Mapping the sand/shale distribution in the Blackfoot field - a geostatistical approach

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ABSTRACT

In oil exploration, our data usually falls into two categories: sparse but accurate well logs and dense but inexact seismic traces. A geostatistical approach allows us to merge the data sets and create detailed geological images.

In the current case, a Vp/Vs data set from seismic isochrons and fractional percentage shale values, estimated from gamma ray logs, was used to generate a fractional percentage shale distribution map of Mississippian to the top of a glauconite sand channel event in Blackfoot area, Alberta.

INTRODUCTION

Geological maps based on sparse well logs depend heavily on the location, since large areas are not covered by any data points. Unlike well log data, seismic data often provide a good coverage of the exploration area but are contaminated with noise, phase error, etc. The geostatistical approach allows us to obtain detailed maps, combining both data sets. In our work we will use cokriging to generate fractional percentage shale distribution map of Mississippian to Top Channel event using gamma ray logs data and Vp/Vs ratio computed for Wabamun to Top Channel event in the Blackfoot area, AB (Township 23, Range 23 W4).

METHODS

Fractional percentage shale (FPS) of Mississippian to Top Channel event in Blackfoot area was estimated from nine gamma ray logs using the following expression:

$$FPS = \frac{GR\log - GRsand}{GRshale - GRsand}$$

The results are shown in Table 1.

well	14-09	08-08	16-08	01-17	09-17	05-16	01-08	12-16	04-16
FPS	0.54	0.37	0.43	0.49	0.57	0.61	0.33	0.64	0.42

Table 1. Fractional percentage shale

Vp/Vs ratio values of Wabamun to Top Channel event were calculated from a 3C-3D seismic survey in the same area (Figure 1) The cross plot of the two data sets a showed cross-correlation coefficient of 0.71.

Cokriging is a procedure by which we estimate an unknown value on a map by linearly weighted sum of the existing values. For two sets of data u and v, it would involve double set of weights, a and b:

$$u_0 = \sum_{i=1}^{n} a_i u_i + \sum_{j=1}^{m} b_j v_j$$

The solution of the problem involves minimizing the error variance, which can be expressed as a covariance function. Once we have derived the covariance functions of the two data sets, performing cokriging is a straitforward task.

The "Geostat" software package from Hampson-Russell was used to calculate three variogram functions: well-to-well, seismic-to-seismic, and well-to-seismic. The cokriging procedure was used to generate distribution of fractional percentage shale map (Figure 2). The cokriging error is shown on Figure 3.

CONCLUSION

Cokriging interpolation method can be used successfully to generate detailed fractional percentage shale maps, based on gamma ray log data and Vp/Vs ratio computed from 3-D seismic survey.

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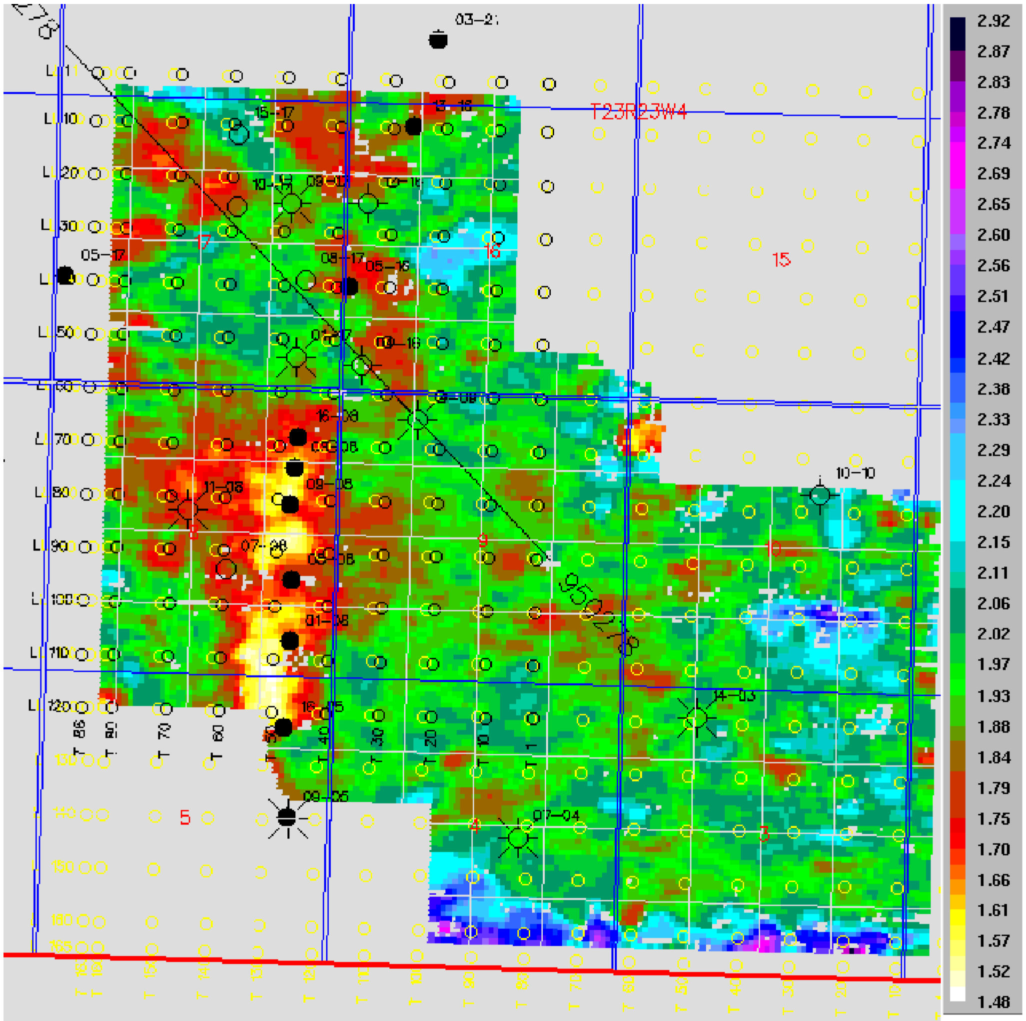

Fig. 1. Vp/Vs derived from P-P and P-S isochrons , the Wabamun to the Top Channel.

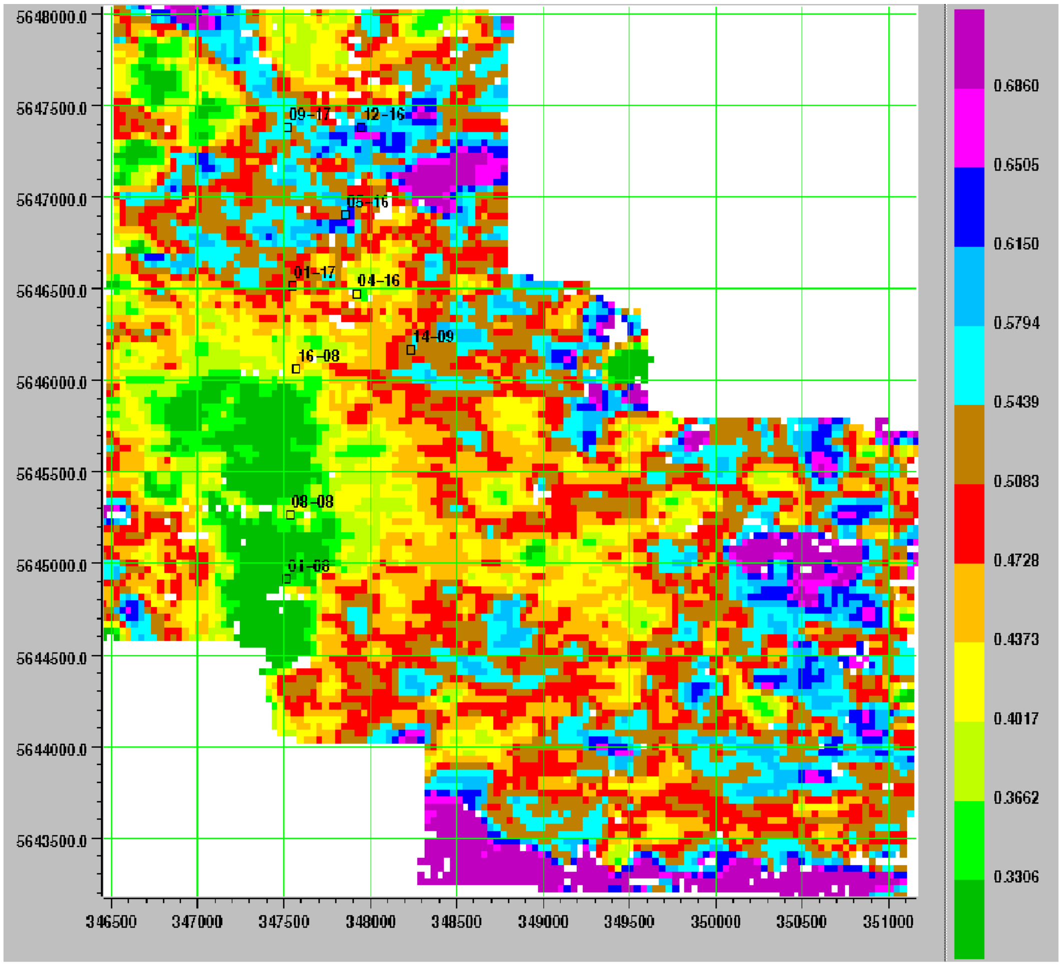

Fig. 2. Distribution of fractional percentage shale from cokriging of wll log data and seismic Vp/Vs values.

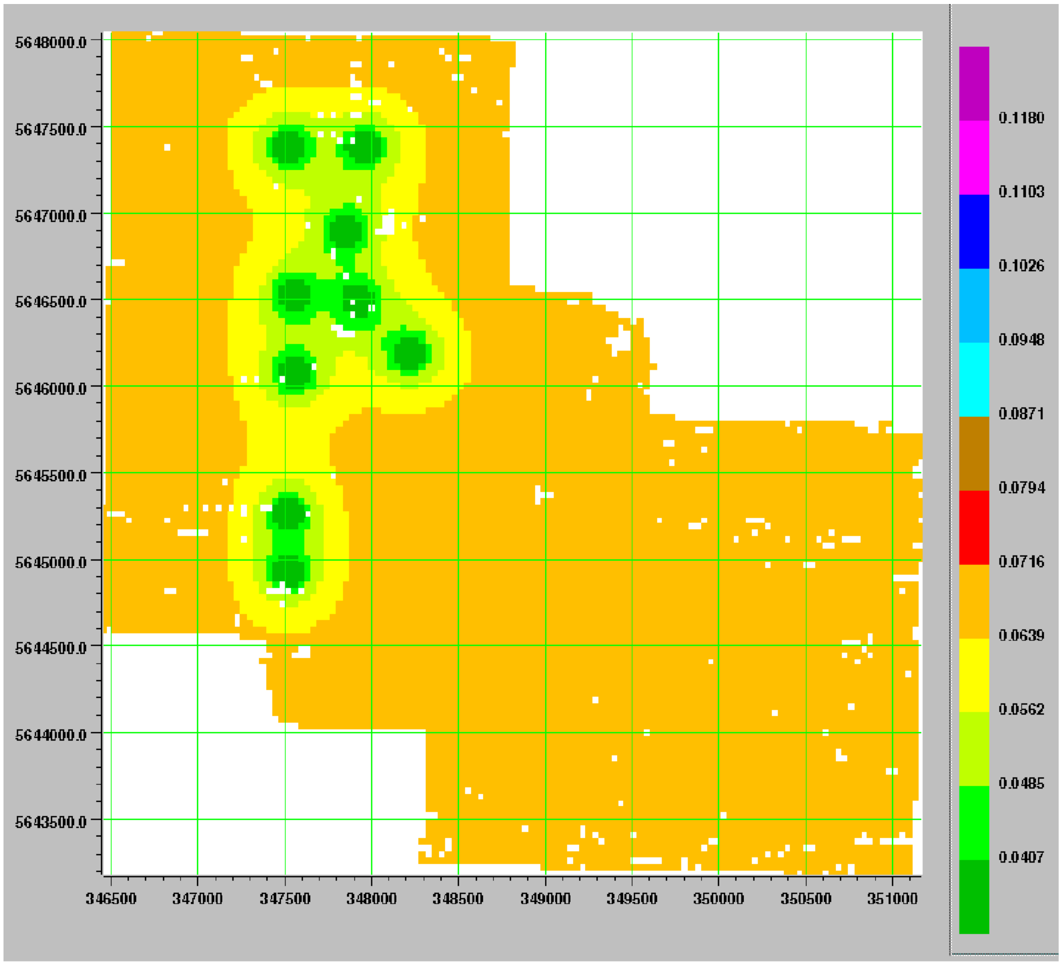

Fig. 3. Distribution of fractional percentage shale error.