Interpretation of Coal Quality Data: the Inorganic Constituents

With Comments on the Quality of Coal from the Sonda Coal Field, Sindh Province, Pakistan

Robert B. Finkelman, Charles L. Oman, John SanFilipo
U. S. Geological Survey
Mail Stop 956
Reston, VA 22092

Ishaq Ghasnavi
Pakistan Geological Survey
Islamabad, Pakistan

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Abstract

Analyses of 191 coal samples from the Sonda Coal Field, Sindh Province, Pakistan are used to illustrate the environmental, technologic, byproduct, and geologic significance of the inorganic constituents in coal. The samples were collected as part of a cooperative investigation between the U.S. Geological Survey and the Geological Survey of Pakistan of the coal resources of Pakistan known as the Coal Resources Exploration and Assessment Program (COALREAP). COALREAP was financed by the Government of Pakistan and grants from the United States Agency for International Development (USAID).

The coals are from the Bara Formation which primarily consists of shoreface sands and tidally dominated mudrocks. In the study area the coal occurs at depths of about 40 to 300 m. The deeper coal beds are more than 6 m thick. The rank ranges from lignite A to subbituminous C.

All the samples used for this report were taken from drill cores. All coal beds greater than 30 cm thick were sampled. Noncoal partings were generally excluded or sampled separately. The samples were analyzed using ASTM standard methods and U.S. Geological Survey trace element analytical procedures.

Mean values for samples from the Jherruck area in the northern part of the Sonda Coal Field are: moisture 31.3%; volatile matter 27.3%; fixed carbon 24.0%, ash yield 18.0%; hydrogen 6.3%; carbon 34.9%; nitrogen 0.7%; oxygen 34.3%; sulfur 3.1%; calorific value 6597 Btu/lb.

The high Na_2O concentrations in the coal ash (5.0%) and the

high ash yield of the Sonda coals (24.9%) indicate a likelihood for boiler fouling. Most of the Sonda coal samples have base/acid ratios between 0.25 and 0.80. The relatively high base/acid ratios for these samples indicate a potential for slagging problems in conventional boilers. The potential for corrosion should be considered in any use of the Sonda coals because of their moderately high Cl contents (mean value 940 ppm). The Si/Al ratio of most Sonda samples is well below three, thus, there appears to be little cause for concern about abrasion of grinding equipment.

There is a real potential for selenium pollution in the Sonda coal field region. The Sonda coal samples average almost 4 ppm selenium with a maximum of 11 ppm. The combination of relatively high selenium concentrations in the coal, a semi-arid environment, and the abundance of grazing animals is a situation that bears watching. Most of the other potentially hazardous elements in the Sonda coal are present in relatively low concentrations and probably pose no environmental threat.

Few elements in the Sonda coal samples had maximum values that are greater than 10 times the mean. Thus, there is little likelihood for economic byproduct recovery or nearby mineralization.

Introduction

Purpose of Report

The primary purpose of this report is to provide guidelines for critically assessing the significance of the inorganic constituents in coal. These constituents, the minerals and the inorganic elements, play an important role in affecting coal use. Table 1 lists some of the ways in which the inorganic constituents can impact coal use.

The guidelines provided here should help the reader determine if the coal has potential for environmental pollution, technological problems, byproduct recovery, or geologic significance. The objective of scrutinizing coal quality data is to be able to recognize these problems and potentials early in the exploration and evaluation process. The earlier that the significance of the inorganic constituents are recognized the easier it will be to minimize or eliminate the problems or to maximize the benefits.

The concentrations of the major, minor, and trace elements are the most commonly available information on the inorganic constituents in coal. Therefore, this report will focus on how to interpret these data. Only brief mention will be made of the standard coal quality parameters because there is a rich literature on how to use and interpret these data.

Several caveats are necessary. First, concentrations of elements provide only a partial picture of the element's potential impact. In order to more fully understand this potential we need to know the element's chemical form or mode of occurrence in coal.

Second, the actual impact of coal depends on a combination of complex factors. The impact of a coal will vary with different technological processes; changes in operating conditions; or under different climates and hydrologic regimes. Moreover, coals used in the same process, under similar conditions, and having similar concentrations of inorganic constituents may still have different impacts if the constituents have different modes of occurrence. Nevertheless, the concentrations of specific elements or combinations of elements can provide a reliable indication of potential impact.

Data from 191 coal samples from the Sonda Coal Field, Sindh Province, Pakistan will be used in this report to illustrate many of the points discussed. Examples of coal analysis from other geographic areas will be used when necessary.

TABLE 1. Effects of the Inorganic Constituents on Coal Utilization and Evaluation

Effect	Reference
Contributes to boiler fouling	Reid, 1981
Contributes to slagging properties	Reid, 1981
Contributes to corrosion	Reid, 1981
Contributes to erosion of combustors	Reid, 1981
Contributes to catalysis of conversion processes	Guin and others, 1979
Poisons methanation catalysis	Jenkins and Walker, 197[illegible]
Contributes to abrasion of mining and grinding equipment	Callcott and Smith, 198[illegible]
Affects washability of coal	Falcon, 1978
Lessens tendency of coal to form dust	Falcon, 1978
Affects oxidizability of coal	Falcon, 1978
Affects tendency of coal to combust spontaneously	Falcon, 1978
Affects calorific value of coal	Falcon, 1978
Affects coke strength	Jenkins and Walker, 197
Affects accuracy of ultimate analysis	Given and Yarzab, 1978
Contributes to environmental pollution	U.S. National Committee for Geochemistry, 198
Causal factors in pneumoconiosis	Falcon, 1978
Potential economic resource	Finkelman and Brown,199
Contains information on environment of deposition, diagenesis, source material	Finkelman, 1981
Useful in seam identification and correlation	Bouska, 1981; Falcon, 1978

Program Background

In 1985, the United States Geological Survey (USGS) and the Geological Survey of Pakistan (GSP) began a cooperative investigation of the coal resources of Pakistan known as COALREAP (Coal Resource Exploration and Assessment Program). COALREAP is a component of the Government of Pakistan (GOP) and United States Agency for International Development (USAID) Energy Planning and Development Project, which is financed by GOP and grants from USAID.

COALREAP included exploratory drilling for coal, regional geologic investigations, upgrading of GSP facilities, and training of GSP scientists in the U.S. and in Pakistan. The objective of the exploratory drilling program was to identify large blocks of coal potentially suitable for electric power generation.

A modern analytical laboratory capable of performing standard coal analysis, such as proximate/ultimate analysis and calorific values, was established at GSP facilities in Karachi under COALREAP. However, the program did not include provisions for upgrading the capability of GSP to determine the composition of the inorganic constituents of the coal beyond gross ash values and forms of sulfur. While GSP has the laboratory equipment required to do most trace element and major oxide determinations, particularly in the Geoscience Laboratory recently installed in Islamabad under a grant from the Japan International Cooperation Agency (JICA), no program for the special requirements for analyzing these constituents in coal has been established. This report provides background into the importance of the inorganic constituents in coal, and illustrates how their composition for one important coalfield in Pakistan can be estimated from the gross ash values. This technique may be applicable to other coal fields in Pakistan and elsewhere, thereby mitigating the need for relatively expensive analytical procedures in the U.S. and potentially improving the efficiency of analytical procedures to be developed in Pakistan.

Most of the COALREAP drilling to date has taken place in the Sonda coal field in Sindh Province (fig. 1). Fifty-three boreholes were drilled by COALREAP in this coal field between 1986 and 1989; 43 of those holes were used in the preparation of this report (the remaining holes were either not cored or produced insufficient sample for trace element analysis). GSP drilled 27 other boreholes in the Sonda coalfield between 1981 and 1986; samples from three of those holes were utilized in this report. Coal quality of the Sonda coal field is also discussed in Landis, Khan and others (1988), Landis and others (1992), and SanFilipo and others, (1993; 1994).

Geology of the Sonda Coal Field

The geology of the Sonda coal field is discussed in detail in SanFilipo and others (1988), Kazmi and others (1990), and Thomas and Khan (1992), and will be touched upon here only briefly.

The Sonda coal field is primarily situated on the crest of an anticlinorium which lies on the eastern edge of the fold and

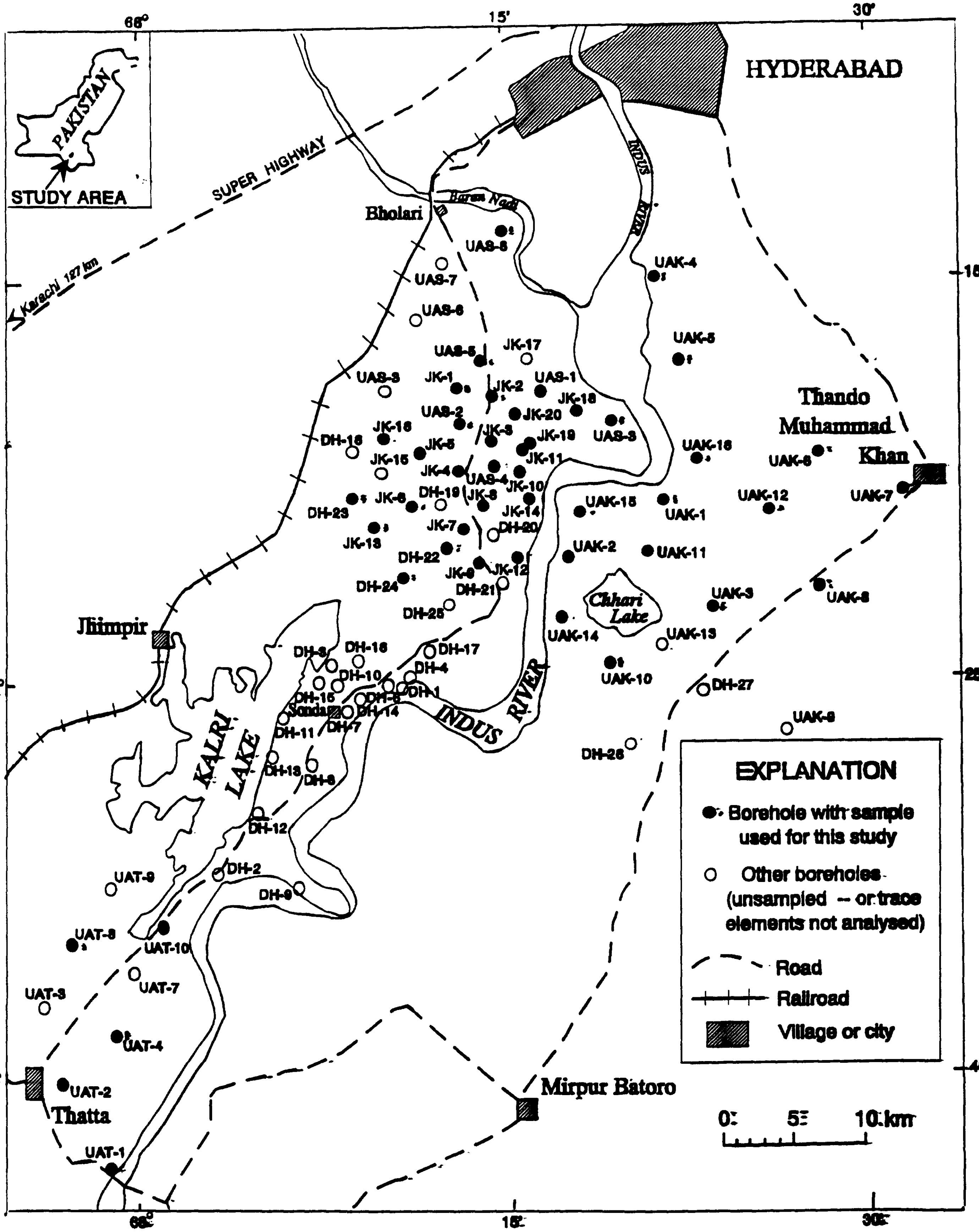


Figure 1. --Location of boreholes drilled in the Sonda coal field through 1989.

thrust belt that developed in southern Pakistan during the Himalyan orogeny (SanFilipo and others, 1988).

A generalized stratigraphic column of rocks exposed in the area is shown in figure 2. The Manchar Formation and younger sediments generally represent post-orogenic molasse deposits shed from the fold belt; these have been largely eroded from the Sonda coal field itself. Pre-orogenic rocks exposed in the study area consist of a transgressive sequence which grades upwards from the nonmarine Bara Formation to restricted marine calcarenites and mudstones of the Lakhra Formation and further upwards to open marine platform carbonates and marl of the Laki Formation. Within this generally transgressive sequence are many oscillations resulting in intertonguing of nonmarine and marine rocks, the most notable of which is the Sohnari Member of the Laki Formation (Sohnari Formation of Outerbridge and others, 1991), which is interpreted as a tongue of the Bara Formation (SanFilipo and others, 1988).

Commercial coal beds in the Sonda area can be found in the Paleocene Bara Formation and ?Paleocene Sohnari Member of the Laki Formation. Oil and gas drilling indicates that the Bara Formation is about 900 m thick near Sonda. Most of the Bara coal is thought to occur in the upper part of the formation, which is dominated by shoreface sands and tidally dominated mudrocks; below that the Bara Formation appears to contain less paralic units. Seven coal zones have been identified in the upper 200 m of the Bara Formation in the Sonda field, which is the maximum depth of penetration of COALREAP drilling (fig. 2). The Bara Formation does not outcrop in the study area, and the shallowest

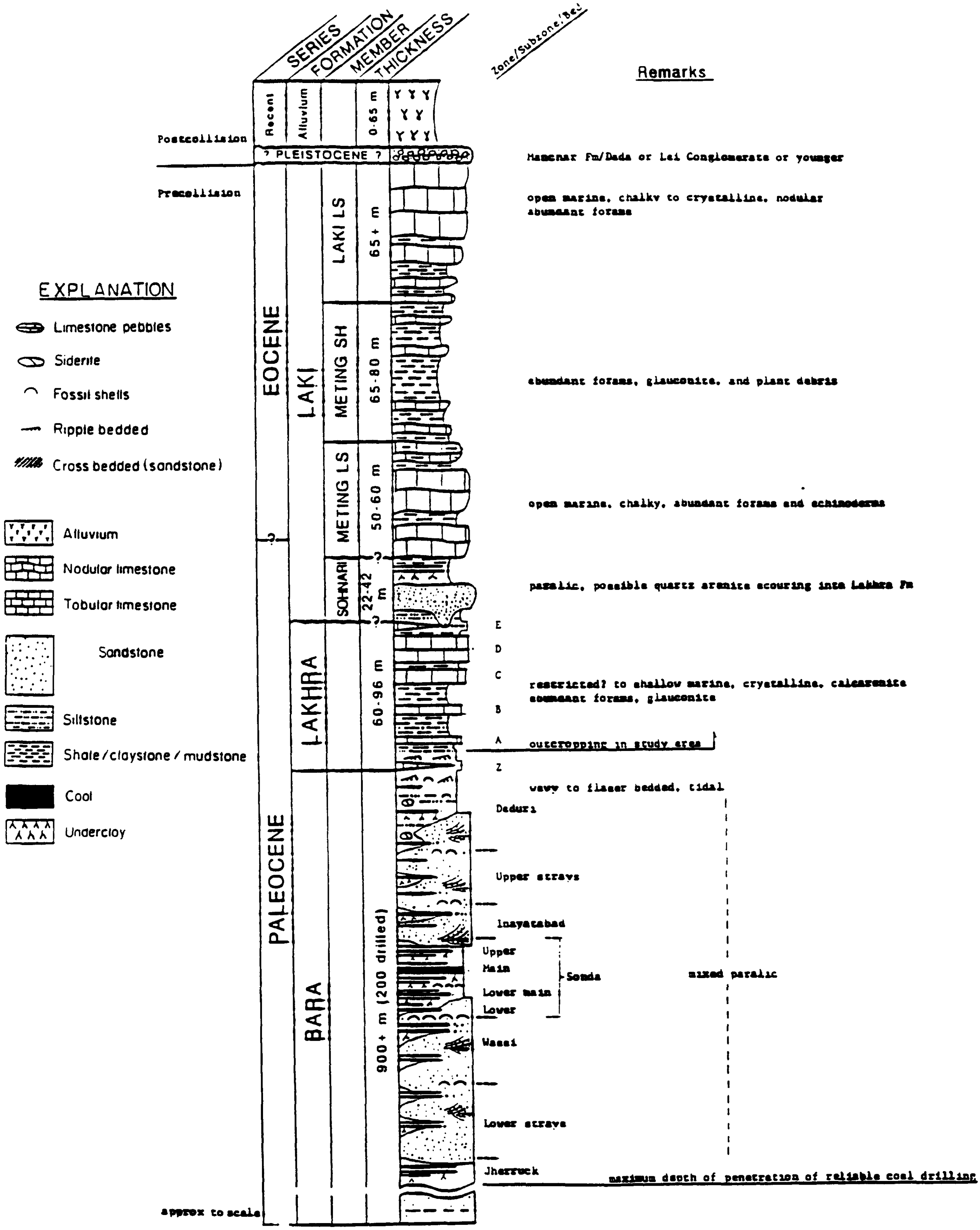


Figure 2. -- Generalized stratigraphic column for the northwestern part of the Sonda coal field. Modified from SanFilipo and others (1994).

coal is over 40 m deep. Bara coal beds more than one meter thick are recorded in the several coal zones, and the main Sonda bed reaches a thickness of more than 6 m, but the thicker beds generally occur at depths of about 100 to 300 m (SanFilipo and others, 1988). Bara coal is being mined from shallow underground mines in the Lakhra coal field, about 75 km north of Sonda village, but is not mined in the Sonda field because it is too deep to be mined by conventional mining practices. Sohnari coal which is used in brick-making is mined from the Meting-Jhimpir coal field, which overlaps the northwest part of the Sonda coal field, but it is thin and lenticular.

Exploration under the COALREAP program focused on the Bara Formation. This report, therefore, will be restricted to the Bara Formation coal. It should be noted that there is a lithic similarity between the Sohnari rocks and the stratigraphically lower Bara Formation. Moreover, the analytical data obtained from a few samples of Sohnari coal (Landis, Khan and others, 1988) are similar to data from Bara Formation coal.

Sample collection

Drilling and sampling methods for this project are described in detail in SanFilipo and others (1988, 1989) and Landis, Thomas and others (1988). All of the samples utilized for this report were taken from HQ (63.5 mm diameter) or NQ-size (47.6 mm diameter) wireline core drilled in a medium of bentonite or polymer. In some cases (UAS, UAK, and UAT- boreholes; fig. 1 and Appendix A) NaCl may have been mixed with the mud to add weight. In general, all coal beds greater than 30 cm thick were sampled, with sampling intervals within the coal bed dependent on megascopic differences that commonly reflect differences in ash yield. Noncoal partings greater than 1 cm thick were generally excluded or sampled discretely. After being described, the coal was double or triple bagged in plastic, wrapped with fiber tape, and sealed in waterproof plastic barrels for shipment to the U.S. by air. During the latter part of the drilling program, a split for the GSP laboratory was made in the field before bagging. Coal shipped to the U.S. was sent to commercial laboratories under contract to the USGS for grinding and standard coal analysis; an analytical split (-250 micrometers; No. 60 USA sieve size) was returned to the USGS for analysis of the inorganic constituents (fig. 3).

Standard Parameters: Figure 3 is a flow diagram showing the sequence of sample preparation and chemical analysis for the coal samples. In this section we discuss the standard parameters (proximate and ultimate analyses, sulfur-form determination, and calorific value). The discussion is based primarily on the analyses of 85 core samples from 20 drill holes from the Jherruck area in the northern part of the Sonda Coal Field (JK series boreholes, fig. 1: JK Point ids. Appendix A). The comments are based on the aggregate average analysis of each drill hole. All of the analytical data used in the discussion are on an as-received basis. The results are summarized in Table 1A. Data for 191 coal samples from the Sonda Coal Field appear in Appendix D.

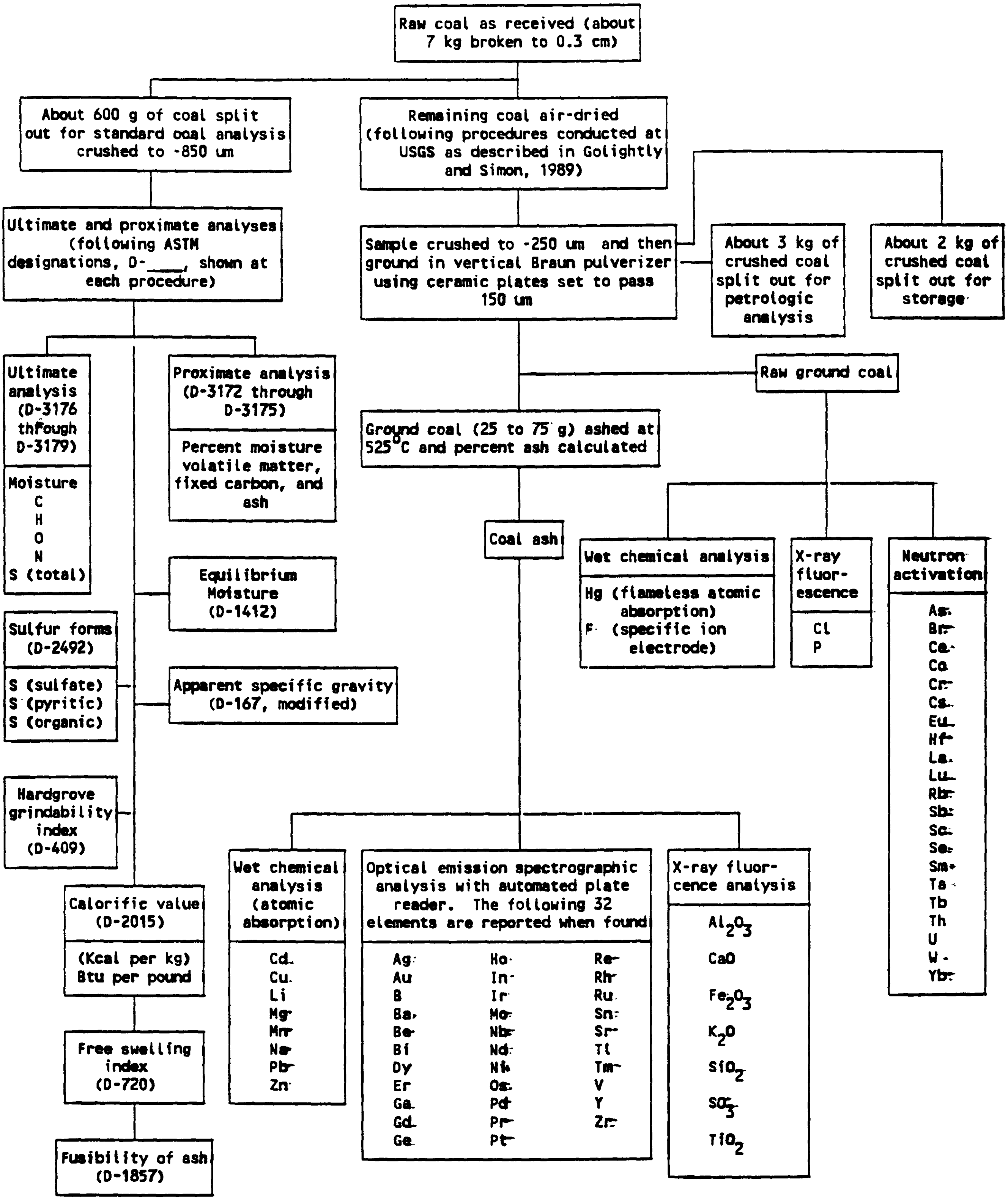


Figure 3. Flow diagram of procedures used for the analysis of coal samples collected. (ASTM--American Society for Testing and Materials--analyses performed by U.S. Bureau of Mines, U.S. Dept. of Energy, and Geochemical Testing Company; remaining analysies performed by the USGS-United States Geological Survey.)

Table 1A. Mean values for standard coal parameters determined on 85 core samples from the Jerruck area, Sonda Coal Field, Pakistan. Values are on an as-received basis.

Moisture	31.3	percent
Volatile Matter	27.3	"
Fixed Carbon	24.0	"
Ash Yield	18.0	"
Carbon	34.9	"
Hydrogen	6.3	"
Nitrogen	0.7	"
Oxygen	34.3	"
Total Sulfur	3.1	"
Pyritic Sulfur	2.3	"
Organic Sulfur	0.6	"
Calorific Value	15.3	mj/kg (6597 Btu/lb)

Proximate Analysis: This is the most common analysis conducted on coal. This analysis gives a measure of the relative amount of light organic matter (volatile matter), and non-volatile organic matter (fixed carbon - determined by difference) as well as the percentage of water (moisture) and non-combustible mineral matter (ash). These analysis are done in accordance with standardized analytical procedures described in D-3172 (ASTM, 1989).

Moisture: In all coals, but especially in those of low-rank, determination of moisture content is a critical part of the analytical sequence. Commercial evaluation of coals for utilization and valuation is commonly done on a moist basis; for example, the rank of low-rank coals is established by the moist, mineral-matter-free calorific value. Moisture determination is critical to all other coal analytical bases including the ultimate analysis. A non-representative moisture determination affects the calculations relative to all other parameters. In low-rank coals moisture may be in excess of 35 weight percent and the importance of moisture in determining the characterization of low-rank coal is much greater than in high-rank coals.

Moisture in coals is commonly present in two forms (a) inherent and (b) free moisture. Inherent moisture is defined (D121-85; ASTM, 1989) as moisture that exists as an integral part of the coal in its natural state, including water in pores but not that present in macroscopically visible fractures. Inherent moisture may not be equal to the moisture remaining in a coal sample after air drying. Free moisture is defined (D121-89;

ASTM,1989) as that portion of total moisture in coal that is in excess of inherent moisture. It is not to be equated with the weight loss upon air-drying (Landis, Khan and others, 1988). Samples obtained from drill core contain both inherent and free moisture. Equilibrium moisture (D-3180; ASTM, 1989) provides an approximation of inherent moisture.

The total moisture content in the Jherruck coal samples is generally higher in the eastern part of the area, and lower in the western part. The mean moisture content of Jherruck coals is 31.3 percent. This high moisture content is typical of low-rank coals.

Volatile Matter: The volatile matter content of a sample is defined (D3175-82; ASTM, 1989) as "... The percentage of gaseous products, exclusive of moisture vapor, in the analysis sample (the sample being analyzed) which are released under the specific conditions of the test. Volatile matter is determined by establishing the loss in weight resulting from heating a coal sample under rigidly controlled conditions. The measured weight loss, corrected for moisture as determined in Method D3173, establishes the volatile matter content".

The volatile matter is of importance because it can be used to establish the rank of coals, to indicate coke yield resulting from carbonization processes, to provide the basis for buying or selling for particular use, or to assist in attempts to predict burning characteristics (Landis, Khan and others, 1988).

In the Jherruck coal samples the trend of volatile matter content, on an as-received basis, is similar to that of moisture.

Generally it is higher on the eastern side of the area and lower on the western side. The highest volatile matter value in these samples is 34.2 percent at site Jk-14 on the eastern side and the lowest value of 22.1 percent is found at Jk-7 in the south. The mean volatile matter content of Jherruck coals is 27.3 percent.

Fixed Carbon: The fixed carbon content of a coal is the carbon found in the material that remains after the volatile matter has been expelled. It represents the decomposition residue of the coal's organic component (Ward, 1984). The reported fixed carbon value is a calculated value. "It is the resultant of the summation of percentage moisture, ash, and volatile matter subtracted from 100" (D3172-73; ASTM, 1989). In higher rank coals the fixed carbon percentage can be used to establish rank (D388-84; ASTM, 1989).

In the Jherruck coals the fixed carbon values on an as-received basis are generally lower on the margins of this coal area and higher towards the central part, especially on the eastern side. The coals of the southern part of the area have lower fixed carbon values as compared to the coals of the northern part. The highest fixed carbon value of 30.8 percent is observed at Jk-11 towards the middle part of the coal field and the lowest value of 16.1 percent is observed at Jk-7 in the southern part of the area. The mean fixed carbon value of Jherruck coals is 24.0 percent. The low fixed carbon values are typical of low-rank coals.

Ash: The ash of a coal is the non-combustible inorganic residue that remains when coal is burned. It represents the bulk of the inorganic substance (mineral matter) present in coal but it may not be identical, in composition or quantity, with the mineral matter present in the coal before ignition. "Incineration causes an expulsion of all water, the loss of carbon dioxide from carbonates, the conversion of iron pyrites into ferric oxide, and other chemical reactions" (D3174; ASTM, 1989).

Determination of ash yield requires heating the coal in a ventilated furnace, and expressing the mass of the residue remaining as a percentage of the original coal. It is difficult to precisely predict the burning characteristics of coals during utilization solely on the basis of ash weight percentage determined by standard test methods (Landis, Khan and others, 1988). To predict the burning characteristics of a coal other tests are performed, such as determining the free-swelling index and ash-fusion temperatures.

In the classification of coals by grade, coals with less than 8 percent ash are classed as low-ash, coals with 8 through 15 percent ash are classed medium-ash, and coals with more than 15 percent ash are classed as high-ash (Schweinfurth and Husain, 1988).

In Jherruck coals the ash is generally higher on the margins of this coal field, the values are especially higher towards the southern margin. The ash yield is generally low in the eastern side of the basin. The highest ash value of 36.0 weight percent is found at Jk-7 in the south, and the lowest value of 6.9 weight percent is observed at Jk-4 in the central part. The mean ash yield of Jherruck coals 18.0 weight percent.

Ultimate Analysis: The organic components of coal consist essentially of chemical elements such as carbon, hydrogen, oxygen, nitrogen, and sulfur. In ultimate analysis the percentage of each of these elements, ash, and moisture are determined. The ash yield and moisture will ordinarily have been determined during the proximate analysis. The hydrogen and carbon are determined in the gaseous product of the complete combustion of the sample; nitrogen, sulfur, and ash are determined on the sample as a whole; and the oxygen is calculated by difference. In assessing the coking, gasification, and liquefaction properties of coal, the percentages of carbon, hydrogen, and oxygen are of great commercial importance. The nitrogen and sulfur in a coal are a possible source of pollution. The percentages of carbon, hydrogen, and oxygen in the organic fraction of coal can also be used to indicate the rank of coal. The ultimate analysis is intended, along with the proximate analysis, to permit cursory valuation of coals for use as fuels or in other processes (D3176-84; ASTM, 1989).

Hydrogen and Carbon: Hydrogen and carbon are liberated as H_2O and CO_2 when the coal is burned. Both hydrogen and total carbon are determined by standard test method (D3178-84; ASTM, 1989). This test method yields the total percentages of carbon and hydrogen in the coal as analyzed and the results include not only the carbon and hydrogen in the organic matter, but also includes a certain amount of carbon and hydrogen derived from the inorganic constituents in the coal.

The carbon and hydrogen values are used to calculate the amount of oxygen (air) required in the combustion processes. Carbon and hydrogen determinations are used in material balances in coal conversion processes. Also carbon or hydrogen is frequently used in correlation of chemical and physical properties, such as yields of products in liquefaction, reactivity in gasification and the density of coal (D3178-84; ASTM, 1989).

In the Jherruck coals there is little variation in the hydrogen content on an as-received basis. The highest hydrogen value of 7.1 percent is observed at Jk-4 in the central part of the area and the lowest hydrogen value of 5.0 percent is found at Jk-7 in the south. The mean hydrogen content of Jherruck coals is 6.3 percent.

No definite trend is observed in the carbon content of Jherruck coals on an as-received basis. The highest carbon value, 47.5 percent, is observed at Jk-11 in the east-central part and the lowest carbon value, 22.9 percent, is found at Jk-7 in the south. The mean carbon content of the Jherruck coals is 34.9 percent.

<u>Nitrogen:</u> The nitrogen found in coals appears to be mainly confined to the organic components. Total nitrogen in coal samples is determined in accordance with Test Method D3179-84 (ASTM, 1989). Determination of the nitrogen content is necessary when oxygen content is derived by difference and is important for evaluation of the potential formation of nitrogen oxides as a

source of atmospheric pollution. In the manufacturing of coke, some of the nitrogen reacts to form ammonium compounds. They may be extracted as a by-product for use as fertilizer, or in the manufacture of nitric acid.

In the Jherruck coals, generally the higher nitrogen values are observed on the margins of this coal area and the lower values are observed in the central and southern part. The highest value on an as-received basis, 0.9 percent, is observed at Jk-13 in the south-west part and the lowest value, 0.4 percent, is found at Jk-8 in the central part. The mean nitrogen value of the Jherruck coals is 0.7 percent.

Oxygen: Oxygen is a component of many of the organic compounds in coal. After determination of the hydrogen, carbon, nitrogen, sulfur, and ash yield of a sample, the oxygen content is determined by difference. Oxygen is of great significance in gasification and liquefaction operations (Ward, 1984).

No definite trend is observed in the distribution of oxygen content, on an as-received basis, in the Jherruck samples. The highest oxygen value of 40.6 percent is observed at Jk-4 in the central part of the field and the lowest value of 28.5 percent is found at Jk-7 in the southern part. The mean oxygen value of the Jherruck samples is 34.3 percent.

Sulfur: Sulfur may occur in coal in the following three forms:

(a) Organic sulfur, in which it is incorporated into the hydrocarbon compounds of the coal substance.

(b) Pyritic sulfur, inorganic sulfur present in the form of sulfides such as pyrite.

(c) Sulfate sulfur, mostly found as hydrous iron or calcium sulfate, is usually produced by atmospheric oxidation. Sulfate sulfur is usually low in fresh coals and higher in oxidized and weathered coals.

The bulk of sulfur in coal occurs as pyritic and organic forms. For both technologic and economic reasons, organic sulfur cannot easily be removed from coal at the present time. Pyritic sulfur may or may not be removable, depending on the size of the pyrite grains. Petrographic studies are a useful first step in determining whether pyritic sulfur is removable, and washability studies are commonly required to determine the amount removable.

Total sulfur is determined as part of the ultimate analysis in accordance with standard test method D3177-84 (ASTM, 1989). Sulfur and ash are considered deleterious constituents when coals are classified by grade. Coals with 1 percent or less sulfur are classed as low-sulfur, coals with more than 1 percent and less than 3 percent are classed as medium-sulfur, and coals with 3 percent or more are classed as high-sulfur (Landis, Khan and others, 1988).

In the Jherruck samples pyritic sulfur, on an as-received basis, is generally higher on the northern and southern parts and lower values are observed in the central and western parts. The highest pyritic sulfur value, 5.5 percent, is observed at Jk-7 in the south and lowest value of 0.3 percent is observed at Jk-16 in the west. The mean value of pyritic sulfur is 2.3 percent.

Generally the organic sulfur, on an as-received basis, in Jherruck coals is higher in the north and northeast side with lower values in the central part. The highest organic sulfur value of 1.7 percent is observed at Jk-2 and Jk-19, and the lowest organic sulfur value of 0.2 weight percent is found at Jk-8 and at Jk-16. The mean organic sulfur value of these coals is 0.6 percent.

The general trend for the total sulfur content of Jherruck coals, on an as-received basis, is similar to that of pyritic sulfur. The highest sulfur value of 6.4 percent is seen at Jk-7 and the lowest value of 0.9 percent is observed at Jk-4 in the central part of the area. The mean total sulfur content of Jherruck coals is 3.1 percent, classifying these as high-sulfur coals.

Calorific Value (Btu/lb): The calorific value is a measure of the heat produced by combustion of a unit quantity of coal under given conditions. The knowledge of the calorific value is critical for a variety of purposes ranging for the classification of coals by rank to estimation of coal resources and from the evaluation of utilization potential of coal for steam generation. The direct measurement of the gross calorific value at constant volume, is the most widely accepted method of determination (D3286-86; ASTM, 1989). In the U.S., the calorific value is reported in Btu/lb; conversion to Mj/kg is obtained by multiplying the Btu/lb value by 0.002326.

In samples from the Jherruck coals the higher calorific values, on an as-received basis, are generally found in the central part of the area and lower values are found in the northern and southern part. The highest values, 20.5 and 20.2 Mj/kg (8807 and 8669 Btu/lb), were observed in samples from Jk-16 and Jk-11, respectively, in the central part of the area. The lowest value, 14.8 Mj/kg (6381 Btu/lb), was determined for a sample from Jk-7 in the south. The mean calorific value for Jherruck coals is 15.3 Mj/kg (6597 Btu/lb).

Sample Analysis

The coal samples were prepared and analyzed according to the procedures outlined in Swanson and Huffman (1976). More recent procedures for analysis of coal samples are described by Golightly and Simon (1989). Elemental analysis required several analytical techniques including wet chemical procedures, atomic absorption spectroscopy, X-ray fluorescence spectroscopy, and instrumental neutron activation analysis. The entire analytical procedure, including standard coal characterization methods, is illustrated in Figure 3. Results of the elemental analysis are in the Appendices B, C, and D.

Discussion

Affect of Inorganic Constituents on Technological Behavior

The inorganic constituents affect the behavior of coal in virtually every technological process. Some of the technological problems caused by the inorganic constituents are listed in Table 1. In this section we will focus on the most widespread and costly problems. The inorganic constituents that contribute to these problems are listed in Table 2.

Table 2. Inorganic constituents that cause technological problems

Inorganic Constituent	Problem
Sodium (Na)	Fouling
Iron (Fe)	Slagging
Chlorine (Cl)	Corrosion
Fluorine (F)	Corrosion
Boron (B)	Corrosion
Quartz	Erosion/Abrasion
Si/Al	Erosion/Abrasion

Fouling

One of the most costly problems of coal utilization is the build-up of sintered ash deposits on the heat exchange surfaces of coal-fired boilers (Reid, 1981). These deposits not only drastically reduce the efficiency of the boiler but they also promote corrosion and erosion (Honea and others, 1982). The size and strength of these deposits is dependent on the configuration of the boiler, the operating conditions, and the inorganic composition of the coal being combusted.

There have been numerous attempts, using chemical data, to develop empirical formulas, models, or indices for predicting the tendency of a coal to form sintered ash deposits. Most of these attempts have focused on generally one, but no more than a few, compositional variables to account for deposit formation. Examples of these indices appear in Table 3. It is apparent from these indices that sodium is commonly cited as the primary cause of fouling in coal-fired boilers.

The only recommended fouling index for low-rank coal is the sodium content of the coal ash. In general, these indices have met with only limited application and success. One reason for the limited success is that the indices are gross oversimplifications of a complex situation. The formation of sintered ash deposits can be the result of the interaction of all of the inorganic constituents, not just one or a few. Moreover, none of the indices take into account the elements' modes of occurrence, a characteristic that can affect the role of the elements in the fouling process.

Finkelman and Dulong (1989) found that ash yield and the concentrations of sodium, calcium, and magnesium were the most important factors influencing the fouling behavior of low-rank coal. A high silicon/aluminum ratio, a function of the coal's mineralogy, was another important factor. Based on these and other compositional factors they were able to develop models that accurately predicted the weight of fouling deposits formed in a test combustion unit.

It is safe to assume that coals having high Na_2O contents (> 5 percent in the ash, dry basis) in combination with high ash yields (>15 percent, dry) are likely to cause fouling of the boiler. High Na_2O contents (> 5 percent in the ash, dry) in a low-ash coal (<10 percent, dry) may yield small but hard, difficult to remove, deposits (Finkelman and Dulong, 1989; Vaninetti and Busch, 1982).

Numerous additives (lime, quartz sand, etc.) have been used to reduce fouling with decidedly mixed results. Blending with low-ash or low-sodium coal should help. Fluidized-bed combustors are less susceptible to fouling than pulverized-coal fired combustors because they operate at lower temperatures.

Table 3: **Common** Fouling Indices
(From: Vaninetti and Busch, 1982)

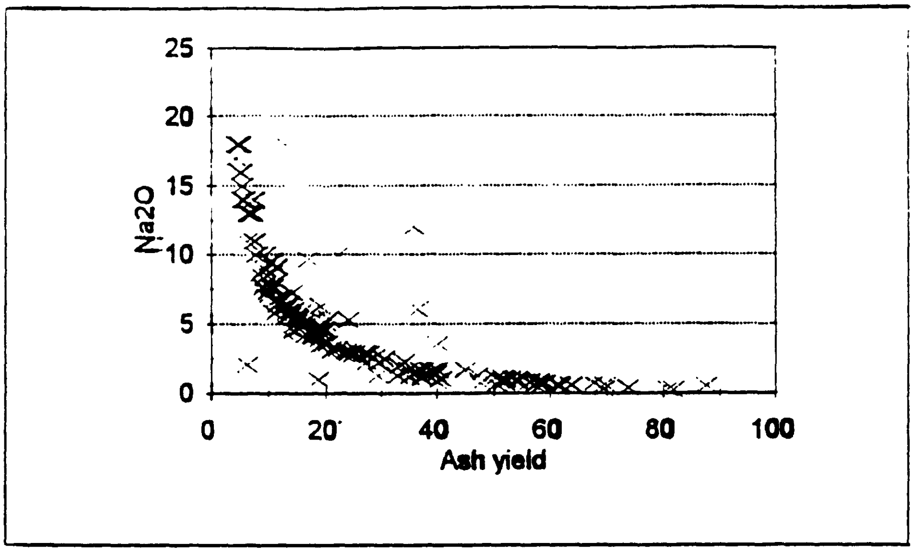
Index	Factors	Application[1]	Fouling Tendency low	medium	high	severe
Fouling factor (R_f)	(Base/Acid[2])/Na_2O	E	<0.20	0.20-0.50	0.50-1.0	>1.0
Fouling factor (R_f')	(Base/Acid)(water soluble Na_2O)	E	<0.10	0.10-0.25	0.25-0.7	>0.7
Alkalis in coal	$\frac{(\%Ash)(Na_2+(0.659*K_2O))}{100}$	E	<0.50	0.50-1.00	1.00-2.50	>2.50
Sodium in ash	Percent Na_2O	E	<0.50	0.50-1.00	1.00-2.50	>2.50
Sodium in ash	Percent Na_2O	W	<3.00		3.00-5.00	>5.00
Ash sintering strength	P.S.I. at 1700^oF		1000	1000-5000	5000-16000	>16000
Chlorine in coal	Percent Cl		<0.20	0.20-0.30	0.30-0.50	>0.50

[1] E = Eastern bituminous ash
W = Western bituminous ash

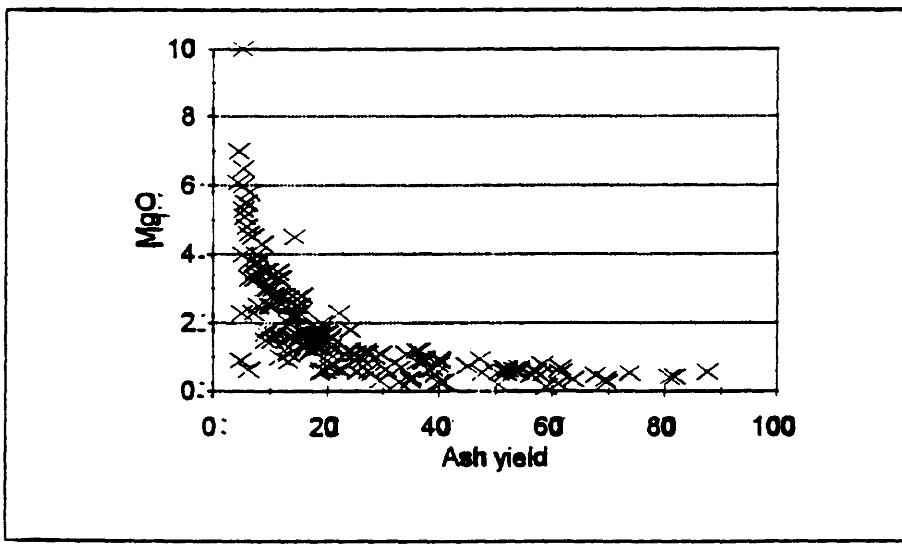
[2] Base = $Fe_2O_3+CaO+MgO+K_2O+Na_2O$ (mass percent in ash,dry basis)

Acid = $SiO_2+TiO_2+Al_2O_3$ (mass percent in ash, dry basis)

Sonda Samples - Data from the 191 coal samples from the Sonda coal field indicate a high probability of boiler fouling. The mean Na_2O concentration in the ash is 5.0 percent, with 24 samples having more that 10 percent. The mean ash yield is 24.9 percent. The combination of high ash yield and high concentration of Na_2O in the ash is conducive to boiler fouling. The strong negative trend of Na_2O, CaO, MgO with ash (Fig. 4) is a good indication that these elements are organically-bound. Organically-bound elements will be more likely to contribute to the fouling process than will be elements contained in refractory minerals.



A-



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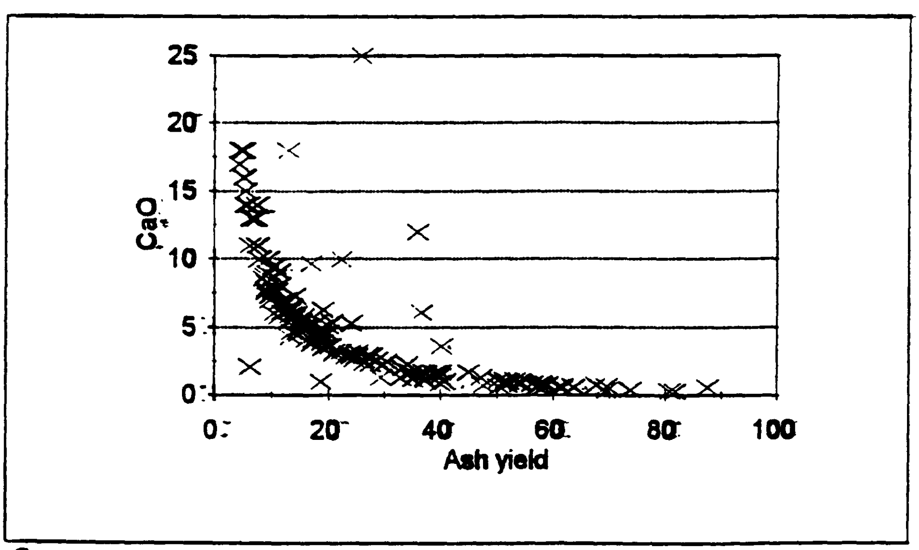

C.

Figure 4. Scatter plots depicting the trend A) Na2O, B) MgO, C)CaO vs Ash yield

Slagging

Slag is defined as a molten ash deposited on boiler walls in zones subjected to radiant heat transfer. Minerals with low melting temperatures tend to stick to the boiler walls and accumulate until massive fused deposits are formed. This process is termed slagging.

To efficiently design a boiler the manufacturer needs to know the slagging propensity of the coal that will be burned in the furnace. The iron content of the coal ash is of major importance in influencing the ash fusion temperature and the slagging potential of a coal. Iron sulfides (primarily pyrite) tend to promote slagging more than do other iron-bearing minerals. Bryers (1986) believes that illite may also play a role in the slagging process by initiating the deposit.

A number of empirical tests and indices have been used to predict slagging potential (Table 4). Nevertheless, it is difficult to predict slagging problems in pulverized-coal fired boilers based on laboratory determined properties (Cudmore, 1984). The base/acid ratio [$(Fe_2O_3 + CaO + MgO + K_2O + Na_2O)/(SiO_2 + TiO_2 + Al_2O_3)$] may be the best estimator of slagging potential that can be derived from the chemical analysis of the coal ash. The data in Table 4 indicate that values between 0.25 and 0.80 may indicate an undesirable slagging tendency.

Sonda Samples - Most of the Sonda coal samples have base/acid ratios between 0.25 and 0.80. Only 20 samples have ratios less than 0.25. The relatively high base/acid ratios (see Table 4) for the Sonda coal samples indicate a potential for slagging problems in conventional boilers. Slagging is not a concern in fluidized-bed combustors.

Table 4: Furnace Slagging Indices
(From: Vaninetti and Busch, 1982)

Index	Factors	Application[1]	Slagging Tendancy Low	Medium	High	Severe
Slagging Factor	(base/acid[2])(S dry)	E	<0.6	0.6-2.0	2.0-2.6	>2.6
Silica Percentage	$\frac{(100)(SiO2)}{SiO_2+Fe_2O_3+CaO+MgO}$	E	30	--30 to 82--		82
Base-acid Ratio	Base % / Acid %	E/DB	<0.5			
		E/WB	>0.27			
Ash fusion temperature	Initial Def.-Fluid	E	HIGH------------------------------LOW			
Slagging Factor	$\frac{(Max.Hem.Temp.)+4(min.ID.Temp)}{5}$	W	>2450	2250-2450	2100-2250	<2100
Base-acid Ratio	Base % / Acid %	W	<0.25 or >0.80		--0.25 to 0.80--	
Iron-calcium	Fe_2O_3 % / CaO %	W/DB	<0.31 or >3.00 --0.31 to 3.00--Ratio			
Silica-alumina Ratio	SiO_2 % / Al_2O_3 %	W	LOW------------------------------HIGH			
Dolomite Percentage	$\frac{(100)(CaO+MgO)}{Fe_2O_3+CaO+MgO+Na_2O+K_2O}$	W	HIGH------------------------------LOW			
T_{250} Tempera-ture (F)	Temp. to attain 250 Poise	DB	>2325	2100-2550	2050-2275	<2200
		WB	<2600			
Temperature -critical Viscosity	Tcv (Poise)	WB	10-100			
Iron Fractionation	Fe_2O_3 in 2.8 S.G. Sink		LOW------------------------------HIGH			
Calcium Fractionation	CaO in 2.0-2.8 S.G.		LOW------------------------------HIGH			

[1] E = EASTEN BITUMINOUS ASH
W = WESTERN LIGNITIC ASH
WB = WET BOTTOM BOILERS
DB = DRY BOTTOM BOILERS

[2] Base = $Fe_2O_3+CaO+MgO+K_2O+Na_2O$ (mass percent in ash, dry basis)
Acid = $SiO_2+TiO_2+Al_2O_3$ (mass percent in ash, dry basis)

Corrosion

Corrosion is the wasting of metal in fossil-fuel-fired boilers. Although combustion conditions play a critical role in influencing the degree of corrosion (Stringer and Banergee, 1991), corrosion is enhanced by nonsilicate impurities in coal that volatilize and deposit on the reactor walls (Raask, 1985). Coals having chlorine values in excess of 1,000 ppm should be considered as potentially corrosive.

Low-temperature corrosion can be caused by condensation of sulfuric acid. High-temperature corrosion is caused by oxidation, sulfidation, or chloridation of the metal. Apparently sulfated alkalis (Na, K) play an important role in the corrosion process. High levels of chlorine and, to a lesser degree, fluorine have also been cited as contributing to corrosion. Raask (1985) notes that some trace elements (arsenic, lead, and perhaps zinc) may enhance corrosion. Under certain conditions boron has also contributed to metal corrosion.

Sonda Samples - Of the 175 Sonda samples analyzed for chlorine 63 had more than 1,000 ppm, three of these samples had more than 3,000 ppm. There is a possibility that some of the chlorine may be due to contamination by drilling fluids (see discussion on page 38). The mean chlorine value for the Sonda samples is 940 ppm. Fluorine values are low, with a mean of 42 ppm. The potential for corrosion should be considered in any use of the Sonda coals because of their moderately high Cl contents.

Erosion/Abrasion

Erosion and abrasion are the physical processes that, like corrosion, lead to wear, that is, loss of material. Erosion/abrasion not only causes wear in boilers but also in mining and grinding equipment. Finkelman and Gluskoter (1991) discuss the coal quality parameters that cause wear in fluidized-bed combustors. The Hargrove Grindability Index (HGI) is commonly used to predict abrasion of equipment, however, HGI tests were not conducted on the Sonda coal samples.

Erosion and abrasion are primarily due to the presence of abrasive minerals in coal such as quartz and pyrite. Table 5 contains a compilation of hardness information for coal and selected minerals. Particle size and shape are other factors that affect erosion and abrasion.

In the absence of mineralogical data coal technologists have used the Si/Al ratio as an indicator of abrasiveness. This index is based on the assumption that the higher the ratio the greater is the quartz content. Coals having Si/Al ratios greater than three are considered to be abrasive. This test should be applied with caution. Finkelman (unpublished data) found a lignite from Texas having a Si/Al ratio of almost four. The principal mineral in this lignite is clinoptilolite, a zeolite having a Si/Al ratio of almost five. Despite the high Si/Al ratio of the lignite, it is unlikely that this lignite will be abrasive as clinoptilolite has a Mohs hardness number of only four.

The Si/Al ratio should be used only as a screening technique. The mineralogy should be determined for coals having Si/Al ratios greater than three. This could be done by X-ray diffraction or by scanning electron microscopy. There are also empirical tests for hardness and abrasiveness of coal (Leonard, 1991).

Table 5.-- Hardness of coal substance and mineral species in typical bituminous coal.

Constituent	Approximate weight percent of coal	Mohs hardness number	Vickers hardness (kg mm^{-2}
Coal substance	85	1.5-2.5	10-70
Quartz	1.6	7	1200-1300
Pyrite	1.5	6-7	1100-1300
Silicates			
Kaolin	5	2-2.5	30-40
Illite	3	2-2.5	20-30
Muscovite	3	2-2.5	40-80
Orthoclase	<0.1	6	700-800
Kyanite	<0.1	6-7	500-2150
Topaz	<0.1	8	1500-1700
Carbonates			
Calcite	0.5	3	130-170
Magnesite	0.1	4	370-520
Siderite	0.2	4	370-430
Alumina	Rare	9	1200

From: Raask, 1985

Sonda Samples - The Si/Al ratio of most Sonda samples is well below three (the average is less than 1.6); only six samples had Si/Al ratios greater than 3, thus, there appears to be little cause for concern about abrasion of mining equipment.

The Role of Inorganic Constituents in Other Technological Processes

The inorganic constituents in coal can affect coal use in several other technological processes. These will be only briefly mentioned here because no clear guidelines exist for assessing the impact of the constituents.

After coal combustion, particulate matter is commonly removed by passing the gas stream through electrostatic precipitators. Sodium in the coal ash has a major effect on the efficiency of these precipitators (Vaninetti and Busch, 1982). In contrast to fouling, higher sodium levels are preferable because sodium reduces the resistivity of the ash thus enhancing precipitator efficiency.

The inorganic constituents in coal can behave as a catalyst or as a poison for a variety of coal conversion processes. The presence of several elements in coal, such as sulfur, phosphorus and vanadium, are undesirable in the coke-forming process. Conversely, pyrite can be useful as a catalyst for liquefaction. Other technological affects of the inorganic constituents are listed in Table 1.

Sonda Samples - We did not detect anomalously high concentrations of any element in the Sonda samples that might be cause for concern in conventional coal technology.

Environmental Impact of the Inorganic Constituents

There are a variety of ways in which coal mining, coal use, and coal waste-product disposal can deleteriously affect the environment. For example, ambient air quality is affected by emissions of combustion gasses, smoke, and dust. Ground and surface water quality can be degraded by acid generation, release of trace elements, and by the influx of particulate matter. The aesthetic appeal of an area can be destroyed by surface mining of coal. Comprehensive discussions of these topics are beyond the scope of this report which will focus on the potential environmental impact of trace elements released from coal.

Recent U. S. legislation (H. R. 3030; 1990 Amendments to the Clean Air Act) cites twelve elements (excluding radionuclides) in the Hazardous Air Pollutant List (phosphorus, antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, and selenium). Combustion of coal is a potentially significant source for several of these pollutants.

Many of the same elements (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) appear in the U. S. Environmental Protection Agency's (EPA) list of potential pollutants in drinking water. Standards setting maximum concentrations for these elements have been published (U. S. EPA, 1976).

The U. S. EPA (1987) has found that most coal wastes are not hazardous as defined by the Resources Conservation and Recovery Act. They note, however, that some ground water contamination has occurred in the vicinity of waste disposal sites. At one site in Virginia, nearby drinking water wells were contaminated with vanadium and selenium from coal combustion wastes (U. S. EPA, 1987).

Many state regulatory agencies now recognize the potentially harmful effects of trace elements released during coal mining and utilization. Boon and others (1987) note that most western U. S. coal-mining states now require baseline information on several trace elements, especially selenium, boron, and molybdenum. The release of selenium from coal combustion wastes has caused significant environmental damage (extensive fish kills) at two sites in North Carolina and one in Texas (Shepard, 1987). New Mexico and Colorado now require data on 10 to 20 trace elements (Boon and others, 1987) for coal mine permits.

Adriano (1986) provides detailed discussions on the potential toxicity to plants and animals of arsenic, boron, cadmium, chromium, copper, lead, manganese, mercury, molybdenum, nickel, selenium, and zinc. Brief discussions are also presented on the environmental impact of antimony, barium, beryllium, cobalt, fluorine, silver, thallium, tin, titanium, and vanadium.

Most chemical elements present in exceptionally high concentrations pose potential threats to the environment. It is, however, difficult to determine the threshold level at which the threat becomes a real problem. This difficulty arises because the threshold level varies with each element, the chemical form of the element, the technological process in which the coal is being used, the hydrological and climatic regimes, and each species of organism.

Unfortunately, there are no available guidelines for indicating acceptable or unacceptable concentration levels of an environmentally hazardous element in coal. Moreover, knowing the concentration of the element is generally not sufficient information to assess its potential impact. Dreher and Finkelman (1992) found that the mode of occurrence of selenium in coal and in overburden played a major role in its release during mining. Moreover, they found the selenium in the coal occurred in: organic association (70 to 80 percent); pyrite (10-15 percent); sphalerite (1-2 percent); lead selenide (1-2 percent); ion-exchangeable sites (5-10 percent); and water soluble forms (5-10 percent). Significantly, the oxidation of the selenium-bearing pyrite was the primary cause for the elevated selenium levels found in the recharged ground water.

Selenium has long been identified as a toxin associated with various animal diseases (Beath, 1982; Rosenfeld and Beath, 1964). Excessive amounts of selenium have been cited as the cause of periodontal disease in humans and as a possible carcinogen (National Academy of Science, 1974). An endemic disease in China has been attributed to selenium intoxication; morbidity was as high as 50 percent (Yang et al., 1983). Selenium also has been cited as the cause of massive fish-kills in Texas and North Carolina lakes and the cause of death of thousands of birds in California (Presser and Barnes, 1984).

Selenium is one of the principle elements focused on by every environmental regulatory agency and all legislation aimed at mitigating trace element pollution from coal. Extremely small amounts of selenium can be potentially dangerous. In the Powder River Basin, coals and associated rocks generally contain less than 1 ppm selenium. Nevertheless, selenium released during coal mining has been sufficient to cause the selenium concentration in the ground water to exceed the State's livestock drinking water standard (Dreher and Finkelman, 1992).

Selenium in coal and associated rocks can invade the environment through several mechanisms. Selenium is an extremely volatile element; Finkelman and others (1990) found that at least 80 percent of the selenium from 10 coal samples was volatilized at 550° C. Selenium volatized during coal combustion can settle out in the vicinity of or down-wind from the power plant. Selenium in the soil can be taken-up and concentrated by a wide variety of plants, thus entering the food chain. Selenium can also contaminate surface and ground water when it is leached from coal outcrops, highwalls, or stockpiles or from spoil piles and backfill sediments, as in the case described above.

Sonda Samples - Selenium - There is a real potential for selenium pollution in the Sonda coal field region. The Sonda coal samples average almost 4 ppm selenium with a maximum of 11 ppm (Appendix D). This mean concentration is similar to the highest mean concentrations found in U. S. coal regions such as the Appalachian Basin and the Gulf Coast. A significant difference, however, is that the high-Se coals in the U. S. are in regions receiving substantial amounts of rainfall. The U. S. Appalachian and Gulf Coast areas receive 2 to 3 times the amount of rainfall than does the Sonda area. The increased precipitation acts to flush selenium from the soils and to dilute its concentration in surface and ground water.

The combination of relatively high selenium concentrations in the coal, a semi-arid environment, and the abundance of grazing animals is a situation that bears watching. Using the coal in a fluidized-bed combustor (FBC) may help reduce selenium emissions because of the low combustion temperatures and the complexing capability of the carbonate bed material. However, there is no documentation on the behavior of selenium in fluidized bed combustors.

Table 6 compares data from the Sonda coals to data from U. S. coals for selected environmentally hazardous elements. Most of the other potentially hazardous elements in the Sonda coal are present in relatively low concentrations and probably pose no environmental threat. The concentrations of Co, Cr, and Ni in the Sonda coal samples are considerably higher than their concentrations in U. S. coals. This could be due to mafic source rocks such as the Deccan traps. Chromium in the Sonda coal samples is strongly correlated with ash (r^2= 0.7). Cobalt and nickel concentrations also appear to be related to the ash yield, although the correlation is weaker.

It is also possible that the U. S. average for these elements may be low in comparison to Cr and Ni contents in coals from other countries. Cr and Ni concentrations in Greek lignites (Foscolos and others, 1989) and Yugoslavian lignites (Ruppert and others, 1991) are even higher than their concentrations in the Jherruck coals. Although none of these elements are considered to be a serious threat to the environment (Swaine, 1990), nickel is known to be a plant toxin at ppm levels (Adriano, 1986).

Table 6. Environmentally Hazardous Elements in Coal From the Sonda Region and From the U.S
(values are in ppm)

Element	Sonda Mean	Sonda Max.	U. S. - All Coals Mean	U. S. - All Coals Max.
As	3.5	23	24	2200
Be	2.4	9.5	2.2	330
Cd	0.08	0.5	0.47	170
Co	**26.4**	**280**	**6.1**	**500**
Cr	**58.3**	**270**	**15**	**250**
Hg	0.03	0.17	0.17	10
Ni	**68.4**	**700**	**14**	**230**
Pb	4.8	48	11	1900
Sb	0.17	0.6	1.2	35
Se	**3.7**	**11**	**2.8**	**150**

Economic Potential of the Inorganic Constituents

Some inorganic constituents in coal have important economic byproduct potential. Extraordinarily high concentrations of elements have been reported from coal. Table 7 lists several examples of the high concentrations. Mineral resources have, historically, been extracted from coal (see Finkelman and Brown, 1991 for citations). More recently, there has been only sporadic activity in this area. For example, in the 1960's there was limited production of uranium from North and South Dakota lignites (Noble, 1973; Schnable, 1975). Other recent efforts at byproduct recovery from coal are described by Burnet (1986) and Cobb and others (1979). The elements with the greatest potential for economic extraction include gold, silver, and the platinum group elements.

Hatch and others (1976a), Cobb and others (1979), and Finkelman and Brown (1989) have suggested that the association of minerals and coal can be used in other ways. For example, the high concentrations of elements in coal may not be economical to extract but may be indicative of nearby mineralization. The coal may thus be used as a geochemical prospecting tool to locate economic mineral deposits. A useful rule to consider for screening trace element data is that element concentrations greater than 10 times the mean value may be indicative of an unusual geochemical process. Concentrations greater than 100 times the mean are definite anomalies and should be given careful consideration. This rule, of course, does not apply to major elements (those present at more that 1 percent) or most minor elements (0.1 to 1 percent).

In considering anomalously high values, the first consideration should be given to the possibility of contamination. We suspect that some of the Sonda samples have been contaminated by bromine (and other chemicals), perhaps from the drilling fluids. In U.S. coal the mean Br content is 17 ppm and the Cl/Br ratio is 36 to 1 (Finkelman, unpublished data). From Figure 5 it is evident that many Sonda coal samples are extraordinarily enriched in Br and that the Cl/Br ratios are exceptionally low. It is possible that some samples were contaminited with chlorine. However, the low Br content of many samples having Cl values in excess of 1,000 ppm (Fig. 5) indicates that, at least, these samples have inherently high Cl contents not attributable to contamination.

Sonda Samples Only nine elements (Ba, Co, Ho, In, Mn, Ni, W, Yb, and Zn) have maximum values that are greater than 10 times the mean. In every case the anomaly is due to a single sample with a concentration slightly more than 10 times the mean (Figs 6 a-c). None of these anomalies indicate potential for economic byproduct recovery or nearby mineralization.

Table 7. Examples of Anomalously High Element Concentrations in Coal

Element	Concentration	Location
Gold	4 ppm[1]	Wyoming
Silver	66 ppm[2]	Texas
Arsenic	~2,000 ppm	Alabama
Selenium	90,000 ppm	China
Zinc	51,000 ppm	Missouri

1 - At $400 per ounce for gold this concentration is worth about $50 per ton of coal.
2 - At $6 per ounce for silver this concentration is worth about $13 per ton of coal.

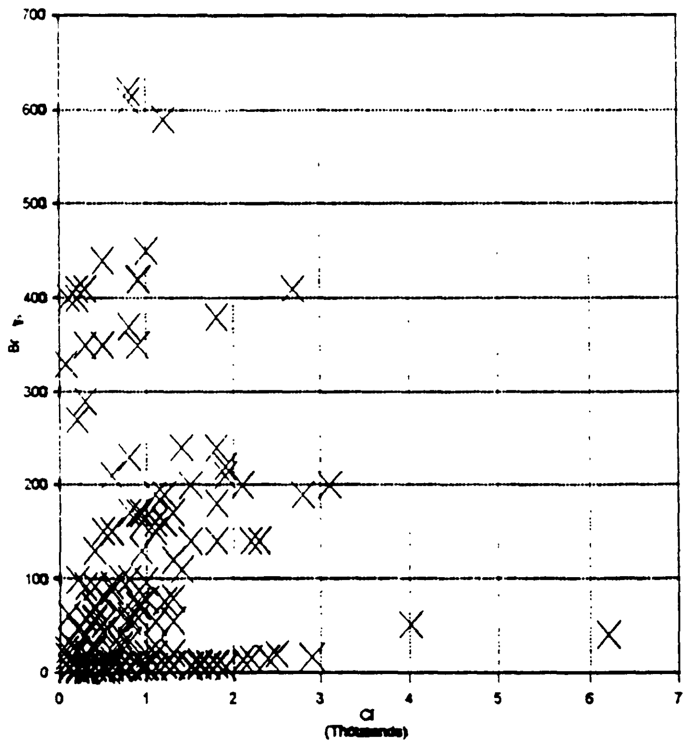

Figure 5. Cl versus Br concentrations in coal samples from the Sonda Coal Field, Pakistan.

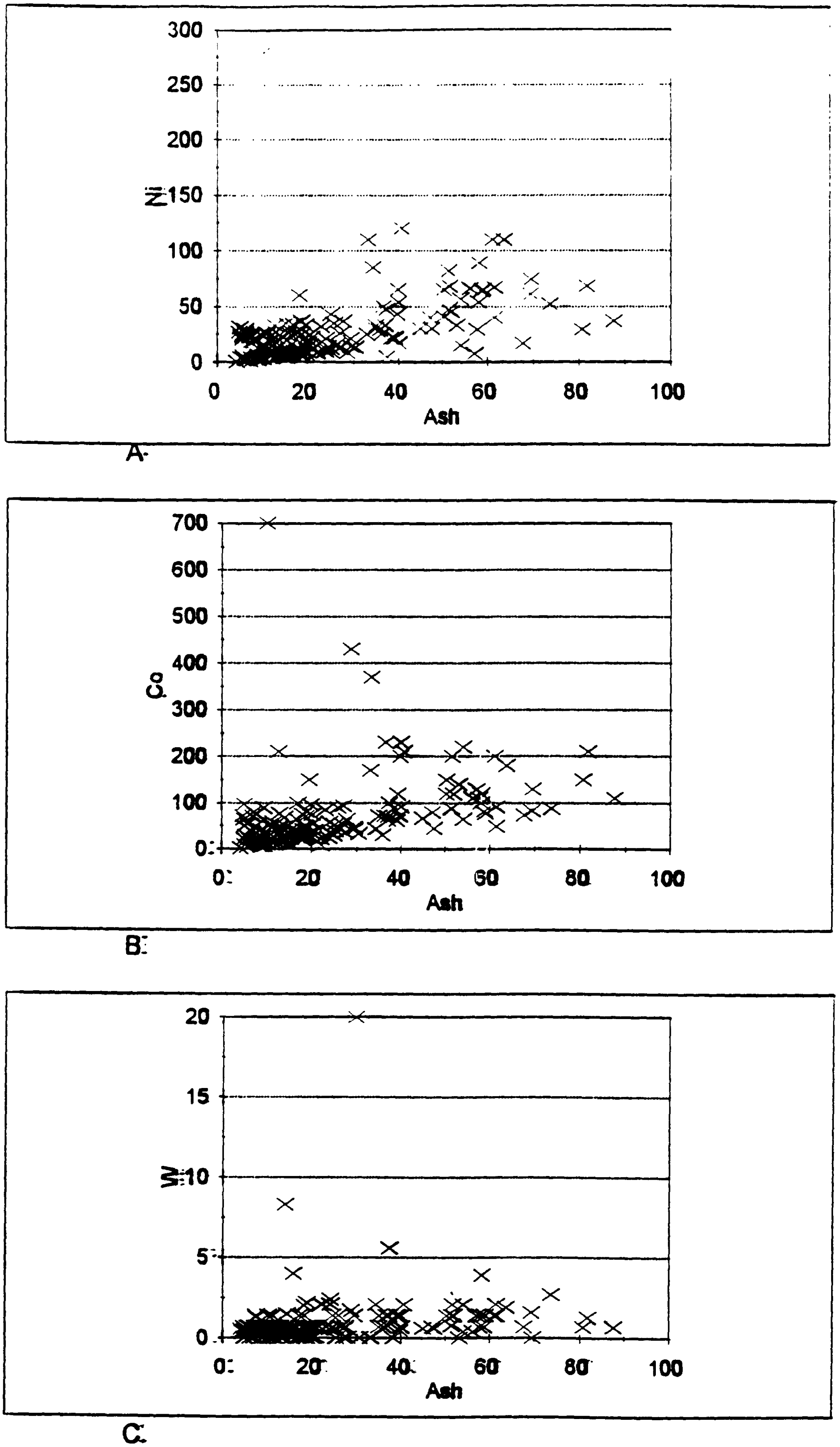

Figure 6. Ash yield vs Ni, Co, W

Geologic Significance of the Inorganic Constituents

There have been numerous attempts to use trace element concentrations in coal as indicators of depositional environments. Most commonly these studies have sought evidence of marine influence on the coal (Goodarzi, 1987; 1988; Swaine, 1983; Chou, 1984; Hart and Leahy, 1983). Among the elements cited as indicators of marine influence are molybdenum, magnesium, boron, chlorine, bromine, sodium, yttrium, and uranium. However, because of problems such as the blurring effect of brackish environments, reworking of sediments, and post-depositional enrichment or leaching, the data are equivocal and there does not appear to be a universal consensus as to a reliable indicator.

There has also been several attempts to use trace element concentrations to correlate coal beds (Butler, 1953; Alpern and Morel, 1968; O'Gorman, 1971; Nichols and D'Auria, 1981; Swaine, 1983; Cebulak, 1984; O'Connor, 1988). Significant vertical and lateral variation of the trace element concentrations within coal beds has limited the success of these attempts. Finkelman (1981) suggested that the selection of elements for such usage is critical. Elements that have a tendency for organic complexing (e.g. boron, germanium, beryllium), for sulfide complexing (zinc, copper, lead), or that are soluble in water or dilute acids (sodium, magnesium, potassium, manganese, calcium) would be poor candidates for correlating coal beds, but those which form relatively inert minerals (zirconium, hafnium, niobium, tantalum, cesium, scandium) should be preferred. The concentrations or ratios of these elements would not be as significantly affected by changes in Eh and pH, rate of detrital influx, changes in plant or bacterial communities, availability of sulfide ions, etc. However, recent studies indicate that in many coal samples even these elements behave in unanticipated ways. Thus it has been determined that hafnium is readily leached from many coal samples by hydrofluoric acid and that cesium is largely removed by nitric acid (Finkelman and others, 1990).

Sources for the Inorganic Constituents - The inorganic constituents in coal can be derived from a number of sources (Finkelman, 1981; Lindahl and Finkelman, 1986). In most coals with ash yields greater than about 15 percent, water-borne detrital material was the primary source. In coals with ash yields less than about 8 weight percent biological input may have been dominant. This could be due to minerals or elements associated with the original plant material, elements complexed by decaying organic matter in the swamp, or elements adsorbed by the coal from ground water.

Air-borne volcanic detritus can be a major source of trace elements in some coals, especially Cretaceous western U. S. coal (Bohor and others, 1979; Crowley and others, 1989). It is widely believed that Pennsylvanian coal from the eastern U. S. experienced little volcanic input. However, recent work by Lyons and others (1990) indicate that volcanic input in Appalachian coals may be significant. Wind-blown dust and cosmic dust occur in all coals but generally are of minor significance. Volcanic ash falls preserved in the coal (tonsteins) have been used for age dating and for correlation of Pennsylvanian age coals (Lyons and others., 1992).

Epigenetic mineralization, the deposition of minerals such as sulfides (pyrite, sphalerite, galena), carbonates (calcite, siderite), and kaolinite in cleat and fractures, is common in many coals. Epigenetic mineralization is particularly notable in coals from the U. S. mid-continent region which exhibit greatly enhanced contents of chalcophile elements, such as zinc, lead, and cadmium (Gluskoter and Lindahl, 1973; Hatch and others, 1976a; 1976b; Cobb and others, 1980).

Sonda samples - Scanning electron microscopy of several Sonda samples indicated the presence of minerals and textures that may be due to a volcanic ash fall. If this can be confirmed, perhaps minerals, such as sanidine, in the tonsteins can be used for age dating and correlation of the coal beds in the Sonda area.

In striving for uniform coal production quality it is common practice to examine the vertical and lateral distribution of the inorganic constituents in coal. In the Sonda coal samples there is such an exceptionally strong correlation (both positive and negative) of element concentration with ash yield, (Table 8) that it only is necessary to track the variation of ash yield to obtain a good estimate of the concentration of most inorganic constituents.

MODES OF OCCURRENCE

Information on variations in element content, however useful, provides only a partial picture of the potential behavior of the trace elements in coal. The picture can be brought into better focus if we know the modes of occurrence of the elements in coal. It is the mode of occurrence of an element that may determine its technological behavior, environmental impact, economic potential, and reveal its geologic significance.

The classic example is that of sulfur. It has long been known that sulfur in coal occurs in sulfides, sulfates, and in organic associa-

Table 8. Correlation coefficients (r) for correlations of element concentrations with ash yield from 175 coal samples obtained from the Sonda coal field, Pakistan. (values are statistically significant at 95% confidence limit)

Element	r
SI	0.96
AL	0.94
CA	-0.21
MG	0.12
NA	-0.33
K	0.81
FE	0.68
TI	0.90
AG	0.74
AS	0.54
B	0.52
BA	0.26
BE	0.17
BR	0.07
CD	0.52
CE	0.83
CL	-0.21
CO	0.46
CR	0.82
CS	0.59
CU	0.79
DY	0.99
EU	0.79
F	0.36
GA	0.48
GD	0.97
GE	0.05
HF	0.80
HG	0.20
HO	0.37
LA	0.83
LI	0.88
LU	0.61
MN	0.56
MO	0.51
NB	0.79
ND	0.78
NI	0.39
P	0.76
PB	0.54
PR	0.87
SB	0.46
SC	0.79
SE	0.15
SM	0.81
SN	0.65
SR	-0.60
TA	0.79
TB	0.77
TH	0.83
U	0.73
V	0.81
W	0.14
Y	0.40
YB	0.62
ZN	0.38
ZR	0.83

tion. Each form of sulfur responds differently to physical, chemical, and biological processes. Even this classification is a gross over-simplification. It is now known that elemental sulfur may exist in some coal (Duran and others, 1986), that almost 30 different sulfide minerals have been identified as occurring in coal (Finkelman, 1992), and that coal contains a complex suite of organic sulfur compounds (Casagrande, 1987).

Many other elements exist in coal in a variety of forms. For example, Dreher and Finkelman (1992) found that selenium in Powder River Basin coal occurred in selenium-bearing pyrite, organically-bound selenium, selenium-bearing sphalerite, lead selenide, water soluble selenium, and ion-exchangeable selenium.

There has been considerable work to determine the modes of occurrence of the elements in coal. Table 9 contains a list of the more likely modes of occurrence for selected elements in coal. Most efforts to determine the modes of occurrence have been qualitative. Future efforts will have to focus on ways to quantify the results.

One practical consequence of knowing the modes of occurrence of the elements in coal is the ability to anticipate how effectively the undesirable inorganic constituents can be physically or chemically removed.

Determining the modes of occurrence of the elements in coal is still more of an art than a science. The tools (for example, scanning electron microscopy, X-ray diffraction) and procedures (selective leaching and heating) used in this endeavor are described by Finkelman and Gluskoter, 1983 , Finkelman et al. 1990, and Swaine, 1990.

Conclusions

Critically evaluating the inorganic geochemistry of a suite of coal samples can provide valuable insights into the coal's potential environmental impact, technological behavior, economic byproduct potential, and geologic significance. Being aware of these potential problems and benefits prior to mining allows for the most efficient and cost effective methods of minimizing the problems and taking advantage of the benefits.

Although we have learned much about coal geochemistry, there is still much to be learned (Finkelman, 1990).

Sonda samples: Analyses of the Sonda coal samples indicates that they may have a tendency to cause fouling and slagging problems in conventional boilers. There seems to be little cause for concern about abrasion of mining equipment. There may be a significant potential for serious selenium pollution due to coal combustion. The combination of relatively high selenium concentrations in these coals, a semiarid environment, and the abundance of grazing animals is a situation that bears watching. No other environmental problems were evident, nor does there appear to be a likelihood for economic byproduct recovery from these coals or their combustion products.

Table 9. Probable Modes of Occurrence of Selected Elements in Coal*

Aluminium	- clays, feldspars, perhaps some organic association
Antimony	— accessory sulfide, some organic association
Arsenic	— solid solution in pyrite
Barium	— barite, crandallite, organic association in low-rank coal
Beryllium	— organic association, clay
Bismuth	— accessory sulfide
Boron	— organic association, illite
Bromine	— organic association
Cadmium	— sphalerite
Calcium	— calcite, organic assoc., sulphates, phosphates, silicates
Cesium	— clays, feldspar, mica
Chlorine	— organic association
Chromium	— clays (?)
Cobalt	— assessory sulfides, pyrite
Copper	— chalcopyrite
Fluorine	— perhaps apatite, clays, mica, amphiboles
Gallium	— clays, organics, sulfides
Germanium	— organic association
Gold	— native gold
Hafnium	— zircon
Indium	— probably sulfides
Iodine	— probably organic association
Iron	— pyrite, siderite, sulfates, oxides, some organic assoc.
Lead	— galena, PbSe
Lithium	— clays
Magnesium	— clays

Manganese	- siderite, calcite
Mercury	- solid solution with pyrite
Molybdenum	- unclear; perhaps with sulfides or organics
Nickel	- unclear; perhaps sulfides, organics, or clay
Niobium	- oxides
Phosphorus	- phosphates
Platinum	- native alloys, perhaps some organic association
Rare-earths	- phosphates, some organic association
Rubidium	- probably illite
Scandium	- unclear; clays, phosphates, or organics
Selenium	- organic association, pyrite, PbSe
Silicon	- quartz, clays, silicates
Silver	- perhaps silver sulfides
Sodium	- organic association, clays, zeolites, silicates
Strontium	- carbonates, phosphates, organic association
Tantalum	- oxides
Tellurium	- unclear
Thorium	- rare-earth phosphates
Tin	- inorganic: tin oxides or sulfides
Titanium	- oxides, clays, some organic association
Tungsten	- oxides, organic association
Uranium	- organic association, zircon
Vanadium	- clays, perhaps some organic association
Yttrium	- rare-earth phosphates
Zinc	- sphalerite
Zirconium	- zircon

*- Modified from Finkelman, 1982

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APPENDICES

Appendix A - Cross reference of field sample and lab numbers

Appendix B - Major and minor oxide concentrations

Appendix C - Major minor and trace element concentrations

Appendix D - Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index and ash fusion temperatures

Appendix E - Mean, maximum and minimum values for coal quality parameters

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Appendix A.--Field numbers (point id) and lab sample numbers cross-referenced for 191 coal samples obtained from Sonda Coal Field, Sindh Province, Pakistan.

Sample Numbers	Point id.	District	Formation	Bed
W241087	UAS-2-1	THATTA	BARA	INAYATABAD
W241088	UAS-2-2	THATTA	BARA	SONDA MAIN
W241089	UAS-2-3	THATTA	BARA	SONDA LOWER MAIN
W241090	UAS-1-1	THATTA	BARA	SONDA UPPER
W241091	UAS-1-2	THATTA	BARA	SONDA MAIN
W241092	UAS-1-3	THATTA	BARA	SONDA MAIN
W241093	UAS-1-4	THATTA	BARA	SONDA MAIN
W241094	UAS-4-1	THATTA	BARA	INAYATABAD
W241095	UAS-4-2A	THATTA	BARA	SONDA MAIN
W241096	UAS-4-2B	THATTA	BARA	SONDA MAIN
W241097	UAS-4-2C	THATTA	BARA	SONDA MAIN
W241098	UAS-4-2D	THATTA	BARA	SONDA MAIN
W241099	UAS-4-2E	THATTA	BARA	SONDA MAIN
W241100	UAS-4-2F	THATTA	BARA	SONDA MAIN
W241101	UAS-4-3	THATTA	BARA	SONDA MAIN
W241102	UAS-4-4	THATTA	BARA	SONDA LOWER MAIN
W241103	UAS-4-5	THATTA	BARA	WASSI
W241104	UAS-5-1	THATTA	BARA	SONDA UPPER
W241105	UAS-5-2	THATTA	BARA	SONDA MAIN
W241106	UAS-5-4	THATTA	BARA	SONDA MAIN
W241107	UAS-5-7	THATTA	BARA	SONDA LOWER MAIN
W241108	UAS-5-9	THATTA	BARA	SONDA LOWER MAIN
W241109	UAS-5-12	THATTA	BARA	WASSI
W241110	UAS-5-14	THATTA	BARA	LOWER STRAY
W241111	UAS-8-1	THATTA	BARA	UPPER STRAY
W241112	UAS-8-2	THATTA	BARA	UPPER STRAY
W241113	UAS-8-3	THATTA	BARA	INAYATABAD
W241114	UAS-8-4	THATTA	BARA	INAYATABAD
W241115	UAS-8-5	THATTA	BARA	SONDA UPPER
W246426	UAS-8-6	THATTA	BARA	SONDA UPPER
W246427	UAS-8-7	THATTA	BARA	SONDA MAIN
W246428	UAS-8-8	THATTA	BARA	SONDA LOWER MAIN
W246528	UAT-10-1	THATTA	BARA	SONDA MAIN
W241116	UAT-1-1	THATTA	BARA	SONDA MAIN
W241117	UAT-8-1	THATTA	BARA	SONDA MAIN
W241118	UAT-8-2	THATTA	BARA	JHERRUCK
W241119	UAT-4-1	THATTA	BARA	SONDA LOWER
W241120	UAT-4-2	THATTA	BARA	JHERRUCK
W241121	UAT-4-3	THATTA	BARA	JHERRUCK
W241122	UAT-4-4	THATTA	BARA	JHERRUCK
W241123	UAT-2-1	THATTA	BARA	SONDA MAIN
W241022	UAK-1-1	HYDERABAD	BARA	UPPER STRAY
W241023	UAK-1-2	HYDERABAD	BARA	SONDA UPPER
W241024	UAK-1-3	HYDERABAD	BARA	SONDA UPPER
W241025	UAK-1-4	HYDERABAD	BARA	SONDA UPPER
W241026	UAK-1-5	HYDERABAD	BARA	SONDA UPPER
W241027	UAK-1-6	HYDERABAD	BARA	SONDA MAIN
W241028	UAK-1-7	HYDERABAD	BARA	NDE
W246430	UAS-9-2	HYDERABAD	BARA	SONDA UPPER

Appendix A.--Field numbers (point id) and lab sample numbers cross-referenced for 191 coal samples obtained from Sonda Coal Field, Sindh Province, Pakistan.

Sample Numbers	Point id.	District	Formation	Bed
W246431	UAS-9-3	HYDERABAD	BARA	SONDA MAIN
W246432	UAS-9-4	HYDERABAD	BARA	SONDA MAIN
W246433	UAS-9-5	HYDERABAD	BARA	SONDA LOWER MAIN
W246437	UAK-2-1A	HYDERABAD	BARA	SONDA UPPER
W246438	UAK-2-1B	HYDERABAD	BARA	SONDA MAIN
W246439	UAK-2-2A	HYDERABAD	BARA	SONDA MAIN
W246440	UAK-2-2B	HYDERABAD	BARA	SONDA MAIN
W246441	UAK-2-2C	HYDERABAD	BARA	SONDA MAIN
W246442	UAK-2-2D	HYDERABAD	BARA	NDE
W246443	UAK-2-3	HYDERABAD	BARA	WASSI
W246429	UAS-9-1	HYDERABAD	BARA	SONDA UPPER
W246435	UAK-1-8	HYDERABAD	BARA	WASSI
W246436	UAK-1-9	HYDERABAD	BARA	LOWER STRAY
W246434	UAS-9-6	THATTA	BARA	WASSI
W246444	UAK-3-1	HYDERABAD	BARA	SONDA UPPER
W246445	UAK-3-2A	HYDERABAD	BARA	SONDA UPPER
W246446	UAK-3-2B	HYDERABAD	BARA	SONDA UPPER
W246447	UAK-3-3A	HYDERABAD	BARA	SONDA MAIN
W246448	UAK-3-3B	HYDERABAD	BARA	SONDA MAIN
W237524	IS-DH-22-1-85	THATTA	BARA	SONDA MAIN
W237525	IS-DH-22-2-85	THATTA	BARA	SONDA MAIN
W237526	IS-DH-23-1-85	THATTA	BARA	SONDA MAIN
W237527	IS-DH-24-1-86	THATTA	BARA	SONDA MAIN
W246127	UAK-4-1	HYDERABAD	BARA	UPPER STRAY
W246128	UAK-4-2	HYDERABAD	BARA	SONDA UPPER
W246129	UAK-4-3	HYDERABAD	BARA	SONDA MAIN
W246130	UAK-5-2	HYDERABAD	BARA	SONDA UPPER
W246131	UAK-5-3	HYDERABAD	BARA	SONDA LOWER MAIN
W246132	UAK-5-4	HYDERABAD	BARA	SONDA LOWER MAIN
W246137	UAK-6-1	HYDERABAD	LAKI	SOHNARI
W246138	UAK-6-2	HYDERABAD	BARA	UPPER STRAY
W246139	UAK-7-3	HYDERABAD	BARA	INAYATABAD
W246140	UAK-8-1	HYDERABAD	BARA	UPPER STRAY
W246141	UAK-8-2	HYDERABAD	BARA	UPPER STRAY
W246142	UAK-10-2	HYDERABAD	BARA	SONDA MAIN
W246143	UAK-10-3	HYDERABAD	BARA	SONDA MAIN
W246144	UAK-10-4	HYDERABAD	BARA	SONDA MAIN
W246145	UAK-10-5	HYDERABAD	BARA	SONDA MAIN
W246146	UAK-10-6	HYDERABAD	BARA	UPPER STRAY
W246147	UAK-10-7	HYDERABAD	BARA	UPPER STRAY
W246148	UAK-10-8	HYDERABAD	BARA	UPPER STRAY
W246149	UAK-11-1	HYDERABAD	BARA	UPPER STRAY
W246150	UAK-11-2	HYDERABAD	BARA	SONDA MAIN
W246133	UAK-5-5	HYDERABAD	BARA	SONDA MAIN
W246134	UAK-5-6	HYDERABAD	BARA	SONDA MAIN
W246135	UAK-5-7	HYDERABAD	BARA	SONDA LOWER
W246136	UAK-5-8	HYDERABAD	BARA	SONDA MAIN
W246151	UAK-12-1	HYDERABAD	BARA	WASSI

Appendix A.--Field numbers (point id) and lab sample numbers cross-referenced for 191 coal samples obtained from Sonda Coal Field, Sindh Province, Pakistan.

Sample Numbers	Point id.	District	Formation	Bed
W246152	UAK-14-1	HYDERABAD	BARA	DADURI2
W246153	UAK-14-2	HYDERABAD	BARA	DADURI2
W246154	UAK-15-1	HYDERABAD	BARA	SONDA MAIN
W246155	UAK-15-2	HYDERABAD	BARA	SONDA MAIN
W246156	UAK-15-3	HYDERABAD	BARA	SONDA MAIN
W246157	UAK-15-4	HYDERABAD	BARA	SONDA MAIN
W246158	UAK-15-5	HYDERABAD	BARA	SONDA MAIN
W246159	UAK-15-6	HYDERABAD	BARA	SONDA MAIN
W246462	JK-3-2	NDE	BARA	SONDA MAIN
W246463	JK-3-3	NDE	BARA	SONDA MAIN
W246464	JK-3-4	NDE	BARA	SONDA LOWER MAIN
W246465	JK-4-2	NDE	BARA	INAYATABAD
W246466	JK-4-3	NDE	BARA	SONDA MAIN
W246467	JK-5-1	NDE	BARA	DADURI1
W246468	JK-5-2	NDE	BARA	DADURI2
W246469	JK-5-3	NDE	BARA	INAYATABAD
W246470	JK-5-4	NDE	BARA	SONDA MAIN
W246476	JK-7-1	NDE	BARA	DADURI1
W246477	JK-7-3	NDE	BARA	UPPER STRAY
W246478	JK-7-6	NDE	BARA	SONDA UPPER
W246479	JK-7-7	NDE	BARA	LOWER STRAY
W246480	JK-7-8	NDE	BARA	LOWER STRAY
W246482	JK-8-1	NDE	BARA	INAYATABAD
W246481	JK-8-CS-1	NDE	BARA	NDE
W246483	JK-8-CS-2	NDE	BARA	NDE
W246485	JK-8-CS-3	NDE	BARA	NDE
W246486	JK-8-3	NDE	BARA	SONDA LOWER MAIN
W246484	JK-8-2	NDE	BARA	SONDA MAIN
W246487	JK-9-1	NDE	BARA	DADURI1
W246488	JK-9-3	NDE	BARA	SONDA MAIN
W246489	JK-9-4	NDE	BARA	SONDA MAIN
W246509	JK-14-A	NDE	BARA	SONDA UPPER
W246510	JK-14-B1	NDE	BARA	SONDA MAIN
W246160	UAK-16-4	HYDERABAD	BARA	SONDA LOWER MAIN
W246449	JK-1-1-88	NDE	BARA	DADURI2
W246450	JK-1-2-88	NDE	BARA	SONDA UPPER
W246451	JK-1-3-88	NDE	BARA	SONDA UPPER
W246452	JK-1-4-88	NDE	BARA	SONDA UPPER
W246453	JK-1-6-88	NDE	BARA	SONDA MAIN
W246454	JK-1-7-88	NDE	BARA	WASSI
W246455	JK-2-1-88	NDE	BARA	DADURI1
W246456	JK-2-2-88	NDE	BARA	SONDA MAIN
W246457	JK-2-3-88	NDE	BARA	SONDA LOWER MAIN
W246458	JK-2-4-88	NDE	BARA	SONDA LOWER MAIN
W246459	JK-3-1	NDE	BARA	INAYATABAD
W246460	JK-3-1A	NDE	BARA	INDYATABAD
W246461	JK-3-1B	NDE	BARA	UPPER STRAY
W246471	JK-6-1-88	NDE	BARA	SONDA UPPER

Appendix A.--Field numbers (point id) and lab sample numbers cross-referenced for 191 coal samples obtained from Sonda Coal Field, Sindh Province, Pakistan. cross-referenced.

Sample, Numbers	Point id.	District	Formation	Bed
W246472	JK-6-2-88	NDE	BARA	SONDA MAIN
W246473	JK-6-3-88	NDE	BARA	SONDA LOWER MAIN
W246474	JK-6-4-88	NDE	BARA	SONDA LOWER MAIN
W246475	JK-6-5-88	NDE	BARA	SONDA LOWER
W246490	JK-10-2	NDE	BARA	UPPER STRAY
W246491	JK-10-A	NDE	BARA	UPPER STRAY
W246492	JK-10-B	NDE	BARA	INAYATABAD
W246493	JK-10-C1	NDE	BARA	SONDA MAIN
W246494	JK-10-C1A	NDE	BARA	SONDA MAIN
W246495	JK-10-C2	NDE	BARA	SONDA MAIN
W246496	JK-10-C3	NDE	BARA	SONDA MAIN
W246497	JK-10-D	NDE	BARA	SONDA LOWER MAIN
W246498	JK-11-1	NDE	BARA	INAYATABAD
W246499	JK-11-2A	NDE	BARA	SONDA MAIN
W246500	JK-11-2B	NDE	BARA	SONDA MAIN
W246501	JK-12-1	NDE	BARA	DADURI1
W246502	JK-12-2	NDE	BARA	DADURI2
W246503	JK-12-3	NDE	BARA	DADURI2
W246504	JK-12-4	NDE	BARA	DADURI2
W246505	JK-12-5	NDE	BARA	UPPER STRAY
W246506	JK-12-6	NDE	BARA	UPPER STRAY
W246507	JK-12-7	NDE	BARA	UPPER STRAY
W246508	JK-12-8	NDE	BARA	SONDA MAIN
W246511	JK-14-CS	NDE	BARA	NDE
W246512	JK-14-B2	NDE	BARA	SONDA MAIN
W246513	JK-14-B3	NDE	BARA	SONDA MAIN
W246514	JK-20-1	NDE	BARA	DADURI1
W246515	JK-20-2AP	NDE	BARA	SONDA MAIN
W246516	JK-20-2BC	NDE	BARA	SONDA MAIN
W246517	JK-20-3	NDE	BARA	SONDA MAIN
W250660	JK-13.1	NDE	BARA	SONDA UPPER
W250661	JK-13.2	NDE	BARA	SONDA UPPER
W250658	JK-16.10	NDE	BARA	WASSI
W250659	JK-16.11	NDE	BARA	WASSI
W250656	JK-18.8	NDE	BARA	SONDA UPPER
W250657	JK-18.9	NDE	BARA	SONDA UPPER
W250662	JK-19.4	NDE	BARA	SONDA MAIN
W250663	JK-19.5	NDE	BARA	SONDA MAIN
W250664	JK-19.6	NDE	BARA	SONDA MAIN
W250665	JK-19.7	NDE	BARA	SONDA MAIN
W250666	JK-19.8	NDE	BARA	SONDA MAIN
W250667	JK-19.9	NDE	BARA	SONDA MAIN
W250668	JK-19.10	NDE	BARA	SONDA MAIN
W250669	JK-19.11	NDE	BARA	SONDA MAIN
W250670	JK-19.12	NDE	BARA	SONDA MAIN
W250671	JK-19.13	NDE	BARA	SONDA MAIN

Appendix B. --Ash yields, major- and minor- oxides concentrations in the laboratory ash of 175 coal samples in Pakistan regions.

[Values in percent, dry basis. Coal ashed at 525°C. L means less than the value shown; H, interference for an element which cannot be resolved by any routine method; G greater than; B not determined; S, after element title indicates determinations by automatic plate reading computer assisted, emission spectrographic analyses. The standard deviation of any single answer should be taken as plus 50% and minus 33%. Sampes W250656 to W250671 were not analyzed using these methods.]

SAMPLE NUMBER	ASH (PERCENT)	SIO2 (PERCENT)	AL2O3 (PERCENT)	CAO (PERCENT)	MGO (PERCENT)	NA2O (PERCENT)	K2O (PERCENT)	FE2O3 (PERCENT)	TIO2 (PERCENT)	P2O5 (PERCENT)	SO3 (PERCENT)	SAMPLE NUMBER
W241087	12.3	26	19	7.0	2.8	4.3	0.28	19	2.8	0.081L	19	W241087
W241088	14.9	43	7.0	5.5	2.3	3.0	.22	23	.83	.067L	16	W241088
W241089	51.5	37	26	1.1	.66	.51	.26	25	3.5	.039	5.1	W241089
W241090	14.2	24	10	5.4	2.5	5.9	.23	32	1.9	.070L	21	W241090
W241091	39.8	42	31	1.4	.78	1.6	.25	13	2.4	.025L	5.1	W241091
W241092	8.5	14	10	8.6	4.3	5.9	.25	22	1.4	.12L	34	W241092
W241093	14.5	22	14	4.5	2.2	4.7	.23	31	2.2	.069L	17	W241093
W241094	6.2	19	8.3	11	4.6	12	.29	16	.91	.16L	38	W241094
W241095	9.8	12	8.6	7.3	2.5	6.5	.23	39	1.2	.10L	27	W241095
W241096	5.8	12	5.0	14	5.5	13	.25	16	.57	.17L	42	W241096
W241097	4.3	12	4.8	17	6.1	16	.27	8.2	.32	.23L	38	W241097
W241098	4.4	13	5.8	18	7.0	18	.28	8.3	.27	.23L	35	W241098
W241099	5.3	11	12	15	6.5	13	.26	9.0	.97	.19L	46	W241099
W241100	18.9	32	26	6.3	2.0	5.4	.22	9.0	4.1	.053L	15	W241100
W241101	17.1	31	18	4.1	1.2	3.4	.36	26	3.1	.058L	14	W241101
W241102	7.9	24	13	10	2.5	7.8	.23	18	2.1	.13L	26	W241102
W241103	20.2	39	31	3.6	1.5	2.2	.24	6.6	2.5	.050L	8.2	W241103
W241104	24.5	25	17	2.7	1.1	2.0	.27	39	2.8	.041L	12	W241104
W241105	9.0	18	15	8.3	3.0	7.3	.21	24	1.4	.11L	25	W241105
W241106	39.0	45	32	1.6	.66	1.3	.21	8.7	3.7	.026	4.4	W241106
W241107	17.9	27	14	4.3	1.4	2.7	.23	32	3.6	.056L	16	W241107
W241108	23.0	39	29	2.9	1.1	2.2	.23	14	2.6	.043L	6.0	W241108
W241109	15.1	29	21	5.4	1.6	2.6	.31	24	2.3	.066L	17	W241109
W241110	15.0	20	10	5.3	2.5	1.8	.33	43	1.3	.067L	16	W241110
W241111	11.6	20	10	6.5	3.3	3.6	.24	26	2.9	.086L	26	W241111
W241112	18.8	27	18	3.5	1.3	3.8	.25	29	2.1	.053L	16	W241112
W241113	29.5	33	19	2.2	1.1	2.4	.36	29	2.8	.034L	7.9	W241113
W241114	9.0	18	12	7.6	3.0	8.5	.38	23	1.4	.11L	30	W241114
W241115	40.1	46	30	3.6	.88	1.5	.36	9.1	2.2	.050	6.5	W241115
W246426	23.8	39	22	3.1	1.2	3.0	.34	20	2.8	.084	7.7	W246426
W246427	18.7	40	31	3.9	1.4	3.5	.20	9.0	2.4	.11	8.3	W246427
W246428	24.9	31	13	2.9	.91	2.0	.22	39	2.2	.040	9.7	W246428
W246528	13.4	16	9.9	4.7	2.2	4.5	.19	44	1.2	.075L	18	W246528
W241116	37.2	45	31	1.1	.86	3.1	.31	9.0	3.1	.054	4.4	W241116
W241117	35.0	39	24	1.2	.40	2.2	.30	25	2.8	.029L	4.0	W241117
W241118	50.4	47	25	.63	.20	1.1	.25	19	3.5	.020L	1.8	W241118
W241119	25.8	13	8.1	25	1.0	1.8	.13	18	1.3	.078	36	W241119
W241120	61.1	56	29	.59	.22	1.1	.39	4.7	3.9	.049	1.2	W241120
W241121	39.9	45	32	.89	.27	2.0	.29	15	2.3	.025	2.8	W241121
W241122	40.7	40	33	1.0	.27	1.8	.27	17	2.0	.049	2.3	W241122

Appendix B. --Ash yields, major- and minor- oxides concentrations in the laboratory ash of 175 coal samples in Pakistan regions.--continued

SAMPLE NUMBER	ASH (PERCENT)	SIO2 (PERCENT)	AL2O3 (PERCENT)	CAO (PERCENT)	MGO (PERCENT)	NA2O (PERCENT)	K2O (PERCENT)	FE2O3 (PERCENT)	TIO2 (PERCENT)	P2O5 (PERCENT)	SO3 (PERCENT)	SAMPLE NUMBER
W241123	29.3	37	20	1.3	0.32	2.2	0.19	31	2.3	0.068	4.4	W241123
W241022	27.3	38	25	2.3	.60	3.0	.24	18	2.7	.037L	8.1	W241022
W241023	20.9	29	23	3.2	.75	3.8	.29	24	2.4	.048L	9.8	W241023
W241024	58.8	33	26	.68	.13	.84	.27	26	2.8	.034	7.1	W241024
W241025	22.2	11	8.2	10	.65	3.1	.14	41	.81	.045L	29	W241025
W241026	34.9	33	28	1.7	.32	2.0	.24	26	2.9	.029	6.6	W241026
W241027	9.2	12	6.8	9.0	1.5	6.1	.23	31	1.7	.11L	30	W241027
W241028	59.0	37	25	.77	.13	.81	.23	23	4.8	.017	4.5	W241028
W246430	15.9	33	20	4.1	1.3	5.9	.20	20	2.2	.063	13	W246430
W246431	20.6	46	28	3.0	1.3	4.9	.53	4.6	3.3	.097	5.8	W246431
W246432	13.2	26	12	6.4	1.6	6.8	.24	24	3.3	.076	19	W246432
W246433	11.1	29	20	5.8	1.7	8.8	.21	17	2.2	.090L	18	W246433
W246437	9.6	10	3.4	7.0	3.0	9.9	.18	39	.54	.10L	30	W246437
W246438	7.4	24	11	11	3.7	11	.28	12	2.8	.14L	24	W246438
W246439	5.9	17	8.5	14	4.8	16	.28	11	.72	.17L	26	W246439
W246440	5.3	21	12	16	5.3	19	.30	4.8	.91	.19L	15	W246440
W246441	8.8	36	23	8.8	3.5	12	.25	2.7	3.3	.11L	7.4	W246441
W246442	50.4	51	30	1.1	.53	1.6	.16	4.7	6.0	.060	2.2	W246442
W246443	18.5	38	25	1.0	.53	1.3	.23	25	3.4	.16	6.0	W246443
W246429	26.3	48	16	2.4	.90	3.6	.17	16	4.7	.038	7.8	W246429
W246435	39.3	38	26	1.6	.50	1.6	.27	22	3.3	.051	4.7	W246435
W246436	19.5	18	9.1	3.6	.61	3.4	.13	51	1.2	.051	13	W246436
W246434	9.4	17	8.8	7.3	1.8	8.9	.19	32	.71	.11L	24	W246434
W246444	13.1	35	24	4.3	.88	4.2	.22	18	2.9	.15	9.4	W246444
W246445	36.5	39	30	6.1	1.2	6.1	.33	6.0	2.0	.027	8.8	W246445
W246446	6.2	48	27	2.1	.63	2.4	.19	5.8	7.5	.48	3.9	W246446
W246447	5.0	21	9.1	16	2.3	13	.31	5.6	8.3	.20	25	W246447
W246448	12.9	12	3.0	18	2.7	16	.36	14	.62	.078	37	W246448
W237524	19.4	28	21	4.6	1.7	2.3	.22	21	3.6	.052L	11	W237524
W237525	20.5	36	27	5.4	1.6	2.0	.23	9.2	2.8	.049L	9.0	W237525
W237526	10.4	24	20	9.5	2.8	6.3	.22	12	1.3	.096L	22	W237526
W237527	11.2	18	13	9.1	3.5	2.7	.18	22	2.3	.089L	20	W237527
W246127	9.0	19	5.1	7.8	3.2	13	.25	22	.86	.11L	31	W246127
W246128	16.9	39	25	3.8	1.7	6.6	.32	9.8	2.4	.059L	9.8	W246128
W246129	17.7	42	21	5.3	1.3	5.9	.21	8.0	3.4	.056L	9.4	W246129
W246130	20.2	36	24	3.6	1.1	4.9	.19	14	3.7	.050	8.3	W246130
W246131	13.2	30	19	5.9	1.3	6.6	.25	18	1.5	.076L	16	W246131
W246132	20.2	22	15	3.6	.71	3.8	.12	40	3.0	.050	14	W246132
W246137	26.9	34	17	2.9	1.2	4.6	.14	25	3.6	.037	12	W246137
W246138	9.2	24	13	7.7	1.7	10	.30	19	1.9	.11L	26	W246138

Appendix B. --Ash yields, major- and minor- oxides concentrations in the laboratory ash of 175 coal samples in Pakistan regions.--continued

SAMPLE NUMBER	ASH (PERCENT)	SIO2 (PERCENT)	AL2O3 (PERCENT)	CAO (PERCENT)	MGO (PERCENT)	NA2O (PERCENT)	K2O (PERCENT)	FE2O3 (PERCENT)	TIO2 (PERCENT)	P2O5 (PERCENT)	SO3 (PERCENT)	SAMPLE NUMBER
W246139	25.2	34	24	3.2	0.58	2.8	0.19	25	3.2	0.040	7.4	W246139
W246140	27.7	37	27	2.9	.52	2.8	.20	19	3.7	.036	6.4	W246140
W246141	69.6	42	28	.65	.25	.68	.18	20	4.3	.029	3.5	W246141
W246142	7.1	15	7.7	13	2.3	15	.27	17	.70	.14L	33	W246142
W246143	5.1	9.9	5.0	18	6.0	19	.31	9.2	.42	.20L	33	W246143
W246144	4.8	12	7.8	18	.90	19	.33	7.6	.82	.21L	32	W246144
W246145	19.9	38	24	5.1	.91	4.2	.16	12	6.6	.050L	9.1	W246145
W246146	33.2	34	24	2.0	.71	2.0	.18	30	2.2	.030L	4.0	W246146
W246147	10.3	9.3	2.8	9.5	2.5	8.1	.15	43	.41	.097L	25	W246147
W246148	7.3	9.6	3.4	13	3.3	19	.20	25	.85	.14L	38	W246148
W246149	15.6	20	10	4.8	1.7	5.8	.19	35	3.6	.064L	21	W246149
W246150	30.4	60	11	2.5	.65	2.8	.18	15	1.5	.033L	7.2	W246150
W246133	10.3	25	15	6.0	1.5	7.7	.19	22	1.7	.097L	20	W246133
W246134	38.2	46	33	1.4	.63	2.3	.26	8.0	2.8	.052	3.5	W246134
W246135	13.2	29	21	5.6	1.1	6.5	.20	19	2.7	.076L	16	W246135
W246136	32.9	11	3.7	1.3	.27	1.8	.06	69	.41	.030L	12	W246136
W246151	18.8	30	20	3.9	.61	3.2	.13	18	4.0	.053L	7.2	W246151
W246152	11.2	20	8.7	6.8	2.8	6.1	.16	24	2.1	.089L	18	W246152
W246153	53.2	42	30	1.1	.63	1.0	.22	17	4.1	.056	2.1	W246153
W246154	6.3	22	14	13	3.3	18	.31	5.8	.93	.16L	23	W246154
W246155	13.7	37	29	5.7	1.6	8.2	.22	5.3	2.2	.073L	9.2	W246155
W246156	5.2	16	12	14	4.0	23	.42	6.4	.60	.19L	24	W246156
W246157	16.8	38	29	9.7	1.4	6.8	.22	3.3	2.1	.060L	6.3	W246157
W246158	18.4	39	31	4.3	1.3	6.2	.19	5.8	3.2	.054	7.4	W246158
W246159	13.6	33	25	5.6	1.6	7.4	.19	12	2.0	.074L	14	W246159
W246462	67.7	59	21	.75	.47	.77	.66	7.0	4.7	.044	2.4	W246462
W246463	6.4	24	16	13	3.8	11	.23	4.7	2.1	.16L	19	W246463
W246464	15.8	33	26	5.1	1.4	3.8	.22	15	1.7	.063L	12	W246464
W246465	14.1	36	19	6.0	4.5	8.2	.22	11	3.1	.071L	14	W246465
W246466	6.8	17	9.8	13	4.5	7.2	.23	15	1.3	.15L	31	W246466
W246467	47.2	39	18	1.3	.95	.74	.27	27	2.9	.021	8.7	W246467
W246468	58.1	44	21	.89	.78	.63	.55	21	2.8	.034	5.7	W246468
W246469	13.0	20	12	6.2	2.7	2.0	.22	35	1.8	.077L	19	W246469
W246470	36.2	34	27	1.6	.88	.58	.23	25	3.1	.028	5.2	W246470
W246476	61.5	37	24	.61	.68	.63	.25	24	3.0	.033	6.9	W246476
W246477	34.2	45	31	2.3	1.1	1.6	.18	4.8	5.7	.058	4.7	W246477
W246478	51.7	37	25	.79	.55	.72	.16	24	3.1	.039	4.2	W246478
W246479	57.1	35	22	.64	.58	.41	.29	28	3.4	.035	5.2	W246479
W246480	37.4	36	24	1.6	.93	.70	.17	21	2.4	.027	4.1	W246480
W246482	18.2	36	17	4.4	1.8	3.8	.21	17	2.7	.055L	12	W246482

Appendix B. --Ash yields, major- and minor- oxides concentrations in the laboratory ash of 175 coal samples in Pakistan regions.--continued

SAMPLE NUMBER	ASH (PERCENT)	SIO2 (PERCENT)	AL2O3 (PERCENT)	CAO (PERCENT)	MGO (PERCENT)	NA2O (PERCENT)	K2O (PERCENT)	FE2O3 (PERCENT)	TIO2 (PERCENT)	P2O5 (PERCENT)	SO3 (PERCENT)	SAMPLE NUMBER
W246481	87.5	58	18	0.55	0.56	0.45	0.61	13	3.6	0.069	2.3	W246481
W246483	81.7	52	29	.24	.42	.54	.21	4.1	5.1	.037	.95	W246483
W246485	80.7	47	35	.28	.40	.54	.16	2.6	3.6	.050	.82	W246485
W246486	28.6	46	21	2.6	1.0	1.4	.11	12	5.0	.035	5.7	W246486
W246484	10.4	30	21	8.7	3.0	5.8	.20	8.0	2.0	.096	12	W246484
W246487	24.0	27	16	5.3	1.8	2.2	.13	26	2.5	.042L	13	W246487
W246488	27.0	51	17	2.9	1.1	1.9	.17	9.7	3.5	.037	6.1	W246488
W246489	52.0	48	31	.99	.65	1.1	.19	3.9	4.0	.038	2.0	W246489
W246509	14.0	24	8.1	7.3	2.2	5.1	.19	27	2.7	.071L	21	W246509
W246510	7.6	17	13	10	4.0	9.3	.20	12	1.5	.13L	27	W246510
W246160	11.7	26	15	6.1	1.0	8.0	.20	20	5.8	.085L	19	W246160
W246449	11.3	11	8.1	8.1	3.3	4.9	.20	36	1.6	.088L	27	W246449
W246450	56.2	33	21	.81	.48	.85	.25	32	2.3	.036	9.1	W246450
W246451	25.1	28	17	2.9	1.1	2.2	.27	32	2.5	.040L	9.4	W246451
W246452	16.1	20	13	5.1	1.7	3.8	.26	39	1.6	.062L	13	W246452
W246453	17.9	32	23	4.7	1.6	3.4	.33	16	3.6	.056	13	W246453
W246454	18.5	20	12	4.6	1.7	1.8	.21	43	1.7	.054L	15	W246454
W246455	37.0	33	22	1.7	.91	1.5	.39	26	3.4	.054	9.6	W246455
W246456	13.2	27	18	6.5	2.0	4.6	.23	19	2.9	.076L	18	W246456
W246457	14.1	23	16	6.0	2.3	4.1	.20	29	1.9	.071L	18	W246457
W246458	54.1	44	35	1.0	.58	.99	.23	8.9	2.3	.037	2.9	W246458
W246459	24.0	42	22	2.9	1.2	2.8	.21	13	4.1	.042L	8.4	W246459
W246460	63.7	29	21	.59	.35	.70	.20	30	2.0	.031	18	W246460
W246461	45.0	33	19	1.7	.75	1.2	.30	29	2.5	.022	12	W246461
W246471	19.9	32	17	4.6	1.7	2.0	.19	25	2.8	.050L	12	W246471
W246472	9.3	23	17	10	3.5	4.3	.22	12	1.4	.11L	23	W246472
W246473	57.8	56	15	.73	.47	.49	.30	20	2.7	.035	4.0	W246473
W246474	18.3	18	8.6	4.8	1.5	1.8	.18	45	1.7	.055L	13	W246474
W246475	40.0	47	33	1.7	.95	.81	.17	6.6	2.9	.050	3.7	W246475
W246490	73.7	47	19	.39	.53	.73	.40	19	2.8	.041	7.3	W246490
W246491	18.8	18	7.2	4.2	1.8	3.5	.26	43	1.5	.053L	16	W246491
W246492	18.3	32	17	4.3	1.7	3.4	.19	20	3.6	.055L	12	W246492
W246493	14.4	20	11	4.9	1.7	3.9	.17	37	1.4	.069L	16	W246493
W246494	69.4	38	23	.31	.35	.57	.23	24	3.9	.043	6.2	W246494
W246495	7.6	10	7.1	11	3.8	8.0	.23	22	1.0	.13L	32	W246495
W246496	5.5	5.3	4.1	15	5.1	11	.21	16	.37	.18L	35	W246496
W246497	18.8	35	20	3.9	1.6	2.7	.41	19	3.5	.053L	9.6	W246497
W246498	15.9	27	9.9	5.1	1.8	4.3	.19	29	3.2	.063L	15	W246498
W246499	7.5	9.4	3.0	14	3.5	9.6	.17	20	.35	.13L	31	W246499
W246500	7.4	4.3	4.1	11	3.3	9.3	.13	31	.43	.14L	34	W246500

Appendix B. --Ash yields, major- and minor- oxides concentrations in the laboratory ash of 175 coal samples in Pakistan regions.--continued

SAMPLE NUMBER	ASH (PERCENT)	SIO2 (PERCENT)	AL2O3 (PERCENT)	CAO (PERCENT)	MGO (PERCENT)	NA2O (PERCENT)	K2O (PERCENT)	FE2O3 (PERCENT)	TIO2 (PERCENT)	P2O5 (PERCENT)	SO3 (PERCENT)	SAMPLE NUMBER
W246501	22.1	23	13	3.2	2.3	2.8	0.15	35	3.2	0.045L	14	W246501
W246502	58.2	33	22	.59	.80	.85	.18	22	2.9	.034	6.0	W246502
W246503	37.1	23	11	1.2	.96	1.2	.10	47	2.6	.027L	8.5	W246503
W246504	54.1	48	23	.82	.68	.86	.12	14	8.0	.055	2.6	W246504
W246505	14.5	17	13	5.5	2.7	3.9	.11	30	2.8	.069L	19	W246505
W246506	35.8	24	17	12	1.2	1.5	.15	20	1.9	.028	15	W246506
W246507	61.5	39	28	.48	.55	.78	.19	22	3.6	.033	3.1	W246507
W246508	6.3	18	13	13	5.8	10	.27	9.1	1.0	.16L	23	W246508
W246511	51.6	46	26	.87	.55	1.2	.16	16	6.0	.039	2.4	W246511
W246512	5.6	8.9	8.4	14	5.5	12	.23	6.3	.92	.18L	36	W246512
W246513	5.2	10	5.2	16	10	12	.29	5.8	.64	.19L	33	W246513
W246514	15.4	17	12	5.8	2.8	3.2	.12	34	1.5	.065L	19	W246514
W246515	47.6	40	23	.73	.55	1.2	.23	23	4.5	.042	2.3	W246515
W246516	10.2	15	11	7.7	2.8	6.3	.15	28	1.4	.098L	23	W246516
W246517	10.7	32	22	7.7	2.7	6.2	.19	7.5	2.2	.093L	12	W246517

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.

[Values in percent or parts-per-million, dry basis, 22 elements are from direct determinations on whole-coal: all other elements calculated from analyses of ash. L means less than the value shown; H, interference for an element which cannot be resolved by any routine method; N, looked for but not found; B, not determined; G, greater than; S, after element title indicates determinations by automatic plate reading computer assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample numbers W250656 - W250671 were analyzed only for uranium.]

SAMPLE NUMBER	SI (PERCENT)	AL (PERCENT)	CA (PERCENT)	MG (PERCENT)	NA (PERCENT)	K (PERCENT)	FE (PERCENT)	TI (PERCENT)	AG-S PPM	AS PPM	SAMPLE NUMBER
W241087	1.5	1.2	0.62	0.21	0.39	0.029	1.7	0.20	0.023	1.3	W241087
W241088	3.0	.55	.58	.21	.33	.027	2.4	.074	.015L	.80	W241088
W241089	8.8	7.1	.39	.21	.20	.11	9.0	1.1	.072	3.8	W241089
W241090	1.6	.78	.55	.21	.63	.027	3.1	.17	.014L	.94	W241090
W241091	7.8	6.4	.40	.19	.48	.083	3.6	.57	.080	1.7	W241091
W241092	.56	.45	.52	.22	.37	.018	1.3	.073	.014	.40L	W241092
W241093	1.5	1.1	.47	.19	.51	.028	3.1	.19	.032	3.3	W241093
W241094	.55	.27	.48	.17	.57	.015	.68	.034	.006L	.82	W241094
W241095	.54	.44	.51	.15	.47	.019	2.6	.069	.010L	1.4	W241095
W241096	.32	.15	.57	.19	.56	.012	.65	.020	.009	.50	W241096
W241097	.25	.11	.53	.16	.52	.010	.25	.008	.004L	.40L	W241097
W241098	.26	.14	.57	.18	.57	.010	.26	.007	.004L	.40L	W241098
W241099	.28	.33	.55	.21	.52	.011	.33	.031	.019	.58	W241099
W241100	2.8	2.6	.85	.23	.76	.035	1.2	.47	.040	.50L	W241100
W241101	2.4	1.6	.50	.12	.43	.051	3.0	.31	.017L	7.7	W241101
W241102	.87	.56	.59	.12	.46	.015	.97	.10	.008L	2.3	W241102
W241103	3.7	3.3	.52	.18	.32	.040	.94	.30	.055	.70L	W241103
W241104	2.9	2.2	.47	.16	.37	.055	6.6	.41	.12	2.2	W241104
W241105	.77	.70	.54	.16	.49	.016	1.5	.077	.024	1.3	W241105
W241106	8.3	6.5	.43	.16	.38	.068	2.4	.86	.090	1.4	W241106
W241107	2.3	1.3	.55	.15	.36	.034	4.0	.39	.018L	3.0	W241107
W241108	4.1	3.5	.48	.15	.37	.044	2.3	.35	.083	4.5	W241108
W241109	2.1	1.6	.58	.14	.29	.039	2.5	.21	.041	2.3	W241109
W241110	1.4	.81	.57	.22	.20	.041	4.5	.12	.015L	3.0	W241110
W241111	1.1	.62	.54	.23	.31	.023	2.1	.20	.035	2.9	W241111
W241112	2.3	1.7	.48	.14	.53	.039	3.9	.23	.075	1.6	W241112
W241113	4.6	2.9	.46	.20	.53	.088	6.0	.50	.086	1.6	W241113
W241114	.74	.57	.49	.16	.57	.028	1.4	.076	.009L	2.2	W241114
W241115	8.6	6.3	1.0	.21	.44	.12	2.6	.52	.080	7.4	W241115
W246426	4.3	2.8	.53	.18	.52	.067	3.3	.39	.067	2.5	W246426
W246427	3.5	3.1	.53	.16	.49	.031	1.2	.27	.095	1.2	W246427
W246428	3.6	1.7	.52	.14	.37	.046	6.7	.33	.11	1.5	W246428
W246528	.99	.70	.45	.17	.44	.021	4.1	.094	.052	.81	W246528
W241116	7.9	6.0	.29	.19	.86	.096	2.3	.68	.15	3.0	W241116
W241117	6.4	4.4	.30	.084	.56	.087	6.1	.60	.095	3.9	W241117
W241118	11	6.7	.23	.060	.39	.10	6.5	1.0	.16	9.2	W241118
W241119	1.6	1.1	4.7	.16	.34	.028	3.3	.20	.026L	11	W241119
W241120	16	9.3	.26	.079	.50	.20	2.0	1.4	.12	18	W241120
W241121	8.3	6.7	.25	.064	.60	.096	4.2	.54	.18	11	W241121
W241122	7.7	7.1	.29	.065	.53	.092	4.8	.49	.18	12	W241122

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	B-S PPM	BA-S PPM	BE-S PPM	BR PPM	CD PPM	CE PPM	CL PPM	CO PPM	CR PPM	CS PPM	SAMPLE NUMBER
W241087	86	14	1.5	8.3	0.037	8.2	500	7.0	24	0.10L	W241087
W241088	100	8.8	1.1	7.5	.12	8.6	400	3.4	23	.10L	W241088
W241089	190	37	2.6	6.5	.18	55	100	82	130	.50	W241089
W241090	98	14	1.6	6.9	.043	10	800	9.9	22	.10L	W241090
W241091	200	33	1.8	7.2	.15	40	500	43	88	.32	W241091
W241092	65	71	1.1	9.5	.051	7.3	1,200	8.3	13	.20L	W241092
W241093	100	17	1.2	8.1	.087	9.5	800	16	33	.20L	W241093
W241094	46	9.9	1.6	5.6	.024	4.2	600	2.9	9.3	.10L	W241094
W241095	68	12	1.6	7.1	.071	6.3	300	3.5	16	.10L	W241095
W241096	44	12	.53	6.0	.017	4.1	300	2.3	6.1	.10	W241096
W241097	33	11	.06L	7.4	.009	.92	500	.26	2.4	.03L	W241097
W241098	33	13	.07L	6.8	.009	1.2	400	.22	1.4	.04L	W241098
W241099	40	16	.14	7.1	.011	5.4	200	3.3	7.1	.07L	W241099
W241100	130	36	2.1	4.5	.038	15	200	4.7	29	.10L	W241100
W241101	130	27	4.8	7.4	.10	10	200	26	50	.23	W241101
W241102	59	24	3.2	3.8	.060	6.0	200	19	16	.10L	W241102
W241103	140	30	2.4	3.6	.16	33	100	17	50	.35	W241103
W241104	140	14	3.2	4.6	.083	15	200	14	49	.20L	W241104
W241105	67	12	.68	4.9	.031	7.9	300	12	14	.10L	W241105
W241106	270	51	2.1	4.1	.23	43	300	22	100	.34	W241106
W241107	130	25	2.0	7.1	.061	16	300	26	42	.20L	W241107
W241108	220	28	3.9	3.1	.17	31	200	32	51	.20L	W241108
W241109	110	17	1.3	5.5	.057	13	200	7.5	30	.20L	W241109
W241110	100	15	2.1	7.6	.045	8.7	200	5.5	18	3.0L	W241110
W241111	88	10	1.7	6.0	.044	7.1	990	7.0	21	.10L	W241111
W241112	130	9.0	2.3	6.6	.056	11	800	11	29	.20L	W241112
W241113	260	22	4.4	4.9	.089	18	400	14	75	.20L	W241113
W241114	69	12	.64	5.7	.027	4.8	700	3.5	12	.10L	W241114
W241115	300	52	3.5	4.7	.15	32	300	17	93	.29	W241115
W246426	130	26	2.6	6.0	.043	14	500	10	45	.21	W246426
W246427	120	24	1.8	4.1	.034	25	500	15	43	.14	W246427
W246428	120	13	4.0	4.1	.042	22	200	9.9	58	.20L	W246428
W246528	130G	54	3.2	10	.009	6.8	1,800	4.9	15	.10L	W246528
W241116	330	48	4.1	41	.37	58	6,200	47	110	.45	W241116
W241117	310	56	3.3	20	.13	32	2,500	33	81	.29	W241117
W241118	200	66	4.9	13	.40	63	600	65	140	.54	W241118
W241119	190	64	5.4	7.6	.39	11	980	35	32	.20L	W241119
W241120	280	130	6.7	15	.49	93	2,200	110	200	.88	W241120
W241121	270	56	4.0	17	.12	49	2,900	65	98	.88	W241121
W241122	260	73	4.1	15	.29	64	2,400	120	95	.46	W241122

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	CU PPM	DY-S PPM	EU PPM	F PPM	GA-S PPM	GD-S PPM	GE-S PPM	HF PPM	HG PPM	HO-S PPM	SAMPLE NUMBER
W241087	15	1.2L	0.32	20L	9.5	2.7L	7.6	0.79	0.050	0.18L	W241087
W241088	8.6	1.5L	.30	20L	8.3	3.3L	4.0	1.1	.010	.22L	W241088
W241089	77	5.2L	1.5	20L	22	11L	19	4.1	.030	.77L	W241089
W241090	16	1.4L	.47	20L	11	3.1L	6.4	.84	.030	.21L	W241090
W241091	72	4.0L	1.2	20L	27	8.8L	3.3	2.9	.020	.60L	W241091
W241092	6.4	.85L	.37	20L	8.3	1.9L	1.5	.40	.020	.13L	W241092
W241093	10	1.5L	.41	20L	8.7	3.2L	6.1	.89	.060	.22L	W241093
W241094	4.3	.62L	.23	20L	.11	1.4L	11	.34	.005L	.09L	W241094
W241095	7.8	.98L	.33	20L	7.6	2.2L	2.9	.39	.040	.15L	W241095
W241096	3.5	.58L	.23	30	4.5	1.3L	.36	.20	.005L	.42	W241096
W241097	2.9	.43L	.01	20L	.22	.95L	.20L	.05	.005L	.06L	W241097
W241098	2.5	.44L	.03	20L	.21	.97L	.20L	.04	.005L	.07L	W241098
W241099	14	.53L	.14	20L	2.3	1.2L	.24L	.16	.005L	.15	W241099
W241100	45	1.9L	.49	20L	16	4.2L	3.6	1.1	.020	.28L	W241100
W241101	19	1.7L	.57	30	19	3.8L	19	1.4	.020	.26L	W241101
W241102	13	.79L	.43	20L	12	1.7L	19	.64	.005L	.87	W241102
W241103	63	2.0L	1.3	30	24	5.1	6.7	1.6	.020	1.1	W241103
W241104	19	2.5L	.66	30	15	5.4L	12	1.6	.005L	.37L	W241104
W241105	11	.90L	.39	20L	8.3	2.0L	2.4	.46	.005L	.90L	W241105
W241106	94	3.9L	1.2	40	25	8.6L	5.5	3.7	.040	3.9L	W241106
W241107	29	1.8L	.57	40	12	3.9L	5.4	1.5	.010	.27L	W241107
W241108	74	2.3L	1.1	40	21	5.1L	17	1.6	.010	.35L	W241108
W241109	8.6	1.5L	.43	20L	8.0	3.3L	5.3	.94	.005L	.23L	W241109
W241110	11	1.5L	.32	50	11	3.3L	9.5	.54	.005L	.23L	W241110
W241111	13	1.2L	.33	20L	12	2.6L	13	.77	.005L	.17L	W241111
W241112	19	1.9L	.46	20L	14	4.1L	14	.96	.005L	.28L	W241112
W241113	56	3.0L	.78	80	16	6.5L	14	2.4	.050	.44L	W241113
W241114	6.5	.90L	.17	20L	4.7	2.0L	2.1	.31	.020	.14L	W241114
W241115	68	4.0L	.90	20L	22	14	10	3.1	.020	.60L	W241115
W246426	26	2.4L	.55	40	17	5.2L	8.6	1.5	.040	.36L	W246426
W246427	50	1.9L	.85	20L	16	4.1L	4.3	1.4	.010	.88	W246427
W246428	23	2.5L	.91	20L	17	5.5L	27	1.8	.040	.37L	W246428
W246528	10	1.3L	.54	40	19	2.9L	16	.58	.020	.20L	W246528
W241116	150	3.7L	1.8	40	34	8.2L	23	3.6	.030	.56L	W241116
W241117	49	3.5L	.97	40	22	7.7L	12	2.6	.020	.53L	W241117
W241118	120	5.0L	2.0	100	23	11L	22	4.8	.050	.76L	W241118
W241119	28	2.6L	1.2	20	25	5.7L	41	1.1	.11	2.6	W241119
W241120	140	6.1L	2.7	100	37	13L	49	6.7	.020	.92L	W241120
W241121	120	4.0L	1.6	40	28	8.8L	56	3.2	.14	.60L	W241121
W241122	110	4.1L	2.0	20L	32	9.0L	49	2.8	.080	.61L	W241122

Appendix C.--Major-, minor-, and trace-element composition of 191 coal in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	IN-S PPM	LA PPM	LI PPM	LU PPM	MN PPM	MO-S PPM	NB-S PPM	ND-S PPM	NI-S PPM	P PPM	SAMPLE NUMBER
W241087	0.84L	5.1	8.4	0.15	25	1.2	1.8	3.9L	16	44L	W241087
W241088	1.0L	4.5	2.5	.11	94	3.1	2.2	7.3	11	44L	W241088
W241089	3.5L	34	57	.27	98	9.8	16	26	88	87	W241089
W241090	.97L	5.6	6.0	.15	110	1.7	2.8	9.9	18	44L	W241090
W241091	2.7L	24	56	.32	39	2.2	3.3	21	72	44L	W241091
W241092	.58L	3.8	2.7	.14	37	1.1	1.2	6.0	13	44L	W241092
W241093	.99L	5.5	7.5	.16	64	2.6	3.5	8.3	49	44L	W241093
W241094	.42L	2.0	1.3	.09	.31	1.1	1.2	3.5	14	44L	W241094
W241095	.67L	3.2	2.1	.16	54	2.7	1.4	3.7	6.4	44L	W241095
W241096	.39L	2.1	.87	.08	27	.58	.46	3.8	4.5	44L	W241096
W241097	.29L	.74	.95	.02L	17	.60	.27	6.5L	1.3	44L	W241097
W241098	.30L	1.0	.48	.02L	21	.66	.29	1.4L	2.3	44L	W241098
W241099	.36L	3.0	1.9	.03	22	2.2	.90	4.0	9.0	44L	W241099
W241100	1.3L	9.0	14	.17	49	1.3	7.4	28L	25	44L	W241100
W241101	1.2L	6.3	8.0	.38	110	11	4.3	5.5L	99	44L	W241101
W241102	.54L	3.2	2.3	.25	40	.87	1.9	5.6	76	44L	W241102
W241103	1.4L	18	24	.38	30	1.2	4.2	13	55	44L	W241103
W241104	1.7L	9.7	18	.49	76	5.9	7.4	12	34	44L	W241104
W241105	.61L	3.6	5.9	.14	30	2.3	1.8	4.0	17	44L	W241105
W241106	2.7L	28	55	.27	43	2.1	9.4	32	62	44	W241106
W241107	1.2L	9.4	7.7	.16	200	4.1	4.5	5.7L	34	44L	W241107
W241108	1.6L	18	30	.31	28	1.1	3.2	30	85	44L	W241108
W241109	1.0L	7.8	12	.15	54	3.0	2.4	11	13	44L	W241109
W241110	1.0L	4.8	3.2	.11	82	5.1	3.5	5.9	11	44L	W241110
W241111	.79L	4.7	9.4	.12	57	2.6	2.3	3.7L	14	44L	W241111
W241112	1.3L	6.8	24	.20	39	4.3	2.8	6.0L	30	44L	W241112
W241113	2.0L	12	32	.46	100	5.3	5.9	22	44	44L	W241113
W241114	.61L	2.8	4.1	.02L	8.2	4.9	1.9	2.9L	12	44L	W241114
W241115	2.7L	21	64	.27	68	7.2	8.8	18	92	87	W241115
W246426	1.6L	9.5	26	.35	100	3.8	5.2	9.5	24	87	W246426
W246427	1.3L	15	32	.21	22	1.2	3.6	6.0L	49	87	W246427
W246428	1.7L	12	17	.40	57	6.7	8.2	25	30	44	W246428
W246528	.91L	3.1	6.3	.29	68	3.4	2.5	5.9	16	44L	W246528
W241116	2.5L	33	78	.34	48	1.9	5.6	45	100	87	W241116
W241117	2.4L	20	70	.35	77	7.4	7.4	29	73	44L	W241117
W241118	3.4L	36	86	.39	40	4.6	15	28	120	44L	W241118
W241119	1.8L	4.2	7.0	.62	770	3.4	6.2	8.3L	90	87	W241119
W241120	4.2L	54	98	.43	73	4.3	26	30	200	130	W241120
W241121	2.7L	27	68	.49	19	3.0	5.6	28	200	44	W241121
W241122	2.8L	34	77	.52	27	3.5	10	22	210	87	W241122

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	PB PPM	PR-S PPM	RB PPM	SB PPM	SC PPM	SE PPM	SM PPM	SN-S PPM	SR-S PPM	TA PPM	SAMPLE NUMBER
W241087	4.4	0.84L	80L	0.20L	6.9	4.6	1.1	1.4	980	0.29	W241087
W241088	4.3	1.2	70L	.10L	5.4	3.7	1.2	2.4	1,300	.13	W241088
W241089	25	3.5L	50L	.18	25	3.3	6.0	6.7	300	1.7	W241089
W241090	4.1	.98	70L	.10L	6.7	4.2	1.4	2.0	1,400	.18	W241090
W241091	13	2.7L	70L	.10L	23	1.6	4.6	3.2	370	1.0	W241091
W241092	2.4	.80	80L	.20L	6.4	3.1	1.2	1.0	1,500	.13	W241092
W241093	4.8	1.1	70L	.10L	7.2	2.7	1.3	2.6	1,400	.33	W241093
W241094	1.7	.50	60L	.10L	6.2	2.4	.70	1.2	1,400	.082	W241094
W241095	2.4	.98	60L	.10L	5.6	3.0	.98	2.4	1,300	.097	W241095
W241096	1.1	.93	60L	.10L	3.6	2.8	.70	1.0	1,300	.074	W241096
W241097	.82	.31	30L	.080L	.17	2.7	.06	.90	1,400	.040L	W241097
W241098	.97	.44	25L	.080L	.15	2.3	.06	.75	1,300	.050L	W241098
W241099	1.0	.80	24L	.080L	1.9	3.5	.61	.64	1,300	.085	W241099
W241100	8.7	2.5	25L	.13	8.7	3.5	1.8	1.7	1,300	.56	W241100
W241101	4.6	1.2L	28L	.41	18	4.0	1.8	3.6	1,600	.52	W241101
W241102	2.1	1.1	26L	.10L	8.2	2.5	1.2	1.1	1,200	.18	W241102
W241103	6.3	2.2	23L	.24	22	2.4	4.9	1.5	930	.61	W241103
W241104	7.1	2.3	30L	.17	20	2.6	2.2	6.9	590	.66	W241104
W241105	1.3	1.1	22L	.090L	6.3	2.9	1.3	1.4	1,300	.17	W241105
W241106	12	2.7L	30L	.10L	22	2.0	4.8	3.2	740	1.4	W241106
W241107	7.9	1.8	70L	.20L	10	4.4	2.0	3.8	1,500	.63	W241107
W241108	8.3	1.8	70L	.30L	17	4.1	4.2	2.5	740	.62	W241108
W241109	3.6	1.3	90L	.20L	8.0	5.4	1.7	2.1	910	.34	W241109
W241110	4.4	1.5	50L	.21	4.8	6.5	1.1	3.5	1,800	.25	W241110
W241111	3.7	1.0	80L	.20L	6.4	5.8	1.2	2.3	1,400	.31	W241111
W241112	3.9	1.4	90L	.20L	9.6	4.6	1.6	4.1	730	.41	W241112
W241113	7.1	2.1	80L	.20L	22	3.9	2.6	6.5	710	.77	W241113
W241114	1.8	.68	70L	.20L	2.9	5.1	.56	1.5	1,300	.12	W241114
W241115	9.2	2.7L	70L	.32	22	4.5	3.8	2.4	880	.93	W241115
W246426	2.4L	1.6L	50L	.15	13	2.9	1.9	4.3	740	.64	W246426
W246427	2.6	1.3	40L	.15	12	3.3	3.2	1.6	920	.49	W246427
W246428	2.5L	2.7	50L	.10L	19	3.5	3.3	8.0	650	.49	W246428
W246528	1.3L	.91L	50L	.10L	16	5.1	1.6	3.9	430	.15	W246528
W241116	19	3.4	120L	.30L	25	2.4	7.6	5.6	230	.99	W241116
W241117	8.8	2.6	50L	.34	25	3.5	3.8	5.6	270	.86	W241117
W241118	16	3.4L	50L	.33	30	5.4	8.3	4.3	210	1.7	W241118
W241119	7.7	2.5	40L	.32	25	4.4	3.8	4.9	750	.35	W241119
W241120	24	5.3	60L	.29	32	1.6	11	5.6	350	2.3	W241120
W241121	14	3.2	50L	.39	27	6.0	6.3	3.6	220	1.0	W241121
W241122	12	3.1	50L	.30L	34	6.3	7.9	5.9	220	.92	W241122

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	TB PPM	TH PPM	U PPM	V-S PPM	W PPM	Y-S PPM	YB PPM	ZN PPM	ZR-S PPM	SAMPLE NUMBER
W241087	0.21	1.2	0.48	18	1.0L	10	1.2	7.7	26	W241087
W241088	.18	1.1	.30	18	.86	9.1	.76	39	39	W241088
W241089	.78	6.9	1.8	93	.79	16	1.9	38	98	W241089
W241090	.24	1.0	.39	16	.70L	10	1.1	8.9	27	W241090
W241091	.59	4.3	1.0	84	.70L	18	2.8	34	84	W241091
W241092	.24	.49	.56	14	.70L	10	1.4	14	16	W241092
W241093	.23	1.1	.56	28	.60L	9.7	1.1	22	32	W241093
W241094	.14	.25	.24L	20	.60L	11	.86	5.3	26	W241094
W241095	.18	.56	.79	15	.60L	11	1.1	18	18	W241095
W241096	.12	.19	.22L	9.9	.60L	7.0	.76	3.7	11	W241096
W241097	.010L	.12	.19L	1.3	.80L	.47	.20L	1.4	3.0	W241097
W241098	.010L	.073	.18L	1.1	.60L	.62	.20L	1.4	3.2	W241098
W241099	.058	.45	.21L	15	.60L	3.2	.27	1.7	10	W241099
W241100	.24	1.8	.23L	87	1.0L	19	1.3	6.0	53	W241100
W241101	.43	1.5	3.4	87	2.0L	21	2.8	17	60	W241101
W241102	.24	.66	.21L	37	1.0L	15	1.9	16	32	W241102
W241103	.63	2.9	.64	120	1.0L	22	3.4	44	44	W241103
W241104	.42	2.1	1.4	54	2.0L	25	3.8	16	71	W241104
W241105	.21	.63	.61	22	.80L	11	1.1	6.2	18	W241105
W241106	.56	5.8	1.2	94	2.0L	15	2.3	51	110	W241106
W241107	.31	1.9	.82	45	1.0L	11	1.2	13	45	W241107
W241108	.52	2.4	.51	94	1.0L	19	2.6	39	51	W241108
W241109	.24	1.8	1.3	30	.90L	10	1.3	12	30	W241109
W241110	.16	1.1	1.5	24	.70L	6.9	.64	10	24	W241110
W241111	.20	1.2	.54	23	1.0L	11	1.2	10	35	W241111
W241112	.28	1.3	.67	41	1.0L	15	1.8	13	41	W241112
W241113	.52	3.3	1.4	100	20	29	3.9	20	100	W241113
W241114	.098	.57	1.7	16	1.0L	5.2	.76	5.9	18	W241114
W241115	.45	4.6	2.0	240	1.0L	23	2.4	31	140	W241115
W246426	.45	2.3	1.8	50	.80L	19	2.2	19	50	W246426
W246427	.46	2.4	.44	73	1.0L	15	1.6	12	41	W246427
W246428	.63	2.3	1.0	72	.80L	25	2.9	27	95	W246428
W246528	.40	.78	.60	15	.60L	13	2.1	15	25	W246528
W241116	.84	5.8	1.5	250	2.0L	22	3.2	120	89	W241116
W241117	.52	3.7	2.0	140	2.0L	20	2.6	26	77	W241117
W241118	.78	6.6	1.6	150	2.0L	18	3.0	130	120	W241118
W241119	.92	1.4	.23	52	2.0L	52	4.7	180	88	W241119
W241120	1.1	11	2.1	310	2.0L	25	3.2	150	270	W241120
W241121	.84	5.4	1.1	180	2.0L	29	3.7	60	100	W241121
W241122	.94	6.0	1.2	190	3.0L	23	4.1	77	73	W241122

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	SI (PERCENT)	AL (PERCENT)	CA (PERCENT)	MG (PERCENT)	NA (PERCENT)	K (PERCENT)	FE (PERCENT)	TI (PERCENT)	AG-S PPM	AS PPM	SAMPLE NUMBER
W241123	5.1	3.1	0.27	0.056	0.47	0.046	6.3	0.40	0.091	1.5	W241123
W241022	4.8	3.6	.44	.098	.60	.055	3.5	.45	.071	2.7	W241022
W241023	2.8	2.5	.47	.094	.59	.050	3.5	.30	.046	2.3	W241023
W241024	9.1	8.1	.29	.047	.36	.13	11	1.0	.11	5.8	W241024
W241025	1.1	.97	1.6	.086	.51	.026	6.4	.11	.060	1.1	W241025
W241026	5.4	5.2	.42	.066	.52	.070	6.3	.60	.10	3.5	W241026
W241027	.52	.33	.59	.084	.41	.018	2.0	.091	.023	.68	W241027
W241028	10	7.8	.32	.047	.35	.11	9.4	1.7	.15	9.3	W241028
W246430	2.4	1.7	.47	.13	.70	.026	2.2	.21	.043	1.6	W246430
W246431	4.5	3.0	.44	.16	.74	.091	.66	.41	.029	.70L	W246431
W246432	1.6	.81	.60	.13	.66	.026	2.2	.26	.013L	3.8	W246432
W246433	1.5	1.2	.46	.11	.72	.019	1.3	.14	.024	2.5	W246433
W246437	.46	.17	.48	.17	.70	.014	2.6	.031	.046	5.7	W246437
W246438	.82	.45	.57	.16	.61	.017	.62	.12	.007L	1.1	W246438
W246439	.47	.26	.59	.17	.71	.014	.46	.025	.006L	.60L	W246439
W246440	.52	.34	.60	.17	.74	.013	.18	.029	.005L	.60L	W246440
W246441	1.5	1.1	.55	.18	.78	.018	.17	.17	.009L	1.0L	W246441
W246442	12	8.1	.39	.16	.61	.067	1.7	1.8	.13	9.0	W246442
W246443	3.3	2.4	.13	.059	.18	.035	3.3	.37	.019L	8.3	W246443
W246429	5.9	2.2	.45	.14	.71	.037	2.9	.74	.058	2.0	W246429
W246435	7.0	5.4	.45	.12	.47	.088	6.2	.77	.16	5.0	W246435
W246436	1.6	.94	.50	.072	.49	.021	7.0	.14	.18	5.2	W246436
W246434	.74	.44	.49	.10	.62	.015	2.1	.040	.037	.80	W246434
W246444	2.1	1.7	.40	.069	.41	.024	1.6	.22	.046	4.3	W246444
W246445	6.6	5.7	1.6	.26	1.6	.10	1.5	.45	.16	5.3	W246445
W246446	1.4	.89	.093	.024	.11	.010	.25	.28	.015	1.7	W246446
W246447	.48	.24	.57	.070	.49	.013	.20	.25	.005L	.60L	W246447
W246448	.73	.20	1.6	.21	1.5	.039	1.3	.048	.013L	.70L	W246448
W237524	2.6	2.1	.64	.19	.33	.035	2.8	.42	.058	1.3	W237524
W237525	3.5	3.0	.79	.19	.31	.039	1.3	.35	.057	1.3	W237525
W237526	1.2	1.1	.70	.18	.49	.019	.90	.078	.037	.27	W237526
W237527	.93	.74	.73	.24	.22	.017	1.8	.15	.016	5.7	W237527
W246127	.80	.24	.50	.17	.89	.019	1.4	.046	.009L	1.0L	W246127
W246128	3.1	2.2	.45	.17	.83	.045	1.2	.24	.029	2.8	W246128
W246129	3.5	1.9	.67	.14	.78	.031	1.0	.36	.044	.70L	W246129
W246130	3.4	2.6	.52	.13	.73	.032	2.0	.45	.095	2.3	W246130
W246131	1.9	1.3	.55	.10	.65	.027	1.7	.12	.036	2.5	W246131
W246132	2.0	1.6	.51	.087	.57	.020	5.6	.36	.081	3.6	W246132
W246137	4.2	2.4	.56	.19	.91	.031	4.6	.58	.10	9.3	W246137
W246138	1.0	.64	.50	.092	.69	.023	1.2	.11	.033	1.1	W246138

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	B-S PPM	BA-S PPM	BE-S PPM	BR PPM	CD PPM	CE PPM	CL PPM	CO PPM	CR PPM	CS PPM	SAMPLE NUMBER
W241123	250	41	3.5	14	0.18	36	2,100	21	61	0.26	W241123
W241022	190	35	1.5	6.0	.10	27	1,100	14	69	.20L	W241022
W241023	190	33	1.9	14	.12	14	1,000	22	43	.27	W241023
W241024	110	39	.88L	7.6	.35	71	400	64	140	.55	W241024
W241025	110	33	1.4	6.0	.044L	8.1	930	7.8	20	.20L	W241025
W241026	180	45	.77	7.7	.11	42	800	30	67	.36	W241026
W241027	61	50	1.3	8.4	.040	7.9	1,200	2.5	25	.10L	W241027
W241028	83	65	.89L	5.3	.14	69	300	65	170	.45	W241028
W246430	100	46	2.1	8.3	.033	11	1,600	14	30	.10L	W246430
W246431	130	76	2.9	8.6	.14	33	1,700	15	53	.21	W246431
W246432	83	67	2.0	7.1	.020	6.6	1,600	12	28	.10L	W246432
W246433	71	48	1.2	8.1	.011	6.5	1,500	25	19	.09L	W246433
W246437	65	340	2.8	8.4	.006	3.7	1,800	25	6.3	.10L	W246437
W246438	52	19	2.4	7.6	.029	6.1	800	22	13	.09L	W246438
W246439	41	140	2.8	11	.011	4.4	1,600	23	4.6	.09L	W246439
W246440	37	26	1.9	7.5	.010	4.5	1,500	22	6.6	.08L	W246440
W246441	62	23	1.3	8.3	.007	6.8	1,300	20	21	.08L	W246441
W246442	290	81	3.6	5.0	.043	43	700	41	170	.21	W246442
W246443	68	22	1.1	9.2	.057	51	600	37	130	.62	W246443
W246429	260	60	4.2	7.1	.008	15	1,600	16	85	.10L	W246429
W246435	180	63	3.5	8.4	.16	38	700	21	92	.50	W246435
W246436	110	51	6.4	6.2	.039	10	1,100	33	23	.20L	W246436
W246434	65	70	1.1	7.1	.049	7.1	1,300	5.7	8.8	.08L	W246434
W246444	77	31	.75	7.5	.033	17	1,000	27	42	.14	W246444
W246445	240	140	8.8	5.6	.14	19	1,500	50	30	.22	W246445
W246446	37	17	1.2	5.3	.040	31	1,500	26	150	.40L	W246446
W246447	35	80	1.6	7.1	.004	5.6	1,700	31	21	.09L	W246447
W246448	89	280	9.5	6.1	.019	4.1	1,900	33	8.9	.09L	W246448
W237524	130	29	.83	2.5	.039	12	330	15	49	.13	W237524
W237525	150	29	3.7	2.3	.082	14	290	25	45	.15	W237525
W237526	81	27	2.1	2.1	.021	5.9	560	2.5	16	.20L	W237526
W237527	82	11	2.7	2.7	.067	7.9	500	26	20	.30L	W237527
W246127	65	23	2.3	190	.025	6.3	2,800	2.2	11	.08L	W246127
W246128	110	37	2.2	140	.052	22	2,200	34	33	.21	W246128
W246129	130	51	2.3	200	.053	17	2,100	12	38	.10L	W246129
W246130	130	53	3.4	200	.014	18	1,500	19	46	.21	W246130
W246131	87	49	2.4	240	.021	13	1,400	22	20	.14	W246131
W246132	120	53	2.2	170	.059	14	940	8.9	32	.10L	W246132
W246137	160	14	3.2	200	.14	14	3,100	12	70	.10L	W246137
W246138	66	37	2.8	240	.022	6.8	1,800	6.4	16	.10L	W246138

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	CU PPM	DY-S PPM	EU PPM	F PPM	GA-S PPM	GD-S PPM	GE-S PPM	HF PPM	HG PPM	HO-S PPM	SAMPLE NUMBER
W241123	47	2.9L	1.2	20L	32	6.4L	59	2.0	0.030	0.44L	W241123
W241022	60	2.7L	.96	30	21	6.0L	6.6	2.1	.070	.41L	W241022
W241023	44	2.1L	.60	10	17	4.6L	6.7	1.5	.080	.31L	W241023
W241024	94	5.9L	2.0	40	12	13L	2.7L	4.2	.070	.88L	W241024
W241025	19	2.2L	.36	10	11	4.9L	1.0L	.67	.080	.33L	W241025
W241026	45	3.5L	1.1	20L	18	7.7L	2.4	2.2	.080	.52L	W241026
W241027	9.2	.92L	.32	20L	14	2.0L	7.7	.79	.080	.14L	W241027
W241028	110	5.9L	1.9	60	24	13L	2.7L	5.9	.15	.89L	W241028
W246430	25	1.6L	.40	20L	16	3.5L	11	.99	.010	.24L	W246430
W246431	47	2.1L	1.1	20L	17	4.5L	4.3	1.8	.005L	.91	W246431
W246432	16	1.3L	.36	20L	11	2.9L	7.1	.95	.090	1.3L	W246432
W246433	21	1.1L	.24	40	14	2.4L	7.0	.65	.030	.17L	W246433
W246437	3.6	.96L	.28	20L	15	2.1L	12	.27	.040	.14L	W246437
W246438	13	.74L	.44	20L	30	1.6L	19	.68	.010	.81	W246438
W246439	4.4	.59L	.25	20L	17	1.3L	15	.17	.005L	.59	W246439
W246440	10	.53L	.24	20L	21	1.2L	7.4	.25	.005L	.42	W246440
W246441	16	.88L	.22	20L	13	1.9L	4.9	.76	.005L	.27	W246441
W246442	71	5.0L	.98	20L	31	11L	2.3L	6.8	.005L	.76L	W246442
W246443	28	1.9L	1.6	30	10	4.1L	2.8	3.8	.005L	.28L	W246443
W246429	34	2.6L	.58	30	26	5.8L	22	3.0	.020	1.4	W246429
W246435	55	3.9L	1.3	30	27	8.6L	13	2.9	.030	3.9L	W246435
W246436	21	2.0L	.82	20L	25	4.3L	43	.66	.080	.29L	W246436
W246434	11	.94L	.24	20L	5.6	2.1L	3.9	.28	.010	.14L	W246434
W246444	30	1.3L	.53	40	11	2.9L	1.7	1.3	.005L	.20L	W246444
W246445	110	3.7L	.73	80	77	8.0L	32	.91	.010	1.7	W246445
W246446	12	.62L	.89	90	6.0	1.4L	1.1	5.8	.11	.09L	W246446
W246447	15	.50L	.38	50	20	1.1L	11	1.0	.030	.08L	W246447
W246448	11	1.3L	.29	30	59	2.8L	21	.22	.005L	2.2	W246448
W237524	25	.89L	.33	20	8.3	1.9L	1.1	1.4	.005L	.29L	W237524
W237525	59	.94L	.52	20L	15	2.1L	9.4	1.4	.005L	.31L	W237525
W237526	27	1.0L	.30	20L	12	1.0L	7.3	.41	.005L	1.0	W237526
W237527	17	.52L	.37	50	7.2	1.1L	7.4	.66	.005L	.17L	W237527
W246127	8.3	.90L	.33	40	23	2.0L	14	.31	.005L	.14L	W246127
W246128	39	1.7L	.68	60	24	4.1	16	1.2	.005L	.54	W246128
W246129	41	1.8L	.54	60	19	3.9L	11	1.3	.005L	1.8L	W246129
W246130	59	2.0L	.57	20L	30	4.4L	19	1.7	.005L	.30L	W246130
W246131	25	1.3L	.53	40	18	2.9L	15	.68	.005L	.20L	W246131
W246132	30	2.0L	.41	20	16	4.4L	6.5	1.2	.020	.30L	W246132
W246137	32	2.7L	.56	50	26	5.9L	7.8	2.2	.020	.40L	W246137
W246138	15	.92L	.41	30	26	2.0L	21	.48	.005L	.68	W246138

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	IN-S PPM	LA PPM	LI PPM	LU PPM	MN PPM	MO-S PPM	NB-S PPM	ND-S PPM	NI-S PPM	P PPM	SAMPLE NUMBER
W241123	2.0L	20	38	0.35	23	2.5	6.7	18	47	87	W241123
W241022	1.9L	13	49	.33	22	1.9	6.0	19	35	44L	W241022
W241023	1.4L	7.7	46	.37	21	3.3	3.8	6.9	38	44L	W241023
W241024	4.0L	33	100	.22	190	11	8.2	24	82	87	W241024
W241025	1.5L	3.7	14	.17	51	3.1	1.7	7.1L	8.2	44L	W241025
W241026	2.4L	21	22	.26	94	6.3	4.5	27	70	44	W241026
W241027	.63L	3.7	2.1	.15	13	1.8	2.5	2.9L	6.9	44L	W241027
W241028	4.0L	33	100	.37	220	4.3	9.4	24	77	44	W241028
W246430	1.1L	7.0	15	.25	24	2.5	3.2	5.1L	38	44	W246430
W246431	1.4L	19	25	.27	25	1.1	6.0	16	39	87	W246431
W246432	.90L	4.0	6.1	.20	88	3.2	5.7	4.2L	46	44	W246432
W246433	.75L	4.1	8.2	.14	19	.94	3.1	3.6L	53	44L	W246433
W246437	.65L	1.8	.96L	.14	30	2.0	.96	5.8	89	44L	W246437
W246438	.50L	3.2	4.0	.14	46	.72	1.7	2.4L	47	44L	W246438
W246439	.40L	2.3	1.4	.04L	50	1.1	1.5	5.7	54	44L	W246439
W246440	.36L	2.8	3.5	.09	69	.53	1.1	1.7L	51	44L	W246440
W246441	.60L	4.4	9.7	.07	67	.45	2.2	2.8L	41	44L	W246441
W246442	3.4L	29	66	.37	110	2.8	25	31	150	130	W246442
W246443	1.3L	30	26	.34	89	3.9	8.7	9.1	50	130	W246443
W246429	1.8L	9.7	20	.24	50	1.8	8.7	17	45	44	W246429
W246435	2.7L	21	75	.34	120	16	13	23	120	87	W246435
W246436	1.3L	4.9	12	.41	25	7.2	6.4	13	150	44	W246436
W246434	.64L	4.2	5.4	.10	10	2.3	1.0	5.5	10	44L	W246434
W246444	.89L	10	24	.11	46	2.9	2.8	4.2L	77	87	W246444
W246445	2.5L	11	62	.24	66	2.5	7.3	24	230	44	W246445
W246446	.42L	22	12	.47	17	.33	3.7	4.0	24	130	W246446
W246447	.34L	2.7	4.8	.12	35	.50	3.4	1.6L	65	44	W246447
W246448	.88L	2.2	6.7	.13	58	2.6	2.5	19L	210	44	W246448
W237524	.43L	7.7	12	.08	68	2.5	4.9	6.2L	47	44L	W237524
W237525	.45L	9.5	18	.18	43	1.5	4.5	6.6L	57	44L	W237525
W237526	.23L	3.7	7.1	.13	38	1.4	1.4	3.3L	9.2	44L	W237526
W237527	.25L	4.6	4.6	.17	21	.75	1.8	8.3	55	44L	W237527
W246127	.61L	3.4	1.5	.15	50	.99	1.2	5.4	5.0	44L	W246127
W246128	1.1L	12	16	.17	16	1.0	2.2	9.3	64	44L	W246128
W246129	1.2L	9.6	17	.26	48	.97	4.8	5.7L	35	44L	W246129
W246130	1.4L	12	28	.20	18	1.4	2.6	6.5L	75	44	W246130
W246131	.90L	7.3	15	.24	7.0	1.0	2.4	4.2L	51	44L	W246131
W246132	1.4L	8.8	22	.13	22	8.7	5.9	6.5L	26	44	W246132
W246137	1.8L	9.3	24	.34	83	7.8	13	17	54	44	W246137
W246138	.63L	3.6	5.6	.21	19	1.2	2.4	14L	17	44L	W246138

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	PB PPM	PR-S PPM	RB PPM	SB PPM	SC PPM	SE PPM	SM PPM	SN-S PPM	SR-S PPM	TA PPM	SAMPLE NUMBER
W241123	7.6	2.1	50L	0.20L	18	2.9	4.3	5.3	190	0.56	W241123
W241022	13	1.9L	80L	.19	21	3.5	3.5	3.0	230	.65	W241022
W241023	11	1.4L	60L	.20L	21	5.1	1.9	2.7	400	.54	W241023
W241024	48	4.0L	50L	.29	26	5.1	7.6	7.1	210	1.6	W241024
W241025	9.1	1.5L	50L	.20L	9.1	6.1	1.2	4.2	580	.29	W241025
W241026	18	2.5	50L	.25	16	4.6	4.4	6.3	300	.89	W241026
W241027	7.5	1.1	50L	.20L	5.8	4.6	1.1	2.0	1,500	.14	W241027
W241028	25	4.0L	60L	.40L	33	3.5	7.6	7.1	220	2.6	W241028
W246430	1.6L	1.1L	40L	.16	9.7	4.1	1.4	2.5	1,900	.37	W246430
W246431	2.7	2.1	50L	.20L	14	1.7	4.3	1.9	1,200	.72	W246431
W246432	1.3L	1.1	50L	.24	6.7	3.2	1.1	2.6	1,600	.39	W246432
W246433	1.6	.75L	40L	.10L	5.6	4.0	.89	1.4	1,400	.25	W246433
W246437	.96L	1.1	40L	.10	4.7	2.8	.86	3.6	2,600	.057	W246437
W246438	2.1	1.3	30L	.22	7.0	1.9	1.5	1.6	2,100	.22	W246438
W246439	1.2	1.2	40L	.080	2.2	2.4	.77	.27L	2,000	.058	W246439
W246440	1.5	1.0	40L	.10L	5.2	2.1	.82	.64	2,100	.071	W246440
W246441	1.6	.68	40L	.10L	4.8	1.8	.82	.68	1,400	.26	W246441
W246442	13	3.4L	30L	.10L	27	3.7	4.5	4.8	910	2.5	W246442
W246443	1.9	1.3L	30L	.30L	26	3.9	5.9	3.3	260	1.5	W246443
W246429	2.6L	1.8L	40L	.10L	16	3.7	2.1	3.4	840	.94	W246429
W246435	3.9	4.7	40L	.31	24	5.7	4.6	8.3	550	1.2	W246435
W246436	3.9	2.1	30L	.10L	11	7.1	2.5	9.8	740	.21	W246436
W246434	.94L	1.1	40L	.10L	3.3	4.6	.92	2.9	1,800	.067	W246434
W246444	2.6	.93	30L	.30L	9.4	3.9	2.1	3.4	300	.55	W246444
W246445	12	2.5L	30L	.26	12	2.5	2.7	4.7	1,200	.30	W246445
W246446	2.2	.61	30L	.40L	29	4.8	3.7	.74	81	2.4	W246446
W246447	2.5	1.2	40L	.18	5.1	3.0	1.3	1.6	750	.49	W246447
W246448	4.6	2.6	27L	.18	6.9	2.3	.83	.59L	4,000	.050L	W246448
W237524	4.3	1.3L	70L	.072	6.3	2.2	1.2	2.5	1,000	.59	W237524
W237525	6.2	1.5	70L	.13	13	3.0	1.8	1.5	980	.55	W237525
W237526	3.3	1.2	80L	.10L	5.1	2.0	.95	1.4	1,200	.14	W237526
W237527	6.3	.87	60L	.18	6.1	3.1	1.2	.52L	540	.23	W237527
W246127	.90L	.61L	50L	.20	4.9	4.6	1.1	1.4	1,400	.093	W246127
W246128	2.5	1.1L	60L	.16	9.2	2.9	2.8	1.3	780	.43	W246128
W246129	2.3	1.2L	60L	.20L	10	2.0	2.2	1.7	1,200	.54	W246129
W246130	3.2	1.4L	60L	.20L	14	5.3	2.2	2.8	870	.73	W246130
W246131	1.8	.90L	60	.20L	8.7	3.3	1.8	1.5	960	.23	W246131
W246132	2.0L	1.4L	50L	.21	8.4	8.4	1.7	5.9	910	.53	W246132
W246137	2.7L	1.8L	50L	.21	13	7.8	2.1	4.3	700	.71	W246137
W246138	.92L	.63L	50L	.20L	8.5	4.3	1.3	1.7	1,200	.19	W246138

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	TB PPM	TH PPM	U PPM	V-S PPM	W PPM	Y-S PPM	YB PPM	ZN PPM	ZR-S PPM	SAMPLE NUMBER
W241123	0.61	2.5	0.56	59	2.0L	16	2.3	35	67	W241123
W241022	.51	3.1	1.1	63	1.0L	13	2.6	21	41	W241022
W241023	.44	2.2	1.5	46	.90L	13	3.0	14	31	W241023
W241024	.79	7.0	2.8	110	1.0L	12	2.0	82	110	W241024
W241025	.21	1.3	.50	22	.80L	9.3	1.2	13	20	W241025
W241026	.51	3.7	1.6	77	1.0L	14	2.0	28	52	W241026
W241027	.20	.97	.48	30	1.0L	9.2	1.2	8.0	30	W241027
W241028	.96	8.7	3.8	88	2.0L	11	2.9	65	83	W241028
W246430	.28	1.6	1.0	33	.90L	17	1.3	7.8	40	W246430
W246431	.58	3.0	.63	68	1.0L	20	1.8	89	78	W246431
W246432	.24	1.3	.64	29	.80L	13	1.3	18	37	W246432
W246433	.15	1.1	.24L	30	1.0L	7.2	.75	19	20	W246433
W246437	.20	.25	.22L	9.6	1.0L	11	.75	5.2	13	W246437
W246438	.28	.86	.22L	17	.80L	13	.99	33	24	W246438
W246439	.16	.27	.21L	10	1.0L	11	.73	12	16	W246439
W246440	.20	.40	.22L	30	.90L	12	.74	11	20	W246440
W246441	.17	.98	.22L	23	1.0L	9.7	.71	7.7	21	W246441
W246442	.67	7.7	1.6	200	2.0L	17	2.5	42	130	W246442
W246443	.77	6.0	4.0	43	1.0L	7.2	2.2	22	39	W246443
W246429	.42	3.5	.97	60	1.0L	14	1.7	16	100	W246429
W246435	.74	4.8	5.8	130	2.0L	25	2.4	39	79	W246435
W246436	.64	1.1	.21L	35	1.0L	31	2.8	20	41	W246436
W246434	.15	.42	.23L	16	1.0L	8.7	.69	17	13	W246434
W246444	.28	2.3	.77	38	1.0L	6.0	.89	14	20	W246444
W246445	.43	1.8	.29L	110	2.0L	44	1.7	730	77	W246445
W246446	.70	6.9	1.6	32	1.0L	3.3	3.0	270	17	W246446
W246447	.28	1.0	.26L	36	1.0L	16L	.87	55	50	W246447
W246448	.20	.38	.22L	100	1.0L	35	.83	64	93	W246448
W237524	.18	1.7	.54	39	1.0L		.58	13	48	W237524
W237525	.33	2.2	.49	66	.090L		1.6	25	57	W237525
W237526	.22	.70	.50	38	1.0L		1.0	7.5	25	W237526
W237527	.26	.88	.26L	18	1.0L		1.3	25	26	W237527
W246127	.24	.38	.24L	16	B	14	1.1	8.5	16	W246127
W246128	.38	2.0	.42	37	B	14	1.6	34	42	W246128
W246129	.38	1.9	.45	73	B	16	1.8	18	53	W246129
W246130	.38	2.8	.51	73	B	13	1.6	18	40	W246130
W246131	.31	1.2	.26L	30	B	15	1.6	13	29	W246131
W246132	.21	1.9	1.1	34	B	11	1.3	7.5	38	W246132
W246137	.42	2.2	2.6	51	B	20	2.5	46	97	W246137
W246138	.29	.72	.39	28	B	17	1.6	10	36	W246138

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	SI (PERCENT)	AL (PERCENT)	CA (PERCENT)	MG (PERCENT)	NA (PERCENT)	K (PERCENT)	FE (PERCENT)	TI (PERCENT)	AG-S PPM	AS PPM	SAMPLE NUMBER
W246139	4.0	3.2	0.57	0.088	0.53	0.040	4.4	0.48	0.33	3.1	W246139
W246140	4.7	4.0	.57	.086	.58	.046	3.8	.61	.078	4.5	W246140
W246141	14	10	.32	.10	.35	.10	9.5	1.8	.15	3.4	W246141
W246142	.49	.29	.64	.099	.78	.016	.82	.030	.016	3.2	W246142
W246143	.24	.13	.64	.18	.71	.013	.33	.013	.011	.80L	W246143
W246144	.26	.20	.62	.026	.67	.013	.26	.024	.015	.90L	W246144
W246145	3.5	2.5	.72	.11	.62	.027	1.6	.78	.046	1.2	W246145
W246146	5.3	4.1	.48	.14	.50	.050	7.0	.44	.11	23	W246146
W246147	.45	.15	.70	.15	.62	.013	3.1	.025	.056	7.2	W246147
W246148	.33	.13	.69	.15	1.0	.012	1.3	.037	.037	4.2	W246148
W246149	1.5	.83	.53	.16	.67	.025	3.8	.33	.081	.90L	W246149
W246150	8.5	1.8	.54	.12	.64	.046	3.3	.27	.082	3.1	W246150
W246133	1.2	.82	.44	.091	.59	.016	1.6	.11	.043	1.8	W246133
W246134	8.2	6.6	.39	.15	.65	.083	2.1	.65	.12	2.6	W246134
W246135	1.8	1.5	.52	.088	.63	.022	1.8	.21	.029	4.6	W246135
W246136	1.7	.64	.30	.053	.43	.016	16	.081	.033L	6.1	W246136
W246151	2.6	2.0	.53	.069	.45	.020	2.3	.45	.066	6.0	W246151
W246152	1.1	.52	.54	.19	.50	.015	1.9	.14	.011L	4.4	W246152
W246153	10	8.4	.40	.20	.41	.097	6.2	1.3	.096	8.8	W246153
W246154	.65	.46	.58	.13	.82	.016	.25	.035	.016	.90L	W246154
W246155	2.4	2.1	.56	.14	.84	.025	.51	.18	.074	.90L	W246155
W246156	.40	.32	.50	.12	.88	.018	.23	.019	.009	1.0L	W246156
W246157	3.0	2.6	1.2	.14	.84	.031	.39	.21	.035	.90L	W246157
W246158	3.3	3.0	.57	.14	.85	.029	.74	.35	.055	1.0L	W246158
W246159	2.1	1.8	.55	.13	.75	.022	1.1	.16	.046	1.5	W246159
W246462	19	7.5	.36	.19	.39	.37	3.3	1.9	.13	1.9	W246462
W246463	.70	.54	.60	.15	.50	.012	.21	.080	.016	1.0L	W246463
W246464	2.4	2.2	.57	.13	.44	.029	1.7	.16	.043	2.9	W246464
W246465	2.4	1.4	.61	.38	.86	.026	1.0	.26	.025	1.0L	W246465
W246466	.53	.35	.62	.18	.36	.013	.72	.051	.007L	1.0L	W246466
W246467	8.7	4.5	.43	.27	.26	.11	9.0	.81	.24	9.7	W246467
W246468	12	6.5	.37	.27	.27	.27	8.4	.98	.15	5.6	W246468
W246469	1.2	.80	.57	.21	.20	.024	3.2	.14	.044	1.9	W246469
W246470	5.8	5.2	.40	.19	.16	.069	6.3	.67	.083	3.3	W246470
W246476	11	7.9	.27	.25	.29	.13	10	1.1	.10	7.1	W246476
W246477	7.2	5.6	.56	.22	.41	.051	1.1	1.2	.034L	8.7	W246477
W246478	8.8	6.8	.29	.17	.27	.069	8.7	.95	.20	3.4	W246478
W246479	9.3	6.7	.26	.20	.17	.14	11	1.1	.23	1.6	W246479
W246480	6.2	4.8	.41	.21	.19	.053	5.6	.54	.10	3.0L	W246480
W246482	3.1	1.6	.57	.20	.51	.032	2.2	.29	.018L	10	W246482

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	B-S PPM	BA-S PPM	BE-S PPM	BR PPM	CD PPM	CE PPM	CL PPM	CO PPM	CR PPM	CS PPM	SAMPLE NUMBER
W246139	140	43	2.1	97	0.10	30	990	12	54	0.21	W246139
W246140	270	47	3.0	130	.086	22	940	37	66	.20L	W246140
W246141	97	64	1.0L	92	.070	57	400	74	210	.80	W246141
W246142	51	66	3.1	380	.016	4.0	1,800	23	5.2	.09L	W246142
W246143	34	120	1.7	220	.003	3.0	1,900	31	2.2	.06L	W246143
W246144	35	120	1.6	220	.014	4.1	1,900	27	3.8	.07L	W246144
W246145	120	86	4.4	160	.004L	16	1,200	22	65	.10L	W246145
W246146	310	130	2.2	190	.13	32	1,200	110	68	.32	W246146
W246147	76	70	3.1	210	.016	3.5	1,900	280	4.3	.20L	W246147
W246148	55	180	2.7	180	.012	4.1	1,800	25	5.5	.09L	W246148
W246149	110	27	3.1	110	.011	9.0	1,400	3.6	32	.10L	W246149
W246150	180	70	.55	420	.073	12	920	13	36	.10L	W246150
W246133	73	48	2.5	80	.071	16	1,300	16	28	.10L	W246133
W246134	320	61	4.2	170	.22	57	900	21	96	.49	W246134
W246135	87	42	.82	160	.059	12	950	17	24	.10L	W246135
W246136	160	33	4.3	230	.20	5.1	800	25	20	.20L	W246136
W246151	110	64	4.3	94	.079	25	600	37	48	.10L	W246151
W246152	84	28	1.6	160	.018	7.7	1,100	11	18	.09L	W246152
W246153	200	59	3.3	130	.13	61	400	33	160	.45	W246153
W246154	54	43	.27	140	.026	6.0	1,800	2.8	6.7	.08L	W246154
W246155	99	38	.21L	140	.019	13	2,300	4.6	35	.10L	W246155
W246156	44	99	.33	170	.057	4.2	1,300	4.3	3.2	.05L	W246156
W246157	110	49	.25L	140	.037	13	1,500	7.1	32	.09L	W246157
W246158	120	48	.28L	190	.022	17	1,100	7.8	48	.14	W246158
W246159	91	45	3.5	150	.023	19	1,100	6.3	31	.20L	W246159
W246462	180	150	1.6	330	.014L	56	100L	17	250	.50	W246462
W246463	64G	17	.61	610	.001L	5.1	800	1.6	9.6	.07L	W246463
W246464	160G	22	1.5	440	.019	8.9	500	8.4	25	.12	W246464
W246465	140G	21	3.1	620	.016	16	800	8.9	33	.10L	W246465
W246466	68G	14	.95	420	.007	2.6	900	1.4	5.9	.07L	W246466
W246467	250	31	4.4	450	.10	39	1,000	40	120	.40	W246467
W246468	210	76	3.3	350	.20	55	900	54	150	.58	W246468
W246469	130G	230	2.3	350	.033	7.4	300	11	19	.10L	W246469
W246470	170	76	1.9	270	.12	31	200	25	79	.21	W246470
W246476	150	120	1.2	210	.18	57	600	67	140	.78	W246476
W246477	310	120	4.4	350	.007L	49	500	85	120	.27	W246477
W246478	190	110	2.4	290	.012	61	300	68	130	.65	W246478
W246479	140	170	2.6	410	.040	13	200	7.2	37	.10L	W246479
W246480	180	97	4.9	58	.16	25	400	4.5	94	.10L	W246480
W246482	180G	40	2.7	14	.009	70	900	60	260	.67	W246482

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	CU PPM	DY-S PPM	EU PPM	F PPM	GA-S PPM	GD-S PPM	GE-S PPM	HF PPM	HG PPM	HO-S PPM	SAMPLE NUMBER
W246139	28	2.5L	0.78	60	19	5.5L	5.5	2.0	0.020	0.38L	W246139
W246140	61	2.8L	.63	100	27	6.1L	6.4	2.3	.005L	.42L	W246140
W246141	84	7.0L	1.1	100	39	15L	3.2L	7.3	.010	1.0L	W246141
W246142	9.9	.71L	.24	20L	20	1.6L	13	.13	.005L	.65	W246142
W246143	4.7	.51L	.08	20L	9.2	1.1L	1.1	.12	.005L	.39	W246143
W246144	20	.48L	.16	20L	16	1.5L	12	.14	.005L	.07L	W246144
W246145	48	2.0L	.72	20	20	4.4L	12	2.7	.005L	.30L	W246145
W246146	90	3.3L	.85	60	22	7.3L	9.6	2.1	.050	.50L	W246146
W246147	7.5	1.0L	.20	20L	12	2.3L	7.7	.20L	.040	.15L	W246147
W246148	6.1	.73L	.40	20L	8	1.6L	25	.22	.005L	.11L	W246148
W246149	23	1.6L	.39	50	17	3.4L	8.6	1.2	.005L	.23L	W246149
W246150	20	3.0L	.26	20L	6.4	6.7L	1.5	1.7	.005L	.46L	W246150
W246133	20	1.0L	.68	60	14	2.3L	5.2	.64	.005L	.15L	W246133
W246134	130	3.8L	1.6	70	28	8.4L	7.6	3.2	.005L	.57L	W246134
W246135	25	1.3L	.28	60	10	2.9L	.90	.88	.005L	.20L	W246135
W246136	11	3.3L	.32	70	28	7.2L	39	.34	.030	.49L	W246136
W246151	41	1.9L	.71	100	23	4.1L	36	2.0	.040	.28L	W246151
W246152	11	1.1L	.44	80	13	2.5L	8.7	.69	.060	.17L	W246152
W246153	80	5.3L	1.5	200	25	12L	2.4L	4.9	.050	.80L	W246153
W246154	7.6	.63L	.21	100	8.8	1.4L	1.0	.37	.005L	.24	W246154
W246155	49	1.4L	.38	100	10	3.0L	.63L	1.1	.005L	.27	W246155
W246156	4.9	.52L	.12	60	5.0	1.1L	.30	.13	.005L	.08L	W246156
W246157	54	1.7L	.28	20L	12	3.7L	.77L	1.1	.005L	.25L	W246157
W246158	81	1.8L	.35	20L	13	4.0L	.85L	1.7	.005L	.28L	W246158
W246159	56	1.4L	.87	20L	20	3.0L	11	.99	.005L	.79	W246159
W246462	53	6.8L	1.1	50	21	15L	3.1L	9.2	.030	6.8	W246462
W246463	14	.64L	.16	50	5.6	1.4L	2.8	.40	.005L	.64	W246463
W246464	30	1.6L	.32	50	13	3.5L	5.2	.79	.050	.24L	W246464
W246465	18	1.4L	.54	40	12	3.1L	11	1.1	.020	.21L	W246465
W246466	6.3	.68L	.10	20L	4.5	1.5L	3.5	.23	.005L	.10L	W246466
W246467	47	4.7L	1.1	90	19	10L	13	4.1	.040	.71L	W246467
W246468	70	5.8L	1.5	80	18	13L	4.9	5.1	.005L	.87L	W246468
W246469	11	1.3L	.35	30	11	2.9L	9.0	.75	.030	.20L	W246469
W246470	47	3.6L	.86	80	18	8.0L	9.4	2.8	.050	.54L	W246470
W246476	86	6.2L	1.6	50	9.8	14L	2.8L	4.1	.030	.92L	W246476
W246477	51	3.4L	1.4	60	24	7.5L	8.6	3.8	.010	.51L	W246477
W246478	98	5.2L	1.7	100	27	11L	6.2	4.1	.040	.78L	W246478
W246479	69	5.7L	.43	100	23	13L	3.0	1.5	.005L	.86L	W246479
W246480	75	3.7L	.61	100	22	8.2L	8.2	3.7	.040	.56L	W246480
W246482	31	1.8L	1.8	100	20	4.0L	11	9.0	.040	.27L	W246482

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	IN-S PPM	LA PPM	LI PPM	LU PPM	MN PPM	MO-S PPM	NB-S PPM	ND-S PPM	NI-S PPM	P PPM	SAMPLE NUMBER
W246139	1.7L	18	40	0.19	76	8.6	11	28	40	44	W246139
W246140	1.9L	14	55	.15	64	3.9	12	12	64	44	W246140
W246141	4.7L	38	110	.21	97	5.9	15	29	130	87	W246141
W246142	.48L	2.3	2.8	.18	11	1.1	.42	11L	71	44L	W246142
W246143	.35L	1.5	1.1	.06L	11	.77	.43	7.7L	97	44L	W246143
W246144	.33L	2.1	1.7	.06L	12	1.1	.86	7.2L	72	44L	W246144
W246145	1.4L	9.8	30	.21	42	1.2	8.8	6.4L	96	44L	W246145
W246146	2.3L	18	40	.23	.33	8.3	6.3	20	370	44L	W246146
W246147	.70L	1.5	1.0L	.10L	8.2	3.7	.98	4.2	700	44L	W246147
W246148	.50L	1.5	.88	.15	11	1.8	1.3	6.0	80	44L	W246148
W246149	1.1L	6.1	14	.29	25	3.1	5.9	23L	9.5	44L	W246149
W246150	2.1L	7.1	20	.07L	76	7.6	8.2	19	33	44L	W246150
W246133	.70L	7.5	8.3	.25	28	4.0	.99	10	37	44L	W246133
W246134	2.6L	33	65	.60	15	2.4	11	34	88	87	W246134
W246135	.90L	7.5	17	.05L	13	2.6	2.2	4.2L	34	44L	W246135
W246136	2.2L	2.3	7.2	.18	110	26	5.9	11L	170	44L	W246136
W246151	1.3L	16	34	.17	53	3.2	9.6	28L	71	44L	W246151
W246152	.76L	4.3	3.9	.13	74	2.6	2.9	5.7	47	44L	W246152
W246153	3.6L	36	52	.35	110	11	20	24	140	130	W246153
W246154	.43L	3.2	5.2	.05L	7.6	.51	1.0	8.2	23	44L	W246154
W246155	.93L	7.2	15	.12	6.7	.52	2.3	5.3	25	44L	W246155
W246156	.35L	2.2	2.9	.05L	6.8	.94	1.1	3.8	49	44L	W246156
W246157	1.1L	9.2	10	.05L	25	.50	2.9	5.4L	40	44L	W246157
W246158	1.3L	12	18	.08	10	.66	3.7	5.9L	42	44	W246158
W246159	.92L	8.6	15	.33	16	.76	2.9	9.7	35	44L	W246159
W246462	4.6L	36	43	.33	200	3.2	35	22L	74	130	W246462
W246463	.44L	3.2	3.3	.05L	22	.52	1.2	5.3	9.0	44L	W246463
W246464	1.1L	6.3	17	.15	21	.98	2.4	5.1L	44	44L	W246464
W246465	.96L	9.9	13	.21	35	.83	4.1	12	30	44L	W246465
W246466	.46L	2.0	2.7	.04L	47	.95	2.0	2.2L	9.5	44L	W246466
W246467	3.2L	23	57	.46	170	10	16	15L	80	44	W246467
W246468	4.0L	32	70	.48	180	12	13	28	100	87	W246468
W246469	.88L	4.5	5.6	.25	44	2.5	2.0	7.0	35	44L	W246469
W246470	2.5L	21	40	.22	62	5.1	4.7	20	72	44	W246470
W246476	4.2L	36	100	.34	200	8.0	6.8	20L	92	87	W246476
W246477	2.3L	31	48	.32	65	1.4	13	21	44	87	W246477
W246478	3.5L	37	62	.39	83	7.8	29	34	200	87	W246478
W246479	3.9L	8.7	50	.20	130	13	13	32	130	87	W246479
W246480	2.5L	21	41	.19	28	4.1	7.5	31	100	44	W246480
W246482	1.2L	42	15	.51	110	1.0	1.7	5.8L	29	44L	W246482

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	PB PPM	PR-S PPM	RB PPM	SB PPM	SC PPM	SE PPM	SM PPM	SN-S PPM	SR-S PPM	TA PPM	SAMPLE NUMBER
W246139	2.8	1.7L	40L	0.59	14	6.6	3.4	4.3	180	0.72	W246139
W246140	2.8	1.9L	40L	.22	14	7.2	2.6	3.6	270	.97	W246140
W246141	7.0L	4.7L	30L	.40L	31	2.3	5.1	10	160	2.7	W246141
W246142	.92	.48L	40L	.16	4.6	2.7	.73	1.6	1,100	.060L	W246142
W246143	.61	.35L	40L	.11	.38	2.5	.31	.23L	1,600	.060L	W246143
W246144	.82	1.1	30L	.10L	1.4	2.7	.61	.22L	2,000	.064	W246144
W246145	6.0	1.4L	40L	.17	13	4.6	2.7	1.9	920	1.2	W246145
W246146	6.3	2.3L	30L	.40	18	5.4	3.5	6.0	310	.74	W246146
W246147	1.0L	.70L	30L	.20L	1.1	4.2	.71	4.9	2,100	.10L	W246147
W246148	5.1	.72	50L	.30	3.5	3.7	1.3	2.3	1,500	.12	W246148
W246149	1.6L	1.1L	29L	.20L	11	5.6	1.3	4.5	720	.56	W246149
W246150	3.0L	2.1L	32	.11	4.2	5.9	1.1	3.3	670	.47	W246150
W246133	1.0L	1.4	40L	.28	10	3.4	2.4	1.5	1,100	.20	W246133
W246134	6.1	2.6L	40L	.20L	33	2.5	6.5	2.0	610	1.2	W246134
W246135	1.8	.90L	50L	.14	5.6	6.9	1.1	1.3	1,100	.36	W246135
W246136	3.3L	2.2L	40L	.25	9.5	4.7	.95	22	460	.19	W246136
W246151	5.5	1.3L	40L	.20	13	8.4	2.7	3.2	360	1.0	W246151
W246152	1.2	.76L	25L	.12	4.8	4.4	1.6	2.1	1,600	.25	W246152
W246153	5.3L	3.6L	27L	.27	32	5.0	6.3	4.7	430	2.1	W246153
W246154	1.2	.43L	30L	.20L	5.4	3.0	.90	.76	1,600	.095	W246154
W246155	2.6	.93L	31L	.20L	12	4.1	1.7	1.1	860	.39	W246155
W246156	.52L	.83	30	.10L	1.1	2.6	.51	.24L	2,100	.044	W246156
W246157	2.7	1.1L	30L	.20L	7.6	4.0	1.2	.77L	790	.43	W246157
W246158	2.9	1.3L	40L	.20L	10	3.5	1.5	1.5	880	.66	W246158
W246159	1.8	1.4	26L	.20L	15	3.3	3.2	.64	1,300	.33	W246159
W246462	8.1	4.6L	17L	.10L	26	2.1	5.6	5.0	450	2.8	W246462
W246463	1.0	.44L	17L	.10L	3.6	2.0	.66	.64	1,500	.16	W246463
W246464	1.9	1.1L	21L	.10L	8.1	3.0	1.2	1.6	1,000	.30	W246464
W246465	2.0	.96L	17L	.20L	9.9	2.7	2.0	1.4	800	.38	W246465
W246466	.68L	.46L	15L	.10L	2.3	3.0	.42	1.0	1,100	.11	W246466
W246467	4.7L	3.2L	18L	.21	23	5.4	4.3	13	290	1.4	W246467
W246468	5.8L	4.0L	17L	.24	28	3.6	6.2	8.7	310	1.6	W246468
W246469	1.3L	.88L	13L	.10L	8.4	3.0	1.1	3.5	1,700	.21	W246469
W246470	3.6L	2.5L	14L	.21	18	2.8	3.5	8.0	510	1.1	W246470
W246476	6.2L	4.2L	16L	.36	29	3.7	6.7	3.6	160	1.8	W246476
W246477	9.2	2.3L	23L	.20L	28	2.5	5.8	2.0	1,100	1.5	W246477
W246478	5.7	3.5L	15L	.27	26	3.7	6.8	12	570	1.8	W246478
W246479	5.7L	3.9L	80L	.20L	11	2.8	1.6	15	470	.44	W246479
W246480	5.2	2.5L	9.0L	.18	13	2.7	2.5	7.9	790	1.8	W246480
W246482	2.2	1.2L	70L	.26	31	1.6	7.9	2.0	1,300	2.7	W246482

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	TB PPM	TH PPM	U PPM	V-S PPM	W PPM	Y-S PPM	YB PPM	ZN PPM	ZR-S PPM	SAMPLE NUMBER
W246139	0.48	3.6	1.8	55	B	17	1.9	17	73	W246139
W246140	.35	3.7	1.1	83	B	7.2	1.0	33	47	W246140
W246141	.62	10	2.4	170	B	6.8	1.8	65	140	W246141
W246142	.19	.28	.26L	9.9	B	13	1.5	11	11	W246142
W246143	.044	.24	.26L	3.7	B	8.7	.50L	5.6	8.2	W246143
W246144	.090	.42	.25L	28	B	8.2	.40L	45	12	W246144
W246145	.57	3.5	.89	74	B	17	1.9	120	44	W246145
W246146	.52	3.3	.99	83	B	12	1.7	40	50	W246146
W246147	.15	.31	.22L	4.5	B	10	.72	12	5.4	W246147
W246148	.30	.27	.22L	13	B	14	1.1	56	23	W246148
W246149	.27	1.9	.97	28	B	17	2.0	6.7	48	W246149
W246150	.13	1.8	.91	46	B	4.6	.50L	17	61	W246150
W246133	.43	.89	1.4	42	B	18	1.8	30	27	W246133
W246134	.88	5.8	1.3	200	B	26	3.8	99	110	W246134
W246135	.15	1.6	.90	29	B	5.3	.60	5.7	28	W246135
W246136	.25	.52	1.3	36	B	12	1.4	24	26	W246136
W246151	.37	2.6	.77	70	B	15	1.3	24	56	W246151
W246152	.32	.97	.40	17	B	15	1.3	12	29	W246152
W246153	.76	7.0	3.5	130	B	15	2.7	59	140	W246153
W246154	.14	.99	.21L	12	B	4.4	.40L	11	14	W246154
W246155	.21	1.9	.40	58	B	4.0	.97	10	30	W246155
W246156	.061	.21	.20L	12	B	4.5	.40L	49	12	W246156
W246157	.14	2.0	.39	44	B	4.0	.61	35	37	W246157
W246158	.19	3.2	.65	59	B	2.9	.50	33	39	W246158
W246159	.54	2.4	.55	73	B	23	2.8	9.1	30	W246159
W246462	.60	12	2.1	120	1.0L	16	2.2	68	240	W246462
W246463	.10	.66	.26	30	1.0L	6.3	.88	2.0	13	W246463
W246464	.22	1.5	.30L	38	1.0L	7.6	1.2	15	17	W246464
W246465	.30	1.6	.64	42	1.0L	14	1.4	25	48	W246465
W246466	.058	.38	.20L	12	.80L	4.4	.43	2.5	16	W246466
W246467	.68	6.5	2.7	120	1.0L	30	3.2	44	150	W246467
W246468	.77	7.3	3.8	170	2.0L	21	3.1	81	170	W246468
W246469	.23	.80	.34	25	1.0L	11	1.5	11	29	W246469
W246470	.47	4.1	1.5	76	1.0L	13	1.8	34	58	W246470
W246476	.77	6.9	3.4	92	3.0L	12	3.0	68	98	W246476
W246477	.75	5.8	1.3	85	3.0L	12	2.8	30	85	W246477
W246478	.77	6.8	1.3	170	3.0L	24	2.8	83	230	W246478
W246479	.27	1.8	3.1	130	2.0L	21	1.4	130	140	W246479
W246480	.36	5.2	1.2	120	8.0L	25	1.4	41	90	W246480
W246482	.89	10	.40	38	1.4	12	3.2	20	47	W246482

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	SI (PERCENT)	AL (PERCENT)	CA (PERCENT)	MG (PERCENT)	NA (PERCENT)	K (PERCENT)	FE (PERCENT)	TI (PERCENT)	AG-S PPM	AS PPM	SAMPLE NUMBER
W246481	23	8.1	0.34	0.30	0.29	0.44	7.9	1.9	0.088L	4.2	W246481
W246483	20	13	.14	.20	.33	.14	2.3	2.5	.20	1.8	W246483
W246485	18	15	.16	.19	.32	.11	1.4	1.7	.25	11	W246485
W246486	6.2	3.2	.52	.18	.29	.026	2.3	.86	.12	.60L	W246486
W246484	1.5	1.2	.65	.19	.45	.017	.58	.13	.028	.70L	W246484
W246487	3.0	2.0	.91	.26	.38	.026	4.3	.35	.055	1.6	W246487
W246488	6.5	2.4	.55	.18	.38	.038	1.8	.57	.054	3.6	W246488
W246489	12	8.6	.37	.20	.41	.082	1.4	1.3	.12	2.6	W246489
W246509	1.6	.60	.73	.18	.53	.022	2.6	.23	.021	2.0	W246509
W246510	.59	.53	.55	.18	.52	.013	.63	.068	.008L	1.0L	W246510
W246160	1.4	.94	.51	.072	.69	.019	1.6	.41	.055	1.9	W246160
W246449	.59	.49	.65	.23	.41	.019	2.9	.11	.057	6.4	W246449
W246450	8.5	6.3	.33	.16	.35	.12	13	.76	.28	5.6	W246450
W246451	3.3	2.2	.52	.16	.40	.056	5.6	.37	.10	3.2	W246451
W246452	1.5	1.1	.59	.16	.45	.035	4.3	.16	.069	2.6	W246452
W246453	2.6	2.2	.60	.18	.45	.049	2.0	.39	.055	1.5	W246453
W246454	1.7	1.2	.60	.18	.24	.032	5.6	.19	.076	3.0	W246454
W246455	5.7	4.3	.45	.20	.41	.12	6.6	.75	.14	9.1	W246455
W246456	1.7	1.3	.61	.16	.45	.025	1.8	.23	.038	1.6	W246456
W246457	1.5	1.2	.61	.20	.42	.023	2.9	.16	.055	4.5	W246457
W246458	11	9.9	.39	.19	.39	.10	3.4	.75	.23	7.2	W246458
W246459	4.7	2.8	.50	.18	.50	.042	2.2	.59	.058	1.9	W246459
W246460	8.6	6.9	.27	.13	.33	.11	13	.77	.20	11	W246460
W246461	6.9	4.6	.54	.20	.39	.11	9.0	.68	.045L	10	W246461
W246471	2.9	1.8	.65	.20	.30	.032	3.4	.33	.084	1.7	W246471
W246472	1.0	.84	.68	.20	.30	.017	.77	.076	.022	2.1	W246472
W246473	15	4.6	.30	.16	.21	.14	8.0	.94	.15	4.3	W246473
W246474	1.5	.83	.62	.16	.24	.027	5.7	.18	.079	4.1	W246474
W246475	8.8	7.0	.49	.23	.24	.057	1.9	.70	.30	6.3	W246475
W246490	16	7.3	.21	.24	.40	.25	9.7	1.2	.14	16	W246490
W246491	1.6	.72	.56	.21	.49	.041	5.6	.17	.068	1.7	W246491
W246492	2.8	1.7	.56	.18	.46	.029	2.5	.39	.026	1.2	W246492
W246493	1.3	.85	.51	.14	.42	.020	3.7	.12	.042	1.1	W246493
W246494	12	8.6	.15	.15	.29	.13	12	1.6	.16	6.5	W246494
W246495	.35	.29	.60	.17	.45	.015	1.2	.047	.014	1.6	W246495
W246496	.14	.12	.59	.17	.43	.010	.60	.012	.009	.82	W246496
W246497	3.0	2.0	.52	.19	.38	.064	2.4	.39	.049	10	W246497
W246498	2.0	.83	.58	.17	.51	.025	9.3	.31	.022	1.3	W246498
W246499	.33	.12	.75	.16	.53	.011	1.0	.016	.020	.60L	W246499
W246500	.15	.16	.55	.15	.51	.008	1.6	.019	.021	2.1	W246500

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	B-S PPM	BA-S PPM	BE-S PPM	BR PPM	CD PPM	CE PPM	CL PPM	CO PPM	CR PPM	CS PPM	SAMPLE NUMBER
W246481	96	250	1.3L	410	0.027	37	300	37	75	0.40	W246481
W246483	130	290	1.6	21	.041	84	300	68	270	.55	W246483
W246485	170	270	1.5	400	.040	23	200	29	76	.20L	W246485
W246486	250	77	5.4	71	.012	81	400	8.1	170	.45	W246486
W246484	100G	22	.46	370	.005	12	800	12	21	.10L	W246484
W246487	240G	46	2.0	410	.067	19	2,700	21	41	.22	W246487
W246488	230	43	4.6	44	.023	18	500	26	62	.20L	W246488
W246489	220	78	6.8	47	.14	53	200	45	140	.47	W246489
W246509	140G	17	2.4	400	.015	9.9	100	8.1	25	.10L	W246509
W246510	76G	9.9	.62	590	.024	6.2	1,200	9.2	10	.08L	W246510
W246160	77	42	2.2	76	.033	11	1,200	19	49	.10L	W246160
W246449	110G	11	3.7	170	.023	5.9	800	7.8	22	.10L	W246449
W246450	190	27	1.3	62	.16	57	100	66	110	.64	W246450
W246451	250	19	3.5	99	.038	15	200	43	50	.20L	W246451
W246452	160G	16	2.4	150	.050	11	500	26	23	.10L	W246452
W246453	180G	790	2.1	58	.039	12	300	9.5	36	.19	W246453
W246454	180	67	2.2	33	.13	10	100	6.7	24	.28	W246454
W246455	350	32	1.4	28	.29	27	700	33	92	.34	W246455
W246456	130G	25	1.1	23	.033	9.7	200	8.2	26	.10L	W246456
W246457	140G	20	1.6	24	.066	8.3	200	15	23	.10L	W246457
W246458	270	87	5.4	18	.22	68	100L	57	110	.47	W246458
W246459	240G	48	3.6	81	.013	14	500	9.5	61	.10L	W246459
W246460	150	45	1.5	24	.20	52	100L	110	100	.57	W246460
W246461	240	14L	2.4	69	.095	33	400	30	89	.22	W246461
W246471	200G	46	4.2	40	.032	12	700	7.1	54	.10L	W246471
W246472	93G	29	.86	30	.029	5.3	700	4.4	12	.08L	W246472
W246473	170	160	2.4	25	.18	53	400	29	150	.36	W246473
W246474	180G	29	4.6	53	.057	8.4	500	12	22	.10L	W246474
W246475	220	100	6.4	41	.37	68	300	54	98	.32	W246475
W246490	120	49	1.5	23	.12	67	600	52	220	.61	W246490
W246491	190G	13	4.1	80	.041	9.6	1,300	6.3	28	.20L	W246491
W246492	180G	18	2.2	63	.012	11	700	9.8	41	.10L	W246492
W246493	140G	7.3	1.3	100	.003L	5.7	700	7.9	18	.13	W246493
W246494	97	65	1.0L	92	.16	77	300	61	180	.74	W246494
W246495	76G	16	.26	55	.027	3.0	800	4.0	7.7	.06L	W246495
W246496	55G	15	1.1	72	.006	4.1	920	20	2.4	.07L	W246496
W246497	190G	19	4.9	88	.096	12	600	25	56	.20L	W246497
W246498	160G	19	3.2	100	.027	14	800	8.1	41	.10L	W246498
W246499	75G	19	.75	76	.014	2.0	900	.90	1.5	.05L	W246499
W246500	74G	16	.89	72	.027	1.8	900	18	3.3	.10L	W246500

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	CU PPM	DY-S PPM	EU PPM	F PPM	GA-S PPM	GD-S PPM	GE-S PPM	HF PPM	HG PPM	HO-S PPM	SAMPLE NUMBER
W246481	78	8.8L	1.3	100	16	19L	4.0L	2.8	0.005L	1.3L	W246481
W246483	150	8.2L	2.3	20L	39	18L	3.8L	9.9	.010	1.2L	W246483
W246485	200	8.1L	.73	90	44	18L	3.7L	3.4	.005L	1.2L	W246485
W246486	54	2.9L	1.8	100	22	6.3L	29	7.0	.030	.43L	W246486
W246484	28	1.0L	.43	60	7.9	2.3L	3.5	.65	.030	.16L	W246484
W246487	34	2.4L	.60	70	14	5.3L	7.2	1.5	.030	.36L	W246487
W246488	57	2.7L	.71	30	19	5.9L	23	2.7	.040	.41L	W246488
W246489	120	5.2L	1.5	70	28	11L	48	5.1	.070	.78L	W246489
W246509	17	1.4L	.49	20L	12	3.1L	9.0	1.1	.040	.21L	W246509
W246510	11	.76L	.27	20L	6.5	1.7L	2.9	.34	.020	.11L	W246510
W246160	63	1.2L	.42	20L	26	2.6L	15	1.6	.005L	.18L	W246160
W246449	15	1.1L	.44	70	17	2.5L	21	.60	.040	.17L	W246449
W246450	73	5.6L	1.7	60	22	12L	4.3	3.3	.020	.84L	W246450
W246451	33	2.5L	.66	20L	10	5.5L	5.8	1.6	.060	.38L	W246451
W246452	21	1.6L	.63	90	13	3.5L	4.2	.80	.12	.24L	W246452
W246453	30	1.8L	.55	40	17	3.9L	10	1.3	.050	.27L	W246453
W246454	16	1.9L	.48	70	11	4.1L	17	.75	.040	.28L	W246454
W246455	44	3.7L	.74	20L	20	8.1L	10	3.0	.050	.56L	W246455
W246456	20	1.3L	.33	20	9.6	2.9L	5.5	.87	.15	.20L	W246456
W246457	20	1.4L	.31	20L	9.9	3.1L	6.3	.69	.14	.21L	W246457
W246458	160	5.4L	1.9	20	34	12L	11	3.8	.17	.81L	W246458
W246459	31	2.4L	.50	20L	20	5.3L	10	2.2	.14	.36L	W246459
W246460	83	6.4L	1.4	70	21	14L	4.1	3.4	.060	.96L	W246460
W246461	54	4.5L	.88	60	19	9.9L	11	2.8	.090	.68L	W246461
W246471	48	2.0L	.60	30	16	4.4L	24	1.6	.040	.30L	W246471
W246472	17	.93L	.17	30	7.0	2.0L	4.6	.37	.050	.14L	W246472
W246473	75	5.8L	1.4	40	9.8	13L	2.7L	6.0	.020	.87L	W246473
W246474	24	1.8L	.45	60	15	4.0L	17	.86	.060	.27L	W246474
W246475	150	4.0L	2.1	90	28	8.8L	26	3.5	.13	.60L	W246475
W246490	60	7.4L	1.7	70	21	16L	3.4L	7.4	.005L	1.1L	W246490
W246491	15	1.9L	.51	30	18	4.1L	18	.98	.020	.28L	W246491
W246492	27	1.8L	.40	30	16	4.0L	11	1.4	.010	.27L	W246492
W246493	16	1.4L	.25	30	10	3.2L	7.3	.51	.050	.22L	W246493
W246494	69	6.9L	2.0	30	17	15L	3.2L	6.2	.12	1.0L	W246494
W246495	7.6	.76L	.11	30	1.7	1.7L	.35L	.23	.040	.11L	W246495
W246496	8.3	1.2L	.21	70	7.2	1.2L	5.0	.09	.005L	.08L	W246496
W246497	36	1.9L	.62	30	19	4.1L	21	1.7	.090	.28L	W246497
W246498	46	1.6L	.48	90	15	3.5L	11	1.7	.050	.24L	W246498
W246499	11	.75L	.06	30	2.9	1.7L	.98	.07	.010	.11L	W246499
W246500	8.9	.74L	.10	90	3.8	1.6L	5.2	.11	.030	.11L	W246500

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	IN-S PPM	LA PPM	LI PPM	LU PPM	MN PPM	MO-S PPM	NB-S PPM	ND-S PPM	NI-S PPM	P PPM	SAMPLE NUMBER
W246481	6.0L	23	48	0.46	630	4.7	44	34	110	260	W246481
W246483	5.6L	55	90	.56	140	3.4	57	47	210	130	W246483
W246485	5.5L	16	130	.30	61	4.6	59	30	150	170	W246485
W246486	1.9L	59	26	.24	54	2.9	9.4	25	430	44	W246486
W246484	.71L	7.2	10	.10L	25	.35	.85	5.8	27	44	W246484
W246487	1.6L	11	26	.27	55	3.8	3.8	7.7L	36	44L	W246487
W246488	1.8L	12	14	.40	92	2.0	8.1	16	94	44	W246488
W246489	3.5L	34	57	.47	68	3.5	18	51	120	87	W246489
W246509	.95L	6.3	4.3	.30	34	1.3	2.9	4.5L	21	44L	W246509
W246510	.52L	3.8	4.0	.10L	15	.31	.57	8.4	14	44L	W246510
W246160	.80L	8.3	12	.22	4.9	1.3	2.9	18L	58	44L	W246160
W246449	.77L	3.6	8.1	.32	42	5.1	3.4	9.8	19	44L	W246449
W246450	3.8L	32	73	.39	170	13	11	19	110	87	W246450
W246451	1.7L	9.0	22	.40	110	7.3	7.0	17	53	44L	W246451
W246452	1.1L	6.1	11	.41	52	4.8	3.5	10	40	44L	W246452
W246453	1.2L	9.0	29	.27	43	2.9	9.3	7.9	20	44	W246453
W246454	1.3L	5.1	9.6	.19	57	8.3	4.3	7.4	24	44L	W246454
W246455	2.5L	17	59	.28	92	15	9.6	18	63	87	W246455
W246456	.90L	5.6	12	.11	51	1.6	2.8	7.1	33	44L	W246456
W246457	.96L	5.3	9.7	.09	54	4.2	1.6	5.9	68	44L	W246457
W246458	3.7L	39	92	.38	34	3.7	15	45	220	87	W246458
W246459	1.6L	10	24	.15	46	1.8	9.6	17	58	44L	W246459
W246460	4.3L	30	64	.29	150	12	13	22	180	87	W246460
W246461	24	19	54	.29	130	8.6	9.0	14L	67	44	W246461
W246471	1.4L	7.8	17	.21	44	2.8	2.2	6.4L	36	44L	W246471
W246472	.63L	3.7	7.1	.07	29	2.0	1.6	5.6	25	44L	W246472
W246473	3.9L	32	35	.34	150	12	7.5	23	110	87	W246473
W246474	1.2L	5.0	5.1	.22	57	7.1	4.0	12	75	44L	W246474
W246475	2.7L	38	64	.51	39	2.3	11	40	230	87	W246475
W246490	5.0L	39	65	.48	390	4.3	6.8	27	88	130	W246490
W246491	1.3L	6.9	6.8	.48	68	3.4	4.1	9.2	26	44L	W246491
W246492	1.2L	7.5	13	.22	48	.90	2.2	5.9L	22	44L	W246492
W246493	.98L	3.5	5.8	.12	39	2.3	1.7	4.6L	22	44L	W246493
W246494	4.7L	44	51	.30	210	4.0	12	30	83	130	W246494
W246495	.52L	1.9	.99	.06L	25	1.2	.99	2.4L	21	44L	W246495
W246496	.37L	2.0	.38	.07L	12	.66	.30	8.3L	29	44L	W246496
W246497	1.3L	7.8	14	.29	75	5.6	2.8	6.6	81	44L	W246497
W246498	1.1L	9.0	6.7	.29	37	1.2	2.4	5.1L	29	44L	W246498
W246499	.51L	1.3	.83	.07L	27	.69	.29	2.4L	12	44L	W246499
W246500	.50L	.70	.37L	.07L	21	1.6	.34	2.4L	47	44L	W246500

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	PB PPM	PR-S PPM	RB PPM	SB PPM	SC PPM	SE PPM	SM PPM	SN-S PPM	SR-S PPM	TA PPM	SAMPLE NUMBER
W246481	8.8L	6.0L	70L	0.20L	20	6.1	4.9	6.6	340	1.0	W246481
W246483	13	5.6L	110L	.30L	46	2.0L	10	5.6	540	3.4	W246483
W246485	19	5.5L	80L	.20L	17	3.6	2.9	6.4	670	1.3	W246485
W246486	8.9	1.9L	60L	.21	41	2.6	7.9	3.7	1,100	2.8	W246486
W246484	2.0	.71L	80L	.20L	7.3	2.8	1.7	.63	820	.25	W246484
W246487	2.4L	1.7	80L	.14	11	5.4	2.3	4.6	220	.61	W246487
W246488	3.8	1.8L	60L	.22	19	2.5	2.6	2.2	1,000	.91	W246488
W246489	14	3.7	70L	.55	.39	3.8	6.6	2.4L	680	1.9	W246489
W246509	1.4L	.95L	50L	.20L	9.3	3.1	1.6	2.7	1,200	.41	W246509
W246510	.76L	.52L	90L	.10L	5.2	2.3	1.1	.84	1,100	.14	W246510
W246160	3.9	1.1	24L	.20L	13	3.2	1.6	2.3	500	.69	W246160
W246449	1.2	.77L	30L	.16	14	2.9	1.4	4.9	1,500	.18	W246449
W246450	5.6L	3.8L	28L	.35	25	4.1	6.2	17	390	1.4	W246450
W246451	2.5L	1.7L	25L	.15	13	2.7	2.2	5.5	730	.58	W246451
W246452	2.4	1.1L	24L	.20	12	2.8	2.0	4.5	2,400	.26	W246452
W246453	2.0	1.2L	18L	.15	12	2.5	1.9	3.0	1,400	.68	W246453
W246454	1.9L	1.3L	18L	.27	6.7	5.8	1.5	6.5	700	.26	W246454
W246455	3.7	2.5L	18L	.46	17	6.2	3.0	8.5	320	1.2	W246455
W246456	1.5	.90L	17L	.093	5.9	2.9	1.2	2.0	1,500	.36	W246456
W246457	1.4L	.96L	24L	.13	6.8	3.6	1.1	2.8	1,700	.25	W246457
W246458	12	3.7L	19L	.19	33	5.0	7.6	4.4	920	1.5	W246458
W246459	4.3	1.6L	17L	.15	12	3.1	1.8	2.9	910	.87	W246459
W246460	6.4L	4.3L	70L	.28	24	3.6	5.5	11	430	1.3	W246460
W246461	4.5L	3.1L	15L	.26	20	4.3	3.6	11	720	1.0	W246461
W246471	2.0L	1.4L	11L	.090L	15	2.7	2.0	2.6	660	.48	W246471
W246472	1.5	.63L	10L	.11	3.9	2.8	.66	.93	860	.11	W246472
W246473	5.8L	3.9L	13L	.23	22	3.6	6.0	5.7	460	1.5	W246473
W246474	1.8L	1.2L	10L	.18	8.2	2.9	1.6	7.7	820	.24	W246474
W246475	10	2.7L	12L	.27	32	3.7	8.3	3.3	880	1.3	W246475
W246490	7.4L	5.0L	60L	.40	28	3.0	7.1	8.8	330	1.8	W246490
W246491	12	1.5	70L	.20L	16	2.9	1.7	6.8	2,100	.26	W246491
W246492	3.5	1.2L	70L	.20L	9.0	2.8	1.5	2.4	730	.53	W246492
W246493	1.4L	.98L	70L	.10L	5.1	3.3	.79	3.6	1,600	.20	W246493
W246494	6.9L	4.7L	70L	.20	26	5.4	8.0	8.3	330	2.5	W246494
W246495	2.4	.52L	70L	.10L	2.3	3.2	.36	2.0	1,400	.058	W246495
W246496	1.9	.88	80L	.10L	2.3	2.0	.65	1.2	2,100	.060L	W246496
W246497	4.5	1.3L	50L	.39	18	3.6	2.1	5.3	810	.55	W246497
W246498	1.6L	1.4	60L	.20L	14	3.3	2.0	3.7	1,700	.43	W246498
W246499	.75L	.51L	60L	.10L	.94	2.9	.24	1.5	1,300	.039	W246499
W246500	.74	.50L	50L	.10L	1.8	3.9	.34	2.0	1,400	.050L	W246500

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	TB PPM	TH PPM	U PPM	V-S PPM	W PPM	Y-S PPM	YB PPM	ZN PPM	ZR-S PPM	SAMPLE NUMBER
W246481	0.66	4.6	2.9	200	1.0L	22	2.8	130	400	W246481
W246483	1.2	13	3.5	360	1.3	31	3.9	68	510	W246483
W246485	.44	4.1	2.9	320	1.0L	27	1.8	89	450	W246485
W246486	.70	12	1.5	89	1.7	16	2.2	25	110	W246486
W246484	.23	1.2	.36	26	1.4	6.1	.85	17	16	W246484
W246487	.38	2.5	.99	46	2.4	16	1.8	50	41	W246487
W246488	.47	3.4	.89	62	.90L	21	2.2	92	84	W246488
W246489	.87	7.1	2.3	170	2.0L	27	3.1	230	190	W246489
W246509	.31	1.2	.48	17	8.3	11	1.6	14	24	W246509
W246510	.19	.64	.21L	11	2.0L	4.9	.78	11	7.6	W246510
W246160	.32	1.7	.31	60	B	11	1.5	8.2	41	W246160
W246449	.33	.94	1.1	46	2.0L	17	2.4	29	36	W246449
W246450	.83	6.0	1.7	130	.60L	21	3.2	96	110	W246450
W246451	.41	2.1	1.3	48	.80L	21	3.0	45	58	W246451
W246452	.43	1.1	1.9	31	.40L	24	3.3	21	43	W246452
W246453	.35	2.0	1.9	45	.40L	18	2.0	25	43	W246453
W246454	.30	1.2	3.1	24	.40L	12	1.3	26	24	W246454
W246455	.43	4.2	3.9	89	.75	14	2.1	74	85	W246455
W246456	.18	1.3	.65	25	.40L	8.6	.89	10	28	W246456
W246457	.19	1.1	.83	28	.60L	7.1	.69	13	28	W246457
W246458	.95	7.0	1.3	270	.60L	28	3.2	70	170	W246458
W246459	.28	2.7	.80	70	2.1	12	1.1	11	100	W246459
W246460	.71	5.6	2.0	130	1.9	15	2.4	70	150	W246460
W246461	.46	4.3	1.9	85	.90L	13	2.1	36	67	W246461
W246471	.40	1.9	.85	56	1.0L	13	1.8	11	36	W246471
W246472	.10	.66	.94	22	.60L	7.0	.54	5.8	18	W246472
W246473	.72	8.1	4.1	100	1.0L	14	2.5	64	140	W246473
W246474	.33	1.2	1.6	24	.90L	14	1.6	22	31	W246474
W246475	1.1	6.0	1.4	200	1.0L	31	3.7	100	140	W246475
W246490	.87	10	5.2	120	2.7	8.1	2.7	100	180	W246490
W246491	.42	.94	.86	32	2.2	24	2.9	24	53	W246491
W246492	.28	2.2	.62	27	2.0	9.3	1.4	14	24	W246492
W246493	.12	.73	.34	17	1.5	3.9	.59	23	11	W246493
W246494	.82	8.5	2.8	120	1.6	6.1	2.4	110	120	W246494
W246495	.068	.40	.25	12	1.3	3.0	.26	7.4	12	W246495
W246496	.11	.14	.22L	4.7	.80L	8.3	.48	8.8	6.6	W246496
W246497	.41	2.1	2.8	75	1.0L	12	2.0	39	51	W246497
W246498	.38	2.5	.58	35	4.0	13	1.9	29	48	W246498
W246499	.039	.19	.23L	2.0	1.0L	3.1	.28	6.2	4.1	W246499
W246500	.071	.18	.20L	7.3	1.0L	4.7	.40	10	6.6	W246500

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	SI (PERCENT)	AL (PERCENT)	CA (PERCENT)	MG (PERCENT)	NA (PERCENT)	K (PERCENT)	FE (PERCENT)	TI (PERCENT)	AG-S PPM	AS PPM	SAMPLE NUMBER
W246501	2.4	1.5	0.50	0.31	0.46	0.028	5.3	0.43	0.053	2.7	W246501
W246502	9.0	6.7	.25	.28	.37	.087	8.9	1.0	.13	5.5	W246502
W246503	4.0	2.2	.33	.22	.33	.030	12	.57	.12	3.0	W246503
W246504	12	6.5	.32	.22	.35	.054	5.2	2.6	.16	2.8	W246504
W246505	1.2	.98	.57	.23	.42	.013	3.0	.24	.054	.60L	W246505
W246506	4.1	3.2	3.1	.26	.39	.045	5.0	.40	.057	3.7	W246506
W246507	11	9.2	.21	.20	.36	.097	9.4	1.3	.10	9.4	W246507
W246508	.54	.43	.58	.22	.47	.014	.40	.038	.014	.87	W246508
W246511	11	7.0	.32	.17	.45	.069	5.6	1.8	.088	7.0	W246511
W246512	.23	.25	.57	.18	.51	.011	.25	.031	.008	.40L	W246512
W246513	.25	.14	.58	.32	.48	.013	.21	.020	.007	.50L	W246513
W246514	1.2	1.0	.64	.26	.37	.015	3.7	.14	.043	4.1	W246514
W246515	8.8	5.8	.25	.16	.43	.091	7.7	1.3	.10	3.5	W246515
W246516	.69	.58	.56	.17	.48	.013	2.0	.088	.033	1.5	W246516
W246517	1.6	1.2	.59	.17	.49	.017	.56	.14	.017	.93	W246517
W250660	B	B	B	B	B	B	B	B	B	B	W250660
W250661	B	B	B	B	B	B	B	B	B	B	W250661
W250658	B	B	B	B	B	B	B	B	B	B	W250658
W250659	B	B	B	B	B	B	B	B	B	B	W250659
W250656	B	B	B	B	B	B	B	B	B	B	W250656
W250657	B	B	B	B	B	B	B	B	B	B	W250657
W250662	B	B	B	B	B	B	B	B	B	B	W250662
W250663	B	B	B	B	B	B	B	B	B	B	W250663
W250664	B	B	B	B	B	B	B	B	B	B	W250664
W250665	B	B	B	B	B	B	B	B	B	B	W250665
W250666	B	B	B	B	B	B	B	B	B	B	W250666
W250667	B	B	B	B	B	B	B	B	B	B	W250667
W250668	B	B	B	B	B	B	B	B	B	B	W250668
W250669	B	B	B	B	B	B	B	B	B	B	W250669
W250670	B	B	B	B	B	B	B	B	B	B	W250670
W250671	B	B	B	B	B	B	B	B	B	B	W250671

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	B-S PPM	BA-S PPM	BE-S PPM	BR PPM	CD PPM	CE PPM	CL PPM	CO PPM	CR PPM	CS PPM	SAMPLE NUMBER
W246501	220G	71	2.1	52	0.060	12	4,000	8.8	44	0.10L	W246501
W246502	190	26	1.3	20	.15	47	1,000	89	130	.42	W246502
W246503	270	12L	1.5	120	.067	27	1,300	47	80	.20L	W246503
W246504	180	70	3.1	78	.015	57	1,000	15	210	.34	W246504
W246505	140G	14	1.3	30	.065	9.6	1,100	23	26	.20L	W246505
W246506	230	290	1.3	34	.11	24	800	29	58	.22	W246506
W246507	86	74	.92L	29	.16	64	400	40	160	.49	W246507
W246508	63G	13	.59	21	.028	4.4	1,300	29	6.5	.08L	W246508
W246511	130	52	.77L	150	.083	47	600	47	170	.27	W246511
W246512	56G	13	.11	55	.011	2.7	1,300	5.6	3.9	.05L	W246512
W246513	52G	17	1.1	54	.006	3.4	1,100	24	3.5	.07L	W246513
W246514	150G	7.4	1.7	59	B	8.7	900	35	25	.10L	W246514
W246515	130	28	.71L	56	.033	45	400	30	130	.42	W246515
W246516	100G	7.7	.41	20	.063	4.9	1,100	5.1	10	.08L	W246516
W246517	110G	11	1.9	60	.024	8.5	800	15	24	.10L	W246517
W250660	B	B	B	B	B	B	B	B	B	B	W250660
W250661	B	B	B	B	B	B	B	B	B	B	W250661
W250658	B	B	B	B	B	B	B	B	B	B	W250658
W250659	B	B	B	B	B	B	B	B	B	B	W250659
W250656	B	B	B	B	B	B	B	B	B	B	W250656
W250657	B	B	B	B	B	B	B	B	B	B	W250657
W250662	B	B	B	B	B	B	B	B	B	B	W250662
W250663	B	B	B	B	B	B	B	B	B	B	W250663
W250664	B	B	B	B	B	B	B	B	B	B	W250664
W250665	B	B	B	B	B	B	B	B	B	B	W250665
W250666	B	B	B	B	B	B	B	B	B	B	W250666
W250667	B	B	B	B	B	B	B	B	B	B	W250667
W250668	B	B	B	B	B	B	B	B	B	B	W250668
W250669	B	B	B	B	B	B	B	B	B	B	W250669
W250670	B	B	B	B	B	B	B	B	B	B	W250670
W250671	B	B	B	B	B	B	B	B	B	B	W250671

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	CU PPM	DY-S PPM	EU PPM	F PPM	GA-S PPM	GD-S PPM	GE-S PPM	HF PPM	HG PPM	HO-S PPM	SAMPLE NUMBER
W246501	24	2.2L	0.42	100	14	4.9L	6.9	1.2	0.060	0.33L	W246501
W246502	87	5.8L	1.3	100	17	13L	2.7L	4.1	.020	.87L	W246502
W246503	41	3.7L	.91	100	19	8.2L	9.6	2.5	.030	.56L	W246503
W246504	46	5.4L	1.4	100	19	12L	2.5L	9.7	.010	.81L	W246504
W246505	29	1.5L	.42	20L	15	3.2L	4.4	.92	.010	.22L	W246505
W246506	35	3.6L	.77	20L	12	7.9L	3.0	1.8	.005L	.54L	W246506
W246507	80	6.2L	1.8	90	17	14L	2.8L	4.9	.005L	.92L	W246507
W246508	15	.63L	.22	20L	6.0	1.4L	5.8	.26	.005L	.09L	W246508
W246511	67	5.2L	1.1	20L	11	11L	2.4L	6.0	.11	.77L	W246511
W246512	9.0	.56L	.09	20L	2.2	1.2L	.26L	.17	.020	.08L	W246512
W246513	7.3	1.1L	.21	20L	5.7	1.1L	4.8	.20	.005L	.29	W246513
W246514	23	1.5L	.42	20L	11	3.4L	17	.63	.005L	.23L	W246514
W246515	67	4.8L	1.2	20L	12	10L	3.4	4.4	.030	.71L	W246515
W246516	10	1.0L	.19	20L	3.8	2.2L	1.1	.31	.040	.15L	W246516
W246517	28	1.1L	.54	200	17	2.4L	9.8	.78	.010	.45	W246517
W250660	B	B	B	B	B	B	B	B	B	B	W250660
W250661	B	B	B	B	B	B	B	B	B	B	W250661
W250658	B	B	B	B	B	B	B	B	B	B	W250658
W250659	B	B	B	B	B	B	B	B	B	B	W250659
W250656	B	B	B	B	B	B	B	B	B	B	W250656
W250657	B	B	B	B	B	B	B	B	B	B	W250657
W250662	B	B	B	B	B	B	B	B	B	B	W250662
W250663	B	B	B	B	B	B	B	B	B	B	W250663
W250664	B	B	B	B	B	B	B	B	B	B	W250664
W250665	B	B	B	B	B	B	B	B	B	B	W250665
W250666	B	B	B	B	B	B	B	B	B	B	W250666
W250667	B	B	B	B	B	B	B	B	B	B	W250667
W250668	B	B	B	B	B	B	B	B	B	B	W250668
W250669	B	B	B	B	B	B	B	B	B	B	W250669
W250670	B	B	B	B	B	B	B	B	B	B	W250670
W250671	B	B	B	B	B	B	B	B	B	B	W250671

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	IN-S PPM	LA PPM	LI PPM	LU PPM	MN PPM	MO-S PPM	NB-S PPM	ND-S PPM	NI-S PPM	P PPM	SAMPLE NUMBER
W246501	1.5L	7.7	15	0.38	21	2.7	3.1	7.1L	22	44L	W246501
W246502	4.0L	30	81	.36	170	7.0	18	19L	120	87	W246502
W246503	2.5L	15	30	.33	96	6.3	5.6	22	70	44L	W246503
W246504	3.7L	41	65	.74	200	2.1	28	17L	65	130	W246504
W246505	.99L	5.8	14	.25	32	2.6	3.8	4.6L	28	44L	W246505
W246506	2.4L	15	25	.30	190	6.4	5.7	11L	30	44	W246506
W246507	4.2L	39	86	.35	280	4.6	13	25	49	87	W246507
W246508	.43L	2.5	4.0	.12	.18	.27	.27	2.0L	21	44L	W246508
W246511	3.5L	30	45	.19	130	3.1	23	35	88	87	W246511
W246512	.38L	1.7	1.6	.06L	17	.43	.31	8.4L	19	44L	W246512
W246513	.35L	2.5	1.2	.07L	13	.41	.11	7.8L	22	44L	W246513
W246514	1.0L	5.1	17	.13	32	3.4	1.4	7.9	23	44L	W246514
W246515	3.2L	29	47	.22	170	3.6	9.5	19	45	87	W246515
W246516	.69L	3.0	4.5	.08	39	1.8	1.1	4.7	15	44L	W246516
W246517	.73L	5.3	9.0	.33	18	.36	1.1	6.8	18	44L	W246517
W250660	B	B	B	B	B	B	B	B	B	B	W250660
W250661	B	B	B	B	B	B	B	B	B	B	W250661
W250658	B	B	B	B	B	B	B	B	B	B	W250658
W250659	B	B	B	B	B	B	B	B	B	B	W250659
W250656	B	B	B	B	B	B	B	B	B	B	W250656
W250657	B	B	B	B	B	B	B	B	B	B	W250657
W250662	B	B	B	B	B	B	B	B	B	B	W250662
W250663	B	B	B	B	B	B	B	B	B	B	W250663
W250664	B	B	B	B	B	B	B	B	B	B	W250664
W250665	B	B	B	B	B	B	B	B	B	B	W250665
W250666	B	B	B	B	B	B	B	B	B	B	W250666
W250667	B	B	B	B	B	B	B	B	B	B	W250667
W250668	B	B	B	B	B	B	B	B	B	B	W250668
W250669	B	B	B	B	B	B	B	B	B	B	W250669
W250670	B	B	B	B	B	B	B	B	B	B	W250670
W250671	B	B	B	B	B	B	B	B	B	B	W250671

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	PB PPM	PR-S PPM	RB PPM	SB PPM	SC PPM	SE PPM	SM PPM	SN-S PPM	SR-S PPM	TA PPM	SAMPLE NUMBER
W246501	6.0	1.5L	60L	0.10L	13	3.6	1.5	5.1	130	0.54	W246501
W246502	5.8L	4.0L	50L	.50L	27	4.8	5.2	7.6	150	1.5	W246502
W246503	3.7L	2.5L	50L	.20L	21	4.2	3.6	13	140	.75	W246503
W246504	6.5	4.7	50L	.38	29	2.6	6.0	8.7	320	3.7	W246504
W246505	1.5L	1.4	50L	.12	10	4.7	1.6	3.6	620	.36	W246505
W246506	3.6L	2.4L	50L	.14	17	4.7	3.1	4.3	750	.61	W246506
W246507	6.2L	4.2L	50L	.24	34	3.6	7.3	8.6	220	2.1	W246507
W246508	1.6	.43L	60L	.10L	2.4	3.1	.76	.63	1,300	.060	W246508
W246511	7.2	3.5L	80L	.20L	23	11	4.6	7.7	620	2.7	W246511
W246512	.56L	.38L	50L	.10L	1.7	2.3	.41	.95	1,400	.053	W246512
W246513	1.1	.35L	70L	.20L	1.5	1.9	.63	.73	1,700	.070L	W246513
W246514	1.5L	1.0L	50L	.26	8.5	5.5	1.4	2.9	380	.25	W246514
W246515	4.8L	3.2L	60L	.10L	21	3.5	5.0	6.7	320	2.0	W246515
W246516	1.0L	.69L	70L	.080	2.7	3.9	.63	2.2	1,700	.13	W246516
W246517	2.4	.73L	50L	.20L	12	1.9	1.7	.85	730	.29	W246517
W250660	B	B	B	B	B	B	B	B	B	B	W250660
W250661	B	B	B	B	B	B	B	B	B	B	W250661
W250658	B	B	B	B	B	B	B	B	B	B	W250658
W250659	B	B	B	B	B	B	B	B	B	B	W250659
W250656	B	B	B	B	B	B	B	B	B	B	W250656
W250657	B	B	B	B	B	B	B	B	B	B	W250657
W250662	B	B	B	B	B	B	B	B	B	B	W250662
W250663	B	B	B	B	B	B	B	B	B	B	W250663
W250664	B	B	B	B	B	B	B	B	B	B	W250664
W250665	B	B	B	B	B	B	B	B	B	B	W250665
W250666	B	B	B	B	B	B	B	B	B	B	W250666
W250667	B	B	B	B	B	B	B	B	B	B	W250667
W250668	B	B	B	B	B	B	B	B	B	B	W250668
W250669	B	B	B	B	B	B	B	B	B	B	W250669
W250670	B	B	B	B	B	B	B	B	B	B	W250670
W250671	B	B	B	B	B	B	B	B	B	B	W250671

Appendix C.--Major-, minor-, and trace-element composition of 191 coal samples in Pakistan regions, reported on a whole-coal basis.--continued

SAMPLE NUMBER	TB PPM	TH PPM	U PPM	V-S PPM	W PPM	Y-S PPM	YB PPM	ZN PPM	ZR-S PPM	SAMPLE NUMBER
W246501	0.31	1.7	0.80	42	2.1	14	2.0	14	38	W246501
W246502	.63	6.1	1.7	130	3.9	11	2.4	58	81	W246502
W246503	.53	2.7	.90	70	5.6	12	2.6	24	70	W246503
W246504	.78	8.7	2.2	120	2.1	22	4.4	30	340	W246504
W246505	.28	1.3	.65	41	1.0L	12	1.6	12	32	W246505
W246506	.44	2.7	2.0	68	1.0L	16	2.1	28	50	W246506
W246507	.85	7.5	3.6	80	2.0L	9.8	3.0	74	86	W246507
W246508	.13	.46	.27L	6.9	1.0L	5.0	.52	57	6.9	W246508
W246511	.49	7.8	2.7	83	2.0L	5.7	1.9	57	120	W246511
W246512	.061	.25	.23L	7.3	.60L	2.1	.24	4.4	5.3	W246512
W246513	.15	.22	.21L	3.6	.70L	5.7	.65	5.1	4.1	W246513
W246514	.29	1.0	2.1	17	.60L	7.9	1.3	15	13	W246514
W246515	.59	5.4	1.9	62	.90L	8.1	2.1	76	57	W246515
W246516	.10	.48	.89	8.2	.60L	3.5	.39	8.5	8.3	W246516
W246517	.36	1.3	.34	22	.70L	11	2.2	22	17	W246517
W250660	B	B	1.4	B	B	B	B	B	B	W250660
W250661	B	B	.97	B	B	B	B	B	B	W250661
W250658	B	B	.22L	B	B	B	B	B	B	W250658
W250659	B	B	B	B	B	B	B	B	B	W250659
W250656	B	B	1.1	B	B	B	B	B	B	W250656
W250657	B	B	.55	B	B	B	B	B	B	W250657
W250662	B	B	.46	B	B	B	B	B	B	W250662
W250663	B	B	B	B	B	B	B	B	B	W250663
W250664	B	B	.59	B	B	B	B	B	B	W250664
W250665	B	B	B	B	B	B	B	B	B	W250665
W250666	B	B	.17L	B	B	B	B	B	B	W250666
W250667	B	B	.20L	B	B	B	B	B	B	W250667
W250668	B	B	6.4	B	B	B	B	B	B	W250668
W250669	B	B	.42	B	B	B	B	B	B	W250669
W250670	B	B	.19L	B	B	B	B	B	B	W250670
W250671	B	B	.18L	B	B	B	B	B	B	W250671

Appendix D.--Proximate and ultimate analyses, calorific value, forms of sulfur, free-swelling index and ash fusion temperature determinations for 191 coal samples from the Sindh Province, Pakistan.

[All analyses except calorific values, free-swelling indexes and ash-fusion temperatures in percent. Sample number is the USGS laboratory number. Moisture values presented are as-received values and because samples were obtained from core, moisture values are questionable therefore rank parameters on a moist basis may not be accurate.]

SAMPLE NUMBER	PROXIMATE ANALYSIS MOISTURE	VOLATILE MATTER	FIXED CARBON	ASH	ULTIMATE ANALYSIS HYDROGEN	CARBON	NITROGEN	OXYGEN	SULFUR
W241087	33.56	29.53	28.53	8.38	6.99	43.58	0.82	38.67	1.56
W241088	33.6	31.44	24.57	10.39	6.7	42.08	0.75	37.86	2.22
W241089	23.45	21.21	16.24	39.1	4.67	21.87	0.43	26.19	7.74
W241090	32.29	32.16	24.58	10.97	7.04	42.52	0.72	36.35	2.4
W241091	28.83	24.07	18.42	28.68	5.88	28.97	0.51	33.34	2.62
W241092	34.55	29.56	29.68	6.21	7.11	45.12	0.81	39.25	1.5
W241093	30.97	30.08	27.93	11.02	6.77	43.31	0.79	34.82	3.29
W241094	37.6	28.75	28.6	5.05	7.16	43.48	0.89	42.49	0.93
W241095	37.43	29.13	26.43	7.01	7.27	41.55	0.75	40.28	3.14
W241096	37.82	31.62	26.6	3.96	7.23	44.57	0.81	42.54	0.89
W241097	38.77	27.33	30.89	3.01	7.26	44.72	0.82	43.7	0.49
W241098	38.21	27.78	31.21	2.8	7.36	45.21	0.74	43.52	0.37
W241099	38.62	29.18	28.59	3.61	7.45	44.27	0.7	43.2	0.77
W241100	34.37	28.63	28.1	8.9	6.95	43.02	0.72	39.77	0.64
W241101	33.92	29.14	25.48	11.46	7.06	40.36	0.66	37.69	2.77
W241102	31.99	36.07	25.84	6.1	7.38	47.86	0.78	37.03	0.85
W241103	32.86	26.32	26.3	14.52	6.67	38.89	0.67	38.15	1.1
W241104	28.76	28.7	23.83	18.71	6.25	35.85	0.59	31.58	7.02
W241105	35.99	30.81	26.33	6.87	7.23	43.12	0.75	40.33	1.7
W241106	26.22	25.26	18.05	30.47	5.56	29.94	0.52	31.43	2.08
W241107	30.22	29.8	26.53	13.45	6.6	40.98	0.65	34.92	3.4
W241108	30.63	26.79	24.83	17.75	6.44	37.27	0.71	35.8	2.03
W241109	30.88	32.87	23.29	12.96	6.58	41.27	0.76	34.99	3.44
W241110	28.83	30.89	29.18	11.1	6.51	43.81	0.76	32.97	4.85
W241111	34.15	30.02	27.03	8.8	7.06	42.53	0.76	38.69	2.16
W241112	35.42	26.91	25.44	12.23	6.91	37.54	0.61	39.28	3.43
W241113	32.58	25.38	21.72	20.32	6.44	32.71	0.59	35.82	4.12
W241114	29.79	31.15	31.29	7.77	6.8	47.38	0.79	35.25	2.01
W241115	29.09	22.01	17.4	31.5	5.76	27.49	0.45	33.04	1.76
W246426	29.89	28.07	25.07	16.97	6.45	38.61	0.64	34.89	2.44
W246427	29.31	27.98	26.87	15.84	6.51	40.87	0.69	35.08	1.01
W246428	32.64	25.64	24.48	17.24	6.47	35.53	0.59	34.69	5.48
W246528	33.65	30.78	25.99	9.58	7.15	42.55	0.7	36.22	3.8
W241116	34.96	19.52	19.44	26.08	6.35	26.87	0.59	38.65	1.46
W241117	25.25	23.98	23.15	27.62	5.67	31.34	0.58	29.17	5.62
W241118	20.13	19.02	18.5	42.35	4.71	23.23	0.44	23.68	5.59
W241119	22.22	37.33	20.93	19.52	6.14	41.99	0.67	27.17	4.51
W241120	25.18	16.23	10.51	48.08	4.84	16.44	0.31	29.21	1.12
W241121	25.5	22.76	19.37	32.37	5.55	28.7	0.55	29.73	3.1
W241122	20.72	25.89	18.74	34.65	5.31	29.37	0.53	25.44	4.7

Appendix D.--Proximate and ultimate analyses, calorific value, forms of sulfur, free-swelling index and ash fusion temperature determinations for 191 coal samples from the Sindh Province, Pakistan.

SAMPLE NUMBER	PROXIMATE ANALYSIS MOISTURE	VOLATILE MATTER	FIXED CARBON	ASH	ULTIMATE ANALYSIS HYDROGEN	CARBON	NITROGEN	OXYGEN	SULFUR
W241123	27.92	25.04	23.94	23.1	6.05	33.29	0.64	31.72	5.2
W241022	33.32	25.49	22.43	18.76	6.63	33.74	0.6	37.66	2.61
W241023	34.63	24.94	25.93	14.5	6.8	35.8	0.59	38.83	3.48
W241024	24.51	18.62	12.72	44.15	4.67	15.98	0.23	26.46	8.51
W241025	31.41	29.25	23.63	15.71	6.47	37.56	0.6	33.53	6.13
W241026	30.79	24.89	21.42	22.9	6.22	30.84	0.49	34.35	5.2
W241027	34.94	30.66	27.62	6.78	7.14	43.86	0.71	39.11	2.4
W241028	24.87	17.11	13.5	44.52	4.76	16.19	0.24	27.19	7.1
W246430	31.78	30.49	26.06	11.67	7.01	41.77	0.68	36.57	2.3
W246431	33.48	25.54	26.21	14.77	6.66	38.25	0.77	39.13	0.42
W246432	31.53	31.59	27.43	9.45	7.17	44.83	0.74	35.55	2.26
W246433	33.32	30.43	27.83	8.42	7.12	43.99	0.8	38.37	1.3
W246437	36.32	28.54	28.61	6.53	7.2	43.41	0.85	39.93	2.08
W246438	48.02	25.53	22.38	4.07	8.33	36.77	0.73	49.7	0.4
W246439	36.99	26.58	31.63	4.8	7.22	45.01	0.88	41.44	0.65
W246440	37.08	29.11	30.21	3.6	7.57	45.62	0.93	42.1	0.18
W246441	38.32	25.92	29.29	6.47	7.31	42.13	0.88	42.98	0.23
W246442	28.97	19.71	14.49	36.83	5.58	22.68	0.47	33.84	0.6
W246443	22.71	20.54	16.1	40.65	4.77	21.2	0.39	25.9	7.09
W246429	30.81	26.94	24.38	17.87	6.55	37.43	0.71	35.4	2.04
W246435	26.74	24.91	19.11	29.24	5.68	29.68	0.53	29.67	5.2
W246436	29.4	32.06	24.58	13.96	6.77	40.76	0.69	31.64	6.18
W246434	32.05	32.04	29.36	6.55	7.15	46.52	0.9	36.37	2.51
W246444	39.07	25.48	23.8	11.65	7.21	36.01	0.68	42.61	1.84
W246445	39.71	26.13	25.56	8.6	7.52	39.03	0.79	43.75	0.31
W246446	44.16	16.67	17.26	21.91	6.83	24.32	0.58	46.08	0.28
W246447	40.91	28.64	26.65	3.8	7.56	42.46	0.86	45.08	0.24
W246448	40.14	28.01	28.91	2.94	7.64	43.71	0.85	44.48	0.38
W237524	19.82	31.52	33.96	14.7	5.54	47.03	1	29.33	2.4
W237525	17.33	34.85	30.9	16.92	5.45	48.65	1.01	26.76	1.21
W237526	19.15	36.31	35.89	8.65	6.06	54.33	1.13	28.75	1.08
W237527	17.93	38.9	34.74	8.43	6.24	54.7	1.05	27.83	1.75
W246127	32.14	33.39	28.33	6.14	7.23	47.53	0.93	36.49	1.42
W246128	32.66	29.64	26.35	11.35	6.83	41.75	0.88	38.08	0.88
W246129	30.82	29.66	27.14	12.38	6.76	42.94	0.93	36.09	0.71
W246130	29.72	29.99	26	14.29	6.67	41.2	0.87	35.06	1.75
W246131	30.79	31.72	28.42	9.07	6.9	45.39	0.92	35.99	1.59
W246132	30.06	30.86	25.3	13.78	6.53	40.17	0.81	32.81	5.8
W246137	37.38	26.72	19.51	16.39	6.89	32.34	0.55	39.67	3.8
W246138	38.05	30.04	26	5.91	7.43	41.94	0.89	42.23	1.43
W246139	31.82	28.42	22.9	16.86	6.48	36.39	0.7	36.07	3.39
W246140	33.93	28.1	20.59	17.38	6.63	34.23	0.64	38.13	2.88
W246141	22.56	16.08	8.94	52.42	4.06	11.21	0.13	24.78	7.32
W246142	36.31	29.89	29.39	4.41	7.16	45.09	0.94	41.38	0.86
W246143	36.58	28.92	31.26	3.24	7.09	46.55	0.98	41.58	0.41

Appendix D.--Proximate and ultimate analyses, calorific value, forms of sulfur, free-swelling index and ash fusion temperature determinations for 191 coal samples from the Sindh Province, Pakistan.

SAMPLE NUMBER	PROXIMATE ANALYSIS: MOISTURE	VOLATILE MATTER	FIXED CARBON	ASH	ULTIMATE ANALYSIS: HYDROGEN	CARBON	NITROGEN	OXYGEN	SULFUR
W246144	35.12	31.1	31.05	2.73	7.31	48.02	0.98	40.55	0.26
W246145	30.64	28.04	27.41	13.91	6.46	42	0.89	35.91	0.7
W246146	29.4	25.52	21.81	23.27	5.92	31.03	0.67	33.67	5.29
W246147	32.87	32.17	27.94	7.02	6.94	45.37	0.96	36.82	2.71
W246148	30.78	36.98	27.46	4.78	7.28	49.51	0.96	36.25	1.05
W246149	31.22	31.59	27.77	9.42	6.74	43.83	0.92	36.05	2.89
W246150	32.62	24.74	23.46	19.18	6.3	34.77	0.7	36.3	2.65
W246133	31.5	32.14	28.18	8.18	6.75	45.81	0.94	36.18	1.99
W246134	29.86	25.95	16.69	27.5	6.03	29.33	0.63	35.16	1.23
W246135	32.22	32.64	25.55	9.59	7.13	42.91	0.78	36.99	2.49
W246136	28.91	26.22	22.91	21.96	5.57	30.07	0.55	26.68	15.05
W246151	27.4	35.35	22.97	14.28	6.72	43.22	0.74	32.13	2.83
W246152	31.67	34.47	25.91	7.95	7.05	45.81	0.87	36.17	2.04
W246153	23.23	21.38	14.41	40.98	4.77	21.62	0.42	27.22	4.9
W246154	35.49	32.61	27.67	4.23	7.23	45.68	0.94	41.38	0.38
W246155	36	28.47	26.52	9.01	6.99	40.96	0.82	41.69	0.4
W246156	42.19	26.88	27.8	3.13	7.53	41.51	0.92	46.47	0.26
W246157	35.95	26.79	25.9	11.36	6.78	39.35	0.82	41.19	0.36
W246158	35.46	26.86	25.34	12.34	6.81	38.54	0.81	40.77	0.59
W246159	32.91	31.01	26.26	9.82	6.95	43.69	0.87	37.52	1.03
W246462	20.27	16.94	8.35	54.44	3.99	15.88	0.37	24.58	0.71
W246463	33.59	6.38	53.57	6.46	6.96	45.83	0.93	39.4	0.37
W246464	28.81	31.08	26.93	13.18	6.53	43.09	0.87	34.4	1.9
W246465	35.5	28.23	27.18	9.09	7.04	41.37	0.87	40.8	0.8
W246466	35.17	29.39	30.56	4.88	7.05	45.68	0.93	40.42	0.99
W246467	25.98	21.46	17.1	35.46	5.06	23.65	0.53	27.6	7.6
W246468	24.68	18.08	13.48	43.76	4.47	17.94	0.37	26.19	7.16
W246469	31.83	30.6	28.78	8.79	6.81	43.72	0.95	36.83	2.87
W246470	24.59	25.64	20.5	29.27	5.31	30.09	0.61	28.81	5.89
W246476	24.75	18.27	11.44	45.54	4.37	14.5	0.31	26.04	9.15
W246477	31.32	24.4	20.32	23.96	6.26	31.32	0.73	37.18	0.51
W246478	25.09	20.87	15.48	38.56	4.81	20.49	0.39	28.25	7.47
W246479	20.98	21.19	13.93	43.9	4.15	18.83	0.37	22.67	10.06
W246480	25.81	25.76	18.46	29.97	5.65	29.19	0.6	29.71	4.86
W246482	34.25	26.76	25.49	13.5	6.84	38.39	0.83	39.14	1.26
W246481	14.71	11.43	0.02	73.84	2.53	3.64	0.07	18.29	1.6
W246483	18.26	12.71	2.59	66.44	3.42	5.72	0.12	24.04	0.23
W246485	19.28	13.84	1.54	65.34	3.72	4.98	0.12	25.75	0.06
W246486	27.24	28.67	22.8	21.29	6.27	37.69	0.73	32.45	1.54
W246484	35.9	27.07	30.15	6.88	7.1	43.05	0.89	41.63	0.42
W246487	34.99	25.46	23.38	16.17	6.55	34	0.7	38.32	4.07
W246488	30.11	26.5	24.11	19.28	6.24	37.33	0.81	35.47	0.84
W246489	25.57	20.91	14.36	39.16	5.22	23.06	0.53	31.78	0.23
W246509	33.36	30.23	26.21	10.2	6.86	41.93	0.87	37.93	2.15
W246510	36.9	28.56	29.62	4.92	7.26	43.91	0.9	42.12	0.83

Appendix D.--Proximate and ultimate analyses, calorific value, forms of sulfur, free-swelling index and ash fusion temperature determinations for 191 coal samples from the Sindh Province, Pakistan.

SAMPLE NUMBER	PROXIMATE ANALYSIS MOISTURE	VOLATILE MATTER	FIXED CARBON	ASH	ULTIMATE ANALYSIS HYDROGEN	CARBON	NITROGEN	OXYGEN	SULFUR
W246160	40.09	27.7	24.51	7.7	7.46	38.32	0.76	43.72	1.92
W246449	35.63	31.37	25.72	7.28	7.26	42.4	0.87	39.05	3.06
W246450	25.28	19.87	15.17	39.68	4.63	19.33	0.37	26.17	9.77
W246451	29.52	28.5	23.73	18.25	6.39	37.1	0.91	32.46	4.86
W246452	32.34	29.94	26.65	11.07	6.75	41.33	0.72	36.22	3.87
W246453	32.74	30.22	24.42	12.62	6.74	40.22	0.86	37.54	1.99
W246454	32	28.92	25.68	13.4	6.79	39.35	0.79	34.07	5.58
W246455	33.01	23.3	19.27	24.42	5.85	27.68	0.77	35.31	5.86
W246456	34.4	29.29	27.01	9.3	6.78	42.37	0.52	39.27	1.73
W246457	31.65	30.68	26.84	10.83	6.55	43.62	0.88	35.2	2.88
W246458	24.44	21.79	12.26	41.51	4.92	21.52	0.88	28.93	2.21
W246459	32.51	33.97	16.54	16.98	6.5	36.73	0.76	37.53	1.46
W246460	21.84	18.45	14.97	44.74	3.95	15.69	0.28	24.46	10.84
W246461	30.28	24.53	20.01	25.18	5.45	28.42	0.61	34.41	5.86
W246471	39.78	27.14	20.55	12.53	7.3	34.45	0.32	42.34	3.01
W246472	37.37	28.36	27.71	6.56	6.85	43.03	0.83	41.67	1.02
W246473	20.22	19.33	14.66	45.79	3.81	20.15	1.04	21.96	7.21
W246474	32.49	29.55	25.39	12.57	6.59	39.5	0.35	35.3	5.66
W246475	28.78	22.68	15.78	32.76	5.63	26.39	0.85	33.36	0.97
W246490	19.97	15.23	7.52	57.28	3.34	4.84	0.22	28.45	5.79
W246491	32.47	28.62	25.96	12.95	6.31	39.25	0.8	35.5	5.12
W246492	32.84	29.78	22.81	14.57	7.03	38.09	0.79	37.06	2.43
W246493	34.62	30.54	24.59	10.25	7.19	39.64	0.76	37.85	4.28
W246494	18.94	17.75	8.41	54.9	3.44	10.1	0.21	21.51	9.81
W246495	33.6	31.59	29.5	5.31	7.44	46.57	0.91	38.12	1.61
W246496	35.5	32.24	28.61	3.65	7.22	47.5	0.92	39.82	0.85
W246497	33.17	28.66	21.88	16.29	6.59	37.19	0.74	36.7	2.45
W246498	29.09	0.00B	0.00B	12.72	0.00B	0.00B	0.00B	0.00B	3.46
W246499	33.17	30.02	30.37	6.44	6.59	46.19	0.94	38.2	1.6
W246500	30.4	32.84	31.19	5.57	6.59	48.78	0.94	36.15	1.93
W246501	35.68	36.08	12.08	16.16	6.35	33.04	0.74	38.48	5
W246502	26.25	19.79	10.91	43.05	4.44	16.35	0.36	28.35	7.34
W246503	31.38	25.49	20.6	22.53	5.88	28.13	0.57	31.13	11.68
W246504	26.49	22.19	10.26	41.06	4.98	20.16	0.39	30.32	2.99
W246505	35.15	29.44	24.93	10.48	6.66	39.85	1.01	38.41	3.5
W246506	27.49	28.8	14.97	28.74	5.41	29.69	0.59	30.25	5.25
W246507	24.22	18.29	9.58	47.91	4.2	12.57	0.24	27.7	7.29
W246508	36.02	30.41	29.21	4.36	7.4	46.55	0.58	40.76	0.26
W246511	26.88	19.85	13.4	39.87	5.07	20.54	0.42	30.08	3.97
W246512	37.53	29.67	29.37	3.43	7.28	48.96	0.9	38.81	0.56

Appendix D.--Proximate and ultimate analyses, calorific value, forms of sulfur, free-swelling index and ash fusion temperature determinations for 191 coal samples from the Sindh Province, Pakistan.

	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				
SAMPLE NUMBER	MOISTURE	VOLATILE MATTER	FIXED CARBON	ASH	HYDROGEN	CARBON	NITROGEN	OXYGEN	SULFUR
W246513	34.54	13.03	49.81	2.62	7.03	49.73	1.01	39.28	0.29
W246514	36.93	27.59	24.98	10.5	6.98	38.52	0.79	39.2	3.93
W246515	27.46	22.39	14.05	36.1	4.11	21.78	0.43	31.4	6.13
W246516	34.45	30.21	27.52	7.82	6.75	43.93	0.86	38.25	2.32
W246517	35.56	29.34	27.14	7.96	7.4	41.95	0.81	41.23	0.59
W250660	26.15	30.6	23	20.25	6.4	38.86	0.88	31.94	1.64
W250661	32.93	27.3	29.88	9.89	6.55	42.44	0.97	38.24	1.87
W250658	29.83	32.81	31.65	5.71	6.64	49.79	1.06	35.66	1.11
W250659	27.56	23.14	18.88	30.42	5.56	28.93	0.69	33.29	1.09
W250656	32.05	24.92	22.15	20.88	6.12	32.5	0.69	35.21	4.47
W250657	35.17	27.58	30.01	7.24	6.62	43.88	0.98	38.59	2.54
W250662	31.45	28.19	27.79	12.57	6.53	40.52	0.91	36.51	2.93
W250663	27.15	30.59	30.05	12.21	6.17	39.12	0.79	36.97	4.69
W250664	31.57	28.47	25.53	14.43	6.57	39.44	0.83	36.84	1.84
W250665	35.15	28.34	29.96	6.55	6.92	43.85	0.88	39.86	1.88
W250666	37.21	26.74	31.18	4.87	7.17	44.07	0.93	41.19	1.71
W250667	37.2	26.73	32.85	3.22	7.24	45.53	1.01	42.26	0.71
W250668	33.35	26.93	29.66	10.06	6.45	40.17	0.73	38.67	3.88
W250669	36.74	27.46	31.95	3.85	6.88	46.45	0.48	41.31	0.94
W250670	34.3	29.43	31.92	4.35	6.79	47.83	0.83	38.86	1.26
W250671	34.14	29.37	29.4	7.09	7.15	44.06	1.31	38.86	1.45

Appendix D.--Proximate and ultimate analyses, calorific value, forms of sulfur, free-swelling index and ash fusion temperature determinations for 191 coal samples from the Sindh Province, Pakistan.

SAMPLE NUMBER	MJ/KG	CALORIFIC VALUE/LBS	ASH FUSION TEMPERATURE, C INITIAL DEFORMATION	SOFTENING	FLUID	FREE SWELLING INDEX	FORMS OF SULFUR SULFATE	PYRITIC	ORGANIC	AIR-DRIED LOSS
W241087	18.0	7769	1930	1950	2110	0	0.02	1.11	0.43	17.61
W241088	17.2	7423	1850	1900	2040	0	0.05	1.43	0.74	17
W241089	9.2	3950	2220	2530	2620	0	0.14	5.49	2.11	10.11
W241090	18.0	7741	1860	1890	2070	0	0.05	1.85	0.5	23.02
W241091	12.1	5228	2620	2780	2811	0	0.04	1.87	0.71	25.74
W241092	18.5	7978	1870	1880	1960	0	0.03	1.04	0.43	16.52
W241093	18.3	7871	1920	1940	2040	0	0.06	2.4	0.83	14
W241094	17.8	7670	1870	1890	1970	0	0.03	0.49	0.41	12.72
W241095	17.4	7513	1950	1970	2030	0	0.05	2.08	1.01	16.28
W241096	18.1	7798	2050	2160	2220	0	0.02	0.35	0.52	17.82
W241097	17.9	7727	2130	2180	2260	0	0.02	0.18	0.29	15.43
W241098	18.2	7867	2210	2300	2360	0	0.01	0.09	0.27	25
W241099	17.9	7733	2100	2230	2270	0	0.02	0.17	0.58	20.04
W241100	17.6	7573	2190	2240	2380	0	0.01	0.25	0.38	19.28
W241101	17.1	7360	1940	2020	2210	0	0.04	1.98	0.75	27.37
W241102	20.1	8687	1920	1960	2000	0	0.02	0.51	0.32	17.44
W241103	15.9	6835	2220	2520	2690	0	0.02	0.5	0.58	21.34
W241104	15.6	6733	1890	2060	2230	0	0.13	5.36	1.53	23.95
W241105	18.0	7780	1890	1980	2050	0	0.03	1.13	0.54	14.37
W241106	12.2	5273	2720	2811	2811	0	0.03	1.49	0.56	13.22
W241107	17.4	7513	1990	2010	2150	0	0.05	2.41	0.94	17.47
W241108	15.7	6780	2160	2430	2480	0	0.02	1.13	0.88	21.7
W241109	17.2	7397	1920	2040	2120	0	0.08	2.19	1.17	14.98
W241110	18.5	7985	1920	1950	2040	0	0.09	3.54	1.22	17.18
W241111	17.6	7568	1910	1950	2000	0	0.07	1.5	0.59	27.4
W241112	15.8	6793	1930	1960	2110	0	0.07	2.83	0.53	29.48
W241113	13.8	5957	1990	2030	2160	0	0.17	3.68	0.27	27.45
W241114	19.4	8357	1900	1940	1960	0	0.06	1.27	0.68	15.2
W241115	11.1	4791	2500	2670	2790	0	0.03	1.5	0.23	23.98
W246426	16.2	6979	2030	2140	2350	0	0.04	2.05	0.35	24.57
W246427	16.6	7144	2180	2390	2711	0	0.03	0.67	0.31	19.47
W246428	15.2	6576	1930	1950	2000	0	0.11	4.91	0.46	28.08
W246528	18.1	7793	1920	1950	2040	0	0.07	3.48	0.25	27.29
W241116	10.9	4713	2730	2800	2811	0	0.03	1.22	0.21	29.28
W241117	13.5	5830	2060	2140	2460	0	0.06	4.63	0.93	21.31
W241118	10.5	4530	2520	2580	2640	0	0.07	4.84	0.68	16.65
W241119	18.0	7743	2370	2440	2560	0	0.05	3.79	0.67	18.51
W241120	6.7	2898	2800	2811	2811	0	0.04	1.01	0.07	21.69
W241121	12.0	5188	2680	2730	2790	0	0.02	2.9	0.18	21.06
W241122	12.7	5489	2680	2740	2790	0	0.05	3.98	0.67	16.02

Appendix D.--Proximate and ultimate analyses, calorific value, forms of sulfur, free-swelling index and ash fusion temperature determinations for 191 coal samples from the Sindh Province, Pakistan.

SAMPLE NUMBER	MJ/KG	CALORIFIC VALUE/LBS	ASH FUSION TEMPERATURE, C INITIAL DEFORMATION	SOFTENING	FLUID	FREE SWELLING INDEX	FORMS OF SULFUR SULFATE	PYRITIC	ORGANIC	AIR-DRIED LOSS
W241123	14.5	6232	1990	2070	2150	0	0.02	4.48	0.7	23.73
W241022	14.0	6051	2150	2190	2300	0	0.02	2.18	0.41	25.49
W241023	15.0	6461	2070	2150	2370	0	0.02	2.46	1	27.13
W241024	7.3	3166	2450	2560	2610	0	0.15	7.85	0.51	19.74
W241025	16.0	6898	2130	2320	2400	0	0.07	5	1.06	20.65
W241026	13.3	5724	2120	2270	2460	0	0.05	4.2	0.95	26.19
W241027	18.2	7861	1820	1880	1990	0	0.01	1.66	0.73	23.6
W241028	7.4	3204	2480	2570	2660	0	0.1	6.69	0.31	21.67
W246430	17.5	7550	2030	2040	2120	0	0.02	1.67	0.61	25.06
W246431	15.4	6620	2190	2260	2480	0	0.01	0.18	0.23	26.41
W246432	18.9	8131	1950	1970	2000	0	0.02	1.7	0.54	22.67
W246433	18.1	7818	2060	2070	2120	0	0.01	1.01	0.28	26.52
W246437	17.6	7611	1960	2000	2160	0	0.02	1.52	0.54	26.93
W246438	15.2	6564	1920	1960	1970	0	0.00	0.19	0.21	42.46
W246439	18.2	7850	1890	1930	1960	0	0.01	0.48	0.16	28.98
W246440	18.5	7960	1970	2030	2060	0	0.01	0.04	0.13	30.51
W246441	17.1	7357	2080	2090	2100	0	0.01	0.09	0.13	31.43
W246442	9.2	3947	2750	2811	2811	0	0.01	0.5	0.09	24.88
W246443	9.0	3862	2320	2480	2510	0	0.15	5.42	1.52	17.79
W246429	15.7	6771	2080	2120	2280	0	0.01	1.65	0.38	24.31
W246435	12.6	5439	2090	2430	2480	0	0.07	3.4	1.73	22.02
W246436	17.9	7737	1980	2030	2120	0	0.05	4.8	1.33	24.65
W246434	19.2	8297	1940	1950	2000	0	0.03	1.53	0.95	23.51
W246444	14.9	6405	2160	2200	2250	0	0.04	1.3	0.5	30.39
W246445	16.0	6911	2200	2290	2460	0	0.01	0.17	0.13	33.01
W246446	9.5	4096	2580	2700	2760	0	0.01	0.21	0.06	37.18
W246447	17.4	7505	2010	2110	2250	0	0.01	0.09	0.14	33.1
W246448	17.8	7691	2170	2280	2330	0	0.01	0.21	0.16	29.56
W237524	18.8	8110	2140	2180	2210	0	0.38	1.93	0.09	0
W237525	19.4	8368	2260	2360	2420	0	0.11	0.75	0.35	0
W237526	22.0	9468	2000	2040	2120	0	0.05	0.67	0.36	0
W237527	22.5	9721	2060	2090	2120	0	0.26	1.3	0.19	0
W246127	19.6	8472	1830	1910	1940	0	0.06	0.88	0.48	26.26
W246128	17.1	7387	2000	2180	2420	0	0.03	0.63	0.22	30.43
W246129	17.5	7552	2010	2190	2300	0	0.03	0.62	0.06	29.24
W246130	17.2	7414	2100	2230	2480	0	0.04	1.65	0.06	26.91
W246131	18.8	8121	2020	2070	2140	0	0.04	1.2	0.35	28.67
W246132	17.1	7375	2090	2140	2220	0	0.11	5	0.69	28.02
W246137	13.8	5948	1970	2060	2240	0	0.09	2.82	0.89	34.92
W246138	17.3	7476	1990	2010	2040	0	0.04	1.12	0.27	34.79
W246139	15.3	6577	2150	2200	2360	0	0.09	2.69	0.61	28.16
W246140	14.3	6186	2220	2310	2630	0	0.11	2.14	0.63	29.06
W246141	4.8	2085	2500	2600	2670	0	0.19	6.45	0.68	21.22
W246142	18.4	7921	2110	2130	2160	0	0.05	0.44	0.37	31.36
W246143	18.5	7982	2130	2430	2540	0	0.07	0.16	0.18	26.1

Appendix D.--Proximate and ultimate analyses, calorific value, forms of sulfur, free-swelling index and ash fusion temperature determinations for 191 coal samples from the Sindh Province, Pakistan.

SAMPLE NUMBER	MJ/KG	CALORIFIC VALUE/LBS	ASH FUSION TEMPERATURE, C INITIAL DEFORMATION	SOFTENING	FLUID	FREE SWELLING INDEX	FORMS OF SULFUR SULFATE	PYRITIC	ORGANIC	AIR-DRIED LOSS
W246144	19.5	8415	2130	2170	2300	0	0.06	0.05	0.15	28.66
W246145	16.8	7236	2140	2230	2290	0	0.04	0.52	0.14	25.36
W246146	13.4	5779	2150	2350	2600	0	0.13	4.62	0.54	25.75
W246147	18.8	8115	2100	2110	2130	0	0.11	2.33	0.27	26.52
W246148	20.6	8880	2120	2160	2180	0	0.09	0.77	0.19	25.32
W246149	17.8	7685	1920	1990	2040	0	0.12	2.14	0.63	22.31
W246150	14.2	6134	1960	2020	2590	0	0.15	1.7	0.8	30.32
W246133	18.8	8091	1940	2030	2080	0	0.11	1.21	0.67	18.68
W246134	12.1	5226	2570	2711	2711	0	0.04	1.01	0.18	27.57
W246135	18.0	7780	2060	2070	2280	0	0.05	1.34	1.1	29.97
W246136	13.8	5945	2350	2360	2380	0	0.26	13.16	1.63	27.3
W246151	18.4	7942	2170	2230	2550	0	0.08	1.93	0.82	21.9
W246152	19.0	8210	1890	1950	1990	0	0.08	1.53	0.43	26.78
W246153	9.0	3877	2450	2530	2640	0	0.1	4.21	0.59	21.37
W246154	18.4	7952	1970	2000	2030	0	0.05	0.01	0.32	31.17
W246155	16.4	7062	2180	2200	2240	0	0.04	0.01	0.35	32.96
W246156	16.5	7136	2040	2080	2110	0	0.02	0.05	0.19	38.84
W246157	15.5	6682	2180	2210	2250	0	0.03	0.15	0.18	31.51
W246158	15.4	6636	2190	2290	2690	0	0.06	0.4	0.13	32.44
W246159	17.8	7692	2080	2120	2360	0	0.01	0.66	0.36	28.73
W246462	5.8	2514	2550	2690	2711	0	0.03	0.47	0.21	18.59
W246463	18.4	7942	2010	2020	2110	0	0.02	0.08	0.27	24.65
W246464	17.7	7632	2180	2290	2500	0	0.03	1.51	0.36	22.34
W246465	17.1	7365	1970	2120	2240	0	0.04	0.56	0.2	30.29
W246466	18.4	7932	1900	2060	2090	0	0.03	0.57	0.39	28.28
W246467	10.1	4371	1960	2210	2350	0	0.13	6.76	0.71	24
W246468	7.6	3257	2070	2400	2560	0	0.14	6.02	1	22.98
W246469	18.2	7864	1870	1890	2020	0	0.06	2.45	0.36	26.47
W246470	12.7	5486	2120	2300	2510	0	0.23	5.14	0.52	20.59
W246476	6.2	2695	2180	2500	2600	0	0.23	7.79	1.13	21.11
W246477	12.7	5480	2600	2711	2711	0	0.03	0.32	0.16	28.61
W246478	8.8	3788	2180	2530	2580	0	0.27	6.3	0.9	21.59
W246479	8.2	3540	2120	2180	2480	0	0.36	8.85	0.85	17.57
W246480	12.5	5381	2440	2580	2640	0	0.17	4.28	0.41	23.65
W246482	15.5	6682	2060	2110	2300	0	0.04	1.02	0.2	28.85
W246481	0.9	380	2370	2480	2660	0	0.09	1.48	0.03	13.74
W246483	1.7	744	2711	2711	2711	0	0.04	0.17	0.02	16.96
W246485	1.4	608	2711	2711	2711	0	0.02	0.03	0.01	18.22
W246486	15.8	6802	2070	2400	2600	0	0.05	1.29	0.2	23.13
W246484	17.2	7436	2040	2090	2400	0	0.01	0.19	0.22	30.81
W246487	14.1	6088	2030	2110	2380	0	0.15	3.09	0.83	30.71
W246488	15.4	6643	2120	2330	2590	0	0.04	0.69	0.11	27.31
W246489	9.3	4008	2711	2711	2711	0	0.03	0.16	0.04	23.58
W246509	17.4	7520	1940	1970	2050	0	0.04	1.86	0.25	28.94
W246510	17.8	7665	1920	2070	2130	0	0.03	0.4	0.4	32.11

Appendix D.--Proximate and ultimate analyses, calorific value, forms of sulfur, free-swelling index and ash fusion temperature determinations for 191 coal samples from the Sindh Province, Pakistan.

SAMPLE NUMBER	MJ/KG	CALORIFIC VALUE/LBS	ASH FUSION TEMPERATURE, C INITIAL DEFORMATION	SOFTENING	FLUID	FREE SWELLING INDEX	FORMS OF SULFUR SULFATE	PYRITIC	ORGANIC	AIR-DRIED LOSS
W246160	16.1	6922	2080	2100	2140	0	0.04	0.02	1.86	24.55
W246449	17.7	7617	1930	1990	2080	0	0.07	1.79	1.2	32.37
W246450	8.5	3683	2080	2320	2510	0	0.11	9.18	0.48	23.15
W246451	15.8	6802	2050	2090	2450	0	0.05	4.28	0.53	26.46
W246452	17.3	7439	1950	1980	2170	0	0.04	3.21	0.62	29.06
W246453	16.5	7125	2090	2230	2510	0	0.04	1.15	0.8	29.3
W246454	16.7	7184	2000	2020	2220	0	0.07	4.5	1.01	28.86
W246455	11.6	4987	2060	2340	2530	0	0.32	3.97	1.57	26.41
W246456	17.1	7388	1980	2080	2340	0	0.08	0.97	0.68	23.91
W246457	17.7	7653	1980	2000	2220	0	0.12	1.94	0.82	22.89
W246458	8.6	3713	2711	2711	2711	0	0.09	1.6	0.52	21.79
W246459	15.1	6492	2180	2380	2560	0	0.07	0.95	0.44	17.22
W246460	6.9	2979	2020	2470	2570	0	0.71	10	0.13	9.89
W246461	11.9	5110	2000	2280	2470	0	0.53	4.18	1.15	16.98
W246471	14.6	6313	2020	2120	2460	0	0.06	2.37	0.58	37.11
W246472	16.9	7267	1950	2080	2290	0	0.04	0.32	0.66	26.36
W246473	8.1	3507	2060	2340	2550	0	0.43	6.18	0.6	15.75
W246474	16.8	7229	1950	1960	2080	0	0.08	4.75	0.83	29.28
W246475	10.5	4542	2690	2711	2711	0	0.02	0.59	0.36	25.7
W246490	4.0	1722	2150	2450	2640	0	0.28	5.29	0.22	10.71
W246491	16.4	7085	1930	1950	2080	0	0.14	4.22	0.76	18.86
W246492	15.7	6783	2060	2150	2420	0	0.1	1.63	0.7	16.13
W246493	16.8	7242	1950	1960	2130	0	0.15	2.62	1.51	21.47
W246494	4.4	1906	2070	2480	2630	0	0.38	9.38	0.05	16.63
W246495	18.9	8140	2110	2170	2220	0	0.07	0.72	0.82	10.31
W246496	19.1	8219	2130	2220	2470	0	0.03	0.29	0.53	15.82
W246497	15.1	6499	2120	2330	2470	0	0.22	1.55	0.68	19.07
W246498	0B	0B	1930	1970	2180	0	0.1	2.35	1.01	16.06
W246499	18.6	8019	1970	2110	2140	0	0.07	0.92	0.61	16.37
W246500	20.1	8669	2050	2160	2180	0	0.05	1.18	0.7	10.93
W246501	14.0	6032	2050	2100	2200	0	0.19	4.16	0.65	13.07
W246502	6.7	2903	2410	2490	2650	0	0.32	6.5	0.52	11.99
W246503	12.9	5575	1980	1990	2130	0	0.18	11.47	0.03	26.31
W246504	8.4	3637	2300	2460	2650	0	0.02	2.24	0.73	19.88
W246505	15.9	6848	2010	2040	2300	0	0.36	1.99	1.15	18.16
W246506	11.9	5113	2160	2320	2410	0	0.63	3.65	0.97	18.88
W246507	5.5	2376	2470	2580	2711	0	0.62	5.86	0.81	19.31
W246508	18.2	7862	2000	2090	2150	0	0.02	0.01	0.23	21.79
W246511	8.0	3450	2360	2570	2670	0	0.08	3.47	0.42	24.08
W246512	18.2	7834	2180	2200	2240	0	0.03	0.13	0.4	13.03

Appendix D.--Proximate and ultimate analyses, calorific value, forms of sulfur, free-swelling index and ash fusion temperature determinations for 191 coal samples from the Sindh Province, Pakistan.

SAMPLE NUMBER	MJ/KG	CALORIFIC VALUE/LBS	ASH FUSION TEMPERATURE, C INITIAL DEFORMATION	SOFTENING	FLUID	FREE SWELLING INDEX	------FORMS OF SULFUR---- SULFATE	PYRITIC	ORGANIC	AIR-DRIED LOSS
W246513	19.6	8448	2150	2570	2590	0	0.14	0.01	0.14	14.62
W246514	15.9	6868	1960	2000	2340	0	0.06	2.57	1.3	28.09
W246515	9.5	4082	2120	2470	2630	0	0.15	5.17	0.81	24.09
W246516	17.8	7665	1910	2000	2200	0	0.15	1.37	0.8	18.43
W246517	17.3	7478	2030	2230	2500	0	0.01	0.01	0.57	29.35
W250660	16.2	6985	2480	2510	2550	0	0.15	1.15	0.34	22.48
W250661	17.2	7426	2020	2040	2100	0	0.14	1.13	0.6	23.88
W250658	20.4	8807	1980	1990	2010	0	0.01	0.6	0.5	16.76
W250659	11.8	5071	1960	1980	2010	0	0.00B	0.00B	0.00B	22.89
W250656	13.6	5873	2080	2110	2240	0	0.09	3.29	1.09	25.92
W250657	17.5	7563	1950	1960	2030	0	0.14	1.6	0.8	18.59
W250662	16.6	7156	1900	1920	1940	0	0.17	1.9	0.86	27.31
W250663	16.5	7101	2320	2360	2450	0	1.59	2.14	0.96	22.23
W250664	16.0	6905	2150	2170	2200	0	0.14	1.01	0.69	27.59
W250665	17.5	7553	1860	1880	1900	0	0.17	0.96	0.75	30.72
W250666	17.5	7559	2020	2040	2090	0	0.09	0.88	0.74	30.86
W250667	18.2	7849	2190	2250	2490	0	0.02	0.17	0.52	30.49
W250668	16.3	7025	2010	2040	2100	0	0.54	1.66	1.68	29.4
W250669	18.2	7835	1940	1990	2180	0	0.03	0.19	0.72	28.12
W250670	18.8	8122	2180	2210	2480	0	0.09	0.5	0.67	27.68
W250671	18.1	7820	1920	1940	1960	0	0.08	0.78	0.59	27.52

Appendix E.--Number of values, minimum, maximum, and mean for coal samples from Sindh, Pakistan.
[Values are reported on an as-recieved, whole coal basis except for oxides which are are reported on an as-recieved, ash basis.]

Component (%)	Values	Minimum	Maximum	Mean
ASH	175	4.3	87.5	24.93
SIO2	175	4.3	60	29.82
AL2O3	175	2.8	35	18.04
CAO	175	.24	25	5.62
MGO	175	.13	10	1.85
NA2O	175	.41	23	5.02
K2O	175	.06	.66	.24
FE2O3	175	2.6	69	20.40
TIO2	175	.27	8.3	2.56
P2O5	175	.014L	.48	.06
SO3	175	.82	46	14.75

Element (ppm)	Values	Minimum	Maximum	Mean
SI	175	.14	23.0	4.22
AL	175	.11	15	2.85
CA	175	.09	4.7	0.56
MG	175	.02	.38	0.16
NA	175	.11	1.6	0.50
K	175	.01	0.44	0.05
FE	175	.17	16	3.49
TI	175	.01	2.6	0.45
AG	175	.003L	.33	0.07
AS	175	.27L	23	3.49
B	175	33.00	350	140.35
BA	175	7.30	790	59.06
BE	175	.04	9.5	2.35
BR	175	2.10	620	98.29
CD	174	.001L	.49	0.08
CE	175	.92	93	22.65
CL	175	70.00	6200	940.29
CO	175	.22	280	26.40
CR	175	1.40	270	58.28
CS	175	.02	2.1	0.21
CU	175	2.50	200	41.44
EU	175	.01	2.7	0.73
F	175	10.00	200	42.45
GA	174	.21	77	16.96
GE	175	.14L	59	10.33
HF	175	.04	9.9	2.01
HG	175	.004L	.17	0.03
LA	175	.70	59	13.60
LI	175	.26	130	26.97
LU	175	.01L	.74	0.24
MN	175	4.90	770	70.35
MO	175	.27	26	3.67
NB	175	.11	59	6.68
ND	175	.98L	51	12.77
NI	175	1.30	700	68.43
P	175	30.80L	260	50.24
PB	175	.36	48	4.81
PR	175	.25L	5.3	1.49
SB	175	.06	0.59	0.17
SC	175	.15	46	13.99
SE	175	1.40	11	3.75
SM	175	.06	11	2.80
SN	175	.22L	22	3.88
SR	175	81.00	4000	957.09
TA	175	.04	3.7	0.74
TB	175	.01L	1.2	0.41
TH	175	.07	13	2.90
U	188	.13L	5.8	1.16
V	175	1.10	360	66.41
W	141	.40L	20	0.97
Y	171	.47	52	13.78
YB	175	.20L	25	2.14
ZN	175	1.40	730	41.10
ZR	175	3.00	510	65.28

	Values	Minimum	Maximum	Mean
MOISTURE,%	191	14.71	48.02	31.2
VOLATILE MATTER,%	191	6.38	38.90	26.9
FIXED CARBON,%	191	.02	53.57	23.7
STANDARD ASH,%	191	2.62	73.84	17.9
HYDROGEN,%	191	2.53	8.33	6.3
CARBON,%	191	3.64	54.70	36.3
NITROGEN,%	191	.07	1.31	0.7
OXYGEN,%	191	18.29	49.70	35.3
SULFUR,%	191	.06	15.05	2.9
CALORIFIC VALUE IN /LBS	191	380	9721	6459
IN Mj/kg	191	.88	22.6	15.0
DEFORMATION,^{o}C	191	1820	2800	2122
ASH SOFTENING,^{o}C	191	1880	2811	2217
ASH FLUID,^{o}C	191	1900	2811	2336
SULFATE SULFUR,%	191	0.01	1.59	0.10
PYRITIC SULFUR,%	191	0.01	13.16	2.26
ORGANIC SULFUR,%	191	0.01	2.11	0.57
FREE SWELLING INDEX	191	0.00	0.00	0.00
AIR DRIED LOSS.%	191	9.89	42.46	23.26