Mineralogical and geochemical differences between Late Carboniferous and Late Cretaceous magmatism at the region of Elatsite ore deposit: preliminary data

Минераложки и геохимични различия между къснокарбонския и къснокредния магматизъм в района на находище Елаците: предварителни резултати

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Introduction

Carboniferous and Late Cretaceous magmatism in the region of the Elatsite ore deposit are very closely spatially overlapped. In addition, they have very similar mineral composition, which makes their distinguishing in the field practically impossible. One way to differ these rocks is measuring of their radiogenic isotopic composition, which as the result of their different time integrated radiogenic isotope decay should be different. Unfortunately, this way is time consuming and more expensive.

Here we provide faster way to distinguish between Upper Carboniferous and Upper Cretaceous rocks, which is based on detailed study of the mineral and chemical composition of the rocks in the region of Elatsite ore deposit.

Location and geology of the area

The largest igneous body in the area of the Elatsite Cu-Au deposit is the Upper Carboniferous Vezhen pluton. It is intruded into Central Balkan green-schist metamorphosed group, consisting of phyllites, diabases, chlorite and actinolite schist, greywackes and sandstones. Most of the Upper Carboniferous and Upper Cretaceous dykes and bodies are intruded into the pluton itself, except for some Upper Cretaceous dykes, intruded in the Mesozoic sedimentary rocks in the northernmost part of the region.

Sampling and analytical methods

Many of the Carboniferous and Upper Cretaceous igneous rocks in the region are altered to varying degree. Therefore, for this study, only macro- and microscopically least altered samples were used. Major and trace elements of the bulk rocks were determined by ICP-AES at Acvateratest laboratory. Major elements of minerals and melt inclusions were analysed by electron microprobe at University of Florence (Italy) and University of Belgrade (Serbia). LA-ICP-MS analyses of the trace elements in the minerals and bulk rocks and U-Pb geochronology were carried out at the Geological Institute of BAS.

Geochemistry

The analyzed rocks are shown in the K_2O vs. SiO_2 classification diagram of Peccerillo and Taylor (1976) (Fig. 1a). Carboniferous Vezhen pluton and contemporaneous dykes fall mainly within the high-K calk-alkaline and calk-alkaline series with few Vezhen analyses falling in shoshonitic series. Upper Cretaceous rocks are predominantly shoshonitic. On the multielement diagrams, both Upper Carboniferous and Upper Cretaceous rocks show typical subduction related trace element signature reflected in peaks of K, Rb, Cs, Ba, Th, U and Pb and throughs in of Nb, Ta, Ti, and P. Chondrite normalized diagrams are LREE enriched with flat HREE.

Petrography

The Vezhen pluton is a voluminous plutonic body of granodiorite to granite composition (Kamenov et al., 2002). It is composed of amphibole, biotite, plagioclase, K-feldspar and quartz and accessories. Mafic microgranular enclaves show evidence for magma mingling and mixing. Upper Carboniferous dykes and bodies are composed of phenocrysts of plagioclase, amphibole and biotite and accessories, accompanied by clinopyroxene in the more mafic lithologies and quartz and K-feldspar in the more felsic rocks. Upper Cretaceous rocks have similar mineral composition:

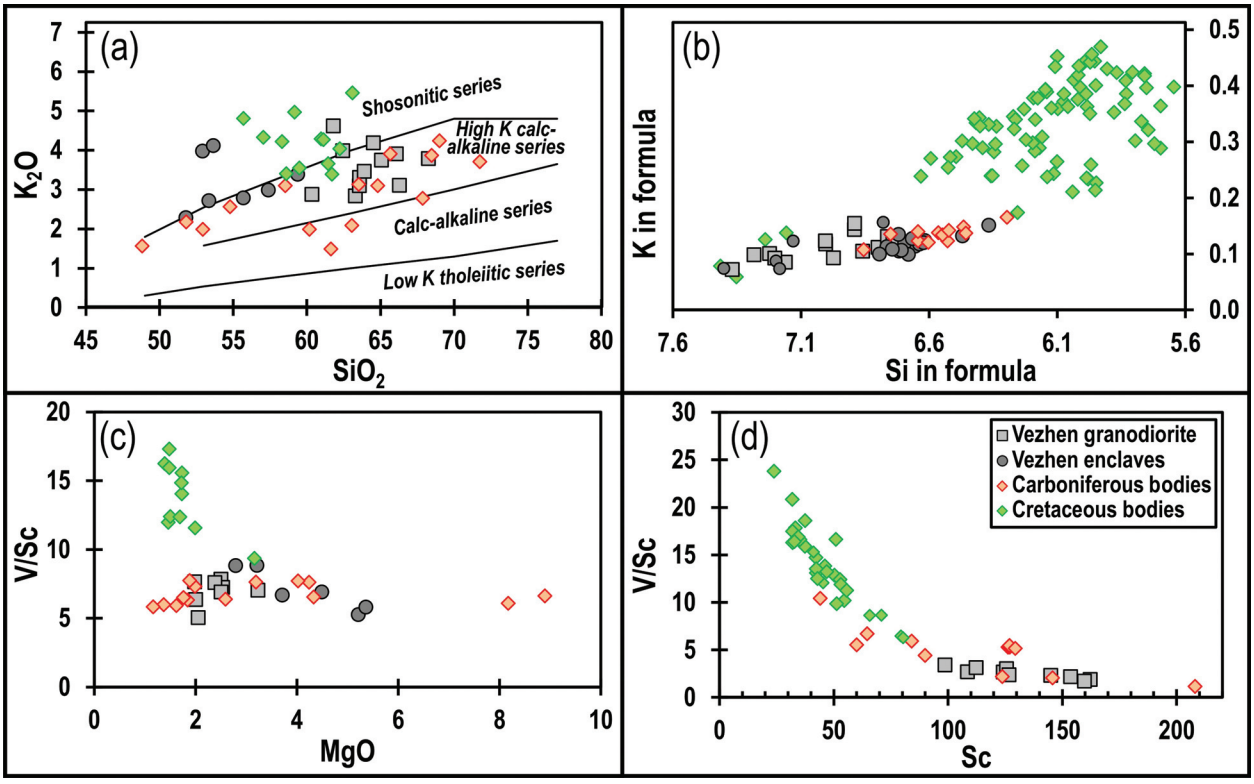

Fig. 1. *a*, SiO_2 vs. K_2O diagram for the Cretaceous and Carboniferous rocks; *b*, Si a.p.f.u. vs. K a.p.f.u. of the amphiboles; *c*, MgO vs. V/Sc ratio in the bulk rocks; *d*, Sc vs. V/Sc ratio in the amphiboles

plagioclase, amphibole, ± clinopyroxene, ± quartz, ± K-feldspar and accessory minerals.

Mineralogical and geochemical differences

The most important differences between the Upper Carboniferous and Upper Cretaceous rock are demonstrated by comparing some element and ratios in the rocks and amphiboles (Fig. 1). Comparison between amphiboles show that Upper Cretaceous amphiboles are predominantly magnesiohastingsite, hastingsite and edenite with $(Na+K)_A > 0.5$ and $K > 0.20$ a.p.f.u.), whereas Carboniferous amphiboles are magnesiohornblende to chermakite with $(Na+K)_A < 0.5$, $K < 0.17$ a.p.f.u.) (Fig. 1b). Amphiboles are easily distinguishable also on the V/Sc vs. Sc diagram (Fig. 1d), reflecting higher Sc contents in the Carboniferous amphiboles. In addition, amphiboles and clinopyroxenes from Upper Cretaceous rocks are relatively enriched in LREE and their bulk rocks are enriched in Sr (not shown). Obviously, the differences in the mineral compositions reflect differences in the chemistry of the melts which produced the rocks (Fig. 1a, c).

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