Fracture System Characteristics in Folded Mississippian Carbonates: Livingstone River Anticline at Beaver Creek

William Jamison*
The Upper Crust Inc., Calgary, AB, Canada
wjamison@shaw.ca

Geoff Rait
Talisman Energy Inc., Calgary, AB, Canada

and

Lindsay Dunn
Compton Petroleum Corp., Calgary, AB, Canada

The Livingstone Range in southern Alberta comprises a series of folds developed in Mississippian carbonates that extend ~ 50 km in a N-S direction. Livingstone River Anticline is located in the northern part of this fold system and is continuous along strike for ~ 20 km. Beaver Creek transects the central part of this fold, providing excellent exposures from the Etherington to Banff Fms. throughout this sharp-hinged, east-vergent anticline.

Fracture system orientation, length and density characteristics were measured at 25 spot locations within the Mt. Head, Livingstone and uppermost Banff Fms. These formations are predominantly limestone (micrite to grainstone) at the Beaver Creek location, though the Mt. Head Fm. does contain some beds of microcrystalline dolomite. The measurement stations cover forelimb, hinge and backlimb regions of the fold. The great majority of fractures observed at all locations have very narrow (hairline) apertures and are void of any cements or surface markings. Large aperture fractures were observed in the hinge and the lower forelimb regions, adjacent to secondary thrusts in the backlimb, and in one region far down the backlimb. Evidence of shear displacement on fractures was found only in the hinge and lower forelimb regions. Elsewhere it appears that all of the fractures are extension (mode I) fractures.

Almost all of the observed fractures are oriented at high-angles to bedding. Type I and type II orientation fractures are the most common orientation sets, but there are many locations where the dominant or secondary fracture sets are oblique to both the type I and type II orientation directions. Fracture densities range from 2 m^2/m^3 to 174 m^2/m^3, but are generally between 25 and 65 m^2/m^3. Low fracture densities occur only in high-porosity grainstones and very high densities occur only in the micrites and microcrystalline dolomites. Mean fracture tracelengths at the individual stations range from 9 to 166 cm, but most are between 15 and 50 cm. There is a rough, negative power- law relationship between mean fracture tracelength and fracture density.

Even though the fracture densities are very high in many parts of this fold, the fractures will generally create only a fraction of 1% porosity because of the very narrow fracture apertures. The observed fractures could potentially create effective permeabilites on the order of a few millidarcies. Higher permeabilites are expected only in the regions containing the larger aperture fractures, primarily the lower forelimb and hinge regions of this fold and in the vicinity of secondary thrusts.