

Table 20. Calculated compositions of liquid fractionates and crystalline residua derived from the basaltic andesite and andesite compositions at 36 kb

Composition	Basaltic andesite			Andesite		
		1,475° C	1,460° C		1,440° C	1,420° C
Temperature						
Nature and estimated % of crystals	Initial liquid	6% ga 2% cpx	12% ga 20% cpx	Initial liquid	3% ga	10% ga tr. cpx (neglected)
<i>Liquid fractionate</i>						
SiO ₂	56.4	57.6 ^a	61.2 ^a	62.2	63.0	64.8
TiO ₂	1.4	1.4	1.6	1.1	1.1	1.1
Al ₂ O ₃	16.6	16.3	15.3	17.3	17.1	16.7
Fe ₂ O ₃	3.0	3.3	4.4	0.3	0.3	0.3
FeO	5.7	5.0	2.8	5.9	5.6	4.5
MnO	0.1	0.1	0.1	0.1	0.1	0.1
MgO	4.3	3.7	2.3	2.4	2.1	1.5
CaO	8.5	8.4	7.3	5.2	5.1	5.0
Na ₂ O	3.0	3.2	3.5	3.3	3.4	3.7
K ₂ O	1.0	1.1	1.5	2.3	2.4	2.6
	100.0	100.1	100.0	100.1	100.2	100.3
<i>Mol. prop.</i>						
	$\frac{100 \text{ MgO}}{\text{MgO} + \text{FeO}_{\text{Total}}}$					
	47.7	45.3	37.8	41.0	38.9	35.9
<i>CIPW norm</i>						
Qz	10.7	12.5	19.2	15.5	16.4	17.6
Or	5.9	6.5	8.8	13.6	14.2	16.0
Ab	25.4	27.1	29.7	27.9	28.8	31.3
An	28.9	26.8	21.6	25.7	24.3	21.3
Diop	10.8	12.0	11.3	0.2	0.8	2.9
Hyp	11.3	7.8	0.5	14.8	13.1	8.7
Mt	4.3	4.8	4.8	0.4	0.4	0.4
Ilm	2.7	2.7	3.0	2.1	2.1	2.1
<i>Crystal residuum</i>						
SiO ₂		42.9	46.1		39.9	39.0
TiO ₂		0.8	1.0		0.9	1.0
Al ₂ O ₃		20.4	19.5		22.9	22.7
FeO		13.8	11.8		16.8	18.4
MnO		0.2	0.1		0.4	0.4
MgO		11.3	8.5		11.0	10.5
CaO		9.8	11.1		7.0	7.4
Na ₂ O		0.8	1.9		—	—
K ₂ O		—	—		—	—
		100.0	100.0		98.9	99.4
<i>Mol. prop.</i>						
	$\frac{100 \text{ MgO}}{\text{MgO} + \text{FeO}}$					
		59.3	56.2		53.9	50.4

^a Denotes compositions determined from analyses calculated in the manner described on p. 116.

18 kb contrasts strongly with the 27 and 36 kb trends as shown on these diagrams, and the latter trends closely approach those typical of the calc-alkaline series (see p. 107 and Fig. 13).

II. Experimental Investigation under Wet Conditions

Results

YODER and TILLEY (1962) conducted pioneering work on the crystallization of a number of natural basalt compositions under controlled water vapour pressure conditions from 0–10 kb. ($P_{H_2O} = P_{LOAD}$) using a gas apparatus. They demonstrated lowering of the liquidus of the compositions with increasing P_{H_2O} , together with an increase in the size of the field of crystallization of amphibole. There was also a pronounced increase in size of the partial melting interval (e.g. from 180 to 300° C in the high-alumina basalt as the P_{H_2O} increased from 0–10 kb).

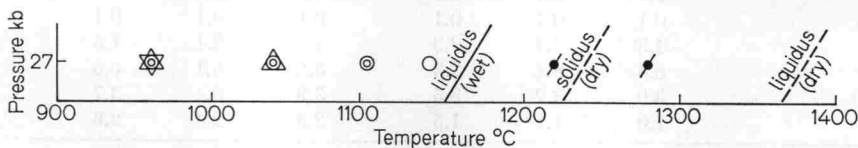


Fig. 12. Results of the experimental runs on the dacite composition under wet conditions. Key: ● Above liquidus. Phases co-existing with liquid: ○ clinopyroxene, ○ garnet, Δ quartz, ▽ kyanite

An investigation of the phases crystallizing under wet conditions in the high-alumina quartz tholeiite, basaltic andesite, andesite and dacite compositions has been carried out. Because of the nature of the experimental procedure and the apparatus available (see p. 114), the P_{H_2O} is not closely controlled, but at 9–10 kb the pressure of water has resulted in lowering the liquidus of the compositions studied by about 200° C. The probable P_{H_2O} causing this effect would be from 2–5 kb P_{H_2O} ; the exact figure is not known.

The results of the wet runs are summarized in Tables 21 and 22, and Fig. 12.

a) Crystallization at 9–10 kb

In the high-alumina quartz tholeiite, clinopyroxene is the liquidus phase at about 1100° C and it is joined by orthopyroxene and amphibole at lower temperatures (e.g. 1040° C). Clinopyroxene becomes subordinate to amphibole at temperatures of about 960° C and less. Orthopyroxene is always only a minor phase. Plagioclase joins the ferromagnesian phases at about 920° C. Small, acicular, high relief and very strongly birefringent crystals occur in accessory amounts in most of the runs. Scanning of the needles using the electron microprobe indicates qualitatively that they are rich in iron and titanium. Identification is uncertain without quantitative analysis but the phase is probably pseudobrookite (as observed by YODER and TILLEY, 1962 in wet runs on basaltic compositions at similar pressures). A similar sequence of crystallization is observed in the basaltic andesite. Clinopyroxene, orthopyroxene and accessory pseudobrookite are the near-liquidus phases at 1020° C, joined by amphibole at 980° C, which becomes the major crystal phase by 960° C. These phases are joined by plagioclase at lower temperatures (e.g. 900° C). In contrast to these two compositions where plagioclase does not appear until temperatures are well below the liquidus for wet conditions, in the andesite composition under wet conditions at 10 kb clinopyroxene and plagioclase are the near-liquidus phases at 940° C. These phases are joined by garnet, amphibole, orthopyroxene and accessory pseudobrookite at 900° C.