FROM PLAGIOCLASE TO MASKYELYNITE VIA SHOCK.

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Introduction: Diaplectic glasses of plagioclase (maskelynite) and silica are characterized by the lack of flow structures and vesicles [1]. These glasses retain the original grain boundaries and chemical zonation of the original minerals from which they derive via shock. Diaplectic glasses have lower densities (refractive indices) than the crystalline precursors, and higher densities compared to thermally quenched glasses of ischemical composition. Different formation mechanisms of diaplectic glasses are proposed including 1) solid-state transformation without melting [2-3] or 2) a combination of shock melting and subsequent quenching at high confining pressure [4-5].

Method: To discriminate between these two mechanisms we conducted a series of shock recovery experiments. Plagioclase with An_{94} was shocked to pressures between 20, 24, 28 and 36 GPa at ambient temperature. In addition, plagioclase with An_{55} was shocked to 28 and 32 GPa at initial temperatures of 293 K and to 28, 32, 36 and 45 GPa at 77 K. The shock metamorphic effects in the samples were characterized by optical microscopy including refractive index measurements and Raman spectroscopy. The chemical compositions of the mineral grains were determined by electron microprobe analysis.

Results: An identical degree of shock deformation was observed in plagioclase (An_{55}) shocked to the same pressures but at different initial T of 293 or 77 K. Shock experiments with An_{94} showed that maskelynite formed at shock pressures of ~24 GPa, thus at lower shock pressure compared to plagioclase with lower An content [6].

Discussion: These results advocate that diaplectic glasses mainly form via static failure of the crystal lattice due to overpressure, i.e., a type of physical crushing. Melting of plagioclase during shock loading appears irrelevant for diaplectic glass formation, because:

1) higher shock pressures (higher shock induced heating) would be required to melt samples shocked at initial temperatures of 77 K compared to those shocked at 293 K, which is not the case (see [1])

2) it would imply that plagioclase with higher An content and thus, higher melting temperature, would transform into a diaplectic glass at higher shock pressure than that with lower An content. The opposite trend was observed. With increasing An content more Si is replaced by Al and the Al-O bounds are weaker compared to Si-O bounds in the lattice structure of tectosilicates [7].

3) in static experiments amorphisation of plagioclase can be enforced at ambient temperature [8] i.e., without melting and for anorthite at similar pressures (~22 GPa; [8]) as in our shock experiments (~24 GPa; An_{94}).

References: [1] Engelhardt W.v. et al. 1967. *Contributions to Mineralogy and Petrology* 15:93-102. [2] Fritz J. et al. 2011. *International Journal of Impact Engineering* 38:440-445. [3] Fritz J. et al. 2005. *Antarctic Meteorite Research* 18:96-116. [4] Langenhorst F. 1994. *Earth and Planetary Science Letters* 128:683-698. [5] El Goresy A. et al. 2013. *Geochimica et Cosmochimica Acta* 101:233-262. [6] Stöffler D. et al. 1986. *Geochimica et Cosmochimica Acta* 50:889-903. [7] Matson D.W. et al. 1986. *American Mineralogist* 71:694-704. [8] Daniel I. et al. 1997. *Journal of Geophysical Research* 102:10,313-10,325.