THE BOSUMTWI IMPACT CRATER, A TERRESTRIAL RAMPART CRATER. G. Wulf1 and T. Kenkmann1, 1Institute of Earth and Environmental Sciences -Geology-, Albert-Ludwigs-University Freiburg, Germany, gerwin.wulf@geologie.uni-freiburg.de.

Introduction: The Bosumtwi impact crater in Ghana (06°30`N, 01°25`W) is one of the youngest and best preserved terrestrial impact craters [1, 2]. The 1.07 Ma old impact structure has a pronounced crater rim with a diameter of 10.5 km [3]. The circular structure is somewhat distorted in the SE sector by the northern flank of the NE–SW trending Obuom Mountain Range [4] (Fig. 1a). The impact structure forms a hydrologically closed basin that is almost completely filled by the 8.5 km diameter Lake Bosumtwi. The impact crater was intensely studied in the framework of various drillings campaigns, e.g., the International Continental Scientific Drilling Program (ICDP) drilling in 2004 [5, 6]. Suevites (polymict, glass-bearing breccias) and polymict clastic impact breccias were found in the boreholes as well as in the northern and southern parts within the crater structure. Although chemical weathering is intense in the tropical rain forest environment and led to the formation of locally thick lateritic soils, a lot of breccias associated with the formation of the craters are still preserved outside of the crater rim (see review by [2]). Moreover, polymict and monomict clastic breccias were reported from numerous places around the impact crater whose impact origin was not unambiguously confirmed [2]. A striking feature of the Bosumtwi impact structure is a shallow, near-circular, depression at 7-8.5 km from the crater center directly beyond the crater rim, followed by a shallow outer topographic ring feature at 18-20 km radial distance from the impact center [7, 8] (Fig. 1b). This feature is visible in radar satellite images as well as in aero-radiometry data, indicating lithological as well as topographic control [4, 8, 9]. It was suggested that preferential removal of ejecta within the area just outside of the crater rim could be the reason for this shallow depression [8] or original depositional patterns as well as impact-induced concentric fracturing could also be involved [4].

Here we present preliminary results showing that the morphological features (circular depression and topographical ring) beyond the crater rim of the Bosumtwi crater are the remnants of an ejecta rampart and thus, that the Bosumtwi crater is a rampart crater.

Methods: The Bosumtwi crater in Ghana was analyzed in detail on the base of remote sensing data. A GIS environment was implemented for geospatial analyses of digital elevation models (DEMs) and multispectral analyses. Digital elevation data from the Shuttle Radar Topography Mission (SRTM) with a resolution of 1 arc-second (~30 m at the equator) were used as base data to derive catchment areas and drainage networks in the surrounding of Bosumtwi crater (Fig. 1a). For morphometric comparisons, we determined the mean elevation of the topography at defined radial distances from crater center (bins of 200 m) in order to construct an averaged radial elevation profile (Fig. 1b). In the process, the southern margin was cropped and not incorporated into the analysis because this area is strongly affected by the northern flank of the NE–SW trending Obuom Mountain Range (Fig 1a).

In addition, we used the principal component analysis (PCA) on the base of Landsat and ASTER data to emphasize variations in the multispectral data and thus bring out strong patterns in the dataset (Fig. 2b). In further steps, we compared the results with a Martian rampart crater of similar size. The Martian crater Steinheim (190.65°E 54.57°N)[11] is a young 11.2 km diameter double-layered ejecta (DLE) crater in Arcadia Planitia and has an excellent coverage of high-resolution image data. We used the Ames Stereo Pipeline to build a high-resolution digital elevation model (DEM) based upon CTX imagery and MOLA (Mars...
Orbiter Laser Altimeter) data for further detailed analyses of the ejecta morphology of Steinheim crater [10], including a radial elevation profile and the determination of a hypothetical drainage pattern and catchment areas (Fig. 1c, d).

Fig.2: A) Mapped breccias in the surrounding of Bosumtwi crater (data from [2]: red = suevites (polymict, glass-bearing breccias); white circles = polymict clastic impact breccias; white triangles = polymict clastic breccias (genetically unclassified, likely impact-related); black circles = polymict and monomict clastic breccias (unspecified, possibly impact-related). B) False colour RGB image of the Principal component analysis (PCA) on the base of ASTER VNIR data.

Fig.3: Derived drainage pattern and accordant catchment areas for Bosumtwi crater (A) and the Martian Steinheim crater (B).

Results and Discussion: The SRTM elevation data and the derived averaged radial elevation profile show a circular depression followed by an elevated ring beyond the crater rim of Bosumtwi crater (Fig. 1a, b). The morphological characteristics of this topographic pattern show striking similarities with regard to position, dimension, and shape to those of Martian DLE craters, which typically possess depressions (called moats) and subsequent broad, elevated ridges (called ramparts) [11] (Fig. 1c, d). In the case of Martian craters, this morphological trend is due to the distribution of the ejecta blanket. Indeed, Bosumtwi also shows a lot of evidence for ejecta deposits within this area including a multitude of impact-related and possibly impact-related breccias (Fig. 2a). Although the multispectral data of this area provide no clear signature for possible ejecta deposits due to the dense rainforest cover, a weak halo-like signal surrounds the impact crater possibly indicating a similar composition of the moat and rampart area (Fig. 2b). Following this approach, it is conspicuous that the drainage network around Bosumtwi crater is showing a circular pattern in the slightly depressed annular zone (Fig. 3a). Assuming Bosumtwi crater as the result of a lunar like impact event, the thickness of the ejecta blanket would decrease with increasing radial distance to crater center as the result of ballistic sedimentation and erosion. Under such circumstances, a radial drainage pattern would be expected in contrast to the actual concentric pattern. As a thought experiment, we have generated a hypothetical drainage network for the Martian DLE crater Steinheim. Interestingly, the drainage pattern of Steinheim crater shows a lot of similarities to Bosumtwi including a local watershed along the crestline of the rampart and a concentric discharge pattern in the moat area (Fig. 3b).

Conclusions and Outlook: The morphological features (circular depression and topographical ring) beyond the crater rim of Bosumtwi crater as well as the ejecta distribution and drainage pattern show many similarities to Martian rampart craters. Therefore, we suggest that Bosumtwi crater shows the eroded remnants of an ejecta rampart, possibly similar to the Ries crater in Germany [12], and thus, is a terrestrial rampart crater. In future works, this assumption will be proven in more detail by using TanDEM-X imagery of higher resolution and further multispectral data analyses.