Frac Sand Evaluation
Peace River Silica Sand Deposit
Final Report

Prepared for:

Peace River Silica Sand Ltd.

ALBERTA RESEARCH COUNCIL

Alberta Geological Survey

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1. PROJECT SUMMARY

1.1 Background

The Peace River sand deposit has been known and recognized for many years as a potential source of high-grade silica sand. Considerable exploration drilling and investigation of the deposit has been done, mostly in the past 12 years; however, no conclusive quality tests for specific industrial silica markets were made. The market of primary interest for the present study is frac sand. If a source of frac sand were to be developed in Alberta, it could replace large tonnages now being imported from sources as far away as Minnesota and Texas.

This study undertook to provide authenticated data on silica sand quality in the deposit with respect to frac sand use, and to indicate whether further evaluation work would be warranted. The study was conducted jointly by Hardy BBT Limited and the Alberta Research Council for the current owner, Peace River Silica Sand Limited.

1.2 Method and Scope of Study

The study is in two parts, Geological Evaluation and Laboratory Investigation. The first part involved a review of all information from previous work, and remapping of the deposit for the purpose of locating testholes in a reconnaissance test drilling program. A 5-hole drilling program was executed in March 1989. Sand samples from these testholes were the basis for the laboratory investigation, to test the suitability of the sand in the deposit for frac sand use.

1.3 Geological Evaluation

The results of the geological evaluation are detailed in

appendix A. The deposit belongs to the Paddy Member, a friable sand unit in the upper part of the Cretaceous Peace River Formation. It straddles the Peace River, outcropping on both east and west banks, to form two separate resource blocks - termed the East Block and the West Block (see map 2-1, in pocket).

The current study included a review of previous test drilling information dating back to 1977, to extract the useful and relevant data for locating new testholes to fill information gaps. A test drilling program comprising 5 testholes was executed on the East Block in March 1989. Figure 1-1 is a NE-SW section through the East Block deposit showing the 1989 testholes. These data were combined with data culled from previous test drilling to map the dimensions and thickness of the deposit (map 2-1). Geological control is provided by 48 testholes on the East Block, and by 10 testholes, 7 trenches and 5 outcrop localities on the West Block. Total sand resources within each block, calculated from these data, are presented below as "measured" or "inferred" depending on the nearness of data points.

	Measured	Inferred	Measured and Inferred
	(tonnes-millions)		
East Block	13.67	8.59	22.26
West Block	14.89	10.97	25.86
Total	28.56	19.56	48.12

These "total sand" resources include all sand grain sizes found naturally in the deposit, in which there is considerable variation in the grain size proportions both laterally and vertically. Weighted average grain sizes computed for the whole deposit are as follows, based on 200 samples from 21 boreholes in the East Block, and 105 samples from 7 boreholes and 3 bulk

Please see figure 1-1 in the back pocket.

trenches in the West Block:

U.S. Standard Sieve No.	East Block	West Block
0-12	1.0	0.2
12-20	2.8	6.2
20-40	16.4	22.5
40-60	20.2	30.5
60-100	31.4	21.3
100-200	14.4	14.9
Minus 200	13.8	4.4
	100.0%	100.0%

The grain size fraction of primary interest for this evaluation is the 20-40 mesh. This is the dominant size grade used for frac sand operations, accounting for about 80% of the frac sand market. Portioning the total sand resource into its various mesh size ranges gives the following tonnages for 20-40 mesh material:

	Measured	Inferred	Measured and Inferred
	(tonnes-millions)		
East Block	2.24	1.41	3.65
West Block	3.35	2.47	5.82
Total	5.59	3.88	9.47

1.4 Laboratory Testing

Detailed results of frac sand quality tests conducted by Hardy BBT Limited are presented in appendix B. The results compared to API suggested requirements are summarized below:

	Peace River Silica Sand 20/40 Range	A.P.I. Suggested Standard
Sphericity	0.7 - 0.8	0.6 or greater
Roundness	0.5 - 0.7	0.6 or greater
Turbidity	7.0 - 79.0	250 FTU or less
Crush Resistance	10.8 - 16.7%	14% or less fines
Acid Solubility	0.53 - 1.12%	2.0% max. wt. solubility
	(17 samples tested)	

These tests were conducted on samples from the 5 testholes drilled for this program on the East Block portion of the deposit. The samples tested generally meet all the API Standard requirements for frac sand except in Crush Resistance, where 6 of the 17 samples tested exceeded the 14% limit for fines. It is noteworthy that 3 of the 6 failed samples are only marginal failures (by 1% or less).

The Crush Resistance test results are also presented graphically in figure 1-2, plotted as histograms beside comparative sections of Paddy sand in the 5 testholes. Data on the percentage of 20-40 mesh size material also are presented. As seen in figure 1-2, not all the relevant samples were tested for Crush Resistance and the results therefore are not fully conclusive; however, they indicate that a substantial proportion of the 20-40 mesh sand in the deposit is of frac sand quality.

1.5 Assessment of Results

Total sand resource tonnages determined from the geological evaluation are based on a significant number of data points and are considered reliable estimates. Resource estimates for the 20-40 mesh sand are less certain, because of the irregularity in grain size distribution which is geologically characteristic of

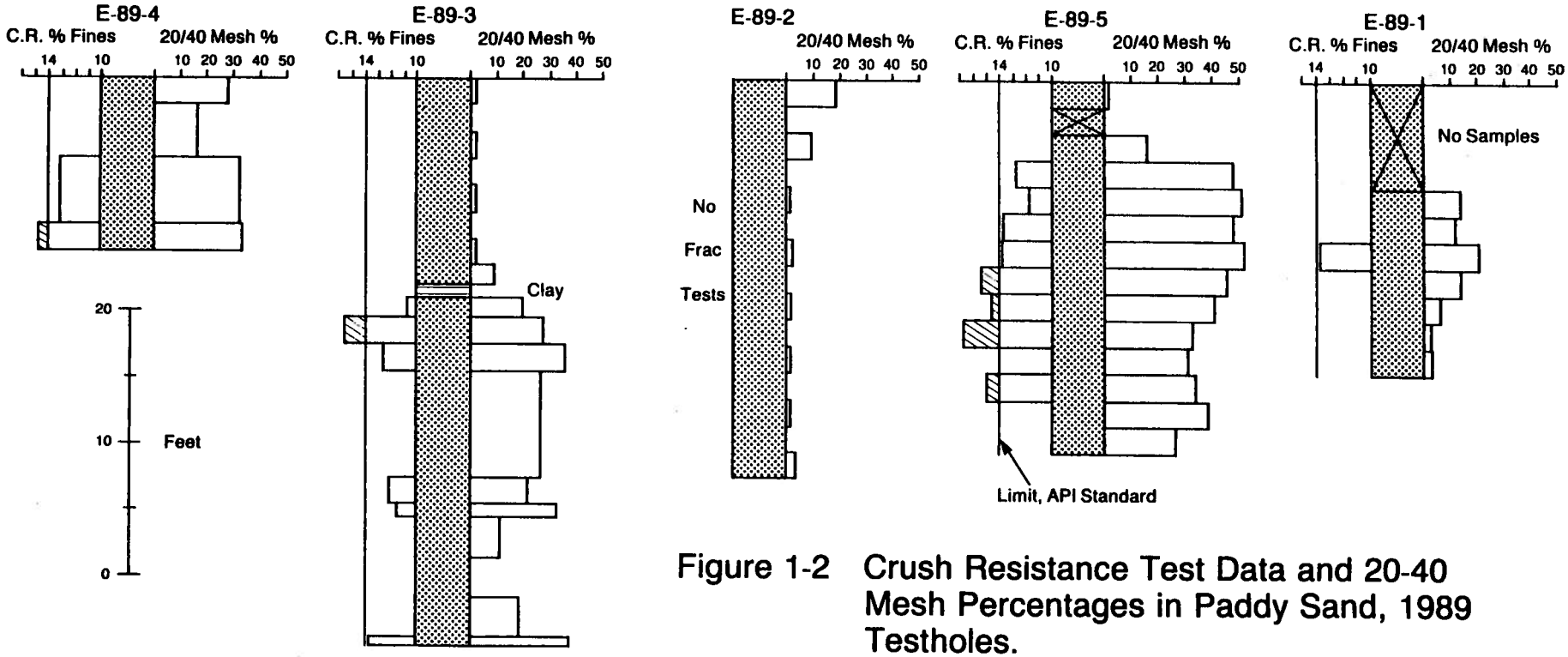

Figure 1-2 Crush Resistance Test Data and 20-40 Mesh Percentages in Paddy Sand, 1989 Testholes.

the deposit. For the East Block in particular, grain size data are from a limited number of data points which are sparse sampling of the deposit. Despite the uncertainty, these estimates are probably reliable to within 25%.

Considering the quality factor, frac sand resource determination becomes more subjective. The laboratory test results show that not all of the 20-40 mesh component is suitable for frac sand. The actual amount suitable is impossible to determine with only 5 testhole data points (actually 4, since no tests were run in E-89-2). Moreover, the data are not complete in that not all the 20-40 mesh samples in each testhole were tested (see figure 1-2).

Nevertheless, it is possible from the data available to make a reasoned estimate of frac sand resources and a first-level assessment of potential frac sand recovery from the deposit. This was done for the East Block by applying variable "recovery factors" to different segments of the deposit based on the frac sand quality test results.

In figure 1-3, the East Block resource map is shown divided into North, Middle and South Sectors, and the North Sector subdivided into Segments A, B, C and D. Each segment of the north sector is an area represented by one of four testholes in this program (E-89-1, 2, 3 and 5). The south sector is represented by the fifth testhole (E-89-4). In between is the middle sector, an area devoid of any test drilling, where total sand resources are all categorized as inferred.

The estimated frac sand resource within each segment/sector of the East Block is given in table 1-1. Tonnages of 20-40 mesh material are computed using grain size data from the representative testholes, and a "recovery factor" is applied to obtain an estimate of the net frac sand tonnage available. The recovery factor assumed for each area is the most subjective part

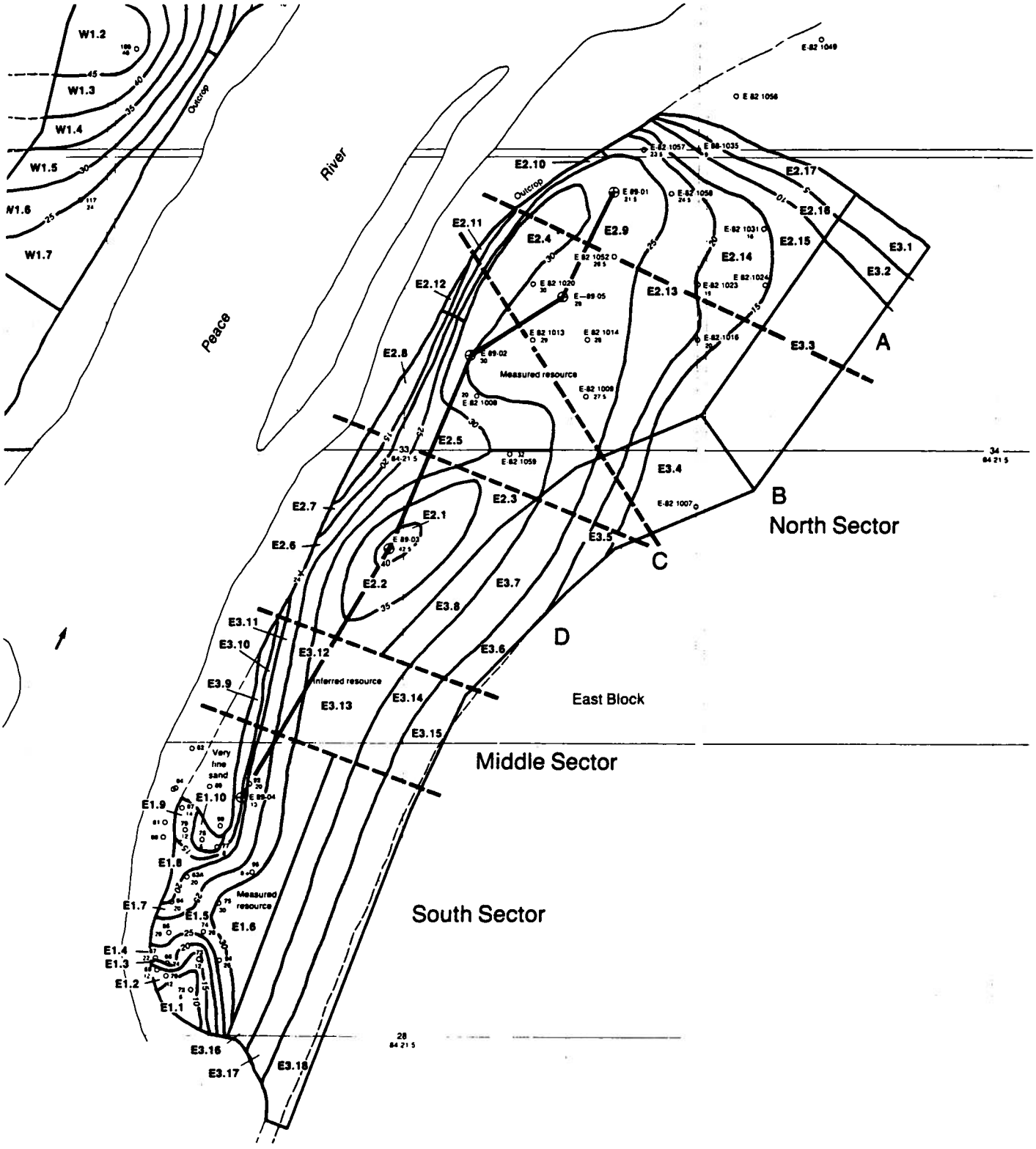

Figure 1-3 Resource Areas for Net Frac Sand Tonnage Estimates (East Block)

Table 1-1 Estimated Net Frac Sand Resource Tonnage - East Block, Peace River Deposit

Area Designation	Control Testhole	Total Sand tonnes	20/40 Mesh %	20/40 Mesh tonnes	Frac Sand Recovery Factor	Net Frac Sand tonnes
Measured Resource						
North Sector (E2.1 to E2.17)						
Segment A	E-89-1	2,401,167	10.3	247,320	.8	198,000
Segment B	E-89-5	3,077,838	33.4	1,027,998	.6	617,000
Segment C	E-89-2	2,570,187	4.8	123,369	.8	107,000
Segment D	E-89-3	3,285,225	12.5	410,653	.9	370,000
South Sector (E1.1 to E1.10)	E-89-4	2,334,750	13.1	305,852	.9	275,000
Total (Measured)		13,669,168		2,115,192		1,567,000
Inferred Resource						
North Sector (E3.1 to E3.8)						
Segment A	E-89-1	508,927	10.3	52,419	.8	42,000
Segment B	E-89-5	994,753	33.4	332,248	.6	200,000
Segment C	E-89-2	418,648	4.8	20,095	.8	16,000
Segment D	E-89-3	1,829,006	12.5	228,626	.9	206,000
Middle Sector (E3.9 to E3.15)	E-89-3 & E-89-4	2,334,480	12.7	296,479	.9	267,000
South Sector (E3.16 to E3.18)	E-89-4	2,501,911	13.1	327,750	.9	295,000
Total (Inferred)		8,587,724		1,257,617		1,026,000

of this analysis: it is based on consideration of both the quality test data and actual recovery efficiency of a quarry operation. Limited quality data available (see figure 1-2) suggest that the sands with substandard crush resistance are a minor proportion of the deposit in all testholes except E-89-5, and that blending with the high-strength sands would allow all or most of the material to meet API Standards.

In testhole E-89-5 the substandard sand is in greater proportion but is confined to the lower half of the deposit. Part, but probably not all of this material could be utilized by blending with high-strength sand from the upper half. Accordingly, a low recovery factor (.6) is assigned to the segment B resources that this testhole represents.

From the foregoing rationale, the combined (measured and inferred) resource of recoverable frac sand in the East Block is determined to be 2.6 million tonnes. No estimate of net frac sand resources for the West Block is possible, because of lack of quality test data.

1.6 Conclusions

Geological evaluation of the Peace River silica sand deposit indicates a substantial tonnage of 20-40 mesh size sand in the deposit. Laboratory results by Hardy BBT Limited, though not entirely conclusive, show a major portion of the 20-40 mesh sand to be suitable for frac sand use. The resource figure of 2.6 million tonnes indicated for the East Block is sufficient to justify further evaluation work on the deposit.

1.7 Recommendations

1. Because not all relevant samples from the 5 testholes were tested, it is recommended that Crush Resistance tests on the balance of the samples (up to 15) be made. For at least half of

these samples, duplicates should be tested by another agency for third-party verification of test results.

2. A comprehensive program of chemical analyses and beneficiation studies on the existing sample material is recommended to evaluate the sand (particularly the minus 40 mesh size) for other commercial uses such as glass.

3. If results from 1 and 2 are favourable, it is recommended that the next phase of evaluation proceed with a systematic grid drilling, sampling and testing program on the East Block. In conjunction with this, a reconnaissance test drilling program on the West Block is recommended for preliminary evaluation of that part of the deposit.

Geological Evaluation of the Peace River Silica Sand Deposit

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Alberta Geological Survey

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2. GEOLOGICAL EVALUATION OF THE PEACE RIVER SILICA SAND DEPOSIT

2.1 Introduction

The Peace River silica sand deposit is situated approximately 10 km north of the town of Peace River, Alberta. The quarriable mineral leases are located on both banks of the Peace River (figure 2-1) and are referred to as the East and West Blocks in this report.

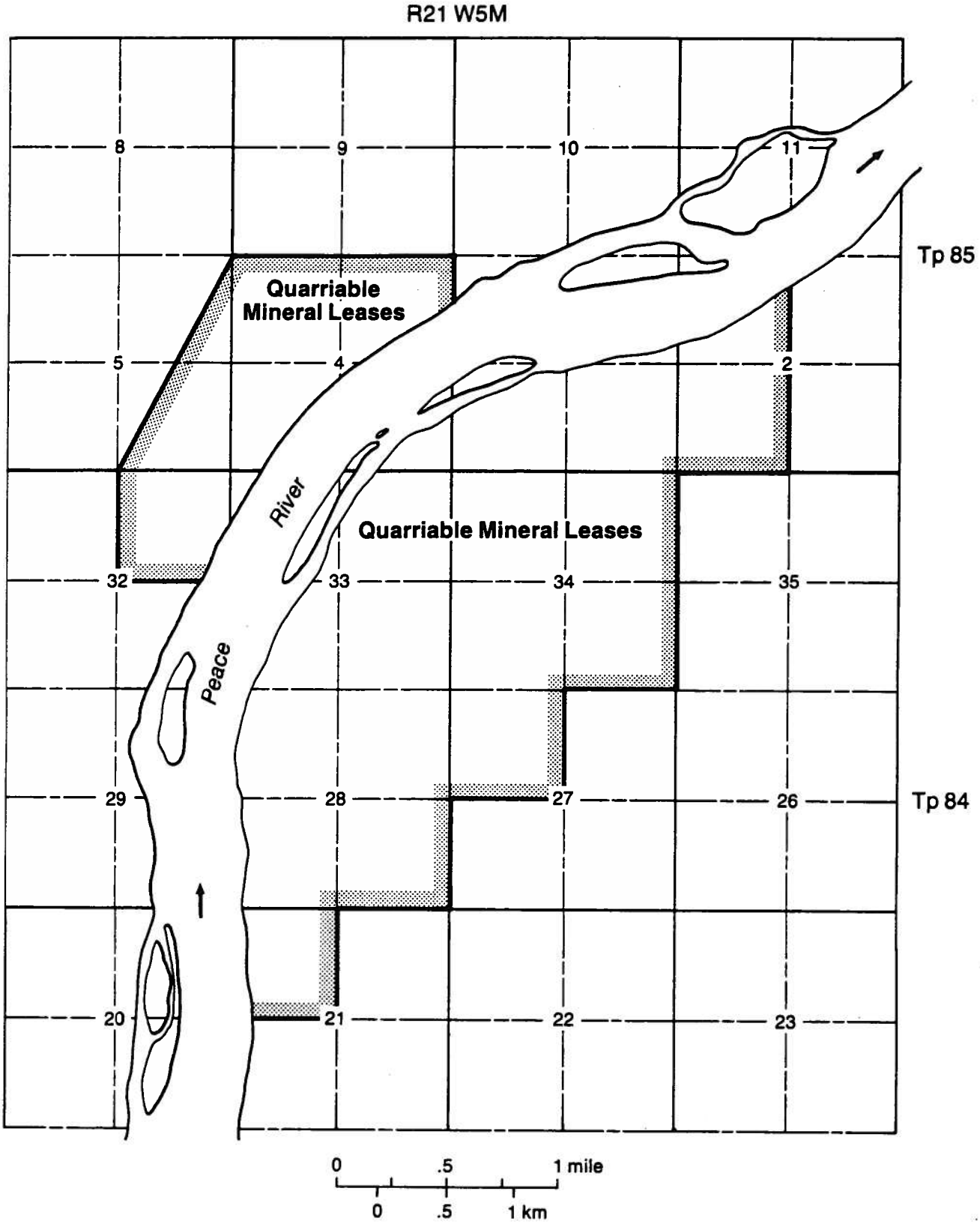
A five-hole test program in the East block was executed during March, 1989. This information has been combined with relevant data culled from previous work to re-evaluate the resource base tonnage and the suitability of the material as a propping agent for use by the petroleum industry.

Proppant, or "frac" sand must be of a certain roundness and strength, as well acid resistant, to maintain shape under high pressure in the production zones of oil and gas wells. Samples collected from the 1989 boreholes were sent to Hardy BBT Limited for analysis and the results are presented in appendix B. These results indicate that the overall values meet the suggested frac sand specifications cited by the American Petroleum Institute. Laboratory analysis has been concentrated on that portion of the silica sand representing the 20-40 mesh size range. The bulk of the total frac sand sales in western Canada consists of this material.

2.2 Geology

2.2.1 General Geology and Stratigraphy

The Peace River silica sands were deposited in marine and non-marine sediments of the Cretaceous Fort St. John Group, which in the project area is overlain by Pleistocene deposits. The silica sand deposit within the project area straddles the Peace



Peace River Silica Sand Ltd.
Quarriable Mineral Leases
Figure 2-1

River. Erosion by the Peace River has removed much of the original silica sand, dividing the deposit into two remnant segments on the east and west banks of the river.

The general stratigraphic sequence within the Peace River Silica Sand Limited lease area is as follows:

FORMATION AND LITHOLOGIES

	Dunvegan Formation (marine sandstone & shale)	
	Shaftesbury Formation (marine shale)	
Fort St. John Group		- Paddy Member non-marine sand sand shale
	Peace River Formation	- Cadotte Member marine shale
		- Harmon Member marine shale

A brief description of each formation follows.

PEACE RIVER FORMATION

Harmon Member

The Harmon Member is comprised of fine, thin bedded, dark grey marine shales. These shales can now be observed on the west bank where recent excavation of the rail access to the Diashowa pulp mill has left them exposed.

Cadotte Member

The Cadotte Member sandstones form prominent cliffs for

many kilometres along the Peace River, north of Peace River town. The sandstones are fine grained, well sorted, massive, and horizontally bedded. They weather grey to dark brown with a commonly observable yellowish oxide stain near the top. The total thickness of the Cadotte Member within the property boundary has not been determined; however, Crockford was able to describe the upper 15 m portion of the Member on the west bank of the river and Lichtenbelt suggests that it is at least 34 m thick.

Paddy Member

The Paddy Member is located above the Cadotte Member, separated in places by minor coal and gravel beds that can be readily used as a marker horizon during exploration. The Paddy represents a case of re-worked, non-marine sands, deposited in a fluvatile environment. It is mainly very clean and consequently, essentially uncemented. Locally, however, the Paddy contains beds of moderately cemented argillaceous material.

The sedimentary texture of the material indicates a tidal situation where the sand has been sorted into beds of larger and smaller grains. Strong cross-bedding also suggests dual wind-action above a waterline.

The grains of sand are almost entirely colorless quartz with a minor amount of smoky quartz. Silica is present also in the form of chalcedony. Rare accessory minerals are feldspars, titanite, limonite, ilmenite and zircon.

Examination of individual grains shows them to vary in roundness from rounded-subangular to almost sperical.

Overall the Paddy ranges from 0 to 16.5 m and averages 7.7 m in thickness.

SHAFTESBURY FORMATION

The marine brown-grey shales of the Shaftesbury are calcareous and contain pancake-shaped claystone beds. A thin gravel bed and a minor coal seam at the base of the formation exists on the east side of the river towards the south end of the property. The formation is at least 180 m thick in this area.

PLEISTOCENE FLUVIAL DEPOSITS

Erosion during and following the Pleistocene has exposed the Peace River Formation on both banks of the river. The Peace River has deposited a 6 - 21 m thick bed of boulders, gravel and sand on the Shaftesbury, and to a lesser extent on the Paddy, in the vicinity of the east bank.

2.2.2 Structure

Dip of the strata in the vicinity of the deposit is less than one degree to the southwest. No faults or other dislocations of the strata have been observed in any of the outcrops or interpreted from boreholes. However, localized slumping of the Shaftesbury shales is evident on the West Block.

2.2.3 Topography

The deposit is separated into the East and West blocks by the Peace River erosional channel. On the east bank the elevations range from 450 m along the upland terrain down to 300 m along the river edge. The terrain on the west bank is that of a 5 - 8 degree slope starting at the 500 m elevation and descending to the river level with 45 m vertical cliffs.

The slope of the river valley is dissected by two creeks, one of which flows all year. One has cut a gully 30 m or more with steep walls that generally dip around 40 degrees from the

horizontal. In places some are almost vertical.

2.3 Exploration

2.3.1 Pre-1989 Exploration

The earliest reference to the Peace River silica sands is contained in a 1935 Geological Survey of Canada report by F.H. McLean. Between 1947 and 1949, four exposures on the west bank and one on the east bank of the Peace River within the property boundaries were described by M. Crockford of the Alberta Research Council. Size and chemical analysis of samples collected from the three localities on the west bank indicated at that time that the sand could be upgraded by beneficiation for glassmaking.

A pilot plant was established early in 1953 by Peace River Glass Syndicate under the supervision of W.F. Banfield, New York City. In 1954, Banfield collected sizable bulk samples from seven trenches on the west side of the river for testing. A comprehensive report of the work was submitted. Size analysis was carried out on all of the trench samples; three of the trenches were concluded to be representative and have been used in this report.

During 1977, C.C. Bevan obtained samples for analysis from outcrop and eight drill holes on the east bank, located in the vicinity of a gravel pit on the south-east part of the property. Various testing was carried out by Halliburton, Denver Equipment Division and Smith International for frac sand and glass sand purposes. This test work was followed by a feasibility study by James Wade Engineering Company concerning the construction and operation of a plant for the production of silica sand to service the petroleum, sand blasting, ceramic and glass industries.

In the years 1980 and 1981, some 46 testholes were drilled,

with over 576 samples obtained and submitted to BBT Geotechnical Consultants Ltd. for grain-size analysis. Associated Mining Consultants Ltd., retained by John Tiberio, completed a pre-feasibility study which was submitted to Alberta Energy and Natural Resources.

This was followed by a 1982 drill program for J. Tiberio under the geologic supervision of H. Lichtenbelt. The work was conducted on the north east portion of the property and established the existence of silica sand in that area. Unfortunately, only random samples from these 17 boreholes were tested to determine the suitability of the sand for hydraulic fracturing use, and the results are inconclusive.

A survey plan showing the locations of all testholes drilled on the property, including the current test drilling program, is included in this report (figure 2-3).

2.3.2 1989 Test Program

Five testholes were drilled in March along the extent of the deposit on the east side of the Peace River, to provide authenticated silica sand samples for frac sand testing. These holes were located in such a manner as to characterize that portion of the deposit considered to have sufficient reserves for commercial frac sand production.

A Hardy BBT Limited technician was on site to log the borehole cuttings and properly identify the samples. The holes were drilled by a Western Caisson, Becker-type hammer drill rig, outfitted with a tricone bit and air system. Sample recovery was estimated to be very good in all of the holes except for the initial hole where the first 7.5 feet was lost. The strategy was to bag the samples at 2-foot intervals. However, some sample intervals tended to be larger whenever drilling was difficult. A brief lithological summary of the testholes is as follows:

Hole	Coordinates (metres)	Interval From (feet)	To (feet)	Description	No. of Samples Collected
E-89-1	11,512.32N	0	0.66	topsoil	
	9,765.45E	0.66	29.5	gravel, sand	
	382.87EL	29.5	86.5	Shaftesbury, shale	
		86.5	94.	Paddy, sand	-
		94.	108.	Paddy, sand	7
		108.	109.	coal	
		109.	120.	Cadotte, sandstone	
E-89-2	11,062.60N	0	0.5	topsoil	
	9,375.08E	0.5	18.0	Gravel, sand	
	387.80EL	18.0	100.5	Shaftesbury, shale	
		100.5	130.5	Paddy, sand	15
		130.5	132.0	coal	
		132.0	148.0	Cadotte, sandstone	6
E-89-3	10,538.20N	0	0.66	topsoil	
	9,157.75E	0.66	1.0	Sand	
	391.47EL	1.0	108.0	Shaftesbury, shale	
		108.	123.5	Paddy, sand	8
		123.5	124.5	clay	
		124.5	150.5	Paddy, sand	
		Hole T.D. at 150.5 feet due to drill rod limitation.			
E-89-4	9,893.17N	0	0.5	topsoil	
	8,765.60E	0.5	44.5	Shaftesbury, shale	
	363.63EL	45.5	48.0	siltstone, very fine sand	
		48.0	51.0	gravel, sand	
		51.0	52.0	coal	
		52.0	54.0	gravel, sand	
		54.0	67.0	Paddy sand	4
		67.0	68.0	coal	
		68.0	127.0	Cadotte, sandstone fine grained	1

E-89-5	11,223.47N	0	32.0	Gravel, sand	
	9,628.26E	32.0	110.0	Shaftesbury	
	391.01EL	110.0	138.0	Paddy, sand	14
		138.0	148.0	coal	
		148.0	150.0	Cadotte, sandstone	1

Total feet drilled - 695.5
Total samples collected - 67

The Hardy BBT section (appendix B) of this report contains drill logs of more detail.

The majority of the laboratory test work on samples was carried out by Hardy BBT Limited. The mineralogical analyses were completed by the Alberta Research Council. These tests and procedures were in accordance with the American Petroleum Institute (API RP 56, first edition, March 1983) for testing of sand used in hydraulic fracturing operations. The test and analysis data are contained in the report by Hardy BBT Limited .

Field surveying was completed by Coordinate Surveys Ltd. of Peace River (figure 2-3).

Table 2-1 provides borehole grain-size data according to the percent weight of the material retained on the various sieves used during the testing.

1989 Test Program

TABLE 2-1

SIEVE SIZE ANALYSIS - PERCENT RETAINED

HOLE	SAMPLE NUMBER	INTERVAL (feet)	+8	+10	+16	+20	+30	+40	+50	+100	+200	-200
B-89-1		86.5 - 94	-	-	N/A	-	-	-	-	-	-	-
	1	94 - 96	-	-	0.1	0.4	2.5	11.0	33.8	41.3	8.7	3.0
	2	96 - 98	-	-	-	0.4	2.2	9.7	31.1	14.5	10.5	31.6
Paddy Member	3	98 - 100	-	-	0.2	1.4	6.8	14.1	28.8	39.0	7.4	3.1
	4	100 - 102	-	0.1	0.4	0.9	3.6	10.4	26.5	48.5	7.3	2.6
	5	102 - 104	-	0.1	0.1	0.5	1.5	4.2	15.2	60.3	13.3	5.1
	6	104 - 106	-	0.6	0.1	0.3	1.0	2.3	8.1	46.9	30.8	9.9
	7	106 - 108	-	-	0.2	0.4	1.2	2.3	7.8	47.6	29.3	11.2
Weighted	Average	94 - 108	-	0.1	0.2	0.6	2.6	7.7	21.5	42.5	15.3	9.5

SIEVE SIZE ANALYSIS - PERCENT RETAINED

HOLE	SAMPLE NUMBER	INTERVAL (feet)	+8	+10	+16	+20	+30	+40	+50	+100	+200	-200
B-89-2	1	100 - 102	-	-	0.7	3.0	0.9	10.4	11.8	22.5	17.6	25.1
	3	104 - 106	-	-	-	0.4	2.1	7.3	12.5	20.4	27.3	30.0
	5	108 - 110	-	-	-	0.1	0.1	1.3	19.2	59.0	13.0	7.3
Paddy Member	7	112 - 114	-	-	-	0.1	0.2	1.9	25.1	58.6	9.6	4.5
	9	116 - 118	-	0.1	-	0.1	-	0.2	1.8	29.6	49.0	19.2
	11	120 - 122	-	0.2	0.1	0.1	-	0.2	0.9	27.0	48.1	23.4
	13	124 - 126	-	-	-	0.1	0.2	1.2	11.8	63.2	14.3	9.2
		128 - 130	-	-	-	0.1	0.5	3.6	19.5	50.9	15.7	9.7
Weighted	Average	100 - 130	-	0.1	0.1	0.5	1.5	3.3	12.8	41.4	24.3	16.0
	18	132 - 134	-	-	0.1	0.1	-	0.1	0.3	11.0	61.0	27.4
Cadotte Member	20	136 - 141	-	0.1	0.1	-	0.3	1.0	4.9	33.5	38.5	21.6
	22	144 - 148	-	0.1	-	0.1	0.6	2.0	4.0	17.4	32.6	43.2
Weighted	Average	132 - 134	-	0.1	0.1	0.1	0.3	1.2	3.7	23.6	40.4	30.5

SIEVE SIZE ANALYSIS - PERCENT RETAINED

HOLE	SAMPLE NUMBER	INTERVAL (feet)	+8	+10	+16	+20	+30	+40	+50	+100	+200	-200
R-89-3	1	108 - 110	-	-	0.1	0.4	0.8	0.8	3.4	19.6	42.8	32.1
	3	112 - 114	-	-	0.1	0.4	0.7	0.4	0.6	17.8	46.0	34.0
	5	116 - 118	-	0.1	0.1	-	0.3	0.2	0.5	8.9	53.9	36.0
	7	120 - 122	-	0.1	-	0.1	-	0.1	0.1	9.5	56.7	33.4
	8	122 - 124	-	0.5	0.2	0.3	1.4	7.5	10.8	17.1	31.0	31.2
	9	124 - 126	-	-	0.1	0.4	3.4	15.9	22.3	15.9	11.8	30.2
	10	126 - 128	-	-	-	0.3	0.4	26.5	44.7	15.8	5.0	7.3
Paddy Member	11	128 - 130	-	0.1	0.1	0.8	7.1	28.3	43.3	13.9	3.6	2.8
	12	130 - 138	-	-	-	0.2	4.1	22.4	33.6	30.7	4.2	4.8
	13	138 - 140	-	-	0.6	1.2	3.7	18.8	26.8	19.8	16.6	16.8
	14	140 - 141	-	-	0.5	0.7	9.6	23.6	22.8	33.8	5.4	4.9
	15	141 - 144	-	0.1	0.1	0.4	2.4	8.6	14.2	52.6	14.6	7.8
	16	144 - 147	-	-	-	-	0.1	1.8	7.6	63.5	15.8	12.8
	17	147 - 150	-	-	1.8	7.1	18.8	8.2	13.1	38.4	18.6	18.8
	18	150-150.5	-	0.1	2.3	20.3	28.2	18.8	8.8	16.2	5.6	8.8
Weighted	Average	108-150.5	-	0.1	0.2	1.1	1.8	18.7	15.7	25.8	24.8	19.8

SIEVE SIZE ANALYSIS - PERCENT RETAINED

HOLE	SAMPLE NUMBER	INTERVAL (feet)	+8	+10	+16	+20	+30	+40	+50	+100	+200	-200
B-89-4	1	54 - 56	-	-	-	0.4	8.7	18.8	22.2	45.2	2.2	2.5
	2	56 - 60	-	-	0.1	0.2	3.9	12.8	18.8	54.9	5.1	4.2
	3	60 - 65	-	-	0.5	5.0	20.1	12.4	10.6	43.3	4.1	4.0
	4	65 - 67	-	0.3	2.1	7.7	18.9	14.4	9.3	26.1	12.6	8.6
Weighted	Average		-	0.1	0.5	3.2	13.2	13.8	14.7	44.6	5.4	4.5

SIEVE SIZE ANALYSIS - PERCENT RETAINED

HOLE	SAMPLE NUMBER	INTERVAL (feet)	+8	+10	+16	+20	+30	+40	+50	+100	+200	-200
B-89-5	1	110 - 112	-	-	-	0.1	0.1	0.2	1.4	13.5	53.0	31.7
	3	114 - 116	-	0.1	1.2	3.4	7.5	7.8	7.5	21.4	33.3	17.8
	4	116 - 118	-	0.1	4.4	11.8	23.2	25.3	20.2	10.5	2.8	1.7
	5	118 - 120	-	-	1.2	5.2	18.9	32.6	27.9	11.8	1.6	0.8
	6	120 - 122	-	0.1	1.5	5.7	16.9	31.5	28.7	13.3	1.6	0.7
	7	122 - 124	-	0.1	3.4	10.3	22.2	29.9	22.5	9.4	1.6	0.6
	8	124 - 126	-	0.2	3.1	8.6	18.7	27.1	23.2	15.8	2.2	1.1
	9	126 - 128	-	-	1.8	4.4	14.0	27.4	26.7	23.0	2.9	0.6
	10	128 - 130	-	0.1	2.0	4.2	10.7	22.7	32.0	25.8	1.9	0.6
	11	130 - 132	-	0.1	1.1	3.4	9.9	22.0	36.7	24.1	2.0	0.7
	12	132 - 134	-	0.1	1.6	4.1	11.4	23.3	36.2	21.3	1.5	0.5
	13	134 - 136	-	-	0.9	3.8	12.4	26.2	35.9	18.5	1.6	0.7
	14	136 - 138	-	-	1.7	4.1	9.4	16.6	27.8	33.9	4.2	2.3
Weighted	Average	110 - 138	-	0.1	1.6	4.9	12.5	20.9	23.3	18.3	11.9	6.5

2.4 Resources

2.4.1 Block Description

East Block

The dimensions of the Paddy silica sand deposit are shown in Map 2-1. The East block is 3000 m long in the N-S direction and 1000 m wide in the E-W direction. The west side of the deposit outcrops from 45 to 52 m above and on the banks of the Peace River. It pinches out at the north end of the block with the east and south limits yet to be defined.

A weighted average thickness of 7.29 m has been determined for that portion of the resource in the "measured" category. The maximum thickness of silica sand recorded on the east bank to date is 12.9 m, intersected in hole E-89-3.

Lithologies near the top of the Paddy in the north and south portions of the deposit do not correspond. Throughout the northern half the Shaftesbury shale makes immediate contact with the underlying Paddy. In the southern portion the contact is more complex with interbedded Cretaceous gravels, coal seams and silts situated between the Shaftesbury and main Paddy body. The correlation chart of the 1989 testholes (figure 2-1) illustrates this feature.

The surficial boulder, gravel, and sand aggregate covering the Shaftesbury is estimated to be in the order of 15 million cubic metres (Lichtenbelt).

West Block

The West Block is approximately 3300 by 800 metres in size. As in the East block, the Paddy sands outcrop on the bank of the Peace River. The overall thickness of the deposit ranges between

2 m at the north end to 16.4 m in hole 112 located near the center of the deposit. The weighted average thickness within the area designated "measured" is 8.06 m. The possible lithologic variations of the Paddy here have not been investigated. However, a minor basal coal seam was reported by Banfield.

2.4.2 Resource Estimation Methodology

The resources were measured by planimetering the areas between total silica sand (Paddy Member) isopach lines drawn on the 1:5000 scale map (map 2-1). The thickness of the unit was derived by averaging the values of the isopachs bordering a particular area. This provided the volume, in cubic yards, of sand in each area.

The tonnages (2000 lb short tons) were determined on a "dry" sand basis because commercial specifications are referred to as a "dry" product. Densities of 1.35 tons/cubic yard for the west bank sand and 1.31 tons/cubic yard for the east bank sand were used to compute short tons. The variation in densities is a reflection of the average grain size in each of the resource blocks. The short ton values were subsequently converted to metric tonnes.

The degree of confidence in the estimated quantities of resource in the silica sand deposit is designated by the terms "measured" and "inferred". Measured resources are tonnages computed from data revealed in outcrops, trenches and boreholes for which the density and quality of points of observation are sufficient to allow a reliable estimate of sand unit thickness. Inferred resources estimates are computed by projection of thickness, sample and geologic data from outcrops, trenches and drill holes for a 250 m distance. There are no sample measurements or inspection sites in the inferred resource area.

2.4.3 Base Data

A thorough review of the existing files was carried out to compile the database for the resource and quality estimations of the deposit. Regrettably, a portion of the records were found to be sketchy or missing and had to be excluded. Geological work completed by Crockford (1947), Banfield (1953), and Lichtenbelt (1982), was considered to be the most acceptable as these individuals provided the necessary geologic control and descriptions. A summary of the number of data points used in each of the resource blocks is as follows.

East Block
Number of boreholes - 48

West Block
Number of boreholes - 10
Trenches - 7
Outcrop localities - 5

Map 2.1 illustrates the total thickness of the Paddy silica sand unit, borehole distributon, trenches and outcrop localities.

2.4.4 Silica Sand Resource Summary

The estimated resources of silica sand in the Peace River sand deposit are as follows:

Location	Measured	Inferred	Measured and Inferred
	(tonnes-millions)		
East Block	13.67	8.59	22.26
West Block	14.89	10.97	25.86
Total	28.56	19.56	48.12

The detailed resource calculations are presented in the following Tables 2-2 and 2-3.

Table 2-2. East Block Resource Estimate

AREA DESIGNATION[t]	AREA SQUARE FEET	THICKNESS FEET	CUBIC YARDS
Measured Category			
E1.1	139,671	10	51,730
E1.2	113,483	12.5	52,538
E1.3	96,024	17.5	62,238
E1.4	122,212	22.5	101,843
E1.5	494,087	27.5	503,237
E1.6	673,913	30.0	748,792
E1.7	310,768	22.5	258,973
E1.8	134,433	17.5	87,132
E1.9	165,859	12.5	76,786
E1.10	57,614	10.0	21,338
E2.1	80,310	41.25	122,696
E2.2	712,323	35.50	936,573
E2.3	1,099,910	32.50	1,323.966
E2.4	1,024,837	30.0	1,138,707
E2.5	588,264	27.5	599,260
E2.6	314,260	22.5	261,883
E2.7	165,859	17.5	107,501
E2.8	235,695	15.0	130,942
E2.9	2,548,999	27.5	2,596,203
E2.10	122,212	22.5	101,843
E2.11	61,106	17.5	39,606
E2.12	13,967	15.0	7,759
E2.13	1,220,377	22.5	1,016,980
E2.14	944,520	17.6	612,193
E2.15	928,813	12.5	430,006
E2.16	293,309	7.5	81,475
E2.17	322,989	2.5	29,906
	12,985,920	23.9*	11,502,105

Silica sand (dry tons) = 1.31** x 11,502,105 = 15,067,757
(or 13,669,168 metric tonnes)

[t]See Map 2-2.

*Weighted average thickness of silica sand unit within the East Block measured category is 23.91 feet or 7.29 metres.

**Density = 1.31 tons per cubic yard

AREA DESIGNATION[t]	AREA SQUARE FEET	THICKNESS FEET	CUBIC YARDS
Inferred Category			
E3.1	239,186	2.5	22,147
E3.2	235,695	7.5	65,471
E3.3	1,566,100	13.5	783,050
E3.4	745,495	13.5	372,747
E3.5	305,530	17.5	198,029
E3.6	576,143	22.5	480,119
E3.7	778,666	27.5	793,085
E3.8	406,792	31.25	470,824
E3.9	96,850	12.5	44,838
E3.10	66,789	17.5	43,289
E3.11	156,719	22.5	130,599
E3.12	196,440	27.5	200,078
E3.13	825,806	30.0	917,562
E3.14	345,686	27.5	352,087
E3.15	352,669	22.5	293,890
E3.16	554,679	30.0	616,310
E3.17	723,232	27.5	736,625
E3.18	846,607	22.5	705,506
	9,019,084	21.6*	7,225,256

Silica sand (dry tones) = 1.31 x 7,226,256 = 9,466,395
(or 8,587,724 metric tonnes)

[t]See Map 2-2.

*Weighted average thickness of silica sand unit in East Block inferred category is 21.6 feet or 6.58 metres.

Table 2-3. West Block Resource Estimate

AREA DESIGNATION[t]	AREA SQUARE FEET	THICKNESS FEET	CUBIC YARDS
Measured Category			
W1.1	2,593,488	21.0	2,017,157
W1.2	462,661	46.5	796,805
W1.3	525,513	42.5	827,196
W1.4	604,078	37.5	838,997
W1.5	787,396	32.5	947,791
W1.6	1,174,984	27.5	1,196,743
W1.7	899,133	22.5	749,277
W1.8	1,763.349	22.5	1,469,457
W1.9	167,605	17.5	108,633
W1.10	97,769	44.0	159,327
W1.11	41,901	17.5	27,158
W1.12	293,309	25.0	271,582
W1.13	335,210	50.0	620,759
W1.14	522,012	35.0	676,694
W1.15	422,505	45.0	704,175
W1.16	199,765	25.0	184,967
W1.17	177,559	15.0	98,644
W1.18	1,309,417	9.0	436,472
	12,377,663	26.46*	12,131,834

Silica sand (dry tons) = 1.35 x 12,131,834 = 16,377,975
(or 14,887,771 metric tonnes)

[t]See Map 2-2.

*Weighted average thickness of silica sand unit within the West Block measured category is 26.5 feet or 8.06 metres.

Inferred Category			
W2.1	8,461,551	26.45	8,289,186
W2.2	2,113,676	8.5	665,416
	10,575,227	22.8*	8,954,602

Silica sand (dry tons) = 1.35 x 8,954,602 = 12,088,713
(or 10,966,638 metric tonnes)

[t]See Map 2-2.

*Weighted average thickness of silica sand unit within the West Block inferred category is 22.8 feet or 6.95 metres.

2.5 Quality

2.5.1 Grain Size

In the East Block, 200 silica sand samples collected from 21 boreholes were used to estimate the grain size average percentages. In the West Block, 105 samples from 7 boreholes were combined with the results from 3 bulk trench samples to estimate the average grain size of the sand. Tables 2-4 and 2-5 illustrate the database used in the calculation. It is apparent that there is significant variation in the distribution of grain size throughout the deposit.

The weighted average grain sizes computed for the deposit are as follows:

U.S. Standard Sieve No.	East Block	West Block
0-12	1.0	0.2
12-20	2.8	6.2
20-40	16.4	22.5
40-60	20.2	30.5
60-100	31.4	21.3
100-200	14.4	14.9
Minus 200	13.8	4.4
	100.0%	100.0%

EAST BLOCK GRAIN-SIZE ESTIMATION

TABLE 2-4

EAST BLOCK SOUTH END (TOTAL UNIT)

HOLE	NUMBER OF SAMPLES	THICKNESS	SCREEN SIZE -% RETAINED +4	+10	+20	+40	+60	+100	+200	-200
63A	10	20	-	1.1	7.1	12.0	5.5	14.7	48.5	10.8
64	10	20	0.4	1.5	3.8	11.0	7.9	19.6	39.1	16.1
66	14	28	-	0.9	3.2	4.9	7.1	37.1	39.1	7.5
67	11	22	0.8	2.4	6.7	9.8	7.1	20.9	38.7	13.1
68	12	24	-	0.4	6.9	17.8	15.6	34.2	18.6	6.4
73	6	12	-	-	0.7	7.8	29.6	55.3	5.1	1.4
74	14	28	0.1	1.2	6.1	17.8	14.1	45.6	10.7	4.1
75	15	30	-	0.6	3.7	8.9	13.7	50.9	16.0	8.4
77	4	8	-	0.70	10.8	19.2	10.3	12.0	30.6	13.0
78	3	6	-	5.7	14.3	25.3	8.3	12.3	22.8	11.3
79	6	12	-	4.8	6.2	14.3	6.3	15.2	26.2	27.1
87	7	14	-	1.1	3.4	15.9	28.8	28.2	11.1	11.4
92	10	20	-	1.0	5.3	20.2	18.5	33.8	12.2	8.9
94	13	26	-	0.2	3.0	8.0	17.8	53.8	12.6	4.5
E-89-4	4	13	-	0.1	3.7	27.6	-	-	5.4	4.5
Weighted Average .5 holes			0.1	1.2	5.1	13.1	13.3	34.4	22.7	10.1

EAST BLOCK - NORTH END (TOTAL UNIT)

HOLE	NUMBER OF SAMPLES	THICKNESS	+8	+10	+16	+20	+30	+40	+50	+100	+200	-200
E-89-1	7	21.5	-	0.1	0.2	0.6	2.6	7.7	21.5	42.5	15.3	9.5
E-89-2	8	30	-	0.1	0.1	0.5	1.5	3.3	12.8	41.4	24.3	16.0
E-89-3	15	42.5	-	0.1	0.2	1.1	1.8	10.7	15.7	25.8	24.8	19.8
E-89-5	13	28	-	0.1	1.6	4.9	12.5	20.9	23.3	18.3	11.9	6.5
E-81-1	8	N/A	-	0.1	2.6	1.7	9.6	18.0	30.2	-	-	-
E-81-2	10	N/A	0.1	0.1	4.9	3.2	8.4	12.3	27.3	-	-	-
			0.1	0.1	1.3	1.9	5.4	11.6	20.20	32.1	12.7	14.6

AVERAGE GRAIN SIZE EAST BLOCK
MESH RANGE

	WEIGHTING	+10	10-20	20-40	40-100	100-200	-200
SOUTH END	17%	1.3	5.1	13.1	47.7	22.7	10.1
NORTH END	83%	0.2	3.2	17.0	52.3	12.7	14.6
	100	3.5	3.5	16.4	51.6	14.4	13.8

WEST BLOCK-GRAIN SIZE ESTIMATION

TABLE 2-5

WEST BLOCK NORTH END (TOTAL UNIT)

HOLE	NUMBER OF SAMPLES	FEET THICKNESS	SCREEN SIZE - % RETAINED +4	+10	+20	+40	+60	+100	+200	-200
102	11	22	-	0.55	8.5	32.8	34.1	18.0	3.9	1.7
109	24	48	-	0.10	14.8	32.0	30.6	16.25	3.9	1.6
111	11	22	-	0.6	1.4	6.2	43.8	33.0	12.1	2.8
112	28	56	-	-	3.1	32.0	39.3	14.9	7.3	2.2
113	19	38	-	-	4.7	17.1	29.3	26.7	8.0	4.2
114	7	14	-	-	1.6	11.3	43.1	28.4	12.0	3.6
116	5	10	-	-	1.2	5.8	37.2	42.4	10.7	2.7
TRENCH 1		17.5				35.71	36.18	16.33		
TRENCH 2		20				33.35	34.76	19.14		
TRENCH 3		16				47.18	35.86	10.08		
WEIGHTED AVERAGE			-	0.1	6.3	27.1	35.8	20.6	7.3	2.7

WEST BLOCK - SOUTH END (TOTAL UNIT)

HOLE	NUMBER OF SAMPLES	THICKNESS (feet)	+4	+10	+20	+40	+60	+100	+200	-200
117	13	26	-	0.4	5.2	8.5	24.6	31.5	23.9	7.5
119	10	20	-	2.0	7.9	23.3	13.6	10.8	28.9	6.2
120	11	22	-	0.2	6.0	23.8	35.2	13.8	15.3	4.8
			-	0.3	6.2	17.8	24.9	22.1	22.5	6.2

AVERAGE GRAIN SIZE - WEST BLOCK
MESH RANGE

	WEIGHTING	+10	10-20	20-40	40-100	100-200	-200
SOUTH END	50%	0.3	6.2	17.8	47.0	22.5	6.2
NORTH END	50%	0.1	6.3	27.2	56.4	7.3	2.7
		0.2	6.2	22.5	51.7	14.9	4.4

The total estimated silica sand resources so far defined in the East and West Blocks are 22.26 and 25.86 million tonnes, respectively. Portioning the total resource into the various sieve size ranges according to the computed grain size averages gives tonnages for each size fraction as follows:

U.S. Std. Sieve No.	East Block (million tonnes)	West Block	Total, East and West Blocks
0-12	0.22	0.05	0.27
12-20	0.63	1.60	2.23
20-40	3.65	5.82	9.47
40-60	4.50	7.89	12.39
60-100	6.99	5.51	12.50
100-200	3.20	3.85	7.05
Minus	3.07	1.14	4.21
	22.26 Mt	25.86 Mt	48.12 Mt

2.5.2 Chemical Analysis

A limited number of chemical analyses were carried out in the past, but no detailed conclusions can be reached from these results since the small number of samples cannot be considered representative of the whole deposit. General indications are that the sand is sufficiently pure for frac sand, and that it could be treated to glass quality sand.

A simple arithmetic average of the available chemical analyses of sand from the Paddy Member is as follows:

	East Block	West Block
SiO_2	98.20 %	98.36 %
Fe_2O_3	0.478	0.153
Al_2O_3	0.127	0.782
TiO_2	0.08	0.257
CaO	0.16	0.04
MgO	0.007	Trace
Na_2O	0.009	0.162
K_2O	0.89	0.23
MnO	0.0039	--
Total	99.955%	99.984%

Hardy BBT Limited

CONSULTING ENGINEERING & PROFESSIONAL SERVICES

Our Project No.
Your Reference No. EA-11423

April 24, 1989

Peace River Silica Sand Ltd.
14010 - 128 Avenue
EDMONTON, Alberta
T5L 4M8

Attention: Mr. Joe M. Grguras, President

Subject: Field Investigation and Laboratory Testing Program
Silica Sand Deposit
Near Peace River, Alberta

Gentlemen:

1.0 INTRODUCTION

As requested, a field and laboratory test program was recently undertaken in accordance with your letter of authorization dated February 20, 1989. The work scope undertaken was in general conformance with the Hardy BBT Limited proposal for the subject project dated January 10, 1989. The program involved advancing five boreholes, recovering selected sand samples, and conducting a series of tests utilizing the American Petroleum Institute, Recommended Practices, for Testing Sand Used in Hydraulic Fracturing Operations, API RP56, First Edition, March, 1983.

The field work portion of the study was completed in March, 1989 and although the laboratory work is nearly complete, the results and findings compiled to-date are presented in this letter-report. The laboratory work scope still underway consists of the sand mineralogical analyses (x-ray differention tests) which are being conducted by the Alberta Research Council. This phase of the study is expected to be completed and available by the end of May, 1989.

2.0 FIELD EXPLORATION

The field work portion of the investigation, including site reconnaissance, borehole drilling, and soil sampling, was conducted during the time period of March 5 to 12, 1989. A total of five boreholes were drilled to depths ranging from 127 feet to 150.5 feet below the existing ground surface elevations. The boreholes were advanced at locations determined and surveyed by representatives of, or acting on behalf of, Peace River Silica Sand Ltd. The locations of the boreholes are shown on the

attached site plan, Drawing No. EA11423-1. Continuous logs of the subsurface conditions, as encountered in the boreholes, were recorded at the time of drilling and are presented on the attached borehole logs, Drawing Nos. EA11423-2 to -6. Drilling was accomplished with a truck mounted Becker drill rig utilizing a combination of casing and hammer, and tri-cone drilling.

Soil sampling consisted of recovering disturbed soil samples from the drill cuttings at selected depths in all of the boreholes. Additionally, two sand samples were recovered from sand deposits within the area, at locations identified by representatives of Peace River Silica Sand Ltd. All soil samples recovered in the field were sealed to prevent moisture loss and were taken to the Edmonton laboratory for testing and analysis.

3.0 LABORATORY TESTING

Selected sand samples were tested in the laboratory to determine certain physical properties of the material relative to the use of the sand for use in hydraulic fracturing operations. Grain size analyses were conducted on a majority of the recovered sand samples to determine the particle size distributions. On the basis of the grain size distributions, a limited number of sand samples were selected for additional testing. The samples were prepared for this phase of the testing by washing and sieving in order to achieve a grain size analysis for each sample which satisfied the 20/40 fractured sand size designation as given in Table 4.1 - API RP 56, First Edition, March, 1983. Subsequent to the processing, the individual samples were tested to determine sphericity and roundness, solubility in acid, turbidity, and crush resistance determinations. All of the above tests were conducted in accordance with the recommended practices of the American Petroleum Institute, API RP 56, First Edition, March, 1983.

The test data and supplementary notes are presented on the attached Table Nos. 1 to 10. Test results which indicated compliance or non-compliance of materials with the American Petroleum Institute recommended criterion are identified.

If there are any questions please contact this office.

Respectfully submitted

Hardy BBT Limited

D.F. Cox, P.Eng.
Senior Engineer
Materials Engineering

DFC/jh/EA11423L.DFC

Distribution: (12) Addressee

Enclosures: Table Nos. 1 to 10
Drawing Nos. EA11423-1 to -6

TABLE 3-1

GRADATION ANALYSES CONDUCTED ON SAND DEPOSITS
BOREHOLE NO. E89-1

Total Percent Passing (By Mass)

Sieve Designation*	Sample No. / Depth (feet)	1 94-96	2 96-98	3 98-100	4 100-102	5 102-104	6 104-106	7 106-108
8		100	100	100	100	100	100	100
10		100	100	100	99.9	99.9	99.4	100
16		99.9	100	99.8	99.6	99.8	99.3	99.8
20		99.5	99.6	98.4	98.7	99.3	99.0	99.4
30		97.0	97.4	92.4	95.1	97.8	98.0	98.2
40		86.0	87.7	78.3	84.7	93.6	95.7	95.9
50		53.0	56.6	49.5	58.2	78.4	87.6	88.1
100		11.7	15.1	10.5	10.0	18.4	40.7	40.5
200		3.0	4.6	3.1	2.7	5.1	9.9	11.2

* U.S.A. Sieve Series (ASTM E 11-81)

TABLE 3-2

GRADATION ANALYSES CONDUCTED ON SAND DEPOSITS
BOREHOLE NO. E89-2

Total Percent Passing (By Mass)

Sieve Designation*	Sample No. / Depth (feet)	1 100- 102	3 104- 106	5 108- 110	7 112- 114	9 116- 118	11 120- 122	13 124- 126	15 128- 130	18 132- 134	20 136- 141	22 144- 148
8		100	100	100	100	100	100	100	100	100	100	100
10		100	100	100	100	99.9	99.8	100	100	100	99.9	99.9
16		99.3	100	100	100	99.9	99.7	100	100	99.9	99.8	99.9
20		96.3	99.6	99.9	99.9	99.8	99.6	99.9	99.9	99.8	99.8	99.8
30		87.4	97.5	99.8	99.7	99.8	99.6	99.7	99.4	99.8	99.5	99.2
40		77.0	90.2	98.5	97.8	99.6	99.4	98.5	95.8	99.7	98.5	97.2
50		65.2	77.7	79.3	72.7	97.8	98.5	86.7	76.3	99.4	93.6	93.2
100		42.7	57.3	20.3	14.1	68.2	71.5	23.5	25.4	88.4	60.1	75.8
200		25.1	30.0	7.3	4.5	19.2	23.4	9.2	9.7	27.4	21.6	43.2

* U.S.A. Sieve Series (ASTM E 11-81)

TABLE 3-3

GRADATION ANALYSES CONDUCTED ON SAND DEPOSITS
BOREHOLE NO. E89-3

Total Percent Passing (By Mass)

Sample No.	1	3	5	7	8	9	10	11	12	13	14	15	16	17	18
Depth (feet)	108-110	112-114	116-118	120-122	122-124	124-126	126-128	128-130	130-138	138-140	140-141	141-144	144-147	147-150	150-150.5
Sieve Designation*															
8	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
10	100	100	99.9	99.9	99.5	100	100	99.9	100	100	100	99.9	100	100	99.9
16	99.9	99.9	99.8	99.9	99.3	99.9	100	99.8	100	99.4	99.5	99.8	100	99.0	97.6
20	99.5	99.5	99.8	99.8	99.0	99.5	99.7	99.0	99.8	98.2	98.8	99.4	100	91.9	76.8
30	98.7	98.8	99.5	99.8	97.6	96.1	99.3	91.9	95.7	88.3	89.2	97.0	99.9	81.1	48.6
40	97.9	98.4	99.3	99.7	90.1	80.2	72.8	63.6	73.3	63.3	65.6	88.4	98.9	72.9	38.6
50	94.5	97.8	98.8	99.6	79.3	57.9	28.1	20.3	39.7	36.2	43.6	74.2	91.3	59.8	30.6
100	74.9	80.0	89.9	90.1	62.2	42.0	12.3	6.4	9.0	6.1	10.3	21.6	27.8	21.4	14.4
200	32.1	34.0	36.2	33.4	31.2	30.2	7.3	2.8	4.8	2.4	4.9	7.0	12.0	10.8	8.8

* U.S.A. Sieve Series (ASTM E 11-81)

TABLE 3-4

GRADATION ANALYSES CONDUCTED ON SAND DEPOSITS
BOREHOLE NO. E89-4

Total Percent Passing (By Mass)

Sieve Designation*	Sample No. / Depth (feet) 1 54-56	2 56-60	3 60-65	4 65-67	5 112-114
8	100	100	100	100	100
10	100	100	100	99.7	100
16	100	99.9	99.5	97.6	99.9
20	99.6	99.7	94.5	89.9	99.8
30	90.9	95.8	74.4	71.0	99.2
40	72.1	83.0	62.0	56.6	98.2
50	49.9	64.2	51.4	47.3	96.6
100	4.7	9.3	8.1	21.2	93.2
200	2.5	4.2	4.0	8.6	29.1

* U.S.A. Sieve Series (ASTM E 11-81)

TABLE 3-5

GRADATION ANALYSES CONDUCTED ON SAND DEPOSITS
BOREHOLE NO. E89-5

Total Percent Passing (By Mass)

Sample No.	1	3	4	5	6	7	8	9	10	11	12	13	14
Depth (feet)	110-112	114-116	116-118	118-120	120-122	122-124	124-126	126-128	128-130	130-132	132-134	134-136	136-138
Sieve Designation*													
8	100	100	100	100	100	100	100	100	100	100	100	100	100
10	100	99.9	99.9	100	99.9	99.9	99.8	100	99.9	99.9	99.9	100	100
16	100	98.7	95.5	98.8	98.4	96.5	96.7	99.0	97.9	98.8	98.3	99.1	98.3
20	99.9	95.3	83.7	93.6	92.7	86.2	88.1	94.6	93.7	95.4	94.2	95.3	94.2
30	99.8	87.8	60.5	74.7	75.8	64.0	69.4	80.6	83.0	85.5	82.8	82.9	84.8
40	99.6	80.0	35.2	42.1	44.3	34.1	42.3	53.2	60.3	63.5	59.5	56.7	68.2
50	98.2	72.5	15.0	14.2	15.6	11.6	19.1	26.5	28.3	26.8	23.3	20.8	40.4
100	84.7	51.1	4.5	2.4	2.3	2.2	3.3	3.5	2.5	2.7	2.0	2.3	6.5
200	31.7	17.8	1.7	0.8	0.7	0.6	1.1	0.6	0.6	0.7	0.5	0.7	2.3

* U.S.A. Sieve Series (ASTM E 11-81)

TABLE 3-6

GRADATION ANALYSES CONDUCTED ON SAND DEPOSITS MISCELLANEOUS LOCATIONS

Total Percent Passing (By Mass)

Sieve Designation*	West Bank Trench #4	West Bank Dynamite Blast
8	100	100
10	99.2	100
16	95.8	99.9
20	85.8	99.9
30	69.1	99.8
40	53.0	99.8
50	30.2	99.7
100	3.5	94.5
200	0.9	18.3

* U.S.A. Sieve Series (ASTM E 11-81)

TABLE 3-7

FRAC SAND SPHERICITY AND ROUNDNESS

Borehole No.	Sample No.	Depth (feet)	Average Sphericity*	Average Roundness**
E89-1	3	98-100	0.7	(0.5)
E89-3	9	124-126	0.7	0.6
E89-3	10	126-128	0.8	0.6
E89-3	11	128-130	0.7	0.6
E89-3	13	138-140	0.7	0.6
E89-3	14	140-141	0.7	0.6
E89-3	18	150-150.5	0.7	(0.5)
E89-4	3	60-65	0.8	(0.5)
E89-4	4	65-67	0.7	(0.5)
E89-5	4	116-118	0.7	0.6
E89-5	5	118-120	0.7	0.6
E89-5	6	120-122	0.7	0.6
E89-5	7	122-124	0.7	0.6
E89-5	8	124-126	0.8	0.7
E89-5	9	126-128	0.8	0.7
E89-5	10	128-130	0.7	0.7
E89-5	12	132-134	0.7	0.7
West Bank Trench #4		--	0.6	0.6

* API RP 56, First Edition, March, 1983, Section 5.2
** API RP 56, First Edition, March, 1983, Section 5.3
() Less than the recommended minimum value of 0.6

TABLE 3-8

SAND SOLUBILITY IN ACID

Borehole No.	Sample No.	Depth (feet)	Solubility* (% by Weight)
E89-1	3	98-100	0.84
E89-3	9	124-126	0.80
E89-3	10	126-128	0.79
E89-3	11	128-130	0.84
E89-3	13	138-140	0.93
E89-3	14	140-141	0.84
E89-3	18	150-150.5	0.86
E89-4	3	60-65	0.53
E89-4	4	65-67	0.81
E89-5	4	116-118	0.74
E89-5	5	118-120	1.12
E89-5	6	120-122	0.82
E89-5	7	122-124	0.81
E89-5	8	124-126	0.84
E89-5	9	126-128	0.81
E89-5	10	128-130	1.01
E89-5	12	132-134	0.81

* API RP 56, First Edition, March, 1983, Section 6
() Greater than the recommended maximum value of 2.0 percent by weight

TABLE 3-9

TURBIDITY MEASUREMENT OF SILT AND CLAY SIZE PARTICULATE MATTER

Borehole No.	Sample No.	Depth (feet)	Turbidity* (FTU)
E89-1	3	98-100	79
E89-3	9	124-126	46
E89-3	10	126-128	63
E89-3	11	128-130	60
E89-3	13	138-140	54
E89-3	14	140-141	56
E89-3	18	150-150.5	54
E89-4	3	60-65	7
E89-4	4	65-67	54
E89-5	4	116-118	44
E89-5	5	118-120	33
E89-5	6	120-122	74
E89-5	7	122-124	36
E89-5	8	124-126	37
E89-5	9	126-128	47
E89-5	10	128-130	21
E89-5	12	132-134	54

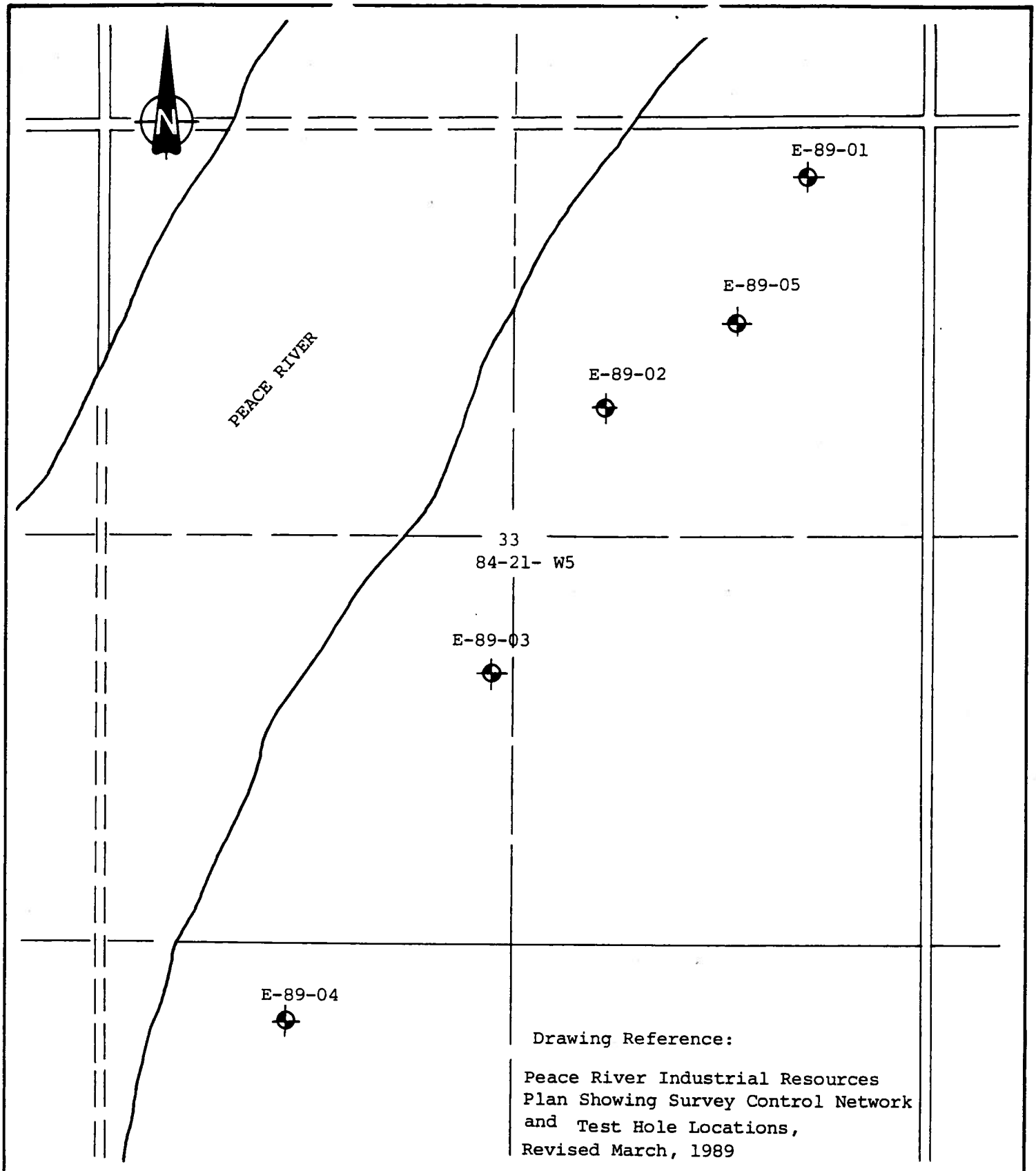
* API RP 56, First Edition, March, 1983, Section 7, Method I
() Greater than the recommended frac sand turbidity value of 250 FTU

TABLE 3-10

FRAC SAND CRUSH RESISTANCE

Borehole No.	Sample No.	Depth (feet)	Crush Resistance* (% Fines by Weight)
E89-1	3	98-100	13.9
E89-3	9	124-126	10.8
E89-3	10	126-128	(15.6)
E89-3	11	128-130	12.5
E89-3	13	138-140	12.1
E89-3	14	140-141	11.7
E89-3	18	150-150.5	13.7
E89-4	3	60-65	13.0
E89-4	4	65-67	(14.7)
E89-5	4	116-118	12.9
E89-5	5	118-120	11.9
E89-5	6	120-122	13.9
E89-5	7	122-124	(14.0)
E89-5	8	124-126	(15.2)
E89-5	9	126-128	(14.8)
E89-5	10	128-130	(16.7)
E89-5	12	132-134	(15.0)
West Bank Trench #4		--	(14.6)

* API RP 56, First Edition, March, 1983, Section 8
() Greater than or equal to the recommended maximum fines value of 14 percent by weight.



Hardy BBT Limited
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

SITE PLAN SHOWING TEST HOLE LOCATIONS
PEACE RIVER SILICA SAND LTD.
NEAR PEACE RIVER, ALBERTA

SCALE	DATE	MADE	CHKD.	Drawing No.
1:10,000	Apr.12/89	AV	DFC	EA11423-1

HBLT 54-87/11

Hardy BBT Limited
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

BOREHOLE LOG

PROJECT PEACE RIVER SILICA SAND LTD.
FIELD INVESTIGATION AND LABORATORY TESTING PROGRAM
SILICA SAND DEPOSIT NEAR PEACE RIVER, ALBERTA

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
GM/AV	DFC	March 7/89	EA-11423	E89-1

DRILL TYPE: Becker, 6 5/8" Casing and 4" Tricone

WATER CONTENT — Wp - □ w - ○ W_L - △ — PERCENT % — 10 20 30 40 50 60

DATUM: Geodetic

SURFACE ELEVATION: 382.9 m

DEPTH FT.	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE CONDITION	SOIL SAMPLE TYPE	SOIL SAMPLE PENETRATION RESISTANCE	OTHER TESTS
0		TOPSOIL, dark brown, frozen				
10		GRAVEL, mixed with SAND, brown, damp, very dense, boulders				
20						
30		CLAY (SHALE), high plastic, dark grey, damp, hard to very hard				
40						
50						
60						
70						
80						
90		SAND (SILICA), light brown, damp, coarse grained - fine grained 87.5'-108' - moist 102'-108'		Bag Samples		
100						
110		COAL, black, seepage				▼ at completion
120		END OF HOLE AT 108'				
130						
140						
150						
160						

Drawing No. EA11423-2

Hardy BBT Limited
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

BOREHOLE LOG

PROJECT PEACE RIVER SILICA SAND LTD.
FIELD INVESTIGATION AND LABORATORY TESTING PROGRAM
SILICA SAND DEPOSIT NEAR PEACE RIVER, ALBERTA

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
GM/AV	DFC	March 8/89	EA-11423	E89-2

DRILL TYPE: Becker, 6 5/8 Casing and 4" Tricone

WATER CONTENT — Wp - □ W - ○ W_L - △ — PERCENT % — 10 20 30 40 50 60

DEPTH FT. | SOIL SYMBOL | SOIL DESCRIPTION | SOIL SAMPLE: CONDITION, TYPE, PENETRATION RESISTANCE | OTHER TESTS

DATUM Geodetic

SURFACE ELEVATION 387.6 m

DEPTH FT.	SOIL DESCRIPTION
0	TOPSOIL, dark brown, frozen
	GRAVEL, mixed with SAND, brown, damp, very dense, boulders
20	CLAY (SHALE), high plastic, dark grey, hard to very hard
80	- trace seepage at 80'
100	SAND (SILICA), light grey to white, fine grained
	-finer grained, yellow tint 118' to 130.5'
130	COAL, black, trace seepage
	SAND, dark brown, fine grained, light brown below 135'
150	END OF HOLE AT 148'

Bag Samples

Drawing No. EA11423-3

Hardy BBT Limited
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

BOREHOLE LOG

PROJECT PEACE RIVER SILICA SAND LTD.
FIELD INVESTIGATION AND LABORATORY TESTING PROGRAM
SILICA SAND DEPOSIT NEAR PEACE RIVER, ALBERTA

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
GM/AV	DFC	March 9/89	EA-11423	E89-3

DRILL TYPE: Becker, 6 5/8" Casing and 4" Tricone

OTHER TESTS

WATER CONTENT — W_p - □ W - ○ W_L - △ PERCENT % (10 20 30 40 50 60)

DATUM Geodetic

SURFACE ELEVATION 391.4 m

DEPTH FT.	SOIL DESCRIPTION	SOIL SAMPLE: CONDITION / TYPE / PENETRATION RESISTANCE
0	TOPSOIL,dark brown,frozen	
	SAND,brown,fine to medium,frozen	
10	CLAY,high plastic,dark grey,moist, hard, slickensides, oxide staining	
20		
	CLAY (SHALE),high plastic,dark grey,damp,very hard	
30	- trace seepage at 26'	
40		
50		
60		
70		
80		
90		
100		
110	SAND(SILICA),light grey,damp,fine grained	Bag Samples
	-very moist high plastic,clay seam 123.5' to 124.5'	
120	-coarser grained,white at 124.5'	
	-brown,iron contamination,fine grained,powdery 140'-150'	
130	-coarser grained at 150'	
140		
150	END OF HOLE AT 150.5'	
160		

Drawing No. EA11423-4

Hardy BBT Limited
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

BOREHOLE LOG

PROJECT PEACE RIVER SILICA SAND
FIELD INVESTIGATION AND LABORATORY TESTING PROGRAM
SILICA SAND DEPOSIT NEAR PEACE RIVER, ALBERTA

LOGGED/DWN. GM/AV	CKD. DFC	DATE OF INVEST. March 12/89	JOB NO. EA-11423	HOLE NO. E89-4

DRILL TYPE: Becker, 6 5/8" Casing and 4" Tricone

OTHER TESTS

DATUM: Geodetic

SURFACE ELEVATION: 363.6 m

WATER CONTENT — Wp - □ W - ○ W_L - △ — PERCENT % — 10 20 30 40 50 60

DEPTH FT.	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE: CONDITION	SOIL SAMPLE: TYPE	SOIL SAMPLE: PENETRATION RESISTANCE
0		TOPSOIL, dark brown, frozen			
10		CLAY, high plastic, dark grey-brown, moist, hard, slickensides, oxide staining			
20					
30					
40					
45		SAND-SILT, brown, damp, fine grained			
50		GRAVEL, mixed with SAND, brown, damp, very dense			
51		coal seam 51' to 52'			
60		SAND (SILICA), dark brown, moist, coal and iron contamination		Bag Samples	
70		SAND (SANDSTONE), grey, weakly cemented, fine grained			
80					
90					
100				Bag	
110					
120					
127		END OF HOLE AT 127'			
130					
140					
150					
160					

Drawing No.
EA11423-5

Hardy BBT Limited
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

BOREHOLE LOG

PROJECT PEACE RIVER SILICA SAND LTD.
FIELD INVESTIGATION AND LABORATORY TESTING PROGRAM
SILICA SAND DEPOSIT NEAR PEACE RIVER, ALBERTA

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
GM/AV	DFC	March 11/89	EA-11423	E89-5

DRILL TYPE: Becker, 6 5/8" Casing and 4" Tricone

WATER CONTENT — Wp - □ W - ○ W_L - △ — PERCENT % (10 20 30 40 50 60)

DATUM: Geodetic

SURFACE ELEVATION: 391.0 m

DEPTH FT.	SOIL SYMBOL	SOIL DESCRIPTION	SOIL SAMPLE: CONDITION	SOIL SAMPLE: TYPE	SOIL SAMPLE: PENETRATION RESISTANCE	OTHER TESTS
0		GRAVEL, mixed with SAND, brown, damp, very dense, cobbles				
10						
20						
30						
40		CLAY (SHALE), high plastic, dark grey, damp, very hard				
50						
60		-trace seepage at 55'				
70						
80						
90						
100						
110						
120		SAND (SILICA), grey, damp, fine to very fine grained -coarse grained, 115' to 124' -medium grained 124' to 138'				
130		-wet coal seam at 134.5'				
140		COAL, black, trace seepage				
150		SAND (SANDSTONE), yellow tint, fine grained, dense END OF HOLE AT 150'				
160						

Bag Samples

Drawing No. EA11423-6

Hardy BBT Limited

CONSULTING ENGINEERING & PROFESSIONAL SERVICES

Our Project No.
Your Reference No. EA-11423

June 19, 1989

Peace River Silica Sand Ltd.
14010 - 128 Avenue
EDMONTON, Alberta
T5L 4M8

Attention: Mr. Joe Grguras

Subject: Field Investigation and Laboratory Testing Program
Silica Sand Deposit
Near Peace River, Alberta

Gentlemen:

A report presenting the results of a field and laboratory test program was previously prepared for the subject project by Hardy BBT Limited, and dated April 24, 1989.

At the time of the report preparation, the x-ray diffraction testing was still in progress. This testing has recently been completed by the Alberta Research Council and the results are attached. The test data basically indicated the materials tested to consist of quartz.

If there are any questions please contact this office.

Respectfully submitted

Hardy BBT Limited

D.F. Cox, P.Eng.

DFC/jh/EA11423L.DC

Enclosure

Distribution: (12) Addressee

ALBERTA
RESEARCH
COUNCIL

June 16, 1989

Mr. D.F. Cox
Hardy BBT Limited
4810 - 93rd Street
Edmonton, Alberta
T5J 2L4

Dear Mr. Cox,

Please find enclosed the x-ray diffractograms for the eighteen samples you submitted for XRD analysis. The results are as follows:

A. RANDOM POWDER IDENTIFICATION (QUALITATIVE ANALYSIS - <75u)

COMMENT: The samples exhibited very strong crystallinity - diffractograms were run at a very high intensity scale (10,1000). Diffraction data was collected and processed using an IBM PDP 11/24 computer with the APD1700 Automated Powder Diffraction computer software system. Unidentified peaks present were very weak and most often only identified by the APD1700 computer software detected peaks file [the system considers peaks having a quality (peak significance) of higher than 1.0 significant and not being noise induced].

WEST BANK TRENCH #4 - [ARC #H1]

Quartz
Two unidentified peaks

HOLE E89-5 SAMPLE 12 (132 - 134) - [ARC #H2]

Quartz

250 Karl Clark Road
Edmonton, Alberta
Canada
403/450-5111
Telex 037-2147
(RESEARCH EDM)

Mailing address:
PO Box 8330
Postal Station F
Edmonton, Alberta
Canada T6H 5X2

HOLE E89-5 SAMPLE 10 (128 - 130) - [ARC #H3]

Quartz
One unidentified peak

HOLE E89-5 SAMPLE 9 (126 - 128) - [ARC #H4]

Quartz
One unidentified peak

HOLE E89-5 SAMPLE 8 (124 - 126) - [ARC #H5]

Quartz
Two unidentified peaks

HOLE E89-5 SAMPLE 7 (122 - 124) - [ARC #H6]

Quartz

HOLE E89-5 SAMPLE 6 (120 - 122) - [ARC #H7]

Quartz
Two unidentified peaks

HOLE E89-5 SAMPLE 5 (118 - 120) - [ARC #H8]

Quartz
One unidentified peak

HOLE E89-5 SAMPLE 4 (116 -118) - [ARC #H9]

Quartz

HOLE E89-4 SAMPLE 4 (65 - 67) - [ARC #H10]

Quartz
Two unidentified peaks

HOLE E89-4 SAMPLE 3 (60 - 65) - [ARC #H11]

Quartz

HOLE 3 SAMPLE 18 - [ARC #H12]

Quartz

HOLE E89-3 SAMPLE 14 (140 - 141) - [ARC #H13]

Quartz
One unidentified peak

HOLE E89-3 SAMPLE 13 (138 - 140) - [ARC #H14]

Quartz

HOLE E89-3 SAMPLE 11 (128 - 130) - [ARC #H15]

Quartz
Two unidentified peaks

HOLE E89-3 SAMPLE 10 (126 - 128) - [ARC #H16]

Quartz

HOLE E89-3 SAMPLE 9 (124 - 126) - [ARC #H17]

Quartz

HOLE E89-1 SAMPLE 3 [98 - 100] - [ARC #18]

Quartz
One unidentified peak

B. CLAY MINERAL IDENTIFICATION (<2u)

COMMENT: Oriented Clay Slide Preparation - the samples (18 grams) were hydrated overnite, centrifuged at 600 RPM according to the time - temperature chart based on Stoke's Law, < 2u fraction decanted, and two slides prepared and treated (glycolated and heated).

The diffractograms were run at an intensity scale of 500. Diffraction data is not collected for semi-quantitative clay mineral estimated (prepared sample is run in the Utilities Program of the APD1700 computer software system and raw data is not collected). The peaks of the clay mineral present (Kaolinite) were very weak suggesting a very low concetntration (trace amounts).

Grinding a sample creates 'non clay fines' which can be confirmed by the strong presence of quartz in the <2u fraction.

WEST BANK TRENCH #4

Clay mineral Kaolinite

Quartz
Several unidentified peaks

HOLE E89-5 SAMPLE 12 (132-134)

Clay mineral Kaolinite

Quartz
Several unidentified peaks

HOLE E89- SAMPLE 4 (65 - 67)

Clay mineral Kaolinite

Quartz
Several unidentified peaks

HOLE E89-3 SAMPLE 14 (140 - 141)

Clay mineral Kaolinite

Quartz

HOLE E89-1 SAMPLE 3 (98 - 100)

Clay mineral Kaolinite

Quartz

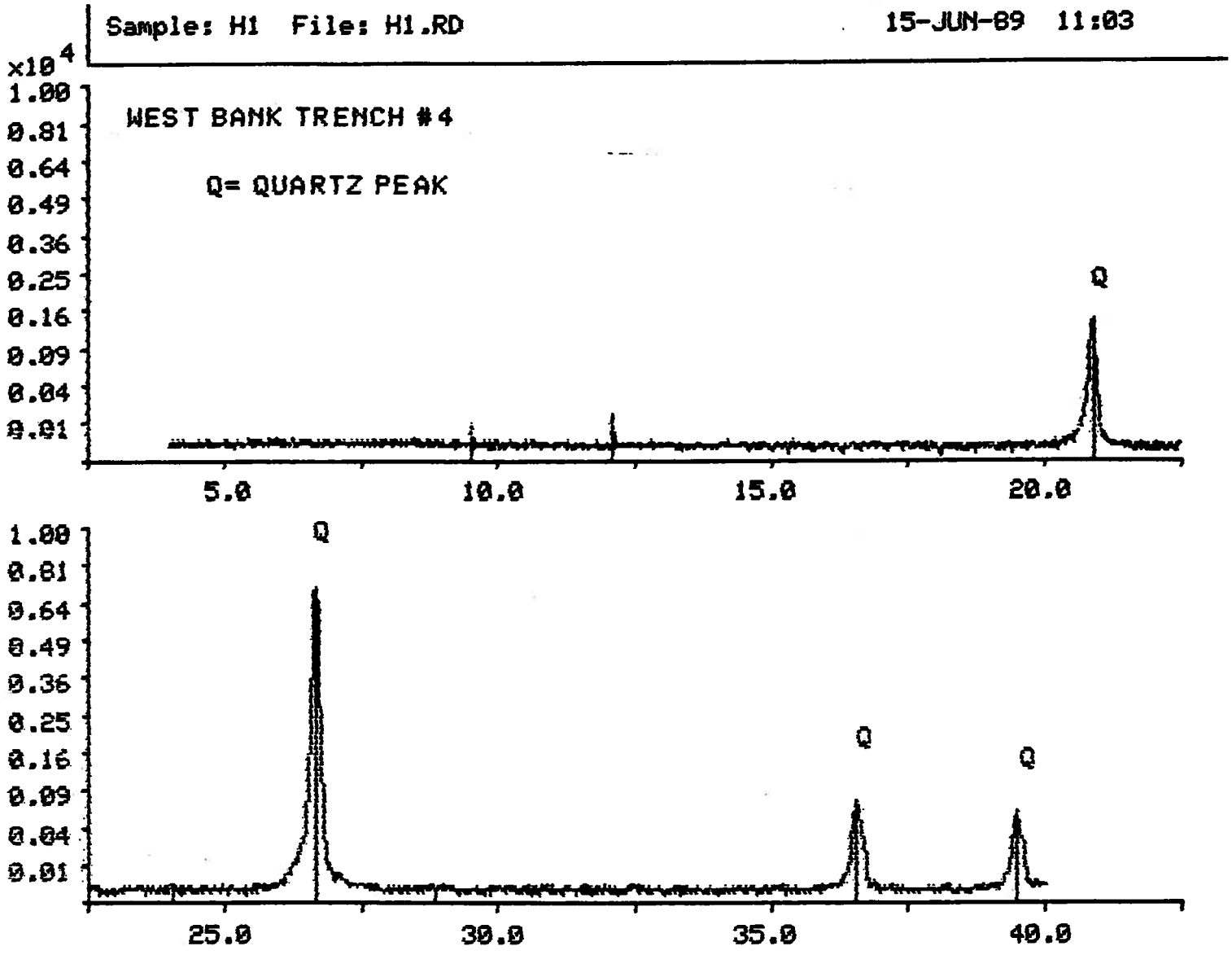
Yours sincerely,

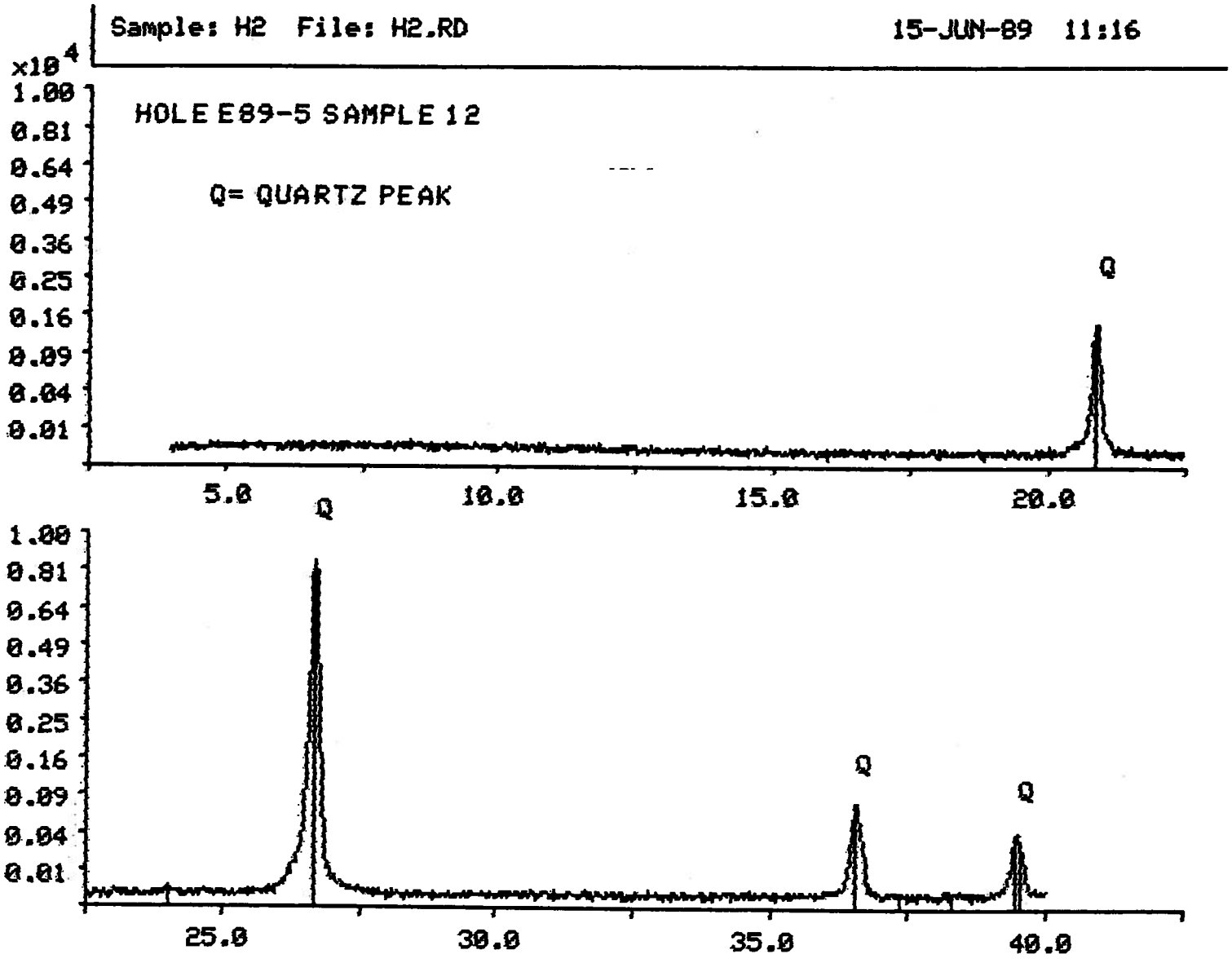
Dianne Goulet

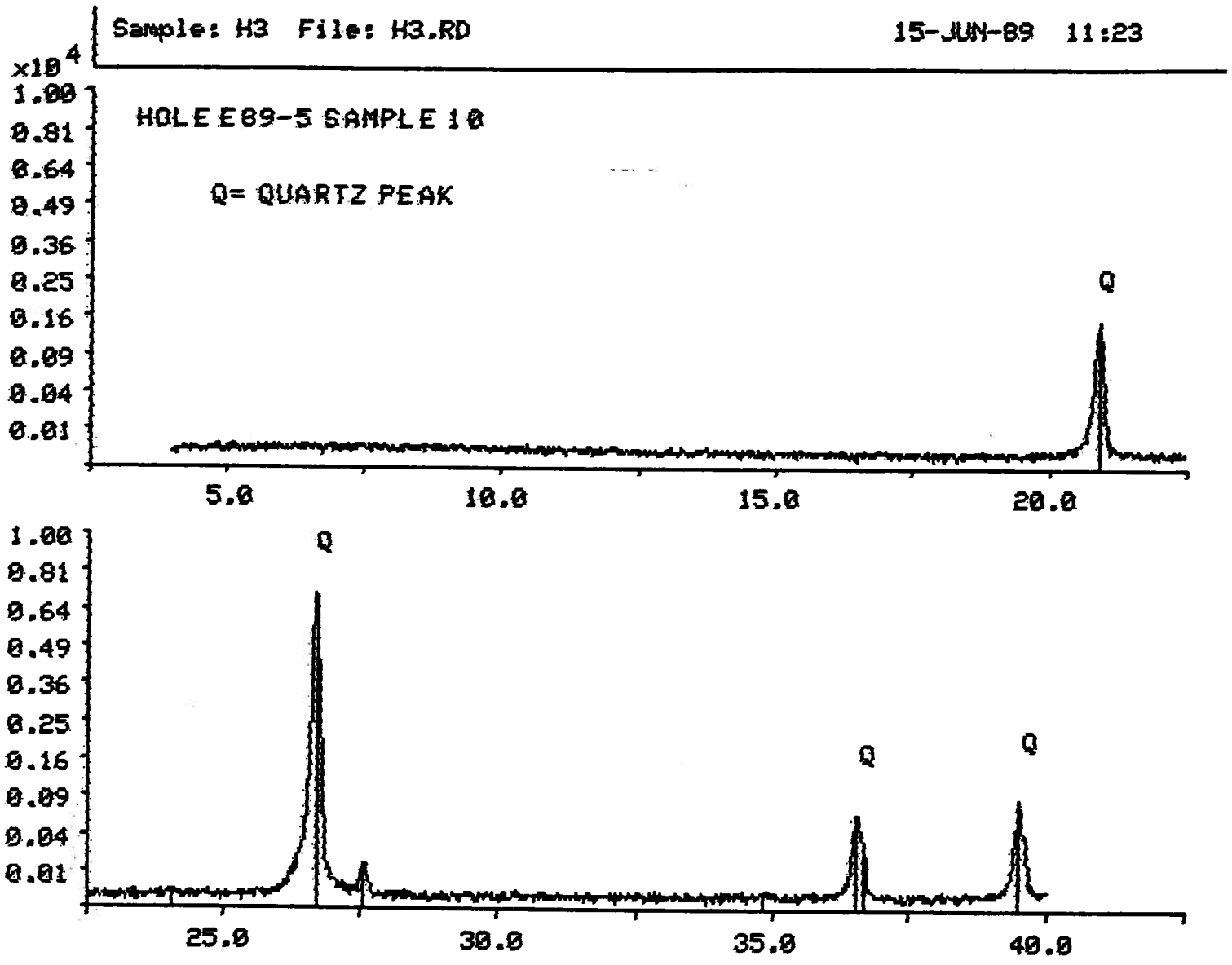
Dianne Goulet

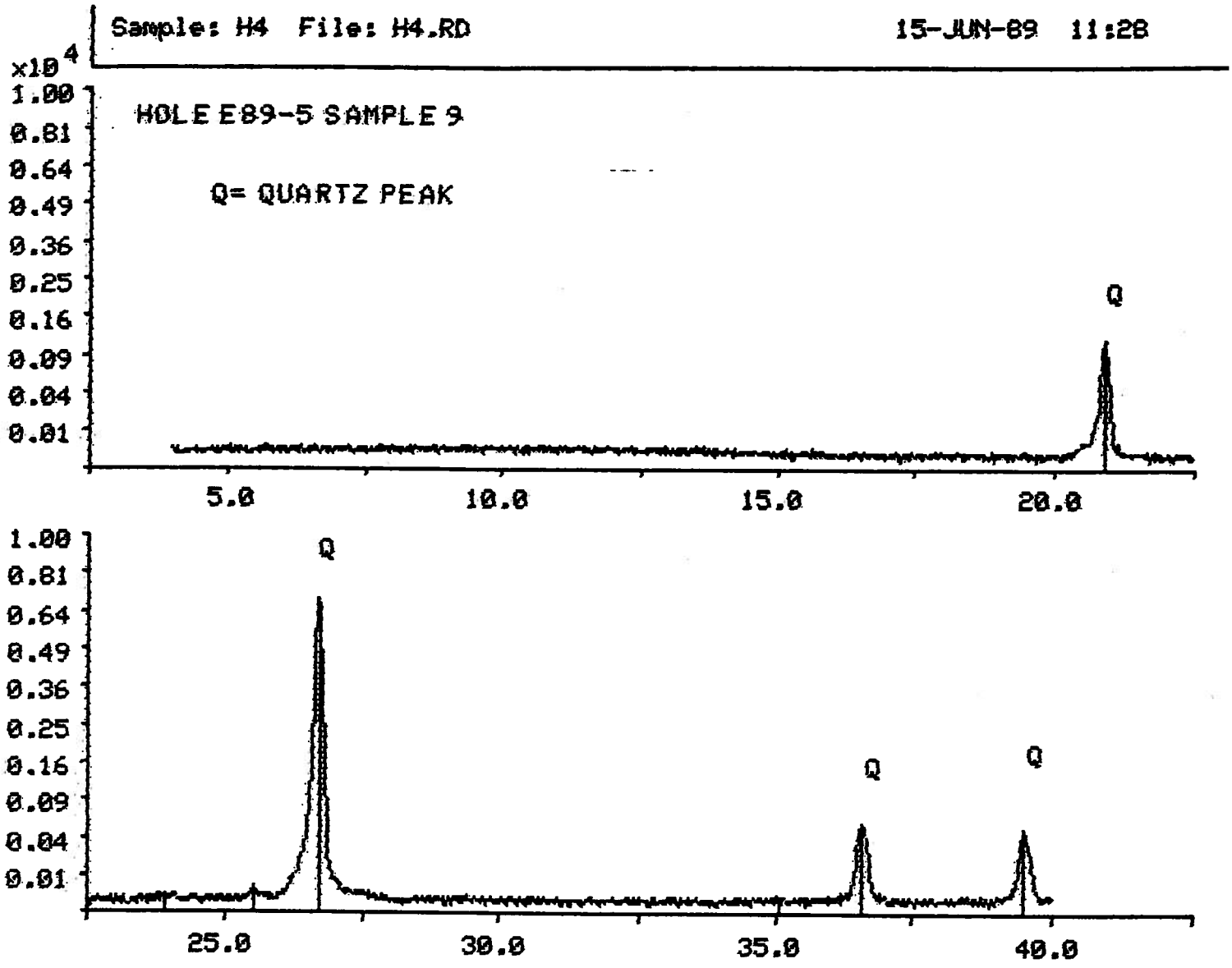
Enclosures

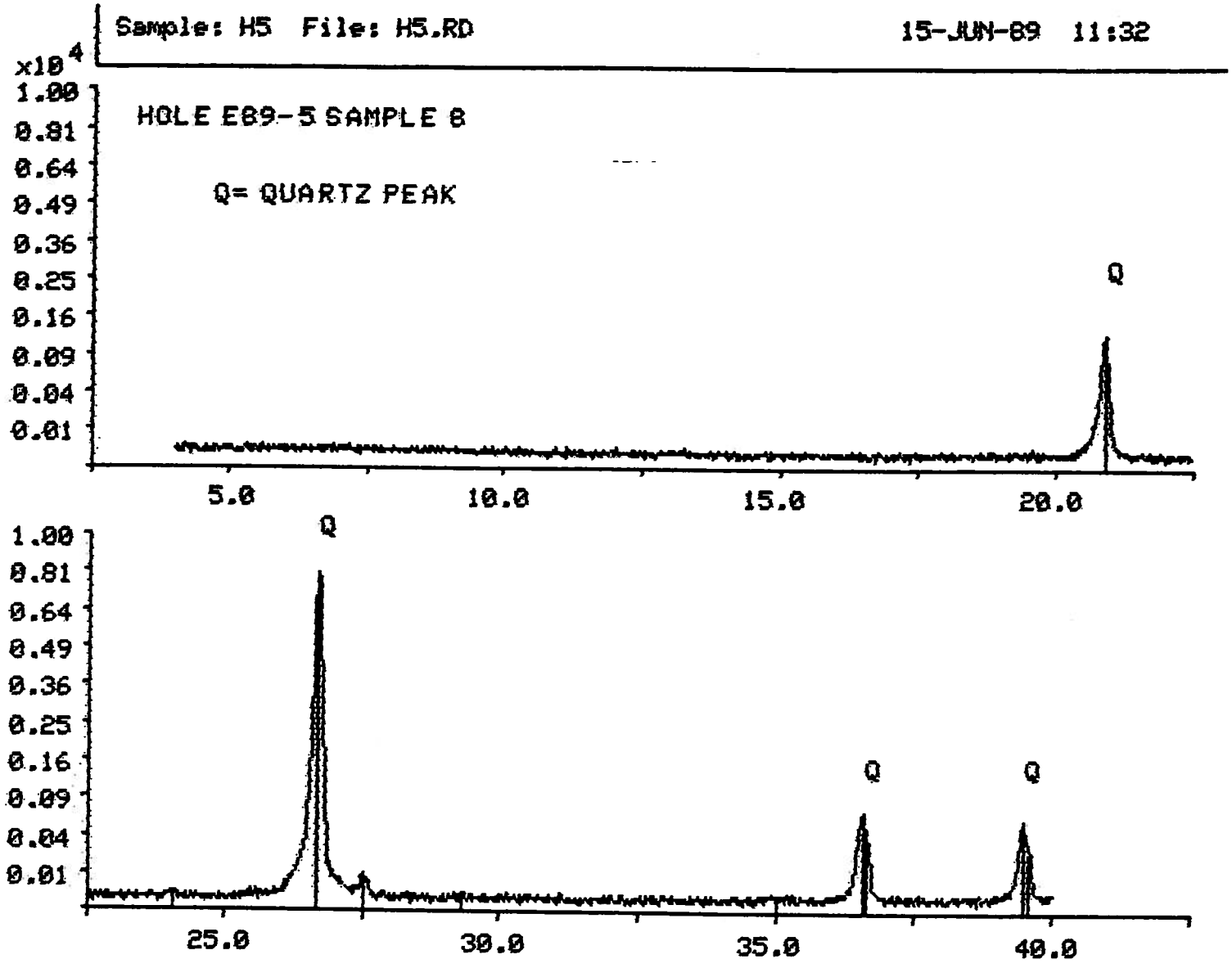
COMPUTER GRAPHIC PLOTS

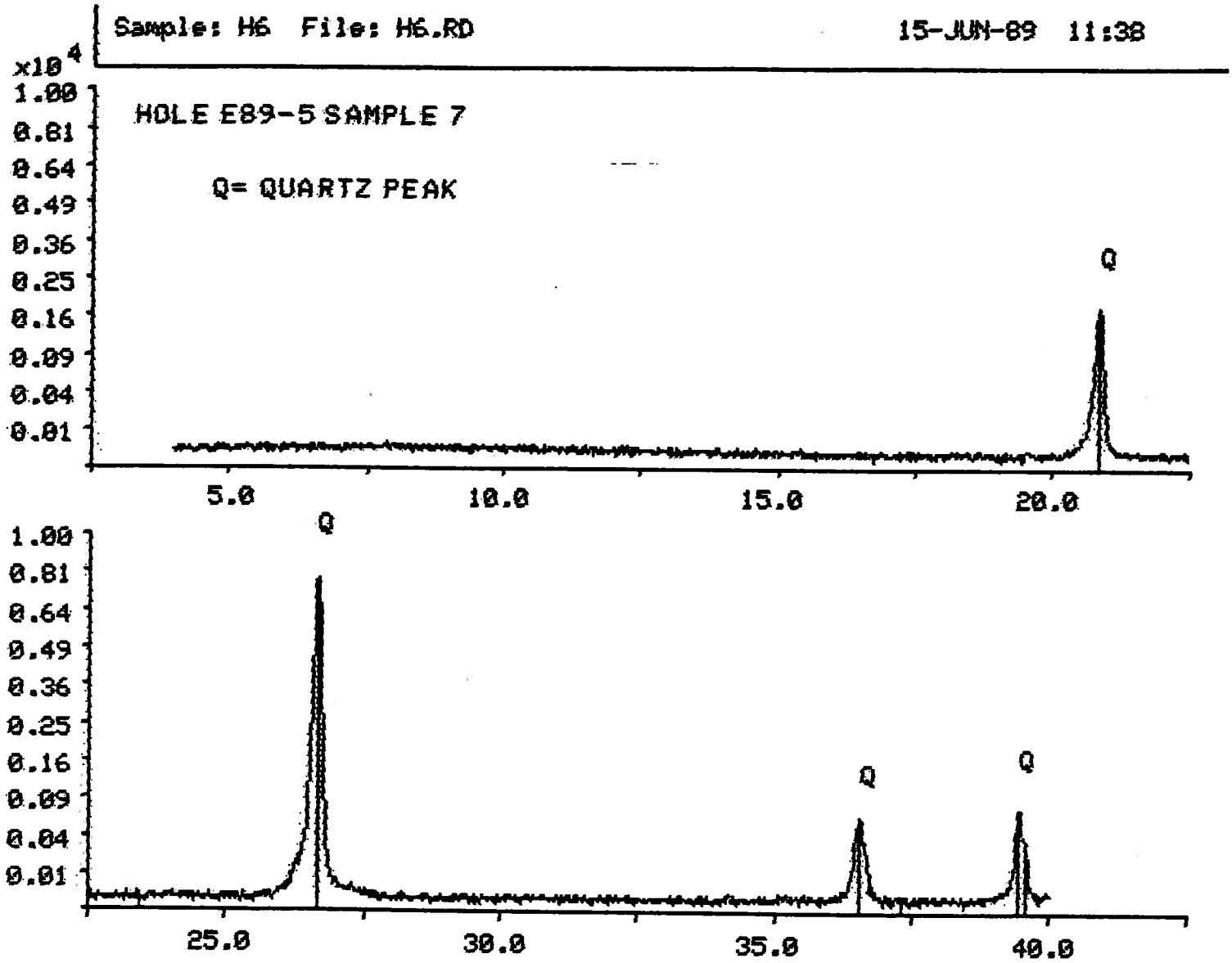

Sample: H1 File: H1.RD
15-JUN-89 11:03
x10 4
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
WEST BANK TRENCH #4
Q= QUARTZ PEAK
Q
5.0
10.0
15.0
20.0
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
Q
Q
Q
25.0
30.0
35.0
40.0

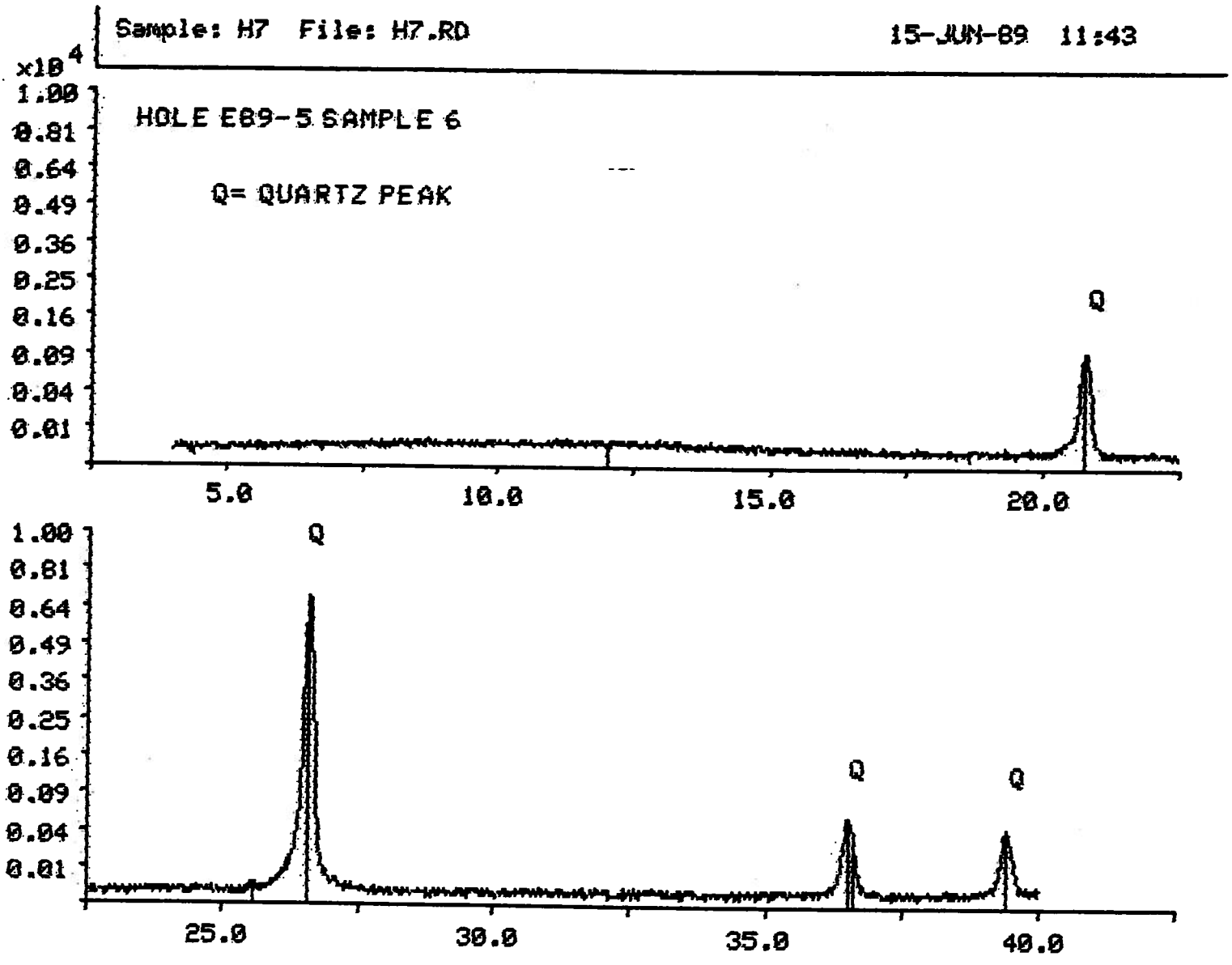

Sample: H2 File: H2.RD
15-JUN-89 11:16
x10^4
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
HOLE E89-5 SAMPLE 12
Q= QUARTZ PEAK
Q
5.0
10.0
15.0
20.0
Q
Q
Q
25.0
30.0
35.0
40.0

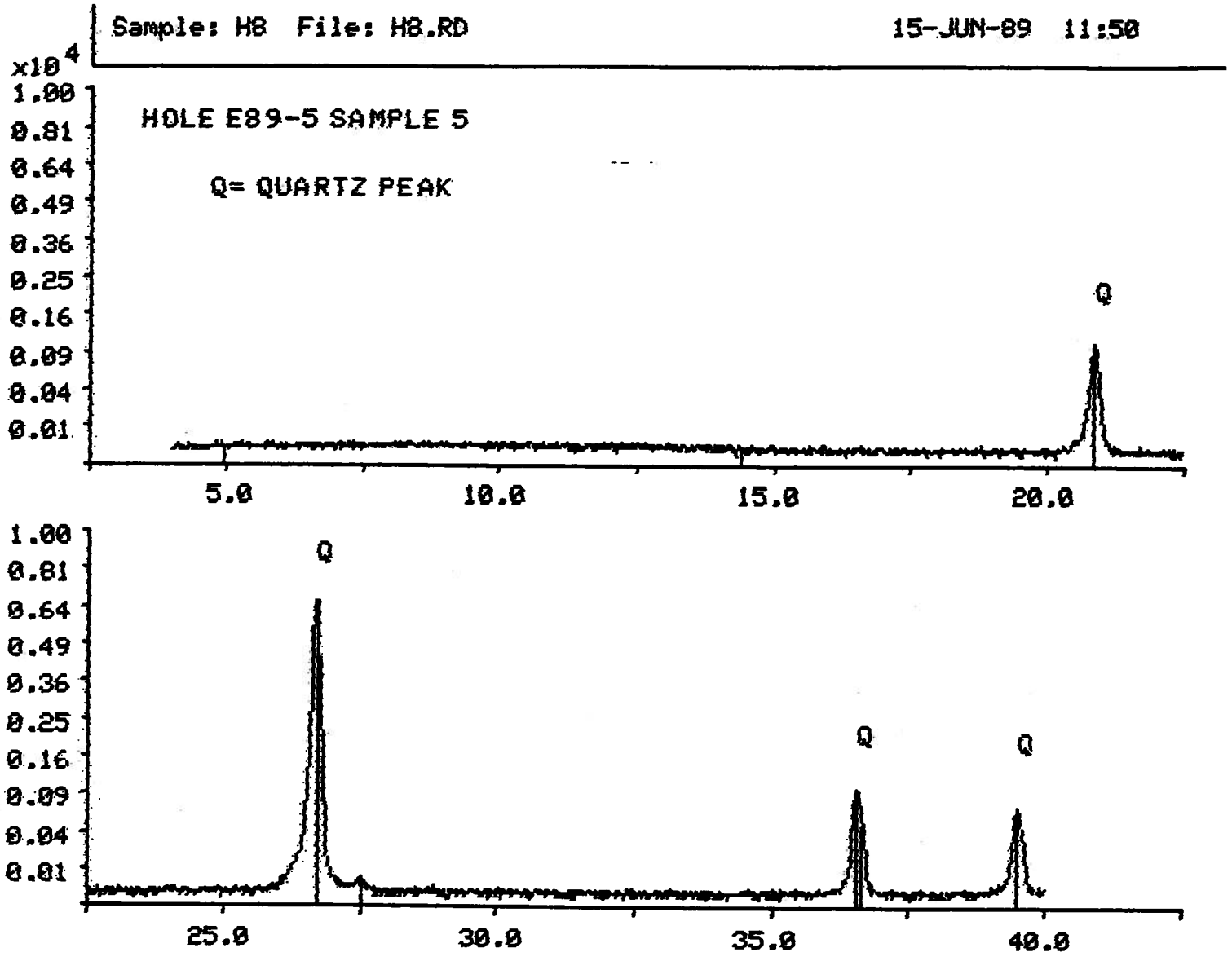

Sample: H3 File: H3.RD
15-JUN-89 11:23
x10 4
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
HOLE E89-5 SAMPLE 10
Q= QUARTZ PEAK
Q
5.0
10.0
15.0
20.0
Q
Q
Q
25.0
30.0
35.0
40.0

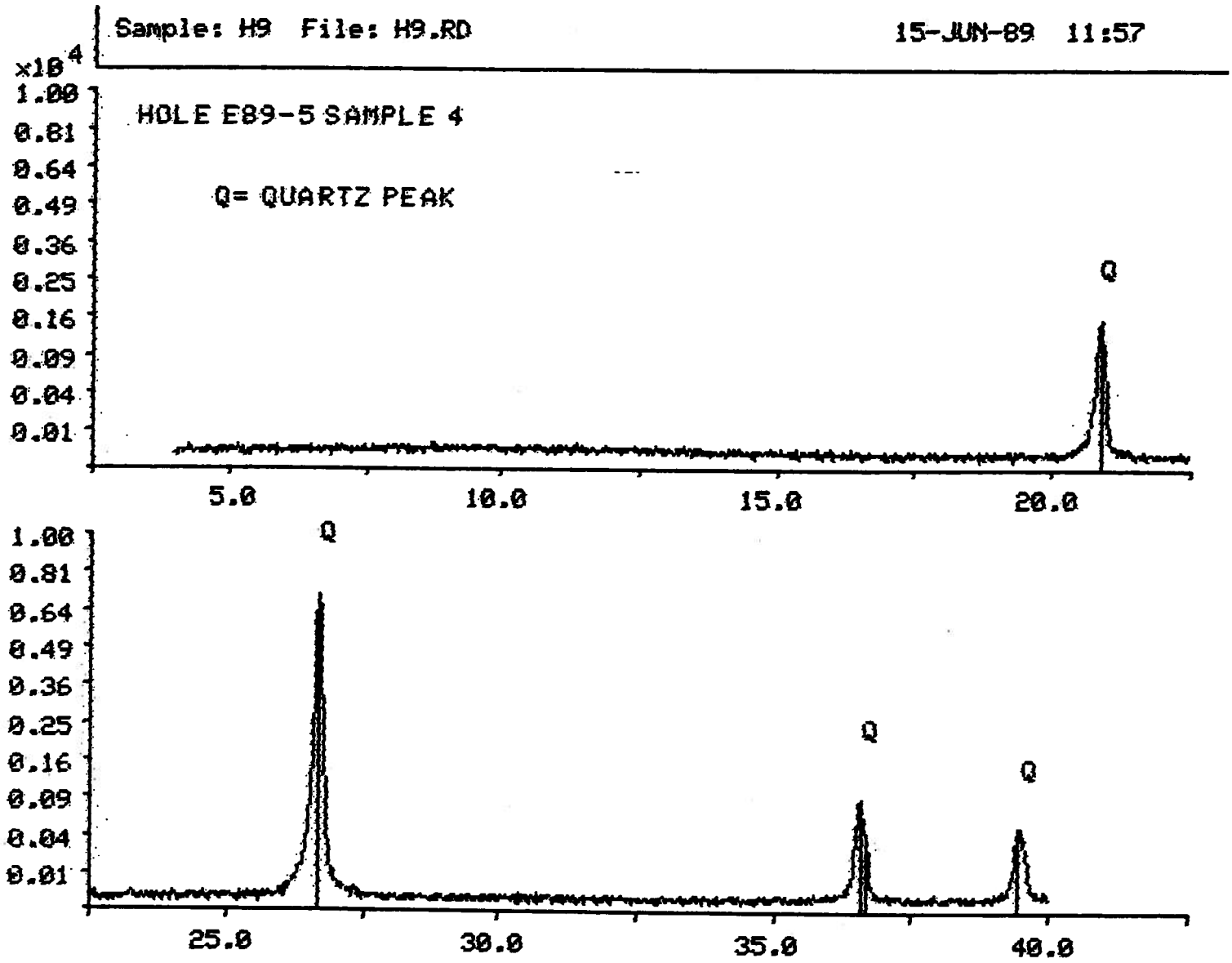

Sample: H4 File: H4.RD
15-JUN-89 11:28
x10 4
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
HOLE E89-5 SAMPLE 9
Q= QUARTZ PEAK
Q
5.0
10.0
15.0
20.0
Q
Q
Q
25.0
30.0
35.0
40.0

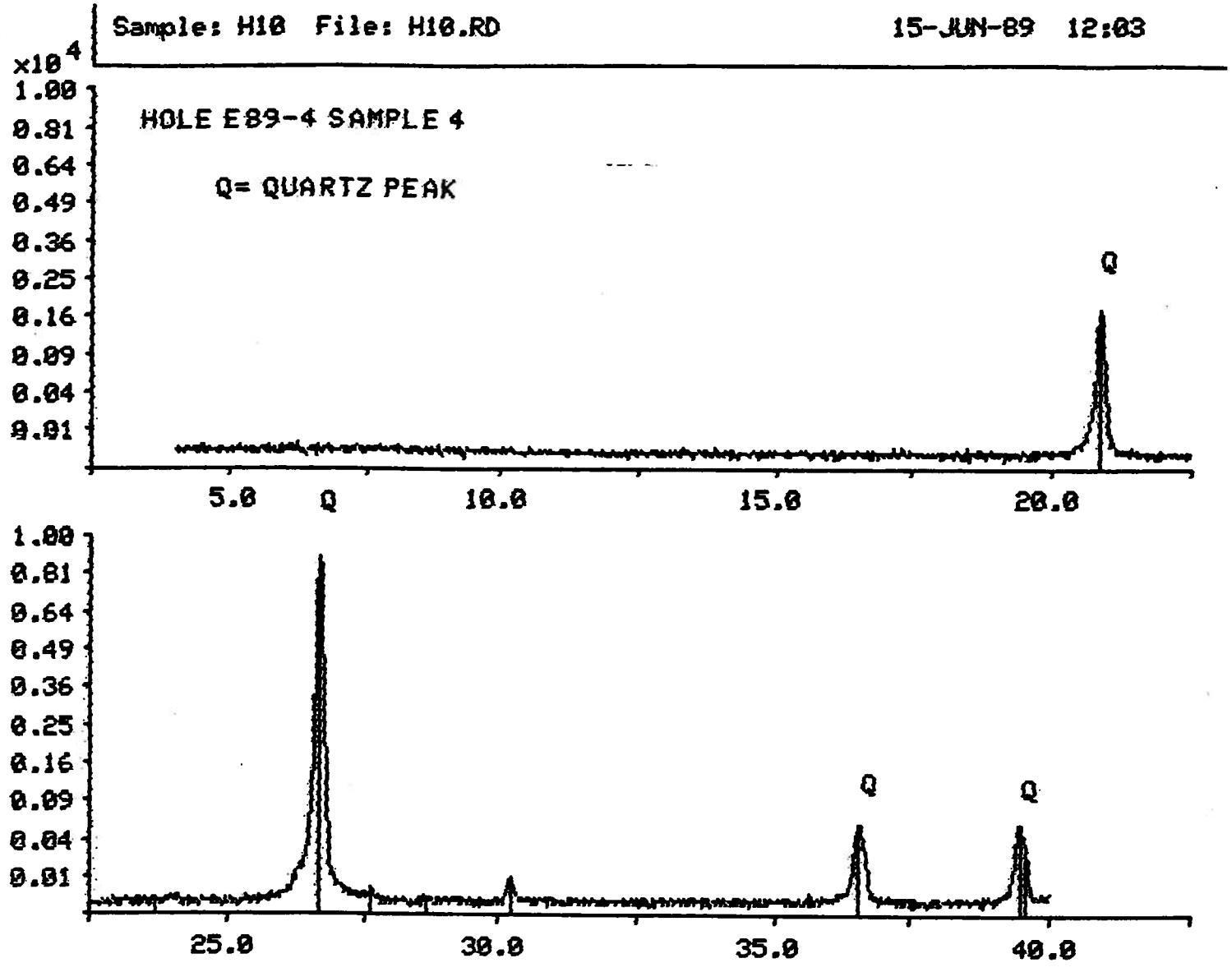

Sample: H5 File: H5.RD
15-JUN-89 11:32
x10^4
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
HOLE E89-5 SAMPLE 8
Q= QUARTZ PEAK
Q
5.0
10.0
15.0
20.0
Q
Q
Q
25.0
30.0
35.0
40.0

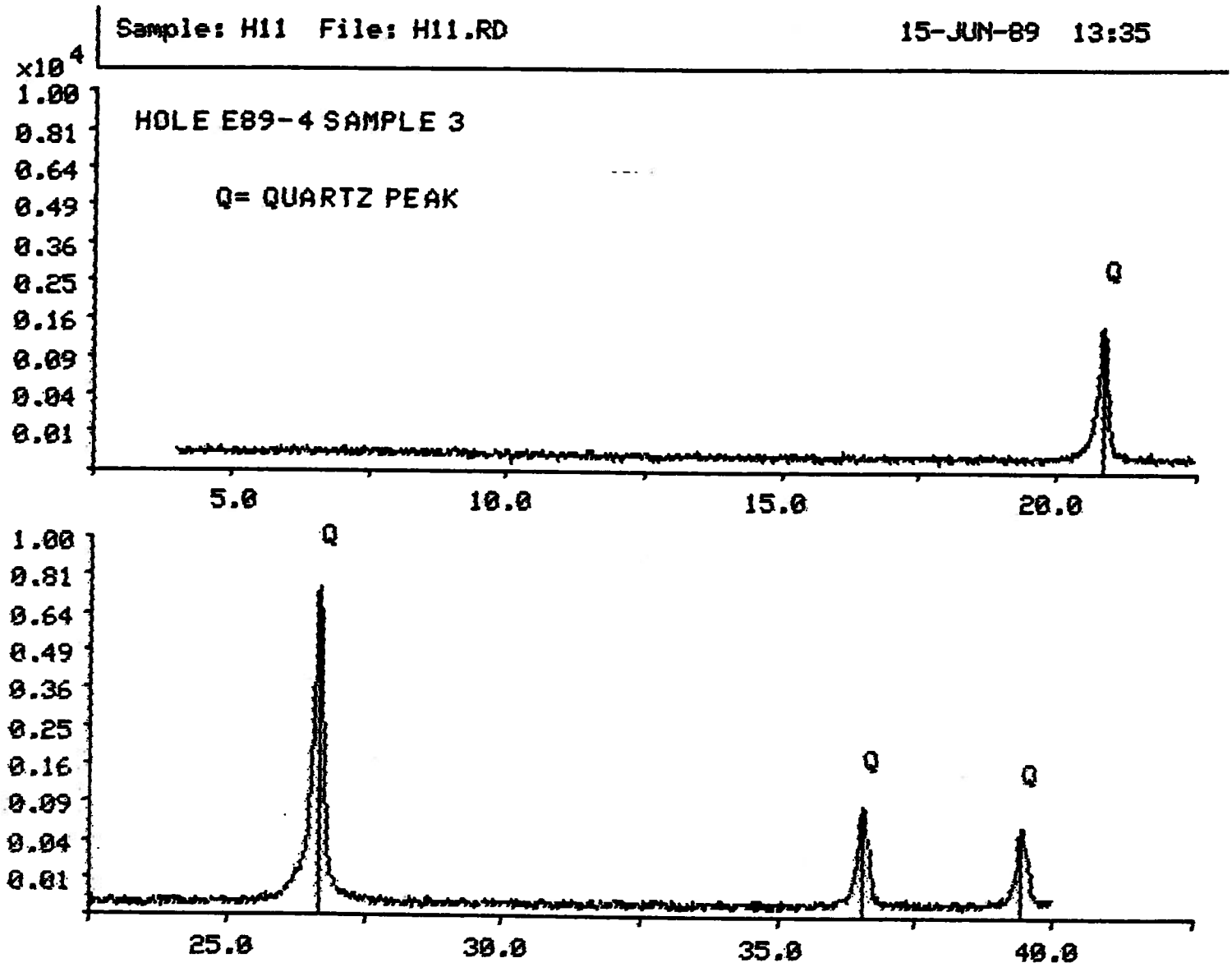

Sample: H6 File: H6.RD
15-JUN-89 11:38
x10 4
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
HOLE E89-5 SAMPLE 7
Q= QUARTZ PEAK
Q
5.0
10.0
15.0
20.0
Q
Q
Q
25.0
30.0
35.0
40.0

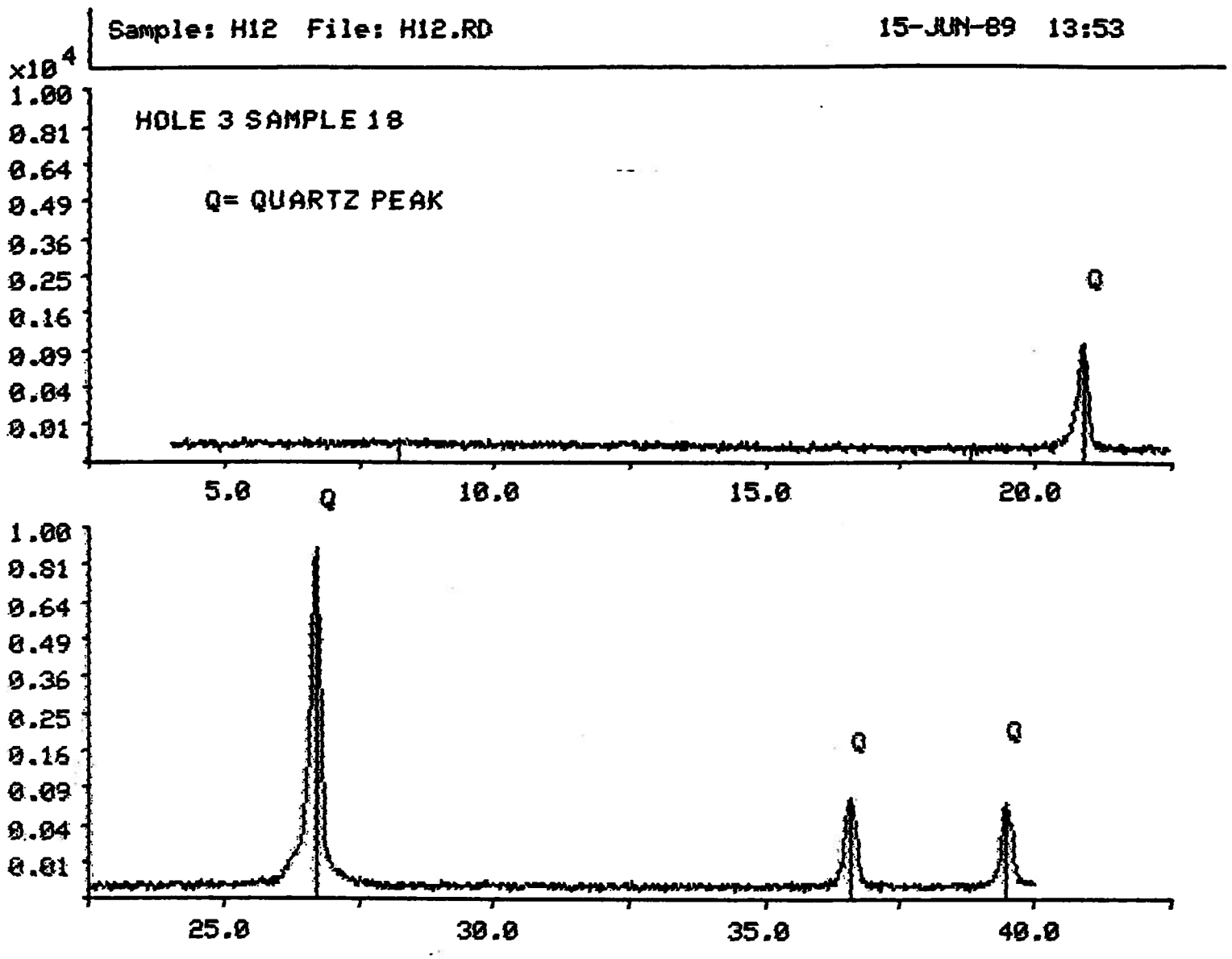

Sample: H7 File: H7.RD
15-JUN-89 11:43
x10 4
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
HOLE E89-5 SAMPLE 6
Q= QUARTZ PEAK
Q
5.0
10.0
15.0
20.0
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
Q
Q
Q
25.0
30.0
35.0
40.0

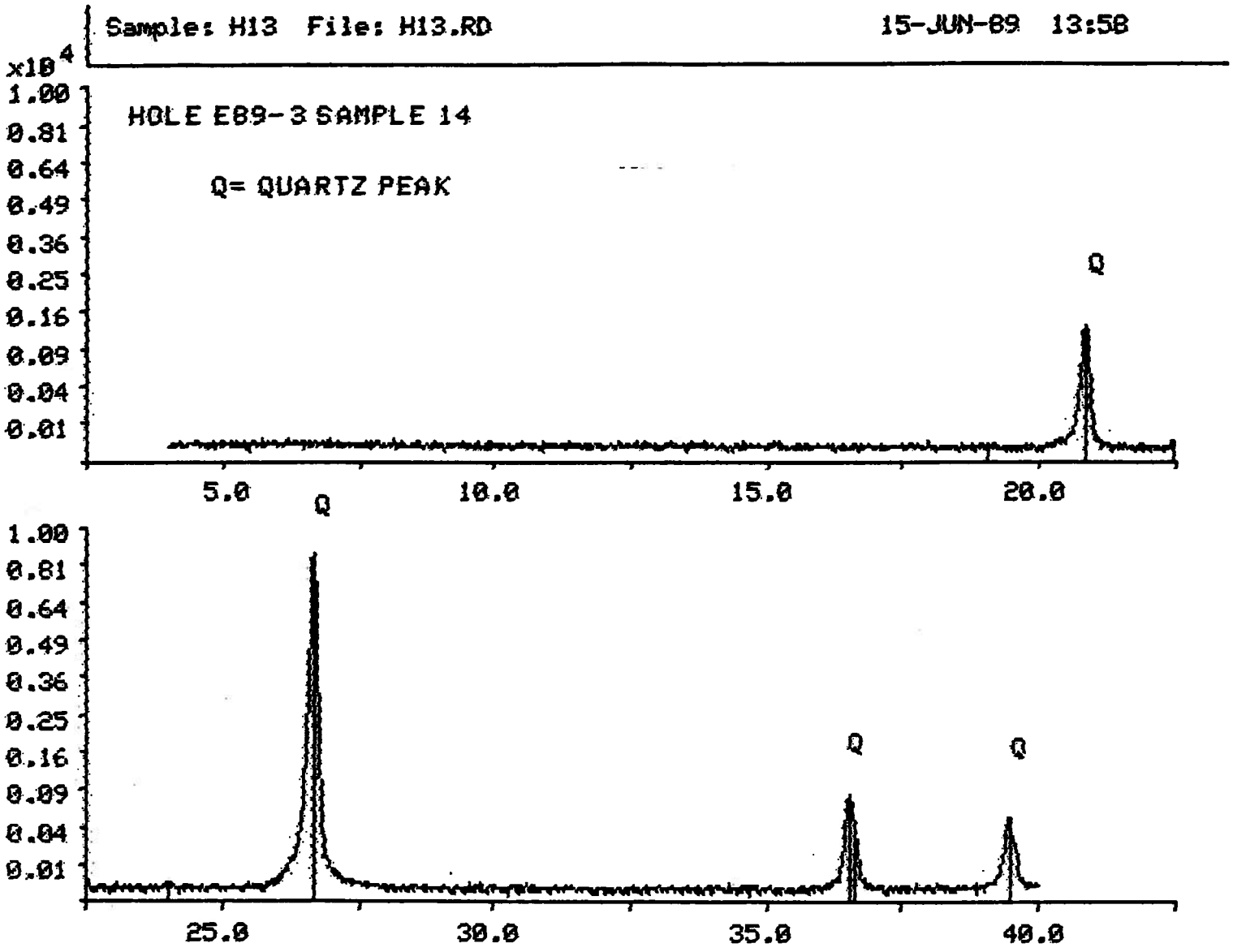

Sample: H8 File: H8.RD
15-JUN-89 11:50
x10^4
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
HOLE E89-5 SAMPLE 5
Q= QUARTZ PEAK
Q
5.0
10.0
15.0
20.0
Q
Q
Q
25.0
30.0
35.0
40.0

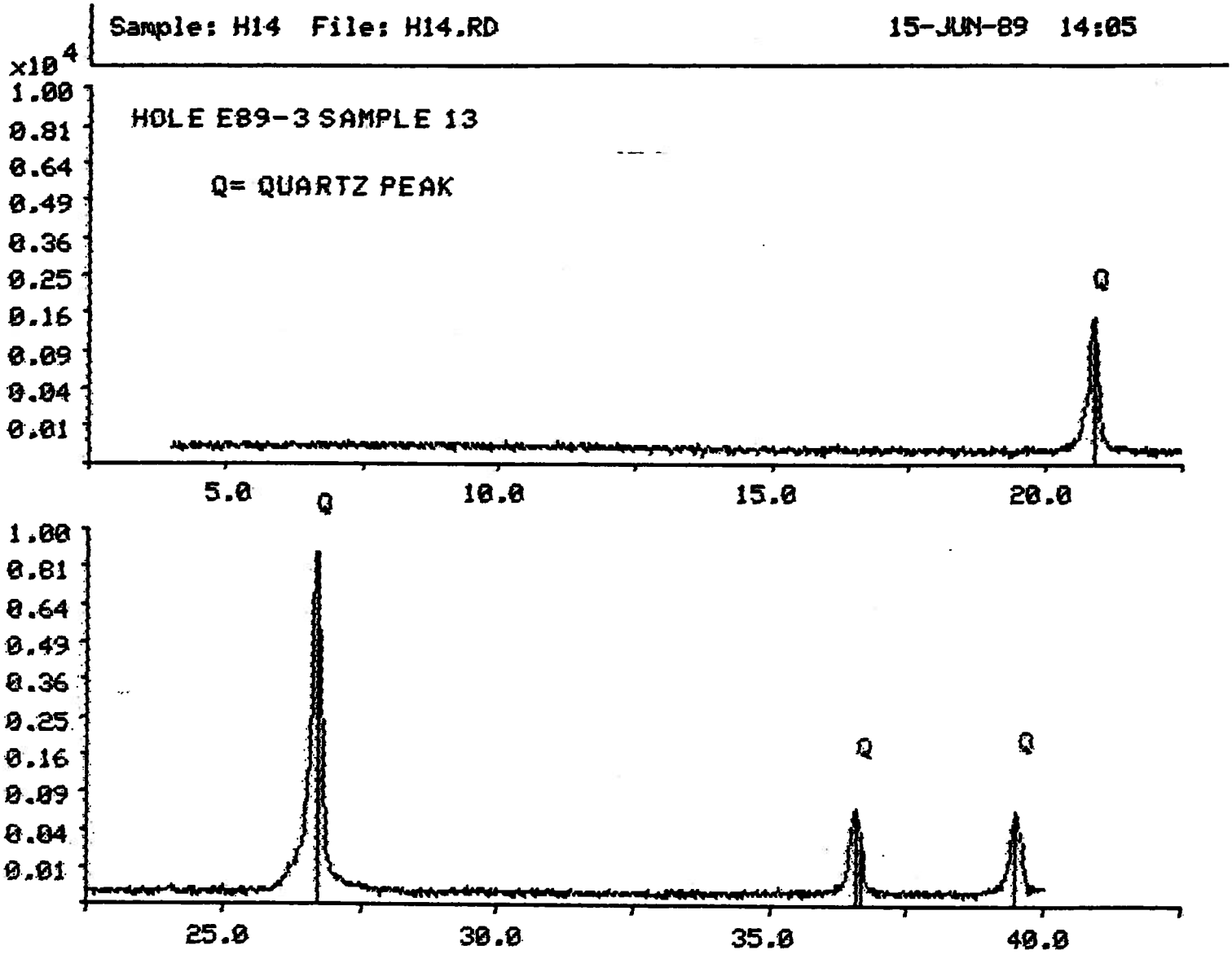

Sample: H9 File: H9.RD
15-JUN-89 11:57
x10^4
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
HOLE E89-5 SAMPLE 4
Q= QUARTZ PEAK
Q
5.0
10.0
15.0
20.0
Q
Q
Q
25.0
30.0
35.0
40.0

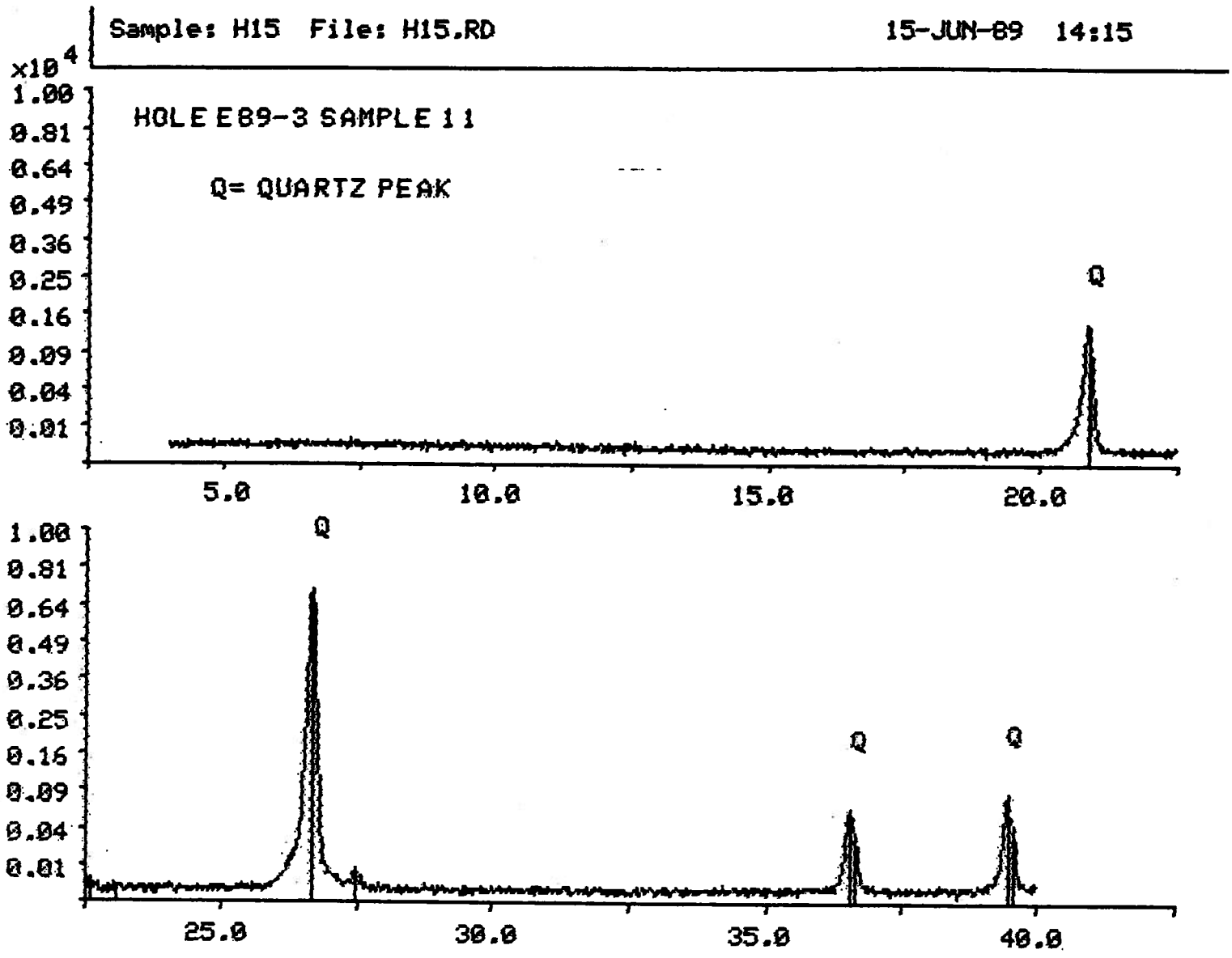

Sample: H10 File: H10.RD
15-JUN-89 12:03
x10^4
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
HOLE E89-4 SAMPLE 4
Q= QUARTZ PEAK
Q
5.0
Q
10.0
15.0
20.0
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
Q
Q
25.0
30.0
35.0
40.0

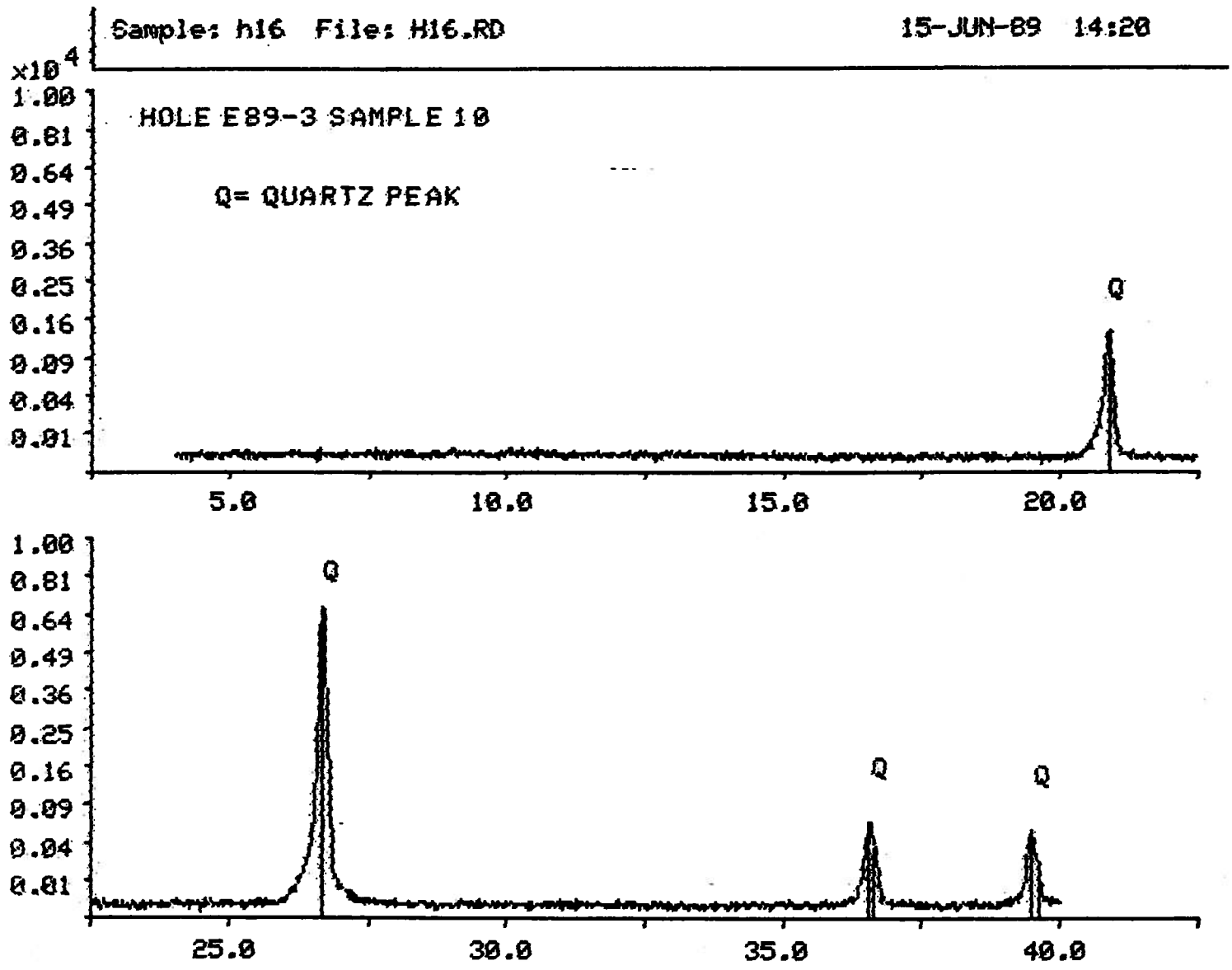

Sample: H11 File: H11.RD
15-JUN-89 13:35
x10^4
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
HOLE E89-4 SAMPLE 3
Q= QUARTZ PEAK
Q
5.0
10.0
15.0
20.0
Q
Q
Q
25.0
30.0
35.0
40.0

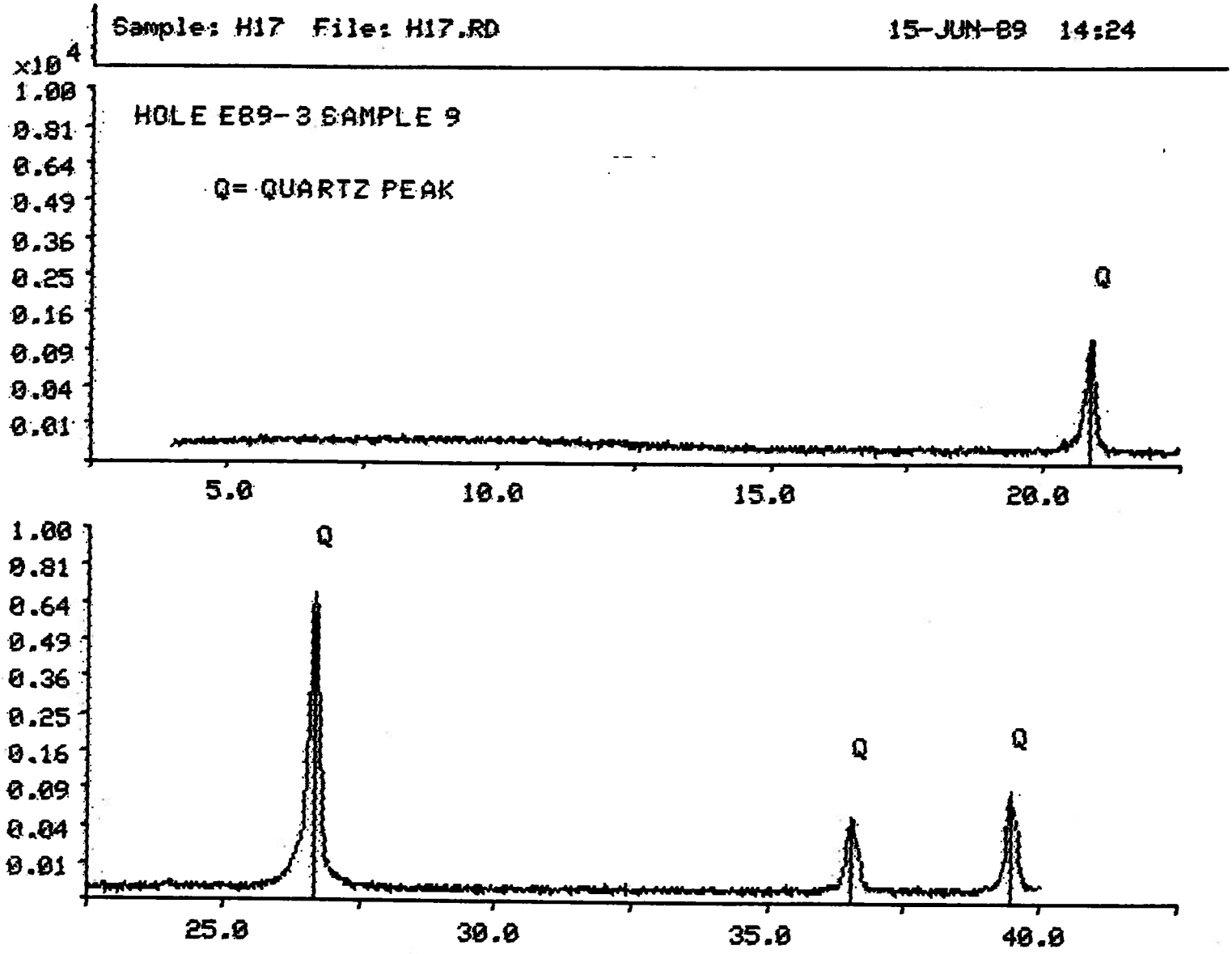

Sample: H12 File: H12.RD
15-JUN-89 13:53
x10^4
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
HOLE 3 SAMPLE 18
Q= QUARTZ PEAK
Q
5.0
10.0
15.0
20.0
Q
Q
Q
25.0
30.0
35.0
40.0

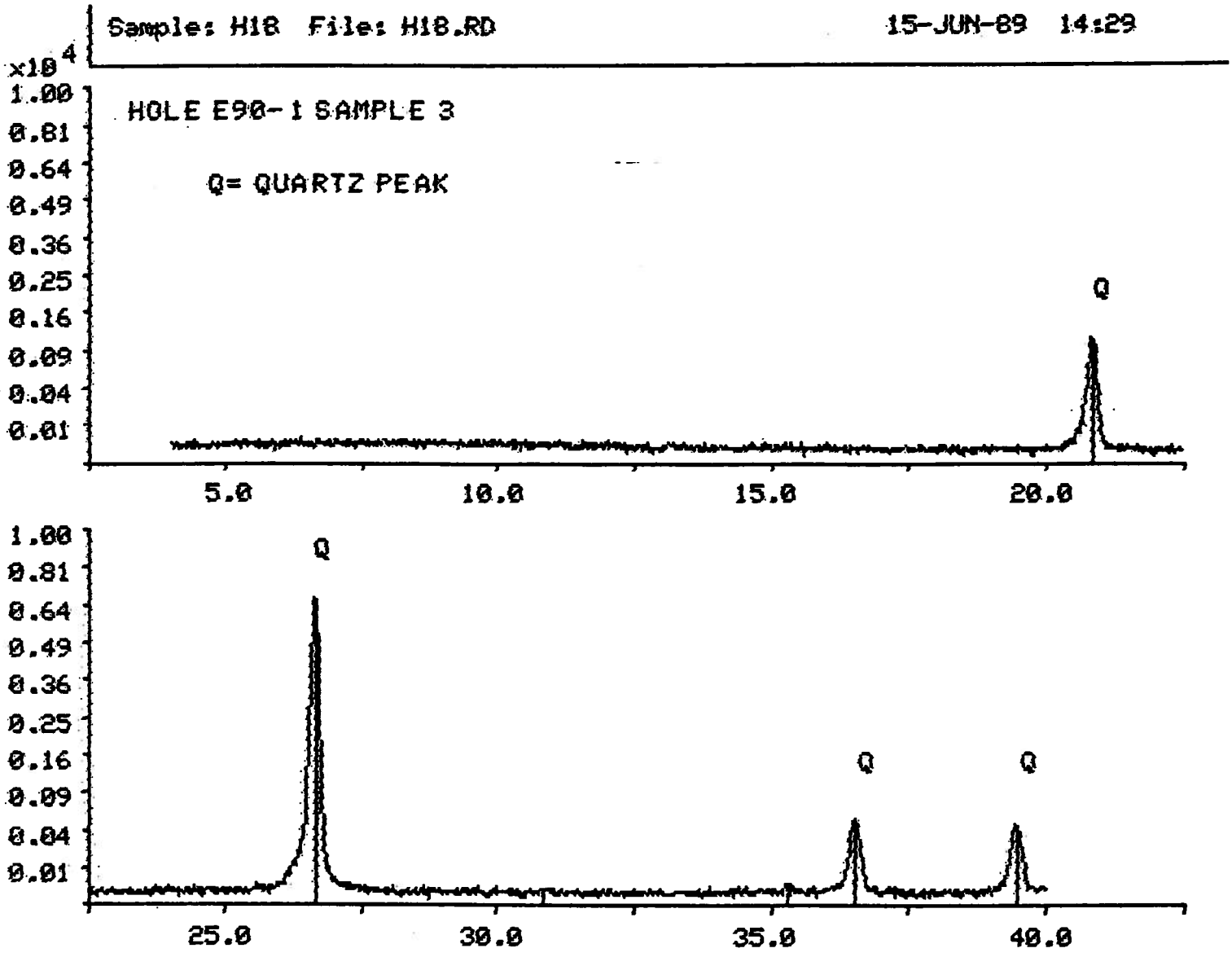

Sample: H13 File: H13.RD
15-JUN-89 13:58
x10^4
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
HOLE E89-3 SAMPLE 14
Q= QUARTZ PEAK
Q
5.0
10.0
15.0
20.0
Q
Q
Q
25.0
30.0
35.0
40.0


Sample: H14 File: H14.RD
15-JUN-89 14:05
x10^4
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
HOLE E89-3 SAMPLE 13
Q= QUARTZ PEAK
Q
5.0
10.0
15.0
20.0
Q
Q
Q
25.0
30.0
35.0
40.0


Sample: H15 File: H15.RD
15-JUN-89 14:15
x10 4
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
HOLE E89-3 SAMPLE 11
Q= QUARTZ PEAK
Q
5.0
10.0
15.0
20.0
Q
Q
Q
25.0
30.0
35.0
40.0


Sample: h16 File: H16.RD
15-JUN-89 14:20
x10^4
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
HOLE E89-3 SAMPLE 10
Q= QUARTZ PEAK
Q
5.0
10.0
15.0
20.0
Q
Q
Q
25.0
30.0
35.0
40.0


Sample: H17 File: H17.RD
15-JUN-89 14:24
x10 4
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
HOLE E89-3 SAMPLE 9
Q= QUARTZ PEAK
Q
5.0
10.0
15.0
20.0
Q
Q
Q
25.0
30.0
35.0
40.0


Sample: H18 File: H18.RD
15-JUN-89 14:29
x10 4
1.00
0.81
0.64
0.49
0.36
0.25
0.16
0.09
0.04
0.01
HOLE E90-1 SAMPLE 3
Q= QUARTZ PEAK
Q
5.0
10.0
15.0
20.0
Q
Q
Q
25.0
30.0
35.0
40.0

DETECTED PEAKS FILE

TETECTED PEAKS FILE 14-JUN-89 13:41

A

Listed DI file name	:	H1.DI
File date	:	14-JUN-89
Raw data file name	:	H1.RD
Sample identification	:	H1
Measurement date/time	:	28-APR-89 8:56
Diffractometer system	:	1
Generator settings	:	40 kV, 20 mA
Cu alpha1,2 wavelengths	:	1.54050, 1.54429 Ang
Step size, sample time	:	0.020 deg, 1.00 s, 50.00 s/deg
Monochromator used	:	Yes
Diversence slit	:	Fixed (1 deg)
Analysis program number	:	30
Peak angle range	:	4.010 - 39.990 deg
Range in D spacing	:	2.25260 - 22.0155 Ang
Peak position criterion	:	Top of smoothed data
Cryst peak width range	:	0.05 - 2.00 deg
Minim peak significance	:	0.75
Number of peaks in file	:	8 (Alpha1: 7, Amorphous: 0)
Maximum intensity	:	7413. cts, 7413.2 cps

Peak no	Angle (deg)	Tip width (deg)	Peak (cts)	Backg (cts)	D spac (Ang)	I/Imax (%)	Type A1	Type A2	Type Ot	Sign
1	9.5225	0.06	42.	61.	9.2797	0.57	X	X		1.58
2	12.0700	0.12	30.	36.	7.3262	0.41	X	X		1.66
3	20.8900	0.12	1789.	15.	4.2487	24.14	X	X		17.78
4	24.0300	0.12	12.	12.	3.3438	0.17			Bt	0.91
5	26.6575	0.14	7413.	11.	3.3411	100.00	X	X		50.12
6	28.8250	0.64	10.	12.	3.0946	0.13	X	X		0.87
7	36.5600	0.18	529.	8.	2.4557	7.14	X	X		21.88
8	39.4750	0.12	384.	9.	2.2808	5.18	X	X		7.76

DETECTED PEAKS FILE 14-JUN-89 13:42

A

Listed DI file name	:	H2.DI
File date	:	14-JUN-89
Raw data file name	:	H2.RD
Sample identification	:	H2
Measurement date/time	:	28-APR-89 9:36
Diffractometer system	:	1
Generator settings	:	40 kV, 20 mA
Cu alpha1,2 wavelengths	:	1.54050, 1.54429 Ang
Step size, sample time	:	0.020 deg, 1.00 s, 50.00 s/deg
Monochromator used	:	Yes
Divergence slit	:	Fixed (1 deg)
Analysis program number	:	30
Peak angle range	:	4.010 - 39.990 deg
Range in D spacing	:	2.25260 - 22.0155 Ang
Peak position criterion	:	Top of smoothed data
Cryst peak width range	:	0.05 - 2.00 deg
Minim peak significance	:	0.75
Number of peaks in file	:	8 (Alpha1: 7, Amorphous: 0)
Maximum intensity	:	8780. cts, 8779.7 cps

Peak no	Angle (deg)	Tip width (deg)	Peak (cts)	Backg (cts)	D spac (Ang)	I/Imax (%)	Type A1	Type A2	Type Ot	Sign
1	20.8775	0.14	1832.	13.	4.2512	20.86	X	X		25.70
2	23.9875	0.12	16.	12.	3.3496	0.18			Bt	0.85
3	26.6675	0.16	8780.	13.	3.3399	100.00	X	X		70.79
4	36.5650	0.12	566.	10.	2.4554	6.45	X	X		9.55
5	37.3325	0.28	7.	10.	2.4066	0.08	X	X		0.91
6	38.3175	0.32	7.	10.	2.3470	0.08	X	X		0.81
7	39.4500	0.08	269.	8.	2.2822	3.06	X			2.00
8	39.5200	0.06	259.	8.	2.2783	2.95	X	X		1.70

DETECTED PEAKS FILE 14-JUN-89 13:44

A

Listed DI file name	:	H4.DI
File date	:	14-JUN-89
Raw data file name	:	H4.RD
Sample identification	:	H4
Measurement date/time	:	28-APR-89 10:45
Diffractometer system	:	1
Generator settings	:	40 kV, 20 mA
Cu alpha1,2 wavelengths	:	1.54050, 1.54429 Ang
Step size, sample time	:	0.020 deg, 1.00 s, 50.00 s/deg
Monochromator used	:	Yes
Divergence slit	:	Fixed (1 deg)
Analysis program number	:	30
Peak angle range	:	4.010 - 39.990 deg
Range in D spacing	:	2.25260 - 22.0155 Ang
Peak position criterion	:	Top of smoothed data
Crust peak width range	:	0.05 - 2.00 deg
Minim peak significance	:	0.75
Number of peaks in file	:	7 (Alpha1: 6, Amorphous: 0)
Maximum intensity	:	7090. cts, 7089.6 cps

Peak no	Angle (deg)	Tip width (deg)	Peak (cts)	Backg (cts)	D spac (Ang)	I/Imax (%)	Type A1	Type A2	Type Ot	Sign
1	20.9100	0.12	1475.	14.	4.2447	20.80	X	X		14.45
2	23.8900	0.48	12.	8.	3.3631	0.16			Bt	0.79
3	25.5075	0.12	34.	11.	3.4891	0.47	X	X		1.51
4	26.6875	0.16	7090.	12.	3.3374	100.00	X	X		58.88
5	35.0475	0.28	8.	8.	2.5581	0.11	X	X		0.95
6	36.6100	0.18	428.	9.	2.4524	6.04	X	X		18.20
7	39.4875	0.12	324.	8.	2.2801	4.57	X	X		6.76

DETECTED PEAKS FILE 14-JUN-89 13:43

A

Listed DI file name	:	H3.DI
File date	:	14-JUN-89
Raw data file name	:	H3.RD
Sample identification	:	H3
Measurement date/time	:	28-APR-89 10:12
Diffractometer system	:	1
Generator settings	:	40 kV, 20 mA
Cu alpha1,2 wavelengths	:	1.54050, 1.54429 Ang
Step size, sample time	:	0.020 deg, 1.00 s, 50.00 s/deg
Monochromator used	:	Yes
Divergence slit	:	Fixed (1 deg)
Analysis program number	:	30
Peak angle range	:	4.010 - 39.990 deg
Range in D spacing	:	2.25260 - 22.0155 Ang
Peak position criterion	:	Top of smoothed data
Crvst peak width range	:	0.05 - 2.00 deg
Minim peak significance	:	0.75
Number of peaks in file	:	8 (Alpha1: 6, Amorphous: 0)
Maximum intensity	:	7208. cts, 7208.0 cps

Peak no	Angle (deg)	Tip width (deg)	Peak (cts)	Backg (cts)	D spac (Ang)	I/Imax (%)	Type A1	Type A2	Type Ot	Sign
1	20.9100	0.12	1901.	14.	4.2447	26.37	X	X		18.20
2	24.0700	0.96	12.	13.	3.3383	0.16			Bt	0.85
3	26.6875	0.16	7208.	12.	3.3374	100.00	X	X		66.07
4	27.5800	0.12	123.	11.	3.2314	1.71	X	X		4.57
5	34.8350	0.24	8.	8.	2.5732	0.11	X	X		0.83
6	36.5625	0.10	502.	7.	2.4555	6.96	X			6.17
7	36.6825	0.06	182.	7.	2.4538	2.53		X		1.23
8	39.5025	0.06	538.	7.	2.2793	7.47	X	X		2.24

DETECTED PEAKS FILE 14-JUN-89 13:44

A

Listed DI file name	:	H5.DI
File date	:	14-JUN-89
Raw data file name	:	H5.RD
Sample identification	:	H5
Measurement date/time	:	28-APR-89 11:20
Diffractometer system	:	1
Generator settings	:	40 kV, 20 mA
Cu alpha1,2 wavelengths	:	1.54050, 1.54429 Ang
Step size, sample time	:	0.020 deg, 1.00 s, 50.00 s/deg
Monochromator used	:	Yes
Divergence slit	:	Fixed (1 deg)
Analysis program number	:	30
Peak angle range	:	4.010 - 39.990 deg
Range in D spacing	:	2.25260 - 22.0155 Ang
Peak position criterion	:	Top of smoothed data
Cryst peak width range	:	0.05 - 2.00 deg
Minim peak significance	:	0.75
Number of peaks in file	:	10 (Alpha1: 7, Amorphous: 0)
Maximum intensity	:	8226. cts, 8226.5 cps

Peak no	Angle (deg)	Tip width (deg)	Peak (cts)	Backg (cts)	D spac (Ang)	I/Imax (%)	Type A1	Type A2	Type Ot	Sign
1	20.9050	0.12	1505.	15.	4.2457	18.30	X	X		15.85
2	24.0425	0.16	15.	13.	3.3421	0.18			Bt	0.89
3	26.6775	0.14	8226.	12.	3.3386	100.00	X	X		50.12
4	27.5275	0.08	81.	12.	3.2374	0.98	X	X		1.41
5	29.3375	0.06	10.	10.	3.0417	0.12	X	X		0.79
6	35.0325	0.48	8.	8.	2.5592	0.10	X	X		1.10
7	36.5700	0.12	534.	9.	2.4550	6.49	X			8.71
8	36.6575	0.06	306.	9.	2.4554	3.72		X		1.15
9	39.4800	0.10	392.	9.	2.2805	4.77	X			5.89
10	39.5975	0.06	207.	9.	2.2796	2.52		X		1.23

DETECTED PEAKS FILE 14-JUN-89 13:45

A

Listed DI file name	:	H6.DI
File date	:	14-JUN-89
Raw data file name	:	H6.RD
Sample identification	:	H6
Measurement date/time	:	28-APR-89 11:58
Diffractometer system	:	1
Generator settings	:	40 kV, 20 mA
Cu alpha1,2 wavelengths	:	1.54050, 1.54429 Ang
Step size, sample time	:	0.020 deg, 1.00 s, 50.00 s/deg
Monochromator used	:	Yes
Divergence slit	:	Fixed (1 deg)
Analysis program number	:	30
Peak angle range	:	4.010 - 39.990 deg
Range in D spacing	:	2.25260 - 22.0155 Ang
Peak position criterion	:	Top of smoothed data
Cryst peak width range	:	0.05 - 2.00 deg
Minim peak significance	:	0.75
Number of peaks in file	:	7 (Alpha1: 6, Amorphous: 0)
Maximum intensity	:	8118. cts, 8118.0 cps

Peak no	Angle (deg)	Tip width (deg)	Peak (cts)	Backg (cts)	D spac (Ang)	I/Imax (%)	Type A1	Type A2	Type Ot	Sign
1	20.8725	0.12	2314.	13.	4.2522	28.50	X	X		18.62
2	23.4200	0.06	12.	11.	3.7951	0.14	X	X		0.76
3	26.6500	0.16	8118.	13.	3.3420	100.00	X	X		69.18
4	36.5400	0.12	458.	8.	2.4570	5.64	X	X		6.76
5	37.2875	0.16	7.	7.	2.4094	0.09	X	X		0.76
6	39.4500	0.08	484.	7.	2.2822	5.96	X			4.68
7	39.5800	0.06	190.	7.	2.2806	2.35		X		0.95

DETECTED PEAKS FILE 14-JUN-89 13:46

A

Listed DI file name	:	H7.DI
File date	:	14-JUN-89
Raw data file name	:	H7.RD
Sample identification	:	H7
Measurement date/time	:	28-APR-89 12:33
Diffractometer system	:	1
Generator settings	:	40 kV, 20 mA
Cu alpha1,2 wavelengths	:	1.54050, 1.54429 Ang
Step size, sample time	:	0.020 deg, 1.00 s, 50.00 s/deg
Monochromator used	:	Yes
Diversence slit	:	Fixed (1 deg)
Analysis program number	:	30
Peak angle range	:	4.010 - 39.990 deg
Range in D spacing	:	2.25260 - 22.0155 Ang
Peak position criterion	:	Top of smoothed data
Crest peak width range	:	0.05 - 2.00 deg
Minim peak significance	:	0.75
Number of peaks in file	:	7 (Alpha1: 6, Amorphous: 0)
Maximum intensity	:	6939. cts, 6938.9 cps

Peak no	Angle (deg)	Tip width (deg)	Peak (cts)	Backg (cts)	D spac (Ang)	I/Imax (%)	Type A1	Type A2	Type Ot	Sign
1	12.0425	1.60	23.	79.	7.3429	0.33	X	X		1.29
2	20.7875	0.16	1197.	17.	4.2694	17.25	X	X		17.38
3	25.5525	0.12	20.	13.	3.4830	0.29	X	X		1.45
4	26.5850	0.16	6939.	12.	3.3500	100.00	X	X		60.26
5	36.4850	0.12	428.	10.	2.4606	6.18	X			6.03
6	36.7275	0.08	243.	10.	2.4599	3.51		X		0.76
7	39.3875	0.14	324.	8.	2.2857	4.67	X	X		9.33

DETECTED PEAKS FILE 14-JUN-89 13:47

A

Listed DI file name	:	H8.DI
File date	:	14-JUN-89
Raw data file name	:	H8.RD
Sample identification	:	H8
Measurement date/time	:	28-APR-89 13:11
Diffractometer system	:	1
Generator settings	:	40 kV, 20 mA
Cu alpha1,2 wavelengths	:	1.54050, 1.54429 Ang
Step size, sample time	:	0.020 deg, 1.00 s, 50.00 s/deg
Monochromator used	:	Yes
Divergence slit	:	Fixed (1 deg)
Analysis program number	:	30
Peak angle range	:	4.010 - 39.990 deg
Range in D spacing	:	2.25260 - 22.0155 Ang
Peak position criterion	:	Top of smoothed data
Crust peak width range	:	0.05 - 2.00 deg
Minim peak significance	:	0.75
Number of peaks in file	:	8 (Alpha1: 7, Amorphous: 0)
Maximum intensity	:	6839. cts, 6839.3 cps

Peak no	Angle (deg)	Tip width (deg)	Peak (cts)	Backg (cts)	D spac (Ang)	I/Imax (%)	Type A1	Type A2	Type Ot	Sign
1	4.9450	1.28	55.	81.	17.8547	0.80	X	X		0.87
2	14.3850	0.10	19.	42.	6.1520	0.28	X	X		0.83
3	20.8700	0.12	1289.	14.	4.2527	18.84	X	X		10.00
4	26.6900	0.16	6839.	13.	3.3371	100.00	X	X		57.54
5	27.3225	0.08	42.	12.	3.2380	0.62	X	X		0.83
6	36.7525	0.14	762.	9.	2.4562	11.14	X			14.45
7	36.4600	0.06	449.	9.	2.4552	6.57		X		1.86
8	39.4925	0.10	515.	8.	2.2798	7.53	X	X		5.89

DETECTED PEAKS FILE 14-JUN-89 13:51

A

Listed DI file name	:	H9.DI
File date	:	14-JUN-89
Raw data file name	:	H9.RD
Sample identification	:	H9
Measurement date/time	:	28-APR-89 13:51
Diffractometer system	:	1
Generator settings	:	40 kV, 20 mA
Cu alpha1,2 wavelengths	:	1.54050, 1.54429 Ang
Step size, sample time	:	0.020 deg, 1.00 s, 50.00 s/deg
Monochromator used	:	Yes
Divergence slit	:	Fixed (1 deg)
Analysis program number	:	30
Peak angle range	:	4.010 - 39.990 deg
Range in D spacing	:	2.25260 - 22.0155 Ang
Peak position criterion	:	Top of smoothed data
Crust peak width range	:	0.05 - 2.00 deg
Minim peak significance	:	0.75
Number of peaks in file	:	5 (Alpha1: 4, Amorphous: 0)
Maximum intensity	:	7157. cts, 7157.2 cps

Peak no	Angle (deg)	Tip width (deg)	Peak (cts)	Backg (cts)	D spac (Ang)	I/Imax (%)	Type A1	Type A2	Type Ot	Sign
1	20.9000	0.14	1980.	14.	4.2467	27.67	X	X		25.70
2	26.6750	0.14	7157.	12.	3.3389	100.00	X	X		48.98
3	36.5700	0.08	702.	10.	2.4550	9.81	X			4.79
4	36.6825	0.06	250.	10.	2.4538	3.49		X		0.83
5	39.4575	0.14	310.	8.	2.2818	4.33	X	X		9.12

DETECTED PEAKS FILE 14-JUN-89 13:56

A

Listed DI file name	:	H14.DI
File date	:	14-JUN-89
Raw data file name	:	H14.RD
Sample identification	:	H14
Measurement date/time	:	11-MAY-89 12:22
Diffractometer system	:	1
Generator settings	:	40 kV, 20 mA
Cu alpha1,2 wavelengths	:	1.54050, 1.54429 Ang
Step size, sample time	:	0.020 deg, 1.00 s, 50.00 s/deg
Monochromator used	:	Yes
Divergence slit	:	Fixed (1 deg)
Analysis program number	:	30
Peak angle range	:	4.010 - 39.990 deg
Range in D spacing	:	2.25260 - 22.0155 Ang
Peak position criterion	:	Top of smoothed data
Cryst peak width range	:	0.05 - 2.00 deg
Minim peak significance	:	0.75
Number of peaks in file	:	5 (Alpha1: 4, Amorphous: 0)
Maximum intensity	:	9025. cts, 9025.0 cps

Peak no	Angle (deg)	Tip width (deg)	Peak (cts)	Backg (cts)	D spac (Ang)	I/Imax (%)	Type A1	Type A2	Type Ot	Sign
1	20.8975	0.14	1936.	12.	4.2472	21.45	X	X		23.44
2	26.6900	0.14	9025.	10.	3.3371	100.00	X	X		54.95
3	36.5750	0.14	529.	8.	2.4547	5.86	X			11.75
4	36.6850	0.06	207.	8.	2.4536	2.30			X	0.87
5	39.4825	0.10	433.	8.	2.2804	4.79	X	X		5.01

DETECTED PEAKS FILE 14-JUN-89 13:57

A

Listed DI file name	:	H15.DI
File date	:	14-JUN-89
Raw data file name	:	H15.RD
Sample identification	:	H15
Measurement date/time	:	11-MAY-89 12:58
Diffractometer system	:	1
Generator settings	:	40 kV, 20 mA
Cu alpha1,2 wavelengths	:	1.54050, 1.54429 Ang
Step size, sample time	:	0.020 deg, 1.00 s, 50.00 s/deg
Monochromator used	:	Yes
Diversence slit	:	Fixed (1 deg)
Analysis program number	:	30
Peak angle range	:	4.010 - 39.990 deg
Range in D spacing	:	2.25260 - 22.0155 Ang
Peak position criterion	:	Top of smoothed data
Cryst peak width range	:	0.05 - 2.00 deg
Minim peak significance	:	0.75
Number of peaks in file	:	9 (Alpha1: 7, Amorphous: 0)
Maximum intensity	:	7259. cts, 7259.0 cps

Peak no	Angle (deg)	Tip width (deg)	Peak (cts)	Backg (cts)	D spac (Ang)	I/Imax (%)	Type A1	Type A2	Type Ot	Sign
1	20.8925	0.12	1866.	16.	4.2482	25.71	X	X		15.49
2	22.5775	0.06	28.	14.	3.9348	0.39	X	X		0.89
3	23.0575	0.24	12.	14.	3.8540	0.17	X	X		1.00
4	26.6600	0.18	7259.	13.	3.3408	100.00	X	X		81.28
5	27.4700	0.08	67.	12.	3.2441	0.93	X	X		1.12
6	36.5350	0.10	454.	10.	2.4573	6.25	X			5.62
7	36.6375	0.08	269.	10.	2.4567	3.71		X		1.32
8	39.4700	0.08	566.	8.	2.2811	7.80	X			4.37
9	39.5800	0.06	243.	8.	2.2806	3.35		X		0.98

DETECTED PEAKS FILE 14-JUN-89 13:52

A

Listed DI file name	:	H10.DI
File date	:	14-JUN-89
Raw data file name	:	H10.RD
Sample identification	:	H10
Measurement date/time	:	28-APR-89 14:31
Diffractometer system	:	1
Generator settings	:	40 kV, 20 mA
Cu alpha1,2 wavelengths	:	1.54050, 1.54429 Ang
Step size, sample time	:	0.020 deg, 1.00 s, 50.00 s/deg
Monochromator used	:	Yes
Divergence slit	:	Fixed (1 deg)
Analysis program number	:	30
Peak angle range	:	4.010 - 39.990 deg
Range in D spacing	:	2.25260 - 22.0155 Ang
Peak position criterion	:	Top of smoothed data
Crust peak width range	:	0.05 - 2.00 deg
Minim peak significance	:	0.75
Number of peaks in file	:	9 (Alpha1: 8, Amorphous: 0)
Maximum intensity	:	9158. cts, 9158.5 cps

Peak no	Angle (deg)	Tip width (deg)	Peak (cts)	Backg (cts)	D spac (Ang)	I/Imax (%)	Type A1	Type A2	Type Ot	Sign
1	20.8775	0.14	2218.	13.	4.2512	24.22	X	X		27.54
2	23.6500	0.10	12.	12.	3.7587	0.13	X	X		0.76
3	26.6700	0.16	9158.	11.	3.3396	100.00	X	X		77.62
4	27.4225	0.06	37.	10.	3.2265	0.41	X	X		1.41
5	28.6475	0.24	10.	10.	3.1134	0.10	X	X		0.89
6	30.2025	0.08	76.	10.	2.9565	0.83	X	X		1.78
7	36.5600	0.14	420.	9.	2.4557	4.59	X	X		10.72
8	39.8650	0.12	416.	8.	2.2813	4.54	X			7.94
9	39.9700	0.08	243.	8.	2.2811	2.66		X		0.98

DETECTED PEAKS FILE 14-JUN-89 13:53

A

Listed DI file name	:	H11.DI
File date	:	14-JUN-89
Raw data file name	:	H11.RD
Sample identification	:	H11
Measurement date/time	:	28-APR-89 15:10
Diffractometer system	:	1
Generator settings	:	40 kV, 20 mA
Cu alpha1,2 wavelengths	:	1.54050, 1.54429 Ang
Step size, sample time	:	0.020 deg, 1.00 s, 50.00 s/deg
Monochromator used	:	Yes
Diversence slit	:	Fixed (1 deg)
Analysis program number	:	30
Peak angle range	:	4.010 - 39.990 deg
Range in D spacing	:	2.25260 - 22.0155 Ang
Peak position criterion	:	Top of smoothed data
Cryst peak width range	:	0.05 - 2.00 deg
Minim peak significance	:	0.75
Number of peaks in file	:	4 (Alpha1: 4, Amorphous: 0)
Maximum intensity	:	7815. cts, 7814.6 cps

Peak no	Angle (deg)	Tip width (deg)	Peak (cts)	Backg (cts)	D spac (Ang)	I/Imax (%)	Type A1	Type A2	Type Dt	Sign
1	20.8600	0.14	1875.	14.	4.2547	23.99	X	X		25.12
2	26.6550	0.14	7815.	12.	3.3414	100.00	X	X		53.70
3	36.5475	0.08	645.	8.	2.4565	8.26	X	X		5.13
4	39.4400	0.10	376.	7.	2.2827	4.82	X	X		5.75

DETECTED PEAKS FILE 14-JUN-89 13:54

A

Listed DI file name	:	H12.DI
File date	:	14-JUN-89
Raw data file name	:	H12.RD
Sample identification	:	H12
Measurement date/time	:	2-MAY-89 8:15
Diffractometer system	:	1
Generator settings	:	40 kV, 20 mA
Cu alpha1,2 wavelengths	:	1.54050, 1.54429 Ang
Step size, sample time	:	0.020 deg, 1.00 s, 50.00 s/deg
Monochromator used	:	Yes
Divergence slit	:	Fixed (1 deg)
Analysis program number	:	30
Peak angle range	:	4.010 - 39.990 deg
Range in D spacing	:	2.25260 - 22.0155 Ang
Peak position criterion	:	Top of smoothed data
Cryst peak width range	:	0.05 - 2.00 deg
Minim peak significance	:	0.75
Number of peaks in file	:	6 (Alpha1: 5, Amorphous: 0)
Maximum intensity	:	8911. cts, 8911.4 cps

Peak no	Angle (deg)	Tip width (deg)	Peak (cts)	Backg (cts)	D spac (Ang)	I/Imax (%)	Type A1	Type A2	Type Ot	Sign
1	8.2425	0.96	32.	67.	10.7177	0.36	X	X		0.87
2	18.8200	0.12	14.	15.	4.2573	0.16			Bt	0.81
3	20.9075	0.12	1274.	14.	4.2452	14.30	X	X		13.49
4	26.6975	0.14	8911.	14.	3.3362	100.00	X	X		53.70
5	36.5800	0.18	562.	10.	2.4544	6.30	X	X		22.91
6	39.4825	0.10	488.	7.	2.2804	5.48	X	X		6.92

DETECTED PEAKS FILE 14-JUN-89 13:55

A

Listed DI file name	:	H13.DI
File date	:	14-JUN-89
Raw data file name	:	H13.RD
Sample identification	:	H13
Measurement date/time	:	11-MAY-89 11:39
Diffractometer system	:	1
Generator settings	:	40 kV, 20 mA
Cu alpha1,2 wavelengths	:	1.54050, 1.54429 Ang
Step size, sample time	:	0.020 deg, 1.00 s, 50.00 s/deg
Monochromator used	:	Yes
Diversence slit	:	Fixed (1 deg)
Analysis program number	:	30
Peak angle range	:	4.010 - 39.990 deg
Range in D spacing	:	2.25260 - 22.0155 Ang
Peak position criterion	:	Top of smoothed data
Cryst peak width range	:	0.05 - 2.00 deg
Minim peak significance	:	0.75
Number of peaks in file	:	8 (Alpha1: 6, Amorphous: 0)
Maximum intensity	:	8836. cts, 8836.0 cps

Peak no	Angle (deg)	Tip width (deg)	Peak (cts)	Backg (cts)	D spac (Ang)	I/Imax (%)	Type A1	Type A2	Type Ot	Sign
1	19.0450	0.40	14.	18.	4.6559	0.16	X	X		0.78
2	20.8650	0.14	1673.	14.	4.2537	18.93	X	X		20.42
3	22.4850	0.12	24.	14.	3.9508	0.27	X	X		1.74
4	24.0200	0.16	13.	12.	3.3452	0.15			Bt	0.85
5	26.6550	0.14	8836.	13.	3.3414	100.00	X	X		52.48
6	36.5350	0.10	600.	7.	2.4573	6.79	X			5.62
7	36.6275	0.08	361.	7.	2.4573	4.09		X		1.38
8	39.4625	0.10	353.	8.	2.2815	4.00	X	X		3.25

DETECTED PEAKS FILE 14-JUN-89 13:58

A

Listed DI file name	:	H16.DI
File date	:	14-JUN-89
Raw data file name	:	H16.RD
Sample identification	:	h16
Measurement date/time	:	11-MAY-89 13:32
Diffractometer system	:	1
Generator settings	:	40 kV, 20 mA
Cu alpha1,2 wavelengths	:	1.54050, 1.54429 Ang
Step size, sample time	:	0.020 deg, 1.00 s, 50.00 s/deg
Monochromator used	:	Yes
Divergence slit	:	Fixed (1 deg)
Analysis program number	:	30
Peak angle range	:	4.010 - 39.990 deg
Range in D spacing	:	2.25260 - 22.0155 Ang
Peak position criterion	:	Top of smoothed data
Cryst peak width range	:	0.05 - 2.00 deg
Minim peak significance	:	0.75
Number of peaks in file	:	6 (Alpha1: 4, Amorphous: 0)
Maximum intensity	:	7022. cts, 7022.4 cps

Peak no	Angle (deg)	Tip width (deg)	Peak (cts)	Backg (cts)	D spac (Ang)	I/Imax (%)	Type A1	Type A2	Type Ot	Sign
1	20.8900	0.12	1781.	14.	4.2487	25.36	X	X		16.60
2	26.6775	0.14	7022.	14.	3.3386	100.00	X	X		44.67
3	36.5525	0.10	449.	7.	2.4562	6.40	X			4.90
4	36.6550	0.08	299.	7.	2.4556	4.26		X		1.10
5	39.4825	0.10	372.	7.	2.2804	5.30	X			5.13
6	39.6150	0.06	156.	7.	2.2786	2.23		X		1.02

DETECTED PEAKS FILE 14-JUN-89 13:59

A

Listed DI file name	:	H17.DI
File date	:	14-JUN-89
Raw data file name	:	H17.RD
Sample identification	:	H17
Measurement date/time	:	11-MAY-89 15:00
Diffractometer system	:	1
Generator settings	:	40 kV, 20 mA
Cu alpha1,2 wavelengths	:	1.54050, 1.54429 Ang
Step size, sample time	:	0.020 deg, 1.00 s, 50.00 s/deg
Monochromator used	:	Yes
Diversence slit	:	Fixed (1 deg)
Analysis program number	:	30
Peak angle range	:	4.010 - 39.990 deg
Range in D spacing	:	2.25260 - 22.0155 Ang
Peak position criterion	:	Top of smoothed data
Cryst peak width range	:	0.05 - 2.00 deg
Minim peak significance	:	0.75
Number of peaks in file	:	4 (Alpha1: 4, Amorphous: 0)
Maximum intensity	:	6856. cts, 6855.8 cps

Peak no	Angle (deg)	Tip width (deg)	Peak (cts)	Backg (cts)	D spac (Ang)	I/Imax (%)	Type A1	Type A2	Type Ot	Sign
1	20.8825	0.14	1347.	14.	4.2502	19.65	X	X		20.42
2	26.6725	0.14	6856.	13.	3.3393	100.00	X	X		44.67
3	36.5450	0.16	396.	8.	2.4567	5.78	X	X		12.88
4	39.4725	0.08	615.	7.	2.2809	8.97	X	X		4.37

DETECTED PEAKS FILE 14-JUN-89 14:00

A

Listed DI file name	:	H18.DI
File date	:	14-JUN-89
Raw data file name	:	H18.RD
Sample identification	:	H18
Measurement date/time	:	11-MAY-89 15:40
Diffractometer system	:	1
Generator settings	:	40 kV, 20 mA
Cu alpha1,2 wavelengths	:	1.54050, 1.54429 Ang
Step size, sample time	:	0.020 deg, 1.00 s, 50.00 s/deg
Monochromator used	:	Yes
Divergence slit	:	Fixed (1 deg)
Analysis program number	:	30
Peak angle range	:	4.010 - 39.990 deg
Range in D spacing	:	2.25260 - 22.0155 Ang
Peak position criterion	:	Top of smoothed data
Cryst peak width range	:	0.05 - 2.00 deg
Minim peak significance	:	0.75
Number of peaks in file	:	6 (Alpha1: 6, Amorphous: 0)
Maximum intensity	:	6806. cts, 6806.3 cps

Peak no	Angle (deg)	Tip width (deg)	Peak (cts)	Backg (cts)	D spac (Ang)	I/Imax (%)	Type A1	Type A2	Type Ot	Sign
1	20.8575	0.14	1459.	14.	4.2552	21.44	X	X		16.60
2	26.6400	0.18	6806.	14.	3.3433	100.00	X	X		79.43
3	30.8175	0.32	9.	11.	2.8989	0.13	X	X		0.79
4	35.3175	0.12	12.	8.	2.5392	0.18	X	X		1.07
5	36.5300	0.14	412.	8.	2.4576	6.05	X	X		10.00
6	39.4625	0.20	331.	8.	2.2815	4.87	X	X		18.62

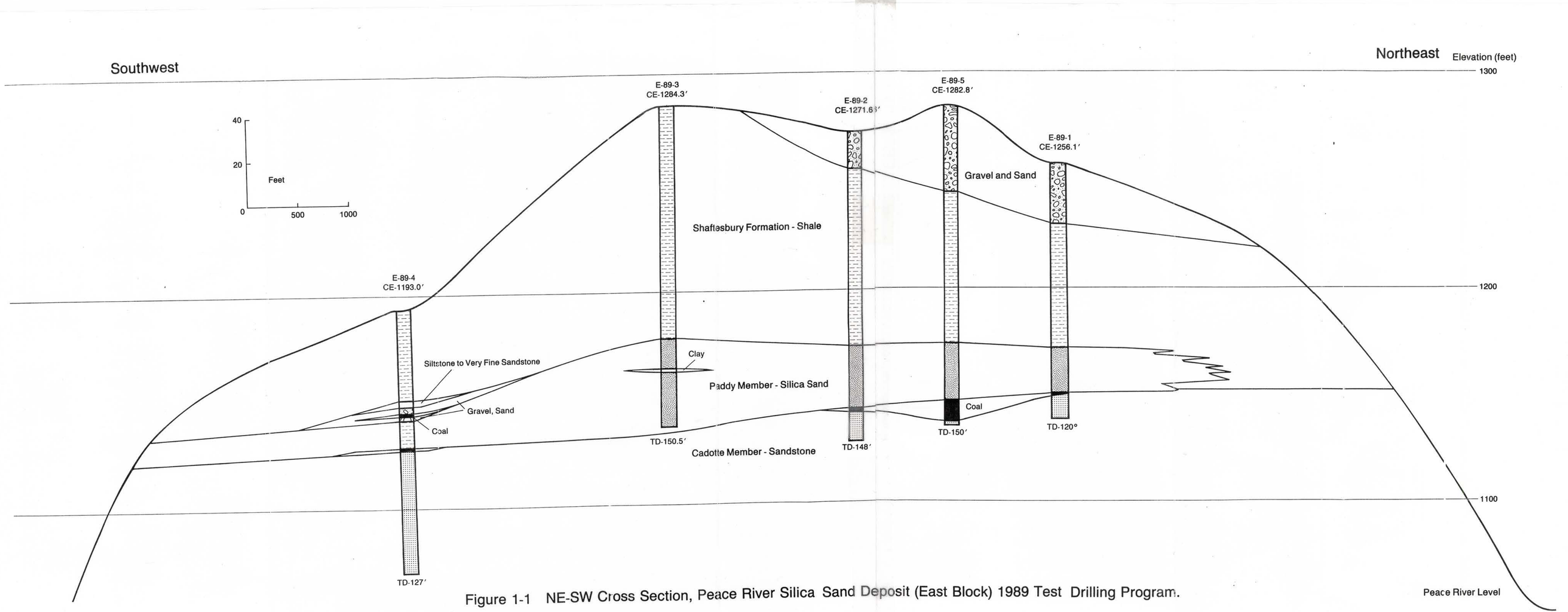


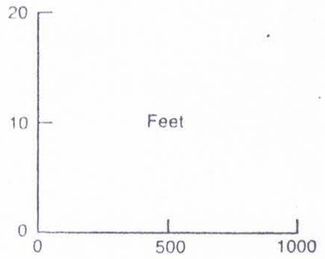
Figure 1-1 NE-SW Cross Section, Peace River Silica Sand Deposit (East Block) 1989 Test Drilling Program.

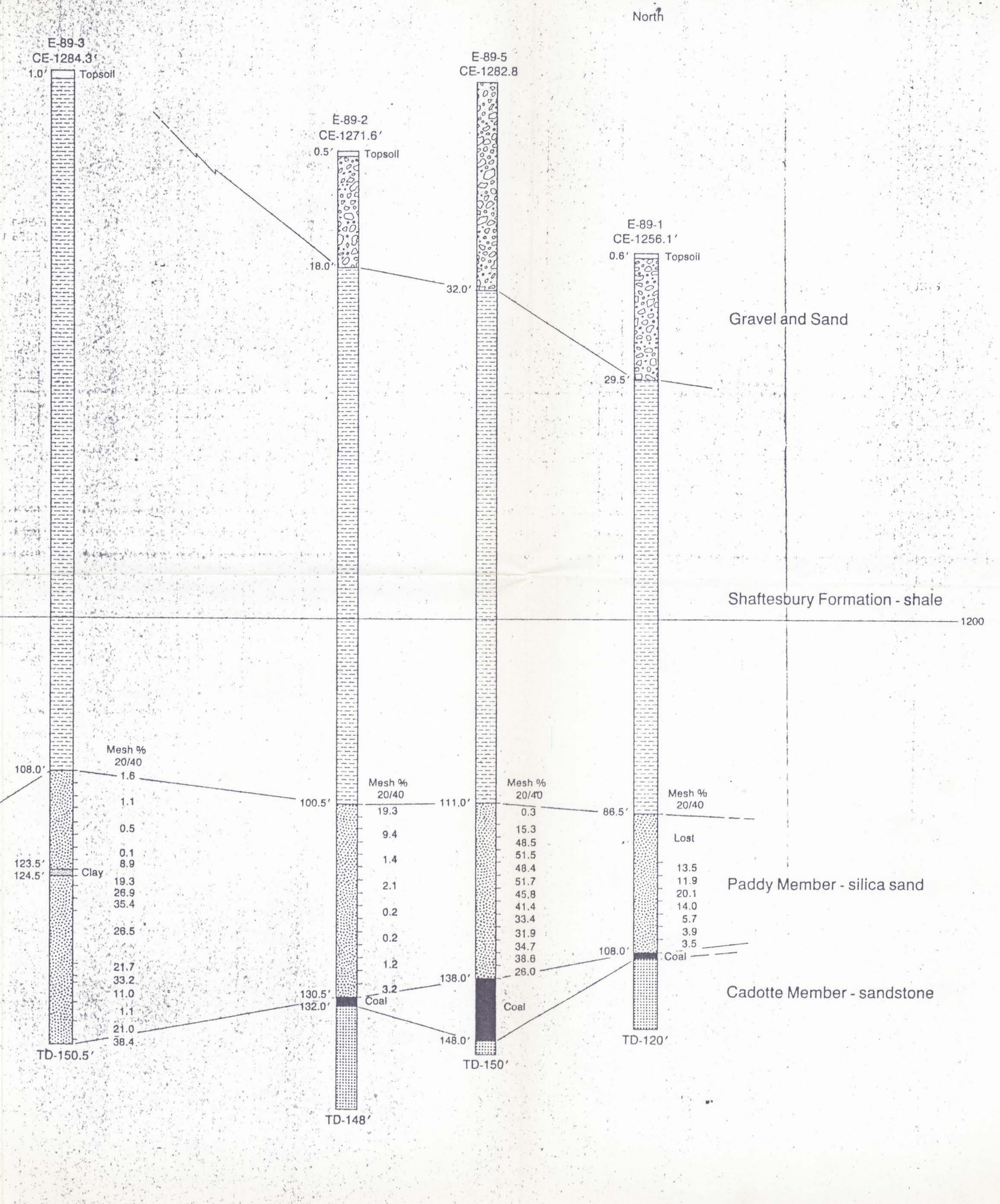
Figure 2-2

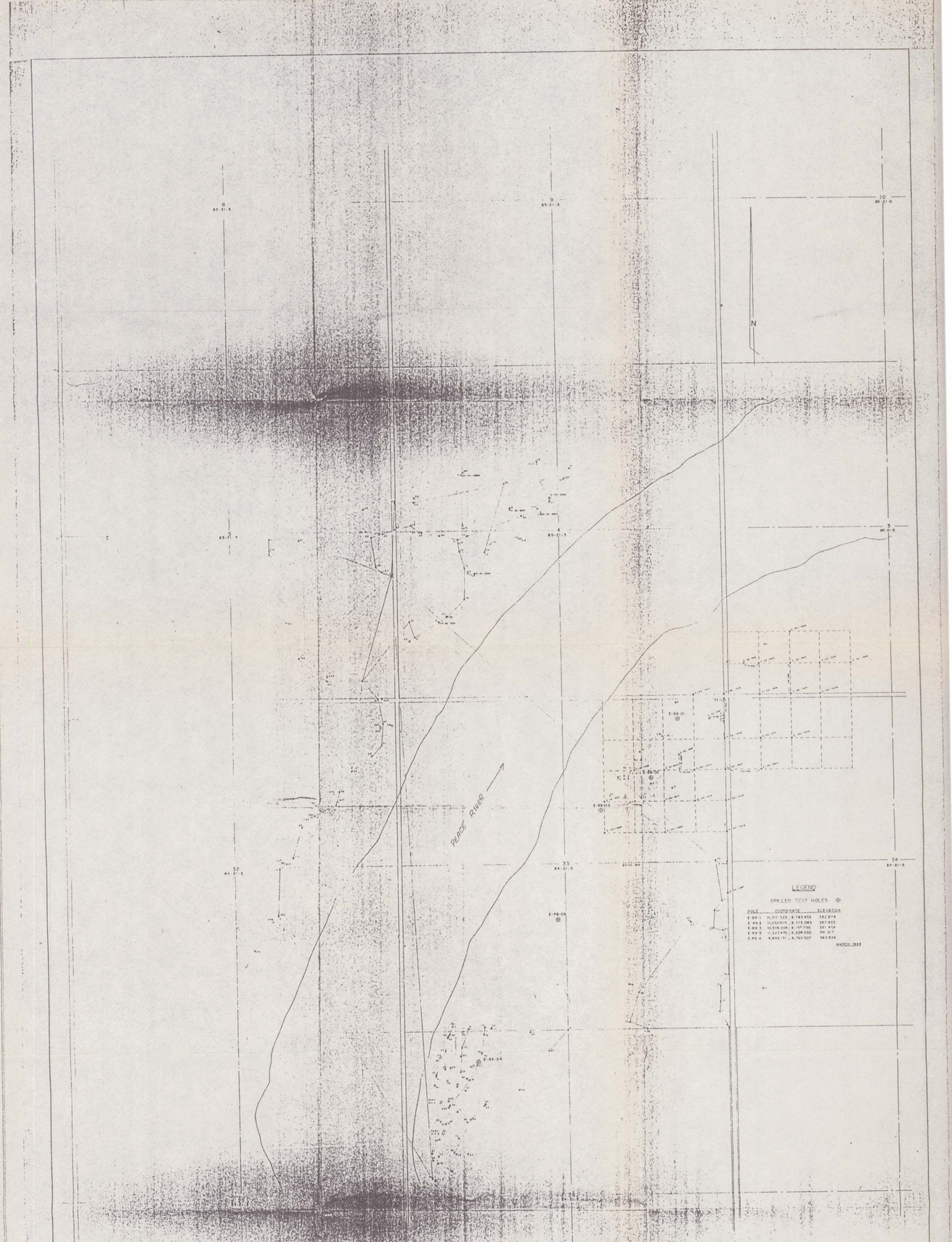
Peace River Silica Sand Ltd.

Correlation Chart

1989 - Test holes







PEACE RIVER INDUSTRIAL RESOURCES

PLAN SHOWING
SURVEY CONTROL NETWORK and
TEST HOLE LOCATIONS in
SEC'S 28,32,& 33, TWP 84, RGE 21, W5M and
SEC'S 4, 5, & 8, TWP 85, RGE 21, W5M
IMPROVEMENT DISTRICTS 17 & 22

SCALE - 1:5000 1981 B SANCHUK A.L.S

Figure 2-3

CONTROL TRAVERSE COORDINATES

TEST HOLE COORDINATES

HOLE	COORDINATE	ELEVATION
E-89-1	11,517,525 N 7,765,455	382.878
E-89-2	11,052,405 N 8,173,085	387.402
E-89-3	10,538,204 N 8,137,730	391.474
E-89-4	11,223,470 N 8,529,260	391.017
E-89-5	9,893,171 N 8,765,407	361.836

Coordinate Surveys Ltd.
PEACE RIVER - ALBERTA

West Block

East Block

Inferred resource

Measured resource

Inferred resource

Measured resource

Very fine sand

Outcrop

Outcrop

Peace River

Quarriable Mineral Lease Boundary

Quarriable Mineral Lease Boundary

L-5 7′

111 20′

116 10′

112 54′

114 14′

102 22′

T-7 L-3 21′

T-6 19′

T-3 19′

T-2 20′

113 38′

T-5 17.5′

T-1 17′

L-1 48′

T-4 L-2 10′

109 45′

117 24′

119 20′

120 22′

E-82-1049

E-82-1056

E-82-1057 23.5′

E-88-1035 9′

E-89-01 21.5′

E-82-1058 24.5′

E-82-1031 16′

E-82-1052 26.5′

E-82-1020 30′

E-89-05 28′

E-82-1024

E-82-1023 19′

E-82-1013 29′

E-82-1014 28′

E-82-1016 20′

E-89-02 30′

E-82-1009 27.5′

20′ E-82-1008

32′ E-82-1059

E-82-1007

E-89-03 42.5′

82

84

89

92 20

E-89-04 13′

87 14′

81

79 12′

80

78 8′

90

77 8′

95 84

63A 20′

64 20′

75 30′

66 28′

74 28′

67 22′

68 24′

73 12′

94 26′

69 12′

70 12′

72 6′

33 84-21-5

34 84-21-5

29 84-21-5

28 84-21-5

Pre 1989 borehole

1989 Borehole E-89-1 thru E-89-5

Outcrop measurement

Banfield bulk sample

Crockford trench sample

Paddy outcrop - projected

Estimated sedimentary edge of Paddy Member

Inferred isopach

Quarriable Mineral Lease Boundary

Resources of Paddy Member and Total Thickness Isopach

eace River Silica Sand Ltd.

F ddy Member - Silica Sand Resources

(Millions metric tonnes)

	Measured	Inferred
E st Block	13.67	8.59
West Block	14.89	10.97
	28.53	**19.56**

0 100 200 300 400 500 metres

0 500 1000 1500 feet

Map 2-1

West Block

East Block

Inferred resource

Measured resource

W2.1 W1.14 W1.15 W1.13 W1.12 W1.18 W2.2 W1.8 W1.17 W1.16 W1.11 W1.10 W1.9 W1.2 W1.3 W1.4 W1.5 W1.6 W1.7 W1.1

E2.10 E2.17 E2.16 E2.11 E2.4 E2.9 E2.15 E3.1 E3.2 E2.14 E2.12 E2.13 E3.3 E2.8 E2.5 E3.4 E2.7 E2.3 E2.1 E2.6 E3.5 E2.2 E3.7 E3.8 E3.11 E3.10 E3.12 E3.6 E3.9 E3.13 E3.14 E3.15 E1.9 E1.10 E1.8 E1.7 E1.5 E1.6 E1.4 E1.3 E1.2 E1.1 E3.16 E3.17 E3.18

Peace River

Outcrop

Very fine sand

Quarriable Mineral Lease Boundary

5 85-21-5 · 4 85-21-5 · 3 85-21-5 · 34 84-21-5 · 33 84-21-5 · 29 84-21-5 · 28 84-21-5

E-82-1046 · E-82-1056 · E-82-1057 · E-88-1035 · E-82-1058 · E-82-1031 · E-82-1024 · E-82-1023 · E-82-1052 · E-82-1020 · E-88-05 · E-82-1013 · E-82-1014 · E-82-1016 · E-88-02 · E-82-1008 · E-82-1059 · E-82-1007 · E-89-01 · E-89-03 · E-89-04

Pre 1989 borehole
1989 Borehole E-88-1 thru E-89-5
Outcrop measurement
Banfield bulk sample
Crossford trench sample
Paddy outcrop - projected
Estimated sedimentary edge of Paddy Member
Inferred isopach

Resource Estimate Area Designations

As per tables 2-2 and 2-3

Resources of Paddy Member and Total Thickness Isopach

Peace River Silica Sand Ltd.

Paddy Member - Silica Sand Resources
(Millions metric tonnes)

	Measured	Inferred
East Block	13.67	8.59
West Block	14.89	10.97
	28.53	19.56

0 100 200 300 400 500 metres
0 500 1000 1500 feet

Map 2-2