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FELDSPAR'S ROLE IN PROVIDING SOIL WITH MACRONUTRIENTS K AND CA (EXAMPLE: WADI EL-ANNAB NORTHEAST OF ALGERIA)

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Feldspars are an abundant mineral group and make up about 60% of the earth's crust. They are present in many sedimentary deposits and are found in almost all igneous and metamorphic rocks. The crust-mantle interaction at the plate boundary and inside the plate is the primary source of these minerals. Common feldspars include orthoclase (KAlSi3O8), albite ($NaAlSi_3O_8$), and anorthite ($CaAl_2Si_2O_8$). Weathering of feldspars is important in soil formation, especially for increasing soil fertility for food production. The Feldspar group of minerals is an important mineral to sustain life on the Earth. The feldspar group minerals play an important role in the overall dynamics of macronutrients such as K and Ca in soils. The massif of Wadi El-Annab is made up of igneous rocks. This massif is surrounded by the forest from all sides and a big part of this massif is covered with plants. This region is characterized by significant rainfall and a good hydrographic system. This study of massif by thin sections shows that it consists mainly of feldspar groups, quartz, micas (biotite and muscovite) and calcite as a secondary mineral. The feldspar group includes orthoclase and plagioclases. The plagioclases represent 50% of all feldspar. The orthoclase represents 50% of all feldspar. The feldspars are altered and show microfractures. The alteration of the feldspars is mainly because of water while the microfractures are because of the incursion of plant roots in the floor.

***Keywords**: Feldspars, Macronutrients, Soil, Wadi El-Annab, weathering.*

INTRODUCTION

Earth is the only planet in the solar system that has the conditions of life. It is divided into the core, mantle and crust. The crust is the Earth's outermost layer, on which humans live, and it has a recognizable landscape (rocks, soil, and seabed). The chemical evolution and construction of continental material are controlled by orogeny, volcanism, and sedimentation [1-7]. Climate, weathering, and erosion have all played a part in the formation of mountain ranges and the formation of the Earth's crust. The upper crust consists of 14% Sedimentary rocks, 50% of felsic intrusions, 6% of gabbros, and 30% of gneisses, mica schists, and amphibolites [8]. The distribution of these rocks is controlled by serval geological processes such as eruption and intrusion of lava, weathering, erosion, and consolidation of sediment particles, and solidification and recrystallization of rock. More than 4000 minerals make up the Earth's crust, but feldspars account for 51% of it followed by quartz at 12%, and pyroxenes at 11% [9]. Common feldspars include orthoclase ($KAlSi_3O_8$), albite ($NaAlSi_3O_8$), and anorthite ($CaAl_2Si_2O_8$). Due to their instability at the Earth's surface, feldspar minerals respond to chemical, biological, and mechanical weathering. Agricultural production is associated with the erosion and weathering of rocks. The feldspar group is very important for the human health and life. The weathering of the feldspar increases the soil fertility. The feldspar group minerals have a significant role in the overall dynamics of macronutrients such as K and Ca in soils.

They include a variety of nutritional metals that become accessible to plants when the soil weathers. K-feldspar (potassium feldspar) is crucial for maintaining Earth's biological equilibrium [10-12]. Feldspars change to secondary minerals as a result of weathering and soil formation [13, 14] like kaolinite, illite, gibbsite, smectite… the latter is used to produce drug (Smecta). The purpose of this work is to study the feldspar group in the parent rock by studying the massif of Wadi El-Annab in the North-east of Algeria and knows the type and properties of their feldspar, know the important geological processes affecting the feldspar and the type of macronutrients liberated from it in this massif.

LOCALIZATION OF THE MASSIF OF WADI EL-ANNAB

The massif of Wadi El-Annab is located in the province of Annaba in Northeast of Algeria near to the Mediterranean coast. It is 16 km northwest of the capital of Annaba (Figure 1). The massif of Wadi El-Annab is one of group of magmatic massifs in Annaba. All of these massifs are surrounded by the forest from all sides and a big part of these massifs is covered with plants (Figure 2a). The region of Wadi El-Annab is also characterized by a good hydrographic system represented mainly by Wadi El-Annab that passes by the massif, and other valleys passing through it like Wadi Salah and Wadi Matma.

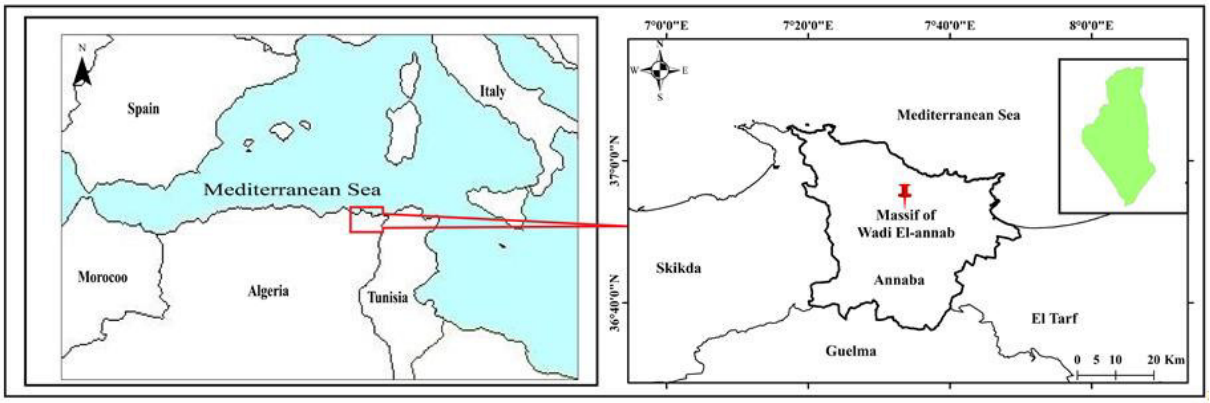

Figure 1. Localization of the massif of Wadi El-Annab

MATERIALS AND METHODS

Three typical samples were collected from the massif of Wadi El-Annab region for this study (Figure 2b). Each sample weighted about 2 kg. The sampling was randomly and the coordinates of the sampling location were recorded on a field notebook using a Global Positioning System (GPS). Each sample was labelled and numbered and sent to the laboratory for preparation of thin sections. The first phase of the preparation the thin sections were carried out at the level of the laboratory "de génie géologie (LGG)" University of Jijel. This phase just included the cutting of samples in the form of sugar cubes. The finalization of the preparation of these sections was carried out at the level of the laboratory "Géoresources-Environment et Risques Naturels" University of Oran 2.

STATISTICAL ANALYSIS AND GRAPHICAL PRESENTATION

The feldspar group is the main resource of potassium (K), sodium (Na) and calcium (Ca). Feldspars are divided into two main families: alkali feldspars and calc-sodium feldspars called plagioclases. The common alkali feldspar minerals are orthoclase and microcline ($KAlSi_3O_8$). They are both an important source of potassium, with potassium up to 16.92%. Calc-sodium feldspars or plagioclases

consisting of an isomorphic series between a sodium pole, albite ($Na[AlSi_3O_8]$), and a calcium pole, anorthite ($Ca[AlSi_3O_8]$).

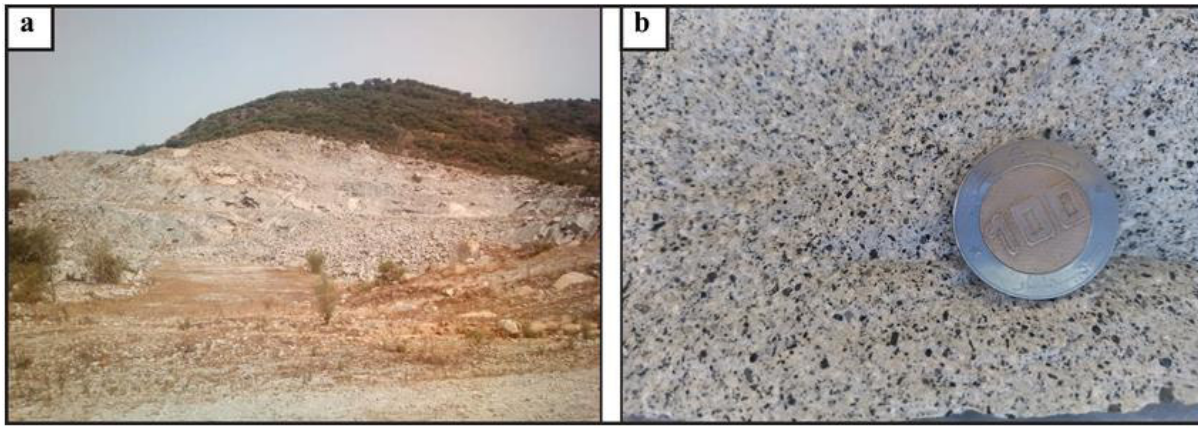

Figure 2. Photograph of the massif of Wadi El-Annab. a: Photo of the massif; b: photo of a sample

RESULTS AND DISCUSSION

The anorthite is the important source of Calcium in this series with 19.2% of Ca, followed by bytownite with 16.31 of Ca (Table 1) [15,16].

Table 1. Theoretical composition of feldspar group [15,16].

Minerals	Mineral Formula	K_2O	Na_2O	CaO	Al_2O_3	SiO_2
Alkali Feldspars						
Orthoclase	$KAlSi_3O_8$	**16.92**	0	0	18.32	64.76
Microcline	$KAlSi_3O_8$	**16.92**	0	0	18.32	64.76
Plagioclase Series						
Albite	$NaAlSi_3O_8$	0	11.82	0	19.44	68.74
Oligoclase	$(Na,Ca)[Al(Si,Al)Si_2O_8]$	0	9.34	4.23	23.05	63.38
Andesine	$(Na,Ca)[Al(Si,Al)Si_2O_8]$	0	6.92	8.35	26.57	58.16
Labradorite	$(Na,Ca)[Al(Si,Al)Si_2O_8]$	0	4.56	12.38	30.01	53.05
Bytownite	$(Na,Ca)[Al(Si,Al)Si_2O_8]$	0	2.25	**16.31**	33.37	48.07
Anorthite	$CaAl_2Si_2O_8$	0	0	**19.2**	35.84	44.4

The massif of Wadi El-Annab is made up of magmatic rock with a microlitic texture. The size of the minerals is millimetric. By observation with the eye, it shows that this massif consists mainly of three minerals: quartz, feldspar and biotite. To confirm this observation and to determine the characteristics of the minerals, a petrographic study was carried out using a polarized microscope. It was found that this massif consists of 45% feldspar, 35% biotite and 19% quartz as essential minerals and calcite as a secondary mineral. These minerals are bound together by cement.

1. Feldspars

Feldspars are the most dominant; they are represented by orthoclase and plagioclase. In orthoclase occurs as tabular and prismatic crystals. The size of the crystals is 0.5 to 1.5 mm in length and 0.3 to 0.7 in wide. The orthoclase always shows low birefringence of the 1st order where they have a light grey to white hue. They also show Carlsbad lusters, which are identified by the different luster of two associated minerals. Orthoclases are generally close to biotites (Figure 3b).

Plagioclases are more dominant than orthoclases. Plagioclases have a tabular shape. The crystal size of plagioclase is larger than the crystal size of orthoclase. It varies from 1 to 4 mm in length and from 0.5 to 2 mm in width. Plagioclases always show low birefringence of the 1st order where they present

a light grey hue. Plagioclases are identified by their polysynthetic lusters formed by repeated crystals and the origin of the typical striped appearance (Figures 3a and 3d).

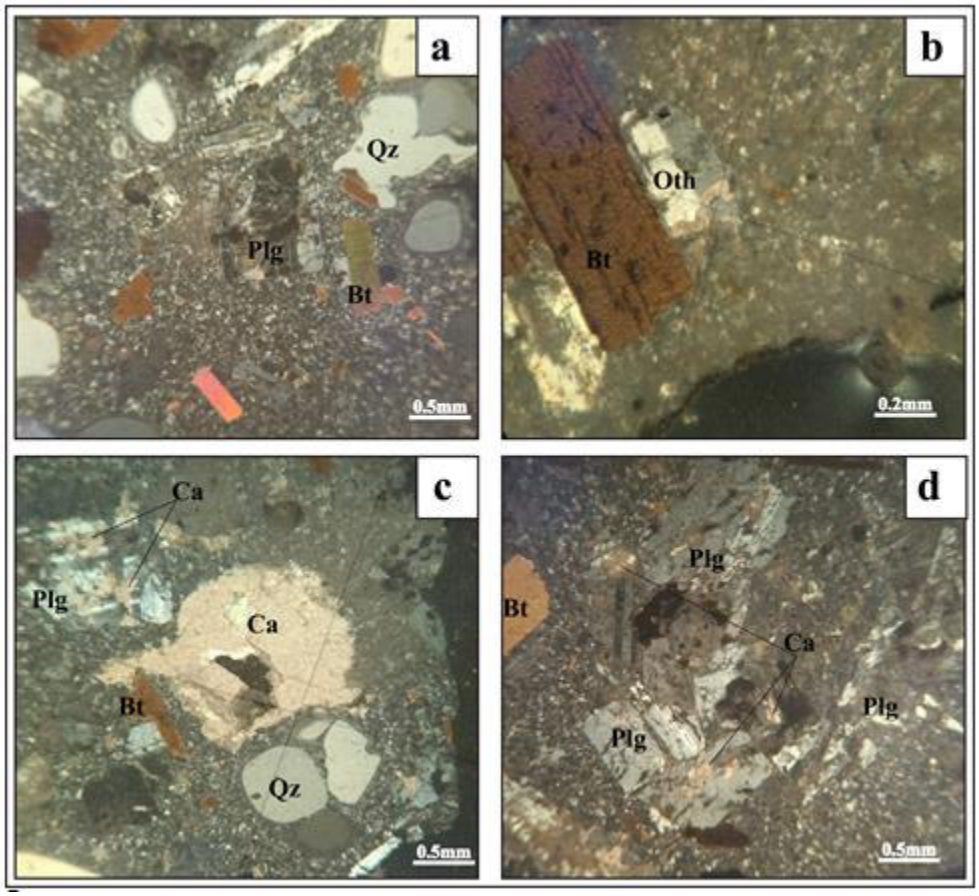

Figure 3. Photomicrographs show the main minerals that make up the massif of Wadi El-Annab. Qz: Quartz; Plg: plagioclases; Oth: Orthoclase; Bt: Biotite; Ca: Calcite.

2. Biotite

Biotite appears as elongated automorphic crystals. The size of the crystals is smaller compared to the crystal size of plagioclase. It is 0.5 to 2.5 mm in length and 0.2 to 0.5 mm in wide. Biotite is characterised by its strong birefringence with a brown and green hue of the 3rd order (Figures 3a and 3b).

3. Quartz

Quartz is less abundant than feldspars and biotite. It appears in the form of very clear patches with 0.5 to 2 mm in length and 0.5 to 1 mm in wide. It shows a weak 1st order birefringence with a light grey to white colour. It does not show any macles or cleavages (Figures 3a and 3c).

4. Weathering of the massif of Wadi El-Annab

Weathering occurs anywhere on the continents and at any time on our planet. Weathering is mainly of three types, namely mechanical, chemical and biological. The region of Wadi El-Annab is characterised by a high precipitation rate and a dense vegetation cover. The Wadi El-Annab massif is weathered. Quartz is a stable mineral that does not show any alteration. The decrease in birefringence of biotite confirms the beginning of the transformation from biotites to chlorites (Figure 3b). The alteration of feldspars is the most important in this massif. Most of the crystals are almost completely altered. They also show large microfractures. Plagioclase is more altered than orthoclase. The potassium feldspars are more stable than the plagioclases, which confirm that the Wadi El-Annab massif is richer in plagioclases than in potassium feldspars. Some crystals of the plagioclases are almost completely transformed into calcite and only relics remain (Figures 3c and 3d). The appearance of calcite is an indication that the dominant type of plagioclase is calcic plagioclase. The Wadi El-Annab massif is altered by three types of alteration: 1) mechanical, 2) chemical and 3) biological. Mechanical weathering is done by physical agents such as wind, water, gravity. Chemical weathering is mainly by water, acid rain, groundwater and air. Biological weathering is mainly by micro-organisms and plants. Plants play an important role in

weathering, as plant roots penetrate the soil and cause the dissolution of minerals, decomposition and humification of organic matter. The Wadi El-Annab region is a forested area causing reduced temperature, high humidity, increased rainfall and decreased runoff to increase the penetration of water into the underlying rocks. This increases the weathering of the underlying rocks. Decomposing plants, organisms and microbes provide the soil with organic matter. Leaves and wood are also major contributors of organic matter. The weathering of the Ca-feldspars in the Wadi El-Annab massif results in the release of calcium (Ca) which is associated with the organic matter released by leaves, wood and microbes, which explains the appearance of calcite.

5. The role of weathering the massif of Wadi El-Annab in providing soil with macronutrient

The soil is important for maintaining life processes. It is where the atmosphere, biosphere, hydrosphere and lithosphere meet. Soil has always been important to humans and their health because it provides a resource that can be used for shelter and food production [17]. Intrinsic soil fertility refers to the nutrients that contain or retain minerals in rocks and sediments and their bioavailability through controlled weathering processes. In general, rock weathering involves the physical and chemical breakdown of the minerals that form the rock, with a corresponding loss of minerals. The elements released by these rocks are minerals that help to increase the fertility of the soil and also increase its ability to retain water. Calcium and potassium are the most important macronutrients that increase soil fertility and help plant growth. The existence of calcium in the soil also reduces the toxicity of elements such as sodium (Na) and magnesium (Mg). Calcium (Ca) also contributes to plant growth by increasing the stiffness of plant tissue. Potassium (K) is important for maintaining the ecological balance of the earth [11-13]. Potassium plays an important role in accelerating plant growth by speeding up cell division, accelerating photosynthesis and increasing respiration. The Wadi El-Annab massif is the only magmatic massif in the region and this makes it the main source of feldspars in this area. The massif is rich in main calcium feldspars. The alteration of the feldspars free calcium (Ca) and potassium (K) and this is what increases the fertility of the soil reflecting the presence of dense vegetation cover in this region.

CONCLUSIONS AND RECOMMENDATIONS

The massif of Wadi El-Annab is located in Annaba province in the northeast of Algeria. It is surrounded by the forest from all sides and covered almost totally with plants. The massif of Wadi El-Annab consists mainly of feldspar group, biotite and quartz. It also contains calcite as a secondary mineral. The feldspar group is the most abundant minerals in this massif. The plagioclases are more abundant than the orthoclase. The feldspars group is almost totally altered. The appearance of the calcite is an indication that the type of plagioclases is the Ca-plagioclases. The weathering of the massif of Wadi El-Annab shows in feldspars and biotite where some feldspars have only trace left and the decreasing of biotite birefringence. The massif of Wadi El-Annab is altered by three types of alteration: mechanical, chemical and biological appear in the microcrackings and the transformation of feldspars to calcite. The massif of Wadi El-Annab is the primary source of the macronutrients especially for calcium (Ca) in the region.

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