Integration of soil gas geochemical and remotely sensed surface lineament data for oil and gas exploration in the Western Canada Sedimentary Basin

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Integration of remotely sensed lineament and soil gas geochemical data with subsurface geological and geophysical datasets has proven useful for searching out tectonically inherited subsurface structures and associated prospective oil and gas targets at several locations in southern Saskatchewan and Alberta.

Remotely sensed images show lineament patterns and diagnostic geomorphic features at regional and local scales throughout the Western Canada Sedimentary Basin. The lineaments are often clustered along two or more dominant azimuthal trends, forming distinctive patterns resembling regional joint patterns in sedimentary rock. These distinctive surface trends and patterns appear to be genetically related to subsurface structural elements that have been observed over a number of oil and gas fields.

Contoured and color enhanced soil gas data maps suggest patterns of hydrocarbon seepage along preferred migration pathways, particularly over and around oil and gas reservoirs. Gas samples are analyzed for trace concentrations of methane, ethane, propane, butane, hydrogen and helium. Diagnostic gas ratios that characterize areas of anomalous gas seepage are used to predict compositions of source reservoirs. Such data are thought to yield direct evidence of hydrocarbons in the subsurface, even though in places gas constituent concentrations in near-surface samples can be affected by multiple gas source mixing and differential gas migration mechanisms.

Structural elements that may contribute to identified soil gas anomalies and surface lineaments include regional systematic fracture patterns, reactivated fault movement associated with regional tectonism, fracture-controlled salt dissolution with associated differential subsidence effects, differential crustal rebound associated with preglacial erosion and deglaciation, and paleoerosion and paleodepositional patterns influenced by underlying structure.

Several case history examples illustrate the different types of data correlated, the techniques used, and study results. They include oil and shallow-gas pool areas in western Saskatchewan and southeastern Alberta. Integration of remotely sensed lineament and soil gas geochemical data is currently being applied at the Weyburn oil pool in southeastern Saskatchewan to help assess the integrity of a Mississippian carbonate reservoir subjected to CO_2 injection for enhanced oil recovery.