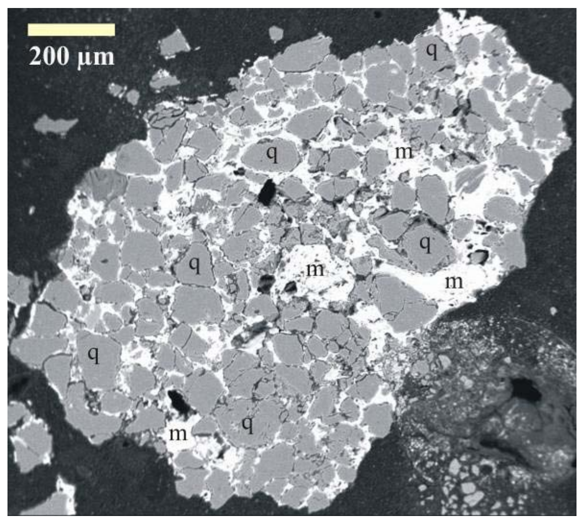
ADDITIONAL STUDIES OF MATERIALS FROM THE RAMGARH STRUCTURE, INDIA. S. Misra[1], H. Newsom[2], D. Panda[3], M. S. Sisodia[4] and A. Dube[5], [1]Indian Institute of Geomagnetism, Navi Mumbai- 410 218, India (misrasaumitra@gmail.com); [2]Institute of Meteoritics and Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM 87131, USA (newsom@unm.edu); [3]Physical Research Laboratory, Ahmedabad- 380 009, India; [4]Dept. of Geology, J. N. Vyas University, Jodhpur- 342 033, India (sisodia.ms@gmail.com); [5]147/3, Janak Road, Kolkata- 700 019, India.

Introduction: The Ramgarh structure, Rajasthan state, northwest India, is a rectangular-shaped crater-structure [1] of an outer ~4 km diameter and ~250m high rim. It is excavated on flat-lying sedimentary rocks including sandstone, shale and minor limestone belonging to Upper Vindhyan Supergroup [2]. The target sandstone of Upper Bhander Group is ~1000 Ma old [3]. Geological and geochemical evidence presented by various authors [4-12] suggest that this structure is/can be an asteroid impact crater. In this study we present some of our new findings on petrography and geochemistry of some probable impactites from this structure that further strengthen the asteroid impact origin of Ramgarh structure.

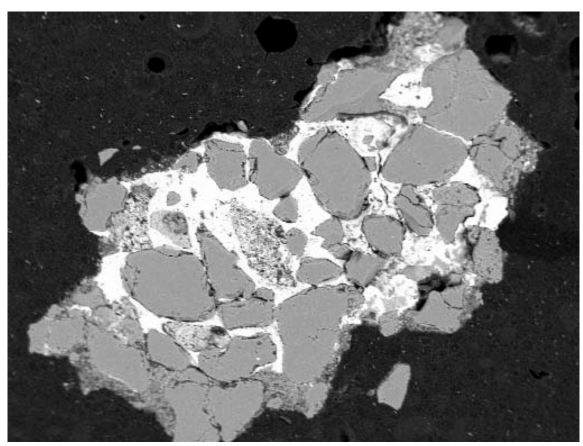
Sampling and experimental procedures: In our earlier report we discussed our results on geochemistry of some glassy spherules collected from soil inside the Ramgarh structure. These spherules were magnetic and mostly homogeneous in internal structure, preliminary microprobe analyses showed that these spherules consist mostly of SiO_2 (average ~27 wt%), Al_2O_3 (~11 wt%) and Fe_2O_3 (~34 wt%) with abundance of Co (up to 7000 ppm) and Ni (up to 4000 ppm) [11]. In the present paper we present results of our investigations on some reddish coloured, subrounded to angular rock particles of $\lesssim$2 mm size from within the finer fraction of reworked debris lying outside the rim in the west of the structure that we collected in our continuing study.

The XRD analyses was carried out at the Central Research Facility, Indian Institute of Technology, Kharagpur, India, with an X'PertPRO, PANalytical machine (model no. PW3040/60, Holland) using Cu target and Ni filter under 30 milliampere (mA) current and 40 kilovolt (kV). The samples were scanned for 10-140^o 2θ with a scanning speed of 0.0533^o 2θ/sec. Software [13] developed by Department of Materials Science and Metallurgy, University of Cambridge, U.K., was used for identification of the individual mineral species. Further analysis of patterns is underway at the University of New Mexico. Necessary microprobe analyses were carried out at the Physical Research Laboratory, Ahmedabad, India, following the analytical procedure described in [11].

Internal structure of magnetic particles: These magnetic particles consist essentially of quartz and iron oxide in various textural arrangements, more common is the angular to sub-rounded grains of quartz within a matrix of iron oxide (Fig. 1). Interstitial occurrence of iron oxide suggests its incorporation in the late stage of the formation of the original (probably) impacted rocks from which the present mm-sized particles were derived due to weathering. Our preliminary microprobe analyses confirm the presence of up to 1000 ppm Ni in this iron oxide matrix. Our detailed analyses on BSE images of glassy spherules also confirm the presence of disseminated metallic oxides as numerous sub-mm sized glasses through out these spherules.



A.



B.

Fig. 1. BSE images (15 kV) of magnetic particles collected from eroded debris outside the west rim of the crater. Note: subrounded to angular fragments of quartz (q) lying within iron oxide (m) matrix. Scales are the same for the two images.

XRD analyses: X-Ray diffraction analyses of magnetic particles collected from the ejecta debris lying at the outer flank of the rim of the structure were analyzed in the present study (Fig. 2a). The results show strong peaks for quartz (PDF no. #83-0542, 85-1054 and 86-1629). The glassy spherules collected earlier from the soil inside the Ramgarh structure [11] were also examined by X-ray diffraction. These were examined in aggregates (six at a time mounted on a glass slide). These glassy spherules do not contain quartz, but may contain an amorphous silica phase.

Discussion: The quartz fragments in the magnetic particles (Fig. 1) are definitely the component of the target sandstone of the Upper Bhander Group. The exact nature of the matrix requires additional work to confirm the possible presence of minor elements such as Ni, and the mineralogical nature of the minor phases. At this time we can say that the nature of the materials may be consistent with an impact, but more work is needed.

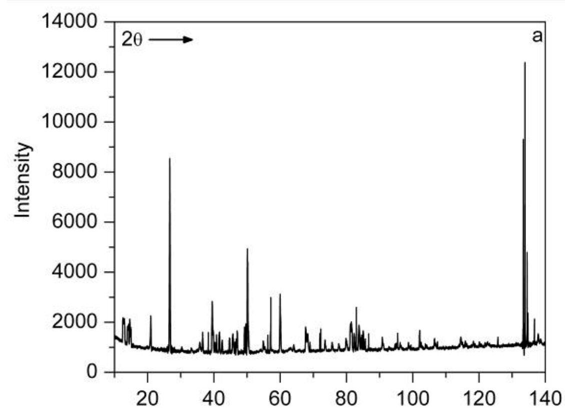
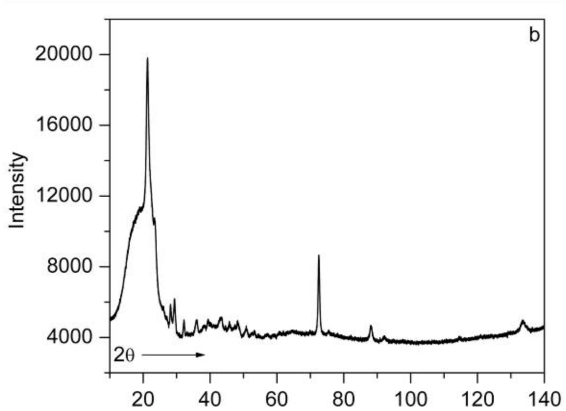


Fig. 2. XRD spectra of (a) magnetic particles from eroded



debris from outside the rim to the west of the crater, and (b) glassy spherules from the soil inside the structure.

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References: [1] Grieve R. A. F. et al. (1988) *LPI report 88-03*, 1-89. [2] Sisodia M. S. et al. (2006) *J. Geol. Soc. India, 67*, 423-431. [3] Malone S. J. et al. (2008) *Precamb. Res., 164*, 137-159. [4] Crawford A. R. (1972) *Nature*, *237*, 96. [5] Balasundaram M. S. and Dube A. (1973) *Nature*, *242*, 40. [6] Ahmed N. et al. (1974) *Curr. Sci., 43*, 598. [7] Dietz R. S. and McHone J. (1974) *Meteorites, 2,* 329-333. [8] Nayak V. K. (1984) *Proc. 71st Indian Sci. Congr.*, 22-23. [9] Master S. and Pandit M. K. (1999) *Meteoritics & Planet. Sci. (suppl.), 34*, 4. [10] Sisodia M.S. et al. (2006) *J.Geol. Soc. India, 68*, 563. [11] Misra S. et al. (2008) *39th LPSC*, no. 1499. [12] Misra S. et al. (2008) 39th LPSC, no.1502. [13] JCPDS-ICCD (1999) http://www.msm.cam.ac.uk/xray/.