

Definition of Williston Basin Basement Structural Trends, Features, and Plays Utilizing High Sensitivity Aeromagnetic Data

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The results of an integrated aeromagnetic/geologic study of a 350-township area of the U.S. portion of the Williston Basin proved useful in delineating undrilled trends and structures. Three of the major recent discoveries (Simon Butte; Interlake; Tracy; Tyler; and the Lodgepole Waulsortian mound) are located along previously mapped lineaments or at lineament intersections. The analyses utilized a 1 mi (1.6 km) E-W x 4 mi (6.4 km) N-S grid of aeromagnetic data acquired with a cesium magnetometer at 3800 ft (1159 m)

above sea level. Data were combined with maps generated from a comprehensive subsurface database and detailed Landsat imagery lineament analyses.

Geoterrex aeromagnetic data was reprocessed and a number of products generated to assess variations in both the regional and local structural grains. Regional structural/fault trends are defined by analyzing numerous shaded relief images of the RTP Total Intensity. Prospect-size structures and more localized basement fault trends are delineated using a vertical derivative map, and residualized stacked line profile displays, in conjunction with 2-D magnetic models. The structural interpretations of these displays were added to those generated via subsurface and Landsat analyses in order to identify which basement signatures and trends were instrumental in controlling production throughout the basin, and where undrilled structures and trend continuations may be present.

The regional trend of the basement structure was constructed using all available basement penetrations in conjunction with a hand-contoured structure map of the Ordovician Red River based on a proprietary data base of over 3,000 wells and a series of isopach maps for the Red River-Winnipeg, Winnipeg-Deadwood, and Deadwood-Precambrian intervals. The Red River structure was digitized and its isopach subtracted via computer gridding routines to derive a best first approximation of the underlying Winnipeg structure. Similar procedures were utilized for the Winnipeg and Deadwood intervals to derive a first approximation of basement structure.

In the area of the Williston Basin analyzed, virtually every producing field, whether structurally or stratigraphically controlled, bears a relationship to the regional and subregional fault trends identified on the shaded relief images. Individual structures identified on the interpreted line profiles also match producing structures. Fields occur parallel to lineaments, at changed orientation of lineaments, or at lineament intersections. Production from certain stratigraphic intervals is grouped on circular "plaid" areas to the exclusion of production from other intervals. Fresh water flow into the basin from the west appears to be controlled by a least two major fracture systems. Interestingly, only major trends defined on the Landsat imagery bear a relationship to those identified on the magnetic data sets.