TEXTURAL ANALYSIS AND CRYSTALLIZATION HISTORIES OF LA PAZ MARE BASALT METEORITES.

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Introduction: La Paz mare basalts, LAP 02-205, -224, -226, -436 and 03-632, are a suite of paired Antarctic meteorites with identical mineral and whole-rock major- and trace-element compositions, modal distributions and textures [1]. We present a quantitative textural study of lunar basalts that further constrains crystallization histories and cooling rates, providing clues to mare basalt lava flow geometries.

Methods: Crystal Size Distribution (CSD) and Spatial Distribution Pattern (SDP) analyses were performed by digitizing the mono-mineralic textures and processing them with image-analysis software using methods outlined in Jerram *et al.* [2].

Crystallization: The La Paz mare basalts are holocrystalline, intergranular to subophitic basalts predominantly composed of pigeonite, augite, ferro-pyroxene, plagioclase and ilmenite [1]. Pyroxene (0.28×0.17mm), plagioclase (0.27×0.10mm) and ilmenite (0.20×0.06mm) fractions all possess nearly straight CSDs indicating continuous nucleation and growth during crystallization. Slight downturns for smaller size-fractions are consistent with either shock-induced annealing or cessation of nucleation accompanied by continued growth. Pyroxenes possess the highest R-values (sample/random nearest neighbor distance) and lowest melt porosity (touching crystal framework) whilst ilmenites have lower R-values and higher melt porosity than plagioclase consistent with the crystallization sequence of these minerals (plagioclase $\geq$ pyroxene $>$ ilmenite).

Comparison of Modal Data: Modal data for La Paz basalts [1] collected using the method of Taylor *et al.* [3] is in good agreement with modal percentages derived from CSD. The modal percentages calculated from CSD are slightly overestimated and are related to the calculated 3-D shape of crystal populations.

Cooling and Growth Rates: Using growth rates of crystals in terrestrial lava lakes with well-constrained P-T histories [4], cooling rates for La Paz pyroxene, plagioclase and ilmenite can be calculated at 0.2ºC/Hr, 0.15ºC/Hr and 1.3ºC/Hr respectively. These are similar to independent cooling rate calculations for the La Paz basalts using the methods of Grove and Walker [5] and Lofgren *et al.* [6]. The fast cooling rate of ilmenite probably reflects differences in the cooling rate of terrestrial ilmenites from which the growth rate was derived, but could also represent more rapid cooling of the magma body on the Moon with increasing crystallization. Calculated residence times are ~0.9yrs for plagioclase, ~0.7yrs for pyroxene and ~0.1 yrs for ilmenite, using these growth rates. Assuming the magma body was a lava flow, cooling rates are consistent with it being 5-20m thick. Employing independently calculated cooling rates [5,6], growth rates for La Paz pyroxenes, plagioclase and ilmenite can be calculated at to be 3×10^{-9} to 3×10^{-8} mm/s, consistent with estimates of minerals in terrestrial basalt lava flows [4].

References: [1] Day J.M.D. *et al.* (2005) *Geochimica et Cosmochimica*, submitted. [2] Jerram D.A. *et al.* (2003) *J. Petrol.* **44**, 2033-2051. [3] Taylor L.A. *et al.* (1996) *Icarus.* **124**, 500-512. [4] Cashman K., Marsh B.D. (1988) *Contrib. Min. Petrol.* **99**, 292-305. [5] Grove T.L., Walker D. (1977) *Proc. Lunar. Sci. Conf.* **8th**, 1501-1520. [6] Lofgren G.E. *et al.* (1975) *Proc. Lunar Sci. Conf.* **6th**, 79-99.