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ON THE MINERALOGICAL CLASSIFICATION OF ZAKER GRANITIC ROCKS OF ZANJAN AREA, WESTERN PART OF TAROM DISTRICT, NORTHWEST IRAN

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Abstract. A generalized geological map of Zaker area is constructed for the first time to the scale of 1:100,000 upon analysing data collected from the field. The granitic rocks of Zaker batholith comprise 37 petrographic varieties ranging from granites to diorites and passing through adamellites and granodiorites.

The presence of myrmekite rims around the feldspar megacrysts of the leuco varieties of the examined granites is attributed to the effect of metasomatic processes with exsolution in the margins of megacrysts. The significance of red coloration of some granites of Zaker area is due to the iron ores resulting from the alteration of biotite and the enrichment in iron oxides during the effect of late hydrothermal solution.

The petrographic classification agrees to a great extent with the classification based on the modal analyses of the examined granitic rocks, which comprise granite, syeno-granite, monzo-granite, granodiorite, quartz-diorite and diorite. The present author is inclined to consider that the examined granites and adamellites are mainly of magmatic origin.

INTRODUCTION

The Zaker batholith forms one of the numerous granitic intrusions of the Tarom District nearest to Zanjan area (Fig. 1). The batholith is located between latitudes 36° 34' and 36° 42' N, and longitudes 48° 35' and 48° 50' E and covers about 80 km^2.

Prior to the present study, the Zaker granitic rocks received very little attention by the Geological Survey of Iran. Some of the earliest observations were made by Hirayama *et al.* (1965) on the general geology of Zanjan area. Hirayama *et al.* (1966) mentioned that the age of the intrusion is not known certainly. However, the basal conglomerate of the younger Tertiary strata contains no granodiorite pebbles. Therefore, it would seem that the intrusions are post-Miocene. The same authors (op. cit.) mentioned that the green diorite rocks grade into quartz-diorite or granodiorite. They also mentioned that the grey granodiorite is the main facies of the intrusive rocks, in addition to the presence of few different types of granites at the margins of the granodiorites. Alavi *et al.* (1969) mentioned that the contact effects of these intrusions on the surrounding lavas have been very weak, and are recognized only as slight hydrothermal alterations, without the formation of typical contact minerals.

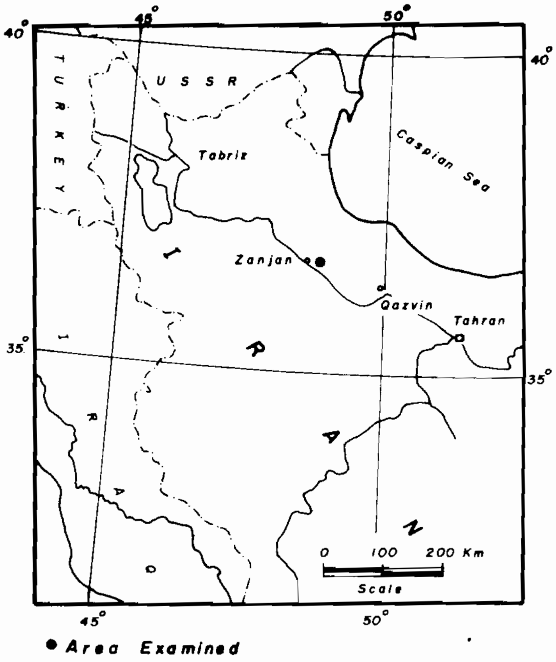


FIG. 1. Location map

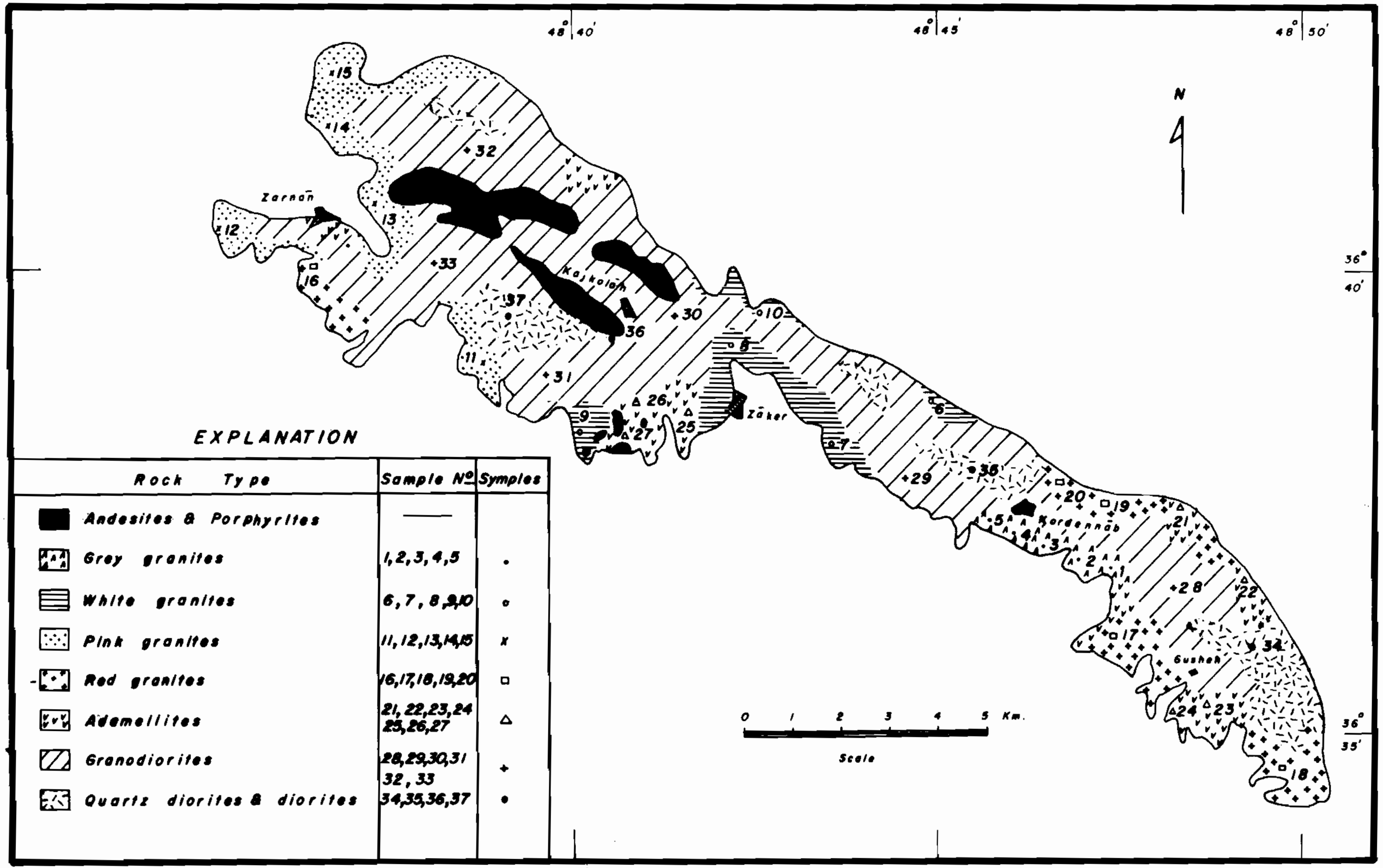


FIG. 2. Generalized geological map of Zaker area showing granitic types and sample location

FIELD OBSERVATIONS

The Zaker area consists essentially of granites, adamellites, granodiorites, quartz-diorites (tonalites) and diorites (Fig. 2). The grey granodiorite forms the main rock type within the area examined.

On the basis of field observations, the batholith shows a very rough zonal form. The innermost zones roughly occupying the core of the granodiorite are characterized by greyish green diorites. Granites and adamellites crop out at the margins of the granodiorites. Four main types of the coarse-grained granites are observed. They are mainly grey, white, pink and red. All granitic rocks grade imperceptibly into each other with rather indefinite contacts. The batholith exhibits various topographic forms. It ranges from relatively low outcrops with gentle slopes to high outcrops with steep slopes. The batholith is poorly dissected by wadis but traversed by many tributaries running in different directions. Stages of bouldery weathering could be observed in the field, from a preliminary splitting of the rocks along joints, to production of cuboidal blocks, and then to bouldery shapes (Fig. 3). The granitic rocks are well-jointed in various directions trending dominantly N 30° E and N 60° W. The joints are mainly inclined in granites, otherwise vertical and horizontal joints are encountered in the granodiorites (Fig. 4). Some of the joints are filled with late epidote minerals, iron ores, feldspars and quartz materials forming fairly straight veins with red hematitic feldspar constituting the walls of most of them. The granitic rocks are dissected by very few andesite dykes running in various directions.


FIG. 3. Pronounced bouldery weathering in grey granodiorites showing vertical joints

Zaker granitic rocks enclose few small subangular xenoliths of acidic, intermediate and basic composition. These xenoliths show sharp contacts and no sign of replacement between the two rocks (Fig. 5). Local brecciation of some granitic rocks is recorded at few places where fragments up to 15 cm across are embedded in a fine-grained matrix of epidote, iron ores and granitic materials.


FIG. 4. Coarse-grained red granites showing inclined joints

PETROGRAPHY

From the field observations, the rock types constituting the intrusion examined are mainly granites, adamellites, granodiorites, quartz-diorites and diorites. These types are grouped into granites and granodiorites.

1. *Granites*

The four field types of granites (grey, white, pink and red) are nearly similar in their mineralogical constituents and textural proper-


FIG. 5. Fine-grained granite xenolith caught up by medium-grained greenish grey diorites with sharp contacts

FIG. 6. White porphyritic leuco granite showing orthoclase crystal with carlsbad twinning. (crossed nicols; x 25)

ties. They are holocrystalline, with a hypidiomorphic granular texture, in addition to the presence of some porphyritic varieties (Fig. 6). Broadly speaking, the essential minerals of the granites are quartz, orthoclase, plagioclase, biotite, muscovite and hornblende with apatite, sphene, zircon and iron minerals as accessories.

Quartz forms interstitial anhedral crystals reaching up to 1.9 mm in length and 1.5 mm in breadth. It is clear, cracked, with a wavy extinction. Orthoclase is clouded by kaolinite. It forms subhedral crystals varying from 1.1 to 2.5 mm in length and from 0.9 to 1.8 mm in breadth. Orthoclase is frequently surrounded by rims of quartz and albite intergrowths. Euhedral tabular plagioclase is represented by albite crystals (An_5 to An_9). The fresh albite shows clear polysynthetic twinning, otherwise it is sericitized. Fine flakes and grains of hematite are observed around the feldspars of the red granite forming heavy reddish rims, in addition to the presence of many stringers of iron minerals penetrating the feldspar and quartz crystals (Fig. 7). The red colour of feldspar in the red granite is attributed to the enrichment in iron oxides during the effect of late hydrothermal solutions. Iron probably occurs in a ferrous state in biotite but after alteration it is redeposited as ferric oxide along the cleavage planes or fractures of feldspar, biotite and quartz minerals of the red granite. Biotite and muscovite are present in fair amounts in some samples as stout flakes filling the interstices between feldspars and quartz. The biotite is considered the main mafic mineral in the four types of granites and forms green flakes varying from 0.77 to 1.05 mm in length and from 0.20 to 0.99 mm in breadth. These flakes are pleochroic with x=pale yellowish green, y=z=dark green. Chlorite is commonly

FIG. 7. Red granite showing feldspar and quartz crystals bounded by haematitic materials in addition to the presence of myrmekite. (crossed nicols; x 40)

FIG. 8. Coarse-grained granite showing plagioclase megacrysts bordered by formation of myrmekite. (crossed nicols; x 40)

FIG. 9. Grey granodiorite showing hornblende crystals enclosing quartz grains and iron ores. (crossed nicols; x 40)

interlaminated with biotite. Hornblende forms euhedral prismatic green crystals which may exhibit simple twinning. These crystals reach up to 1.2 mm in length and 0.8 mm in breadth. It is strongly pleochroic with x=yellowish green, y=green, z=dark green. Some crystals of hornblende contain numerous rounded grains of quartz and iron ores.

Graphic and myrmekitic textures occur in some samples of granites, especially in the leuco varieties (Fig. 8). Myrmekitic texture is moderately well developed, forming partial rims on the outer margins of orthoclase and albite phenocrysts. The present author has confirmed the explanations by Ashworth (1972) and Phillips and Carr (1973) on the origin of myrmekite in which metasomatic processes could interact locally with exsolution in megacryst margin situations. The margins of megacrysts, in close proximity to the matrix phases of the rock and a limited diffusion, may be more readily attained through the matrix. Therefore, this hypothesis stands in agreement with the genesis of myrmekite rims around the phenocrysts of orthoclase and albite crystals in the granites examined.

The four types of granite grade into different varieties of adamellite in which fair amounts of green biotite and hornblende are observed, in addition to the presence of fresh oligoclase crystals (An_{12} to An_{20}) which are slightly more abundant than the potash feldspars and quartz.

2. *Granodiorites*

The grey granodiorite shows a holycrystalline hypidiomorphic granular texture and consists chiefly of plagioclase, potash feldspar, quartz, biotite, hornblende, and monoclinic pyroxene with iron ores, apatite, sphene and zircon as accessories.

Fresh crystals of plagioclase are within the oligoclase range (An_{15} to An_{26}) and form stumpy crystals up to 4.5 mm in length and 2.2 mm in breadth. Euhedral tabular crystals of oligoclase are characterized by polysynthetic twinning. Alkali feldspar is represented by orthoclase and forms altered crystals which enclose kaolinite dust. The alkali feldspar forms subhedral crystals up to 2.9 mm in length and 2.1 mm in breadth. Quartz forms interstitial anhedral crystals reaching up to 3.5 mm across. It may be cracked, show undulatory extinction and commonly encloses trails of iron ores specially in samples containing altered biotite. Biotite is of green variety and is largely chloritized and contains fair amounts of magnetite inclusions. In some samples biotite occasionally replaces some amphibole crystals. Hornblende is considered to be the common mafic mineral and it forms green prismatic crystals up to 3.5 mm in length and 2.3 mm in breadth. It is pleochroic with x=pale yellow, y=green, z=dark green. Hornblende commonly encloses quartz grains, epidote aggregates, and iron ores giving rise to poiklitic texture (Fig. 9). Some euhedral crystals of pale green augite and diopside are present in the core of some green hornblende showing that these hornblende crystals are crystallized in reaction relationship with pyroxene and melt.

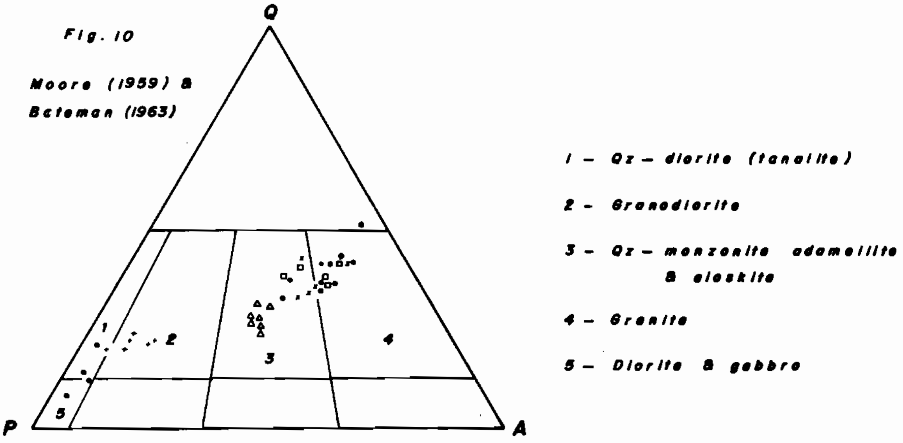
Granodiorite rocks grade into grey tonalite and medium grained diorite. The colour is greenish grey due to the increase of chloritization and epidotization processes of minerals.

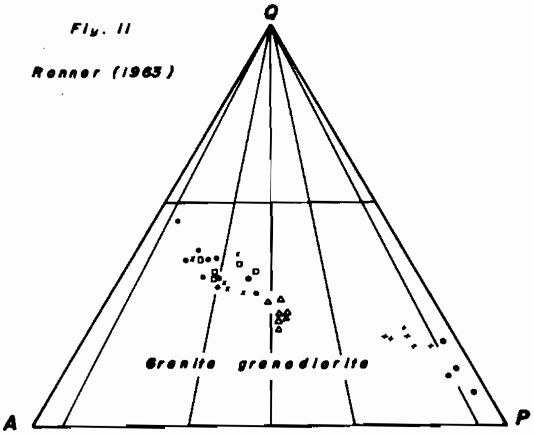
MINERALOGICAL CLASSIFICATION

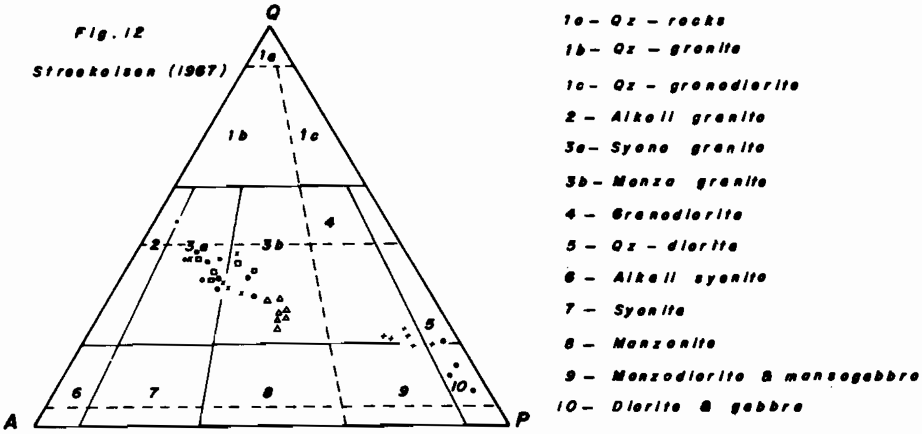
The modal analyses of granitic rocks of Zaker batholith are plotted in triangular diagrams in which Q=quartz, A=alkali feldspar and P=plagioclase. These diagrams have been subdivided in different ways by different authors.

The explanation of the three schemes of classification with respect to the modal analyses of the granitic rocks of Zaker area (Tables 1-4) is discussed below.

Fig. 10 shows the scheme advanced by Moore (1959) and Bateman *et al.* (1963). The granites and adamellites of Zaker area fall within the fields of granite and adamellite (zones 4 and 3). The granodiorites, quartz diorites, and diorites fall within the fields of granodiorite, quartz diorite and diorite (zones 2, 1 and 5 respectively). Fig. 11 shows the classification proposed by Ronner (1963) in which the granitic rocks of Zaker area plot within the fields of granite and granodiorite. Fig. 12 shows the classification given by Streckeisen (1967). From this figure, it is evident that granites and adamellites fall within the fields syeno-granite and monzogranite (zones 3a and 3b). Streckeisen (1967) mentioned that zone 3b comprises the eutectic composition of most magmatic solutions leading to granitic rocks. Therefore, the granites and adamellites of Zaker area are most probably of magmatic origin. The granodiorites, quartz-diorites and diorites plot within the fields granodiorite, quartz-diorite and diorite (zones 4, 5 and 10 respectively).







FIGS. 10-12. Zaker granitic rocks plotted according to classification schemes by various authors.

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TABLE 1. Modal Analyses of Granite Rocks

	Grey Granites					White Granites				
	1	2	3	4	5	6	7	8	9	10
Quartz	32.3	31.6	32.4	49.9	40.5	30.6	27.2	35.9	37.8	42.7
Orthoclase	30.6	30.8	38.9	40.8	45.8	38.4	31.5	37.3	44.1	41.8
Perthite										
Plagioclase	15.1	22.2	16.5	6.3	8.9	15.5	23.7	13.6	15.4	10.9
Biotite	14.5	12.3				12.4	2.1			
Muscovite			6.7					10.8		
Hornblende							12.4			
Augite										
Diopside										
Accessories	7.5	3.1	5.5	3.0	4.8	3.1	3.1	2.4	2.7	4.6
Total	100	100	100	100	100	100	100	100	100	100
Colour Index	22.0	15.4	12.2	3.0	4.8	15.5	17.6	13.2	2.7	4.6
% Quartz	41.5	37.3	36.9	51.4	42.5	36.2	33.0	41.3	38.8	44.8
% Alkali feldspar	40.0	36.3	44.3	42.0	48.1	45.4	38.2	42.9	45.3	43.7
% Plagioclase	18.5	26.4	18.8	6.6	9.4	18.4	28.8	15.8	15.9	11.5

Grey granites
1—Medium-grained biotite granite
2—Porphyritic biotite granite
3—Coarse-grained muscovite granite
4—Coarse-grained leuco granite
5—Porphyritic leuco granite

White granites
6—Porphyritic Biotite granite
7—Coarse-grained hornblende biotite granite
8—Porphyritic muscovite granite
9—Coarse-grained leuco granite
10—Porphyritic leuco granite

TABLE 2. Modal Analyses of Granite Rocks

	Pink Granites					Red Granites				
	11	12	13	14	15	16	17	18	19	20
Quartz	27.4	35.3	26.5	30.3	39.4	30.9	25.5	30.4	39.9	37.9
Orthoclase	32.6	29.8	30.3	36.3	44.6	36.2	27.2	26.3	42.8	40.3
Perthite										
Plagioclase	19.5	16.5	20.5	20.8	12.7	16.2	22.6	20.9	11.8	17.5
Biotite	14.9	12.5	11.1			12.4	8.5	6.7		
Muscovite							10.4			
Hornblende			7.9	9.7				10.2		
Augite										
Diopside										
Accessories	5.6	5.9	3.7	2.9	3.3	4.3	5.8	5.5	5.5	4.3
Total	100	100	100	100	100	100	100	100	100	100
Colour Index	20.5	18.4	22.7	12.6	3.3	16.7	24.7	22.4	5.5	4.3
% Quartz	34.5	43.2	34.2	34.6	40.8	37.0	39.9	39.1	42.1	39.4
% Alkali feldspar	41.0	37.7	39.6	41.8	46.2	43.4	36.1	33.8	45.4	42.3
% Plagioclase	24.5	19.1	26.2	23.6	13.0	19.6	24.0	27.1	12.5	18.3

Pink granites
11—Coarse-grained biotite granite
12—Porphyritic biotite granite
13—Coarse-grained biotite hornblende granite
14—Coarse-grained hornblende granite
15—Coarse-grained leuco granite

Red Granites
16—Coarse-grained biotite granite
17—Medium-grained muscovite biotite granite
18—Coarse-grained hornblende biotite granite
19—Coarse-grained leuco granite
20—Porphyritic leuco granite

TABLE 3. Modal Analyses of Adamellite Rocks

	Adamellites						
	21	22	23	24	25	26	27
Quartz	24.2	20.9	22.2	22.2	20.9	19.4	29.7
Orthoclase	25.3	24.9	20.3	25.1	24.3	28.2	30.9
Perthite							
Plagioclase	29.4	31.8	32.8	30.3	30.4	34.5	33.9
Biotite	14.5	15.8	5.4	6.5	9.4		
Muscovite							
Hornblende			11.1	9.7	10.3	14.6	
Augite							
Diopside							
Accessories	6.6	6.6	3.0	6.2	4.7	3.3	5.5
Total	100	100	100	100	100	100	100
Colour Index	21.1	22.4	19.5	22.4	24.4	17.9	5.5
% Quartz	30.7	26.8	27.5	28.5	27.1	23.6	31.1
% Alkali feldspar	32.0	32.0	31.6	32.3	33.4	34.3	33.0
% Plagioclase	36.3	41.2	40.9	39.2	39.5	42.1	35.9

Adamellites

21—Coarse-grained biotite adamellite
22—Porphyritic biotite adamellite
23—Medium-grained hornblende biotite perthite adamellite
24—Porphyritic hornblende biotite adamellite
25—Coarse-grained hornblende biotite adamellite
26—Coarse-grained hornblende adamellite
27—Porphyritic leuco adamellite

TABLE 4. Modal Analyses of Granodiorite, Quartz-diorite and diorite Rocks

	Granodiorites						Quartz-Diorites & Diorites			
	28	29	30	31	32	33	34	35	36	37
Quartz	16.7	13.3	18.5	15.3	14.8	14.8	14.4	8.8	7.8	6.2
Orthoclase	7.5	7.9	12.2	6.9	5.2	10.5	4.1	3.1	5.0	2.1
Perthite			15.1							
Plagioclase	47.8	45.4	33.3	46.2	53.3	46.3	49.2	48.1	53.9	57.3
Biotite	10.4	10.2	9.1	8.3			10.9	10.6		
Muscovite										
Hornblende	12.9	19.1	8.6	12.2	12.7	9.8	15.9	13.9	16.8	16.9
Augite				5.5				8.7	9.7	
Diopside					9.6	12.9				9.8
Accessories	6.7	4.1	4.2	5.6	4.4	5.7	5.5	6.8	6.8	7.7
Total	100	100	100	100	100	100	100	100	100	100
Colour Index	30.0	33.4	21.9	31.6	26.7	28.4	32.3	40.0	33.3	34.4
% Quartz	23.2	20.0	23.4	22.4	20.2	20.6	21.3	14.6	11.7	9.4
% Alkali feldspar	10.4	10.4	15.4	10.0	7.0	14.6	6.0	5.0	7.5	3.2
% Plagioclase	66.4	69.6	61.2	67.6	72.8	64.8	72.7	80.4	80.8	87.4

Granodiorites

28—Coarse-grained hornblende biotite granodiorite
29—Porphyritic hornblende biotite granodiorite
30—Coarse-grained biotite hornblende perthite granodiorite
31—Coarse-grained hornblende biotite augite granodiorite
32—Coarse-grained hornblende diopside granodiorite
33—Porphyritic diopside hornblende granodiorite

Quartz - diorites and diorites

34—Medium-grained hornblende biotite quartz-diorite
35—Medium-grained hornblende augite biotite diorite
36—Medium-grained hornblende augite diorite
37—Medium-grained hornblende diopside diorite

حول التقسيم المعدني للصخور الجرانيتية في زاكير ــ منطقة زانجان غرب تاروم ــ شمال غرب ايــران

عــادل محمــد رفعــت

معهد التربية للمعلمين ــ العديلية ــ الكويت

خلاصـــة

لقد امكن التعرف على ٣٧ نوعا بتروجرافيا للصخور الجرانيتية ، تتدرج من صخور الجرانيت حتى صخور الدايورايت في المنطقة المدروسة .

وقد اتضح ان بعض بلورات الفلدسبار الكبيرة الحجم محاطة باطار من المرميكيت، وهذا يوضح فعل عمليات التحوال التي تمت بتأثير المحاليـل المتبقية من عمليـة التبلور . كما أن اللون الاحمر لبعض صخور الجرانيت يرجع الى خامات الحـديد الناتجة من عمليات التغير لمعدن البايوتايت ، بالاضافة الى ترسب خامات الحديد من المحاليل الحارة اللاحقة لتكوين الصخور الجرانيتية . ويتفق التقسيم البتروجرافي الى حد كبير مع التقسيم المعتمد على التحليل الفعلي للصخور الجرانيتية . ومن خلال بعض التطبيقات للتحليل الفعلي ، اتضح ان هذه الصخور تشمل صخور الجرانيت ، والسيانوجرانيت ، والمونزوجرانيت ، والجرانودايورايت ، والكوارتزدايورايت ، والدايورايت ، هذا بالاضافة الى انه من الممكن اعتبار صخور الجرانيت والاداميللايت ذوات **أصـــل صهـيري** .