History of Water Conservation in Shendong Mining Area, China

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Abstract

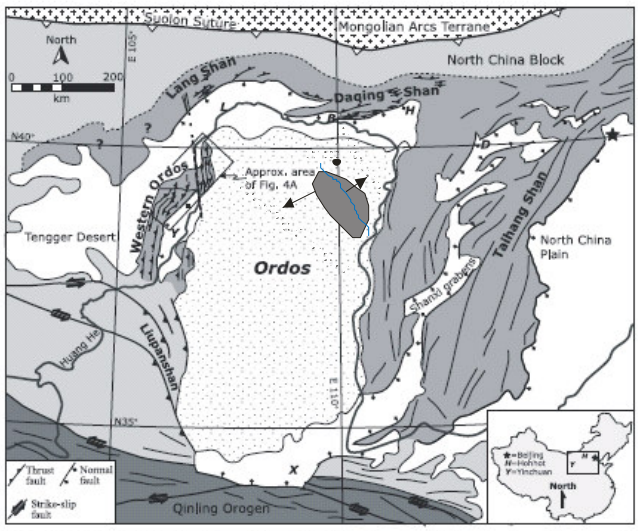
Shendong Coalfield is located in the semi-arid, semi-desert Ordos Basin of the NW China, where surface water is rare, the shallow Pleistocene Sala-u-su Formation is the main available aquifer and the environment is vulnerable. This article presents the history of water conservation in the Shendong Mining area since the 1980s.The coal excavation from the shallow-buried Jurassic Yan'an Formation inevitably destroys the surface water and Sala-u-su aquifer. At the beginning of the 1980s, a number of little coal mines mushroomed, and large areas of vegetation, the Sala-u-su aquifer and the environment were destroyed. In the late 1990s, these small coal mines were incorporated and water-conservation mining initiated in Shendong. In recent years, a new round of water conservation technologies are being researched and developed.

Key words: Shendong mining area, arid-semiarid region, water-conservation, mining

Introduction

The Ordos Basin is a large Mesozoic non-marine basin in NW China, and lies entirely within the North China Platform (Figure 1). It is surrounded by mountain belts on all four sides: the Yinshan to the north, the Qinling to the south, the Luliang to the east, and Helan Shan to the west.

Figure 1 *Location of Ordos Basin and Shendong Coalfield (from Ritts, 2004)*



The Shendong Coalfield lies in the north-east of the Ordos Basin (Fig. 1), and is one of the largest coalfields in the Ordos Basin. The Shendong Coafield extends 35–55 km from east to west and 38–90 km from south to north and covers approximately 3,500 km^2. The Wulanmulun River is the main river flowing through the coalfield. The coalfield is surrounded by the Maowusu Desert to the south-east and by the Kubuqi Desert to the north.

The climate is typical of a semi-arid, semi-desert and a continental plateau. The rainfall mainly occurs in the wet season from July to September. The annual average rainfall, evapotranspiration and temperature are 368.2 mm, 1319 mm and 6.2-8.5 □ respectively. The water resource is scarce, the vegetation is sparse, and the environment is deteriorating and vulnerable.

The geologic sequence of the coalfield upwardly is Early Jurassic Yan'an Formation ($J_{1\text{-}2y}$), Middle Jurassic Zhiluo Formation (J_{2z}), Pleistocene Sa-la-wu-su Formation (Q_{3s}) and Holocene aeolian sand (Q_4). The Yan'an Formation ($J_{1\text{-}2y}$) is mainly composed of fine-medium sandstone and mudstone,

averaging 205 m in thickness, and consisting of 5-9 coal seams. The overlying Zhiluo Formation is mainly composed by sandstone, averaging 0-30 m in thickness. The Sa-la-wu-su Formation non-uniformly overlies the coal measure strata, the thickness of which varies from 0-30 m. The topmost stratum is aeolian sand, 0-80 m in thickness.

The proved reserves of the Shendong coalfield is up to 223.6 trillion tons/tonnes?, accounting for 1/4 of the total proved coal resources of China, and is one of the 8 largest coalfields in the world. During "the Eleventh five-year" plan, the Shendong coalfield will be the important coal base. A key characteristic of these coal measures is their shallow depth burial, ranging from 10 to 100 m, with a maximum of 300 m.

The two main available aquifers are in the Sa-la-wu-su Formation (Q3s). Both of the aquifers overlie the shallow coal seams and are therefore easily damaged by mining.

So, the challenge is how to protect the rare Salawusu groundwater and prevent the roof of underground mines from caving up to the base of the aquifers.

Anarchic Mining in the 1980s

From mid-1980s, coal mining at the Shendong Coalfield had always been disordered. The state key coal mines, local state-owned coal mines, and township collective coal mines mushroomed along both sides of the Wulanmulun River. As statistics, by 1989, the anarchic mining encroached over an area of about 6300×10^4 m^2, destroyed vegetation in an area of about 18000×10^4 m^2 and caused a net increase of water erosion and land loss by some 2800×10^4t. As a result, this region contributed 2019×10^4 t of erosional deposits per year into the Yellow River, which accounted for 25% of the total Yellow River deposits and also made this region the main source of coarse sand to the Yellow River.

Respectively in July of 1989 and August of 1992, the Shendong mining area was twice flushed by 50-year floods, 26 pairs of pits ruined, and life and property suffered heavy losses. The basic reason is that disordered mining severely damaged the vegetation and fields along both sides of the Wulanmulun River, and upset the balance of the vulnerable environment.

Start of water protection in the 1990s

In the 1990s, to protect water resources and the environment, two kinds of measures were taken.

The first measure is to incorporate those low-capacity coal mines such as township collective coal mines and local state-owned coal mines. That is because the low-capacity mines of that day appropriated more land, drained more groundwater resources, and re-utilized less mining water.

In 1995–1996, the Shenhua Shenfu Preparing Coal Co. and Shenhua Dongsheng Preparing Coal Co. were set up; the Bao-Shen Railway opened to traffic; and, after incorporating many low-capacity coal mines, the modern large-capacity coal mines, including Daliuta, Majiata, Wulanmulun, Bulianta etc., went into production. The production capacities of the two modern mining areas are 360×10^4 t/a and 540×10^4 t/a respectively. In 1998, the twocoal companies. incorporated as Shenhua Shenfu-Dongsheng Coal Limited Co., were simply called "Shendong". By 2005, Shendong rebuilt and enlarged the 10 pairs of coal mines, 8 of which reach the production capacity of tens of million tons per year.

The other kind of measure is to research and adopt water and environment protection techniques. The most important research project is the "Ninth Five" Key technology R&D Programme "Research on environmental geology and water protection in northwest Jurassic coalfield", organized and undertaken by the China Coal Geology Bureau, China University of Mining and Technology etc. in 1995–1998.

This project investigated (1) the characteristics of surface and groundwater systems, (2) integrated water use and resource of mine water, and (3) the environmental problems and protection.

The increasingly worsening situation was controlled by the outcomes of this project. This project is the beginning of China's water-protection mining technology in a semi-arid region. However, the research mainly focused on the geological and environmental perspectives. The research still cannot meet the need of water and environment protection and conservation.

Further research on water-protection and mining since 2000

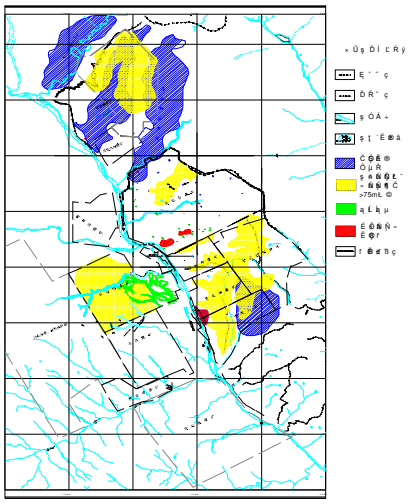
In 2004, the□Strategic Research on Water Resources Allocation and Ecosystem Development of North-west Regions□, compiled by the Chinese Academy of Engineering, points out that the function of groundwater in the north-west region is not water supply, but conserving and improving ecological

and environmental quality. From the strategic view, the water demands of the Shendong mining area will be fully met by transmitting water from the Yellow River.

In 2006, a second round of the water conservation project "Research on techniques of water-conservation mining in the Shendong Mining Area" sponsored by Shenhua Shenfu-Dongsheng Coal Limited Co., taken by China University of Mining and Technology, commenced.

The research presented that the Jurassic Zhiluo Formation is the key stratum to prevent roof caving to the Pleistocene Salawusu/ Sa-la-wu-su aquifer. According to the rock mechanics and thickness of the roof, especially the Zhiluo Formation, the coalfield is divided into different kinds of water-conservation districts, which represent different water-protection modes, and relevant techniques such as face design, strata control are adopted (Figure 2).

Figure 2 *water-conservation districts of Shendong Coalfield*



At the same time, Shendong also takes some ground measures to protect and conserve the Salawusu groundwater water systems. For example, Shendong has instituted the ecological conservation into its "1999–2008 Ten Year Plan". Shendong abstracts 0.45 *yuan* per ton coal as ecological conservation fund. By 2007, the fund has added up to 950×10^6 *yuan*. Now, the mining area is 59 km^2, while the ecosystem conservation area is 153 km^2, and the coverage of vegetation has increased from 3–11% to 59.45.

Conclusions

(1) The history of water protection in Shendong Coalfield can be divided into 3 phases.
(2) The water-protection mining technology was initiated in China in the 1990s, aiming to retain, transit or store the groundwater as much and fresh as possible;
(3) On the basis of water-protection districts, the matched water-protection techniques include face design, strata control, goaf backfill, etc.
(4) Water protection means not simply keeping the groundwater in the aquifer, but retaining and restoring its environmental functions. That is the great challenge still for water-protection mining.

Acknowledgements

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