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China Geological Survey conducted the first natural gas hydrates production test in the South China Sea

## China achieved fruitful results in oil–shale gas–coalbed methane exploration and development in 2021

Xi–jie Chen, Li–qiong Jia, Ting Jia

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## News and Highlights

### China achieved fruitful results in oil-shale gas-coalbed methane exploration and development in 2021

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2021 is the year with the least amount of oil and gas exploration and discoveries in the past 75 years. The world's new proven oil and gas reserves were  $6.6 \times 10^9$  barrels of oil equivalent, compared with  $19 \times 10^9$  barrels of oil equivalent in 2020, with a significant decline in new proven oil and gas reserves.

In 2021, the three major oil companies of China, PetroChina, Sinopec and China National Offshore Oil Corporation (CNOOC), achieved good results in the exploration and development of oil-shale gas-coalbed methane -unconventional oil and gas which is mainly reflected in three aspects, the first is to achieve a breakthrough in 7500 m deep exploration, the second is a breakthrough in offshore oil and gas exploration, and the third is a major breakthrough in unconventional shale oil exploration, adding  $5.393 \times 10^9$  t of proven oil and gas reserves. The following highlights the top 10 achievements of China's oil and gas exploration in 2021.

(i) "Bozhong 13-2" in Bohai Oilfield discovered a 100 million-ton scale oil and gas field. On February 22, 2021, CNOOC announced that the oil and gas field is located in the central waters of the Bohai Sea, about 140 km away from Tianjin, with an average water depth of about 23.2 m. It belongs to the type of buried hill covered by the sea area, and has important promotion value for the future exploration of the same type of buried hill in the Bohai Sea and offshore China.

(ii) The "Kenli 10-2" billion-ton scale oil and gas field was discovered in Bohai Oilfield. On September 30, 2021, CNOOC announced that the oilfield is about 245 km away from Tianjin City, with an average water depth of about 15.7 m, drilling into an oil layer of 27 m, and drilling to a depth of

1520 m. The daily crude oil production per well can reach 81.55 t. This is the first time that a 100-million-ton scale lithologic and lithologic reservoir has been obtained in the shallow layer of the sag belt of the Bohai Oilfield, which has broad exploration prospects.

(iii) "Huizhou 26-6" in the eastern South China Sea discovered a  $50 \times 10^6$  m<sup>3</sup> oil equivalent oil and gas field. On January 25, 2021, CNOOC announced that the oil and gas field is located in the Pearl River Mouth Basin of China, 162 km southeast of Hong Kong SAR, with an average water depth of about 113 m, and the thickness of the oil and gas layers drilled by exploration wells is about 422.2 m, belonging to the ancient buried hill type in the sea. The daily output of the test well exceeds 500 m<sup>3</sup> of crude oil and more than 60 m<sup>3</sup> of natural gas, breaking the 40-year history of no commercial discoveries in the area and showing good exploration prospects.

(iv) A tight gas field with reserves of  $101 \times 10^9$  m<sup>3</sup> was discovered in Linxing, Shanxi. On February 28, 2021, CNOOC announced that the gas field is located in the Carboniferous-Permian in the Linxing area of the Jinxi flexural fold belt in the eastern Ordos Basin. It is a "multi-layer and quasi-continuous" accumulation model. In the next three years, the Linxing gas field will build a large gas field with an annual output of  $2.7 \times 10^9$  m<sup>3</sup>.

(v) The Ordos Changqing Oilfield discovered  $1 \times 10^9$  t of shale oil. On June 20, 2021, PetroChina announced that the oil field is located in the laminar shale of the Chang 7 Member of the Triassic Yanchang Formation in the Ordos Basin. Since the discovery of the Qingcheng shale oil field in 2019, the cumulative proven reserves so far have reached  $1.052 \times 10^9$  t. It is the largest shale oil integrated oilfield with the largest proven reserves in China. For the first time, the oil-bearing mechanism and new accumulation model of mud shale in large inland freshwater lake basins have been revealed.

(vi) On August 25, 2021, Daqing Oilfield announced that

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$1.268 \times 10^9$  t of shale oil was discovered in Gulong shale oil of Daqing Oilfield. Daqing Oilfield, discovered on September 26, 1959, is a world-class super-large sandstone oilfield. The annual oil output from 1975 to 2002 was  $50 \times 10^6$  t, the annual oil output from 2003 to 2014 was  $40 \times 10^6$  t, the annual oil output from 2015 to 2019 was between 3850 t and 3200 t, and it reached  $43 \times 10^6$  t in 2020. The oil field entered an unstable period of withering. In recent years, Daqing Oilfield has introduced unconventional oil and gas theory to guide oil and gas exploration, and discovered  $1.268 \times 10^9$  t of shale oil in the shale of the Upper Cretaceous Qingshankou Formation in the Songliao Basin, which has brought new life to Daqing Oilfield.

(vii) Shengli Oilfield in Shandong Province has discovered  $458 \times 10^6$  t of shale oil, with prospective reserves of  $1.85 \times 10^9$  t. In October 2021, Sinopec announced that Well Fanyeping 1 deployed in the fourth member of Shahejie Formation in Boxing Sag of Jiyang Depression achieved peak daily production of 171 t of oil and  $16000 \text{ m}^3$  of gas. For the first time, a breakthrough in the commercial productivity of shale oil in the Jiyang Depression has been achieved, proving that matrix shale oil with a medium degree of evolution has good development value.

(viii)  $350 \times 10^6$  t of shale oil resources were discovered in the North Jiangsu Basin. On December 15, 2021, Sinopec announced that shale oil was discovered in Well Shaduo 1 in the risk exploration of the second section of the deep-sag zone in Qintong Sag, North Jiangsu Basin, with a maximum daily oil production of 50.9 t and a resource of  $350 \times 10^6$  t. The newly added oil reserves are  $31.86 \times 10^6$  t. The discovery has important guiding significance for the exploration of shale oil in small and medium-sized fault depression basins in the East China.

(ix) A one billion-ton scale ultra-deep fault-controlled super-large Fuman oil and gas field was discovered in the Tarim Basin. On June 18, 2021, PetroChina announced that the oil and gas field is located in the Fuman area in the hinterland of the Taklimakan Desert and the southern part of the Tarim River. The drilling depth reaches 8470 m, and the test oil column height reaches 550 m, setting the deepest oil production record and the highest oil column height record in the large desert area of the Tarim Basin, and confirming the ultra-deep fault-controlled oil and gas reservoir area of about  $20000 \text{ km}^2$ .

(x) The Shunbei oil and gas field in the Tarim Basin has obtained a new block of 100-million-tons scale. In August 2021, Sinopec announced that the oil and gas field is an ultra-

deep carbonate oil and gas field. The key exploration well deployed in the Tarim Basin in 2021, Well Shunbei 44X, has obtained a daily oil and gas equivalent output of over 1000 t, marking the major discovery of the 100-million-ton scale oil and gas area in the No. 4 fault zone of the Shunbei Oil and Gas Field. So far, the proven oil and gas reserves of the No. 4 fault zone have exceeded  $200 \times 10^6$  t.

At the same time, in 2021, China's domestic production of crude oil will be  $198.976 \times 10^6$  t, a year-on-year increase of 2.4%; natural gas production will be  $205.26 \times 10^9 \text{ m}^3$ , a year-on-year increase of 8.2%. The 2021 production for the Big Four oil and gas companies is as follows:

(i) PetroChina: In 2021, the output of oil and gas will exceed  $210 \times 10^6$  t, the output of natural gas will exceed  $100 \times 10^6$  t, and the output of crude oil will continue to grow for three years. There are three main oil fields, and the production volume is: (1) Changqing Oilfield is the largest oil and gas field in China, and it is also the oil and gas field with the largest oil and gas production in the past 10 years. In 2021, it will produce  $25.36 \times 10^6$  t of crude oil and  $46.5 \times 10^9 \text{ m}^3$  of natural gas. Oil and gas production equivalent reached  $62.44 \times 10^6$  t. (2) Daqing Oilfield will produce  $30 \times 10^6$  t of domestic crude oil and  $5.02 \times 10^9 \text{ m}^3$  of natural gas in 2021. Oil and gas production equivalent reached  $43.22 \times 10^6$  t. (3) The oil and gas production equivalent of Tarim Oilfield will reach a record high of  $31.82 \times 10^6$  t in 2021, achieving an increase of over  $1 \times 10^6$  t for five consecutive years.

(ii) Sinopec: In 2021, it will produce  $35.15 \times 10^6$  t of crude oil and  $33.9 \times 10^9 \text{ m}^3$  of natural gas, an increase of 12%. Among them, Sinopec Shengli Oilfield has made outstanding achievements in exploration and development. The oil and gas equivalent of Shengli Oilfield in 2021 will be about  $23.9 \times 10^6$  t, and four major breakthroughs and four commercial discoveries have been made, consolidating the foundation for stable production in the old area, and the effective and stable production of more than  $23.4 \times 10^6$  t for five consecutive years.

(iii) CNOOC: CNOOC's domestic crude oil production was  $48.64 \times 10^6$  t, a year-on-year increase of  $3.23 \times 10^6$  t, and the increase accounted for about 80% of the total domestic crude oil increase.

(iv) Yanchang Petroleum Group: In 2021, the oil and gas equivalent of Shaanxi Yanchang Petroleum Group will reach  $16.6 \times 10^6$  t, ranking the eighth largest oil and gas field in China, of which  $11.3379 \times 10^6$  t of crude oil will be produced.

(According to the data of the Ministry of Natural Resources and major oil and gas companies)