THE KILMICHAEL STRUCTURE, MISSISSIPPI: NO EVIDENCE FOR AN IMPACT ORIGIN FROM A PRELIMINARY PETROGRAPHIC STUDY. Christian Koeberl[1], Wolf Uwe Reimold[2], David T. King, Jr.[3], and Stephen L. Ingram, Sr.[4]. [1]*Institute of Geochemistry, University of Vienna, Althanstrasse 14, A-1090 Vienna, Austria (christian.koeberl@univie.ac.at);* [2]*Impact Cratering Research Group, Department of Geology, University of the Witwatersrand, Johannesburg 2050, South Africa (065wur@cosmos.wits.ac.za);* [3]*Department of Geology, Auburn University, Auburn, AL 36849-5305 U.S.A (kingdat@mail.auburn.edu);* [4]*Mississippi Office of Geology, P.O. Box 20307, Jackson, MS 39289-1307, U.S.A.*

Introduction. The Kilmichael structure is a roughly circular feature with a diameter of about 9 km, centered at about 33°30'N and 89°33'W, 6.5 km north of the town of Kilmichael, in Montgomery County, Mississippi, U.S.A. Early work by Priddy [1] was followed by a detailed geological and geophysical study by Robertson and Butler [2]. In the center of the structure, Tertiary and Cretaceous sedimentary rocks occur about 450 m above their normal stratigraphic position and form a central uplift about 2 km across. The central uplift is surrounded by an annular graben with rocks about 180 m below their normal position. The graben is, in turn, partly surrounded by a zone of angular blocks, which are ringed by a discontinuous outer graben. The structure shows no distinct surface expression. A 3 mGal positive gravity anomaly marks the central uplift, which is surrounded by a gravity low over the inner graben. Seismic studies show subsurface structures that are consistent with those of complex impact craters. Robertson and Butler [2] noted the absence of distinctive evidence for shock metamorphism, but, without giving any details, briefly mention the occurrence of planar features in quartz from a sandstone derived from the central part of the structure. Robertson and Butler [2] estimated the age of the Kilmichael structure to be less than about 40 Ma.

Petrographic Studies. In an attempt to search for confirming evidence to support the hypothesis that Kilmichael could represent an impact structure, we performed some field work to study unusual faults that occur only within the structure (which will be described elsewhere) and obtained a set of drill core samples from the Kilmichael #2 core hole, to search for evidence of shock metamorphism. The Mississippi Office of Geology (formerly Mississippi Geological Survey) drilled the Kilmichael #2 drillcore (as an offset to the Gulf-Parker test well, which was drilled in 1940 about 0.5 km south of the center of the structure [2]) in 1996 as part of the 1996 Statemap grant. The core starts in the Upper Paleocene Wilcox Group (Nanfalia Formation), and penetrates into to Gravel Creek Member of the Nanfalia Formation; at 77.7 m it reached the Midway Group, and at 91.4 m the Selma Group, in which it bottoms at a total depth of 143.3 m. Twenty samples, all composed of sandy particulate and pebble-size massive rock fragments were collected from the Kilmichael #2 core at depths ranging from 0 to 3.3 m (sample 1) to 124.8 m (sample 20). Samples were taken at spacing of about 3 to 10 m and comprise bulk samples each representing up to 3 m of the drill core. Thin sections were prepared of both particulate material and, for each sample, various pieces of rock, for detailed petrographic analysis. Invariably, all specimens represent sandstones and quartzites, distinguished only on the basis of more or less than 10 volume percent of matrix. All clast populations are dominated by quartz (generally more than 90%), with more or less accessory contributions from feldspar, mica (muscovite as well as biotite), chert, quartz-vein derived clasts, and traces of shale or schist. The feldspar component is variable, with from case to case different plagioclase to K-feldspar (mostly microcline) ratios. The matrix is generally submicroscopic, but in a few cases it was possible to identify either sericite or a light-brownish phyllosilicate. Carbonate occurs in the form of rare clasts in sample 4 (depth 18.3-21.3 m), but is significant in samples 14-16, and makes up the bulk of sample 20. Samples vary significantly with regard to grain size distributions, mean grain sizes, and grain shape variations. No significant differences were detected between hard-rock and particulate specimens, although occasionally the relative mineral proportions (e.g. ratio quartz/feldspar) show some variation between samples. However, overall, all samples could well belong to a single, though somewhat heterogeneous, sandstone unit (with the exception of carbonate sample 20).

Summary and Conclusions. Commonly, quartz grains display microdeformation in the form of deformation bands and, occasionally, irregular fracturing. A few mica clasts were seen to have widely-spaced kinkbands. Fluid inclusion trails or bands may, in individual grains, be dense and crudely aligned in several sets. However, these features are invariably non-planar. In conclusion, evidence of tectonic deformation of the source lithologies for these clastic rocks is abundant. In contrast, evidence of shock deformation is completely absent in these samples. This leaves the question regarding the impact origin of the Kilmichael structure unresolved and arguments in favor of an impact origin are restricted to structural data. This situation is somewhat similar to the evidence at the Upheaval Dome structure in Utah, where good structural arguments exist for an impact origin, but no evidence for shock metamorphic features has been found so far (e.g., [3]). It is possible, however, that the fact that Kilmichael is a more or less a structure that has formed in soft-sediment. The target may well have been “wet”, which could have had a negative influence on the development of shock metamorphic features (which are known to be best developed in crystalline rocks). A similar case might be the Marquez Dome impact structure, where a few rare shocked quartz grains occur in surface exposures, but where a detailed study of two drill cores (which penetrated a sequence of interbedded sands, silts, chalk, and shales) from the center of the structure revealed no shock features [4]. It might be useful to study (maybe from a series of experiments) what kind of evidence for an impact origin can be used in the case of wet targets.

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