

## Neogene diatom assemblages from lacustrine sediments of Serbia and their distribution in the correlative formations in South-West Bulgaria and Republic of Macedonia

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### INTRODUCTION

Large-scale palaeogeographic changes in the southern part of Europe, which in the Paleogene still belonged to the Tethyan realm, began to take place during the Upper Cretaceous-Paleocene in the present-day area of the Balkan Peninsula. In the Eocene a number of islands had already risen from the sea but the marine (Tethyan) regime lasted until the end of the Oligocene (Capoa & Radoičić 2000). The Balkan Land was formed at the very beginning of the Miocene by emersion uniting the existing islands, thus separating the Paratethys from Tethys (Laskarev 1924). During the Lower Miocene in the Balkan Land a succession of three lake systems was formed (Krstić et al. 2003).

The evolution of and distribution mechanism for lacustrine diatoms in Serbia, Montenegro, and Kosovo are explained here for the first time. This study provides preliminary description the Neogene non-marine sediments, their precise age, and clarifies the conditions under which they were deposited. The evolution of the Miocene and Pliocene diatom floras in the region and the colonization history of the regional continental basins is also presented.

### MATERIAL & METHODS

As a part of the IGCP project № 329 "Palaeogeographic and Palaeoecological Evolution of Paratethyan Basins during Neogene and their Correlation to the Global Scales" outcrop materials from fourteen grabens on the territory of Serbia, Montenegro and Kosovo were studied (Ognjanova-Rumenova 2006). In five of them diatom-bearing samples were separated: "Lubnica", open coal mine; Kolubara Basin, open coal mine; Pljevlja Basin, open coal mine; Vranje Basin, Vranje Miocene complex, open coal mine; Metohia Basin (Dakovica), Metohia Formation.

Samples were cleaned by the modified method of Ognjanova-Rumenova (1991), which combined the methods of Schrader (1973) and Hasle & Fryxell (1970). Abundance counts were made using relative Schrader's scale (Schrader 1973). Preparation for scanning electron microscopy (SEM) followed Hasle & Fryxell (1970) and samples were examined on Jeol JSM 5510 at Sofia University "St.Kl.Ohridski".

### RESULTS

#### Lubniza Basin (Open Coal mine)

Miocene coal-bearing deposits lie transgressively and unconformably over volcano-clastic deposits of andesitic composition and Upper Cretaceous sediments.

Coals are interbedded by thin coal clay seams and limy siltstones (Middle Miocene age according to very deformed fossil lacustrine molluscs and marsh macroflora remains). Coals are covered by tuffaceous sandstones (Knežević 1995).

The studied profile is generally dominated by diatom species belonging to centric genera *Actinocyclus* Ehrenb. and *Aulacoseira* Thwaites.

### **Kolubara Basin (Open Coal mine)**

Kolubara Coal Basin is one of the largest in Serbia, covering about 600 km<sup>2</sup>. It was a partially isolated gulf of the Paratethys sea with marine deposits of the Badenian, Sarmatian, Pannonian and Pontian age, and maybe the lowermost are the Lower Miocene lacustrine deposits. During the Pontian, the sea transgression towards the south formed two different sedimentary belts with coal deposits, separated by a regional dislocation of the W-E direction (Jovanović 1997). The basin is divided by the Kolubara river into east and west segments, both of which are productive with respect to coal, but only the eastern part supports diatomite production. Field B is located in this eastern part of the basin. Two coal seams are determined (Obradović et al. 1994):

- the main coal seam with average thickness of 22 m;
- upper coal seam, alternated by grey plastic clay associated with diatomite, grey sandy clays and sands.

Diatom bearing sediments have been analyzed by Obradović et al. (1994), but there is only scanty information about the diatom flora. The studied profile is dominated by different species of *Aulacoseira*, *A. granulata* (Ehrenb.) Simonsen, *A. ambigua* (O.Müll.) Simonsen, as well as one interesting coarse ornamented form *Aulacoseira* sp. Subdominants are species belonging to the genus *Actinocyclus* and various pennate diatoms.

### **Pljevlja Basin (Open Coal mine)**

Montenegro is situated in the south-east of the Dinaridic domain. Lacustrine deposits are limited in the northern part of the region - Pljevlja Basin.

The Neogene sediments of Pljevlja are covering about 14 km<sup>2</sup>. The thickness is 350 m. The main coal seam appears in the form of single bed desintegrated into several beds towards the periphery and the underlying horizons. Its thickness varies from a few to 30 m in the central basin part. Below the coal there are green and pale yellow variegated clay (Žic et al. 1995).

The determined diatom flora is of poor taxonomical diversity. The community is composed of species belonging to the genus *Aulacoseira*, but there is a high degree of dissolution of diatom frustules due to increasing pH in the paleobasin (Marović et al. 1999).

### **Vranje Basin (Open Coal mine)**

A succession of grey-greenish marl, brown clay, bentonitic clay and grey sand (220 m in thickness) is centrally located in the Vranje depression. Its uppermost part includes 4 m of the bipartite coal seams and the underlying diatomite. Diatomite sediments (thickness 1.0–8.0 m) have been traced on the sides of the Bunuševac stream ravine, south of the coal outcrops (Krizak 2003).

The dominant complex of the investigated diatom flora consists of different *Aulacoseira* species. The most abundant *Aulacoseira* species was identified by Héribaud as *Melosira tenuissima* Grunow from Neogene sediments in Auxillac, France (Héribaud 1893). After revision of Héribaud's raw materials (Hustedt collection, Alfred Wegener Institute – Hust. 173-21), a lot of differences in the morphology and the ultrastructure of the frustules of *Aulacoseira italica* var. *tenuissima* (Grunow) Simonsen (Syn.: *Melosira tenuissima*) sensu Grunow and this *Aulacoseira* sp. are established. The main differences are in the form, number and position of rimoportule, as well as in the structure of the velum. This again underlines the need for proper deposition of type material according to the rules of Botanical Nomenclature and for cataloguing the collection housing such material.

### **Metohia Basin (Metohia Formation)**

Neogene basins - Kosovo, Metohia and Drenica, formed a unified basin only for a short time in their history. Neogene deposits are divided into three series - Peć Series, Kosovo Series and Metohia Series and each of them has a different extent.

The Metohia Formation extends throughout the Metohia depression from north to south in a thickness of 300 m. Its lower part consists of sandy silt bearing benthic molluscs, overlain by ca. 100 m of diatomitic silt topped with conglomeratic sand of a prograding delta facies.

The Metohia Formation was dated as Pliocene, more specifically equivalent of Dacian stage (Krstić 1995).

Two diatom assemblages can be distinguished in the development of the diatom flora in the investigated profile. The lowermost part of the sequence is again determined by the coarsely ornamented *Aulacoseira* species. The diatom flora of the second association is characterized by the dominance of one very variable form – a species belonging to the genus *Cyclotella* (Kütz.) Bréb., subdominants are species belonged to genera *Stephanodiscus* Ehrenb. and *Cyclostephanos* Round.

## DISCUSSION

Due to the evolutionary history of planktonic centric diatoms, the main stages in the biochronological scheme for the Balkan Peninsula have been established. They are more useful for high resolution biostratigraphic analysis than benthic diatoms, which have a more localized distribution controlled by depth, pH, salinity, substrate, etc. The development of the genera in the class Coscinodiscophyceae is dependent on the palaeoenvironmental changes in the lake evolution like oscillations in the depth of the basin, changes in the water pH, temperature, different trophic phases, etc..

The oldest lacustrine centric diatoms in Serbia are from an unnamed unit of open coal mine “Lubnica”, Middle Miocene age. *Aulacoseira*, *Ellerbeckia* R.M.Crawford, *Melosira* C.Agardh and *Actinocyclus* developed during that time. Similar but dissolved and poorly preserved taxa are present in the Simitli Basin (Simitli Fm) of Bulgaria (Ognjanova-Rumenova 2000). The Late Miocene stage is represented by coarsely ornamented *Aulacoseira* species in the Vranje and Kolubara Basins. Similar species from the genus *Aulacoseira* are the dominants in diatomaceous sediments of Gotse Delchev Basin (Baldevo Fm) and Elhovo Basin (Elhovo Fm), SW Bulgaria and Prespa Basin, Macedonia (Ognjanova-Rumenova 2001). The Pliocene stage coincides with the gradual extinction of fossil *Actinocyclus* species, the first occurrence of taxa from the genera *Pliocaenicus* Round & Håk. and *Cyclostephanos* Round, and domination of different species from the genera *Stephanodiscus*, *Cyclotella* and *Aulacoseira*. Very interesting and specific is the *Cyclotella* diatom flora from the Metohia Basin (Metohia Fm).

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