Estimation of Porosity from KTB-Well-Logs

G. Zimmermann and H. Burkhardt
Institut für Angewandte Geophysik
Technische Universität Berlin

Introduction

Estimation of physical properties, transport processes and investigation of fluids in the continental crust are essential objectives of the Continental Deep Drilling Project (KTB). For these objectives the porosity of rocks under in-situ conditions is an important controlling factor. Since in-situ porosity can not be measured directly, it is estimated in this study from borehole measurements of other pysical parameters by a statistical approach.

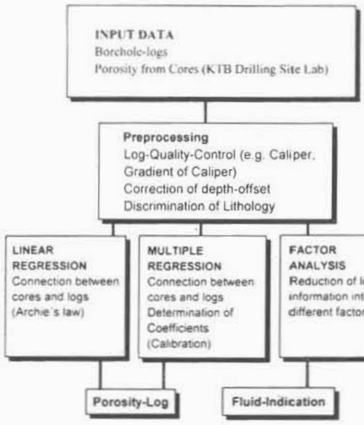


Fig. 1 Concept of analysis

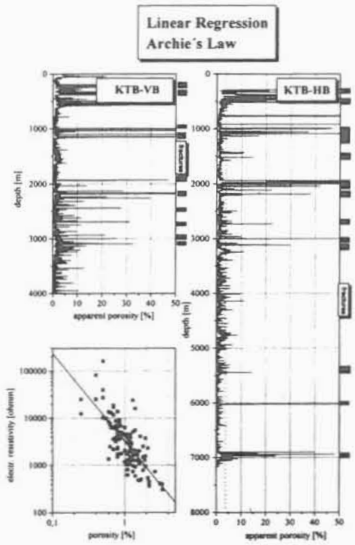


Fig. 4 Porosity estimation due to Archie's law. The crossplot (lower left) contains the calibration of electrical resistivity from Laterolog Deep (LLD) with porosity measurements from cores at the pilot-well of KTB yielding apparent porosity-logs for both boreholes. apparent porosities in the range of the calibration data (< 4 %) can be interpreted as true matrix porosities where as higher porosities are indications for fluid filled or mineralized fracture zones.

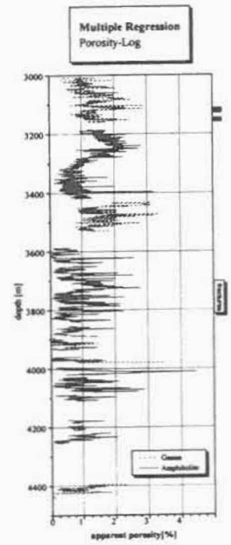
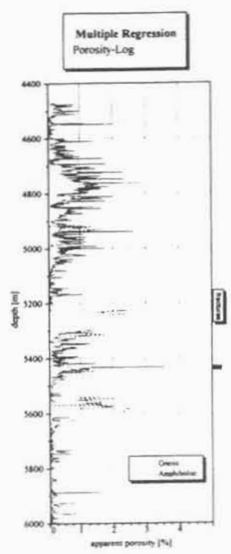


Fig. 2a, 2b Porosity estimation due to Multiple Regression. Calibration by Multiple Regression from the pilot-well (Zimmermann, 1991) leads to a continuous porosity-log in the depth range from 3000m to 6000m for the main borehole. The analysis was carried out for gneisses and amphibolites respectively, the data were separated by the gamma-ray log (SGR) (Gneiss > 70 API > Amphibolite) to avoid lithological influences.
Comparison with Fig. 2 shows a good correlation between both. Interpretation of apparent porostity is identical to Fig. 2. Motivation for multilinear aproaches is the higher significance and higher correlation coefficients than for linear approaches.



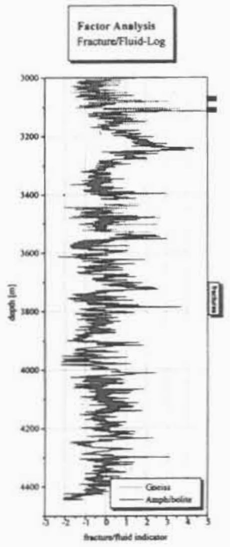
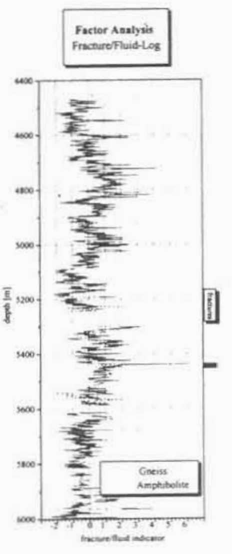


Fig. 3a, 3b Results from factor analysis. Factor analysis was carried out at the depth interval from 3000m to 6000m due to the reduced data set in the other depth ranges. Here too the data were separated for the different lithologies (Gneiss, Amphibolite) before analysis to eliminate lithological effects. The results are corresponding to those of the pilot-well. There is an analog arrangement of logs to so-called 'factors', which can be interpreted according to former work (Zimmermann, Burkhardt, Melchert, 1992) as fluid/fracture indication-log and is therefore a qualitative measure for effective porosity in an arbitrary scale.



Conclusion

The analysis leads to the estimation of matrix porosities as well as to an indication for fracture zones with higher apparent porosities.
The similar results with different approaches support the interpretation.

References

Zimmermann, G. (1991) Integrierte Auswertung von Bohrlochmessungen der Kontinentalen Tiefbohrung (KTB) mit Verfahren der Multivariaten Statistik, Dissertation, Technische Universität Berlin

Zimmermann, G., Burkhardt, H., Melchert, M. (1992) Estimation of porosity in cristalline rock by a multivariate statistical approach, Scientific Drilling 3