Unusual acid melts at unique epithermal Roşia Montană (Romania) gold deposit

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Roşia Montană is known as one of the largest gold ore deposits in Europe. It is located at the Northern part of the Southern Apuseni mountains and also called as "The Golden Quadrangle". The deposit was discovered in pre-Roman times and is mined nowadays having large ore stocks (218 mln ton with 1.52 g/ton Au and 7.5 g/ton Ag) (Manske et al., 2006). The main aim of our studies was the determination of the chemical composition of silicate melt inclusion, the former being in quartz porphyry phenocrysts.

Roşia Montană can be compared with well known gold deposits in Au-Ag diatreme-hosted epithermal ore deposits in Acupan (Philippines) and Kelian (Indonesia) (Manske et al., 2006). The deposit is connected with the Miocene intrusions of intermediate and acid composition and neck breccia of the maar-diatreme complex. The ore mineralization is spatially associated with dacites, presented by biotite and amphibole-bearing hypabyssal rocks with rare quartz phenocrysts. Those intrusions form two main bodies (Cetate and Cârnic) which protrude into a large explosive breccia body and maar sediments and include the predominant stocks of Au and Ag. The hydrothermal processes had cyclic character and were interrupted by eruptions within the maar-diatreme complex and were responsible for alteration of country rocks as well as for the ore mineralization.

The main gold ore mineral of the deposit is electrum, being well known by famous large crystals and dendrites. The andesite and dacite intrusions were dated by geological mapping and isotopic geochronology (U-Pb, magmatic zircon) and Ar-Ar (hydrothermal adularia). It was shown, that the magmatic intrusions accompanied by the phreatomagmatic brecciation and epithermal ore formation was performed within narrow time intervals between 13.6 and 12.8 Ma (Wallier et al., 2006). These data indicate the tight temporal connection of magmatism and the Roşia Montană epithermal mineralization.

This deposit is thoroughly studied in terms of its geology, mineralogy and geochemistry of ores and altered country rocks as well as in age, physico-chemical mineral-forming process parameters and ore fluid sources (Cook et al., 2004 etc). Recently the fluid inclusion data, obtained from the studies of large bipyramidal magmatic ß-quartz crystals in Montană dacites were published (Wallier et al., 2006). Those dacites are spatially associated with Au-Ag ore mineralization. The existence of high-temperature (above 460 °C) and high saline (32-55 eq mass% NaCl) fluid inclusions was found, which are interpreted as magmatic fluid relics.

We took some samples of bipyramidal magmatic quartz at two Montană dacite exposures, the former being analogous to those investigated by Wallier et al. in 2006. We studied the primary silicate melt inclusions as well as crystal inclusions. The crystal inclusions were observed as plagioclase (An_{51-62}), orthoclase, amphibole (F = 0.19 mass%, Cl = 0.04 mass%), zircon, magnetite (TiO_2 = 2.8 mass%) and iron sulphide. The melt inclusion dimensions are usually not above 10 - 15 µm, rarely near 30 µm. Melt inclusions were heated in muffle furnace (Naumov, 1969) up to their homogenisation, chilled and exposed to the surface by grinding on the diamond paste. The glasses were analysed by the X-ray microprobe SX-100 (Vernadsky Institute, Moscow) and by ion microprobe IMS-4f (Yaroslavl', Russia). Two types of melts were established (see Fig. 1). The first type is very unusual in chemical composition. The 19 studied inclusions are represented by the following average composition (in mass%): 76.3 SiO_2, 0.37 TiO_2, 6.37 Al_2O_3, 4.55 FeO, 0.09 MnO, 1.61 MgO, 2.90 CaO, 2.79 Na_2O, 3.77 K_2O, 0.07 P_2O_5, 0.02 Cl. The second type of inclusions are typical for the acid melts and the 21 studied inclusions have a composition as follows (in mass%): 79.4 SiO_2, 0.16 TiO_2, 11.25 Al_2O_3, 0.65 FeO, 0.09 MnO, 0.30 MgO, 1.88 CaO, 3.53 Na_2O, 2.66 K_2O, 0.07 P_2O_5, 0.05 Cl. The comparison of these data shows the remarkable variations in Ti, Al, Fe, Mg, Ca, Na and K. High values of the total sums, being near to 100 % (98.8-99.1 mass%) are indicative of a low water content in these melts. Two inclusions of Type I and two inclusions of Type II were analysed by the use of the ion microprobe and it was found that those are largely different in terms of their rare element composition. Respective values are as following (in ppm): 10.0 and 0.69 Be, 29.3 and 5.7 B., 6.4 and 1.4 Cr, 146 and 6.9 V, 74 and 18 Cu, 92 and 29 Rb, 45 and 15 Zr, 1.7 and 0.6 Hf, 10.3 and 2.3 Pb, 52 and 1.3 U. Such results support the assumption of probable contamination of magmatic melt by unusual crustal rocks (sedimentary rocks?). The specific ore mineralization could be responsible for such contamination.

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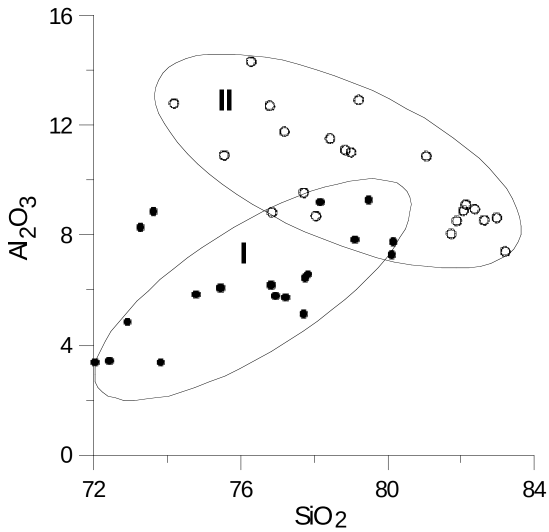

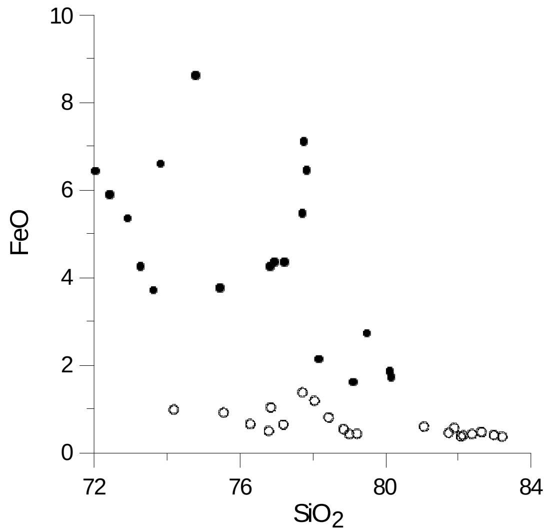

Fig. 1. Variation diagrams SiO_2 – Al_2O_3 and SiO_2 - FeO