High Resolution Seismic Imaging of a Potential Eroded Impact Structure. Wei Xie[1], Douglas R. Schmitt[1] . [1]Inst. for Geophysical Research, Dept. of Physics, U. of Alberta, Edmonton, AB, Canada. T6G2E1 (wxie3@ualberta.ca).

Introduction: The possible buried impact crater, Bow City structure, is centered around 50.45°N and 111.91°W in SE Alberta. Currently, the structure is estimated to have a rim-to-rim diameter of 8 km and to be of undetermined age of less than 73 Ma by detailed geological mapping [1,2]. Due to the lack of the obvious morphological expression at the surface, the geophysical seismic technique including reflection and refraction methods are being applied to characterize the detailed structural features [2].

The preliminary interpretation of the legacy 2D seismic data acquired in 1980s shows three listric normal faults in the west outer rim and a seismic transparent central uplift (figure 1). These interpretations support the impact origin of Bow City structure, however, it is difficult to display the shallow subsurface target in details because these legacy seismic data are optimized for the deeper petroliferous formations. Therefore, a high resolution seismic survey was acquired in July, 2013. After processing and interpreting the new seismic data, structural features including concentric normal faults in the structure rim and curve reflectors in the highly disturbed central uplifted area are further delineated. All of these features reinforce the possibility of the structure to be the remnant of an impact crater. In order to detect the velocity anomalies, seismic velocity tomography analyses are also performed to indicate variations of damage across the structure.

Seismic Survey Description: In the summer of 2013, a total of 5 km of high resolution seismic profiling was shot across the expected rim faulted region (line 1) and central uplift area (line 2) of the buried structure (figure 2). To capture the features of the upper 500 m near-surface targets, 4 m shot spacing and 4 m geophone group interval were used. The U of Alberta Minivib® (IVI, Tulsa) provided seismic sweeps from 12 to 180 Hz. An average fold of 400 was maintained in this profile, much larger than the 12 fold from the vintage donated data. Far offset shots were also collected to facilitate the seismic refraction modelling.

The seismic reflection data was processed in Vista® software (Gedco, Calgary) with a work flow designed for shallow subsurface imaging. The signal to noise ratio was improved by suppressing the source-generated noise and multiples to better extract the near surface structure information. The stacked profiles (figures 3 and 4) were further interpreted in Petrel® (Schlumberger) software.

Interpretation: Figures 3 and 4 are the final seismic profiles with the interpreted geological formations. The seismic to well tie was generated using the geophysical well logs near the lines. Both of these two sections show a number of detailed features of the structure.

The line in Figure 3 covers the rim faults region and the most obvious feature is the four listric normal faults with significant displacement and tilting. The flat Belly River reflector (light blue line) significantly dropped down to 200 ms at common midpoint position (CMP) 400 which is interpreted as a normal fault on the outer edge (blue tilting line). The other three such faults displacement (draw by green, purple, yellow line) further interrupt the continuity of Belly River reflector from CMP 400 to CMP 200. Moreover, the shallow area below Belly River horizon is quite disturbed and the seismic horizons beneath the faults zone are under light disruption.

The line in figure 4 locates in the estimated central uplift area. A pronounced disturbed zone (highlight by yellow shading) can be observed from the west of CMP 71. The seismic events in this area are barely visible which means the seismic energy is not uniform and the horizons are broken into discontinuous pieces. This seismic 'transparent' zone (lack of seismic coherency) may be due to the severe disruption of the material as part of the impact. Also, the curved behavior of the Belly River reflector (light blue) between CMP 300 and CMP 71 reveals a significant uplift feature. The three underlying reflectors, the McKay Coal (blue), the Lea Park (green), and the Milk River (orange) show an apparent raised area also, but with less continuity [3]. These bending horizons display the anticlinal uplift in the disruptive area which suggests it be the central uplift of a complex crater.

Discussion: Compared with the earlier seismic profile (figure 1), the high resolution seismic reflection study brings up more information in describing the structural faults in the outer rim and the curved reflector in the central uplifted area. The Belly River reflector is better imaged and four significant listric faults are detected instead of three. Moreover, the curved feature of the Belly River, McKay Coal, Lea Park and Milk River reflectors in the central peak is clearly imaged and the obvious anticlines are suggestive of the center uplift of a complex impact crater. The ongoing investigation of the refraction tomography study might provide more hints in the velocity anomalies as well. Regardless, these seismic data appear to provide new information on the deep structures existing in impact structures in sedimentary rock masses.

References: [1] Glombick, P. (2010a), Open File Report 2010-10Rep. [2] Glombick, P.and Schmitt R. D (2013), *Meteoritics & Planet. Sci.*, (under review) [3] Schmitt D.R. (2013) AGS Report 2013.

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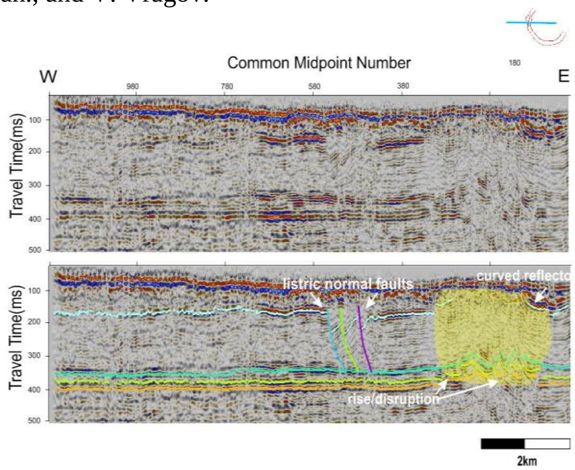

Figure1. Stacked profiles from earlier legacy data. The top and bottom are the uninterpreted and interpreted images respectively. The light blue line represents top of Belly River formation, blue line represents base of McKay Coal formation, green line represents top of Lea Park formation and orange represents Milk River shoulder. The image in the right upper corner shows the line location.

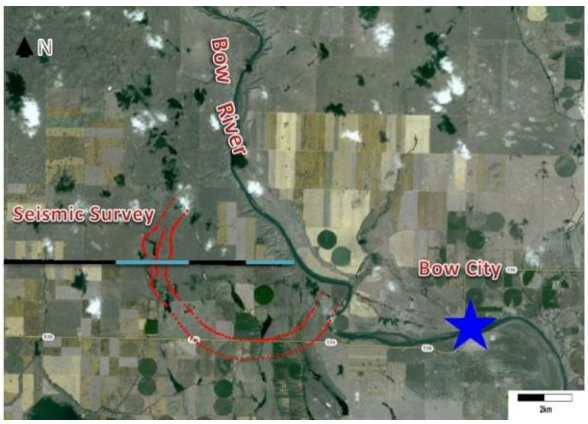

Figure2. Map of the seismic survey. Blue lines are the high resolution lines line1 (left) and line2 (right). Black line shows the location of the earlier study in figure1. The red curve shows the estimated rim faults (Source: Google Map).

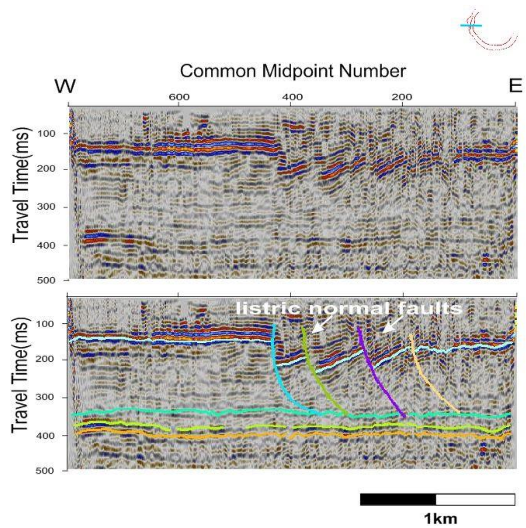

Figure3. Stacked profiles of line 1. The top and bottom are the uninterpreted and interpreted images respectively. The light blue line represents top of Belly River formation, blue line represents base of McKay Coal formation, green line represents top of Lea Park formation and orange represents Milk River shoulder. The tilting lines colored by blue, green, purple and yellow show the interpreted rim faults. The image in the right upper corner shows the line location.

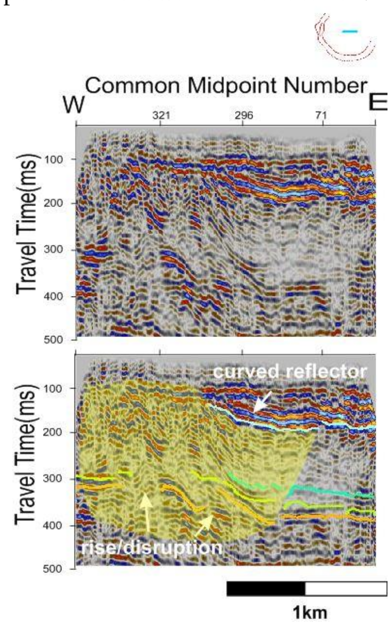

Figure4. Stacked profiles of line 2. The top and bottom are the uninterpreted and interpreted images respectively. The light blue line represents top of Belly River formation, blue line represents base of McKay Coal formation, green line represents top of Lea Park formation and orange represents Milk River shoulder. The yellow shading area shows the center disruptive zone. The image in the right upper corner shows the line location.