Kontinentales Tiefbohrprogramm der Bundesrepublik Deutschland

Oberpfalz, Electrical Conductivity Studies

Gundelach, Steveling (Göttingen)

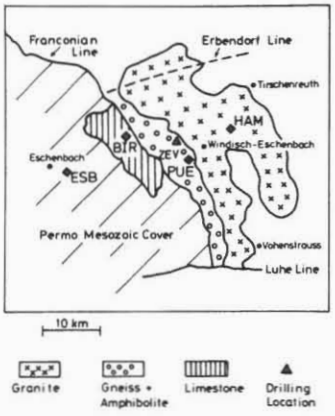
Aims of the project:

a) to derive transfer functions between magnetic variations at the proposed drilling site (NAB) before drilling operations are started and those at the reference site (BIR) for comparison with future borehole observation,

b) to determine the depth distribution of electrical conductivity in the area of the deep drilling location Windisch-Eschenbach,

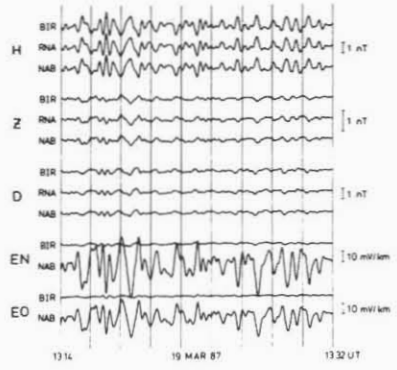
c) to study the ZEV (Zone Erbendorf Vohenstrauss) and FL (Franconian Line) in the depth range of penetration of pulsations (8-300s),

d) to interpret this area with multidimensional models.



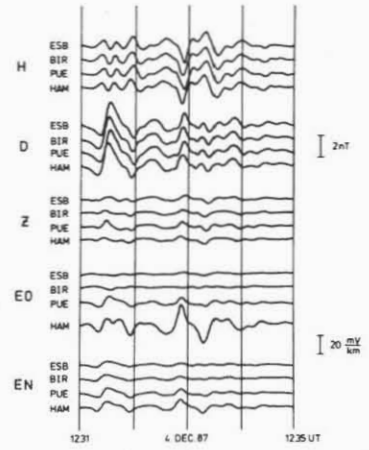
Field Observations

were in two phases, march 1987 simultaneously at NAB (drilling location) and BIR just westward of the FL; november/december 1987 simultaneously on Falkenberg granite (HAM), within the ZEV gneiss (PUE), on the permo-mesozoic foreland westward of the FL (BIR,ESB). Magnetic observations were carried out with inductioncoil magnetometers in both phases, in addition with fluxgate magnetometers for variations in the first phase.

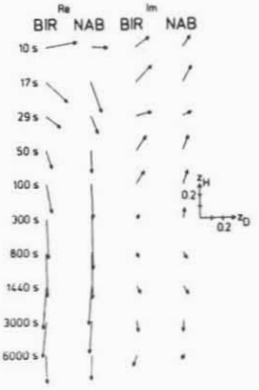


Stacked sample records

indicate the essential findings by visual comparison between components and sites of observation. Vertical bars are minute marks, H Z D denote magnetic and EN EO telluric field components. First phase records (RNA=NAB for control): magnetic pulsations are without visible differences, constant Z of remarkable size (Z:H=0.3), at longer periods correlated with H, reflects BERKTOLD regional anomaly. Strongly polarized large telluric pulsations (EN and EO appear parallel) at the drilling site NAB, when compared to those at reference site BIR.

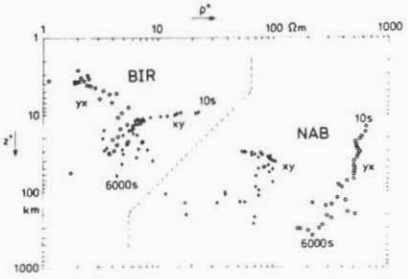


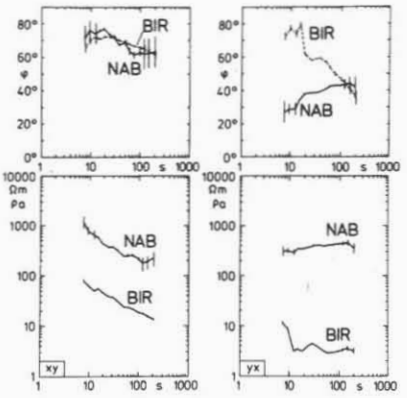
Second phase records: Again spatial uniformity of magnetic pulsations, but clearly discernible short period anomaly in Z (cf. first minute interval) which is correlated to D and thus correlated to the FL surficial conductivity contrast. Note the smooth disappearance of the northward telluric pulsations EN going from the crystalline across the FL into the foreland, to be interpreted as E-polarization induction with respect to the FL and thus most susceptible for depth estimates of electrical conductivity.



Geomagnetic depth sounding analysis

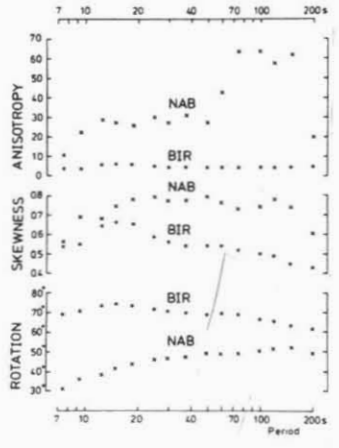
is presented in the form of induction arrows for the anomalous Z, covering the period range from 10s to 6000s (first phase only). At short periods eastward arrows with substantial out-of-phase components indicate local shallow conductivity contrast across the FL, southward arrows at longer periods with disappearing out-of-phase parts are identical at both sites and reflect the mentioned regional eastwest striking BERKTOLD structure. Analysis of H,D pulsations reveals anomalous frequency independent parts in the order of 0.05 at the most, perturbation vectors tending southeast.





Magnetotelluric depth sounding analysis

is described in terms of apparent resistivities and phases for the off diagonal impedance tensor elements, unrotated and for the first phase only (x: north, y: east). CAGNIARD apparent resistivity RHOA-curves for northward current (xy-symbol) are downward towards longer periods, in the RHO*(z*) plot translates to the sharp resistivity reduction at 10km below BIR. Between crystalline and foreland stations appears one decade offset of possibly local origin. The eastward currents show a larger offset between RHOA-curves of NAB and BIR and can be associated with the conductivity contrast at the FL in B-polarization induction.



Impedance characteristics are represented for rotated coordinates, from bottom to top the rotation angle, the skewness to indicate 3-D complications, the anisotropy to indicate the degree of telluric polarization. In the foreland the rotation angle is stable and conforms with the strike of the FL (60^{o}-70^{o}). Within the crystalline the large skewness prevents any simple interpretation of rotation angle and anisotropy which is extreme (up to 60!).

Plans for further work

involve data analysis of second phase, third phase of operations of long term observing at one typical foreland site and one typical crystalline site either on granite or gneiss. Possibly a further experiment will be conducted to substantiate the results from the second phase with parallel line of stations further southeast.