GEOLOGICAL SETTING AND AGE OF THE COKA MARIN POLYMETALLIC ORE DEPOSIT (EASTERN SERBIA)

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Abstract: The polymetallic (Au-Ag-Cu-Zn-Pb-BaSO₄) Coka Marin ore deposit is situated in the northern part of the Timok magmatic complex (TMC). This massive ore deposit differs in its mineral assemblage, association of elements, importance of precious metals, etc. from all other massive ore deposits of the TMC. The ore deposit is situated in a large volcanic system and consists of three bodies occurring in brecciated marginal parts of dacito-andesitic dykes, at their contact to weakly altered volcanoclastic deposits of hornblende-biotite andesites. The ore bodies are steep deeping lenses with apophyses. They consist of collomorphic to very finegrained pyrite in which veinlets and nests of enargite, luzonite, chalcopyrite, sphalerite, galena, sulfosalts, barite and other ore and gangue minerals were deposited later in several phases. Hydrothermal alterations in/and around the ore bodies are silification, kaolinization, sericitization, aluninitization, etc., grading sidewards to chloritization and epidotization. The neighbouring hornblende-biotite, hornblende and pyroxene andesites belong to the Santonian (85-83 Ma, but with some minerals rejuvenated). The mineralized dacito-andesitic dykes are of Lower Maastrichtian age (72.6 ± 3.2 Ma) and the unmineralized diorite porphyry dykes in the neighbourhood of the ore bodies consolidated in the Upper Maastrichtian (69-63 Ma). Finally a group of data scatter between 59 and 56 Ma indicating a rejuvenation (heating phenomenon). The mineralization occurred around 71 (± 1) Ma ago and was related to volcanic processes.

Introduction

The Coka Marin polymetallic ore deposit, situated in the northern part of the Timoc magmatic complex, differs from other massive sulphide deposits in this area and is therefore of special interest.

This mineralization was indicated by systematic successive exploration works during 1970's; after detailed geological mapping (1:5,000), when the area of hydrothermally altered rocks was separated (Fig. 1), systematic mapping of alterations by investigation of fragments in soil and geochemical prospection were performed. The drilling began in 1981 and two Cu-Zn-Pb-pyrite ore bodies were detected. In the eighties drilling continued followed by other necessary investigations and the ore bodies are now well determined in their composition, shape and other peculiarities important for explanation.

The similarity of volcanic rocks in this area and their tectonic or intrusive relationships made difficult to explain the evolution in the discovered volcanic system. For this reason isotope age determinations were needed, and 8 analyses were performed in the ATOMKI Institute at Debrecen by Z. Pecskay. The
Fig. 1 - Geological map of the Coka Marin area (according to mapping in sixties by GEO AVOD, Belgrade) and its position in Yugoslavia (upper left, TMC - Timoc magmatic complex). Explanation of signs: 1, Alluvium; 2, Dacite; 3, Projection at the surface of the latter by drilling detected ore bodies; 4, Hydrothermally altered rocks: chloritized, pyritized and silicified; 5, Pyroxene-bearing hornblende andesites; 6, Hornblende andesite; 7, Biotite-hornblende andesite volcanoclastics; 8, Senonian marls and limestones; 9, Boundaries of geological units: sharp (covered), transitional and intrusive (covered); 10, Drillholes; 11, Cross-section presented at Figure 2.
GEOLOGICAL SETTING AND AGE OF THE COCA MARIN ORE DEPOSIT

Table 1

<table>
<thead>
<tr>
<th>Lab no.</th>
<th>Locality, borehole depth</th>
<th>Rock</th>
<th>Dated fraction</th>
<th>K (%) content</th>
<th>K/Ar age (Ma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2277</td>
<td>B-533</td>
<td>Biotite-hornblende andesite fragment from pyroclastics</td>
<td>whole rock</td>
<td>0.54</td>
<td>58.8 ± 2.5</td>
</tr>
<tr>
<td></td>
<td>38.5 m</td>
<td></td>
<td>amphibole</td>
<td>0.24</td>
<td>85.5 ± 3.4</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>feldspar</td>
<td>0.48</td>
<td>56.3 ± 2.8</td>
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<tr>
<td>2279</td>
<td>B-528</td>
<td>Pyroxene-bearing hornblende andesite</td>
<td>whole rock</td>
<td>1.23</td>
<td>83.8 ± 3.8</td>
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<tr>
<td></td>
<td>577.0 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29/2*</td>
<td>B-529</td>
<td>Hornblende andesite weakly altered</td>
<td>whole rock</td>
<td>1.38</td>
<td>82.89</td>
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<td></td>
<td>439.2 m</td>
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<tr>
<td>2281</td>
<td>B-570</td>
<td>Dacitoandesite (mineralized dyke)</td>
<td>whole rock</td>
<td>2.34</td>
<td>72.6 ± 3.2</td>
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<tr>
<td></td>
<td>174.5 m</td>
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<td>B-528</td>
<td>Dioriteporphyry</td>
<td>whole rock</td>
<td>1.59</td>
<td>69.6 ± 4.1</td>
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<td>577.0 m</td>
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<tr>
<td>2282</td>
<td>B-551</td>
<td>Quartzdioriteporphyry</td>
<td>whole rock</td>
<td>0.94</td>
<td>69.1 ± 3.5</td>
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<td></td>
</tr>
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<td>2278</td>
<td>B-603</td>
<td>Biotite hornblende andesite</td>
<td>whole rock</td>
<td>2.25</td>
<td>63.9 ± 2.4</td>
</tr>
<tr>
<td></td>
<td>58.5 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35-K-9*</td>
<td>B-535</td>
<td>Dacitoandesite</td>
<td>whole rock</td>
<td>62.92</td>
<td></td>
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<td></td>
<td>286 m</td>
<td></td>
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</tbody>
</table>

* Determination by A. Lovrič at the Department of Geochronology University of Geneve others by Z. Pecskay, ATOMKI-Debrecen

results are presented in Table 1.

For measurements samples with the lowest grade of alterations were used; however, only in one case mineral fractions could be separated, all the other analyses were made on the whole rock. The samples were degassed in a conventional extraction system using induction heating and measured by mass spectrometric isotope dilution with an 38Ar spike using a mass spectrometer (magnetic sector type of 150 mm radius and 90° deflection) in the static mode. Recording and evolution of Ar spectrum were controlled by a microcomputer. Potassium analyses were made using standard flame photometric techniques. K- and Ar-determinations were checked regularly by interlaboratory standards LP-6, GL-0, HD-B.1 and Asia 1/155.

Atomic constants suggested by Staiger and Jager (1977) were used for calculating the age. All errors represent on standard deviation (i.e. 68 % analytical confidence level).

Details of the instruments, the applied methods and results of a calibration have been described elsewhere (Balogh, 1985).

Geological position of the Coca Marin ore deposit

The ore deposit, i.e. the three discovered ore bodies are situated in the central parts of a deeply eroded volcanic system. The rock units and the ore body in this system are presented by a cross-section presented in Figure 2. The volcanic system was built of biotite-hornblende volcanoclastics with hornblende andesites in its core intruded by dykes of pyroxene-bearing hornblende andesites. These rocks are of Santonian age, i.e. they were consolidated 85.5 ± 3.4 m.y. ago (age of an amphibole concentrate from volcanoclastics) to about 83 m.y. (two whole rock age determinations).

In the central, andesitic part of this Santonian volcano new melts were much lated (72.5 to 63 m.y. ago) intruded. First were the dacito-andesitic ones which gave the dacitoandesite (1) of Lower Maastrichtian age (72.6 ± 3.2 m.y. ago). This rock was partially altered in its higher level; in the inner zone silicified, alunetized, with kaolinite, sericite and diaspore and chloritized, zeolitized, calcitied, kaolinitized and sericitized with albite and epidote locally in the outer zone.

Ore minerals were deposited in the strongly altered zone. Younger Upper Maastrichtian (69.6 to 69.1 m.y. ago) dioriteporphyry and quartzdioriteporphyry dykes, as well as Paleocene (63.9 and 62.9 m.y. ago) biotite-hornblende andesites and dacitoandesites (2) cut the older andesites and dacitoandesites (1). The Upper Maastrichtian to Paleocene magmatic activity probably partly rejuvenated some rocks, especially in overheated water easily percolating volcanoclastics rich in feldspars, which are the mineral with the lowest closing temperature.

The mineralization is younger than the Lower Maastrichtian dacitoandesite (1), which is the host rock, and older then the cutting it dioriteporphyries of the Upper Maastrichtian age. The rock alterations and the mineralization belong probably to the same magmatic activity which gave the dacitoandesite (1), i.e. it originated about 71 ± m.y. ago.
The time of origin of the silicified dyke-shaped body in Santonian hornblende andesites is unclear, probably it is connected with the early magmatic activity - it is sterile and with disseminated Cu-mineralization in the depth and therefore differs from the silicified and alunitized zones with mineralization.

After the deposition of ore minerals and before the intrusions of Upper Maastrichtian dyke rocks the cen-
Fig. 3 – Evolution of the Coka Marin volcano and explanation of the present distributions of units, for circa 72, 70 and 69 m.y. ago. Signs as in Figure 2. Ages of units are given in million years (m.y.).

The relationships among rock units and the ore body about 72, 70 and 69 m.y. ago and the evolution of the Coka Marin volcano in its late phases is presented in Figure 3.

Ore composition

In the Coka Marin 1 body and in central parts of the Coka Marin 2 ore body, the ore bodies consist of massive to dense stockwork ore grading into impregnations of ore minerals in a silicified, aluminized, sericitized and argillilitized rock with occurrences of diaspore dacitoandesitic rocks. In the upper parts of the polymetallic mineralization occurs, grading sidewards into Cu-pyritic ore and further sidewards into an aureole with strong pyritization. The fault at the SW cuts this zonal distribution in the first ore body immediately next to the polymetallic ore, and in the second one in the Cu-pyritic zone.

According to Rakic (unpublished report, quoted by Janković, 1990) four phases of mineral deposition can be distinguished: (1) deposition of gel-pyrite and gelmarcasite, with subordinate enargite, luzonite, sphalerite, galenite and locally chalcopyrite, (2) deposition of crystalline luzonite, enargite, sphalerite and subordinate galena, pyrite and rare arsenopyrite, associated with the recrystallization of the gels, (3) transformation of enargite to tenantite and later into chalcocite and covellite, as well as of chalcopyrite into bornite and later chalcocite and covellite, (4) the younger sphalerite and galena deposited from colloidal solutions, chalcopyrite, tetrathedrite and sulfosalts. The sphalerite is rich in cadmium, and the ore is rich in silver and gold. Gold occurs as native in quartz and
as interstitial in chalcopyrite, pyrite, enargite etc. The gangue minerals are quartz, barite, anhydrite, carbonates and in deeper levels fluorite.

According to these data the ore is in general rich in Au and as exception for the mineralizations in the Timoc magmatic complex rich in Zn. The chemical compositions of Cu-pyrite and the polymetallic ore in both ore bodies are given in Table 2. The same table presents the contents of the main ore compounds in the Coka Marin deposit in total but separately for the Cu-pyritic ore, the pyrite aureole and the polymetallic ore.

Conclusions

The Coka Marin polymetallic ore deposit is unique in the Timoc magmatic complex. It is a volcanic ore deposit with high Zn, Cu and less Pb, and with high gold and silver contents. In its peculiar mineral and metal composition it differs from all other deposits in the Timoc magmatic complex: they are Cu-rich, very poor in Zn and almost without Pb.

The Coka Marin ore deposit differs from other ore deposits in the Timoc magmatic complex also by age and its geologic setting; the other Cu-ore deposits are related to older magmatic activities (Jankovic et al., 1981) or deep intrusions. This can be the reason for the special character of this new-discovered ore deposit.

References


