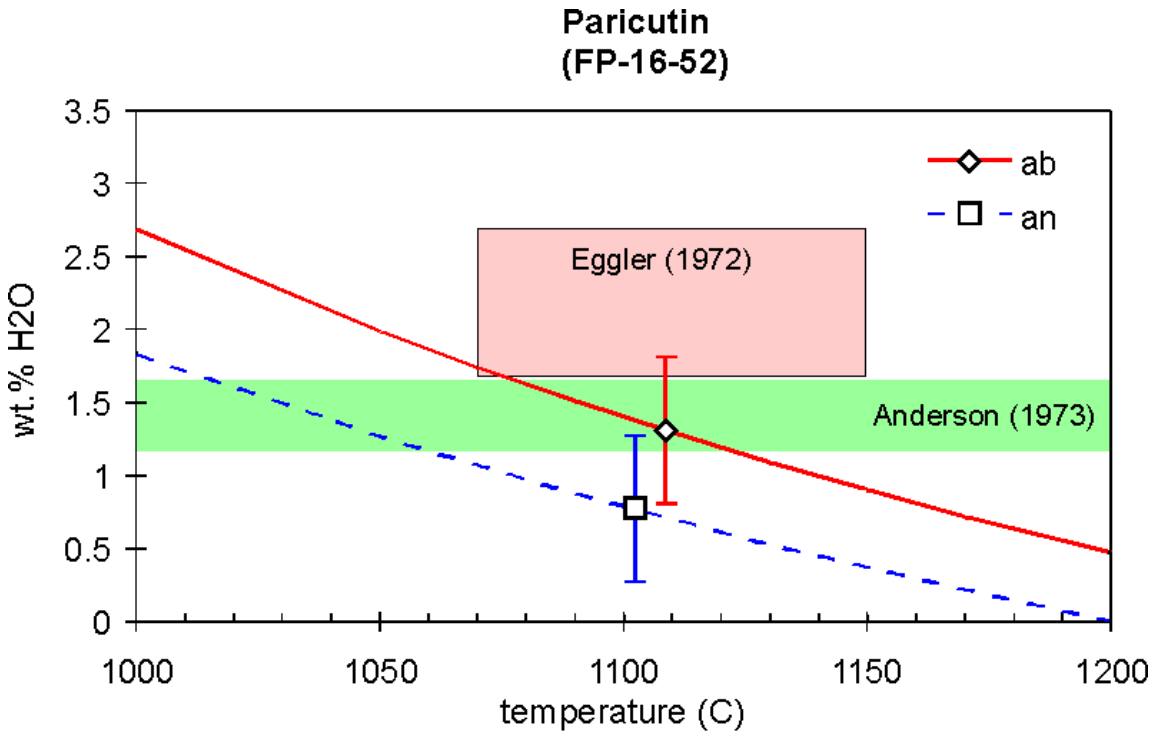
Plagioclase - Melt Equilibria

Housh and Luhr (1991, 1994) presented a model for plagioclase - melt equilibria in silicate melts. The equilibria between the albite and anorthite components in a melt and coexisting plagioclase were calibrated over a range of pressures, temperatures, and water contents in equations 5 and 6. Variations in water content have a profound effect on plagioclase composition for a given pressure, temperature, and melt composition. If there are independent constraints on temperature and pressure (which has only a small effect), then equations 5 and 6 can be used to calculate the water content of the melt. Housh and Luhr (1991) indicated that a Basic program was available for this task. For a compiled version of that program for PCs please contact Todd Housh.

We present here one example of one use of this approach. The issue of the volatile content in the magmas from Parícutin has been approached in a several ways since its eruption between 1943 and 1952. Fries (1953) estimated the amount of water released in the fume cloud to be around 1.1 wt.% of the magma based upon an analysis of the aerodynamics of ejected rock fragments. Anderson (1973) likewise estimated the water content of the melt to have been between 1.2 and 1.7 wt.% based upon a difference method from electron microprobe analyses of trapped melt inclusions in olivine phenocrysts. Finally, Eggler (1972) estimated the water content of the magma to have been 2.2 ± 0.5 wt.% based upon experimental phase equilibria of sample FP-16-52. Eggler, likewise, estimated the equilibrium temperature of sample FP-16-52 to have been 1110 ± 40ºC.

In the figure below we have calculated the equilibrium between melt present in sample FP-16-52 (from Eggler, 1972) and plagioclase rims ($An_{60.8}$, J.F. Luhr unpublished data) measured from the same sample. Fe^{2+}/Fe^{3+} partitioning in the melt was calculated using the equation of Kilinc et al. (1983) assuming an fO_2 2 log units above FMQ. The two curves, representing albite and anorthite mineral/melt equilibria, overlap within uncertainty over the interval of 1000 and 1200ºC. In the temperature range of 1110 ± 40ºC the water contents calculated from the plagioclase-melt equilibria are generally below that postulated by Eggler, and are much closer to those estimated by Fries and Anderson.



Anderson, A.T., 1973, The before-eruption water content of some high-alumina magmas. Bull. Volcanol. 37:530-552.

Eggler, D.H., 1972, Water-saturated and undersaturated melting relations in a Parícutin andesite and an estimate of water content in a natural magma. Contrib. Mineral. Petrol., 34:261-271.

Fries, C. Jr., 1953, Volumes and weights of pyroclastic material, lava, and water erupted by Parícutin volcano, Michoacán, México. Trans. Amer. Geophys. Union, 34(4):603-616.

Housh, T.B. and Luhr, J.F., 1991, Plagioclase-melt equilibria in hydrous systems. American Mineralogist, 76:477-492.

Housh, T.B. and Luhr, J.F., 1994, Erratum. Plagioclase-melt equilibria in hydrous systems. American Mineralogist, vol. 79, nos. 3&4.

Kilinc, A., Carmichael, I.S.E., Rivers, M.L., and Sac, R.O., 1983, The ferric-ferrous ratio of natural silicate liquids equilibrated in air. Contrib. Mineral. Petrol., 83:136-140.

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