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Interactive comment on "Quantifying the impact of the structural uncertainty on the gross rock volume in the Lubina and Montanazo oil fields (Western Mediterranean)" *by* Carla Patricia Bárbara et al.

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GENERAL COMMENTS

Awareness about significance of structural uncertainty in the subsurface models and its effects on costly decisions has risen sharply in the oil industry over the last decade. Commercial tools to model and simulate structural uncertainty have become easily available, either as stand-alone applications or fully integrated in widely used reservoir modeling software packages. However, understanding how the uncertainties affect the

results, how to parametrize the models (determine priors, trends, variograms), or how to use results (which are probability distributions) remains a challenge. The bridge between statistics on one hand and geophysics and geology on the other is still not easy to cross for a typical geoscientist.

The paper touches upon some of these issues in an interesting case-study. It is nicely structured. It starts with a clear motivation and a nice overview over the most important elements needed to be considered. It continues with a description of the geological setting for the reservoir.

The dataset if described very shortly and lacks some important information, which should be included when assessing the uncertainties discussed in the paper.

The paper continues to discuss specifics of the uncertainty modelling for both horizons and the faults. Fault uncertainty modelling is not often included in the structural modelling, due to several reasons. The authors demonstrate the importance of fault uncertainty on the observed differences in GRV. In the interpretation of the results, the authors show how structural uncertainty affects GRV and distribution of oil in the reservoir. They use clearly the cross-sections of the reservoir, histograms and box-plots to describe the effects of structural uncertainty.

What lacks in the paper is a more detailed discussion about two important issues.

The first one is related to the specification of the interpretation uncertainty. What type of seismic survey is used? How is the frequency content related to the width of the envelopes used in manual uncertainty picking? What is the main source of uncertainty in picking top reservoir?

The second issue is related to what affects uncertainty in top structure. It is a combined effect of uncertainty in velocity model, uncertainty in well picks and seismic interpretation. For a reservoir at this depth (time), depending on the choice of velocity model, velocity uncertainty could have a much bigger impact on the structural uncertainty than time interpretation. By including only one, and leaving all others out, what may happen is often called "ballooning effect". All the other uncertainties are squeezed and their effect pops out in an ambiguous way within the time interpretation uncertainty. This might lead to overestimating the effect of picking uncertainty on the top structure.

The paper is however interesting and shads light on an important topic which needs more investigation.

SPECEFIC COMMENTS

In Section 3.1. the authors introduce uncertainty envelopes around initial horizons. They base the uncertainty on variations in diffractions and amplitude of the data. Judging from the example and illustration in Figure 4., diffractions do not seem to play a role in the picking uncertainty. In general, it is difficult to see clear footprint of diffractions (smiles) in the seismic presented in the work. What seems to guide uncertainty picking in Figure 4. is frequency of the seismic event (Top lower BTG Lubina). The lower the frequency, the higher picking uncertainty is introduced.

It is not argued why this should be the case. In broadband surveys, which contain more low-frequency information, the seismic image displays wider reflection "bands". At the same time, increased low frequency content provides higher resolution in the seismic. This means that picking visually might seem more ambiguous. At the same time, the increased resolution will improve detection of elastic changes in the subsurface.

A counter example is a conventional survey with narrow frequency band. Such a survey will suffer from dominant side lobes in the wavelet. Visually, they seem to provide higher frequency content and narrow reflection events which are easy to pick. Typically, a geologist will prefer to pick on such seismic. However, this is an erroneous assumption, which will lead to overconfidence in picking based on events which do not represent real elastic changes in the subsurface.

More information about the seismic survey, tuning effects and frequency content should

be provided to be able to specify picking uncertainty in a more confident way. As it is demonstrated in the paper, these prior uncertainties are very important away from the wells.

In Section 3.3. the prior model is presented in detail. For the spatial continuity of the residuals, spherical variogram is chosen, which is reasonable choice for this kind of applications. However, the variogram range was set to 500m, based on the argument that it should not be more than half the reservoir width (Section 5.3). The expected lateral continuity of the geological layering is mentioned but not further discussed. The range of 500m is very short for most of the structural settings. The kriged depth surfaces will be uncorrelated for distances larger than 500m. However, already at much shorter distances (e.g. 250m), spherical variogram will only require weak correlations. If the prior uncertainties are large, and there are few data points in the data set, the simulated surfaces will exhibit large depth fluctuations over short distances. On one hand, it is geologically questionable. On the other, it will lead significant local changes in GRV which might not be realistic or informative.

This is to some degree illustrated in Figure 6 (b) where significant changes in depth over short distances can be observed in some areas, which apparently are not related to fault transitions.

As the uncertainty in velocity model could strongly dominate the total uncertainty in the structure, the model needs to be presented and some discussion needs to included. The uncertainty in depth can be roughly described as $d(Z)=d(V^*t)=dV^*t + V^*dt$. Considering time of the event, average velocity and uncertainty in both variables, the effects of the two can be roughly compared.

Quite often, changing the time interpretation does not change the depth surface significantly, given a large uncertainty in the velocity.

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