DEPARTMENT OF THE INTERIOR
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Report on coal resource exploration assessment program drilling and related activities September 1987 to February 1988 Conducted in the Indus East coal area Southern Sind Province, Pakistan:

SUMMARY
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Contents

Illustrations

Tables

COALREAP Drilling Summary and Related Activities

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Abstract

Thirteen coal exploration drill holes were completed in the Indus East coal area of the southern Sind Province, Pakistan, as part of COALREAP during the period from September, 1987, to February, 1988. These widely spaced exploratory holes form the basis for a preliminary coal resource assessment of the area east of the Indus River and just south of Hyderabad.

A total of 3,914 m of rock was drilled, of that, 2,431 m were cored. Lithologic logs were prepared from descriptions of rock cuttings and cores, and 64 coal samples were collected from cores for proximate and ultimate analyses and determinations of major, minor and trace elements. Geophysical logs were obtained for each drill hole when possible, upon its completion. All cores and rock cuttings (except coal) are available for study at the Geological Survey of Pakistan facility at Sonda.

In addition to providing regional coal-resource information, some of the drill-hole data will be used as a basis for more detailed exploration in future studies to define the geometry of minable coal zones and beds. For example, 6 drill holes penetrated coal beds from 0.75 to 1.5 m thick and 3 drill holes penetrated coal beds 1.5 m thick or greater. The thickest coal bed drilled was 1.85 m. Further exploration by closer-spaced drilling is needed to attain more accurate knowledge of the coal resource potential of the area.

Introduction

The Coal Resource Exploration and Assessment Program (COALREAP) in Pakistan comprises component 2a of the Energy Planning and Development Project (391-0478) of the United States Agency for International Development. The COALREAP is conducted by the Geological Survey of Pakistan (GSP) with assistance from the U.S. Geological Survey (USGS) under financing from the Government of Pakistan (GOP) and the U.S. Agency for International Development (USAID). The coal-exploration program described in this report was conducted according to the "Plan for coal-resources-assessment drilling and related activities, Sind Province, Pakistan" which was prepared jointly by the four cooperating groups.

This report satisfies the requirement for submittal of a report that summarizes drilling results as soon as possible after termination of drilling.

The drilling was done by the Indus Valley Construction Co. Ltd. of Lahore, Pakistan under USAID Contract No. 391-0478-C-00-5078-00. Drilling started in September, 1987 and was completed in February, 1988. The distribution and numbers of these coal-exploration holes are shown in Figure 1.

Acknowledgements

Individual acknowledgement is impossible because of the large number of people involved in the drilling program. However, key personnel in the program were the well-site geologists and support personnel of the GSP and the drill crews and support personnel of the Indus Valley Construction Company. Their expertise, industry, fortitude, and good humor deserve special thanks.

Basic data for drill holes

Location

The locations of the drill holes are listed in Table 1. Drill hole locations were surveyed by Geological Survey of Pakistan topographers and surveyors. Those coordinates shown with an asterick were taken from 1:50,000 scale topographic maps.

Meterage drilled

Table 2 shows the amount of drilling (both non-core and core) for each exploratory drill hole. Non-core drilling extended from the surface to a depth shown by the figure in the table; core drilling extended below the non-core drilling an amount shown by the figure in the table; when added, the figures equal total depth of the hole. The total amount of drilling was 3,913.85 m including 138.90 m (hole 14R) redrilled for sampling and geophysical-logging purposes. Of the total, 1,483.17 m were non-core drilling and 2,430.68 m were cored, amounts comprising 38 and 62 percent, respectively, of the total.

Two sizes of equipment were used in core-drilling and recovery. A total of 2,329.13 m, or 96 percent of all meterage cored, was with the larger equipment, designated HQ (interior diameter 7.78 cm). In the lowest part of drill hole UAK-9, a total of 101.55 m, or 4 percent of the total meterage cored, was with smaller equipment, designated NQ (interior diameter 6.03 cm). The larger-sized core was used more extensively and is preferred because it has a better core-recovery rate and produces a slightly larger volume or rock for inspection, description, and sampling.

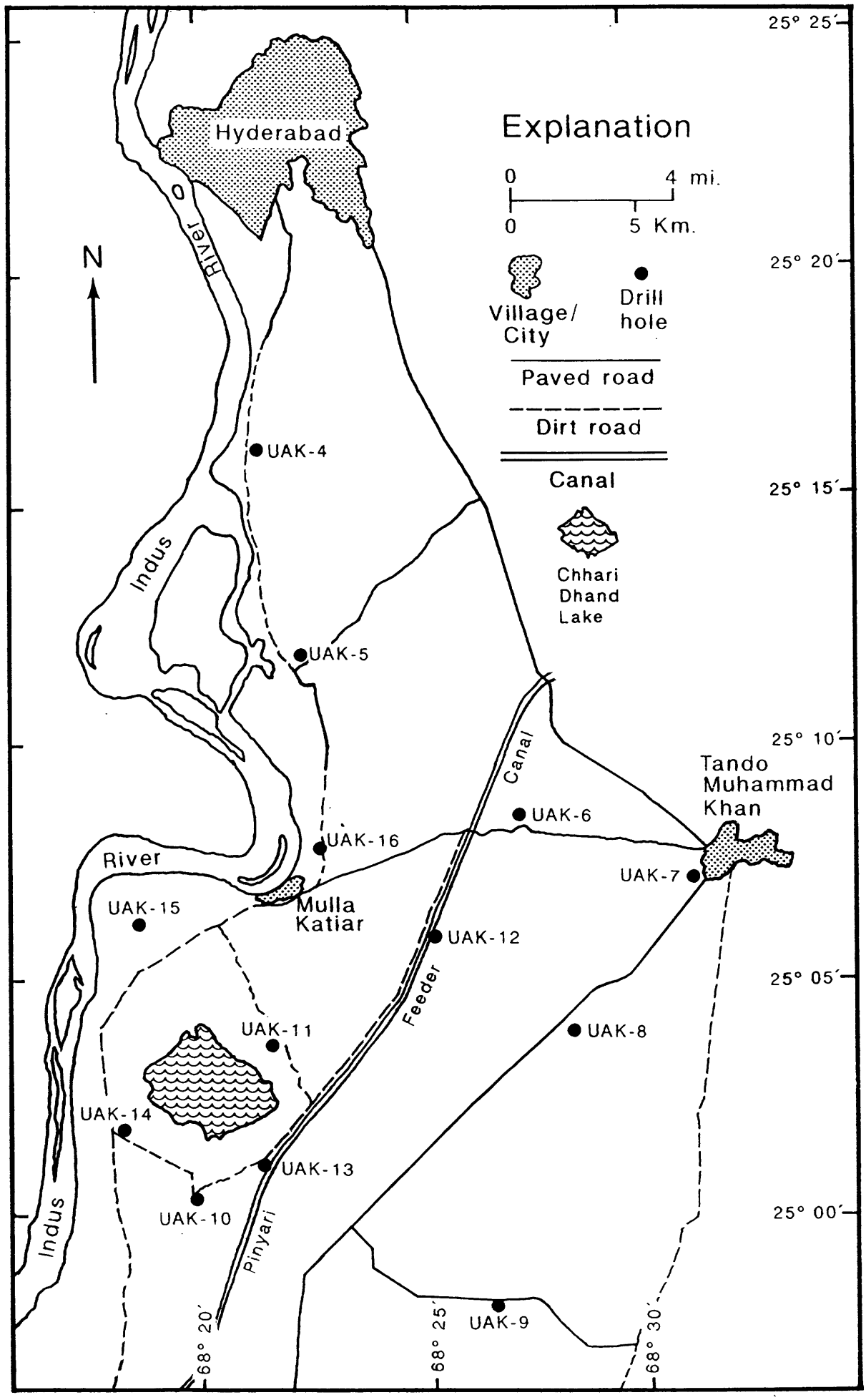

Figure 1.-General location of drill holes

Table 1.--Locations and elevations of drill holes

Drill Hole No.	Easting (m)	Easting (yds)	Northing (m)	Northing (yds)	Altitude above mean sea level (m)	Altitude above mean sea level (ft)
UAK-4	2175220*	2378710	845780*	922223	18.0*	59.0
UAK-5	2176470	2380217	837643	916058	20.4	67.0
UAK-6	2185023	2389570	830970	908760	13.1	43.0
UAK-7	2191315	2396451	828194	905724	12.5	41.0
UAK-8	2184931	2389470	821607	898520	11.6	38.0
UAK-9	2182495*	2386631	811850*	887928	11.3*	37.0
UAK-10	2170796	2374011	817186	893685	14.6	48.0
UAK-11	2173750*	2377161	824350*	901652	14.3*	47.0
UAK-12	2181498	2385715	826905	904314	12.5	41.0
UAK-13	2174299	2377842	818421	895036	12.8	42.0
UAK-14	2167709	2370635	820335	897129	13.1	43.0
UAK-14R*	2167710	2370636	820336	897130	13.1	43.0
UAK-15	2169200	2372266	827604	903079	15.5	51.0
UAK-16	2177140	2380949	830634	908392	12.5	41.0

* UAK-14R: redrill of UAK-14.

Table 2.--Drill-hole basic data

Drill hole No.	Non-core	Core (1)			Total depth	Stand-by
		HQ	NQ	Total		
	(m)	(m)	(m)	(m)	(m)	(min)
UAK-4	250.00	62.00	---	62.00	312.00	220
UAK-5	3.00	397.00	---	397.00	400.00	230
UAK-6	150.58	146.47	---	146.47	297.05	279
UAK-7	132.00	243.55	---	243.55	375.55	300
UAK-8	151.40	189.90	---	189.90	341.30	120
UAK-9	119.50	129.00	101.55	230.55	350.05	200
UAK-10	40.00	137.85	---	137.85	177.85	150
UAK-11	101.00	150.30	---	150.30	251.30	240
UAK-12	160.00	150.00	---	150.00	310.00	264
UAK-13	63.39	142.61	---	142.61	206.00	200
UAK-14	62.30	117.70	---	117.70	180.00	201
UAK-14R	125.00	13.90	---	13.90	138.90	---
UAK-15	75.00	154.20	---	154.20	229.20	165
UAK-16	50.00	294.65	---	294.65	344.65	245
TOTAL	1,483.17	2,329.13	101.55	2,430.68	3,913.85	2,814

(1) Core types: HQ = 7.78 mm (3 1/16 in.) diameter
NQ = 6.03 mm (2 3/8 in.) diameter

Sample recovery

Non-core. The drilling plan specified that rock cuttings representative of 2-m increments of depth be recovered from those parts of the holes not cored. Table 3 shows the drilling statistics for each of the thirteen holes drilled.

Core. Core recovery is expressed in percentage as the ratio of the amount of core recovered to the total amount that was core drilled. Average core recovery for the 13 drill holes was 54 percent. Average core recovery according to diameter of core was 55 percent for HQ-size and 29 percent for NQ-size. Individual drill holes had core recoveries ranging from 19 to 80 percent (table 3).

Drill hole records--lithologic and geophysical logs

Concurrent with the drilling of each hole, the well-site geologists described the rock cuttings and cores and prepared lithologic logs. These logs are recorded as Part 2 of this report.

Geophysical logs were obtained immediately upon completion of drilling in each hole. Table 4 summarizes the depths logged by the various geophysical methods in each drill hole. These geophysical logs are recorded as Part 3 of this report.

The geophysical logs aid interpretations of the rock sequence penetrated by the drill. This is especially important where the percentage of recovery is low, as in parts of the Bara Formation that consists largely of unconsolidated sand that is very difficult to recover as core. The lithologic logs will be integrated with the geophysical logs to produce a composite log that will present the best interpretation of the strata penetrated by the drill. Also, the geophysical logs can be used along with the lithologic logs to determine the exact thickness and depth of coal beds.

Coal beds

Table 5 shows the thicknesses and depths to top and base, of coal beds penetrated in each drill hole. Beds of impure coal are not shown in the table, nor are beds that are indicated on geophysical logs but not recorded on the lithologic logs.

The drill holes provide regional data about the distribution and characteristics of the coal-bearing rocks in the Indus East coal area and were not specifically located to prospect for minable coal or to delineate individual beds of thick coal. However, 6 drill holes penetrated coal beeds ranging from 0.75 to 1.5 m in thickness, and 3 drill holes penetrated coal beds 1.5 m thick or greater. The areas around and between many of the drill holes merit further exploration by more closely spaced drilling to attain a more accurate knowledge of the coal-resource potential of the area.

Table 3.--Core-drilling and core recovery statistics

Drill Hole	Total Depth (m)	Non-core drilling (m)	Core-drilling				Core recovered				Percent core recovery			
			HQ (m)	NQ (m)	Total (m)	Cummulative total(m)	HQ (m)	NQ (m)	Total (m)	Cumulative total (m)	HQ	NQ	Total	Cumulative
UAK-4	312.00	250.00	62.00	----	62.00	62.00	45.00	-----	45.00	45.00	73	----	73	73
UAK-5	400.00	3.00	397.00	----	397.00	459.00	266.16	-----	266.16	311.16	67	----	67	68
UAK-6	297.05	150.58	146.47	----	146.47	605.47	110.67	-----	110.67	421.83	76	----	76	70
UAK-7	375.55	132.00	243.55	----	243.55	849.02	193.67	-----	193.67	615.50	80	----	80	72
UAK-8	341.30	151.40	189.90	----	189.90	1038.92	71.97	-----	71.97	687.47	38	----	38	66
UAK-9	350.05	119.50	129.00	101.55	230.55	1269.47	54.22	29.13	83.36	770.82	42	29	36	61
UAK-10	177.85	40.00	137.85	----	137.85	1407.32	59.48	----	59.48	830.30	43	----	43	59
UAK-11	251.30	101.00	150.30	----	150.30	1557.62	28.60	----	28.60	858.90	19	----	19	55
UAK-12	310.00	160.00	150.00	----	150.00	1707.62	70.70	----	70.70	929.60	49	----	49	54
UAK-13	206.00	63.39	142.61	----	142.61	1850.23	54.26	----	54.26	983.86	38	----	38	53
UAK-14	180.00	62.30	117.70	----	117.70	1967.93	45.28	----	45.28	1029.14	38	----	38	52
UAK-14R	138.90	125.00	13.90	----	13.90	1981.83	9.68	----	9.68	1038.82	70	----	70	52
UAK-15	229.20	75.00	154.20	----	154.20	2136.03	66.09	----	66.09	1104.91	43	----	43	52
UAK-16	344.65	50.00	294.65	----	294.65	2430.68	201.19	----	201.19	1306.10	68	----	68	54
TOTAL	3913.85	1483.17	2329.13	101.55	2430.68		1276.97	29.13	1306.11					
										Average	55	29	--	54

Table 4. - Geophysical Logs

Drill Hole No.	4PI Max Logged Depth (m)	NGR Max Logged Depth (m)	NEU Max. Logged Depth (m)	RES Max Logged Depth (m)	CAL Max Logged Depth (m)
UAK-4	307	306	308	211	215
UAK-5	373	371	373	122	125
UAK-6	289	288	290	157	163
UAK-7	365	364	366	235	247
UAK-8	320	318	320		247
UAK-9	341	338	340		
UAK-10	173	171	173	171	173
UAK-11	246	244	246	219	220
UAK-12	302	300	302	238	246
UAK-13	198	198	200	198	198
UAK-14	176	176	178	176	179
UAK-14R	135	133	135		135
UAK-15	223	225	227	225	227
UAK-16	331	330	332	174	174

Types of geophysical logs:
4PI = 4PI density--measures specific gravity of rocks
NGR = Natural gamma ray--measures natural gamma radiation
NEU = Neutron--measures hydrogen concentration (bound water)
RES = Resistivity--measures resistance to the flow of electricity
HDR = High resolution density--more precise measurement of specific gravity
CAL = Caliper--measures hole diameter

Table 5.--Coal beds intercepted

Drill hole No.	Depth to top of bed (overburden) (m)	Depth to base of bed (m)	Coal thickness (m)
UAK-4			
a.	255.52	255.65	0.13
b.	265.28	265.98	0.70
c.	268.07	268.22	0.15
d.	283.30	283.50	0.20
e.	294.20	295.00	0.80
f.	302.20	303.00	0.80
g.	304.60	304.83	0.23
UAK-5			
a.	102.51	102.89	0.38
b.	212.67	212.97	0.30
c.	289.30	289.98	0.68
d.	296.27	296.51	0.24
e.	296.82	297.84	1.02
f.	298.14	298.33	0.19
g.	313.52	314.90	1.38
h.	349.48	349.75	0.27
i.	356.60	356.70	0.10

Table 5.--Coal beds intercepted (continued)

Drill hole No.	Depth to top of bed (overburden) (m)	Depth to base of bed (m)	Coal thickness (m)
UAK-6			
a.	153.80	154.45	0.65
b.	236.59	236.79	0.20
c.	239.26	239.38	0.12
d.	269.50	270.02	0.52
e.	277.22	278.14	0.92
f.	281.40	282.19	0.79
g.	285.20	285.96	0.74
UAK-7			
a.	216.00	216.60	0.60
b.	340.25	340.42	0.17
c.	347.25	347.31	0.06
d.	358.95	360.45	1.50
UAK-8			
a.	172.50	172.62	0.12
b.	207.05	208.55	1.50
c.	216.75	216.95	0.20
d.	253.77	253.86	0.09
e.	253.96	254.03	0.07
f.	267.65	267.99	0.34

Table 5.--Coal beds intercepted (continued)

Drill hole No.	Depth to top of bed (overburden) (m)	Depth to base of bed (m)	Coal thickness (m)
UAK-9			
a.	218.50	218.74	0.24
UAK-10			
a.	86.69	86.74	0.05
b.	86.89	87.73	0.84
c.	91.92	91.97	0.05
d.	97.97	98.05	0.08
e.	101.84	102.24	0.40
f.	107.02	107.32	0.30
g.	110.95	112.07	1.12
h.	136.06	136.40	0.40
i.	146.02	146.40	0.38
j.	166.55	166.80	0.25
k.	169.70	169.94	0.24
UAK-11			
a.	101.00	101.40	0.40
b.	107.60	107.80	0.20
c.	160.05	160.25	0.20
d.	162.70	163.05	0.35

Table 5.--Coal beds intercepted (continued)

Drill hole No.	Depth to top of bed (overburden) (m)	Depth to base of bed (m)	Coal thickness (m)
UAK-12			
a.	213.40	213.65	0.25
b.	228.50	228.72	0.22
c.	231.95	232.15	0.20
d.	245.10	245.30	0.20
e.	252.96	253.22	0.26
f.	263.70	263.75	0.05
g.	284.80	285.55	0.75
UAK-13			
a.	63.39	63.49	0.10
b.	134.65	135.18	0.53
c.	163.35	163.83	0.48
d.	192.48	192.75	0.27
UAK-14			
a.	91.00	91.35	0.35
b.	98.96	99.58	0.62
c.	109.05	109.15	0.10
d.	155.32	155.45	0.13
e.	157.20	157.27	0.07
f.	160.35	160.48	0.13
g.	171.96	172.60	0.13

Table 5.--Coal beds intercepted (continued)

Drill hole No.	Depth to top of bed (overburden) (m)	Depth to base of bed (m)	Coal thickness (m)
UAK-14R*			
a.	65 80	66.03	0.23
b.	90.10	91.40	1.30
c.	99.00	99.80	0.80
d.	108.50	108.78	0.28
e.	131.10	132.20	1.10
UAK-15			
a.	114.66	114.81	0.15
b.	183.15	183.55	0.40
c.	183.75	185.60	1.85
d.	186.00	186.10	0.10
e.	190.05	190.95	0.90
f.	195.28	195.52	0.24
g.	225.94	226.14	0.20
UAK-16			
a.	140.30	140.60	0.30
b.	181.15	181.30	0.15
c.	195.71	195.90	0.19
d.	199.60	199.90	0.30
e.	221.50	222.00	0.50
f.	229.23	229.80	0.57

*Taken from 4 Pi density log.

Table 5.--Coal beds intercepted (continued)

Drill hole No.	Depth to top of bed (overburden) (m)	Depth to base of bed (m)	Coal thickness (m)
g.	230.72	230.90	0.18
h.	233.80	233.95	0.15
i.	238.20	238.70	0.50
j.	240.75	241.20	0.45
k.	309.85	310.50	0.65

Coal samples collected for quality analysis

Table 6 shows the distribution by drill hole of the 64 coal samples that were collected from the drill holes shown in Figure 1. Two drill holes contain coal beds too thin to warrant analysis. All coal samples will be chemically and physically analyzed so that the coals of the Indus East coal area may be adequately characterized for development and utilization potential. Proximate and ultimate analyses and heat value, forms of sulfur, agglomerating character, ash-fusion behavior, equilibrium moisture, and Hardgrove grindability index will be determined on all coal samples. In addition, selected samples will be analyzed for major, minor, and trace elements.

Some preliminary conclusions

The exploratory drilling program has provided new information about the distribution, character, and resource potential of coal over an area approximately 21 by 35 km in the Indus East coal area (Fig. 1). Much of this area, and adjoining areas, remain to be explored, but a resource assessment can be made now from available drilling data in the area. Although the drill holes are widely spaced, they provide a basic understanding of the geology and coal resources of the Indus East exploratory area.

Table 6.--Coal samples collected for analysis

Drill hole	Number of coal samples
UAK-4	3
UAK-5	14
UAK-6	5
UAK-7	3
UAK-8	2
UAK-9	0
UAK-10	10
UAK-11	0
UAK-12	1
UAK-13	4
UAK-14	5
UAK-14R	0
UAK-15	12
UAK-16	5
TOTAL	64