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AN INNOVATIVE GIS-BASED APPROACH TO CHARACTERIZING FRACTURES IN THE MONTEREY FORMATION

We applied GIS-based techniques to map fractures in the Monterey Formation in an effort to better characterize the relationship between fracture style and mechanical stratigraphy. The case study was performed in exposures of organic phosphatic marl at Arroyo Burro Beach in Santa Barbara, California. Alternating lithologies exhibit different styles of brittle deformation, with joints predominating in porcellanite beds whereas small faults are concentrated in phosphatic-rich mudstones. Our efforts focused on quantifying the two-dimensional distribution of faults and joints, as well as establishing any parametric differences between their populations. GIS may serve as a powerful tool to analyze bedrock fracture patterns because (1) it can easily incorporate and manipulate linear features from 2-D maps, photographs and remotely-sensed images, and (2) it can calculate values of fracture properties for each cell within a gridded map area.

Fractures (joints and faults) and stratigraphic boundaries were mapped in a cross-sectional exposure covering ~ 4 square meters in area. The fractures were digitized as linear traces into a GIS, and the map area was divided into 1cm by 1cm cells. The fracture intensity was then calculated for each cell in the map by summing the lengths of all fracture traces within a prescribed 5 cm search radius centered on that cell. Results show that porcellanites have joint intensities ranging from 0.3-0.4 cm^{-1}, whereas mudstones display fault intensities between 0.1 and 0.2 cm^{-1}. A second parameter, the network fractal dimension (D) was calculated for the two populations. Higher D values correspond to greater connectivity, and hence greater overall conductivity for the fracture network. Joints in the porcellanites yield a fractal dimension of 1.5, which is above the percolation threshold of 1.35 required to accommodate fracture-enhanced flow. In contrast, the D=1.2 measured in mudstones indicates that clusters of small faults are isolated, and do not contribute significantly to the flow system.