MAGMATIC-HYDROTHERMAL Cu-Au-(Mo-Pb-Zn-Ag) SYSTEMS IN THE SW-PART OF
THE CARPATHO-BALKANIDES

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\textbf{ABSTRACT:} Magmatic-hydrothermal systems with polymetallic mineralizations are common in the SW parts of the Carpatho-Balkanides. Nevertheless, generally they are most remarkable in three metallogenic units, that consists of igneous-volcanic rocks and ore mineralizations of different age. That are the Ridanj-Krepoljin and Bor-Donje Nevlje metallogenic zones, where ore systems connected with Cretaceous magmatism dominate, and metallogenic zone of Lece-Chalkidiki, where numerous volcano-intrusive complexes of Neogene age are located. With these volcanic complexes important Cu-Au polymetallic mineralization is connected.

\textit{Key words: Carpatho-Balkanides, magmatic-hydrothermal systems, metallogeny.}

\textbf{INTRODUCTION}

Magmatic-hydrothermal Cu-Au-(Mo-Pb-Zn-Ag) systems in the East Serbian sector of the SW-part of Carpatho-Balkanides are located at the Ridanj-Krepoljin metallogenic zone and the Bor-Donje Nevlje metallogenic zone (Fig. 1). They were formed in the front of the Jurassic-Cretaceous oceanic slab, subducted from the Vardar zone beneath the Eurasian plate and differ with regard to the styles of mineralization and environments of deposition.

The second magmatic-hydrothermal polymetallic systems are related with the Lece-Chalkidiki metallogenic zone (Fig 2). These systems are formed in post-collision period, mainly at the contact between the Vardar zone and Serbo-Macedonian massif. As typical represents are: Plavica, Borov Dol, Lece-Kiseljak, Pontokerasia in Greece etc. On this worked numerous researchers, but for this paper of special interest are the papers presented by: Jankovic et al. 1995a, Jankovic et al. 1995b, Jankovic et al. 1996, Jankovic et al. 1997, Jelenkovic et al. 1997a, Jelenkovic et al. 1997b, Serafimovski et al. 1999, Serafimovski 1999, etc.

\textbf{DISCUSSION}

The Ridanj-Krepoljin metallogenic zone is located along the western margin of the Carpatho-Balkan block. It can be traced from the area of Poiana Rusca north to Krepoljin the south for over 200 km. This major fracture is, at intervals, marked by hypabyssal granitoid intrusions, locally by the volcanics as well; its S-SE extension is possible for the next 200 km-up to the Rhodope block. The width of zone is mostly up to 1 km, but at local intervals-up to 2-10 km. A major fracture is, at intervals, accompanied
Fig. 1. Carpatho-Balkanic metallogenic province - Eastern Serbia sector
Fig. 2. Geotectonic and metallogenic position of the Lece-Chalkidiki zone (Serafimovski, 2000)
by second-order fractures. A mineral zoning is displayed along Ridanj-Krepoljin metallogenic zone: in the area of Krepoljin dominates hydrothermal metasomatic Pb-Zn mineralization, accompanied by high concentration of Au/Ag, skarn Pb-Zn mineralization, and low temperature Sb-W mineralization. In its S-SE extension, the metallogenic zone is characterized by low temperature Cu mineralization in the Permian red sandstone, and, further southeastwards, by hydrothermal Ba and occasionally Hg mineralization.

This zoning is most likely due to erosional levels, or due to depth of magma emplacement.

The petrochemical characteristics, mode of occurrence, and age of igneous complexes at the Ridanj-Krepoljin metallogenic zone are not uniform. In the sector south of the Danube, two groups of igneous rocks are distinguished: the calc-alkaline, and the alkaline basaltic rocks. The calc-alkaline rocks are represented by subvolcanic intrusions of dacite and andesite, locally developed as pyroclastics, and minor quartz diorite porphyry. The absolute age of dacites and andesite in the area of Krepoljin (K-Ar determination) ranges from 72.6 my to 60.6 my, but mostly between 72.6 and 67.1 my.

The alkaline rocks occur sporadically as dykes of olivine-nephelite, limburgite, nephelinite, teschenite. Genesis of these rocks is still uncertain. The principal associations of elements at the Ridanj-Krepoljin metallogenic zone are identified in the ore deposits are classified as follows: (i) Cu, Pb-Zn, +/- Mo, Bi (skarn); (ii) Sb, W +/- Au (epithermal) and (iii) Cu-S (telethermal).

The Bor metallogenic zone is associated with a rift-greben environment, where volcano-intrusive complexes are developed, but the polygenic volcanics of central type development prevail. The ore deposits associate with the Upper Cretaceous +/- Paleocene multistage igneous complexes, are located within a narrow basin of rift-graben structure, filled by sedimentary and volcano-sedimentary rocks, mainly of the Upper Cretaceous age. This basin is, at present, 0.5-10 km wide and over 100 km long. It can be traced from Majdanpek in the north, to the Donje Newvlje in the southeast. Copper and gold are the dominant metals, accompanied by iron (sulphide, oxide) and base-metals, molybdenum, sporadically PGE. The most prominent morphogenetic types of deposit are porphyry copper/molybdenum, volcanogenic cupferous pyrite, massive base-metal sulphides, and hydrothermal veins, skarns of iron oxides, volcanogenic epithermal gold mineralization of high sulphidation type and exceptionally clasts of copper sulphide ore mechanically accumulated in the small sedimentary basin filled by pyroclastics. The ore deposits are grouped into several ore fields and districts, each characterized by some specific metallogenic features.

This paper aims to briefly review of the magmatic-hydrothermal Cu-Au-(Mo-Pb-Zn-Ag) sistems in the SW-part of Carpatho-Balkanides, and their classification from the aspect of morphogenetical, structural and textural types of mineralizations.

In the third metallogenic unit (the Lece-Chalkidiki zone) are localized the magmatic-hydrothermal systems related with Tertiary magmatism. Some metallogenic features are given as follows. The ore mineralization in the Lece deposit is located within the silicified fracture zones. In addition to hydrothermal lead-zinc deposits, porphyry copper deposits discovered are also of interest.
The basic metallogenetic features of this type of deposits, similarly to those already described, are shown in Table 1.

Table 1. General features of the porphyry deposits in the Lece-Chalkidiki zone

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Kiseljak</th>
<th>Buchim</th>
<th>Borov Dol</th>
<th>Vathi</th>
<th>Pontokerasia</th>
<th>Skouries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Host rock</td>
<td>Andesite</td>
<td>Gneiss/Andesite</td>
<td>Andesite</td>
<td>Brecciated rhyodacite</td>
<td>Rhyodacite/Granosyenite</td>
<td>Granodiorite Porphyry</td>
</tr>
<tr>
<td>Parent igneous rock</td>
<td>Subvolcanic stock/andesite</td>
<td>Subvolcanic stock/andesite</td>
<td>Subvolcanic stock/andesite</td>
<td>Rhyodacite dyke/Subvolcanic stock/dyke.</td>
<td>Stock; Granod</td>
<td></td>
</tr>
<tr>
<td>Absolute age, my</td>
<td>12-23</td>
<td>25-28</td>
<td>24-28</td>
<td>30</td>
<td>32</td>
<td>29.6</td>
</tr>
<tr>
<td>Horizontal projection</td>
<td>0.24 km²</td>
<td>0.25 km²</td>
<td>0.15 km²</td>
<td>150x700 m</td>
<td>300x400 m</td>
<td>200x400 m</td>
</tr>
<tr>
<td>Vertical extent</td>
<td>300-500 m</td>
<td>250 m</td>
<td>300 m</td>
<td>500 m</td>
<td>700 m</td>
<td></td>
</tr>
<tr>
<td>Hydrothermal alteration</td>
<td>Biot, Ser, Sil, Pyr, Arg, Ch, Ty, Di, Cd Cr</td>
<td>Pot, Biot, Ser, Sil, Ch</td>
<td>Pot, Biot, Ser, Sil, Arg, Ch, Ep, Ca</td>
<td>Pot, Biot, Ser, Sil</td>
<td>Ser, Sil, Ch, Ar, Pyr</td>
<td>Pot, Ser, Arg, Ch</td>
</tr>
<tr>
<td>Association of minerals</td>
<td>Cy, Py, Mg, Mo, Au, T, Ga, Sp, E, Bi</td>
<td>Cy, Py, Mg, Au, He, B, Bi, E, Ga, Sp, Te, Ag, Pd</td>
<td>Cy, Py, Mg, He, Mo, Au, B, Sp</td>
<td>Cy, Py, B, E, Ga, Sp, Mg, He</td>
<td>Cy, Py, Stockwork dss, Ga, Sp, Veins</td>
<td>Cy, Py, B, Au, Mg, Sp, Ga, T</td>
</tr>
<tr>
<td>Main Constituents of ore</td>
<td>0.3 % Cu, 0.3 ppm Au, 1.0 ppm Ag, 23 ppm Mo, 4-10 % pyrite</td>
<td>0.3 % Cu, 0.6 ppm Au, 1.1 ppm Ag, 13 ppm Mo, 1-4 % pyrite</td>
<td>Traces: Pd, Se, Te</td>
<td>0.3 % Cu, 0.25 ppm Au, 150 ppm Ag, 24 ppm Mo, 2 % pyrite</td>
<td>Traces: Pd, Te, Pt</td>
<td></td>
</tr>
</tbody>
</table>

The table shows that they are low grade porphyry deposits of small horizontal and vertical range. Almost all porphyry deposits mentioned are in direct connection with subvolcanic dykes and stocks of the Tertiary igneous rocks.

**CONCLUSIONS**

Regional and local metallogenic explorations shows that in the terrains of the SW-parts of the Carpatho-Balkanides exists few complex magmatic-hydrothermal systems arranged in two metallogenic zones. Ridanj-Krepoljin zone and Bor-Donje Nevije zone belongs to the first metallogenic zone with dominating Cu-pollymetallic mineralizations while Lece-Chalkidiki zone belongs to the second metallogenic zone with dominating Cu-Zn deposits.

**REFERENCES**


