Psychology and Behavioral Science
International Journal
ISSN 2474-7688

Mini Review
Volume 19 Issue 4 - October 2022
DOI: 10.19080/PBSIJ.2022.19.556018

Psychol Behav Sci Int J

Biomathematical analysis on reservoir oil and gas identification during COVID-19 pandemic

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Submission: October 10, 2022; **Published:** October 13, 2022

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Abstract

The prediction of oil and gas property and physical property of reservoir is very important for oil and gas exploration. In this paper, BP neural network will be constructed based on existing logging data, so as to realize the identification of reservoir oil and gas properties, as well as the prediction of porosity and permeability during COVID-19 pandemic. In view of the first problem, the types of oil and gas anomalies are summarized by collecting data, and the existence of anomalies can be judged by observing the curves drawn.

Aiming at the second problem: according to the existing oil and gas stratification data, resistivity, acoustic time difference and compensating neutron are selected as input sources to predict oil and gas layers. In view of problem 3: porosity, permeability value, logging depth through neural network (BP) method to simulate the function relationship of the three, through the function relationship to achieve the prediction of unknown data during COVID-19 pandemic.

Introduction

Introduce the Problem

In oil and gas exploration, geophysical logging is a common method to study the properties of underground rocks and fluids. Well logging was done in a Under various geological conditions and borehole conditions, according to certain geological or engineering purposes, the use of measurement of electricity, sound, heat and radioactivity, Such as resistivity, acoustic time difference, radioactivity, etc Features. The data obtained from logging is usually referred to as logging data or logging data. Log data are usually separated by depth. Once measured at 0.125m, it is formally shown as a curve that changes with depth, also known as a logging curve during COVID-19 pandemic [1].

It is a very efficient method to use different forms of logging curves to divide drilling geological profiles and understand the studied reservoirs, It is one of the main ways to know the stratum. Because there are different rocks.

A certain difference, so the log curve will show different changes, based on this, can use the difference of the log curve, Morphological division of drilling geological section to understand the reservoir under study. Reservoir engineers analyze logging data to study subsurface rock composition, classify formations, identify reservoirs, and predict reservoirs, Logging data interpretation is called reservoir physical properties and determination of reservoir fluid properties. Due to the heterogeneity and structure of the underground medium, It is an important research to identify reservoir oil - gas property and predict reservoir physical property by using logging data Subject. Reservoir oil-gas identification is an important task in logging data interpretation, and its essence is a classification problem, namely Distinguish a reservoir is dry, water, oil, etc. The reservoir here has a certain property, a certain thickness. A section of continuous formation. In research, it is often described by a set of logging values with different characteristics at a certain depth of reservoir [2].

The reservoir is called the eigenvalue (or eigenvector) of the reservoir, such as the natural gamma (GR) of a certain depth, Formation resistivity (RT), density (DEN), resistivity of different sounding depths (AT10) and resistivity (AT20) are used. Is the characteristic value of the reservoir. The oil-gas characteristics of reservoirs include dry layer, water layer, oil-water coexisting layer, poor oil layer and oil layer. Reservoir prediction plays an important role in every stage of oil and gas exploration and development [3].

Describe Relevant Scholarship

By using different basic data, prediction methods can usually be divided into two kinds, one is the storage prediction method based on geological knowledge, the other is the prediction method based on seismic data.

The method of reservoir prediction based on geological knowledge base is to build a reservoir prediction model by analyzing various practical parameters such as reservoir genesis, spatial characteristics, boundary conditions, physical characteristics, and sedimentary model. The key of this method is the construction of geological knowledge base, which mainly includes the following aspects: (1) outcrop knowledge base, (2) modern sedimentary knowledge base, (3) sedimentary simulation experiment knowledge base, (4) well data knowledge base. Each knowledge base has its advantages and disadvantages. For example, the advantage of reservoir prediction method based on outcrop knowledge base is that the model is fine and accurate, while the disadvantage is that the space scope of outcrop geological knowledge base is limited. The advantage of reservoir prediction method based on modern sedimentary knowledge base is that the model is complete and intuitive, but the disadvantage is that it is difficult to characterize the sedimentation characteristics in the geological deposition period. The advantage of reservoir prediction method based on sedimentary simulation experiment knowledge base is that it is easy to observe, but the disadvantage is that the model is limited by time and space [4].

The reservoir prediction method based on seismic data is based on seismic information, comprehensively using other data (geology, logging, reservoir, etc.) as constraints, to predict and measure the quality parameters of oil and gas reservoirs, mainly including seismic data inversion, seismic attribute analysis, seismic attribute fusion, etc. The advantage of seismic inversion reservoir prediction method is the combination of well and seismic reservoir characterization, but the disadvantage is that seismic inversion process is complex. The advantage of seismic attribute analysis and fusion reservoir prediction method is that multiple attributes are used to jointly represent reservoir parameters and improve the accuracy of reservoir prediction, but the disadvantage is that attribute optimization and weight determination need complex calculation and repeated test. Most of the actual reservoir prediction is the comprehensive application of various data and methods [5,6].

Method

There are various reservoir prediction methods, such as neural network, LSTM, and random forest.

In this paper, BP neural network is selected.

The main steps are as follows:

a) Collect data, including training data and test data.

b) Clean and complete the data.

c) Analyze the relationship between data elements and reduce dimension

d) Build neural network through existing labeled data

e) Conduct training and error analysis

Result

Oil and gas layer identification method of neural network is the first application is the basic idea of reservoir fluid property known to try on different period of well logging, mud logging and gas logging data of network training, and then will the unknown interval of well logging, mud logging and gas logging data input training after the network, to final identification of unknown interval contained fluid properties.

The neural network consists of an input layer, an output layer and an intermediate hidden layer.

The input layer consists of 10 neurons including lateral resistivity, acoustic time difference, compensated neutrons, density, natural gamma ray, porosity, permeability, water saturation rate,

natural potential, mud content and value depth, and the output layer consists of 6 neurons: Water layer, dry layer, oil layer, poor oil layer, oil-water layer, oil-water layer. Take 8 hidden layers in the middle. The first 60 samples from pool 102 were taken as training samples and the last 23 samples as test samples. Finally, the difference between predicted value and expected value was plotted (Figure 1-3).

The function relation of porosity, permeabiity and logging depth is simulated by neural network (BP), and porosity and permeability can be predicted by function relation under the condition of known logging depth. In the neural network, the number of nodes in the input layer is 1, that in the hidden layer is 8, and that in the output layer is 2 (Figure 4&5) (Table 1).

$$P = \frac{E - R_i}{R_i}$$

Where P is the model error, E is the size estimated by the model, and is the target storage obtained by the ith experiment. Finally, the error calculated by each experiment is represented by scatter diagram, as shown in the figure. Combined with the analysis of the experimental error chart, it can be seen that the data of the fifth and seventh groups have great errors and are likely to be abnormal data (Figure 6&7).

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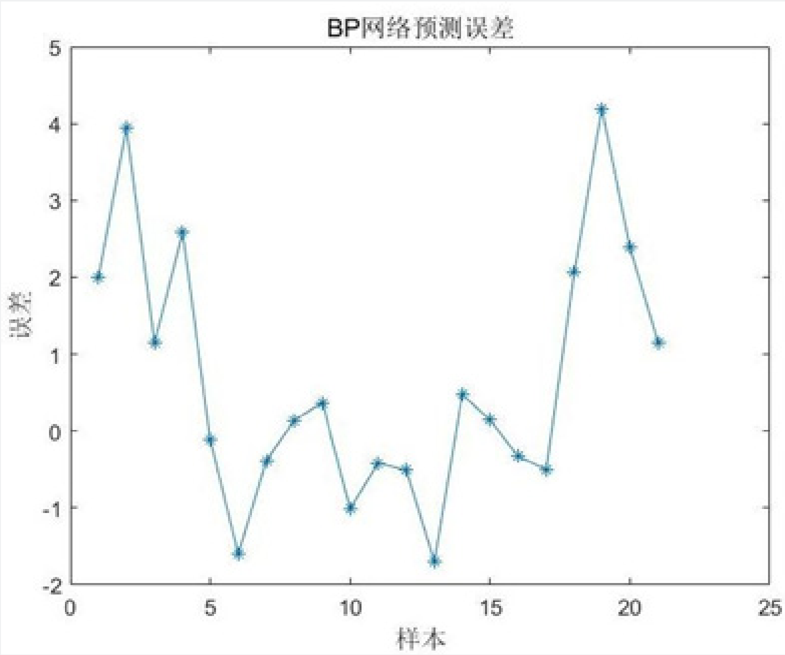

Figure 1: Sample prediction error.

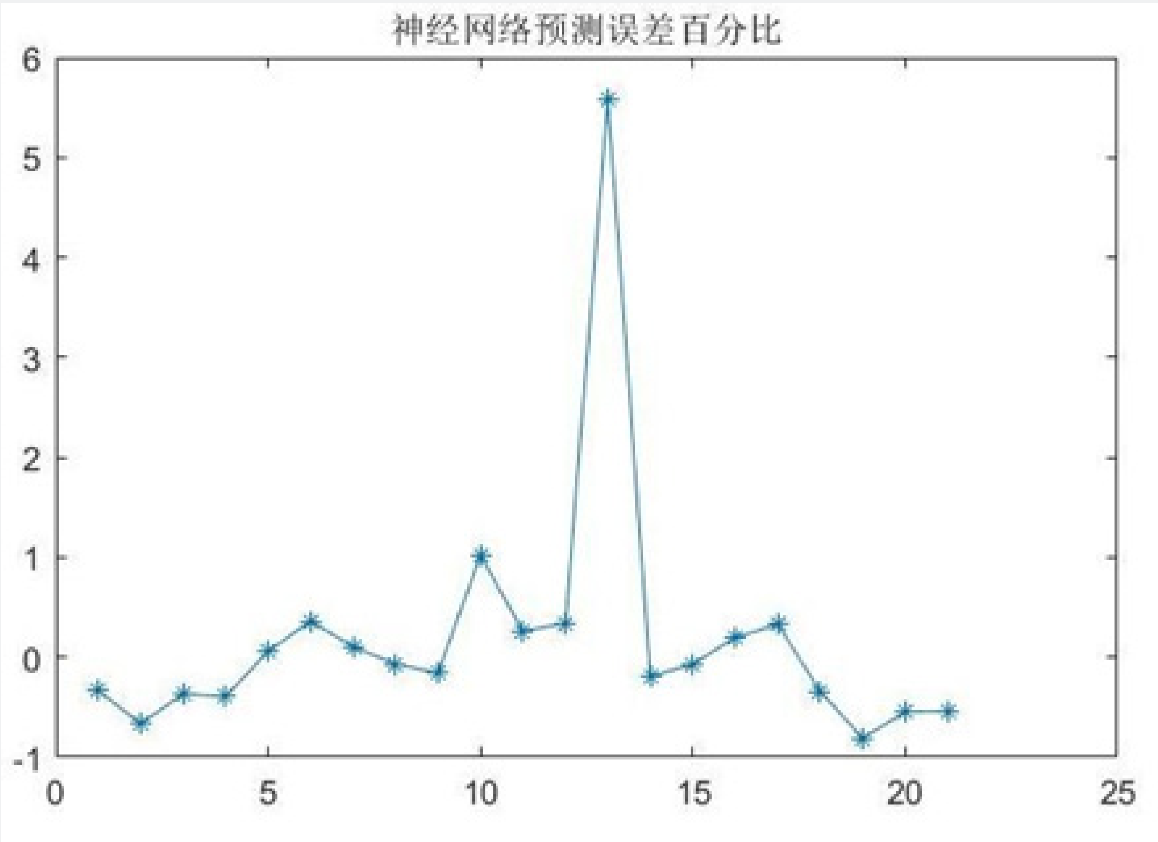

Figure 2: Percentage of sample prediction error.

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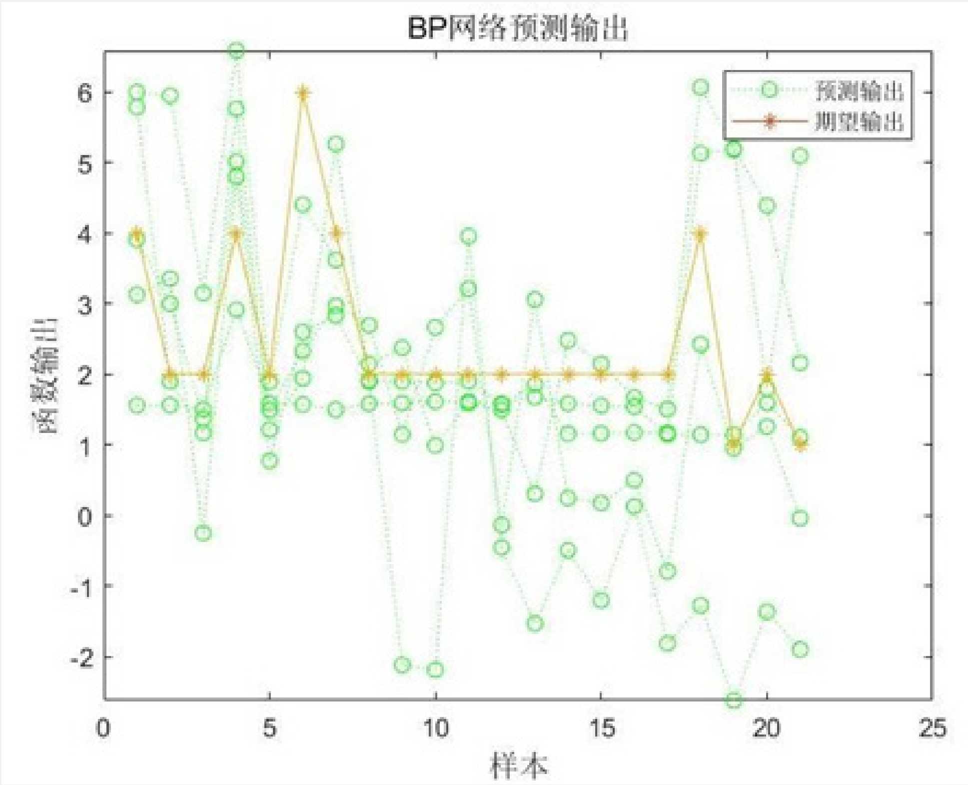

Figure 3: Comparison of predicted output and expected output.

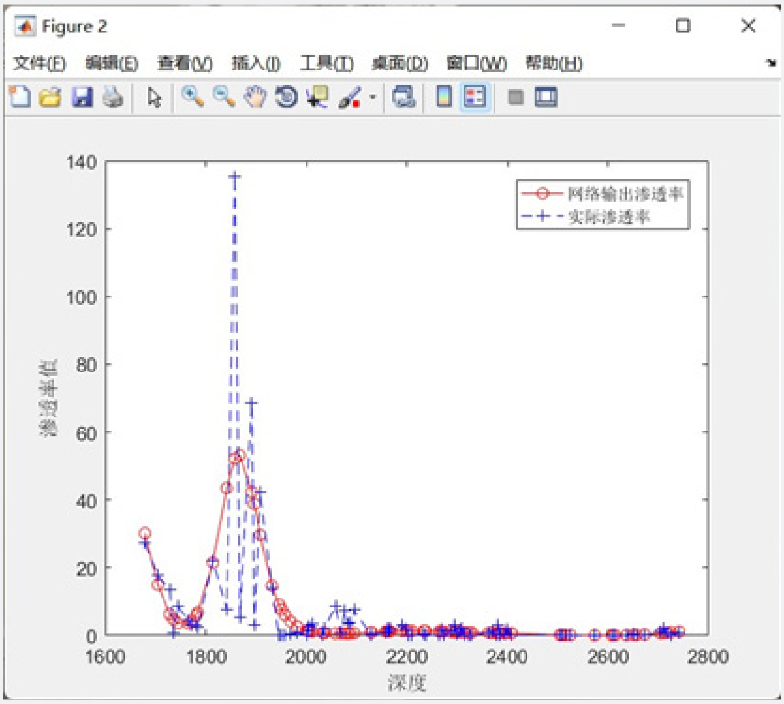

Figure 4: Comparison of predicted porosity and actual permeability.

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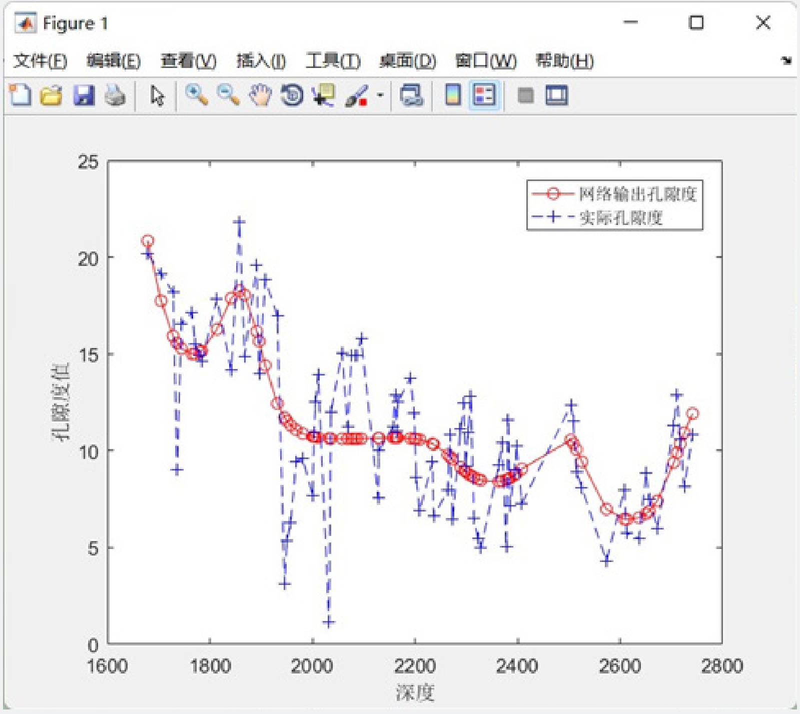

Figure 5: Comparison of predicted and actual porosity.

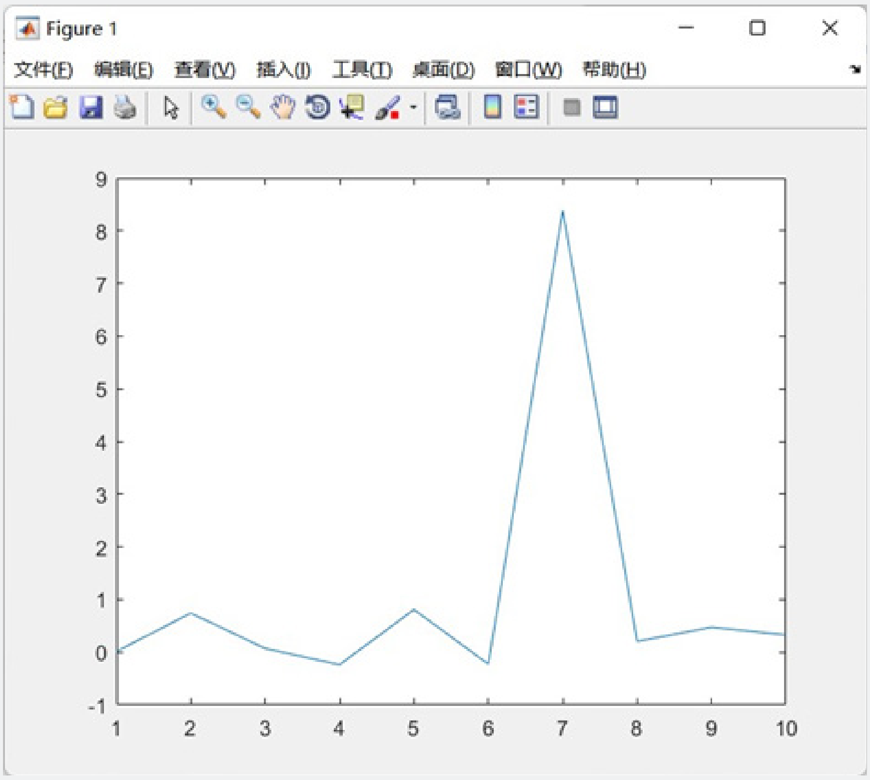

Figure 6: Model error of porosity.

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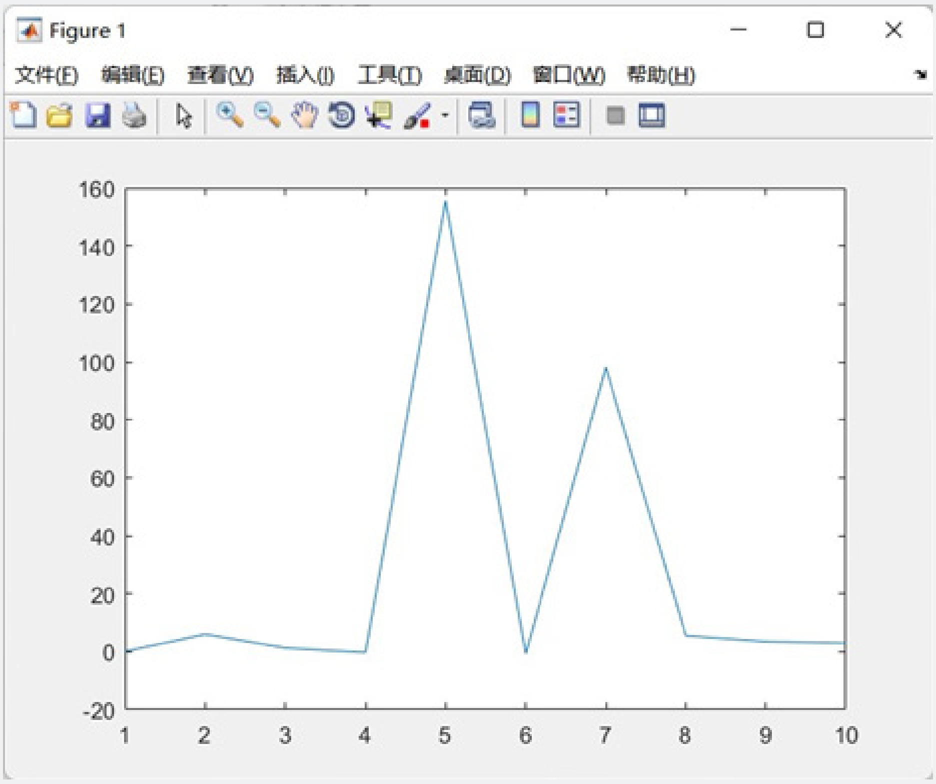

Figure 7: Model of penetration rate.

Table 1: Comparison of real and predicted results.

Depth	Real Result		Forecast Result	
	Porosity	Penetration Rate	Porosity	Penetration Rate
1679.07	20.17	27.28	20.42	29.74
1736.15	9.03	0.75	15.72	5.32
1784.25	14.64	2.59	15.66	5.93
1908.13	18.85	42.31	14.33	30.57
1957.65	6.3	0.04	11.39	6.26
2011.33	13.94	3.55	10.76	1.39
2032.43	1.14	0.01	10.7	0.99
2202.71	8.63	0.2	10.4	1.32
2273.33	6.45	0.23	9.49	1.04
2725.29	8.14	0.25	10.8	1

Acknowledgment

This work was supported by the Philosophical and Social Sciences Research Project of Hubei Education Department (19Y049), and the Staring Research Foundation for the Ph.D. of Hubei University of Technology (BSQD2019054), Hubei Province, China.

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