THE COMPOSITIONAL ZONING OF FELDSPATHIC PHASES IN ALLAN HILLS 77005,32

C.O'Neill[1], Y.Ikeda[2], and J.S.Delaney[3]. (1) Appld. Sci. Dept., College of Staten Island, S.I., N.Y. 10301. (2) Dept. Earth Sci., Ibaraki University, Japan. (3) Dept. Min. Sci., Amer. Museum Nat. Hist., N.Y., N.Y. 10024.

The original igneous feldspar grains of ALHA77005,32 have been converted by shock metamorphism to two feldspathic phases: vesicular glass of R.I.= 1.53 (1,2) and crystalline plagioclase of R.I.=1.56 (n_y). Shock induced melting of feldspar [(45GPa)(3)] produced a totally disordered melt glass instead of partially disordered diaplectic glass (maskelynite) such as produced by lower shock pressures in Shergotty (4). Shock pressures of 80 GPa produced whole rock melt pockets (5). Multiple shock events have been suggested to explain the different shock pressures (1) but are unnecessary as variable shock pressures are inferred to have occurred during shocking of both experimentally and naturally shocked polycrystalline samples (4,6). Localized stress concentrations by shock reflection and reverberation of a single shock event could be the mechanism for producing the observed variable shock effects (4).

Compositional profiles were drawn from traverses across five feldspathic glass grains having birefringent feldspar rims, delineating feldspar/glass interfaces. Zoning profiles indicate that plagioclase nucleated at olivine/pyroxene boundaries with a composition of An55.3, Or0.5 and grew inward toward the center of the shock produced glass until the composition reached An53, Or0.6. At this point the system quenched, preserving the zoning in the feldspar. The feldspar/glass interface is marked by alkali enrichment in the glass. The range of values of glass at the interface is An46.4, Or3.4 to An49.1, Or10.0. The compositional contrast between the feldspar and the glass cannot be explained by suggesting that the observed features resulted from localized shock concentration in the center of every feldspar grain that produced central shock pressures of 45 GPa while the rims remained below 25 GPa. The undulose extinction in feldspar rims is due to crystallites radiating from grain boundaries. The rims do not show the preferred orientation of crystals produced by thermally annealed maskelynite (7). The feldspar is therefore a late crystallizing post shock mineral produced by crystallization from a feldspathic melt under supercooled conditions (8).

The compositional range of the feldspars, as determined by broad beam analysis of the center of fifty glass grains, is An37.4, Ab55.6, Or7.01 to An51.1, Ab46.9, Or2.0. Subophitic lath shaped grains are more calcic (An50-An45) than the irregular shaped intergranular grains (An42-An37). Texturally the subophitic grains grew earlier than the irregular grains. The alkali contents of the glass are probably higher than in the pre-shocked feldspar because of late enrichment of alkalis in the glass as the post shocked feldspars crystals grew. The original igneous fractionation trend of this meteorite may nevertheless be defined by the observed compositional range of the glass.

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CONCLUSIONS:

(1) Feldspathic phases in ALHA77005,32 are unshocked plagioclase and melt glass, not maskelynite.
(2) One shock event is sufficient to explain the shock melting of the feldspar at 45 GPa and the whole rock shock melting at 80 GPa as both phenomena are produced by single shocks in naturally and experimentally shocked rocks.
(3) The plagioclase formed by partial crystallization of the shock melt glass and grew from nucleation sites on the grain boundaries of the original feldspar inward toward the center of the glassy grains. Quenching of remaining melt prevented homogenization.
(4) The zoning profiles across feldspar/glass interfaces reflect the growth of feldspar from the melt phase and cannot be explained as relict zoning of pre-shock feldspar.
(5) Fractionation at the glass/feldspar interface has produced alkali enrichment in the glass, including presumably Rb, and resulting in resetting of the Rb-Sr age at 180 my (9,10).
(6) The original igneous compositional variation of the feldspar phases may be inferred from broad beam analyses of glass centers. These analyses correlate compositionally with the texturally inferred order of crystallization of the feldspars.

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