



GEOLOGICAL SURVEY

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**LITHOLOGY AND VOLCANIC STRATIGRAPHY
OF GIVOT SHEHORET, ELAT REGION**

Sergiu Peltz and Moshe Eyal*

* Department of Geology, Ben Gurion University, Beer Sheva

TR - GSI / 10 / 95

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INTRODUCTION

Volcanologic and petrologic studies were initiated in the Givot Shehoret area as part of a program started in 1990 for a comprehensive understanding of the late Precambrian volcanism in Southern Israel.

Field work and microscopic studies revealed the lithologic and structural complexity of the area.

Manifested are: 1) a variety of massive and clastic rocks, ranging from rhyolitic to basaltic; 2) a variety of lithofacies from lava flows to ash flows and resedimented volcanic deposits, in addition to near vent to distal facies; 3) remnants of volcanic structures are present but the paleovolcanologic reconstruction is difficult due to the high erosion and complex tectonic history.

The first step of our work was focussed on the deciphering of the lithology, of the volcanoclastic areas, carrying out detailed vertical sections, with a total thickness of 365 m, and detailed sampling and petrographic studies.

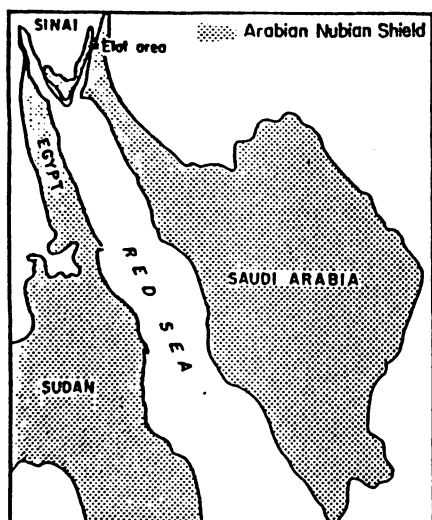
Seven whole rock analyses of the representative rock types are presented, they facilitate in an accurate nomenclature of the vitric rocks.

Givot Shehoret is an area about 1 km², comprised of seven hills with a maximum altitude of 162 m, and a mean altitude of about 50 m above the sea level. It is located 6 km north of Elat (Fig. 1).

The Givot Shehoret volcanic area is part of the Late Precambrian Elat volcanic field, remnants of which are exposed also in the Ramat Yotam, Nahal Roded, Har Amram and Har Neshef areas (Fig. 1).

Bartura, 1958 gave the first description of the rock types encountered in the Givot Shehoret area, mentioning that this is based only on megascopic observations. Most of the area is occupied by quartz porphyry conglomerate. In the southern part the presence of Precambrian conglomerate is mentioned. The area is traversed by dikes constituted of microsyenite, quartz porphyry and diabase.

Bentor, 1961 considered the Shehoret as the most northern part of the Elat Massif, without describing to the petrography of the area.



LEGEND

PHANEROZOIC SEDIMENTS

- Young sedimentary cover q
- Paleo-Cenozoic sediments s

ALKALINE STAGE

KATHARINA GROUP

- Silicic volcanic rocks π
- Elat Conglomerate e

ALKALINE INTRUSIVES

- Amram Granite γ_a
- Yehoshafat Granite γ_y

CALC ALKALINE STAGE

- CALC-ALKALINE INTRUSIVES
- Elat Granite γ_e
- Roded Quartz Diorite q δ

ISLAND ARC STAGE

- Elat Granitic Gneiss v_e
- Roded Quartz Dioritic Gneiss v_r
- Taba Gneiss v_t
- Metabasites μ
- Elat Schists σ

- Fault —
- Ramat Yotam Caldera π π
- International border +++
- Road ==

0 5 km

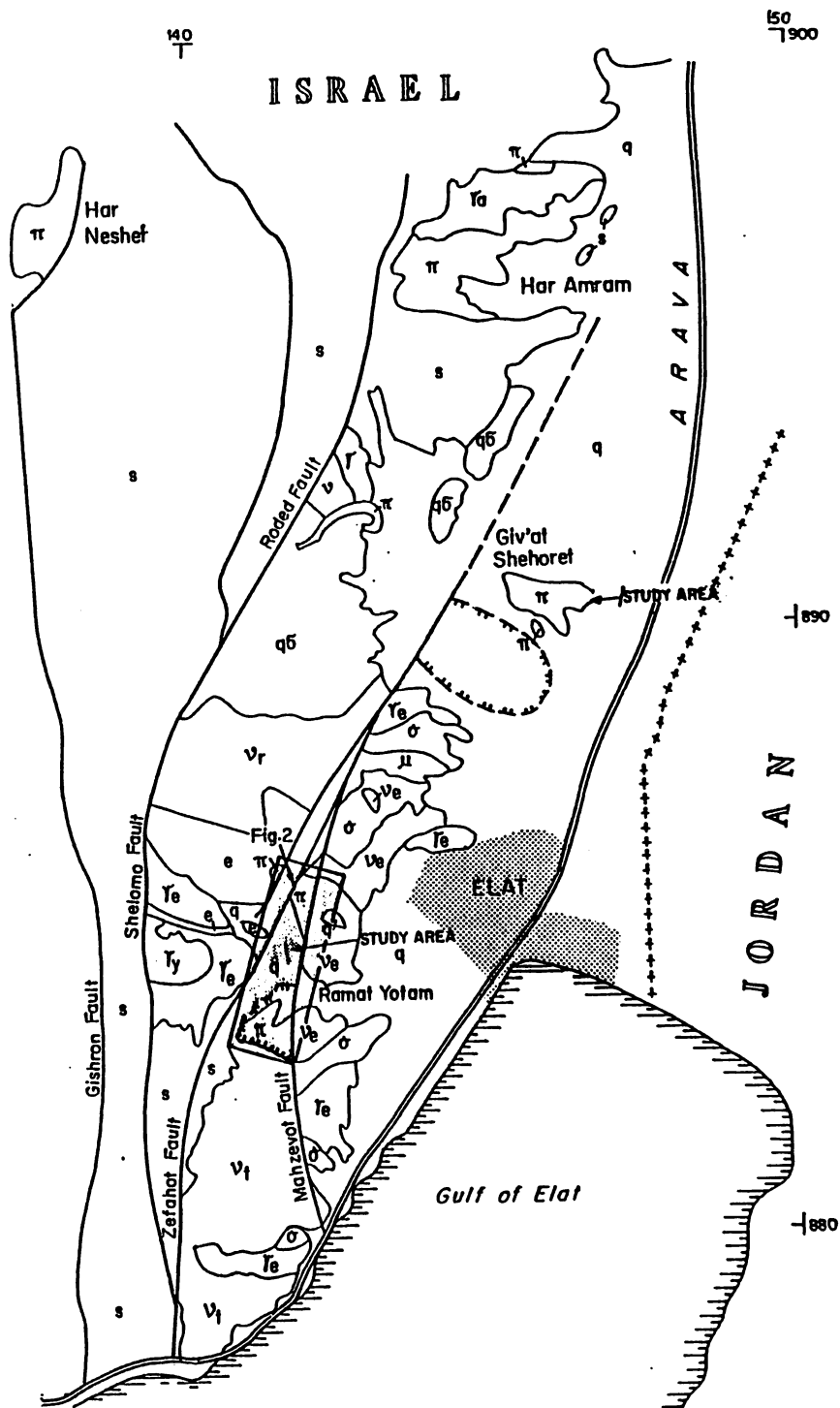


Figure 1. Simplified geological map of the Elat area with the location of the Givot Shehoret volcanic area.

Garfunkel, 1970, mentioned the presence of a Volcano-Conglomeratic Complex (in sense of Bentor, 1961) in the Givot Shehoret area.

On the Geological Map of Israel scale 1: 100,000, Yotvata and Elat sheets (Druckman et al., 1993), most of the Givot Shehoret area consist of rhyolitic quartz porphyry. Only in the north-westernmost corner of the area, the presence of the Roded Conglomerate was mentioned.

Eyal and Peltz, 1994, consider the plane south of Givot Shehoret a probable location for the eastern part of the Ramat Yotam Caldera

This report describes the lithology and volcanic stratigraphy of the Givot Shehoret, focussing on the volcanoclastic rocks which cover about 90% of the area.

GENERAL PETROGRAPHY

Mineral composition

The Givot Shehoret Volcanic Complex (GSVC) consist of basaltic, andesitic, trachytic and rhyolitic lava flows and volcanoclastic rocks.

The flows are basaltic, tracybasaltic to trachytic and of a lesser importance rhyolitic, whereas the volcanoclastics are andesitic to rhyolitic (Fig. 2).

Basaltic and rhyolitic dikes cuts the northern and northwestern parts of the GSVC (Fig. 2).

Plagioclase, alkali feldspar, and quartz are the principal minerals of the felsic rocks, with accessory zircon and apatite.

Crystals of plagioclase are dominant as phenocrysts (0.5-4 mm long), microphenocrysts (0.3-1 mm) or as broken crystals. In some cases contain glass inclusions.

Alkali feldspar occurs in euhedral to subhedral crystals (0.5 to 2 mm long), or fragments of crystals. Some of the feldspars are partially or completely argillitized.

Quartz is subhedral (0.2- 1 mm) and fractured. Chips of quartz are commonly present throughout the matrix of the volcanoclastics.

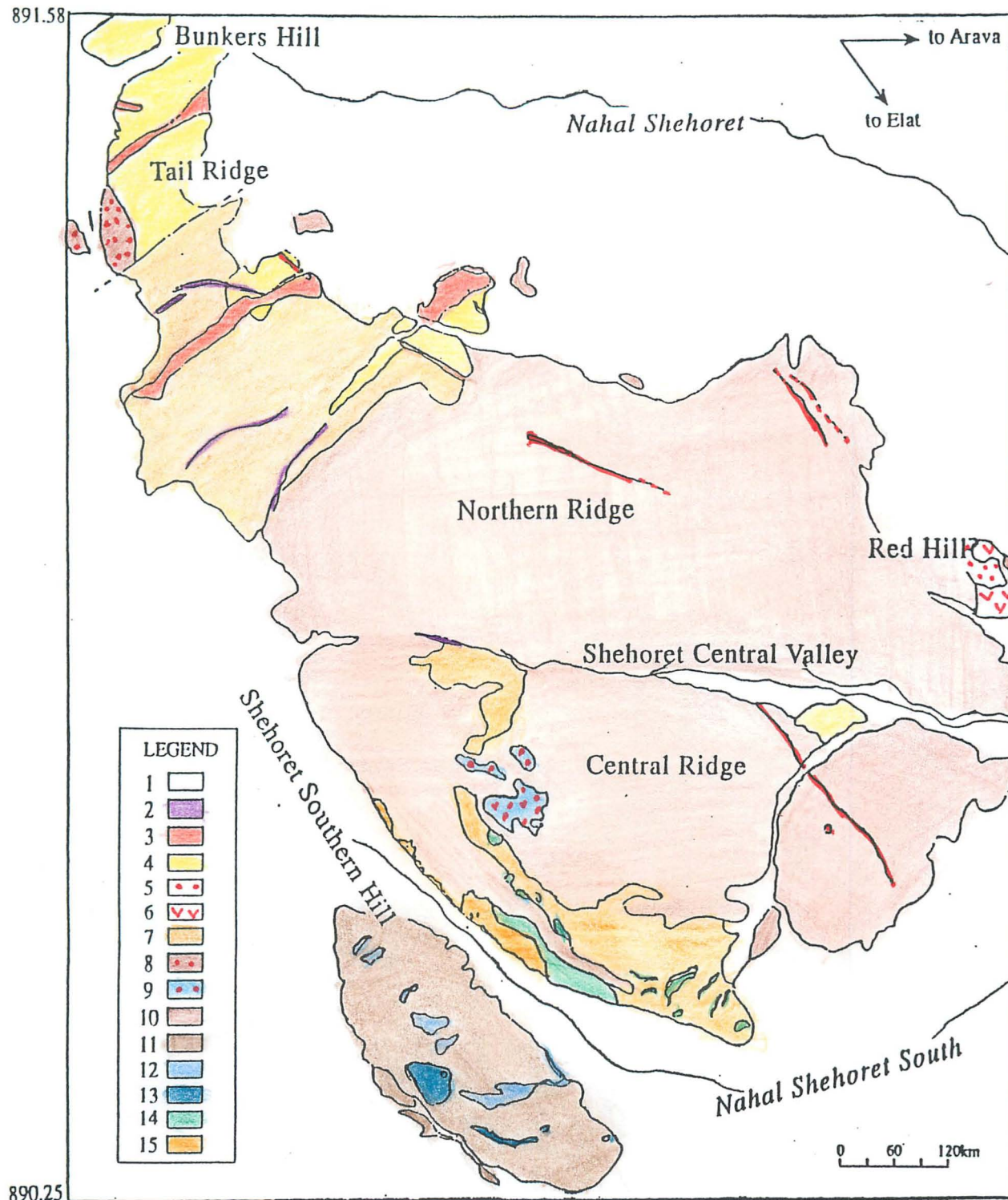


Figure 2. Preliminary geological map of the Givot Shehoret.

1, Quaternary deposits. 2, Doleritic dike. 3, Rhyolitic dike. 4, Elat Conglomerate. 5, Red Hill rhyolitic ignimbrite. 6, Red Hill rhyolitic flow. 7, Tail Ridge lapilli tuff. 8, Tail Ridge fine tuff. 9, Central Ridge resedimented pyroclast-rich breccia. 10, Central Ridge andesitic tuff complex. 11, Southern Hill trachytic flows. 12, Southern Hill trachyandesite - trachybasaltic flows. 13, Southern Hill pyroclastic complex. 14, Central and Southern hills basaltic and andesitic flows and pyroclastics. 15, Elat Granite.

There is no correlation between feldspars/quartz abundance ratio and the lithostratigraphic position of the tuff.

Plagioclase pyroxene and olivine (0.3 to 1.5 mm) are the principal minerals of the basaltic rocks. Some of the melanocratic minerals are partly to completely chloritized.

Opaque oxides occur as equant or euhedral grains (0.2 to 1.2 mm), or as groups of grains.

Zircon is a common accessory (0.7 mm), forming single crystals or aggregates.

Fiamme

Fiamme are rhyolitic (the Red Hill ignimbrite) and andesitic (the Shehoret Tuff). They consist of a glassy devitrified matrix, sporadic phenocrystals of plagioclase in excess of alkali feldspar and quartz. The fiamme are lenticular in some cases with preserved frayed-like ends, they show sharp contacts with the matrix, and their size varies from 2 to 40 mm. Because of the low to medium degree of compaction within fiamme, the pumice relict texture was not preserved. It is evidenced by microspherulitic devitrification.

Lithic fragments

The Shehoret pyroclastics and epiclastics contain up to 50% lithic fragments, they are angular to rounded in shape, varying from 0.4 to 100 mm in diameter. Four distinct groups of lithic fragments were recognized: 1) volcanic rocks representing: a) pre-Shehoret Tuff phase volcanism (the wall of the vent and of the magma chamber); b) syn-Shehoret Tuff volcanism (the case of the resedimented syn-eruptive volcanoclastic deposits). One can here distinguish fragments of basaltic andesite, andesite, latite and vitrophyre; 2) hypabyssal rocks mainly of andesitic composition; 3) plutonic and metamorphic rocks from the basement represented by granite, diorite, monzonite, gneiss and biotite schist.

Matrix

The texture of the groundmass of the massive volcanic rocks is fluidal, pilotaxitic, intergranular and microlitic.

The matrix of all the volcanoclastic rocks is completely devitrified shearing various degrees of crystallization from cryptocrystalline to spherulitic. The constituent particles in the

matrix are ash-sized crystals and interstitial dusty or muddy material.

Within the Red Hill ignimbrites platy shards shows molding or squeezing against the crystals or lithics.

Vesiculation

The vesicles are the dominant structure in a few lava flows exposed in the Shehoret Southern Hill area (Fig. 2). Commonly the vesicles are elliptical and spherical (1/0.5 to 25/8 mm), showing irregular walls. A part of the vesicles are filled with grains of limonitized opaques, carbonate or siliceous material. The fluidal texture of some trachytes is commonly associated with collapsed microvesicles showing a flow structure. The initial vesicular structure of the Red Hill ignimbrites was obliterated by microspherulitic devitrification.

CHEMICAL CLASSIFICATION

In the case of the fine-grained vitric volcanics with few phenocrysts of feldspars and melanocrates, the modal composition is not relevant for their denomination. Such rocks constitute a part of the massive and clastic rocks of the investigated area.

Seven representative fresh samples of lava flows and vitric tuffs were analysed for major elements (Table 1). The total alkali and silica data were used for the chemical classification in accordance with IUGS recommendations (TAS diagram, Le Maitre et al., 1989).

The distribution of the analyzed samples on the TAS diagram show that the analyzed rocks plot in the andesite, basaltic trachyandesite, trachyandesite, trachyte and rhyolite fields (Fig. 3). The Shehoret vitric tuff is andesitic but SiO₂-rich, appropriate to the dacitic composition. The ignimbrites of the Red Hill are rhyolites. The type rocks constituting the flows of the Shehoret Southern Hill are alkaline, from basaltic trachyandesite to trachyte.

T A B L E 1

MAJOR ELEMENT ANALYSES OF REPRESENTATIVE SAMPLES
FROM THE GIVOT SHEHORET AREA

Sample	1299	1338	1361	1366	1407	1415	1428
SiO ₂	64.06	56.16	56.21	54.34	77.89	62.77	61.12
TiO ₂	1.22	1.63	1.64	1.03	0.10	1.33	1.53
Al ₂ O ₃	15.84	16.64	16.59	19.71	11.81	15.84	15.96
Fe ₂ O ₃	6.74	9.39	10.72	7.43	2.74	7.30	7.47
MnO	0.11	0.17	0.12	0.17	0.05	0.13	0.13
MgO	1.73	3.57	3.50	4.85	0.30	2.16	2.14
CaO	1.73	3.57	2.26	5.67	0.30	3.49	4.50
Na ₂ O	5.11	6.02	6.08	4.54	3.66	4.11	4.40
K ₂ O	3.16	2.45	2.47	2.06	3.15	2.36	2.14
P ₂ O ₅	0.30	0.40	0.41	0.20	0.10	0.51	0.61
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
%LOI	1.4	2.1	2.0	2.2	0.6	2.0	1.5
Total*	99.2	100.0	99.0	99.1	98.8	99.2	99.2

Analyses recalculated to 100% loss-free accompanied by %LOI and pre-normalization totals (Total*). All iron given as Fe₂O₃.

Sample location and TAS classification:

1299, Shehoret Southern Hill, NW corner; trachyte, lava flow.

1338, Shehoret Southern Hill, central part; trachyandesite, lava flow.

1361, Shehoret Southern Hill, NW part; trachyandesite, lava flow.

1366, Shehoret Southern Hill, NW part, basaltic trachyandesite, lava flow.

1407, Red Hill; rhyolite, ash-flow tuff.

1415, Central Ridge, NE part; andesite, vitric tuff.

1428, Shehoret Central Valley; andesite, vitric tuff.

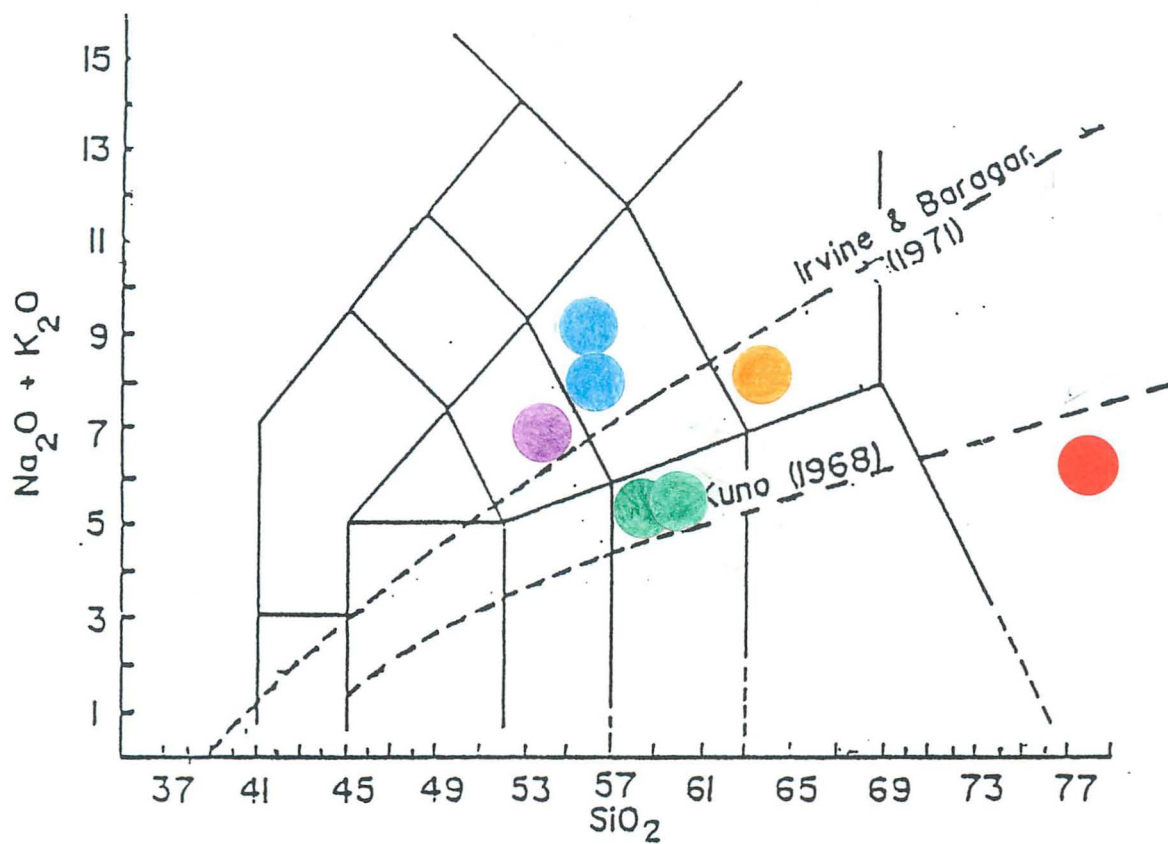
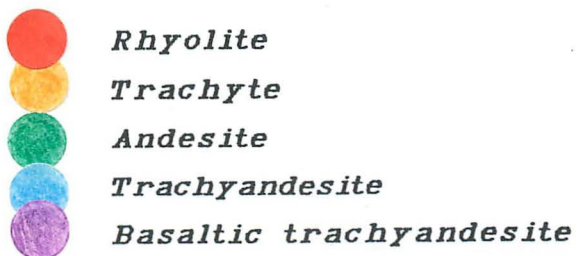


Figure 3. Total alkalies versus silica content diagram for the representative volcanics of Givot Shehoret.



THE GIVOT SHEHORET VOLCANICLASTIC COMPLEX (GSVCC)

About 90% of the whole Givot Shehoret volcanic area is represented by an assemblage of intermediate to silicic ash-fall and ash-flow tuffs, resedimented, syn-eruptive, volcaniclastic deposits and volcanogenic sedimentary deposits. Table 2 represents a classification of the Givot Shehoret volcaniclastics, whereas table 3 includes the descriptive names used for such type of deposits.

The structural-textural and lithologic peculiarities of most of the GSVCC lithotypes are common with those of the Yotam Caldera Formation (Peltz and Eyal, 1992, Peltz and Eyal, 1994).

Dominant within the volcanic section of GSVCC (with an exposed thickness of about 365 m) is the Shehoret Tuff (ST), an alternance of vitric tuffs, fine and coarse tuffs with turbiditic tuffs (Fig. 4).

The turbiditic tuff and tuff-breccia lithofacies has a maximum extension in the Central Ridge and Northern Ridge areas (thickness about 60 m). In exposures the tuff beds are massive showing locally normal size grading and partially distinct parallel lamination. Sequences of graded laminated beds are distinct in thin sections. Locally intraclasts of granite up to 1 meter in diameter were encountered. The breccias are prevalent in the Tail Ridge area (Fig. 2). Exhibits blocky lithic clasts of fine tuff, vesicular trachyte, granite and diorite. The reduced matrix is a turbiditic tuff.

The Shehoret turbiditic volcaniclastics indicate sin-volcanic activity with the western and southwestern areas (Nahal Netafim and Nahal Roded). The material was deposited by high density flows in a shallow basin.

A similar origin can be considered for the resedimented volcanic breccia. Remnants of the deposit were encountered only in the Central Ridge (Fig. 2) overlying the highly eroded deposits of the Shehoret Tuff. The breccia consist of angular blocks (up to 2 m) and lapilli chaotic distributed in a reduced matrix. Most of the constituents are vitric tuff and turbiditic tuff. The matrix consist of muddy chloritic material.

T A B L E 2

**CLASSIFICATION AND NOMENCLATURE OF VOLCANICLASTIC ROCKS
FROM THE GIVOT SHEHORET AREA**

(Modified from McPhie et al., 1993)

Clasts mm	Pyroclastic	Resedimented Syn-Eruptive	Resedimented Post-Eruptive
> 64 mm	pyroclastic breccia	resedimented pyroclast-rich breccia	volcanogenic conglomerate
2-64 mm	lapilli-tuff or lapilli-breccia	resedimented pyroclast-rich lapillistone	volcanogenic microconglomerate
1/16-2 mm	coarse tuff	resedimented ash-rich sandstone	volcanogenic sandstone
< 1/16 mm	fine tuff	resedimented ash-rich mudstone	volcanogenic mudstone

T A B L E 3

DESCRIPTIVE NAMES FOR THE GIVOT SHEHORET VOLCANICLASTICS

(From McPhye et al., 1993)

Grain size	mm
fine tuff/mudstone	<1/16
coarse tuff/sandstone	1/16-2
lapilli tuff/microconglomerate	2-64
breccia/conglomerate	>64
Components	
crystals	
lithic fragments	
fiamme (collapsed pumice)	
shards	
volcanic or non-volcanic, polymict or monomict	
Lithofacies	
massive (non-bedded); (non-graded or graded)	
bedding: laminated	<1 cm
thinly bedded	1-10 cm
fabric: clast-supported or matrix supported	
poorly sorted, moderately sorted, well sorted	

I			II		
1	2	3	2	3	
45		☼☼☼☼☼	1545	*****	
	1445	☼☼☼☼☼	1544	*****	
	1444	☼☼☼☼☼		☼☼☼☼☼	
	1443	oooooo	1543	☼☼☼☼☼	
	1442	oooooo		☼☼☼☼☼	
40		oooooo	1542	oooooo	
	1441	oooooo		oooooo	
		oooooo		oooooo	
	1440	oooooo	1541	oooooo	
	1439	oooooo		oooooo	
35		oooooo	1540	oooooo	
	1438	oooooo		oooooo	
	1437	oooooo		oooooo	
	1436	oooooo		oooooo	
		oooooo	1539	oooooo	
30	1435	oooooo	1538	oooooo	
	1434	>>>>>		oooooo	
		>>>>>		oooooo	
		>>>>>		oooooo	
	1433	<<<<<	1537	oooooo	
25	1432	<<<<<	1536	oooooo	
	1431	<<<<<		oooooo	
	1430	<<<<<		nnnnn	
	1429	<<<<<		nnnnn	
		<<<<<	1535	nnnnn	
20	1428	<<<<<	1534	nnnnn	
		<<<<<		nnnnn	
	1427	<<<<<		nnnnn	
		<<<<<	1533	nnnnn	
	1426	nnnnn	1532	nnnnn	
15		nnnnn	1531	nnnnn	
	1425	nnnnn		nnnnn	
	1424	nnnnn	1530	oooooo	
		nnnnn	1529	oooooo	
	1423	nnnnn	1528	oooooo	
10		nnnnn		oooooo	
	1422	nnnnn	1527	oooooo	
		nnnnn		oooooo	
	1421	nnnnn		oooooo	
	1420	@@@@@		oooooo	
5		@@@@@	1526	oooooo	
	1419	@@@@@		oooooo	
	1418	<<<<<		oooooo	
	1417	<<<<<		oooooo	
	1416	<<<<<	1525	oooooo	
0					

LEGEND

oooooo	Fine (vitric) tuff
☼☼☼☼☼	Coarse tuff (crystals>lithics)
nnnnn	Coarse tuff (lithics>crystals)
@@@@@	Coarse tuff fiamme-bearing
<<<<<	Fine tuff (laminated)
>>>>>	Coarse tuff (laminated)
*****	Volcanogenic sandstone

Figure 4. Detailed lithology of Shehoret Tuff

1, Elevation; 2, Sample number; 3, Lithotypes. I and II, vertical section.

EVOLUTION OF THE VOLCANIC ACTIVITY

Four distinct episodes of volcanism have been recognized in the Givot Shehoret area.

(1) In the Late Precambrian volcanism started with the eruption of basaltic lava flows and pyroclastic rocks. Large volcanic structures are not exposed; only remnants of the volcanic deposits cover the highly eroded granitic pluton in the southern part of the Central Ridge (Fig. 2).

(2) A subsequent phase of volcanism is represented by more silicic and alkaline products. The trachybasaltic - trachytic flows overlie the basalts in Shehoret Southern Hill. Remnants of a supposed eruption center may be postulated in the peak area of the hill. The volcanic center is evidenced by highly brecciated vesicular trachyte, associated with opal and argillic - limonitic deposits of fumarolic origin.

(3) After the cessation of the trachytic volcanism, the eruption of the andesitic pyroclastics and lavas became dominant. This is evidenced by a thick complex of fallout and flow tuffs alternating with resedimented syn-eruptive and post-eruptive volcanoclastic rocks. The variety of lithotypes also point to a variety of eruptive activity and variable conditions of accumulation. Notable is the prevalence of ash-fall volcanism.

The products of the andesitic phase cover a major part of the Givot Shehoret area (Fig. 2).

(4) During the last and fourth phase of volcanic activity the silicic Red Hill ash-flow tuffs and flows were deposited. The deposits were highly eroded and nowadays some remnants are encountered only in the northeastern corner of the Givot Shehoret area.

After the cessation of the volcanic activity in Givot Shehoret and surrounding areas, the products were eroded, transported and deposited under shallow water conditions. The polymict conglomeratic deposits encountered in the northwestern corner of Givot Shehoret reveals lithologic and structural-textural similarities with the Elat Conglomerate.

Peltz and Eyal (1994) showed that the source area of the Garof ignimbrite, the main lithologic component of the Yotam Caldera

T A B L E 4

CORRELATION CHART OF ELAT LATE PRECAMBRIAN VOLCANISM

RAMAT YOTAM CALDERA	MIZPE ELAT	HATAVOR HANOZEL	GIVOT SHEHORET
--	--	--	basaltic dikes
r h y o l i t i c d i k e s			
--	--	--	Elat Conglomerate
rhyolitic ignimbrites	rhyolitic pyroclastic flows	rhyolitic pyroclastic flows and falls	rhyolitic ignimbrites and flows
--	rhyolitic	dome	--
--	--	--	andesitic pyroclastics
--	--	--	trachytic and trachybasaltic flows + pyro- clastics
--	--	--	trachyandesitic flows
--	--	--	basaltic flows and <u>pyroclastics</u>
Taba Gneiss	???	???	Elat Granite

Formation, was north-northeast of the actually preserved part of the Ramat Yotam Caldera. According to the structural model of the RYC adopted by Eyal and Peltz (1994), the plane south of Givot Shehoret is the probable location for the eastern, nonexposed part of the RYC (Fig. 1). Accordingly, part of the lithologic units of Givot Shehoret may represent RYC extracaldera areas. But in accordance with our data only the Red Hill ignimbrites are correlative with the RYC ignimbrites (Tab. 4). We believe that the products of the earlier volcanic phases, so well exposed in the Givot Shehoret area, also constitute the basement of the Yotam Caldera Formation. The above view is demonstrated by lithic fragments of Shehoret (basaltic andesite, trachyandesite, andesite), within the matrix of the RYC ignimbrites.

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