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Impact Craters in Seismic Data: A New Look At Old Structure

Amanda K. Obodovsky
Geophysical Imager, Divestco

Summary

Over the years many sub-surface impact craters have been discovered through acquiring and interpreting seismic data. These events occurred a long time ago by meteorite impact and have since been buried deep underground. An overview will be given of some well-known astroblemes and their value to the oil and gas industry. Three astrobleme examples will be presented and it will be shown how new processing techniques can improve our knowledge and understanding of these ancient structural events.

Introduction

Since the acquisition of seismic data in the 1960's, impact structures have been seen in seismic data. These are structures that were created earlier in the Earth's history from a meteorite impact and have since been buried underground. While many of these unique structures are known to be located in the Western Canadian Sedimentary Basin, we also find these buried impact craters around the world with many well-known astroblemes located in the US. Some of these structures occur in areas with oil and/or gas concentrations and are of interest to the industry for economic reasons, while others exist in zones without any hydrocarbons and are of scientific interest in gaining a better understanding of these structures and events.

Theory

To begin, let us start with definitions:

<u>Astrobleme:</u> (from Greek *astron, blema,* "star wound"), remains of an ancient meteorite-impact structure on the Earth's surface, generally in the form of a circular scar of crushed and deformed bedrock.

<u>Impact Crater:</u> a depression that results from the impact of a natural object from interplanetary space with Earth or with other comparatively large solid bodies such as the Moon, other planets and their satellites, or larger asteroids and comets.
For this project the terms 'astrobleme' and 'impact crater' can be used interchangeably.

Before we can interpret seismic data for astroblemes, first we need a basic understanding of what the structure of an impact crater looks like. The following image shows both a simple and complex crater in profile view. A few features to note are: the overall bowl shape of the structure, the raised rim, and the vertical faults radiating outwards from the impact often causing blocks to slump downwards towards the center. All three of these features can be seen in seismic data when looking at impact events and are clues to determining if a structure is indeed an astrobleme.

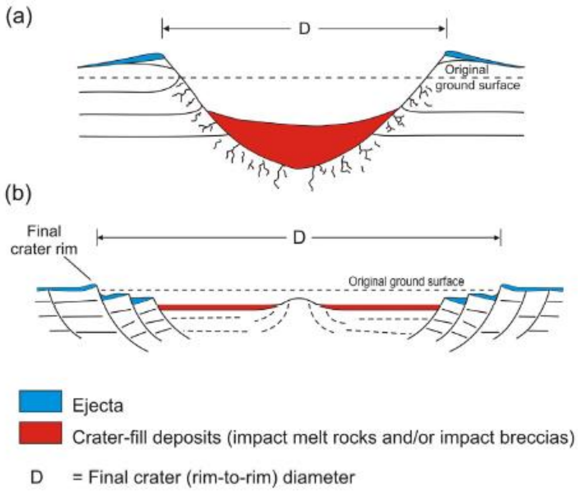

Figure 1. General structure of an impact event. The top image shows a simple crater, while the bottom image shows a complex crater.

Examples

A few astroblemes will be showcased in this project. The first, a cryptoexplosion event detailed in the paper 3-D seismic expression of a cryptoexplosion structure by Issac and Stewart located in the Alberta foothills. The second is located near Manyberries Alberta and has only recently been studied. The third, Hotchkiss is located in Alberta and is known with the Canadian oil and gas community.

The seismic data containing all three astroblemes has been processed using the newest seismic processing software. For the 3D data, new techniqiues such as Divestco's SPRINT 6D interpolation and diffraction imaging are used to show how using new techinques we can better image the details in these ancient complex structures.

Conclusions

Impact craters are an important part of the Earth's history and by uniting astrophysical knowledge with geophysical processing and interpretations we can gain a better understanding of these structures. This will add value for both the oil and gas industry that seeks to extract hydrocarbons from around these structures and the scientific community that seeks to better understand and catalogue these impact events. By completing a geophysical analysis of the Tookoonooka astrobleme located in Australia we gain valuable information for both of these fields of study.

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