SHOCKED QUARTZ AND LOCAL SELECTIVE FELDSPAR MELTING IN A LITHIC BRECCIA DIKE INTERSECTING SHATTER-CONED TARGET ROCKS AT THE SANTA FE IMPACT STRUCTURE, NEW MEXICO, USA.

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Introduction: The ~6–13 km Santa Fe impact structure, first described in 2008 [1], is located ~8 km northeast of the city of Santa Fe, New Mexico, USA. Distinct shatter cones in Paleoproterozoic crystalline rocks are exposed over an area of 5 km^2. Fackelman et al. [1] reported shocked quartz grains within the shatter-coned target rocks that usually exhibit a single set of decorated planar fractures (PFs) or planar deformation features (PDFs). The PFs and PDFs, presumably mechanical Brazil twins, are dominated by a basal crystallographic orientation (0001), which indicates a peak shock pressure of ~8–10 GPa, consistent with the shatter cone formation (e.g., [2]). Shocked apatite, muscovite, and zircon in various shatter-coned target rock types (and associated colluvium), as well as nanoscale deformation twinning in xenotime from a shatter cone in granite, were reported from Santa Fe by [3-5].

Samples and Sample Locality: The rock sample investigated in this study was collected during a field trip to the Santa Fe impact structure in October 2015, in the woods (35°44'23''N/105°51'30''W) alongside the Chamisa hiking trail that runs perpendicular to New Mexico State Highway 475. The sample stems from an apparently non-shattered, ~10 cm thick lithic breccia dike that intersects shatter-coned, partially altered granitoid rocks (Fig. 1, left). The reddish lithic breccia dike itself is composed of broken granitoid rock fragements and cataclastic veins. The angular rock fragments in the lithic breccia dike as well as in cataclasitic veins within the dike mainly consist of quartz, potassium feldspar, minor plagioclase and nests of mica (mainly biotite).

Characterization of PFs, PDFs, and K-feldspar melt domains: Shocked quartz grains occur in granitoid rock fragments in the dike and as mineral clasts in cataclastic veins within the dike. PFs of the basal crystallographic orientation (0001) are common in quartz grains in the dike. PDFs parallel to (0001) and {10$\bar{1}$3} were also observed, however, most quartz grains exhibit just one distinct set of PDFs. Occassionally, shocked quartz grains show two or even three sets of PDFs (Fig. 1, middle); PDFs parallel to {10$\bar{1}$2} seem to be rare. In some clasts, mechanically deformed K-feldspar crystals are surrounded by a brownish, optically isotropic phase with flow textures (and skeletal K-feldspar crystals) interpreted to be zones of recrystallized K-feldspar melt (Fig. 1, right).

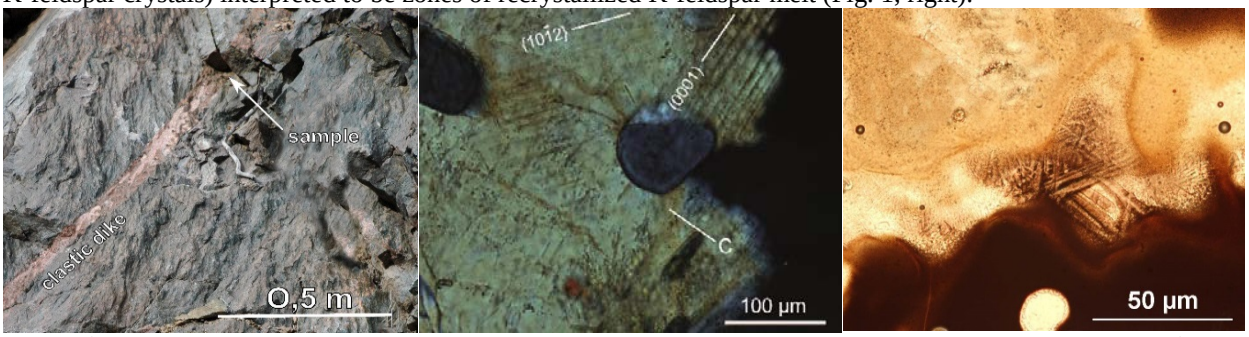

Fig. 1: Left: Unshattered clastic dike in shatter-coned Paleoproterozoic granitoid rocks; Middle: Shocked quartz grain in a granitoid rock fragment in the clastic dike exhibiting two distinct sets of PFs and PDFs; Right: Initial selective KFs melting in the otherwise cataclastic breccia in the dike.

Discussion: The non-shattered lithic breccia dike intersects shatter-coned granitoid rocks and, hence, dike formation postdates the shatter cone forming process. Peak shock pressure that affected the clasts in the dike is slightly higher compared to the shattered host rocks. Quartz grains in host rocks show PFs and PDFs that ususlly follow the basal orientation (0001), suggesting peak shock pressures of 8-10 GPa [1,6]. PDFs of the orienations (0001), {10$\bar{1}$3}, and {10$\bar{1}$2} in shocked quartz grains in the dike argue for a peak shock pressure of ~10-20 GPa, compatible with the formation of shocked apatite, muscovite, and zircon [3,4,5], and shock-produced (<20 GPa) twin lamellae in xenotime [6] in the target rocks at Santa Fe. The melting of K-feldspar requires post-shock temperatures of ≥850°C [2,7], incompatible with such moderate shock pressure conditions. Thus, K-feldspar melting may have been driven by local friction melting. The occurence of K-feldspar melt at Santa Fe is of interest regarding future ^{40}Ar/^{39}Ar dating.

References: [1] Fackelman S. P. et al. 2008. *Earth Planet. Sci. Lett.* 270:290–299. [2] French B. M. 1998. *Traces of Catastrophe*. LPI Contrib. 954, 120 pp. [3] Montalvo P. E. & Cavosie A. J. 2015. Abstract #1337. *46th Lunar Planet. Sci. Conf.* [4] Colón Lugo D. & Cavosie A. J. 2014. Abstract #2033. *45th Lunar Planet. Sci. Conf.* [5] Cavosie A. J. & Lugo Centeno C. 2014. Abstract #1691. *45th Lunar Planet. Sci. Conf.* [6] Cavosie A. J. et al. 2016. *Geology* 44:803–806. [7] Stöffler D. & Langenhorst, F. 1994. *Meteoritics Planet. Sci.* 29:155–181.