PRODUCTION FORECAST

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Introduction

TGS Production Forecast creates projections of producing oil and gas data streams, which allow the calculation of Estimated Ultimate Recoverable (EURs) and other values needed to perform well and field evaluations. The projection of oil and gas data can be very difficult because of the variety of reservoir and outside influences that can change producing trends. Production Forecast is designed to recognize production variations and to forecast future production based on the best available data.

Production Forecast accomplishes this through proprietary algorithms which include the use of extended Kalman filters and heuristic rule-based decisions. This is the first time, to our knowledge, that these techniques have been utilized in oil and gas forecasting. There are six different steps in the Production Forecast process, which are outlined below.

1. Data Conditioning

Data conditioning involves the removal of leading, trailing and embedded zeros and outlier data points. Figure 1 shows a curve before and after data conditioning. The original data is shown as a dashed line, the conditioned data is drawn over it as a solid line. Outliers are rejected based on their distance from a smoothed version of the data.
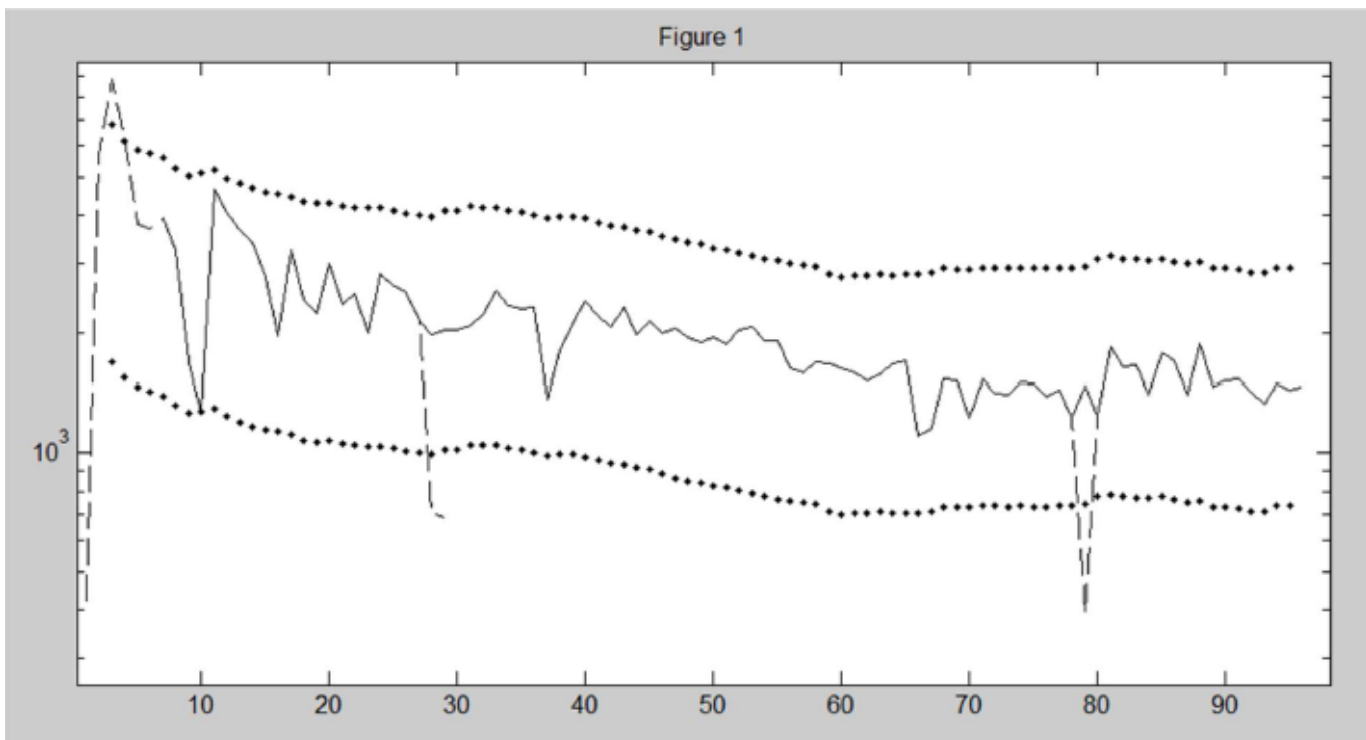
Figure 1

2. Curve Characterization

Curve characterization is chiefly concerned with the problem of finding an appropriate location in the historical data to begin the Kalman filter curve fit. In the ideal case, the data resembles Figure 1. That is, there is a short initial uptick followed by a decline, but the starting point for curve fitting is the obvious initial maximum in the conditioned data.

A more typical case is illustrated in Figure 2. In this data there are two major discontinuities in the production history indicated by the arrows. We would like to identify these points and evaluate them as possible starting points for curve fitting. In this case, we would use the second point, since there is sufficient data following it to indicate a continuing trend.
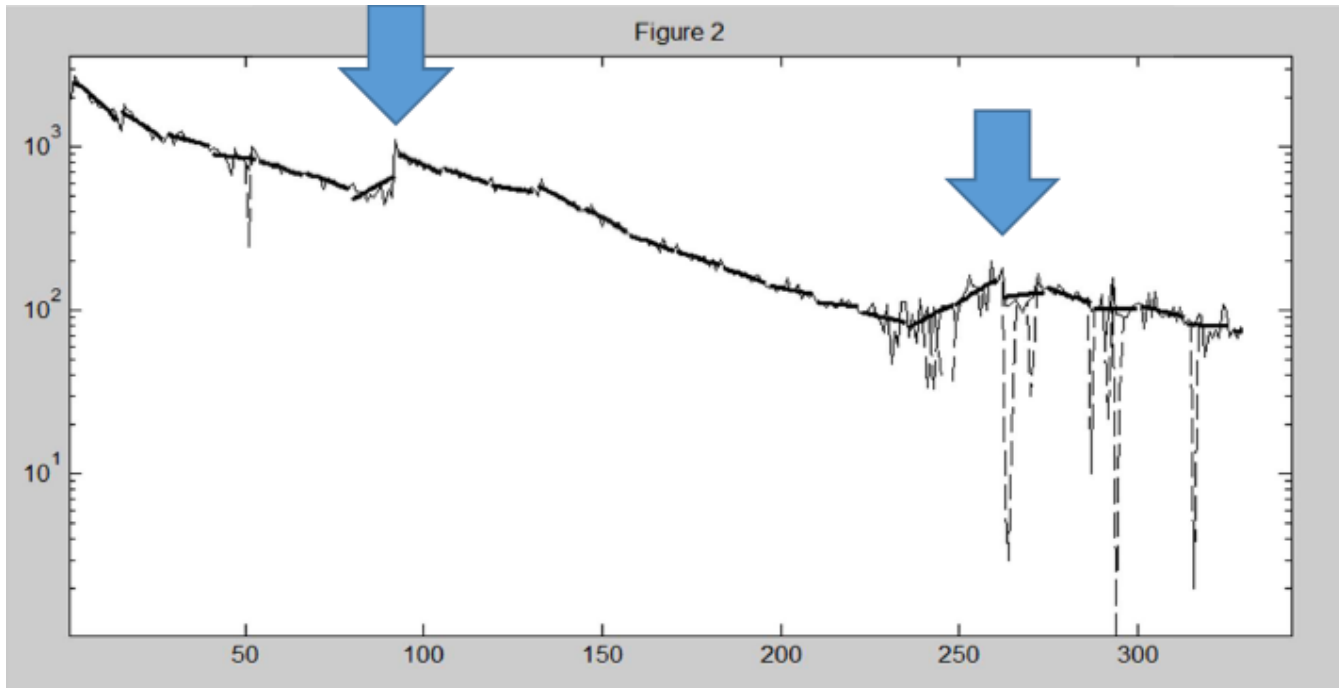
Figure 2

In curve characterization, short segments are fitted to the conditioned data. These are shown in Figure 2 as wide lines over the data. These segments are used for rapid identification of regions of interest in the data. Once identified, more complex analysis can be carried out on limited regions of the data to identify the conditions for specific rules which affect processing.

3. Type Curve Libary

Production Forecast creates a type curve library based on county and formation for the dataset it is running against, usually a state. Production Forecast evaluates the initial production for each well/lease stream to determine if the initial data is consistent enough to be used in the type curve generation. If the analysis of the initial production data results in a reasonable curve fit then that projection is included as part of the type curve library and the curve parameters are stored to the database. If the initial production data does not result in a reasonable trend then that well/lease is excluded as part of the type curve calculations.

4. Curve Fitting

In curve fitting, the Kalman filter is used to attempt to estimate the parameters of a specific model curve which describes the data. A certain number of data points are required for the Kalman filter to function properly. If a well has limited production history, such as a very new well or a well with a major production change, a least squares fit is used to determine initial rates and then the projection is based on the curve in the type curve library. The type curve library is very useful for conditions like the need to forecast undrilled locations. The utilized projection is then written to the production forecast table as monthly values for the full time of the evaluation period and the individual curve parameters are written to the database.

If the data follows the curve being modeled, the Kalman filter will produce a result equivalent to a least squares fit. Figure 3 shows data from a well that is extremely close to an actual hyperbolic curve with n approximately 0.3. The dashed line shows the result of a gradient descent optimization of the least squares difference between the data and a hyperbolic function. The solid line is the result of the Kalman filter for the hyperbolic projection.

Figure 3
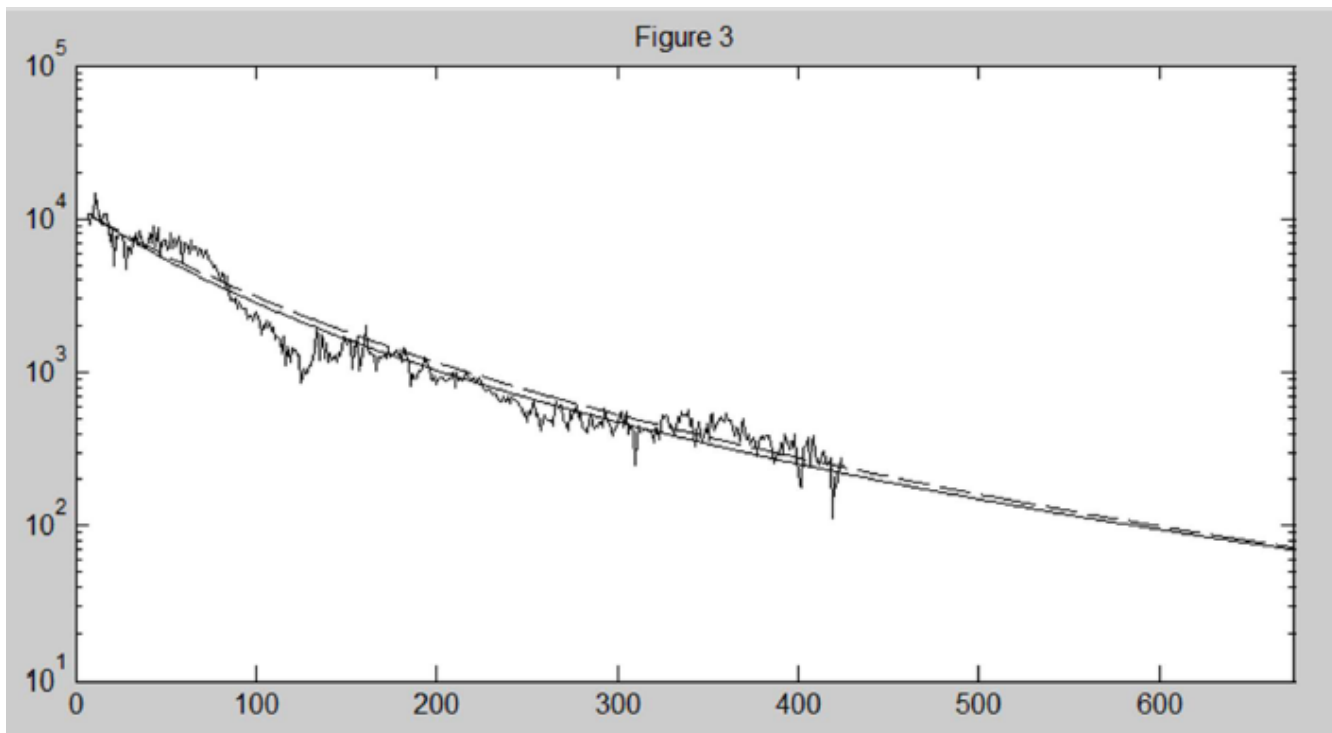
5. Economic Limit

Production Forecast processing includes a calculation of the economic limit. This economic date is calculated based on a number of different factors. The most significant factor is the forecasted oil and gas production. The estimated operating costs are part of the type curve library and have been generated primarily on well depth but are also adjusted based on the GOR to determine if the well is primarily an oil or gas well. Oil and Gas prices also play into the economic limit calculation. The utilized oil and gas prices can be changed to reflex changing economic conditions.

This calculation is made on each well/lease and applied to the forecast streams for that well/lease. That means is that any forecasted production is "zeroed out" after the economic date. If the economic calculation determines that the well is currently uneconomic than the forecast is limited to six months.

6. Statistics Table

The last step of the Production Forecast process is to generate statistical table of the cumulative production, estimated remaining reserves and the estimated ultimate reserves. These values are all written to the database. Also calculated are a series of helpful values like max rates, BOE values, GORs, Yields and other historical production cumulative values.

Forecast EUR Values:

▪ Forecast Oil Remaining	▪ Forecast Oil Ultimate
▪ Forecast Gas Remaining	▪ Forecast Gas Ultimate
▪ Forecast Water Remaining	▪ Forecast Water Ultimate
▪ Forecast BOE Remaining	▪ Forecast BOE Ultimate

Longbow Visualization Examples:

EUR Sweet Spot Map - Identify spatial patterns of High and Low Well Performance
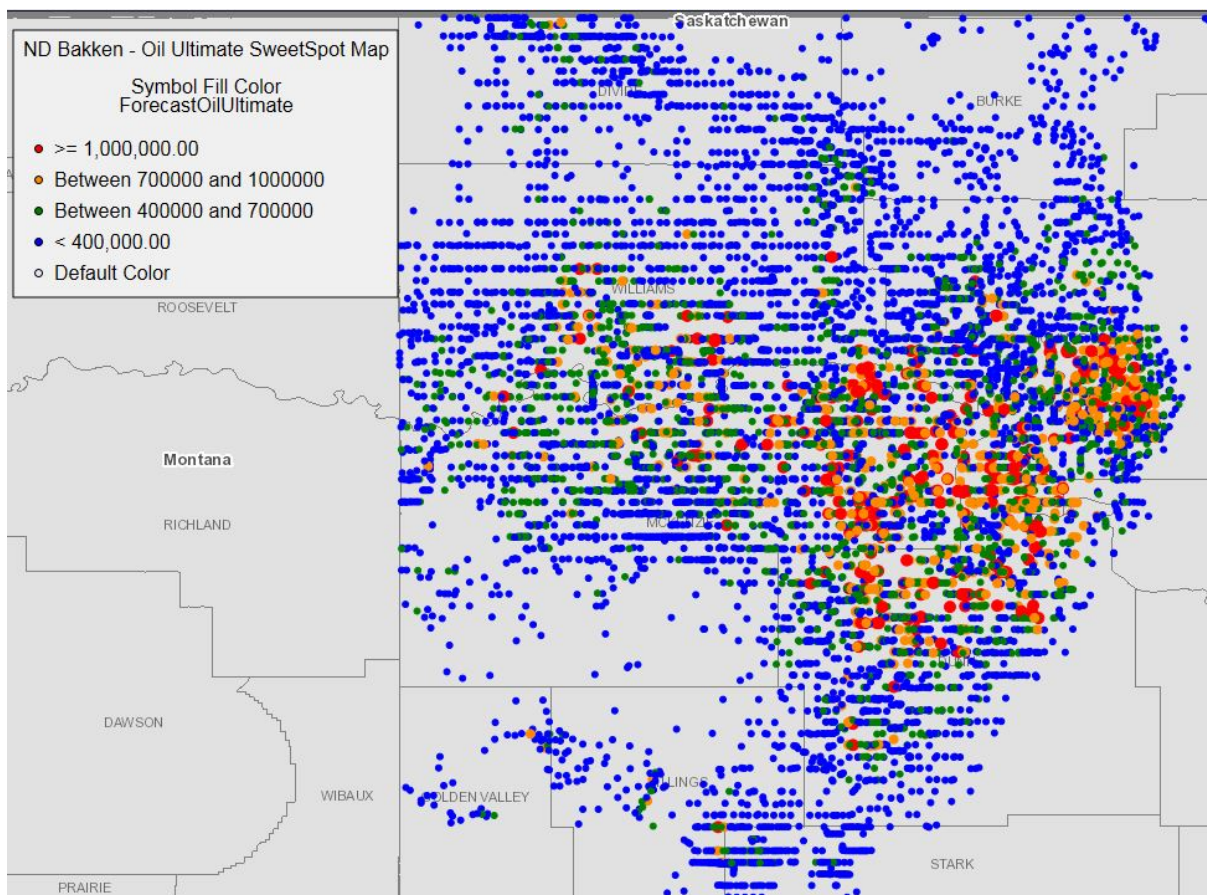
About TGS

TGS is headquartered in Oslo, Norway, and publicly traded on
the Oslo Stock Exchange. Our other main offices are in Calgary,
Houston, London and Perth, and we have employees in cities around
the globe. Our primary business is to provide geoscience data to
energy companies worldwide. We offer extensive global libraries
that include seismic data, magnetic and gravity data, multibeam
and coring data, digital well logs, production data and directional
surveys. Additionally, we offer advanced processing and imaging
services, interpretation products and data integration solutions.

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