SHOCK ATTENUATION AT THE SLATE ISLANDS REVISITED; Wu S., Institute of Mineral Deposits, Chinese Academy of Geological Science, Beijing, China, P.B. Robertson and R.A.F. Grieve, Geological Survey of Canada, Ottawa, Canada

The Slate Islands, off the north shore of L. Superior, represent the emergent portion of the central uplift of a complex crater with an estimated diameter of 30 km (1). Previous systematic studies of the shock metamorphism at the Slate Islands have concentrated on the orientation of shatter cones, complemented by paleomagnetic data (5), and observations of the distribution of planar deformation features in quartz (6) to locate the "shock center" and to estimate the rate of shock pressure decay from the center. The impact origin of the Slate Islands, however, has not been accepted by Sage (2,3), who attributes the shock metamorphic effects to the intrusion of diatreme breccias. This argument, in turn, has been used by others (e.g., 4) to dispute the established relationship between shock metamorphism and impact and to argue that the existence of planar deformation features in quartz from K/T boundary deposits does not require the occurrence of a hypervelocity impact event. Because of Sage's continuing assertion that the planar deformation features at Slate Islands are associated with breccia dikes and have, therefore, an endogenic origin, we have extended the earlier analysis to a more spatially extensive suite of samples than observed previously (Fig. 1).

The methodology used to determine the shock pressures recorded by the planar deformation features in quartz is that used previously (6), with orientations determined by the U-stage for 25 quartz grains in each sample. An additional 24 samples were examined, bringing the total number of samples examined to 42 and making the Slate Islands the most intensively studied impact structure in Canada from the perspective of planar deformation features in quartz. Samples with quartz but no planar deformation features have been assigned a recorded shock pressure of 5.5 GPa, provided they occur within the outer limit of shatter cone development. As with other complex impact craters, shatter cones are developed at Slate Islands out to a greater radial distance than are planar deformation features (7). The combined data sets (6 and this work) clearly indicate the relatively systematic radial decay of recorded shock pressure from a central location on Patterson Island. The "shock center" based on the development of planar deformation features is located < 1 km south of the "shock center" based on shatter cone orientations (5). Using the planar deformation feature data, Fig. 2 shows attenuation of the rate of recorded shock pressure with distance from the shock center. As previously, this is normalized to the distance to the edge of the peripheral trough, which is taken to approximate the edge of the transient cavity (6). The rate of decay is similar to previous estimates for the Slate Islands and Charlevoix but slower than that derived from comparable observations at Manicouagan. We interpret this difference as due to the effects of erosion, with Manicouagan being less deeply eroded than the Slate Islands or Charlevoix structures. The relatively high variation in recorded shock pressure in some samples at an equivalent radial distance (Fig. 2) has been noted previously and attributed to grain size effects (8).

Planar deformation features also have been observed in clasts in one of the breccia dikes located on the east coast of Patterson Island, where the surrounding country rocks do not display planar deformation features in quartz. This evidence of the deformation chronology agrees with observations by Sage (3) for a breccia dike on the west coast, and is complemented by the occurrence of shatter cones in some breccia clasts (1). We interpret these observations to indicate that brecciation occurred after passage of the shock wave, making these dikes so-called type-B breccia dikes (9). The higher recorded shock levels in clasts compared with levels in the adjacent country rocks, and the presence of clasts of now missing, stratigraphically higher lithologies (1) indicate that the dikes formed during cavity growth with material being driven down into the target. As well, the occurrence of clasts with recorded shock pressures of ~ 13 GPa within cm of country rocks displaying no planar deformation features conflicts with the argument of Sage (2,3) that the source of energy for the development of shock metamorphic effects is diatreme intrusion.

CONCLUSIONS:

This study of a more extensive suite of Slate Islands samples confirms previous interpretations. It indicates clearly that recorded shock pressures, as determined by planar deformation feature orientations, increased towards the center. The "shock center" is very close, (considering the structural movements during cavity modification) to that from an independent determination from shatter cone orientations. Shock metamorphism at a higher level in breccia clasts than in the adjacent country rocks is evidence that the shock event preceded the formation of the breccia dikes. These observations, which are consistent with those at other impact structures, are all contrary to the interpretation by Sage (2,3) that breccia dike formation by diatreme action was the source of the shock event. There is no plausible reason to consider the Slate Islands as anything but the emergent portion of the central uplift of a complex impact crater. It cannot be cited as an example of endogenic shock in arguments regarding evidence of impact in the terrestrial stratigraphic record.

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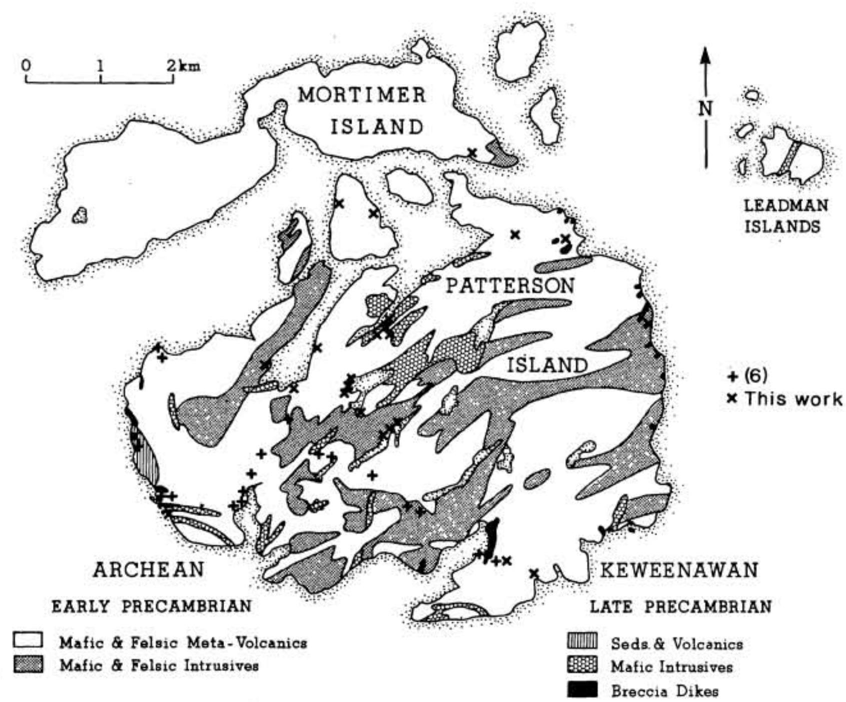
Fig. 1. Sample locations and general geology of the Slate Islands.



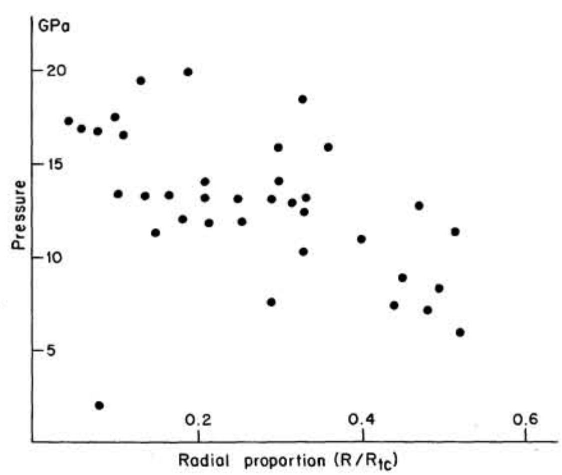


Fig. 2. Attenuation of shock pressure (GPa) with distance from shock center.