DISTAL IMPACT EJECTA, UPPERMOST EOCENE, TEXAS COASTAL PLAIN. M. Glidden[1], D. T. King, Jr. [2], and K. O. Pope[3], [1]P. O. Box 343, Industry, TX 78944 (glidden@industryinet.com), [2]Dept. Geology, Auburn University, Auburn, AL 36849 (kingdat@auburn.edu), [3]Geo Eco Arc Research, 16305 St. Mary's Church Road, Aquasco, MD 20608 (kpope@starband.net).

Introduction: In this paper we report the occurrence of distal impact ejecta, within uppermost Eocene strata of the Texas coastal plain. The ejecta are redeposited within fluvial facies of the gently coastward-dipping Whitsett Formation and occur in point-bar and thalweg deposits in discontinuous beds and lenses along a 120 km trace of outcrop strike. These ejecta include shocked and non-shocked materials. Layers of volcanic ash provide the basis for an interpolated date of 33.8 Ma for the alluvium containing the ejecta (assuming continuous sedimentation between two ash layers dated at 33.7 Ma and 34.93 Ma). This interpolated date is for the lowermost occurrence of the ejecta, which are found at several intervals throughout a 30-meter section. As this age does not match any of the known impact structures in the region, there is as yet no candidate structure for the origin of these ejecta, which range from fine sand size to 3 cm.

The ^{3}He-enriched interval within upper Eocene strata of the global stratotype section (GSSP) at Massignano, Italy [1] has been interpreted as evidence of an increased incidence of comet activity within the inner solar system with consequences for a number of impacts dating to that age. These structures include Chesapeake Bay, eastern U.S. [2], Popigai, Russia [3], and other smaller structures (Mistastin, Logoisk, and Chyly), plus less well-documented structures including Kilmichael (Mississippi) [4]. The ejecta reported here apparently derived from none of these structures, judging from ejecta size and age. We suggest a heretofore unrecorded impact, one whose structure may no longer exist, as the source for these ejecta whose unusual characteristics we describe herein.

Nature of the ejecta: The ejecta consist mainly of quartz and chert, with minor other siliceous materials, in the form of grains, granules, and clasts and small pebbles to 3 cm in size. The surfaces and shapes of the ejecta present much variation and contrast: round to angular, smooth or rough, regular shapes or contorted, polyhedral or pebbly, and other aspects and all combinations thereof. The ejecta bear a pristine aspect, showing little of the usual abrasion of fluvial transport. Fractioning the sediments of this interval reveals that the entire coarse fraction (> 1 mm) is ejecta. Surface features include polish, impact pits and dimples, large-scale impact features, shatter effect, striations, and gouge marks. Plastic deformation is evident in much of these features. Exteriors and interiors of ejecta may show contrast, as revealed by fracture, with exterior surfaces displaying a darker hue and an alteration-rind. Some specimens exhibit a zoning from the exterior toward the center. The intensity of the polish varies, but usually is a high polish comparable to that produced by lapidary methods (Fig. 1). The polish is universal, and is seen on all surfaces, including fine grains. Rough, irregular surfaces may show polish even in the recesses. An SEM image of this polish (Fig. 2) reveals a smooth surface dotted by micron-size pits which merge with polish as they diminish in size. Pits and dimples are small, several mm or less, pervasive, and show signs of plastic formation without associated spalling. Imprints of projectile grains may be seen at the bottom of pits or the center of dimples. Commonly, the projectile grain is retained in a chert target, embedded in the surface. Projectile grains are usually quartz. Pits may show perimeter effects such as circumferential wrinkles or ridges. Shatter effect is seen as facets or more complex configurations or incipient fracture. Striations are seen on a small fraction of the chert ejecta, and are short, random, under 1 mm in width, and sometimes curved. Gouge marks are spoon-shaped features on chert appearing as if a divot were removed from the surface of the clast.

This interval has also yielded fine (300-400 µm), sub-angular grains of shocked quartz (Fig. 3). These have been isolated from the sand fraction and display one or two prominent sets of closely spaced PDF's. What may be altered glass is preserved in fragments of sandstone from this interval, and some individual specimens seem to be altered and recrystallized glassy impactite.

Discussion and interpretation of surface features: Extraordinary high polish, like the polish exhibited here, is rare and difficult to explain by non-impact processes. Previous reports describe several instances of polish on impact ejecta [5, 6]. However, the polish of these ejecta, in contrast with the polish of other reports, is not associated with striations, and is universal rather than partial, and apparently formed dissimilarly. Magnified images reveal a polish produced by the impact of clay-size projectiles, a process that can be characterized as "clay-blasting." Polish, pits and dimples, embedded grains, striations, etc. form a continuum of effects derived from a single process involving targets, projectiles, and great disparity of velocities. This process most likely originated in the entrainment of ejecta by the expanding vapor component of the impact, thus facilitating those target/projectile interactions, which produced these surface features. An inverse relation of particle size to velocity may have been operative, i.e., the smaller the particle, the higher the velocity. This principle is best shown by the grain-size ejecta, which were polished as they were targets of the smaller (and higher velocity) clay-size projectiles, while simultaneously propelled as projectiles to targets of larger (and slower) granule and pebble-sizes, producing the pits, dimples, embedded grains, etc. Pits and dimples formed plastically, as is evident by these indications: 1) depressed pit perimeters, 2) imprints of projectile grains, 3) embedded projectile grains, 4) lack of spalling, and 5) circumferential perimeter effect of pits. After conversion by shock to a plastic or semi-plastic state, surfaces of the ejecta may have been further heated by the very considerable friction of the smaller projectiles thereby enhancing (or inducing) surface plasticity. Such surface effect is indicated by the conjunction of plastically formed surface features with shatter effect, and by the alteration rinds seen on some specimens.

Implications and conculsions: Ejecta lithology indicates an impact involving a target of sedimentary strata that included chert, sandstone, and perhaps a quartzose, chert-bearing conglomerate. This target stratigraphy does not presently occur within a radius of hundreds of km of the outcrop of these ejecta. The impact structure itself may be buried or it may have been removed by erosion.

Little sign of the inevitable abrasion of fluvial processes is seen on these ejecta, whose pristine appearance seems to exclude lengthy fluvial transport. Likewise, the absence from these sediments of a coarse, non-ejecta component seems to exclude an inland contribution of these ejecta to the paleodrainage. These considerations indicate that the ejecta were entrained into the sediments locally, after having been deposited in the area as distal ejecta.

It is probable that the impact was far inland of the outcrop of host strata, and that the event was of a sufficient magnitude so as to disperse these distal ejecta of uncommon characteristics over a wide area. Consideration of the processes involved in the initial transport of these ejecta suggests a paramount role for the vapor component of this impact event. An impact, which is dated at or near the terminal Eocene level, and which is of undetermined yet possibly large magnitude, suggests that this event may have had profound and far-reaching consequences.

References: [1] Farley K. A. et al. (1998) *Science, 280,* 1250-1253. [2] Poag C. W. and Aubry M.-P. (1995) *Palaios, 10,* 16-43. [3] Bottomley R. J. (1997) *Nature, 388,* 365–368. [4] Koeberl C. (2000) *LPS XXXI,* Abstract #1602. [5] Chao E.C.T. (1976) *Science*, 194, 615-618. [6] Pope K.O. and Ocampo A.C. (2000) LPS XXXII, Abstract #1419.

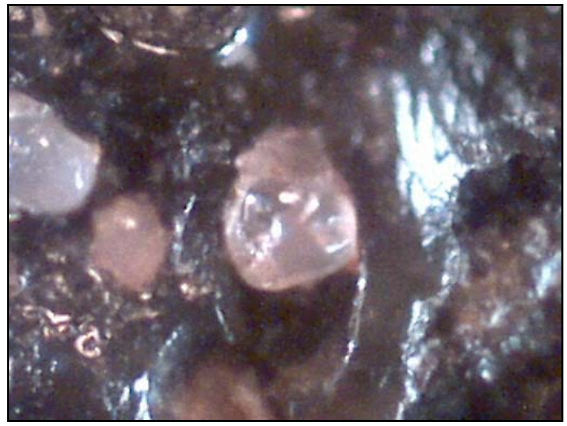

Figure 1. Higly polished chert showing embedded quartz grain (also polished) residing inside an impact crater.

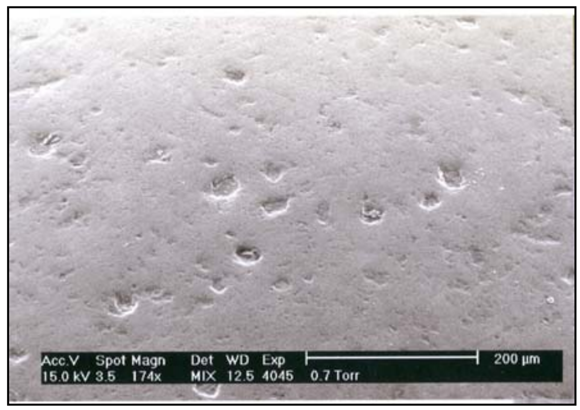

Figure 2. SEM image of fine polish on chert. Scale is 200 microns.

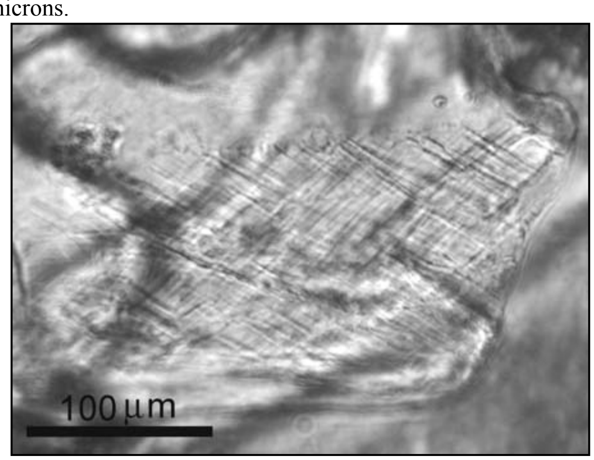

Figure 3. Shocked quartz displaying two sets of PDFs. Grain mounted in oil, in plain polarized light.