Linear model for low frequency pore liquid oscillations observed in Hydrocarbon Microtremor Analysis (HyMAS)

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Hydrocarbon Microtremor Analysis (HyMAS) is an innovative passive technology identifying the hydrocarbon content of geological structures by analyzing low frequency seismic signals. Hydrocarbon indicating information is extracted from spectral modifications of naturally occurring seismic background noise waves in the 0.01 – 10 Hz range passing through hydrocarbon bearing porous structures.

In this paper, a simple description of this reproducibly observable phenomenon in terms of a one-dimensional linear model of an oscillating liquid filled porous medium is presented and its relevance for an explanation of the underlying basic HyMAS signal creating mechanisms and related parameters are discussed. Observed values of about 3 Hz for the oscillation and $2 \cdot 10^{-6}$ m/s for the amplitude of the vertical surface movement velocity could be reproduced by introducing realistic parameter values for the geophysical properties in the model.

As a direct hydrocarbon indicator, HyMAS is an ideal complement to 2D- and 3D-seismic structural imaging technologies. Numerical modeling of suitable geological structures both in the macroscopic as well as in the microscopic domain shows how the seismic background noise spectrum can be modified in a different way when interacting with geological structures containing hydrocarbon filled pores compared to interacting with similar structures not containing hydrocarbons. Pure HyMAS data can already be used to qualify areas for adequate geological programs. Integrated with existing geophysical and geological data, HyMAS allows for cost and time saving optimization of well placement during exploration, appraisal and production. HyMAS is fast, safe, cost-effective and environmentally unobtrusive.