Integrated Management Technology of Geophysics and Geology Data

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Abstract. This paper describes the three main development stages of geophysics and geology data management, analyzes the business and data characteristics faced at each stage, discusses the development trend of integrated geophysical and geological data management with the development of information technology and database technology; analyzes the challenges faced by geophysical and geological data in terms of data collection, data storage and data application, explains the sources and causes of the problems. The concept of integrated management of geophysical and geological data is proposed, based on the data governance framework system, the integrated data management platform is built, covering the construction of data source collection, efficient data services and comprehensive data management, so as to realize unified, efficient and secure data collection, management and application services, the content and characteristics of the main data management strategy of geophysical and geological data are analyzed, and on the basis of the above discussion. Finally, it explores and practices the application of this technology system outside the oil and gas field, proposes the application support scheme of integrated geophysical and geological data management for business, and further demonstrates the value and significance of the wide business application of integrated data management.

Keywords: Geophysics; Geology; Data Management; Integration; Digital Oilfield.

1. Introduction

The development history of geophysics and geology data management can be divided into three main stages from the perspective of management means and objectives: the first stage is from manual to asset management stage, with the objective of assetization of data, focusing on data standard unification, quality system unification, integration of management processes and data integration. The second stage is the digital oilfield stage, with the goal of business networking, focusing on building business model integration, workflow integration, comprehensive asset awareness, and remote collaborative work. The third stage is the intelligent and smart oil and gas field stage, with the goal of intelligent decision making, focusing on building integrated operation models, enterprise process reengineering, and big data analysis and decision support, etc. From the perspective of information technology, the development history of geological data management technology for geophysical exploration can be roughly divided into the era of paper media and file system, the era of database system, the era of Internet, and the era of artificial intelligence. In the above development process, the number, dimensionality and inner connection of the managed physical objects of geophysical and geological data have been greatly improved, and we can find that the number of indicators is growing exponentially and rapidly, while the rapid development of information technology such as big data, the integrated management of holographic geological data is an inevitable trend [1].

Geophysical exploration data and geological data are inseparable and complementary, both of them come from the same geological entity and must be integrated and consistent, and master data management is an important technical means [2]; the correctness of technical methods can be

mutually verified at the level of information integrity of data management and the level of comprehensive study of processing and interpretation of business applications, and the integrated management of geophysical exploration and geological data is of great business value and broad in the fields of intelligent oil and gas fields and urban geology. It has important business value and broad application prospect in the fields of smart oil and gas field and urban geology.

2. Challenges and Strategy

2.1 Challenges of geophysics and geology data management

In the field of oil and gas exploration and development and natural resources management and other earth science related fields, geophysical prospecting technology is commonly used to obtain field data, and after processing and interpretation and comprehensive geological research related technology application, which is an important means to find out the real situation of the earth's subsurface, and has an extremely important role in oil and gas exploration and development operations and even modern urban underground space planning [3].

In recent years, for the analysis of the current situation of geophysical and geological data management in physical prospecting, currently facing challenges in the following three aspects, the first aspect is to face challenges in data collection, there are several aspects: many sources of legacy data, complex environment, data management forms exist in the form of paper storage, a variety of database form storage and even some in personal computers, etc., the above data will also exist duplicate entry phenomenon, such as well number and well data, the same well is entered by engineering service companies, some are information service companies, so the same well number and data are prone to inconsistencies in various situations, this decentralized management of data history model will also lead to the difficulty of data quality assurance, the above-mentioned large amount of heterogeneous data is very difficult to unify into the database, into the data lake, to achieve data integration is a great challenge. The second aspect is the challenge in storage management, data standards are not uniform, for example: some data stored in Oracle, some data stored in SQL Server, and stored in file-based databases (Foxpro, Access, etc.), data access consistency is poor, data governance is very complex, data security is also difficult to guarantee. The third aspect is that the data application is facing challenges.

Due to the above reasons, the data integration, data sharing, real-time data application, professional software support and multidisciplinary collaborative application that must be realized in the construction of digital oilfield and intelligent oilfield today are facing great challenges, and we need to study the corresponding technical means and strategies to cope with and solve the problems.

2.2 Concepts of integrated management

In response to the above challenges of geophysical and geological data management, the following 3 demands are put forward to support data collection systems in multiple ways, establish unified data standards, data quality assurance system and provide efficient data services. The concept of integrated management of geological exploration data is to build an integrated data management platform based on the data governance framework system, covering the construction of data source collection, efficient data services and comprehensive data management, realizing unified, efficient and secure data collection, management and application services, and supporting the integrated management of national or enterprise-level data assets based on cloud data centers (Figure 1 The concept of integrated management of geophysical and geological data) .

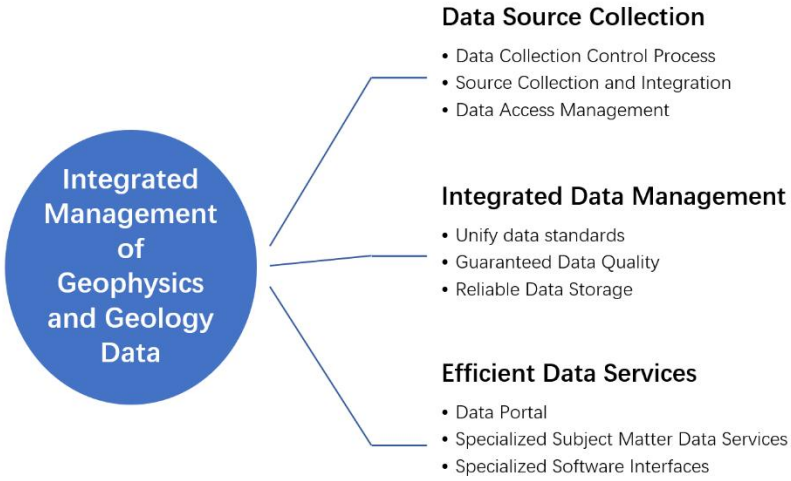

Figure 1 The concept of integrated management of geophysical and geological data

The integrated management of geophysical and geological data must protect data security from multiple dimensions such as deployed hardware server, network, system, data transmission, identity authentication, role, function authority, data authority, secure storage, secure encryption, etc. Based on the organization, role and user, hierarchical authorization can be carried out. With the support of data quality control scheme and established quality control rule base, the quality control rule engine can monitor the data before, during and after the storage, so as to guarantee the quality of the stored data.

3. Master Data Management Strategy

Master data refers to the public, relatively static data between systems that play an associated index. The main difference between master data and daily production data is that the changes are relatively slow and need to be reused by multiple systems, and all data of each professional system can be retrieved through master data as a clue.

Master data management is concerned with the common information of data, i.e., the public basic information of data, rather than the business information generated in each business link. Master data management requires enterprise business departments and information departments to share management responsibilities and work together in order to bring into play the application value of master data in business. By establishing a unified master data standard system and management process, and building a master data management platform as technical support, we can improve the quality of enterprise master data, realize the authenticity, effectiveness, consistency and sharing of enterprise master data, and provide the foundation and support for business management and decision analysis.

Master data management is not only to build master data management platform as a technical support means, but also to strengthen master data governance, including the establishment of data operation and maintenance process and master data management organization, to strengthen data change management and guarantee data quality. At the same time, master data management is not only a matter for information department, but also more valuable for business departments that apply data, so information department and business departments should jointly undertake the responsibility of master data management. The value of master data management is mainly reflected in four aspects: optimizing enterprise management, strengthening business collaboration, consolidating data foundation and reducing information cost.

Specifically for data in the field of geophysical exploration, it mainly supports enterprise data governance and control through unified management of business objects such as organization,

project, seismic area, well/borehole, including acquisition, integration, change, distribution and release, statistical analysis, etc. Geophysical and geological master data realize hierarchical, hierarchical and whole life cycle management of enterprise data (Figure 2 Geological and geological master data management strategy).

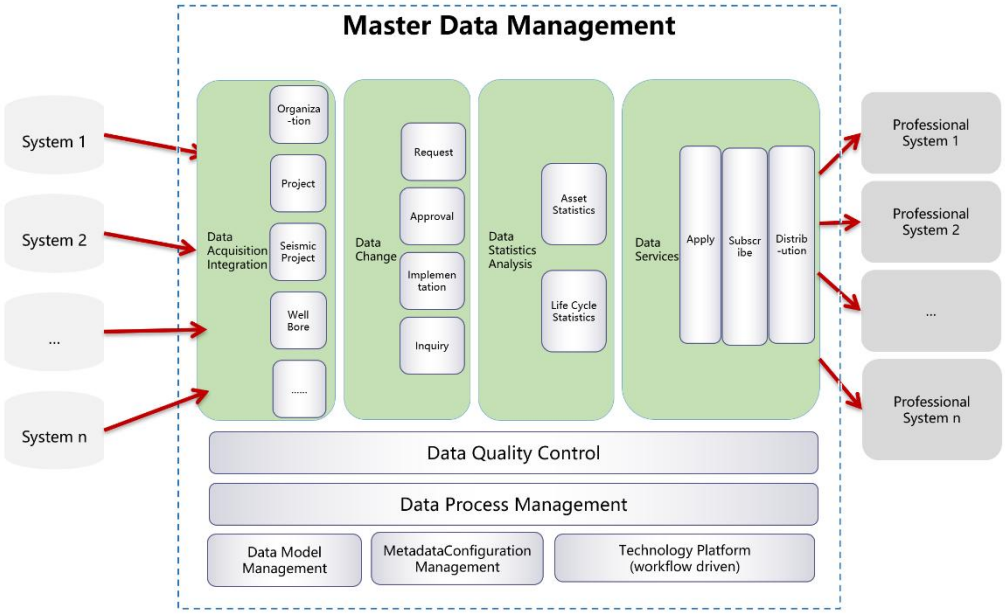

Figure 2 Geological and geological master data management strategy

The distinctive features of the Geophysical and geological master data management strategy are that it has a complete data quality management process, supports garbage data cleaning to save data collation cost; eliminates data inconsistency to save data maintenance cost; supports two data distribution modes, direct and indirect, and flexibly adapts to the unified management of master data of various systems, which will bring lasting and long-term potential value to users.

4. Technology Platform and Application Solutions

The cloud platform [1] built based on core technologies such as containers, microservices, DevOps, etc., agilely supports data integration, big data analysis, and multi-terminal applications, incorporates public, private, and hybrid cloud modes, and provides an open, inclusive, and secure information technology support platform for the construction of digital oilfield and smart oilfield application ecology (Figure 3 Information Technology Support Platform).

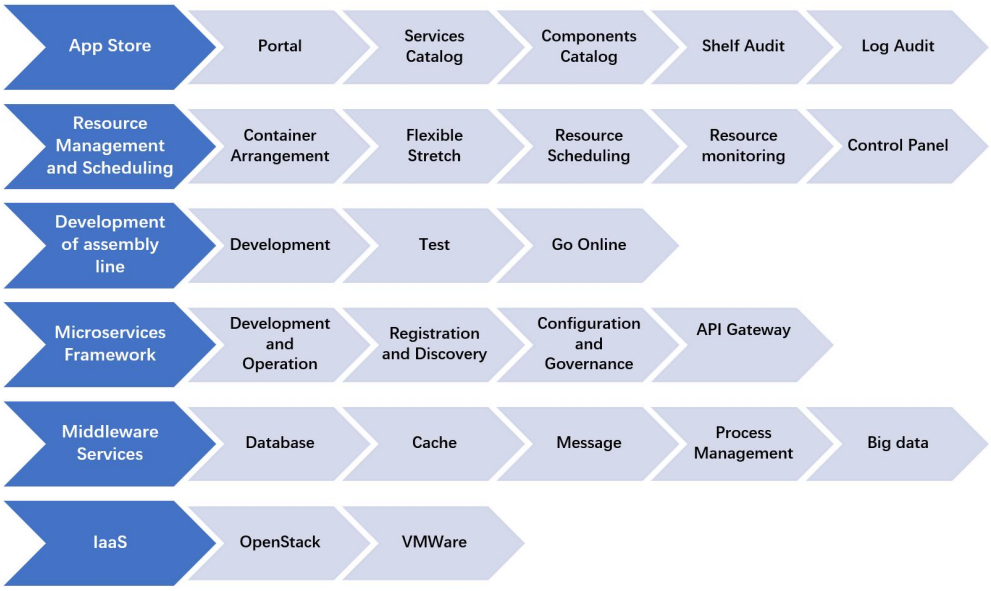

Figure 3 Information technology support platform

The above technical solutions have wide practical values and cases in the field of oil and gas exploration and development. In recent years, we have also done some exploratory researches in fields other than oil and gas business, and after many exchanges with national geological survey, land and other natural resources management departments, we have proposed targeted solutions for integrated management of urban geological multi-data, and have also achieved some preliminary exploratory practices and project applications in Huizhou City, Guangdong Province and other regions.

The development and safe use of urban underground space is an inevitable requirement for the new stage of urbanization. Underground space development will change the way of urban development, expanding from surface to underground development; it will reduce the hard demand for land and improve the satisfaction of urban function; it will require space to the depth and develop a new model of "underground city"; it will eradicate the criticism of big cities and scientifically utilize underground space, forming a new business industry chain, including Geological survey and underground exploration, geological research and visualization, urban geological data resource management, application and service, etc. Our information technology platform is to support the above new business industry chain (Figure 4: Application support for urban geological business).

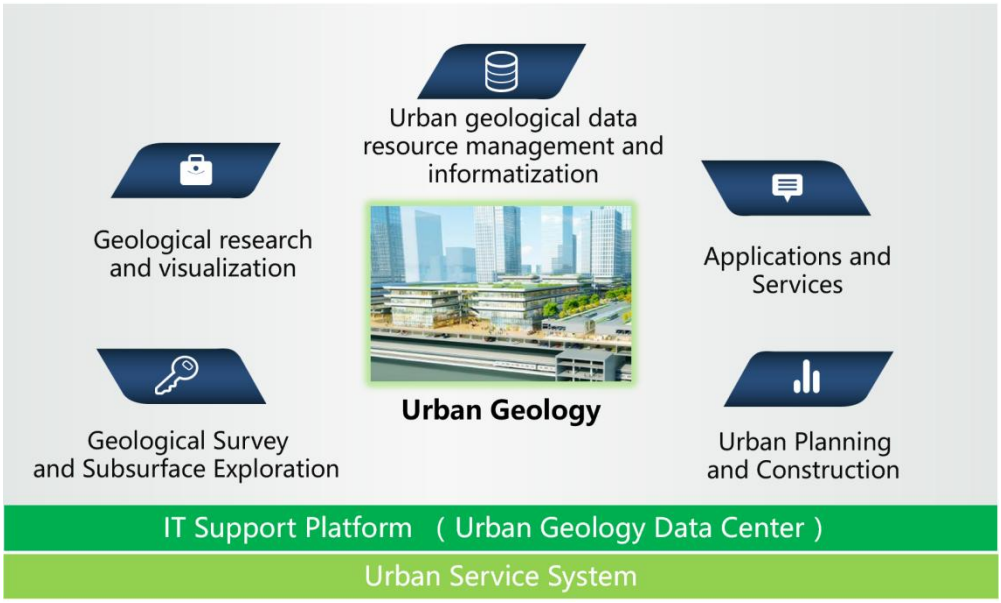

Figure 4 Application support for urban geological business

5. Conclusions

In the era of cloud and big data, what users need is not simple aggregation of data, but service aggregation and knowledge aggregation after data integration and processing, which puts forward a higher level demand for integrated data management and knowledge integration in the future. The integrated data management service is a systematic project, whose work includes: standard specification and index system research, geophysical exploration, geological drilling, data processing, geological modeling, IT support platform construction, urban planning and construction services, etc. Therefore, according to the different work contents and fields, the following multi-disciplinary collaborative teams and integrated software and hardware resources can be organized to establish standard specification and evaluation index system, fully apply cloud infrastructure, and efficiently establish an integrated physical exploration geological data management platform, which will certainly be able to play an increasingly important role in the fields of smart oil and gas field construction and urban geological information application, and make valuable and outstanding contributions to the realization of smart oil and gas fields and transparent underground space, and promote the harmonious development of energy and natural environment.

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