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Quantitative and qualitative characterization of coal formations expansion in Iran; introducing and case study: coal mines of East Azarbaijan coal-bearing zone

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Abstract

Coal is one of the most important fossil energy sources, which has long been used by humans. Hardness of work in underground coal mines and dangerousness that are lurking for miners in coal mines more than any other type of mines perhaps have a significant role in creating a different and more violent environment in coal mines than plants. After exploitation of coal mines in Central Alborz Mountain region in the Second World War, the first efforts to systematic exploration and exploitation of Iran coal mines was considered in the Iran steel production plan. First and foremost problem of coal mines in Iran is negative attitude of high-ranking mining authorities that such a negative attitude will certainly not followed if hardness of work and professional dangerousness as well as the situation of coal mines in the world have been considered. The second problem is its purchaser who always determines the price. If the problems mentioned above, have been considered together with poor technical condition of Iran coal reserves, assignment to the private sector is not an appropriate solution in such situation and will not be able to solve the problems of this section. Coals of this zone are better than coals of other parts of Alborz zone in terms of coking. Current coal mines in East Azarbaijan province are located in areas such as Minbashi Hesar, Khattab 1 and 2, Chali, Khormazard, Ghezel Castle, Goidargh, Amir Maragheh etc. with different quantity and quality.

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Introduction

Coal is one of the most important fossil energy sources, which has long been used by humans. The value of this mineral became more visible especially during industrial revolution which had started from Europe and its consumption as fuel for locomotives (1839), iron oxide (iron ore) regenerator in steel production blast furnace (1860) and power plants (1880) were increased every day. During the Second World War when steel requires to war machines culminated, coal mining became even more important. further mastery of nuclear energy and constructing nuclear power plants, especially in Western Europe, s well as discussions about the environmental impact of fossil fuels and also developing direct regeneration method for steel production. Hardness of work in underground coal mines and dangerous that are lurking for miners in coal mines more than any other type of mines perhaps have a significant role in creating a different and more violent environment in coal mines than plants and underground coal mines in all countries had experienced more personnel issues.

Apart from power plants and coking, coal is also used to steel industry, as well as pharmaceutical, food, fabrics colors and wood preservative industries. Methane and Carbon Dioxide released by some coking plants are used to gas production and cooking materials. During the Second World War in Germany, and now in South Africa gasoline (petrol) and heating oils were extracted from coal. Coal ash is used as additives in concrete and also in road foundations. Coal downward trend, began after changing fuel type used in vehicles (locomotive) and plants and then further mastery of nuclear energy and constructing nuclear power plants, especially in Western Europe, s well as discussions about the environmental impact of fossil fuels and also developing direct regeneration method for steel production. Hardness of work in underground coal mines and dangerous that are lurking for miners in coal mines more than any other type of mines perhaps have a significant role in creating a different and more violent environment in coal mines than plants and underground coal mines in all countries had experienced more personnel issues. Although futuristic forms of government due to assume coal as a strategic mineral, argued that shutting down all underground coal mines is not in the interest of their countries, so they helped to continue mining in large coal mines by giving subsidies to them. But, recent decade have witnessed events such as oil price rising, massive economic developments in China, economic policy of East Block countries moving faster due to capitalist after the collapse of former Soviet Union etc., which had a strong influence on downward trend of mineral prices, thus despite the opinion of some analysts, mines including coal mines were adopted a new direction. Recent economic and social changes in the world had also affected Iran and due to implement policies such as the cutting subsides, privatization and competitive market more discomposed state powerless industries such as coal mines which priory were active regardless of competition. The privatization of this sector had more specific and worse problems than other industries not only in Iran but also around the world. Even in some empowered countries in coal production, resistance to cutting subsidies and shutting down mines has caused troubles to economic policy executives.

Whereas Iranian Mines and Mining Industries Development and Renovation Organization has taken more effective steps in privatization but assignment of mines especially coal mines had its own problems. Encouraging investors to invest in coal mines had limited success. Therefore, the authorities have decided to choose other ways most notably encouraging coal mines staff to separate from government system and continue as private sector. It was almost successful, but coal mines problems were not solved by this assignment, rather have associated with new exploitation. Thus, some actions were performed to help them, including providing facilities to equip mines as well exploration.

If it is honestly admitted that it is necessary to support this sector like other countries having coal preserves due to coal requires of the country steel plants as well as poor economic status of workers in this sector, then the government will be forced to adopt a tougher policy in this field, while coal price rising and its global purchase problems have created an especially importance for urgent action in this field. First and foremost problem of coal mines in Iran is negative attitude of high-ranking mining authorities so that if hardness of work and professional risks as well as the situation of coal mines in the world have been considered, such a negative attitude will certainly not followed. The second problem is its sole customer who always determines the price. Most of the value added derived from coal industry had been diverted to plants and social class differences became clearer in this small mining and mineral industry. Third problem was the lack of proper investment in renovation of coal mines and their assignment with their following problems.

If the problems mentioned above, together with poor technical condition of Iran coal reserves assignment have been considered to the private sector is not an appropriate solution in such situation and will not be able to solve the problems of this section. So while the government pays the cost of exploration of coal deposits, should also help equip new mines, renovate existing mines, train private sector personnel, and improve safety etc. in different ways, so that a part of steel industry needed for coal could provide by private sector through adjustment planning; because the recent situation in coal global market has shown that this mineral is so important that authorities pay particular attention to it. The aim of this study was quantitative and qualitative characterization of coal formations expansion in Iran, Introducing and case study: coal mines of East Azarbaijan coal-bearing zone.

Material and methods

Important uses of coal

Coal is used as fuel in thermal power plants, steam generating in steam turbines in plants, railways and ships, and also as home fuel in some countries. Almost 87% of the world's coal is burned to heat generation and other relevant energies.

Obviously, side products such as fuel gas, coke and coal tar are also obtained from coal burning. It should be noted that in some countries a part of urban fuel gas has been made from coal. In order to make this gas, coal is adjacent to a stream of water vapor and oxygen at a pressure of 20 to 30 atmospheres. Then, these gas products are converted to hydrocarbons in the presence of iron catalyst or to methyl alcohol by zinc and copper catalysts. In addition to fuel consumption, coal is also used to produce a lot of useful and important organic and non-organic materials which mainly are prepared from distillation of coal tar derived from pyrolysis of coal or its remaining solids.

The dangerous of coal mines

One of safe and health risks that coal industry workers face is methane which usually exists in coal mines because a mixture of 5 to 15 percent of it with air is explosive. Therefore, amount of methane in coal mines must be controlled. Of course, in addition to methane, there are also other gases like carbon monoxide, sulfur dioxide in coal mines that are not explosive but their poisoning can be harmful to the health of miners. To avoid the dangers of this gas usually it is exploited with special equipment from the coal mine. Pyrite oxidation in the air may lead to create sulfuric acid and enter it into water supply through surface waters and make it polluted. Breathing coal dust causes pneumoconiosis disease which is also called black lung, in this disease coal dust covers lung with a black layer and makes breathing difficult.

Result and discussion

West Alborz coal-bearing zone

Coal mines of west Alborz coal-bearing zone start from Chalus-Karaj road; pass Zanjan and continue to East Azarbaijan. Coals of this zone are better than coals of other parts of Alborz zone in terms of coking

because they are high-grade metamorphic coals whit higher degree of coalification. Coal mines in this zone are exploited by underground mining just like coals in other coal-bearing zones of Alborz. Abyek and Loshan are two important mines in this zone.

Also Chali coal mines in south of Maragheh and Kaghloogozloo in northeast of Kaliber can be classified as a part of this zone. West Alborz zone coals based to their origin are generally semi-opaque clarain to opaque clarain with humic origin. These coals are often formed of sycadophyta plants. Clastic materials are abundant in these coals; it indicates that they are formed in a stream, flooding, lagoon and warm sedimentary facies. Most of coals explored in this province are thermal coal (lignite) and just a limited amount of them are coking.

Most of Iran's coal resources are located in the following five zones:

1. Kerman-Nayband (Tabas) zone
2. Alborz zone
3. Northeast of Khorasan zone
4. Kashan-Isfahan zone
5. Maragheh and Kaliber (East Azarbaijan)

General geology of East Azarbaijan coals

This area is located at Alborz-Azarbaijan zone based on Nabavi zoning, Soltanieh zone based on Eftekharnejad zoning, Central Iran based on Aghanabati zoning. The general trend of geological structures in this region follows Alborz general trend.This region geologically is quite similar to other regions in Alborz, and is located between the two main fractures in northwest of Iran, Tabrize fault and Zarrinehrood fault, as a large pit.

Permian limestone-dolomitic sediments are the oldest rocks in the region and are associated with Ruteh formation. This formation widely expanded to west and covered by Triassic limestones. The boundary of this between this formation and Jurassic is faulted. However, there are some areas in south and west of mine where the boundary of two formations is normal and Jurassic is laid directly on the Triassic formation. Based on lithological evidences a more or less marine environment had prevailed in the region until mid-Mesozoic (Upper Jurassic and Lower Cretaceous) and in some periods progression and regression have been done. According to the situation of environment, marine and continental deposits have been formed. It seems to in line with priory Alpine compressional orogenic movements starting in the Middle and Upper Triassic (Earlier Cimmerian) similar to the rest parts of Alborz proper continental environment for the growth of dense plants and has leaded to deposit Shemshak coal-bearing shale rocks and sandstones in Liassic that in the next stages have been followed by Jurassic sea high waters. According to field evidence, it seems that Former Cimmerian compressional stresses had continued to the beginning of Cretaceous which resulted in folding Jurassic geological units. When Cenozoic had begun this region just like most regions of Alborz affected by Alpine orogenic phases and volcanic activities occurred which was continued to Quaternary. Based on field and lithological evidence, volcanic eruptions had occurred frequently so that there was a relative calm period after a period of volcanic period eruptions and then eruptions continued again. This condition had been continued until the Late Quaternary. This process is led to the expansion of volcanic rocks and their products especially pyroclastic materials. In addition to rock units mentioned above, the present age sediments have outcrop in Maragheh. Maximum expansion is related to calcareous sediments from limestone fountains. In some parts of the region particularly along rivers, young loose alluvium and young and old river terraces were formed.

Approximate analysis of coals in the region

Approximate analysis of coal samples is done according to the standard method (ASTM D 3172).average moisture content of these coals is low at around 1.58%. Average ash percentage is 18.51% which represents coals with mean ash, average percentage of volatiles and fixed carbon are

determined 19.92 and 50 percent, respectively, that based on Russian classification these coals are related to coke and bitumen coals class.

Mineralogy of coals in the region

Mineral material is the sum of minerals and inorganic materials accompanying coal. The presence of mineral material in coal can be classified into three categories:

1) Soluble salts and other inorganic components of coal interstitial waters;

2) Inorganic elements associated with coal macerals;

3) The separate inorganic part (crystalline or amorphous)

Two first parts are called inorganic-non mineral components and are abundant in lower ranks coals. Removing moisture and chemical changes associated with increasing coal rank led to partial withdrawal of these two components and makes mineral material richer than separated inorganic component. Considering that coals of East Azarbaijan mines are lignite so the main part of mineral material of this coal is the second type.

Lignite coals in East Azarbaijan are called soft brown coals. Based on international classification these coals are humic to semi-humic and are formed after peat creation. Lignite is basically low-grade coal and still some remnants of lipids, leaves and barks of plants can be found in it.

In field samples, lignite is black towards brown. Porosity and impurity of lignite is less than peat and its density is about 1.5. Porous texture of lignite is like dry wood coals. Some of them have a loose texture and some other have dense texture like soil. Their heating value is low. For this reason they have not industrial value spite peat. Moisture of lignite is also more than bitumen and is about 35 to 75 percent. Their volatiles are relatively high and sometimes reach 40-55% (Table 1).

Table 1. Classification of coals based on carbon percentage.

Carbon percentage	Coal type
60-70	Lignite

Because of this reason lignite usually produce much smoke during burning. Lignite contains 35-75 percent of water. There are abundant mud cracks in lignite and in the presence of air become into small pieces. Dust produced by comminuted lignite is highly flammable and ignite automatically due to burning (Table 2).

Table 2. Classification of coals based on moisture content (Moein al-Sadat and Razavi Armaghani, 1993).

Moisture content (%)	Coal type
20	Lignite

Since the vast majority of coal mines in East Azarbaijan exploit underground, characteristics of all mines of Iran with respect to their exploitation method is given in Table 3.

Table 3. New classification of coals based on coal type, sulfur content and heating value.

Sulfur content	Heating value	Coal type	Mine type
0.25	2.47	Thermal coal	Open pit
0.31	32.24	Coking coal	Large open pit
0.48	29.15	Coking + thermal coal	Mining using dredge shovels
0.52	27.50	Thermal coal	Underground

The last state of coal mines and exploration zones in East Azarbaijan

The last state of coal mines and exploration zones in East Azarbaijan are as follows:

Minbashi Hesar coal mine: The license number is 45720 dated 23/12/88, has 10 years of exploitation 3 million tons in year, 44 thousand tones definitive reserve, 50 thousand tones probably reserve, 1501 million riyals investment, and employment of 10 persons, is located at 64 kilometers southeast of Maragheh. This mine is currently inactive.

Kaghloogozloo coal mine: The license number is 75232 dated 14/12/79, has 15 years of exploitation 3 thousand tons in year, 50 thousand tones definitive reserve, 100 thousand tones probably reserve, 466.5 million riyals investment, and employment of 14 persons, is located at 65 kilometers northeast of Kaliber. This mine is vested in auction.

Ghareh Daghli coal mine: The license number is 21808 dated 19/12/80, has 9 years of exploitation 3 thousand tons in year, 70875 tones definitive reserve, 100 thousand tones probably reserve, 443.5 million riyals investment, and employment of 14 persons, is located at 68 kilometers southeast of Maragheh. Exploitation stops and has been warned with 2 months deadline to secure the mine.

Kattab 1 coal mine: The license number is 31873 dated 24/12/88 has 10 years of exploitation 3 thousand tons in year, 367341 tones definitive reserve, 734682 tones probably reserve, 1168.5 million riyals investment, and employment of 18 persons, is located at 51 kilometers southeast of Maragheh. This mine is currently inactive (Fig. 1).

Chali coal mine: The license number is 5733 dated 11/10/79 has 12 years of exploitation 2.5 thousand tons in year, 30 thousand tones definitive reserve, probably reserve more than definitive reserve, 232 million riyals investment, and employment of 7 persons, is located at 19 kilometers southeast of Maragheh. This mine is currently inactive (Fig. 1). Under letter no. 103677/60 on 22/5/88 based on the vote of Council of Mines in the meeting on 22/4/88, due to failure to pay outstanding debt of the government's right and activation of the mine by exploiter before ending deadline, the mine exploiter has been disqualified by letter no. 21530/105 on 3/9/88. (Fig.2)

Fig.1. Khattab 1 inactive mine.

Fig. 2. Chali active mine.

Pir-E Saqa coal mine: The license number is 9885 dated 2/7/83 has 9 years of exploitation 6 thousand tons in year, 50625 tones definitive reserve, 297 thousand tones probably reserve, 894 million riyals investment, and employment of 18 persons, is located at 42 kilometers south of Ghareaghaj, Charaymagh city. This mine is currently active.

Ghezel castle coal mine: The license number is 29440 dated 25/12/83 has 5 years of exploitation 3 thousand tons in year, 18225 tones definitive reserve, 40 thousand tones probably reserve, 799.2 million riyals investment, and employment of 15 persons, is located at 40 kilometers north and northeast of Kaliber. This mine is currently active. Under letter no. 140542/60 on 28/7/88 based on the vote of Council of Mines in the meeting on 13/7/88, due to failure to

set up and activate the mine, the mine exploiter has been disqualified by letter no. 30880/105 on 20/8/88. This mine is vested in auction.

Khattab 2 coal mine: The license number is 12706 dated 30/7/84 has 15 years of exploitation 3 thousand tons in year, 112680 tones definitive reserve, probably reserve more than definitive reserve, 594 million riyals investment, and employment of 15 persons, is located at 52 kilometers southeast of Maragheh. This mine is currently active. Under letter no. 156486/60 on 23/3/88 based on the vote of Council of Mines in the meeting on 25/7/88, due to failure to pay outstanding debt of the government's right and activation of the mine by exploiter before ending deadline, the mine exploiter has been disqualified by letter no. 31490/105 on 19/9/88. (Fig. 3)

Fig. 3. Khattab 2 active mine.

Oskanloo-Kaliber coal mine: The license number is 11096 dated 22/5/84 has 25 years of exploitation 3 thousand tons in year, 85575 tones definitive reserve, 342300 tones probably reserve, 799.2 million riyals investment.

Khorma zard coal mine: The license number is 13873 dated 12/8/82 has 25 years of exploitation 3.5 thousand tons in year, 87.5 thousand tones definitive reserve, 175 thousand tones probably reserve, 799.2 million riyals investment, and employment of 15 persons, is located at 12.5 kilometers northwest of Maragheh. This mine is vested in auction.

Ghoosh ghieh si coal mine: The license number is 13020 dated 30/7/84 has 25 years of exploitation 3 thousand tons in year, 139500 tones definitive reserve, probably reserve more than definitive reserve, 894 million riyals investment, and employment of 15 persons, is located at 65 kilometers southeast of Maragheh. This mine is currently active.

Gooydargh coal mine: The license number is 6936 dated 7/7/86 has 25 years of exploitation 12 thousand tons in year, 300 thousand tones definitive reserve, probably reserve more than definitive reserve, 21575 million riyals investment, and employment of 34 persons, is located at 13 kilometers south of Maragheh. This mine is currently active.

Amir Maragheh coal mine: The license number is 43058 dated 3/12/88 has 6 years of exploitation 2 thousand tons in year, 12288 tones definitive reserve, 15360 tones probably reserve, 140854 million riyals investment, and employment of 12 persons, is located at 9 kilometers southeast of Maragheh. This mine is currently inactive.

Overall, active coal mines in the province are including two mines describes above, those operate with 200 thousand tones reserve and exploitation of about 9 thousand tons per year, 1800 million riyals investment and employment of 33 persons in Maragheh and Charavimagh.

Conclusions and Future Study

Coals in East Azarbaijan are located in two regions, Maragheh and Kaliber, but coal also exists in Mianeh and Charavimagh cities. In the past, Turkey was the main costumer of this mineral which had used this coal to heating. Due to exporting gas from Iran to Turkey and changing its heating system, sailing coal in the province is facing issues. This is the main reason of coal mining recession. On the other hand, the lack of processing plants (coal washing and coking) is cause that raw materials produced in mines have no purchaser or sold at very low prices. Another problem of coal mines in the province is the presence of sulfur and ash in the combination of most existing reverses which reduced heating value of this mineral.

Tests carried out on coals of Khattab and Minbashi (Maragheh) showed that they contain 87% of carbon and are easily burned and grinded. Coals of this region (Maragheh) can be converted to coke.

Coals of Kaliber have less coking value but can be exported to neighboring countries (Azarbaijan and Armenia) and require more studies.

Based on Haj Aliloo studies (1997) coal has also been observed in Mianeh region especially Bozghoosh, Shirinbolagh and Ghizghalasi.

Constructing large coking and coal washing plants seems necessary regarding the boom in steel industry in the province and sufficient coal reverse in the region.

According to needs of major coal investment, direct investment by the government to buy mines and exploration zones, doing systematic exploration and principled mining like many countries in the world seems essential.

References

Alastuey A, Jimenez A, Plana F, Querol Suarez–Ruiz. 2001. Geochemistry, mineralogy and technological properties of the main Sthephanian (Carboniferous) coal seams from the Puertollano Basin, Spain, *International Journal of Coal* **45**, 247-265.

Barath I, Meszaros F, Szendro D. 1991. Coal prospecting and interpretation. *Proceeding of third mining symposium*, *Iran* **2**, 91-108.

Bouska V. 1981. Geochemistry of coal, *Academia, Prague* 128-141.

Burger K, Zhou Y, Ren Y. 2002. Petrography and geochemistry of ton steins from the 4th Member of the Upper Triassic Xujiaha formation in southern Sichuan province, China, *International Journal of Coal Geology* **49,** 1-17.

Eskenazy GM. 1999. *International Journal of Coal Geology* v **38**, 285-295.

Fazl Mohammad M. 1984. Coals of Iran, Third Meeting of Earth Sciences, *Geological Survey of Iran*.

Moein al-Sadat SH, Razavi Armaghani MB. 1993. Geology of Iran-coal, *Geological Survey of Iran press*.

Mozafari M. 1985. Geology of coals, Course Notes, *Iran steel Company* 110.

Rezaei B, Jalilian AH. 1998. Petrology of sedimentary rocks, *Hormozgan University Press*, 275-304.

Shariatnia MH. 1995. Geological characteristics of Parvade zone in coal-bearing basin of Tabas-central Iran, *Journal of Earth Sciences*, **15-16**, 50-60.

Yazdi M. 1999. Geochemistry and origin of non-organic elements of coals and their environmental effects, Quarterly Journal of mines and Metals **68**, 16-19.