BALLEN-STRUCTURED QUARTZ IN GLASSES OF THE WANAPITEI IMPACT STRUCTURE, ONTARIO, CANADA. B. C. Schuraytz[1] and B. O. Dressler[2], [1]Planetary Science Branch, SN4, NASA Johnson Space Center, Houston, Texas 77058, USA (schuraytz@snmail.jsc.nasa.gov); [2]Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston, Texas 77058, USA (dressler@lpi.jsc.nasa.gov).

The Wanapitei impact structure in Ontario, Canada, is ~8 km in diameter and lies within Wanapitei Lake, ~34 km northeast of the city of Sudbury [1,2]. Shock metamorphic rocks and suevitic breccias related to the 37 Ma impact event [3] occur as pebbles and boulders in Pleistocene deposits south of the lake. Target rocks are mainly meta-sedimentary rocks of the Huronian Supergroup and diabase of the Nipissing intrusions, both units of Proterozoic age. All the common shock metamorphic features diagnostic of asteroid or comet impact have been observed in the pebbles and boulders, amongst them planar deformation features in quartz and feldspars, diaplectic glasses, quenched liquid glasses, and so-called ballen structures [4,5] in relic quartz grains in impact glasses. An inferred admixture of ~1% chondritic material [6] and platinum group element abundances [7] in impact glasses, and the presence of coesite in strongly shock metamorphosed arkosic sandstones, are further evidence for the impact origin of the Wanapitei structure [8].

Two types of ballen-structured quartz grains have been noted in shock-melted, quartz-rich meta-sedimentary rocks. One is translucent, commonly embayed, drop-like, or fluidally stretched. The other is brownish, semi-translucent and angular to sub-rounded. The distinct ballen or groups of ballen in one quartz grain exhibit optical orientations different from each other or fine, flecky recrystallization. Both types of ballen-structured quartz grains may contain small glass "inclusions" or larger glass bodies. The glass in the quartz grains in places contains microlites, indistinguishable from microlites of the glass in which the ballen-structured quartz grains are embedded. The small "inclusions" possibly represent embayments of glass into the quartz grains. The larger glass bodies within the ballen-structured quartz grains may exhibit faintly visible, semicircular heterogeneities, strongly resembling the shape of ballen rims (Fig. 1).

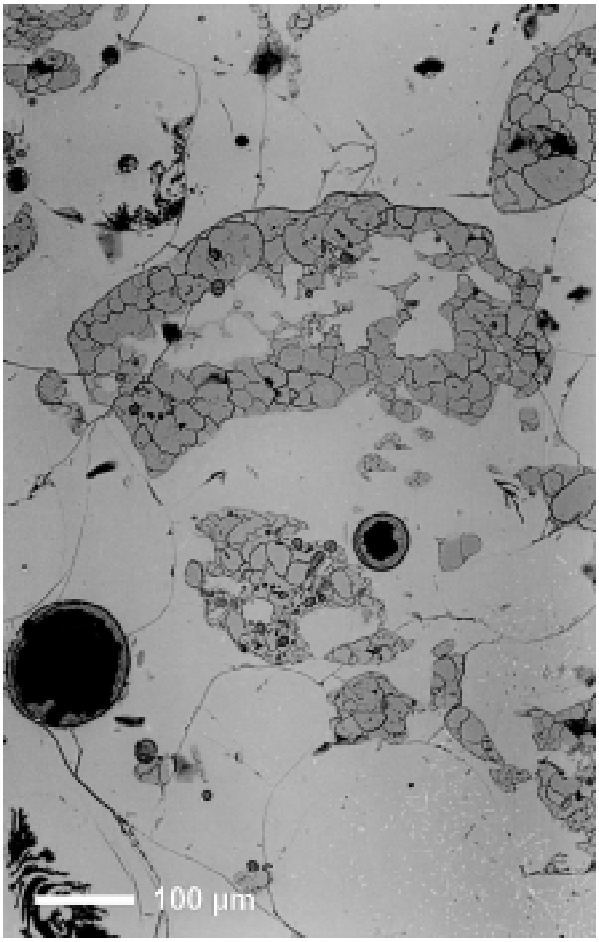

Figure 1. Backscattered electron image of a ballen-structured quartz grain. Within the glass in the interior of the quartz are relic ballen rims of essentially pure silica.

The glass within the ballen-structured quartz grains and around and very close to the quartz grains is distinctly enriched in SiO_2 and K_2O, and poorer in Al_2O_3 compared to the matrix glass in which the quartz grains are embedded

(Table 1, [9]). The semicircular heterogeneities, resembling ballen rims, were identified by microprobe as essentially pure silica.

Table 1. Microprobe analyses of glasses in and around ballen-structured quartz grains.

	1	2	3
SiO_2	66.18	75.15	74.72
TiO_2	0.35	0.42	0.25
Al_2O_3	16.41	11.38	11.92
FeO	3.40	2.09	1.36
MnO	0.02	0.04	0.02
MgO	1.57	1.11	0.86
CaO	0.86	0.39	0.41
Na_2O	3.11	2.67	2.44
K_2O	3.17	3.92	4.12
P_2O_5	0.09	0.05	0.12
Cr_2O_3	0.02	< detection	0.02
Total	95.18	97.22	96.24

(1) Glass matrix in which ballen-structured quartz is embedded; average of 12 analyses. (2) Glass at contact with quartz grains; average of 4 analyses. (3) Glass within ballen-structured quartz grains; average of 9 analyses.

Ballen-structured quartz has been observed in several terrestrial impact structures. It has been interpreted to represent pseudomorphs after cristobalite which, in turn is thought to have replaced quartz glass quenched from the liquid state, i.e. lechatelierite, formed by shock [5]. It may also represent recrystallized diaplectic glass or lechatelierite which underwent transition to cristobalite and α-quartz [10, 11]. The shape of some of the translucent ballen-structured quartz grains are suggestive of liquid-state melting and support the first interpretation [5]. On the other hand, the angular and sub-rounded shape of many of the brownish, semi-translucent, ballen-structured quartz grains are reminiscent of detrital sand grains of sandstones and support the interpretation that some of the ballen structured quartz grains are pseudomorphs after diaplectic quartz glass [10, 11]. The relic ballen rims in larger glass bodies in ballen-structured quartz grains are suggestive of incipient melting and assimilation of the quartz by the melt in which the quartz is embedded. The configuration of glass within the quartz grain shown in Figure 1 is thought to be an embayment of glass along the quartz grain margin, partially exposed by the thin section cut.

In a study of rocks from the Lappajärvi impact structure in Finland [10, 11] specific shock pressure ranges were assigned to specific ballen structures. According to that study, ballen structures are formed in a wide range of shock pressures from ~10-55 GPa. Incipient formation of ballen is thought to represent pressure ranges of ~10-30 GPa. Ballen structures that are optically homogeneous may represent shock ranges of ~30-45 GPa. Ballen with different optical orientations in one quartz grain and intra-ballen recrystallization were assigned to pressure ranges of ~45-55 GPa.

Assuming that the above interpretations [10, 11] are correct, the ballen-structured quartz grains observed in impact glass samples from Wanapitei Lake were subjected to shock pressures of ~45-55 GPa. This view is supported by the fact that the ballen-structured quartz grains are embedded in impact glass indicative of shock melting in response to pressures of >50 GPa.

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