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2January 1976

Mr. R. Cunningham

International Engineering

220 Montgomery Street

San Francisco, California

Dear Mr. Cunningham:

Enclosed is the final copy of the report on "Longshore Transport in the vicinity of Ubu, Brazil, based on Heavy Mineral Studies". The large scale map which is an enlargement of Figure 1 of the report is being sent to you under separate cover. An additional copy of the report is being sent to Professor J. W. Johnson.

Enclosed also is a bill for services. If there are any questions, please contact me after 15 January 1976, as I will be on an oceanographic cruise until then.

Yours truly,

Pat Wilde

Pat Wilde
Registered Geologist
No. 997
State of California

LONGSHORE TRANSPORT IN THE VICINITY OF UBU, BRAZIL, BASED ON HEAVY MINERAL STUDIES

by

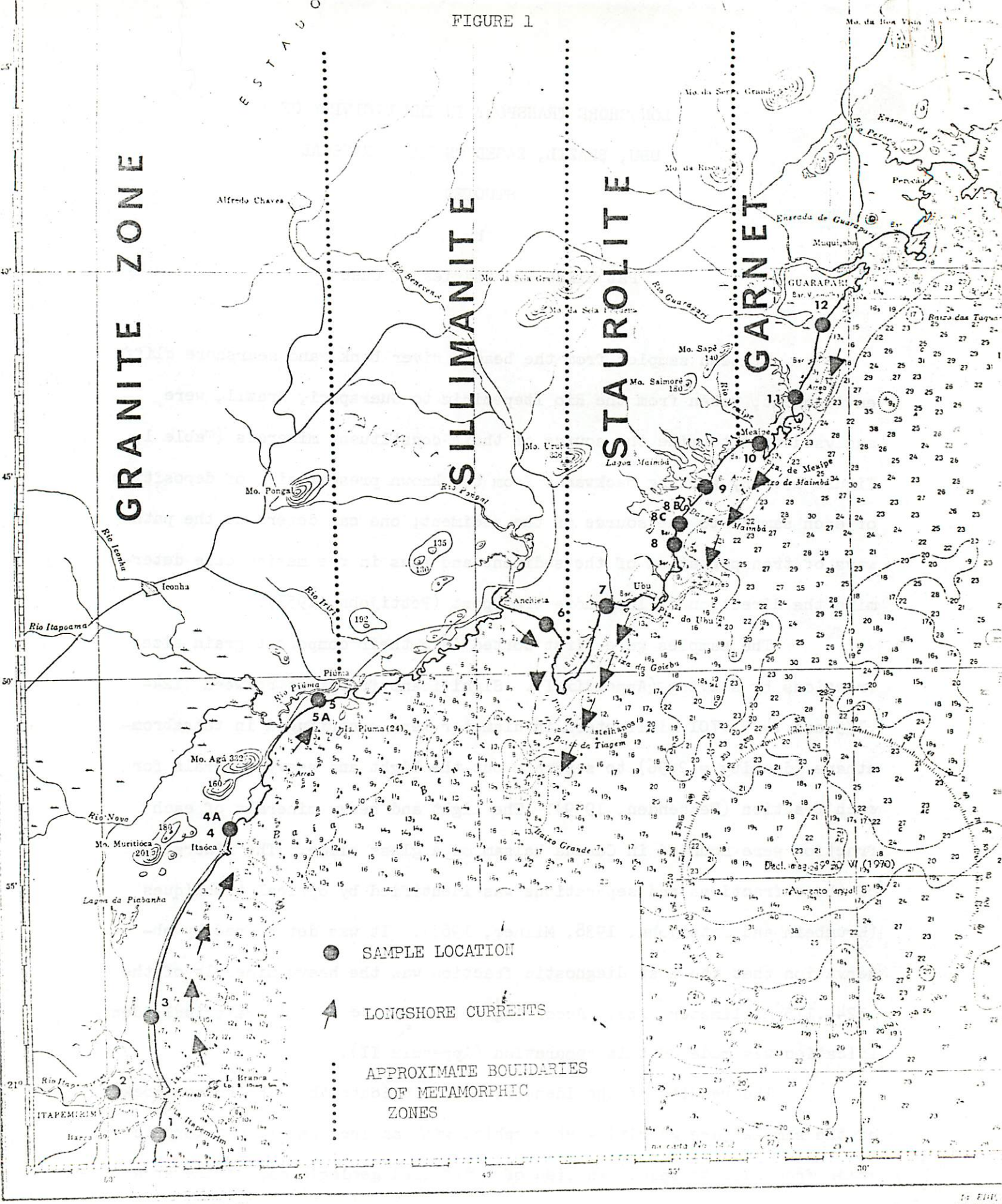
Pat Wilde and Charles W. Case

Sixteen samples from the beach, river bank, and nearshore cliff enviornment, taken from the Rio Itapemirim to Guarapari, Brazil, were analysed to determine the source of their constituent minerals (Table 1, Figure 1). By working backwards from the known present site of deposition of each sample to the source of the sediment; one can determine the pathways of transportation of the sediment and thus in the marine case determine the direction of longshore transport (Pettijohn, 1957).

The samples were first sorted into their component grain size fractions by sieving (Appendix I). Significant fractions between .124-.175 and .495-.701 millimeters in diameter were centrifuged in tetrabromethane (density = 2.96) to separate out the light and heavy minerals for each fraction (Fessenden, 1959). The light and heavy minerals of each fraction were mounted in Canada balsam on a glass slide. The mineralogy of these fractions and separations was identified by optical techniques (Krumbein and Pettijohn, 1938, Milner, 1962). It was determined by observation that the most diagnostic fraction was the heavy minerals of the .124-.175 millimeter size. Accordingly, a complete mineralogical identification was made of this separation (Appendix II).

The results of the identification indicate that the source rocks of the samples are granitic-metamorphic, with an increase in metamorphic grade from east to west. In lieu of a detailed geologic map of the area

FIGURE 1



Pequenas correções

J. PAULINI
Rua Santa Luzia, 15 - Loja J

TABLE ONE

SAMPLE LOCATIONS

Sample #	Location
1	beach 1.5 km south of Rio Itapemirim
2	riverbank at the bridge at the town of Itapemirim
3	beach 1.9 km north of the mouth of Rio Itapemirim
4	beach 1/2 km north of Itaoca
4A	dune sand at same location
5	beach 1/2 km west of the mouth of Rio Piuma
5A	river bank in Rio Piuma west of Piuma
6	beach 1.1 km east of Anchieta
7	beach 1.1 km west of Ubu
8	beach at the Projeto Samarco job site
8B	beach 1/2 km north of location 8 where Lagoa Maimba comes close to the ocean
8C	cliff sand deposit at location 8B
9	beach 1.7 km south of Meaipe
10	beach in Meaipe
11	beach 3.1 km south of Guarapari
12	beach 1.5 km south of Guarapari

SOURCE: 12 May 1975 letter of F. C. Kintzer to L. Moraes

a sketch map of the significant units in shown in Figure 1, based on data from this study. As the angle of the coast in this area is to the northeast, and the metamorphic zonal boundaries are north-south; streams and rivers emptying into the Atlantic here carry sediments containing minerals of increasing metamorphic grade also from north to south. The metamorphic grade to the south apparently is sufficiently high enough to partially re-melt the country rock and produce granites with their characteristic mineral suites.

The analyses of the heavy minerals suggest that the longshore distribution of the beach sediments can be considered as three cells: (1) from Guarapari to the southern end of Barrade Maimba; (2) from the southern tip of Barrade Maimba to Pta. Castelhanos, including Ubu; and (3) from Pta. Castelhanos to the mouth of Rio Itapemirim. In the first cell, the dominant longshore drift is to the south. Material from the intermediate metamorphic rocks in the Rio Meaipe drainage, characterized by staurolite and andalusite, is transported south to produce the barrier bar of Laoga Maimba. In the second cell, around Ubu, the mineralogy shows an abrupt change from location 8 at the Projecto Samarco job site to 8b near the southern edge of the Lagoa Maimba bar. 8b shows the characteristic mineralogy of the Maimba bar but the cliff material here (8c) and at 8 are very different with extremely high values of monazite, a placer mineral rather than a common metamorphic mineral. This indicates that the longshore current by location 8b has essentially been depleted of river-derived material from the north, and that south of 8b the beach material is derived from erosion of the local sea cliffs. At location 7 south of the

town of Ubu, the mineralogy of the beach material has shifted back to the dominance of intermediate rank metamorphic minerals, indicating that the total amount of material contributed by the erosion of the cliffs is small and is swamped wherever local streams drainging the metamorphic terrain reach the coast as near location 7. South and west of Pta. Castelhanos, in the third cell, the mineralogy of the beach material again changes. The influence of the granitic rocks to the south is seen in (1) the lack of intermediate rank metamorphic minerals, (2) the increasing dominance of hornblende (granitic source) to the south, (3) the appearance of sillimanite (high rank metamorphic mineral). In this cell the river transported material dominates over local cliff erosion. The high hornblende content and the lack of intermediate rank metamorphic minerals suggest the longshore drift here is predominately to the north with the major source being the Rio Itapemirim. Local steams that enter the Atlantic near Piuma must flow over similar source rocks as does the Rio Itapemirim. North of Piuma and east of Pta. Castelhanos, the granitic material is mixed with high rank metamorphics as seen at location 6, probably indicative of the Rio Pongal drainage.

SUMMARY-REGIONAL LONGSHORE TRANSPORT

The investigation of the heavy minerals in this area indicates that the major longshore drift north of Pta. Castelhanos is to the south. South of Pta. Castelhanos there is indication of northerly drift which appearantly shifts to the east at the mouth of the Rio Pongal. However, much more detailed sampling is required to completely substantiate the northerly drift. Nonetheless, it is evident that no material from the south gets north of Pta. Castelhanos. The most reasonable explanation of the longshore currents, based on this study, is the northerly drift is a

gyre of the major southerly drift along this coast (Figure 1).

The amount of sediment transported by longshore drift is chiefly determined by (1) the angular wave power imparted to the coast, and (2) the amount of material introduced at the mouths of rivers with a minor contribution from sea cliff erosion. Because of the abrupt changes in the mineralogy around points and the lack of continuous beaches along this coast, the amount of material transported by longshore drift seems relatively small and significant longshore transport is confined to the vicinities of the mouths of rivers. The relatively low wave heights in the area reported by Prof. Johnson also suggest that effective or significant longshore transport is localized.

IMPLICATIONS TO PROJECTO SAMARCO

The heavy mineral studies indicate that at the Projecto Samarco site, the source of the beach sand is primarily local coming from the erosion of sea cliffs in the area. The longshore drift in the area is to the south, but the amount of material must be small as the dominant material is local and not similar in content to the barrier bar of Lagoa Maimba to the north. The complete difference in the mineralogy between the area around Ubu and that of the area to the south and west of Pta. Castelhanos indicates no effective transport to the north. At the site sediment may build up on the north side of the breakwater. An estimate of the amount could be made by calculating the annual retreat of the cliffs in the area north of the Projecto Samarco site. In any case the amount of sediment transported to the site should be small as indicated by the lack of extensive barrier beaches in the immediate area.

REFERENCES

Fessenden, F. W., 1959, Removal of heavy liquid separates from glass centrifuge tubes: Jour. Sed. Petrology, V. 29, p. 621.

Krumbein, W. C. and F. J. Pettijohn, 1938, Manual of Sedimentary Petrology: New York, Appleton-Century-Crofts, 549p..

Milner, H. B., 1962, Sedimentary Petrology, New York, Macmillian, V. II, 715p..

Pettijohn, F. J., 1957, Sedimentary Rocks: New York, Harpers, 718p..

APPENDIX I

GRAIN SIZE ANALYSES

SIZE ANALYSIS

Sample #1

Lat. _____ Long. _____

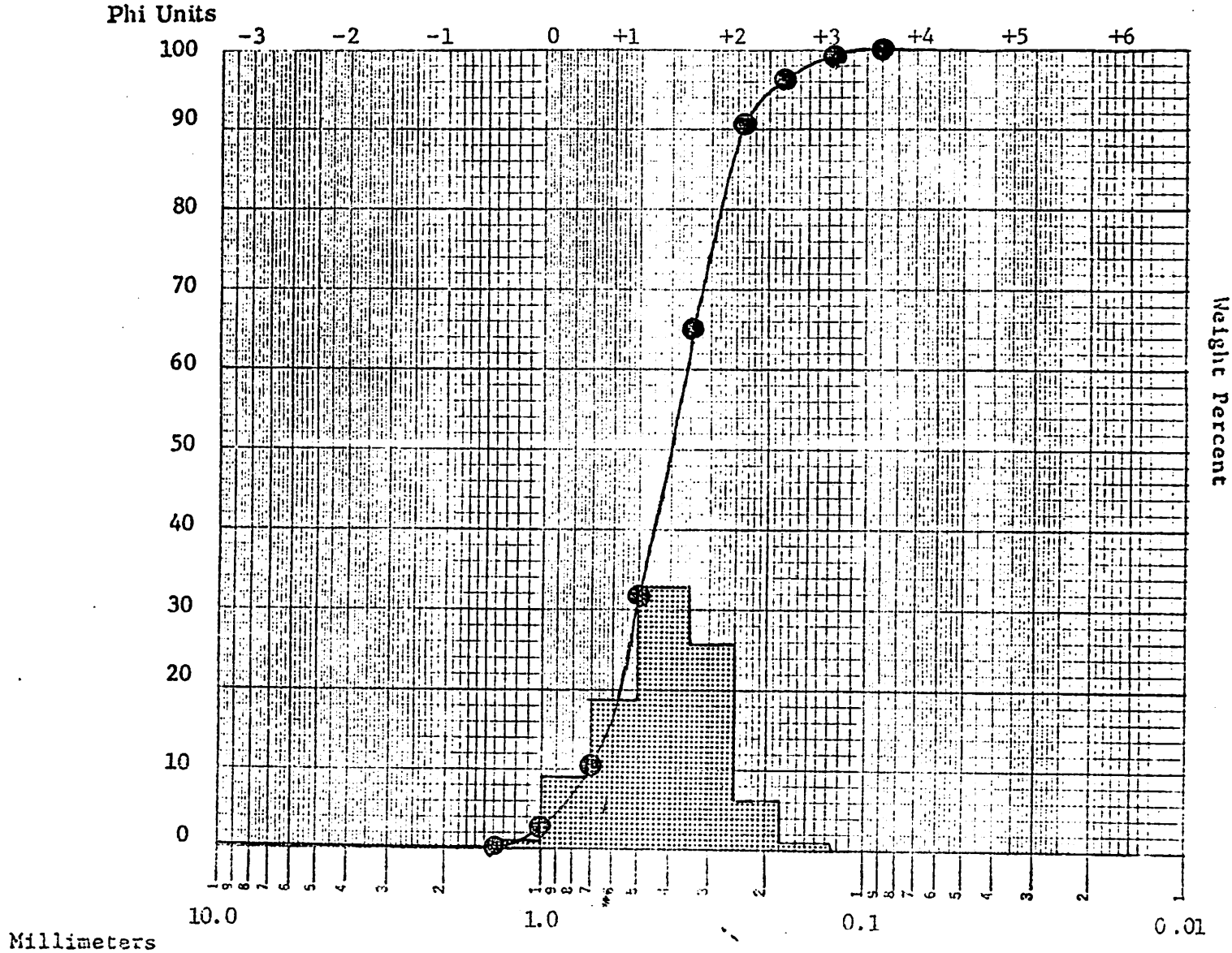
Depth _____ Fathoms

_____ Meters

_____ Feet

Sample description Beach 1.5 km south of Rio Itapemirim

Sample Weight 92.4619 grams



P_{10} .70mm

P_{90} .25mm

SIZE PARAMETERS

1st Mode .351 - .495mm

2nd Mode _____

3rd Mode _____

Q_{25} .53mm

Median .40mm

Q_{75} .32mm

Sorting Coef. 1.287

Skewness 1.060

Kurtosis 0.233

Mean _____

SIZE ANALYSIS

Sample #2

Lat. _____ Long. _____

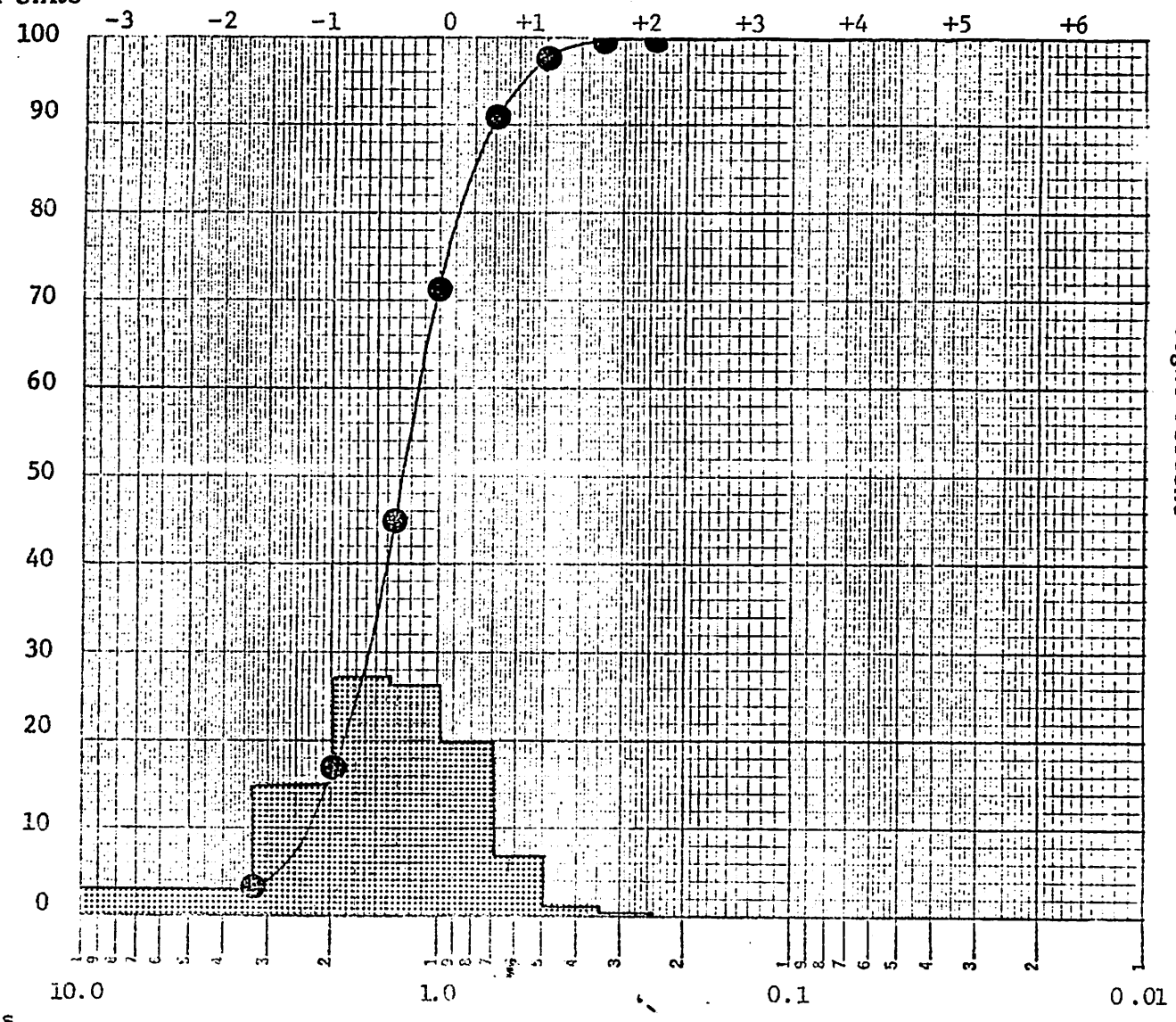
Depth _____ Fathoms

_____ Meters

_____ Feet

Sample description Riverbank at bridge at town of Itapemirim

Sample Weight _____



SIZE PARAMETERS

P_{10} 2.35mm

P_{90} 0.71mm

1st Mode 1.397 - 2.000mm

2nd Mode _____

3rd Mode _____

Q_{25} 1.65mm

Median $_{50}$ 1.30mm

Q_{75} 0.97mm

Sorting Coef. 1.1266

Skewness 0.9470

Kurtosis 0.2073

Mean _____

SIZE ANALYSIS

Sample #3

Lat. _____ Long. _____

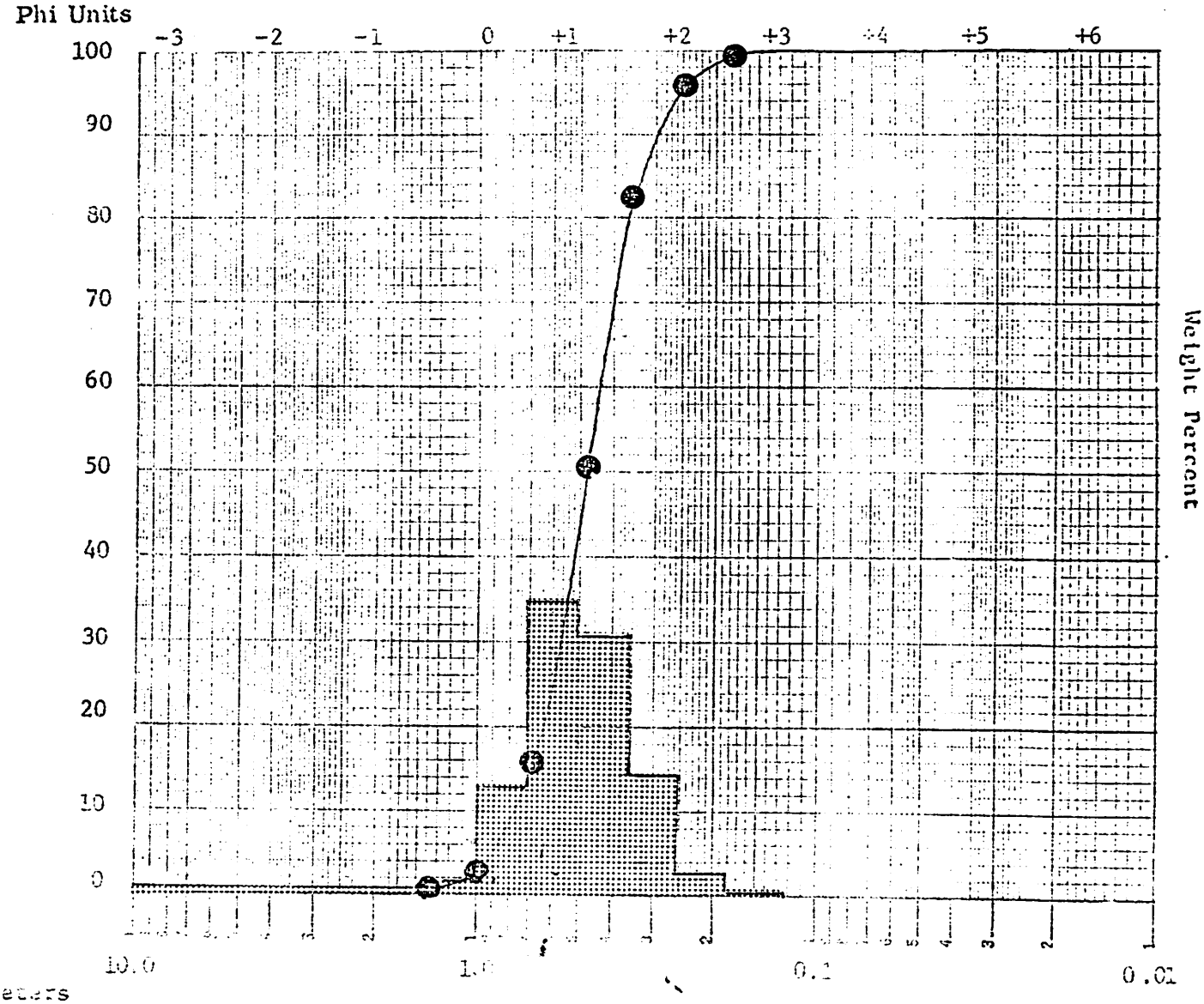
Depth _____ Fathoms

_____ Meters

_____ Feet

Sample description Beach 1.9km north of mouth of Rio Itapemirim

Sample Weight 83.6438 grams



P_{10} 0.77mm

P_{90} 0.33mm

SIZE PARAMETERS

Inclusive Mean .495 - .701mm

0.63mm

Inclusive Std. Dev. 1.271

0.50mm

0.983

0.39mm

0.273

SIZE ANALYSIS

Sample #4

Sample description Beach ½km north of Itaoca

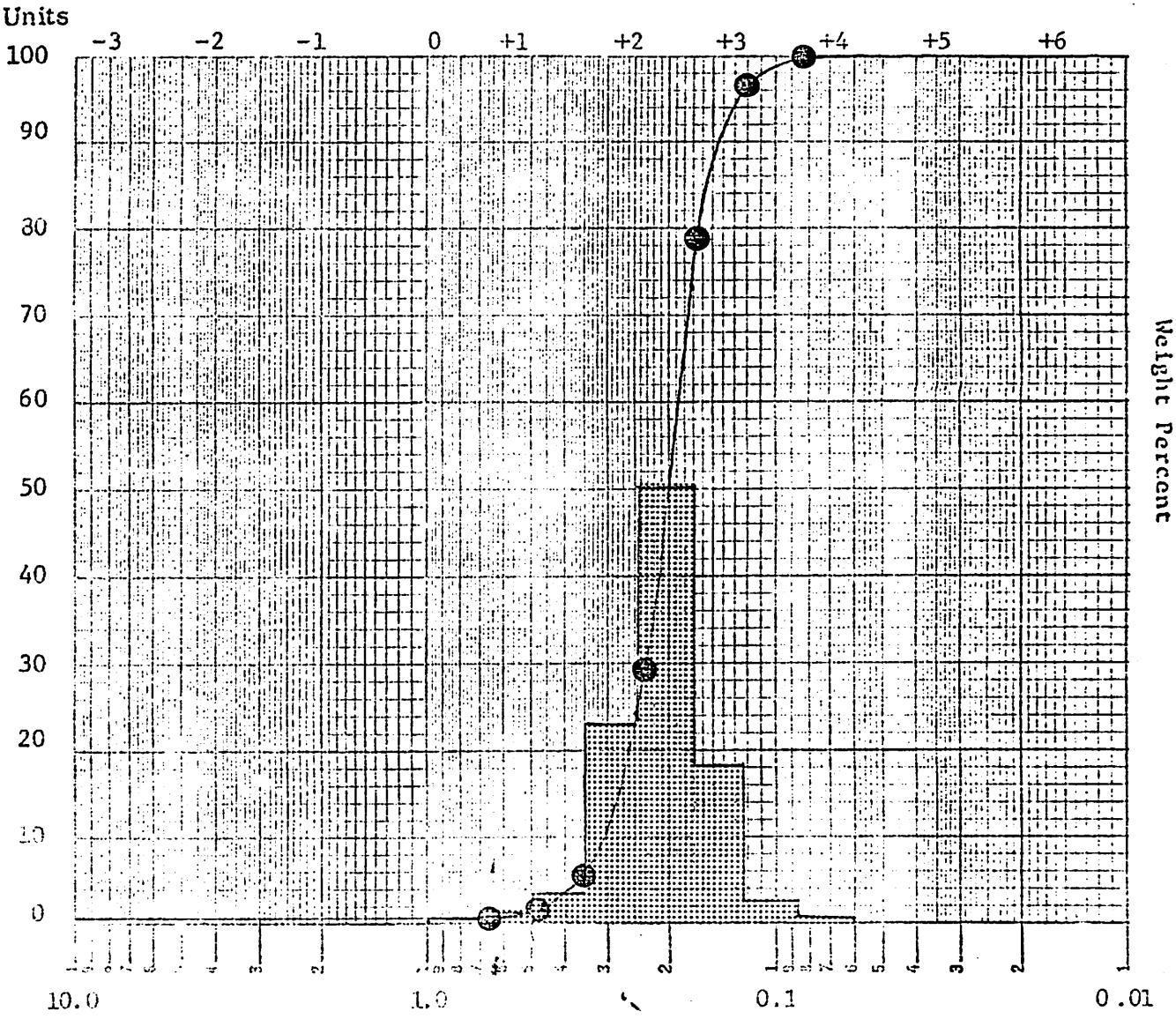
Lat. _____ Long. _____

Depth _____ Fathoms

_____ Meters

_____ Feet

Sample Weight 97.6522 grams



P_{10} 0.30mm

P_{90} 0.140mm

SIZE PARAMETERS

1st Mean .175 - .246mm

M_{25} 0.26mm

Sorting Coef. 1.202

2nd Mean _____

M_{50} 0.21mm

Skewness 0.813

3rd Mean _____

0.18mm

Kurtosis 0.250

Mean _____

SIZE ANALYSIS

Sample #4A

Lat. _____ Long. _____

Depth _____ Fathoms

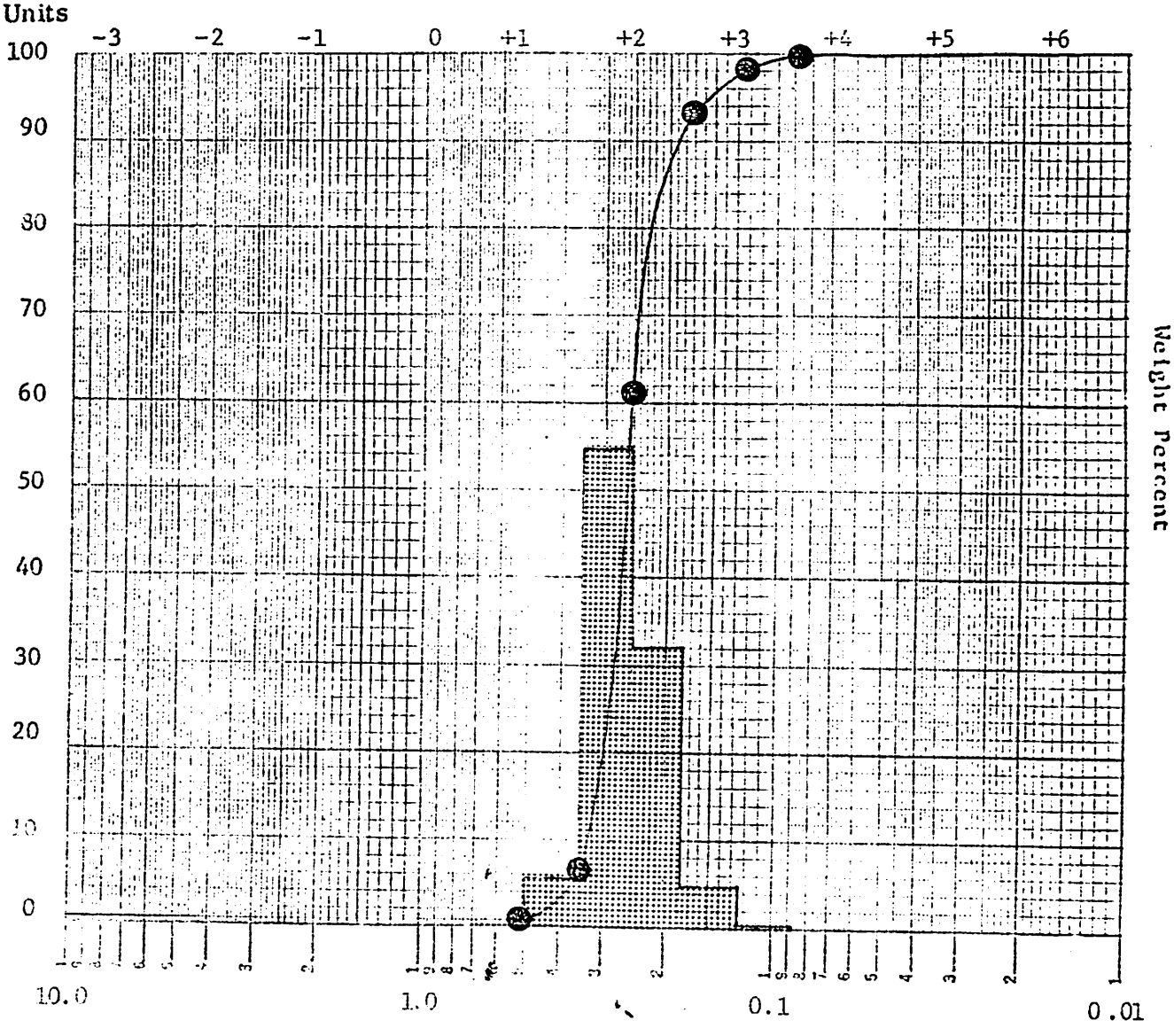
_____ Meters

_____ Feet

Sample description Dune sand - beach

½km north of Itaoca

Sample Weight 121.5199 grams



P_{10} 0.31mm

P_{90} 0.185mm

SIZE PARAMETERS

1st Mode .246 - .351mm

2nd Mode

Median 0.26mm

Q_{25} 0.29mm

Q_{75} 0.24mm

Sorting Coef. 1.099

Skewness 1.030

Kurtosis 0.161

Mean

SIZE ANALYSIS

Sample #5

Lat. _____ Long. _____

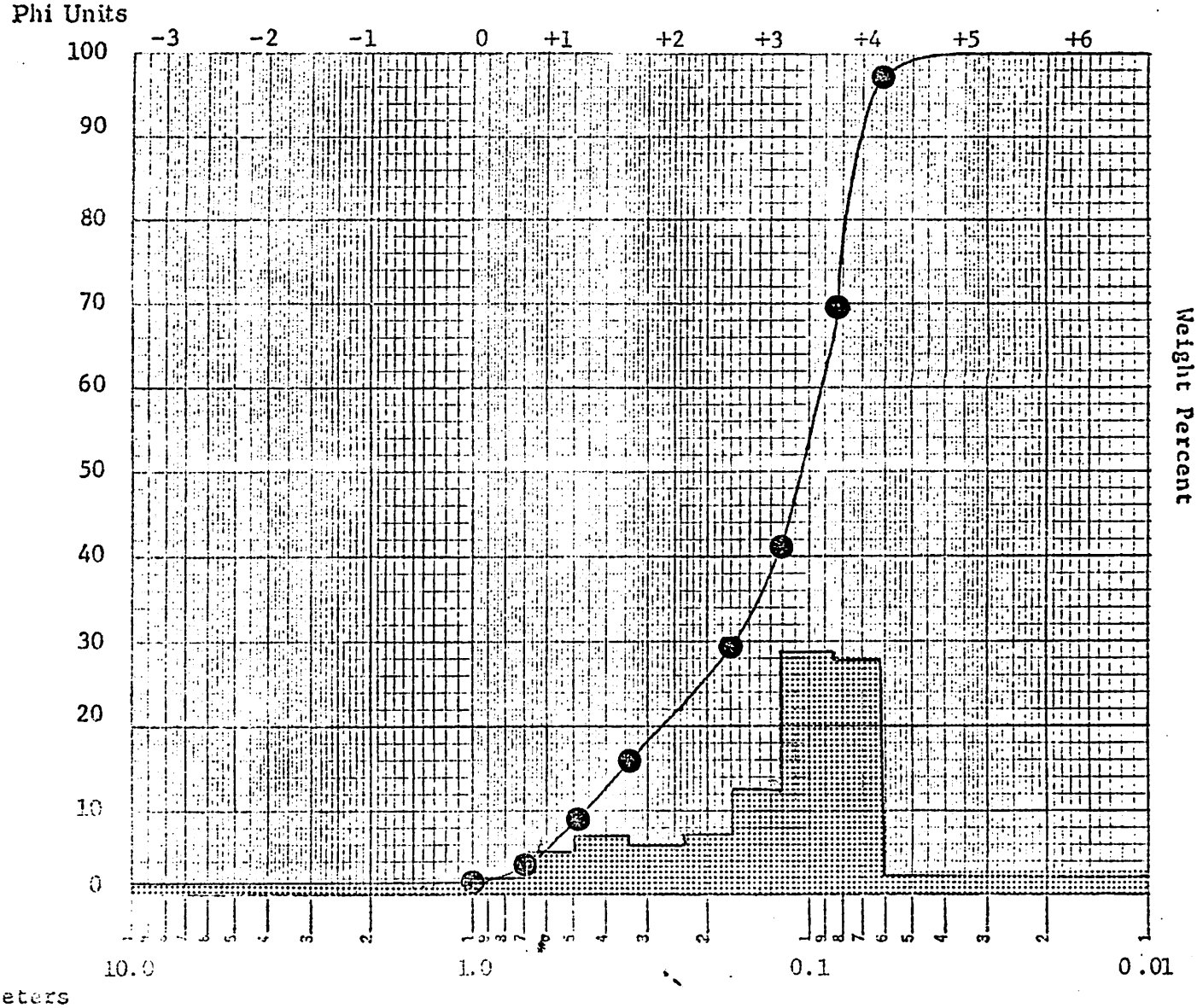
Depth _____ Fathoms

_____ Meters

_____ Feet

Sample description Beach ½km west of mouth of Rio Piuma

Sample Weight 83.4690 grams



P_{10} 0.16mm

P_{90} 0.080mm

SIZE PARAMETERS

1st Mode .088 - .124mm

2nd Mode _____

3rd Mode _____

Q_{25} 0.21mm

Median 0.105mm

Q_{75} 0.085mm

Sorting Coef. 1.572

Skewness 1.619

Kurtosis 0.165

Mean _____

SIZE ANALYSIS

Sample #5A

Lat. _____ Long. _____

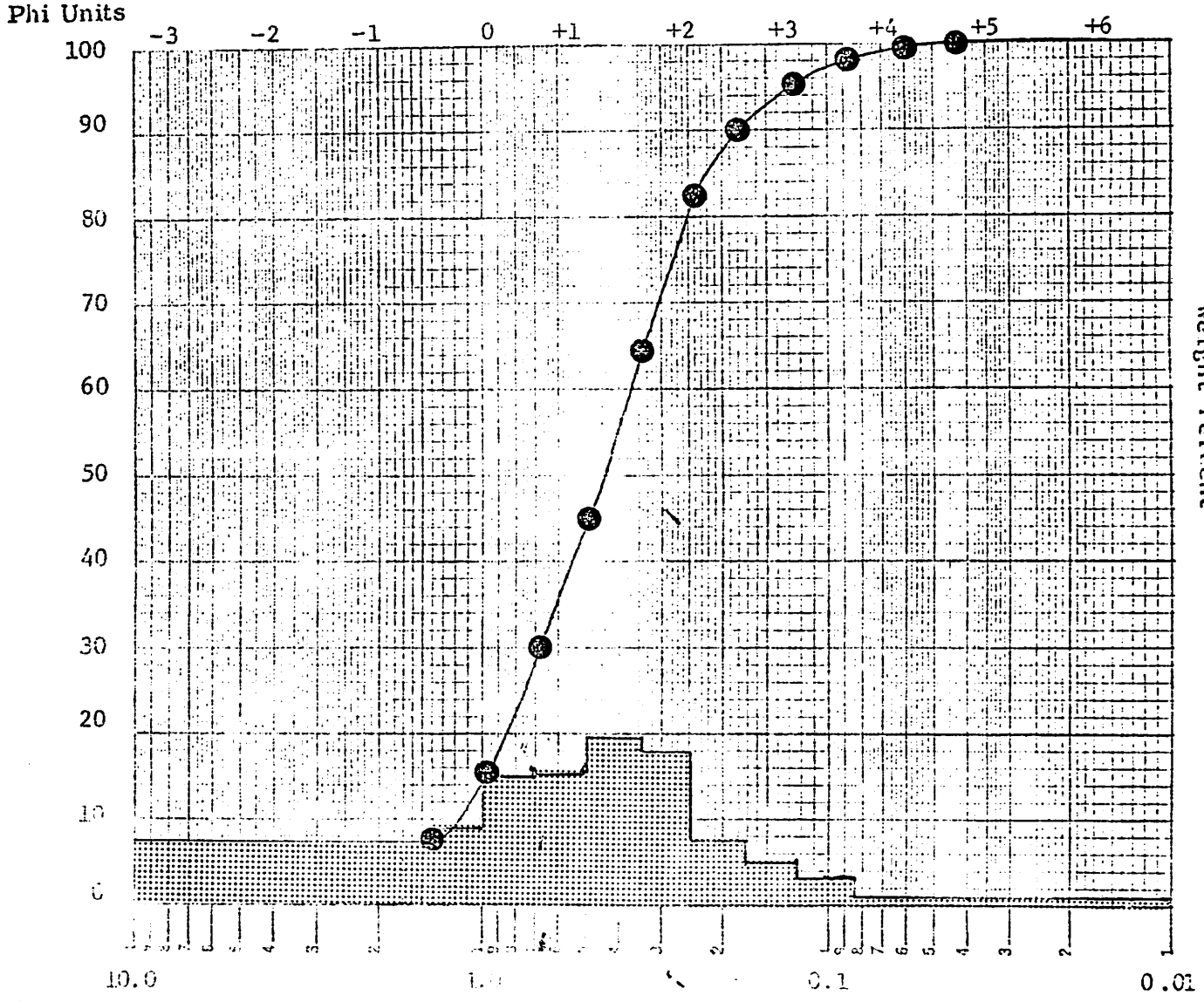
Depth _____ Fathoms

_____ Meters

_____ Feet

Sample description River bank in Rio Piuma west of Piuma

Sample Weight 83.9189 grams



P_{10} 1.20mm

P_{90} 0.170mm

SIZE PARAMETERS

1st Mom. .351 - .495mm ... 0.76mm ... Sorting Coef. 1.648

2nd Mom. ... Mean 0.435mm Skewness 1.051

3rd Mom. ... 0.2?mm ... Kurtosis 0.233

SIZE ANALYSIS

Sample #6

Lat. _____ Long. _____

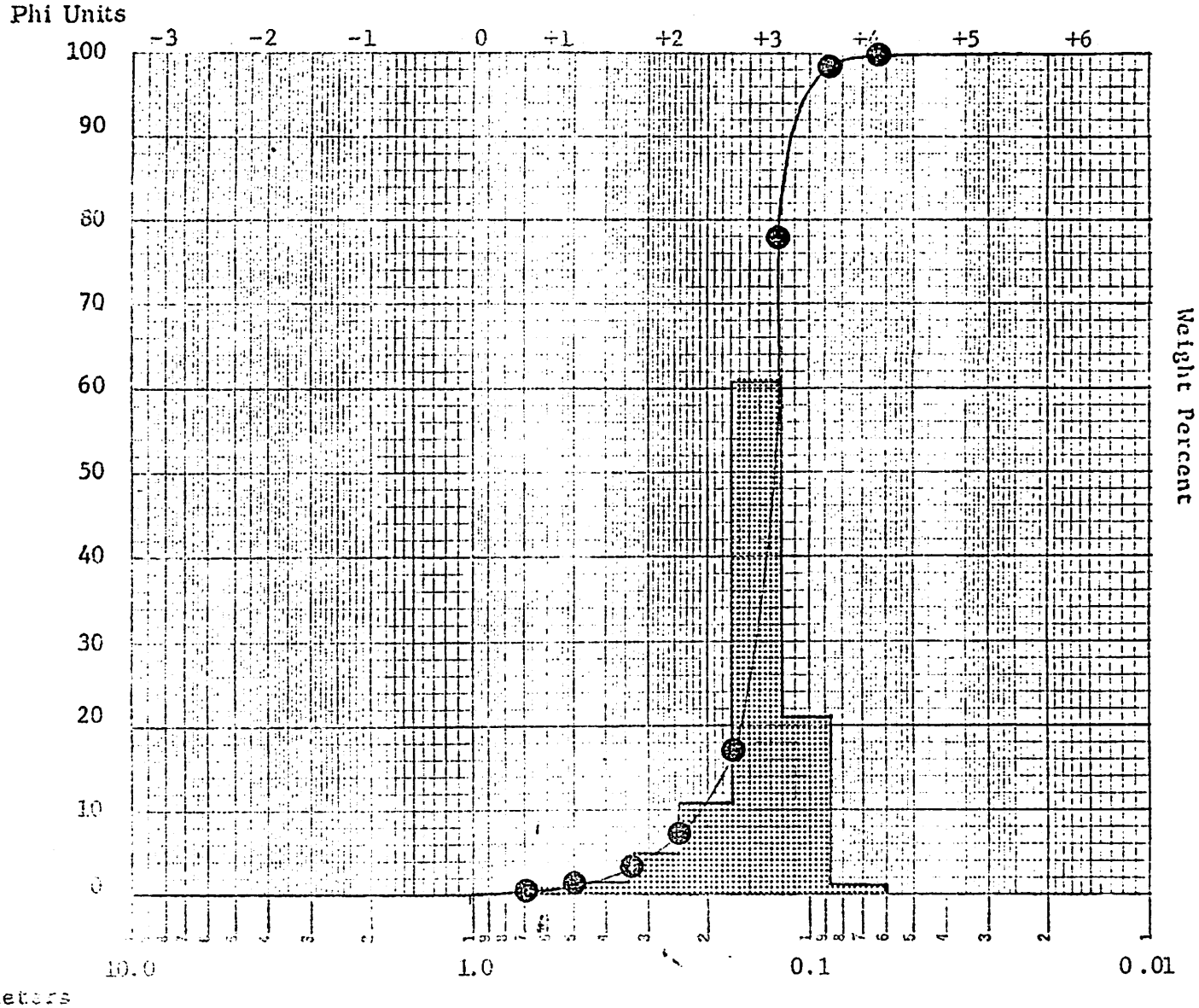
Depth _____ Fathoms

_____ Meters

_____ Feet

Sample description Beach 1.1km east of Anchieta

Sample Weight 115.5604 grams



P_{10} 0.21mm

P_{90} 0.115mm

SIZE PARAMETERS

1st Mode .124 - .175mm

2nd Mode _____

3rd Mode _____

Q_{25} 0.15mm

Median 0.13mm

Q_{75} 0.125mm

Sorting Coef. 1.095

Skewness 1.110

Kurtosis 0.132

Mean _____

SIZE ANALYSIS

Sample #7

Lat. _____ Long. _____

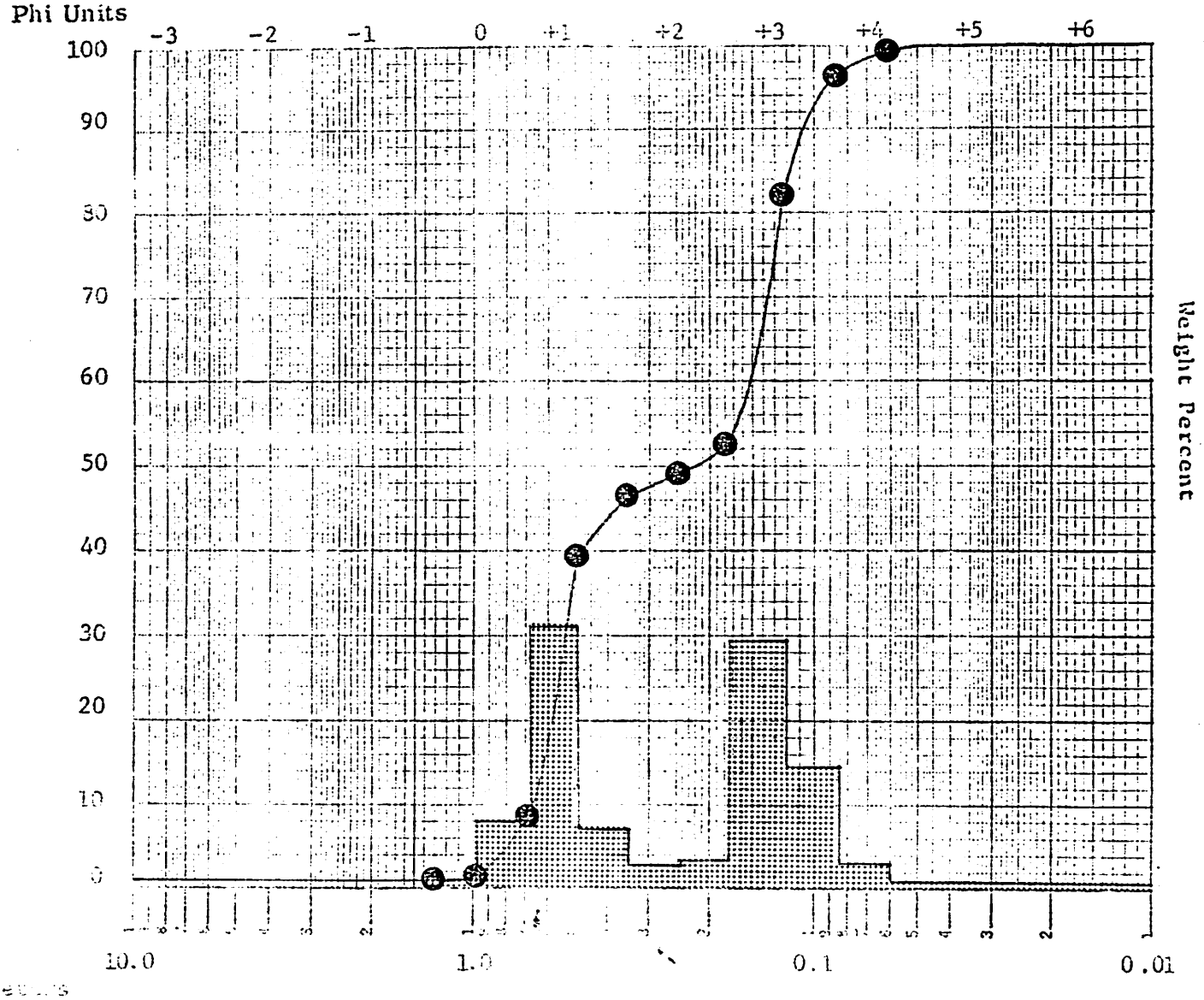
Depth _____ Fathoms

_____ Meters

_____ Feet

Sample description Beach 1.1km west of Ubu

Sample Weight 79.2832 grams



P_{10} 0.67mm

P_{90} 0.11mm

[illegible]	.495 - .701mm	0.56mm	[illegible] 2.076
[illegible]	.124 - .176mm	0.23mm	[illegible] 1.376
[illegible]		0.13mm	[illegible] 0.384

SIZE ANALYSIS

Sample #8

Lat. _____ Long. _____

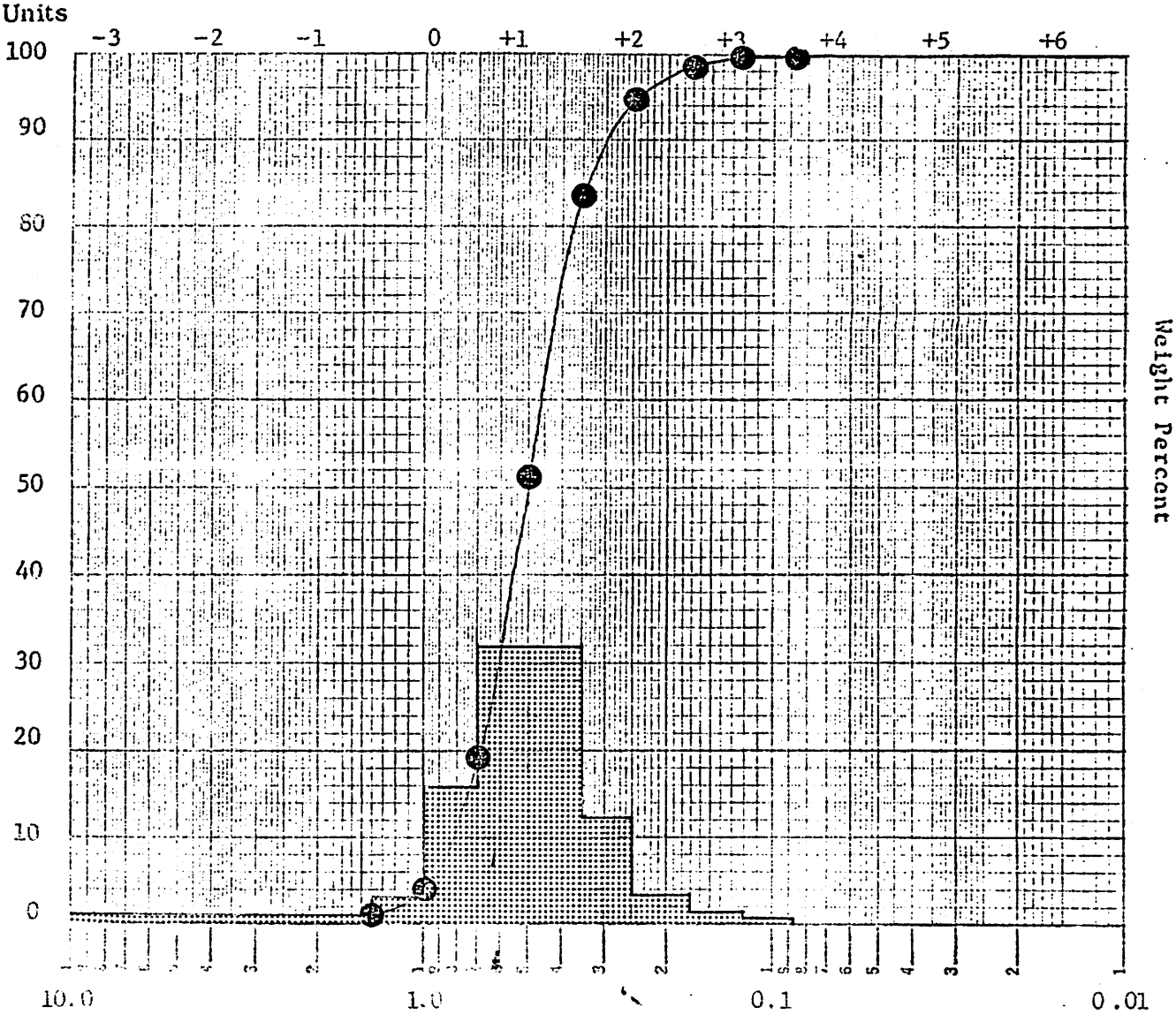
Depth _____ Fathoms

_____ Meters

_____ Feet

Sample description Beach at Projeto Samarco job site

Sample Weight 132.8456 grams



P_{10} 0.80mm

P_{90} 0.31mm

SIZE PA[illegible]

1st Mod .351 - .701mm

[illegible] 0.65mm

Sorting Coef. 1.275

[illegible] 0.52mm

Skewness 0.962

[illegible] 0.40mm

Kurtosis 0.255

Mean _____

SIZE ANALYSIS

Sample #8B

Lat. _____ Long. _____

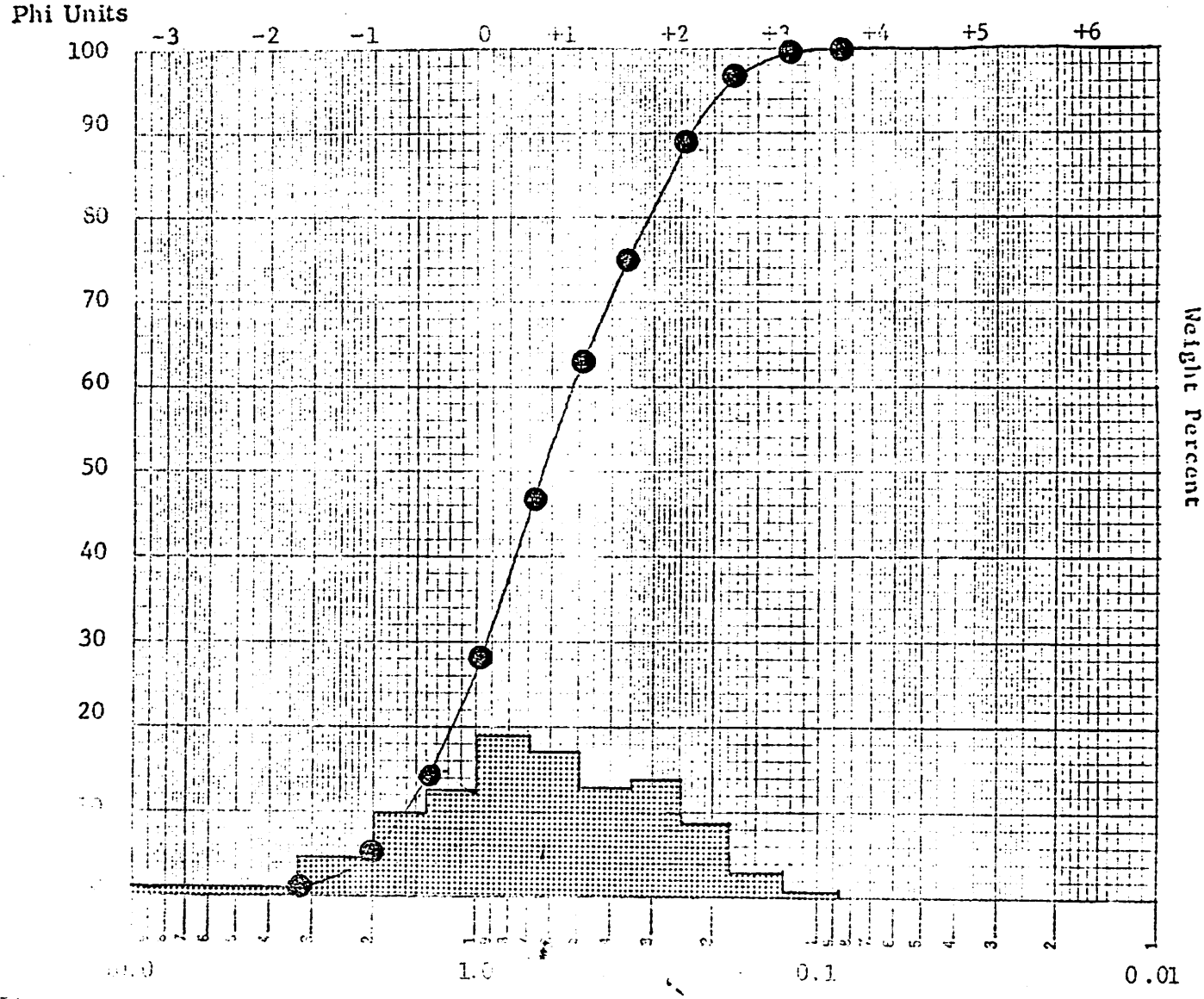
Depth _____ Fathoms

_____ Meters

_____ Feet

Sample description Beach ½km north of Projeto Samarco job site

Sample Weight 99.9731 grams



Millimeters

P_{10} 1.60mm

P_{90} 0.24mm

.701 - .991mm

1.05mm

1.732

0.66mm

0.35mm

0.257

SIZE ANALYSIS

Sample #8C

Lat. _____ Long. _____

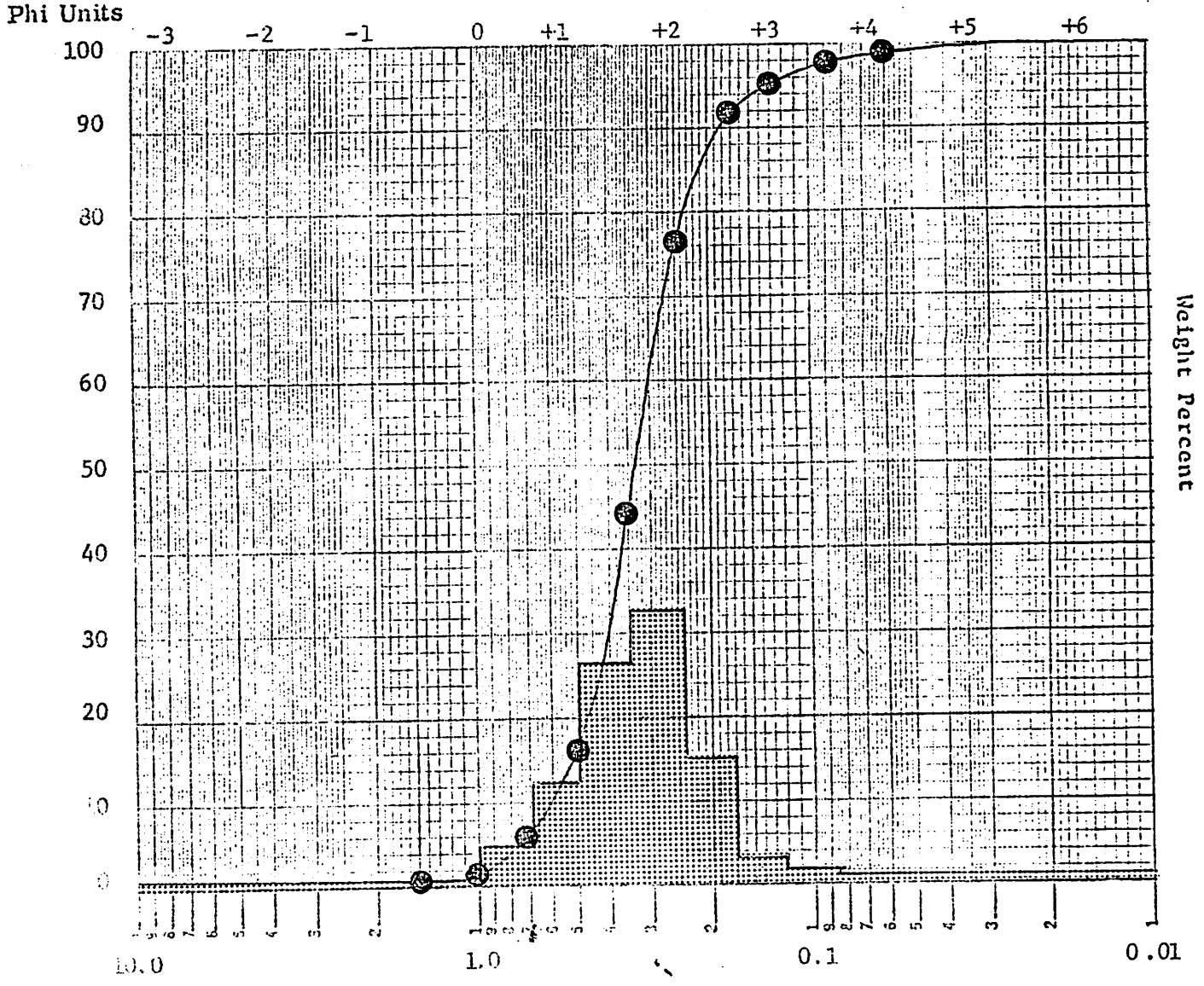
Depth _____ Fathoms

_____ Meters

_____ Feet

Sample description Cliff sand deposit ½km north of Projeto Samarco job site

Sample Weight 135.3521 grams



P_{10} 0.60mm

P_{90} 0.18mm

SAS PARAMETERS

.246 - .351mm

Q_{25} 0.44mm

Median 0.35mm

Q_{75} 0.255mm

Sorting Coef. 1.314

Skewness 0.916

Kurtosis 0.220

Mean _____

SIZE ANALYSIS

Sample #9

Lat. _____ Long. _____

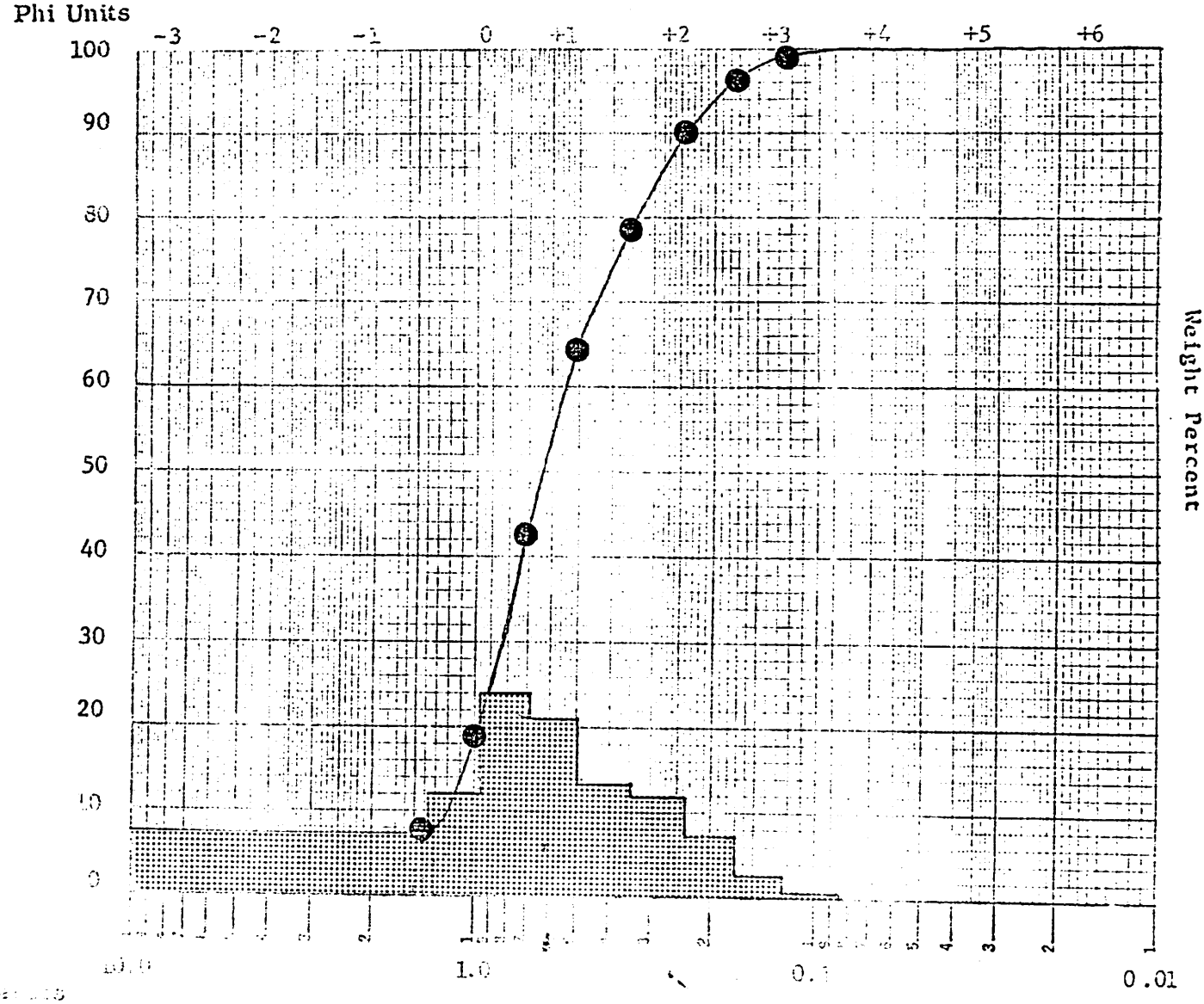
Depth _____ Fathoms

_____ Meters

_____ Feet

Sample description Beach 1.7km south of Meaipe

Sample Weight 118.0705 grams



Millimeters

P_{10} > 1.397mm

P_{90} 0.21mm

.707 - .991mm 0.90mm 1.500

0.61mm 0.879

0.10mm -

SIZE ANALYSIS

Sample #10

Lat. _____ Long. _____

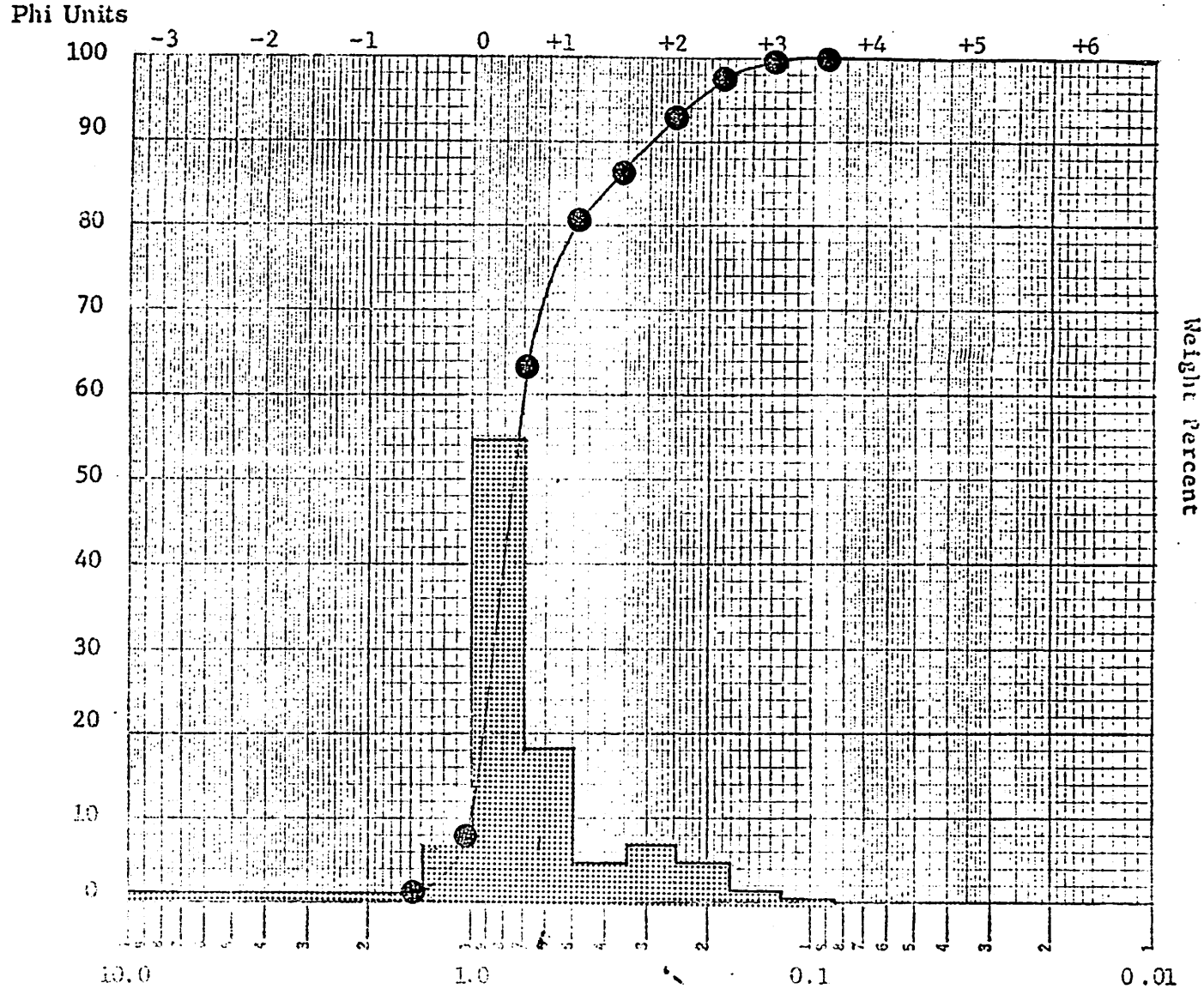
Depth _____ Fathoms

_____ Meters

_____ Feet

Sample description Beach in Meaipe

Sample Weight 88.0086 grams



P_{10} 0.96mm

P_{90} 0.29mm

SIZE PARAMETERS

1st Mode .701 - .991mm

2nd Mode _____

3rd Mode _____

Q_3 0.78mm

Median 0.71mm

Q_1 0.57mm

Sorting Coef. 1.170

Skewness 0.812

Kurtosis 0.157

Mean _____

SIZE ANALYSIS

Sample #11

Lat. _____ Long. _____

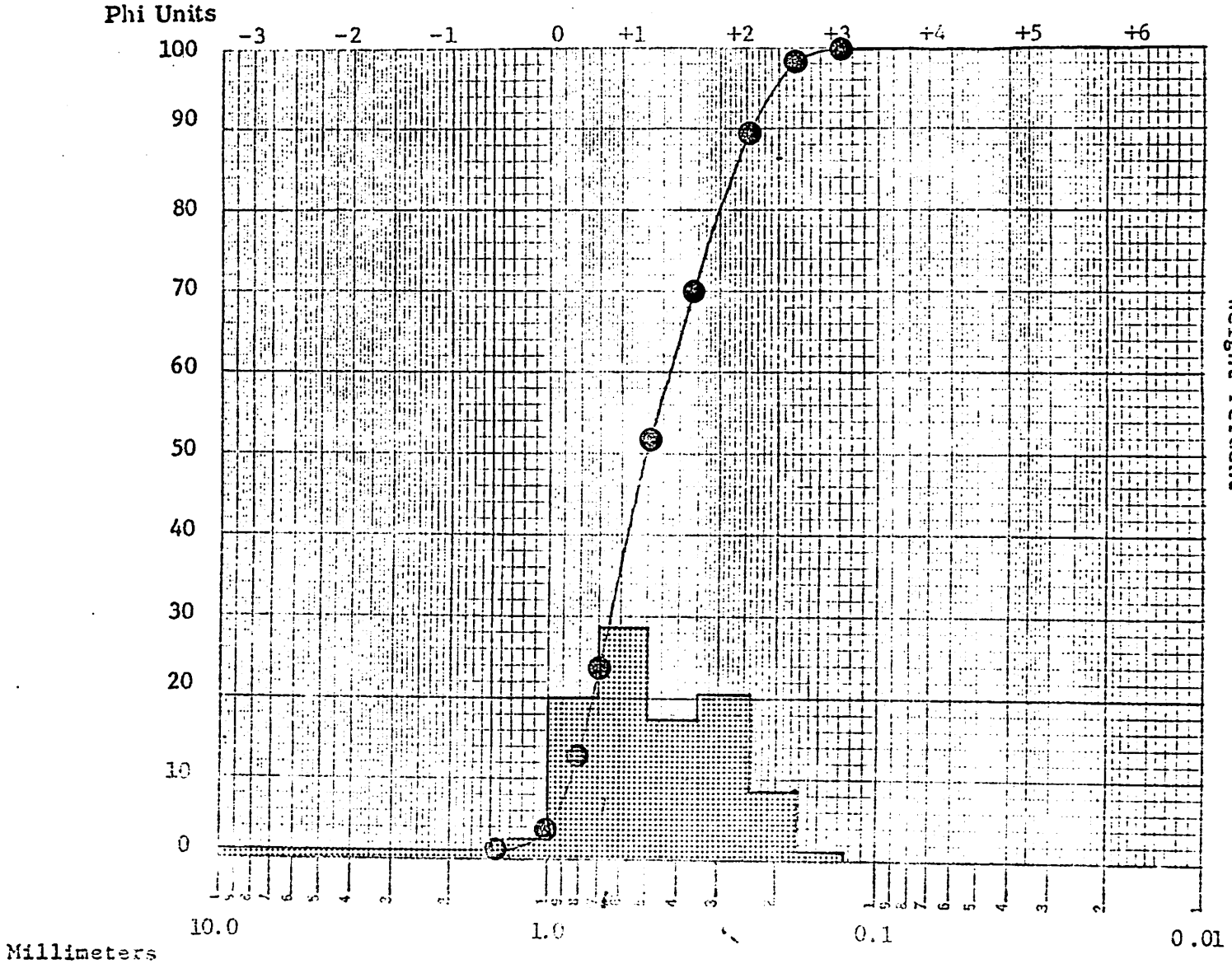
Depth _____ Fathoms

_____ Meters

_____ Feet

Sample description Beach 3.1 km south of Guarapari

Sample Weight 85.4077 grams



P_{10} 0.81mm

P_{90} 0.235mm

SIZE PARAMETERS

1st Mode .495 - .701mm

2nd Mode _____

3rd Mode _____

Median 0.68mm

Mean 0.49mm

Sorting Coef. 1.356

Skewness 1.818

Kurtosis 0.356

SIZE ANALYSIS

Sample #12

Lat. _____ Long. _____

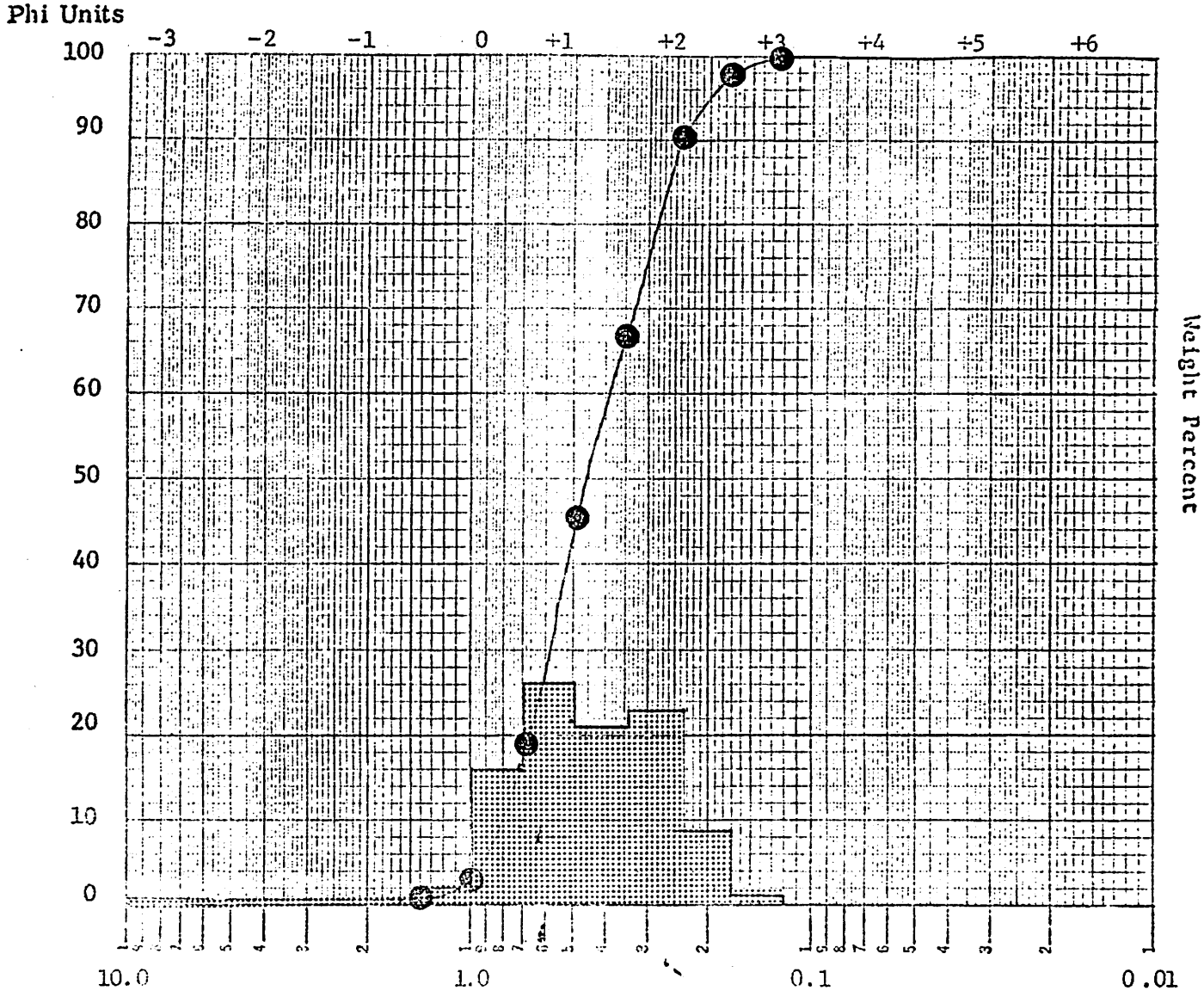
Depth _____ Fathoms

_____ Meters

_____ Feet

Sample description Beach 1.5 km south of Guarapari

Sample Weight 78.0490 grams



P_{10} 0.81mm

P_{90} 0.21mm

SIZE PARAMETERS

1st Mode .495 - .701mm

2nd Mode .246 - .351mm

3rd Mode _____

Q_{25} 0.61mm

Median Q_{50} 0.46mm

Q_{75} 0.31mm

Sorting Coef. 1.403

Skewness 0.894

Kurtosis 0.405

Mean _____

APPENDIX II

MINERALOGICAL ANALYSES

SAMPLE #1

Location Beach 1.5 km south of Rio Itapemirim

Depth _____ meters _____ fathoms

Size Fraction (SF) .124 mm

Graph % = Total % of Each Mineral
Total % of Transparent Grains

Wt. % of SF/Total Sample 1.92%

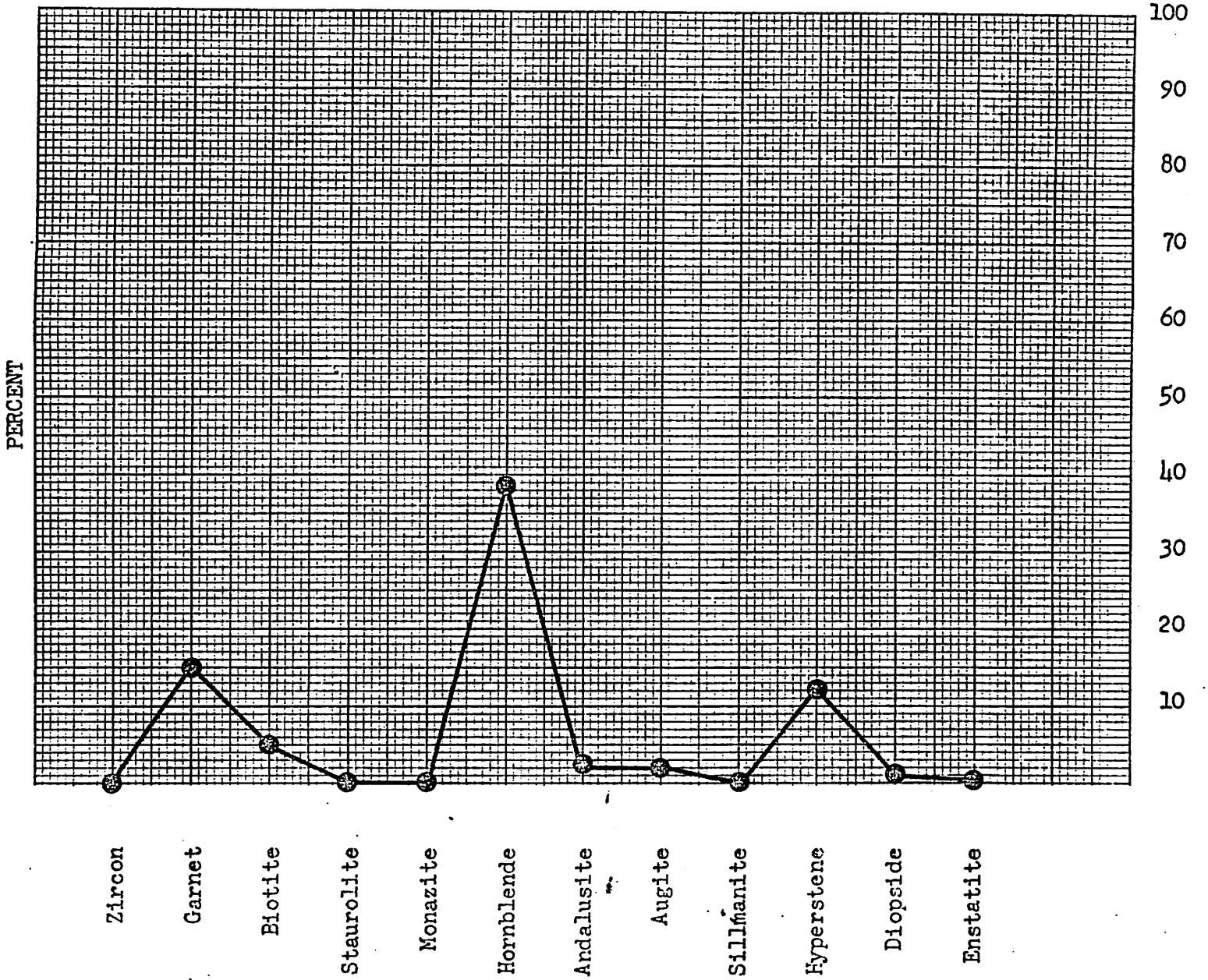
Wt. % of HM/SF 41.17%

Total Grains Counted 164

% Transparent Grains 61.6%

% Opaques 38.4%

% Composite Gr. and Unknowns 15.9%
(includes quartz, feldspars, and shells)



Other Transparent Minerals

_____

_____

SAMPLE #2

Location Riverbank at bridge - town of Itapemirim

Depth: _____ meters _____ fathoms

Size Fraction (SF) .124 mm

Graph % = Total % of Each Mineral / Total % of Transparent Grains

Wt. % of SF/Total Sample 0.07%

Wt. % of HM/SF 18.62%

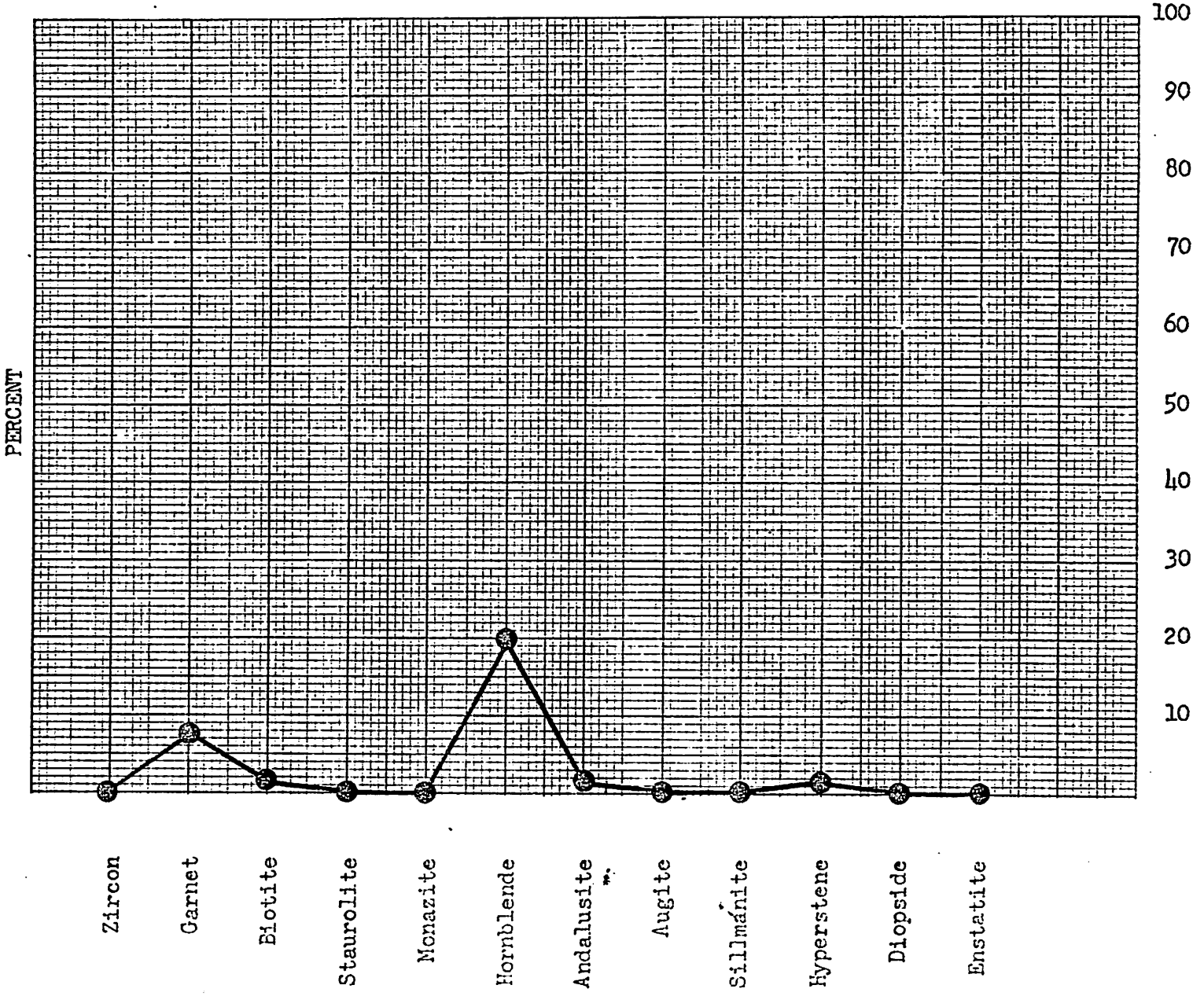
Total Grains Counted 99

% Transparent Grains 68.7%

% Opaques 31.3%

% Composite Gr. and Unknowns 47.5%

(includes quartz, feldspars, and shells)



Other Transparent Minerals

_____

SAMPLE #3

Location Beach 1.9 km north of mouth of Rio Itap.

Depth _____ meters _____ fathoms

Size Fraction (SF) .124 mm

Graph % = Total % of Each Mineral
Total % of Transparent Grains

Wt. % of SF/Total Sample 0.49%

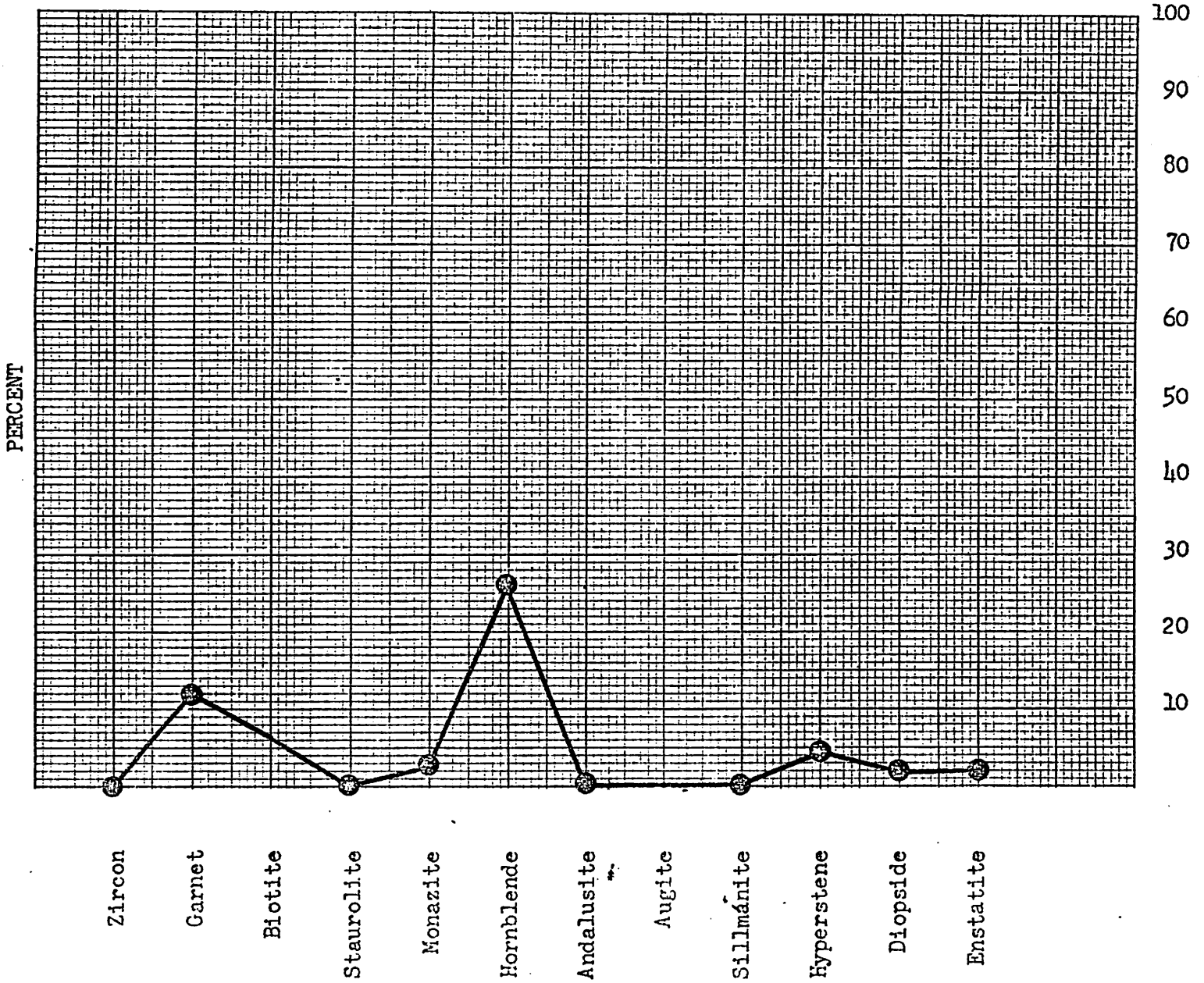
Wt. % of HM/SF 24.96%

Total Grains Counted 173

% Transparent Grains 62.4%

% Opaques 37.6%

% Composite Gr. and Unknowns 27.7%
(includes quartz, feldspars, and shells)



Other Transparent Minerals

_____

_____

SAMPLE #4

Location Beach ½ km north of Itaoca

Depth _____ meters _____ fathoms

Size Fraction (SF) .124 mm

Graph % = Total % of Each Mineral
Total % of Transparent Grains

Wt. % of SF/Total Sample 18.29%

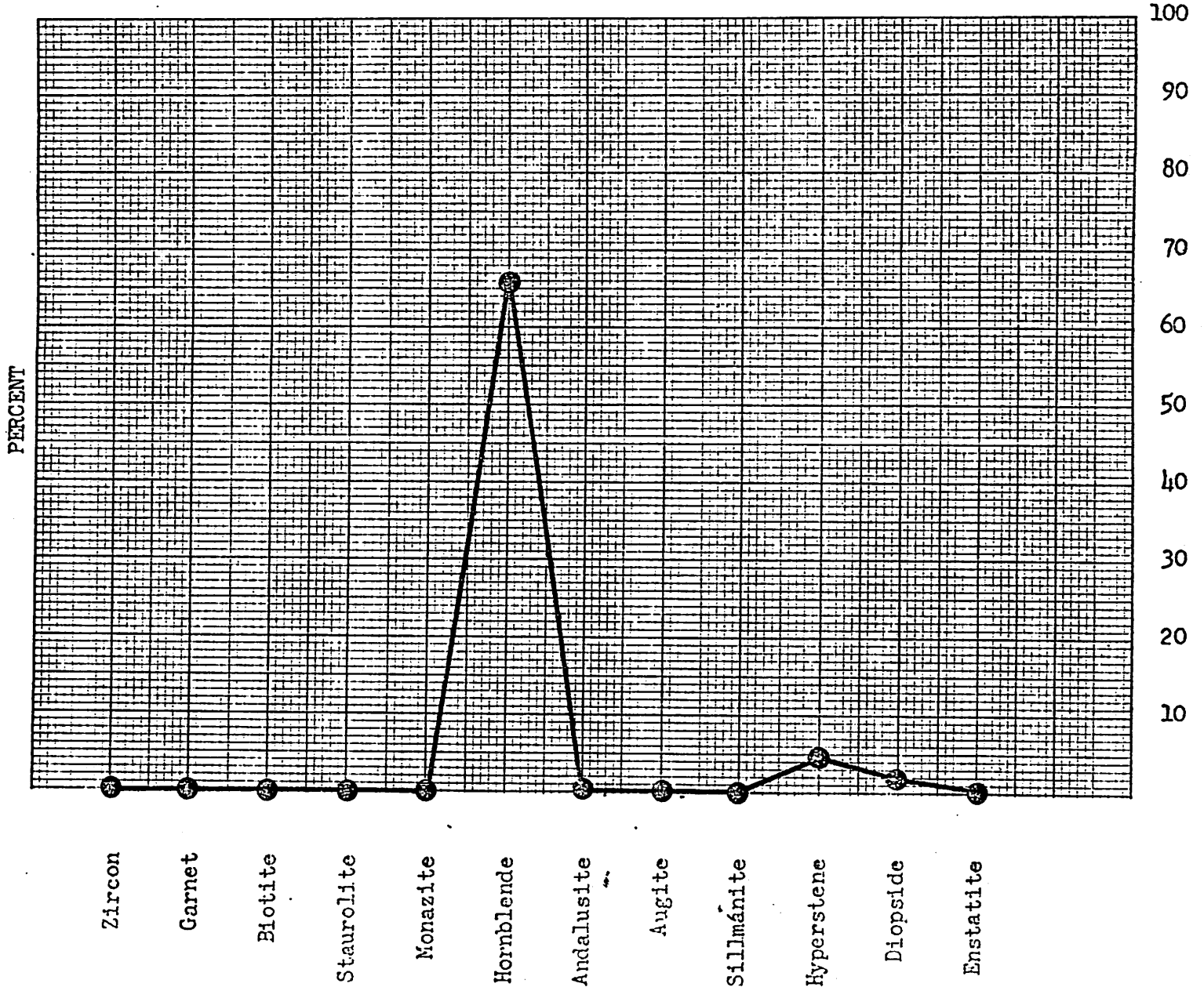
Wt. % of HM/SF 0.13%

Total Grains Counted 106

% Transparent Grains 95.3%

% Opaques 4.7%

% Composite Gr. and Unknowns 24.5%
(includes quartz, feldspars, and shells)



Other Transparent Minerals

_____

SAMPLE #4A

Location Dune sand ½ km north of Itaoca

Depth _____ meters _____ fathoms

Size Fraction (SF) .124 mm

Graph % = Total % of Each Mineral
Total % of Transparent Grains

Wt. % of SF/Total Sample 5.33%

Wt. % of HM/SF 14.61%

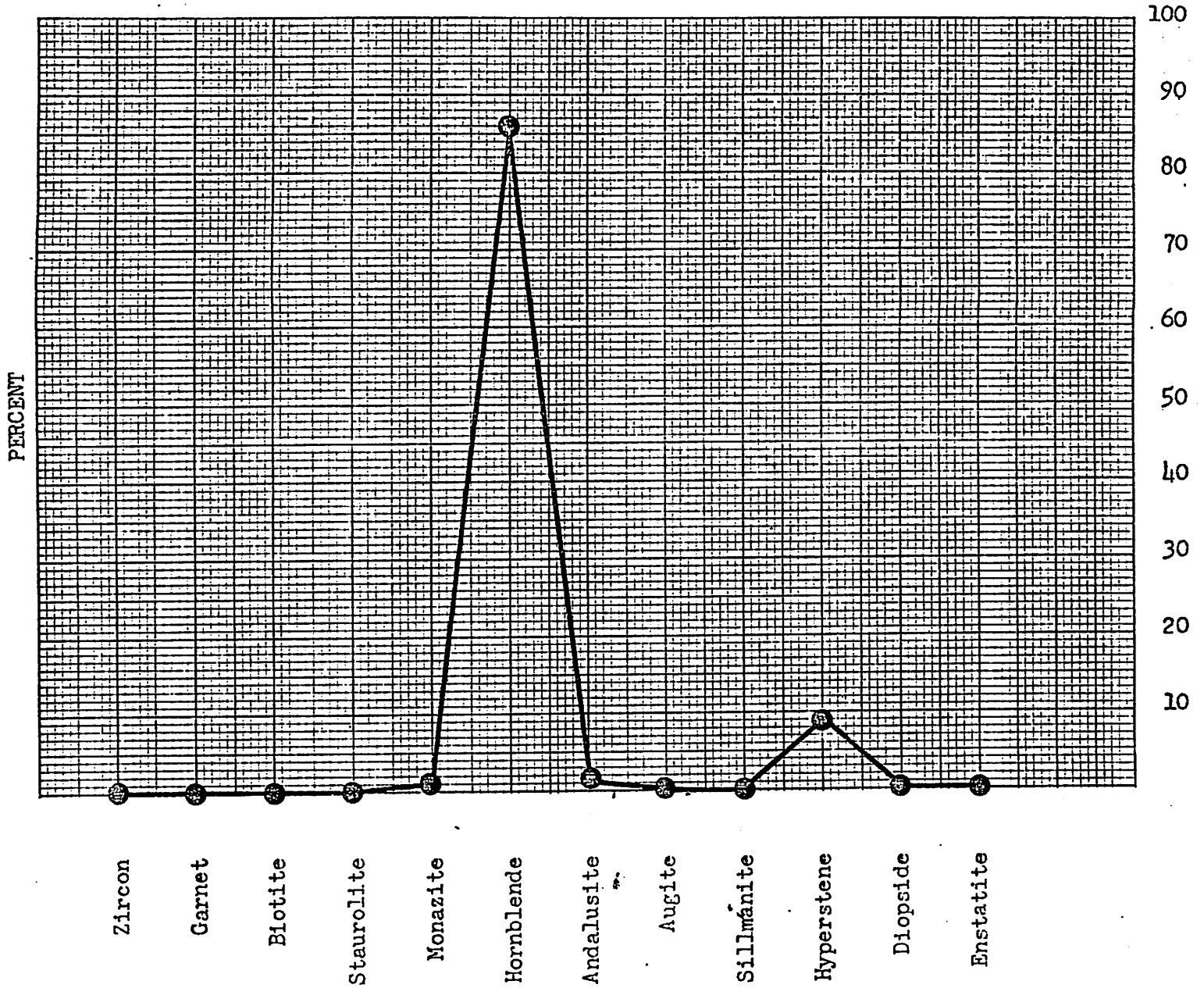
Total Grains Counted 109

% Transparent Grains 94.5%

% Opaques 5.5%

% Composite Gr. and Unknowns 2.8%

(includes quartz, feldspars, and shells)



Other Transparent Minerals

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_____

SAMPLE #5

Location Beach ½ km west of mouth of Rio Piuma

Depth: _____ meters _____ fathoms

Size Fraction (SF) .124 mm

Graph % = Total % of Each Mineral / Total % of Transparent Grains

Wt. % of SF/Total Sample 12.25%

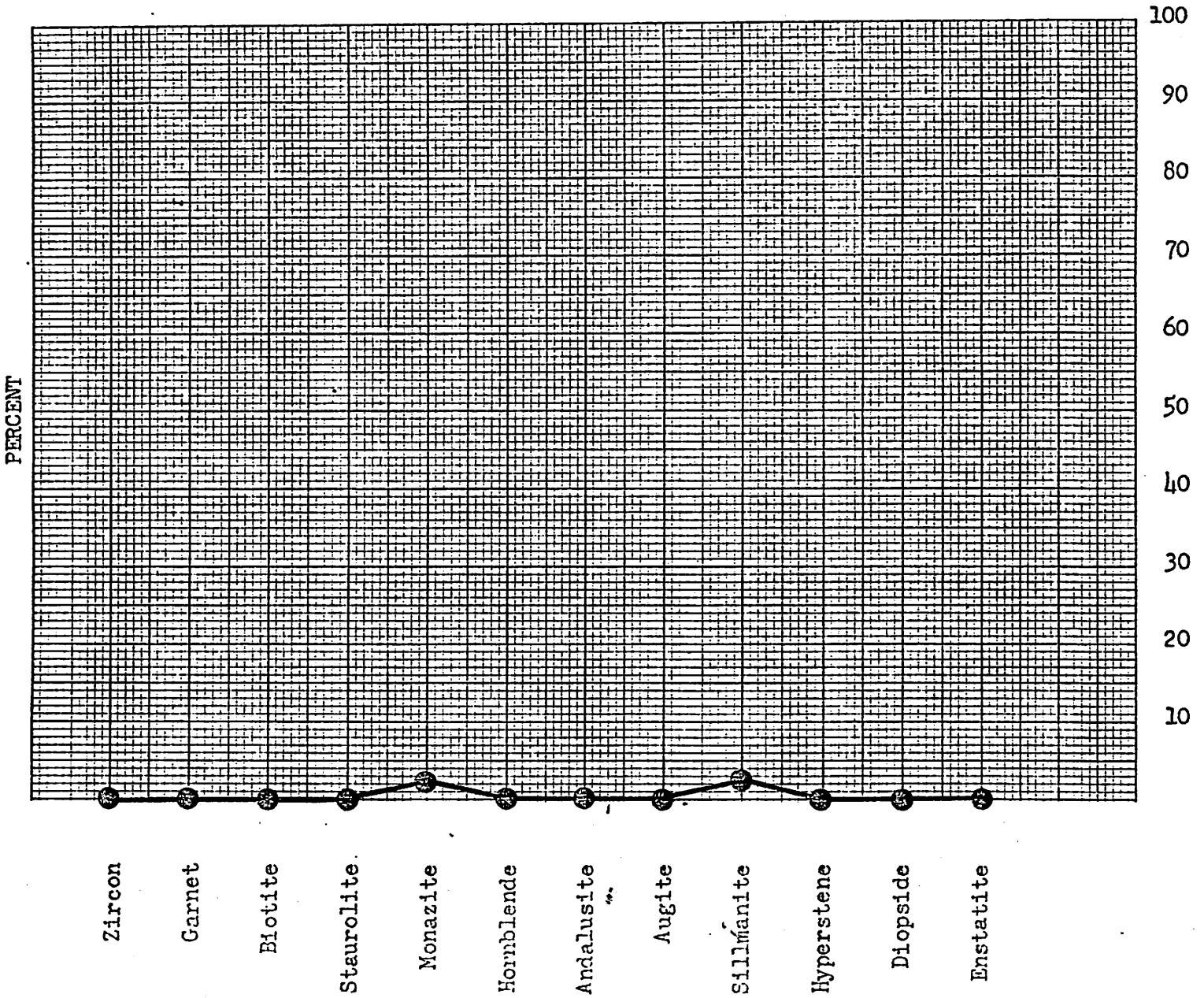
Wt. % of HM/SF 0.12%

Total Grains Counted 158

% Transparent Grains 25.9%

% Opaques 74.1%

% Composite Gr. and Unknowns 24.7%
(includes quartz, feldspars, and shells)



Other Transparent Minerals

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SAMPLE #5A

Location Riverbank in Rio Piuma west of Piuma

Depth _____ meters _____ fathoms

Size Fraction (SF) .124 mm

Graph % = Total % of Each Mineral / Total % of Transparent Grains

Wt. % of SF/Total Sample 5.50%

Wt. % of HM/SF 9.22%

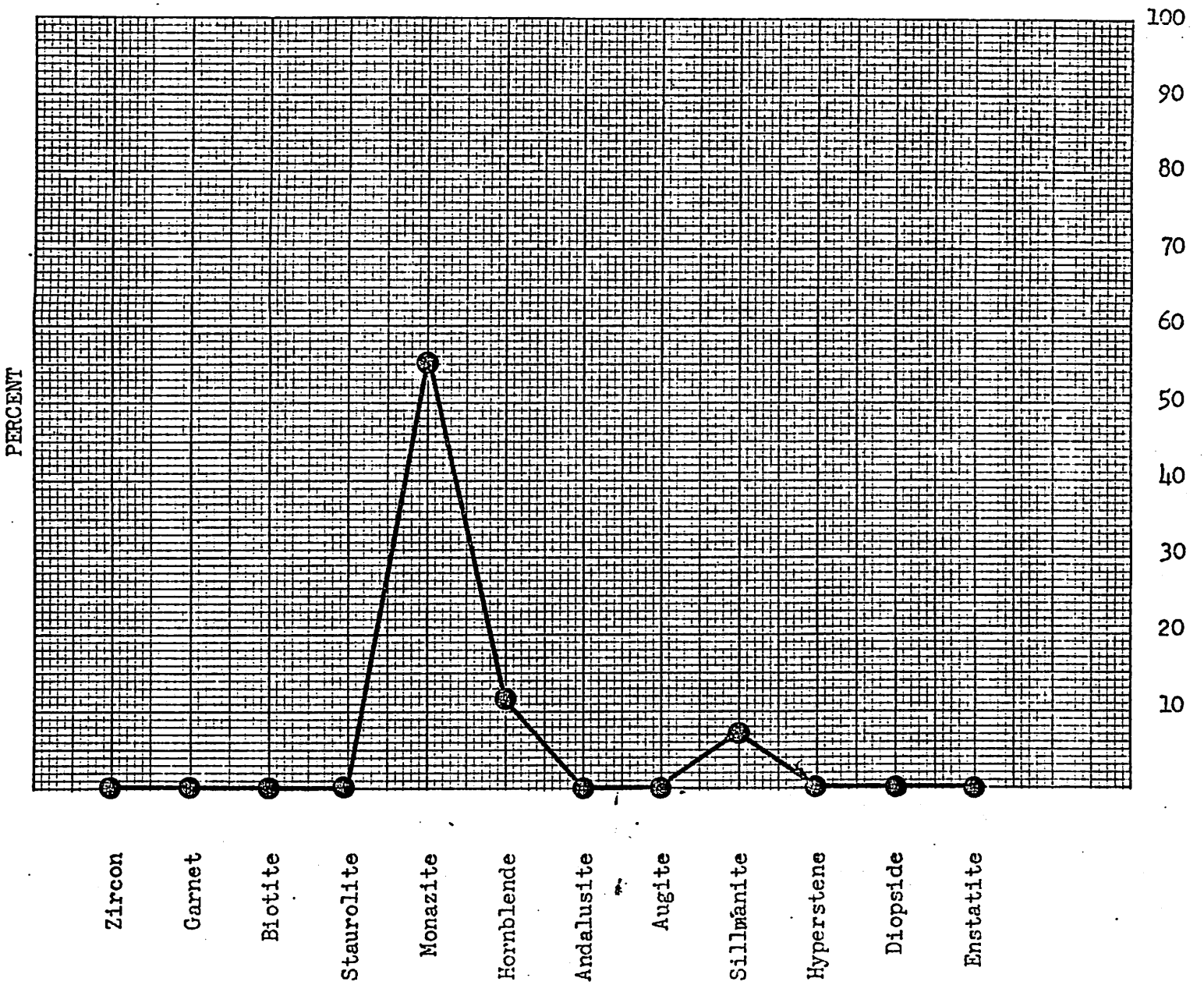
Total Grains Counted 425

% Transparent Grains 16.5%

% Opaques 83.5%

% Composite Gr. and Unknowns 4.25%

(includes quartz, feldspars, and shells)



Other Transparent Minerals

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SAMPLE #6

Location Beach 1.1 km east of Anchieta

Depth _____ meters _____ fathoms

Size Fraction (SF) .124 mm

Graph % = Total % of Each Mineral / Total % of Transparent Grains

Wt. % of SF/Total Sample 60.70%

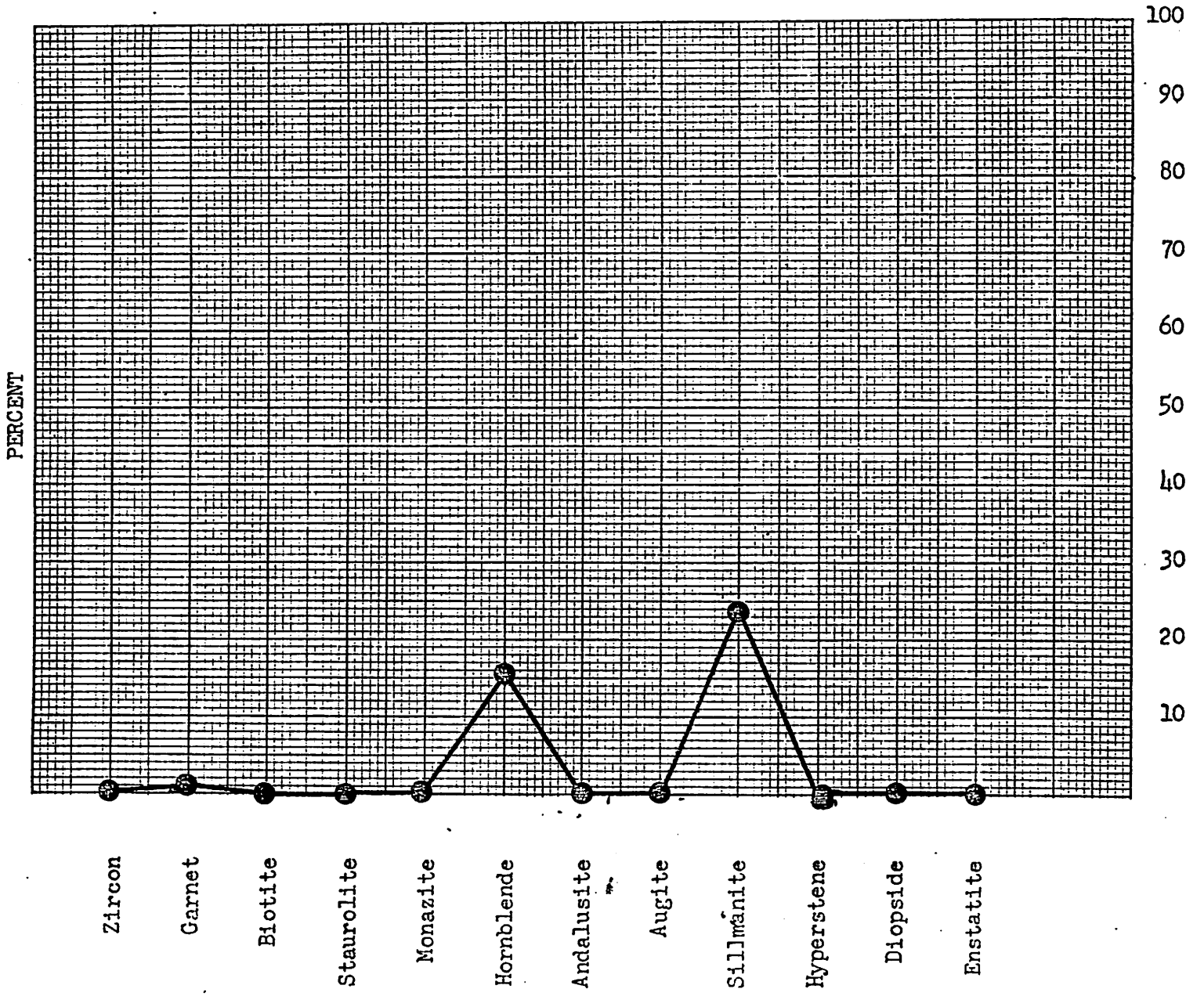
Wt. % of HM/SF 0.20%

Total Grains Counted 181

% Transparent Grains 75.1%

% Opaques 24.9%

% Composite Gr. and Unknowns 45.3%
(includes quartz, feldspars, and shells)



Other Transparent Minerals

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SAMPLE #7

Location Beach 1.1 km west of Ubu

Depth _____ meters _____ fathoms

Size Fraction (SF) .124 mm

Graph % = Total % of Each Mineral / Total % of Transparent Grains

Wt. % of SF/Total Sample 29.80%

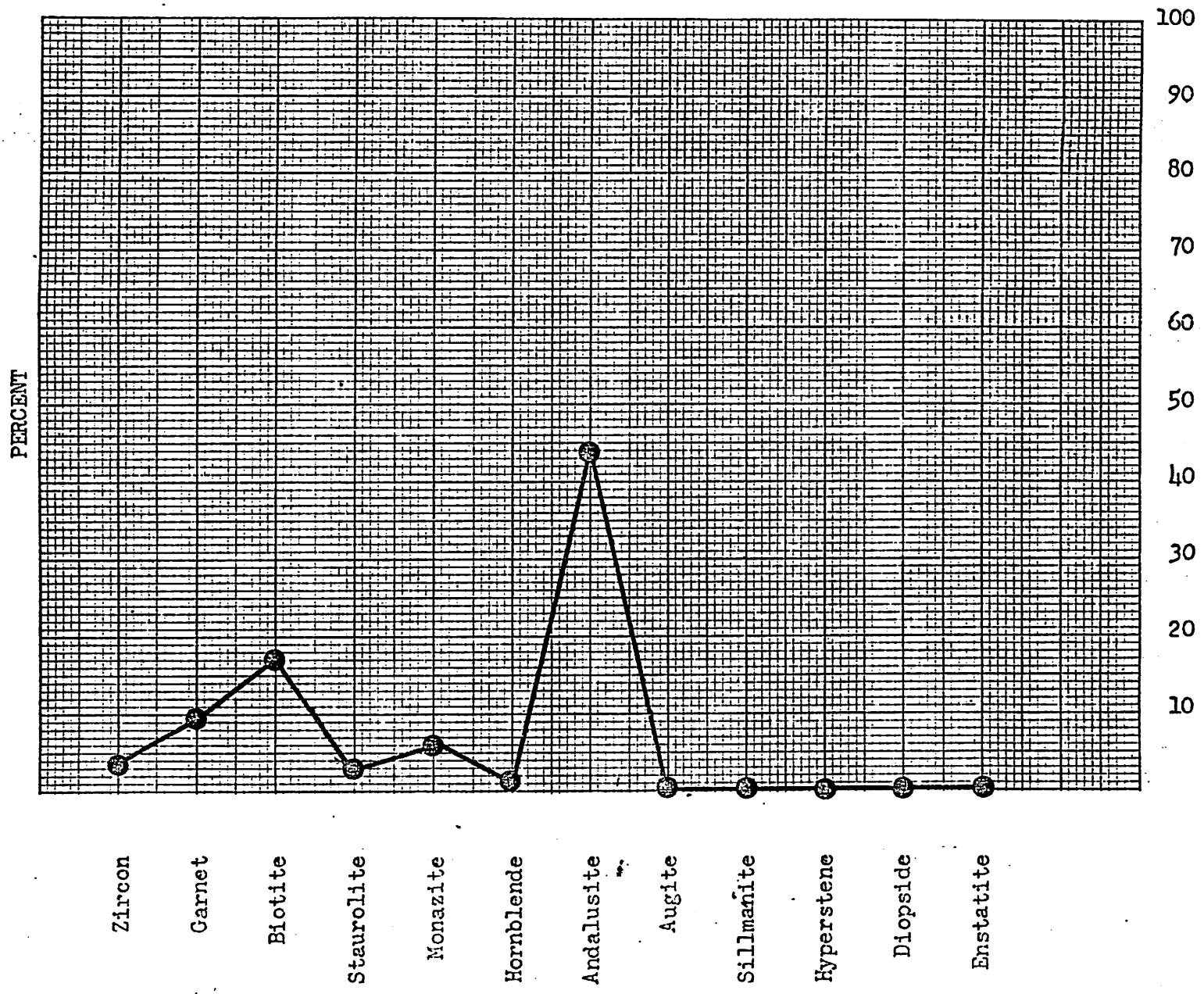
Wt. % of HI/SF 0.11%

Total Grains Counted 314

% Transparent Grains 45.2%

% Opaques 54.8%

% Composite Gr. and Unknowns 7.6%
(includes quartz, feldspars, and shells)



Other Transparent Minerals

_____

SAMPLE #8

Location Beach at Projeto Samarco Job Site

Depth _____ meters _____ fathoms

Size Fraction (SF) .124 mm

Graph % = Total % of Each Mineral
Total % of Transparent Grains

Wt. % of SF/Total Sample 1.11%

Wt. % of HM/SF 30.02%

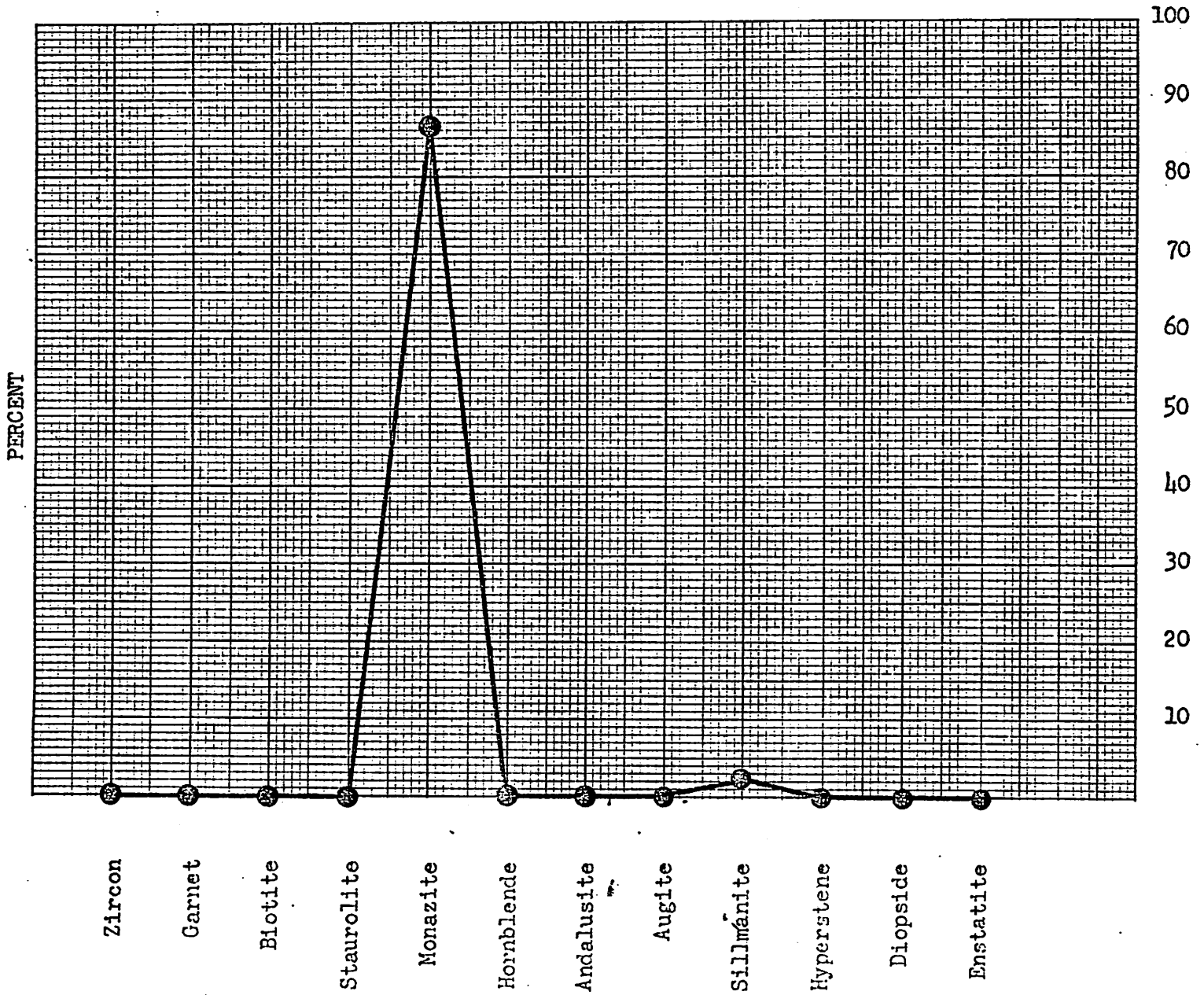
Total Grains Counted 298

% Transparent Grains 60.4%

% Opaques 39.6%

% Composite Gr. and Unknowns 7.4%

(includes quartz, feldspars, and shells)



Other Transparent Minerals

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SAMPLE #8B

Location Beach ½ km north of Projeto Samarco

Depth _____ meters _____ fathoms

Size Fraction (SF) .124 mm

Graph % = Total % of Each Mineral
Total % of Transparent Grains

Wt. % of SF/Total Sample 2.40%

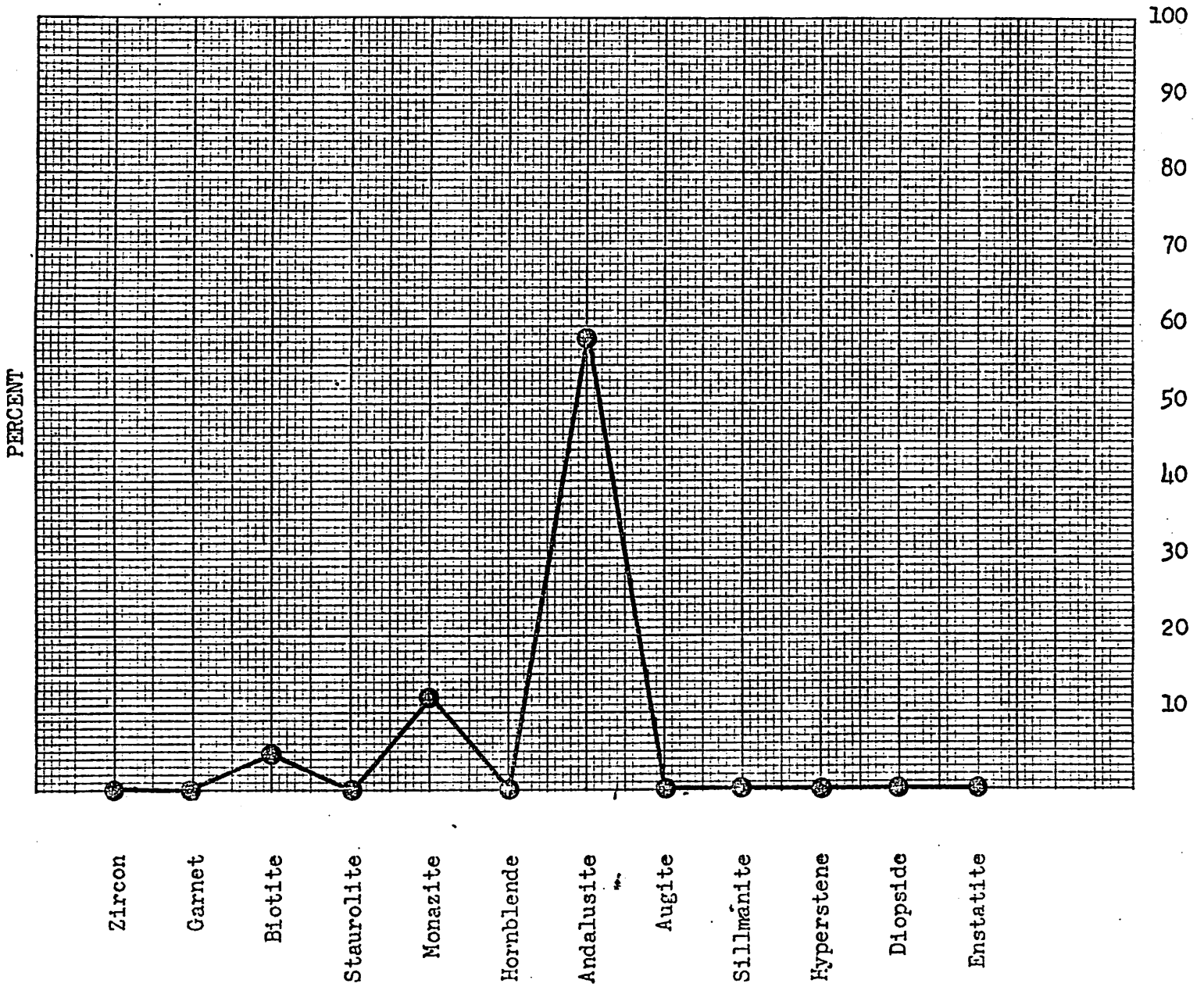
Wt. % of HM/SF 0.22%

Total Grains Counted 248

% Transparent Grains 50.8%

% Opaques 49.2%

% Composite Gr. and Unknowns 29.8%
(includes quartz, feldspars, and shells)



Other Transparent Minerals

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SAMPLE #8C

Location Cliff deposit ½ km north of Projeto S.

Depth _____ meters _____ fathoms

Size Fraction (SF) .124 mm

Graph % = Total % of Each Mineral / Total % of Transparent Grains

Wt. % of SF/Total Sample 3.40%

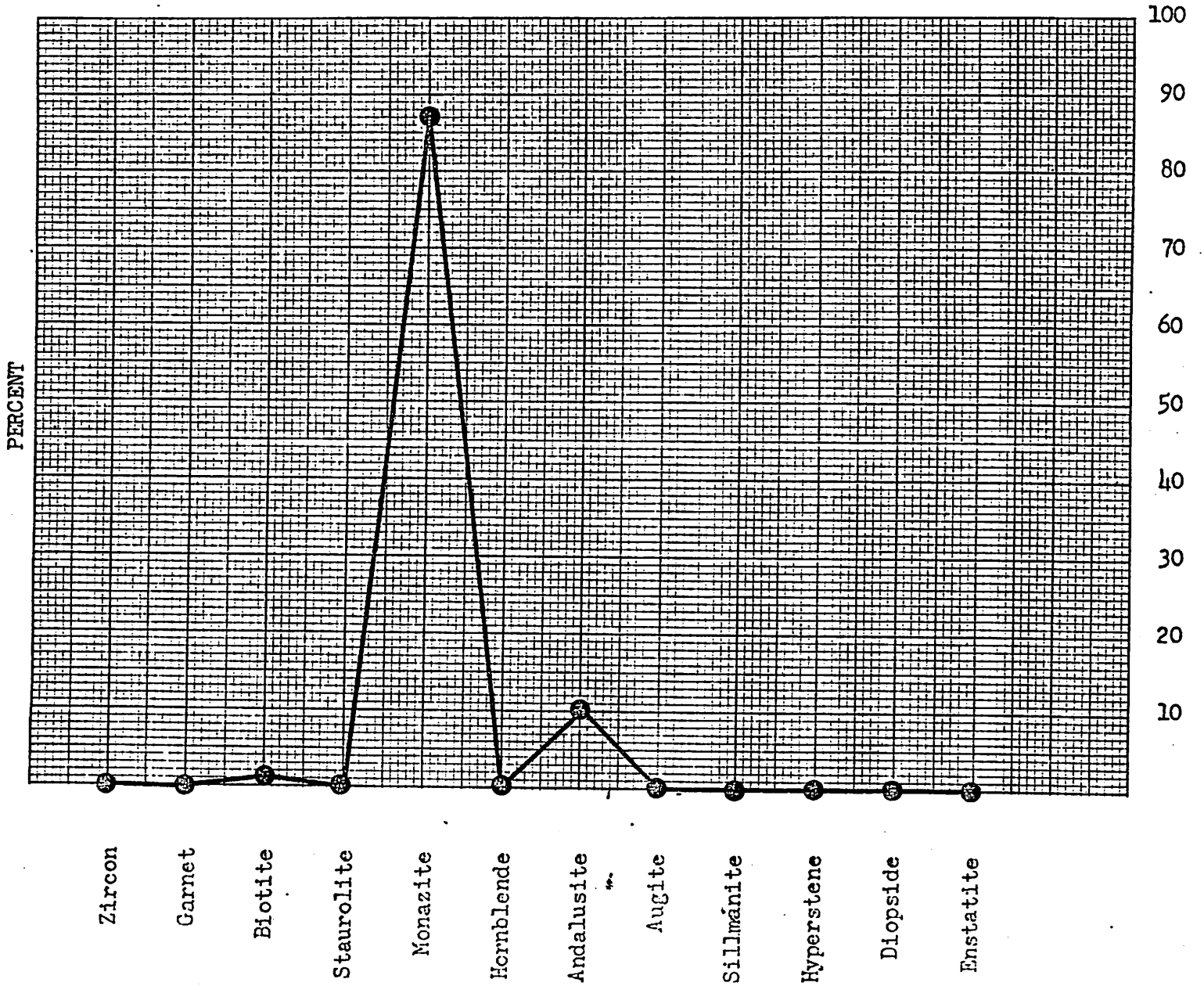
Wt. % of HM/SF 9.11%

Total Grains Counted 437

% Transparent Grains 43.7%

% Opaques 56.3%

% Composite Gr. and Unknowns 5.5%
(includes quartz, feldspars, and shells)



Other Transparent Minerals

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SAMPLE #9

Location Beach 1.7 km south of Meaipe

Depth _____ meters _____ fathoms

Size Fraction (SF) .124 mm

Graph % = Total % of Each Mineral
Total % of Transparent Grains

Wt. % of SF/Total Sample 2.31%

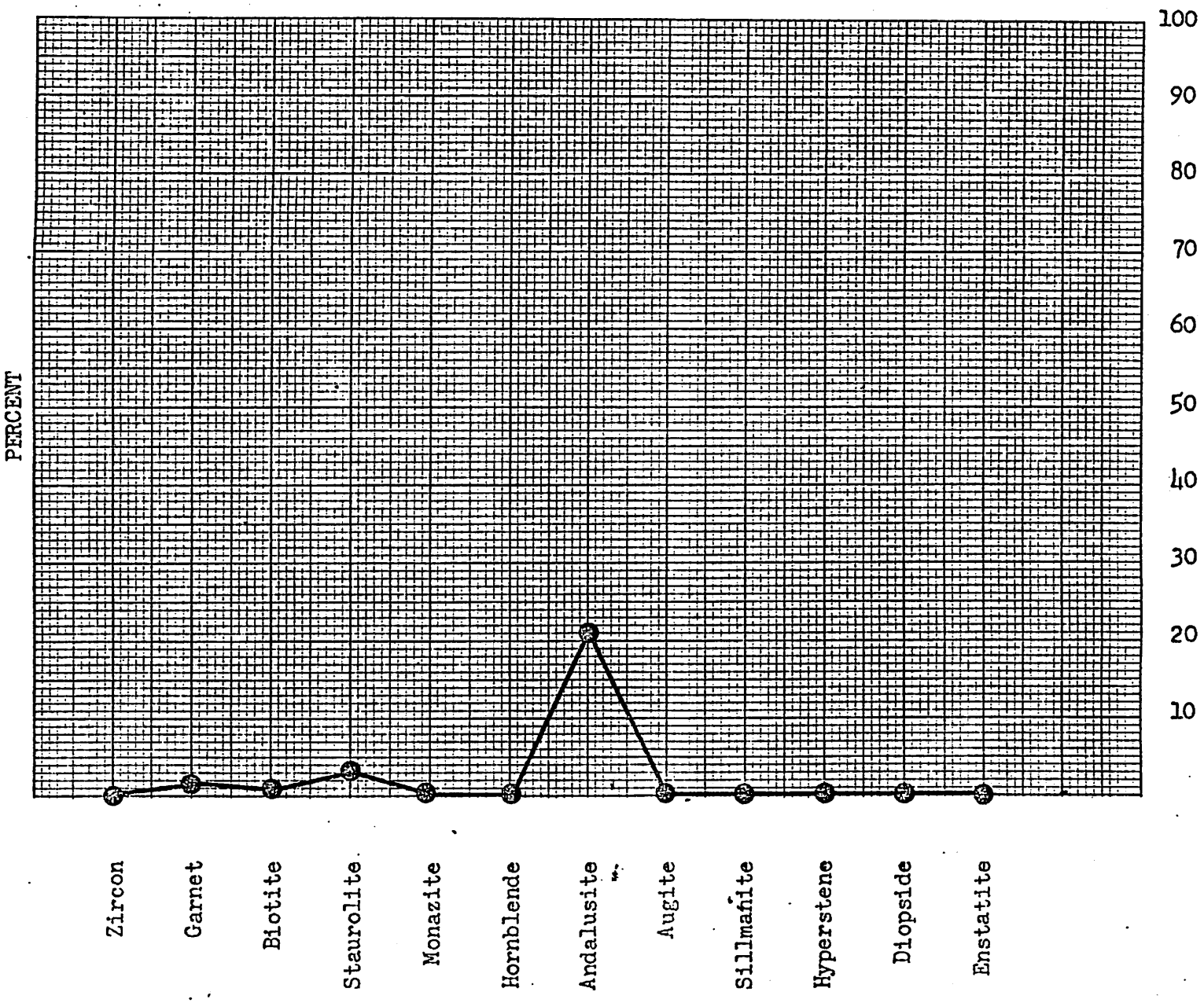
Wt. % of HM/SF 2.32%

Total Grains Counted 289

% Transparent Grains 66.1%

% Opaques 33.9%

% Composite Gr. and Unknowns 48.4%
(includes quartz, feldspars, and shells)



Other Transparent Minerals

_____

SAMPLE #10

Location Beach in Meaipe

Depth _____ meters _____ fathoms

Size Fraction (SF) .124 mm

Graph % = Total % of Each Mineral / Total % of Transparent Grains

Wt. % of SF/Total Sample 1.50%

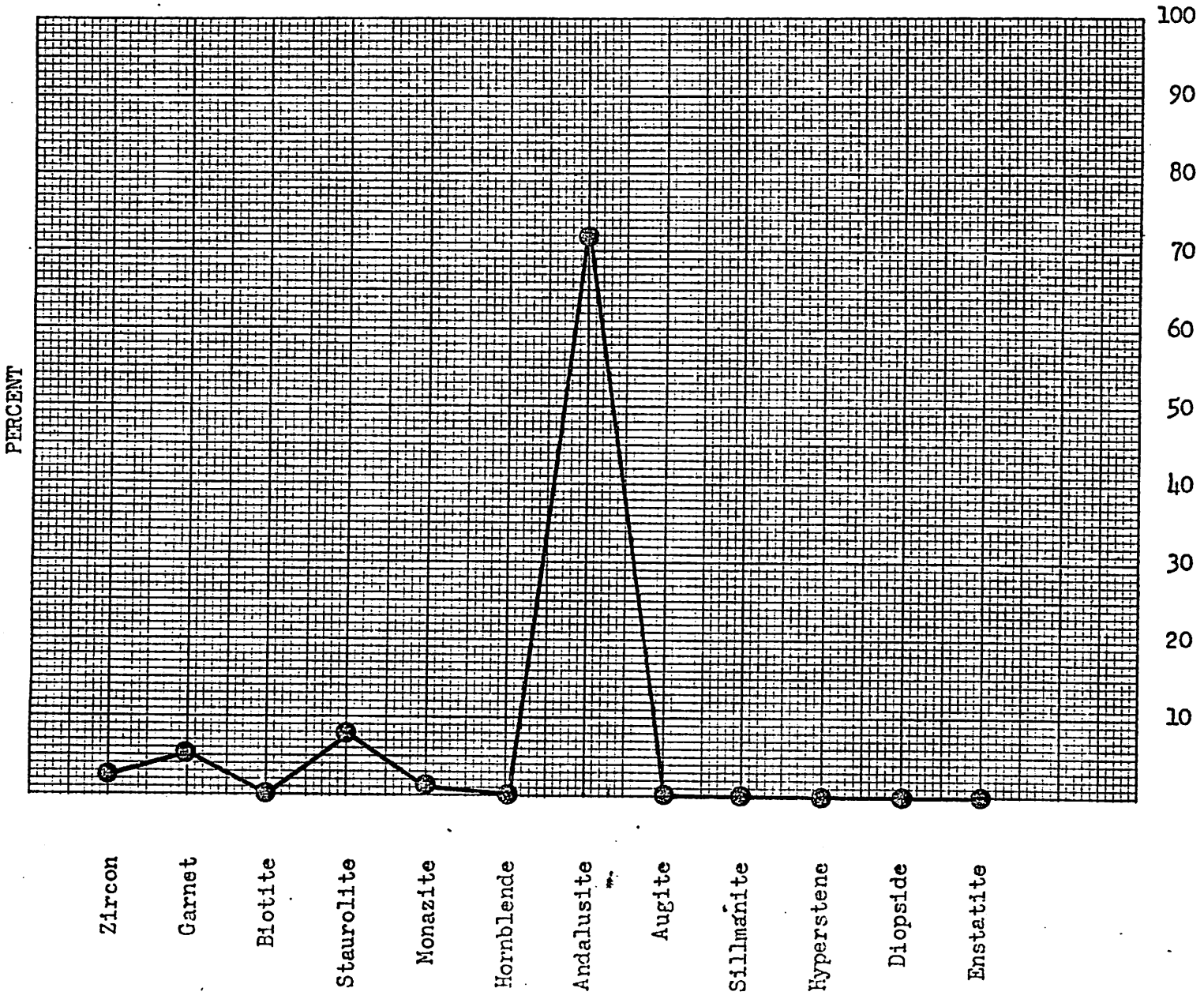
Wt. % of HM/SF 1.69%

Total Grains Counted 397

% Transparent Grains 29.7%

% Opaques 70.3%

% Composite Gr. and Unknowns 4.0%
(includes quartz, feldspars, and shells)



Other Transparent Minerals

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SAMPLE #11

Location Beach 3.1 km south of Guarapari

Depth _____ meters _____ fathoms

Size Fraction (SF) .124 mm

Graph % = Total % of Each Mineral / Total % of Transparent Grains

Wt. % of SF/Total Sample 1.60%

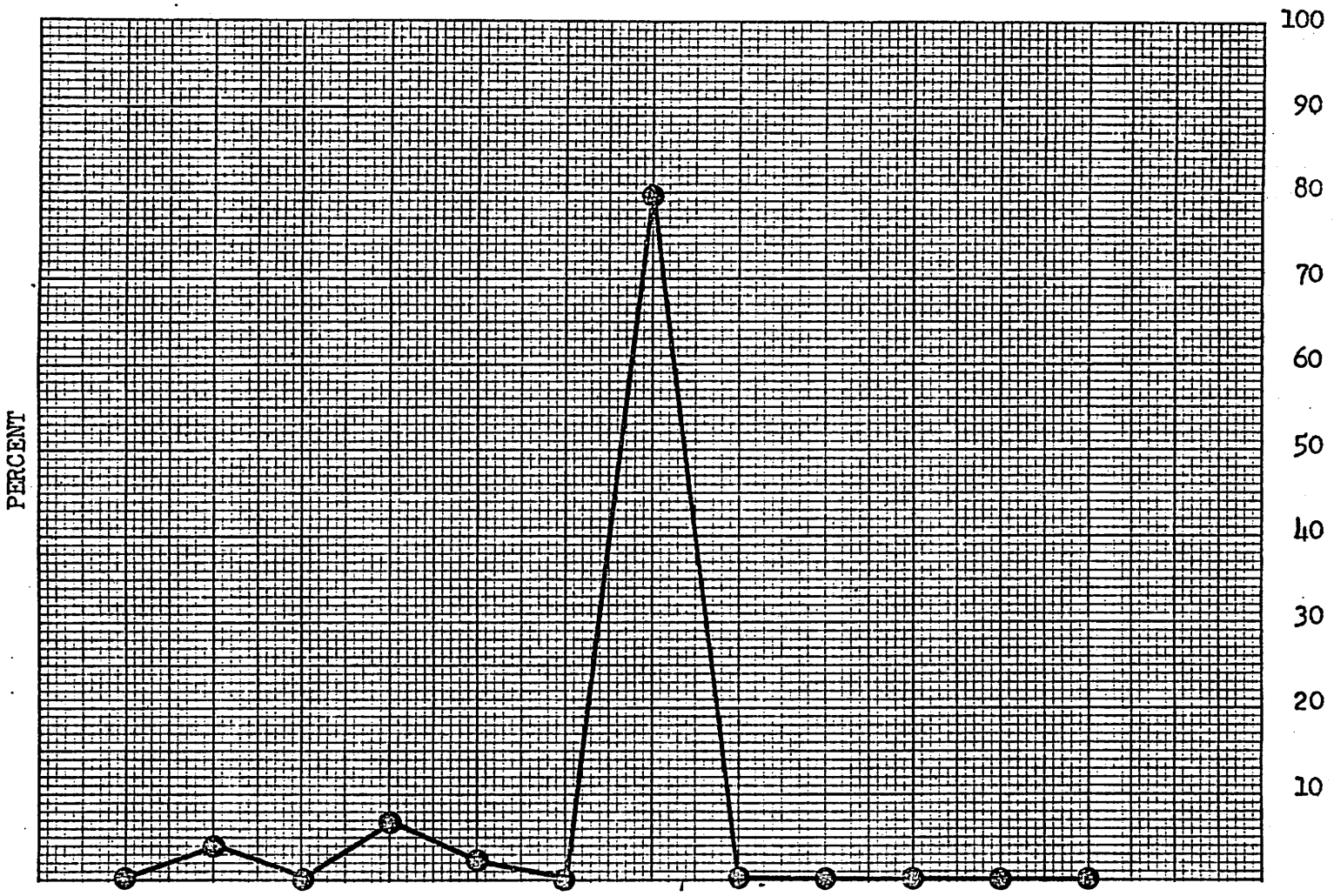
Wt. % of HM/SF 1.07%

Total Grains Counted 252

% Transparent Grains 69.8%

% Opaques 30.2%

% Composite Gr. and Unknowns 4.8%
(includes quartz, feldspars, and shells)



Other Transparent Minerals

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SAMPLE #12

Location Beach 1.5 km south of Guarapari

Depth _____ meters _____ fathoms

Size Fraction (SF) .124 mm

Graph % = Total % of Each Mineral
Total % of Transparent Grains

Wt. % of SF/Total Sample 1.42%

Wt. % of HM/SF 1.65%

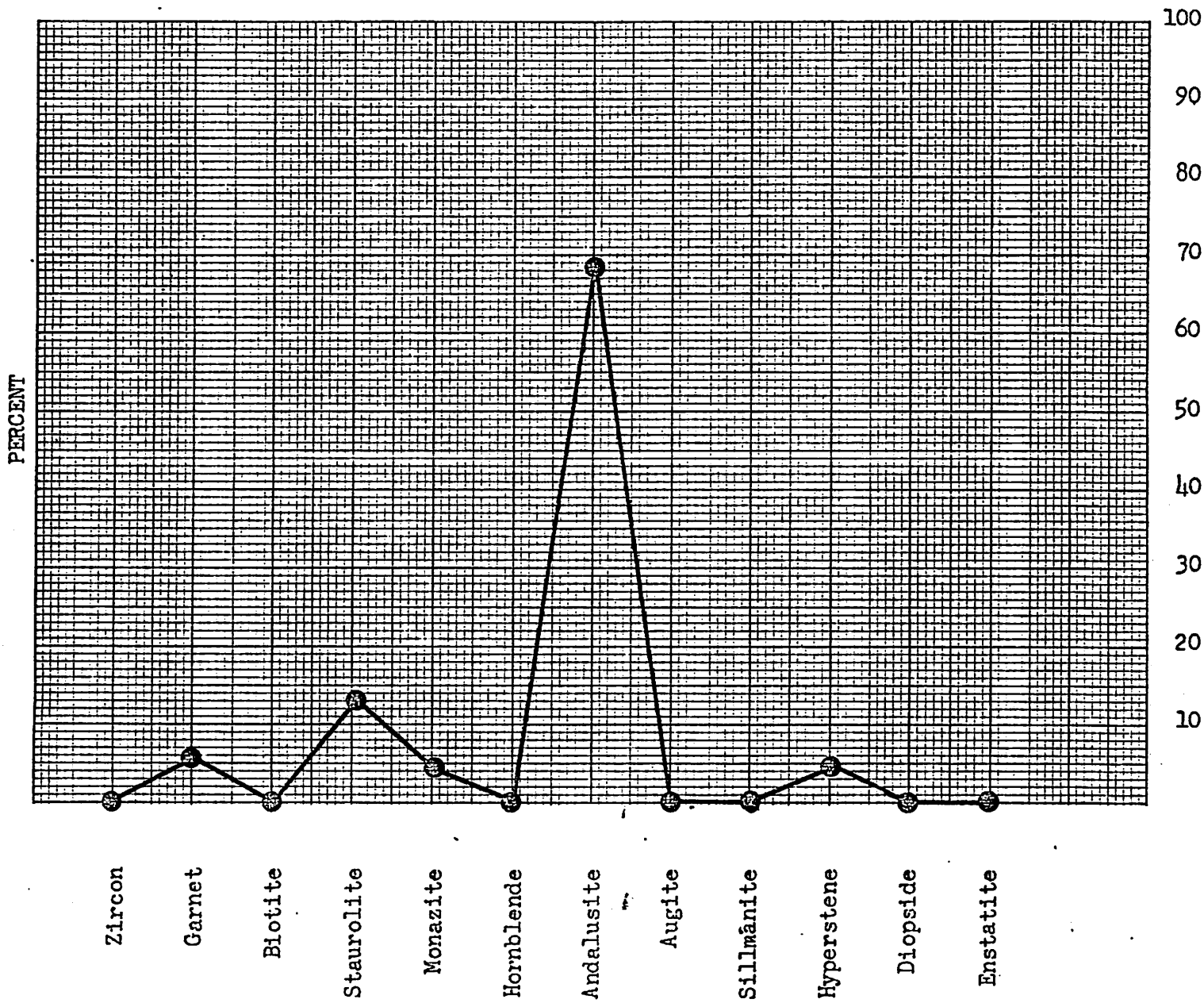
Total Grains Counted 246

% Transparent Grains 36.2%

% Opaques 63.8%

% Composite Gr. and Unknowns 2.0%

(includes quartz, feldspars, and shells)



Other Transparent Minerals

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