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Enhanced inversion image of lithology through multi-parameter filtering

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Lithology prediction has often been done by cross-plotting elastic parameters, taken from inversion results and well logs. Obviously, it does not accounted for difference of information contents of inversion and well logs, i.e. scale, frequency content and correlation between the parameters. An alternative way is cross-plotting facies log and inversion result, but this raises the question of alignment. If misalignments is not accounted for the inversion results will be too pessimistic, if alignment is optimized this might result in a too optimistic prediction. Here, we present the multi-parameter filter introduced in Ng *et al.* (2008) for enhanced inversion image of lithology, when we estimate facies probability from inverted elastic parameters based on the Bayesian AVA inversion method by Buland *et al.*, 2003. This filter defines what information content the inversion is able to capture, i.e. inversion resolution. It gives a realistic and proper picture of what we can obtain from seismic data and inversion. To obtain facies probabilities from posterior distribution and well log information, we use a local point-wise approach. Based on the difference in the prior and posterior covariances, we can define the filter we mentioned above. Formally written as $\hat{m} = Fm$. The filter is such that it shrinks the information content of the well-log m to match the information content of the inversion $\hat{m}$. The filter does this such that it preserves the structure of the well-log. Since we use the approach of Buland *et al.* (2003) we can work on each frequency k separately. From inversion, the resolved covariance is defined as the difference of the prior and the posterior covariance, $\Sigma_r = \Sigma_m - \Sigma_{m|d_{obs}}$. It shows the information that has been resolved by the inversion. With that using Cholesky and eigenvalue decomposition, we are able to define the filter. It can be verified that if the parameter m has covariance Σ_m, then the filtered parameter Fm has variance Σ_r.

This method has been tested on a real data set. From cross-plots of residuals for raw logs and logs filtered to seismic resolution, we see that the frequency filtered logs will be different from what we get from the inversion, due to correlation between the parameters has not been taken into account. From this study we have shown that it is possible to estimate realistic probabilities for different facies using Bayesian inversion, Bayesian updating and multi-parameter-filtering. It is demonstrated that only filtering the elastic parameters to inversion frequency will give not us a correct picture of elastic parameters from the inversion. When taking both frequency and correlation into account, we are able to get a proper estimate of facies probability from posterior distribution of elastic parameters.

References: Ng S., Dahle P., Hauge R., Kolbjørnsen O., *Estimation of facies probabilities on the Snorre field using geostatistical AVA inversion*, SEG Annual Meeting, SI4 AVO, Laplace, Others..., 2008 and Buland A. and Kolbjørnsen O. and Omre H., *Rapid spatially coupled AVO inversion in the Fourier domain*, geo, **68**, 2003, 824–836