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Rosia Poieni porphyry Cu-Au and Rosia Montana epithermal Au-Ag deposits, Apuseni Mts., Romania: Timing of magmatism and related mineralisation

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Abstract. The Rosia Poieni porphyry Cu-Au and Rosia Montana epithermal Au-Ag deposits are the largest operating mines in the South Apuseni mineral district, Romania. Rosia Montana is a breccia-hosted low- to intermediate-sulfidation epithermal system, related to strong phreatomagmatic activity due to shallow emplacement of a dacitic dome structure. The Rosia Poieni deposit, situated about 4 km NE of Rosia Montana, is a porphyry copper system with a high-sulfidation epithermal overprint. This study provides the first high-precision U-Pb dating of Miocene magmatic and hydrothermal events in the South Apuseni Mountains. Together with the existing ^{40}Ar-^{39}Ar data, the new results show clearly that the two deposits belong to two separate magmatic-hydrothermal systems, the porphyry copper system of Rosia Poieni being about 3 Ma younger than the neighbouring Rosia Montana epithermal deposit. The timing of the porphyry mineralization at Rosia Poieni has been bracketed by dating the main Poieni diorite intrusion (9.42 ± 0.14 Ma) and a later intra-mineralization dike (9.16 ± 0.10 Ma), cutting a mineralized porphyry stockwork and cut by later porphyry veins. Whereas the magmatism at Rosia Montana is dated at 13.15-13.61 Ma by U-Pb dating on zircons and the epithermal mineralization there – at 12.71-12.85 Ma by ^{40}Ar-^{39}Ar dating on hydrothermal adularia.

Key words: porphyry, epithermal, U-Pb dating, Rosia Poieni, Rosia Montana, Apuseni Mts.

Introduction

The calc-alkaline Miocene magmatism in the South Apuseni Mountains was related to transtensional and rotational tectonics. The magmatic activity was focused within NW-SE oriented extensional basins and developed mainly between 14.7 and 7.4 Ma (Rosu et al, 2004). These structures host some of the Europe's largest porphyry Cu-Au and epithermal Au-Ag deposits, both associated with shallow subvolcanic intrusions. One of the particularities of the South Apuseni district consists of the common spatial association between porphyry Cu-Au and epithermal deposits. Some recent studies (Alderton and Fallick, 2000; Wallier et al, submitted) demonstrated that the mineralizing fluids in both systems have a dominantly magmatic origin, a direct genetic link between the large porphyry and associated epithermal deposits in the area is still controversial. With the present study we tried to highlight the temporal and genetic succession of magmatic and hydro-thermal events within the Rosia Montana-Bucium volcano-intrusive structure in the northern part of the district, hosting the largest operating mines in the South Apuseni Mts – Rosia Poieni porphyry Cu-Au deposit and Rosia Montana breccia-hosted epithermal Au-Ag deposit. Bucium-Tarnita is a porphyry stock cut by epithermal veins, about 3 km south of the map area of Fig. 1.

Geological setting and sample description

Figure 1 summarizes the geology of the Rosia Montana – Rosia Poieni area. The Rosia Montana deposit is intimately related to a diatreme breccia complex associated with two dome-like dacitic bodies. The Rosia Poieni deposit is hosted by the Poieni diorite porphyritic stock, about 4 km NE of Rosia Montana. Rotunda type volcanic andesites and their pyroclastic derivates, cropping out in the area between the two deposits and also east and south of Rosia Poieni, have a subhorizontal basis and they cover the volcanoclastic breccia and dacites from the Rosia Montana structure, as well as earlier folded Cretaceous sedimentary rocks.

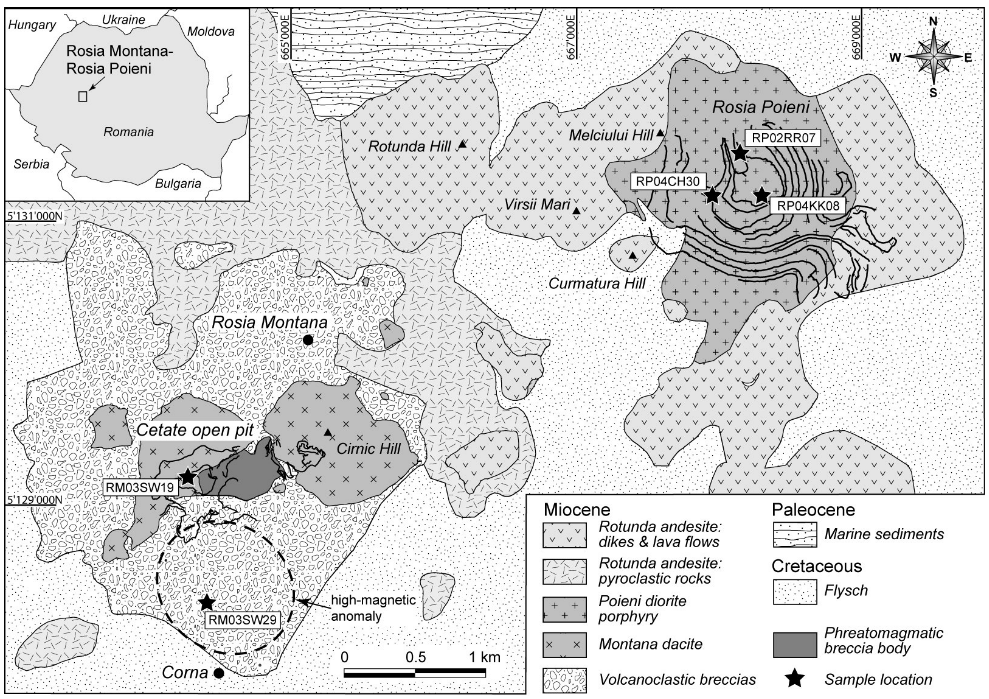

Fig. 1. Geological map of the Rosia Montana-Rosia Poieni area, showing the proximity of the two deposits. Location of samples used for U-Pb dating is indicated as well

For the purpose of the present study, we have selected two samples from the Rosia Montana area and three samples from the Rosia Poieni porphyry deposit. Sample locations are shown on Fig. 1. Sample RM03SW19 comes from the Cetate open pit and is a representative sample of the Montana dacite, affected by quartz-sericite ± adularia alteration – the main magmatic rock, hosting the epithermal mineralization. Sample RM03SW29 is a clast of quartz-bearing amphibole-biotite andesite from the volcanoclastic breccia, about 1 km south of the Cetate open pit, where a high-magnetic anomaly has been mapped by Rosia Montana Gold Corporation. Sample RP04CH30 is a representative sample of the Poieni diorite porphyry, cropping out in the western part of the Poieni open pit. Sample RP04KK08 is biotite-bearing diorite porphyry from 662m depth from drill core RPSP-002 (Gabriel Resources Ltd) in the central part of the Rosia Poieni open pit. Sample RP02RR07 is an intra-mineralization fine-grained dark dike, cutting the Poieni diorite intrusion, as well as early stage porphyry veins and cut by later quartz and quartz-pyrite-sericite veins.

Geochronology and geochemistry of host rocks

Conventional U-Pb single zircon dating has been used to determine the crystallization ages of the studied magmatic rocks, as this method combines the relative resistance of zircons to hydrothermal overprint with the high precision of the ID-TIMS (Isotope Dilution – Thermal Ionization Mass Spectrometry) technique (for details, see von Quadt et al., 2002). Scanning electron microscopy-cathodoluminescence (SEM-CL) images and laser ablation (LA) ICP-MS analyses of zircons help with the interpretation of the zircon data and contribute to the understanding of the chemical evolution of the magma source.

The zircons of the five studied samples reveal similar morphology and are usually transparent, orange or beige-rose-orange colored. For the analyses the most elongated prismatic morphology has been chosen with the aim of avoiding inheritance of older zircon generations. A reason for this is given by the SEM-CL images of the zircons from the Rosia Montana samples showing inherited cores in some of the separated grains, which were also confirmed by discordant older U-Pb isotope data. In Fig. 2, only the results for concordant zircons of all studied zircon crystals are shown. The concordant age is calculated using Isoplot program (Ludwig, 2001), with 95% confidence, decay-constant errors included.

Figure 2a summarizes the results for the Rosia Montana samples. The calculated ages are 13.61 ± 0.07 Ma and 13.15 ± 0.04 Ma for the Montana dacite and the clast from the volcanoclastic breccia, respectively. Thus the magmatic activity at Rosia Montana is confined in the time interval 13.6-13.2 Ma.

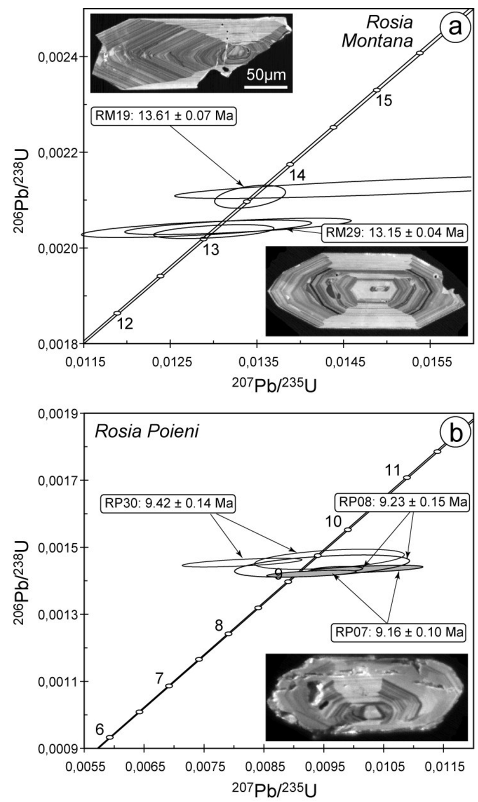

Fig. 2. U-Pb concordia diagrams for magmatic zircons: a) Rosia Montana area; b) Rosia Poieni area

Results from the Rosia Poieni porphyry deposit (Fig. 2b) differ significantly from those in Rosia Montana. The Poieni diorite porphyry has an age of 9.42 ± 0.14 Ma; the biotite-bearing diorite from the deep drill core has an age of 9.23 ± 0.15 Ma, and the late intra-mineralization dike – an age of 9.16 ± 0.10 Ma.

XRF major element and ICP-MS trace element analyses of the studied samples, as well as other representative samples from magmatic rocks in the studied area, show normal calc-alkaline character of magmas. They are more evolved at Rosia Montana, where they have dacitic composition, compared to Rosia Poieni, where the compositions plot within the andesitic field. No adakitic-like trend has been observed (Rosu et al., 2004).

Discussion and conclusions

The new data, in combination with the existing ^{40}Ar-^{39}Ar dating on hydrothermal adularia from the Rosia Montana deposit (Manske et al., 2004) and Wallier et al. (submitted), and K-Ar dating on whole rocks (Rosu et al., 2004), allow reconstruction of the magmatic and hydrothermal history of the Rosia Montana-Bucium volcano-intrusive structure in the northern part of the district (Fig. 3).

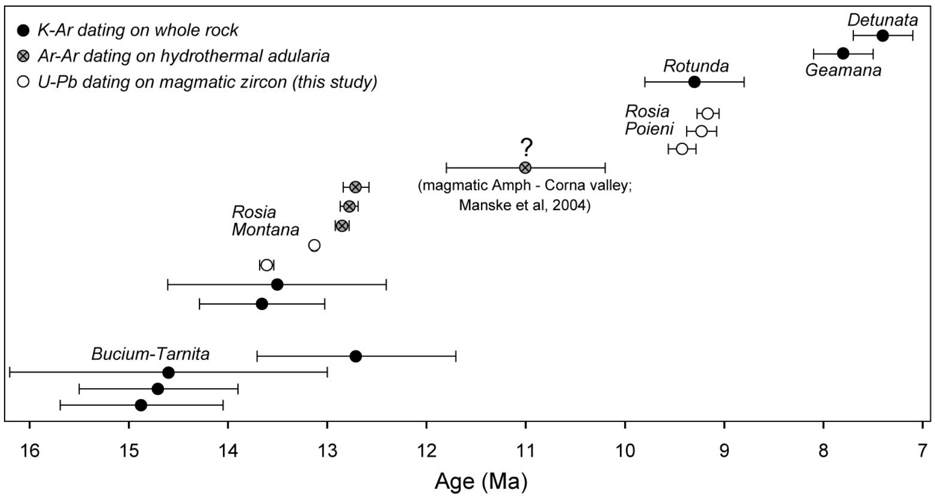

Fig. 3. Summary diagram for the timing of magmatism and mineralization in the northern sector of the South Apuseni district, including the U-Pb data on magmatic zircons from this study, as well as published Ar-Ar dating on hydrothermal adularia (Manske et al., 2004; Wallier et al., submitted) and K-Ar dating on whole rock (Rosu et al., 2004)

Bucium-Tarnita, occupying the southern part of the complex is a porphyry-copper system with high-sulfidation style epithermal overprint, and according to K-Ar data of Rosu et al. (2004) is the oldest part of the volcano-intrusive structure (14.87-14.60 Ma). The magmatic activity in the Rosia Montana area took place between 13.61 and 13.15 Ma and was immediately followed by the economic hydrothermal mineralization (12.85-12.71 Ma; Fig. 3). The ^{40}Ar-^{39}Ar amphibole age of 11.0 ± 0.8 Ma of a clast from the high-magnetic anomaly in Corna valley, south of the Cetate open pit (Fig. 1), reported by Manske et al. (2004) has a suspiciously high analytical error for an ^{40}Ar-^{39}Ar analysis and doesn't help to understand the exact age relationship between this high-magnetic breccia body and the mineralization at Rosia Montana.

The timing of magmatism and related porphyry mineralization at Rosia Poieni ranges within the narrow interval of 9.42-9.16 Ma. The timing of the porphyry mineralization has been bracketed by dating the main Poieni diorite intrusion and a later intra-mineralization dike. ^{40}Ar-^{39}Ar dating of the high-sulfidation epithermal veining overprinting this porphyry system (Kouzmanov et al., 2004) is in progress. The similar K-Ar age for Rotunda andesite (9.30 Ma; Rosu et al., 2004) suggests a direct genetic link between the Poieni diorite porphyry and the overlying volcanic rocks. Finally, the magmatism ended by the emplacement of small barren basaltic andesite and andesite intrusions in the eastern part of the structure at 7.8-7.4 Ma.

This study provides the first high-precision U-Pb dating of Miocene magmatic and hydrothermal events in the South Apuseni Mountains. The results show clearly that despite their proximal location, and the magmatic character of the mineralizing fluids in both, the Rosia Montana and Rosia Poieni deposits belong to two separate magmatic-hydrothermal systems. The porphyry copper system at Rosia Poieni is about 3 Ma younger than the neighbouring Rosia Montana epithermal deposit, which is much longer than the thermal lifetime even of a very large upper-crustal magma chamber.

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