Lunar Glass I: Densification and Relaxation Studies

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In order to provide large quantities of "calibrant" and trial material for several studies, batches of three synthetic compositions simulating lunar glass composition corresponding to typical high titania (A), high iron (B) glasses (Science, Vol. 167, p. 646, Composition B-14 and C-9) and anorthite have been prepared and melted to glasses under varying pO_2 ($10^{-12.5}$ and $10^{-11.2}$).

Following Roy and Cohen's (1) suggestion, these glasses have been used to give us a model system for determining the magnitude of a pressure event by studying frozen-in density and refractive index changes. The pressure-temperature metastable equilibrium-refractive index dependence of these glasses has been determined in the range from 0 - 65 kb and 50 - 525°C. They show that the changes which are caused are very substantial. For example, Glass A goes from a normal R.I. value of 1.693 to 1.762 at 45 kb and anorthite glass from n = 1.578 to n = 1.668 at 60 kb, 400°C. The time-temperature conditions needed to relax out these index changes have been determined, and most can be returned to their original value between 500 - 600°C in approximately 1 - 2 hrs.

Seven sets of lunar glasses have been relaxed out by temperature annealing, and measurable changes observed. The R.I. is found to increase in some cases (Apollo 11, 10-085.49) from 1.662 to 1.675, whereas other fragments in the same sample decreased from 1.673 to 1.660. In spite of the use of sealed Pt tubes, it is difficult to avoid changes in valence state.

However, the calibrant synthetic glass A does not show any R.I. change in air. These results are analogous to those for anorthitic glass obtained by von Engelhardt, et al., (Science 167, p. 669, 1970) and very large for 'annealing' changes in terrestrial materials. No simple interpretation of these changes is evident at this time but the effect of shock metamorphisms may turn out to be best expressed as a negative pressure.

(1) Roy, R. and Cohen, H.M. Effects of High Pressure on Glass: A possible piezometer for the 100 kb region. Nature, 190, 798 (1961).