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## Geologic Setting of the Unconventional Antrim Gas Play, Michigan Basin

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The Upper Devonian Antrim Shale is an organic-rich marine shale that provides significant unconventional U.S. gas reserves. Gas production in June, 1994, reached 315 MMCFD from approximately 3,700 wells. The productive trend, which covers 700 square miles, occurs near the formation's northern subcrop in the Michigan Basin. The reservoir is a fractured, algal-rich, highly siliceous, pyritic shale with minor interparticle porosity. The productive trend dips basinward at a rate usually less than two degrees. Three primary factors contribute to the un-

conventional nature of the Antrim gas play;

- methane desorption from kerogen
- orthogonal regional fractures
- a portion of the gas is self-sourced from rock of low thermal maturity

The Antrim Shale represents a desorption-type reservoir, in which gas is stored primarily on the kerogen's internal surfaces through the process of adsorption. Gas desorbs from the kerogen as pressure is reduced. This is ac-

complished during production by pumping water from the fracture system to lower the reservoir pressure. Desorbed gas then migrates through the shale to the fracture system. Initial water production is dominated by flow from the fractures but it declines over time to moderate rates. Initial gas production rates rise with time as reservoir pressure falls and gas saturation builds in the fractures. Gas rates may peak in a few years, then slowly decline through the expected 20- to 30-year life of the wells.

### Biographical Sketches

Bruce A. Cain is a Senior Staff Geologist with Shell Western currently assigned to the Permian Basin Infield Group. Bruce received a B.S. in Geology from Kutztown University in 1975 and an M.S. in Geology from the University of Pittsburgh in 1978. During 16 years with Shell, Bruce has worked on projects ranging from the Gulf Coast Jurassic and Cretaceous carbonates to the Euphrates graben in Syria to the Tertiary basins of Southeast Asia. Bruce is active with the Gas Research Institute and is contributing to the forthcoming SPE publication *Fractured Shale Reservoirs*.

Charles J. Kaiser is a Senior Geologist with Shell Western currently assigned to the Michigan Engineering Group. Charles has a B.S. degree in Geology and Geophysics from the University of Wisconsin, Madison, a M.S. degree in Geology from the University of Michigan, and a Ph.D in Geochemistry and Mineralogy from the Pennsylvania State University. Since joining Shell in 1988, he has worked on projects in the Michigan Basin, the Gulf Coast, and the Southern Appalachians.

Mark G. Picha is also a Senior Geologist with Shell Western in Houston working in the Unconventional Resources Group. Mark received his B.A.

in Geology from St. Thomas University in 1980 and his M.S. in Geology from the University of New Mexico in 1982. During his 12 years with Shell, Mark

has explored for conventional and unconventional sources of oil and gas in the Rocky Mountains, California, and the Mid-Continent.