AMELIA CREEK, NORTHERN TERRITORY, AUSTRALIA: A 20 × 12 KM OBLIQUE IMPACT STRUCTURE WITH NO CENTRAL UPLIFT. F. A. Macdonald[1] and K. Mitchell[2], [1]Division of Geological and Planetary Sciences, Mail Code 170-25, California Institute of Technology, Pasadena, CA 91125, USA, francis@gps.caltech.edu, [2]Gerringong, NSW, Australia.

Introduction: The Amelia Creek Structure is located in the Davenport Ranges of the Northern Territory, Australia at lat. 20˚55'S, long. 134˚50E. Shock metamorphic features are developed on the southern, down-range side of the structure. No central uplift is developed and the dimensions of the impact structure are at least 20 × 12 km.

Geological Observations: Geologically, the Amelia Creek structure is situated within the Proterozoic sedimentary and volcanic rocks of the southern Tennant Creek Inlier. The structure is characterized by a central syncline flanked by a series of ramping, SSW trending thrust sheets. The canoe-shaped central trough (syncline) runs NNE-SSW and is ~1 km wide and 5 km long. Shatter cones, impact breccias and hydrothermal deposits were also discovered during detailed mapping of the central region in June of 2002.

Shatter cones at Amelia Creek are prolific in many quartzite beds on the southern side of the structure (fig. 1), and are invariably oriented upward, which in itself excludes the possibility that the impact occurred before the regional folding at ~1700 Ma [1]. The surface distribution of shatter cones forms a crescent-like shape approximately 1 × 3 kilometers on the southern side of the structure, extending at least 4 km south from the central syncline. Similiar lithogies are present throughout the structure; however, shatter-cones are only developed on the southern, down-range side. Allogenic breccias are developed along many of the major thrust faults within the structure and show evidence of baked margins and shocked clasts.

Discussion: Most impacts occur obliquely, not vertically as typically modeled [3]. In very oblique impacts, the initial transfer of energy into the target is less efficient and the resulting craters are smaller for a given impactor mass and velocity [2]; oblique impacts should produce much shallower deformation than their more vertical counterparts, and perhaps central uplifts do not develop even for large structures.

Structurally, the level of erosion at Amelia Creek appears to be less than a kilometer, however, the exhumed land surface that makes up the flat tops of the hills across the Davenport Ranges is early Cambrian or late Neoproterozoic in age [4], indicating that the structure may have been buried for much of the Phanerozoic. Some breccias in and around the structure were originally mapped as Cambrian and Tertiary breccias [1], but they may actually be impact breccias and impact ejecta. Thus, the age of the structure remains equivocal until relationships mapped in earlier work [1] are verified.

The rocks up-range of the structure also appear to be anomalously deformed, so there is a distinct possibility that Amelia Creek is part of a crater field or a ricochet structure. On geological maps, Aster and aeromagnetic images, the total area of anomalous deformation around Amelia Creek is strikingly similar in shape to the extremely oblique impact structures on Mars and the Moon [3].

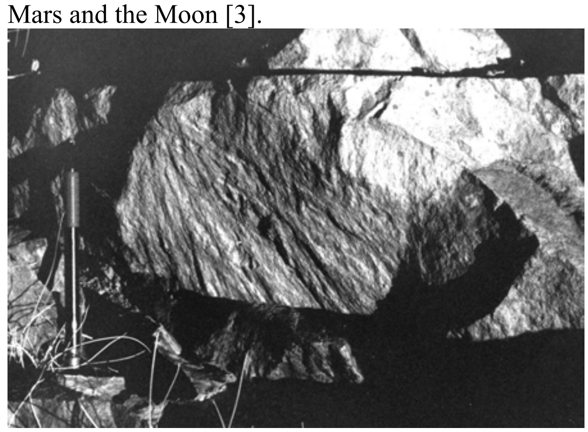

Fig. 1 Shatter cones on southern side of structure.

Conclusion: We believe that the shock metamorphosed rocks at Amelia Creek are the relict of an extremely oblique impact event. Evidence for this includes the elongation of the deformed area, the SSW direction of movement of most of the structural elements, the presence of a central trough and syncline in place of a central uplift, and the distribution of shatter cones only on the downrange side of the structure.

The mechanics of large, very oblique impact cratering is poorly understood [2]. This is due in part to the fact that no exposed, extremely oblique terrestrial impact structures have been previously reported [5]. As such, there are very few field measurements to put constraints on theoretical models. The impact-deformed rocks in the Davenport Ranges are incredibly well exposed, and this structure promises to be the world's type locality for oblique impacting.

References:

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