Karroo sediments [*Partridge*, 1999]. Outward directed overthrusts were measured within the uplifted crater rim and crosscut by concentric listric faults formed when portions of the upper crater wall collapsed downward [*Brandt and Reimold*, 1995, 1999]. In a recent study, one of us [*Kumar*, 2005] examined the ~50 ka Lonar Crater, which is ~1.8 km in diameter, but, in this case, carved from basalts of the Deccan Traps. Deformation of crater walls at Lonar was accommodated in a series of radial, concentric, and conical fractures [*Kumar*, 2005]. Despite these studies, it is not yet clear how impact deformational features might be affected by preexisting tectonic fractures in a target medium. Nor is it clear if deformation in a sedimentary target sequence might be significantly different than that in granite and basalt. To explore both of these issues, we conducted a structural analysis of the bedrock exposed on the walls of Meteor Crater, which is arguably the world's best preserved hypervelocity impact crater (Figure 1). It is approximately similar in size to Tswaing and Lonar craters (~1.2 km diameter) and similarly young (~50 ka). Previous work [*Shoemaker*, 1960; *Roddy*, 1978] demonstrated that the target sequence contained at least two sets of preexisting joints and that these joints may have influenced the final shape of the crater, which is square in plan view, rather than circular.

[4] We examine the fracturing that occurs in the upper crater walls and compare them with preimpact tectonic features seen outside the crater, in order to understand how the preexisting tectonic structures influence the formation of impact structures. Our analysis examines the deformation around the entire circumference of the crater. Existing data are sparse and most of them are based on map measurements rather than field measurements [*Roddy*, 1978]. Furthermore, we compare the impact structures of Meteor Crater with Lonar Crater for which the detailed structural geological data are already available [*Kumar*, 2005]. In addition, we consider the results of numerical modeling studies, laboratory impact experiments, spacecraft craters, and nuclear explosion craters to better understand the mechanics of impact deformation. It is worth mentioning here that the structural framework of Meteor Crater can be used as an analog to the simple craters of Mars, where sedimentary rocks are abundant. For example, the crater wall pictures of Endurance Crater taken by Mars Exploration Rover Opportunity clearly point to the occurrence of fractures on the inner crater wall [*Grotzinger et al.*, 2005], which could probably be related to preimpact tectonic fractures in the target sedimentary rocks [*Watters*, 2006].

2. Meteor Crater

[5] Meteor Crater (also known as Barringer Meteorite Crater) was formed as a result of a hypervelocity impact of an iron asteroid into the Paleozoic-Mesozoic sedimentary rocks of the southern Colorado Plateau in north central Arizona about 50 ka. For a complete review of the geological and geophysical aspects of this crater, see *Kring* [2007]. Meteor Crater is a bowl-shaped topographic low (a simple impact crater) of ~180 m depth and ~1200 m diameter (Figure 2). The rim crest rises ~30 to ~60 m above the surrounding plains. As seen along the upper crater wall, the rim is produced by up to 50 m of impact ejecta and an uplifted sequence of sedimentary strata. The Coconino Formation is partly exposed on the present-day middle to lower crater wall; it consists of white, fine-grained, granular, cross-bedded quartzose sandstone (>95% quartz). The thickness of this sandstone unit varies from 210 to 240 m around the crater. It is overlain by an approximately 3-m-thick Toroweap Formation, which consists of a white to yellowish-brown, medium- to coarse-grained, calcareous sandstone interbedded with thin dolomite beds. It is overlain by ~80-m-thick Kaibab Formation, which consists of three members: Alpha (yellowish, vuggy, well-bedded dolomite interbedded with a few white sandstone beds), Beta (yellowish, massive dolomite), and Gamma (white to yellowish massive dolomite), from the top to bottom, respectively. The Moenkopi Formation unconformably overlies the Kaibab Formation. It consists of two members: a ~6-m-thick, upper, Moqui Member (fissile dark brown siltstone) and a 3-m-thick, lower, Wupatki Member composed of pale reddish-brown, cross-bedded, massive sandstone. Below the present-day crater floor, there is a ~30-m-thick lens of lake sediments, a ~200-m-thick lens of impact breccia and an underlying >750-m-thick sequence of Paleozoic sedimentary rocks. Crystalline basement rocks (e.g., granites) occur at a depth of ~1070 m from the surface.

[6] The ejecta deposits are very well preserved out to a radial distance >1 km from the crater rim; the blanket consists of thrown-out debris derived from the rock types exposed on the inner crater wall. Debris also occurs within the crater in the form of complex breccia deposits that *Shoemaker* [1963] mapped as three units (Figure 2): authigenic breccia, allogenic breccia, and mixed debris. The authigenic breccia is basically the fault gauge materials that occur along crater wall faults, whereas the allogenic breccias are composed of shocked rock fragments and meteoritic materials, which are well exposed on the middle to lower parts of the western and northern walls. Mixed breccias are composed of rock fragments derived from the crater wall and meteorite fragments; these are interpreted to be fallback ejecta materials.

[7] In this study, we present the results of a detailed structural analysis of the rock exposures far outside the crater, which are considered to be a proxy of preimpact target rocks, and bedrocks on the crater wall that preserve impact-generated structures. Both outside and inside the crater we have measured the geometries of the bedding planes of Moenkopi and Kaibab formations, the fracture systems, and where ever possible, the geometry of faults and worked out their kinematics. Over 2500 measurements were made in June 2007. The strike/dip data have been imported into digitized equal-area plots (Schmidt net) and evaluated using computer techniques (e.g., RockWorks-2006 software) in order to separate the unique features generated by the impact event from regional tectonic features [e.g., *Kumar*, 2005]. In section 3, we present the results of the structural geological mapping that will allow a comparison of the nature of target rocks before and after the impact event.

3. Preimpact Structures

[8] Preimpact structures include topography, geometry of rock formations, and weak zones (e.g., faults and fractures)