NASA REMOTE SENSING PROJECT

Technical Letter #9

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GROUND TRUTH PARAMETERS FOR PADRE ISLAND, TEXAS

by

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INTRODUCTION

The Manned Spacecraft Center took delivery in July, 1967, on an airborne filterwheel infrared spectrometer operating in the 8-14μ bandwidth from the Lockheed Space and Missiles Corporation, Sunnyvale, California. During the latter portion of July and into August the spectrometer received bench checks as a part of its acceptance tests, and then it was installed on NASA 927 aircraft for the flight checks.

The instrument's principal investigator, Dr. R. J. P. Lyon, of Stanford University, designated Padre Island, Texas, as an acceptable site for the check flight, and requested the Ground Truth Team of the University of Nevada obtain data for the calibration of the spectra developed on the check flight.

Because Padre Island is underdeveloped and lacks an axial road it was necessary to resort to heliocopter for transportation and the collection of samples. A flight line worked out with the captain of NASA 927 was flown in the heliocopter, with the realization that if NASA 927 were to deviate slightly from the flight line, no scientific loss would accrue. Grab samples were taken from the surficial material using a common gardener's trowel. Sampling was biased, based on physical variations visible from an altitude of 150-250'.

Ideally, the samples should have been collected a day or two after the check flight utilizing the boresight camera photos to recover the precise spot sensed. Due to the exigency of the situation, the samples were collected several days prior to the check-out flight. Analyses of the samples indicate no deleterious effect is likely to have occurred as a result of the procedures followed.

Through the courtesy of Cdr. W. S. Petterson, USCG, it was possible to arrange for meteorologic data to be read at several Coast Guard stations on and adjacent to Padre Island. Stations supplying data for the times of aircraft overflight were: Port Aransas, Corpus Christi, Port Mansfield, and Port Isabel. Their data is appended to this report, together with calculations of dew point, relative humidity, and mixing ratios prepared by Eugene Sheppard, meteorologic consultant to the University of Nevada ground truth team. Although the meteorologic data was obtained at sea level, it is Mr. Sheppard's opinion that these values would hold to elevations of 3,000-5000 feet. Since NASA 927 flew the majority of the flight path at 2,000 feet, the meteorologic data can be assumed to be uniform over the distance surveyed by the spectrometer. For the short flight line that was flown at 10,000 feet, assumption of uniform meteorologic conditions is unwarranted. Unfortunately, the aircraft's weather sensors were not operational during the flights, and only the empirical results of the spectrometer are available for study.

SUMMARY OF RESULTS

Dr. R. J. P. Lyon, Principal Investigator for the Infrared Spectrometer and Chairman of NASA's Infrared Team, selected Padre Island, Texas, as the site for the check-flight of the infrared spectrometer with the hope that the island consisted of a high percentage of quartz sand with but minor impurities in the form of lithologic constituents and minimal vegetation. Also important to its selection was the presence of water on both sides of the island to act as a blackbody, and proximity to the aircraft base at Ellington AFB.

A survey of the previous literature on Padre Island discloses papers by Bullard (1942) and Garner (1967). Bullard concerned himself with the one to two percent heavy mineral content, showing relationships of the heavy minerals found along the beach with the contributions of the various rivers emptying into the Gulf of Mexico. Garner's paper reviews the sands from the Texas Gulf Coast from the economic point of view. He utilizes much of Bullard's data. The reader is referred to Garner for a worthy bibliography.

The problems created by the decision to use Padre Island for the check-out flight for the infrared spectrometer were: (1) to verify the suspected high silica content of the sands, (2) to determine any variations in grain size, (3) to determine any variations in grain composition, (4) to evaluate surficial vegetation which would affect the infrared spectra, (5) to determine variations in moisture content of the sands.

Padre Island is a typical offshore bar or barrier beach lying on the margin of a large body of water with a low land surface behind the strand-line and a shallow beach profile. It is part of a series of such islands extending from the western half of the Florida panhandle to central Tamaulipas, Mexico. This is one of the longest of these islands, extending from approximately off shore of Brownsville, Texas, on the left bank of the Rio Grande River to the vicinity of Corpus Christi, a total distance of approximately 110 miles. The nature of these islands is somewhat imper-manent. For example, what was formerly Mustang Island immediately north of Padre Island is now an intregal part of Padre Island, although local usage still refers to Mustang Island.

The cross section of Padre Island is typical of the type. On the side of the active waters (surf) the sands are extremely well sorted, generally with good to well rounded grains. Calcareous material is coarse and usually recognizable as shell. Beyond the usual high tide mark at approximately three feet above mean sea level lies an irregular area of beach grass and low brush. This area receives some of the wind blown sand from near the strandline when it has dried out. The vegetation stabilizes the sands and stops the drifting and shifting. It should be pointed out that this line of vegetation is not continuous. There are places not conducive for such growth, and bare sand stretches from the sea to the lagoonal side of the island. The active beach on which the surf falls is quite uniform in width, while the width of the vegetation belt varies considerably.

Beyond the vegetation belt is a zone that appears to be somewhat lower than the vegetated region, for here occurs a zone of relatively flat lying sand without much characteristic. During analysis of the samples it was found that a calcareous cement is usually present in the top one-quarter inch which acts as a binding agent and forms a light crust. Occasionally this zone has its own vegetation and one sample (N-751) shows a mat of fine vegetation and calcareous cement together. Samples from this and the next or lagoonal zone show the widest distribution of sizes. Towards the lagoon there accumulates very finely ground calcareous material which approximates clay particle size. In fact on field examination these samples were believed to be argillaceous, for they possess a dull, earthy appearance. Shell material on the lagoonal side is present, but rare.

Generally, then, these four belts can be found in a cross section of Padre Island anywhere along its length. The widths of the individual belts must shift constantly with seasonal and climatic changes. The vegetation belt may be lacking locally. Also another feature was seen locally. This was an area of unstabilized sand dunes, perhaps as high as 10-15 feet, which in one spot lie directly behind the vegetation zone. However, they did not occur beneath the projected flight line and thus were not sampled.

While these physical zones are discernible to even the untrained eye, they tend to merge and fade upon laboratory analysis. True, the vegetation is nearly eliminated during the sampling process and what little survives that is totally removed subsequently. Nevertheless, the analyses of the various sands shows great consistancy. In every sample the most important sizes are the 0.124 and 0.175mm grains. On the beach side they possess a marked extreme in concentration. The heavy minerals never exceed 2% and are ubiquitous. Calcite, always organic, is present as (1) recognizable shell along the beach, and (2) as a crustal cement and (3) as the finest material towards the lagoon.

Approximately six to twelve hours prior to the collecting flight, Padre Island was swept by a severe electrical storm with moderate accompanying rains. Therefore, the samples collected might have reason to be suspect as to their moisture content. The moisture content of the samples varied from 41.75 to 1.75% and showed a definite pattern correlative with the physical zones. The moisture content of the beach side was lowest, with definite increases through the various belts and the samples of the lagoonal side possessing the highest moisture contents, along with the calcareous fine material.

It should also be noted that during the summer of 1967, coastal Texas has received abnormally low rain fall. This resulted in an unexpected increase in the width of Padre Island and made the recognition of various spits and inlets suggested on the Corpus Christi Sectional Aeronautical Chart quite difficult at several points. There were several places near the oil field, for example, where, at the time of collecting, Padre Island extended to the very margin of the inland waterway.

It was not possible to take as many samples of the island as would be considered optimal. But certainly there is a tremendous region between lines 3 and 6 that shows no discernible change from 250 feet and would have to be considered uniform. Adverse headwinds precluded the planned sampling at the north end of the island which would have placed this report on a slightly firmer footing.

Summarizing the five points of inquiry, it has been determined: (1) Padre Island consists of quartz sand to at least 95% and in many places 98%. (2) Most of the quartz sand measures 0.124 and 0.175mm. Wider variation in sizes is seldom due to quartz grains, but to (a) shell fragments, or (b) calcareous fines. (3) The mineralogy of the grains is exceptionally uniform. The major variation is in the shell material: large in size and quantity on the beach and sometimes in excess of 10% as fines along the lagoon. (4) Surficial vegetation is found to exist irregularly in a zone immediately behind the beach. It stabilizes dunes, but is not ubiquitous. (5) The moisture content varies with the physical zones and is correlative with the vegetation and calcareous fines.

Detailed data for the various samples will be found in the appendix.

Literature Cited

Bullard, F. M., 1942, Source of beach and river sands on Gulf Coast of Texas: Bulletin of the Geological Society of America v. 53, pp. 1021-1044.

Garner, L. E., 1967, Sand resources of the Texas Gulf Coast; Texas Bureau of Economic Geology, R.I. 60. 85 pp.

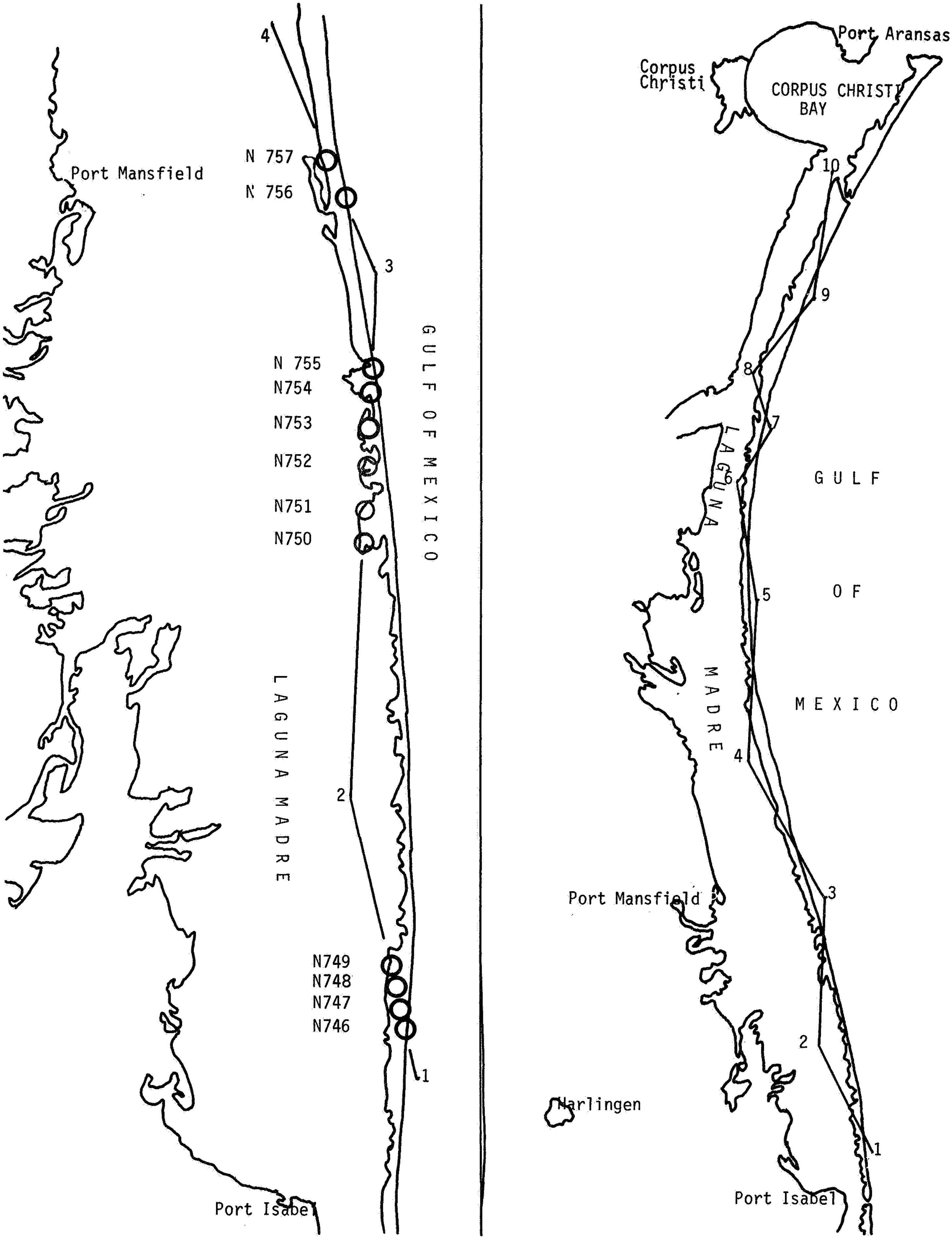
METEOROLOGIC DATA

1967

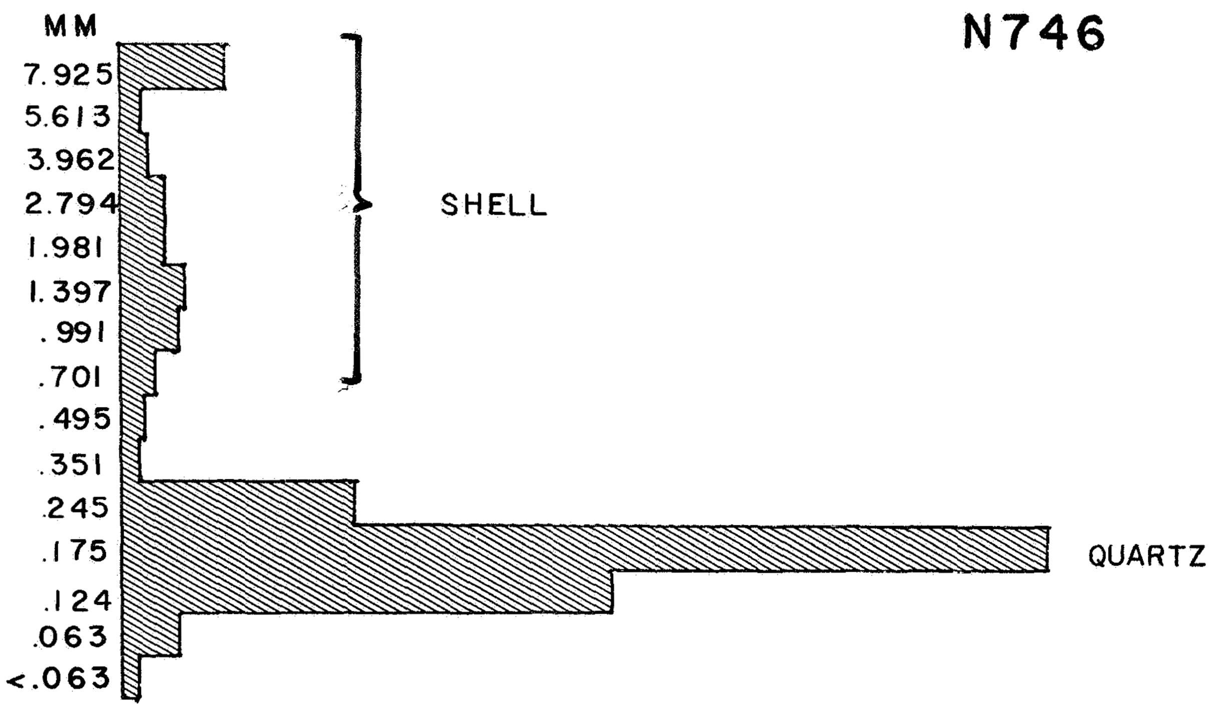
August 17th		Port Aransas	Corpus Christi	Port Mansfield	Port Isabel
	Dry Bulb	84	82	87	86
	Wet Bulb	79	76	85	84
1830 Z	Dew Point	78°	74°	85°	83°
	Relative Humidity	81%	75%	93%	93%
	Mixing Ratio	21.0 gm/Kg	18.0 gm/Kg	26.0 gm/Kg	25.1 gm/Kg
	Dry Bulb	84	82	86	85
	Wet Bulb	79	76	83	83
1930 Z	Dew Point	78°	74°	82°	82°
	Relative Humidity	81%	75%	89%	92%
	Mixing Ratio	21.0 gm/Kg	18.0 gm/Kg	24.0 gm/Kg	24.0 gm/Kg

August 18th		2250 Z	2310 Z	2250 Z	2250 Z
	Dry Bulb	80	83	85	83
	Wet Bulb	76	75	84	81
	Dew Point	74°	72°	83°	80°
	Relative Humidity	82%	70%	96%	92%
	Mixing Ratio	18.4 gm/Kg	17.0 gm/Kg	25.0 gm/Kg	22.4 gm/Kg

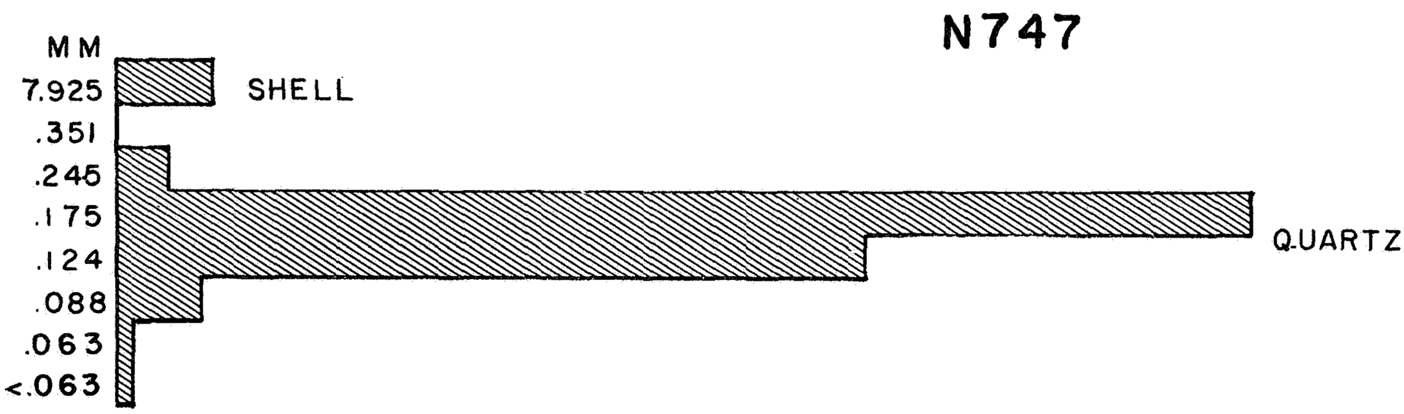
All readings furnished by U. S. Coast Guard Stations indicated
Aircraft flew between 2100 and 2145 Z on 8/18
Local time (Central Daylight Time) = Z - 5 hours



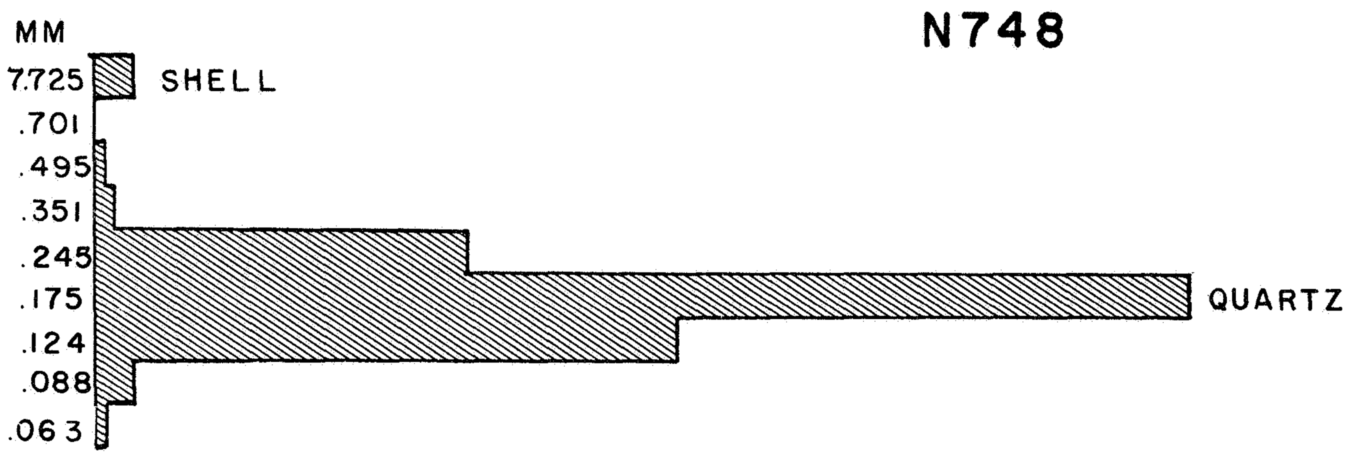
Index map of Padre Island, Texas, showing flight line for acceptance test for the infrared spectrometer, sand sample locations, and sites for meteorologic data.



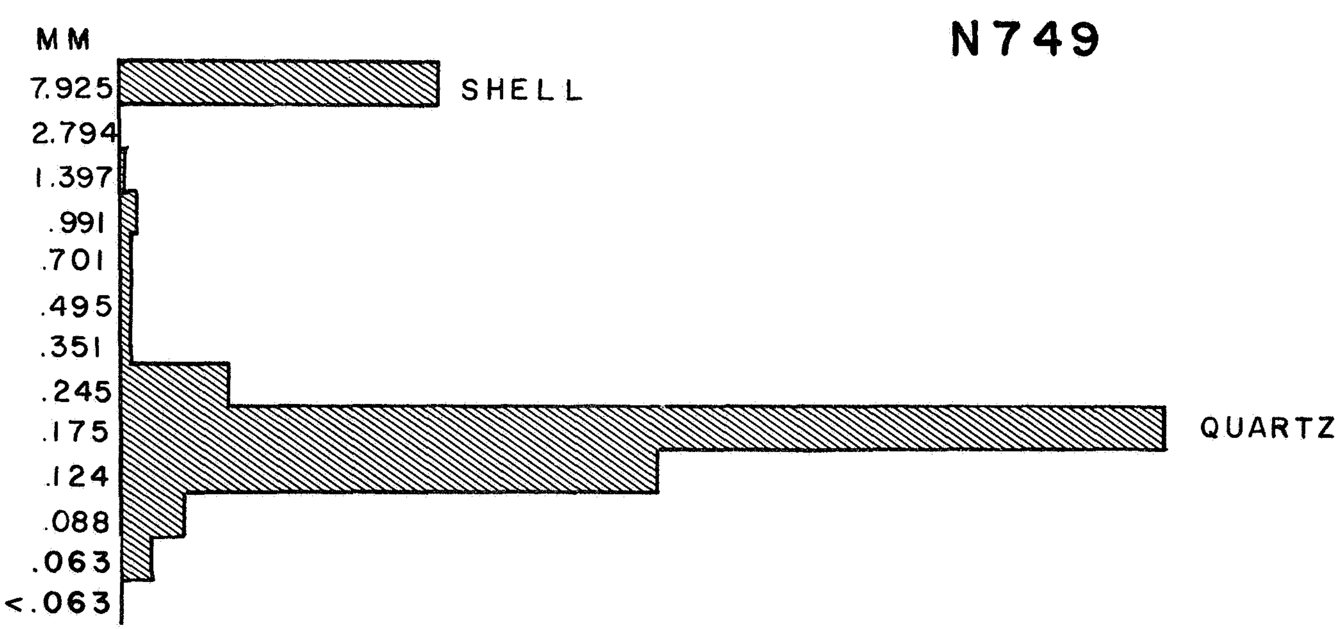
Skewness -.88; Kurtosis +1.96; Wt. % Water 1.75; Phi Mean +1.59; Phi Std. Dev. 1.68



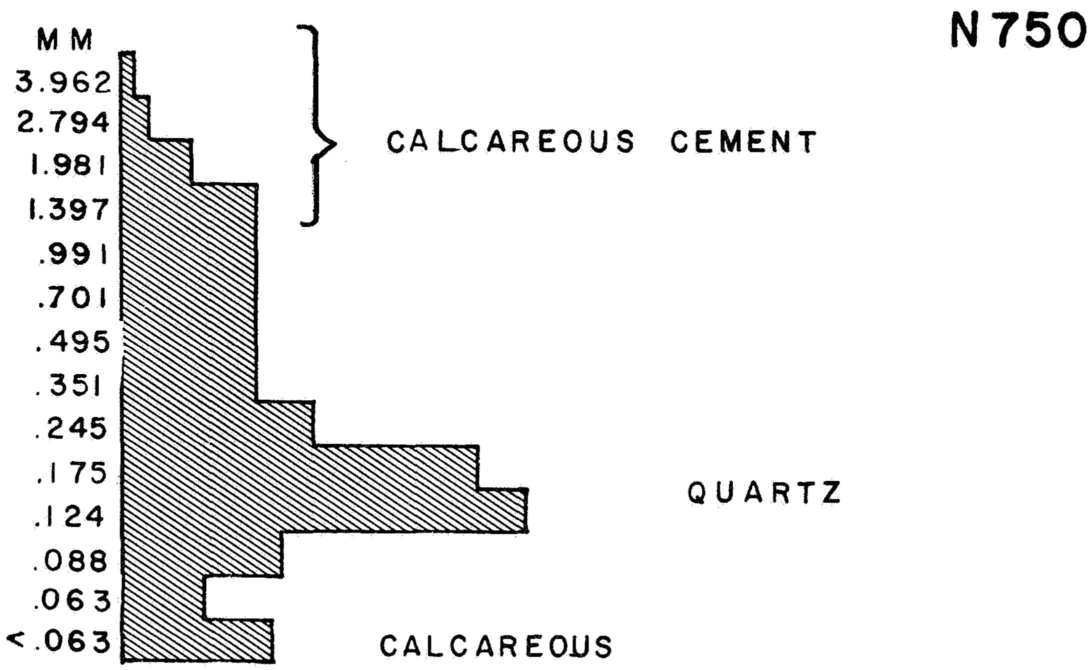
Skewness -1.87; Kurtosis +13.60; Wt. % Water 2.2; Phi Mean +2.21; Phi Std. Dev. 1.26



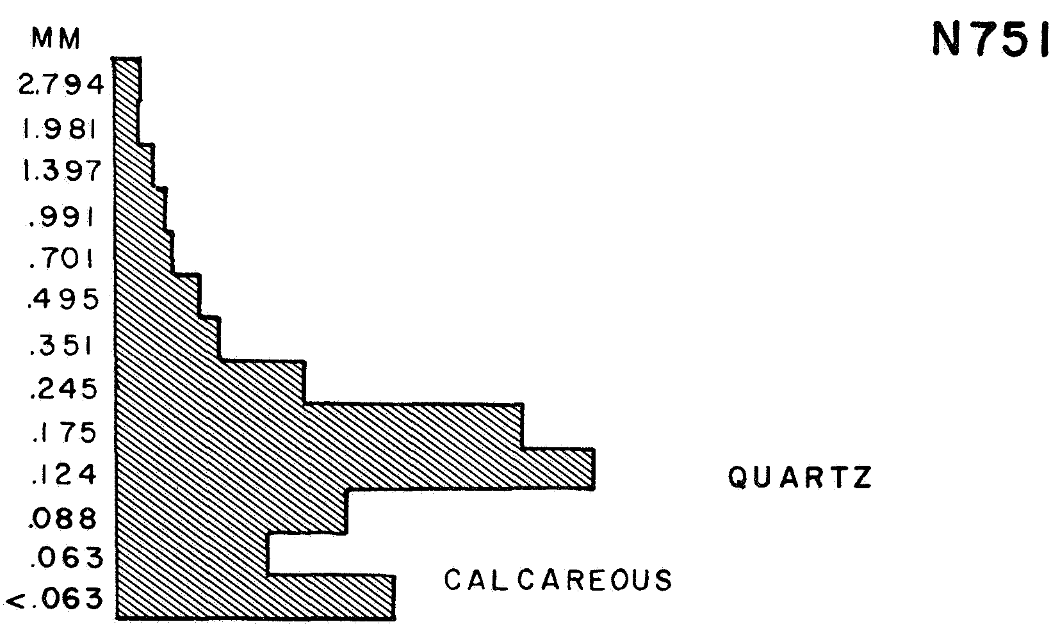
Skewness -2.41; Kurtosis +28.12; Wt. % Water 16.6; Phi Mean +2.20; Phi Std. Dev. .86



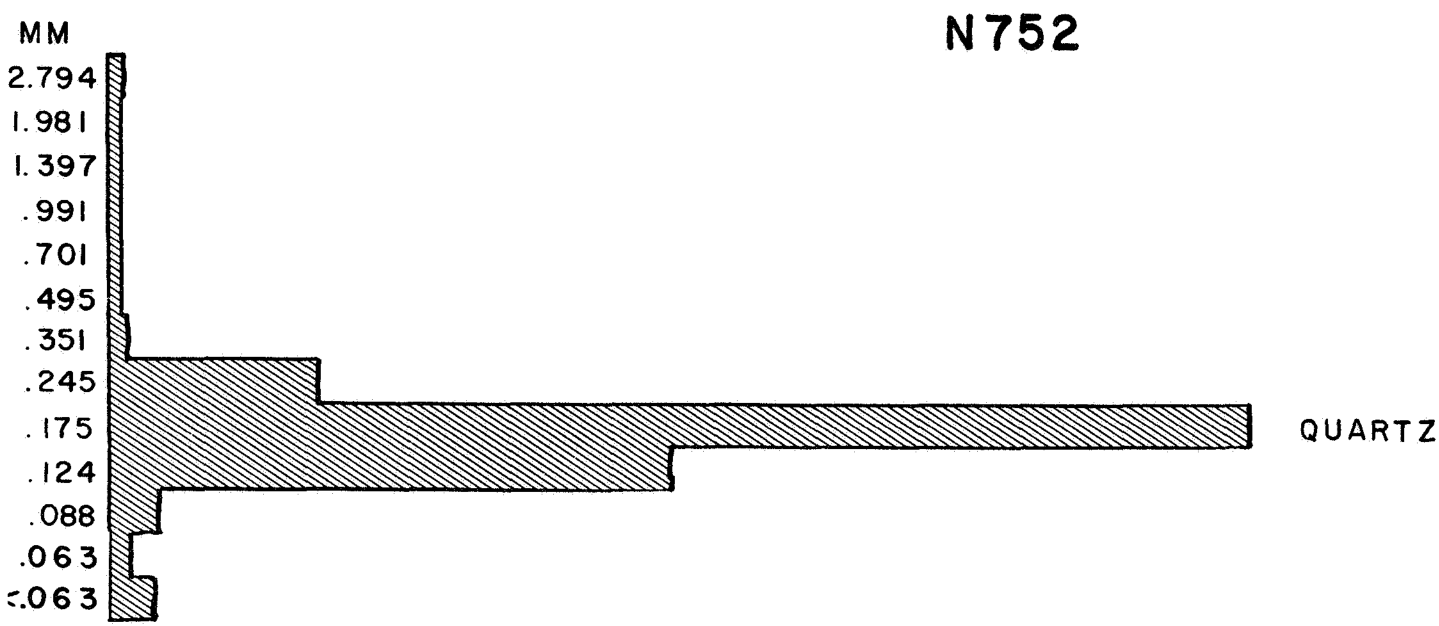
Skewness -.89; Kurtosis +1.47; Wt. % Water 12.8; Phi Mean +1.54; Phi Std. Dev. 2.05



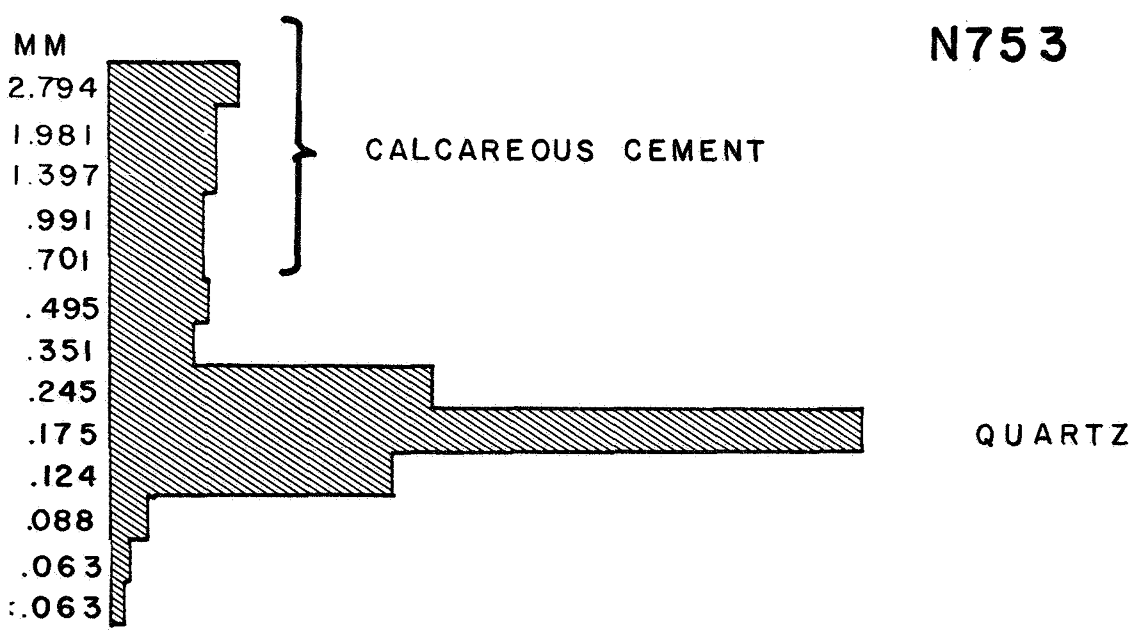
Skewness -.22: Kurtosis -.62: Wt. % Water 41.7: Phi Mean +1.73; Phi Std. Dev. 1.57



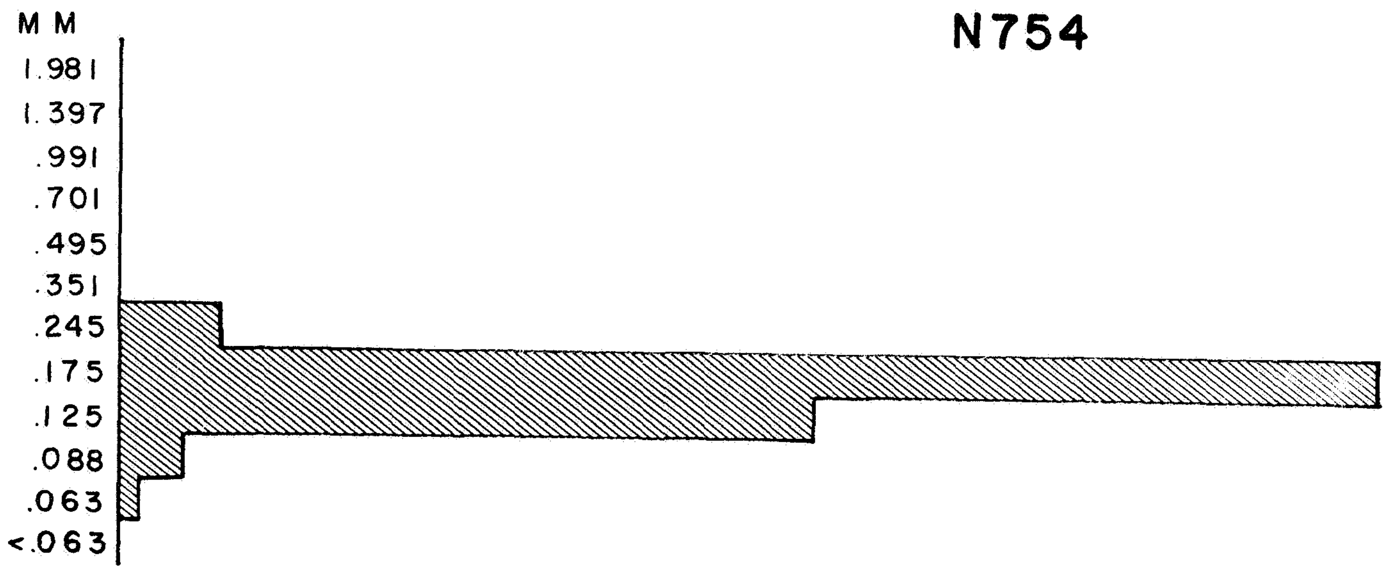
Skewness -.45; Kurtosis +.78: Wt. % Water 31.2: Phi Mean +2.41; Phi Std. Dev. 1.33



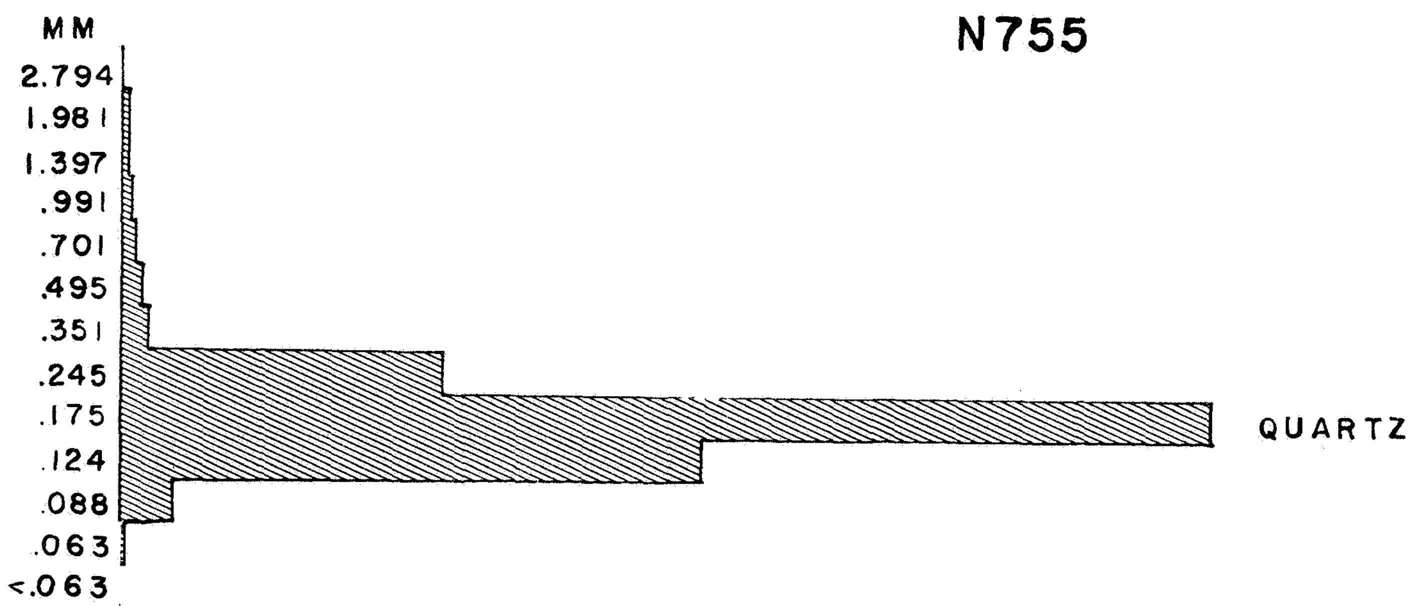
Skewness -1.15; Kurtosis +10.24; Wt. % Water 1.6; Phi Mean +2.28; Phi Std. Dev. .80



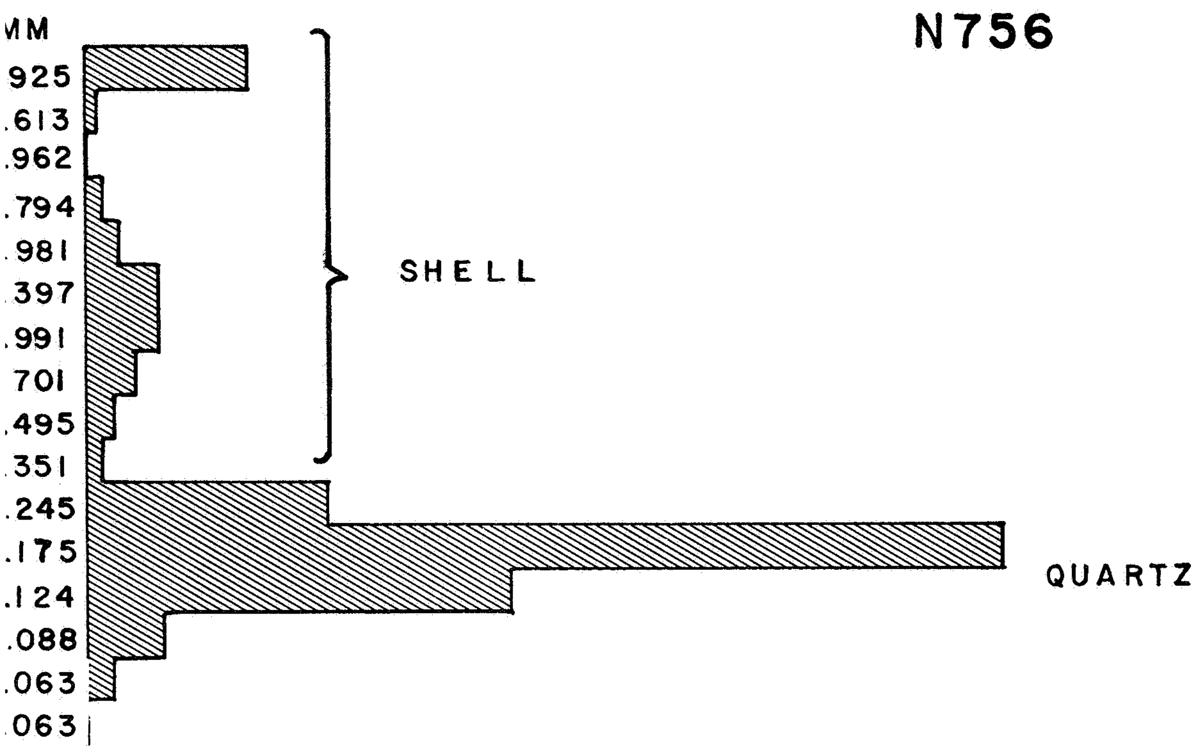
Skewness -.46; Kurtosis -.34; Wt. % Water 14.6; Phi Mean +1.39; Phi Std. Dev. 1.44



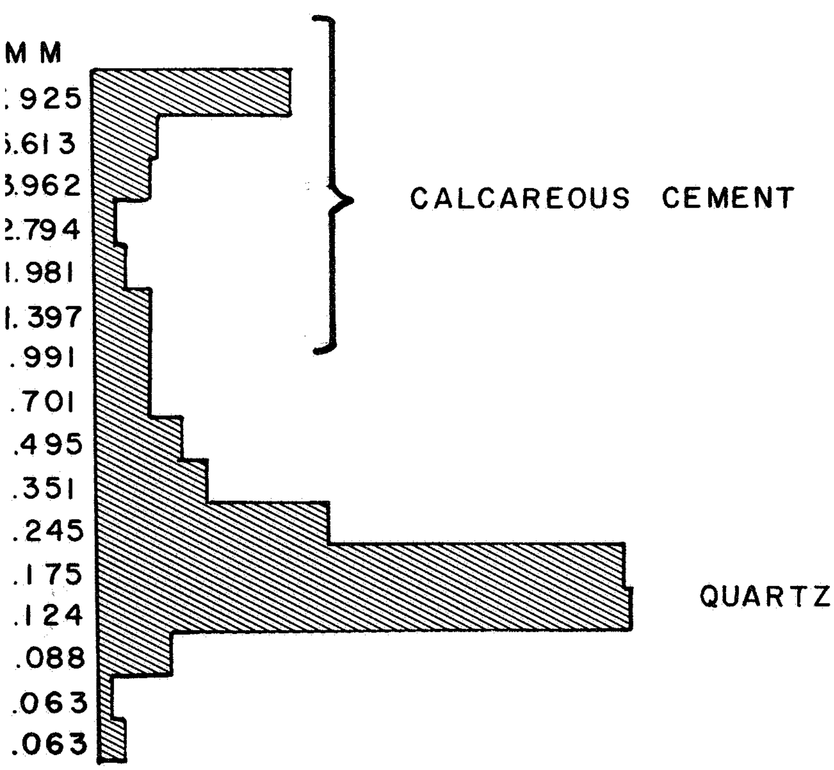
Skewness -.62: Kurtosis +15.69; Wt. % Water 4.7; Phi Mean +2.43; Phi Std. Dev. .40



Skewness -1.11; Kurtosis +11.31; Wt. % Water 15.8; Phi Mean +2.27; Phi Std. Dev. .54

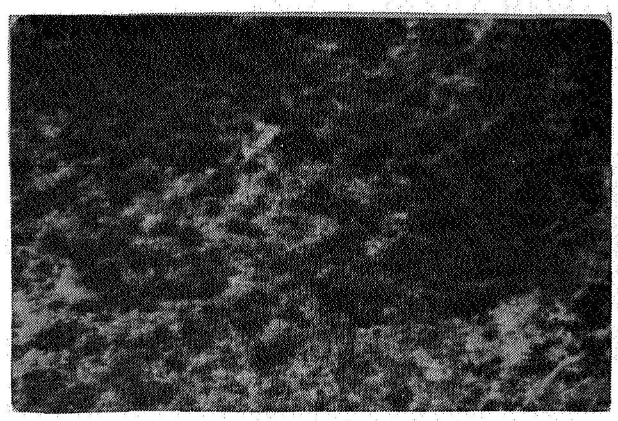


Skewness -.87: Kurtosis +1.95; Wt. % Water 1.75; Phi Mean +1.55 ; Phi Std. Dev. 1.75



Skewness -.57; Kurtosis -.08; Wt. % Water 6.0; Phi Mean +1.17; Phi Std. Dev. 2.06

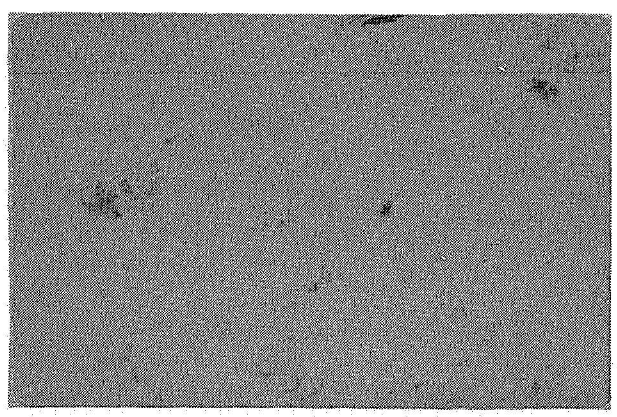
N746 10-15 feet



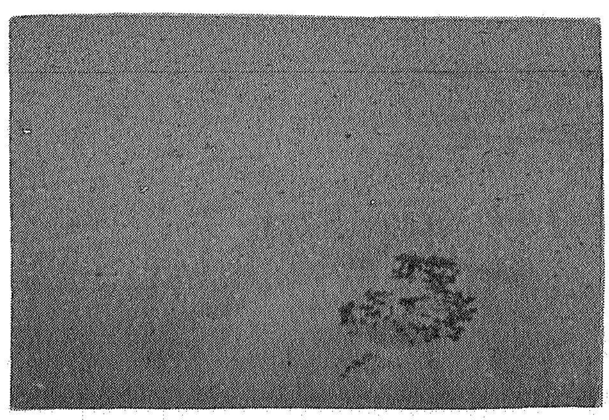
N747 10-15 feet

N748 10-15 feet

M751 30 feet



N754 10-15 feet



N756 20-30 feet

Snaps of representative grab sample sites. Figures give approximate height above terrain for camera level.