X-RAY DIFFRACTION STUDY OF THE STRUCTURE OF DIAPLECTIC ANORTHOSITE GLASS FROM MANICOUAGAN IMPACT CRATER, CANADA.

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Our previous studies (1,2) have shown that the diaplectic Manicouagan anorthosite glass exhibits the characteristic glass properties low-temperature viscous flow, the related phenomenon of the glass transition and crystallization far below the liquidus temperature. It can thus be included into the category of "real" glasses. However, considerable differences exist in these properties in comparison to its fusion-formed glass analog, indicating structural differences between these two kinds of amorphous materials. In this paper we report the results of some X-ray diffraction studies on this diaplectic glass and its laboratory fused glass analog for comparison.

In Fig. 1 is shown the X-ray scattering pattern from the diaplectic glass. Almost the same scattering pattern is obtained from the fused glass. The only difference is an additional, relatively sharp reflection in the pattern of the diaplectic glass at about 28 deg ($\approx$320 pm) (cf. arrow in Fig. 1) which could be either the 040 or, more probably, the 002 reflections from the original lattice. Using Scherrer's equation, the halfwidth of this reflection gives an estimate of the range of order in either direction of approximately 8 nm. Furthermore, transmission photographs taken with monochromatic X-radiation from a suitable grain in a fixed position show intensity spots in addition to the expected Debye ring. Closer inspection reveals that the spots are systematically split into two maxima, the one of them being relatively sharp, the other having an intensity tail producing the halfwidth of the above mentioned powder peak.

In order to elucidate the principal short-range order in the diaplectic and fused glasses, we have calculated the intensity distribution using Debye's equation (3) employing the High Albite crystal structure (4). One calculation included only distances <320 pm, while another used a complete unit cell. Comparison of the results with the experimental pattern clearly demonstrated that the short-range order of the crystalline plagioclase is retained in both the fused and diaplectic glass since the main features are reproduced by this simple approach. A similar conclusion has been reached (5) in a detailed study on fusion-formed feldspar glasses. However, our data also suggest that there is a considerable amount of disorder already present in the range below the unit cell dimensions in both kinds of glasses.

The amorphous nature of the diaplectic glass is obviously due to a high concentration of lattice defects such as

Structure of Diaplectic Glass.

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disordered distribution of the Na^+ and Ca^{2+} cations, disorder of the occupancy of the tetrahedral sites and rupture of Si-O and Al-O bonds (2,6,7). However, in contrast to the fused glass, the diaplectic glass also exhibits remnants of the previous crystalline state as revealed by its X-ray scattering which indicates the presence of regions of long-range order, "twinning" of these ordered regions and relics of cleavage parallel 001. All these various factors contribute to its unusual behavior in thermal expansion, low-temperature viscous flow and crystallization in comparison to the fused glass (1,2).

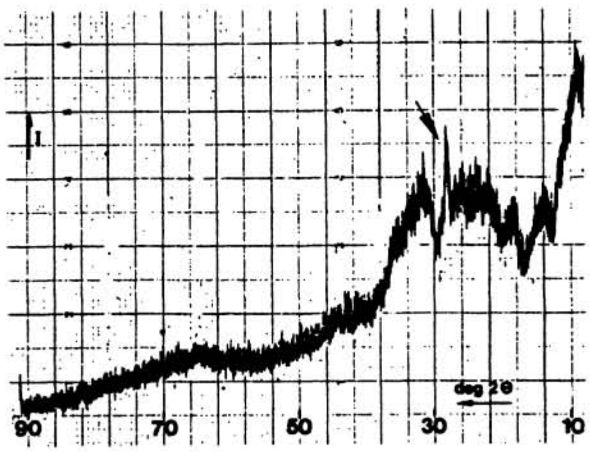

Fig. 1

Scattered X-ray intensity of diaplectic Manicouagan anorthosite glass as a function of the Bragg angle (Cu-K_α radiation, graphite monochromator, scintillation counter, PHD).

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