WANAPITEI IMPACT STRUCTURE: RECONSTRUCTION OF THE EVENT; **R.A.F. Grieve, Geological Survey of Canada and Institut für Planetologie, Univ. Münster, and T. Ber, Univ. Ottawa, Canada.**

The ~ 7.5 km diameter Wanapitei impact structure (46°45'N; 80°45'W) lies entirely within Lake Wanapitei in central Ontario, Canada. Impact lithologies are known only from glacial float samples. They consist of >50% suevite breccias, <20% glassy impact melt rocks, <20% highly shocked target lithologies, and <5% impact glass breccias, which may represent original fall-back material. The major element composition of the impact melt rocks can be modelled as a geologically reasonable mix of specific target lithologies. The melt rocks fall into two textural and mineralogical types, which also differ in their degree of meteoritic contamination. This begs the question of whether they would be recognized as coming from a single event if they were recovered from a situation with less geological control, as exists for extraterrestrial samples of impact melt rocks.

The potential target rocks at Wanapitei consist of Huronian meta-sediments of the Gowganda, Serpent, Espanola, Bruce, and Mississagi Formations (mostly arkosic quartzites and wackes), overlying Archean granite - greenstone and cut by Nipissing Intrusives [1]. Impact lithologies occur in glacial till at the south end of the lake [2]. From the till only lithologies with shock metamorphic effects could be assigned to having come from within the structure. From the examination of ~ 150 thin sections showing evidence of shock metamorphism, the recovered impact lithologies can be subdivided into:

1. <u>Suevite breccias</u> Lithic clasts show a range of shock features up to partial vitrification and constitute up to 40% by volume. They are Huronian meta-sediments and subordinate Nipissing Intrusives. No unequivocal Archean clasts were observed. Glass fragments contain vesicles and clastic debris and make up to 15%. They show a wide range of optical homogeneity but even when homogeneous contain areas corresponding to SiO_2. Their bulk composition is, however, relatively constant and corresponds to no specific target lithology. The overall composition of the suevite breccias is variable, depending on clast content.

2. <u>Highly shocked meta-sediments</u> They are partially vitrified and vesiculated, with a density of ~ 2g cm^{-3}, and can contain coesite [3]. They appear to be of a single lithology and correspond chemically most closely to the Mississagi Formation (Table 1). They occur as single cobbles but the presence of equivalent material as lithic clasts in the suevite breccias suggests that they too originated as large clasts in suevite.

3. <u>Glass breccias</u> These are relatively rare and resemble suevite breccias, except they contain up to 50% glass clasts and lithic clasts are dominated by highly shocked varieties. Their matrix is extremely fine grained and contains glass particles. They may represent samples of fallback material.

4. <u>Impact melt rocks</u> There are two variants. One has a colorless glass matrix, which may show perlitic fracturing. It contains ~ 5% round vesicles, up to ~ 25% mineral and rare lithic clasts, and microlites of hypersthene up to 1.0 mm long and containing up to 11.5% Al_2O_3. The second consists of brown or mixed glass with ~ 15% elongate vesicles, up to 30% mineral and lithic clasts defining schlieren, and tabular crystals of hypersthene up to 0.05 mm with up to only 2% Al_2O_3. Although there is abundant evidence of flow prior to solidification, the tabular hypersthene is randomly oriented. Both variants have similar major element bulk compositions (Table 1). Like the glasses in the suevite breccias, they have areas in the matrix corresponding to pure SiO_2, which represent most likely ghost lechatelierite inclusions preserved because of the high SiO_2 content and high viscosity of the melt (Table 1) and the rapid chilling. The differences between the two variants is ascribed to different cooling histories, with the low Al_2O_3 hypersthene believed to have crystallized after the melt had quenched to a supercooled glass [4] that was then held at elevated temperature within the crater filling lithologies.

<u>Reconstruction of the impact event</u> The lithic clasts in the suevite indicate that only Huronian and Nipissing lithologies were within the transient cavity. This is consistent with the super-position of a transient cavity of ~ 5 km [5] on the present outcrop pattern extended across the Lake Wanapitei. The identification of the highly shocked meta-sediments as Mississagi restricts impact melting to lithologies stratigraphically higher than the Mississagi. Mixing models of the major element composition of the impact melt rocks (Table 1) suggest that they can be modelled as ~ 46% Gowganda, ~ 46% Serpent, and ~ 8% Nipissing. This is also generally consistent with the extrapolated outcrop pattern. Assuming the highly shocked meta-sediments are Mississagi, it begs the question of why the intervening Espanola and Bruce Formations were

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not within the zone melted. The Espanola is a calcareous siltstone and only one clast of such a lithology was observed in the suevite breccias. This would appear to confirm the most obvious explanation; namely, that these units thin dramatically along strike across the lake [1] and they were not a component of the target volume. Using the mixing model to correct for indigenous components, the Ni/Cr, Ni/Co, and Cr/Co ratios of the two impact melt rock types are 3-3.8, 15-20, and 5-5.2, respectively. These are similar to chondritic ratios and support previous interpretations based on siderophile [6] and PGE abundances [7] that suggest a chondritic impactor. The amount of meteoritic contamination in the impact melt rock with the tabular hypersthene, however, is a factor of five higher. Whether this difference in some trace elements and different mineral chemistry would be sufficient to erroneously ascribe these melt rocks to more than one impact event, in the absence of geological control [8], is a moot point. It does underscore, however, that not all the experiences gained in the study of large coherent impact melt sheets, e.g., [9], can be applied without caveat to smaller impact events.

Table 1. Chemistry of some lithologies at Wanapitei.

	1	2	3	4	5	6
SiO_2	84.9	86.9	74.1	76.3	74.8	75.1
TiO_2	0.07	0.10	0.19	0.20	0.20	0.27
Al_2O_3	7.3	6.9	12.3	10.8	11.6	11.7
Fe_2O_3	0.5	0.4	0.6	0.6	--	--
FeO	0.6	0.5	1.3	1.8	*2.3	*2.8
MnO	0.01	0.00	0.02	0.03	--	--
MgO	0.6	0.4	1.0	1.8	1.6	1.6
CaO	0.2	0.2	0.8	1.3	1.3	1.2
Na_2O	1.1	2.4	2.9	1.8	2.3	2.3
K_2O	1.7	1.7	2.8	2.3	2.5	2.6
H_2O	2.7	0.25	3.2	2.5	--	--
Total	99.68	99.75	99.21	99.43		

1. Average highly shocked and partially vitrified meta-sediments. 2. Average Mississagi Formation, 3. Average impact melt rocks with high Al-hypersthene. 4. Average impact melt rocks with low Al-hypersthene. 5. Average all impact melt rocks. 6. Calculated impact melt rock from mixing model (see text). *All Fe as FeO.

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