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Teza de abilitare

Aportul studiilor vulcanologice şi petrologice a rocilor vulcanice la interpretarea proceselor geodinamice

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Rezumat in limba Engleză

The contribution of volcanological and petrological studies in revealing the geodynamic processes

Ioan Seghedi

Summary

The habilitation thesis entitled “The contribution of volcanological and petrological studies in revealing the geodynamic processes” synthesizes the most relevant results of my field and laboratory studies I carried out after obtaining my degree in geology in 1972. Magmatic processes, in general and those shaping volcanic domains, in particular have captured my attention since the beginning of my professional career. After graduation, I started working as exploration geologist at the Prospecţiuni Enterprise. Here I was carrying out applied research for three years, doing geological prospecting (including geological mapping and petrographical studies) for mineral resources in magmatic and metamorphic areas of the Apuseni and Banat Mts. (Romania).

In 1975, I moved to the Geological Institute of Romania. Here I got involved in a wide range of fundamental scientific research as well as applied studies in volcanology, petrology and metallogeny, geological mapping in the Neogene and pre-Neogene volcanic areas of Romania, but also in other European countries like Hungary, Ukraine and Spain. My research largely relied on generating lithological and structural maps. After obtaining my PhD degree in 1987 (thesis title: “Petrologic study of the Călimani caldera, East Carpathians”, adviser Prof. Dr. Acad. Dan P. Rădulescu), my research in geological mapping and volcanology in Romania continued within several research teams, either as a member, or project director. I have improved my research methodology in the field of Volcanology and Petrology benefiting of a Fulbright grant in Menlo Park, USA (1997), a Royal Society grant in London, UK (1997-1999), a NATO grant in Madrid, Spain (2002), and an ISES grant in Utrecht, Netherland (2004, 2008, 2009). I have used these opportunities to advance my research by combining geological fieldwork with qualitative and quantitative analytical techniques (e.g. ICP-MS for trace elements and isotope, Laser Ablation ICP-MS for trace element studies, electron microprobe) applied to various volcanic rocks and their associated minerals.

Since 2001, I am working at the Institute of Geodynamics, Romanian Academy where I pursue fundamental scientific research involving principally geodynamic studies focusing on the relationships between magmatism and geotectonic evolution in the Carpathian-Pannonian region, but also in the broader Europe, Anatolia and North America. My main goals were to interpret petrological (petrography, mineralogy, geochemistry) and volcanological processes in terms of geodynamics and perform a series of detailed volcanological mapping and reconstructions.

The habilitation thesis summarizes the results obtained by collaborating with several national and international research groups on volcanology and igneous petrology. The presentation is structured in eight chapters, which address my past contributions as well as the development perspectives of my scientific career including teaching.

The thesis is in the field of Geology. My scientific activity focused on eight major directions, presented here in separated chapters:

1. Geocronology, space-time evolution of the volcanism in Romania and the Carpathian-Pannonian region;

2. Neogene/Quaternary volcanic areas in Romania and the Carpathian-Pannonian region;

3. Paleozoic and Mesozoic volcanic areas in Romania;

4. Volcanic hazard in Romania and adjacent areas;

5. Alteration and mineralization studies of volcanic rocks;

6. Volcanological studies abroad;

7. Petrological studies of volcanic areas in Romania and the Carpathian-Pannonian region;

8. Geodynamic reconstruction based on geochronological, petrological and geotectonic analyses.

The **first chapter** presents my results obtained after 1990. Among the scientific results corresponding to each research topic, several relevant outcomes can be mentioned:

- Documenting the southward migrating volcanic activity in the Călimani-Gurghiu-Harghita range between 10.6-0.03 Ma (1995);

- Elaborating the first (1995) and the second (2006) synthetic work on K-Ar age development in the Carpathian-Pannonian region;

- Dating the last eruption of the Ciomadul volcano at ~ 35 Ka (1995, 1996);

- Dating the volcanism in Apuseni Mountains between 15-7 Ma (2001, 2004);

- Separating six episodes in the generation of Persani Mts. basaltic volcanic field, at 1220, 1142, 1060, ~900? (not yet dated), 800, and 683 Ka (2013, 2016);

- Dating the Gătaia (Banat) lamproite volcano, unique in the Carpathian-Pannonian region, at 1.32 Ma. The published study has been awarded with the LUDOVIC MRAZEC prize of the Romanian Academy (2008);

- The first comprehensive dating of the Neogene felsic volcanism in the Pannonian Basin in three episodes: 21.0-18.5 Ma, 17.5-16.0 Ma and 14.5-13.5 Ma (1998);

- The first dating of the calc-alkaline volcanic activity in Transcarpathian Ukraine at 14.8-9 Ma (2000).

The **second chapter** addresses the topic of volcanology of Neogene/Quaternary age areas in Romania and the Carpathian-Pannonian region. The main achievements are presented in four subchapters:

(a) Features of volcanic edifices and their associated products

(b) Studies on tuffs

(c) Instability of volcanic edifices

(d) Relationships between volcanism and tectonic activity

Results are the followings:

a. A new synthesis of Călimani-Gurghiu-Harghita range, based on the facies concept and estimation of migration rates and volumes (1995, 1996, 1997); the first modern volcanological reconstruction of the Ciomadul volcano (2015); the first description of the largest composite volcano in the Apuseni Mts (Bontău) (2010); the first volcanological synthesis of the Neogene-Quaternary volcanism in the Carpathian-Pannonian region (2010); the first and second (improved) volcanological reconstruction of the Perşani Mts. volcanic field (1994. 2016);
b. First evidence of the ignimbritic character of the "Dej Tuff" sequence from Măgura Ciceului (western Transylvanian Basin) (1991); the study of zeolitization processes of the "Dej Tuff" sequence in the western Transylvania (2000); a discussion of the premises of Quaternary tuff investigations in Romania (1998); the first correlation of the Quaternary tuff sequences from the southern part of Romania with the Campanian tuff (~ 37 Ka) (2002).
c. Identification of the first two debris avalanche deposits in Romania in the Călimani-Gurghiu-Harghita range, considered to be among the largest of their kind in Europe (2000); identification of other three debris avalanche deposits along the western margin of the Călimani-Gurghiu-Harghita range (2017).
d. Evidence of contemporaneous generation of the fault system and volcanoes from north to south along the Călimani-Gurghiu-Harghita range, at ~10-0.3 Ma (2005); Tectonic deformations led to the rise of the Călimani-Gurghiu-Harghita volcanic mountains and to the subsidence of the N–S oriented intermontane Borsec/Bilbor–Gheorgheni–Ciuc and Braşov pull-apart basins.

The **third chapter** is dedicated to my volcanological studies on Paleozoic and Mesozoic volcanic areas of Romania. The main achievements are:

- The first volcanological study of the Carapelit formation, assumed Carboniferous in age (1987);

- Characterization of the bimodal Triassic volcanism and tectonic deformations in Consul Unit, North Dobrogea (1990);

- The first modern volcanological reconstruction of the rhyolitic volcanism in Sirinia Basin, South Banat (2011);

The **fourth chapter** presents my contributions to the volcanic hazard in Romania. The study is compiling an inventory of potential volcanic hazard sources for the Romanian territory, irrespective of their location inside or outside the country (2002, 2013). External volcanic sources implying ash-fall hazard from tephra dispersion following explosive volcanic eruptions include the Central Italian field of active volcanoes (e.g. Campii Flegreii and Vesuvius), the active Aegean volcanic arc, the Eifel region of Central Europe (Germany), and Iceland. Geologic evidence of thick tephra deposition from Campi Flegreii caldera (its Campanian ignimbrite eruption ca. 39 Ka ago) found in southern Romania clearly indicates that this type of volcanic hazard is real. Potential internal volcanic source, can be considered the Ciomadul volcano that suggest having a magma plumbing system not yet fully solidified, put in evidence by a well-focused and strongest-in-Romania heat-flow anomaly, crustal and sub-crustal local seismic activity, seismic wave attenuation patterns recorded in seismic tomography images, and most intense “postvolcanic activity”, including mantle-originated gas emanations.

The **fifth chapter** is a short presentation of studies I have authored on the following subjects: alteration and mineralization processes of the intrusive body inside the Călimani Caldera (1985); a synthesis of the metallogenetical particularities of the Călimani-Gurghiu-Harghita range (1994); consideration on the meaning and significance of Golden Quadrangle in the Metaliferi Mts. (2001); unpublished contribution on the mineralization processes in Apuseni Mts. and the Fâncel-Lăpuşna Caldera, East Carpathians.

The **sixth chapter** is dedicated to volcanological studies performed abroad, beyond the Carpathian-Pannonian region. The main results include:

- The first modern volcanological description of the Miocene lamproite volcanoes in south-east Spain (2007);

- The first account of petrogenetic processes in a Cambrian kimberlitic diatreme, Tuzo, Canada (2009);

- The first description of two Miocene composite volcanoes in an extensional corridor in the western Turkey (2015);

- The first account of the Kırka-Phrigian Caldera, western Anatolia, Turkey (2016).

The **seventh chapter** is dedicated to petrological studies carried out between 1982 and present:

- The first petrological interpretations of the Caldera Călimani volcanologic and petrologic system (1982);

- The first characterization of the Ciomadul, as a dacite-dominated volcanic complex (1986);

- Co-authoring an article revealing the history of the term „dacite" (1996);

- A first comprehensive study of the acid, dominant rhyolitic rocks from North Dobrogea (1992);

- The first (1995) and the second (2013) modern petrological study of Perşani basalts;

And - Petrologic study of the Călimani-Gurghiu-Harghita range (1995, 1996);

- Petrologic study of the Miocene volcanism in Ukraine (2001);

- Petrologic study of the Rodna-Bârgău subvolcanic area (2005, 2016);

- Petrologic study of the Gutâi and Oaş volcanic areas (2017);

- Synthetic petrological studies of all volcanic rock types in the Carpathian-Pannonian region (2004, 2015);

- Editing a Special Issue in Lithos, 2013 (with Dejan Prelević): „Magmatic response to the post-accretionary orogenesis within Alpine–Himalayan belt";

- A comparative study of the volcanism in the Pannonian region and Menderes region (Anatolia) (2013);

- Contributions to the petrology of Paleogene basanites in Poiana Ruscă Mts., western Romania (1995, 2010);

- Contributions to the petrology of Permian bimodal volcanism in the Apuseni Mts. (2014);

Chapter eight presents my contributions to the geodynamic reconstructions of various volcanic areas based on geochronological, petrological and tectonic data. The geodynamic models focusing on the Carpathian–Pannonian region, done in 1998, 2004 and 2011, evolved and gained complexity over time and emphasize the dominantly post-collisional character of the Neogene-Quaternary magmatism.

In the **second**, final part of the thesis, I present my career (professional and scientific) development plan and the main directions of future research.

The development of my scientific research in the field of Geology will continue the research topics I pursued in the past decades: volcanology and petrology of volcanic rocks.

My intention is to constantly continue publishing articles in ISI indexed journals with high impact factor and high relative score of influence. I will continue attending conferences in my field, especially at the international level (ISI indexed, if possible) both in Romania and abroad. I plan to publish specialized books with national and international publishing houses.

The development plan of my research and eventually teaching activity will entail courses and interaction with students. Modern teaching methods will represent central elements of this plan. In this respect, I intend to combine field and laboratory work with modern computational techniques, and will rely on the full involvement of graduate students.

I would like to express my special thanks to the colleagues from the research team, some of which have already retired: Nicolae Ionel, Alexandru Szakács, Mihai Tatu, Péter Luffi, Viorel Mirea, Mădălina Vişan, Răzvan-Gabriel Popa, Luisa Elena Iatan.

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