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Surface Seep Gas Signals in Relation to Reservoir Pressure: Surface Gas Expression Built-Up and Decay of Over Fields

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Summary

Micro-seep gas surveys have been in use as an aid to exploration for decades; however, the interpretations of surface gas readings are often controversial. This is mainly due to various sources of HC gases at depth, reservoir sealing properties, and the history of micro-fracture pattern in overburden sediments. Last, but not least, reservoir geometry and reservoir conditions at depth are considered to play a role in the possible expression of seep gas signals over the field at or near the surface.

Based on numerical data processing techniques which eliminate surface noise HC gases from valid HC gases of seep origin, we demonstrate the significance of the original reservoir pressure for the recognition of active seepage and the interpretation of often complex surface gas readings.

Three case studies are used here:

- The Kisbey oil field in Saskatchewan, Canada, was a normally pressured oil field with API and GOR values typical for the region when discovered in 1985. A first surface gas survey in 1987 during the initial stage of reservoir development clearly demonstrated active gas seepage from the reservoir body at roughly 1500m depth. In addition – and also confirmed from a number of subsequent surveys – the seepage patterns over the field indicated additional reservoir potential to the NE and SW. Subsequent full reservoir development of the field confirmed this surface gas pattern previously observed. However, these subsequent surveys over the years also showed a slow surface seep gas decay as the field was developed and exploited under long-term reservoir pressure drop coning of 25-30% of the original reservoir pressure. The field is now depleted and a most recent survey shows a more or less complete surface seep loss over the depleted reservoir body.

- A second case study is from the ultra-shallow Rainbow gas field of NW-Alberta where shallow thermal reservoir gas from the field appears to be in a dynamic equilibrium of continuous reservoir gas supply from depth and reservoir gas loss towards the surface. The seep gas response over this field was extreme before discovery, but completely collapsed with the depletion of the field.

- A third example is from the deep, but highly overpressured Devonian Berland River / Alberta gas pool, resulting in a prominent seep gas expression at surface despite the reservoir depth.

Based on the observations from the three case studies, several conclusions can be drawn:

- Surface gas data need extensive "clean-up" procedures to distinguish seep from non-seep HC gases
- As expected, shallow pools show more intense surface gas signals given otherwise identical conditions.
- Reservoir gas pressure is a key factor for the expression of surface seep signals. Reservoir depletion associated with reservoir pressure drop results in a rapid decay of the surface seep gas signal.