THE PETROLOGY OF AN ANDESITIC MELT ROCK AND A POLYMICT BRECCIA FROM THE INTERIOR OF THE CHICXULUB STRUCTURE, YUCATÁN, MEXICO -- David A. Kring, Alan R. Hildebrand, and William V. Boynton, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721.

The Chicxulub structure, ~180 km in diameter and buried beneath ~1 km of Tertiary sediments on the Yucatán peninsula of Mexico, has been interpreted to be an impact crater on the basis of circular gravity and magnetic field anomalies, stratigraphic sequence within the structure, and associated evidence of shock metamorphism [1, 2, 3]. This structure is particularly interesting because it formed at or near the end of the Cretaceous period, in the region where a terminating impact is believed to have occurred [2, 4, 5, 6]. We report here on the petrology of two samples, a polymict breccia and an igneous unit, both from the Yucatán #6 well drilled within the structure by Petróleos Mexicanos, ~50 km from the structure's center.

Y6 N14. This sample came from a depth of 1208 to 1211 m in the well, in a unit previously described to consist of marls, sandstones, and tuffs [7]. It is a partly-chloritized polymict breccia with angular to subrounded igneous and sedimentary clasts. The igneous clasts are dominated by a microcrystalline groundmass consisting of alkali feldspars ($Ab_{93}Or_{2}An_{5}$ to $Ab_{14}Or_{85}An_{1}$), plagioclase feldspars ($An_{13}Ab_{84}Or_{3}$), and augite ($Wo_{50}En_{39}Fs_{11}$). Large quartz crystals and aggregates of quartz crystals with undulose extinction are found imbedded in the groundmass of these clasts. Quartz crystals in the aggregate inclusions have polygonal margins and may represent recrystallized sandstone xenoliths. Two of the clasts contain quartz crystals with multiple sets of planar elements; clay- and carbonate-free mineral residua of the breccia also contain quartz with multiple sets of planar elements. Phyllosilicates occur interstitially between feldspar laths in the groundmass of some of these clasts and probably represent altered glass. Some clasts are composed entirely of ropy-textured phyllosilicates, and thus may once have been wholly glass. Some of these clasts appear to have been vesicular, although any voids that once existed are now filled with secondary anhydrite and micritic calcite or aragonite. In clay- and carbonate-free mineral residua of the breccia, lithic sand-sized igneous grains also exist, consisting of feldspar, microlites of pyroxene (augite?), and sphene; these sand grains look very similar to the sample of the melt rock Y6 N17 described below. The breccia also contains clasts of carbonate sediments and others consisting of radiating anhydrite laths with prominent cleavage.

Y6 N17. This sample came from a depth of 1295.5 to 1299 m in the well, in a 380-m-thick unit previously described as andesite [7]. Our analyses indicate it is similar in composition to low-K to medium-K calcalkaline acidic andesites or trachyandesites. It consists predominantly of a microcrystalline groundmass of plagioclase feldspars ($An_{30}Ab_{64}Or_{6}$ to $An_{49}Ab_{48}Or_{3}$), alkali feldspars ($Ab_{99}Or_{0}An_{1}$ to $Ab_{17}Or_{82}An_{1}$), and augite ($Wo_{45}En_{44}Fs_{11}$ to $Wo_{49}En_{17}Fs_{34}$). Minor amounts of magnetite, ulvöspinel, and apatite occur interstitially. Scattered throughout the rock are large quartz grains or aggregates of quartz grains, each surrounded by coronas of medium-grained augite and feldspar which apparently nucleated on the pre-existing quartz. The presence of these coronas, and the absence of glass, indicates this sample probably cooled slower than the igneous clasts incorporated into the Y6 N14 breccia. The quartz crystals in the aggregates have moderately sutured margins and rare quartz overgrowths, are not consertal with any plagioclase, and thus appear to be sandstone or metaquartzite xenoliths. One quartz clast has widely spaced planar features in one direction, which may be a result of shock, but are not definitely so.

This sample lacks plagioclase phenocrysts, which are typical of most volcanic andesites, but does contain pods of microcrystalline feldspar. These pods are typically free of any augite, but otherwise look very similar to the mesostasis. The one exception is the largest feldspar-rich pod, which consists of regions of sieve-textured, crystallographically coherent plagioclase feldspar ($An_{39}Ab_{57}Or_4$) with interstitial quartz or alkali feldspar ($Ab_{91}Or_4An_5$). Some of the areas with this texture are surrounded by radiating halos of both alkali and plagioclase feldspar laths and skeletal crystals, which are indicative of quench growth. Minor amounts of augite and magnetite also occur in this large pod. The source of the feldspar-rich melt regions, which are very deficient in Mg and Fe, is not clear. However, their presence in the rock indicate that melts of different compositions were rapidly mixed and cooled to subsolidus temperatures. Other features in the andesitic melt rock include oxide-rich xenoliths composed principally of streaming magnetite, intermixed with albite, and minor augite. The petrogenesis of these clasts is unknown. Small pockets of secondary calcite or aragonite permeate the sample, which is also crosscut with veins of quartz, indicating the unit was affected by post-impact solution processes.

Summary. The presence of shocked quartz, sometimes within microcrystalline melt rocks, in the Y6 N14 breccia confirms that the Chicxulub structure is probably an impact crater. The accompanying clasts of ropy-textured phyllosilicates in the breccia may also represent shocked material, originally quenched to glass rather than to a microcrystalline groundmass, and subsequently altered. The presence of both shocked and unshocked material in the breccia, and the lack of a shock-induced glass matrix, suggests the unit is a post-impact sedimentary breccia, although an origin as a fallback breccia cannot be excluded because any glass matrix may have been altered. Interestingly, the ratio of shocked polycrystalline grains to monocrystalline grains is much higher in these rocks than in the K/T boundary sediments found in Haiti. This may mean that (1) the ejected material found in Haiti was derived from a different stratigraphic level of the target than the material in the breccia, (2) the disruption of the target rock was more extensive in the ejected material than that incorporated in the breccia, or (3) the Chicxulub structure did not supply the bulk of the quartz found in Haiti.

No direct evidence, such as glassy silica schlieren or unambiguous shock lamellae in quartz, exists to indicate that the melt rock Y6 N17 is a shock-induced melt rock. However, the presence of quartz and quartz aggregate xenoliths, and the absence of plagioclase phenocrysts or any orthopyroxene, are unusual for volcanic andesites. Because of these peculiarities and the association of this melt rock with the breccia Y6 N14 which contains shocked quartz, we interpret this unit to be an impact melt rock that formed within the confines of the Chicxulub crater. Because the quartz xenoliths in this melt rock are surrounded by augite coronas, whereas those in the igneous, melt-rock clasts in the breccia are not, it appears that the melt rock cooled slower than the clasts. This is consistent with the clasts representing thin, upthrown melt, while the melt rock represents larger, more centralized melt pools.

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References: [1] Penfield G.T. and Carmago A. (1981) *51st Annu. Mtg. Soc. Explor. Geophys. Abstr.*, 37. [2] Hildebrand A.R., Kring D.A., Boynton W.V., Penfield G T., and Pilkington M. (1990) *Abstracts with Program, Geol. Soc. Am. 1990 Annual Meeting*, A280. [3] Hildebrand A.R. and Penfield G.T. (1990) *Eos, Transactions, American Geophysical Union* 71, 1425. [4] Hildebrand, A.R. and Boynton, W.V., 1990, *Science* 248: 843-847. [5] Hildebrand A.R., Kring D.A., and Boynton W.V. (1990) *Meteoritics* 25, in press. [6] Hildebrand A.R. and Boynton W.V. (1990) *Eos, Transactions, American Geophysical Union* 71, 1424-1425. [7] Lopez Ramos E. (1975) Geological Summary of the Yucatan Peninsula. In *The Ocean Basins and Margins*, Vol. 3 - *The Gulf of Mexico and the Caribbean*, edited by A.E.M. Nairn and F.G. Stehli, Plenum Publishing Corp., New York, 257-282.