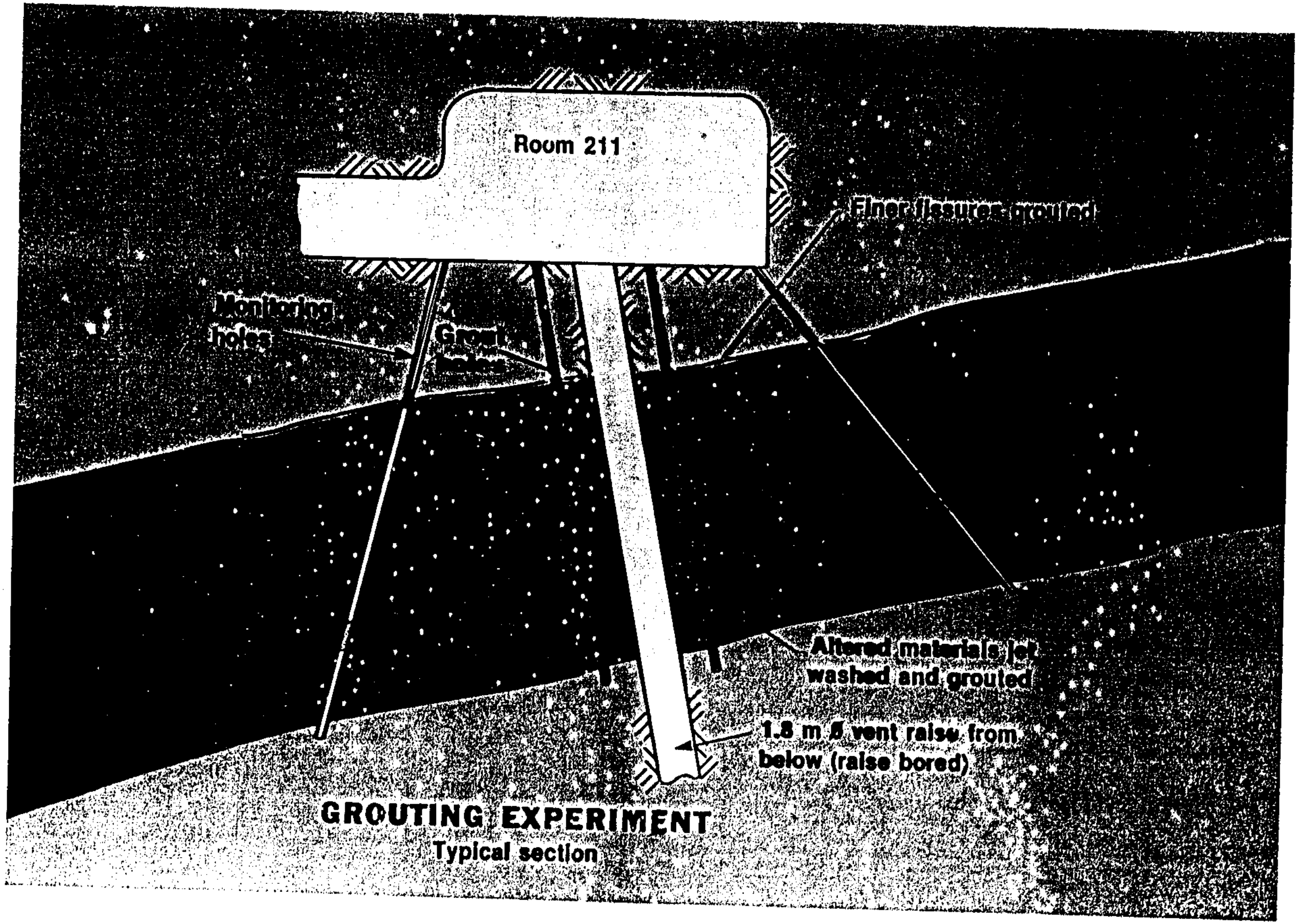
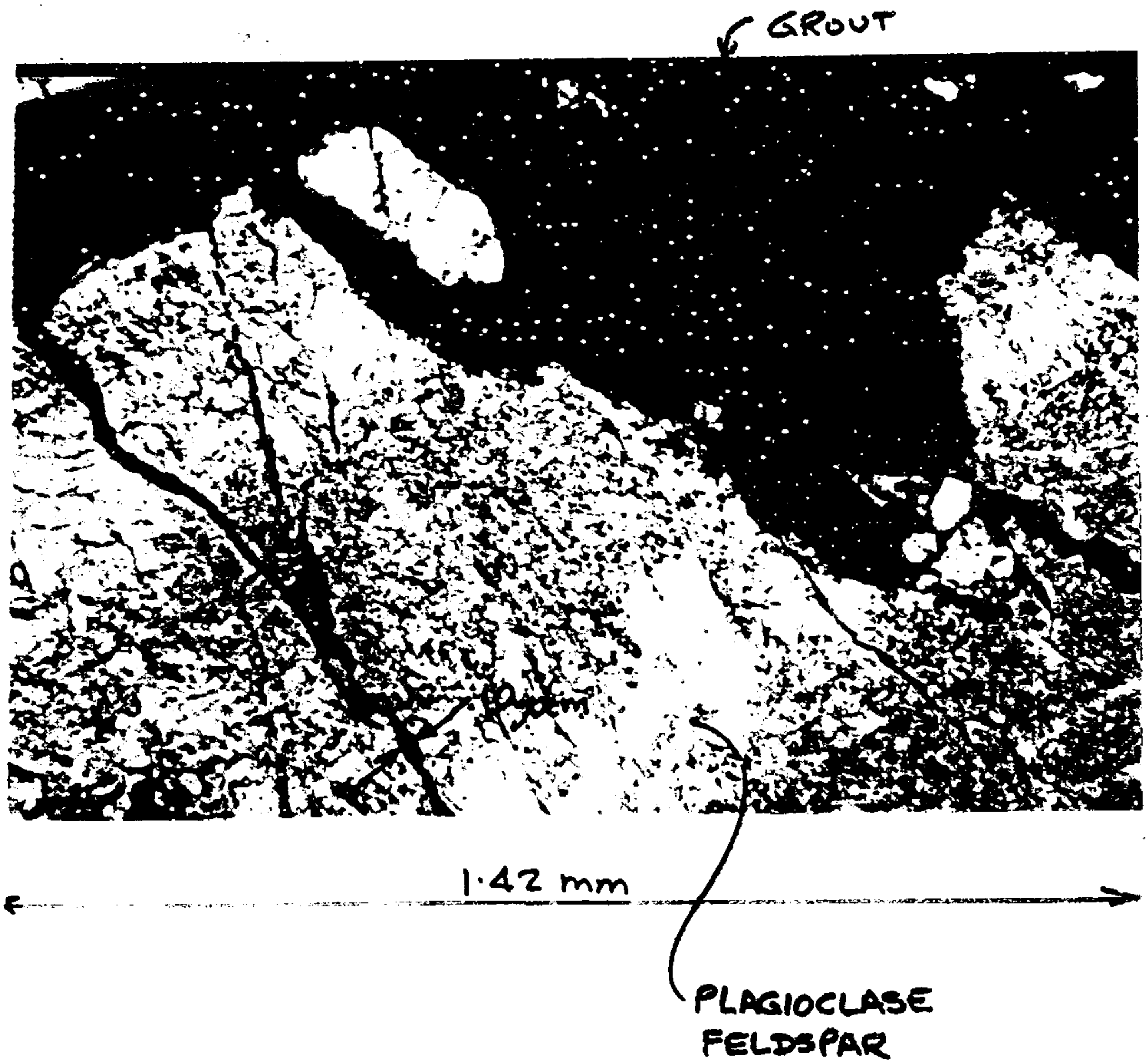
OBJECTIVES OF LARGE-SCALE IN SITU TESTING

- EXAMINE M-H-T INTERACTIONS
- GAIN EXPERIENCE IN EVALUATING ROCK BOUNDARY CONDITIONS AND INSTALLATION AND PERFORMANCE OF INSTRUMENTS AND LARGE VOLUMES OF SEALING MATERIALS
- EVALUATE MATHEMATICAL MODELS AGAINST OBSERVED BEHAVIOUR

STRIPA PHASE	ISSUES ADDRESSED			
	ENGINEERING FEASIBILITY	LABORATORY STUDIES OF MATERIAL PROPERTIES & BEHAVIOUR	NUMERICAL MODELLING OF SYSTEM PERFORMANCE	*IN SITU* OBSERVATIONS FOR DESIGN DEVELOPMENT
Phase 1 (1980 to 1985)	° Borehole drilling ° Buffer placement ° Backfill placement	° Buffer swelling ° Buffer K & α ° Clay longevity	° Hygro-thermo-mechanical properties of buffer & backfill	° Buffer/backfill/rock interactions
Phase 2 (1983 to 1988)	° Borehole sealing ° Shaft &tunnel plugs		° Isothermal water uptake by clay barriers ° Bentonite extrusion	° Water uptake by bentonite ° Hydro-mechanical interactions between clay/concrete/rock
Phase 3 (1986 to 1992)	Grouting: ° fracture zones ° moderately fractured rock ° excavation disturbed zones	Clay & cement grouts: ° rheology ° sealing properties ° longevity	° Water flow in grouted rock ° Grout penetration ° Rock movement ° Cement longevity	° Limits of sealing by grouting ° Morphology of injected grouts ° Effects of heat on grouted rock



GROUTING EXPERIMENT
Typical section



STO 19

In Situ Hydraulic Conductivity Test Results

URL Shaft

Property	GH1		GH2		HC9	
	Before	After	Before	After	Before	After
Transmissivity (m^2/s)	$3.2*10^{-7}$	$1.0*10^{-8}$	$4.2*10^{-7}$	$5.7*10^{-9}$	$1.5*10^{-5}$	$1.1*10^{-}$
Equivalent single fracture aperture (μ m)	83.4	26.3	91.2	21.7	298	58
Hydraulic conductivity (m/s)	$4.0* 10^{-8}$	$1.2*10^{-9}$	$7.0* 10^{-8}$	$9.5* 10^{-10}$	$2.1* 10^{-6}$	1.6* 10

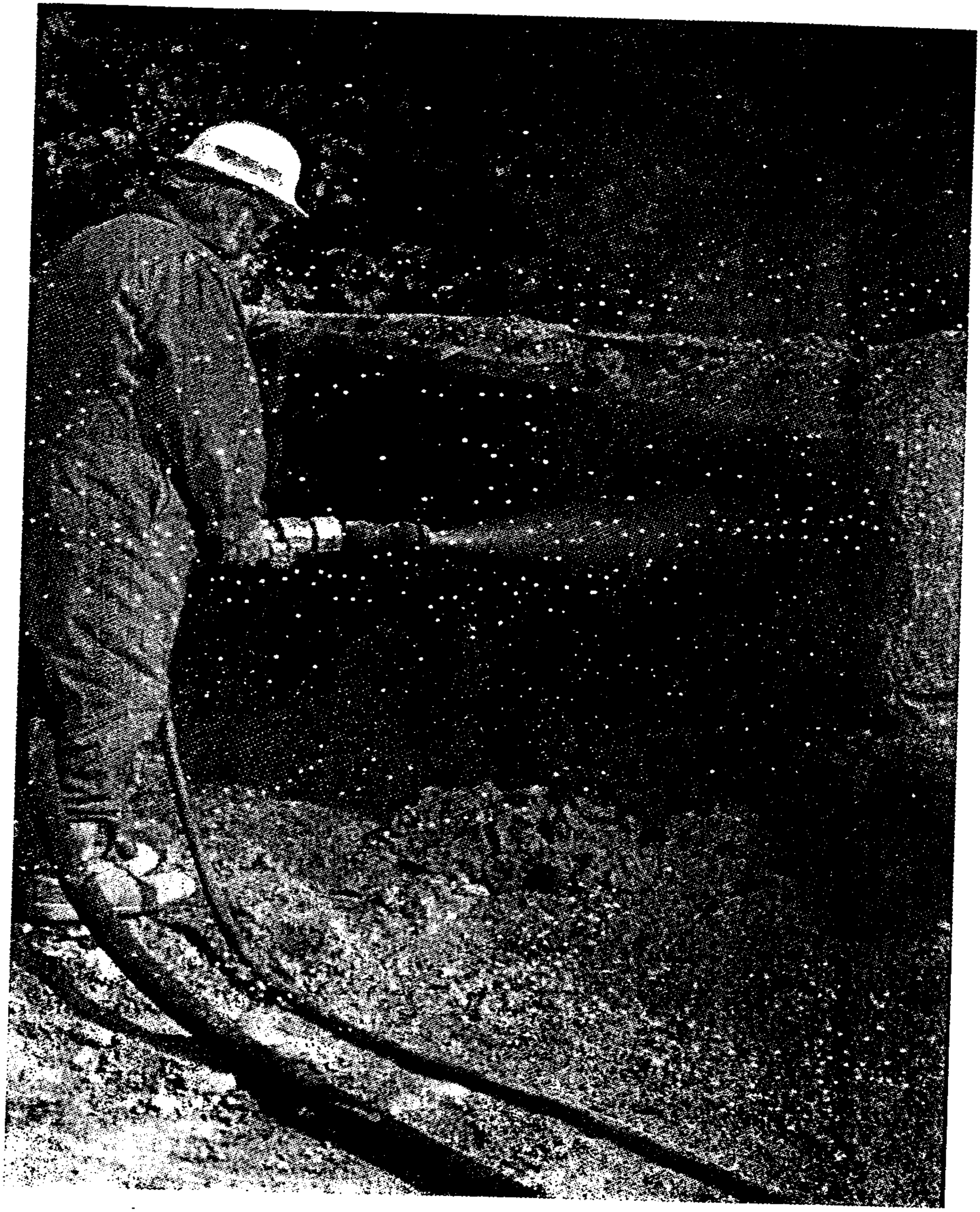
Notes: 1. Hydraulic conductivity is calculated using the total thicknesses of the fracture zone observed in the drillhole logs.

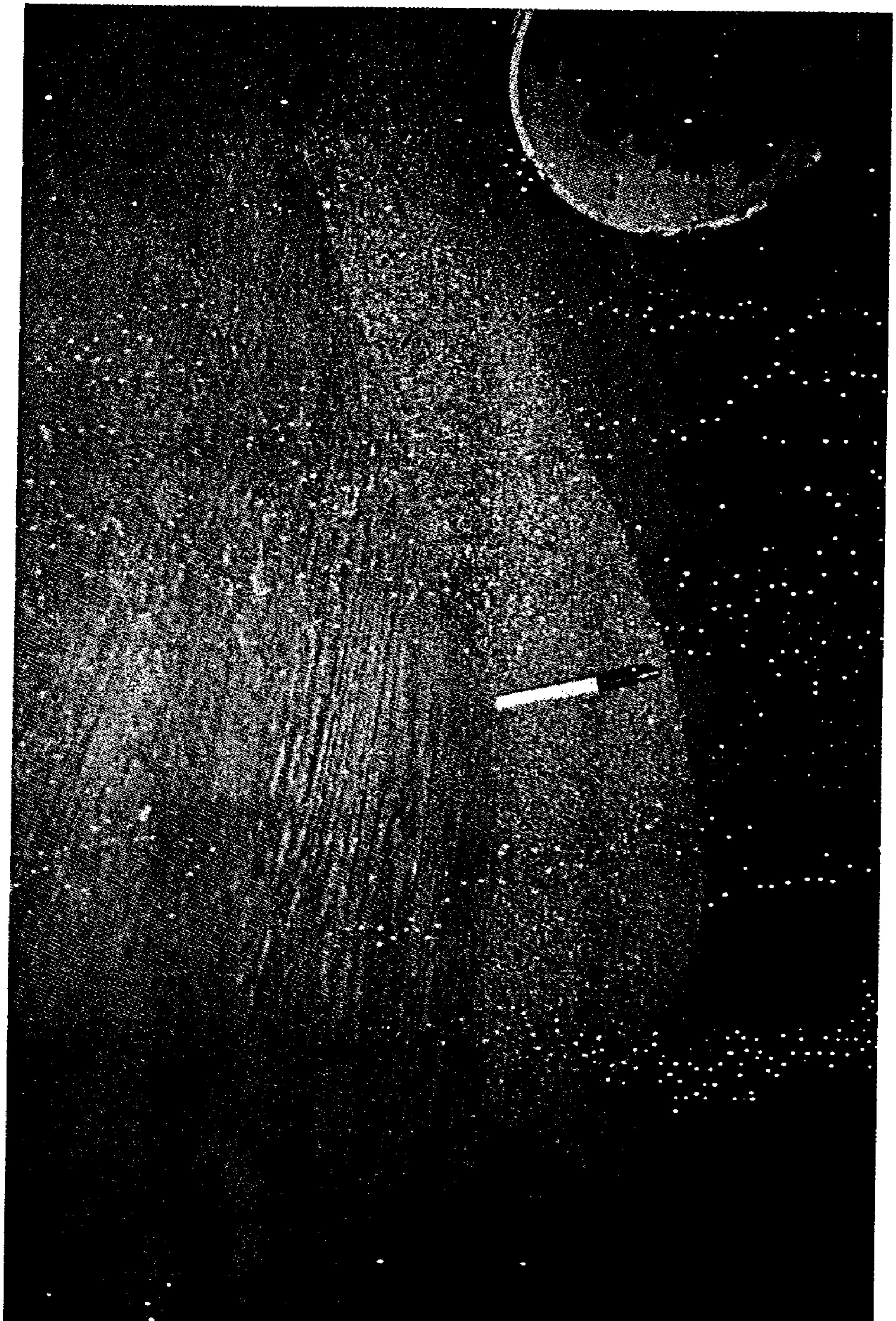
"SHOT- CLAY", WHAT IS IT ?

A Pneumatically Placed Bentonite or Bentonite/ Aggregate Material

Purposes:

- To fill cracks or voids not occupied by blocks
- To create a dense, level base for block placement
- Create tight contact with walls, roof
- can be trimmed as required
- To create a uniform, relatively low permeability wetting surface





"SHOT - CLAY" EXPERIENCE

Trial:

Clay - Aggregate mixtures placed using shotcreting technology.

Results:

Various mixtures of bentonite and aggregate were successfully placed

Materials: 25% to 70 % Bentonite

Bulk Densities	1.6 to 1.8 Mg/m3
Dry Densities	1.3 to 1.5 Mg/m3
Clay Densities	0.5 to >0.8 Mg/m3

"SHOT - CLAY"

Material Properties Expected

Hydraulic Conductivity:

Shot-Clay	5×10^{-12} to 1×10^{-10} m/s
Bulk Seal	1×10^{-12} to 1×10^{-13} m/s

Swelling Pressure:

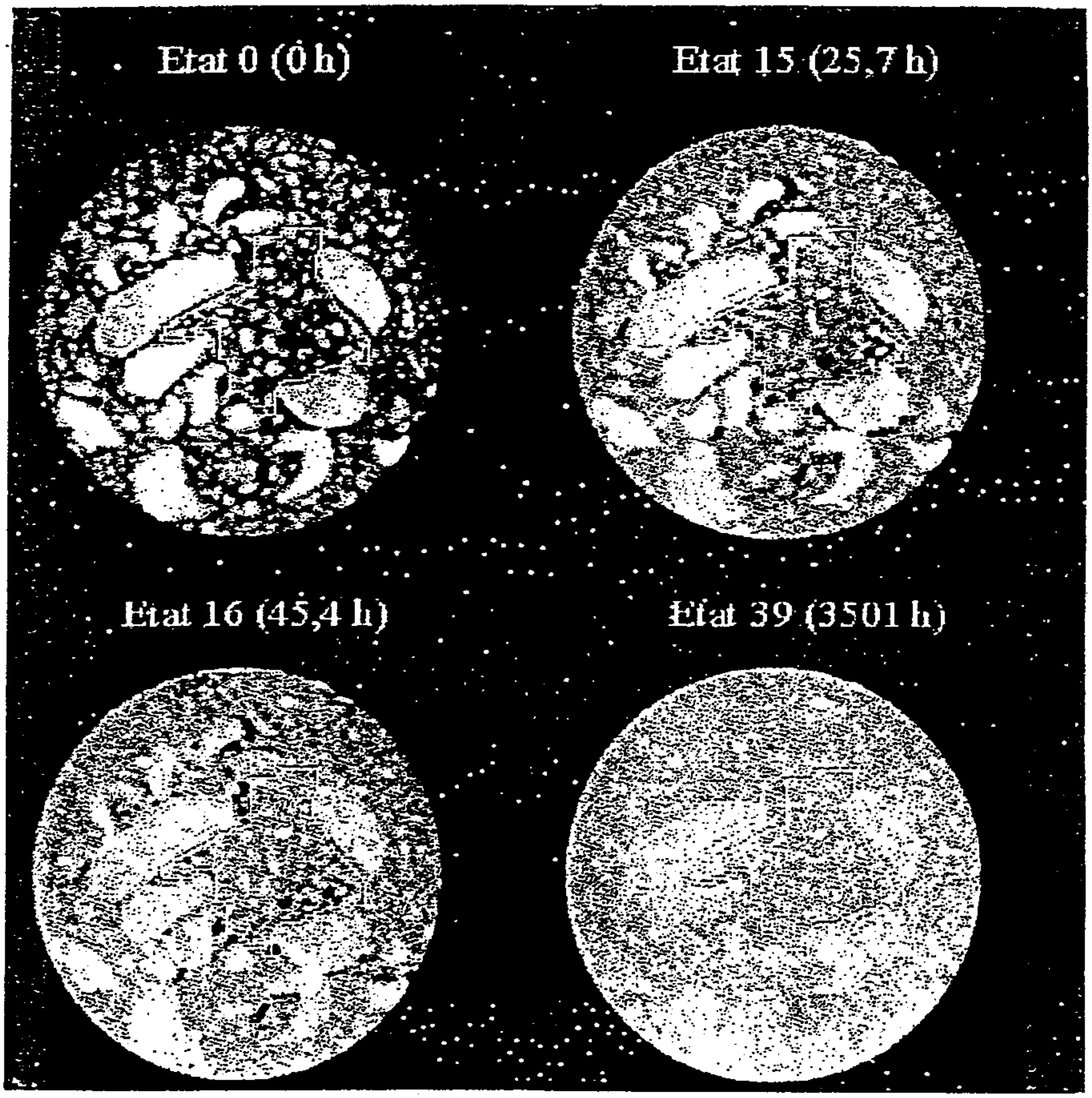
Shot-Clay	Kunigel VI Material	<	200	kPa
	Wyoming Material	<	600	kPa
Bulk Seal	Kunigel VI Material	>	600	kPa
	Wyoming Material	>	6000	kPa

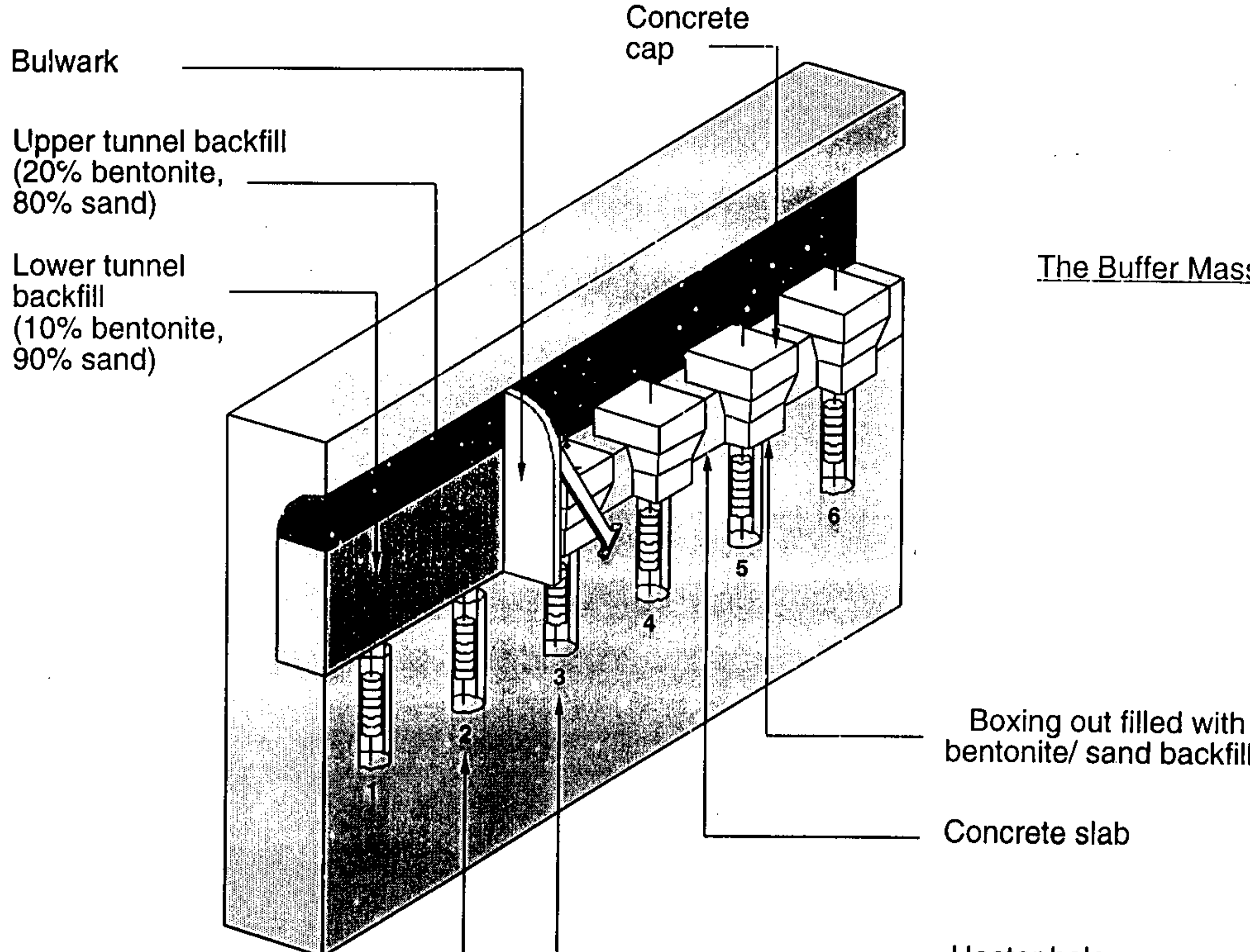
GRANULAR BACKFILL

- CEC STUDY (1) HAS DEMONSTRATED PREPARATION OF A GRANULAR BACKFILL OF HIGH DENSITY PELLETS MIXED WITH CLAY POWDER

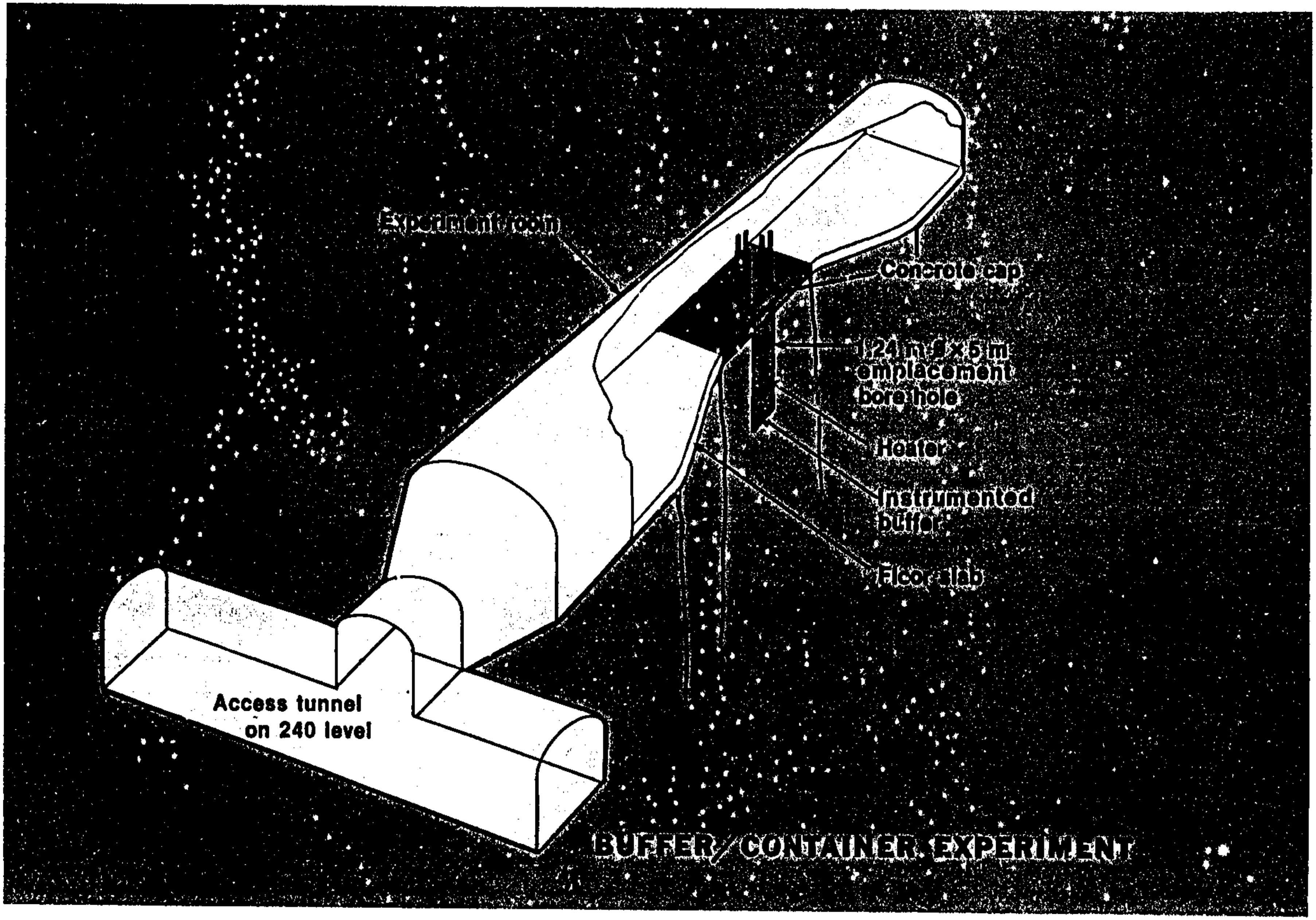
- EMPLACED DENSITY OF 1.7 Mg/m^3 ACHIEVED, WITH k OF 10^{-11} m/s

(1) G. Volckaert et al. (1995)
W & D 95/66/C072052/FB/mvo/P-27


Etat 0 (0 h)
Etat 15 (25,7 h)
Etat 16 (45,4 h)
Etat 39 (3501 h)



The Buffer Mass Test



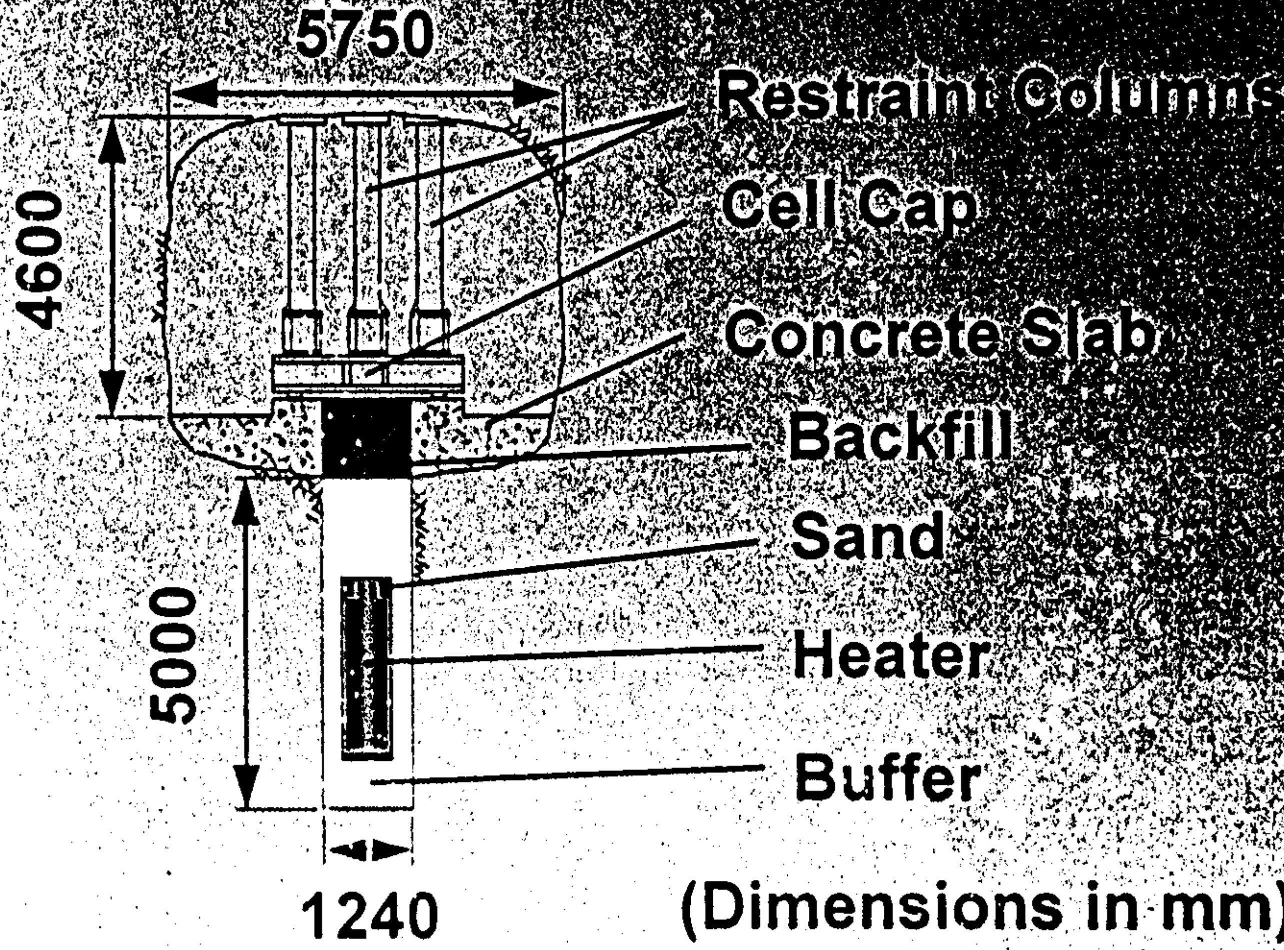
Experiment room
Concrete cap
1.24 m ø x 5 m
emplacement
bore hole
Heater
Instrumented
buffer
Floor slab
Access tunnel
on 240 level
BUFFER/CONTAINER EXPERIMENT

OBJECTIVES OF BUFFER-CONTAINER EXPERIMENT

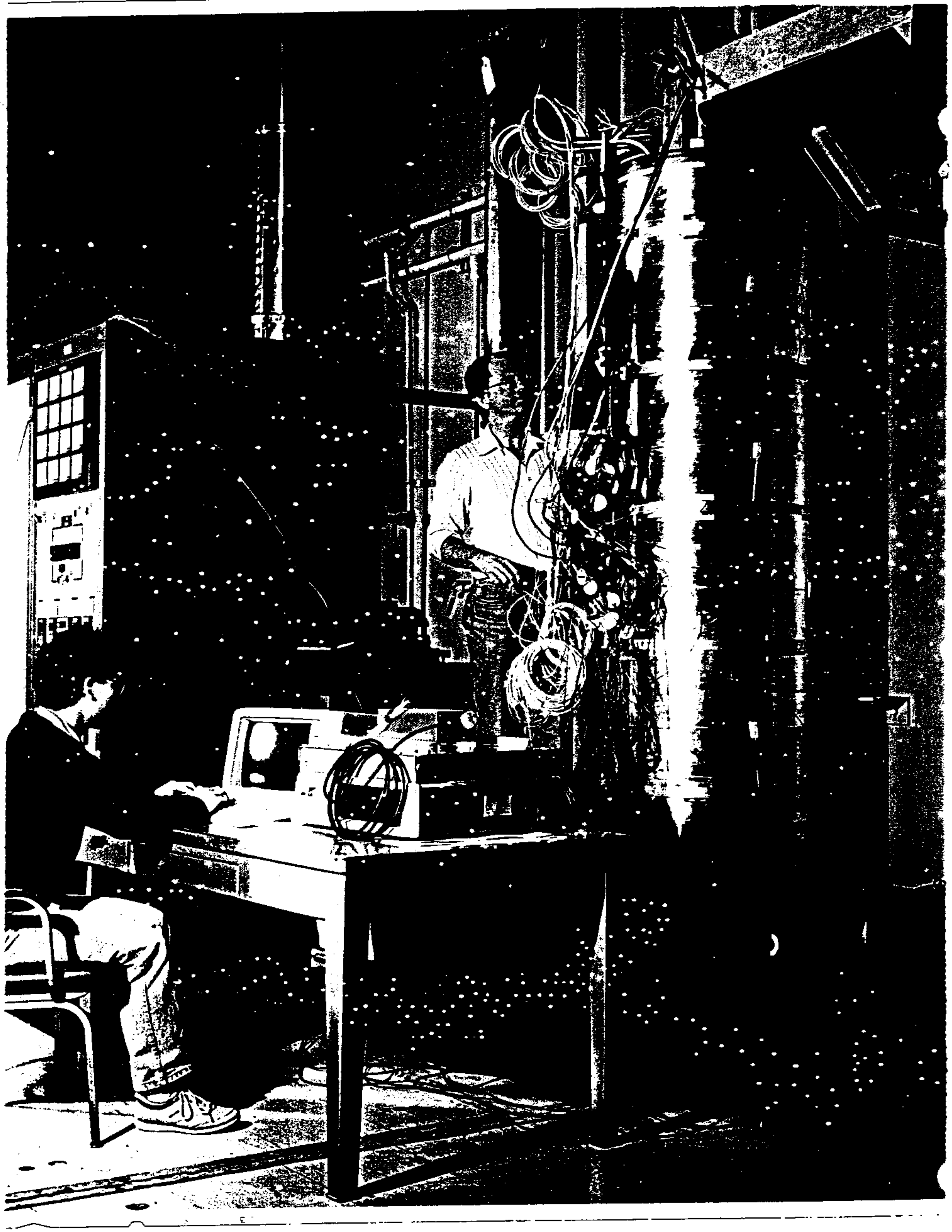
EVALUATE

- THERMAL CONDUCTIVITY AND TEMPERATURE DISTRIBUTIONS
- SWELLING CRACKING AND SELF-HEALING OF BUFFER
- MODELS AGAINST OBSERVATIONS

Buffer/Container Experiment



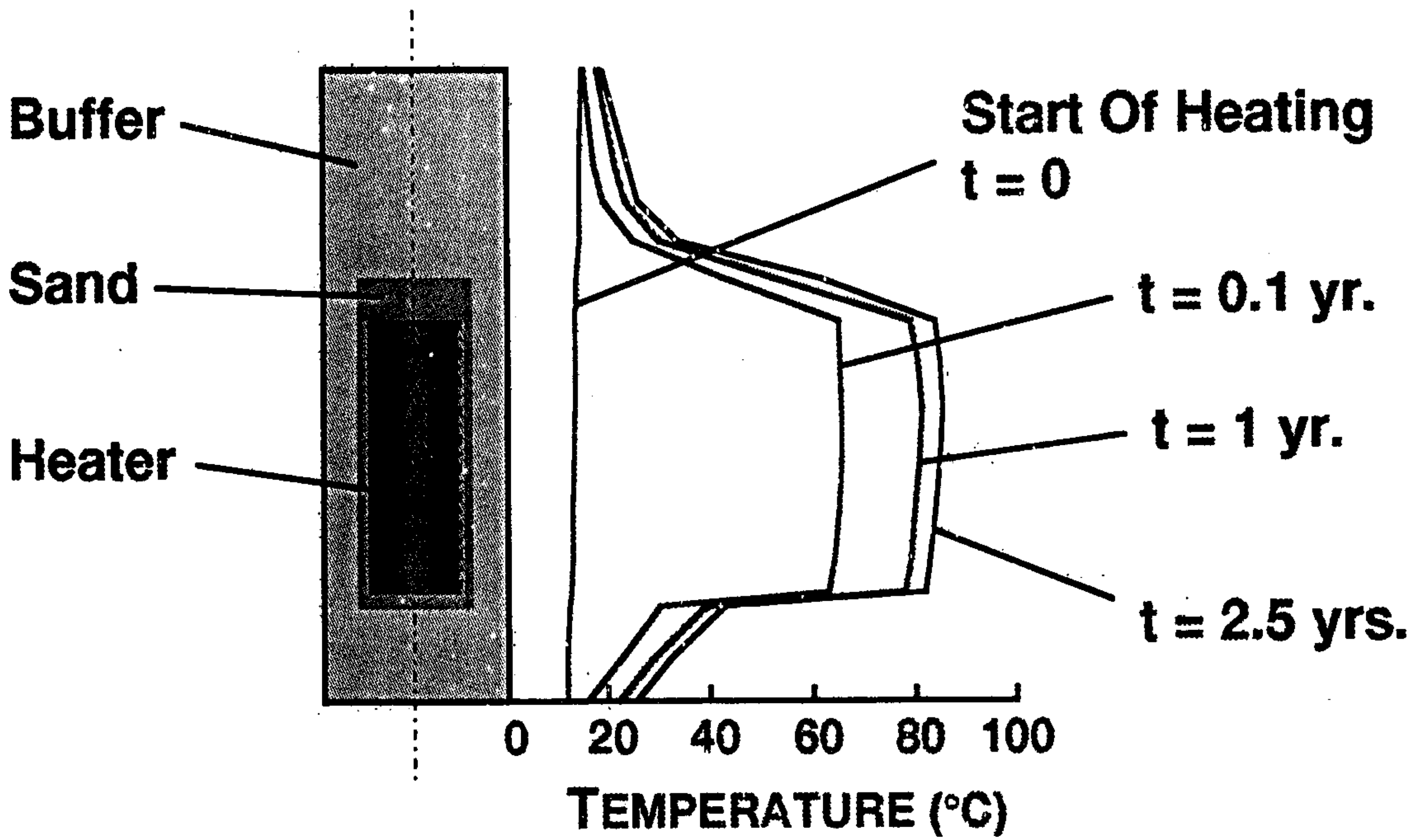
AECL

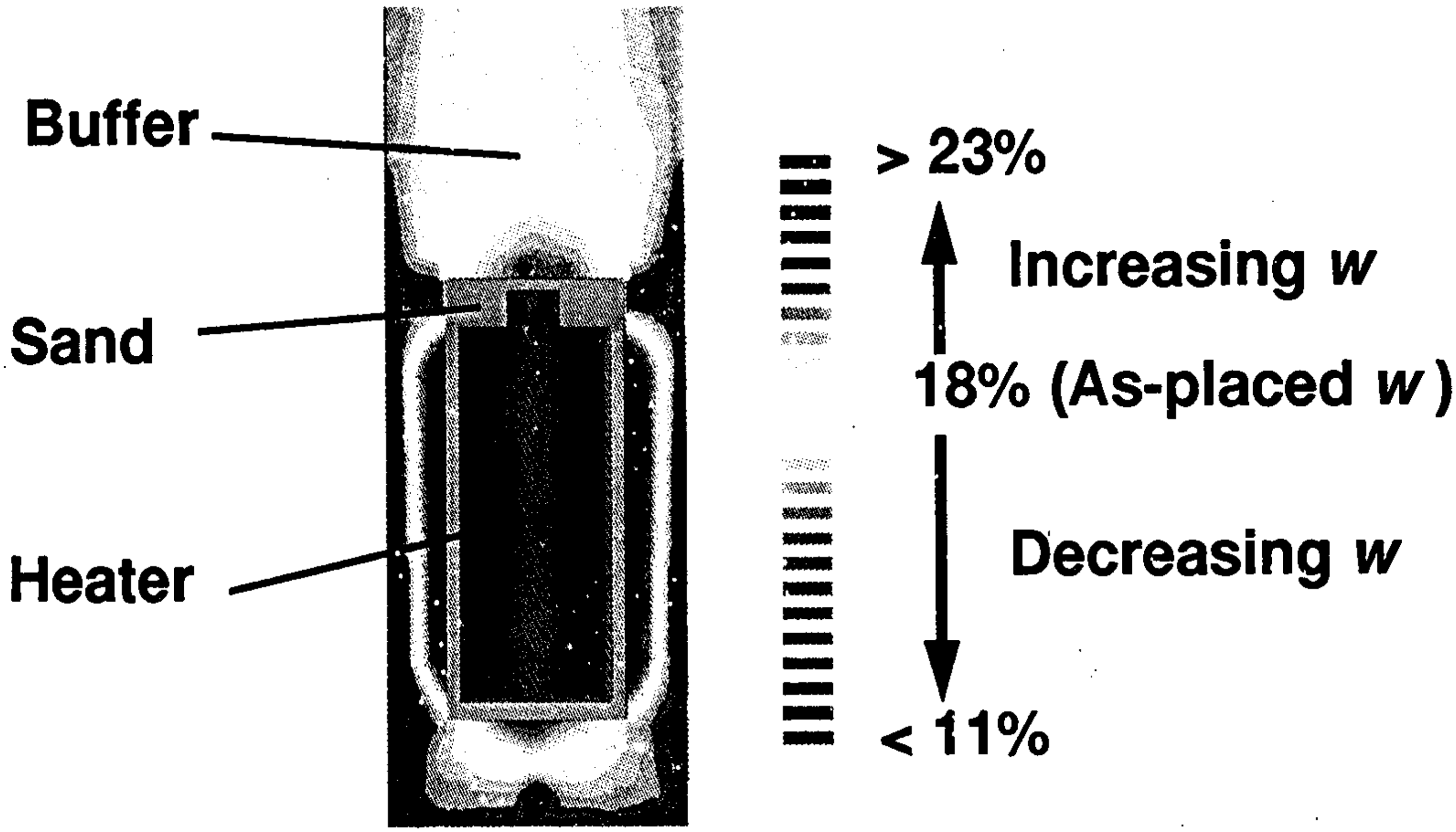


INSTRUMENTATION IN BUFFER-CONTAINER EXPERIMENT

- THERMOCOUPLES
- THERMISTORS
- EARTH PRESSURE CELLS
- PSYCHROMETERS
- THERMAL NEEDLES
- PIEZOMETERS

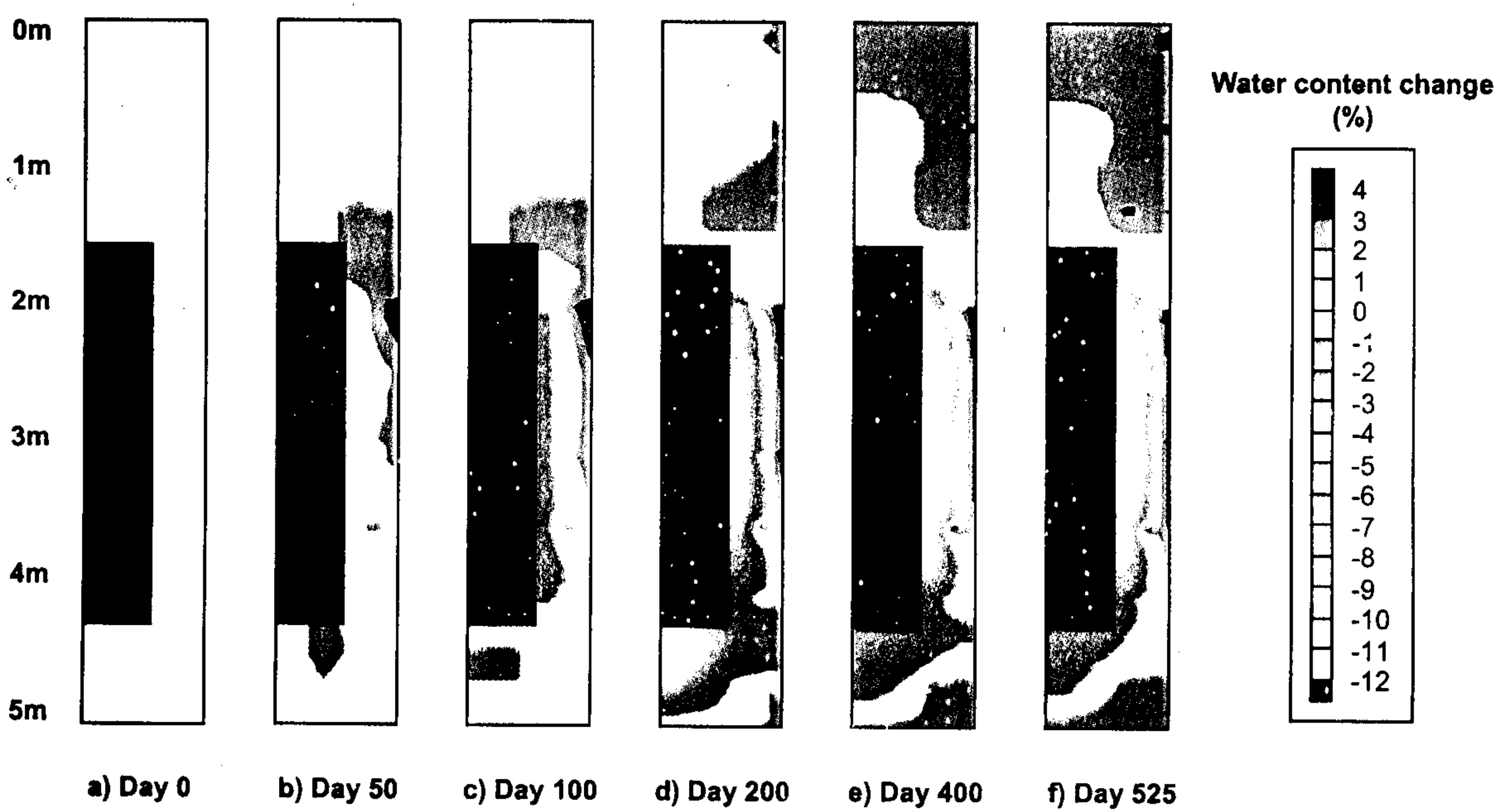
Temperatures Along Buffer Centre And On Heater Surface





Moisture Content Distribution In The Buffer/Container Experiment After 30 Months

Interpretation of water content changes measured by psychrometers and thermal needles in the Buffer/Container Experiment



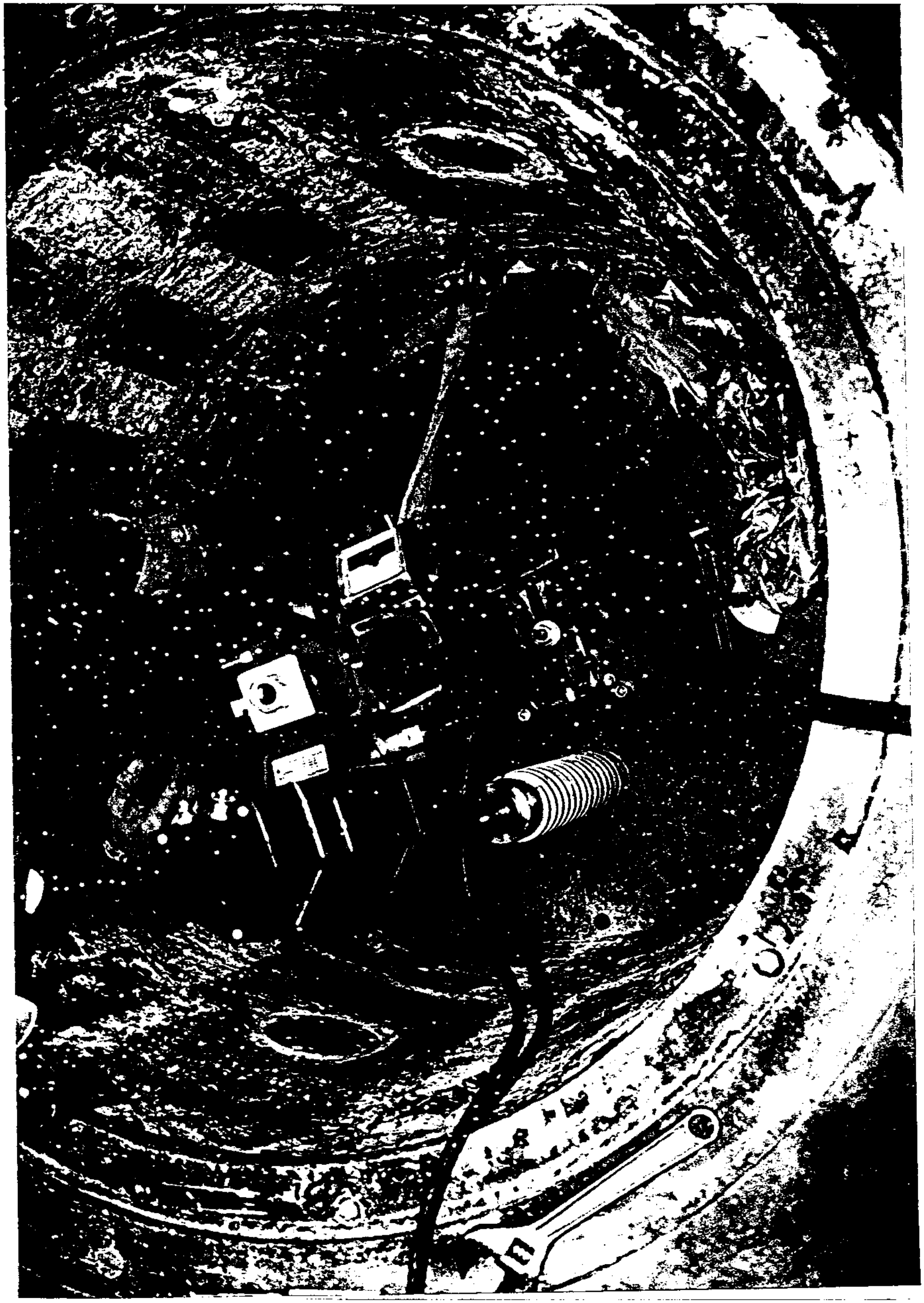
Comparison of water content distibutions in the Buffer/Container Experiment

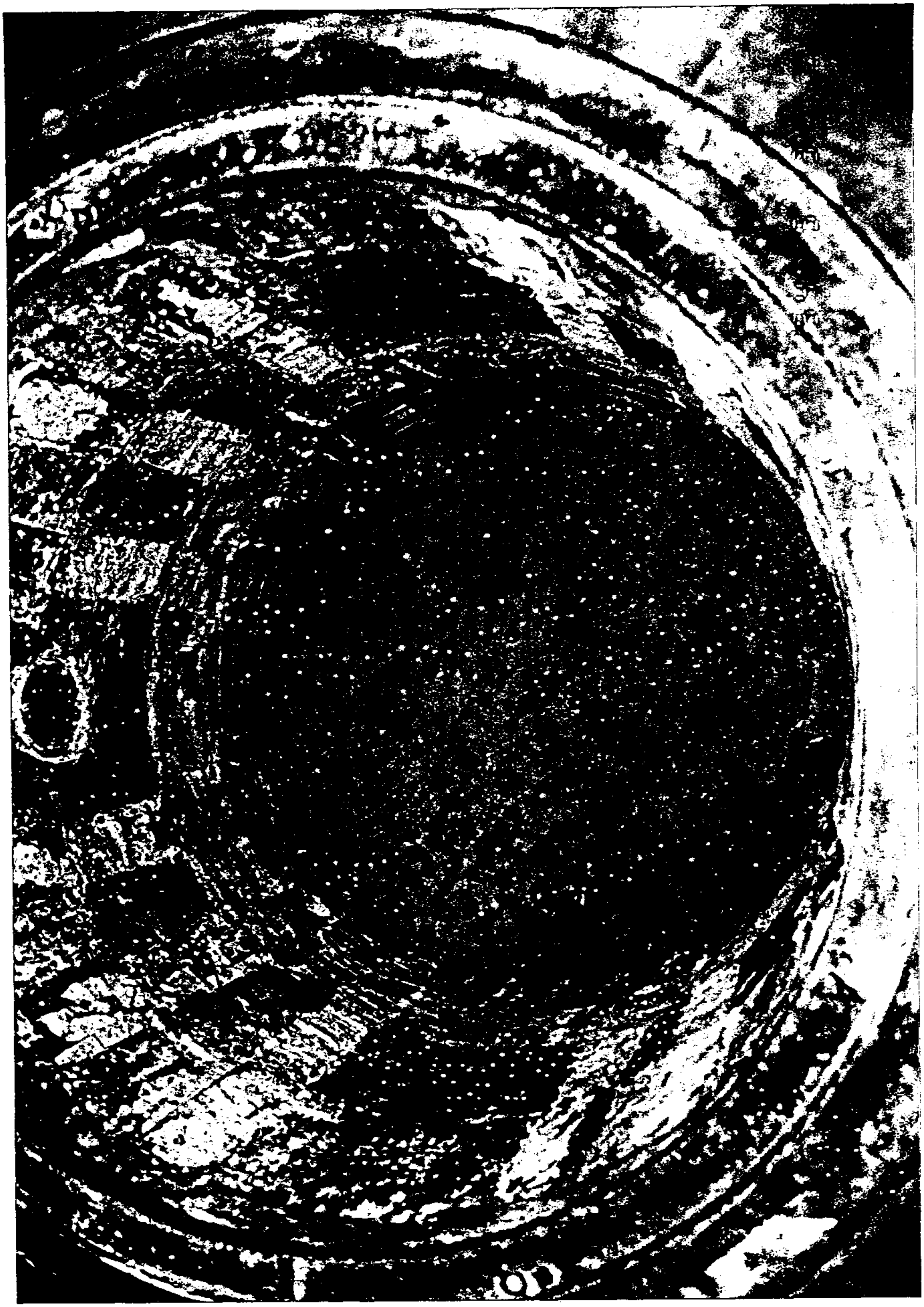
(a)

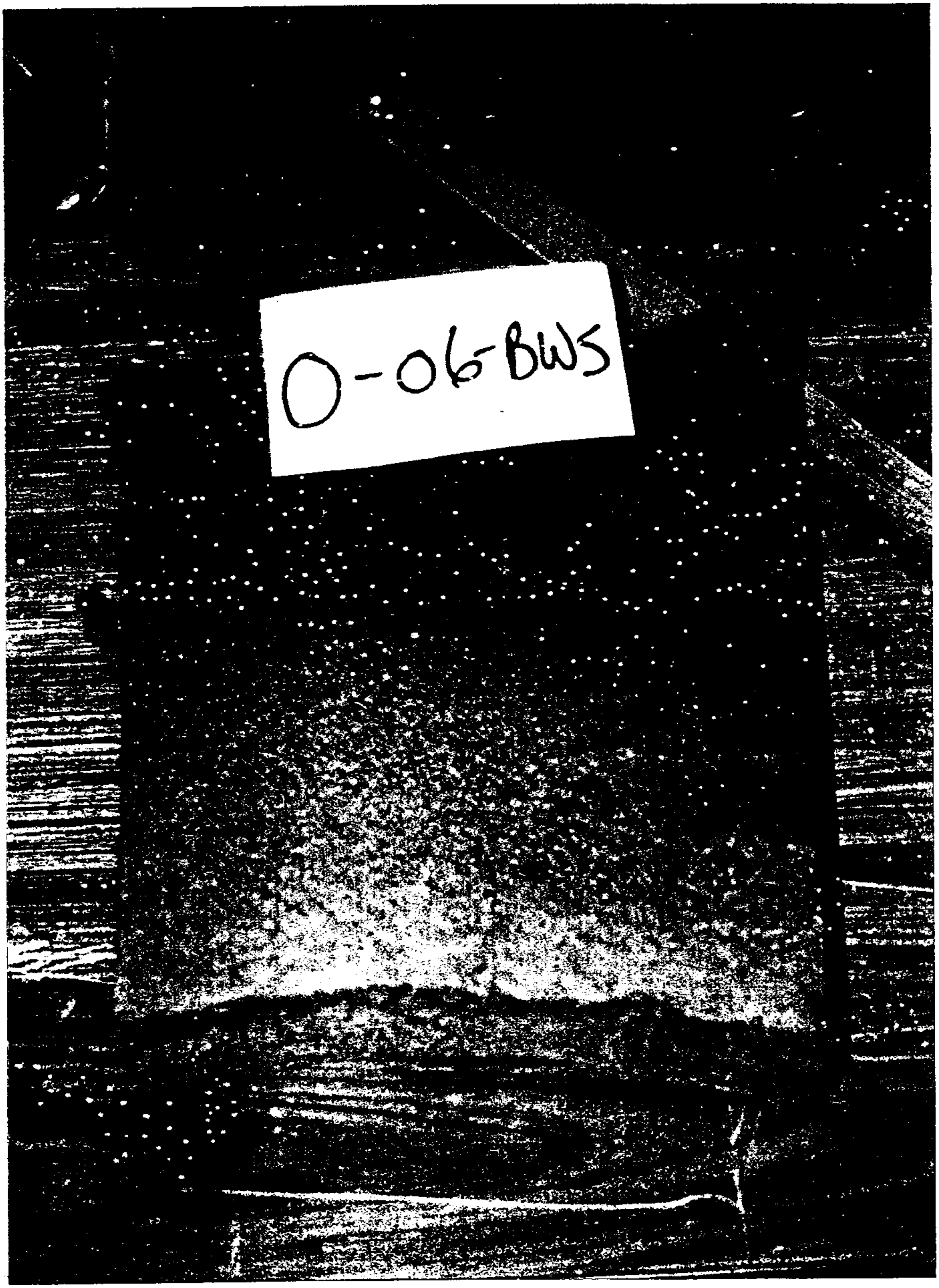
(b)

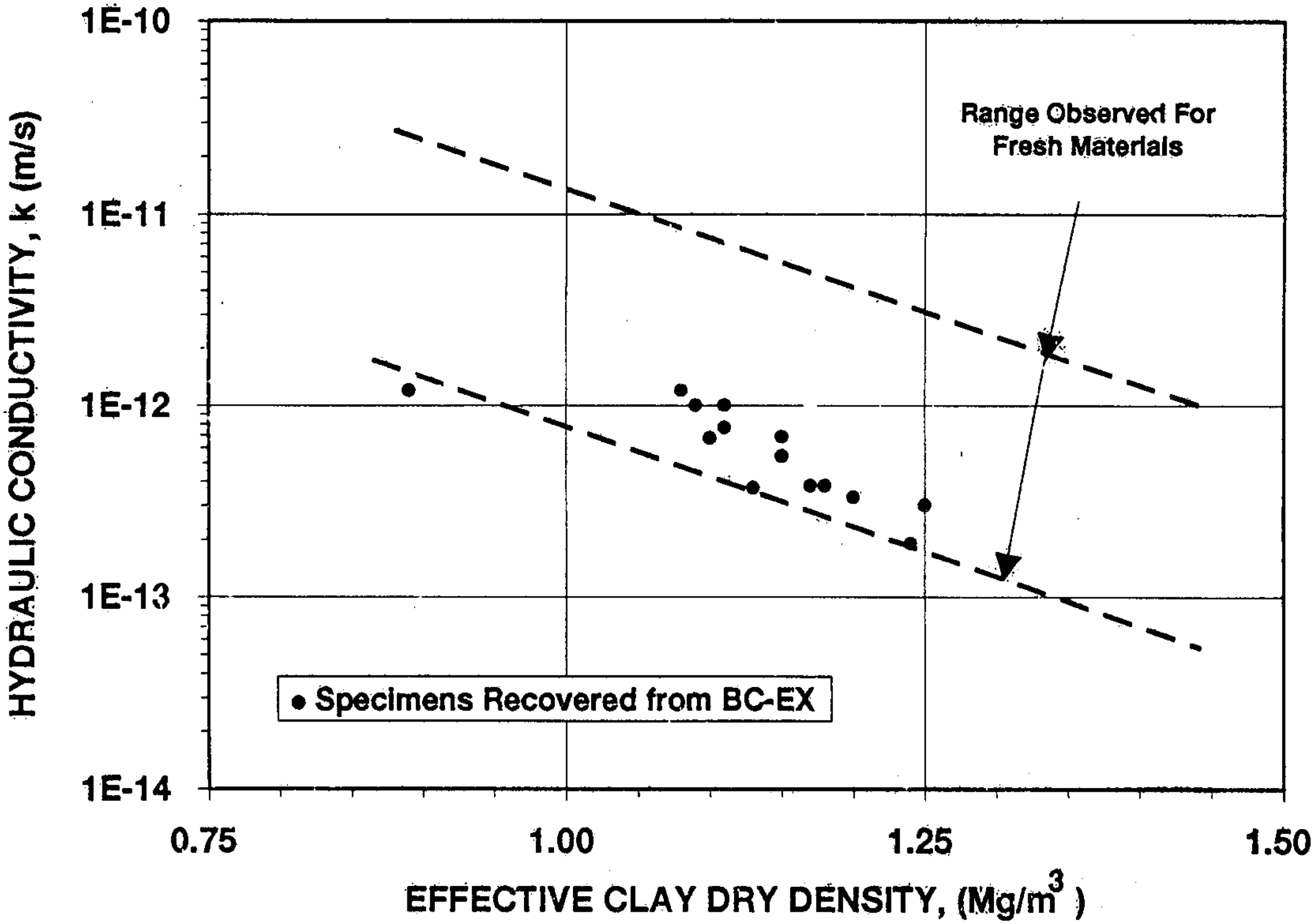
(a) End-of-test water content **distribution at Day 897.**

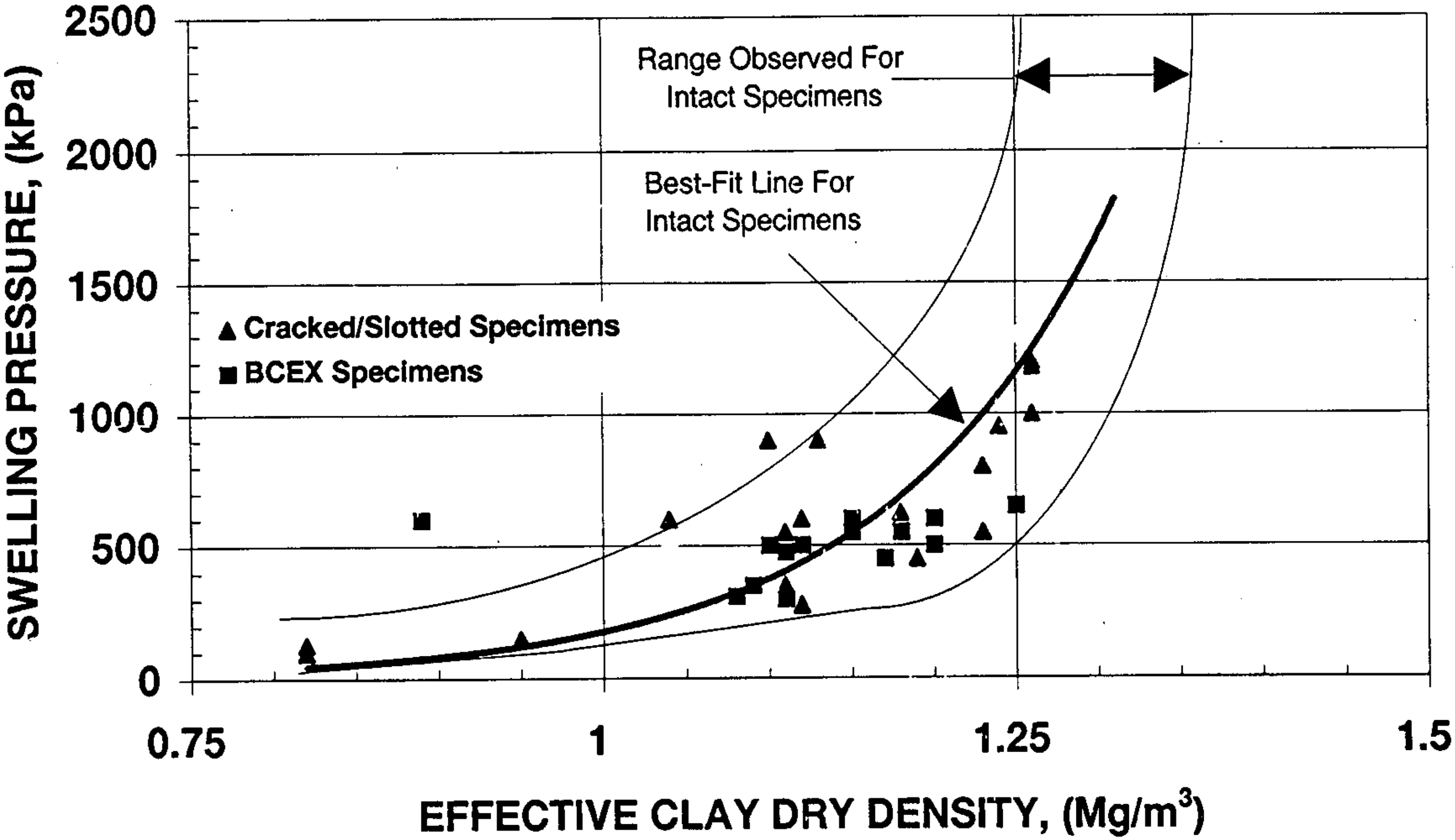
(b) Best interpretation of water content **distribution measured by** psychrometers and **thermal needles at Day 525.**






0-06-BWS

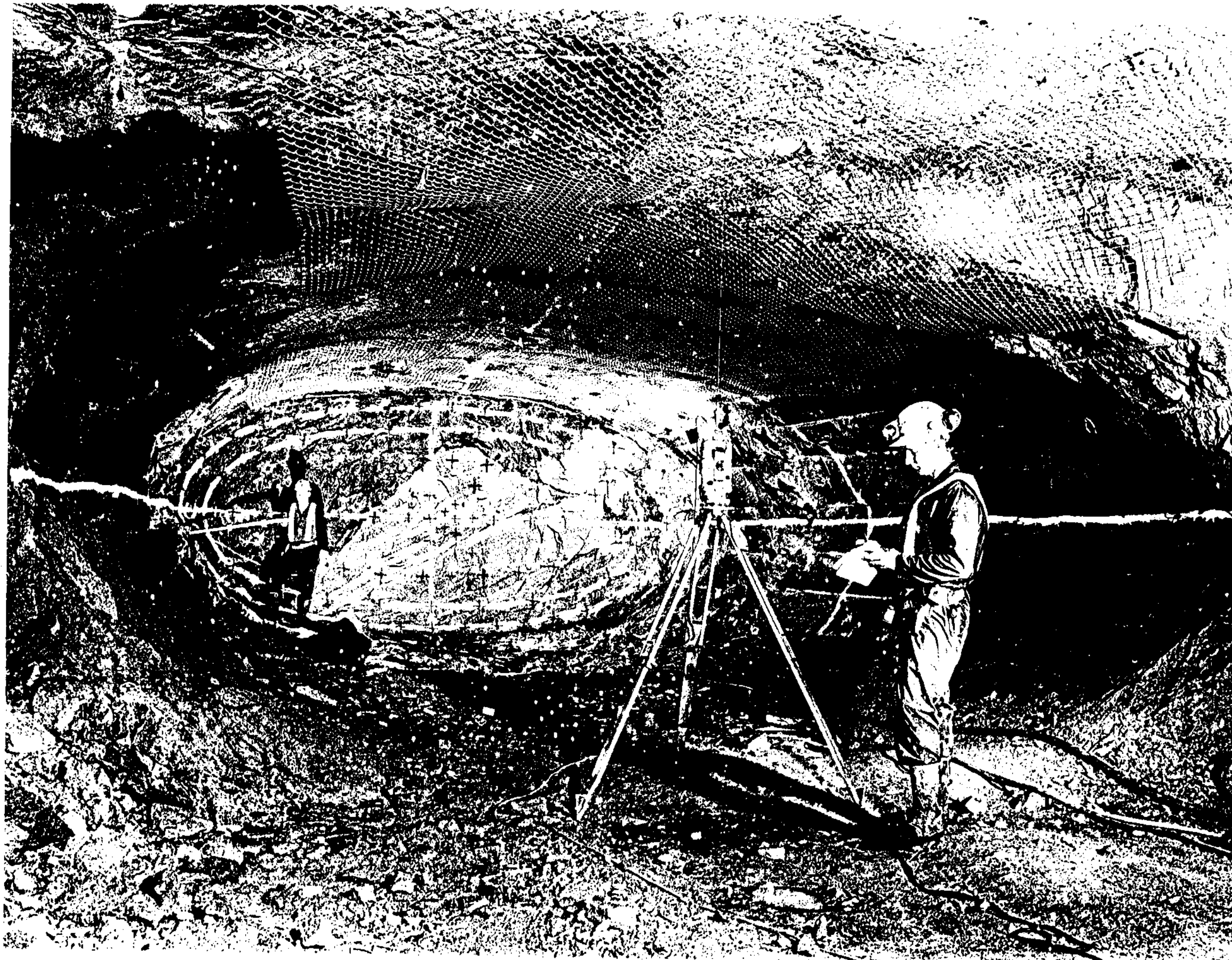

1E-10
1E-11
1E-12
1E-13
1E-14
HYDRAULIC CONDUCTIVITY, k (m/s)
Range Observed For Fresh Materials
• Specimens Recovered from BC-EX
0.75
1.00
1.25
1.50
EFFECTIVE CLAY DRY DENSITY, (Mg/m^3)

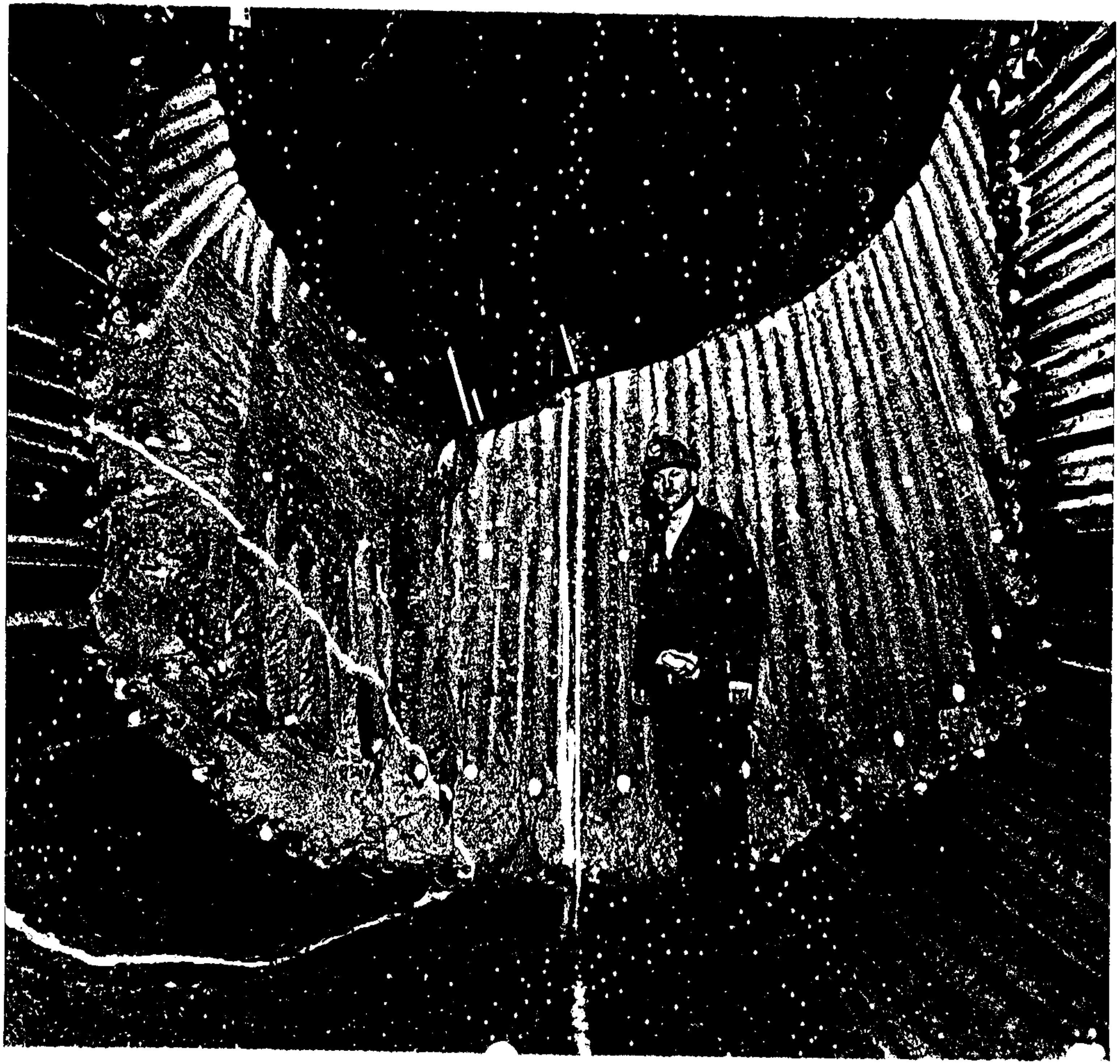


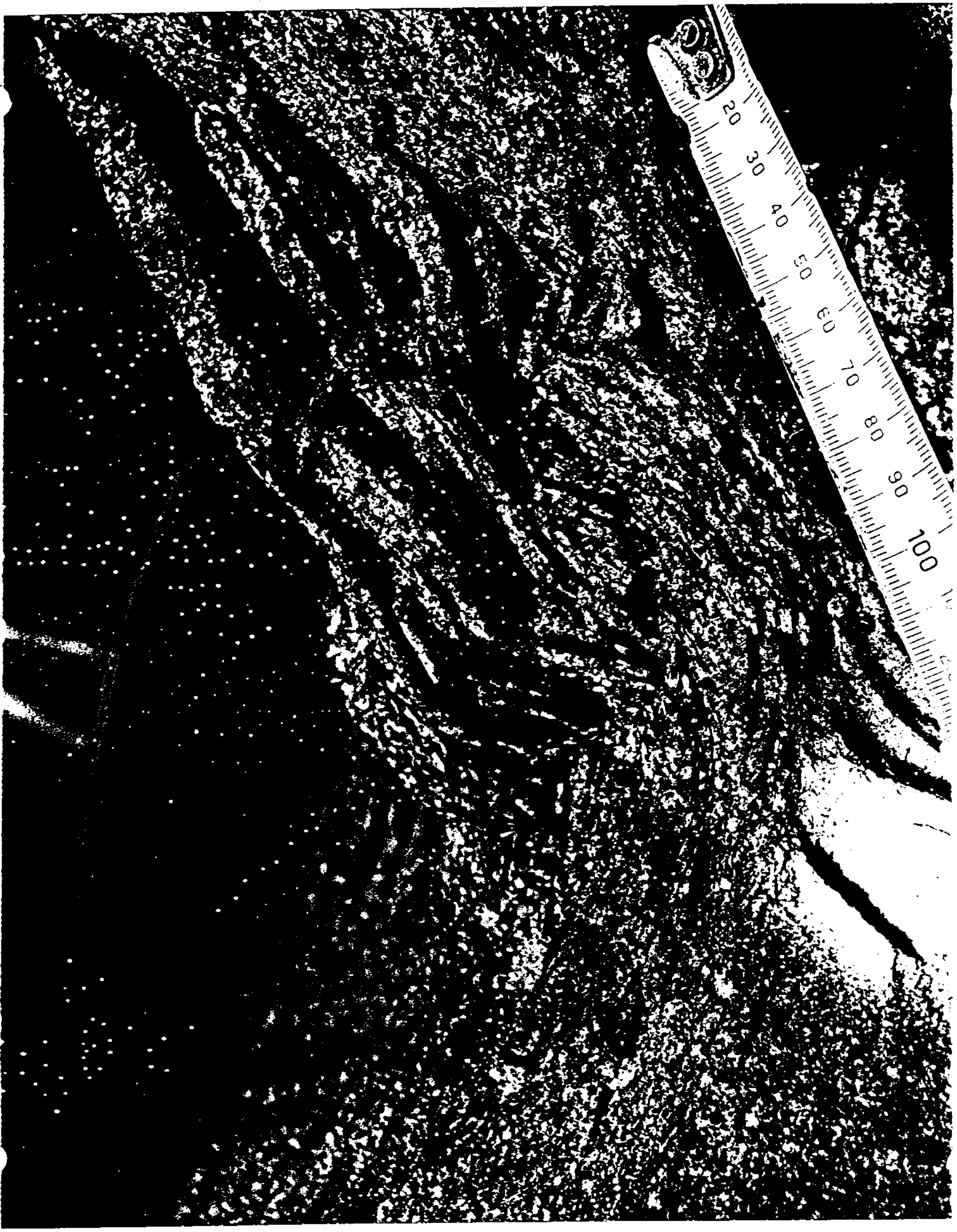
2500
2000
1500
1000
500
0
SWELLING PRESSURE, (kPa)
Range Observed For
Intact Specimens
Best-Fit Line For
Intact Specimens
▲ Cracked/Slotted Specimens
■ BCEX Specimens
0.75
1
1.25
1.5
EFFECTIVE CLAY DRY DENSITY, (Mg/m3)

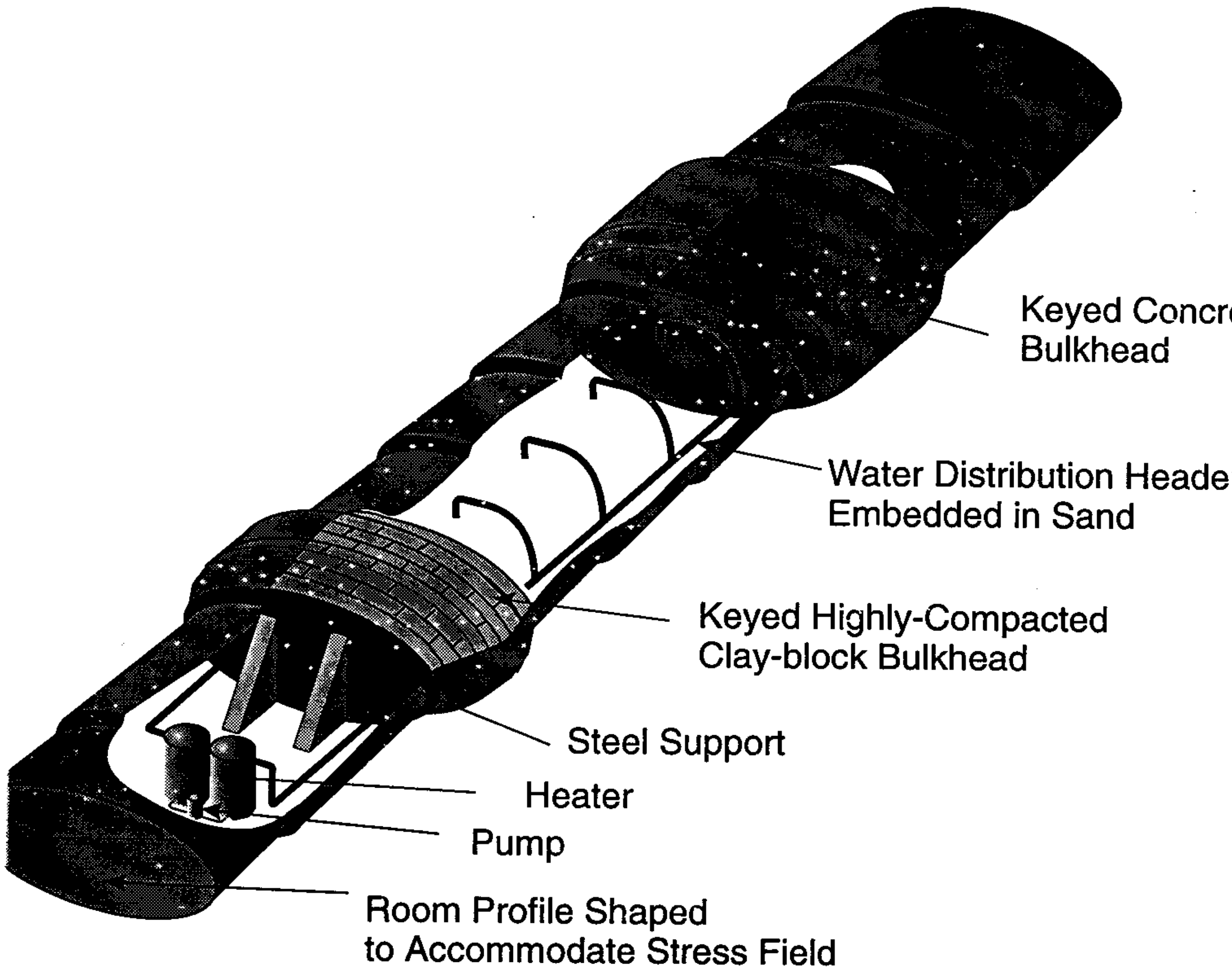
EDZ SEALING REQUIREMENTS

- SITE AND DESIGN DEPENDENT; OVERALL SYSTEM PERFORMANCE WILL DETERMINE THE SPECIFIC SEAL SYSTEM PERFORMANCE REQUIREMENT
- EXTENT OF EXCAVATION DAMAGE CAN BE REDUCED BY
  - CONTROLLED BLASTING
  - OPTIMIZING EXCAVATION SHAPE AND ORIENTATION
- SIGNIFICANCE OF THE EDZ CAN BE REDUCED BY
  - SEALING THE EDZ TO ITS PRACTICAL LIMIT
  - USING IN-ROOM EMPLACEMENT TO ENSURE CONTAMINANTS GO THROUGH BACKFILL
- IT IS POSSIBLE THAT EVEN IF PERFORMANCE ASSESSMENT SUGGESTS NO ADVERSE EFFECTS FROM AN UNSEALED EDZ, A DECISION MAY BE MADE TO SEAL IT





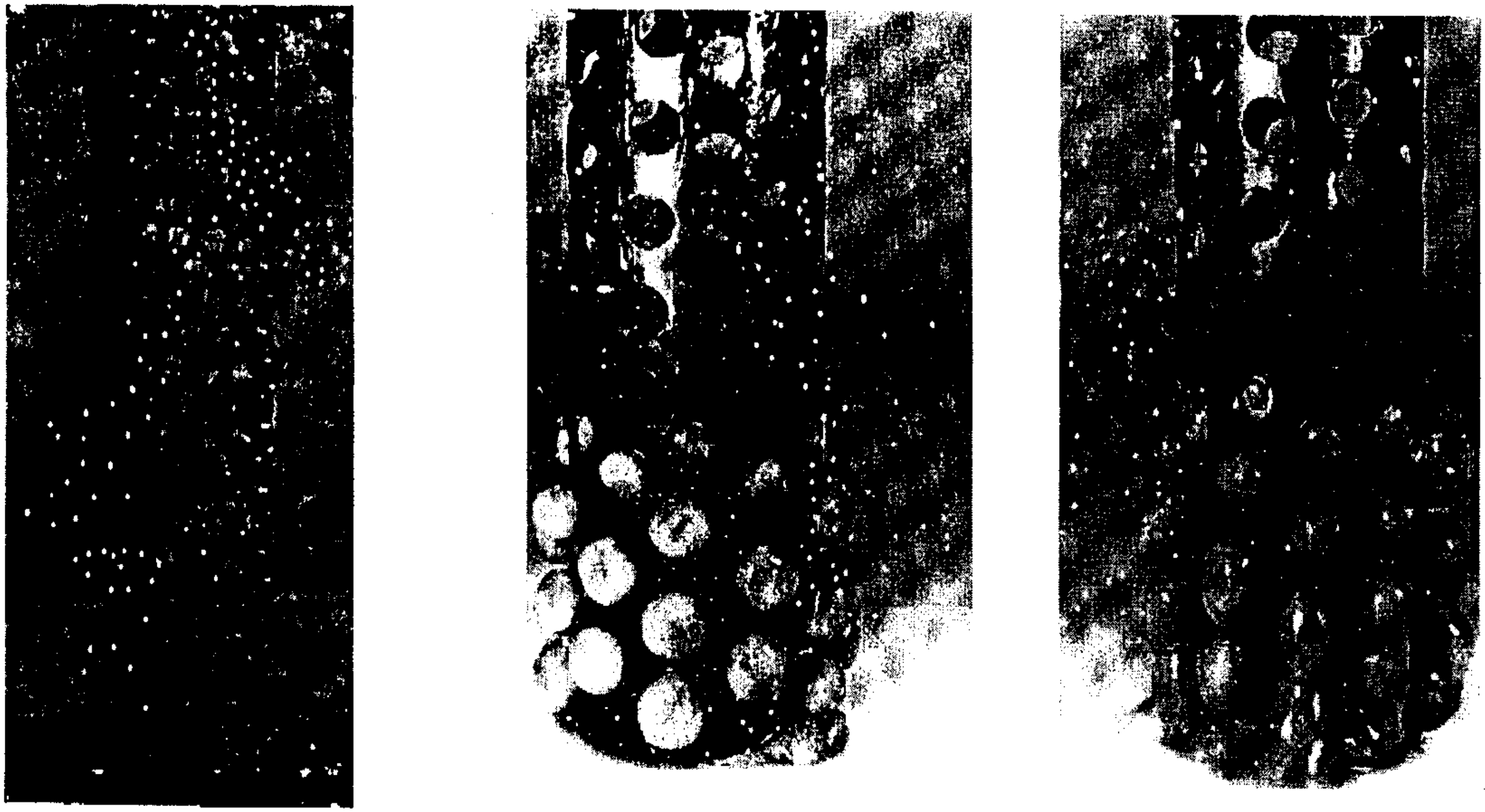

20 30 40 50 60 70 80 90 100



THE TUNNEL SEALING EXPERIMENT

Borehole Sealing

Use of compacted bentonite plugs has been demonstrated for sealing of exploration boreholes.



Copper Tube with Bentonite for Borehole Sealing