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Late Cretaceous Orbicular Gabbro Cropping Out West Of Elazig (Turkey): Mineralogy, Petrography And Magma Mixing Processes

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Abstract **–** The lithological units outcropping in the study area, located in the Southeast Anatolian Orogenic Belt, one of the most important parts of the Alpine-Himalayan Orogenic Belt. The study area crops out in a local area within the Hısırık creek in the north of Sarıgül village of Baskil county, which is located in the west of Elazig province in Southeast Turkey. Elazig Magmatics contains plutonic and sub-volcanic rocks, mainly felsic and mafic compositions. Plutonic rocks with felsic composition include granite, granodiorite, tonalite and quartz monzonites, while sub-volcanic rocks include aplite. Plutonic rocks with mafic composition are represented by diorite, quartz diorite, gabbro and orbicular gabbro, and sub-volcanic rocks are represented by diabase and diorite porphyries. The orbicular gabbros, which are the subject of the study, macroscopically contain orbicles ranging in size from 1 cm to 15 cm, formed by repetitive concentric circles of fine and coarse grains. All these orbicles consist of concentric circles that show magmatic textures both in macro specimens and under the microscope. The orbicles contain olivine, pyroxene amphibole and plagioclase minerals. Olivines are characteristic of their yellow, orange and bluish interference colours and abundant cracked structures. Pyroxenes show one or two planes of cleavage and have high interference colours. Plagioclase inclusions point to magma mixing from the sub-ophitic and ophitic textures. Orbicular circles were formed by the crystallization of basic magma in the form of a circular texture by conventional repetition as a result of adding a basic new magma that was later included in the magma chamber during the crystallization of basic magma. Mineralogical and petrographic features suggest that the orbicular gabbro is part of mafic igneous enclaves within intrusive mafic rocks.

Keywords – Orbicular Gabbro, Late Cretaceous, Petrography, Mineralogy, Magma mixing

I. INTRODUCTION

In an east-west trending part of the Alpine-Himalayan Orogenic Belt, Turkey presents various arc, collision and post-collision geological environments. Igneous rocks that are formed by subduction or collision are common in many tectonic environments. Such rocks are classified based on the amount of crust, mantle or mixture components involved during their petrogenesis. The origins and lithospheric evolution of igneous rocks have a very important place in understanding the geodynamic processes throughout the history of the world [1-4].

Orbicular gabbro, which is rarely seen in the world, was first announced by Schaller [5] based on the orbicular gabbro balls he encountered in the California region of the USA. [6-7]. Orbicular rocks are rarely encountered in different parts of the world, such as the Sierra Nevada Batholith-Canada [8-9], South Africa, New Zealand and the island of Corsica [7].

II. MATERIALS AND METHOD

Samples taken from the Orbicular gabbros, which are the subject of investigation within the scope of petrographic studies, were cut in 0.5x2x4 cm dimensions in Fırat University, Department of Geological Engineering, Thin Section Laboratory, and glued on 2.5x4.5 cm glass after one surface was smoothed (25 units of Epoxy resin, three units of mixed with epoxy hardener). After the glued rock piece was cut to approximately 0.5 mm, it was

thinned to a thickness of 0.025 mm with the help of abrasives and was prepared for petrographic examinations.

III. REGİONAL GEOLOGY

Lithological units outcropping in the ice-cold area within the Southeast Anatolian Orogenic Belt, one of the most important parts of the Alpine Himalayan Orogenic Belt, are Paleozoic-Mesozoic Keban Metamorphics, Late Cretaceous Elazığ Magmatic Complex, Upper Maastrichtian- Thanetian Seske Formation, Middle Eocene-Upper Oligocene Kırkgeçit Formation. It includes the formation and Quaternary units (Figure 1). Palaeozoic-Mesozoic aged Keban Metamorphics constitute the basement rocks in the study area. The unit is generally represented by calcschists and marbles [7, 10-13]. Keban Metamorphics have an intrusive relationship with Upper Cretaceous aged Elazığ Magmatic Rocks, generally tectonic [7]. The Late Cretaceous Elazig Magmatic Complex is observed in two groups as felsic and mafic compositions [7,12]. Felsic plutonic rocks are represented by granite, granodiorite, tonalite, and mafic plutonic rocks by diorite, quartz diorite, gabbro and orbicular gabbro. Orbicular gabbro crops out in a very local area in the study area (Figure 2). The orbicular gabbros, which are the subject of the study, macroscopically contain orbicles ranging in size from 1 cm to 15 cm, formed by repetitive concentric halos of fine and coarse grains. All these orbicles are concentric circles that show magmatic textures both in macro specimens and under the microscope. The Upper Maastrichtian-Thanetian Seske Formation unconformably overlies the Elazig Magmatic Complex in the study area. At the top of the formation, it is overlain by the Middle Eocene-Upper Oligocene Kırkgeçit Formation [7].

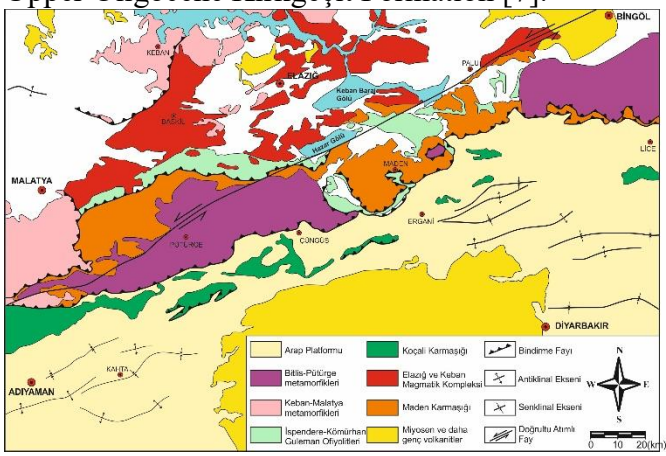

Fig. 1 Geological map of the study area

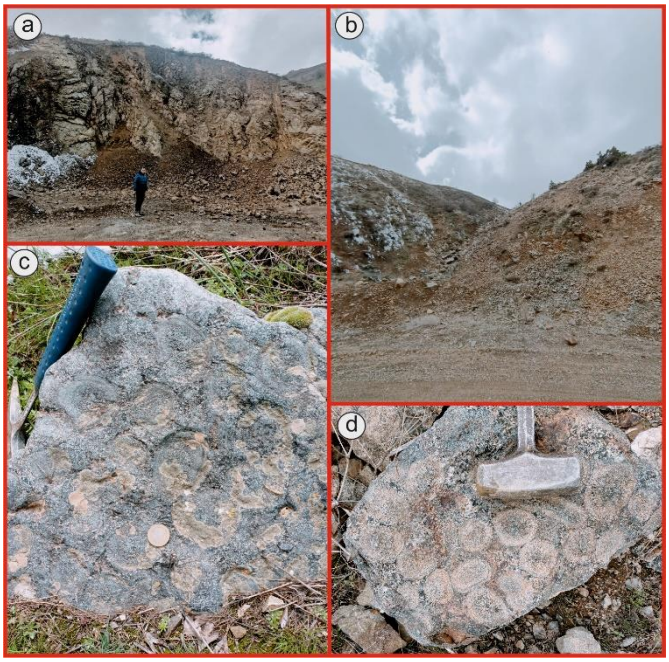

Fig. 2 Field photos of study area

IV. MINERALOGY AND PETROGRAPHY

Orbicular gabbros, which are the study's subject, consist of plagioclase, olivine, pyroxene and opaque minerals. Plagioclases are observed as prismatic crystals. It shows albite and polysynthetic twinning. Olivines are characteristic of their colourless in single nicol, green, yellow, orange and blue interference colours in double Nicols and their abundant cracked structures. Amphiboles have pleochroism in shades ranging from light green to dark green in a single nicol. It shows interference colours in shades of orange and brown. It has bidirectional cleavage in its hexagonal sections. Pyroxenes have vibrant interference colours. In some pyroxene minerals, plagioclases form ophitic and sub-ophitic textures in the form of inclusions. This indicates magma mixing. As in macro samples, fine and coarse grains appear as concentric circles under the microscope (Figure 3).

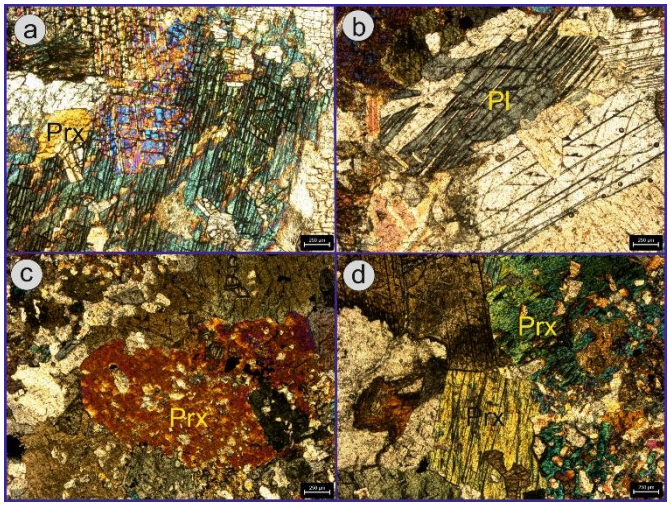

Fig. 3 Polarizing microscope images of orbicular gabbro. Abbreviations: (prx) pyroxene, (pl) plagioclases.

V. DISCUSSION

Late Cretaceous Orbicular gabbros within the Elazığ Magmatic Complex crop out in a narrow area in the study area. In macro and micro samples, it has concentric circles, called orbicular, varying in the 1-15 cm range, formed by coarse and fine grains. Petrographically, it contains plagioclase, pyroxene, amphibole and olivine minerals. Plagioclase minerals found as inclusions in pyroxenes indicate that magma-mixing processes formed these rocks. Orbicular circles were formed by the crystallization of basic magma in the form of a circular texture by conventional repetition as a result of adding a basic new magma that was later included in the magma chamber during the crystallization of basic magma. Mineralogical and petrographic features suggest that the orbicular gabbro is part of mafic igneous enclaves within intrusive mafic rocks.

VI. CONCLUSION

Within the scope of this study, Late Cretaceous Orbicular gabbros were observed to be petrographically composed of pyroxene, plagioclase, amphibole and olivine minerals, and it is thought that fine and coarse-grained concentric rings were formed as a result of magma mixing processes.

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