MAGMATIC EVOLUTION OF THE CRETACEOUS ROCKS WITHIN THE PANAGYURISHTE DISTRICT (CENTRAL SREDNOGORIE, BULGARIA) BASED ON U-PB AND HF-ZIRCON, ND AND SR WHOLE ROCK DATA

Albrecht von Quadt[1] and Irena Peytcheva[1,2]

[1] Institute of Isotope Geology and Mineral Resources, ETH, 8092 Zurich, Switzerland, vonquadt@erdw.ethz.ch
[2] Bulgarian Academy of Sciences, Central Laboratory of Mineralogy and Crystallography, 1113 Sofia, Bulgaria, peytcheva@erdw.ethz.ch

Introduction

The Apuseni-Banat-Timok-Srednogorie Belt (ABTSB, Popov et al., 2000, 2003) is a major metallogenic region in Eastern Europe. The belt is an L-shaped structure of intensive ore-bearing late Cretaceous magmatic activity. It can be traced from the Apuseni Mountains and the Banat region in Romania/Serbia through the Serbian Timok and Ridanj-Krepoljin area to the Srednogorie zone in Bulgaria, the latter comprising late Cretaceous rocks from the western border of Bulgaria to the Black Sea. The belt is considered to extend further to the North in the Western Carpathians, and to the East in Northern Turkey, Iran, and southeast Afghanistan, reaching the Himalayas and building the "Tethyan Eurasian Metallogenic Belt" (Jankovic, 1976 and 1977). For the ABTS orogen a few attempts have been made so far to relate large-scale tectonic processes with mineralisation. Abundant new data on the geodynamic control of various ore deposits, the geochronology and geochemistry of the Late Cretaceous magmatism and the special features of the related Cu-Au deposits in ABTSB have been added during the activity of the GEODE (GEodynamic and Ore Deposit Evolution) project funded by the European Science Foundation. These allow new insights on the regional setting, but also on large-scale relationships and genesis of major ore provinces.

Aims and methods

In the present study we focus on the geological, geochronological and isotope-geochemical characteristics of Cretaceous magmatic rocks in Pangyurishte district, Central Srednogorie, Bulgaria (Fig. 1). The region is especially suitable for study of the ore-forming processes, as there are situated economically important Cu-Au porphyry/epithermal deposits Elatsite, Chelopech, Medet, Assarel, Vlaykov Vruh, Krassen, Radka, Elshitsa and Tsar Assen (Fig. 1). Fertile and barren magmatic rocks crop out in a profile of about 80 km and the changes in the tectonic environment across the belt are supposed to be the key to understand why in a specific place and time an economic deposit was formed. The results show that despite some similarities in the geochemical features of the different magmatic bodies, however latitudinal variations are also recognised. The high precise new isotope data (U-Pb zircon, rutile, Sr-Pb-Nd-Hf tracing) for the Central Srednogorie are considered in the context of the evolution of the whole ABTSB, whereas some constraints on the regional geological setting and timing of fertile magmatism and mineralisation are made.

Geological setting and sampling

The geology of the Panagyurishte district consists of metamorphic and igneous basement rocks, cross cut and overlain by abundant late Cretaceous magmatic and sedimentary rocks, and covered by Tertiary sedimentary rocks (Fig. 1). The oldest basement rocks are high grade metamorphites referred to the so called pre-Rhodopean Supergroup of presumably Precambrian age, the Pirdop Group (Dabovski et al., 1988) or Srednogorie type metamorphic rocks (Cheshitev et al., 1995). They consist of two-mica gneisses, mica schists, ortho-amphibolites, small serpentinite bodies and anatexites. Ivanov (in print) referred to them as „Balkanide type metamorphic complex" of Palaeozoic age on the basis of their field relations with the Upper Carboniferous–Permian conglomerates, and the U-Pb ages obtained on zircons from these basement gneisses (406 ± 30 Ma, 480 ± 30 Ma and 485 ± 50 Ma; Arnaudov et al., 1989). Recently, Peytcheva and von Quadt (2004) confirmed the prevailing Lower Palaeozoic protolithic age of the metamorphics using the high-precision ID-TIMS U-Pb zircon method; the authors obtained an age of 502.8 ± 3.2 Ma for a gneiss north of town Koprivshitsa, and 440-460 Ma in inherited zircons of the Cretaceous magmatic rocks. The last high grade metamorphic overprint is late Variscan (Velichkova et al., 200*3*), but pre-dates the Variscan granitoids in Central Srednogorie. The age of the Srednogorie plutons was constrained by Rb-Sr isotope method (Zagorchev and Moorbath, 1987) in the range 342 ± 27 Ma to 238 ± 37 Ma. Recent U-Pb zircon dating on samples from the different granitic phases yielded an age of 307.7 ± 4.5 Ma for the oldest Smilovene pluton and 285.5 ± 5.2 Ma for the youngest Strelcha pluton (Carrigan et al., 2003; Peytcheva and von Quadt, 2004).

In the region of Central Srednogorie phyllites and diabase of the volcanic-sedimentary sequence (Berkovitsa group) crop out. A diabase sample revealed a U-Pb zircon age of 443 ± 1.5 Ma (Peytcheva and von Quadt, 2004). The sequence is later intruded by the granodiorites of the Vejen pluton, dated recently at 314.8 ± 4.9 Ma (Kamenov et al., 2002).

The type and composition of the late Cretaceous magmatic rocks vary as a function of latitude in the Panagyurishte district (Kamenov et al., 2003), with sub-volcanic and effusive rocks becoming progressively more abundant from south to north with respect to intrusive rocks, but then the tendency changes and in the most southern parts of Central Srednogorie only intrusive rocks crop out. Andesites predominate in the northern and central Panagyurishte district, whereas dacites are more abundant in its southern part. Rhyodacites and rhyolites occur only in the central and southern Panagyurishte district (Kamenov et al., 2003). In the south in the region of Elshitsa-Vlaykov Vruh deposits, andesites are the earliest volcanic rocks, followed by dacites, and a final stage of dacitic-

rhyodacitic subvolcanic intrusions occurred. The late Cretaceous magmatic rocks are calc-alkaline to high-K calc-alkaline with a local transition to sub-alkaline, and their trace element data are coherent with destructive continental margin and/or volcanic arc related magmatism.

Isotope geochronology

Published models up to now were based (apart of the field relationships) on the K-Ar whole rock and mineral ages (e.g. Lilov and Chipchkova, 1999), whereas in the last two years more precise geochronological data were involved (Ciobanu et al., 2002; Lips et al., 2003, Velichkova et al., 2004). The K-Ar whole rock and different mineral ages are scattering between 50 and 112 Ma. The majority of analyses overlap with this range, but ages of 95-65 Ma and more seem to be more widespread in the Srednogorie zone, compared to the other parts of ABTSB. Apart from the question for the duration of the magmatic activity, there is no latitudinal geochronological trend in the Srednogorie zone from north to south or from west to east, based on published data. The main cause is unfortunately the low stability of the K-Ar and Rb-Sr mineral isotope systems to tectonic and thermal/hydrothermal overprint, which hamper the reliable reconstruction. Nevertheless, the dataset of K-Ar and Rb-Sr ages imply mainly Upper Cretaceous magmatism and ore-formation.

The new geochronological data throughout Panagyurishte district in Bulgaria indicate that the late Cretaceous magmatic episodes are regionally discrete in time and space, and in many places are separated by a significant temporal gap in magmatism. In the northern Panagyurishte part of the Srednogorie zone, from the emplacement of the porphyry intrusion at Elatsite and the magmatism at Chelopech at 92.10 – 91.3 Ma, the geochronological data indicate a temporal gap between the Elatsite-Chelopech area and Medet spanning around 1.3 Ma (Fig. 1).

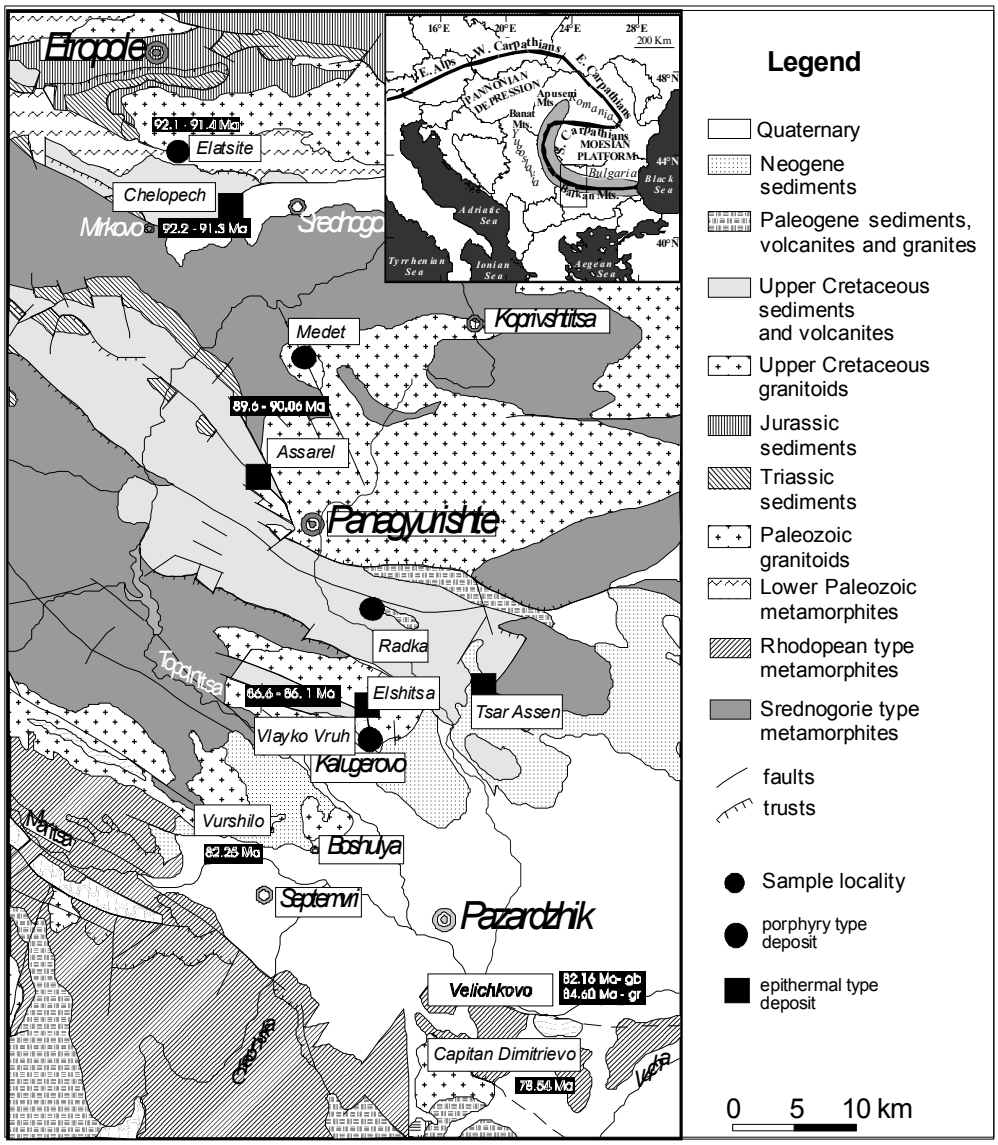

Fig. 1. Simplified geological map of the Etropole-Panagyurishte-Pazardzhik strip with the porphyry and epithermal deposits, (modified after Cheshitev et al., 1989), and the age range for the main magmatic center at Elatsite, Chelopech, Assarel/Medet, Elshitsa, Velichkovo and Capitan Dimitrievo. In the small window – the regonal position of ABTSB and the location of the studied area.

Further south, the next magmatic gap occurs between the intrusions of the Medet-Assarel area at about 90 Ma and the granite-dacite emplacement at Elshitsa at 86.6 Ma; continuing to the south there is one additional magmatic gap between the Vurshilo granite (82.25 Ma) and Capitan Dimitrievo (78.54 Ma) of approximately 4 Ma and a second one between the emplacement of the Vitosha intrusives and the granodiorite of Gutsal of about 4 Ma. Magmatic gaps within the Panagyurishte area are observed between different magmatic centres (Elatsite/ Chelopech – Medet/Assarel; Medet/Assarel – Elshitsa; Vurshilo – Capitan Dimitrievo; Vitosha – Gutsal) and compare to the life time of one single porphyry intrusion centre these gaps are 2-4 times longer. The temporal break of the Cretaceous magmatism on the regional scale is not accompanied by major changes in the regional distribution of magmatism, with the magmatic front migrating not gradually but sporadically from north to south.

Geochemistry and isotope tracing

All geochemical signatures (major-, trace and REE studies) are typical for island-arc magmas of subduction-related origin. The petrographic and geochemical data are consistent with a combination of magma-mixing and fractional crystallization processes (Kamenov et al., 2003).

Sr, Nd and Pb isotope compositions of whole rocks for the Cretaceous magmatites and the Variscan basement rocks show that both have clearly separate evolution trends. The iso-topic fingerprints show that the source of the Cretaceous magmatites is not a remelted material from the existing Variscan basement. The isotopic studies demonstrate within the magmatic rocks a reduction of crustal material in Panagyurishte district from north to south or in other words from the oldest intrusive rocks (92.10 Ma) to the youngest (78.54 Ma).

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