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Dome-building volcanic activity in the Oaş-Gutâi Neogene volcanic area, Eastern Carpathians, Romania

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Abstract

A complex dome-building volcanic activity developed during a 5 Myr time interval (13.2-8.0 Ma) in Oaş-Gutâi Mts., associated to the intermediate volcanism of the Oaş-Gutâi Neogene volcanic area (OG). Numerous domes were built up in the entire volcanic region also triggering both non-explosive and explosive fragmentation volcanic processes. The volcanic forms consist of extrusive domes, lava domes and dome-flows/coulées and cryptodomes predominantly as solitary domes, or compound domes and dome complexes. The domes are comprised of andesites, dacites and rhyolites (acid andesites and dacites are prevalent). The volcanic rocks show a calc-alkaline and medium to high-K character and typical subduction-zone geochemical signatures. Overall, either subaerial or subaqueous, the dome growth and collapse associated with fragmental explosive or non-explosive processes, was dominantly responsible for most of the volcanic products. Dome emplacement in submarine setting is commonly associated with marginal auto-brecciation, much subordinated explosive events and subsequent resedimentation. Overall, the dome-building volcanic activity in OG is recorded to a monogenetic-type of volcanism. The series of dome-building events which were triggered and controlled by magma-mixing and -mingling processes developed from time to time in different locations of OG.

Keywords: *Neogene, calc-alkaline volcanism, domes, dacites, volcaniclastics*

Introduction

The Oaş-Gutâi Neogene volcanic area (OG) forms the north-western segment of the Romanian Eastern Carpathians volcanic arc, which has been built up in connection with the post-collisional magmatism related to the Miocene subduction of the European Plate beneath the two, Alcapa and Tisza-Dacia microplates (Csontos 1995). The OG volcanic activity took place in Miocene (15.4-7.0 Ma, Pécskay et al. 2006) and comprised two types of calc-alkaline volcanism: an acidic/felsic, extensional-type volcanism of explosive origin and an intermediate volcanism of extrusive and intrusive origin (Kovacs and Fülöp 2003). The dominant intermediate calc-alkaline volcanic rocks, represented by a series of rocks ranging from basalts to rhyolites (andesites are prevalent) overlap the previous, felsic calc-alkaline volcanic rocks (rhyolitic ignimbrites). A complex dome-building volcanic activity developed in OG associated to the intermediate volcanism. The shape and morphology, as well as the distribution of the specific co-genetic fragmental counter-parts and the relationships with the hosted formations revealed the processes involved in the evolution of each of the edifices. Previous data about the dome-building activity in OG are published by Fülöp and Kovacs (1999, 2006), Kovacs and Fülöp (2002, 2005), Lexa et al. (2010), Kovacs et al. (2013). This paper aims to integrate all the available geomorphological, volcanological, sedimentological, petrological and geochronological data on the dome-building volcanism from OG.

General features of the domes

Space and time distribution. The domes are prevalent in Oaş Mts. where they preferentially locate in the western part of the volcanic area along specific alignments (possibly tectonically-controlled fissures) oriented parallel to the volcanic arc. In Gutâi Mts., the domes are common in the southern and central part of the mountains where they inter-finger with the complex, predominant effusive volcanic structures of the area (Fig. 1). Overall, the dome-building volcanic activity in OG took place during a 5 Myr time interval (13.2-8.0 Ma, Fig. 2A), which was a shorter time interval comparative with the OG intermediate volcanism (approx. 6.5 Myr) and with the entire volcanic activity in OG (around 8 Myr). In Oaş Mts., the dome-building volcanism was shorter (11.0-9.5 Ma) than the corresponding volcanism in Gutâi Mts. (Fig. 2A).

Morphometrical features. The volcanic forms attributed to the dome-building activity are dominantly solitary volcanoes located adjacent to the main volcanic area and surrounded by Neogene-Quaternary sedimentary deposits in Oaş Mts. In Gutâi Mts., the domes mainly located within the main volcanic area inter-finger with the complex, polygenetic structures. Overall, the domes are subround or elongate (circular to quasi-circular, or ellipsoid map-outline), conical or flat-topped, with steep or shallow slopes. The morphologies suggest simple extrusive domes like lava domes, dome coulées, cryptodomes. More complex shapes and morphologies suggest compound domes and dome complexes. The sizes vary from 300 m (e.g. Turulung dome-Oaş Mts., 5 in Fig. 1) to 5 km (e.g. Oraşu Nou dome-coulée from Oaş Mts., 9 in Fig. 1, Gutin cumulodome from Gutâi Mts., 17 in Fig. 1) with the common 1-2 km in length/diameter. The actual height of the volcanic edifices (in respect to the surrounding geological formations, either sedimentary or volcanic rocks from the adjacent volcanic structures) varies from tens of meters (e.g. 40 m Turulung small dome) up to 400 m (e.g. Batarci dome in Oaş Mts., 3 in Fig. 1, Gutin cumulodome-Gutâi Mts.).

Petrographical and geochemical data. The domes are comprised of andesites, dacites and rhyolites. The acid andesites and dacites are prevalent. Most of the domes show a remarkable petrographic homogeneity, comprising a single rock-type. Subordinately, two or several different rock-types (e.g. andesite and dacite) were identified in some of the compound domes.

Major, trace element and isotope geochemistry revealed the geochemical features of the volcanic rocks from the OG domes with indications about their source magmas. The calc-alkaline and medium to high-K character and typical subduction-zone geochemical signatures are confirmed for all the volcanic rocks. Crustal assimilation processes involved in the evolution of the generated magmas are constrained by the high Sr ratios (0.7063-0.7083). Besides the main AFC petrogenetic process, magma-mixing and mingling processes were also involved in the evolution of the magmas responsible for the

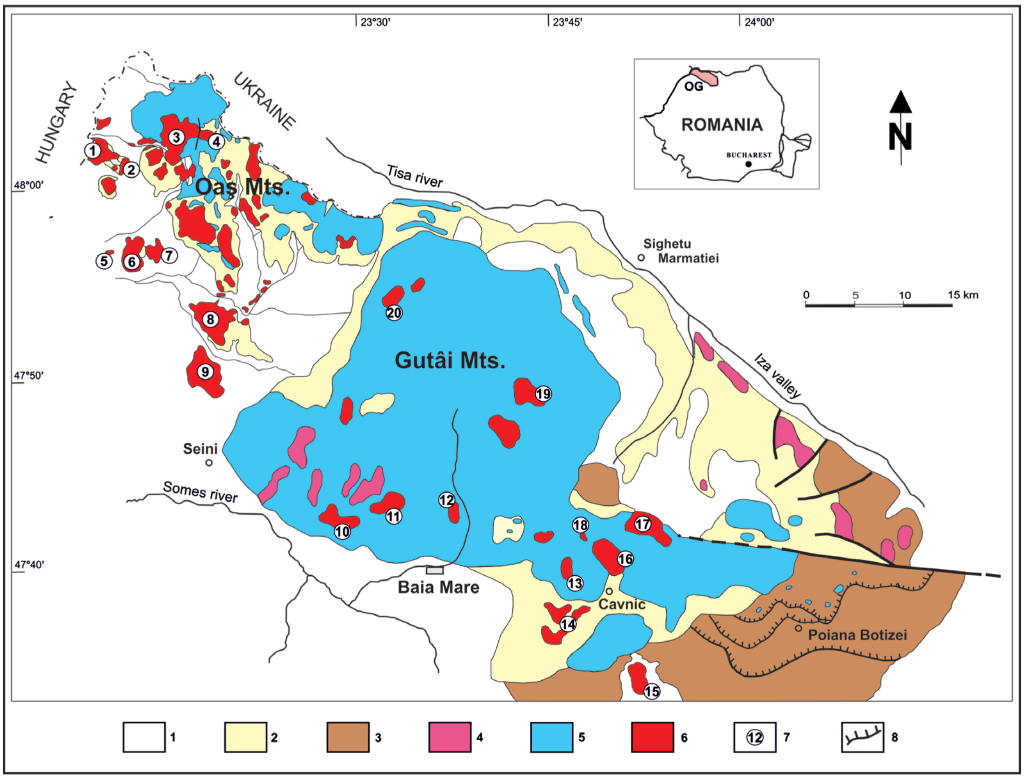

Figure1. Simplified geological map of the Oaş-Gutâi Neogene volcanic area (OG) with the location of the domes. 1. Quaternary sedimentary deposits; 2. Neogene sedimentary deposits; 3. Paleogene sedimentary deposits; 4. Felsic volcanic rocks; 5. Intermediate volcanic rocks; 6. Domes; 7. Numbers allocated to the described domes; 8. Overthrust.

dome-building volcanism. With this respect, the mineralogical and textural features of the dacite domes strongly constrain these processes (e.g. the large-sized embayed sanidine crystals coexisting with high Mg# (85-90) chromian-diopside, large-sized sieve-textured or strongly reverse zoned plagioclases, high amount of gabbroic-type mafic microgranular enclaves/MME).

Volcanic and petrogenetic processes.

The investigations conducted on the main domes of OG enabled the reconstruction of the dome-forming extrusive processes, often complex because of additional non-explosive or explosive fragmentation events. Subaerial or subaqueous setting could also be assigned to the main domes. Lava domes, dome coulées and cryptodomes form the dominant group which does not suggest subsequent fragmentation: e.g. Penigara (7 in Fig. 1) and Colnic (2 in Fig. 1) in Oaş Mts., Pleşca Mare (19 in Fig. 1) and Hircea (12 in Fig. 1) in Gutâi Mts. lava domes; Hatu Lung (1 in Fig. 1) in Oaş Mts. dome coulée, Ghezuri (4 in Fig. 1) in Oaş Mts. and Ulmoasa (11 in Fig. 1) in Gutâi Mts. cryptodomes. However, a non-explosive type of fragmentation was common during dome growing due to auto-brecciation /quench fragmentation and overload-driven gravitational collapse: extrusive domes with hyaloclastic and autoclastic shells (e.g. Pusta Heghii-6 in Fig. 1 and Jeleznic-8 in Fig. 1 in Oaş Mts., Şatra-15 in Fig. 1 and Vezău-20 in Fig. 1 in Gutâi Mts.) and talus breccias (e.g. Gutin-17 in Fig. 1 in Gutâi Mts.), respectively. Less common but more complex, a second group of solitary domes and dome complexes (single or multiple interconnected edifices) were investigated with respect to the magma source, the growing process, and the role played by explosive processes in their evolution history. Some examples of this group are: in Gutâi Mts. Şindileu dacitic solitary lava-dome (10 in Fig. 1) shows a large portion of the dome comprised by block and ash flow deposits suggesting subaerial emplacement; in Oaş Mts., Turulung dacitic lava-dome develops *in situ* and resedimented phreatomagmatic volcaniclastics at its margins, indicative of subaqueous setting. Large dome complexes such as Batarci which occupies a large area in the north western part of Oaş Mts. comprise thick piles of lavas and wide spread pumice-and-ash flow deposits which testify for the dome growth co-genetic subaerial explosive activity. Two interconnected and subaqueously emplaced lava domes, Dăneşti and Piatra Roşie (14 in Fig. 1) located in the southern part of Gutâi Mts. comprise of coherent lavas and *in situ* and resedimented hyaloclastites with co-genetic primary and reworked phreatomagmatic volcaniclastics.

Overall, either subaerial or subaqueous, the explosive or non-explosive dome growth and collapse-related fragmental processes, seem to be dominantly responsible for most of the volcaniclastic products. Dome emplacement in submarine setting commonly conducted to marginal quench fragmentation, subordinate rootless explosive events and subsequent resedimentation.

The petrological features of the volcanic domes from OG suggest different extrusion-controlling genetic magmatic processes. The petrographic and geochemical homogeneity of the majority of the OG volcanic domes correlated with the morphologic features (solitary, simple-shape, small volume of magma volcanoes) suggest a likely monogenetic volcanism. Less common, some domes show petrographic complexity and at least two petrographic rock-types generated by magma-mixing and mingling processes in the same open-magmatic system: e.g. Laleaua Albă dome (18 in Fig. 1) with a core of macroporphyric sanidine dacite (8.42 ± 0.33 Ma) surrounded by an envelope of aphyric andesite (8.47 ± 0.42 Ma); Pleşca Mare large-sized dome (19 in Fig. 1) comprised of a well-developed biotite dacite core, partially bordered by a biotite andesite. Hereby, extrusion was controlled by magma-mixing and mingling processes during at least two distinct magmatic events: the formation of the hybrid andesitic rocks of the envelope and the subsequent generation of the dacitic rocks within the core. Building of several other domes in OG was triggered and controlled by the mixing of two compositional different magmas (Fig. 2B) which generated hybrid rocks: a basaltic magma and a silicic magma. Hybrid rocks (acidic andesites and dacites) are considered to be common in OG domes.

Conclusions

Dome-building volcanic activity (13.2-8.0 Ma) represents a significant part of the CA intermediate volcanism in the Oaş-Gutâi Neogene volcanic area (OG). Numerous domes were built up in the entire

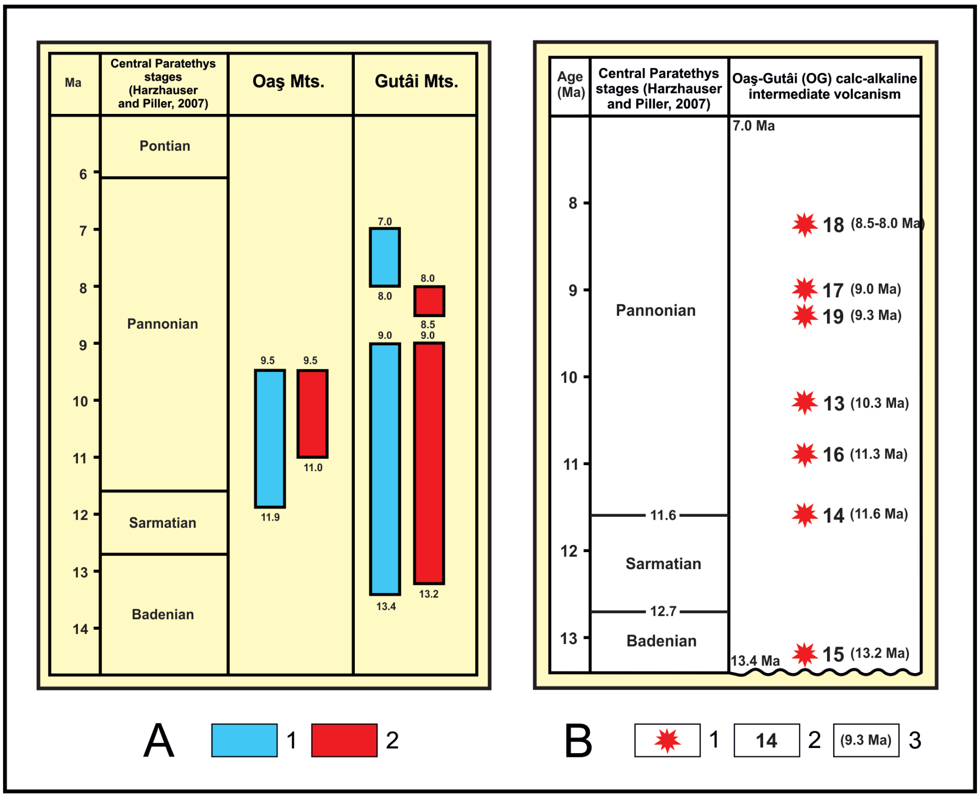

Figure 2.
A. Temporal evolution of the dome-building volcanic activity in Oaş Mts. and Gutâi Mts. 1. Intermediate volcanism; 2. Dome-building volcanism.
B. Dome-building events triggered and controlled by magma-mixing and -mingling processes. 1. Volcanic events; 2. Examples of domes (numbers according to Fig. 1): 15-Şatra; 14-Dăneşti-Piatra Roşie; 16-Poiana Cremenii-Şuior; 13-Valea Morii-Mogoşa; 19-Pleşca Mare; 17-Gutin; 18-Laleaua Albă. 3. K-Ar ages.

volcanic region and fragmentation by both non-explosive and explosive volcanic processes related to the dome growth is very common. The majority of domes grew up in subaqueous setting. The acidic volcanic phases of the OG intermediate volcanism are strictly associated to the dome-building volcanism. Overall, the dome-building volcanic activity in OG is assigned to a monogenetic-type of volcanism. To a small extent, dome-building events were triggered and controlled by repeated magma-mixing and -mingling processes.

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