Title: Model Multiplication to Explore Uncertainty in AVA Amplitude Interpretation

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In times of data scarcity in exploration, a handful of wells, successful or otherwise, may be our only grasp on the rock properties represented by our seismic data. Given the accessibility of today's computing power, it is inexcusable to become fixated on a small number, or even single, model for the interpretation of AVA amplitudes at an early stage.

Exploring the uncertainty, and possible range of responses from viable reservoir facies and hydrocarbon accumulations can be achieved though statistical evaluation of hundreds of forward seismic models, produced by iterative, and reproducible, computational workflows on a desktop machine. The qualitative likelihood of their occurrence can then be evaluated through a geological filter.

The presentation introduces a workflow for:

1) Expansion of the observed dataset through iterative modelling, and evaluation of the model sensitivity to poorly constrained variables.
2) Generation of forward seismic models for all possible interfaces between the sampled facies/fluids though a Monte Carlo style workflow, and extraction of the AVA amplitudes for assessment of the uniquity and range of pre-stack amplitudes associated with good quality, hydrocarbon bearing reservoir.

In addition to indicating the probability of hydrocarbon presence on the basis of AVA amplitude, this workflow also allows insights into the likely reservoir quality, and potentially hydrocarbon saturation.

Expansion of the sampled dataset is achieved through iterative computation of fluid substitutions, allowing the continuous variation in properties with hydrocarbon saturation to be observed, and also the sensitivity of the fluid substitution to poorly known variables (e.g. gas-oil ratio, reservoir pressure, clay/shale parameters) to be observed, such that significant variability due to these factors can be identified and evaluated. Elastic media models, where calibrated and considered to provide a good prediction of elastic properties with varying mineralogical composition or structure, can also be used to expand the dataset in terms of observed facies.

Following expansion of the sampled dataset, the workflow considers clusters within the logs which correspond with discrete facies, which can be characterised by statistical distributions and sampled to fuel a Monte-Carlo style iterative workflow for creating half space interface models. The relative pre-stack amplitudes, and Shuey approximation of the AVA response, are extracted. The output dataset can then be queried to find whether a given response is likely to uniquely characterise a given facies or fluid, prompting the erstwhile question, "what else could it be?". The suggestions yielded by the modelling can be assessed for plausibility, taking into account qualitative knowledge of the geological environment and facies relationships, to inform the estimated change of success. The model may also be used to identify the potential range and distribution of responses yielded by good quality, hydrocarbon bearing reservoir.

Generalised Python scripts for portions of the workflow will be made freely available on github.