Middle Eocene Rastiš formation and Upper Eocene-Oligocene? Adriatic flysch formation in southern Montenegro (South Adriatic zone)

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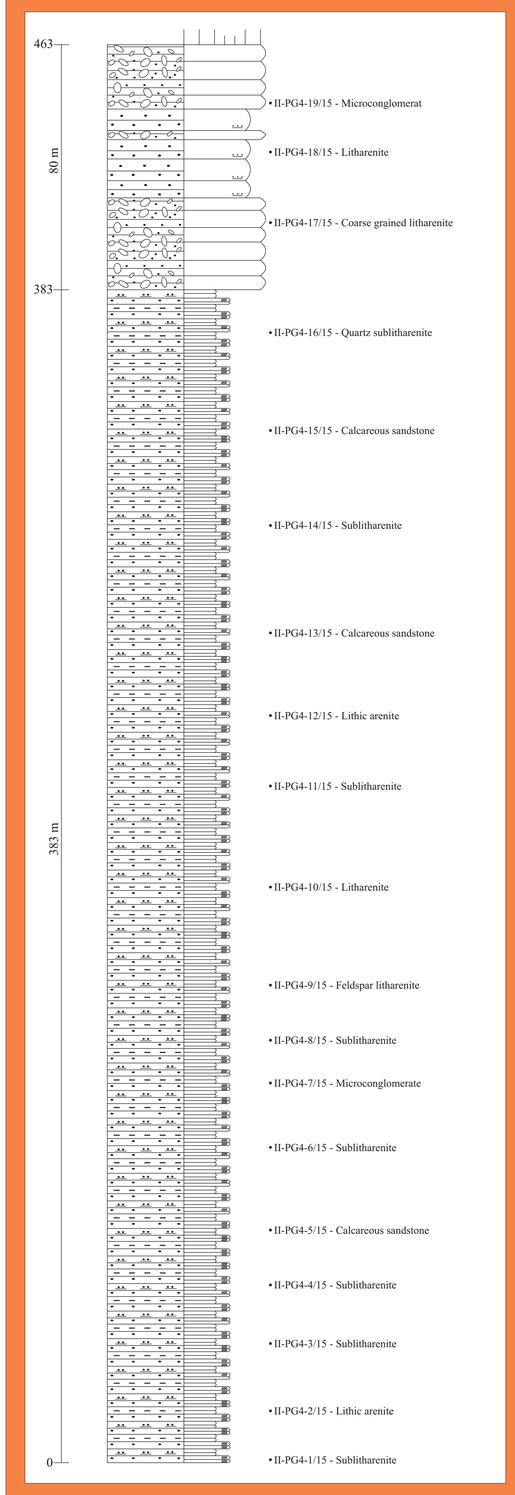
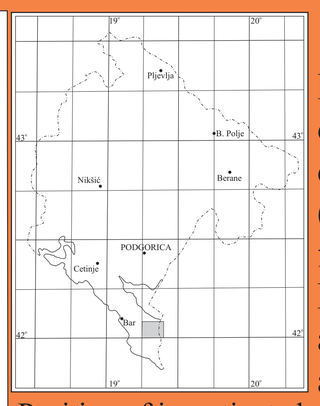


General geological column of Rastiš Formation

Geological map of investigated area, 1:50 000
FKR/E_2 - Rastiš Formation
JFL/E_3-Ol? - Adriatic flysch Formation



Position of investigated area in Montenegro

Sandstone and marl series of Rastiš Formation

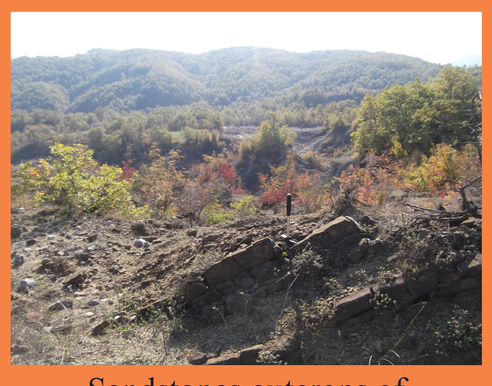
Coarse grained sandstones of Rastiš Formation

Poorly sorted conglomerates of Rastiš Formation

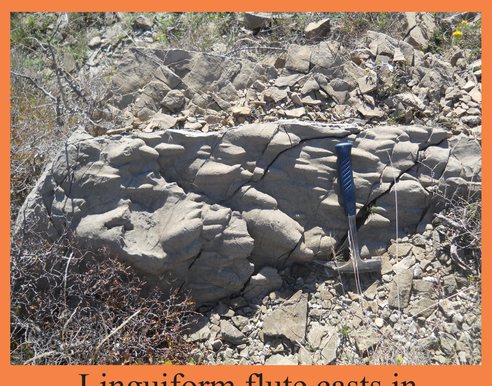
Clays with gravel of Rastiš Formation

Ichnofossils found during field work:
1-3. *Scolicia strozzi*
4. *Palaeodictyon hexagonum*
5. *Palaeodictyon praedictum*
6-8. *Ophiomorpha* sp.
Ichnofossils 1-5 were collected from Adriatic flysch formation, and 6-8 were collected from Rastiš formation sediments.
All photos natural size.

General geological column of Adriatic flysch Formation



Sandstones outcrops of Adriatic flysch Formation



Linguiform flute casts in Adriatic flysch Formation

In the area of southern Montenegro, north of the town of Ulcinj, clastic sediments of Eocene age are developed, i.e. molassic sediments of Rastiš formation (Middle Eocene), and sediments of Adriatic flysch formation (Upper Eocene-Oligocene?).

Rastiš formation sediments build a column 450 m thick and are represented with sandstones, marls, alevrolites and clays in the lower part, and conglomerates and coarse grained sandstones in the upper part. Sandstones, as the dominant member of the lower part of the series, are represented with litharenites, sublitharenites and calcareous sandstones. Main components are quartz, rock fragments, feldspars and mafic minerals, while the matrix is carbonate. Horizontal and cross bedded stratification is common in these rocks. Sandstones often contain ichnofossil *Ophiomorpha* sp. In the upper part of the formation, conglomerates and coarse grained sandstones are equally represented. Conglomerates are poorly sorted, with clast size up to 15 cm, rarely more, comprised of Upper Cretaceous and Middle Eocene limestones, rarely cherts and volcanic clasts. Coarse grained sandstones often have graded bedding. These rocks actually represent molassic sediments, formed in shallow marine conditions on the upper part of continental shelf, at times dominated by fluvial processes of sedimentation, and not turbidites as previously interpreted. The age of the series, based on calcareous nannoplankton (*Blackites gladius*, *Chiasmolithus gigas*, *Chiasmolithus grandis*, *Coccolithus formosus*, *Discoaster barbadiensis*, *Dictyococcites hesslandii*, *Sphenolithus spiniger*, *Reticulofenestra dictyoda* etc.) is determined as Middle Eocene (Lutetian), i.e. it belongs to nannoplankton biozones NP14/NP15.

In the Adriatic flysch formation, that is around 140 m thick, it is possible to observe sequences with graded calcarenites (Ta), lower interval of parallel lamination with coarse grained laminae (Tb), interval of cross lamination, ripple lamination and convolute lamination (Tc), upper interval of parallel lamination with fine grained laminae (Td) and interval with pelagic to hemipelagic clayey or marl sediments (Te). Dominant member of this series are thin bedded sandstones, with carbonate grains and matrix, while clayey and marl sediments are rare. Sedimentary structures are often represented with linguiform flute casts, and rarely with overlapping elongated flute casts and groove casts. In sandstones, trace fossils are represented with ichnogenera *Scolicia* (trace made by echinoids) and *Palaeodictyon*. Čađenović et al. (2010) consider these sediment to be of Upper Eocene to Oligocene age in the region of Bar. Calcareous nannoplankton sampling north of Ulcinj did not indicate this age, but also gave Middle Eocene forms. Considering that these are flysch sediments, it is possible that these forms are reworked, so Upper Eocene to Oligocene age is conditionally accepted. Further sampling of marly sediments for calcareous nannoplankton will give a more accurate age.

Clastic sediments of Eocene age in southern Montenegro indicates a gradual deepening of the basin, where shallow water mollasic sediments of Rastiš formation are being deposited first, and after that the depositional environment changes, so turbidite deposites of Adriatic flysch formation are formed.

REFERENCES

Čađenović, D., Milutin, J., Kilibarda, Z., Radulović, N. 2010: Paleogene in Southern Adriatic Zone (Montenegro). 15th Congress of the Geologists of Serbia, Proceedings, 143-147.