IMPACTOR COMPONENT IN DHALA IMPACT MELT BRECCIA IDENTIFIED.

J. K. Pati[1,2], W. J. Qu[3], C. Koeberl[4,5], W. U. Reimold[6,7], M. Chakarvorty[1] and R. T. Schmitt[6], [1]Department of Earth and Planetary Sciences, Nehru Science Centre, University of Allahabad, Allahabad-211 002, India (jkpati@gmail.com, mchakarvorty@gmail.com), [2]National Center of Experimental Mineralogy and Petrology, 14 Chatham Lines, University of Allahabad, Allahabad-211 002, India, [3]National Research Center for Geoanalysis, 26 BaiwanzhuangDajie, Xicheng District, Beijing 100037, P. R. China (quwenjun03@163.com), [4]Department of Lithospheric Research, University of Vienna, Althanstrasse 14, A-1090 Vienna, Austria (christian.koeberl@univie.ac.at), [5]Natural History Museum, Burgring 7, A-1010 Vienna, Austria, [6]Museum für Naturkunde Berlin, Invalidenstrasse 43, 10115 Berlin, Germany (uwe.reimold@mfn-berlin.de, ralf-thomas.schmitt@mfn-berlin.de), [7]Humboldt-Universität zu Berlin, Unter den Linden 6, 10099 Berlin, Germany.

Introduction: To date, there are 188 confirmed impact structures on Earth, and in 54 of them the impactor component has been recognized [1]. The Dhala structure in central India with an estimated diameter of about 11 km [2] and an age constrained between 1.7 and 2.5 Ga [3] was formed in granites and gneisses of the basement to the Archean Bundelkhand craton. The present study is the first attempt at impactor identification for one of oldest terrestrial impact structures. Impact melt rock, polymict lithic impact breccia, and two target rock samples were analysed for siderophile element abundances, platinum-group element (PGE) systematics, and $^{187}Os/^{188}Os$ ratios.

Materials and Methods: Six rock samples from surface and subsurface levels chosen for this study comprise three impact melt breccia samples (D6-57, D6-33, and MCB-7/2), a polymict lithic breccia (MCB-7), one biotite-granitoid (MCB-10/5), and a gabbro (JAD-8/4). The samples were analyzed for their major and minor elements by X-ray fluorescence spectrometry, and trace elements by instrumental neutron activation analysis, and for their Re-Os isotopic ratios using HR-ICP-Mass spectrometry (with an ELEMENT2 instrument).

Results and Discussion: The analyzed rocks range in SiO_2 content between 46.4 and 72 wt.% with a low loss on ignition (0.7-3 wt.%) indicating only a slightly post-impact alteration. The samples plot into the trachyandesite-dacite-trachyte-rhyolite fields in a total alkali-silica diagram [4], and the gabbro shows basaltic composition. The contents of the siderophile elements (V, Co, Ni and Cr) in the analyzed samples show negative correlations with the SiO_2 content and a positive correlation with the $Fe_2O_3^T$ content. Ni-Cr, Ni-Co and V-Cr show positive correlations. The analyzed samples show fractionated REE patterns with variable La_N/Yb_N ratios and negative Eu anomalies (Eu/Eu*=0.49-0.95). The target rocks and the three impact breccia compositions have similar LREE contents, but the HREE abundances in the impact melt breccia samples are 3 to 5 times higher. The Ir content in the analyzed samples varies from <0.9 to 1.2 ppb, which is close to the detection limit for the INAA data. Of the six analyzed samples only one impact melt rock (D6-57) shows a siderophile element ratio (Ni/Cr =1.23) and Ir content indicating the presence of a small chondritic impactor component (between 0.1 and 0.5 %). In contrast, the Os^{187}/Os^{188} values (0.1333 and 0.3168) of the two Dhala impact melt breccias (D6-57 and D6-33) are indicative of the presence of a meteoritic component [4].

Conclusions: In addition to Ir concentrations and siderophile element ratios, the two impact melt breccias (D6-57 and D6-33) show Re^{187}/Os^{188} and Os^{187}/Os^{188} values similar to chondritic or iron meteorites. The variable Os contents in three impact melt breccia samples suggest non-uniform dilution of the Os-bearing impactor component and/or variable fractionation of siderophile elements in the impact melt. All three impact melt rock samples are variably contaminated by the impactor and only one impact melt breccia sample (D6-57) of granitic composition has a close to chondritic osmium isotope ratio (Os^{187}/Os^{188}=0.133), providing unequivocal evidence for the presence of an extraterrestrial component in some of the Dhala impact melt rocks. Further studies are aimed for the identification of the meteorite type of the impactor.

References: [1] Earth Impact Database. 2016. [2] Pati J. K. et al. 2008. *Meteoritics & Planetary Science* 43:1383-1398. [3] Pati J. K. et al. 2010. *Geological Society of America Special Paper 465*:571-591. [4] Walker R. J. et al. 2002. *Geochimica et Cosmochimica Acta* 66:4187–4201.

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