

GC Flat Spots Are Not Always Flat

By
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General Statement

Everyone has heard of a flat spot, so, interested as we are in hydrocarbons, we tend to look for something flat! Also, flat spots have some mystical appeal for explorationists. A flat spot is, of course, the seismic expression of a fluid contact, and normally the fluid contact will be flat.

Within the complexities of the seismic response are many reasons why a fluid contact reflection may not be flat; so “flat spot” is actually a rather poor name. Velocity of the hydrocarbon in the reservoir, velocity effects in the overburden, and tuning effects all can introduce significant dip. Unconformability rather than flatness is the important property of a fluid contact reflection in seismic data.

Examples

Figure 1 shows some gas reflections from the Nile Delta in Egypt. The high amplitude red reflection is from the top of the gas in an anticlinal trap. The high amplitude blue reflection is from the base of the gas -- in other words, from the fluid contact. This fluid contact reflection is significantly un-flat, bowing down in the center where there is maximum thickness of low-velocity gas sand.

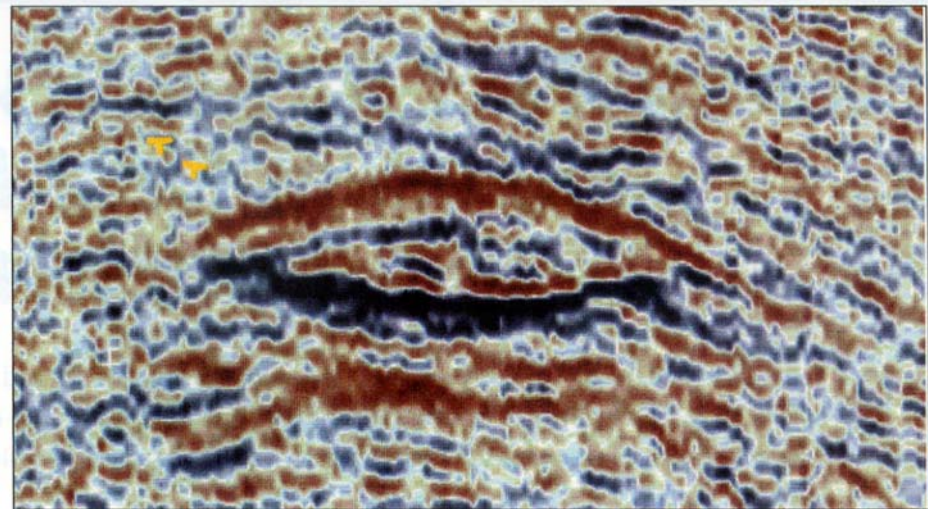


Figure 1. Gas reflections from the Nile Delta in Egypt. The high amplitude red reflection is from the top of the gas in an anticlinal trap. The high amplitude blue reflection is from the base of the gas -- in other words, from the fluid contact. (Courtesy of BP [Amoco Egypt]).

Figure 2 shows a prominent fluid contact reflection from the Gulf of Mexico. It might be interpreted by some as multiple contacts, suggesting that there are multiple reservoirs.

This is, in fact, a single contact affected by a tuning phenomenon. The strong reflections dipping down to the east above the contact are internal reflections that are caused by "illumination of internal layering." In a thick clastic reservoir, this is a fairly common effect of gas. The strong internal reflections then interfere or tune with the fluid contact reflection causing these apparent steps in the contact.

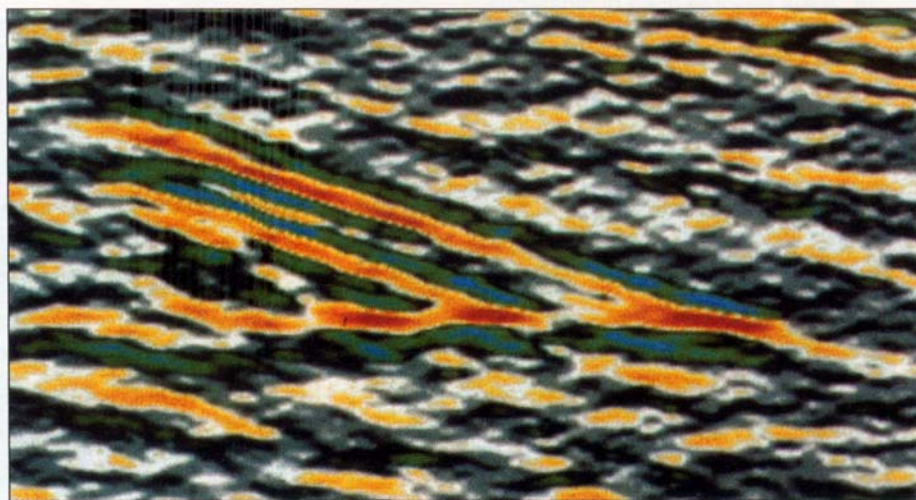


Figure 2. A prominent fluid contact reflection from the Gulf of Mexico. It is, in fact, a single contact affected by a tuning phenomenon. The strong reflections dipping down above the contact are internal reflections caused by "illumination of internal layering." (Courtesy of ChevronTexaco [Chevron USA]).

Figure 3 shows a flat spot associated with a bright spot in offshore Indonesia. The flat spot is fairly flat, but actually dipping slightly to the left -- that is, against structure. This again is the effect of the gas within the reservoir. There is a clear top and base gas reflection, as there should be.

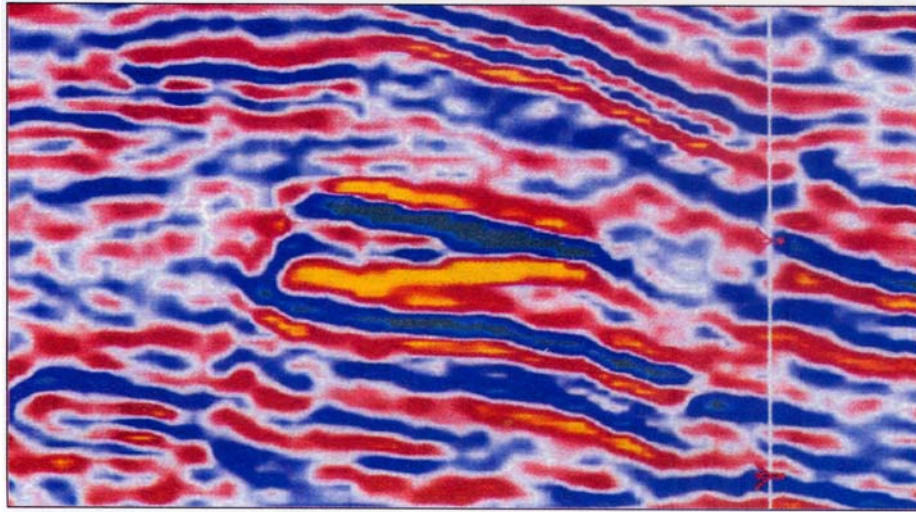


Figure 3. A flat spot associated with a bright spot offshore Indonesia. The flat spot is fairly flat, but actually dipping slightly to the left -- that is, against structure. (Courtesy of Premier Oil Natuna Sea).

Concluding Remarks

A flat spot should never be sought or studied in isolation from the other reservoir reflections. The key is to see the flat spot at the downdip limit of brightness and fitting in between the top and base reflections. The whole package of reflections must always be studied together. The character and color of the reflections is also of the utmost importance and this depends on the phase and polarity of the data, but this is the subject of another article.

Flat spots are wonderful indicators of hydrocarbon, but please consider all the characteristics of the reservoir reflections together. Remember, flat *spots* don't have to be flat, but they do have to be discrete and fit with top and base reflections.