reservoir pressure gradients are about 0.42 to 0.46 psi/ft (9.5-10.4 kPa/m). Reservoir pressure gradients in excess of 0.5 psi/ft (> 11.3 kPa/m) are considered overpressured. However, most overpressured reservoirs have pressure gradients greater than 0.6 psi/ft (> 13.6 kPa/m). Although a variety of conditions can cause overpressuring, most high pressures in the region are interpreted to be caused by the "active" generation of oil and gas in sequences that still contain organic matter capable of yielding thermally generated hydrocarbons. Several authors have proposed that hydrocarbon generation can cause overpressuring. It is important to note that significantly overpressured water reservoirs are rare in the Rocky Mountain region and, where present, are usually in pressure continuity with overpressured oil and gas reservoirs. Some slightly overpressured water reservoirs can be explained by local conditions, such as a pressure measurement at a location significantly lower than a topographically high-elevation water recharge area (artesian conditions).

Rocks with above normal pressure in Rocky Mountain basins range in age from Late Devonian to Tertiary and are commonly associated with low-permeability (tight) reservoirs. Most overpressured reservoirs occur in Cretaceous and Tertiary sandstone sequences. Overpressuring is not common in rocks older than Cretaceous except in very organic-rich sequences, probably because lean source beds that have been heated over a long period of time are no longer capable of yielding enough hydrocarbons to maintain abnormal pressure.

Statistically, nearly all overpressured reservoirs and source rocks have temperatures of about 200°F (93°C) or higher. In many basins, the onset of overpressuring occurs rather abruptly at this temperature in organic-rich sequences. In addition, available data indicate that hydrocarbon-related overpressuring does not usually occur if vitrinite reflectance values are $< R_o = 0.5\%$ in oil-prone sequences or $< R_o = 0.7\%$ in gas-prone sequences. These reflectance values are the lower limit for onset of significant generation of oil and gas, respectively.

Hydrocarbons expelled into widespread, high-permeability reservoirs probably migrate owing to hydrodynamic flow and buoyancy. These reservoirs usually have normal pressures. In contrast, low-permeability (tight) reservoirs retain the overpressuring and have maximum pressures about equal to the natural fracture gradient for rocks in a given area. In a 1978 study, F. F. Meissner proposed that pore pressures in excess of the natural fracture gradient initiate formation fracturing, and the hydrocarbons are expelled laterally and vertically until the pore pressure is reduced and the fractures close. These fracture-initiation pressure gradients range from ≈ 0.7 psi/ft (15.8 kPa/m) to > 0.85 psi/ft (> 19.2 kPa/m). The highest reservoir pressure observed to date in the Rocky Mountains is in the Merna area (T36N, R112W), Sublette County, Wyoming, where reservoir pressure gradients in Upper Cretaceous sandstones exceed 0.9 psi/ft (>20.4 kPa/m). Artificial hydraulic-fracturing pressure data indicate that in this area regional fracture gradients also are higher than normal.

Regional pressure analyses indicate overpressured hydrocarbon-bearing reservoirs occur in the following Rocky Mountain basins: Williston, Powder River, Bighorn, Wind River, Hanna, Green River, Washakie, Great Divide, Sand Wash, Piceance, Uinta, and Paradox.

SPENCER, MARY ALICE S., Bur. Land Management, Billings, MT

Inexpensive Remote Sensing Techniques

Professional aerial photographic missions are expensive, but periodic updates can be obtained for considerably less money using a hand-held camera in a small plane.

Environmentally related problems such as strip-mine reclamation can be monitored by periodic photography, both color and false-color infrared, obtained in this manner. Problem areas such as uneven settling of leveled spoils can be identified for further work.

Photography and imagery available from government agencies can also be used to supplement data from a baseline aerial photographic mission. Landsat imagery acquired during periods of snow cover may accent subtle structural features concealed by vegetation.

Examples of such techniques, and supporting data, will be on display at the poster session.

STEARNS, DAVID W., Univ. Oklahoma, Norman, OK

Considerations of Vertical Tectonics for Big Horn Basin

Referring to the tectonic style of the Big Horn basin as either "horizontal" or "vertical" is an oversimplification. However, these terms have come into vogue and I support vertical tectonics. This term implies that on most structures the vertical component of displacement is larger than the horizontal component of displacement. It does not imply that all faults are absolutely vertical, nor does it preclude crustal shortening. If high-angle reverse faults (dips steeper than 45°) dominate in a basin, a net shortening will result even in a vertical tectonic domain. Furthermore, when applied to the Big Horn basin, the expression "vertical tectonic style" only characterizes behavior 10 to 15 km (6 to 9 mi) into the basement. It implies nothing concerning causative conditions in the lower crust or upper mantle. A given mantle stress condition can produce several different displacement fields in the upper crust depending upon the behavior of the crust.

In accepting either horizontal or vertical as the tectonic style of a region, all of the structures produced during the deformation episode should be considered together as opposed to examining one feature at a time. It is also important to separate second and third order features from primary features. Finally, if there is a governing style, it should be consistent with three-dimensional movements, not just individual cross sections.

STEIDTMANN, JAMES, R., and LINDA C. MCGEE, Univ. Wyoming, Laramie, WY, and LARRY MIDDLETON, Northern Arizona Univ., Flagstaff, AZ

Laramide Sedimentation, Folding, and Faulting in Southern Wind River Range, Wyoming

Surface observations along the southern margin of the Wind River Range in Fremont County, Wyoming, indicate that early motion along the Wind River and Continental faults controlled depositional patterns and lithologic characteristics of the local syntectonic sediments, and that the latest motion on a segment of the Wind River fault between Oregon and Pacific buttes folded some of these same sediments into a monocline. The stratigraphic sequence exposed in the monocline consists (in ascending order) of a lower distal fan or alluvial plain unit (main body of the Wasatch Formation), a lake margin unit (Tipton Tongue of the Green River Formation), a fluvial and deltaic sandbody (Tipton Sandstone), and an alluvial fan unit (Cathedral Bluffs Tongue of the Wasatch Formation). Current direction, clast composition, and clast-size data indicate that a granitic and mafic distal source to the east and a proximal granitic source to the north supplied sediment. Subsequent movement on the Wind River fault warped this sequence into a monocline 2 mi long. This structure dies out in both a northwest and southeast direction along the inferred trace of the Wind River fault and is overlain by undeformed middle Eocene sediments.

Other syntectonic units (e.g., Fort Union, Ice Point, White River, Arikaree, and South Pass conglomerates) occur in patches along the Wind River and Continental faults in this area. Each deposit is of local extent, exhibits rapid thickness and petrofacies changes, and probably represents proximal alluvial fan deposition. These characteristics are typical of syntectonic sediments in transcurrent-faulted terrains, and we are investigating the possibility of such faulting in this area.

Tectonic implications of these interpretations are: (1) early motion on the Wind River fault controlled the margin of Eocene Lake Gosiute and generated a distal sediment source to the east; (2) late early Eocene uplift of the north side of the Continental fault provided a proximal source for pegmatitic and granitic boulders to the north; (3) last motion on the Wind River fault was latest early Eocene or earliest middle Eocene between Oregon and Pacific buttes; (4) the Wind River fault consists of several segments which moved separately rather than as one, long continuous zone of concurrent faulting; (5) while the Wind River Range was being thrust to the southwest it may have been uncoupled from the basins to the south by a zone of transcurrent faulting; (6) Pliocene or younger recurrent motion along the Continental fault was opposite to that in the Eocene.

SUNDELL, KENT A., Univ. California, Santa Barbara, CA, and Ram Oil Co., Inc., Casper, WY

Volcanic Stratigraphy, Timing, and Petroleum Exploration in Southeastern Absaroka Range, Big Horn Basin, Wyoming