HARD COAL BEYOND SILESIA

Keith Philpott, Steffen, Robertson and Kirsten (UK), reports on work undertaken at Bogdanka coal mine in eastern Poland.

Steffen Robertson and Kirsten (UK) (SRK) was mandated by PriceWaterhouseCoopers (PWC) to carry out the technical due diligence study of the Bogdanka mine as part of PWC's contract with the Polish Ministry of State Treasury for the pre-privatisation analysis of KWK Bogdanka SA. A team from SRK visited the mine during the Spring of 1999 to examine the geological, mining, environmental and coal preparation aspects of the operation, as well as to review management, manning levels, performance and other broad factors affecting the operation of the mine.

Bogdanka

The Bogdanka mine complex lies 180km to the southeast of Warsaw, close to the town of Lublin, and is the only mine operating outside of the Silesian coalfields of southern Poland. Shaft sinking commenced in 1975 with production, currently running at approximately 3.5 million tpa, starting in 1984. In 1993, the joint stock company Bogdanka J.S. was created with the Ministry of State Treasury owning 86 per cent of the shares. Coal is delivered on site to a coal preparation plant owned by the subsidiary Lublin Coal. Here, waste rock is removed to produce some 3.25 million tpa of medium grade (22Mj/kg) steam coal, which is mostly moved by rail to power stations and other bulk users in eastern Poland. Some 0.25 million t of sized high grade (27Mj/kg) household and industrial coal is produced and sold locally.

Mineral rights

Mineral rights fall under Poland's Geological and Mining Law, promulgated in February 1994, which covers all aspects of control over the minerals sector, including the award of exploration and minerals concessions, royalties and the responsibilities of mine operators. The law distinguishes between 'basic' minerals, including all energy materials such as coal, and 'common' minerals, comprising greenfield occurrences of materials such as sand, clay and aggregates. The former fall under the jurisdiction of the Minister of Environmental Protection, Natural Resources and Forestry, while the latter (and also the treatment of tailings or old waste material) fall under the Voivodes or Provincial Governors. The exploration and production stages of projects and applications require the submission of environmental impact studies. The law makes provision for an initial payment for mining rights and sets limits on royalty payments. The latter are directed to the local commune and the National Fund for Environmental Protection and Water Management. It is assessed on the sale value after benefication where this has been undertaken. Hard coal attracts a basic rate of two per cent compared to four per cent for lignite or brown coal and six per cent for oil, natural gas or coalbed methane.

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Exploration

At Bogdanka, the mining concession covers some 57km^2 and allows for the extraction of coal from Seams 382 and 385/2 until 2015. Terms of the licence permit the continued exploration of deeper seams by underground drilling while extensions in time or to additional seams would be subject to government approval. Economic prospecting was carried out between 1968 and 1974, following earlier investigation by the Upper Silesian Branch of the Geological Institute. Within the Westphalian coalbearing strata of the Lublin Basin, some seven mines were originally planned but only two commenced. The most southerly located of the three shafts, Stefanow, was abandoned in 1987, while the other two at Bogdanka and Nadrybie remain. Numerous surface boreholes were drilled at an approximate spacing of 1500m, with holes continuously cored and geologged. Underground coring is extensive at a spacing of some 700/800m and at 93mm diameter. Surface seismic surveys

carried out in 1985 were at the time thought to have shown a significant network of faulting, but subsequent working has shown the deposit to be remarkably free of faults.

Cover strata

The workings in Seams 382 and 385/2 vary in depth from 820 to 970m with coal bearing strata being encountered at approximately 700m. The shallowest cover strata are some 30-50m of Quaternary (Czwartorzed) age glacially derived sediments, principally sand, together with gravel and clay. Tertiary age deposits are generally absent.

Beneath lie 500-550m of Cretaceous (Kreda) strata, principally limestones. The upper section comprises mostly chalky limestone, the middle and thickest section chalk with flints, and the lowest sandy and oolithic, dolomitic limestones. At the base is a thin (1.5-3.0m) bed of sand, soft sandstone and conglomerate (Albian). Above the coal bearing strata is 100-150m of Jurassic limestone with a basal section of sands and clays.

Coal seams and geological structure

Carboniferous (Karbon) Strata have been proven to depths of 1000-1300m and contain a sequence of coal seams, shales, mudstone, claystones, seatearths and, less frequently, sandstone. Seams are assigned correlation numbers with eight identified to be of possible economic importance. Seam partings are not generally prone to rapid changes and seam thickness is up to approximately 3m. The upper two seams, overlying those currently being worked, have not been considered for working to date, due to their proximity to the overlying water bearing Jurassic limestones.

The mine is characterised by a relatively simple geological structure with seams dipping towards the axis of the northwest-southeast trending Bogdanka Syncline. To the west of the axis, which passes through the centre of the Bogdanka and Stefanow shaft locations, the strata dip at increasing gradients (1 in 18 increasing to 1 in 6 or more) as the incrop against the overlying Jurassic strata is approached. Strata on the eastern limb dip more gently at 1 in 35 to 1 in 55. Minor normal faults with throws of less than 2.5m are occasionally present.

Seam 382 has been worked centrally within the mine take, with occasional second horizon workings in seam 385/2 approximately 30m below. The upper seam averages 2.5-3.5m in thickness to date, with mudstone dirt partings of 0.1-0.3m. Locally, the dirt parting increases such that only the top section is cut. Seam 385/2 has been worked less extensively and is 1.7-2.0m thick with one or two thin dirt bands. Both seams are subject to thinning elsewhere within the mine take. Coal is classified under the Polish system as 'gas-flame' or 'gas' coal with average ash and sulphur percentages of approximately 10 per cent and 1.0-1.5 per cent respectively.

Water

Four different water bearing aquifers have been identified in the sequence.

- Quaternary and Upper Cretaceous aquifer to a depth of 150-200m, controlled by fissure systems and provides supplies of drinking water in the region.
- Lower Cretaceous aquifer related to a thin layer of water bearing Albian sands with pressures of up to 5.6Mpa, and responsible for partial infilling of the Stefanow shafts.
- Jurassic aquifer associated with fissuring and cavern development in the limestones and also with fissuring and high porosity within sandstones.
- Carboniferous aquifer usually associated with permeable sandstone beds.

The middle aquifers are thought to be recharged from the surface by mainly meteoric water via faults in the Cretaceous strata. Inter-connection to lower aquifers remains a possibility in the future as further coal working in the basin results in subsidence collapse.

The mine is basically dry in operational areas with only nuisance water, except where a face approached the overlying Jurassic strata in the southwest of the mine, where there is now a consistent flow of 2.5-3.0m^3/min. There was also a major shaft lining failure at Bogdanka due to excessive pressure on the lining by the Albian sands aquifer, resulting in infilling and abandonment. Other shafts (diameter approximately 7.5m) are now protected from damage by pressure relief drainage.

Reserves

Estimates for workable reserves at the mine exclude shaft pillars, coal within 100m of the overlying limestone, coal of thickness less than 1.2m and areas where the ratio of dirt bands to coal is greater than 0.2. Mining losses provide for narrow pillars left between panels, roadway protection pillars and irregular shaped areas of coal which cannot be developed. Suffice to say, there are many decades of coal available at the current extraction rate of 3.5 million tpa.

In view of the simple geological structure, proven seam continuity, close proximity of the two seams being worked, and extensive proving by boreholes and underground roadways, there is a high degree of certainty attached to the coal available for future working. One unproven factor is the effect of working panels in seam 385/2, directly below seam 382.

Extraction

The mine uses longwall mining with caving behind the face. There is a 'total' extraction system where the faces are placed 'skin to skin' with only a narrow 5m pillar left between. Roadways are generally not reused as the mining process destroys them due to the pre-mining and mining induced stresses. Due to the absence of faulting, the mine has been able to be laid out in a very orderly manner with long face runs, in excess of 2000m in some cases. The length of face has gradually been increased from 100m to the present 285m. The size of panels gives a long production life between installation and recovery of face equipment. Roadways are supported with heavy duty yielding arches set as close as 0.6m with spacing dictated by local geological conditions. The floor is soft with a strength in the region of 15-25Mpa and as a result, a separate floor invert is put in place behind the development machine. Currently arches are removed as the face passes but have been subject to high loading and are not reusable. The mine has three longwall sets of equipment, utilising Joy 4LS and KSW 500-2A2V/2BPN face machines, and eight heading machines (two deployed by contractors), mostly Voest Alpine AM65s or AM60s, to develop new roadways.

Mine management reported no incidents of spontaneous combustion at the time of SRK's visit and methane emissions were very low. Heating is a problem at the mine. Standard 300kW chillers are in use on headings and faces to aid the comfort of underground workers and permit the working of shifts longer than six hours (a requirement of Polish law).

Coal preparation

At the coal preparation plant all processes are manually operated and controlled, including the density and cut controls on the major washing vessels. It is designed to

upgrade the run of mine product by removing waste from the +20mm coal using a dense medium machine and a water jig. A high density wash (specific gravity 1.7) produces a float product which becomes the feed for the second stage, and a discarded sinks product. The product is refined by a low density wash (specific gravity 1.4) which results in a floats product sold as large coal and a sinks product which is crushed to less than 20mm and transferred to the fine coal preparation plant for re-washing. Waste water is pumped to two high-rate thickeners where flocculents are added and the coal slurry is separated from the effluent water which is pumped to the waste water reservoir. The plant currently has a capacity of nearly four million sales tonnes.

Environmental legislation and liabilities

Any industrial operation in Poland is subject to a number of operating permits covering such aspects as land use, air emissions, water usage and discharge, noise and vibration, and waste generation and disposal. Responsibility for administration and enforcement lies with the Regional (District) offices of the Environment Ministry, which for Bogdanka is located in Lublin. The control of local environmental ordinances relating to land use matters is the responsibility of the planning authorities of the self-governing communes which operate at the local level within the regional office area of jurisdiction. In Poland, environmental liability can encompass violations of the operational permits, damage under civil and criminal statutes, and the requirement for long term rehabilitation of the operational site.

As at many mine sites throughout the world, the most significant environmental liabilities and associated costs relate to subsidence, rehabilitation of the waste dump, decommissioning and rehabilitation of the mine site at closure, and operational constraints and permitting. Subsidence has already taken place in this largely rural area from the existing operations and this could be further exacerbated if widespread second seam working were to be instigated, particularly beneath areas with a shallow water table which are vulnerable to water logging and flooding. Tentative proposals for the creation of a large water reservoir with the primary intention of encouraging recreation and wildlife thus have considerable merit. Part of the waste dump has already been rehabilitated and there is incentive to continue with such work in that the area could then be treated as non-industrial use and attract lower fee payments. Closure costs and liabilities are complicated by the fact that within the Bogdanka mine complex, several operating companies have an ownership interest in the various activities. The largest operational permitting costs are those associated with the deposition of mine waste and royalties, while others include licensing, water supply and air emissions from vehicles.

Conclusion

The Bogdanka mine ranks with the best deep coal mines in the world in terms of the absolute performance of its longwalls and development headings, and has long term reserves available for future exploitation. The impression gained was of a progressive organisation willing to embrace the changes required to move the operation from a command to a free enterprise economy.