https://ntrs.nasa.gov/search.jsp?R=19930000970 2020-03-17T10:05:41+00:00Z

475194 C5729333
S46-90 N93-10158

SEARCH FOR A METEORITIC COMPONENT AT THE BEAVERHEAD IMPACT STRUCTURE, MONTANA.

Pascal Lee[1] and Robert W. Kay[2], [1]Department of Astronomy, Cornell University, Ithaca NY 14853, USA, [2]Department of Geological Sciences, Cornell University, Ithaca NY 14853, USA.

The Beaverhead impact structure, in southwestern Montana (44°36'N;112°58'W), was identified recently by the presence of shatter cones and impactites in outcrops of Proterozoic sandstones of the Belt Supergroup [1]. The cones occur over an area >100 km². Because the geologic and tectonic history of this region is long and complex, the outline of the original impact crater is no longer identifiable. The extent of the area over which shatter cones occur suggests, however, that the feature may have been at least 60 km in diameter. The absence of shatter cones in younger sedimentary units suggests that the impact event occurred in late Precambrian or early Paleozoic time.

We have collected samples of shocked sandstone from the so-called "Main Site" of dark-matrix breccias, and of impact breccias and melts from the south end of Island Butte. The melts, occurring often as veins through brecciated sandstone, exhibit a distinctive fluidal texture, a greenish color, and a cryptocrystalline matrix, with small inclusions of deformed sandstone. Samples of the same type, along with country rock, were analyzed previously for major- and trace-element abundances [2]. It was found that, although the major-element composition was relatively uniform, the trace-element composition showed variations between the melt material and the adjacent sandstone. These variations were attributed to extensive weathering and hydrothermal alteration.

In a more specific search for a possible meteoritic signature in the breccia and the melt material we have conducted a new series of trace-element analyses on powders of our own samples by thermal neutron activation analysis. Our results indicate that Ir abundances in the breccia, the melts, and the adjacent sandstone clasts are no greater than about 0.1 ppb, suggesting no Ir enrichment of the breccia or the melts relative to the country rock. However, both the breccia and the melt material exhibit notable enrichments in Cr (8- and 10-fold), in U (9- and 5-fold), and in the heavy REEs (1.5- and 3-fold), respectively (normalization carried out relative to La) (see Table 1). Such enhancements relative to the country sandstone suggest that weathering and hydrothermal alteration alone might not be sufficient to account for the observed variations in trace-element abundances, and that the incorporation of a Cr, U, and HREE-rich component in the breccia and the melts is likely. Because both the breccia and the melts show no Ir or Ni enrichments relative to the sandstone, the invoked additional component is unlikely to be chondritic or iron-rich meteoritic material. Instead, the low Ni/Cr ratio in the breccia and the melts points either to an achondritic impactor or to some other (terrestrial) source of Cr enrichment.

Meteoritic geochemical signatures at large and/or ancient terrestrial impact craters are difficult to find [3]. Possible reasons for this include the high impact velocities and energies involved in large impacts, the possibility of chemically inconspicuous (achondritic) projectiles, weathering and hydrothermal alteration of impactites and their associated country rock, and inadequate sampling. Our search for a meteoritic component in samples from the Beaverhead impact structure will be discussed in the context of this general problem.

TABLE 1. Trace-element concentrations in ppm ("±" indicates 2-sigma measurement error).

	BHSS	BHM	BHB
Cr	17.76±0.6	127.88±0.5	71.94±0.4
Ni	14.50±2.5	15.65±1.0	7.68±0.9
U	1.48±0.1	5.54±0.2	6.99±0.3
Yb	1.38±0.1	3.23±0.1	1.13±0.1
Ta	0.39±0.1	1.66±0.1	1.33±0.1
La	52.49±0.5	39.04±0.3	26.49±0.2
Ir	<0.1 ppb	<0.1 ppb	<0.1 ppb

BHSS = Beaverhead sandstone (country rock). BHM = Beaverhead impact melt. BHB = Beaverhead dark-matrix breccia.

References: [1] Hargraves R. B. et al. (1990) *Geology, 18,* 832–834. [2] Koeberl C. and Fiske P. S. (1991) *Meteoritics, 26,* 358–359. [3] Palme H. et al. (1978) *GCA, 42,* 313–323.

475195 S47-46 N93-10159

ORDOVICIAN IMPACTS AT SEA IN BALTOSCANDIA.

M. Lindström[1], V. Puura[2], T. Flodén[1], and Å. Bruun[3], [1]University of Stockholm, Sweden, [2]Estonian Academy of Sciences, Estonia, [3]Swedish Geological Survey, Sweden.

Northern Europe has an assemblage of Ordovician probable impacts that is exceptional because the structures involved are relatively old yet well preserved because they formed at sea and because they formed within a restricted geological time in a relatively small area. The Tvaren, Kardla, and Lockne structures might not be strictly contemporaneous but all formed near the beginning of the Caradoc Age (about 460 Ma), whereas the Granby structure is about 20 Ma older. The range of diameters is from about 2 km (Tvaren, Granby) to 8 km (Lockne). The stratigraphic succession formed on impact at sea, as uniformly documented by these structures, begins with a breccia lens consisting of basement rocks that are intensely crushed. Owing to expulsion of sea water by the impact, this breccia formed under essentially dry conditions. Later on this breccia was in part hydrothermally altered. It is overlain by backsurge turbidite that formed from fragments of local sedimentary bedrock and crystalline basement when the sea water returned to the crater site. Either the turbidite is simply a Bouma sequence (although quite thick—as much as over 50 m) from very coarse rubble to mud, or it is more complex.

After deposition of the backsurge turbidite, or turbidite complex, the craters still remained as 150–200-m-deep holes in the sea bed. Together with the presence of relatively shallow water over the rim wall, this situation created predictable hydrologic conditions for extended histories of sedimentation and biological development at the crater as well as within it. For instance, hypoxia frequently developed in the bottom water before depth had been appreciably reduced by sedimentation. The insights acquired at these craters make it possible to improve paleoecological reconstructions applied to Ordovician sea beds.

The presence of a concentration of craters within a limited area of well-preserved and accessible Ordovician deposits raises a question about the Ordovician, especially its middle portion, as potentially an age of relatively intense impact activity even in wider areas. In this connection it may be apposite to mention that the only fossil stony meteorites so far recorded in rocks are from the late Early and the Middle Ordovician.

S3187788 GU993630
AA454496