

## News and Highlights

# Ten Major Scientific and Technological Progresses of the Chinese Geological Survey in 2018



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The China Geological Survey has annually invested tens of billions of yuan in China's geological surveys in order to set up ten major plans, 60 programs and more than 400 projects, which will deliver hundreds of geological survey results every year. In early 2019, the China Geological Survey organized relevant experts to select ten major achievements among the completed projects of 2018, which were awarded the “Ten Major Scientific and Technological Progresses of the Chinese Geological Survey” as follows.

### 1 Major breakthroughs of shale gas investigation in western Hubei Province

The well Eyang Shale2HF produced 55, 300 m<sup>3</sup>/d and 198, 200 m<sup>3</sup>/d (open flow capacity) of high-yield shale gas flow. This work achieved a major breakthrough in the investigation of the Sinian Doushantuo Formation shale gas, and discovered the oldest shale gas producing interval in China, which has opened up a new interval for shale gas exploration. Based on the analysis of the investigation of Cambrian and Sinian shale gas, a reservoir-forming model of paleo-uplift reservoir-controlling shale gas was established; a ‘trinity’ evaluation method of shale gas resources was innovatively established and the potential evaluation of shale gas resources in western Hubei was carried out; three technological systems of the evaluation technology of selecting strata in complex structural areas, excellent and fast drilling technology for horizontal wells and fracturing back-drainage gas-testing technology for complex reservoirs were formed.

### 2 Theoretical innovations of gas hydrate reservoir formation in the marine realm and prospecting breakthrough in a new area

This work is led by the China Geological Survey and is implemented by the Guangzhou Marine Geological Survey. The controlling factors in the formation of gas hydrate reservoirs were studied in depth on the basis of the exploration of natural gas hydrate resources in the South China Sea, the exploration and evaluation of natural gas hydrate pilot test areas in the South China Sea, and the trial production projects of natural gas hydrate resources in the marine realm. The accumulation mechanism of the natural gas hydrate system was revealed through a gas

source-gas migration-enrichment process, and a ‘chimney-driven’ gas hydrate accumulation model in the uplift/slope zone of sedimentary basins was novelly proposed. Multi-disciplinary and multi-informational fusion technology was improved, and favorable mineral targets were optimized, which has effectively guided the deployment of natural gas hydrate exploration in 2018. Among the six pilot holes drilled in the new area of the northern South China Sea, high resistivity anomalies and low acoustic time difference anomalies were discovered at three stations, indicating the presence of gas hydrates. Drilling, coring and *in situ* testing were carried out at three stations. For the first time, gas hydrate deposits with large thickness, a high purity, of multiple types and multi-layer distributions were found here, which has become the third gas hydrate enrichment area in the northern South China Sea. In addition, the contribution of deep pyrolysis gas to gas hydrate reservoir formation was confirmed, and the genetic relationship between shallow gas hydrate reservoirs and deep oil and gas system evolution was revealed, which provides a new concept for comprehensive exploration and exploitation in the pilot test area.

### 3 Completion and major geological discovery of Deep Continental Scientific Drilling Engineering in the Songliao Basin

The well Songke 2, implemented by the Institute of Exploration Technology of the China Geological Survey and other organizations, completed at 7018 m, and achieved a series of major geological science and technology innovations. This well is the deepest continental scientific drilling well in Asia and is also the deepest well created over the 22 years since the establishment of the International Continental Scientific Drilling Program (ICDP). The innovative development of deep-well coring technologies such as 311mm large-diameter coring, ultra-long drilling distance coring and dynamic rope coring at the bottom of hollow wells has been achieved in this well, which has acquired 4134 m of large diameter core with a core recovery rate of 96.6%. This has formed the world's leading deep-well coring technology system and created four world records in deep coring technology. This well successfully developed high-temperature resistant water-based drilling fluid, cementing

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and temperature measurement while drilling. A series of high-temperature drilling technologies have created a new record of drilling at the highest temperature (241°C) in China. Two kinds of clean energy resources with good prospects for exploration and development were found, i.e., deep shale gas and basin-type dry-hot rocks in the Songliao Basin. The most complete and continuous continental strata in the Cretaceous were characterized with high resolution at the centimeter-level for the first time in the world, and the climate evolution history of continental facies in the Cretaceous was reconstructed at a scale of millions to 100,000s of years, and the major events of climate fluctuation in the Cretaceous were determined. A standard profile of continental strata in the Songliao Basin was established, and a new evolution model for the Songliao Basin was made, which has enriched the Cretaceous continental oil-generation theory and made great progress in basic geological research.

#### 4 Construction and operation of a national groundwater monitoring network

The work is organized and implemented by the Environmental Monitoring Institute of the China Geological Survey, assisted by many natural resource departments in various provinces (regions and municipalities) and geological environment monitoring agencies. The construction of the national groundwater monitoring project in natural resource departments has been completed in a thorough way, and the level of specialization and automation of groundwater monitoring has been greatly improved. The project establishes 10,168 national groundwater monitoring stations with clear horizons and a data-receiving and equipment management system based on ‘Internet of Things’ technology, realizes automatic collection, real-time transmission and multi-source analysis of groundwater monitoring data in major plain basins and economic development zones of population activities in China, and develops a monitoring information application service system using cloud platform and big data technology. The real-time simulation system of 3D groundwater cloud computing has established a working model of joint modeling in different places, and realized the management of monitoring data, dynamic analysis, comprehensive evaluation of water quality and quantity and information release. For the first time, the monitoring technology of confined-artesian wells has been developed and successfully applied, and two groundwater balance test sites have been built in arid and semi-arid areas of northwest China, and 12 groundwater monitoring standards have been compiled to achieve theoretical innovation and technological breakthroughs. In addition, abundant hydrogeological parameters were obtained by using the drilling data of monitoring boreholes, such as formation cataloguing, pumping tests and geophysical exploration wells, which has achieved a deeper understanding of regional hydrogeological conditions.

#### 5 Compilation of the first set of natural resource maps of China

Organized by the China Geological Survey, the first set

of natural resource maps of China has been compiled, with support from many natural resource departments of various provinces (regions and municipalities) and relevant geological prospecting units. For the first time, the quantity, quality, structure, ecology, current situation, potential and problems of natural resources in China were systematically organized, emphasizing that ‘landscape, forest, field, lake, grass and sea’ is the life community and the concept of green development. A total of 2,316 maps were compiled in eight categories at the national, provincial and thematic levels.

#### 6 Operation of the GeoCloud 2.0 Online Service

Organized by the China Geological Survey and implemented by 29 subordinate units, including the Development Research Center, an integrated and large-scale service platform of the GeoCloud 2.0 Online Service was operated, relying on geological big data and information service engineering. This platform integrates geological survey data, information products, software systems and computing resources effectively by using cloud computing and big data technologies, completes the construction of the node system, achieves the interconnection of 29 nodes and units under the bureau, and realizes the demonstration of two provincial node access. More than 160 geological databases were shared by using distributed database, Web Service and API interface technologies, and more than 7,000 products and 140,000 geological data were fully connected to cloud services, which has greatly improved the number and types of shared data and enlarges the scope of geological information services and service objects. This project independently developed the GeoCloud resource service warehouse and unified development platform (PaaS), constructed a shared cloud ecosystem, and provided a driving force for the rapid development of the GeoCloud thematic service and business system. Based on the GeoCloud 2.0 development platform and the resource service warehouse, the evaluation system of resources and environmental carrying capacity and the suitability evaluation of land and space, urban geological information service system and eight thematic services were rapidly developed, providing support services for national natural resource management, urbanization and green development. Based on the GeoCloud development platform, the GeoCloud Mobile App was developed to provide field assistance, geological maps, geological data, standards and norms, geological records, mineral records, mining yearbooks, geo-products, geological dictionaries, cloud mail, cloud disk and other functional applications. This has innovated the ‘cloud+mobile’ service mode, expanded the scope of the GeoCloud service, and provided ubiquitous information services.

#### 7 Construction and demonstration of a modern regional geological mapping technical system

Organized and implemented by the Institute of Geology, Chinese Academy of Geological Sciences, Institute of Geomechanics, Chinese Academy of Geological Sciences and the Xi'an Geological Survey Center of the China

Geological Survey, great progress has been made in the construction and demonstration of a modern regional geological mapping technical system, relying on comprehensive investigation of key geological problems and geological mapping projects in special areas. A system of 1:50,000 regional geological mapping methods has been constructed, technical standards for the 1:50,000 regional geological survey have been compiled, and 15 kinds of mapping guidelines have been compiled to solve the technical problems faced by geological mapping in the new era. This achievement fills in the blank of mapping technology in special geological and geomorphic areas with different types of coverage areas, inherits and develops mapping technology for different rock types, and has milestone and epoch-making significance.

### 8 Innovative results of geological structure and deep oil and gas investigation in the Tarim Basin

Organized and implemented by the Oil and Gas Center of the China Geological Survey, this project systematically processed and interpreted 350,000 km<sup>2</sup> of 2D seismic data to form 34 key seismic profiles covering the whole basin, totaling 17,191 km, and compiled 136 basic maps, relying on the strategic area survey of oil and gas resources in the Tarim Basin, the basic geological survey of oil and gas in the Tarim Basin, and the basic geological survey projects of oil and gas in the southwestern and southeastern depressions of the Tarim Basin. The basin structure has been redrawn, and the division scheme of 'five uplifts and five depressions' has been proposed for the first time, which lays a foundation for the overall study of the basin. The deep oil and gas resources in the basin have been evaluated at 24.2 billion tons, and the deep oil and gas resources in the basin have been preliminarily identified. Four oil and gas prospective areas and eight favorable areas have been selected for the deep basin, which provide targets for the breakthrough of oil and gas exploration. The basin-scale seismic data mosaic processing technology was formed, which has good application effect and great popularization value.

### 9 Completion of a new round of compilation of provincial regional geological records

The Institute of Geology of the Chinese Academy of Geological Sciences has organized the six regional

geological survey centers of the China Geological Survey and also geological survey institutes of various provinces to compile and complete a new round of provincial regional geological records relying on the integrated project of national geological structure regionalization and regional geological survey. Comprehensive integrated innovation research and new methods of geological mapping have been carried out in a holistic way. New achievements and data of massive regional geology, geophysics, geochemistry and remote sensing geology in China over the past 30 years have been systematically integrated, and new ideas of Ocean Plate Geology (OPG) have been innovatively proposed. It provides a new theoretical basis for understanding the tectonic evolution of China's continental landmass and a new idea for solving the major difficult geological problems of orogenic belts and mineral exploration. New breakthroughs have been made in the study of Precambrian geology, and a new scheme for the division and correlation of the Mesoproterozoic and Neoproterozoic in China has been proposed.

### 10 Major prospecting breakthroughs in southern Xinjiang to strongly support industrial development and local poverty alleviation and prosperity

The Xi'an Geological Survey Center of the China Geological Survey, in cooperation with the Xinjiang Uygur Autonomous Region Geological and Mineral Exploration and Development Bureau and the China Metallurgical Geology Bureau, has made prospecting breakthroughs in southern Xinjiang relying on the project of 'Investigation and Exploration Demonstration of Iron, Lead and Zinc Resources in West Kunlun', which has strongly supported local industrial development and poverty alleviation. A number of large-scale and super-large deposits have been discovered to form three large-scale resource bases of the Huoshaoyun lead-zinc mine, Dahongliutan lithium mine and Malkansu manganese-rich mine, which has laid a resource foundation for mining development in southern Xinjiang.

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