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Geothermal Properties of Fan Yaghnab Coal Deposit

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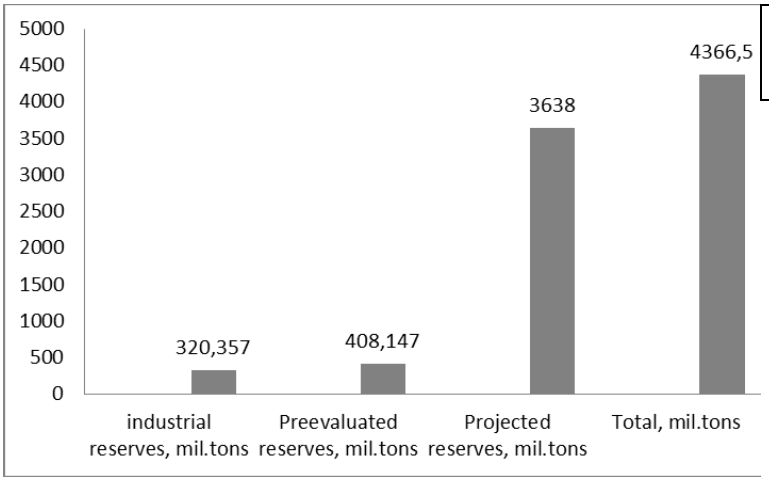
The Republic of Tajikistan has a mountainous geography with over than 93% of its territory covered by mountains belonging to the highest mountain ranges - Pamir and Tian Shan. As a result of extensive geological explorations, more than 600 oil and gas fields and over 50 types of mineral raw materials sources such as coal, lead, zinc, copper, bismuth, antimony, mercury, precious and semiprecious metals, iron, tungsten, molybdenum, strontium,fluorspar, borates, ornamental and building materials, thermal and mineral water sources have been explored and surveyed.

The coal deposit of Fan Yaghnab is the largest in the Republic of Tajikistan and one of the largest in Central Asia. The area of the deposit is about 102 km^2. It spreads northwest in a narrow strip form with a length of 24 km and width of 4.5-6 km, and conventionally is divided into 3 parts: The Western, Central and Eastern fields. Administratively, the area of the coal mine Fan Yaghnab belongs to the Ayni district of Khujand region of Tajikistan. It is located on the southern slope of the Zarafshan and the northern slope of the Hisar Ranges in the confluence of the Yaghnab, Iskandar-darya, and Pasrud-darya rivers [1-3].

Tajikistan has more than 4.4 billion tons of potential coal reserves, of which 320.3 million tons are industrial reserves with high-calorie content (Fig. 1). Along with a large reserve of coking coal (259 850 thousand tons) and heat coals (136160 thousand tons) at the Fan Yaghnab deposit, there are geothermal zones formed by the burning of coal stratum for over 500 years. The underground combustion of coal (Figure 2) at the Fan-Yaghnab deposit in Tajikistan is also mentioned by the famous Roman writer-encyclopedist Pliny the Elder, who lived in the first century of our era [2].

Industrial reserves, mil.tons	320.357
Pre-evaluated reserves, mil. tons	408.147
Projected reserves, mil. tons	3638.0

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Total, mil. tons	4366.504

Figure 1. Coal reserves in the Republic of Tajikistan.



Figure 2. Coal geothermal effects.

Much research has been conducted on the causes of spontaneous combustion of Fan Yaghnab coaldeposit and on the formation of high underground temperatures in the area [1]. Numerous studies onformation of geothermal strata link them to the large content of hydrogen sulfide in coal bodies and the rate of erosion. Besides, the formation of high underground temperatures is also affected by carbonaceous argillites, which have direct contact with active packs of coal. According to the study [4], geothermal layers of the Fan Yaghnab deposits are confined to the overthrust zone and the coal-bearing rocks are complicated by faults that contribute to aeration. Self-ignition occurs due to exothermic reactions during oxidation of coal and coal-bearing rocks, pyrite minerals and oxidation of the coal itself in near-surface areas [5].
The construction of an isotherm from the available measurements of temperatures along the tunnel and borehole allowslocating the possible combustion sites and the maximum temperature along the strata (Figures 3-4).

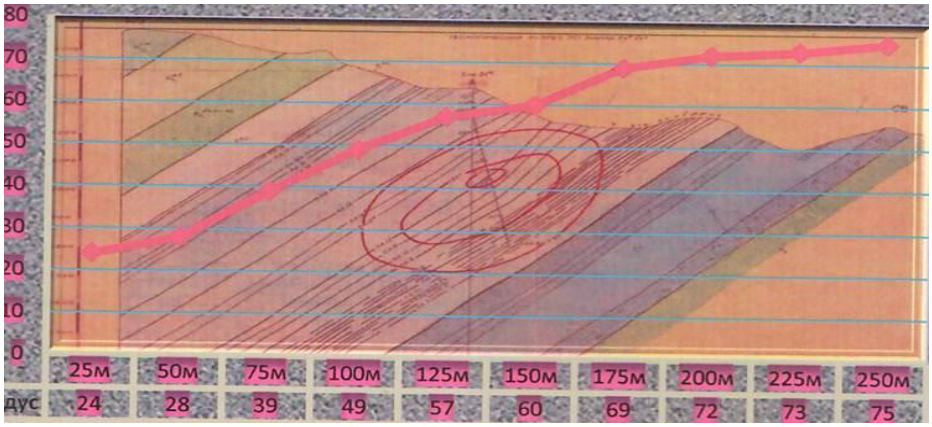


Figure 3. Temperature changes in the active combustion zones of the Kuhi Malik site.

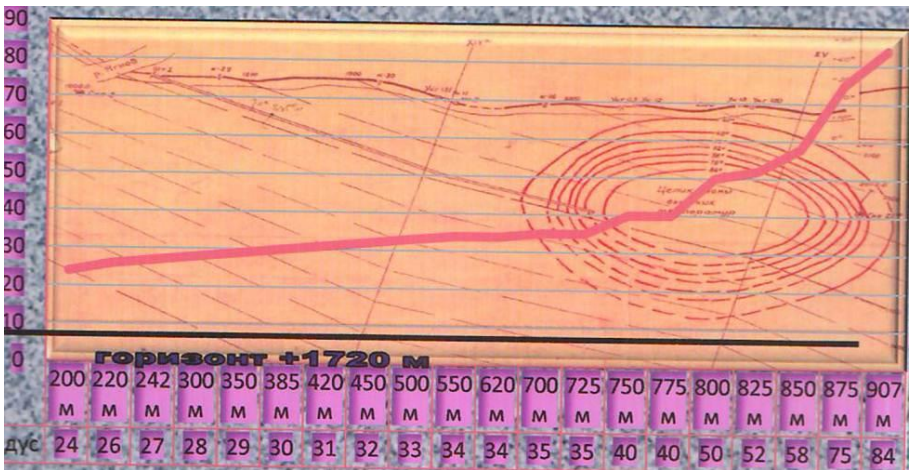


Figure 4. Temperature changes in the active combustion zones of the Ravat site.

These geothermal phenomena are compared to a high temperatureslaboratory, with temperature raises up to 1200 ^{0}C and above and where unusual or completely new compounds might be synthesized. Depending on the proximity to the intense combustion sites, it is possible to distinguish zones of minerals formation. The geothermal underground combustion of the coal in the Fan Yaghnab deposit lead to the contractionsin the soil and the formation of a network of deep cracks through which hot (70-300 ^{0}C) jets of gas are released from the combustion site to the surface, that are formed as a result of combustion, remelting and calcination processes accompanied by the formation of gases. These emissions of gases are very similar to volcanic forms. As an example, sulfur-containing gas jets are formed in the depths of the dumps that eventually emerge at vertices in the form of fumaroles with a temperature of 400-5000 ^{0}C.

Geothermal coal beds of the Fan Yaghnab deposit are environmentally harmful as the vast amount of carbon dioxide is released adversely affecting nearby settlements. Also, it is economically unprofitable, as it burns out large quantities of high-quality coal. Therefore, there is a problem that should be addressed without any delays.

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