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Research status of computational rock physics in China

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Abstract: Computational rock physics is a frontier subject which combines computer science, mathematics and rock physics with each other.This paper introduces the development of the calculation of rock physics, and describes the necessity of developing the method of calculating rock physics.The scientific methods of calculating rock physical methods are discussed.The present research situation of the calculation of rock physics is analyzed.Finally, the problems in the calculation of rock physics are summarized.

Keywords: *Rock physics; Numerical simulation; Computational rock physics*.

I. INTRODUCTION

The foundationstudy of rock physicalbegan to study the mechanical properties of rock[1-2]at the end of seventeenth Century.1946,Bridgeman was awarded the Nobel prize for physics in the study of high pressure rock properties, which indicates that rock physics has become a mature subject.Computational rock physics and numerical rock physics is a branch of Geophysics computing. It consists of rock physics, mathematics and computer, through the application of the three perfunctory solve unable massively by analysis methods solve various theoretical and practical problems of the application subject in rock physics .This branch subject has become a modern rock physics theory and application of all aspects of the essential scientific and strong backbone[2].

Computational rock physics is a relatively new concept which is try using the method of computer simulation measure seismic wave to obtain rock physics experimental facing lack of experimental object and scale effect problems.Computational science is one of the fastest developing subjects at present.In recent years, the development of computer technology is flourishing, so that we can carry out an extremely complex and near real physical phenomena by numerical simulation . New ideas and methods are provided for the study of complex problems in rock physics analysis[2].

II. THE NECESSITYOFCOMPUTATIONALROCKPHYSICS

With the study of underground reservoir deepening understanding gradually, the economic benefit is gradually improved by mainly drilling well and coring, lead to the serious shortage of the samples in the rock physics experiment measure, the cost is too high, especially measurement of anisotropy and attenuation characteristics.At present, the seismic rock physics calculation method is still in the small scale seismic wave field simulation exploration stage, has not yet formed the effective technology.Need point,Rock physics experiments and computational rock physics are mutually facilitated,computational rock physics is not a substitute for rock physics experiment,some basic parameters of seismic wave propagation simulation need to be accurately determined by rock physics experiments[3].For example,in different temperature and pressure conditions under different rock component elastic modulus, crack

flexibility coefficient etc.Through a large number of experimental data in the laboratory, the researchers can get the regional empirical formula, and can not adapt to all of the situation completely.In theory,The rock physical model makes the assumption of the underground rock structure.Computational rock physics is a gray area between the rock physics and theory of rock physics, effectively compensate for its shortcomings.at the same time,The combination of rock physics and experimental rock physics,add radiance and beauty to each other,Common analysis processing problems.The materials in the rock physics research are usually very small.A lot of problems will be encountered in the promotion to the earth physics.So the proposed hypothesis to meet a lot of the actual situation.It is very necessary to establish an effective and reasonable and simple mathematical model.If there is no reasonable model,The empirical formula is applied to the practical problems of the earth will not get the conclusion of the expected.

III. TECHNICALMEANSFOR COMPUTATIONAL ROCK PHYSICS

When dealing with the problems in the computational rock physics by numerical analysis method, it is usually used to the regional type and the boundary type method.The finite element method is the best effective and the most commonly used method for the regional solution.For another type of regional solution, the finite difference method is commonly used.Finite difference method has been widely used in the study of seismic wave

forward modeling, migration and imaging.It is a kind of important seismic wave field numerical simulation method.However, the conventional finite difference method has serious numerical dispersion problem.This will reduce the wave field simulation accuracy and resolution of the results, the staggered grid finite difference method can improve the accuracy of the spatial and temporal derivative, reduce numerical dispersion and the complex heterogeneous medium has funny hungry calculation speed and flexibility.In view of this,Staggered grid finite difference method has been developed and widely used in seismic numerical simulation[4-6].BEM and FDM are capable of the same time in most cases,FDM calculation is simple and easy to achieve which is a numerical algorithm that is used more widely.BEM shows great advantages in many problems,it is worth promoting.Comparisons between different numerical methods are often not simple straight forward,many factors should be considered,For each of them has its own advantages and disadvantages.In the case of finite difference, the prominent advantage of boundary element method lies in its explicit expression of the boundary conditions of the medium, which can effectively deal with the internal boundary problems such as internal power failure and fault[7].

In 2016, Xi Wu Liu[7] makes the shale reservoir in Luojia area of Shengli Oilfield as an example, based on core data,Starting from the random process of shale deposition,with "layer" and "pattern" as the basic unit, build lower shale small scale numerical geologic model and random addition of organic matter, boring machine, inter layer fractures and vertical fractures and matrix pores.In the small scale grid, the macroscopic rock physical equivalent medium model is applied, and the heterogeneity of the medium is fully considered, and the small scale geological model is transformed into the geophysical parameters model.Based on small scale geologic models with small grid geophysical parameter model, different angle to the plane of non uniform simulation of seismic wave propagation, propagation time extraction, rock physics parameters of the seismic wavelength scale is directly calculated.The elastic parameters were calculated by changing the TOC content, layer and layer thickness, and the fracture distribution, respectively.The computational rock physics method was verified by selecting sensitive elastic parameters.

IV. RESEARCH STATUS OF COMPUTATIONAL ROCK PHYSICS

The equivalent medium theory is an important research content in rock physics[2].A relatively complete theoretical system is not put forward in many research models,instead of putting forward different hypotheses from different point of departure, in future research, Whether it is worthwhile to establish a comprehensive and effective theory and a unified model is worth discussing..The theoretical model is determined by numerical method in the computational rock physics.Li Feng jun[8] use the micro fracture model and the linear sliding model to add the gap system,the variation characteristics of an isotropic parameters with longitudinal shear wave velocity are analyzed when the gap is filled with different fluids.Jinlong[9]proposed a new method for simultaneous inversion of porosity and saturation based on rock physical model and hybrid optimization algorithm.These studies to a certain extent, to a certain extent, to fill the gaps in domestic research.Because the petrology characteristics and geological conditions are very complicated, and the different regional variation is as long as a theoretical applicability range extending outward and also violate the assumptions it will produce erroneous results, which leads to the seismic data have been erroneously interpreted.

V. THEPROBLEMSINTHECOMPUTATION ROCK PHYSICS

Although in recent years, computer technology has greatly improved, for most areas of geophysics is a very delightful news, then the scientific theory is clear, in the application and the practice problems is very difficult.As a simple and interesting concept, seismic anisotropy is usually used to describe the fracture reservoir., but the conventional exploration and development tools are not completely accepted.In the past ten years, the seismic response of the crack has made considerable progress in the theoretical research,In practice, a lot of field data can be obtained through laboratory research and field investigation, which can be very good to distinguish seismic wave in fracture media.

At present, more mature theories and models of rock physics are based on the study of the middle and high porosity sandstone and mud stone strata in foreign countries,For the tight sandstone gas reservoirs and heterogeneity is strong for carbonate reservoirs, there is no mature rock physics model and theory, the existing theory and model applicability in our country remains to be studied. Therefore the direct use these existing theory and model of guidance in seismic exploration of quantitative explanations for the existence of a great risk.

VI. CONCLUSIONS

With the improvement of science and technology, the development of the earth science has changed greatly from the simple description of the earth to the mathematical modeling, numerical simulation and visualization.Despite the scientific progress, there are still many areas facing severe challenges.In the future, to explore the establishment of complex reservoir rock physical calculation method, clear its geophysical response, to provide a set of new methods of calculation of rock physics.

Computational rock physics does not rely on itself calculation method to deal with the problem of rock physics, it can solve the restriction of experimental conditions and core samples, Rock physical parameters are obtained by numerical simulation, in order to get the parameter which is hard to get in the laboratory.

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