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Research Article

Petrographic features of Late Cretaceous biotite granites in the Kurtoğlu region (Elazığ/Turkey)

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Abstract – The study area is located in a local area around Kurtoğlu village of Elazığ province, located within the Southeast Anatolian Orogenic Belt. The studied biotite granites belong to the Elazig Magmatic Complex. The Elazığ Magmatic Complex is grouped into volcanic, sub-volcanic and plutonic rocks and mafic and felsic. Felsic rocks belonging to the Elazığ Magmatic Complex are represented by granite, granodiorite, tonalite, quartz monzonite, monzodiorite, and mafic rocks are represented by diorite, quartz diorite and gabbros. The biotite granites are porphyric biotite minerals with an average size of one cm. Petrographically, they are composed of K-feldspar, plagioclase, quartz, biotite and opaque minerals. K-feldspars have low birefringence colours, grey tones, and earthy colours in single nicol. Plagioclases; anhedral, euhedral and mostly subhedral crystals. They typically indicate albite, albite+karlsbad and polysynthetic twinning. In some samples, sericitization and carbonation are observed mostly in the middle parts of the plagioclase resulting from alteration. Biotites; It is generally in the form of subhedral platy-prismatic, rod-like crystals. Pleochroism is seen in brown tones in single nicol. It has high birefringence colours and indicates vivid interference colours in yellowish, blue and green, especially brown tones in double nicol. Porphyritic texture in which phenocryst and smaller crystals are generally observed in granites.

Keywords – Late Cretaceous, Biotite Granite, Petrography, Kurtoğlu, Elazığ

I. INTRODUCTION

Granitoids are the main components of the continental crust. Understanding the origins of these rocks is of great importance for continental crust studies and geodynamic evolution [1-2]. Chappel and White [3] examined granitoids in four groups according to their petrography, geochemistry and isotopic properties. These are S-I-A-and-M types. S-type granitoids were interpreted to derive from sedimentary protoliths, generally in collision zone [4] I-type granitoids is of magmatic origin, mostly in convergent margin and collisional settings. A-type granitoids represent collision-related intra-continental anorogenic environments. A-type granitoids are mildly alkaline, with low Al_2O_3 and CaO and high Fe/(Fe + Mg) and K_2O/Na_2O contents [4-5]. While M-type were interpreted to form by fractional crystallization of mantle-derived magmas in subduction related or oceanic intraplate settings [4, 6].

An intense magmatic activity is observed during the Late Cretaceous period in the Elazığ region within the Southeast Anatolian Orogenic Belt. These rocks were developed due to the subduction of the southern branch of the Neotethys Oceanic lithosphere towards the north [1, 7-8].

II. Materials and Method

Within the scope of petrographic studies, 20 samples were taken from biotite granite, the subject of investigation. The samples taken were cut in 0.4x2x5 cm dimensions and glued on 2.5x4.5 cm glass in Fırat University Geological Engineering Department Thin Section Laboratory. (5 parts Epoxy resin mixed with 1 part epoxy hardener). After the bonded rock pieces were cut to an average size of 0.3 mm, they were thinned to a thickness of 0.020 mm with the help of abrasives and prepared for petrographic examinations.

III. Regional Geology

Biotite granites located within the Late Cretaceous Elazığ Magmatic Complex located in the Southeast Anatolian Orogenic Belt are outcropping in and around Kurtoğlu village in the north of Elazığ province (Figure 1). The lithological units outcropping in the study area are the Late Cretaceous Elazığ Magmatic Complex [1, 7-11], the Middle Eocene-Upper Oligocene Kırkgeçit Formation, the Miocene-Pliocene Karabakır Formation [12-13] and the Pleistocene Harput Volcanics [14]. The rocks belonging to the Late Cretaceous Elazığ Magmatic Complex are grouped as plutonic, sub-volcanic and volcanic rocks with mafic and felsic composition [1,7-8]. Plutonic rocks with felsic composition are represented by granite, granodiorite, tonalite, and quartz monzonites, and plutonic rocks with mafic composition are represented by diorite, quartz diorite and gabbros. The volcanic rocks in the study area generally include basalt, andesite and dacites. The biotite granites, which are the subject of the study, are located in a local area. Depending on the alteration in the region, arenaizations are observed in the rocks. Biotites are observed in an average of 1 cm in size and are intensely observed in the rock (Figure 2). The Middle Eocene-Upper Oligocene aged Kırkgeçit Formation generally consists of clastic rocks. Kırkgeçit Formation starts with basal conglomerates [12-13]. These conglomerates are derived from the Keban Metamorphics and Elazığ Magmatites [12]. It then continues with sandy, clayey limestones, sandstone, claystone and fossiliferous regular bedded limestones [12,15] Miocene-Pliocene Karabakır Formation is represented by terrestrial environment sediments such as conglomerate, sandstone, mudstone marl and limestones and terrestrial volcanism products [13]. This formation constitutes a part of the western distribution of volcanics, defined as Neogene volcanics in the entire Eastern Anatolia Region. The Pleistocene-aged Harput Volcanics are the youngest volcanism products in the study area. It is represented by andesite, basalt and pyroclastics.

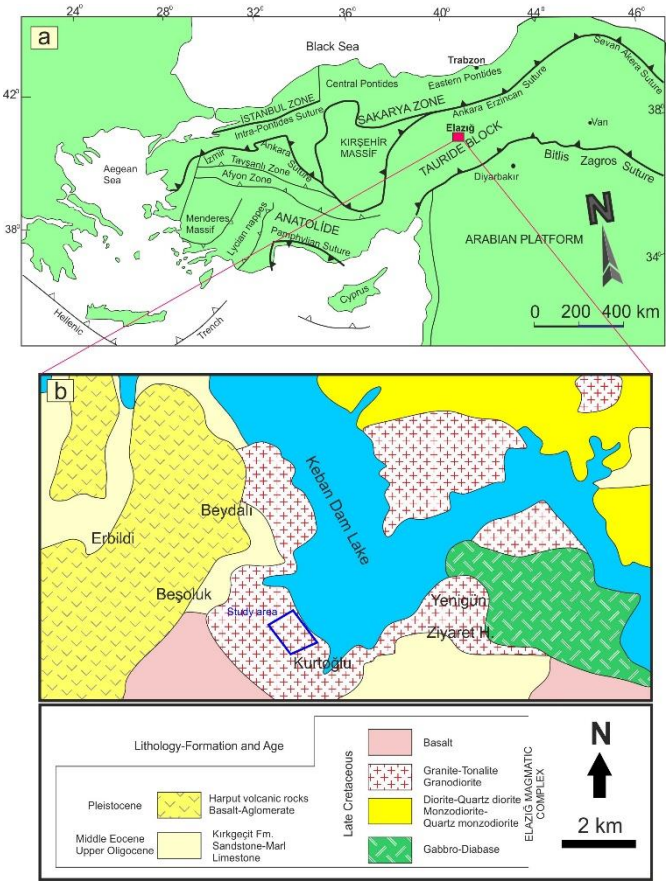

Fig. 1 (a) Tectonic location of the study area [16] (b) Geological map of the study area [17]

VI. Mineralogy and Petrography

The granites in the study area are seen as pink, pinkish-white, medium coarse-grained rocks in macro samples. These rocks contain the main minerals of plagioclase, K feldspar, quartz, amphibole, biotite, and opaque minerals. They comprise approximately 25-35% quartz, 25-35% plagioclase and 35-40% K feldspars. They also consist of 5-10% mafic minerals and 5% opaque minerals. Porphyritic texture in which phenocryst

and smaller crystals are generally observed in granites. Quartz; It appears as anhedral crystals and shows wavy extinction due to deformation. Plagioclase; euhedral, anhedral and mostly subhedral crystals. It typically shows albite, albite+karlsbad and polysynthetic twinning. In some samples, carbonation and sericitization are observed mostly in the middle parts of the plagioclase resulting from alteration. K feldspars; It has low birefringence colours, grey tones in double nicol, and earthy colours in single nicol. Biotites; It is generally in the form of subhedral platy-prismatic, rod-like crystals. It has high birefringence colours and shows vivid interference colours in blue, green, yellowish and especially brown tones in double nicol. At the same time, pleochroism is seen in brown tones in single nicol. (Figure 3).

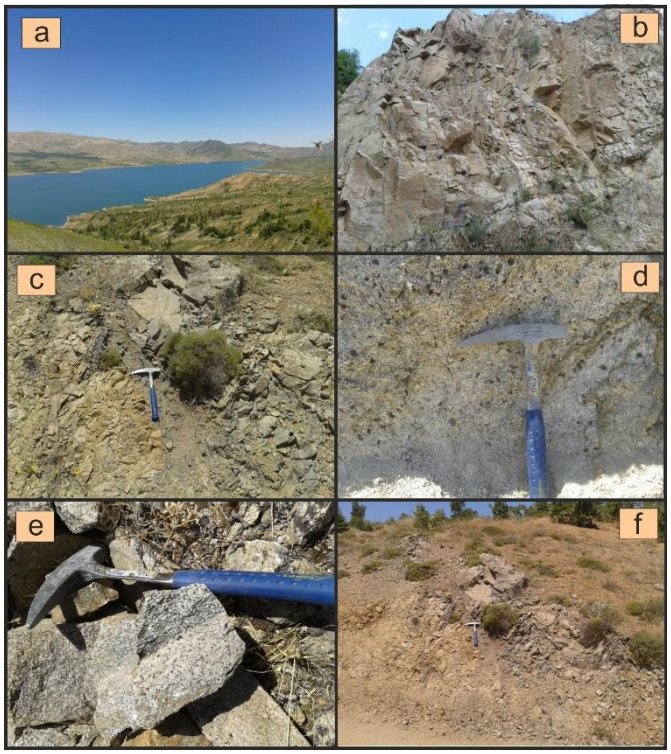

Fig. 2 Field photos of study area

V. Discussion

Felsic and mafic composition rocks belonging to the Elazıg Magmatic Complex are represented by granite, granodiorite, tonalite, quartz monzonite, diorite, quartz diorite and gabbros in the study area. The studied biotite granites contain dense biotite minerals with an average size of one cm in macro samples. The formations of biotite granites located in the Late Cretaceous Elazığ Magmatic Complex in a very local area in the study area.

The plutonic rocks belonging to Elazığ Magmatic Complex are divided into three subgroups: first-, second-, and late-stage. The first-stage samples are low K-tholeiite; the second-stage samples are calc-alkaline, and the late-stage samples are the shoshonitic character. The first- and second-stage

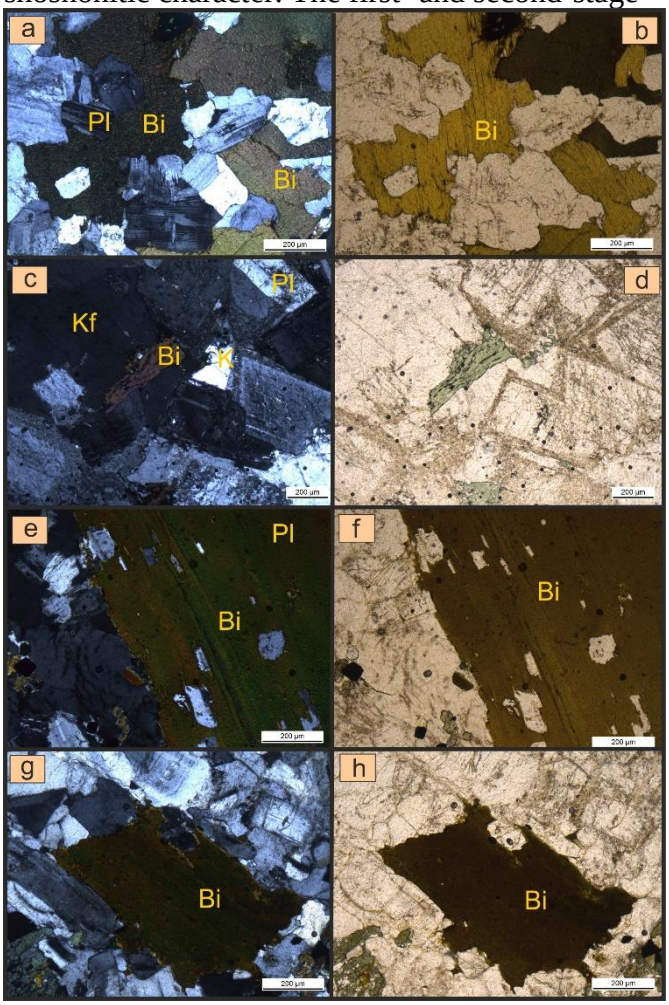

Fig. 3 Polarizing microscope images of biotite granites. Abbreviations: (bi) biotite, (pl) plagioclases (Kf) K-feldispar (Q) quartz

plütonic rocks have geochemical characteristics of typical intra-oceanic arc rocks, while the late-stage rocks have geochemical characteristics of collisional zone rocks [1, 18]. According to zircon U-Pb analysis, Elazığ Magmatic Complex formed in the 84–72 Ma time interval at different stages of the regional geodynamic evolution (island arc = 84–79 Ma and collision = 74–72 Ma) [1, 8, 18]. The lithologies and geochemical characteristics of the Late Cretaceous intra-oceanic arc-system rocks of the Southeast Anatolian orogenic belt (e.g., ophiolites and Elazığ magmatics) are similar to

modern arcs [19-20]. The intra-oceanic arc system formed through the subduction of the southern branch of the Neotethys Ocean during the late Cretaceous [1, 8, 14].

VI. CONCLUSION

The biotite granites that are the subject of the study are petrographically composed of quartz, plagioclase, K-feldspar, biotite and opaque minerals. The formation of these rocks, located in a very local area in the study area, is thought to have formed in the Upper Cretaceous due to the northward subduction of the southern branch of the Neotethys Ocean.

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