FIRST RESULTS OF A MULTIDISCIPLINARY ANALYSIS OF THE HAUGHTON IMPACT CRATER, DEVON ISLAND, CANADA. II STRUCTURAL GEOLOGY; Bischoff L., W. Oskierski Geologisch-Paläontologisches Institut, Correnstrasse 24, D-4400 Münster.

Previous investigations (1,2) gave an insight into structural relationships and the multi-ring character of the Haughton crater. However, little was known about the internal geological structure, the type and intensity of fracturing and folding, and of movements which took place during the modification stage of the crater-forming event. Therefore, the lithologies, their lithostratigraphic correlations, strike and dip of bedding planes, faults and breccia dikes, degree of brecciation, fold axes and fold morphologies were studied in 4 segments of the crater, in the inner ring, and in the central basin. The preliminary results of our studies will be substantiated by statistical treatment of the data.

Segment I (Northern to north-eastern part of the crater, fig. 1 (3)):
Dolomites and limestones of the Allen Bay Formation are the only lithologies present at the surface. Both are strongly disrupted and show variable block sizes which range from tens to several hundreds of meters. Despite a wide scatter of bedding data three orientation maxima could be determined. One maximum represents slabs gently inclined towards the crater center, another reflects dips radially away from the center and the third shows dips to the east. Monomict brecciation is present in almost all rocks; the occurrence of breccia dikes is restricted to the southern part of the segment.

Segment II (North-eastern to eastern part of the crater):
The middle ring and outer part of this section exhibit large, continuous rock-segments which become more disintegrated towards the inner ring. A set of annular faults is accentuated by valleys. While the outer part of the middle ring is characterized by a dominant outward dip of the fault bounded segments, the part closer to the center is composed of several small rock segments which either dip towards the center, or are tilted outward or sub-horizontal. Close to the inner ring, the primary rock sequence is strongly disturbed which results in a mixture of different stratigraphic units, sometimes with vertical or overturned bedding. A centro-symmetric arrangement of the fault blocks is evident. Except for Allen Bay dolomites of the outer ring all rocks display cataclasis (4) and autochthonous, monomict brecciation. Breccia dikes are rare and only found in blocks of the Irene Bay Formation. In this zone complex vertical movements of at least 250 m could have taken place as deduced from the existence of fault bounded blocks of underlying Bay Fiord Formation (2). These blocks, like the overturned rock-segments in the inner part of this zone, could also reflect lateral displacement. They could have been emplaced by outward and downward gliding from an initially high central uplift region (5). The lateral displacement is also supported by structural relationships within the inner ring.

Segment III: (Southern to south-western part of the crater):
The structural rim is apparent from the change of the bedding dip from SW in the undisturbed part to NE in disturbed areas. This differs from segments I and II where a sharp annular fault separates the complex middle ring from the relatively undisturbed outer ring. Segment III shows a simple structure of large Allen Bay rocks gently dipping towards the crater center. Monomict brecciation is observed and breccia dikes are found in the innermost parts of this segment close to the central basin. The inner ring (2) is not exposed in this zone, and may be hidden under the allochthonous breccia sheet.

Segment IV (Western to south-western part of the crater):
As in segment III the rim of the crater is poorly defined. The whole segment

reveals a more uniform sequence of rock plates with a strong orientation maximum of all measured bedding planes dipping towards the crater center. Apart from faulting most of the rocks are undisturbed. The innermost parts of this segment again exhibit monomict brecciation and some breccia dikes.

Inner ring:

The inner ring consists of uplifted sediments of the Bay Fiord (gypsum and dolomite), Eleanor River and Allen Bay Formations (limestone and dolomite) covered by polymict breccias. Shatter cones were not observed in the uplifted sediments of the inner ring (with one exception) which indicates very low shock pressures in these rocks suggesting an inward movement of slabs to their present positions. The Bay Fiord Formation delineates one half of a ring surrounding the central basin area. Nearly all of the uplifted sediments dip moderately away from the crater center. The gypsum layers are deformed in open folds with decameter amplitudes, but have also suffered brittle deformation. Two groups of folds can be distinguished, one with fold axes parallel to the ring arch, and the other with radially striking axes. Both fold types seem to have been formed at the same time during centripetal movements of rock slabs, as deduced from the occurrence of drag folds. The folds predate a set of flat shear fractures and decollement structures. They indicate mass movements radially away from the central uplift. These structural relationships support a multiphase deformation during the modification stage of the crater.

Central region:

The interior hills of the central basin, consist of cherty and marly limestones of the Eleanor River Formation. Their bedding indicates a flat dome-like structure. Only in the border zone of the inner ring are isolated segments of Lower Paleozoic rocks strongly tilted up to 90°. Structural relationships of these isolated fault blocks to the dome-like inner part could not be determined because of the lack of outcrops. All rocks in the central basin display shatter cones, and monomict brecciation is common.

Summary:

Important structural differences between the N and E segments and the S and W segments are evident. The complex and highly disrupted northern and eastern regions contrast with the more "calmly" structured zone in the W and S. One reason for this asymmetry is the pre-impact geological structure (1). During the modification stage of the crater formation the slightly westward dipping Lower Paleozoic sediments surrounding the transient cavity moved downward and inward towards the crater center. In the eastern part the inward movement was favoured by the original dip of the bedding in this direction and by the high level of the main decollement horizon, the Bay Fiord gypsum. This inward movement interfered with the simultaneous formation of the central uplift. These countercurrent motions could have caused the rocks in the eastern flanks of the central uplift to overturn and are therefore possibly responsible for the outwardly directed displacements of the rock slabs. The structural and tectonic relationships in the eastern part of the Haughton impact structure reveal that the formation of the central uplift took place during the modification stage of the crater formation and that it is not the result of long-term isostatic adjustment processes.

References: (1) Frisch T. and Thorsteinsson R. (1978) Arctic 31, 108-124. (2) Robertson P.B. and Sweeney J. F. (1983) Can J. Earth Sci. 20, 1134-1151. (3) Robertson, P.B., Ostertag, R., Bischoff, L., Oskierski, W., Hickey, L. and Dawson, M. (1985) (this volume). (4) Bischoff L. and Oskierski W. (1985) Earth Evol. Sci. (In press). (5) Grieve R.A.F., Robertson, P.B. and Dence, M.R. (1981) Proc. Lunar Planet. Sci. Conf. 12A, 37-57.