Jackpine Creek Magnetic Anomaly: A Case of the HRAM Prospect Scale Interpretation

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Summary

The utility of the High Resolution AeroMagnetic (HRAM) data for a prospect-scale interpretation is illustrated by the example from the HRAM survey in northeast British Columbia. The identified Jackpine Creek magnetic anomaly was compared with available geological information from wells and interpreted to be due to a buried impact structure or astrobleme. This structure may present a potential petroleum exploration target in several horizons within the Lower Cretaceous sedimentary section.

Introduction

The portion of the HRAM study under consideration covers an area of the eastern limit of the Laramide fold-and-thrust belt and adjacent Foreland Basin that includes the western continuation of the Peace River Arch (PRA). Periodic uplifts of the PRA provided a sediment source and faulting in the mid-Devonian and contributed to localization of the sands, reef and carbonate bank edges. Later deformations during the Antler and Laramide orogenic events created block faulting and produced local structural traps. Laramide faulting has had some control upon the Cretaceous sediment supply and deposition and it also could have been linked to a movement of diagenetic fluids and precipitation of hydrothermal dolomites. Reservoirs are found primarily in the Devonian, Mississippian, Permian, Triassic and Cretaceous rocks and include both clastic and carbonate reservoirs. The study area lies within the boundaries of an alluvial fan of the Cadomin delta depositional system (Masters, 1984).

HRAM Survey Parameters and Processing

The Wapiti high-resolution aeromagnetic survey was flown in NE British Columbia with the objective of mapping the magnetic anomalies associated with structural discontinuities within the Precambrian basement and sedimentary cover. The survey was flown by the Spectra Aviation Services Corp. (now Fugro Airborne Surveys Corp.) with East-West traverse line spacing of 600m and North-South control line spacing of 1800m in the drape mode at an average ground clearance of 200m.

The standard processing included: 1) corrections for the diurnal variations and the Earth's gradient field, 2) elimination of misties between traverse and control lines, i.e. leveling, 3) cultural editing (Hassan et al, 1998) to remove magnetic anomalies caused by man-made objects, 4) gridding with the minimum curvature algorithm at 200m grid cell size. The gridded data were Wiener filtered to remove extreme high-frequency noise and then reduced to the Pole to compensate for the local inclination and declination of the Earth's magnetic field and center the magnetic anomalies over their sources.

The resultant reduced-to-the-pole Total Magnetic Field grid was processed with various techniques including the band-pass filtering, calculation of the horizontal gradient, first and second vertical derivatives, total gradient and applying the cascaded Goussev filter (Goussev et al, 1998).

Jackpine Creek Anomaly Interpretation

The Jackpine Creek magnetic anomaly located in NTS Grid 93-P is shown most clearly on the "shallow" version of the cascaded Goussev filter map as a distinct oval to circular positive anomaly crosscut in the middle by the north-south striking linear positive anomaly (Fig. 1). For this study, the "shallow" cascaded Goussev filter was designed as a 1.2-3.6km band-pass of a difference between the total gradient and horizontal gradient grids calculated after applying a 0.6-1.2km Jacobsen separation filter (Jacobsen, 1987) to the total magnetic field.

In order to increase the lateral resolution of the Jackpine Creek anomaly, we performed additional processing tests and selected a 2.4-7.2km band-pass of the total gradient as the most resolving image for interpretation of faults at this location (Fig. 2).

The anomaly's shape and internal fabric of quasi-concentric segments indicate the presence of an elliptical structure similar to an astrobleme. Other non-magnetic data have been examined to find an independent support for this interpretation. Since filtered magnetic maps suggest the dominant magnetic sources are located within the upper sedimentary section, we constructed two isopach maps, the Bluesky-to-Cadomin and Base of Fish Scales-to-Bluesky, from available well data.

The Bluesky-to-Cadomin isopach shows almost a near circular anomaly with a relative decrease in thickness at the center and a relative increase in thickness at periphery of the anomaly (Fig. 3).

The isopach anomaly closely matches the location of an anomaly on the cascaded Goussev filter map (Fig.4). In our fault interpretation based on the filtered magnetic data, the faults bound the area of an isopach thickening. The Base of Fish Scales-to-Bluesky isopach shows a "mirror" structure – a relative thickening in the center and thinning at periphery of the isopach map. The geometric form of both isopach maps is consistent with our interpretation of the Jackpine Creek Anomaly as perhaps representing an impact structure or astrobleme.

The estimated rim-to-rim diameter of the interpreted Jackpine Creek Impact Structure is about 25km. Depth of occurrence is about 1400-1600m sub-sea or 2400-2600m subsurface. The estimated time of origin is after the Cadomin/Bluesky deposition but before the Base of Fish Scales time, i.e. Lower Cretaceous.

Sometimes, the uplifted rims associated with impact structures have excellent reservoir properties and petroleum exploration potential. For example, commercial production from a rim structure of the Steen River Astrobleme is about 1000BOPD and 35 MMCF/d with estimated 72 BCF of gas reserves (Mazur et al, 2000). The Viewfield structure, in Saskatchewan, is another example of a producing field created by an astrobleme.

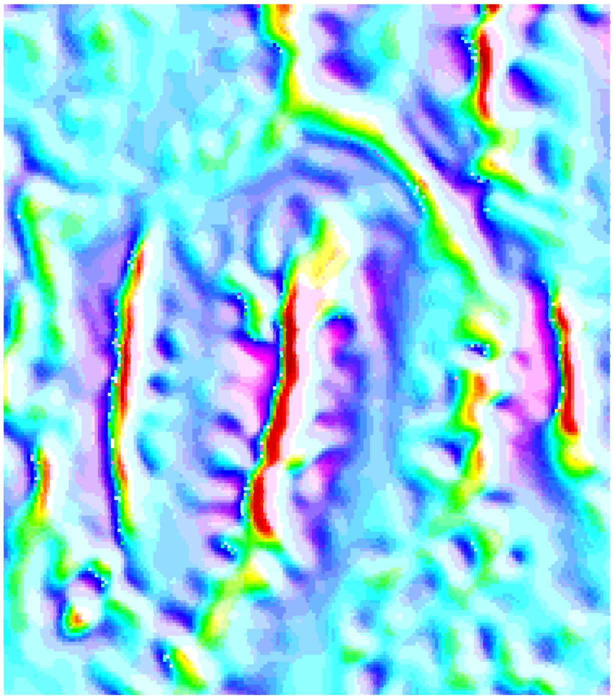

Fig. 1

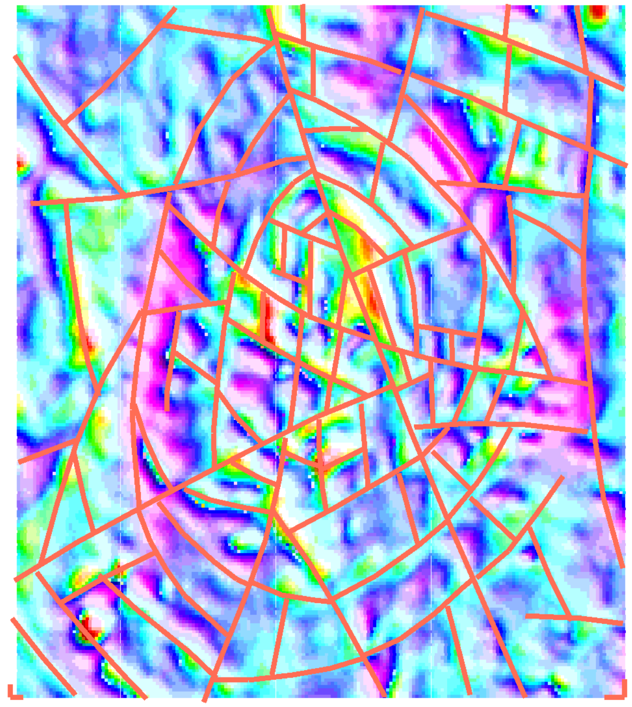

Fig. 2

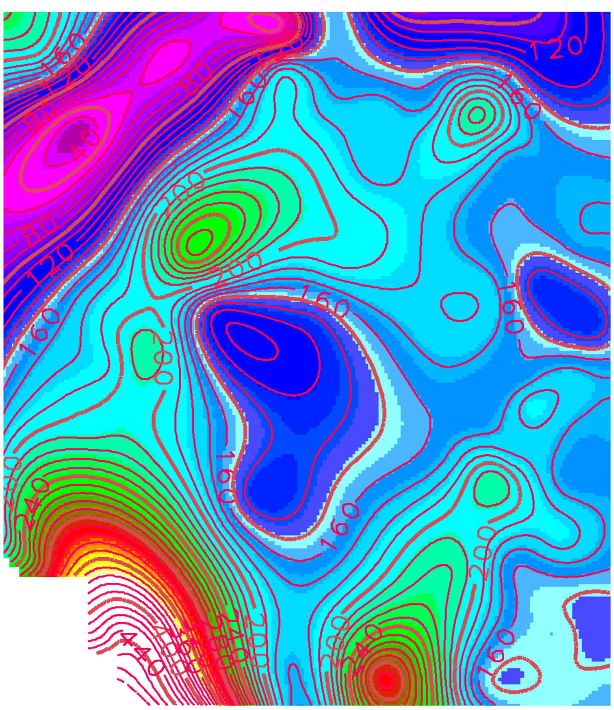

Fig. 3

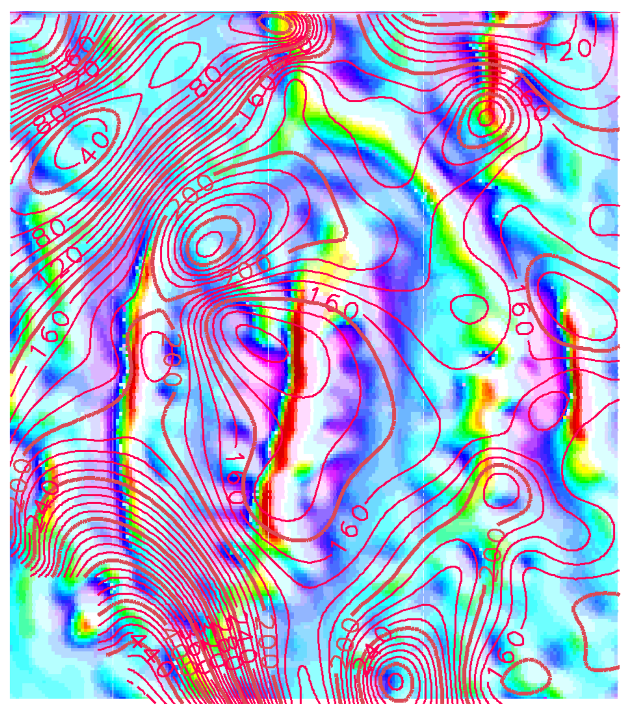

Fig. 4

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