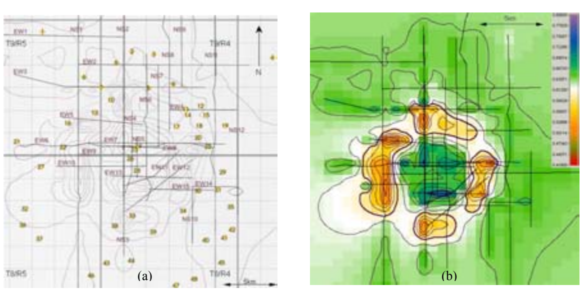
3D STRUCTURAL INTERPRETATION OF THE EAGLE BUTTE IMPACT STRUCTURE, ALBERTA, CANADA. J. Hanova[1], D.C. Lawton[1], J. Visser[2], A.R. Hildebrand[1], L. Ferriere[3]. [1]Department of Geology and Geophysics, University of Calgary, Calgary AB Canada T2N 1N4, jhanova@ucalgary.ca, [2]EnCana Corporation, Calgary AB Canada T2P 2S5, [3]Laboratoire d'Etude de la Matière Extraterrestre, CP 52, Muséum national d'Histoire naturelle, 61, rue Buffon, 75005 Paris, France.

Introduction: A study of well, 2D and 3D seismic data was conducted in order to better understand impact processes and the deformational history the Eagle Butte impact structure. The impact feature was first identified by Sawatzky [1]; Lerbekmo et. al. [2] suggested a 200m impactor formed this structure. Located within the Western Canada Sedimentary Basin, in southern Alberta, this 15 km complex structure displays a prominent central uplift, annular synform, and rim uplift within Cretaceous and Lower Tertiary strata. Formed primarily in shaly sediments mineralogical evidence of shock metamorphism has not been found, but shattercones occur at one subcrop locality near the center of the central uplift (Figure 1).

Figure 1. Shattercone obtained from the Eagle Butte central uplift.

Methods and Results: Well and seismic data from the Eagle Butte area in southeastern Alberta were used to interpret the impact structure. Well locations were superimposed on a seismic grid spanning the crater (Figure 2a). Synthetic seismograms were created from the identified formation tops, which were then used to interpret the 2D seismic profiles (Figure 2b).



Figures 2a and b. (a) Well locations and the seismic grid and general crater shape of the Eagle Butte crater area, (b) Interpreted 2D lines were used to create an isochron map.

A seismic line most representative of the true structure crosses the central uplift as displayed in Figure 3and shows the dense fault network within the crater. (All seismic lines are vertically exaggerated ~10x)

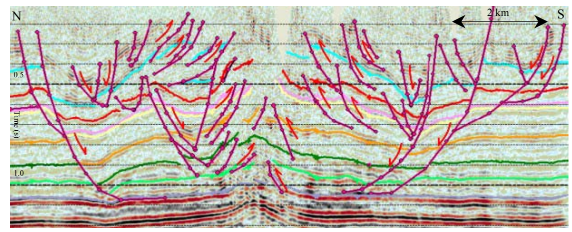


Figure 3: A representative cross-section though Eagle Butte. Arrows indicate movement along fault planes.

This study also exposed the geometry of accurate listric faults viewed in a plane cutting a minor chord through the crater (Figure 4). In these sections the faults appear as synformal fault planes displacing the material in a plane perpendicular to this viewing aspect. Figure 4 shows an E-W line through the northern portion of the impact structure's synform; intensive normal faulting and structural thinning characterize this area.

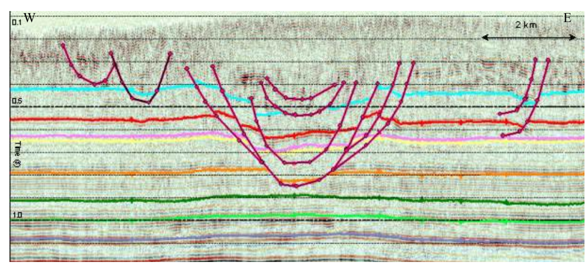


Figure 4. Bowl-shaped normal faults interpreted on an E-W 2D line across the annular synform of the impact structure; displacement is toward the reader.

Following interpretation of the well and 2D data, a 3D seismic volume of the NE portion of the structure was interpreted to better understand the geometry of the fault network. The horizons and fault network were interpreted on radial cross-sections instead of a limited number and orientation of 2D lines. An iterative interpretation revealed a substantially more complex fault environment. Figure 5 shows a sample time-domain interpretation of one geological layer located approximately in the middle of the sedimentary package (the 2nd White Specks Formation (2WSPK)). Far more detail can be observed on this interpretation; the gray areas in the NE and SW portions represent areas where seismic data were not acquired, whereas the gray areas dispersed throughout the interpretation depict fault planes across which the 2WSPK has been displaced.

After the initial interpretations of horizons, main faults were identified on all the lines (e.g., Figure 6). This process involved several iterations, as interpretations on (1) radial, (2) N-S and (3) W-E lines had to be consistent. The outermost main slump fault can be best described as bowl-shaped, and showed striking similarities to its interpretation on the 2D lines. The 3D interpretation revealed specifics/asymmetries about the nature of the displacement that the 2D lines were not able to portray. The northern area of the fault creates a fault scarp, whereas the eastern portions of the fault have a more gentle dip. The gaps in the Pakowki Formation (Figure 6) again represent locations where faults have caused displacement; it is noteworthy, however, that the resolution of the 3D data lacked sufficient coherency for the identification of reverse faults in the central uplift. Figure 7 shows an interpretation of the main bounding fault and portions of the minor fault network.

Discussion: The interpretation of the 2D and 3D seismic data revealed a complexly faulted crater dominated by arcuate fault planes. Lines running through all areas outside the central uplift can only be interpreted in a simplistic manner. The 3D interpretation reveals the fault network that resembles a rose-petal structure, as opposed to simply only bowl-shaped faults. This discontinuous nature of the minor faults cannot be completely accounted for on 2D lines, as such inferences about the nature of the faults cannot be made; however, the 2D lines are more accurate at delineating the reverse faults located within the central uplift.

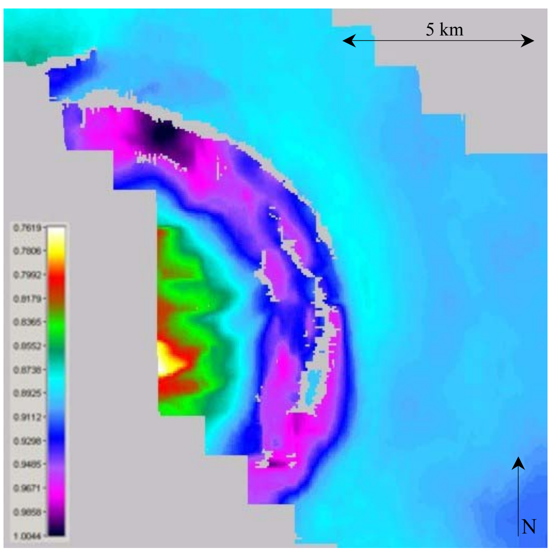


Figure 5. Time structure map of the 2nd White Specks Formation. Blue areas correspond to regional times, deep blue and pink areas represent the annular synform, and green, red and yellow colours depict the central uplift.

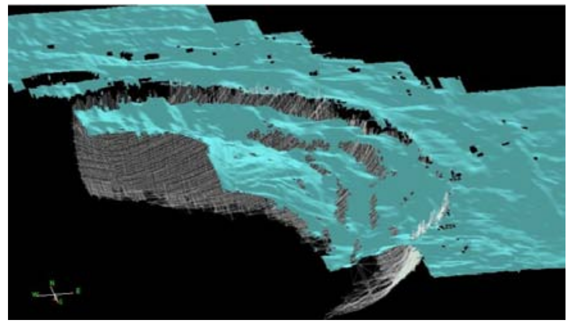


Figure 6. 3D visualization of the main fault displacing the Pakowki Formation

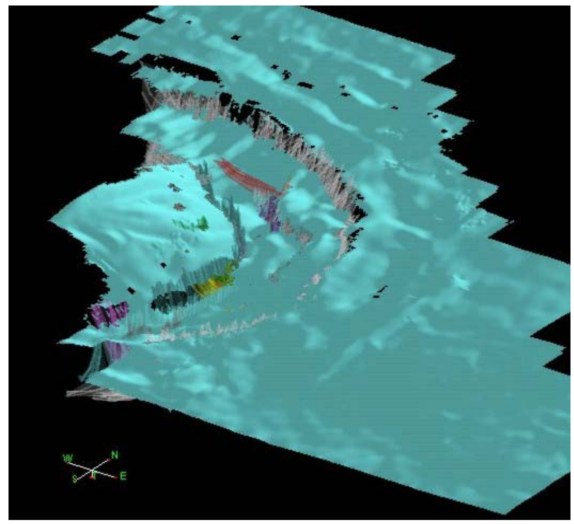


Figure 7. Pakowki Formation superimposed onto fault network.

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References: [1] Sawatzky H. (1976) Geophysics, 41: 1261-1271. [2] Leberkmo J., Rutter N., Sweet A., Catuneanu O., and Langenberg C. (2000) 2000 Field Trip. Edmonton Geological Survey, Edmonton.