P. 811

INCLUSIONS AND INTERFACE RELATIONSHIPS BETWEEN GLASS AND BRECCIA IN LUNAR SAMPLE NO. 14306.50

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Preliminary observations of the glass portion of a 2 mm wide glass-filled fracture of breccia rock sample #14306.50 indicate the presence of numerous metallic spherules ranging from about 30 Å to 100 μm in size. Metallic inclusions in lunar glasses have been noted previously by several authors in both the Apollo 11[1] and 12[2] mission samples. The inclusions in the 0.1 to 1 μm range are abundant and evenly distributed throughout the glass phase while the particles at the larger and smaller ends of the size range are more sparsely distributed. X-ray energy dispersion, X-ray diffraction, electron microprobe and magnetic susceptibility analyses suggest that the spherical bodies are mainly iron-nickel with segregated zones of iron-nickel sulfide (troilite) and iron-nickel phosphide (schreibersite) although some of the inclusions appear to be nearly all sulfide and/or phosphide. As many as five magnetic phases may be present and there is evidence of single crystal formation. The magnetic analysis indicates magnetic centers as small as 40 to 50 Å.

The glass-breccia interface was sharply defined with the transition band being about 150 μm wide. The transition zone contained a few irregular shaped metallic inclusions, ample evidence of flow lines and moderate numbers of breccia grains with rounded edges. X-ray energy dispersion analysis of breccia grains in the vicinity of the glass-breccia interface indicate at least four phases of different chemical composition. No indication of crystallization from the glass was found at the interface or in the main body of the glass region. Electron microprobe isometric concentration maps of glass-breccia grain interfaces indicated no diffusion of breccia constituents into the glass within the resolution of the microprobe. These observations suggest rapid flow and cooling of the glass melt.

Inclusions and Interface Relationships

J. F. Wosinski

P.812

Quantitative chemical analysis of two general areas of glass, one near the center of the 2 mm glassy vein and the other near the glass-breccia interface, with the electron microprobe indicated some variation in the iron concentration in the two zones. The average concentration of the glass constituents in the glass phase expressed in weight percent oxides are: SiO_2, 46.63 ± 0.24; FeO, 11.60 ± 0.47; Na_2O, 0.72 ± 0.04; TiO_2, 1.32 ± 0.03; CaO, 8.67 ± 0.35; MgO, 13.53 ± 0.75; Al_2O_3, 15.87 ± 0.36; K_2O, 0.61 ± 0.04; Total, 98.95.

A synthetic glass batch of sample 14306.50 was melted in a resistance fired furnace in an inert (N_2) atmosphere at 1400°C for two hours. The batch melted rapidly and the resulting glass was free of solid and gaseous inclusions. The following physical properties were determined: softening point, 823°C; annealing point, 669°C; strain point, 633°C; expansion, $53.9 \times 10^{-7}/°C$ (average expansion 0 - 300°C); density, 2.767 gm/cc; liquidus, 1205°C, phases pigeonite and magnetite. Gradient furnace and microscope furnace tests on the synthetic batch and glass also indicated both melt rapidly and at relatively low temperatures, as low as 1035°C depending upon exposure time at temperature.

(1) Ramdohr, P. and El Goresey, A., Science 167, pp. 615-618, (1970); Duke, M. B., Woo, C. C., Bird, M. L., Sellers, G.A., Finkelman, R. B., ibid, pp. 648-650; Simpson, P. R. and Bowie, S.H.U., ibid, pp. 619-621; Skimmer, B. J., ibid, pp. 652-654; McKay, D. S., Greenwood, W.R., Morrison, D.A., ibid, pp. 654-656; Mason, et al, ibid, pp. 656-659; von Engelhardt, W., et al, ibid, pp. 669-671.

(2) Goldstein, J. I. and Yakowitz, H., Proc. Apollo 12 Lunar Sci. Conf., Geochim. Cosmochim. Acta., Suppl. 2, Vol. 2, pp. 177-191, (1971); Glass, P. B., Jour. Geophys. Res., Vol. 76, #23, pp. 5649-5657, (1971); Wood, J. A., Marvin, U.B., Reid, J. B., Jr., Taylor, G. J., Bower, J. F., Powell, B. N., and Dickey, J. S., Jr., Smith. Astrophys. Observatory, Special Report, 333, p. 121 (1971).

Inclusions and Interface Relationships

J. F. Wosinski

P. 813

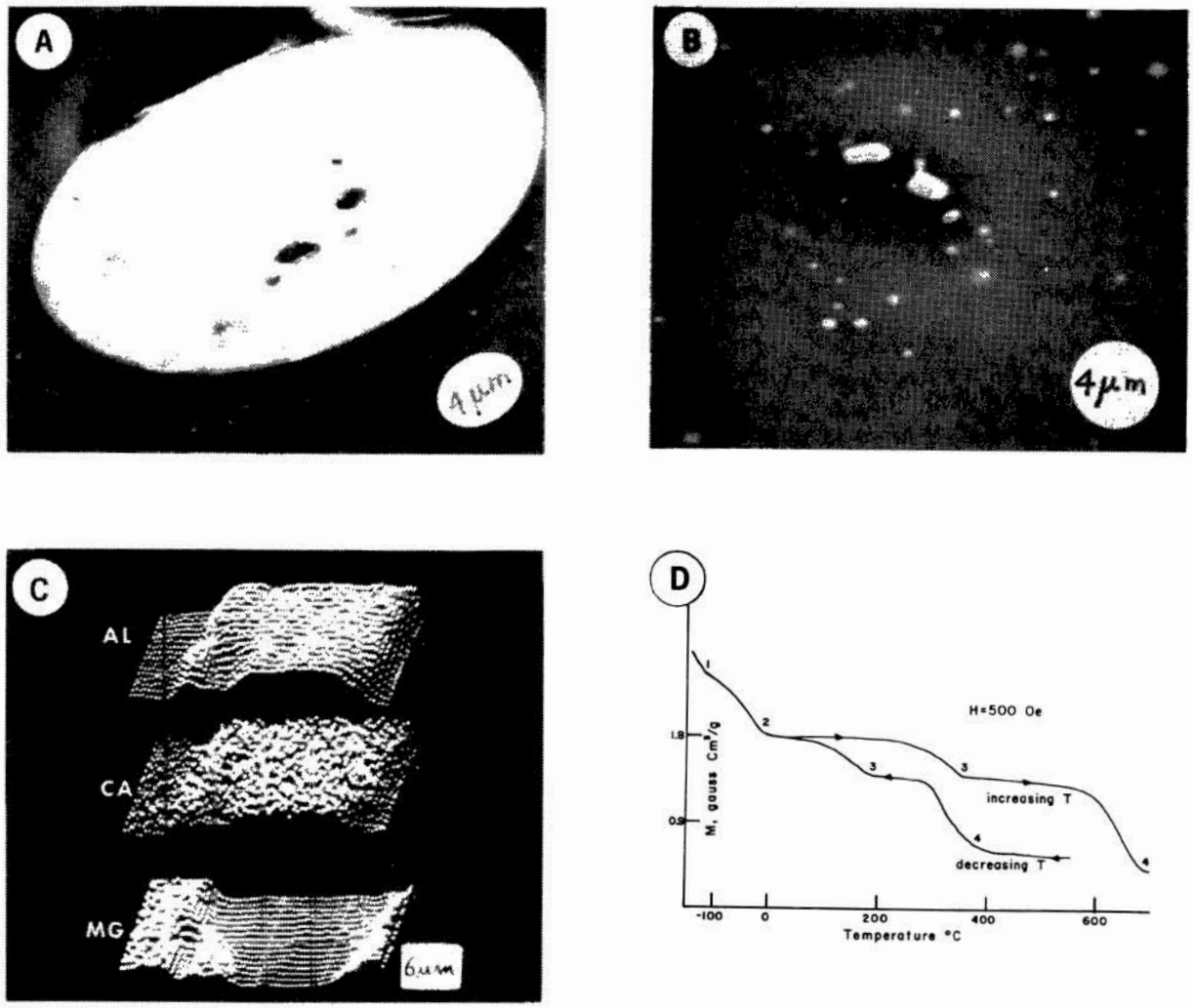

Fig. 1. Inclusion and Interface Detail. (A) Scanning electron micrograph of iron-inckel phosphide particle with troilite inclusions and rim. (B) Scanning electron micrograph of metallic particles, one with pronounced nodule. (C) Electron microprobe isometric concentration maps for aluminum, calcium, and magnesium at a glass-breccia grain interface. Diffusion interface very sharp. Resolution 1 to 2 μm. (D) Magnetization vs. temperature curve showing four magnetic phases and indicating a fifth with Curie temperature > 670°C.