THE COMPOSITION AND DISTRIBUTION OF FELDSPATHIC SHOCK GLASS IN ALH 84001. C.K. Shearer, and C. T. Adcock. Institute of Meteoritics, Department of Earth and Planetary Science, University of New Mexico, Albuquerque, New Mexico 87131.

INTRODUCTION: Feldspathic shock glass in ALH 84001 has been described in numerous studies [1,2,3]. Yet its origin is still poorly understood. Unlike maskelynite in many other SNC, feldspar morphology is not preserved in this feldspathic glass, it is commonly more sodic and its composition may deviate from feldspar stoichiometry. Understanding the origin of the shock glass is critical to deciphering the petrologic and thermal history of ALH 84001. Is the glass in ALH 84001 simply shocked feldspar-rich intercumulus melt or is its history much more complex? Does the shock glass represent multiple shock events and periods of alteration? Here, we present preliminary evidence to suggest that the glass may represent more than one episode of injection-remobilization and that the glass does not represent unaltered intercumulus melt.

APPROACH: The distribution and composition of the feldspathic shock glass in ALH 84001 was determined in two thin sections of ALH 84001: ,83 and ,87. Prior to electron microprobe analysis, the distribution of fractures and shock glass was determined using a JOEL 5800LV scanning electron microscope (SEM) equipped with secondary and backscattered electron and cathodoluminscence imaging detectors. Particular attention was paid to the textural relation between the shock glass and carbonate globules and the distribution of different glass compositions. For the quantitative analysis of the glasses, we used a JOEL 733 Superprobe electron microprobe (EMP) equipped with an Oxford LINK eXL II analyzer. To minimize Na loss during electron bombardment, the analyses were performed at 15 kV potential, 5 nA beam current and with a 10 μm beam diameter.

DATA: The feldspathic glass shows a wide range of chemical composition that includes glasses of essentially plagioclase composition (An_{30-40} Ab_{67-55} Or_{3-5}), feldspar compositions with excess Si, and K_2O-enriched feldspathic compositions (Figure 1). These results match previous analyses of the shock glass [1,2,3]. Preliminary ion probe analyses indicate that the glasses all possess a (+) Eu anomaly and a $(La/Lu)_N$ greater than 1. The high-K_2O glass appears to consistently deviate from plagioclase stoichiometry with enrichments in Si and depletions in Al (Figure 2). In the two thin sections that we used in this study, we noted obvious differences in the textural relationships between the high-K_2O glass and the more typical plagioclase glass (plagioclase and plagioclase + SiO_2). These two types of glasses appeared to occupy different sets of fractures and cavities in the host orthopyroxene. The high-K_2O glass is commonly associated with disrupted carbonate globules and occupies fractures and cavities adjacent to olivine clusters in the host-orthopyroxene [4,5]. Carbonate fragments in this glass range in size and morphology from 100 μm shards of broken carbonate globules to elongate, micron to sub-micron "filaments". In contrast, the more typical feldspathic shock glass generally wrapped around the carbonate globules. Olivine clusters in the orthopyroxene-host are not spatially associated with fractures containing this type of glass. Backscattered electron images of these textural differences are illustrated by Shearer and Adcock [4,5]. Both types of glass appear to be heterogeneous on a micron to sub-micron scale. Brearley [6] documented small-scale chemical interaction at the interface between carbonate (non-globule) and glass and micron size SiO_2 grains in the glass.

DISCUSSION: Based on our textural and chemical observations, the history of ALH 84001 is fairly complex involving multiple periods of glass mobilization and alteration. Our data indicates that the carbonate globules were disrupted by a shock event that injected or remobilized the feldspathic glass. Only the high-K_2O feldspathic shock glass appears to significantly disrupt the carbonate globules. This may be interpreted as indicating that either chemical differences between the feldspathic glasses effected their mechanical properties or that the high-K_2O feldspathic glass represents injection of material into the ALH 84001 lithology during a different shock event.

The compositional variation in the feldspathic shock glass has been attributed to homogenization of small amounts (1 to 2%) intercumulus melt consisting predominantly of plagioclase with minor amounts of SiO_2 and potassium feldspar [3, 7]. The low Ca content of the plagioclase component in the shock glass presents a potential problem. First, the feldspathic glass composition in ALH 84001 is more sodic than the shergottites meteorites. Second, the first plagioclase to crystallize from primitive shergottite magmas is approximately An_{70} and not An_{40-30} [3,8]. Alternatively, the shock glass compositions do not represent a pristine intercumulus melt component, but igneous feldspar that was altered during the hydrothermal event. In low temperature (<300°C), low pH (<2.5) hydrothermal systems, the more calcic portions of plagioclase in igneous lithologies are replaced by amorphous silica [9]. This essentially results in an increase in SiO_2, Na_2O and perhaps K_2O in the bulk lithology. The CaO released from the break down of calcic plagioclase may have been incorporated into the carbonate. Potential vestiges of the amorphous silica were observed by Brearley [6] in the shock glass. Additional K_2O may have been added during the alteration of the intercumulus lithology by hydrothermal solutions [10].

In conclusion, the shock glass in ALH 84001 is a product of numerous processes: alteration of an intercumulus melt assemblage by low-temperature hydrothermal solutions, at least 1 shock episode, and remobilization or injection of high-K glass component. There is no indication that the carbonate and shock glass were both produced from a shock melt. However, we anticipate that the final shock event that disrupted the carbonate globules may have also had a thermal effect on the carbonates.

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Figure 1.

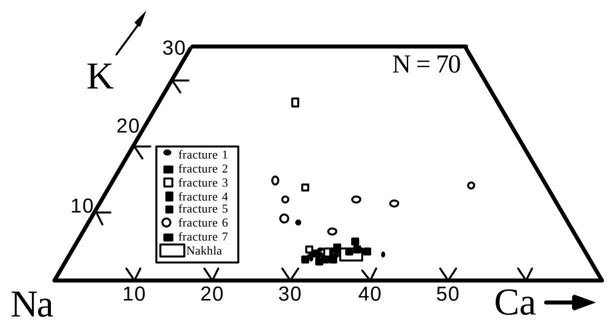

Figure 2.