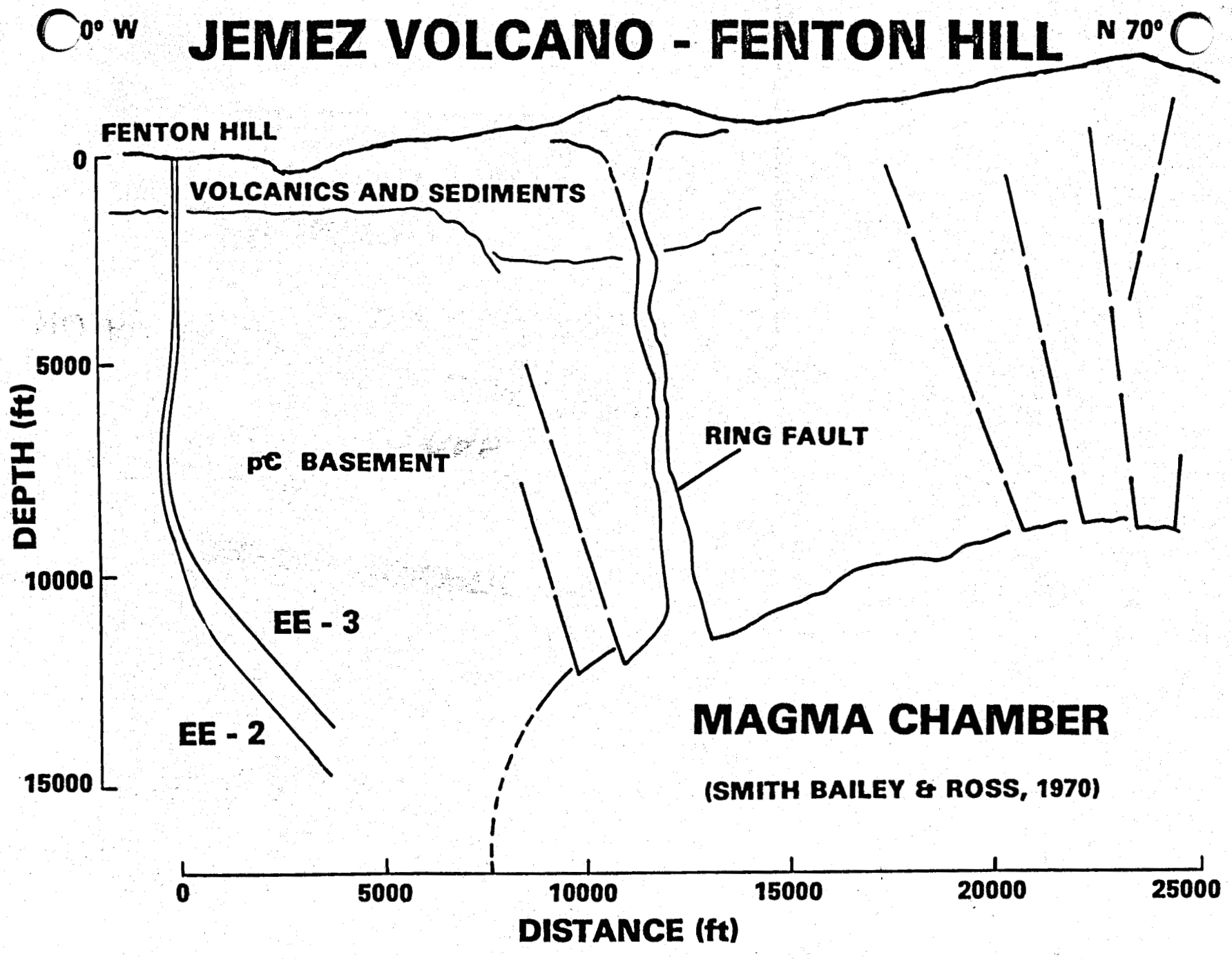
Learn How to Work With Inclined, Deep, Hot Wellbores

EXPECTED TECHNOLOGY CONTRIBUTIONS FROM INTERIM PHASE II SYSTEM

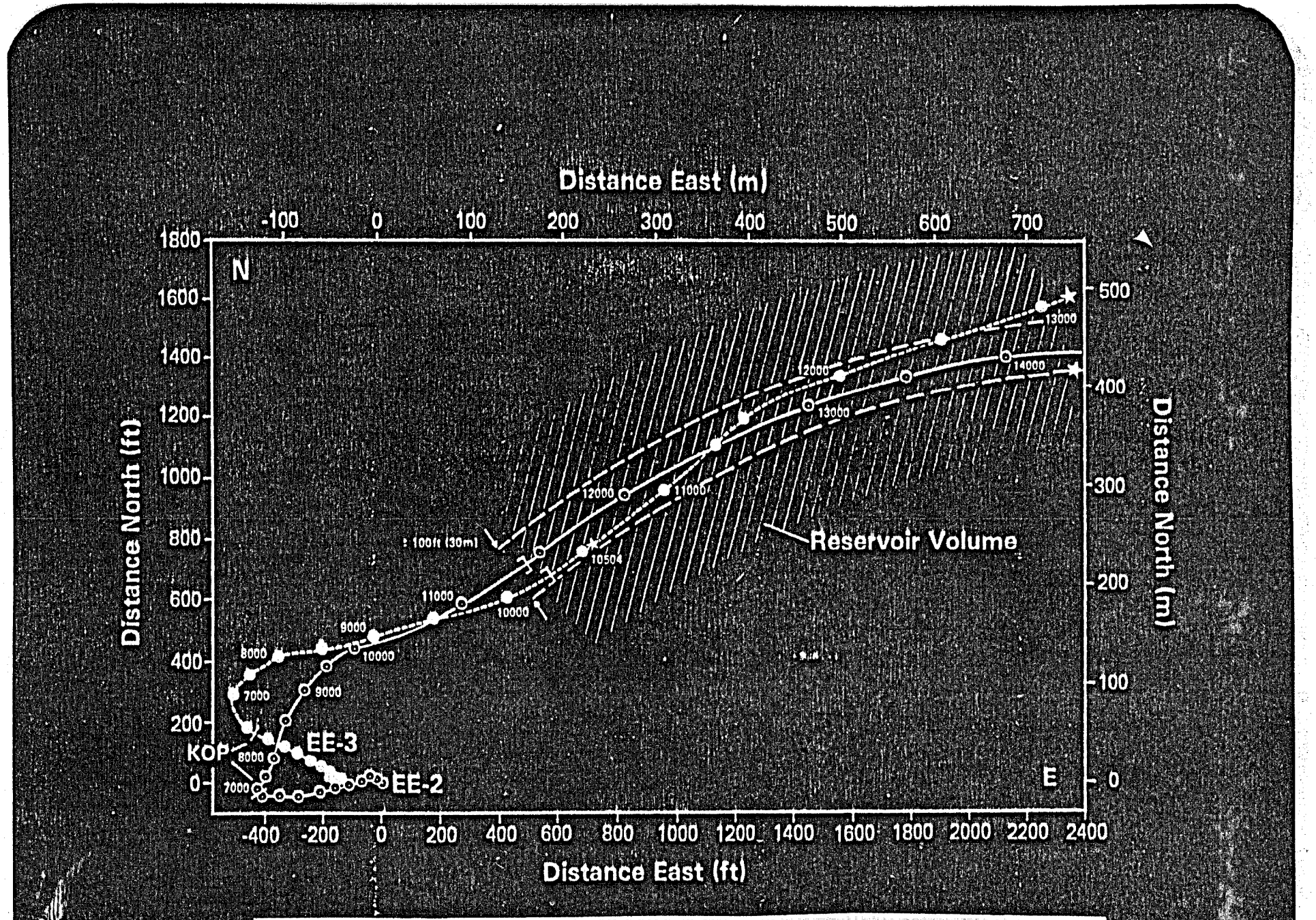
- SHORT-TERM INDICATIONS OF
  - HYDRAULIC STABILITY
  - IMPEDANCE VARIATION
  - WATER LOSS RATE VARIATION
  - GEOCHEMICAL EFFECTS
- MEASURABLE TEMPERATURE DRAWDOWN TO CALIBRATE SECONDARY SIZE-ASSESSMENT TECHNIQUES
- PRELIMINARY DATA ON REPETITIVE FRACTURING TECHNIQUE (FOR APPLICATION TO FINAL SYSTEM)

WORKOVER OPERATIONS

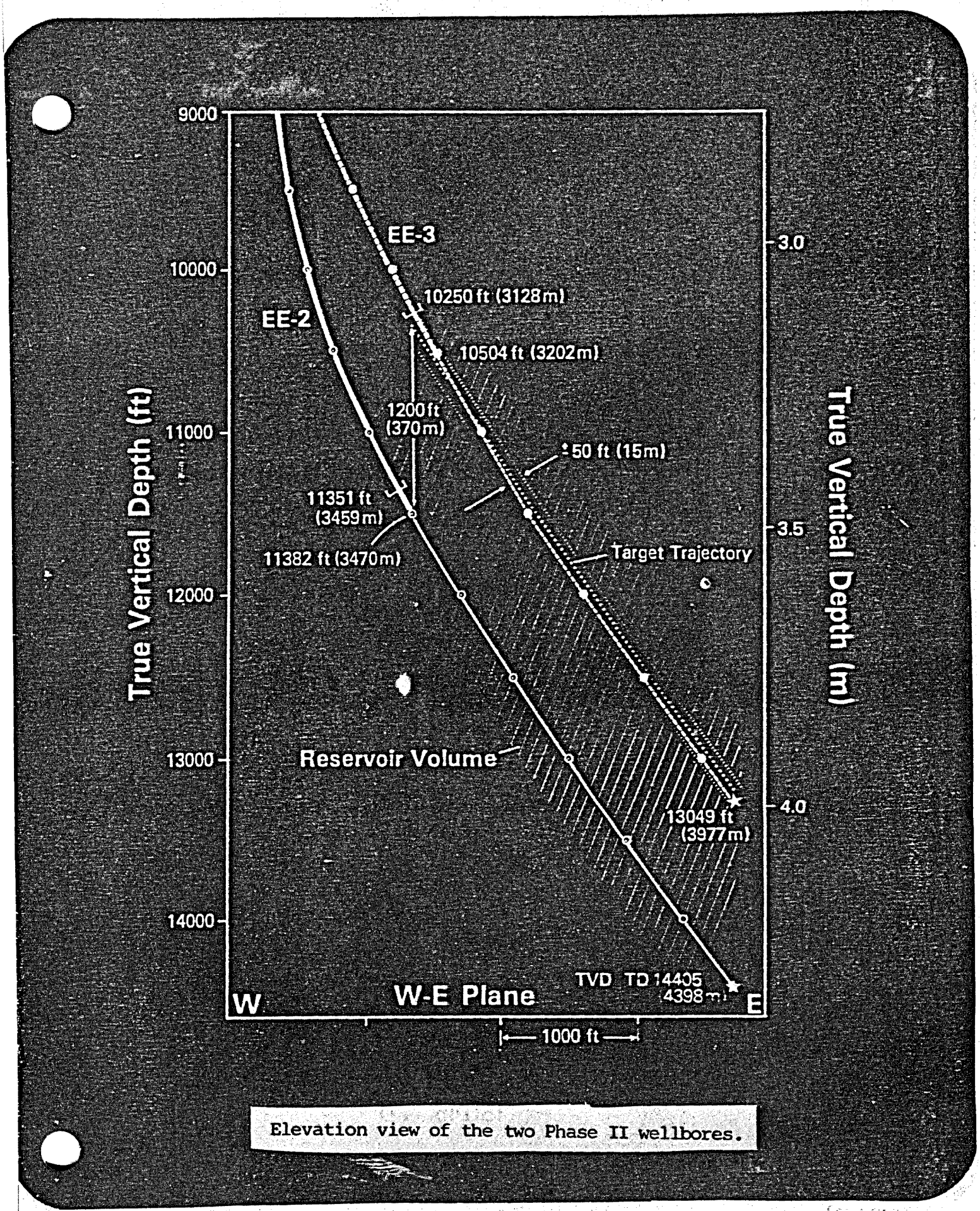
1	PREFRACTURE OPERATIONS	FISH, CLEANOUT, TORQUE TEST, RABBIT RUN, LOGGING, CEMENT TEST
2	EFI FRACTURE	SET OFF H.E.(~25#), PRESSURE AND DRIVE TO EE-3
3	PACKER TESTS	LYNES INFLATABLE PACKERS, SINGLE CONFIGURATION, TWO OR MORE TESTS.
4	LINER AND PBR INSTALLED	INSTALL SAND PLUG, CEMENT IN LINER AND PBR, MILL, HONE, WASH OUT SAND
5	PRESSURE FRACTURE	RUN IN 4 1/2 FRAC. STRING, STAB IN PBR, PRESSURE UP TO FRACTURE, DRIVE TO EE-3
6	THERMAL FRACTURE	CHILL DOWN OPEN HOLE TO 150 °C PRESSURE UP, AND DRIVE TO EE-3
7	PERFORATION FRACTURE	SET BRIDGE PLUG, PRESSURE UP, DRIVE TO EE-3 , TREAT PERF.
8	SHUTDOWN	DRILL OUT BRIDGE PLUG (S), WASH OUT SAND, POH, DEMOB.



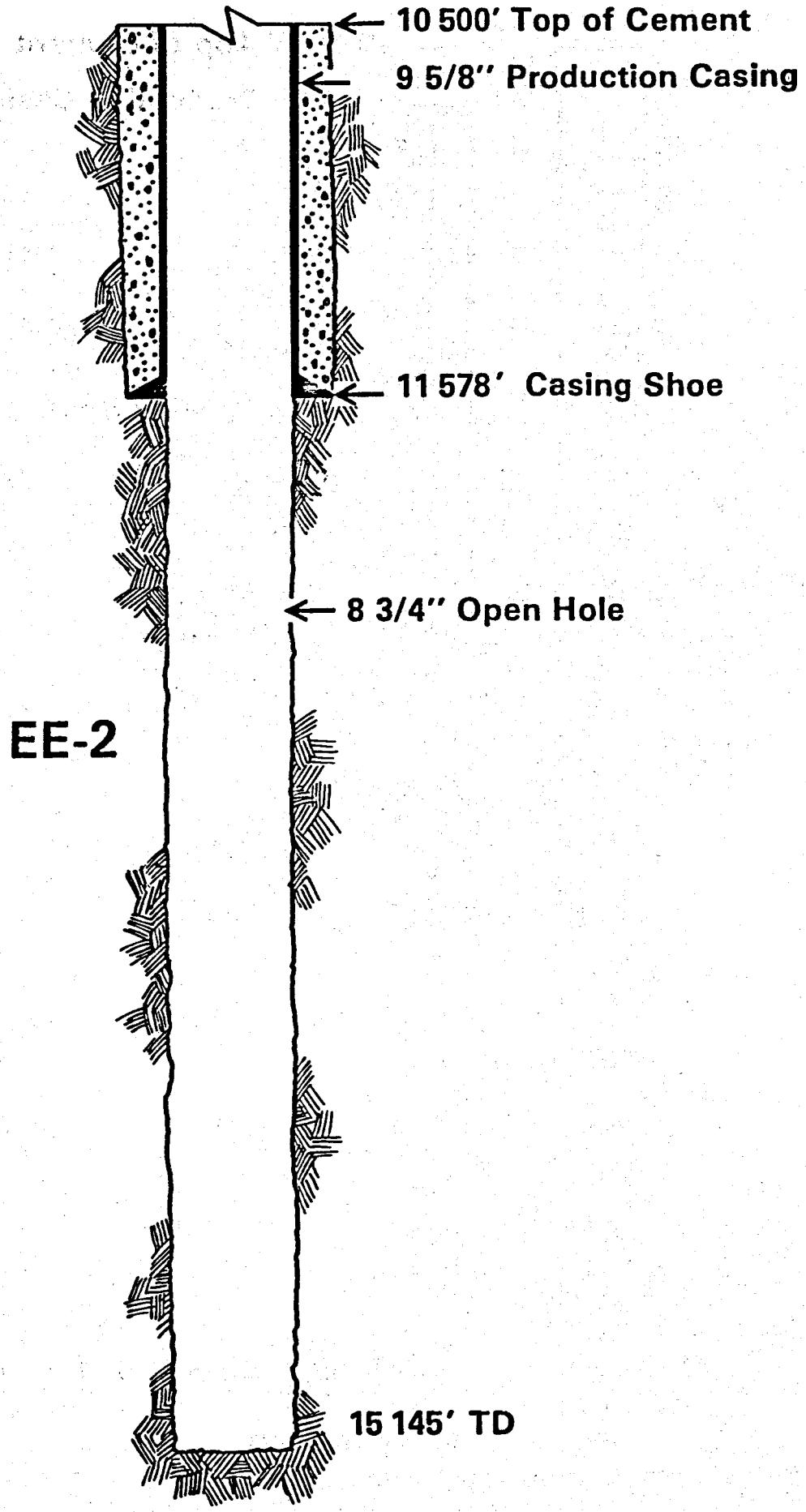
Cross section showing location of the Phase II system as related to the volcanic structure.



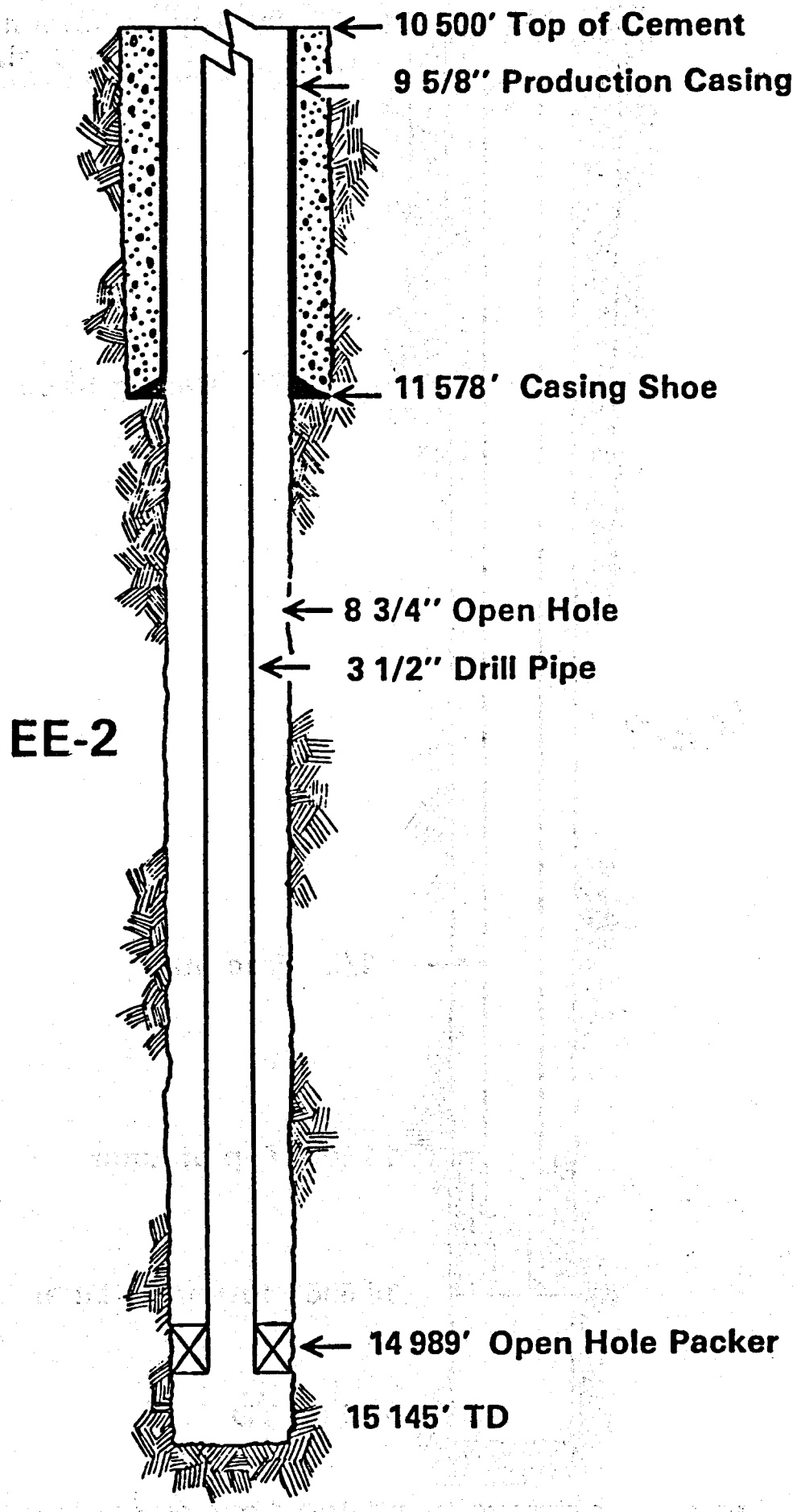
Plan view of the several wells drilled at the Fenton Hill site. Depths in feet are indicated along the wellbore traces.



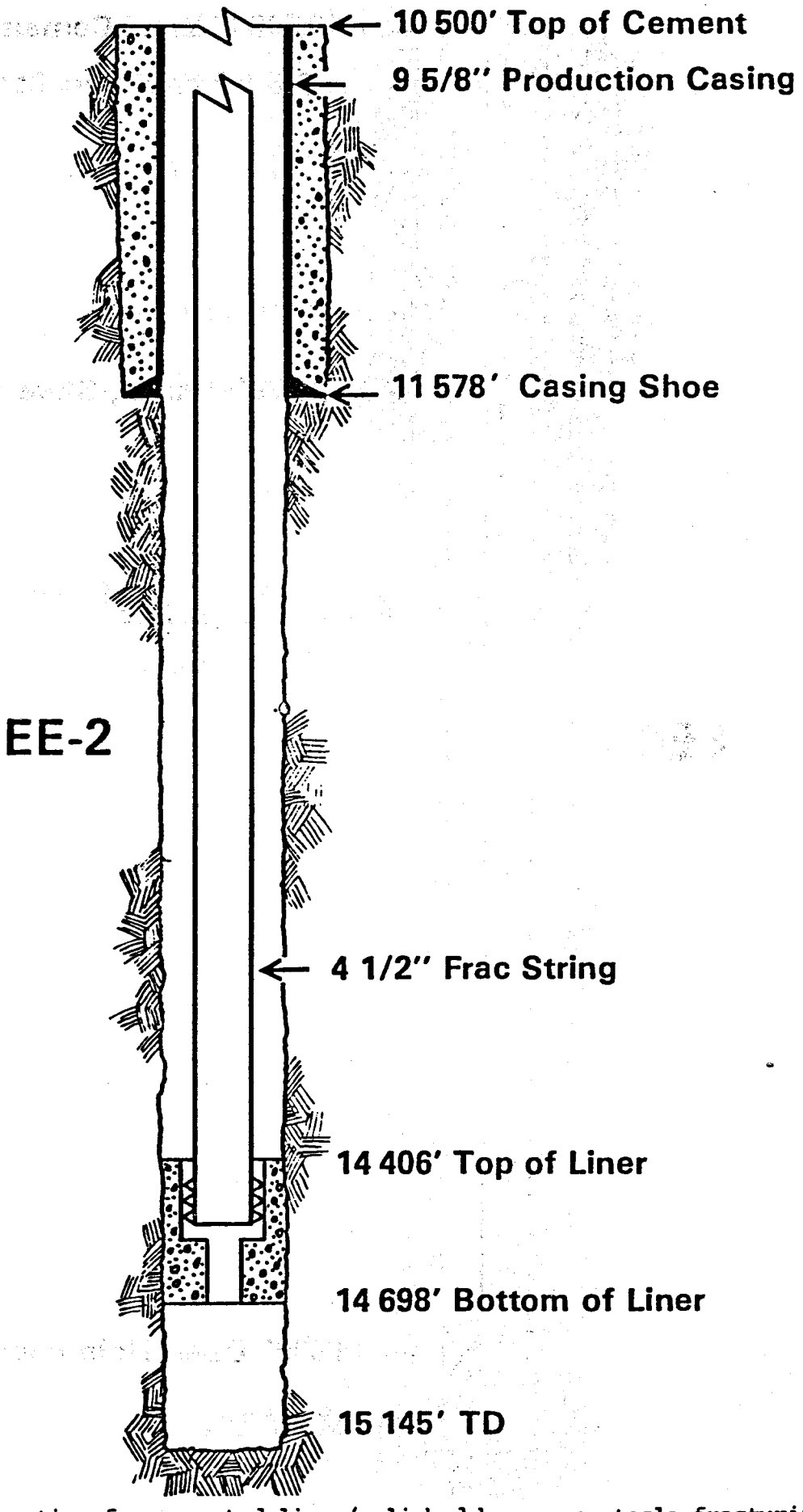
Elevation view of the two Phase II wellbores.



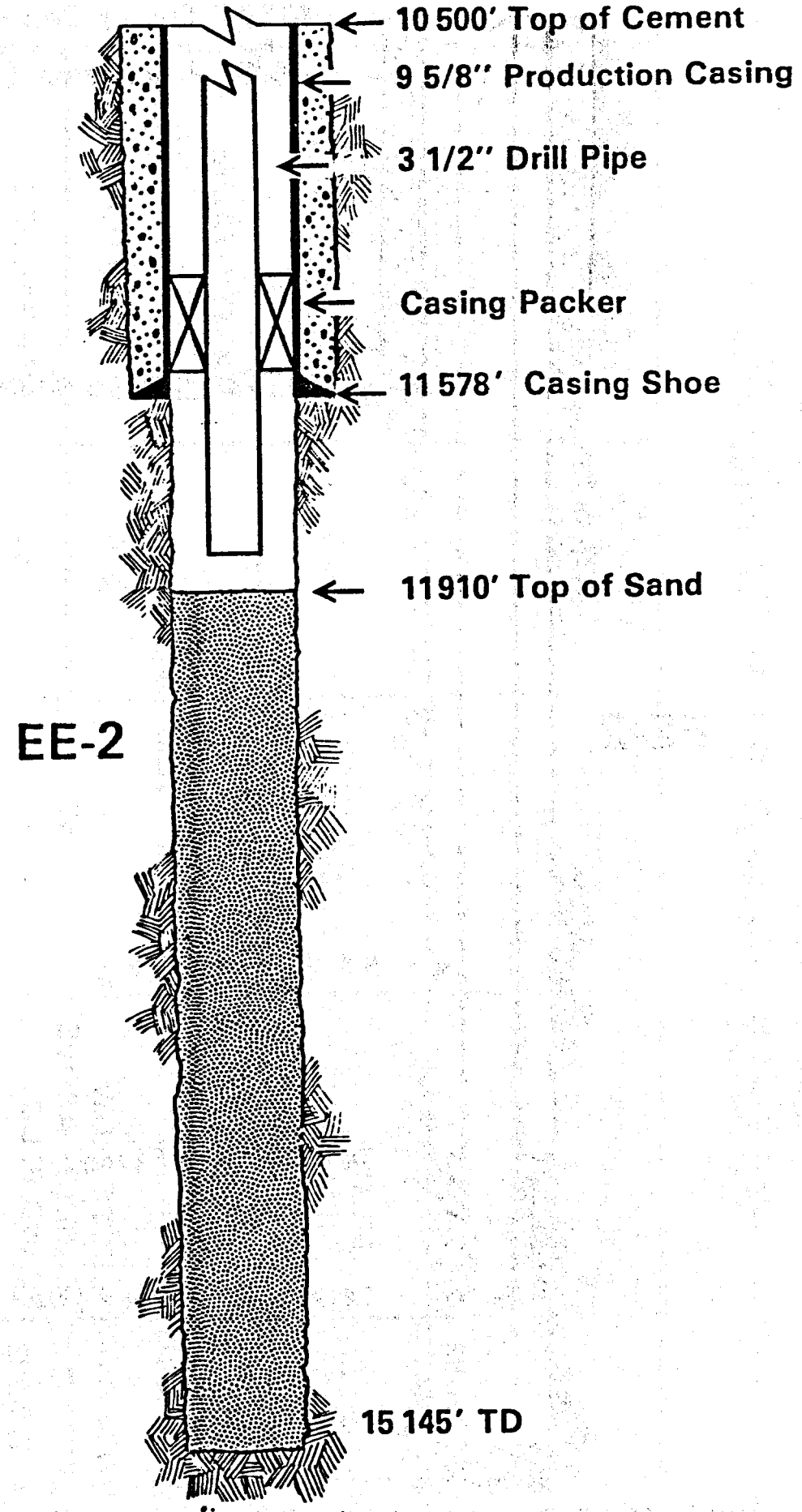
EE-2 openhole section as completed (actually inclined to ∿35° from the vertical.



EE-2 configuration for packer test.



EE-2 configuration for cemented liner/polished bore receptacle fracturing test (lower zone).



EE-2 configuration for casing packer/sand plug fracturing tests (upper zone).

SUMMARY OF MAJOR FRACTURING EXPERIMENTS

DATE	LOCATION IN WELL EE-2	FRACTURING PRESSURE (psi)	VOLUME PUMPED (10^3 GAL)	REASON FOR TERMINATION
5/30/82	BELOW PBR/LINER ASSEMBLY	5450	130	PUMPING EQUIPT. BREAKDOWNS
6/4/82			800	SCHEDULED SHUTDOWN. SEALS FAILED ON RESTART
6/20/82			1,300	MASTER VALVE LEAK
7/19-20/82	JUST BELOW CASING , ABOVE SAND PLUG	4500	240	PIPE FAILURE
7/24/82			11	PIPE FAILURE
10/6-7/82			840	PIPE FAILURE

INTERIM SYSTEM COMPLETION

- CURRENTLY IN PROGRESS
- SEVERAL FRACTURES INITIATED IN EE-2
- CONNECTION WITH EE-3 NOT YET ESTABLISHED
  - MULTIPLICITY OF OPERATIONAL PROBLEMS IN THIS UNIQUE ENVIRONMENT
  - UNEXPECTED LITHOLOGIC BEHAVIOR OF PHASE II RESERVOIR FORMATION

Major Problems During Workover Operations

1. High fracturing pressure $\geq$ 4500 psi
2. Logging difficulties
3. Evolution of gasses (CO_2 and H_2S)
4. Failure of commercially obtained equipment

CONTINUATION PLANS FOR INTERIM SYSTEM

- PROCURE CORROSION RESISTANT FRAC STRING
- RESUME WORKOVER OPERATIONS CIRCA 20 - 30 OCT
  - CLEANOUT RUNS
  - EMPLACE MODIFIED CASING PACKER
  - COMPLETE 2-TO-3 FRACTURE CONNECTIONS BY PUMPING UPPER REGION THROUGH NEW FRAC STRING
  - INSTALL OPERATIONAL STRING AND DISMISS RIG
- CONNECT SURFACE SYSTEM OF FLOW LOOP
- CONDUCT EVALUATIVE FLOW TESTS (~6 MO.)