Characterizing Spatial Deformation Patterns in a Laramide Rocky Mountain Basin

Cody W. Bomberger[1], Brianna Berg[1], Jenica Andersen[1], and Michael H. Hofmann[1]

[1]AIM GeoAnalytics, Missoula, MT

ABSTRACT

This study seeks to identify spatial patterns in structural deformation that are important to hydrocarbon exploration. Using techniques from Fourier analysis, expanded into two dimensions, we identify characteristic scales of structural deformation and map the locations of the most prominent patterns spatially. Previous applications of these methods include identifying the characteristic length scales of hillslopes with a high potential for landslides and mapping, along with determining patterns in topography and strain rates associated with active tectonics in the western United States to identify the characteristic scales of deformation and map their spatial variations. In this study we use the mapped surface of the Cloverly formation as a proxy for the subsurface structures across the entire Bighorn Basin and is the input dataset for the analysis. Using the techniques from Fourier analysis, a power spectrum of the mapped Cloverly formation is created which shows amplitude (prominence of features) as a function of the spatial scales of structures. In the power spectrum two ranges of spatial scales are identified as prominent. Through creating a power summation map of these dominant frequencies, we show where the two prominent scales are most important in the basin. The spatial analysis of the power spectra allows for interpretations about which structures and deformation processes are most important in creating the patterns. Additionally, and most importantly for hydrocarbon exploration, the comparisons of structural pattern prominence to production data, produces predictive maps of potentially undeveloped areas that aid additional geologic analysis. This new and original re-tooling of established methods from signal processing is designed to complement the exploration for hydrocarbon resources in structurally complex basins away from current production, as well as help identifying underdeveloped areas in producing fields. These methods have the potential for future applications to a range of hydrocarbon basins across the Rocky Mountains and beyond.