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Geologic, Technologic, and Economic Aspects of Deep Natural Gas Resources in North America

Deep natural gas resources are widespread and occur in either conventionally-trapped or unconventional basin-center accumulations that are essentially large single fields having spatial dimensions that often exceed those of conventional fields. In 1996, the USGS estimated that 114 Tcf of deep technically-recoverable conventional and unconventional gas remains to be discovered in onshore areas and State waters of the U.S. An additional 22 Tcf of undiscovered conventional gas remains to be discovered in priority provinces in Canada and Mexico according to the USGS World Petroleum Assessment 2000. Based on a geologic analysis of deep plays and assessment units, many North American basins hold promise for future exploration and development. Factors contributing to the generation of deep gas include the thermal stability of methane, the role of water and non-hydrocarbon gases, porosity loss with increasing thermal maturity, kinetics, thermal cracking of oil to gas, and source rock potential based on thermal maturity and kerogen type. Recent experimental simulations using laboratory pyrolysis methods on oil and source rocks have provided much information on the origins of deep gas. Technologic and economic problems offer significant challenges to deep drilling. For successful well completion, problems associated with overcoming hostile drilling environments (e.g. high temperatures and pressures, and acid gases such as CO₂ and H₂S) present the greatest obstacles to developing deep gas fields. Even though the overall success ratio for deep wells is about 50 percent, a lack of geologic and geophysical information such as reservoir quality, trap development, and gas composition continues to be a barrier to deep gas exploration. Results of recent finding-cost studies by depth interval for the onshore U.S. indicate that, on average, deep wells cost nearly 10 times more to drill than shallow wells, but well costs and gas recoveries vary widely among different gas plays in different basins.