

Integrated Exploration Research Platform

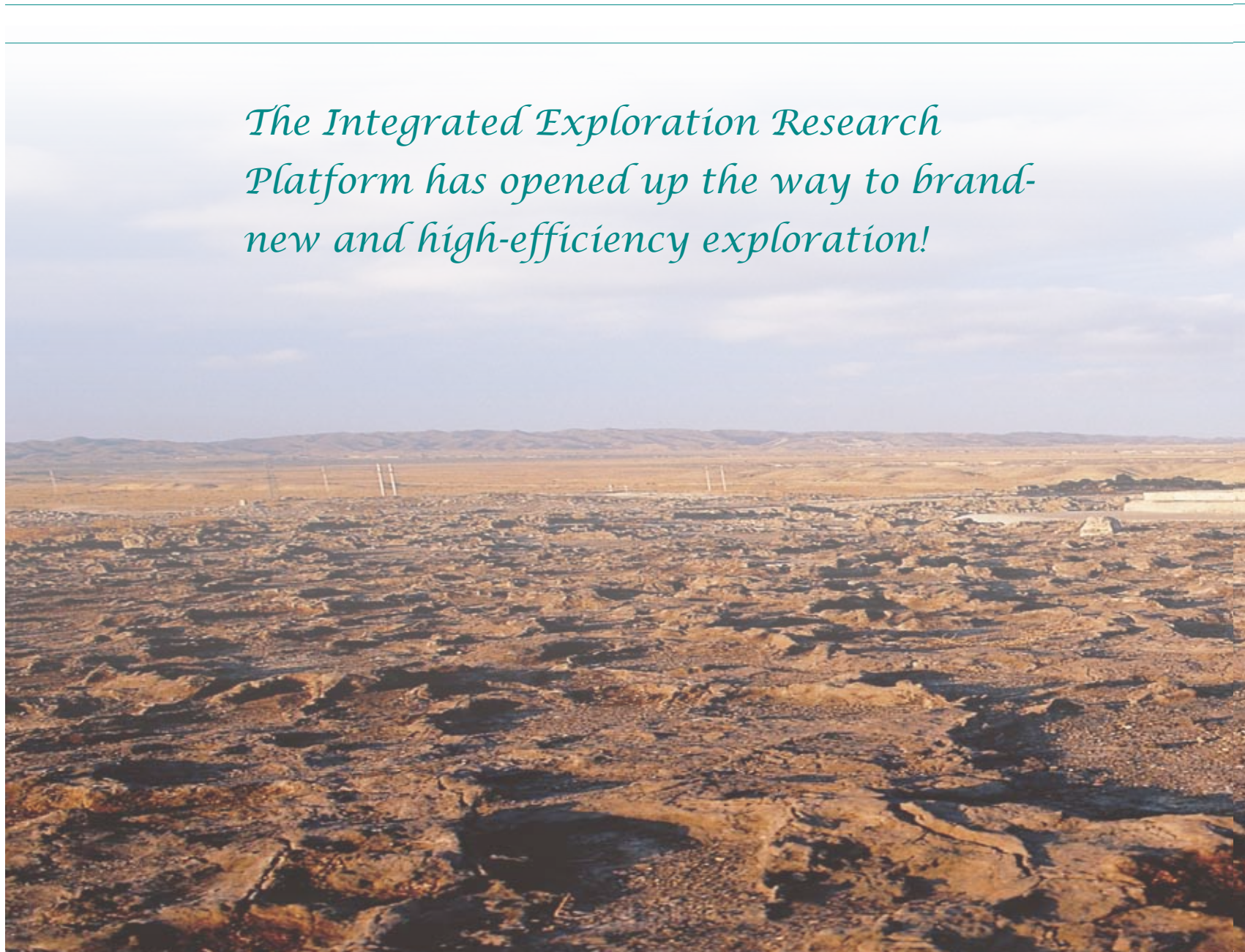
Science & Technology Management Department

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CHINA NATIONAL PETROLEUM CORPORATION

*The Integrated Exploration Research
Platform has opened up the way to brand-
new and high-efficiency exploration!*





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CNPC

China National Petroleum Corporation (CNPC) is a state-authorized investment agency and a state holding company. As an integrated oil company of cross-regions, cross-industries and cross-countries, it adopts modern enterprise system to realize the integration of upstream and downstream operations, internal and external trade and production and marketing. CNPC has 17 upstream companies, 33 downstream companies and 36 large-scale marketing companies. It is China's largest producer and supplier of oil and gas, and also one of the largest refined oil products and petrochemicals. In 2010 CNPC produced 105 million tons of crude oil and 72.5 billion cubic meters of natural gas, while crude processing volume reached 135 million tons. The total revenue of RMB1,720 billion with a profit of RMB172.7 billion had been achieved the same year. Its profit is among the highest of the domestic enterprises in China.

CNPC was ranked 10th in Fortune Global 500 in

2010 and 5th among global top 50 oil companies.

CNPC strictly follows by the combined strategies of increasing resource capacity, expanding market shares and consolidating the international role, and persists in regarding technical innovation as a key framework to advance technological progress. To develop its core businesses, focuses will be placed on the solutions of key bottleneck technologies and key proprietary technologies. Thanks to continuously improving of the technical innovation system, optimizing the configuration of technological resources and strengthening the construction of strong talent teams, CNPC's technological creativity has been considerably upgraded. Consequently, a large number of technologies have been developed independently, with its own intellectual property.

The Integrated Exploration Research Platform (IERP) is one of representatives for major innovations of CNPC.

CLEAN ENERGY SUPPLY FOR BETTER ENVIRONMENT

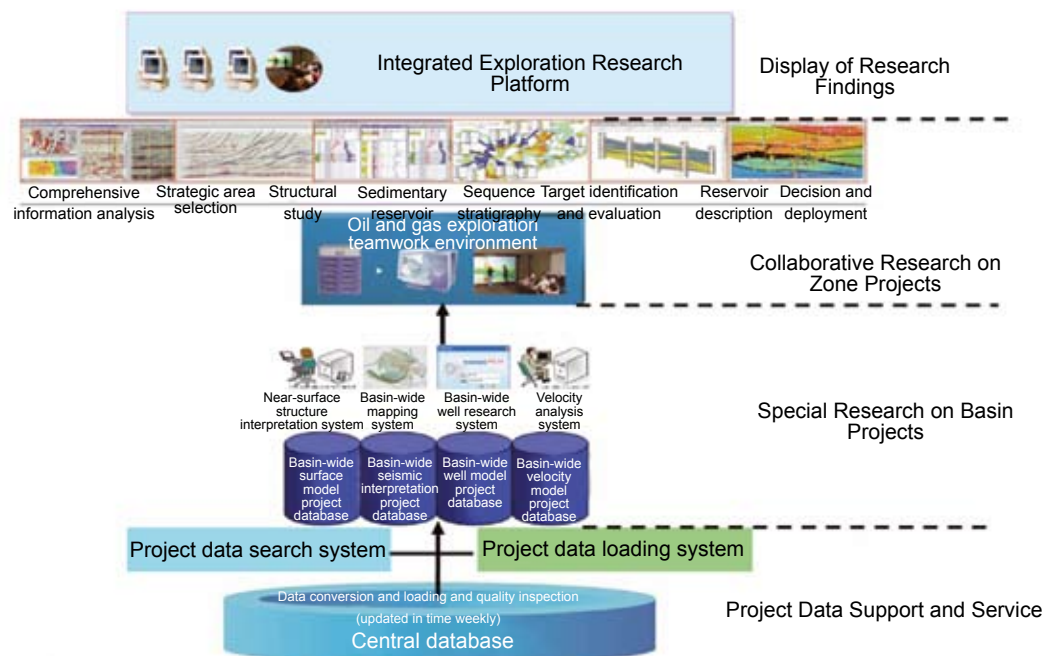
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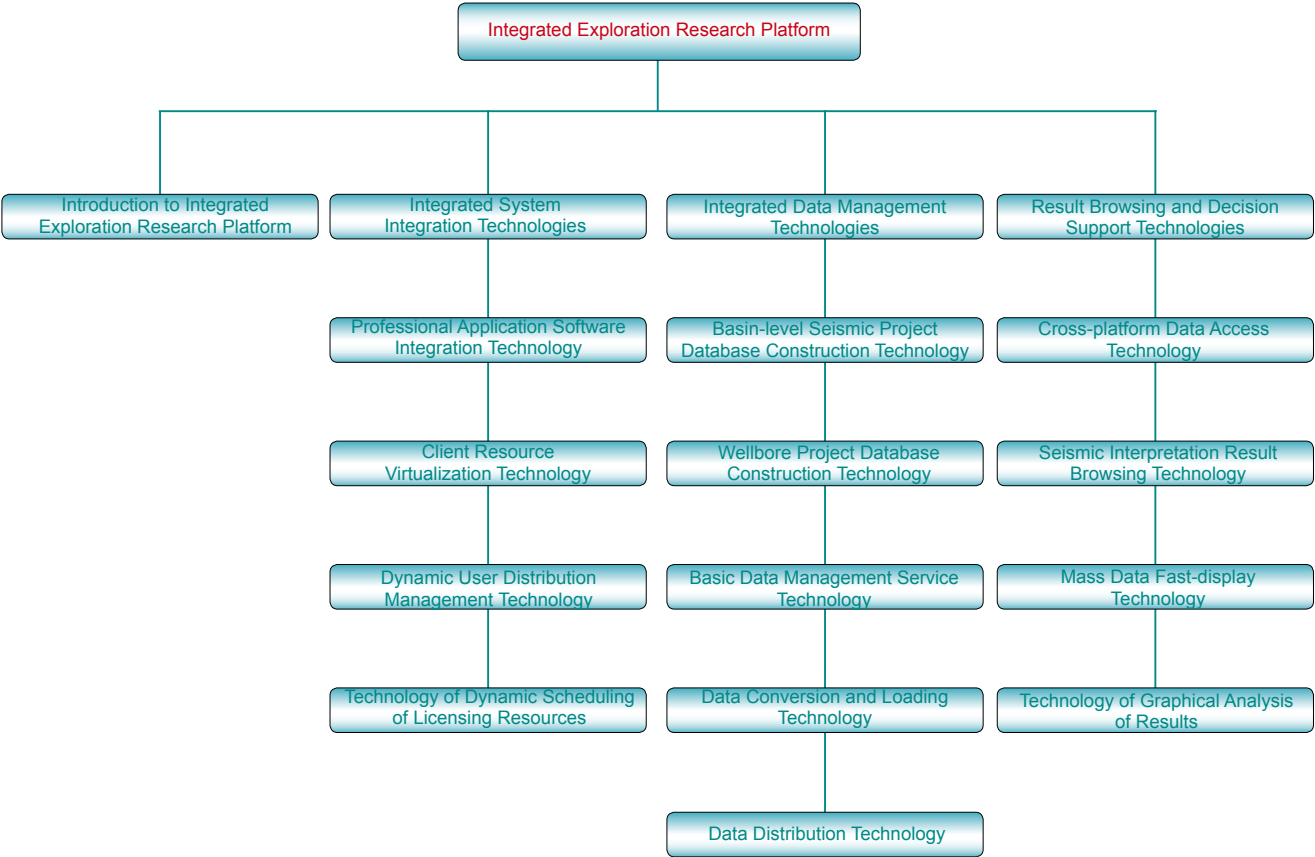
INTRODUCTION

Nowadays, the oil and gas exploration is being diverted to mainly lithologic and complex structural reservoirs of low amplitude. Due to their low efficiency, conventional exploration research processes and working methods have greatly restricted the acceleration of exploration pace. To find more exploration targets quickly and evaluate complex reservoirs accurately, the change of exploration research working modes becomes paramount. By integrating and using advanced software and hardware technologies, CNPC has independently developed an Integrated Exploration Research Platform, thereby providing plenty of information and means for oil and gas exploration research decision

making, realizing collaborative interaction between multiple disciplines, improving research efficiency and result quality and reducing exploration risks.

By use of the IERP, a series of studies can be made in an identical data environment based on a uniform geologic model from basin-level exploration strategic area selection, structural research, sedimentary facies analysis, reservoir evaluation, oil and gas identification, reservoir description, well location demonstration to exploration decision making and deployment. The IERP can obtain any information fully in real time and use various research means most conveniently.

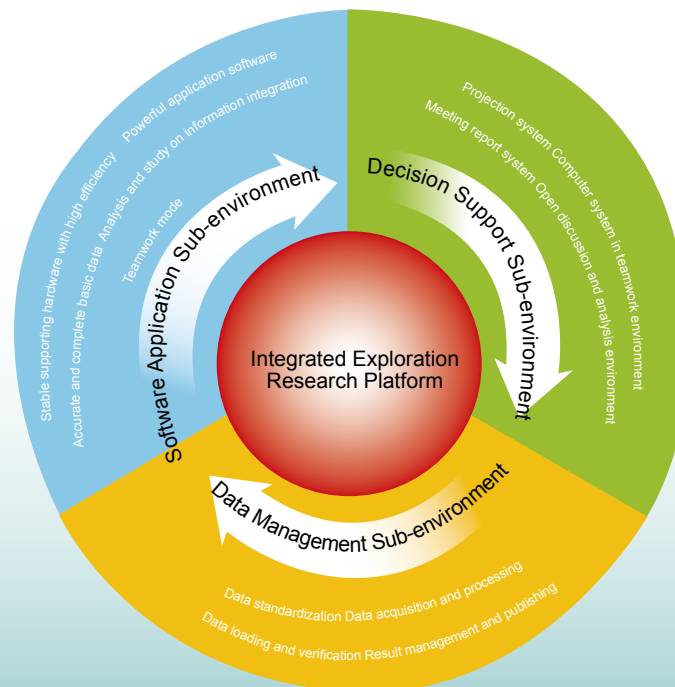




1.1 Logical Architecture

The overall architecture of the IERP consists of three parts:

- **Data Management Sub-environment:** It realizes specialized loading and centralized management and sharing of multiple data (e.g. seismic data, drilling data, log data, well logging data, testing data and analysis data) required by research project, and provides data for the application software of the Application Software Sub-environment. More importantly, application software research findings are stored in the Data Management Sub-environment in real time, thus facilitating research work and providing customized services for decision making of the Decision Support Sub-environment.
- **Application Software Sub-environment:** A centralized professional software management mode “network storage + server + client” has been established. The software of the Application Software Sub-environment obtains source data from the Data Management Sub-environment for exploration and development research. In addition, the research result provides a decision-making basis for the Decision Support Sub-environment.
- **Decision Support Sub-environment:** It combines the Data Management Sub-environment with the Application Software Sub-environment, and meets the requirements by researchers and decision makers for research project initiation, discussion and research in a teamwork room or a meeting room. The Decision Support Sub-



environment can realize web publishing and browsing of seismic data interpretation results of basin scale via Web browsers, so that the exploration experts and decision makers can get all seismic data within the scope of basins by simple and quick methods, the demand of basin-scale great exploration thought is satisfied, and the decision of exploration targets is made more scientifically, quickly and accurately.

1.2 Applications

The IERP is the best platform for carrying out multidisciplinary collaborative panorama exploration. Its commercial value involves:

- Basin-level project research database; realizing a zone-level teamwork environment;
- Centralized data management; data flow normalization; providing the researchers with real-time accurate data information service systems;
- Integrating software and hardware resources and realizing enterprise-level shared applications;
- Optimizing work flow, shortening work cycle and improving result quality and decision level.

By use of the Incorporated System Integration Technology, an interpretation software operation mode “network storage + server + client” has been established, thereby realizing centralized management of software, license and project data, facilitating software upgrading and maintenance, improving the security of project data and realizing dynamic distribution and management of users.

In addition, users can use any workstation in the Enterprise LAN to run software and can start project data for interpretation and research, thus enhancing the utilization efficiency of software and workstations.

By use of the Integrated Data Management Technology, multiple data, such as seismic data, drilling data, log data, well logging data, testing data, analysis & assay data, are integrated from the viewpoint of basins, and the centralized management and sharing of multi-disciplinary comprehensive research data are realized. A method for loading, description and comprehensive applications of multiple wellbore geologic data (e.g. well logging data, well testing data, log data, gas survey data and analysis & assay data) in the Integrated Interpretation Software have been developed. In addition, the geologic application scope of software has been expanded.

The Result Browsing and Decision Support Technology allows the realization of web publishing and browsing of seismic data interpretation results of basin scale; the researchers and decision makers are provided with an easy-to-use platform for seismic data access. The exploration experts and decision makers can use all seismic data within the scope of different scales of basins by easy and quick ways, and the demand of basin-level great exploration thought is satisfied.

By use of the IERP, multi-angle and multi-dimensional comprehensive hydrocarbon exploration studies of different extents can be made, so that the decision on exploration targets is made more scientifically, quickly and accurately.

2.1 Incorporated System Integration Technologies

The Incorporated System Integration Technology has established a computer software and hardware platform for experts in different disciplines for teamwork exploration target & problem analysis, exploration plan & deployment decision and realized uniform management of users and sharing of software and hardware resources.

Many years of research on the system architecture of the IERP have generated the mature unique technologies as follows.

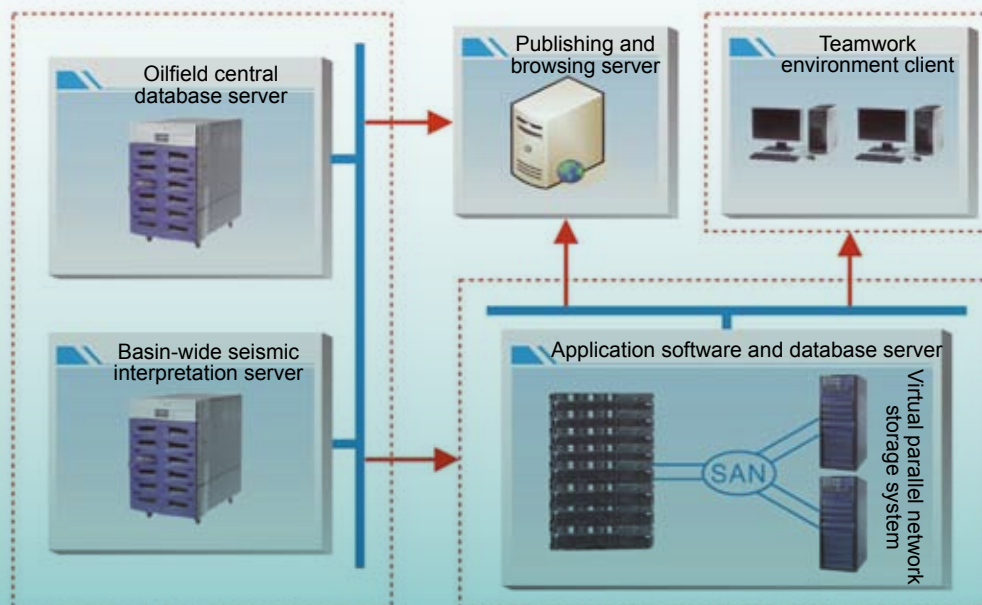
- **Professional Application Software Integra-**

tion Technology

The technology integrates different kinds of application software into the same server, thus realizing uniform management of cross-platform professional application software, facilitating software installation & upgrading and enhancing the software utilization efficiency.

- **Client Resource Virtualization Technology**

The technology realizes uniform management and sharing of software, license, project data and user information resources, etc., and enhances the expandability of software and hardware. Moreover, the technology makes the data and resources easy



to be used by researchers and improves the resource utilization efficiency and data security.

- **Dynamic User Distribution Management Technology**

This technology allows users to employ any workstation in LAN for project studies, thereby facilitating researchers' use and improving the utilization efficiency of hardware resources.

- **Technology of Dynamic Scheduling of Licensing Resources**

The technology realizes scheduling, management and control of network licenses of various kinds of professional application software, thereby improving the utilization efficiency of license resources.

The Incorporated System Integration Technology provides a quick and stable system environment with high efficiency for the IERP.

2.2 Integrated Data Management Technologies

Centering on comprehensive exploration research businesses and taking the central database of the oilfield as the data source, the Integrated Data Management Technologies integrate and apply advanced data management concepts and techniques, and realize specialized management of seismic data and wellbore data, and free exploration researchers from tedious work such as data acquisition and processing.

Applications of the Integrated Data Management Technologies in the IERP have formed high-efficiency normative data flows and realized collaborative interaction between data management and comprehensive exploration research.



The Integrated Data Management Technologies consist of the following 5 unique technologies.

- **Basin-level Seismic Project Database Construction Technology**

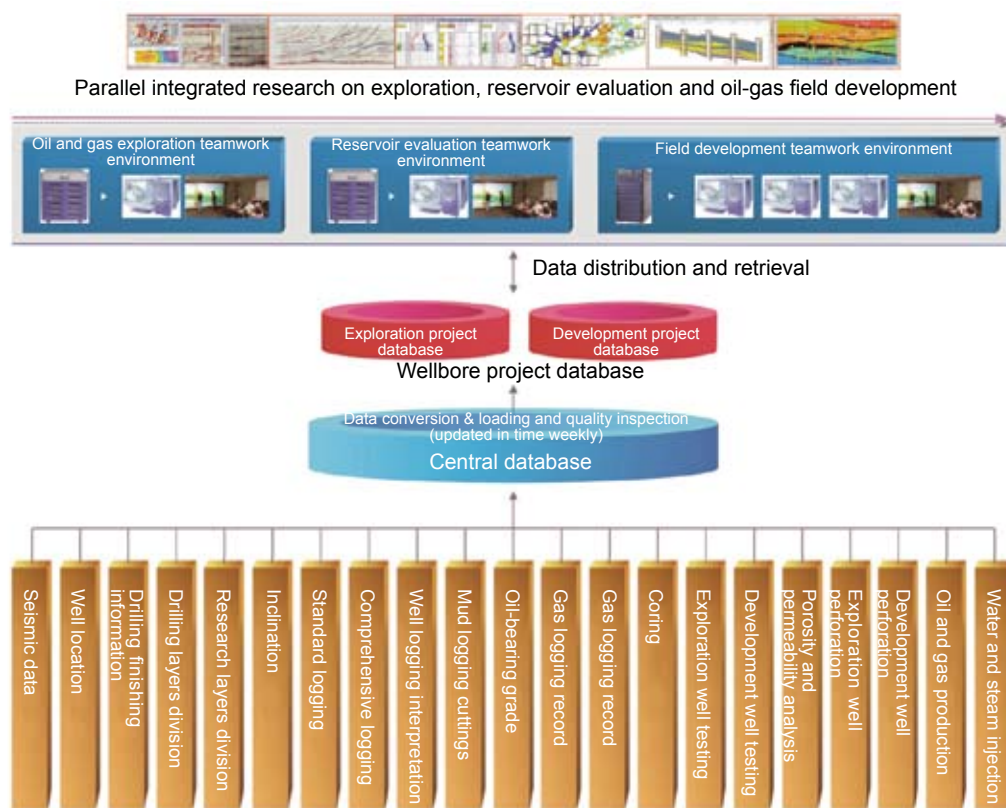
By using the methods such as RG line pickup and after-stack processing, seismic data and interpretation solutions with a uniform datum plane of basin scale have been established. As demanded by researchers, seismic data and interpretation solutions can be directly distributed into an interpretation system.

- **Wellbore Project Database Construction Technology**

The technology integrates Oracle data management technology and international POSC and PPDM data model standards, realizes the high-degree data sharing, and supports multi-user parallel work.

- **Basic Data Management Service Technology**

Established on the basis of universal data



models for oilfield exploration and development and information standard system, the Basic Data Management Service Technology uses modern communication means and advanced data acquisition flows, and integrates multiple data such as seismic data, drilling data, log data, well logging data, testing data and analysis data from the viewpoint of basins, and forms a highly integrated and shared central database of the oilfield. By using the technology, we can customize an oilfield business management system conveniently and adapt to business variation quickly.

● Data Conversion and Loading Technology

Developed on the basis of the middleware OpenSpirit, the technology can adapt to the variation and upgrading of basic data models and multi-disciplinary interpretation system data models quickly,

thereby realizing automatic data loading from the central database of the oilfield to the comprehensive exploration interpretation system and getting rid of conventional manual data loading modes.

● Data Distribution Technology

The technology can distribute data to a target research area in due time, and can link the project research areas of different regions, operating systems and users, and can realize a uniform outlet of project research data and high-degree data sharing.

2.3 Result Browsing and Decision Support Technologies

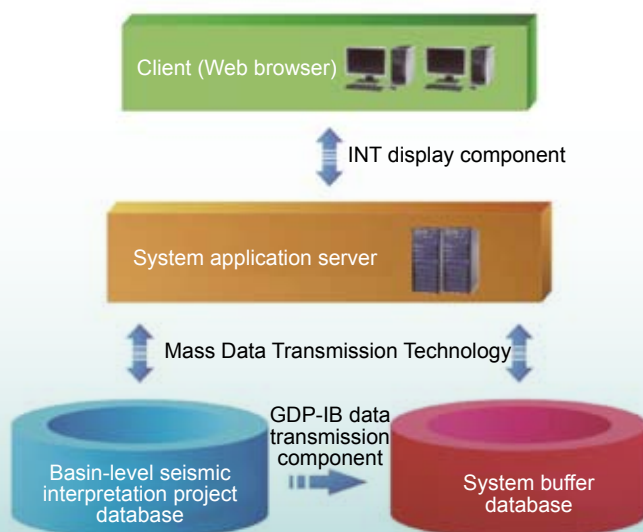
The realization of web publishing and browsing of seismic data interpretation results of basin scale has been the urgent demand of researchers and decision makers. The main causes for non-realization

used to include large data quantity, cross-platform access and slow display speed. The Result Browsing and Decision Support Technologies have solved the above problems effectively and provided an easy-to-use result data access platform for researchers and decision makers.

By using the Result Browsing and Decision Support Technologies, CNPC has established the first system that can directly access the seismic interpretation scheme in the interpretation system on line via Web browser. The system uses the following 4 unique technologies.

● Cross-platform Data Access Technology

The technology realizes the accessing of seismic data and comprehensive seismic interpretation results in the platform OpenWorks in Linux and Unix environments, and can effectively improve the efficiency of simultaneously reading plenty of data.



In addition, the data reading format conforms to professional data standards.

● Seismic Interpretation Result Browsing Technology

The technology realizes the comprehensive display of seismic profiles, seismic interpretation results and geologic result data, and conforms to professional application software display standards.

● Mass Data Fast-display Technology

The technology realizes 2D and 3D seismic data access and transmission and graphical display of mass data, increases mass data transmission speed effectively, ensures data integrity and increases graphical display speed and plotting efficiency by use of a double-buffer technique.

● Technology of Graphical Analysis of Results

The technology uses general international standards and realizes graphical analysis and fidelity display of CGM graphs.

3

TYPICAL CASES

3.1 Successful Applications in Karamay Gas Field

By using plenty of well data and seismic data of the IERP and advanced technical means, we have made a study of multi-disciplinary collaborative interaction, interpreted the Carboniferous volcanic strata, cycles, sequences, stages, lithology and lithofacies in Ludong-Wucaiwan Region, analyzed gas reservoir types and reservoir control factors, and determined Carboniferous exploration areas and favorable belts. Meanwhile, we have broke through the previous route for finding the Carboniferous top face traps, identified and optimized numerous volcanic exploration targets, and improved the quality of results and the efficiency of research work. Furthermore, we have completed the overall deployment of pre-exploration wells and

reservoir description and evaluation, made breakthroughs in many wells, determined the Carboniferous gas reservoirs in the middle section of Dinan Uplift and discovered Karamay Gas Field with the scale of 100 billion cubic meters.

The establishment of a similar volcanic strata project needed half a year in the past. By using the IERP, it takes only half a month to complete the construction of a project environment. The probable reserves of Karamay Gas Field were submitted in 2007, and they were evaluated in the same year. The probable reserves were upgraded into proven reserves in 2008, and the gas field was then put into complete development. It took only two years to discover the gas field, obtain its proven reserves and build up its production capacity.





3.2 A Breakthrough Made in Well Fengcheng 1

Well Fengcheng 1 is located in Wuxia structural belt in the northern section of the western uplift in Junggar Basin, with complex structures and diversified reservoirs. A comprehensive comparative analysis of various data of well intervals with abnormal oil/gas displays in Well Xia 72 and Well Feng 7, etc. has been made with the IERP. In addition, by using the result browsing system of the IERP, we have made a comprehensive superposition display analysis of multiple research findings (e.g. seismic sections, interpretation schemes, structural

maps and sedimentary facies maps) of Wuxia Region, and determined Fengcheng Fm. of Wuxia structural belt as a favorable exploration area. Based on this, by fully using the well data and seismic data of the IERP and advanced technical means, we have made a study of the multi-disciplinary collaborative interaction, performed the fine identification and description of traps and determined the favorable targets quickly. The high-yield oil and gas flows have been obtained in the risk exploration of Well Fengcheng 1. This has opened up a new situation of exploration in Permian Fengcheng Fm. in Wuxia Region and fully reflects the advantage of abundant data of the IERP and the advancement of its comprehensive technical means.

4

R&D EQUIPMENT

4.1 Data Management R&D Equipment

Oracle database server: IBM P5 570

Project data management and loading: SUN E4900 server, SUN Blade2500 workstation.

Project data management software: open Oracle and OpenWorks database management system, centralized PetroBank seismic data management platform

4.2 Data Storage R&D Equipment

Data storage and backup servers: SUN STK6540, NetApp VTL1400

Online storage equipment: IBM 3494 automatic

tape pool, IBM 3584 backup tape pool, EMC CX700 disk array

4.3 Professional Application R&D Equipment

Professional application software server: IBM X3950

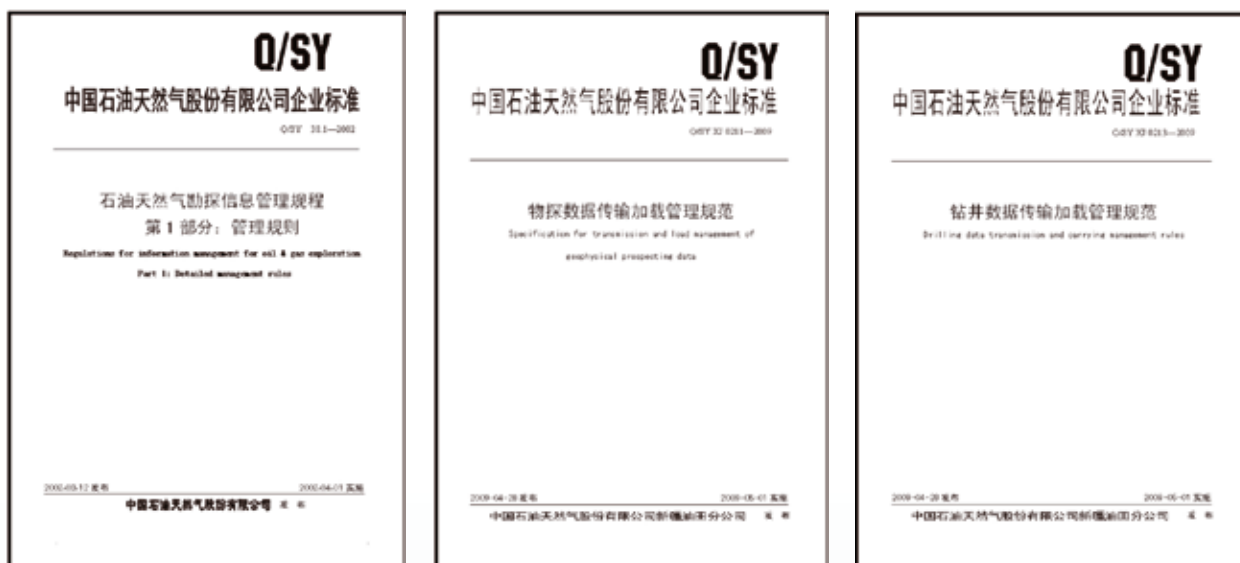
High performance graphic workstations: HP XW9400, SUN Ultra45 to perform integrated interpretation and comprehensive research

Professional application software: OpenWorks, Eops integrated application interpretation system



5 QUALIFICATION AND STANDARD

The standards and specifications used by the IERP include the 24 enterprise standards and specifications on oilfield central database and project database etc., issued from 1998 till now. Processing and conversion of seismic data, drilling data, log data, well logging data, testing data and analysis & assay data, etc. have been completed according to the enterprise standards and specifications, thereby providing accurate data for the exploration and development research.



- Regulations for Oil and Gas Exploration Information Management Part 1: Detailed Management Regulations
- Regulations for Oil and Gas Exploration Information Management Part 2: Static Data Sheet Structure
- Regulations for Oil and Gas Exploration Information Management Part 3: Normative Values
- Stratigraphic Horizon and Reservoir Information Code
- Specification for Coding of Data Sheets of Exploration and Development Database
- Specification for Database Logical Structure Management
- Specification for Writing Well History Data in Drilling Database
- Normative Values of Drilling Data
- Normative Values of Log Data
- Normative Values of Well Logging Data
- Normative Values of Well Testing Data
- Specification for Management of Transmission and Loading of Geophysical Exploration Data
- Specification for Management of Transmission and Loading of Well Location Data
- Specification for Management of Transmission and Loading of Drilling Data
- Specification for Management of Transmission and Loading of Log Data
- Specification for Management of Transmission and Loading of Well Logging Data
- Specification for Management of Transmission and Loading of Well Test Data
- Logical Structure of Mining Right Management Database
- Logical Structure of Trap Management Database
- Logical Structure of Log Database
- Specification for Data Coding of Project Database
- Data Loading Process of Project Database
- Specification for Data Quality Inspection of Project Database
- Specification for Conventional Diagrams of Project Database

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EXPERT TEAM



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