DETRITAL ZIRCON GEOCHRONOLOGY AND SEDIMENTARY PROVENANCE OF THE LOWER DANUBE RIVER

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INTRODUCTION

The Danube River with a length of ca. 2,800 km is the second longest European river after the Volga. As the Danube River crosses multiple sedimentary basins (Vienna, Pannonian, Dacian) its drainage basin covers a variety of geological units of the Alps, Carpathians, Dinarides and Balkans; hence, its tributaries contain a large sedimentary diversity. Detrital zircon (DZ) studies are appropriate for understanding the pattern of orogenic erosion, sediment routing and mixing of different signals during the transport and preservation of the river sediments. This work presents U-Pb geochronology data obtained from modern sediments of seven tributaries in the Lower Danube: Cerna, Topolniţa, Jiu, Olt, Argeş, Ialomiţa and Siret. Additionally, one sample was collected from the Danube Delta front.

METHODS

For a homogenous sedimentary material, several samples were collected from the same GPS localized point from different years and mixed for subsequent zircon grain extraction. Specifically, in March 2015, April and July 2016 were collected for each campaign 8 unconsolidated sand samples from 1-2 km upstream of major left Danube River tributaries (Cerna, Topolnita, Jiu, Olt, Arges, Ialomita rivers) utterly from South and South East of Romania and one sample collected from Mm (maritime mile) 54 on Danube, located West of the Danube Delta, upstream the spliting the Danube into its delta (Fig. 1). Standard mineral separation techniques included digestion of carbonates and other organic matter using HCl (~15%), heavy density liquid - SPT (~2.8g/cm^3) and magnetic susceptibility separations for all samples. Nonmagnetic heavy mineral separates were poured onto double sided tape (~2.54 cm) on epoxy resin mounts. Zircon grains were chosen randomly for analysis by laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) to obtain U-Pb ages. Sample mounts were loaded into a large-volume Helex sample cell and analyzed with a magnetic sector, single collector Element2 ICP-MS with a PhotonMachine Analyte G.2 excimer laser.

Fig. 1. Sample location along the major left Romanian tributaries and the Danube River (red circles)

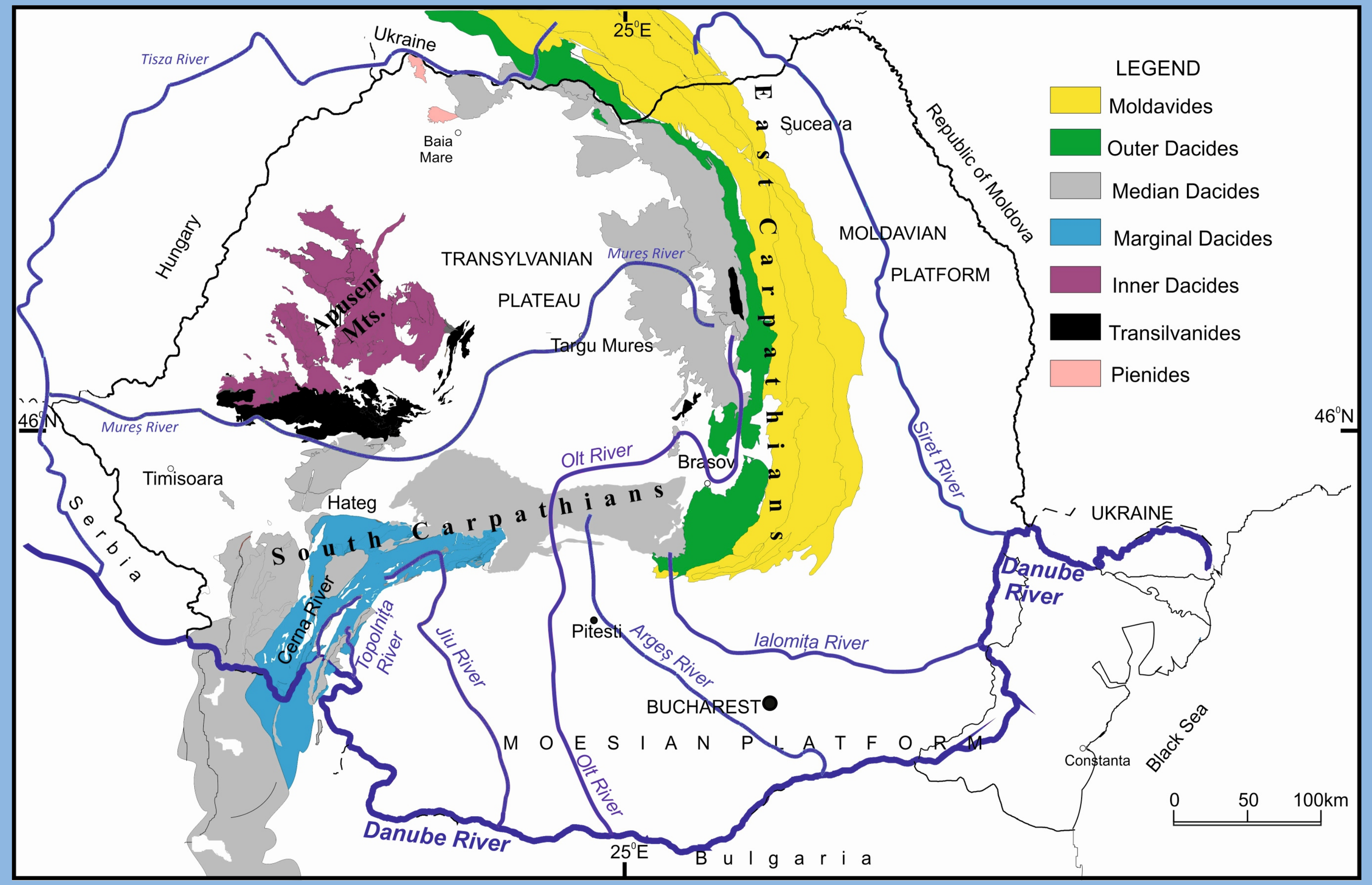

Fig.2. Tectonic map of Romania (from Melinte-Dobrinescu et al., 2009 modified after Săndulescu, 1984; Bădescu, 2005) and the sampled Danube River left tributaries.

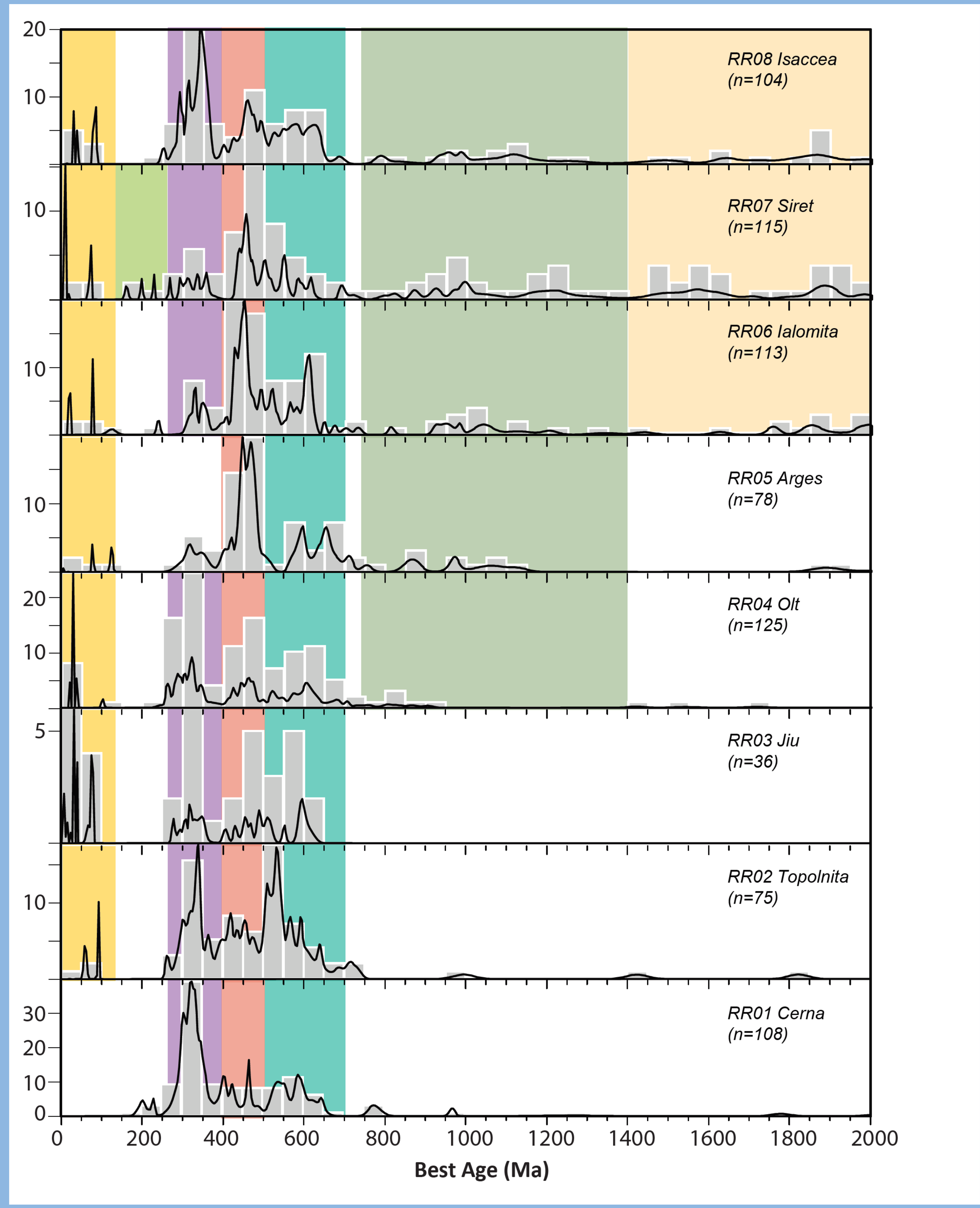

Fig. 3. Danube River and tributaries samples. Number of zircon cristals analysed mentioned above each sample

RESULTS AND DISCUSSIONS

The studied samples exhibit several main peaks, which are from oldest to newest: (i) Cambro-Ordovician, linked to the backarc basins and island arcs of Peri-Gondwana subduction (600 - 440 Ma); (ii) Lower to Middle Carboniferous from Variscan magmatic and metamorphic rocks (350 - 320 Ma), showing significant values in most analysed samples; iii) Alpine, younger than 100 Ma, most probably related to the Southern Carpathian Late Cretaceous Banatitic arc and to the Neogene volcanism of the Eastern Carpathians and Apuseni Mountains . The obtained ages on the DZ geochronology show downstream mixing, similarly to recent published data focused on the sediment provenance studies (Balintoni et al., 2014; Ducea et al., 2018).

For the Lower Danube western investigated samples, such as Cerna, Topolniţa and Jiu, our results show as main source the metamorphic rocks characteristic for the Upper and Lower Danubian tectonic units of the Southern Carpathians (ca. 300 Ma). These Danubian units are identified as components of Dacia mega-unit (Roban et al., 2020) and consist of high grate metamorphic rocks (Medaris et al., 2003). Weak signals of Variscan events (325-340 Ma) were identified by Ducea et al. (2018) and Roban et al. (2020), while in the present study above mentioned samples indicate a regional Variscan metamorphism. The analysis performed on both western samples (Cerna, Topolniţa, Jiu and Olt rivers) and easternmost sample from Danube sediments show a strong Variscan peaks that could corelate principally with the former Ceahlău-Severin oceanic basin (Roban et al., 2020).

Some larger tributaries in the eastern (downstream) Lower Danube, such as Olt, Argeş, Ialomiţa and Siret rivers show temporal disperse peaks on the DZ geochronology, feature probably reflecting successive processes of recycling. Notably, the most representative sources of DZ identified in the samples from easternmost Lower Danube tributaries (Siret and Prut rivers) are the Variscan metamorphites.

Major sources belonging to Variscan orogen and post-Variscan events are, additionally to those already mentioned, reprezented by different types of rocks encountered by Danube River and its tributaries in distinctive units:

a) the Danubian units (250-310 Ma) have late Variscan signatures and are litological defined by postcollisional granitoids (Balintoni et al., 2010; Balintoni and Balica, 2016); the Danubian units are crossed by westernmost rivers Cerna, Topolniţa and Jiu;

b) Nord Dobrogea units are considered post-Variscan intrusions aged 245-255 Ma (Krezsek et al., 2017) and outcrop South of Danube Delta;

c) Several areas involving Variscan relics along the Moesian Platform (Roban et al., 2020) or Cimmerian nappe structures (Săndulescu, 1984, Seghedi 2001, Seghedi et al., 2004).

CONCLUSIONS

The results suggest that the sediments of the western studied tributaries, characterized by small drainage basin, are mainly composed by igneous and metamorphic rocks. The eastern tributaries with larger drainage basins and therefore a much varied type of rocks show a more complex DZ distribution; probably, only a small amount of DZ grains indicates the "primary" source rock. The sample from the Danube Delta Front yielded a wide DZ distribution, mirroring the huge amount of sedimentary material from various sources belonging to all basins crossed by the Danube.

The conducted U-Pb analysis on detrital zircons from major Romanian rivers and the Danube's modern sediments show a mixture of different ages, most important peaks observed at ~300-360 Ma, overlapping the Variscan and post-Variscan periods.

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