

FLUORINE AND CHLORINE VARIATIONS IN AN ISLAND ARC BASALT SUITE
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Total fluorine and chlorine in the island arc basalt suite of Papua New Guinea (New Britain), was determined using a pyrohydrolytic combustion ion chromatographic technique developed by Evans et.al.(1). A LECO induction furnace was used for sample combustion and a Dionex model 10 ion chromatograph for quantification. This basalt suite (IA) of 12 samples was selected by NASA for incorporation in the LPI Basaltic Volcanism Study Project(1981)(2).

The arc region represents the convergence of two microplates in a N—S trend with the southerly plate subducting northward. Figure 1 details the area, the labelled sample locations and the zones delineated from comparison studies of the major element chemistry. Figure 2 shows these same zones in relation to the Benioff zone, a subduction profile.

Total fluorine and chlorine and F/Cl and K_2O/F ratios are given in Table 1. The F/Cl ratios are all very low, ranging from 0.12 to 0.84. A plot of fluorine and chlorine concentrations in ppm vs the zoned seismic profile is shown in Figure 3. The chlorine content of these island arc samples clearly increases toward zone H, the deepest seismic zone. Similar trends should be expected from elements such as K and P and other incompatible elements. Potassium and phosphorus show a mild correlation, with K data being scattered and P concentrations only slightly increasing. Fluorine mildly increases toward zone H but a convincing trend is not evident. It cannot be overstressed that the number of basalt samples available from this area is statistically limiting.

Correlations between Cl and K, La and Rb are very poor having correlation coefficients of 0.3, 0.3 and 0.2, respectively. Coefficients for F vs K, La and Rb are 0.7, 0.8, and 0.5. Fluorine and P_2O_5 show the best correlation of 0.9.

The good F and P_2O_5 correlation may suggest a partial melting of apatite but the low F/Cl ratios and generally low F concentrations does not easily support this inference. The low fluorine concentrations may be due to fractionation of fluorine. K_2O/F ratios between 20-30 are indicative of island arc basalts and higher ratios may indicate an amphibole fractionation of fluorine (3). K_2O/F ratios represented in Table 1 exhibit a wide range but almost half the ratios are greater than 30.

The simplest explanation for the low F/Cl ratios is the incorporation of Cl from seawater (4) but Sr and Nd isotope data is not consistent with contamination of the generated magma by seawater, altered oceanic crust or ocean floor sediments (2). A possibility of addition of an unaltered slab-derived melt was suggested for these New Britain Basalts (2). The question of the source of such high chlorine concentrations cannot be completely resolved, however chlorine's chemical significance in subduction zones and fluorine's interesting behavior should not be overlooked. A more comprehensive look at the behavior of fluorine and chlorine in other tectonic environments is needed. Work is in progress determining total fluorine and chlorine in the representative basalt suites of the Basaltic Volcanism Study Project (1981), a set of Lunar basalts and basaltic meteorites.

References: (1) Evans K.L. Tarter J.G. and Moore C.B. (1981) Anal. Chem., 53, p. 925-928. (2) Basaltic Volcanism on the Terrestrial Planets (1981) Pergamon Press, Inc., New York. 1286pp. (3) Aoki K. Ishiwaka K. and Kanisawa S. (1981) Contrib. Mineral. Petrol., 76, p.53-59. (4) Smith J.V. Delaney J.S. Hervig R. L. and Dawson J.B. (1981) Lithos, 14, p.133-147.

F AND Cl; ISLAND ARC BASALTS

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Table 1: Total Fluorine and Chlorine (ppm) and F/Cl and K_2O/F ratios. * K_2O data (2)

Samples	F	Cl	F/Cl	* K_2O/F
IA-1	9.5	76	0.12	231
IA-2	71	201	0.35	42
IA-3	92	313	0.29	34
IA-4	157	660	0.24	38
IA-5	90	107	0.84	19
IA-6	121	433	0.28	47
IA-7	184	372	0.49	22
IA-8	98	412	0.24	20
IA-9	129	879	0.15	16
IA-10	225	429	0.52	33
IA-11	161	365	0.44	10
IA-12	292	530	0.55	23

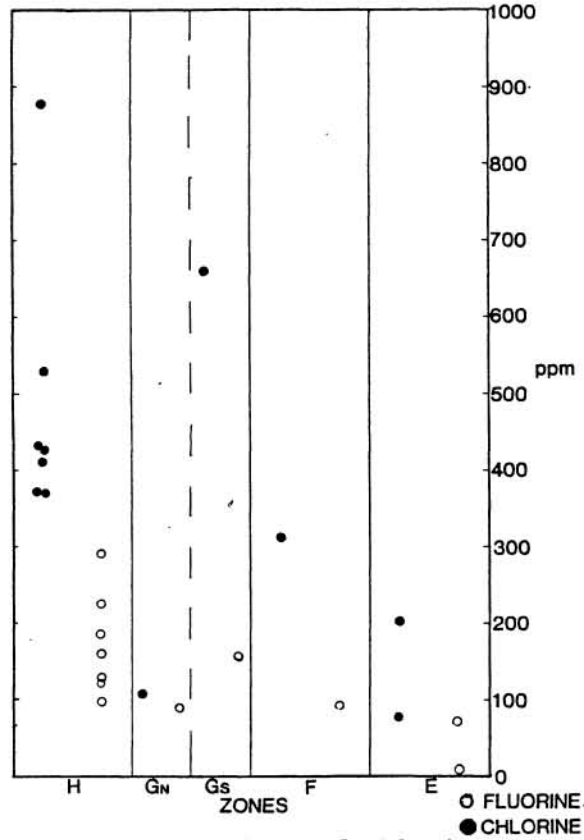


Figure 3: Fluorine and chlorine concentrations (ppm) vs zoned seismic profiles E-H.

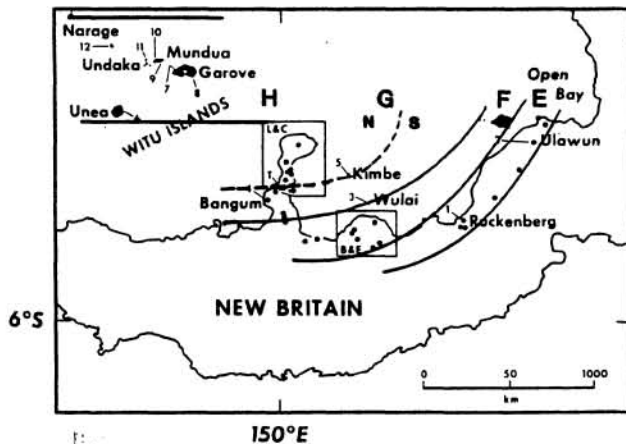


Figure 1: New Britain showing location of IA reference suite and grouped zones E-H (after Basaltic Volcanism Study Project (1981), Figs. 1.2.7.5 and 1.2.7.6). (2)

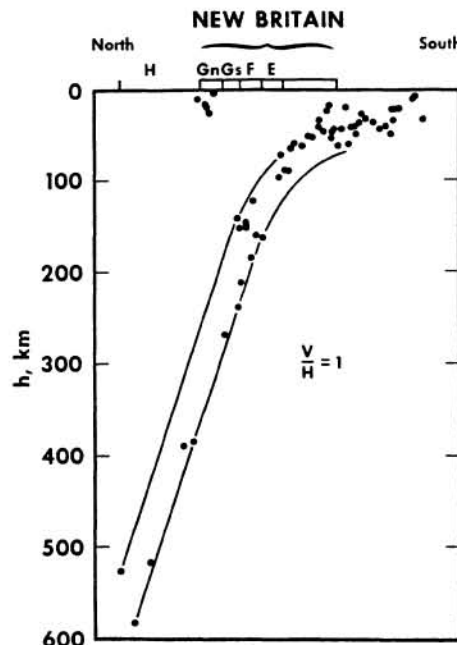


Figure 2: Benioff beneath New Britain showing zones E-H (after Basaltic Volcanism Study Project (1981), Fig. 1.2.7.4). (2)