Application of 3D digital core technology in live fault detection

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ABSTRACT

The core is the first-hand physical information that can directly reflect the formation conditions. Core data preservation become one of the concerns of scientific researchers, with the development of core image high resolution acquisition and processing technology and application of increasingly mature, 3 d digital core technology become an important technical means of complete preservation core library, greatly reduced the weathering, broken and sample selection natural or artificial reasons such as data distortion. This study is the first to introduce this technology into the field of live fault exploration, which can provide new methods and beneficial exploration for the core research in the field of geology.

Keywords: Three-dimensional digital core, active fault detection, geology

1. INTRODUCTION

Core is the first-hand physical information that can directly reflect the formation situation. Through core analysis, the stratum lithology, mineral composition, physical and electrical characteristics, paleontology and fracture information can be studied, and then the stratigraphic comparative study, the sedimentary environment, the distribution and stratum changes of minerals and reservoirs, etc. can be studied, which is an important basis for understanding geological information. Drilling core as one of the technical means to obtain deep geological environment[1], the collected entity core volume is large, heavy, not easy to carry, at the same time after many sampling and handling, and natural weathering and human factors, can cause different core damage and core information loss, difficult to save, and core observation laborious, information sharing, resulting in the core resources utilization low, affect the related research of geology.

In order to solve the problems of core preservation and core analysis, experts and scholars proposed to scan the core, store core images, core spectrum and element content data and parameters in the computer, build a standard core database, reduce the distortion of geographic data, realize the permanent preservation of core resources and access the database to analyze geological information [2-5]. With the development of remote sensing technology, hyperspectral scanning provides a new technical method for core analysis, that is, the color linear digital scanning camera with CCD sensor will output the color image analog RGB image format to realize the detection of continuous process [6]. At the same time, based on the Internet technology, carry out the core three-dimensional scanning test, establish the core graphic database and network release, and realize the online sharing of the core graphic data, which can greatly improve the utilization value of the core data. At present, 3 D digital core technology has been widely used in petroleum systems. [7-12]

In the study of active fault detection, drilling is the most direct and important method to study the active fault in the hidden area, and it is one of the most important means to determine the fault position and activity. And live fault detection of core due to the quaternary strata loose, has not yet cemented curing diagenesis, so the core preservation time shorter, and quaternary drilling core unearthed air oxidation, combined with the air humidity lead to core mildew factors, core color change, its preservation compared to the oil, coal field industry more difficult, utilization rate is lower. So 3 d core scanning technology is particularly important for live fault detection research, this paper relying on the seismic structure exploration project in Henan province, the first use of 3 d core exploration technology in Henan province of standard hole (400m) in the 3 d core scanning test, and achieved good results, opened up a live fault exploration field core preservation and new way of geological information comprehensive analysis, can provide new methods and beneficial exploration.

2. THREE-DIMENSIONAL CORE DIGITAL IMAGING SYSTEM

Three-dimensional core digital imaging technology is a system technology, including scanner and other hardware equipment, core information comprehensive database, and application software for comprehensive analysis. The whole

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International Conference on Optics, Electronics, and Communication Engineering (OECE 2024), edited by Yang Yue, Proc. of SPIE Vol. 13395, 1339523 · © 2024 SPIE · 0277-786X · Published under a Creative Commons Attribution CC-BY 3.0 License · doi: 10.1117/12.3049865

system is basically composed of two parts: core image acquisition instrument and database management and analysis system. This work adopts the core image high-resolution imaging instrument and data application system produced by Jingzhou Huafu Information Technology Co., LTD.

Core image high-resolution imager is mainly composed of five parts: three-way true color integrated high-density wire array camera device, no-frequency flash source, driving mechanical device, acquisition automatic control, acquisition device and the interface of core image library. The equipment measures 1200450700 mm, weighs 60kg and can scan 360° cores of 1m and 40-160mm diameter (see Figure 1). Through the interface operation of core image acquisition and processing, the automatic collection, editing and processing of core image, storage, management, processing, quantitative analysis and other functions of core graphic information and related geological data, and directly stored in core image library in common image format or JPEG standard compression format. The instrument imaging physical resolution is 400 DPI, clear image, rich color, scanning broken core without virtual shadow, which can meet the needs of core observation, and provide high definition original image data for the storage, management and quantitative analysis of core images.

Figure 1. Core image high resolution imaging instrument

Database management analysis system includes drilling graphic information, drilling, formation, logging, sample test analysis data, the traditional relationship database management technology and image processing technology, and introduce the object-oriented method into the system, implements the core image and geological information storage, management and analysis. At the same time, the core graphic information and related geological data are shared, so that the scientific research and management personnel can easily observe, analyze and process the core information at any time and anywhere (see Figure 2).

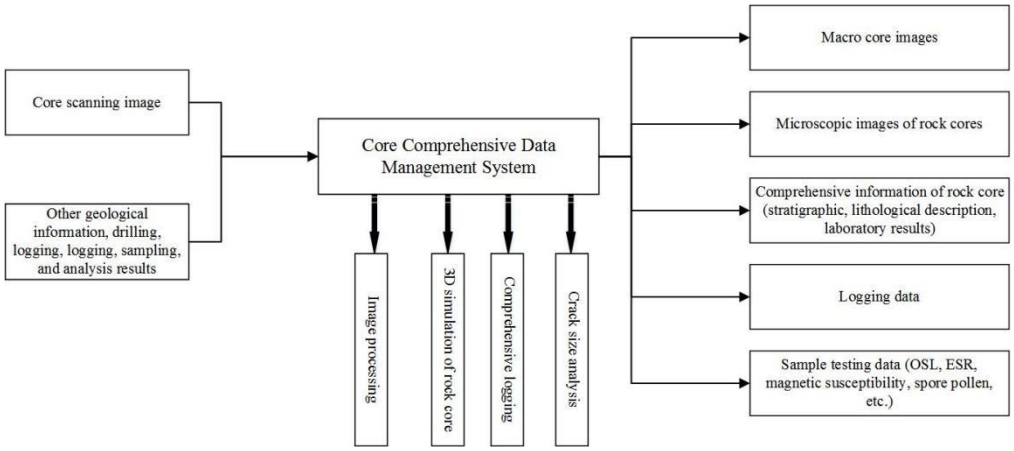

Figure 2. Design principle of the core database management and analysis system

In addition, the system comprehensively applies core image data, logging and geochemical data, can measure the geological characteristics of core crack, rock gravel diameter and sedimentary structure, quantitative description accuracy can reach 1 / 100mm, directly improve the geological information, establish digital network information release platform of field core image, realize resource sharing, expand the application scope of core image, and greatly improve the comprehensive utilization rate of core data.

3. SYSTEM APPLICATION

In the active fault detection of Henan Province structural exploration project, the project team conducted a three-dimensional core image acquisition test on the quaternary standard drilling hole in Kaifeng depression.first, Remove the core from the rig core barrel, Identify the upper and lower interface and depth of the core, Arrange the cores at 1m intervals, Remove the mud from the core wall; The core was then placed on a high-resolution imaging instrument for 3 D rotational scanning, And the scanned image is trimmed and stitched; According to the Technical Specification for Live Fault Detection, Identify the image by depth, Enter core catalog formation information into the database with the core, And selected typical samples are sent to the laboratory for testing (including C14, spore powder, photorelease, magnetic susceptibility, etc.), Finally, the drilling and logging data, formation information, core catalog and sample information are input into the database simultaneously (see Figure 3).

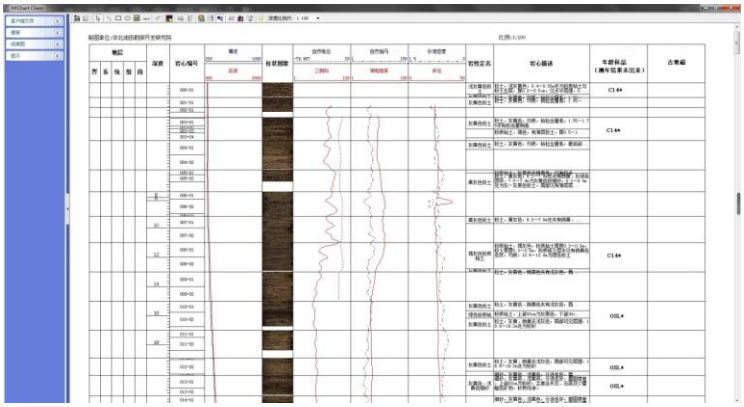

Figure 3. Standard hole core database

Figure 3 shows the results of the 3 D core of the open standard hole. The system can click and view the core image, zoom in and out, and consult the core photos of the specified depth and the specified bucket times. Click the core photo can also conduct 3 D rotation observation, image expansion observation and other microscopic observation (see Figure 4). Each layer of soil samples in accordance

with the core number, formation time, depth, main record natural potential, natural gamma, compensation density, lithology name, core description, age samples, ancient geomagnetic category information, used to reveal the real stratum geological characteristics, long-term preservation formation effective information, provide basic data for living fault detection for scientific research.

4. CONCLUSION

The 3D core technology realizes the automatic collection of macroscopic core image and core microscopic image, the permanent preservation, comprehensive management and quantitative analysis and processing of core graphic data and related geological data, which can provide useful evidence for revealing the active fault detection.

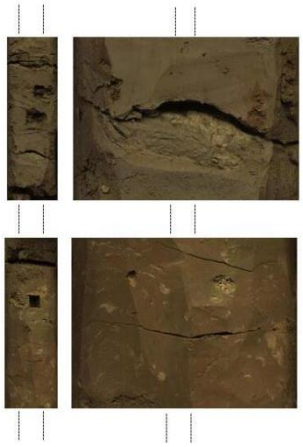

Figure 4. Image expands the microscopic observation view

(1) The outer surface image of the core can be restored to the original appearance of the core, Collect images with a physical resolution of 400 DPI, Realize high resolution acquisition of digital core images and permanent preservation of core maps and text data, The quantitative description accuracy of geological features such as core crack, rock and gravel diameter and sedimentary structure can reach 1 / 100mm, Directly improve the geological information information, quantitative degree; In terms of core observation and description, query, multi-well comparison, graphic and text display, output and other aspects, to replace the physical core library, Saving a lot of manpower and time, Improve the work efficiency; Core image compression technology provides conditions for the storage and management of mass core images and the multi-user sharing of core graphic data on the network, Effectively improve the utilization rate of the core.

(2) This technology can realize the three-dimensional core simulation effect, establish the core graphic database, and easily conduct the online text transmission through the network, reduce the damage of human factors to the core, and provide favorable conditions for multiple observation, quantitative description, data storage, data retrieval and comprehensive utilization of core information.

(3) The first test of three-dimensional digital core technology in the standard hole of Henan Province, which can reveal the real stratum geological characteristics, preserve the effective stratum information for a long time, and provide basic data for living fault exploration for scientific research. In addition, this technology also has a broad application prospect in the joint drilling exploration, which can truly reflect the formation information, compare the drilling strata, and directly reflect the drilling section shape and the fault activity position.

With the continuous popularization and application of this technology in the field of live fault detection, it will play an increasingly important role in judging the sedimentary environment and analyzing the structure and fracture situation (such as stratum inclination, stratum contact relationship, etc.).

ACKNOWLEDGMENTS

The drilling work is supported by the Geophysical Exploration Center of China Earthquake Administration, and the core scanning access is strongly supported by the Henan Oilfield Branch of China Petroleum and Chemical Company.

The reviewers have put forward valuable opinions on the manuscript. Thank you here!

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