

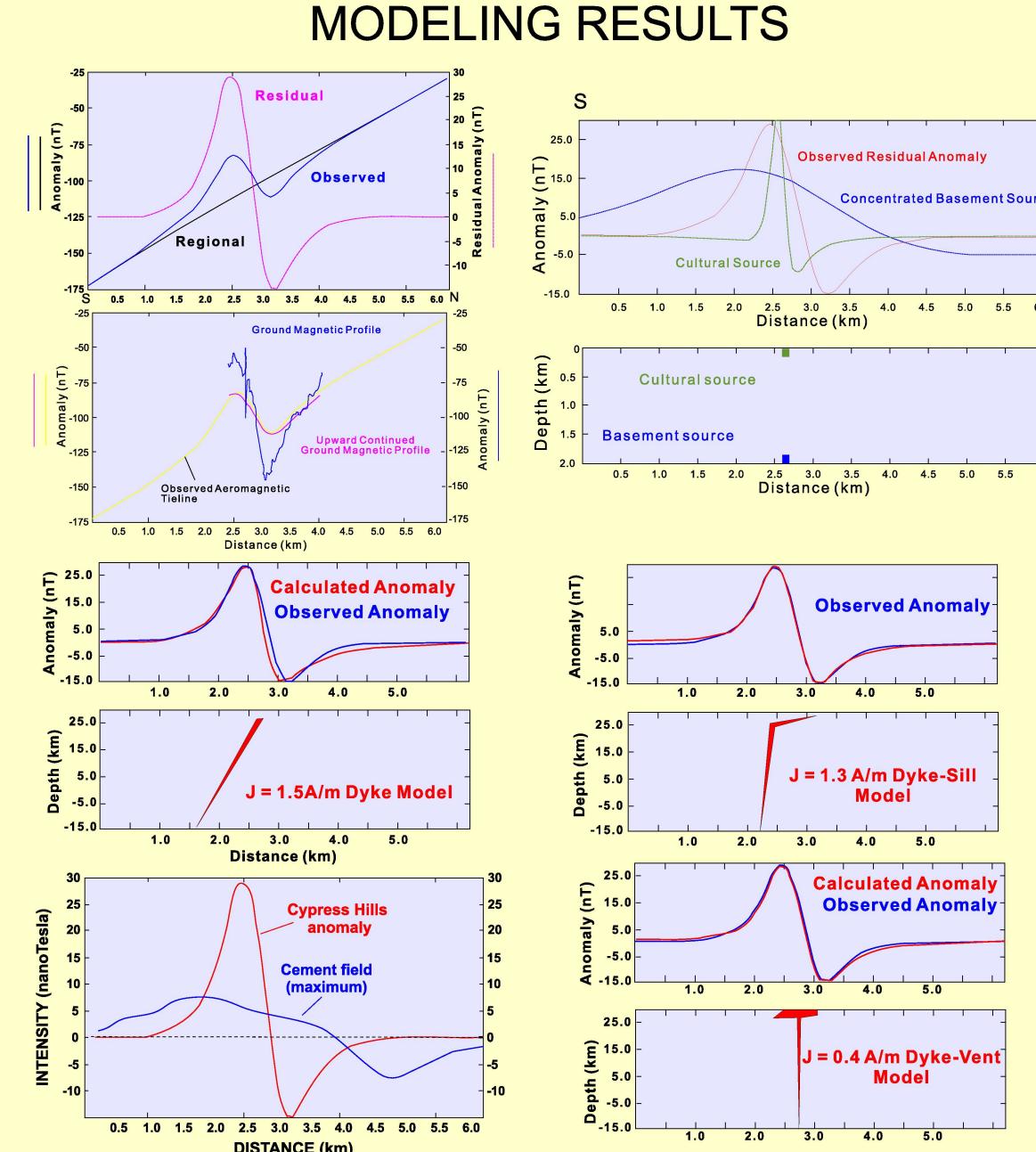


EOCENE MAGMATISM IN SOUTHERN ALBERTA: MAGNETIC EXPRESSION AND IMPLICATIONS FOR PETROLEUM EXPLORATION

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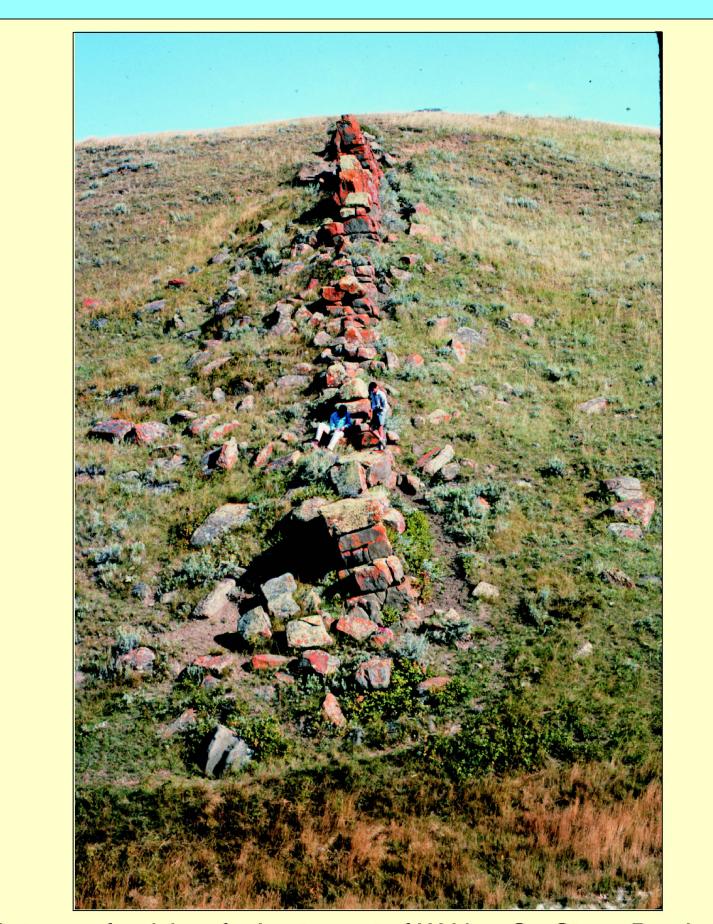
ABSTRACT

New, high resolution aeromagnetic anomaly data acquired over the Phanerozoic Western Canada Sedimentary Basin and underlying Archean Medicine Hat Block of southern Alberta reveal the presence of striking short wavelength anomalies that clearly are distinct from longer wavelength anomalies from sources within the basement. The most dramatic anomalies comprise a series of northwest-striking linear features, up to 30 km long, between the towns of Milk River and Lethbridge. A second, less prominent, set of north-northeast-trending anomalies occurs south of the city of Medicine Hat. The linear nature of the anomalies and their subparallel disposition in a "swarm" is similar to the aeromagnetic expression of mafic dyke swarms in the Canadian Shield. We believe that the southern Alberta anomalies represent dyke-like igneous bodies and further hypothesize that they are correlative with mafic potassic dykes of Eocene age exposed in the Sweet Grass Hills of southern Alberta and northern Montana. If correct, this hypothesis implies that dyke emplacement and associated extension occurred over a broad region of southern Alberta and may represent an eastward continuation of the association of Eocene alkaline magmatism and extension observed in the southern Canadian Cordillera. This may have important implications for understanding the formation of, and exploration for, hydrocarbon traps in the sedimentary section formed by post-Cretaceous fault movement and development of fracture porosity.



Top left shows the general character of one of short wavelength anomalies. A comparison with the results of an upward-continued ground magnetometer survey shows a good match. A shallow intrasedimentary source is suggested by comparing the observed waveform with that produced from modeling a concentrated basement source vs. a cultural source (pipeline). Preliminary 2-D magnetic models show the match between observed and modeled responses for a dyke with magnetization (J) similar to that measured from minettes in the Sweet Grass Hills Igneous Complex. Plot in lower left is a comparison between a typical magnetic profile from a southern Alberta dyke and the magnetic response from the most magnetized interval at the Cement field in Oklahoma, considered to be exemplary of hydrocarbon-seepage induced magnetization (Reynolds et al., 1990, Geophysics). The dramatic difference between the Cypress Hills anomalies and the Cement anomalies precludes a hydrocarbon seepage origin along fault zones for the anomalies in southern

Regional magnetic anomaly map for southern Alberta showing the location of the Cypress Hills survey (green outline),



Outcrop of a dyke of minette east of Writing-On-Stone Provincial Park, southern Alberta. The exposed dykes in southern Alberta are a northern extension of the Sweet Grass Hills Igneous Complex and contain microphenocrysts of magnetite. Attempts to locate dykes in areas of strong magnetic anomalies (Lethbridge and Milk River for example) failed.

and orientation of normal faults, wells with Banff oil shows and

location of seismic line. Seismic data show two, down-to-the-

(from Wright et al., 1993 WCSB Atlas)

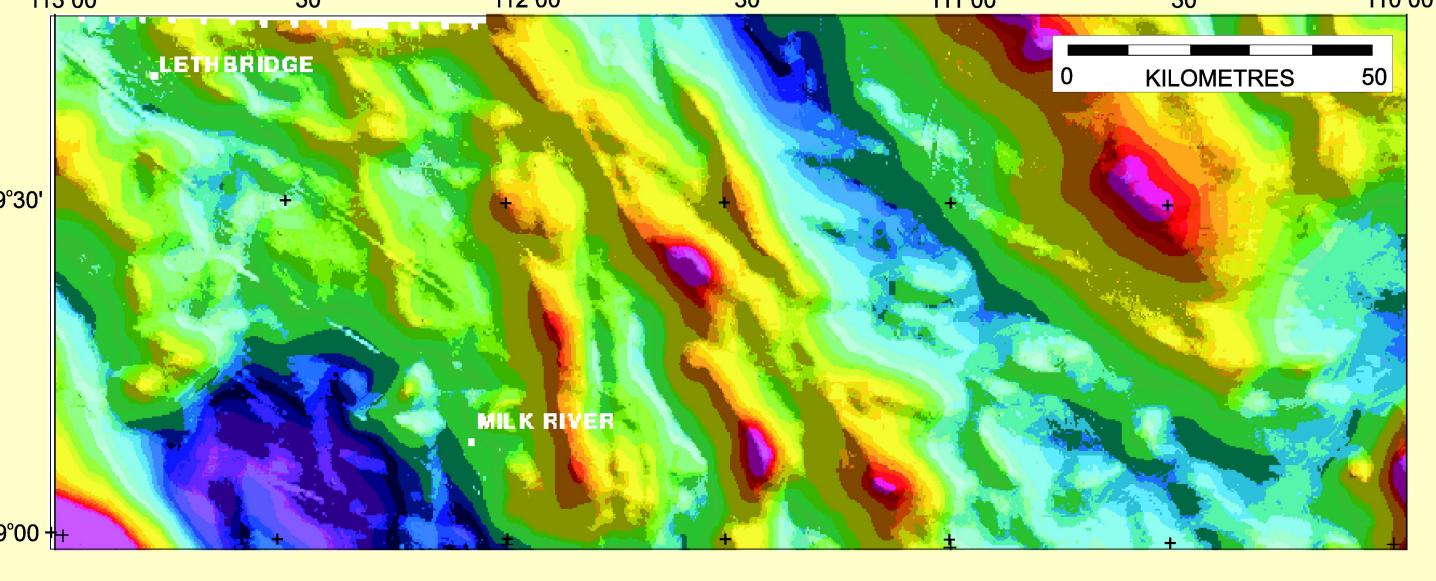
STRUCTURE MAP

BASE OF FISH SCALES

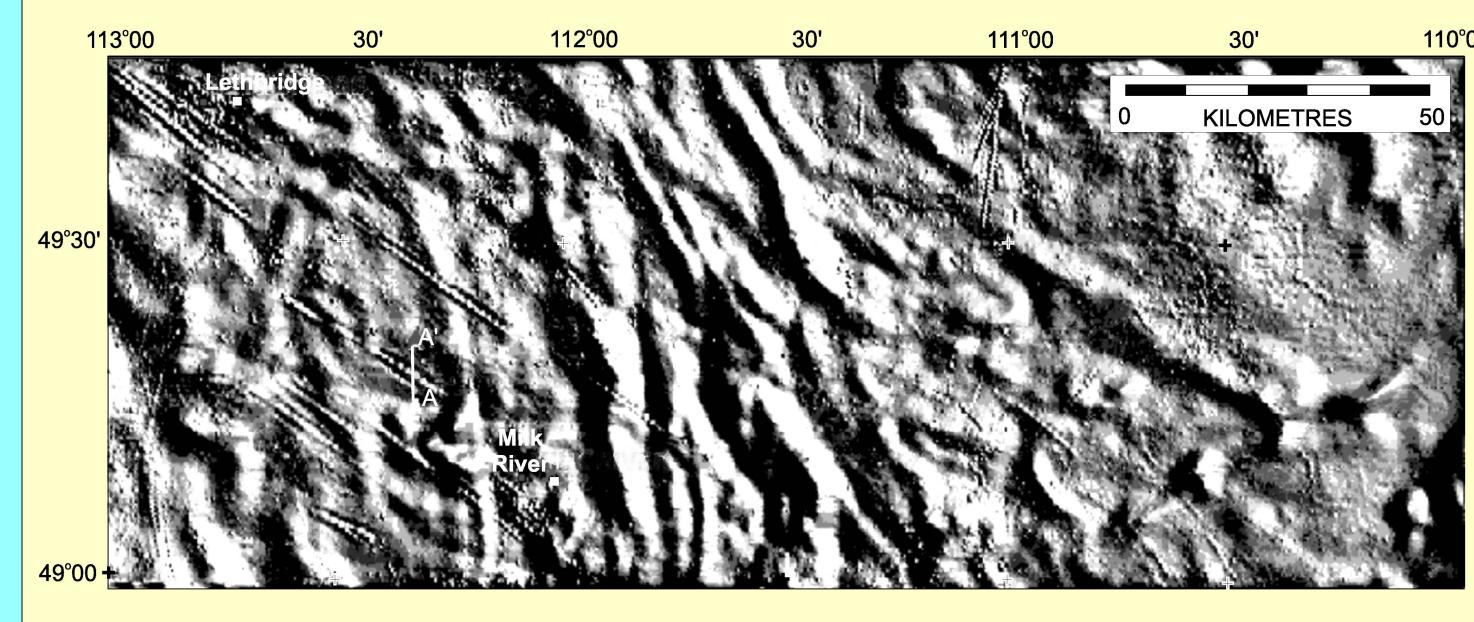
10 km

(from, Wright et. al., 1993)

MAGNETIC ANOMALY DATA, CYPRESS HILLS SURVEY



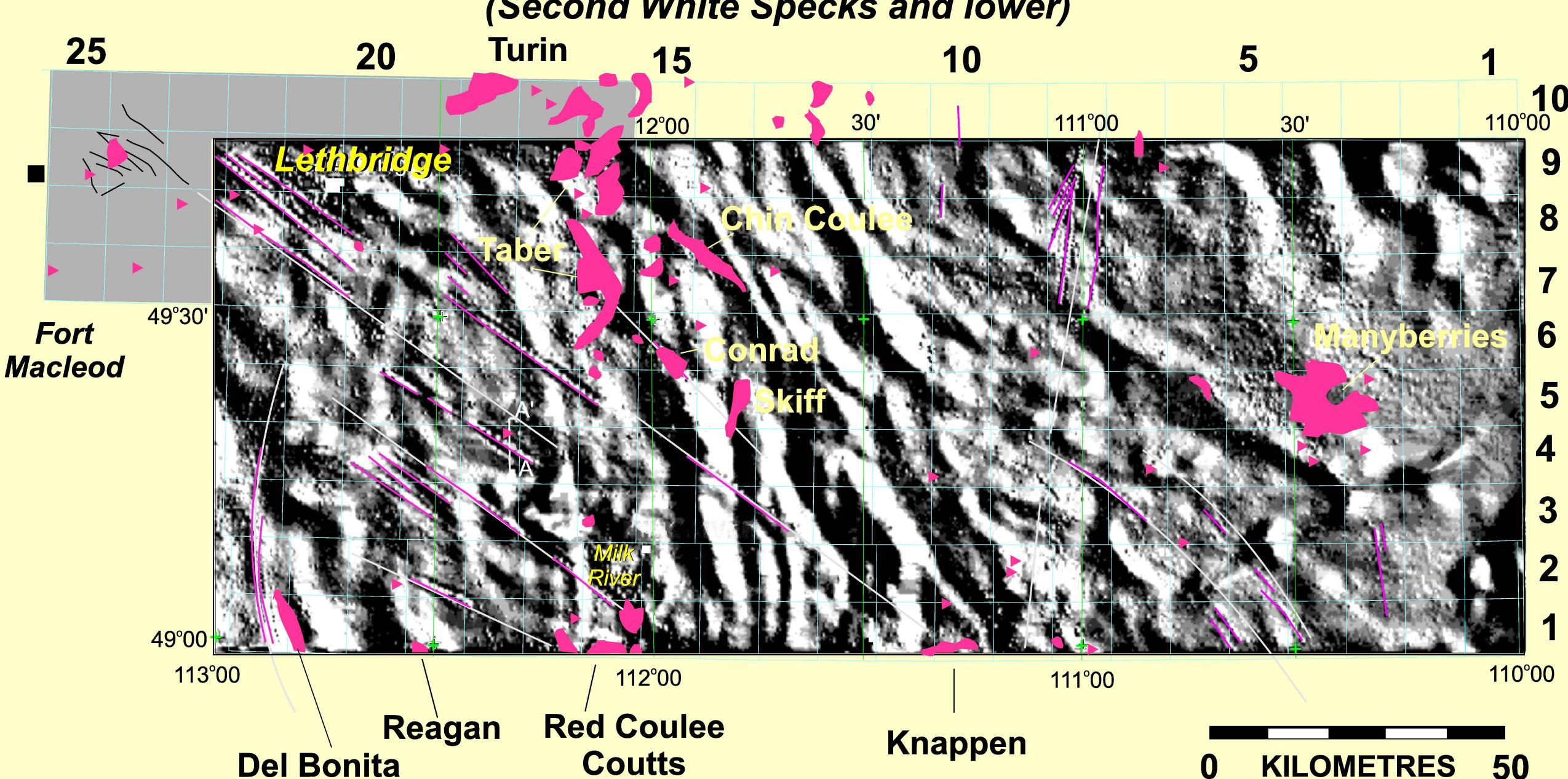
Shaded relief map of the total intensity magnetic anomaly data for the Cypress Hills survey area with illumination from the northeast. The data have been corrected for the International Geomagnetic Reference Field at an altitude of 1.1 km and contoured at an interval of 30 nT.



Shaded first vertical derivative of the total intensity magnetic data for the Cypress Hills survey area with illumination from the northeast. Broader anomalies are basement fabric of the Archean Medicine Hat Block whereas the narrow linear anomalies are interpreted as dykes. Profile "A" is the location of ground magnetometer survey used to verify the presence of the short wavelength anomalies.

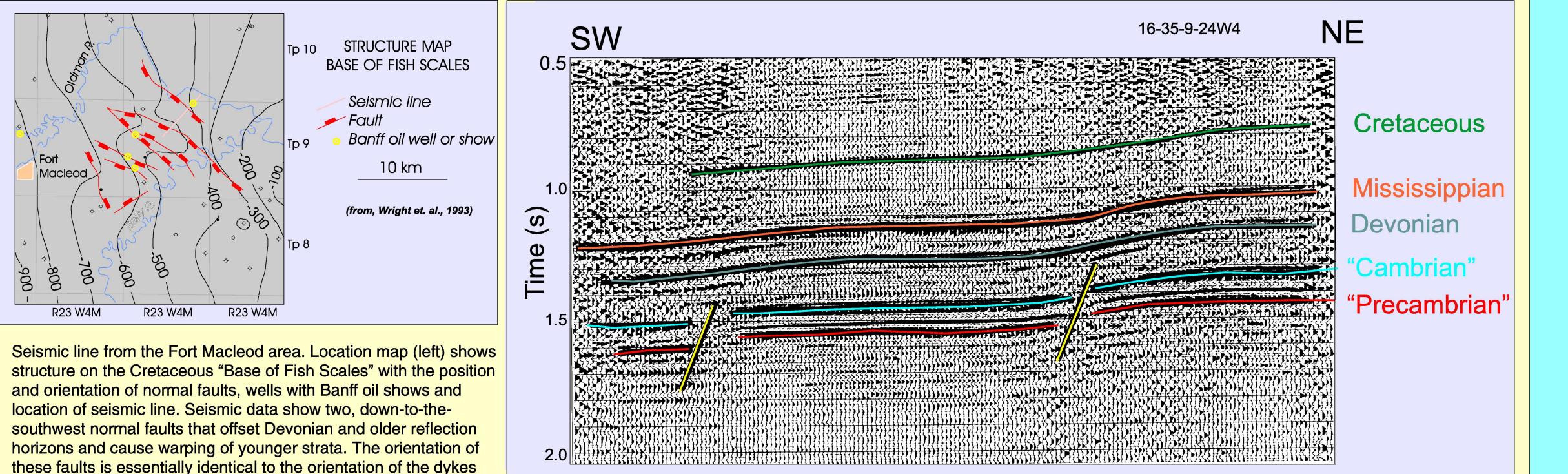
POOL DISTRIBUTION, SOUTHERN ALBERTA

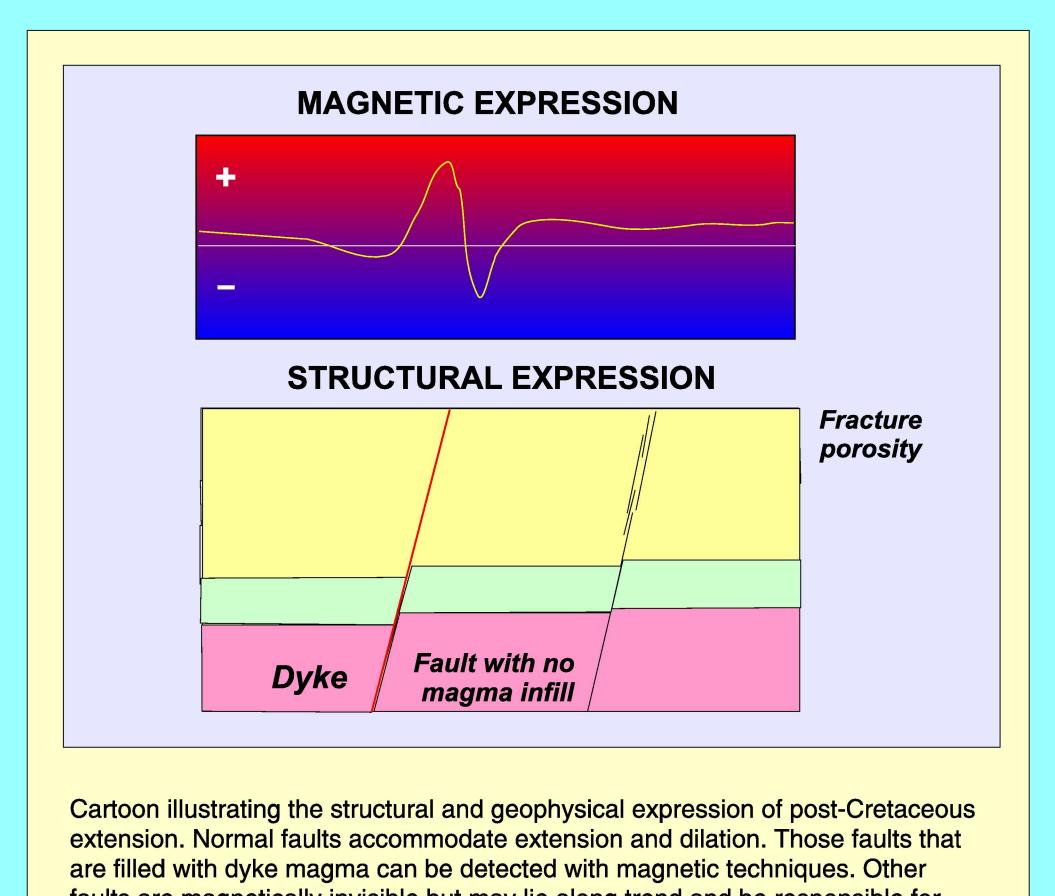




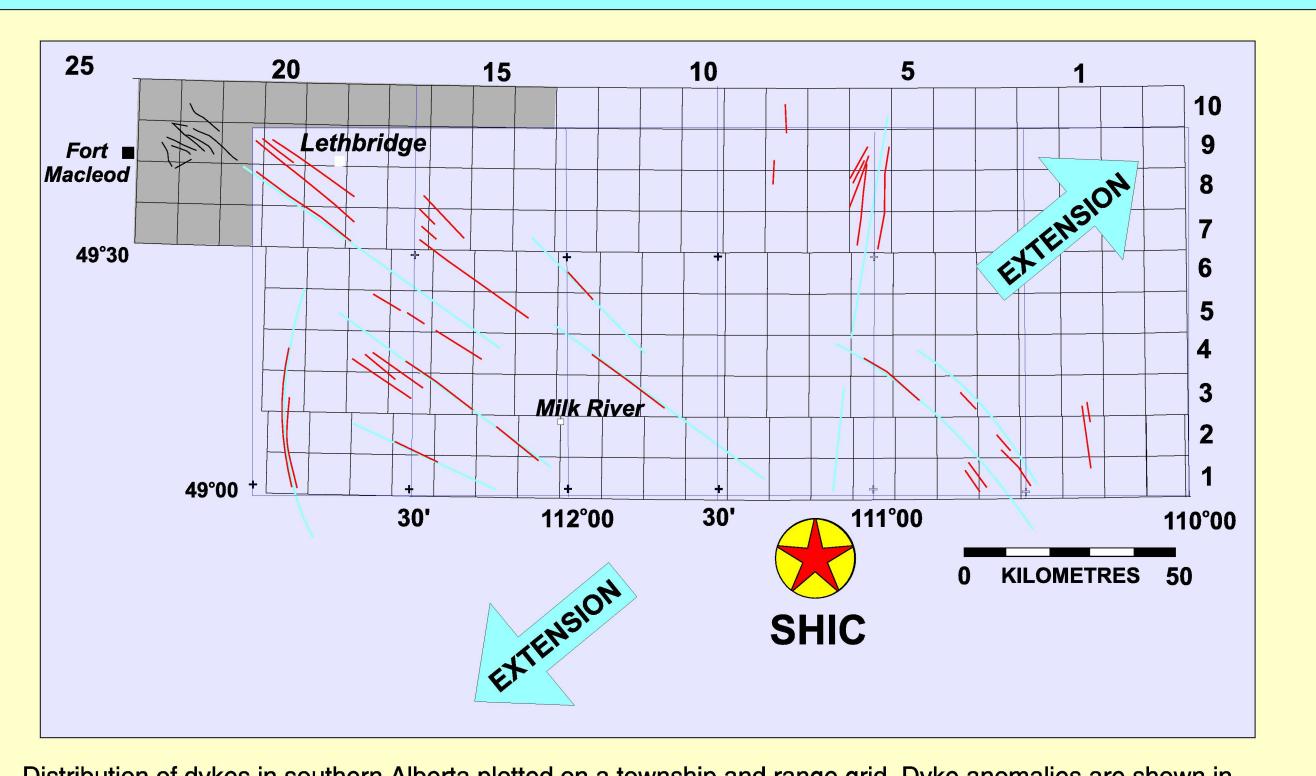
Map of the Cypress Hills anomalies with a selection of wells and production fields in southern Alberta. Well picks and production are all Second White Specks and lower. Reagan and Del Bonita are both interpreted as structural traps. Most fields show little apparent influence by northwest-trending structures with the exception of Chin Coulee and Conrad. Red segments are linears traced directly from magnetic anomaly data and gray linears are extrapolated trends. Note the general noncorrelation of magnetic trends with production areas, further emphasizing the poor likelyhood for a hydrocarbon seepage origin for the magnetic anomalies.

SEISMIC EXPRESSION





faults are magnetically invisible but may lie along trend and be responsible for structural closures and fracture porosity.



Distribution of dykes in southern Alberta plotted on a township and range grid. Dyke anomalies are shown in red and generalized trends are shown in pale blue. Generalized northeast-southwest extension shown relative to the Sweet Grass Hills Igneous Complex (SHIC). Black lines in Fort Macleod area are post-Cretaceous normal faults shown on seismic sections in WCSB Atlas (Wright et al. 1993). Note the close match in the strike of the faults and dyke anomalies.