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Structural arrays and depositional geometries in hydrocarbon provinces: a view from orbit

Exploration success, whether for resources on Earth or on neighboring planets, depends on an explorer's skill in three-dimensional visualization and pattern recognition. In some provinces, fault and fracture patterns replicate from the scale of an entire orogen down to the scale of a thin-section. In repeatedly and complexly deformed regions, the challenge becomes one of discriminating among superposed patterns—critical for evaluating trap integrity and predicting porosity/permeability distribution. Three-dimensional relationships between structures, basin configurations, sediment-body geometries, and volcanic vent distribution are readily observable in photographs by astronauts. Photographic data can be registered to maps and plots of other data and co-displayed using off-the-shelf computer programs. Such displays reveal details of source-reservoir juxtapositions and variations in fracture networks over a basin.

The primary pattern of rifts, for example, is one of long, straight, steeply dipping faults bounding basins that are longer than they are wide. Basins are generally half-grabens, and the flanks with greatest structural relief are depositional sites for coalesced alluvial fans. Axial lakes with evaporites, abundant algae, and fine-grained, low-permeability sediments provide oil-prone source beds. Half-grabens are separated by transfer zones, across which the tilts of grabens reverse. Volcanic vents occur at rift/transfer-zone junctions and, less commonly, along basin-bounding faults; thermal effects on surrounding strata are minimal. Most of these attributes can be examined in single synoptic frames captured from orbit.

Geomorphologist Hoover Mackin observed that geology is rarely a science of brilliance; it is a science of wisdom. The best geologist is one who has observed a lot of rocks from every possible vantage point. Orbiting spacecraft provide an exceptional vantage point for viewing rocks at the scale of an entire tectonic province, for the eyes and minds of informed observers.

Biographical Sketch

Pat Dickerson was born at a very early age in Waukegan, Illinois. She has worked as a geologist, editor, photographer, writer, dancing instructor and apricot cutter for a California fruit-packing firm (not in that order).

For the past two years, as a scientist in the NASA Office of Earth Sciences, she has been training Shuttle, Mir and Space Station crews in global tectonics and drawing from their photographs in her tectonics research and publications. She is creating electronic handbooks on global tectonic topics for crew use—handbooks that will eventually become resources for public education—and has received an award from the Astronaut Office for those efforts.

The Rio Grande Rift of west Texas and New Mexico—particularly the Big Bend province—has been the subject of much of her geological/geophysical research, field work, and her publications over the past 30 years. She returned to the rift this spring to stage, in collaboration with colleagues at the New Mexico Bureau of Mines and Mineral Resources, the first field geophysical training exercise to prepare astronauts for planetary exploration.

In addition, Pat has worked in Argentina, Norway, Denmark, the Netherlands, United Kingdom, Indonesia, Belize, northern Mexico, the Adriatic region, the gold mines of Nevada, the Rocky Mountains, and the Midcontinent. →

HGS Dinner Meeting • Monday, November 8 • Westchase Hilton, 9999 Westheimer • Social 5:30 p.m., Dinner 6:30 p.m.

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Attempts have been made to educate her in geology and archaeology at various institutions, among them California State University at San Jose and the University of Texas at Austin, where she received a bachelor's degree in geology/Greek archaeology (1970), a doctorate in geology (1995), and held a postdoctoral fellowship in tectonics (1996). □