

**U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT**

**PRESENTATION TO
THE NUCLEAR WASTE TECHNICAL REVIEW BOARD**

**SUBJECT: SITE POTENTIOMETRIC
LEVEL EVALUATION**

PRESENTER: RICHARD R. LUCKEY

**PRESENTER'S TITLE
AND ORGANIZATION: HYDROLOGIST
U.S. GEOLOGICAL SURVEY
DENVER, COLORADO**

**PRESENTER'S
TELEPHONE NUMBER: (303) 236-5033**

**REGISTRY HOTEL, DENVER, COLORADO
JUNE 25-27, 1991**

INVESTIGATION 8.3.1.2.3

SATURATED HYDROLOGIC SYSTEM AT SITE (ONE OF THREE SATURATED-ZONE INVESTIGATIONS)

STUDY 8.3.1.2.3.1

CHARACTERIZATION OF THE SITE SATURATED-ZONE GROUND-WATER FLOW SYSTEM (ONE OF THREE STUDIES IN ABOVE INVESTIGATION)

ACTIVITY 8.3.1.2.3.1.2

SITE POTENTIOMETRIC-LEVEL EVALUATION (ONE OF EIGHT ACTIVITIES IN ABOVE STUDY)

SITE POTENTIOMETRIC-LEVEL EVALUATION

- **DEFINE POTENTIOMETRIC SURFACE,
PARTICULARLY UPPER-MOST SURFACE**
- **DETERMINE IF LONG-TERM TRENDS EXIST**
- **ANALYZE WATER-LEVEL FLUCTUATIONS TO
DETERMINE CAUSES AND ESTIMATE FORMATION
PROPERTIES**
- **PROVIDE INPUT TO GROUND-WATER TRAVEL-
TIME CALCULATIONS**

SITE POTENTIOMETRIC-LEVEL EVALUATION

(CONTINUED)

DATA NETWORKS:

- **PERIODIC NETWORK - MONTHLY MEASUREMENTS -
STARTED 1981**
- **CONTINUOUS NETWORK - HOURLY MEASUREMENTS -
STARTED 1985**

DATA ANALYSIS:

- **HYDROLOGIC/GEOLOGIC HOLES (G-, H-, b#1, p#1)**
- **WATER TABLE HOLES (WT-)**

SITE POTENTIOMETRIC-LEVEL EVALUATION

(CONTINUED)

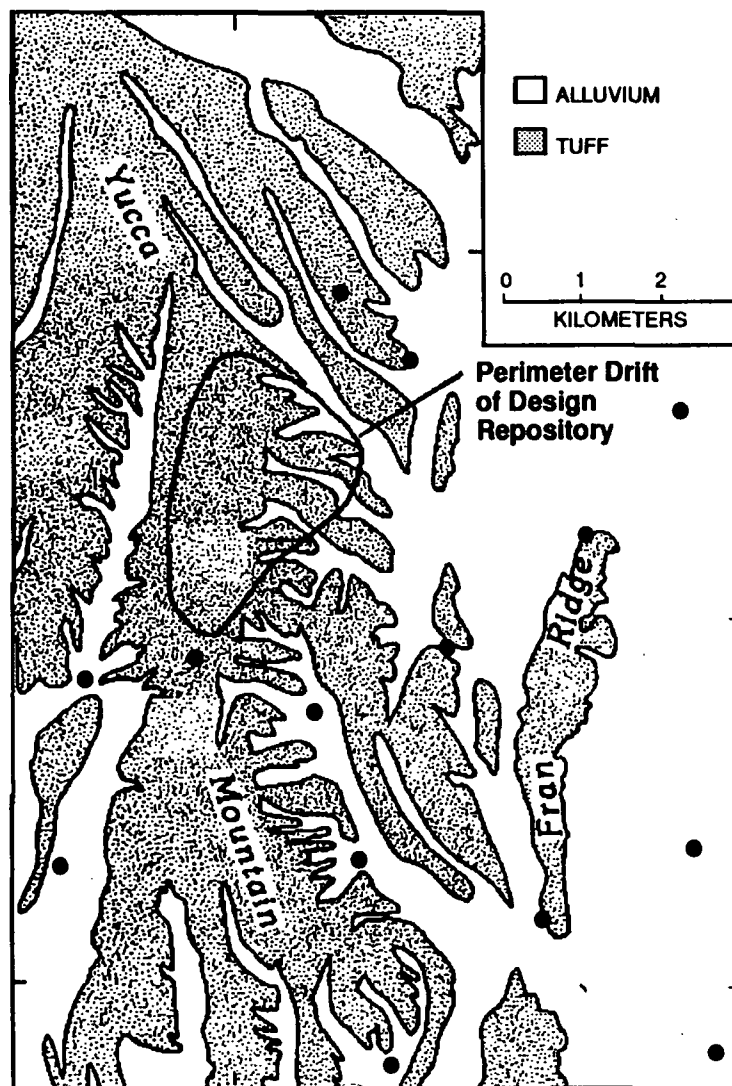
DATA RELEASES:

- **PERIODIC DATA THROUGH 1988 PUBLISHED
(2 REPORTS)**
- **PERIODIC DATA FOR 1989 APPROVED FOR PUBLICATION**
- **CONTINUOUS DATA THROUGH 1988 SENT TO DOE AND
USGS DIRECTOR FOR APPROVAL (JUNE 1991)**
- **CONTINUOUS DATA FOR 1989—REPORT IN
PREPARATION**
- **DATA FOR 1990 BEING PROCESSED**

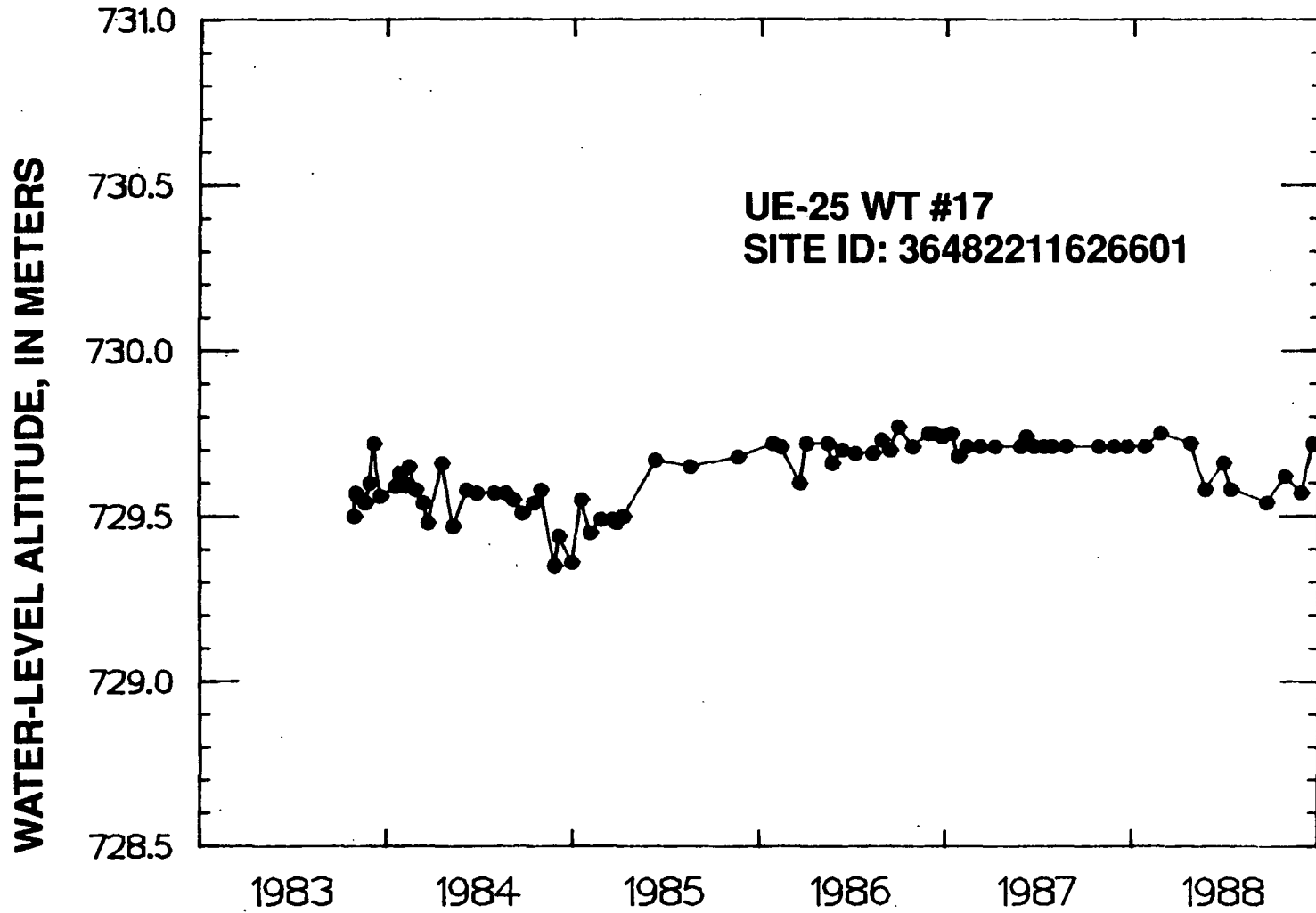
PERIODIC WATER-LEVEL NETWORK

- **16 WELLS MEASURED MONTHLY (JUNE 1991)**
- **3 WELLS MEASURED QUARTERLY**
- **STEEL TAPE MEASUREMENTS**
- **HIGH PRECISION; HIGH ACCURACY**
- **USEFUL FOR LONG-TERM TRENDS**
- **USED FOR TRAVEL-TIME CALCULATIONS**

PERIODIC WATER-LEVEL NETWORK



PERIODIC WATER-LEVEL NETWORK



STABLE WATER LEVELS

CONTINUOUS WATER-LEVEL NETWORK

(CONTINUED)

- **12 WELLS; 19 ZONES (JUNE 1991)**
- **PRESSURE TRANSDUCERS TO MEASURE DEPTH OF SUBMERGENCE**
- **DATA LOGGER OR DATA COLLECTION PLATFORM TO READ TRANSDUCER**
- **SYSTEMS CALIBRATED EVERY 4 MONTHS; INCLUDES MANUAL WATER-LEVEL MEASUREMENT**

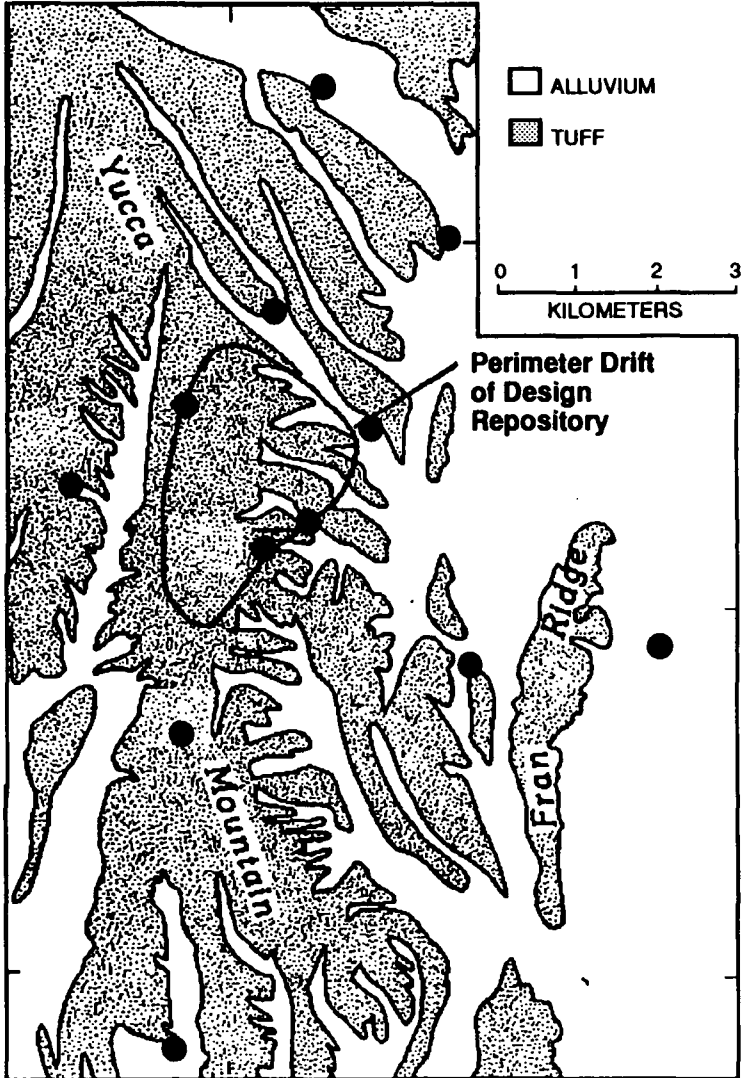
CONTINUOUS WATER-LEVEL NETWORK

(CONTINUED)

- **HOURLY MEASUREMENTS (IN MOST CASES);
NOT REALLY CONTINUOUS**
- **CONTINUOUS GRAPHICAL OUTPUT IN FEW
CASES**
- **HIGH FREQUENCY MEASUREMENTS IN
SPECIAL CASES**

CONTINUOUS WATER-LEVEL NETWORK

(CONTINUED)

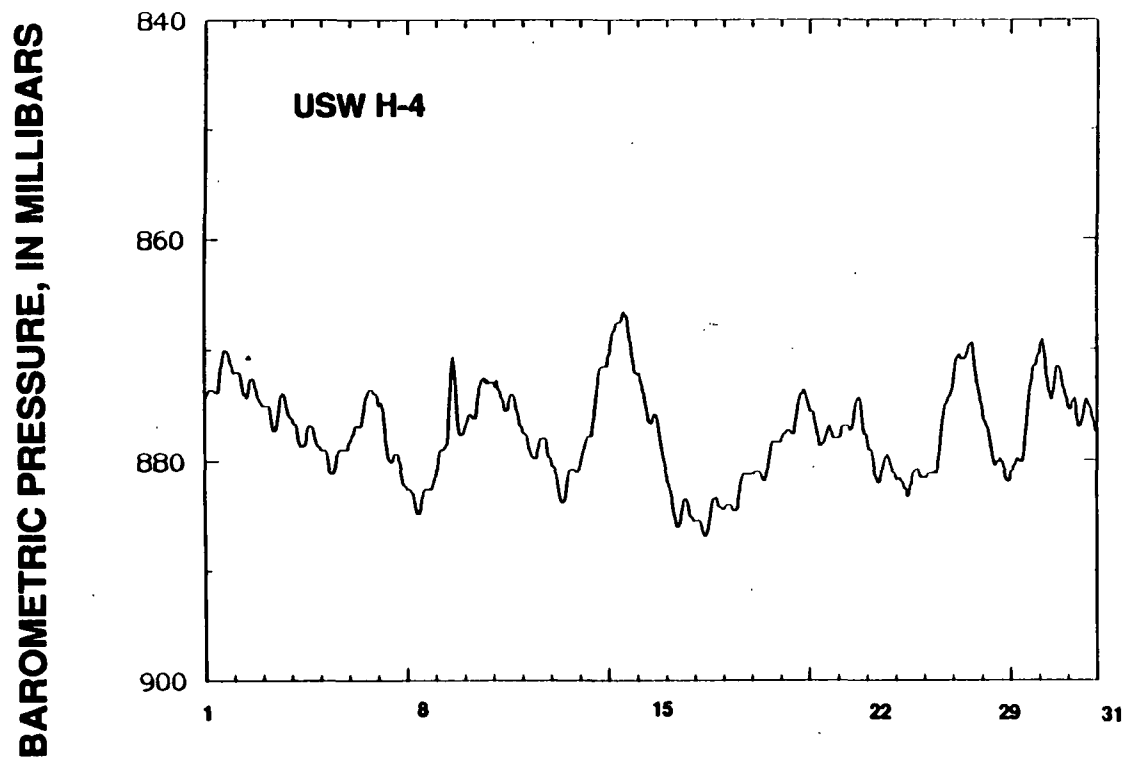


SHORT-TERM WATER-LEVEL FLUCTUATIONS

- **BAROMETRIC PRESSURE CHANGES
(DAILY TO A FEW DAYS)**
- **EARTH TIDES
(TWICE DAILY; 14-DAY CYCLE)**

SHORT-TERM WATER-LEVEL FLUCTUATIONS

(CONTINUED)

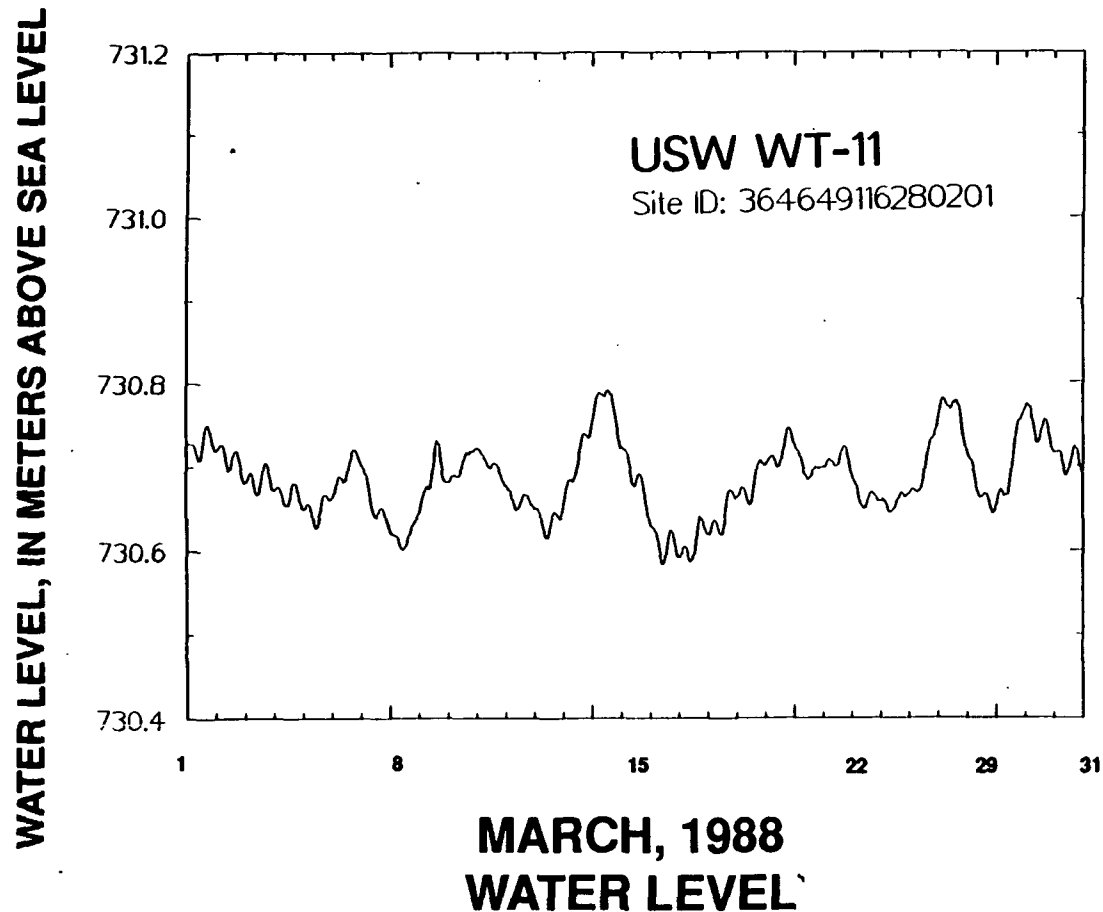


MARCH, 1988

BAROMETRIC PRESSURE - INVERTED

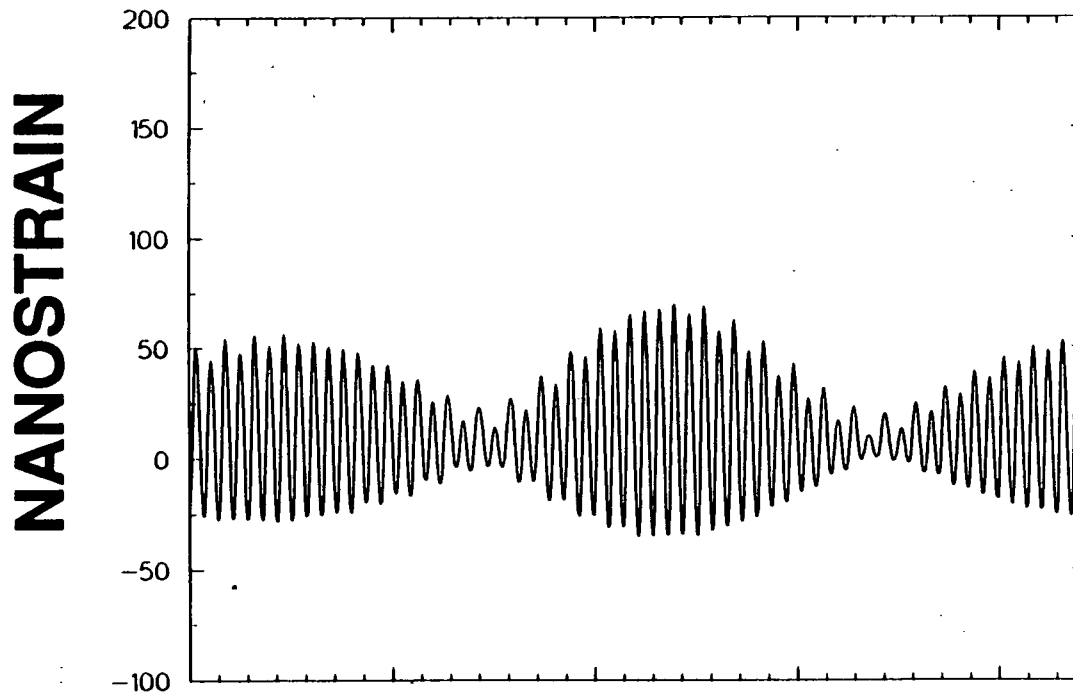
SHORT-TERM WATER-LEVEL FLUCTUATIONS

(CONTINUED)



SHORT-TERM WATER-LEVEL FLUCTUATIONS

(CONTINUED)

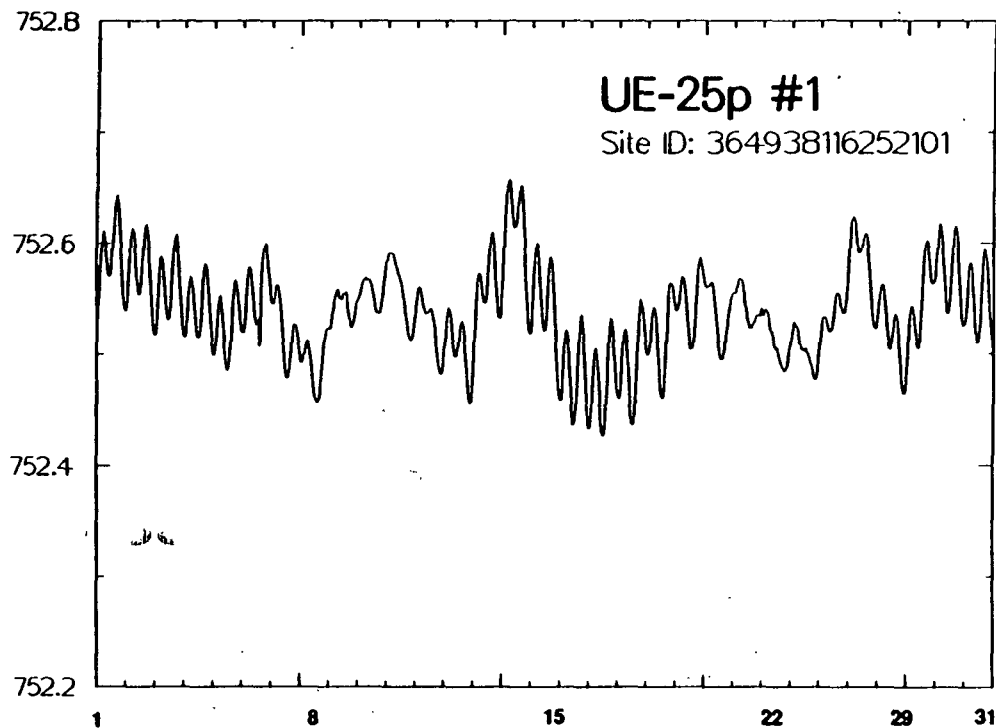


MARCH, 1988
EARTH TIDES

SHORT-TERM WATER-LEVEL FLUCTUATIONS

(CONTINUED)

WATER LEVEL, IN METERS ABOVE SEA LEVEL



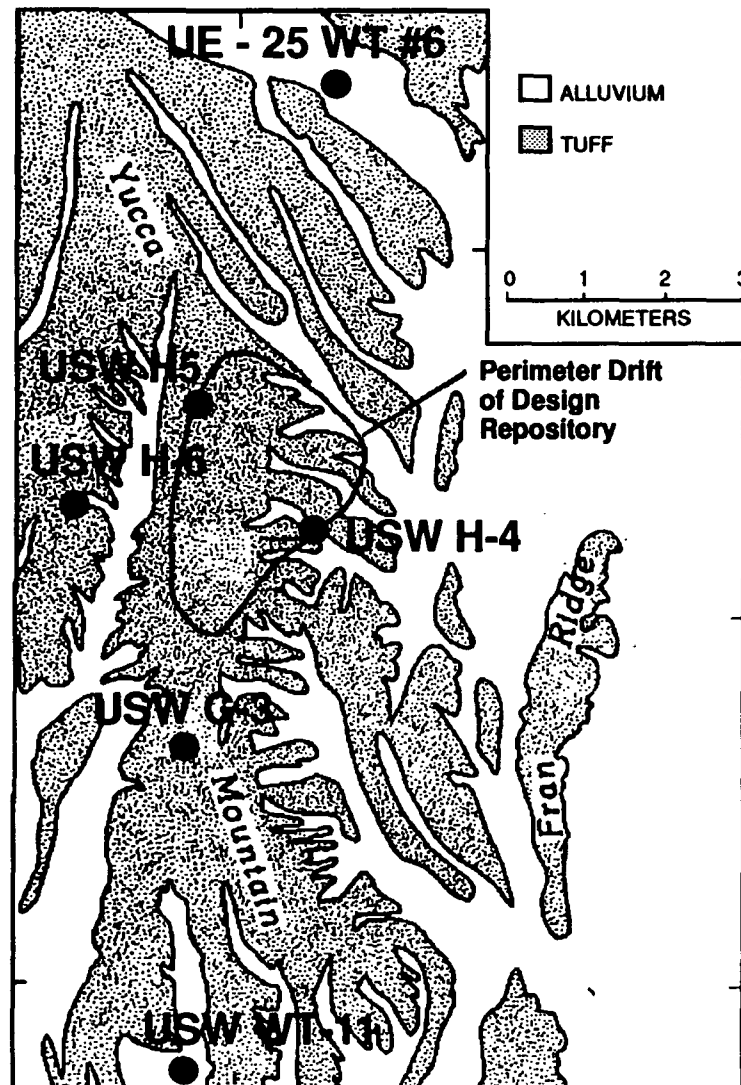
MARCH, 1988
WATER LEVEL

DATA COLLECTION PLATFORMS

- **NEAR REAL-TIME ACCESS TO DATA - PLATFORM TO SATELLITE TO GROUND STATION TO COMPUTER**
- **NORMAL OPERATION: RELAY DATA EVERY 4 HOURS**
- **ALERT OPERATION: RELAY EMERGENCY DATA IMMEDIATELY**
- **DATA ARE EXAMINED DAILY UNDER NORMAL CIRCUMSTANCES**
- **DATA ARE EXAMINED EVERY FEW HOURS UNDER SPECIAL CIRCUMSTANCES**

DATA COLLECTION PLATFORMS

(CONTINUED)



DATA COLLECTION PLATFORMS

(CONTINUED)

- USW G-3 SOUTH END OF CREST, IN SERVICE
JANUARY 1990**
- USW H-5 NORTH END OF CREST; IN SERVICE MARCH 1990**
- USW WT-11 SOUTH OF YUCCA MT; IN SERVICE
NOVEMBER 1990**
- USW H-4 EAST FLANK OF YUCCA MT; IN SERVICE
NOVEMBER 1990**
- USW H-6 WEST OF YUCCA MT; IN SERVICE MARCH 1991**
- UE-25 WT #6 NORTH OF LARGE HYDRAULIC GRADIENT;
IN SERVICE APRIL 1991**

TYPES OF "WATER-LEVEL EXCURSIONS"

- TYPE 1 - DRAMATIC, BUT EXPECTED RESPONSE TO BAROMETRIC PRESSURE CHANGES;
LOW AMPLITUDE**
- TYPE 2 - LOW AMPLITUDE, UNEXPECTED RESPONSE
(CONCURRENT WITH BAROMETRIC
PRESSURE CHANGES)**
- TYPE 3 - LOW AMPLITUDE, UNEXPECTED RESPONSE
(NOT CONCURRENT WITH BAROMETRIC
PRESSURE CHANGES)**
- TYPE 4 - HIGH AMPLITUDE, UNEXPECTED RESPONSE
(NOT CONCURRENT WITH ANYTHING)**

TYPES OF "WATER-LEVEL EXCURSIONS"

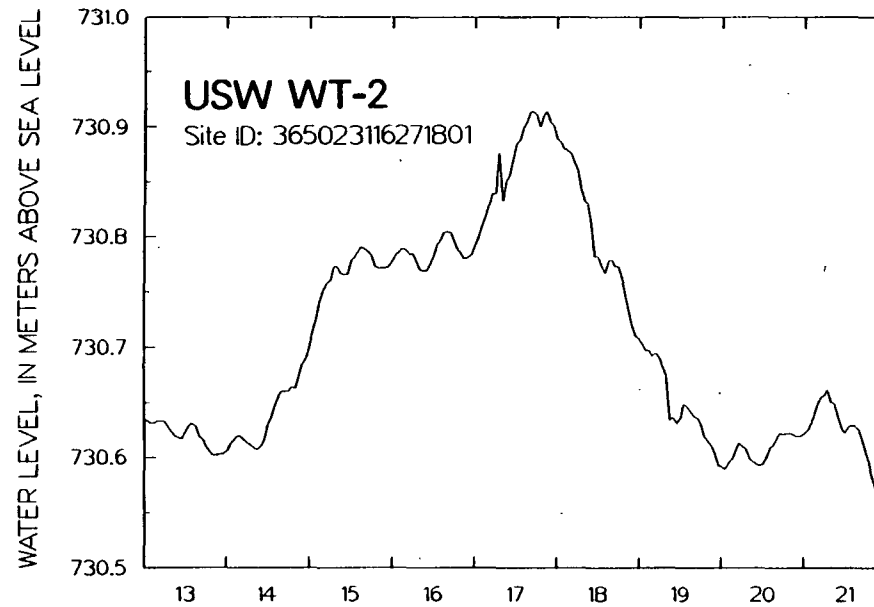
TYPE 1 - DRAMATIC, BUT EXPECTED RESPONSE TO BAROMETRIC PRESSURE CHANGES; LOW AMPLITUDE

TYPE 2 - LOW AMPLITUDE, UNEXPECTED RESPONSE (CONCURRENT WITH BAROMETRIC PRESSURE CHANGES)

TYPE 3 - LOW AMPLITUDE, UNEXPECTED RESPONSE (NOT CONCURRENT WITH BAROMETRIC PRESSURE CHANGES)

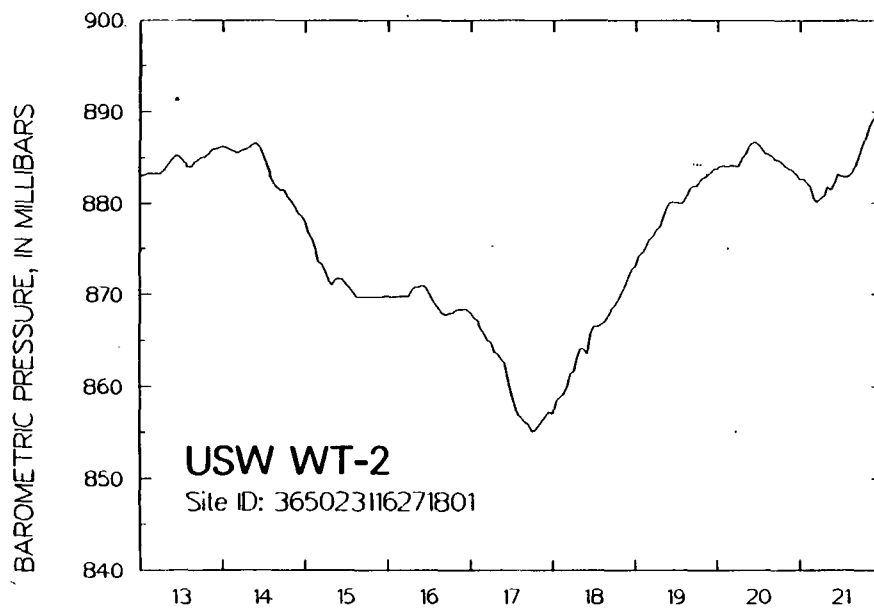
TYPE 4 - HIGH AMPLITUDE, UNEXPECTED RESPONSE (NOT CONCURRENT WITH ANYTHING)

TYPE 1 "WATER-LEVEL EXCURSIONS"



**JANUARY
1988**

TYPE 1 "WATER-LEVEL EXCURSIONS"



**JANUARY
1988**

TYPES OF "WATER-LEVEL EXCURSIONS"

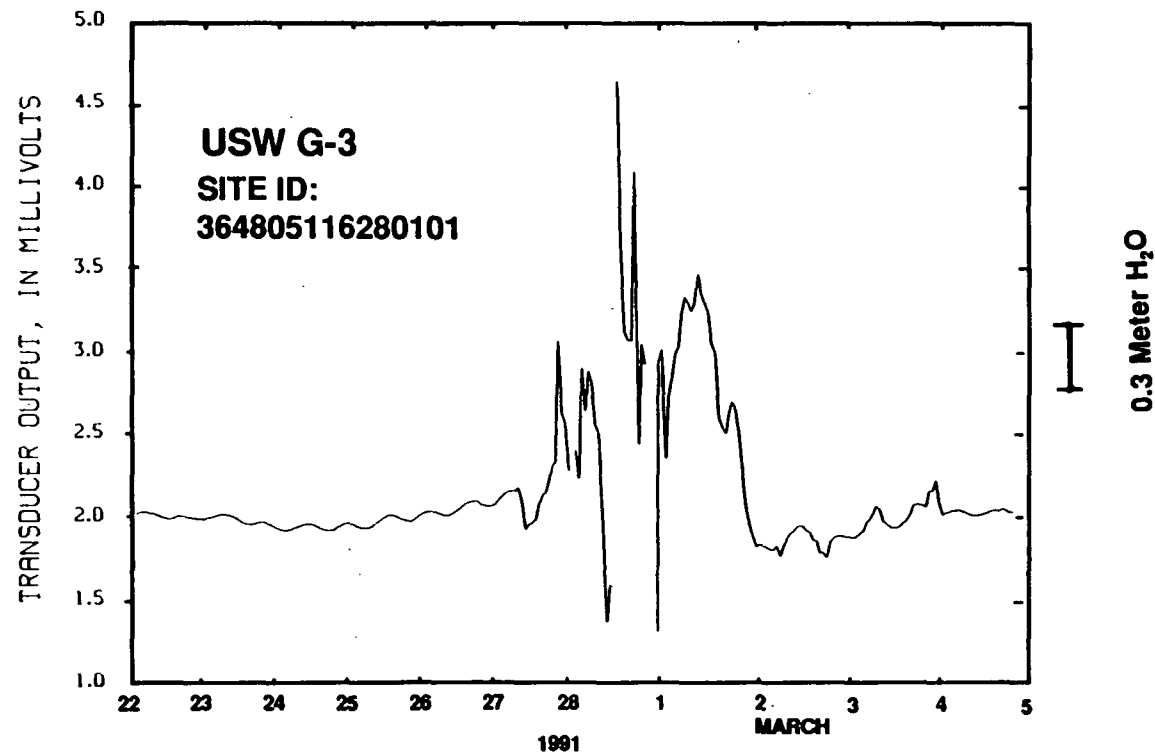
TYPE 1 - DRAMATIC, BUT EXPECTED RESPONSE TO BAROMETRIC PRESSURE CHANGES; LOW AMPLITUDE

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TYPE 3 - LOW AMPLITUDE, UNEXPECTED RESPONSE (NOT CONCURRENT WITH BAROMETRIC PRESSURE CHANGES)

TYPE 4 - HIGH AMPLITUDE, UNEXPECTED RESPONSE (NOT CONCURRENT WITH ANYTHING)

TYPE 2 "WATER-LEVEL EXCURSION"



GENERALLY NOT KNOWN IF THEY REPRESENT REAL WATER-LEVEL FLUCTUATIONS

TYPES OF "WATER-LEVEL EXCURSIONS"

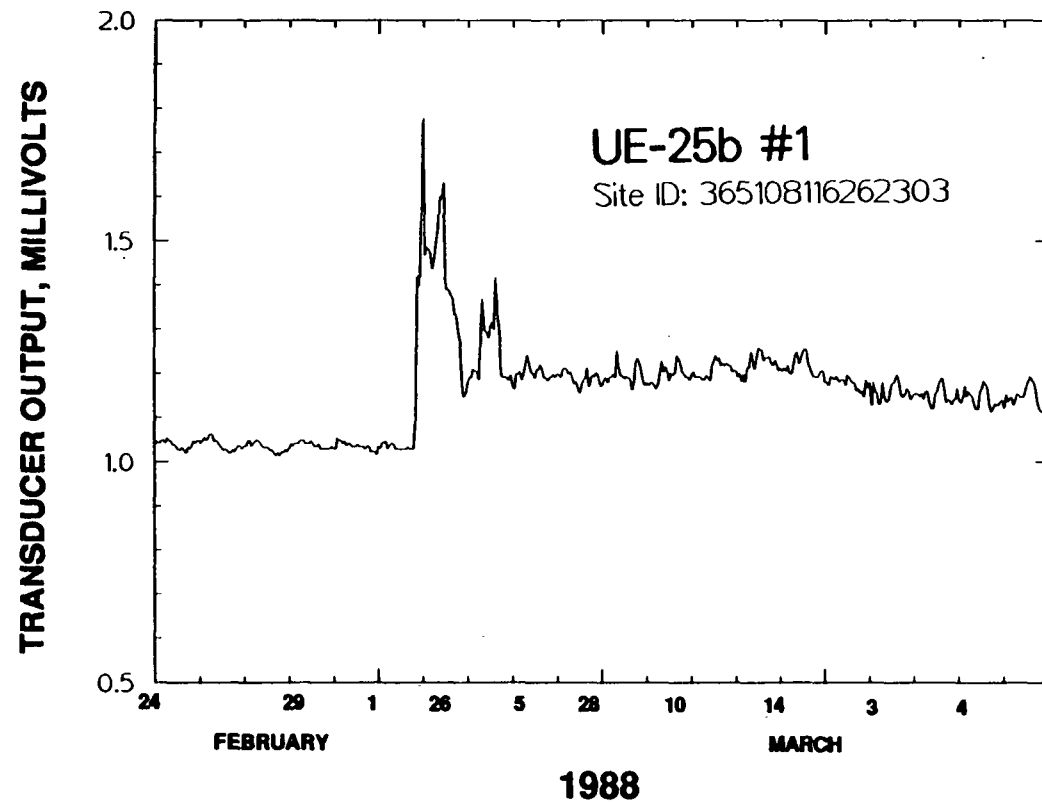
TYPE 1 - DRAMATIC, BUT EXPECTED RESPONSE TO BAROMETRIC PRESSURE CHANGES; LOW AMPLITUDE

TYPE 2 - LOW AMPLITUDE, UNEXPECTED RESPONSE (CONCURRENT WITH BAROMETRIC PRESSURE CHANGES)

TYPE 3 - LOW AMPLITUDE, UNEXPECTED RESPONSE (NOT CONCURRENT WITH BAROMETRIC PRESSURE CHANGES)

TYPE 4 - HIGH AMPLITUDE, UNEXPECTED RESPONSE (NOT CONCURRENT WITH ANYTHING)

TYPE 3 "WATER-LEVEL EXCURSION"



UNKNOWN IF THIS REPRESENTS REAL WATER-LEVEL FLUCTUATIONS

TYPES OF "WATER-LEVEL EXCURSIONS"

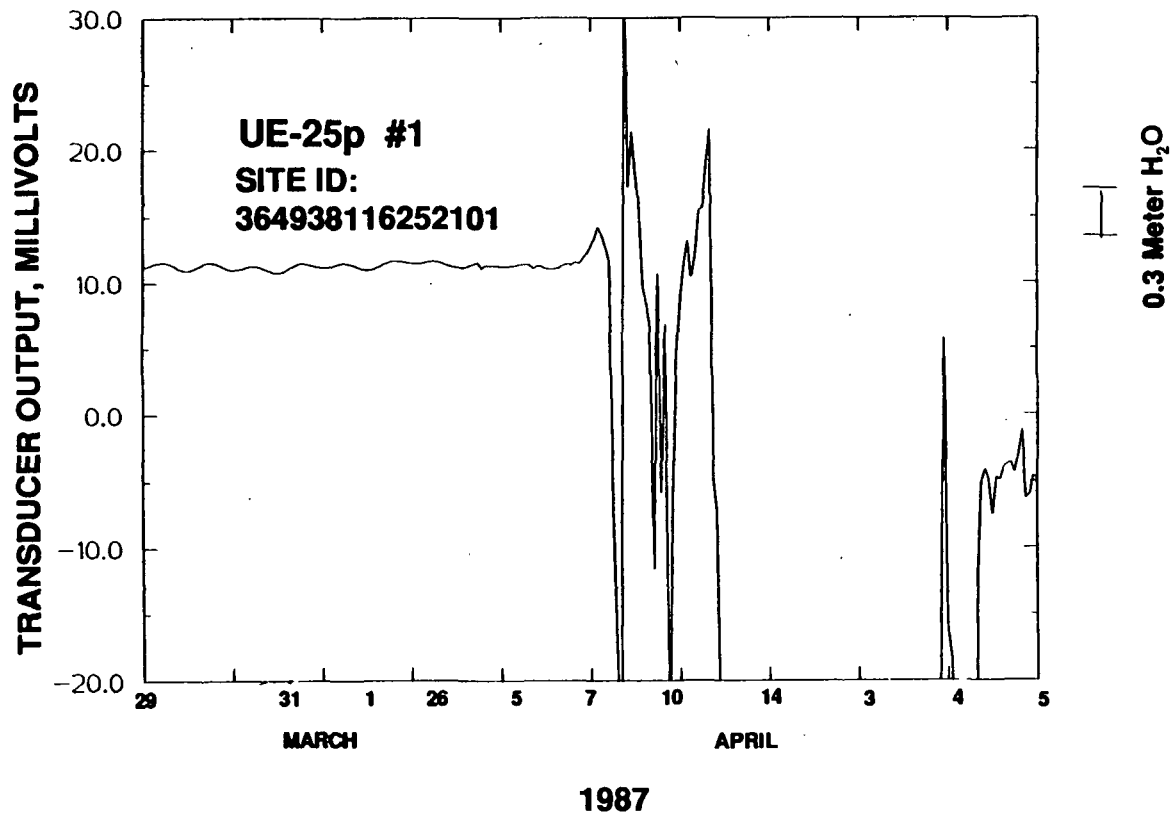
TYPE 1 - DRAMATIC, BUT EXPECTED RESPONSE TO BAROMETRIC PRESSURE CHANGES; LOW AMPLITUDE

TYPE 2 - LOW AMPLITUDE, UNEXPECTED RESPONSE (CONCURRENT WITH BAROMETRIC PRESSURE CHANGES)

TYPE 3 - LOW AMPLITUDE, UNEXPECTED RESPONSE (NOT CONCURRENT WITH BAROMETRIC PRESSURE CHANGES)

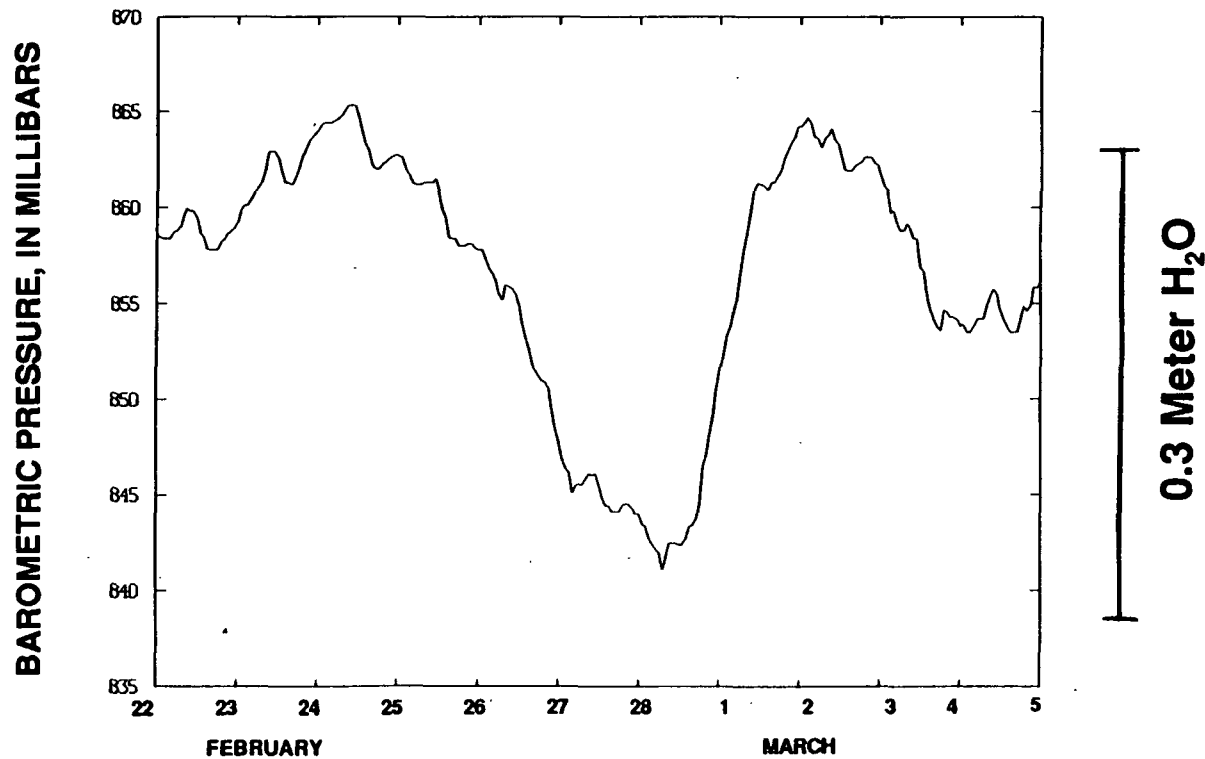
TYPE 4 - HIGH AMPLITUDE, UNEXPECTED RESPONSE (NOT CONCURRENT WITH ANYTHING)

TYPE 4 "WATER-LEVEL EXCURSION"



UNLIKELY THAT THIS REPRESENTS REAL WATER-LEVEL FLUCTUATIONS

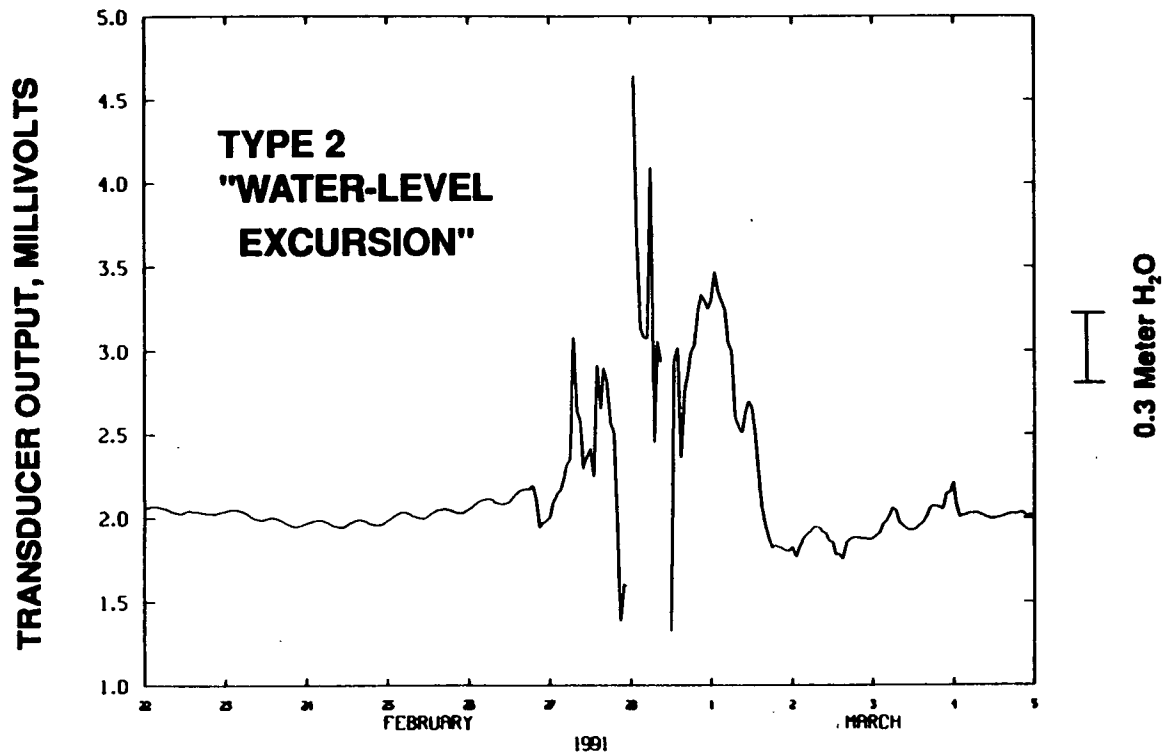
EXCURSION AT USW G-3 FEBRUARY 27 - MARCH 2, 1991



CONVERSION BAR TO WATER LEVEL ASSUMES
100 PERCENT BAROMETRIC EFFICIENCY

EXCURSION AT USW G-3 FEBRUARY 27 - MARCH 2, 1991

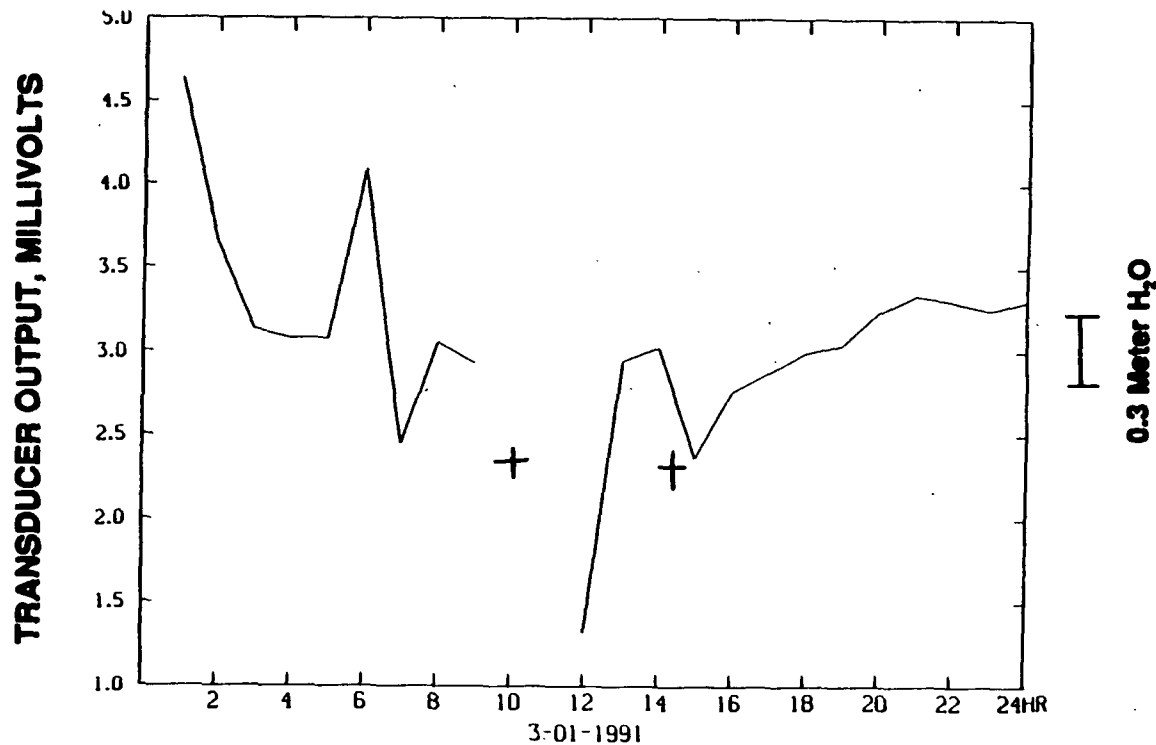
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GAPS IN DATA REPRESENT TRANSDUCER OUTPUT GREATER THAN 5.0 MILLIVOLTS

EXCURSION AT USW G-3 FEBRUARY 27 - MARCH 2, 1991

(CONTINUED)



**GAPS IN DATA REPRESENT TRANSDUCER OUTPUT
GREATER THAN 5.0 MILLIVOLTS**

CROSS REPRESENTS WATER-LEVEL TAG CONVERTED TO TRANSDUCER OUTPUT

EXCURSION AT USW G-3 FEBRUARY 27 - MARCH 2, 1991

(CONTINUED)

- **VISIT AT 10:00 a.m. MARCH 1 INDICATED WATER LEVEL UP 0.3 METERS; TRANSDUCER INDICATED WATER LEVEL UP 6.0 METERS**
- **NOTES CONCLUDE "...THIS EXCURSION, BEYOND THE EXPECTED WATER -LEVEL CHANGE GIVEN THE BAROMETRIC-PRESSURE CHANGE, WAS NOT REAL."**
- **CANNOT CONCLUDE ALL OTHER EXCURSIONS ARE NOT REAL, BUT AT LEAST SOME ARE NOT REAL**

FUTURE PLANS

- **CONTINUE TO MONITOR WATER LEVELS TO DETERMINE LONG-TERM TRENDS AT ALL SITES**
- **MOVE CONTINUOUS MONITORING EQUIPMENT TO NEW SITES**
- **DRILL 8 TO 14 ADDITIONAL WELLS TO AUGMENT CURRENT NETWORK**
- **CONVERT UZ AND SELECTED SD HOLES TO MONITOR WATER LEVELS**
- **INITIATE STRAIN MONITORING TO DIRECTLY MEASURE EARTH CRUSTAL STRAIN**
- **DETERMINE IF EXCURSIONS ARE REAL**

FUTURE PLANS

(CONTINUED)

- **DETERMINE IF FAULT CREEP IS OCCURRING AT YUCCA MOUNTAIN**
- **PRODUCE UPDATED MAP OF UPPER-MOST POTENTIOMETRIC SURFACE**
- **CONTINUE TO ANALYZE WATER-LEVEL FLUCTUATIONS TO ESTIMATE HYDRAULIC PARAMETERS**
- **INVESTIGATE POSSIBILITY OF ESTIMATING HYDRAULIC PROPERTIES AT WATER-TABLE HOLES**
- **INVESTIGATE ROLE OF FAULTS IN SATURATED-ZONE FLOW SYSTEM (ANOTHER ACTIVITY)**