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[*Manuscript received 18 June 1971; revised 25 August 1971*]

MINERALOGICAL MAGAZINE, SEPTEMBER 1972, VOL. 38, PP. 897–9

Piercing-point analysis of the system anorthite–diopside–åkermanite

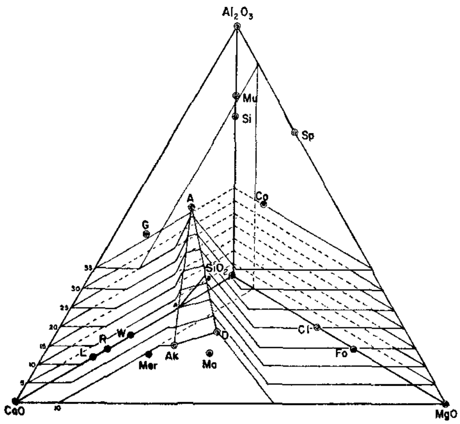
THE ternary system anorthite–diopside–åkermanite (de Wys and Foster, 1958) serves as an approximate partition plane within the quaternary system $CaO–MgO–Al_2O_3–SiO_2$. Later data (Schairer and Yoder, 1968) tends to indicate that the approximate plane $An–Di_{ss}–Åk_{80}Geh_{20}$ may be regarded as the partition plane instead. Such ternary planes serve to partition the interior of the tetrahedron into smaller tetrahedra that can be isolated and investigated separately. The established ternary system anorthite–diopside–åkermanite simply serves for practical purposes as a partition separating liquids that during crystallization must remain on one side of this partition from those that must remain on the other side. This is true whether fractional or equilibrium crystallization takes place. A number of investigators such as Osborn *et al.* (1954) and Prince (1954) have attempted to develop rapid insight into the quaternary system by developing phase distribution patterns at fixed oxide composition. The former authors investigated the quaternary at fixed five per cent intervals of alumina level while Prince investigated the ten per cent magnesia plane.

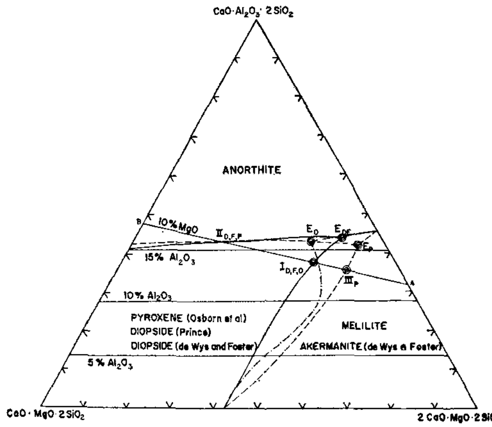
The above mentioned fixed oxide per cent planes are intersected by the system anorthite–diopside–åkermanite (fig. 1) and thus one would expect reasonably good correlations to exist between all the experimental data indicated by the phase relationships of the published planes. An attempt was made to determine, by means of a piercing-point analysis, if a good correlation may be observed.

Results and discussion of the piercing-point analysis. The results of the piercing-point analysis are projected on the anorthite–diopside–åkermanite partition plane (fig. 2).

The boundary curve, separating the anorthite and diopside primary fields, obtained experimentally by de Wys and Foster agrees quite well with that obtained from the data of Prince. The experimentally determined boundary curve (de Wys and Foster, 1958) separating the åkermanite (melilite) and anorthite regions also agrees with the one deduced from the published data by Osborn *et al.* (1954) but not too well with that obtained from the data of Prince (1954).

The initial trend of the diopside–melilite subtraction curves obtained by all authors is in general agreement but the various locations of the ternary eutectics show discrepancies. The data by de Wys and Foster would indicate that the primary field of melilite should be significantly larger both in the system published by Osborn *et al.* and in that of Prince. It is of interest to note that the intersection of the diopside–melilite boundary curves, of de Wys and Foster as well as that of Osborn *et al.*, with the MgO plane are in total agreement. The tendency of this boundary curve as deduced from the data of Osborn *et al.* to change from a subtraction curve to a reaction curve is somewhat puzzling, in view of the nature of this curve as indicated by the results of Prince as well as those by de Wys and Foster.





FIGS. 1 and 2: FIG. 1 (left). The $CaO–MgO–Al_2O_3–SiO_2$ tetrahedron, showing the various % Al_2O_3 and the 10 % MgO planes pierced by the system anorthite–diopside–åkermanite. FIG. 2 (right). The system anorthite–diopside–åkermanite with the various boundary curves deduced from the piercing-point analysis in comparison with the actual experimental curves of de Wys and Foster. E_O, E_{DF}, E_P, the eutectics deduced from the data of Osborn *et al.*, de Wys and Foster, and Prince, respectively. --- boundary curve deduced from the data of Prince; -·-·- boundary curve deduced from the data of Osborn *et al.*; —— experimental curve of de Wys and Foster, I, II, III, the intersections of the various boundary curves with the 10 % MgO plane.

It appears from the above comparisons that the piercing-point analysis method is capable of revealing remarkably close correlations when they indeed exist. One is therefore led to believe that some indication of lack of agreement between experimental data is present where significant deviation in the deductions are observed. Such an apparent lack of agreement appears to exist between the experimental results indicated on the ten to fifteen per cent alumina planes and the published data of de Wys and Foster and Prince as far as they concern the nature of the diopside–melilite boundary curve as well as the general location of the ternary eutectic. In terms of weight per cent the deviations indicated in fig. 2 appear too large to be due to the inherent inaccuracies of the piercing-point analysis method. It may well be that the particular technique used by Prince (unannealed glass) could account for the large diopside primary field revealed by his work.

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[*Manuscript received 19 May 1971*]

MINERALOGICAL MAGAZINE, SEPTEMBER 1972, VOL. 38, PP. 899–900

A Fortran IV plotting program utilizing an on-line printer

CHAYES (1971) has briefly summarized the problems encountered in the design of a routine for the storage and retrieval of large sets of chemical data. Although most geologists are probably not concerned with working with tens of thousands of rock analyses, the problems discussed by Chayes are a real concern to those researchers who are interested in setting up limited data storage systems that include routines for data reduction and data presentation.

At the University of Houston a programme has been initiated to store rock data on magnetic tape. Lacking a computer-driven automatic plotter, we have had to resort to the on-line printer for graphical presentation of selected data. Plotting options include: a histogram with a variable number of intervals, an X–Y plot, and a ternary plot. As many as 5 variables can be combined to generate one variable for plotting.

This programme offers several advantages over those plotting routines with which the author is familiar. The first 62 samples can be assigned unique, one-character symbols—assuming use of an IBM 029 key punch. A total of 160 samples can be plotted with samples 63 to 160 indicated on the plot by an asterisk. An option is available to allow the operator to select the symbol to be associated with each sample so that the same symbol can be assigned to similar samples. A listing that includes assigned symbol, plotted values, and identification of each plotted sample accompanies each plot. A table indicating the number of plotted samples, the number of overlaps, and the position of each point not plotted because of overlap follows the X–Y and the ternary plots. For each histogram requested, the number of samples in each interval and the symbols of the samples within the interval are plotted. All plotted variables for each plot are identified and numerical scales are printed adjacent to the reference axes.

The programme can be used as offered, or it can easily be added as a subroutine to existing programmes. At the University of Houston, the plotting routine has been