EXPLORATION FOR INDUSTRIAL MINERALS IN MISSISSIPPI SOUND AND ADJACENT OFFSHORE TERRITORIES OF MISSISSIPPI AND ALABAMA

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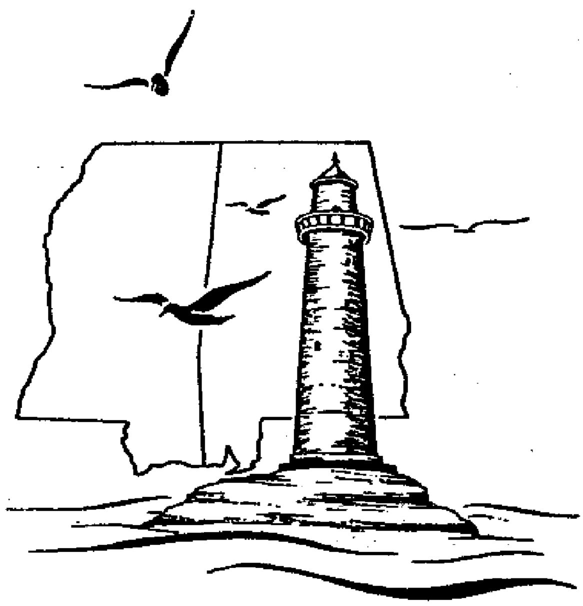

MISSISSIPPI-ALABAMA
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Introduction

Background

A variety of industrial minerals are known to occur in the offshore territories of Mississippi and Alabama in the region of Mississippi Sound. These include particular heavy minerals and specialty sands associated with the barrier island chain (Cat to Dauphin Islands) and related offshore sand bodies. In addition, shell deposits have been identified within the Sound.

The heavy mineral suites are known to contain oxides of titanium, which include ilmenite and rutile, the oxide of zirconium, zircon, and the complex rare earth-bearing phosphates, monazite and xenotime. Specialty sands mainly include glass sand, abrasive blasting sand, and foundry sand. Shell occurs principally as oyster reef deposits of both aggregate and chemical grade.

A number of general scientific studies have been conducted relating to various mineral occurrences in the Mississippi Sound region, many under the auspices of the Gulf Coast Research Laboratory. Notable work has also been performed by Stow and others (1975). However, a systematic investigation encompassing both exploration and preliminary evaluation phases has not been undertaken. In 1980, a Sea Grant program directed by Dr. Scott Brande, the University of Alabama, and joined by Dr. Fred Manley, the University of Mississippi, was initiated. The study involved a subbottom profiling reconnaissance of Mobile Bay with tracks extending through Mississippi Sound to Lake Borgne. In 1981, this work was expanded by The Mississippi Mineral Resources Institute in cooperation with the U. S. Geological Survey, Corpus Christi, Texas and the Department of Geology, the University of Southern Mississippi. A number of subbottom profile tracks, leeward and seaward of the barrier islands were run, linking the tracks of the previous year with an extensive offshore BLM survey. These data are currently being incorporated with the existing background studies. These studies, together with the ongoing work described in this report, will be integrated into a comprehensive investigation of the industrial mineral resources of the Mississippi Sound region.

The need for a thorough investigation of these potential mineral resources has become increasingly important. Industrial heavy minerals, some of strategic importance, contain the oxides of titanium, zirconium and silicon, as well as various rare earth elements. These oxides are essential constituents of a wide range of materials critical to the most advanced technologies. The bulk of these mineral commodities are presently dependent on foreign supply, which has become increasingly more uncertain in recent years. Further, the rapid development of urban and industrial areas along the Gulf Coast have provided expanding markets not only for the traditional industrial minerals such as specialty sands and shell, but for many of the strategic minerals as well. Such expansion is evidenced by the titanium oxide plants in Gulfport, Mississippi, and Mobile, Alabama, and a new rare earth plant in Freeport, Texas.

Area Description

When the potential for economic mineral deposits located within the sedimentary framework of Mississippi Sound and its environs is considered, sediment thicknesses and general composition become important factors. The best information concerning sand thickness on the barrier islands is from the work of Brown, et al. (1944), who documented in a drill hole 86 feet of sand overlying the Pliocene-Pleistocene Citronelle formation. In all probability, these 86 feet represent a maximum thickness of sand to be expected in the area to be investigated.

Priddy, et al. (1955), estimated that the bottom sediments of Mississippi Sound consist of 80% silty clay, 15% silt or sandy silt, and 5% sand. Most of the sand is restricted to a narrow band paralleling the mainland shore and to a wider band on the leeward side of the barrier islands (Van Andel, 1960); however, small zones of predominantly sandy substrata are found in the interior of the basin. Large zones of blanket sands found seaward of the barrier islands are more prevalent offshore of the easternmost members of the barrier island chain.

A series of 26 borings were made across Mississippi Sound in 1954 in conjunction with a feasibility study for a proposed causeway between the mainland and Ship Island. Subsequent examination of samples from these cores by Rainwater (1964) determined that the recent sediments in the basin average 20 feet in thickness and lie on top of the weathered Pleistocene surface. The material below this contact is slightly more compacted and indurated than is the recent sediment.

Water depth of Mississippi Sound averages about 10 feet while the bathymetry seaward of the barrier islands drops off moderately, reaching depths of 20 feet within a half mile. From this contour, the upper continental shelf, which possesses little relief, approaches greater depths more gradually. The bottom is largely sand with local areas of silt and clay mud.

Heavy Minerals

Heavy minerals are known to exist in appreciable quantities in the Mississippi Sound and offshore region. At least 26 mineral species have been identified by various investigators including Harding (1960), Fairbanks (1962), and Foxworth, et al. (1962). From the standpoint of origin of these minerals, the region is divisible into two provinces, the Eastern Province and the Mississippi Province, with an apparent zone of transition located due south of Horn Island.

The heavy minerals in the Eastern Province are mainly metamorphic mineral suites containing abundant ilmenite, kyanite, staurolite, zircon, and tourmaline. Their suggested origin is the metamorphic rocks of the Appalachian Piedmont. The Mississippi Province consists of a more typically igneous suite which includes pyroxenes and amphiboles, as well as epidote, ilmenite, and biotite. The igneous suite is thought to be derived from the drainage basin of the Mississippi River. Of the heavy minerals known to occur in the Mississippi Sound region, ilmenite, rutile, kyanite, staurolite, zircon, monazite, and xenotime are of commercial interest.

High concentrations of heavy minerals occur in laminae along the storm berms and dunes of the Gulf of Mexico barrier island beaches. Although these beaches contain economic concentrations of heavy minerals, they are no longer accessible on Petit Bois, Horn, and Ship islands, which are within the Gulf Islands National Seashore.

Other than the barrier islands, the most promising area for investigation of heavy mineral occurrence is a zone between Petit Bois Island and the western end of Dauphin Island, and seaward therefrom for about 6 miles. This zone was identified by Van Andel (1960) as containing sands with greater than 4% heavy mineral content. Seaward of Horn Island lies another sandy bottom with a potential for heavy minerals, with concentrations of between 1% and 3% over a broad area reported by Van Andel (1960) and more recently by Simonson (1983).

Specialty Sands--Marine

Specialty sands are typically silica sands which are used for specialized purposes. Specialty sands include sands used in the manufacture of glass, blasting sand, and foundry sand.

Glass sand contains over 90% SiO_2 (quartz) and requires a minimum of certain deleterious elements, i.e., no more than 0.0030% Fe (iron) or 0.003% Cr (chromium). In addition, certain refractory minerals are deleterious to glass sand, including sillimanite, kyanite, andalusite, zircon, spinel, corundum and chromite. Most of these mineral species, indicative of the Eastern Province, occur in the heavy mineral suite that is present on three of the barrier islands (Petit Bois, Horn, and Ship) and seaward of these islands. Therefore, it would be logical to concentrate the exploration for glass sand in the portion of the proposed study area that is dominated by the suite of heavies from the Mississippi River, approximately the western one-third of the proposed study area. Glass sand has been produced in the past from Cat Island.

Foundry sands are those sands used in the manufacture of cores and molds used in the casting of metals. The majority of foundry sands used today are those known as "silica sands", which is a general term used to describe washed, graded, and dried quartz sand. Natural molding sand is a very fine-grained silica sand in which over 50% of the particles pass through a 270-mesh screen.

Reef Shell

Commercial shell dredging is a well-developed industry along the northern coast of the Gulf of Mexico. The shell reefs dredged are dead reefs that were developed during the recent geological past and were silted over by fine-grained sediments. Almost exclusively oyster and clam shells, these dead reefs are valuable economic deposits, as they often represent the sole source of lime in the coastal areas. Shells are used locally as a road base material; in crushed form, they are used as "grit" for poultry. In some instances, shells have been used as a component of building materials such as cinder blocks. However, the largest demand for the shells, which consist of approximately 99% $CaCo_3$ (calcium carbonate), is as an industrial chemical.

Buried shell reefs have been previously dredged from the shallow waters of Mississippi Sound and both east and west of its limits (Mobile Bay and Lake Borgne). There is a good possibility that a far greater volume is available than has been estimated by previous methods. The zone in which these dead shell reefs are found typically underlies the recent estuarine sediments, developed on top of the Pleistocene section, which is encountered between 20 and 40 feet, subbottom.

Offshore Operations

As a part of the 1983 Sea Grant study, a geophysical survey was successfully completed in March of 1983. The purpose of the survey, which included 107 nautical miles of shallow seismic, side-scan sonar and gamma ray sled work, was to define surficial areas of heavy mineral concentration and shell reef occurrence to guide a vibracore sampling investigation scheduled for May of 1983. Several zones of probable heavy mineral concentration as well as buried reefs were located. In addition, a possible fault zone with several possible extinct gas craters along its axis was encountered northwest of Cat Island (Figure 1).

Sampling work, both completed and ongoing, includes 58 vibracore sites. Of 14 completed sites, 8 fall within the limits of Mississippi Sound, augmenting the University of Mississippi Sea Grant cores included in this study. 44 vibracore sites still remain to be drilled offshore of the barrier island chain (Figure 2). The more densely packed sands of the offshore province proved too difficult for the light vibracore system provided for the project by the Sea Grant contractor. A heavy duty vibracore utilizing a 300 lb. pneumatic vibrator head will be used in the work planned, beginning in May of 1984. The vibracore was designed and built by M.M.R.I. as part of matching participation in the project.

Preliminary Statistical Data

Gamma Ray Spectrometry

Gamma ray readings were recorded by a spectrometer sled towed along a prescribed tract. The sled was provided by The Center for Applied Isotope Studies, the University of Georgia. The spectrometer was tuned to natural emitting species of heavy minerals such as zircon, monazite and xenotime for the purpose of indicating occurrences of these and the more common heavy mineral species with which they are associated. Table 1 lists the levels of U, Th, K, and Th/U, keyed to specific tract locations from which grab samples were also taken for heavy mineral analysis as a means of investigating possible relationships. This work will continue in 1984 upon completion of the transition to the new geology laboratories at the University of Mississippi.

Heavy Mineral Analysis

Suites of heavy mineral assemblages (minerals with a specific gravity greater than 2.97) were separated from sixteen interface (grab) samples and analyzed microscopically for specific mineral content. The sample sites from which the interface samples were taken are located more or less along an East-West traverse across the seaward side of the barrier island system (Figure 2). The sample sites shown in Figure 2 that were sampled for heavy mineral content analysis specifically for this report are HM sites 3, 5, C, 6, 8, D, 10, 11, F, G, 13, H, 16, 17, 18, and 19.

Samples were wet sieved for a sediment separation of 62 microns. The greater than 62 micron fraction was subsequently dried and sieved at one phi intervals from one to four, yielding 1-2, 2-3, and 3-4 phi fractions (a phi interval is equivalent to the $-\log_2$ transform of the standard Wentworth millimeter interval, see Table 2). Significant abundances of heavy mineral grains were not observed in either the less-than-4-phi or greater-than-1-phi fractions.

Minerals with a specific gravity greater than 2.97 were separated from each phi fraction using tetrabromoethane ($C_2H_2Br_4$) as the separatory liquid (Sp.G.=2.97) and centrifugation as the separation method. Heavy mineral grain assemblages for each phi fraction per sample were randomly mounted in piperine on 27x46 mm glass petrographic slides and examined optically. Mineral identification was made by comparison with a standard grain mount slide of each heavy mineral species. A grain count was made for each mineral species observed in two hundred total counts for each slide.

The weight percentage of heavy minerals in the sand-size fraction (1-phi) for each sample was determined and is presented in Table 3. The sample variance (s_2) of the total heavy mineral population over the entire sampling distribution is .26, whereas the theoretical variance is .08. The difference between the two indicates, but does not demonstrate, a pronounced variability in the density of total heavy mineral content.

Table 4 shows the distribution of heavy minerals by weight percentage for each sample site and phi range. For most samples, the greatest percentage is in the 3-4 phi fraction. The overall percentage of heavy minerals in the 1-2 phi fraction is negligible, and this fraction may be discounted. The two remaining phi ranges are considered to form two separate populations for the purposes of analysis.

A single factor one-way analysis of variance was used to obtain some idea of variability between the phi ranges and among the samples. The results of this analysis are shown in Table 5. According to the analysis of variance, the calculated F value is much less than the tabled value at a 5% level of significance with 1 and 30 degrees of freedom. Essentially, the analysis indicates that the population means of the 2-3 and 3-4 phi fractions are equal. Therefore, the entire sand fraction (1-4 phi) can be considered as a single population with the individual phi ranges within the sand fraction possible considered as sub-populations.

The heavy mineral percentage data within the sand-size fraction was numerically tested for distribution normalcy using a Chi-square goodness-of-fit analysis. The calculated Chi-square distribution value (U) for the heavy mineral data is 12.90. The tabled value at a 5% level of significance with 1 degree of freedom is 3.84. The heavy mineral percentage data is not interpreted to be a normal distribution, but could be a discrete (binomial) distribution or even a highly skewed (gamma) distribution. Most sediment percentage data is either normal or log normal. Count data is usually discrete. Therefore, the weight percentage values are either meaningless or need adjustment.

One grain mount for the sand-size fraction of each sample was prepared. Percentage values for each heavy mineral species were obtained from 200 grain counts per sample grain mount; the values are summarized in Table 6. The percentage values show that ilmenite is the most abundant species of the samples, followed by kyanite, leucoxene and garnet. All mineral species have equality of means between sample sites, but not all show a normal distribution density, for example, garnet, rutile and epidote.

Each heavy mineral species was numerically analyzed for the population parameter characteristic and distribution density using analysis of variance and Chi-square procedures. For the analyses, sample sites were segregated into three sample populations. An example of the data organization, using ilmenite, is shown in Table 7. Results of the analyses are summarized in Tables 8 and 9.

A more precise estimate of heavy mineral species distribution and grouping is necessary in order to properly evaluate economic potential. This can be accomplished with a more thorough sampling program where samples are taken at designated population sites (Figure 3). Eight sample sites would be randomly selected for each sampling area, and core samples taken at each site would yield a set of subsamples. At least two and preferably three replicate grain mounts would be made from each subsample. Numerical analyses to be used would include a three-level nested analysis of variance for examining variation of mineral species population parameters throughout the study area, and factor analysis to establish mineral species groupings (provinces).

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Table 1

Sea Grant Cruise - Heavy Minerals

May 23-26, 1983

I.D. No.	Loran C Coordinate		U(ppm)	Th(ppm)	K(%)	Th/U
5-23-1	12050.7	47077.5	1.80	7.04	1.42	3.90
5-23-2	12052.3	47076.8	0.98	2.66	0.54	2.71
5-23-3	12041.6	47075.8	1.37	4.52	0.71	3.29
5-23-A/g	12046.5	47074.3	2.72	9.26	1.90	3.41
5-23-4	12043.7	47073.2	1.15	2.87	0.44	2.50
5-23-5	12030.1	47070.1	0.33	0.72	0.07	2.14
5-23-B/g	12050.7	47070.3	1.74	4.90	1.21	2.82
5-23-C/g	12073.4	47067.0	1.69	4.83	1.09	2.86
5-23-6	12090.1	47063.4	0.63	1.33	0.19	2.11
5-23-7	12107.6	47061.9	0.47	0.71	0.53	1.51
5-23-8	12113.3	47061.5	1.97	4.30	1.52	2.19
5-24-D	12245.2	47080.6	1.40	3.65	0.40	2.61
5-24-9	12352.6	47082.6	1.25	1.09	0.06	0.88
5-24-E	12307.1	47076.3	0.54	0.85	0.03	1.58
5-24-10	12307.0	47072.8	1.76	4.64	0.51	2.63
5-24-11	12343.3	47073.5	1.53	4.28	0.42	2.79
5-24-F	12384.9	47075.6	9.41	30.71	0.19	3.27
5-24-G	12405.4	47074.9	2.32	5.84	0.35	2.51
5-25-H	12453.7	47080.6	0.28	0.45	0.03	1.61
5-25-12	12444.2	47076.8	0.23	----	0.03	----
5-25-13	12433.1	47071.5	1.90	5.17	0.42	2.73
5-25-14/g1	12480.2	47072.2	0.39	0.59	----	1.52
5-25-14/g2	12480.2	47072.2	0.63	0.81	----	1.29
5-25-15	12486.7	47071.3	0.52	1.00	----	1.93
5-25-16	12512.0	47070.7	0.84	1.23	0.05	1.46
5-25-17/g1	12538.0	47068.7	0.66	0.77	----	1.17
5-25-17/g2	12538.0	47068.7	0.59	0.76	----	1.28
5-25-18	12558.2	47069.8	5.46	18.43	0.12	3.38
5-25-19	12593.8	47074.2	0.74	1.61	0.14	2.18
5-25-20	12588.8	47078.3	3.86	2.53	----	0.66
5-25-21	12572.9	47077.5	0.30	0.33	----	1.08
5-26-I	12500.0	47061.2	2.55	6.84	1.32	2.69
5-26-J	12529.0	47063.8	1.07	2.46	0.05	2.30
5-26-K	12557.4	47064.5	0.58	0.83	0.05	1.44
5-26-L	12582.2	47066.8	1.04	2.26	0.08	2.16
5-26-M	12603.7	47067.4	1.46	3.31	0.05	2.27
5-26-N	12575.8	47075.0	0.58	0.50	----	0.87
5-26-O	12562.0	47076.5	0.19	----	0.03	----
5-26-P	12538.0	47073.8	0.32	----	0.03	----
5-26-Q	12559.0	47077.0	0.28	0.43	----	1.54
5-26-R	12564.0	47082.1	1.62	4.05	0.35	2.50
5-26-22	12515.9	47076.0	0.48	1.22	0.18	2.55
5-26-23	12504.8	47074.5	2.85	7.05	1.70	2.47
5-26-S	12564.3	47087.5	2.99	7.59	1.19	2.54

Table 2

mm Range	phi Range
1.00 - 0.50	0 - 1
0.50 - 0.25	1 - 2
0.25 - 0.125	2 - 3
0.125 - 0.062	3 - 4
0.062 - 0.031	4 - 5

Table 3

Sample	% Heavies 1 to 4 Ø
5 - 23 - 3	1.00
5 - 23 - 5	0.30
5 - 23 - C	0.70
5 - 23 - 6	0.70
5 - 23 - 8	0.20
5 - 24 - D	1.00
5 - 24 - 10	0.40
5 - 24 - 11	0.34
5 - 24 - F	1.95
5 - 24 - G	0.90
5 - 25 - 13	0.85
5 - 25 - H	0.40
5 - 25 - 16	1.10
5 - 25 - 17	1.00
5 - 25 - 18	1.70
5 - 25 - 19	0.50

Table 4

Ø Range	Sample Site															
	3	5	C	6	8	D	10	11	F	G	13	H	16	17	18	19
1 - 2	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.11	0.02	0.00	1.04
2 - 3	0.15	0.31	0.43	0.34	0.00	0.22	0.00	0.07	0.15	0.14	0.11	0.29	0.62	1.40	0.13	0.21
3 - 4	1.35	0.00	0.93	0.05	0.16	1.46	0.38	0.52	3.29	1.12	1.56	2.25	5.61	0.00	3.80	0.68

Table 5

ANOVA Of Heavy Mineral Percentage By
Weight For The 2 - 3 and 3 - 4 Phi
Range Populations

Source of Variation	D.F.	Sum of Squares	Mean Square	F	F(.5,1,30)
Between-groups	1	35.59	35.59	1.45	4.17
Within-groups	30	738.26	24.61		
Total about x	31	773.85			

Table 6

Sand-Size Fraction Heavy Mineral Percentages (Count)

Sample	ILM	RUT	LEUC	TOUR	ZIR	KYN	SILM	STAUR	GAR	MAG	HORN	EPID	MONA	XENO
5-23-3	5.67	2.33	5.43	2.00	0.77	9.67	0.50	0.90	2.10	0.67	1.67	2.00	0.00	0.00
5-23-5	10.67	2.67	14.00	2.00	1.33	17.00	0.33	3.00	7.33	0.67	2.33	5.33	0.00	0.00
5-23-C	28.83	3.00	3.33	1.50	1.67	8.67	2.00	3.00	7.33	0.67	2.83	4.00	0.00	0.17
5-23-6	30.00	3.67	15.67	0.67	3.50	11.83	4.00	8.00	12.83	1.00	2.17	4.83	0.00	0.00
5-23-8	11.33	2.67	3.33	0.00	0.00	8.00	0.33	2.00	1.33	0.00	3.17	0.67	0.00	0.00
5-24-D	19.00	2.17	8.73	2.50	1.33	11.00	2.33	2.90	8.33	1.07	2.57	4.50	0.17	0.00
5-24-10	8.07	1.50	6.17	0.17	0.57	10.40	0.43	0.33	3.33	0.00	1.40	0.83	0.13	0.00
5-24-11	14.50	0.60	9.53	2.10	2.50	19.80	2.33	2.23	8.30	0.00	3.37	0.90	0.17	0.20
5-24-F	15.17	1.83	7.40	2.50	2.00	20.40	1.53	1.50	8.93	0.83	2.50	1.50	0.00	0.33
5-24-G	27.83	3.13	14.90	1.70	1.37	29.23	4.80	3.63	7.17	0.67	4.50	3.53	0.00	0.00
5-25-13	19.13	2.40	10.23	3.20	1.00	14.77	1.67	1.57	7.13	1.40	2.73	1.40	0.10	0.00
5-25-H	18.40	1.90	4.83	1.43	2.57	17.77	2.83	4.07	8.83	0.57	2.23	1.50	0.17	0.00
5-25-16	24.67	5.33	11.00	5.33	4.83	17.33	4.00	6.17	9.33	1.67	5.67	4.17	1.00	0.00
5-25-17	6.67	1.83	2.83	0.67	1.10	4.47	0.50	6.17	4.67	0.83	1.07	2.57	0.00	0.00
5-25-18	16.90	1.73	6.63	1.73	1.93	16.90	1.93	2.83	7.57	2.13	3.27	2.93	0.17	0.17
5-25-19	23.17	1.97	6.73	2.30	4.27	13.80	1.60	2.57	6.03	2.17	0.83	1.00	0.33	0.00
$\bar{X}$	17.19	2.42	8.48	1.94	1.92	14.44	2.07	3.18	6.91	0.90	2.75	2.60	0.15	0.06
s	7.47	1.06	3.90	1.28	1.33	6.04	1.36	2.06	2.90	0.70	1.19	1.59	0.25	0.11

ILM = Ilmenite
RUT = Rutile
LEUC = Leucoxene
Tour = Tourmaline
ZIR = Zircon
KYN = Kyanite
SILM = Sillimenite
STAUR = Staurolite
GAR = Garnet
MAG = Magnetite
HORN = Hornblende
EPID = Epidote
MONA = Monazite
XENO = Xenotine

Table 7

Ilmenite Percentages By Count
For Three Sample Groups

	A	B	C	
	(3) 5.67	(10) 8.07	(16) 24.67	
	(5) 10.67	(11) 14.50	(17) 6.67	
	(C) 28.83	(F) 15.17	(18) 16.90	
	(6) 30.00	(G) 27.83	(19) 23.17	
	(8) 11.33	(13) 19.13		
n =	5	5	4	N = 14
$\bar{X}$ =	17.30	16.94	17.85	
s =	10.09	6.50	7.08	

Table 8

ANOVA Of Eight Selected Heavy Mineral Species From 14 Samples

Mineral	Source of Variation	D.F.	Sum of Squares	Mean Square	F	F (.5,2,11)
Ilmenite	Between-groups	2	1.86	0.93	0.01	3.98
	Within-groups	11	920.93	83.72		
	Total about x	13	922.79			
Kyanite	Between-groups	2	165.27	82.64	2.53	3.98
	Within-groups	11	359.26	32.66		
	Total about x	13	524.53			
Leucoxene	Between-groups	2	21.07	10.53	0.60	3.98
	Within-groups	11	192.72			
	Total about x	13	213.79			
Garnet	Between-groups	2	5.50	2.75	0.25	3.98
	Within-groups	11	114.27			
	Total about x	13	119.77			
Rutile	Between-groups	2	2.71	1.36	1.08	3.98
	Within-groups	11	13.83			
	Total about x	13	16.54			
Zircon	Between-groups	2	6.96	3.48	2.01	3.98
	Within-groups	11	19.02			
	Total about x	13	25.96			
Epidote	Between-groups	2	7.64	3.82	1.18	3.98
	Within-groups	11	35.69			
	Total about x	13	43.33			
Staurolite	Between-groups	2	13.97	6.99	1.55	3.98
	Within-groups	11	49.39			
	Total about x	13	63.36			

Table 9

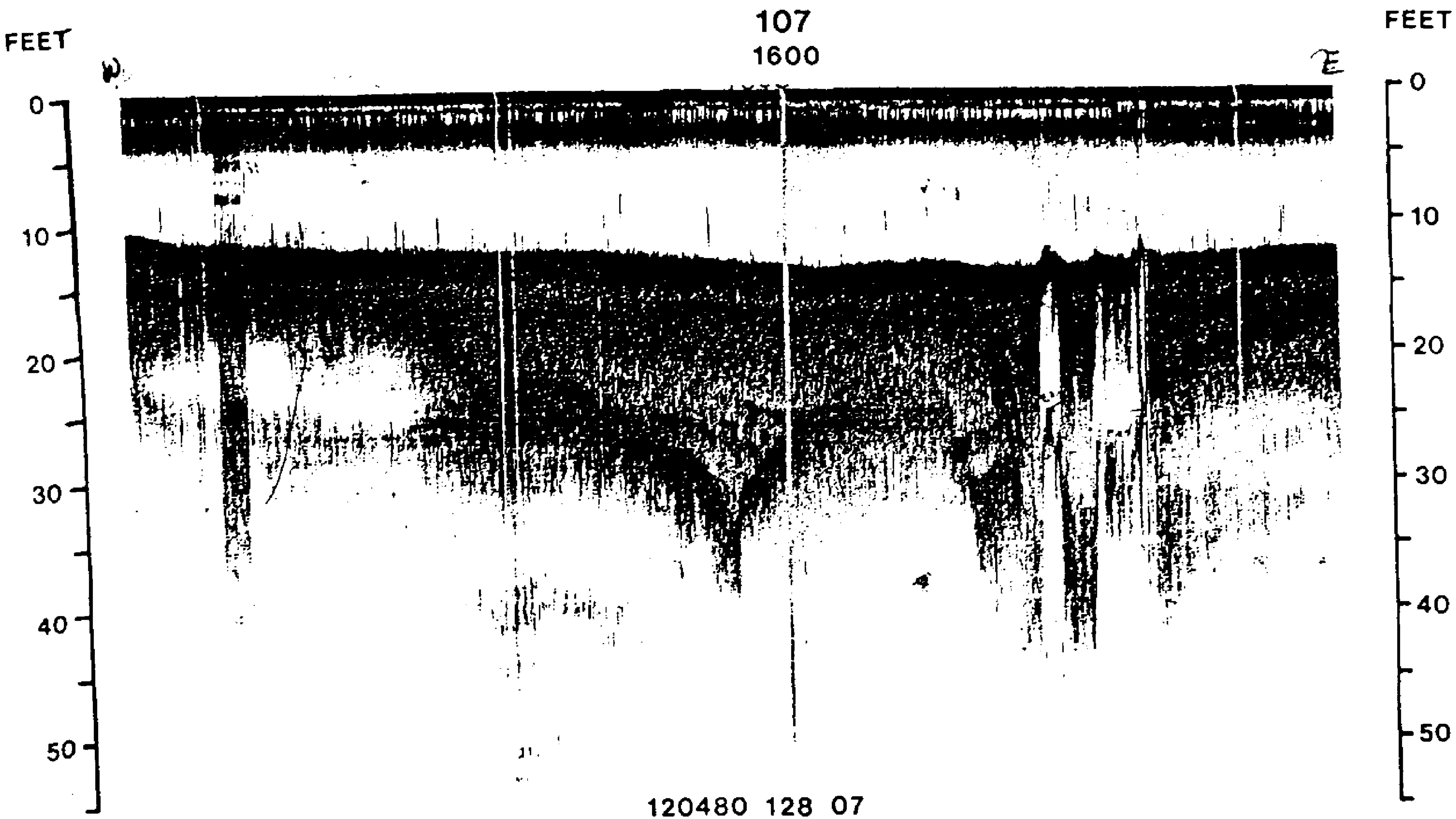
Chi-square Goodness-of-fit

$X^2_{(.05,1)} = 3.84$

Mineral	U
Ilmenite	1.00
Kyanite	0.50
Leucoxene	0.50
Garnet	6.50
Rutile	5.50
Zircon	0.50
Epidote	4.50
Staurolite	3.50

Figure 1

NORTHWEST CROSSING



120480 128 07
470770 070 07

SUB BOTTOM PROFILE