

CONODONT COLOUR ALTERATION FROM SUBSURFACE PALAEOZOIC STRATA OF NORTH-WESTERN BULGARIA: BURIAL HISTORY AND HYDROCARBON EXPLORATION

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Introduction

The thermal maturation and burial history of one Palaeozoic sedimentary sequence has been investigated for the first time in Bulgaria by using the method of colour alteration indices (CAI) of conodonts developed by Epstein *et al.* (1977) and completed by Rejebian *et al.* (1987). The application of the study of CAI to the determination of thermal maturation levels has been documented in several countries in the last two decades.

Most of the conodont samples investigated in this study have been obtained from carbonates, mainly limestone rocks, and only few ones from dolomites. The biostratigraphic range and the thermal maturity of the organic matter were determined by evaluating all the conodont elements in each sample. Assignment of the conodont colours has been done by comparison with a standard set made with the supervision of Dr A.G. Harris (Geological Survey, USA). Textural characteristics for different CAI values were also examined with SEM.

Geological setting

The migration of the Palaeozoic basement of North Bulgaria from Peri-Gondwana towards the Eurasian continent took place at the end of the Devonian. During Carboniferous times (Late Visean) began the collision between Moesian and Balkan terranes which gave the shape of the pre-Alpine Bulgarian microplate (Yanev & Boncheva, 1997 with previous references). Related to these events, folds, sedimentary breaks and a different relief were developed in the Moesian area.

The studied Palaeozoic succession, within the Moesian terrane, belongs to Gomatarci borehole located in the westernmost part of the Bulgarian territory.

Biostratigraphy and CAI records

Based on palaeontological data several biostratigraphic intervals were recognised. The first one occurs between the depth interval of 2,435 and 2,820 m, and its age has been established as Visean by means of brachiopods and foraminifera (Spasov, 1977). The younger conodont association has been recovered within the interval of 3,108 - 3,115 m, and is placed within the range of *Siphonodella crenulata* Biozone (Tournaisian). Colour alteration of the conodont elements are indicative of 1.5, 2, 2.5 and 3 CAI values (nearly 90 to 110°C). Within the interval of 3,206 - 3,346 m the presence of *Polygnathus pseudofoliatus* Wittekindt and *P. xylus ensensis* Ziegler, Klapper & Johnson indicates an Eifelian age. An homogeneous CAI value of 3 was measured for these beds. From the interval of 3,349-3,480 m, *Polygnathus ansatus* Ziegler, Klapper & Johnson, *P. xylus xylus* Stauffer and *P. varcus* Stauffer are indicative of the Givetian *Polygnathus varcus* Biozone. The respective conodont colour alteration values are 2, 2.5 and 3.

Discussion and conclusions

Recently, a geothermal gradient of 1°C/33 m has been obtained for direct temperature measurements in the Vidin borehole, 15 Km south-western from Gomatarci locality. According this data the geothermal gradient is very similar to that mentioned by Epstein *et al.* (1977) for the Appalachians. These authors, also presented evidence that CAI values correlate closely primarily with the thickness of the overburden. Applying their experiences to the subsurface palaeozoic sequence in the westernmost region of Bulgaria, several inferences could be done:



-A stratigraphic control is suggested for the studied locality, the thermal maturity levels correlate mainly with the overburden. In this sense, Eifelian sediments with an homogeneous CAI value of 3 overlapped the Givetian ones after reaching the palaeotemperature deduced by the colour alteration of the conodonts.

-The original sedimentary thickness measured from the Gomatarci borehole, is perhaps reduced if we consider that there are at least two erosional surfaces in the examined sequence. According with the data provided by some boreholes located about 50 km farther south, ca. 500 - 600 m of Upper Carboniferous-Lower Permian materials are missing and were probably eroded.

-The coexistence of three different CAI values from Tournaisian and Givetian assemblages could be attributed to the influence of hydrothermal fluids or warm saline solutions. Textural analysis reveal that some of the conodont elements are covered by a film of mineral deposits.

-Information gave by the illite crystallinity (>0.42) in Permian sediments is in accordance to the palaeotemperatures deduced by the CAI values for the Carboniferous and Devonian materials.

-From an economic viewpoint, the examined stratigraphic interval, which ranges from Eifelian to Viséan, is within the hydrocarbon window. Occurrence of heavy to light oil, wet and dry gas (especially the last two ones), could be expected if other geological favourable requirements are present (Nowlan & Barnes, 1987). Information provided in this paper complement a regional study of Yanev (1997).

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