Shock deformation in feldspar: Partial amorphisation in feldspar twins

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Introduction: The formation of hypervelocity impact structures causes shock deformation in the impacted material [1,2]. In this study, samples from the Chicxulub impact structure (Yucatán Peninsula, Mexico) have been investigated to study shock deformation in feldspar. Due to its high abundance [3], feldspar can be a useful tool in shock barometry. Feldspar from both the plagioclase and alkali feldspar series were identified in these samples with Na-rich plagioclase in particular containing more shock related deformation features than K-rich feldspar. These deformation features have since been investigated using the crystallographic technique electron backscatter diffraction (EBSD) and chemical changes within these microstructures have been investigated by energy dispersive X-ray spectroscopy (EDS) and electron probe microanalysis (EPMA).

Methods: The Chicxulub samples were collected in 2016 during the IODP-ICDP Expedition 364 [4]. Three samples were studied in this project (collected from depths 1160.7, 1199.6 and 1216.5 mbsf (metres below seafloor)). These samples have been analysed using optical microscopy, scanning electron microscopy (SEM), including backscatter electron (BSE) imaging and EDS mapping at the University of Glasgow. One sample (CHX_1160.7) was also analysed using EBSD at the University of Glasgow and EPMA collected at the University of Edinburgh.

Results: CHX-1160.7 was found to contain planar features in Na-rich feldspar. EBSD analysis of the areas containing planar features revealed that in some areas they were partially amorphized twins, alternating between amorphous and crystalline twins, evidenced by non-indexed and indexed llamellar regions in EBSD maps (Fig 1A). Interestingly, the chemistry of these partially amorphous twins is different from the neighbouring crystalline twins: the Ca content (which overall is no more than ~2.5 at. %) is ~1 at. % lower in the partially amorphous twins (i.e., more deformed twins have less Ca). When comparing the deformation features found in the Na-rich feldspar to K-rich feldspar, there were notably more deformation microstructures found in the Na-rich than the K-rich feldspar. The K-rich feldspar contained few deformation microstructures beyond fractures.

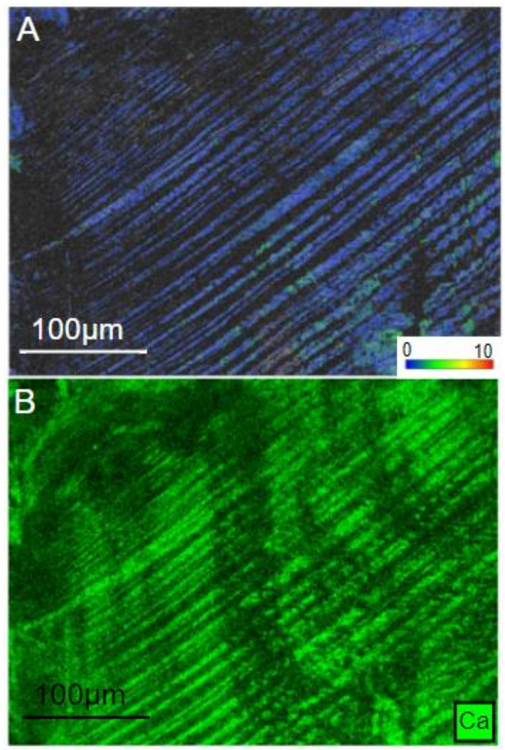

Figure 1 – A) GROD angle EBSD map showing the misorientation of an area within a Na-rich feldspar in sample CHX-1160.7. B) A false colour EDS map showing the distribution of Ca across the same area of Na-rich feldspar.

Discussion: This alternate twin deformation has been identified in shocked feldspar before [5,6], although the role of low level variations of Ca content in Na-rich feldspar twins that have been shocked has not been discussed. Based on the findings from this investigation it seems likely that partial amorphisation of alternating twins has influenced the Ca concentration post shock. It is also clear from these findings that Na-rich feldspar is more susceptible to shock than K-rich feldspar.

References: [1] Melosh, H. (1989) *Impact cratering: a geologic process.* [2] French, B & Koeberl, C. (2010) *Earth Science Reviews* 98:1-2. [3] MacKenzie, W. S. and Adams, A. E. (1994) *A colour atlas of rocks and minerals in thin section.* [4] Gulick, S. et al. (2017) *Proceedings of the International Ocean Discovery Program 364*. [5] Stöffler, D. (1966) *Contributions to mineralogy and petrology* 12:15–24. [6] Pickersgill, A, E. et al. (2015) *Meteoritics & Planetary Science 50:*1546–1561.