perature (Fig. 8). Amphibole results from synthesis in all these garnet-clinopyroxene seeded runs, and does not show any consistent compositional trend. This is similar to amphibole crystallizing in unseeded experiments. One other feature of these seeded runs is the electron microprobe identification of a few crystals of sphene at 13.5 kb, 850° C. Sphene has not been identified in any other charge.

Thus, from these experiments, it is concluded that garnet is in fact stable in the hydrous andesite composition at 9–13.5 kb at temperatures from 800–900° C. Its absence in some of the synthesis runs is due to nucleation problems in the time interval allowed for these experiments.

Controls on Fractionation Trends

In island arc areas the Mg/Fe and K/Na ratios are important in characterizing the igneous rock sequences. The analyses of garnet, clinopyroxene, and amphibole in this work enable categorization of 3 main depth intervals of hydrous fractionation, resulting in different trends for these two ratios. These depth intervals correspond broadly to the following pressures:

(a) 5–15 kb. Fractionation involves mainly amphibole with subordinate clinopyroxene. It results in an Mg/Fe decrease and a slight K/Na increase since both phases have an Mg/Fe ratio less than the parent composition and amphibole has a K/Na ratio slightly less than the starting composition[2].

(b) 15–25 kb. Amphibole, clinopyroxene and garnet all crystallize and influence fractionation trends, resulting in only a slight decrease in the Mg/Fe ratio (because of separation of Fe-rich garnet) and a moderate K/Na increase because of the subordinate role of amphibole containing some K).

(c) >25 kb. Garnet and clinopyroxene only crystallize. There is only a slight decrease in Mg/Fe but a strong increase in K/Na occurs (due to removal of sodic clinopyroxene). Also this "eclogite" controlled fractionation is most efficient for silica enrichment.

Calculated Liquid Fractionation Trends

Using the analyses of phases crystallizing in the three depth intervals it is possible to calculate compositions of liquids genetically related, through crystal fractionation, to the andesite starting composition. These compositions may then be compared with analyses of other members of the second period of eruption on Fiji (Gill, 1970, and pers. comm.) given in Table 2.

The calculated derivative compositions are given in Table 2 based on the analyses of phases obtained and approximate observed proportions of phases crystallizing in the experimental runs. The results obtained can be directly applied to obtaining the composition of more silicic fractionates (e.g. dacites) as shown in Table 2. This demonstrates that "eclogite" fractionation most satisfactorily explains the major element chemistry of the dacites, and suggests that they are derived through high pressure hydrous fractionation of a parent andesite or through low degrees of melting of hydrous eclogite.

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[2] The Mg/Fe decrease may be reduced or eliminated if small amounts of magnetite (2% or less) also crystallize. An opaque phase could not be positively identified in the experimental runs.

Table 2. *Typical analyses of rocks from the second period of eruption, Fiji (Gill, 1970 and pers. comm.) compared with calculated compositions derived by addition or subtraction of typical garnet and clinopyroxene crystallizing from andesite 68–66 at 36 kb 1000–1100° C, 10% H_2O*

	Andesite 68–66	Dacite 874	68–66 less 5% garnet	68–66 less 15% garnet 12% clinopyroxene	Basaltic andesite 876	68–66 +15% garnet 5% clinopyroxene	68–66 +4% garnet 1% clinopyroxene
SiO_2	60.24	65.45	61.4	65.0	55.43	57.6	59.4
TiO_2	0.69	0.52	0.66	0.56	0.82	0.7	0.7
Al_2O_3	16.98	16.59	16.7	17.0	18.05	17.4	17.1
FeO_{tot}	6.14	3.86	5.6	3.4	8.03	7.5	6.5
MnO	0.13	0.09	0.11	0.08	0.13	0.2	0.14
MgO	3.14	1.59	2.8	1.7	4.26	4.1	3.4
CaO	7.22	5.17	7.0	5.2	8.36	8.1	7.5
Na_2O	3.91	4.60	4.1	4.5	3.42	3.4	3.8
K_2O	1.26	1.45	1.3	1.7	1.28	1.0	1.2

N. B. Such calculations can only be approximate, particularly in the case of addition of crystals—this modifies the bulk composition so that the compositions of crystals in equilibrium with this new parent liquid will differ from those in equilibrium with the andesite near its liquidus. Nevertheless these calculations demonstrate the adequacy of the garnet-clinopyroxene model for governing the observed fractionation trends in the second period of eruption.

Lower pressure fractionation models cannot explain the Al content or the Mg/Fe ratio of the dacite, unless plagioclase and magnetite are also removed. Removal of plagioclase and amphibole together in significant quantities is difficult since the water present necessary for the crystallization of amphibole inhibits the appearance of plagioclase (see Figs. 2–4). If essentially dry fractionation conditions are considered then plagioclase, clinopyroxene and magnetite would control the fractionation trends and ~3% magnetite must crystallize with the pyroxene to produce satisfactory Mg/Fe ratios in the derivative liquids. Such a model is not compatible with the work of Taylor *et al.* (1969).

To a limited extent the results can also be applied to determining possible fractionation models linking the andesite composition (68–66) with more mafic compositions in the second eruptive phase on Fiji. In this exercise small proportions of analysed phases are added to the andesite starting composition and the resulting bulk compositions compared with the natural rock compositions (Table 2). It demonstrates that the high pressure regime of fractionation (e.g. "eclogite") gives close compositional trends to the natural rocks.

Difficulties encountered with similar calculations in the lower pressure regime in the case where the water content is too low to stabilize amphibole include values for Al_2O_3 and Na_2O which are incompatible with the observed content. Thus if plagioclase is added to satisfy the alumina requirements, Na_2O then becomes too high (unless the plagioclase is more calcic than labradorite; this is unlikely if little water is present). Also magnetite must be added with the clinopyroxene to satisfy the Mg/Fe value. This is limited by the data of Taylor