WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts

REFERENCE NO. 72-2

SEDIMENTS OF THE EAST ATLANTIC CONTINENTAL MARGIN
A PRELIMINARY REPORT

by

John D. Milliman

January 1972

TECHNICAL REPORT

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Approved for Distribution ______________________
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ABSTRACT

The location of sediment samples from the northern and equatorial portions of the western African continental shelf and upper slope are presented, along with a discussion of analytical techniques and some preliminary results.

One part of the Woods Hole IDOE program off western Africa is an investigation of the petrology, provenance and history of surficial sediments on the continental margin. Some sediment samples will be taken with an underway sampler during the 1972 and 1973 cruises. To supplement these samples, however, approximately 1000 samples have been obtained from the collections of various marine biologists and geologists who have worked in the area. Because of the depth limitations in underway sampling, all sediments studies have been limited to depths less than 500 meters--that is the continental shelf and the upper slope.

Most samples have been supplied by the Graduate School of Oceanography, University of Rhode Island (samples from Morocco to Sierra Leone); British Museum of Natural History (scattered samples from throughout western Africa); Royal Dutch Shell (Niger Delta); OSTROM, France (Ivory Coast); Imperial College of London (Spanish Sahara and Morocco); and NOAA, United States (Senegal to the Ivory Coast). The distribution of sediment samples already collected is shown in Figures 1-9. Most northern areas have relatively good coverage; only the margin off Mauritania, Liberia, and from Ghana to Dahomey lack adequate samples. The shelf and slope south of the Niger have not been sampled sufficiently to merit analysis at this point. Hopefully, the forthcoming sample collection aboard IDOE cruises will correct this situation.

Sample Analysis

The analyses of sediment samples have been separated into two distinct phases: geochemical and mineralogical (including textural) (Figure 10). The geochemical phase includes three analyses: organic carbon, nitrogen and calcium carbonate. Although the organic content of a sediment is strongly dependent upon grain size, regional trends usually can be defined on the basis of relatively few samples. Therefore only a portion of the west African sediment samples are being analyzed for nitrogen and organic carbon. Probably 500 analyses will be sufficient for the entire west African margin. Calcium carbonate shows a far greater variation with respect to sample location and grain size, and therefore most samples are being analyzed for carbonate content.

Mineralogical analysis consists of two separate steps, a petrographic study of the sand size fraction and an x-ray diffraction analysis of the clay-size fraction. Separation of these two size fractions also permits a determination of grain size. The untreated sample (4 to 6 grams of sample is sufficient for the entire procedure) is dried, weighed and then soaked in a 0.1 percent solution of sodium metaphosphate, $(NaPO_3)_6$. After soaking for about 12 hours, the samples are disaggregated with an ultrasonic probe; the $(NaPO_3)_6$ eliminates floculation of the clay particles. The samples are then washed through a 62-micron sieve, the coarser sand particles being collected for subsequent petrographic analysis. The portion that passes through the sieve is separated into silt (2 to 62 microns) and clay (finer than 2 microns) fractions by centrifuging at predetermined speeds for standard time intervals. The clay fraction, which remains in suspension after the centrifuging, is then passed through a silver filter and set aside for subsequent x-ray diffraction analysis. The dry weights of the silt and sand fractions are totalled and the difference between these and the dry weight of the total sample is assumed to be clay.

The sand fraction is studied in two steps. First, the total sand sample is investigated for carbonate components using a binocular microscope. After the carbonate assemblages are defined, the sample is washed with dilute HCL and the 125-250 micron insoluble fraction is removed by sieving. Past experience has shown that the size-dependence of sediment composition necessitates that petrographic analysis be restricted to a discrete size fraction; the 125-250 micron fraction is best because it is present in nearly all sediment types (Milliman, 1971). When practicable, the 125-250 micron fraction is treated with bromoform (sp.g. 2.90) to separate heavy and light minerals. Both fractions then are mounted on glass slides with Canadian Balsam. The light fraction is stained for sodic and potash feldspars using the Hayes and Klugman (1959) method.

Preliminary Results

At present the sedimentological analyses are incomplete. Therefore, the discussion of sedimentary trends off western Africa must be restricted to only general terms. On the basis of present data, three broad depositional areas can be recognized on the upper continental margin off northwestern Africa: Gibraltar to Cape Verde, Cape Verde to Liberia, and Liberia to the Niger.

Sediments on the shelf and upper slope from Gibraltar to Cape Verde are rich in carbonate, primarily because of the lack of fluvial sedimentation. Stream-derived sediments are limited to those areas immediately adjacent to coastal wades. The carbonate assemblages are temperate to subtropical, and resemble those in the western Mediterranean. Aeolian sediment appears to be limited to the shelf off Spanish Sahara. Absence of chemical weathering in this arid climate results in the retention of large amounts of feldspar in the terrigenous sediments. Glauconite and phosphorite are important components in many northwest African sediments; many of these grains probably have been derived from early to mid-Tertiary formations that crop out across much of the shelf (Summerhayes, 1970). Organic carbon and nitrogen content in the sediments are very low.

South of Cape Verde the shelf and slope sediments become increasingly terrigenous as fluvial sedimentation increases. Carbonate values drop from 75 to 95 percent north of Cape Verde to an average of less than 30 percent to the south. The carbonate assemblages are subtropical to tropical; the oolite deposits off Sierra Leone are the only such occurrences reported from the entire west coast of Africa. The tropical rivers in this area drain chemically-weathered terrain. The result is a dominance of quartz-rich sediments. Heavy minerals also show the results of heavy chemical-weathering with hematite and limonite being common. Outer shelf and upper slope sediments are dominated by large quantities of relict and residual glauconite, suggesting that at least since the late Pleistocene and Holocene, offshore transport has been restricted. Perhaps most active sedimentation has been concentrated in the accretion of the coast line in this area (McMaster and others, 1971). Locally, organic matter in the shelf sediments is abundant. Much of the organic matter, however, may be river-derived rather than due to marine biologic productivity.

Shelf sediments to the south and east of Liberia are dominated by fluvial muds. Many rivers in this area are short and drain coastal hills and mountains that are composed of crystalline rocks. As a result, the sediments tend to be more felspathic than normally would be expected in such a tropical area. Much of the mud on the outer shelf has been formed (by biological activity) into fecal pellets, and is presently undergoing early stages of glauconitization. Organic content in these sediments is high, probably the result of coastal upwelling as well as the deposition of river-borne plant material.

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Summerhayes, C.P., 1970, Phosphate deposits on the northwest African continental shelf and slope. Unpubl. Ph.D. Dissertation, Royal School of Mines, Imperial College London, 282 p.

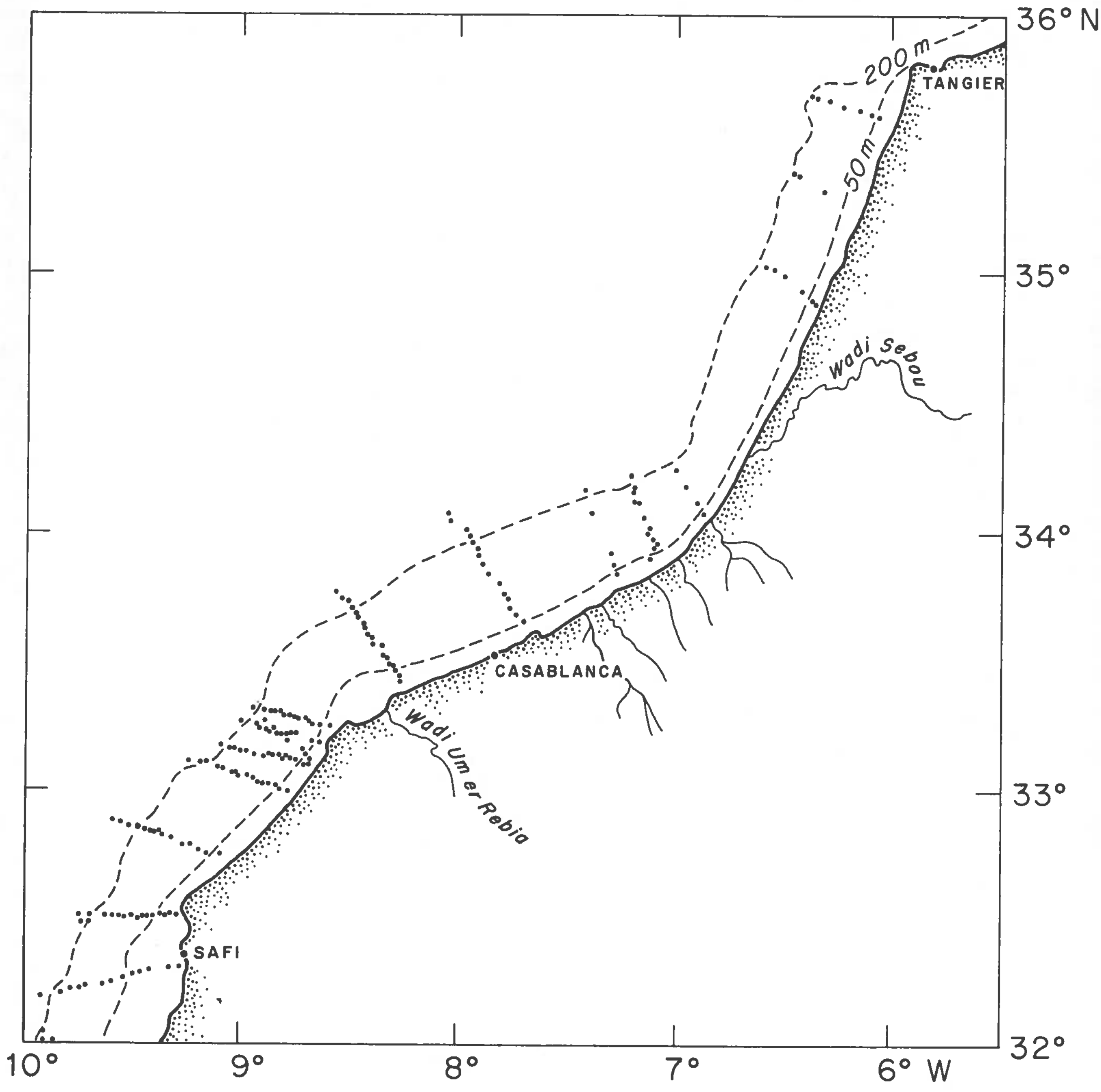

Figure 1. Location of sediment samples from Northern Morocco

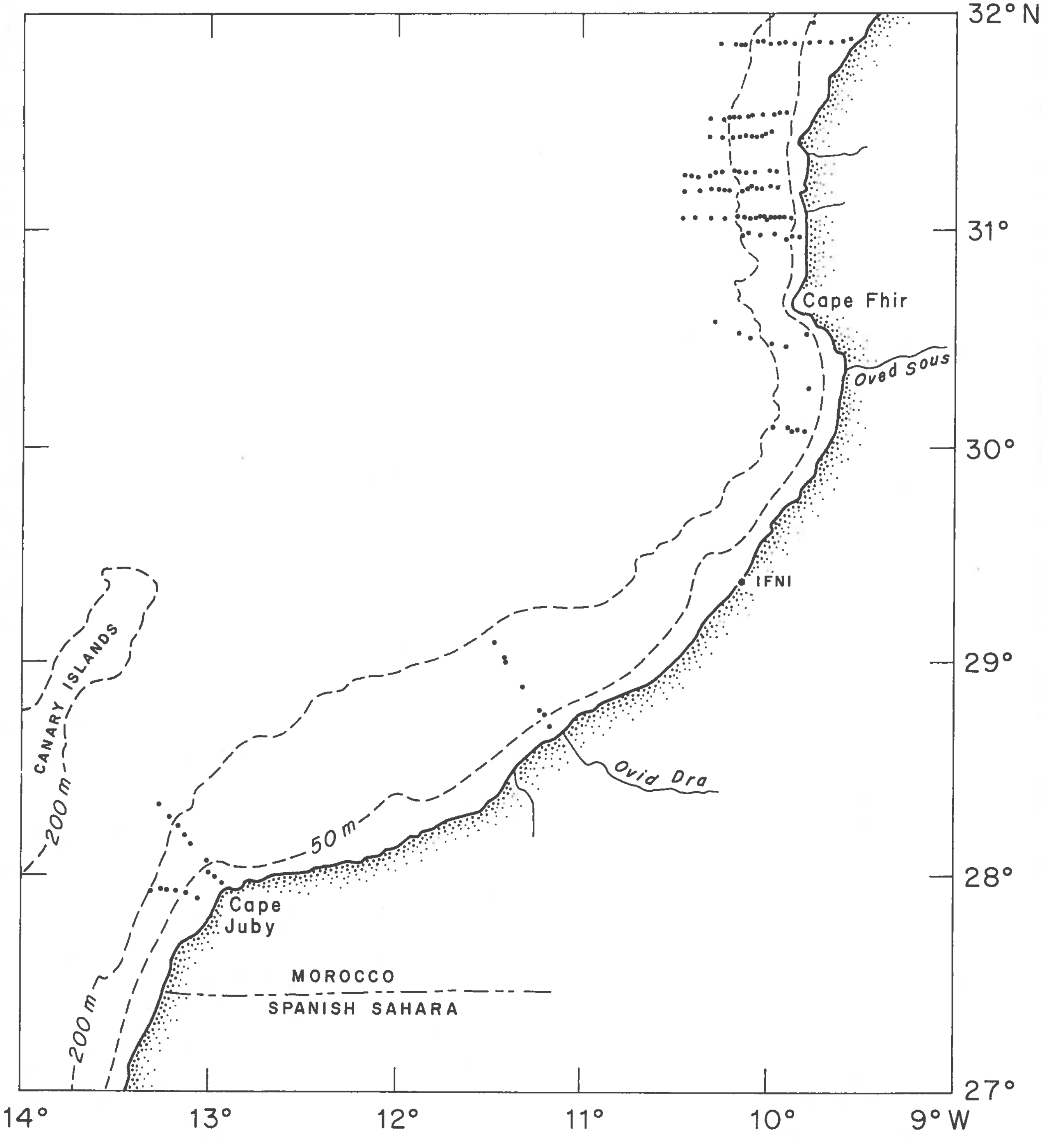

Figure 2. Location of sediment samples from southern Morocco

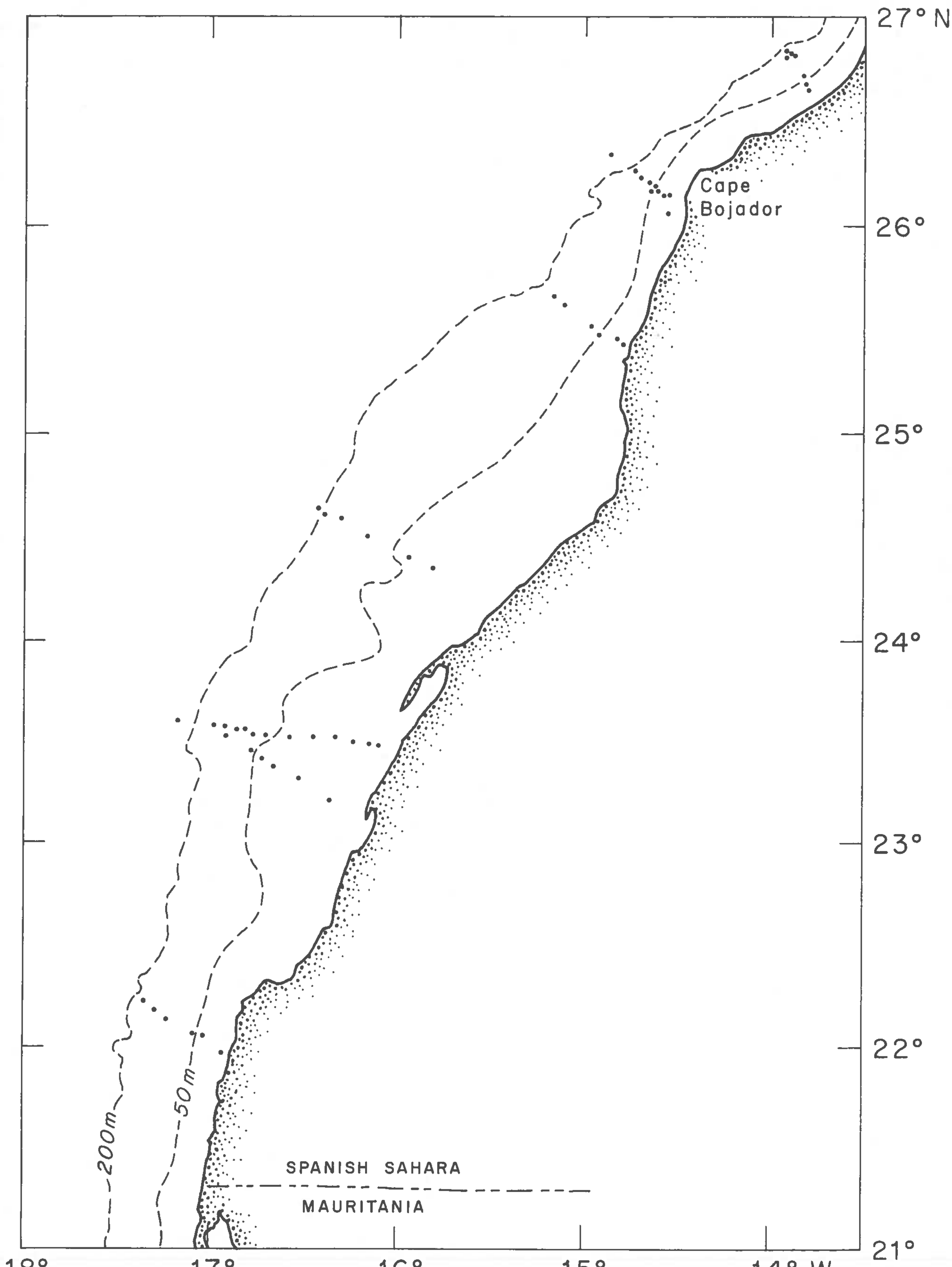

Figure 3. Location of sediment samples from Spanish Sahara

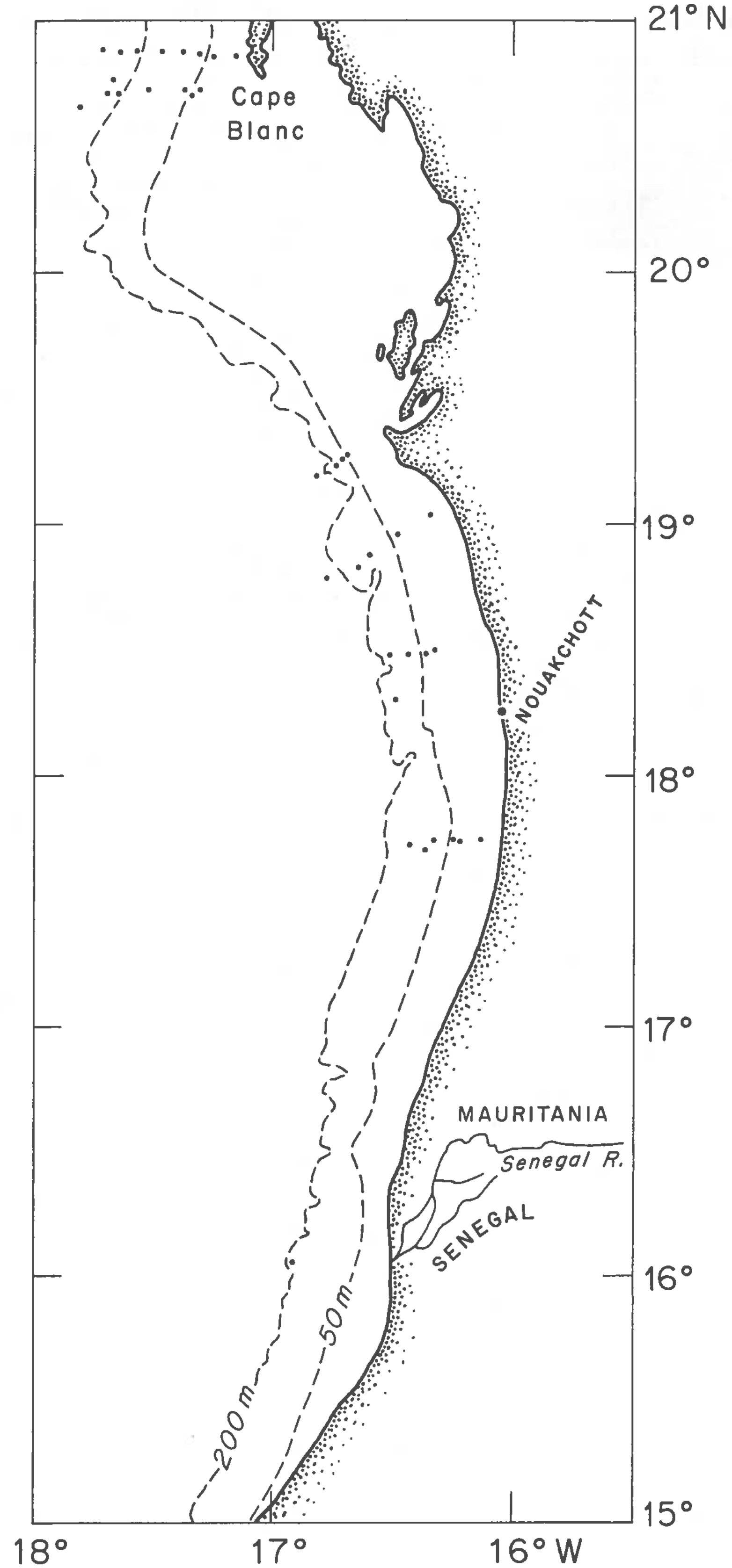

Figure 4. Location of sediment samples from Mauritania and Senegal

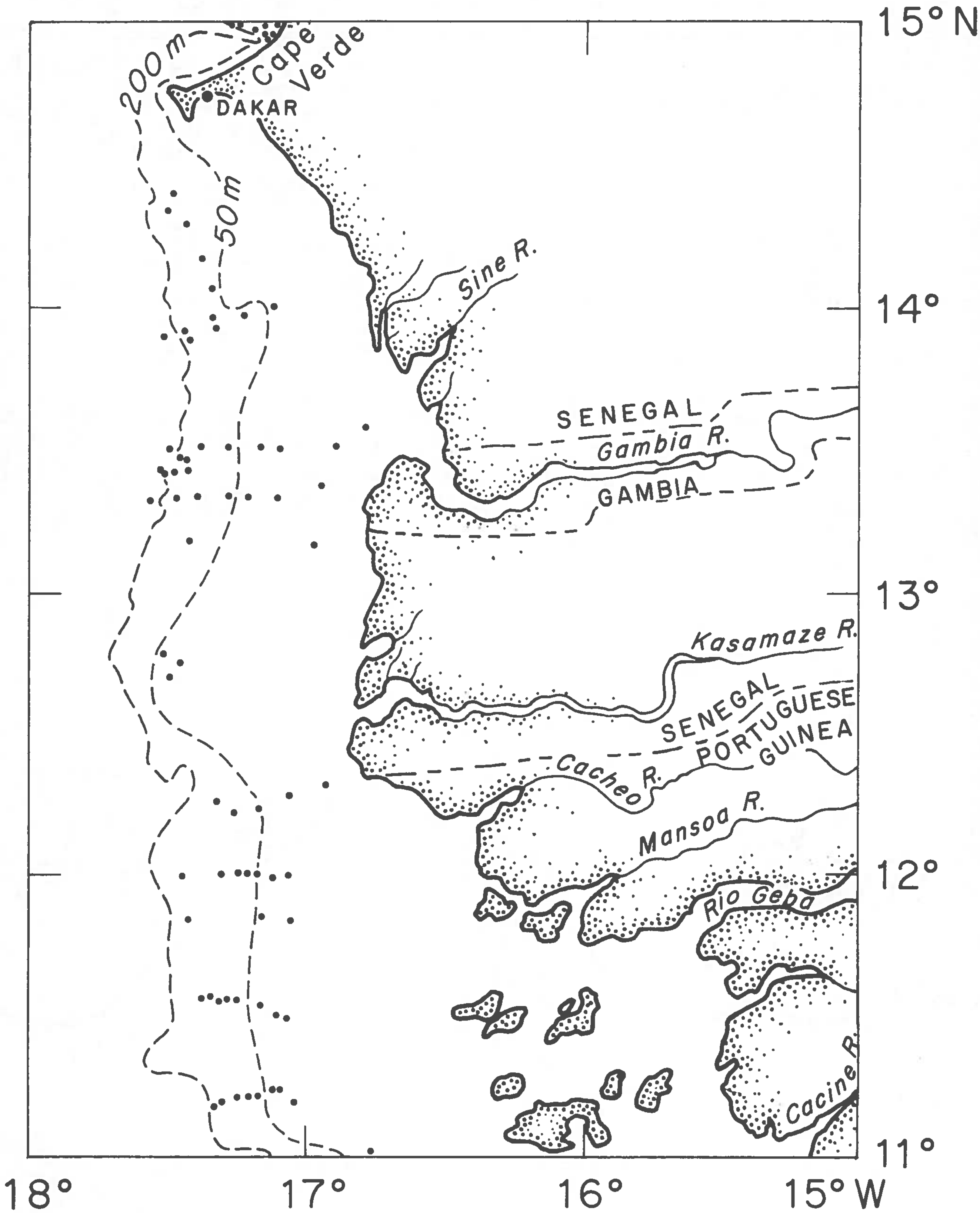

Figure 5. Location of sediment samples from Senegal, Gambia and Portuguese Guinea

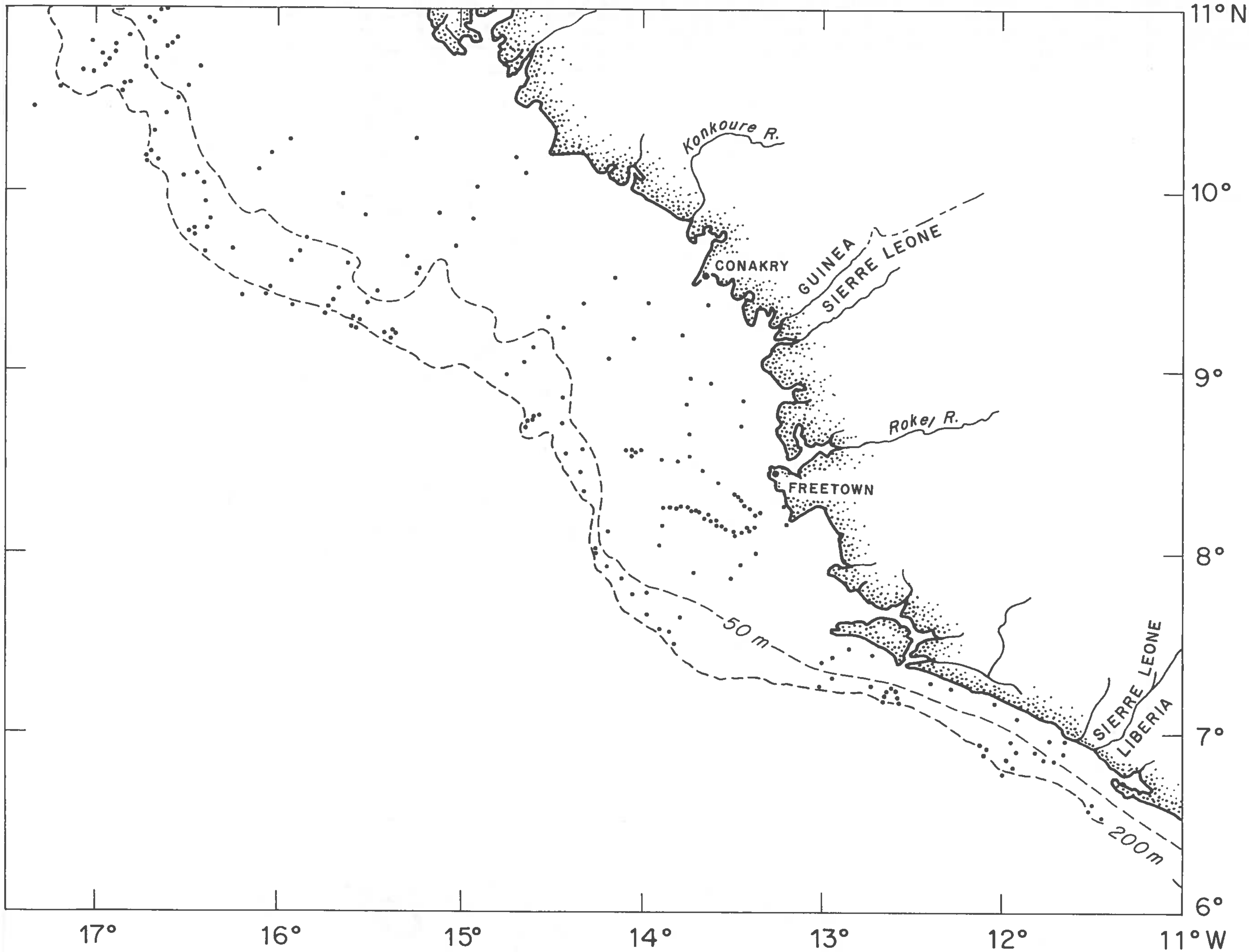

Figure 6. Location of sediment samples from Guinea, Sierra Leone and Liberia

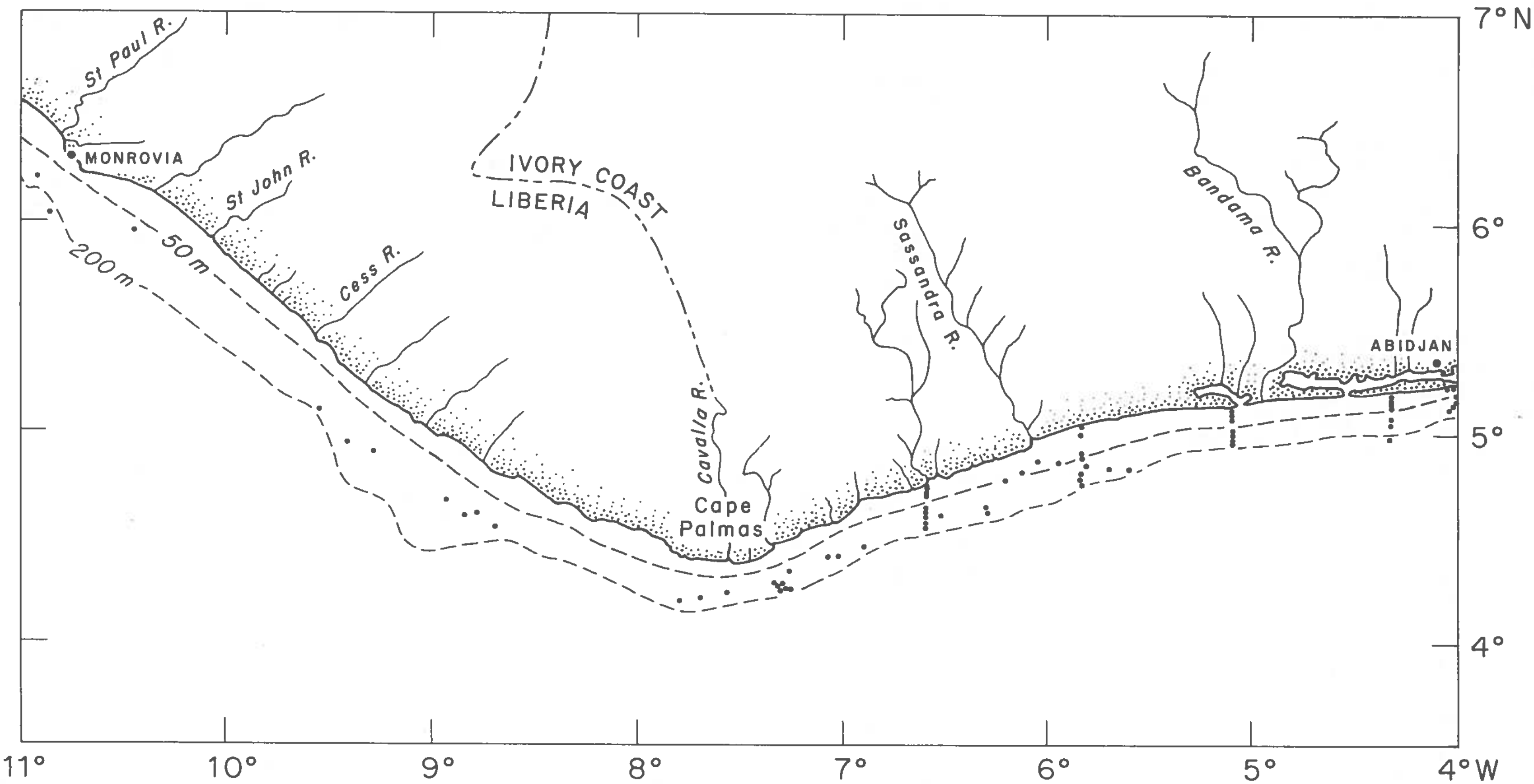

Figure 7. Location of sediment samples from Liberia and Ivory Coast

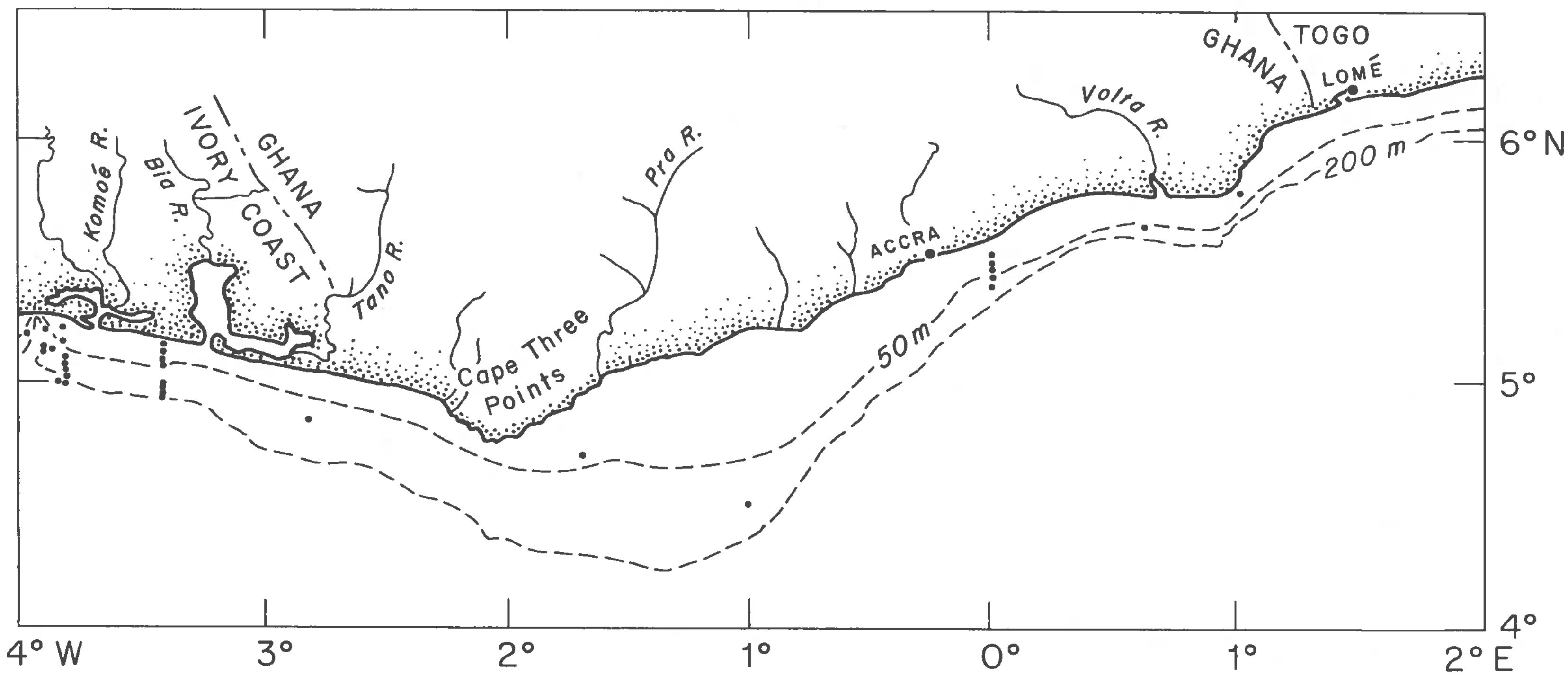

Figure 8. Location of sediment samples from Ivory Coast, Ghana and Togo

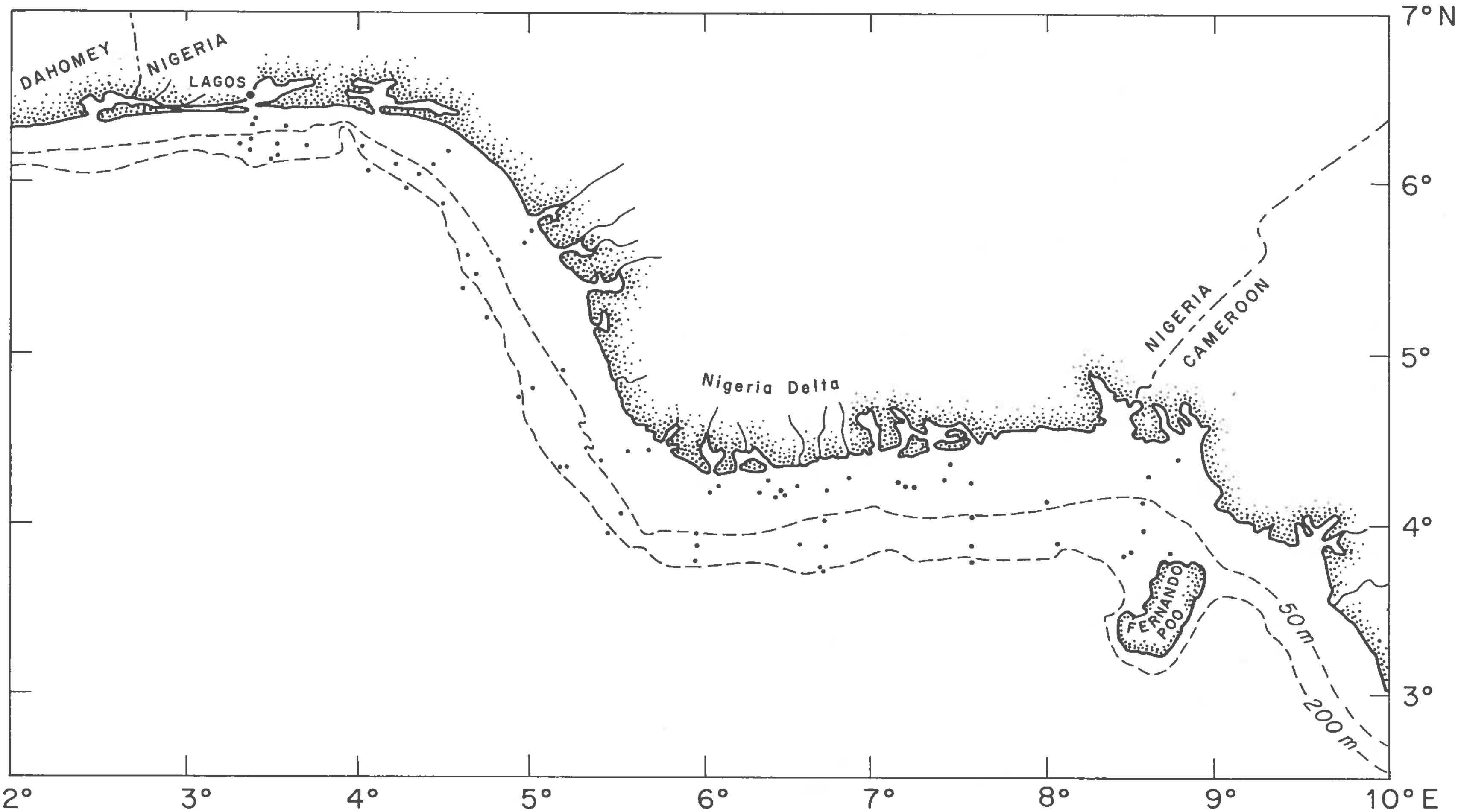

Figure 9. Location of sediment samples from Dahomey, Nigeria and Cameroons

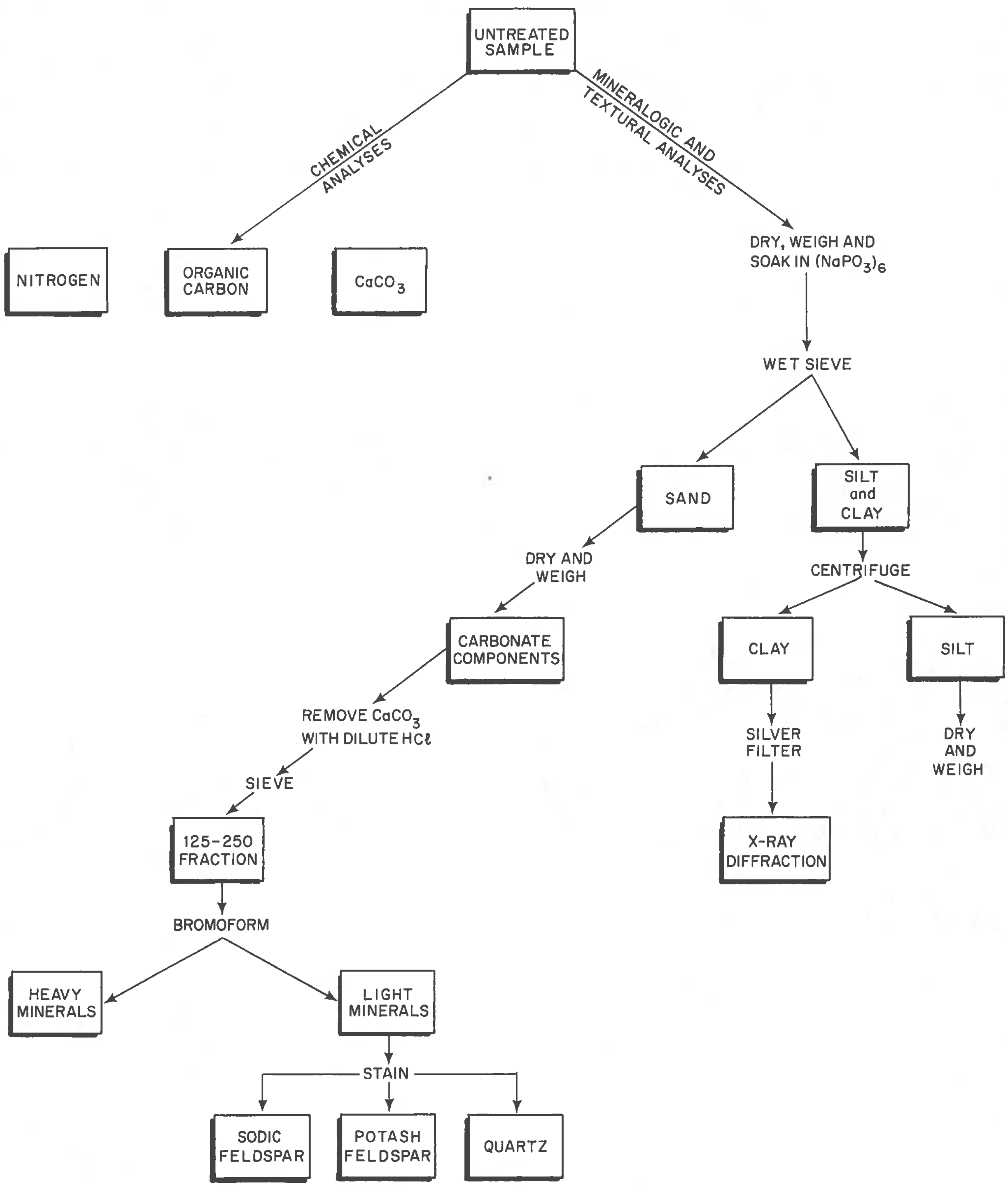

Figure 10. Flow chart of analyses of African sediments

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