UDC 550.1

INFLUENCE ESTIMATION OF SEISMIC DATA UNCERTAINTIES ON OIL IN PLACE CALCULATION

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Abstract. *The article presents an analysis of influence of uncertainties in seismic data on geological model and calculation of oil in place (OIP). This analysis was used during the work of oil in place calculation of Kynskoe oilfield. It is presumed to construct a number of velocity maps by stochastic method then a number of structural maps and as a result several different variants of OIP can be calculated. In order to find an aggregate result there should be constructed a distribution of OIP and the mode is the net result. The described method permits estimating a confidence level of reserves and to get the most realistic figures of OIP.*

Keywords: *calculation of oil in place***,** *uncertainties in seismic data, distribution, structural maps, stochastic method*

Results of oil in place (OIP) estimation is influenced by not only volumetric parameters such as porosity, oil saturation, net to gross but also location of oil water contact (OWC) and closure structure of the productive formation. Uncertainties in determination of these geological parameters can produce a large mistake in OIP calculation. Results of geological reserves calculation of Kynskoe oilfield had a great data scattering. This problem is associated with uncertainties in structural construction.

Construction of formation top and base structural maps is one of the major parts of geological reserves estimation process. Results of interpretation of 3D seismic surveys are the input data for structural maps building but the mistake can achieve a great values. Usually, structures are built on a base of velocity maps with aid of different methods of interpolation: kriging, co-kriging, inverse distance method, cubic spline etc.

So, for the areas with rear well network the uncertainty increases.

In order to solve this problem it is necessary to analyze an influence of original seismic data on geological model, results of oil in place calculation and to choose the most correct method for geological reserves estimation.

Kynskoe oilfield is located in Krasnoselkupskij area of Yamalo-Neneckij Autonomous district of Tumen region. It was discovered in 1982.

2D and 3D seismic surveys were performed there during 2002-2003.

Analysis of structural maps based on 3D seismic and well tops in new drilled wells indicated the following moments:

1. well tops and structural maps are not coincided;

2. due to the reason that the area of oil deposit exceeds the area of 3D seismic, so 2D seismic have a great significance.

As a result, it was decided to circumstantiate a structural and tectonic model of the field. First of all, in 2009 3D and 2D seismic data were re-interpreted on a base of whole available data set. The main issue of this stage was the most correct data matching of 3D and 2D seismic data. There was evaluated closure error between 2D seismic lines and 3D seismic cube. These errors were minimized that permitted increasing of investigating area.

Traditional approach for structural maps construction presumes building of isochrones maps using correlation of reflection horizons and then multiplying of these maps on velocity maps.

As input data for the structural buildings there were used well tops and reflection horizons. These operations were performed in GeoGlobe software (developed by OOO "RN-UfaNIPIneft"). In order to switch over seismic time data into depth vertical seismic profiles were used. Well tops of productive formations were detected in appraisal wells. Averaged velocity maps were constructed by interpolation method in association with data from deep wells located inside of the investigating area. Assessment of accuracy of structural constructions was performed using intrinsic convergence of seismic and well data.

Velocity maps in edge zones of the area were built using reference points which were calculated from regression formula $H=f(to)$ (Fig. 1).

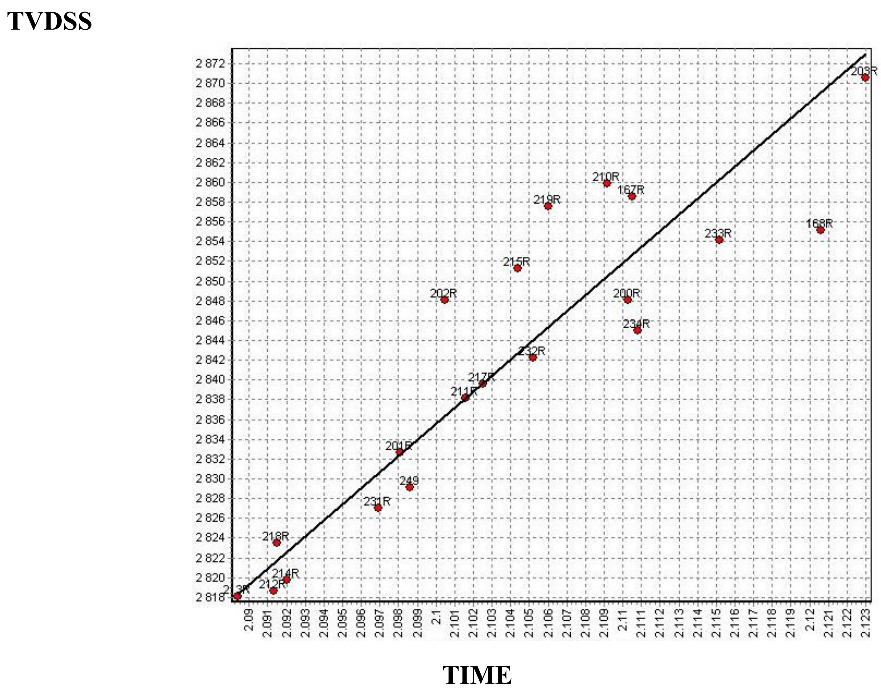

Fig. 1. Plot of relationship between seismic waves travel time and TVDSS of productive horizons

As it can be clearly seen on the Fig. 1, there can be a number of variants of trend-line and as a result a number of structural surfaces.

Histogram of velocity values distribution (Fig. 2) indicates that the velocity, calculated by interpolation corresponds very poor to values measured in wells.

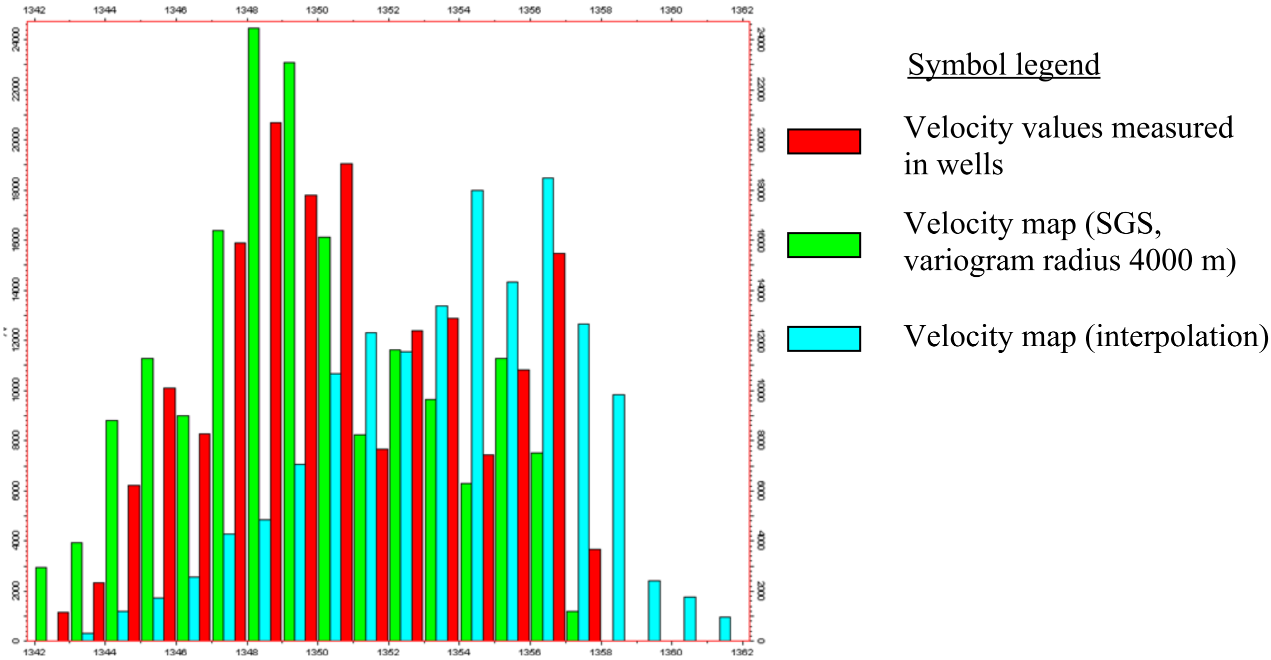

Fig. 2. Histogram of velocity values distribution

In a result it was decided to construct velocity maps by stochastic modeling which describes wells values more correct (Fig. 3). Previously, the method has been realized in the INPRESS interpretation software, in this case it was used Petrel software.

Variogram analysis was performed during stochastic modeling (variogram radius is 4000 m).

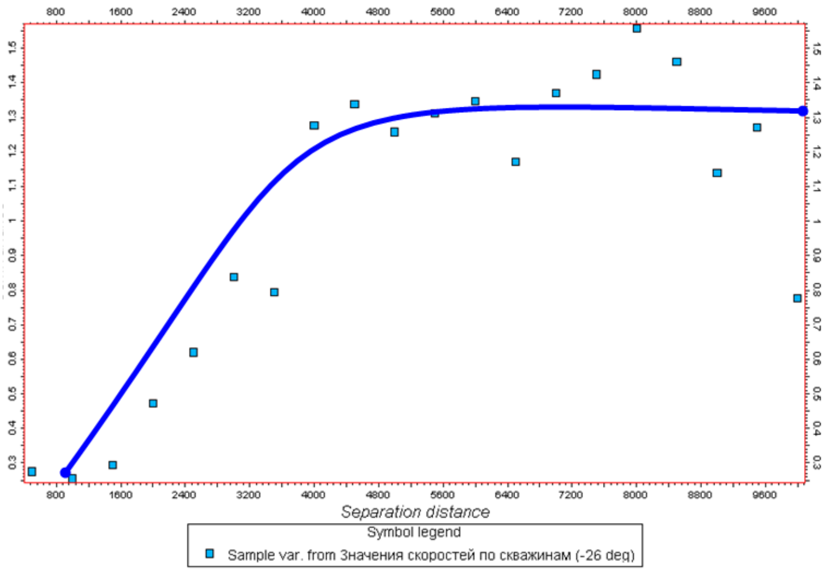

Figure 3. Variogram built on values from wells

There were constructed several realizations of velocity maps by stochastic modeling. Then structural maps were calculated by multiplying the velocity maps on isochron map. The next step was an estimation of pore volume of the reservoir above the OWC.

For the optimization of this routine procedure (construction of structural maps) there was built workflow in Petrel software which included some general stages:

1. Velocity maps construction.
2. Structural maps construction.
3. Oil in place calculation.

There is a histogram below of net pay volume distribution which permits estimating reliability of structural constructions (Fig. 4). The mode of the distribution is the most realistic value of net pay volume.

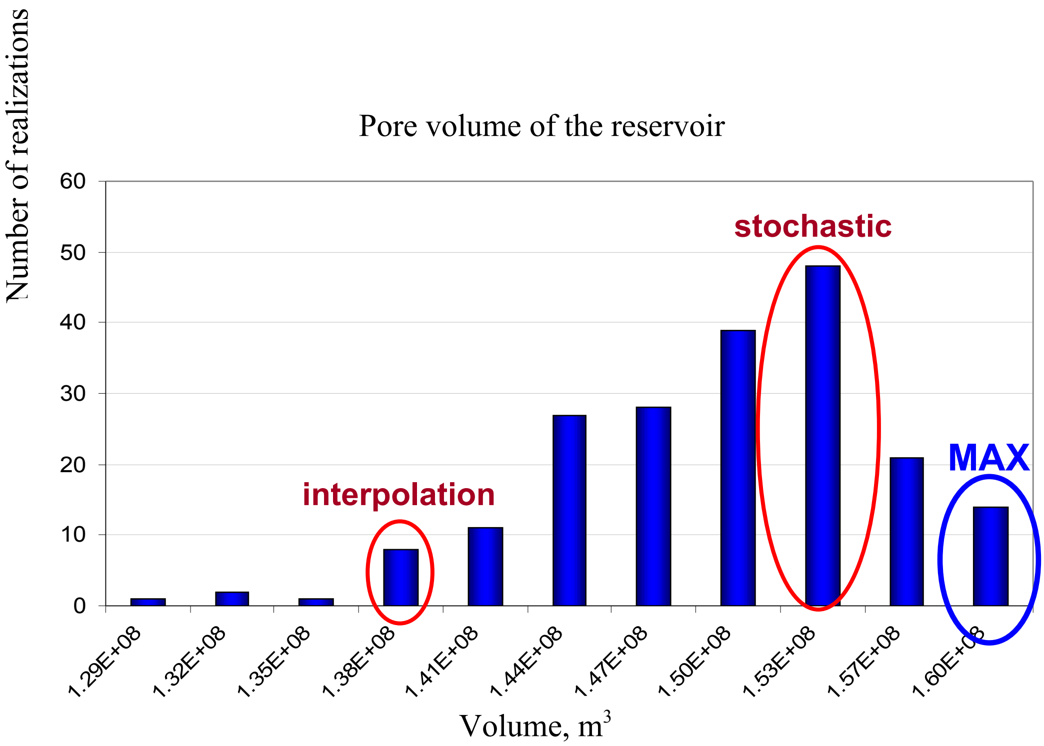

Fig. 4. Histogram of net pay volume distribution

With a probability of 90 % the net pay volume will be located inside the interval of values 1.41 - 1.44 * 10^8 m^3 (Fig. 5).

Oil in place calculated by stochastic method is confirmed with a probability of P50. So, the net pay volume is not less then 1.41 * 10^8 m^3 with a probability of P90. This fact proves that the interpolation method is incorrect (Fig. 4). It means that the construction of structural maps by interpolation method could result in decreasing of OIP. By stochastic method it was estimated that the most realistic value of OIP will be in case if the net pay value equals 1.53*10^8 m^3.

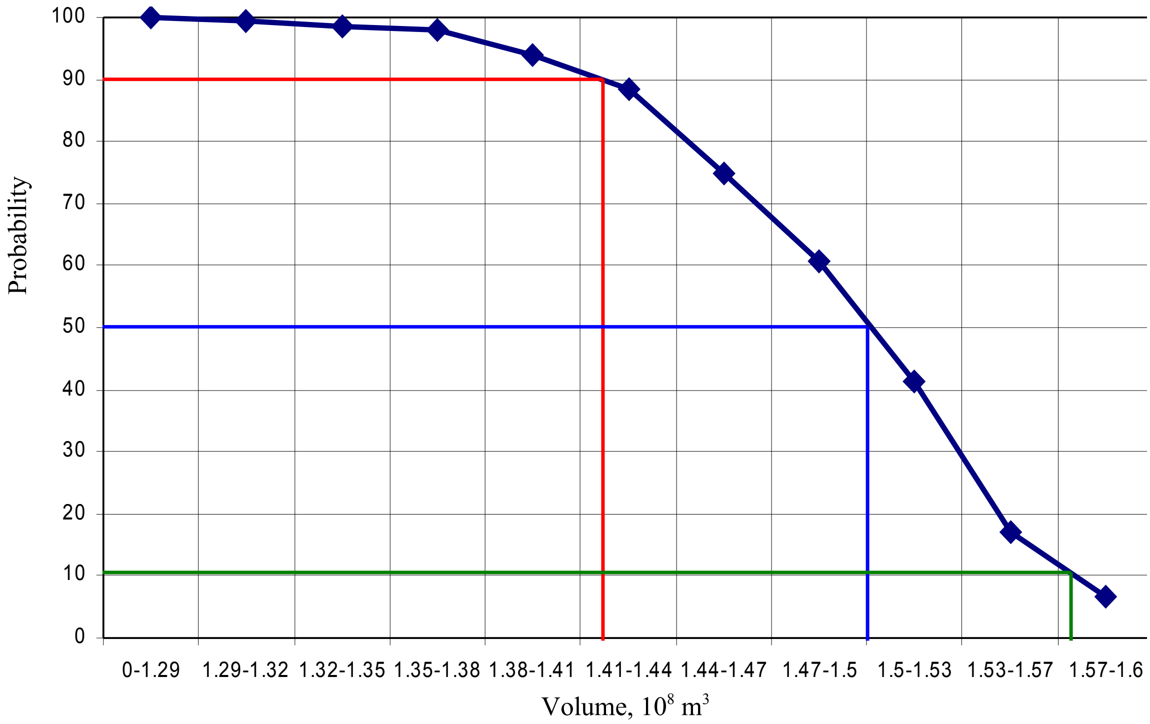

Fig. 5. Net pay volume distribution

The form and the area of oil-drainage boundary depend on structural surface and as a result for each realization of structure there will be its own variant of contours and OIL will vary. As it known, marginal zones are characterized by greatest uncertainty. To minimize an influence of this uncertainty it is proposed to average a set of maps which characterized by the most probable reservoir net pay volume and the resulted map will be the most probable realization of structural map. It can be seen that this map include perspective zones as against the map built by interpolation method.

Conclusion

Stochastic approach for the structural maps modeling is the most appropriate method especially for oilfields with the lack of information. It is very important to take into account all available set of data and estimate uncertainties impact onto final result. It is obviously that the correct OIP estimation is affected not only by uncertainties in structural modeling but also uncertainties in poroperm properties.

This article describes a method which permits to estimate an impact of uncertainties in seismic data on results of OIP calculation. As an example it was used one of the productive formations of Kynskoe Field. There were proved that the interpolation methods could lead to decreasing of OIP value, but on the other hand stochastic approach gives more information about probabilistic distribution of reserves.

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