IMPACT MELTING IN SEDIMENTARY TARGET ROCKS? G. R. Osinski[1], J. G. Spray [1] and R. A. F. Grieve[2], [1]Planetary and Space Science Centre, University of New Brunswick, 2 Bailey Drive, Fredericton, NB E3B 5A3, Canada. [2]Earth Sciences Sector, Natural Resources Canada, Ottawa, ON K1A OE8, Canada (osinski@lycos.com).

Introduction: Sedimentary rocks are present in the target sequence of ~70% of the world's known impact structures [1]. One of the outstanding questions in impact cratering studies is: do sedimentary rocks undergo impact melting? This question cannot be addressed through experimentation in the laboratory, which is limited to impact velocities generally below that required for wholesale melting [2]. Numerical and computer-based modeling may offer some important information, however, as Pierazzo et al. [3] note, "there is no good model for melt production from impact craters in sedimentary targets". Studies of naturally shocked rocks, therefore, offer the only true ground-truth data on the response of sedimentary rocks to impact. We have carried out detailed field and analytical studies of naturally shocked sedimentary rocks that will hopefully provide constraints for future modeling.

Physics of impact melt generation: Theoretical considerations of the impact process reveal some important results regarding the generation of impact melt [4]: (i) the volume of target material shocked to pressures sufficient for melting *are not* significantly different in sedimentary or crystalline rocks; (ii) Hugoniot curves indicate that *more* melt should be produced upon impact into sedimentary targets as compared to crystalline targets. Impacts into sedimentary targets should, therefore, produce as much, or even greater volumes of, melt as do impacts into crystalline targets [4].

Where have all the melts gone? It is generally considered that the high volatile content of sedimentary rocks results in the "unusually wide dispersion" of impact melt [4]. However, it is becoming increasingly clear that such lithologies can undergo shock-melting and are preserved in significant quantities in some impact craters.

Haughton impact structure: The target rocks at the 24 km diameter, 23 Ma Haughton structure comprised a ~1750 m thick series of sedimentary rocks (predominantly carbonates, with minor evaporites, sandstones and shales), overlying Precambrian metamorphic basement. Osinski and Spray [5] have recently interpreted the crater-fill deposits at the Haughton impact structure as carbonatitic impact melt rocks. Importantly, the volume of these crater-fill deposits (>12 km^3) is roughly equal to the observed impact melt volumes for comparably sized craters developed in crystalline targets (e.g., >11 km^3 melt at Bolytsh (diameter 24 km) [6]).

Ries impact structure: The 24 km diameter, 15 Ma Ries impact structure comprised a target sequence of ~ 850 m sedimentary rocks (limestone in upper parts, predominantly sandstones in lower parts), overlying Hercynian granites and gneisses. Carbonate melts have been documented at the Ries impact structure by Graup [7] and Osinski [8]. In addition, Osinski [8] has also recognized the presence of SiO_2-rich impact glasses that were clearly derived from sandstones in the lowermost part of the sedimentary sequence.

Implications: Based on our studies of the Haughton and Ries structures, we suggest that sedimentary rocks can undergo shock-melting during impact events. Thus, it should NOT be assumed that all sedimentary rocks and minerals completely degas and disperse at pressures sufficient for melting. This will have implications for the way in which we model the cratering process.

Modeling: The Ries impact event has recently been the focus of numerical modeling studies and 3D hydrocode simulations [9]. These models suggest substantial melt generation from sandstones in the sedimentary sequence, seemingly at odds to the general held view that these lithologies were not shock-melted [e.g., 10]. Recent studies by Osinski [8] have shown that sandstone-derived melts are present. This is an instance where modeling and field studies clearly agree. This is not the case when carbonates are considered. All models to date have considered that carbonates are completely degassed above a certain pressure threshold (e.g., >55 GPa in [9]). This is despite the fact that carbonate melts are known to occur in the Ries and other structures. We suggest that the melting of carbonates should be included in any future modeling studies.

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