

Kontinentales Tiefbohrprogramm der Bundesrepublik Deutschland Oberpfalz: Optimized EM Interpretation Newman, Strack, Wolfgram (Köln)

THE PROBLEM

DUE TO THE RELATIONSHIP BETWEEN THE ELECTRICAL RESISTIVITY AND THE FLUID CONTENT, THE EXACT DEFINITION OF THE ELECTRICAL STRUCTURE IS A CENTRAL QUESTION FOR THE DEEP DRILLING PROJECT.

DURING THE PRESITE INVESTIGATION LONG OFFSET TRANSIENT ELECTRO-MAGNETICS (LOTEM) HAS CONTRIBUTED SIGNIFICANTLY TO THE UNDERSTANDING OF ELECTRICAL STRUCTURE. WE PROPOSE THE APPLICATION OF LOTEM AND MAGNETOTELLURICS (MT) FOR DEFINITION OF THE 3 - D STRUCTURE FOR :

- LOCAL COVERAGE OF THE DRILL SITE (1.5 KM X 1.5 KM)
- EXTENSION TO REGIONAL COVERAGE (15 KM X 15 KM)
- TIME DEPENDENT RESISTIVE MONITORING TO DETERMINE CHANGES CAUSED BY THE WELL ITSELF
- COMBINATION WITH DOWNHOLE EM MEASUREMENTS

THE METHOD

THE LOTEM METHOD CONSISTS OF A GROUNDED WIRE TRANSMITTER THROUGH WHICH A CURRENT STEP OF SEVERAL TENS TO SEVERAL HUNDREDS AMPERES IS INJECTED INTO THE GROUND (RESULTING FIG. 1). THE AMPLITUDE AND SHAPE OF THE TRANSIENT CONTAINS THE INFORMATION OF THE SUB-SURFACE. REPETITIVE CURRENT SWITCHING CAUSES ANOTHER TRANSIENT WHICH IS THEN VERTICALLY STACKED AND PROCESSED USING DATA PROCESSING TECHNIQUES SIMILAR TO THOSE USED FOR SEISMIC DATA. USING ELECTRICAL FIELD MEASUREMENT LOTEM CAN DEFINE AS THE ONLY EM METHOD RESISTIVE STRUCTURES. THE DIFFUSION PROCESS OF THE INDUCTION CURRENT CAN BE VISUALIZED WITH THE SMOKE RING CONCEPT. IN FIG. 2 CONTOURS OF THE ELECTRIC FIELD ARE DRAWN FOR DIFFERENT TIME STEPS TO VISUALIZE THE DOWNWARD AND OUTWARD MOVEMENT AT THE INDUCTION CURRENTS.

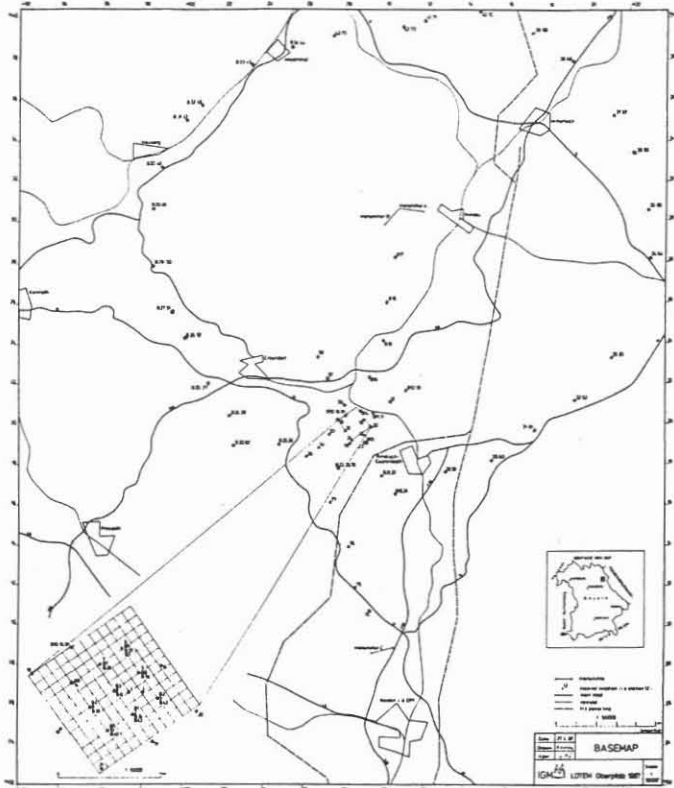


FIG. 3

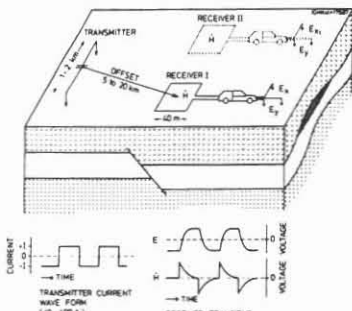


FIG. 1

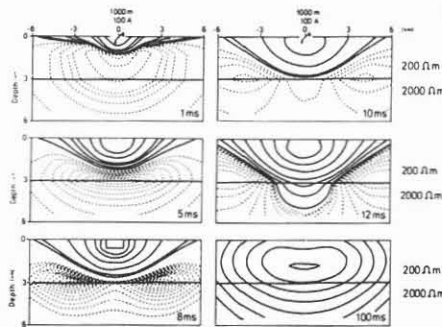


FIG. 2

COMBINATION MT - LOTEM :

- INTERPRETATION OF MT - DATA WITH OPTIMIZED NEW ALGORITHMS ACCOUNTING FOR SPECIAL SITUATION IN THE OBERPFALZ
- JOINT INVERSION ; MT - LOTEM

3 - D LOTEM INTERPRETATION

- START WITH MODELS FROM PRIMARY GOAL
- INTEGRATE MODELS FROM 3 - D SEISMIC AND DERIVE 3 - D MODELS USING EXISTING
- 3 - D PROGRAM (SEE FIG. 4)
- CONFIRM OR DISAPPROVE INITIAL INTERPRETATION
- TIE RESULTS WITH DOWNHOLE EM MEASUREMENTS

PREVIOUS WORK DONE

DURING THE PRESITE SURVEYS LOTEM MEASUREMENTS WERE SUCCESSFULLY DONE IN THE BLACK FOREST AND OBERPFALZ (SEE SEEHEIM 1986). THE BLACK FOREST EXHIBITED A TEXT BOOK INTERPRETATION WHERE A LOW VELOCITY CHANNEL COINCIDES WITH A LOW RESISTIVITY ZONE. THE OBERPFALZ SHOWED A HIGHLY QUESTIONABLE CONDUCTOR AT 10 - 11 KM DEPTH. FROM THE FIELD SURVEY IN 1986 SERIOUS CONCERNS ABOUT THE THREE DIMENSIONALITY EXISTED.

DURING SPRING 1987 A COMPLETE 3 - D LOTEM SURVEY WAS CARRIED OUT (SEE FIG. 3). DETAILED COVERAGE OF 1 KM AROUND WELL SITE PLUS FIRST CONNECTION TO REGIONAL STRUCTURE WAS DONE. IN ORDER TO TIE THE DRILL SITE TO THE REGIONAL EM STRUCTURE TWO COMPLETE 360° "FAN SHOOTING" TESTS WERE DONE AROUND TWO PERPENDICULAR TRANSMITTER AS WELL AS WALK-AWAY TESTS FROM TRANSMITTER TO THE DRILL SITE.

SHORT TERM GOALS

- CONTOUR SIMPLE PARAMETERS (MMR - FACTOR, E - POLARISATION ETC.) TO OBTAIN FIRST INDICATORS FOR LATERAL CONTRASTS.
- TIE RESULTS FROM DRILL SITE INTO REGIONAL EM STRUCTURE USING 1 - D INVERSION.
- DEFINE RESISTIVITY OF RESISTIVE SECTION MORE ACCURATE USING ELECTRIC FIELDS.

LONG TERM GOALS

- COMBINE MT - MEASUREMENT WITH LOTEM MEASUREMENTS
- 3 - D LOTEM INTERPRETATION
- EM MONITORING OF CHANGES CAUSED BY DRILLING

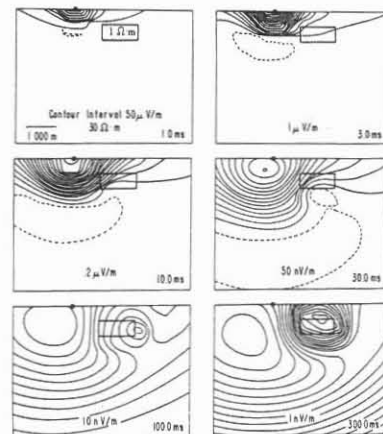


FIG. 4