CONFORMITY AS MEASUED BY A STRAIGHT LINE - A PETROLOGICAL SHIBBOLETH SET STRAIGHT. J.C. Butler, Department of Geosciences, University of Houston-UP, Houston, Texas 77004.

Many petrologic models are defined so that conformity to the model is judged by the degree to which points plotted in some space fall on (or at least close to) a straight line. For example, if a Harker-type variation diagram constructed for a set of basalts displays a nearly linear negative relationship in silica-MgO space one might conclude that the plot defines a liquid line of descent.

On the other hand there is an alternative explanation that must not be summarily dismissed. As MgO and silica are percentages of the same whole in an individual analysis, is it not possible that an increase in silica for whatever reason will be accompanied by a decrease in MgO? After all, the sum of the major element analyses remains constant and an increase in one component must be accompanied by a decrease in the sum of all of the others. Therefore, one must be able to separate this effect (essentially a numerial constraint) from that controlled by, for example, crystal fractionation in order to correctly interpret the observed negative relation. In general (1) this has proven to be an arduous task.

As the ratio of a pair variables is retained when percentages are formed, some (1) have argued that petrological space defined with respect to ratios might be a viable alternative to attempting an interpretation of percentages. Ratio-space petrological variation diagrams abound in the literature. Often, however, such models are defined by ratios which share common parts. For example, Beswick (2) argues that the degree of alteration of a suite of komatiites can be determined by reference to a plot of the molecular proportions of (SiO_2/TiO_2) and (($MgO+FeO)/TiO_2$). These two ratios are subject to what Pearson (3) defined as a spurious correlation. That is, if the correlation between the parts of the ratios are zero, there will be a positive correlation between the ratios because of the presence of a common denominator. Beswick (3) notes that iron, magnesium and silicon enter the olivine structure and titanium does not. Therefore, according to the model (3), the trend on the ratio diagram should be nearly linear with a slope of 1:2 in terms of ($MgO+FeO)/SiO_2$ if olivine was precipating from the magma. If one or more of the numerator components had been mobilized during metamorphism, however, the trend would be expected to be scattered and not related to the olivine fractionation trend. One can inquire as to the extent to which "spurious" correlation could produce a trend which would appear to conform to the model. Fifty pairs of ratios were drawn from uncorrelated components having means and standard deviations of the set of Gorgona Island komatiites (4) and are plotted in Figure 1. It would appear that olivine control is in evidence although the strength of variation is entirely the result of forming ratios with a common denominator.

Beswick (3) notes that Al_2O_3 and TiO_2 appear to be immobile during metamorphism/metasomatism of komatiites. Thus, the ratios

(SiO_2/Al_2O_3) and (($MgO+FeO)/TiO_2$), for example, could serve as axes of a variation diagram for detecting departures from expected magmatic trends. Ratios which lack common parts have an expected spurious correlation of zero. If, for example, olivine is the only crystallizing phase, one would expect both ratios to decreas with increasing degree of crystallization. Such a variation diagram is given in Figure 2. The correlation between the ratios is 0.890 and clearly significant at the 95% level with as few as 10 samples. On the basis of the variation displayed in Figure 2 one would argue that the set of 10 samples have not been affected by post-crystallization metasomatism.

The construction of petrological models with respect to ratios with parts in common should be avoided.

References. 1) Chayes, F. (1971) Ratio Correlation, U. Chicago Press. 2) Beswick, A., (1982) Komatiites, George Allen and Unwin , p. 239. 3) Pearson, K. (1896), Proc. Royal Soc. (London),, v. 60, p. 489.4) Escheverria, X. (1981), Komatiites, George Allen and Unwin, p. 200.

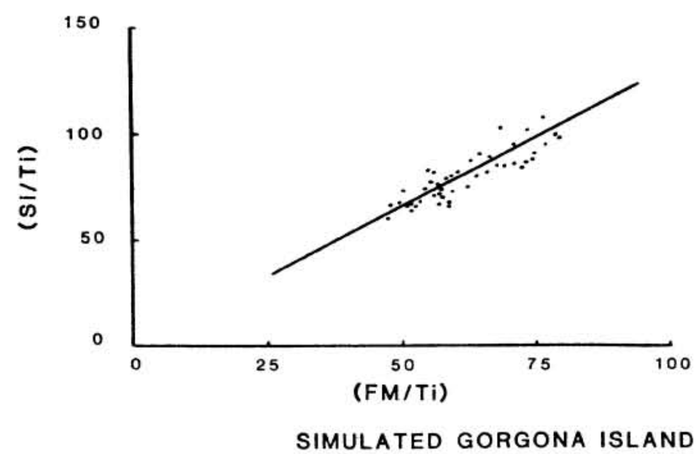

Fig. 1. Simulated set of Gorgona Island Komatiites drawn from independent components. The strong linear trend is due to the use of Ti as the common denominator.

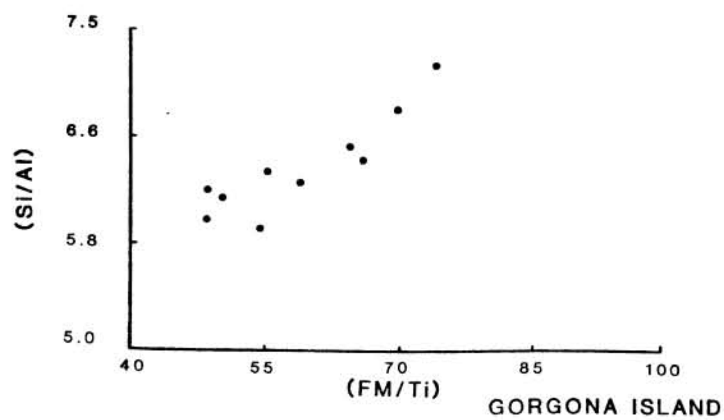

Fig. 2. An alternative diagram for estimating the degree to which komatiite compositions have been modified during metasomatism.