A CRITICAL REVIEW OF THE EVIDENCE CONCERNING THE DEPTH OF THE MARE BASALT MAGMA SOURCE REGION. A.B. Binder, Erde-Mond Forschergruppe, Institut für Mineralogie, Universität Münster, 4400 Münster, W. Germany.

Before a definitive model of the mare basalt magma souce region can be derived, the question about the depth of the source region must be answered. Delano and co-workers assume (1,2,3) that the proposed pristine magmas were saturated with Py±Ol±other phases (the latter being of no significance (4,5)) in their source regions, which therefore must be several hundreds of km deep in the moon. I argue (5) that the data indicate that the magmas were saturated only with Ol in their source regions, which therefore must be at <200 km depths. Because the number of proposed pristine magmas, i.e., the pyroclastic glass magmas (1), is small, their interpretation is largely statistical. This interpretation is the topic of this paper.

Delano and I (1,2,3,4,5) argue that magmas of the type which formed the pyroclastic glass units are probably the only true pristine melts derived from the mare basalt magma source regions. Of the 23 units defined (1,2,3), only the Array I VLT units have sufficiently uniform TiO_2 contents (0.2%-1%), and are numerous enough (9) to allow one to determine if they have compositional trends which are due to differing degrees of partial melting of source region materials whose residual phases are Ol or Py±Ol.

If the source regions for these 9 magmas were absolutely identical, their compositional points would plot exactly on Ol control lines or Py±Ol control lines in various oxide plots or in the quaternary phase diagram. However, it is unrealistic to expect that the source regions are absolutely uniform. As can be easily calculated, the compositional variations between these 9 magmas are partially due to variations on the 0.1% and 1% levels of the normative amounts of the minor (Pl, Cpy, Ilm, Chr) and major (Ol, Opy) constituents, respectively, regardless of whether the source region is dominantly Ol, Py, or a cotectic mixture of both. Though these calculations show that the sources are not absolutely uniform, these variations are still very small, especially when one considers that the source regions for these Apollo 11, 14, 15, and 16 units must be separated by several 100's to 1000 km. As such, the 0.1 to 1% compositional variations of the source regions lead to a statistical scatter of the data around any possible control lines. Such scatter is generally greatest in double oxide plots and, as expected, becomes smaller when increasing numbers of oxides are plotted together or when the data are plotted in the phase diagram, Fig. 1.

This being the case, it is also clear from Fig.1 that the 9 VLT glass unit data tend to scatter along a Fo_{83} control line (Fo_{83} being the predicted residual phase in my model (5)) in the majority of the multiple oxide plots and an Ol control line in the quaternary phase diagram. In contrast, the possible trends in the data are not consistent with a wide range of Py (En to Fs) or cotectic control lines in the majority of the oxide plots or with Ol-Py cotectic control in the quaternary phase diagram.

Finally, as is shown in Fig. 2, Monte Carlo calculations, assuming the above range of source region compositional variations and a ±7% (absolute) variation in the degree of partial melting around its mean value (5), show that the pattern of any 9 points randomly generated by the cotectic partial melting of a Py-Ol dominated source region defines a scatter ellipse which lies along the cotectic line, while the pattern generated by the partial melting of an Ol dominated source region defines a scatter ellipse lying along an Ol control line. The latter pattern is always similar in appearance to the pattern of points observed for the 9 VLT glasses, as shown in Fig. 1.

In conclusion, the observable trends of the data are statistically the same as those for Ol control. Hence the data are consistent with the shallow source region model.

References: 1) Delano J.W. (1979) Proc. Lunar Planet. Sci. Conf. 10th, p. 275-300. 2) Delano J.W. (1980) Proc. Lunar Planet. Sci. Conf. 11th, p. 251-288. 3) Delano J.W. and Livi K. (1981) Geochim. Cosmochim. Acta, 45, p. 2137-2149. 4) Binder A.B. (1980) Proc. Lunar Planet. Sci. Conf. 11th, p. 1-22. 5) Binder A.B. (1982) Proc. Lunar Planet. Sci. Conf. 13th, in press.

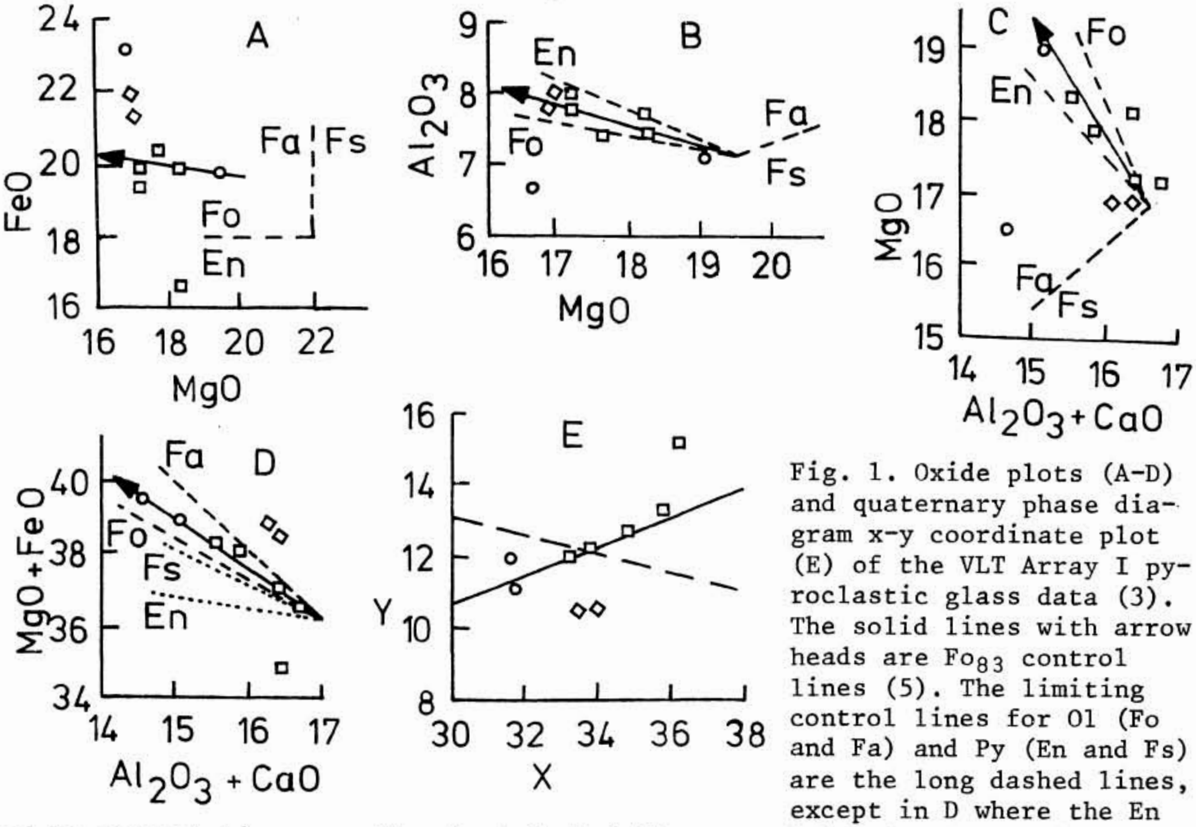

Fig. 1. Oxide plots (A-D) and quaternary phase diagram x-y coordinate plot (E) of the VLT Array I pyroclastic glass data (3). The solid lines with arrow heads are Fo_{83} control lines (5). The limiting control lines for Ol (Fo and Fa) and Py (En and Fs) are the long dashed lines, except in D where the En and Fs control lines are the short dashed lines, as labeled. The continuous line and the dashed line in E are Ol control lines and Ol-Py cotectic lines, respectively. Squares, circles, and diamonds are the Apollo 15, 14, and 11/16 data, respectively.

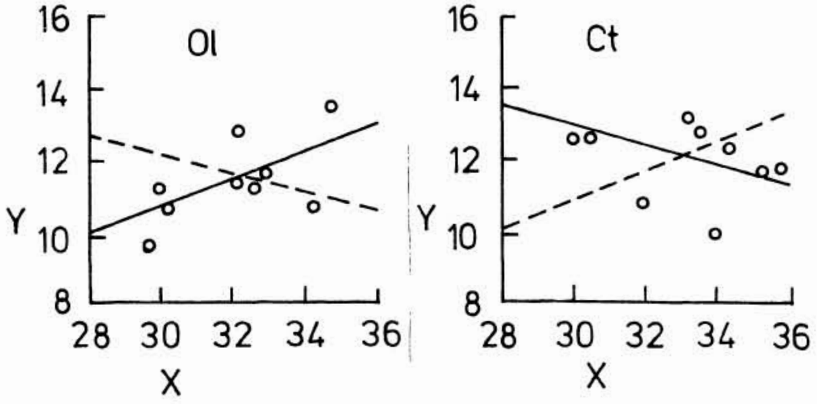

Fig. 2. Monte Carlo models for Ol control (Ol) and Ol-Py cotectic control (Ct) partial melting. Note the similarity between the Ol model and the actual data given in Fig. 1 E. In Ol the solid and dashed lines are Ol control- and Ol-Py cotectic lines, respectively, while the reverse is the case in Ct.

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