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Anatomy of Flat Spots

Seismic flat spots are caused by the interface between two different types of fluids in a reservoir. They are recognizable when the reservoirs are more than twice the seismic tuning thickness and relatively soft. This phenomenon is frequently used as a direct hydrocarbon indicator (DHI) in conjunction with seismic amplitudes and AVO techniques in exploring for hydrocarbons. Flat-spot recognition has been particularly successful in the North Sea where it has been applied to both exploration and reservoir monitoring (e.g., the Gannet-C Field). Sometimes, however, seismic reflections caused by other phenomena, such as remnant multiples and lithology variations, have been misinterpreted as fluid contacts simply because they look flat seismically and show up in the downdip location, leading to drilling of unsuccessful prospects. To help understand the characteristics of flat spots and reduce the risk of misidentifying fluid contacts, some theoretical analyses and synthetic seismograms are presented that will help characterize a genuine flat spot. The primary findings of this study are that flat spots: (1) are rarely flat in time; (2) are always positive in amplitude; (3) always show increasing amplitudes with offset; and (4) always show tuning effects at the extremities of the fluid wedge. Synthetic seismograms and case studies from a variety of basins will be shown to help shed light on essential flat spot characteristics.