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Petrographic properties of major coal seams in Turkey and their formation

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ABSTRACT

Most types of coal in Turkey are generally low in rank: lignite, and subbituminous. Most of the coal was formed during the Miocene, Eocene, and Pliocene ages. There are only a few thin Jurassic-age coal occurrences in Turkey. Pennsylvanian age bituminous coal is found on the Black Sea coast. General implications of the petrographic properties of Turkey's coal seams and coal deposits have not yet been taken into consideration comparatively or as a whole.

For this study, about 190 channel samples were collected from different locales. The composite profile samples of the seams were taken into considerations. The content and depositional properties as well as some chemical and physical properties of the main coal seams are compared. All coal samples tend to have similar coal petrographic properties and were deposited in intermontane lacustrine basins. Later, they were affected by faulting and post-depositional volcanic activity. As a result, there are variations in the properties and rank of the coal samples. The most abundant coal maceral group is huminite and the most abundant maceral is gelinite. The liptinite and inertinite contents of the coal are low and the maceral contents of the coals show great similarity. The depositional environments of the all coals are lacustrine dominated.

1. Introduction

Turkey has large coal reserves—about 9 Gt (Turkish Lignite Authority, 2008). Coal may be distributed throughout the country. The better quality coal reserves seem to be concentrated in western Turkey, but the biggest reserve is located in the inner part of the country in the Elbistan area.

Except for a few Jurassic formations, most Turkish coal was formed in two different geological ages. The Pennsylvanian (Westphalian) coal is bituminous and Tertiary coal is brown (lignite and subbituminous) coal (Fig. 1).

The most abundant and widespread coal deposits are Tertiary subbituminous and lignite (brown) coal deposits. These coal deposits cover an area of approximately 230,000 km^2 and tend to have low calorific values (<2500 kcal/kg). They also have high ash contents between 18 and 45% (Devlet, 2001). Therefore, they are generally utilized for combustion in power plants. Eighty-five percent of the coal produced in Turkey is consumed in power plants. Based on the established power generation of the power plants, in 2000, this was about 6.55 GW which was equal to 22% of the whole power scheme of the nation (source: www.tki.gov.tr).

Low-rank coal deposits are concentrated in the central and western part of Turkey and are mostly subbituminous and lignite (coal basins shown as Miocene and Pliocene basins, on Fig. 1). Their most common age is Miocene. The Miocene coal deposits have relatively higher calorific values and lower mineral matter contents than other Tertiary coals. Therefore, they have been consumed domestically for home use, but, today, they are consumed by power plants to provide electricity to the nation. There are a few Eocene and Oligocene coal seams in the northwest of Turkey. They are mostly intercalated with marine sediments (Palmer et al., 2004). Pliocene–Pleistocene-aged coals are found in the east of the central region of Turkey. The Elbistan coal deposit (basin 9 on Fig. 1) is the largest one of these and the youngest coal deposit in the nation. Its quality is very poor due to the low calorific value, high moisture, and high ash content.

The only Pennsylvanian age coal deposits are located [in the Zonguldak Coal Basin (basin 7 on Fig. 1)], on the Black Sea coast in the northwest of Turkey. The region has various multiphase deposited coal seams (more than 20, with thicknesses varying from a few centimeters to a few meters). The thickest coal seam (from 2 to 6 m) is Cay Damar. Zonguldak coal seams have undergone severe paleotectonic events and disintegrated into big slab masses. The slabs have been dislocated vertically and horizontally mostly in different directions due to the effect of the tectonic activities in the region, and therefore, the seams cannot be easily traced underground. In order to maintain the production in the region, drilling has always been a reference instrument. The bituminous coal deposit is 200 km length, with an area of 7000 km^2. The reserve is thought to be around 1.3 Gt of coal based on many years of drilling. The coal calorific values seem to be between 5529 and 7500 kcal/kg (Devlet, 2001).

The current total amount of coal consumption of the country, including imported coals as well, is about 60 Mt each year. Power plants and iron-steel plants consume most of this coal and cause the

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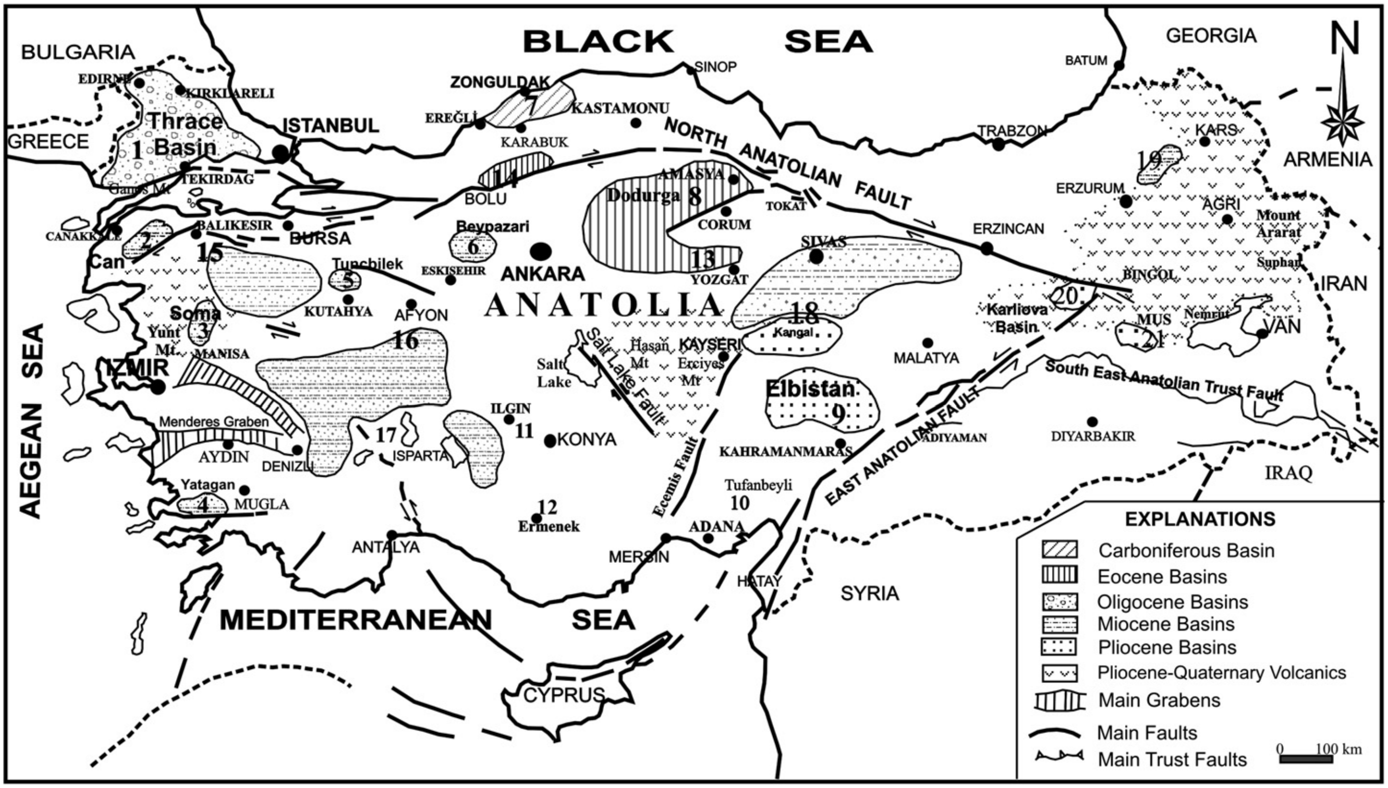

Fig. 1. Location of major coal basins and important geologic features of Turkey. Numbers refer to Tables 1, 2, 3 and 4. Developed from Mineral research and Exploration Directorate (MTA)'s unpublished documents; (1—Thrace, 2—Can, 3—Soma, 4—Yatagan, 5—Tuncbilek, 6—Beypazari, 7—Zonguldak, 8—Dodurga, 9—Elbistan, 10—Adana, 11—Ilgin, 12—Ermenek, 13—Yozgat, 14—Bolu, 15—Balikesir, 16—Eskisehir, 17—Isparta, 18—Sivas, 19—Erzurum, 20—Erzincan, 21—Mus basins indicate the major coal basins in Turkey).

emission of high amounts of gas each year. Some domestic uses of coal are also common in the colder locations, mostly situated in the east and central parts of the nation. The amount of coal consumption has shown a recent decrease since natural gas has become more preferred for domestic usage and combustion. Previously, the annual coal consumption was more than 65 Mt of coal.

2. Geological setting

Turkey is rich in Tertiary-age (coal-bearing) units (mostly lignite and subbituminous coals). The western and central parts of Anatolia (Fig. 1), which comprise the biggest territory in Turkey in the Asian section of the country, are covered with terrestrial Tertiary units and young volcanics.

There are two big young active faults dividing the Turkish territory. One, the North Anatolian Fault (NAF), is east–west trending and extends up to Greece; the second is a SW–NE trending fault, the East Anatolian Fault (EAF) (Fig. 1). The ages of these faults are thought to be Quaternary. The faults, as well as their accompanying movements, have divided the territory into many land slabs (Ketin, 1966, 1983; Luttig and Steffens, 1976). Young volcanic rocks that have formed in the vicinity of the sediments caused higher heat and pressure effects resulting in higher ranks (from lignite to subbituminous, bituminous, or even meta-anthracite levels in some places) as well as higher diagenetic effects on the rocks and minerals which caused physical changes to other phases or forms.

Luttig and Steffens (1976) described the early Miocene period in Anatolia as an almost completely terrestrial environment with regression of the sea towards the south and east. There were only early Miocene marine deposits in the south, southeast and east part of Turkey. In the middle Miocene, the terrestrial environments became larger and much more widespread in Anatolia. Meanwhile, volcanic activity also took place in the central and western part of Anatolia during these periods. In the late Miocene period and Pliocene, terrestrial environments became much more abundant and the sea disappeared except from Adana (south) and south of Thrace (1 on Fig. 1). Depressional zones which started to form in the Middle Miocene period in terrestrial areas were still active in the late Miocene as well. Over the entire course of the Miocene period, the sea regressed southward; the first intermontane basins developed; and later, basic volcanism took place.

The Anatolia plains formed as a result of the activity of the surrounding faults and associated movements (Sengör, 1980). The central Anatolian plains were probably influenced to form the coal deposits. The most accelerating force, of course, is the movement of the Arabian Plate towards the north and a big part of Anatolia to move westward along NAF transform fault and conversion of this movement into rifting mechanism to the west. These plains are thought to have probably been favorable as coal-forming lacustrine environments and are mostly fault related basins and depressional zones (Luttig and Steffens, 1976; Sengör, 1980; Sengör and Yilmaz, 1981).

Coal-bearing terrestrial units formed in the plains as well as in the lacustrine environments that are mostly situated among these tectonically and volcanically formed areas. This implies that the coal-bearing formations have been controlled by either faults or volcanics, or sometimes both, such as in the Soma and Dodurga regions. Some volcanic activities probably also caused by tectonic events have limited the extensions of the coal-forming environments. Some examples are Yunt volcanic mountain in the southern part of the Soma region, volcanic activities surrounding the Dodurga coal basin (8) and the Beypazari coal basin (6) as well, amongst others (Fig. 1).

Today, the basins located in the Anatolia region are found at lower elevations than the other coal basins in Turkey. From the east to west of Turkey, Erzurum (19), Mus (21), Erzincan (20), Sivas (18), Yozgat (13), Tokat (North of 18), Kahramanmaras (9), Adiyaman (East of 9) Adana (10), Konya (11, 12), Amasya (8), Corum (8), Cankiri (8),