

Unconventional shale gas and oil resource systems

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Shale, or more accurately mudstone, with high petroleum content or potential is often described as oil shale, shale oil, shale gas, or simply shale resource plays. In this paper the term kerogen oil resource system is used to describe a continuous resource system requiring anthropogenic heat input, whereas the terms shale resource system, shale gas and shale oil are used to describe systems that can produce petroleum without additional heat input or "cooking". This paper is focused strictly on shale resource systems that contain naturally occurring gas and oil in potentially producible amounts. As such these systems can be described as continuous organic-rich petroleum source rocks that may also have juxtaposed (overlying, interbedded, or underlying) organic-lean rocks both of which may contain naturally occurring oil and gas in commercial amounts. In a very general sense these are classified as being continuous systems (1) an organic-rich mudstone (M), (2) a naturally open-fractured organic-rich mudstone (FM), (3) or a hybrid containing organic-rich and organic-lean intervals that are juxtaposed to one another (H). Examples of M include the Barnett, Fayetteville, Marcellus, Haynesville, and Tuscaloosa Marine shales; FM examples include the Monterey, Bakken, Niobrara, and Pierre shales, and H examples include also the Bakken and Niobrara, but also the Eagle Ford and Montney shales. A key difference between M or H versus FM is the need for high energy stimulation in order to achieve the maximum contact with the tightly held and isolated micro-reservoirs within the shale or shale hybrid system. Horizontal drilling alone is not the reason for success as Barnett and Bakken horizontal wells were poor performers through most of the 1990s until high-energy stimulation was utilized with multiple stages. Shale resource systems are highly variable in their characteristics and also their production volumes, which result from a variety of geological, geochemical, and petrophysical characteristics as well as the completion method. These variables are compared for elucidation of key characteristics by play and play type (gas or oil).