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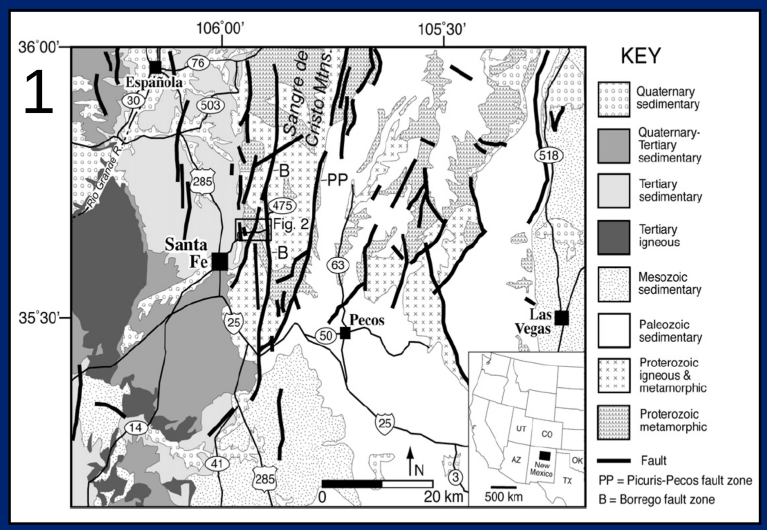
THE "BRECCIA TOWERS" AT THE SANTA FE IMPACT STRUCTURE, NEW MEXICO, USA – PRIMARY IMPACT/TECTONIC BRECCIA VERSUS COLLUVIAL/ALLUVIAL DEPOSITS?

ELMAR BUCHNER[1,2] & MARTIN SCHMIEDER[3,4]

[1]HNU – Neu-Ulm University of Applied Sciences, Wileystraße 1, 89231 Neu-Ulm, Germany
E-mail: elmar.buchner@hs-neu-ulm.de
[2]Institut für Mineralogie und Kristallchemie, Universität Stuttgart, Azenbergstraße 18, 70174 Stuttgart, Germany
[3]Lunar and Planetary Institute, 3600 Bay Area Blvd, Houston TX 77058, USA; [4]NASA–SSERVI
E-mail: schmieder@lpi.usra.edu



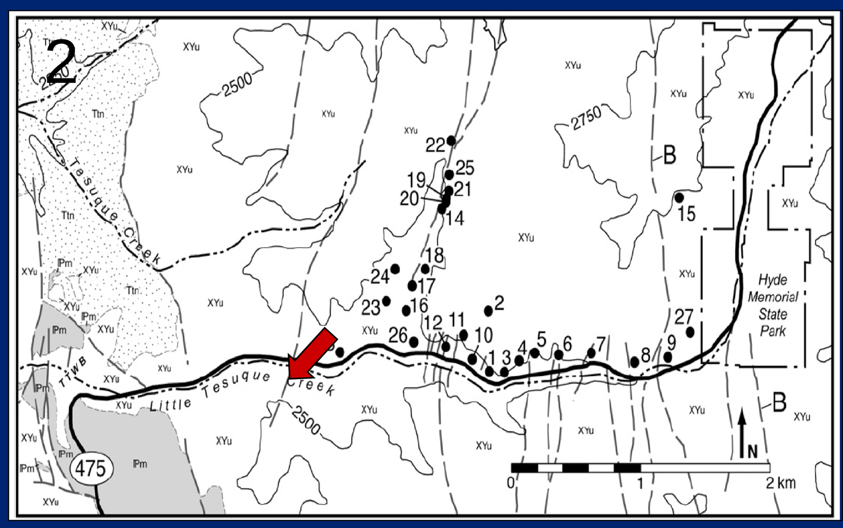
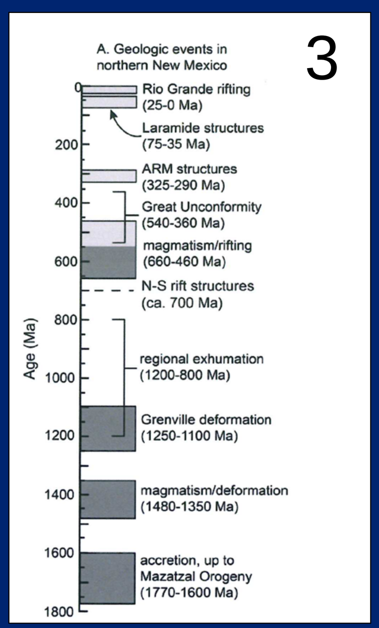
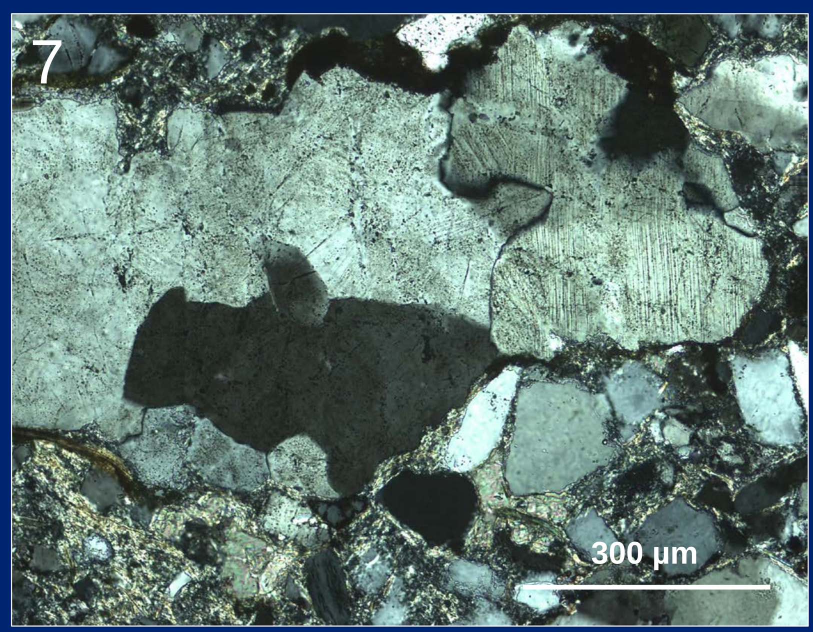


Fig. 1: Geological map of the Santa Fe area [1];
Fig. 3: Main geological events in northern New Mexico [2].

Fig. 2: Samples investigated taken from breccia tower #2 shown in Figs. 5 and 6.



INTRODUCTION: The ~6–13 km Santa Fe impact structure, ~8 km northeast of the city of Santa Fe, New Mexico, USA (Fig. 1), was first described in 2008 [1]. Distinct shatter cones in Paleoproterozoic crystalline rocks are exposed over an area of 5 km^2. The presence of unshocked Paleozoic (Mississippian–Pennsylvanian) limestones overlying those Proterozoic crystalline rocks and breccias suggests the impact probably occurred before ~340 Ma [2,3]. At least three different types of breccias, some exposed in so called "breccia towers" alongside Highway 475 (Fig. 2), have been reported [2,3]. The breccia towers (Fig. 5) are interpreted as the remnants of impact and/or fault breccias by [2], who proposed that the breccias may not represent original impact breccias but could possibly be related to faults resulting from the impact event .



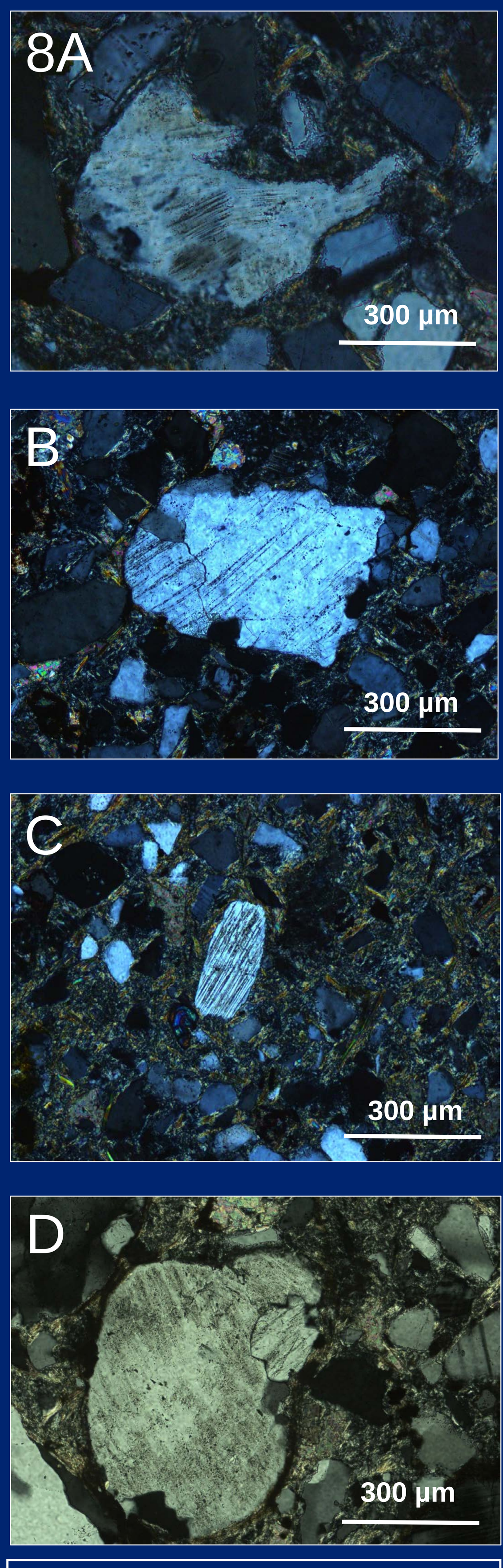


Fig. 4: Nun's curve: unshocked Paleozoic (Mississippian–Pennsylvanian) limestones overlying Proterozoic crystalline rocks and breccias.

Fig. 5: Breccia Tower #2 with angular to rounded, shocked and unshocked matrix-supported "block-in-matrix colluvium" [4].

SAMPLE AND SAMPLE LOCALITY: A field trip to the impact structure was undertaken during the 80th MetSoc Conference in Santa Fe in 2017. The rock samples investigated in this study (Figs. 2, 4) were collected from breccia tower #2 [2] (35°43'40''N/105°52'25''W) at a height of ~2 m above the base level of this breccia outcrop. The reddish samples were taken from a comparatively fine-grained section of the deposits that contain clasts of fine sand to fine pebbles in grain size. The clast portion mainly consists of quartz and feldspar grains, granitoid and gneiss fragments, and relatively coarse-crystalline, sparitic carbonate rock clasts. The rounding of clasts ranges from angular via moderately rounded to well rounded. Shocked quartz with a maximum of three distinct sets of PDFs is abundant, and occurs as angular, sub-rounded, and well rounded grains. The matrix of the breccia tower deposits contains microscopic shards of quartz and feldspar, as well as mica, clay minerals, and secondary carbonate.

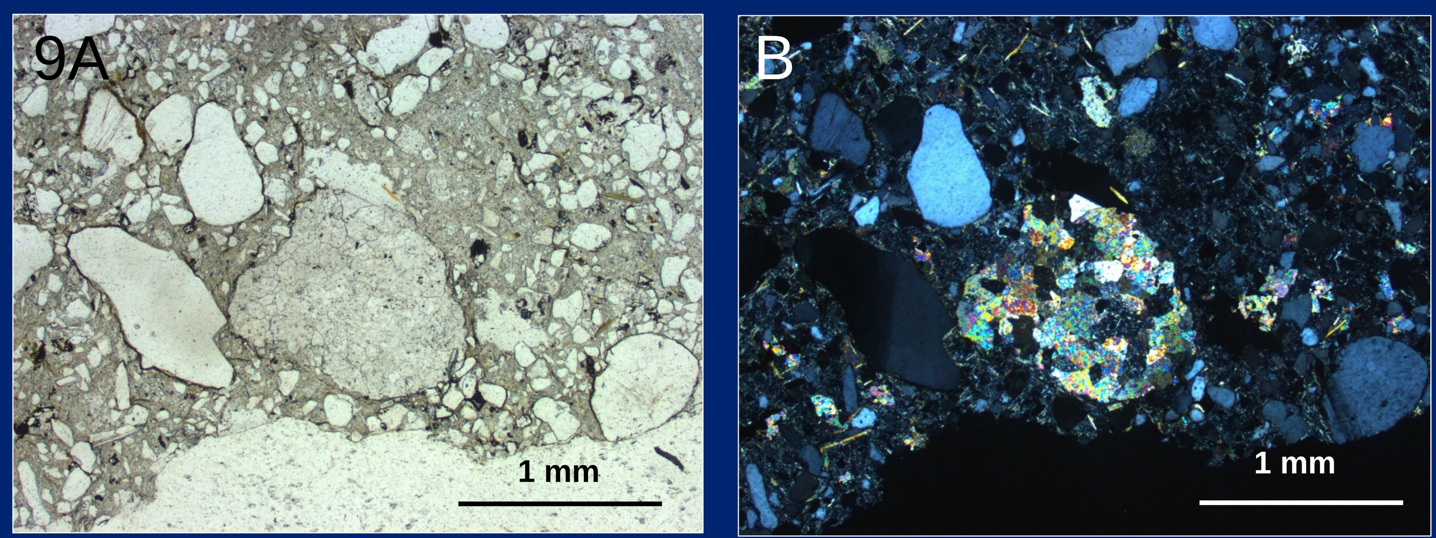
SEDIMENTOLOGIC OBSERVATIONS: Several macro- and microscopic features can be observed in breccia tower #2 on an outcrop scale. Macroscopic features include: Moderate to well rounding of pebbles, cobbles, and boulders in layers; moderate sorting of clasts and indistinct bedding; imbrication of clasts in conglomeratic layers (Figs. 4, 6). The rock fabric is matrix-supported in the breccia-like domains, and is clast-supported in the conglomeratic layers. The microscopic features include: Quartz and feldspar occur as angular, subrounded, and well-rounded grains; in sandstone interlayers, most quartz and feldspar grains are well or even perfectly rounded; most carbonate grains are well rounded; in some sections, sandstone exhibits distinct layering and sorting; coarser-grained sections are matrix- to grain-supported; finer-grained sections are typically matrix-supported.

Fig. 8: Polarization microscope pics of abundant shocked quartz grains in our samples from breccia tower #2. Shocked quartz grains are either angular (A), subrounded (B), rounded (C), or even well-rounded (D); A-D: crossed polarizers

Fig. 7: Polarization microscope picture of a shocked quarzt grain with at least two sets of PDFs in the deposits of breccia tower #2.

Fig. 6: Matrix-supported conglomeratic layers with rounded clasts, (indistinct) sorting, and layering provide evidence for deposition in a regime dominated by water flow processes.

Fig. 9: Polarization microscope pics of abundant limestone particles in our samples that are subrounded or even well-rounded. A: plane polarizers; B: crossed polarizers



DISCUSSION AND RESULTS: Coarse-grained (pebbles, cobbles, and boulders), matrix-supported sections with angular to subrounded clasts are seemingly devoid of characteristic sedimentologic features typical for deposits transported by running water and were, thus, interpreted as primary impact or tectonic colluvial breccias [2]. This may be in analogy to the matrix-supported "block-in-matrix colluvium" of [4]. However, several transitions in rock fabric within the breccia tower deposits towards finer-grained and matrix-supported conglomeratic layers provide characteristic sedimentologic evidence for deposition in a regime dominated by water flow processes. The breccia towers are, thus, interpreted as the erosional remnants of colluvial–alluvial fans (Fig. 6). The clasts of the colluvial–alluvial deposits include various types of breccia, interpreted as impact and/or fault breccia, and possibly even of impact-breccias-within-fault-breccias [2]. Abundant shocked quartz grains in the samples (Figs. 7, 8) prove that a larger portion of the clast population was derived from local impact ejecta and/or shocked target rocks. Angular shocked quartz grains likely stem from a provenance area close to the deposition site, whereas well-rounded shocked quartz grains indicate the reworking of material from a more distal source area, fluvial transport [5], and deposition in the fans. Abundant rounded limestone particles (Fig. 9) in our samples could be derived from either Mississippian (Arroyo Peñasco Gp.) and Pennsylvanian (Sandia and Madera Fm.) marine limestones (e.g., as exposed along "Nun's curve"; Fig. 4), or from minor occurrences of Neogene carbonates (e.g., Miocene Nambé Member, Santa Fe Gp.) [6–8]. Thus, the colluvial/alluvial fans may have been deposited long after the Santa Fe impact event, and could be related to the Rio Grande rifting that has been active for the last ~26 Myr (Fig. 2). Nevertheless, larger portions of impact and fault breccias were preserved at the impact site until the time of fan deposition, evidenced by reworked breccias (from inside and/or outside the original impact crater) that occur frequently as clasts in the colluvial–alluvial fan deposits.

References:[1] Fackelman S. P. et al. (2008) EPSL 270:290–299. [2] Wright S. and Cavosie A. (2017) Field Guide to 80th MetSoc Conf., Santa Fe, 23 pp. [3] Wright S.P. et al. (2010) Abstract #1286. 41st Lunar Planet. Sci. Conf. [4] Pan Y.W. et al. (2008) Abstract #0851. 42nd US Rock Mech. Symp. and 2nd U.S.-Canada Rock Mech. Symp., San Francis-co. [5] Buchner E. and Schmieder M. (2009) MAPS 44:1051–1060. [6] Galusha T. and Blick J. C. (1971) Bull. AMNH 144, 132 pp. [7] Read A. et al. (2000) Geologic Map of the Santa Fe 7.5-minute quadrangle. [8] Bauer, P. et al. (1996) Geologic map of the McClure Reservoir quadrangle, Santa Fe County, New Mexico.