SHATTER CONES AND ASSOCIATED SHOCK-METAMORPHIC MICRODEFORMATIONS IN MINERALS – THE CASE OF THE SUDBURY IMPACT STRUCTURE, CANADA. L. Ferrière[1] and G. R. Osinski[2], [1]Natural History Museum, Burgring 7, A-1010 Vienna, Austria. (ludovic.ferriere@univie.ac.at), [2]Dept. Earth Sciences/Centre for Planetary Exploration, University of Western Ontario, London, ON, Canada.

Introduction: Shatter cones are the only diagnostic evidence of hypervelocity impact that develop on a macro- to megascopic scale [e.g., 1]. They have been reported in extremely different lithologies, with large variations of cone size (cm to m), and generally occurring in-situ only in the central part of the impact structure. Different models for their formation exist in the literature [2-7], but none of them account for all of the current field observations of shatter cones [7-9].

Here, we report on macroscopic and petrographic investigations of shatter cone samples from the Sudbuy impact structure. This work is part of an ongoing study of shatter cones from several impact structures, combining observations on the occurrence, distribution, and characteristics of shatter cones at the scale of the impact structure with macroscopic and microscopic observations of (shocked) minerals, to infer the course of events that result in the formation of shatter cones.

Results and Discussion: Shatter cones were observed, documented, and sampled at dozens of outcrops (Fig. 1), mainly from the South Range of the Sudbury structure (only a few from the North Range). They mainly occur within quartzites (or metamorphosed sandstones), more rarely in conglomerates, and in a few rare cases in gabbro (reported here for the first time in this lithology). At each outcrop, basic description and structural measurements were recorded. In the laboratory, petrographic and shock metamorphic investigations were conducted using an optical microscope. All together 14 thin sections of shatter cone samples were investigated. The entire area of each thin section was investigated under the optical microscope (with a magnification of 200x), and all mineral grains, especially quartz grains, were subjected to a systematic analysis of their properties.

In term of shatter cone distribution, our observations are very consistent with earlier studies of shatter cone distribution at Sudbury, such as by [10] – but see also [11]. However, with the help of B. Church (UWO, London, Canada), we were able to document an occurrence of shatter cones (up to ~1 m in size) in a quartzite outcrop located at ~35 km away from the outer limit of the Sudbury Igneous Complex, which is of interest in terms of reconstructing the original diameter of the Sudbury structure. In previous studies of shatter cones at Sudbury, they were not reported at such a great distance.

Our petrographic study confirms that microdeformation features occur in shatter cones from the Sudbury structure, including random penetrative fractures and kink bands in micas. It is notable, however, that no grains with either planar fractures (PFs), planar deformation features (PDFs), or feather features, were detected. This is interesting as recent work by [9] have clearly shown that shock-induced deformations in minerals, especially PFs and PDFs in quartz, are relatively abundant in shatter cones. Thus, either the investigated samples did not experienced peak shock pressures high enough to form PFs and/or PDFs, or these features were then annealed. In the present case it is possible that both processes are responsible for the observations.

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Fig. 1: Exposure view of shatter cones in quartzite from the Sudbury structure (Canada).