Mapping of the Cretaceous-Tertiary boundary in the coastal area of Køge Bugt by gamma- and resistivity logging.

Ole Larsen
Geologisk Institut, University of Copenhagen,
Øster Voldgade 10, DK-1350 Copenhagen K., Denmark.

INTRODUCTION

In the coastal region of Køge Bugt Maastrichtian chalk and Danian bryozoan limestone form the prequaternary basement. Maastrichtian chalk forms the prequaternary basement along a section of the coastline, while Danian bryozoan limestone inland appears above the chalk. On a regional scale the Maastrichtian/Danian boundary surface dips westwards. However, differences in elevation of the boundary surface up to 10m are recorded between wells separated less than 1 km. Previously tectonic movements along vertical faults have been suggested in order to explain these observations (Rosenkrantz 1925, 1938, Christensen 1979, I.Krüger A/S 1987, N&R Consult A/S 1989).

In the opinion of the present author the suggested fault lines are founded on very meager evidence, and none of the faults have actually been proven to exist. This paper reports the results of resistivity logging and gamma logging of water wells in the municipalities of Solrød and Greve with the aim of checking the recorded lithological data. The results suggest that a weak folding of the chalk and limestone would adequately to explain most of the available well data.

The use of resistivity logging for identification of the boundary between chalk and bryozoan limestone was suggested to the present author by Kurt Klitten, senior scientist at GEUS. Bryozoan limestone displays a variable apparent resistivity, while Maastrichtian chalk is characterised by a stable and lower resistivity. The boundary between chalk and bryozoan limestone is generally not recognised on gamma logs. However, layers of marl in the uppermost Maastrichtian chalk give characteristic anomalies on both gamma and resistivity logs. The marls have large lateral extent and may be used as stratigraphic marker horizons.

GEOPHYSICAL LOGGING

Resistivity logging was made using a 32” normal electrode configuration. The gamma logs were recorded using an integral gamma scintillation probe with an outer diameter of 40mm (1” x 2” NaJ(Tl) crystal). In the limestones this probe gives an counting rate of 200-300 counts per minute.
A reference log was made in an uncased well at Højerup, Stevns, located only 400 m inland from the exposures along the coastal cliffs. The apparent resistivity shows a marked drop from 140 Ohmm in the Danian bryozoan limestone to a level of 80 Ohmm in the chalk below. The uppermost Maastrichtian Grey Chalk displays intermediate values in the range 80-100 Ohmm. The boundary between bryozoan limestone and chalk is marked by well-defined resistivity minimum, probably caused by high porosity in the Ceritium Limestone. At Stevns a narrow gamma peak probably representing the Fish Clay is seen at the formational boundary. It probably represents the Fish Clay. No gamma anomalies are seen below this level.

Wells in Karlstrup and Karlsunde in the Køge Bugt area display resistivity patterns similar to the one described from Højerup. Variable resistivity in the range 150-250 Ohmm, typical of bryozoan limestone, is recorded above sections with stable resistivity below 100 Ohmm, interpreted as chalk. The resistivity pattern observed in the bryozoan limestone cannot be correlated from one well to the next, because changes in apparent resistivity reflect differences in porosity within the bryozoan mound structures. A gamma peak from Fish Clay at the formational boundary is very seldomly observed. However, a set of two peaks, approximately 2 m apart, are often recorded on the gamma log between 6 and 10 m below the formational boundary. In cases where only one peak is seen, this peak is asymmetrical hiding the low-intensity peak as a shoulder on its lower side. A minimum may be seen in the resistivity log at the position of the uppermost gamma peak. From lithological logs and preserved drill cores it is evident that these anomalies are caused by layers of marl. Uppermost Maastrichtian marls are well-known from the Copenhagen area, where they cause similar anomalies on both gamma logs and resistivity logs (Andersen & Klitten, 1995, Hansen, 1997). The marls appear to correlate with similar layers found in outcrops in northern Jylland (Hansen et al. 1987). The marls therefore appear to be useful as stratigraphic marker horizons in northeastern Denmark.

**STRUCTURAL INTERPRETATION**

The elevation of the Maastrichtian/Danian boundary surface may be estimated from lithological data available from the Zeus database at GEUS. Wells penetrating both Danian limestone and Maastrichtian chalk are naturally of prime importance. However, deep wells with bryozoan limestone continuing to the bottom may be used to place an upper limit to the position of the boundary surface in places, where more direct information is lacking. Similarly, wells in which Maastrichtian chalk occurs immediately below thin quaternary deposits may be used to indicate a minimum elevation for the boundary surface. The information from the Zeus database has been checked wherever wells were available for geophysical logging. In several cases errors were detected, and well logs have been reinterpreted. A preliminary interpretation of the elevation of the Maastrichtian/Danian boundary surface is presented as a contoured map. Contouring was made manually and is based on a subjective evaluation of the available data. Elevations recorded from some wells, not accessible to geophysical logging, seem to be in conflict with elevations determined from neighbouring wells, unless one is willing to cut the area into a number of individual fault blocks. The author is inclined, at the present stage of this work, to accept a certain amount of conflicting data in order to present a simple structural model involving only weak folds similar to those seen along the cliffs at Stevns Klint (Rosenkrantz 1938).


