Rock Magnetic Properties of IODP/ICDP Expedition 364 Site M0077 Core, Chicxulub Crater – Preliminary Results. J. Urrutia-Fucugauchi[1] (juf@geofisica.unam.mx), L. Pérez-Cruz[1], M. Rebolledo-Vieyra[2], S.M. Tikoo[3], W. Zylberman[4,5] and IODP-ICDP Expedition 364 Science Party. [1]Instituto de Geofísica, Universidad Nacional Autónoma de México, Coyoacan, Ciudad de México 04510, México. [2]Centro de Investigación, Científica de Yucatán, Cancún, Quintana Roo 77500, México. [3]Department of Earth and Planetary Sciences, Rutgers University, Piscataway Township, New Jersey 08854, USA.[4]Aix-Marseille Université, CNRS, IRD, Collège de France, CEREGE UM34, Aix-en-Provence, France.[5]University of Western Ontario, Centre for Planetary Science and Exploration and Dept. Earth Sciences, London, Ontario N6A 5B7, Canada.

Introduction: Chicxulub crater formed by an asteroid impact on the Yucatan carbonate platform ~66 Ma ago at the Cretaceous/Paleogene (K/Pg) boundary. The crater and impact deposits are not exposed at the surface, covered by 0.6-1.2 km of sediments; their study requires geophysical surveys and drilling [1,2]. The IODP/ICDP Expedition 364 aimed to investigate the Chicxulub peak ring by drilling in the marine crater sector [3]. Continuous coring was completed from 506 to 1335 mbsf (meters below sea floor), which sampled the post-impact carbonates (506-617 mbsf), the impactite section of breccias and melt (617-747 mbsf) and the basement rocks with igneous, melt and suevitic dikes (747-1335 mbsf) [3]. Here we present initial results of a rock magnetic study aimed to characterize the magnetic properties and mineralogy in the different units, investigating the magnetic mineralogy, remanence carriers, acquisition mechanisms and alteration effects.

Methods: Low-field susceptibility is measured at low and high frequencies with the Bartington MS2 meter. Intensity and direction of remanent magnetization are determined with the JR-6 spinner magnetometer. Alternating field (AF) demagnetization is carried in 12-14 steps up to 100 mT in a Molspin demagnetizer. Anhysteretic remanent magnetization (ARM) is imparted in steps up to 100 mT with a Molspin system. Isothermal remanent magnetization (IRM) is given in steps with a pulse magnetizer. Magnetic hysteresis and direct field IRM and back-field demagnetization of saturation IRM are measured in a MicroMag system. Variation of susceptibility with high/low temperatures is determined with the Bartington system. For the preliminary study, 105 discrete samples from the various units are analyzed.

Results: The post-impact carbonate sediments are characterized by weak susceptibilities, variable positive and negative frequency dependent factors, weak NRM and ARM intensities, higher IRM saturation intensities and variable mainly negative ARM intensity/magnetic susceptibility ratios. Magnetic logs show a signal dominated by diamagnetic and paramagnetic minerals. Titanomagnetites and higher coercivity minerals, possibly hematites and iron hydroxides are indicated by the coercivity and magnetic hysteresis data. Hysteresis loops show variable saturation magnetizations with low coercivities.

The impact breccias and melt show variable higher susceptibilities, low positive frequency dependent factors, high NRM, ARM and IRM intensities and intermediate ARM intensity/ susceptibility ratios. The magnetic signal is dominated by fine-grained magnetite and titanomagnetites, with PSD domain states. The melt units show the highest susceptibility and magnetization intensities.

The basement rocks show variable low magnetic susceptibilities, with higher values in the dikes. The frequency factor shows variable low to intermediate values. The NRM and ARM intensities show low values, with higher values towards the base of the section in a thick dyke zone, correlating with the susceptibility log. IRM intensities show higher values, corresponding to magnetite and titanomagnetite contents. The ARM intensity/susceptibility ratios show low to intermediate values. Granitoids are affected by fracturing, which relates to reduced seismic velocities, densities and magnetic properties. Textural, grain size and color characteristics suggest different types, which further magnetic measurements might characterize from their ferromagnetic minerals.

Discussion: Paleomagnetic studies in impact craters have provided evidence on cratering, structural deformation, hydrothermalism, emplacement of breccias and melt, impact age, etc. Rock magnetic studies provide information on type and contents of magnetic minerals, with properties varying over a wide range, depending on different factors during rock formation, hydrothermal alteration and weathering [4-7]. Studies on Expedition 364 cores are directed to constrain (a) magnetostratigraphy of Paleogene carbonates (including the K/Pg boundary, Early Paleocene, Paleocene-Eocene boundary and Paleogene climatic events), (b) magnetic properties and emplacement mode of impact breccias, (c) structural deformation and alteration of lower peak ring unit basement rocks and dikes, (d) shock, pressure and heating effects on minerals in target lithologies, (e) physical property contrasts and relation to magnetic anomalies in the annular ring, (f) unit characterization and lateral correlation with other wells, (g) core azimuthal orientation, (h) hydrothermal system and (i) alteration effects.

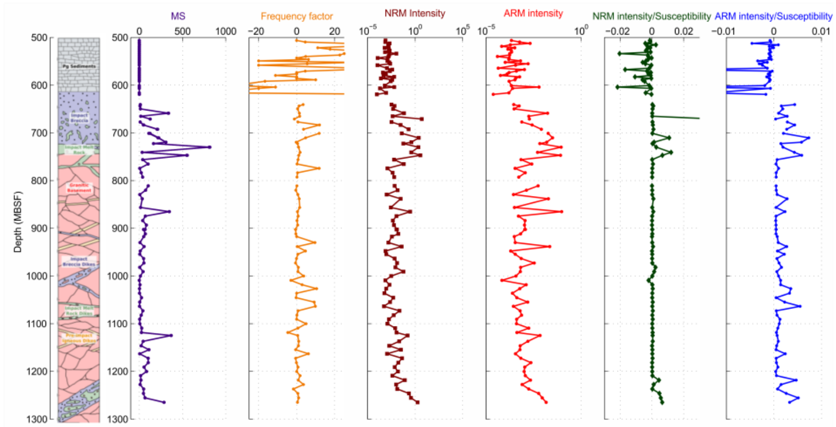

Fig. 1. Rock magnetic logs for Chicxulub M0077A drill core. (a) Schematic column [3], (b) Magnetic susceptibility at low and high frequencies, (c) Frequency dependent factor, (d) Natural remanent magnetization NRM intensity, (e) Anhysteretic remanent magnetization ARM intensity at 100 mT, (f) NRM intensity/ susceptibility, (g) ARM intensity/susceptibility.

Tikoo et al [7] present the results of the onshore sampling, with the NRM intensity and direction data including AF demagnetization at 20 mT fields. Impact melt and breccias show dominantly reverse polarity that correspond to chron 29r [4]. Remanent directions in basement rocks show upward NRM inclinations and downward inclinations after demagnetization, suggesting a remagnetization possibly associated with deformation and alteration. Stepwise AF demagnetization up to 100 mT in our samples confirms the multivectorial nature, with in some cases two polarity components. Results correlate with the MSCL high-resolution logs. Joint analysis will permit further characterization of physical properties, lithology and mineralogy. For instance, the high susceptibilities and remanence intensities at the base of the breccias section show high P-wave velocities, high densities, decreased porosity and electrical resistivity [8].

The central crater zone is marked by high amplitude magnetic anomalies, with a large inverse dipolar anomaly and several small amplitude high frequency anomalies. The gravity high is limited by the annular low, marking the peak ring with by low seismic velocities and densities. Magnetic logs suggest that the magnetic signal in this zone is dominated by the response of the breccias and clast-poor melt. The basement rocks are altered associated with high degree of fracturing observed, which is consistent with the low densities and seismic velocities. The igneous and melt dikes show higher susceptibilities and remanence intensities. Basement rocks might present higher magnetic values in the central uplift sector, in contrast to the peak ring. The new cores offer the opportunity to further document physical property contrasts, in particular for the impact breccias, melt, dikes and basement rocks.

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