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However, outcrops are few: generally these sedimentary rocks have been long and deeply weathered and are now completely decomposed to depths of many feet, leaving red clay and sand, and laterite in extensive areas.

Surrounding the Voltaian sedimentary basin, and underlying it. are pre-Cambrian rocks which range in age from 600 million to billions of years. These are crystalline rocks, with granites at the surface over extensive areas both in northwest and southwest Ghana, and metamorphosed sediments and lavas in even more extensive areas. The youngest of these ancient metamorphosed sediments appear to be rocks of greatest economic value in Ghana. The Tarkwaian Formation, outcropping in a belt extending from the Southern Highlands near Konongo southeastward past Tarkwa, has been a major source of gold and manganese (Hirst, 1938, 1962). The Togo Formation includes the quartzite that crops out at Akosombo Dam, and the intensely folded and metamorphosed rocks that form the Akwapim Range (southwest of the Volta River) and the Togo Range extending northeast to the Togo border and thence north to form the "Eastern Highlands."

1.1. Effect of Volta Lake Upon Geologic Environment

At its maximum controlled elevation - 276 feet above sea-level - Volta Lake inundates about 8,500 km^2 (3,275 mi^2) or about eight percent of the Voltaian sedimentary basin. Very few mineral resources are known to have been inundated, a and they were of limited economic value: limestone in the bed of Afram River, suitable for the manufactures of cement; limestone on the eastern flank of the Volta Gorge at the Mem Rapids, suitable for agricultural use (Mitchell, 1960); sands and gravels along the Volta River and its tributaries, which have yielded isolated diamonds from time to time.

Volta Lake has also inundated the floodplains of the Volta River and its major tributaries. Doubtless some valuable agricultural land was lost. But the lake required resettlement of only 80,000 people (about 10 per km^2 or

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25 per mi^2 of inundated area), whereas the average density of population throughout Ghana in 1960 was 30 per km^2 or 75 per mi^2. Thus the pre-lake riverine area was evidently supporting less than its share of the population. The area of the sedimentary basin is still the least populated in Ghana, with extensive areas containing fewer than 10 per km^2 (or 25 per mi^2).

In the rising water of Volta Lake many trees and shrubs have been submerged, including extensive areas of woodland and even forest. According to Addo-Ashong (1969), the submerged wood is likely to be preserved for many years, and the large trees with more heartwood will last longer. The rate of deterioration will depend upon durability of the wood. These submerged trees unless physically removed become hazards to shipping, boating, fishing, and even studies of sediment.

Volta Lake may have changed the geologic environment and geologic processes significantly in at least two respects. Sediment is no longer transported by the Volta River from its drainage basin to the ocean - instead, that sediment is deposited in Volta Lake. And the creation of the lake has added weight to the underlying rocks, amounting to 165 thousand million metric tons when the lake reaches its estimated capacity of 165 km^3, and fluctuating through a range of 25 thousand million tons during normal fluctuations of lake level at Akosombo Dam. These changes and their effects are not documented or monitored, and they therefore can raise unanswered questions for the Present and problems for the Future.

1.2. Reservoir Sedimentation

The waters of the Volta and its tributaries are generally muddy and sediment-laden. Naturally the river transported sand and gravel through the Volta Gorge, which might rest temporarily in bars and islands, and be covered by several centimeters of clay and silt during declining stages of the river. The sediment is now accumulating in Vol

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river. The sediment is now accumulating in Volta Lake at rates that are not known or even estimated. The volume of the lake is so great that the sediment accumulation can be conceded as only a little problem. But little problems, like children, puppies, and even baby elephants, may grow big in several years. The Geological Survey Department proposes to measure the suspended sediment carried by principal tributaries (Barning and Banson, 1969, p.86), but this should be done as an extension of the stream-gaging program, coordinating sediment-samplers and current meters to determine both the histogram of suspended sediment and the daily and annual flow of water and sediment. Existing gaging stations (Oti River at Saboba, Black Volta at Bamboi, White Volta at Yapei, Pru River at Prang or Pruso, Afram River at Aframso) may be satisfactory for sediment gaging, and if so the data may be correlated eventually with river discharge to provide estimates of the sediment transport since Volta Lake began to fill.

A complete record of sediment inflow will not answer the question: where has the sediment been accumulating in the past nine years, and where is it likely to go in the future? A similar question, concerning Lake Mead on the Colorado River in southwestern USA, led to a comprehensive survey 14 years after the reservoir began filling. The survey included echo-sounding techniques, with some transducers that obtained reflections from thetop of the reservoir sediment and some that penetrated the thin muds and obtained reflections from more solid stuff below. The total accumulation, about 2 thousand million tons, checked closely the aggregate quantity of suspended sediment passing the Grand Canyon gaging station upstream from the reservoir. The sediment formed a delta in the artificial lake, with bottomset beds of silt and clay extending along the lowest part of the reservoir to the dam, where the clay was more than 30 meters (100 feet) thick; foreset beds of sand that were formed by the river as it entered the lake; and horizontal topset beds that covered the

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foresets when the lake was at highest stage*.

A similar sonar survey of Volta Lake might be rendered difficult in areas of submerged forest, where trees might give false, conflicting, or confusing reflections. Modern technology may develop a better way of surveying man-made lakes by special sensors in satellites. There is now hope that scientists of USSR and USA may be able to cooperate in developing means of surveying various earth resources from satellites, which hopefully would be beneficial to many nations.

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*The survey of Lake Mead was made in 1949, and I am hazy about some of the details in this paragraph. The publications of the survey will be checked when I get back home.

1.3 Seismic Effects

History indicates that most of Ghana is stable seismically, but the triangle extending southeastward from the Togo quartzite - or roughly from a line joining the cities of Accra and Ho - is earthquake country. Disatrous earthquakes occurred in Accra in 1862, 1906, and 1939, and the 1906 shock was even more severe at Ho. In the century before Akosombo Dam was built, minor tremors occurred in 1883, 1907, 1911, 1918, 1923, 1925, 1930, 1933, 1935, and 1942.

Three earthquakes of intensity 5 on the Modified Mercalli scale are reported (Kumi, 1973) since filling of the Volta Lake began in May 1964. The first occurred in November 1964 when 28 km^3 of water had been impounded: eleven countries recorded the tremor and placed its epicenter near Koforidua, about 40 km south of the reservoir. Another earthquake occurred in December 1966 when the reservoir contained 102 km^3, and a third occurred in February 1969 with storage at 162 km^3, but the epicenters for these shocks were offshore from Accra and more remote from the reservoir. Unfortunately there has been no instrumentation that might indicate the stress of this

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increasing load upon the earth's surface, or the earth's reaction to the stress. The Geological Survey Department proposes (Barning and Banson, 1969, p.38) to record micro-earthquake activity around Volta Lake by portable seisimometers of high sensitivity, and hopes that micro-earthquake research eventually may be helpful in predicting the occurrence of larger events.

The earthquake-triggering effects of changes in pressure, changes in weight, vibrations, etc. are of great interest to people in all earthquake-prone parts of the earth. Instrumentation to measure the effect of Volta Lake upon seisimic activity might therefore deserve and receive support from international organisations such as UNESCO and from scientific academies in many nations. Also, Ghana might well obtain cosponsorship of such a scientific project from neighbors along the Atlantic Coast and in the Volta River Basin.

2. THE HYDROLOGIC ENVIRONMENT OF VOLTA LAKE

This chapter is intended to emphasize ground water as it might affect Volta Lake or be affected by it. But I have been unable to find any data concerning the ground water beneath the lake; nor have I found any syntheses or analyses that might relate the lake to the occurrence or movement or quality of ground water. From the history of water resources development in Ghana (Lartey and Smith, 1968), it is evident that meager data, unreliable data, or no data are chronic complaints in all fields of water development, including water supply, irrigation and drainage, water power, flood control, water transportation. And of course, ground water. This chapter is therefore organised to summarise several phases of the h hydrologic cycle as they affect Volta Lake or are modified by it; followed by a discussion of ground water as a separate resource which is commonly treated like an unfavoured stepchild.

2.1. Precipitation Inflow vs. Evaporation Outflow

Six stations near Volta Lake, all in localities where average annual rainfall is 1400 to 1,500 millimeters (55 to 60 inches), provide records of pan evaporation ranging from 1,450 to 1,700 mm. annually (57 to 70 inches). The evaporation rate from pans is characteristically greater than that from large reservoirs, and a correction factor is commonly applied. For Volta Lake only a small correction would make the inflow from rainfall equal to the outflow by evaporation. Researches at Lake Hefner and Lake Mead in U.S.A. have developed heat balance and energy balance techniques for more accurate determination of evaporation from large reservoirs, and I can refine this discussion by reference to the the publications. The data available in Ghana indicate that loss by evaporation (from the lake surface) is nearly balanced by gain due to rainfall upon that surface.

2.2. Possible Climate Change Caused by Volta Lake

To check on the possible effect of the lake upon rainfall, Amissah (1969) made statistical analysis of data from four rainfall stations - Accra, Akuse, Kete Krachi, and Tamale - and could find no conclusive evidence that monthly rainfall at thos stations has changed since the creation of the lake. However, comparison of monthly runoff of Volta River before and after the lake was created (Kumi, 1973) indicates some change in runoff pattern, with a greater proportion occurring in August and September and less in October. However, since 1964 the monthly runoff has been calculated from the monthly outflow from the dam, plus or minus any changes in storage in Volta Lake, and its reliability thus depends upon the accuracy of the gage-height - storage-capacity curve. Storage changes comprised a large part of the calculated river flow in years prior to 1968, while the lake was filling. As Amissah suggests, several more years of data will need be studied before definite statements can be made as to climatic changes caused by the lake.

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2.3. Surface Inflow to and Outflow from the Lake

A summary of the water resources of Ghana (Krishnamurty, 1964) provides tabulations of average annual runoff of the Volta River and its major tributaries as well as of other rivers in Ghana. I have seen only one tabulation of monthly and annual runoff, and this shows that the Volta River at Senchi (before Akosombo Dam was constructed) ranged from 13 km^3 runoff in 1958 to 91 km^3 in 1963; also that the runoff in 1963 was greater than the total runoff in the three years 1958 to 1960. In 28 years the recorded runoff was within 10 percent of the mean in only 3 years, but it was more than 25 percent below the mean in 8 years and 25 percent above the mean in 8 other years. It is important to know about the deviations from the mean, because they cause problems and even crises in water management.

In practically every aspect of water-resource development, the government and its consultants have long been handicapped by lack of streamflow data. Interest in the Volta Basin development led to a decision in 1954 to start hydrologic observations on a continuing basis, but this decision was not implemented until 1959. Streamflow records were published in water year books for the years 1961 to 1967 by Hydrologic Services (Ghana Public Works Department) but these were limited to gage heights and instantaneous discharge measurements. Data have now accumulated for another five years, and plans are to use rating curves to calculate average daily discharge, and to publish monthly and annual runoff totals also. To learn more of Hydrologic Services' future plans for streamflow data, it may be necessary to track Mr. S.A. Acheampong, Senior Hydrologist, to Stanford University where he is now engaged in advanced studies. Since this is close to my house, I plan to do just that.

After the urgency of data for operations and management has passed, the daily details of streamflow have no more interest than old daily newspapers. For historical studies,

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runoff records are most convenient if compiled and tabulated by months and years, and several countries are now publishing tabulations of streamflow data that may cover 25 to 50 years of record on a single page. An experienced hydrographer, with collaboration and assistance of Ghanaian stream gaging staff, could doubtless derive the desired runoff totals from existing data in Ghana, perhaps by computer programming. International support may be available during this last year of the International Hydrologic Decade, particularly if the project becomes regional in scope, by including all the Volta River basin and other international streams - and particularly if Ghana proposes that the publication be in international units units (metric system) rather than in cusecs and acre-feet.

2.5. <u>Subsurface Inflow to and Outflow from the Lake</u>

People are likely to expect too much of me as a groundwater expert unless I start out by admitting that I have no supernatural powers, and cannot see underground any better than than they can. I have been underground in caves and tunnels and mines, but as to groundwater I have to depend on wells or boreholes, which thus become the periscopes through which I see the rocks and the water, the recharge and discharge, the statics and dynamics, and quality and chemical reactions.

Unfortunately, I am told there are no observation wells in Ghana - no records of water-level fluctuations, or of the effects of pumping in the pumped well or in adjacent wells, or of progressive lowering of water table by pumping, or of wells whose yield is sustained year after year by recharge. Thus in ground water we are flying blind, in our yellow sub-marines, without a periscope. Specifically, in the Voltaian sedimentary basin during the filling of Volta Lake there are no records of water levels in wells near the lake, to show whether those levels were affected by the progressively increasing volume of water in the lake. Of course, the areas that are inundated by the lake during high stages and then re-emerge as the lake level recedes have been subjected to infiltration and percolation of the water into soil, c

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percolation of the water into soil, subsoil, and underlying rock material wherever pore space is available. This subsurface water becomes of critical value to drawdown agriculture whenever the roots of cultivated crops can reach it and sustain the plants. But no one knows the extent of the lake's influence upon ground water.

Each new dam and new reservoir presents an opportunity to measure the effect of surface impoundment upon ground water. As an example, a dam is planned at Weija on the Densu River, to provide water for municipal and some irrigation in western suburbs of Accra. The Densu Basin is being instrumented for water balance studies (Water Resources Research Unit, 1971). Periodic measurements of water level in any wells in the vicinity of the proposed reservoir would provide data as to natural conditions. Drilling of additional boreholes at suitable locations would provide data on ground water during the period the surface reservoir is filling. These wells could also be pumped to provide water supply to communities that will ulteriately depend upon the lake, until the lake and distribution system are ready to serve them.

2.3 The Ground-Water Resource - [illegible]ic

Metamorphic rocks, granites, shales, and mudstones are among the most impermeable rocks on earth. They are also the rocks underlying most of Ghana, and it is fortunate that they are so ancient, because there has been a long time for jointing, fracturing, and deep weathering of these rocks, which thus gain a variable but low secondary permeability. Water that saturates these pores becomes ground water, which is encountered in boreholes and may be withdrawn for use.

As summarized by the Nathan Consortium (1970) after testing the yields of about 1200 boreholes: The crystalline rocks decompose to sand and clay with low permeability down to a depth of nearly 25 meters (75 feet). Boreholes should penetrate 10 to 15 meters into the weathered rock beneath this sand and clay, and thus to a total depth averaging 35 meters (110 feet).

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Ninety percent of the wells thus constructed will provide enough water for a hand pump. If the wells penetrate all the weathered zone, to a probable depth of 60 meters (200 feet) or more, fifty percent will have yields sufficient for a motor pump, and the probability could be increased to 75% by geological and geophysical exploration. The sedimentary rocks are completely decomposed to depths averaging about 10 meters; boreholes in the sedimentary rocks have generally lower yields and higher failures, but geological and geophysical exploration can improve to 60% probability of a yield sufficient for a motor pump.

2.6 Ground-Water Development

In their analysis of water-resource development and planning in Ghana, Lartey and Smith (1968) consider ground wate water only as a source of rural water supply, where it has a very essential role. In 1960 there was 37 Urban Communities (population 10,000 or more) with aggregate population of 1,145,000. The rest of the population - 5,582,000 or 83% of the total - lived in about 30,000 rural communities. About 5 million people (75% of the total population) lived in 9800 localities with population between 100 and 9,999. Many of these communities are too remote from potable surface water, or too small to justify piping a supply to them. These are the communities where a ground-water supply would be a blessing.

The present policy of the Ghana Water and Sewerage Corporation (Bannerman, 1972a) is that rural communities with population of 2,000 or more would have pipe-borne drinking water supplies, whether from deep wells with motor pumps or from surface-water sources by means of packaged "P.C.I. Units." For villages of 500 to 2,000, the corporation provides a village well equipped with hand pump. These have generally been called "shallow" wells, which is a misnomer,

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unfortunate if it results in abandonment of a hole after drilling only 30 or 35 meters (100 to 120 feet), because greater depth may yield enough to meet demand. Some boreholes must go as much as 300 meters to obtain sufficient supply even for a small village.

About 1,200 boreholes had been tested for yield by 1969, and the Nathan Consortium (1970) serving as a sort of Certified Public Accountant for the ground-water development program, has provided the statistics presented in Table 1.

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BOREHOLE TEST DATE

GEOLOGIC UNIT		BOREHOLES		YIELD OF BOREHOLES PERCENT		
Name of Formation	Area of Ghana percent	Number	Average Depth, Feet	Failures	Hand-pump wells 500-2000 gph	Motor pump wells 2000 gph
Granite	20	414	160	20	42	17
Togo Quartzite, sandstone	1	80	240	31	30	29
Tarkwaian Formation Quartzite, phyllite	2	32	230	9	50	22
Formation Metamosphic	27	259	200	10	38	45
Dahomeyan Formation Queiss and schist	4	20	150	80	5	0
CRYSTALLINE ROCKS	54	805	200	19	38	28
Eocene - Cretaceous	1	103	350	22	15	52
(Sandstone in Western Region)	-	(26)	(240)	(15)	(31)	(50)
(Limestone in Volta Region)	-	(77)	(471)	(25)	(9)	(53)
Voltaian Formation Sandstone, shale	42	203	290	28	34	22
(Volta Region)		(26)	(216)	(7)	(30)	(56)
(Brong/Ahafo Region)		(35)	(328)	(23)	(40)	(31)
(Upper Region)		(3)	(157)	(33)	(33)	(33)
(Estern Region)		(58)	(296)	(33)	(32)	(23)
(Ashanti Region)		(26)	(413)	(38)	(47)	(12)
(Northern Region)		(55)	(305)	(31)	(29)	(4)
Buem Formation shale, Volcanics	3	94	220	12	42	39
SEDIMENTARY ROCKS	46	400	290	23	31	34
ALL GHANA	100	1205	230	20 (244 wells)	36 (434 wells)	30 (257 wells)

(also 170 wells yielding 60-500 gpm to be used in di e need)

From: Nathan Consortium, Ghana Sector Studies, 1970 Interim Report B, Occurrance of ground Water, Page 7 Table 2.

These statistics show that about 30 percent of the boreholes throughout Ghana have yields sufficient to justify a motor pump - 2,000 imperial gallons per hour, or 40 U.S. gallons per minute. Even this "most successful" group have small yields for municipal supply, and hopelessly inadequate for irrigation, in most other parts of the world. Some geologic formations do better than average: the younger rocks along the southeast and southwest coast, in very small areas; the Birrimian metamorphic rocks that underlie the southwest areas of greatest rainfall and extend northward along the west margin and include all the Upper Region. But the Voltaian Sedimentary basin is poorer than average, especially in the Ashanti and Northern Regions; the Dahomeyan (beneath the Accra Plains) is worst of all - and it is fortunate those plains are in an area that can be irrigated by water from Volta Lake, although irrigation is likely to create problems, too, in such impermeable country.

In the U.S.A. similar crystalline rocks, deeply weathered, are found in the Piedmont of the Appalachian Mountains, and North Carolina is the place to go to see ground-water development for municipal and modest industrial use. The only other "developed country" with a similar ground-water province is South Africa. Robt. Bannerman, hydrogeologist of GWSC in Kumasi, has visited North Carolina for ground-water studies under Ralph Heath, and he appears to be well qualified for the task of borehole development, and training of hydrogeologic assistants, in Ghana (Bannerman, Atobrah, and Nerquaye-Tetteh, 1972). I suspect he now has greater expertise for Ghana's specific environment than any expert who could be imported from Europe or North America.

One brand of expertise that may be of great value in selecting sites for productive boreholes has not yet been developed or imported into Ghana. Photogeologists can do an amazing job at identifying and interpreting geologic formations and structure on aerial photographs of country they have never seen. In Ghana the occurrence of ground water is related to such features as joints, fractures, folds, and shear zones, linear features that may be identifiable in aerial photos. Thus, before importing any hydrogeologists into Ghana, make sure of their qualifications in photogeology. Meantime, the aerial photos available (in Akosombo) could be important tools in the ground-water development programme, and Messrs. Bannerman and Hefodadonna should get together and see what they can work out.

2.7 Ground-Water Management

In the broadest sense, water management includes all aspects of planning, exploitation, development, utilization, allocation, regulation, conservation, and protection of the water resources, presumably in the public interest and benefit. Ground-water management is an integral part of water management, just as the ground-water resource is an integral part of the total water resource. In comparison with the large rivers and abundant rainfall, and the huge reservoir formed by Akosombo Dam, the ground-water resource of Ghana is practically microscopic and likely to be neglected in most water planning and management, even though it is vital to many people in extensive areas as the only potable and unpolluted water supply.

In the restricted sense of a single well, Development is like the production of a new automobile or airplane which should be functioning properly in all respects when it is delivered to the user. For a borehole, Development includes exploration and selection of site, drilling into water-bearing rocks, improving the yield by using screens and gravel pack and removing clay and silt particles, and installing a suitable pump and motor.

Thereafter comes the problem of "upkeep", and this includes careful operation, and also proper maintenance of the pump and motor - and of the well - to insure that water can be produced as needed, without breakdowns or stoppages

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that can cause crises when water supplies fail. Efficient operation requires adequate inspection and monitoring of all the elements that contribute to the water production. Wells are designed and constructed to produce water at specific rates and at optimum efficiency, but yields may decrease and drawdowns increase in time, because of reduced efficiency of an aging pump or motor, or because of corrosion or incrustation of well casing and screen, or because of gradual accumulation of clay or silt, or slime produced by iron bacteria.

However, declining yield may not be the fault of the well or its construction or equipment, but may instead result from inadequate recharge to the zone from which the well has been drawing water. In most places boreholes must go through 10 to 15 meters (30 to 50 feet) of decomposed soil to reach weathered rock that is water-bearing. This decomposed soil is so impermeable as to prevent infiltration, and practically all the rain upon the land necessarily runs off. Thus, even though the average yield of a well in Ghana is quite low, it may be greater than the rate of replenishment, and the well therefore, in pumping water that has accumulated very slowly, depletes the storage progresively.

Ghana has so far neglected to monitor the effects upon the ground-water resource of pumping from boreholes. I have heard that in some wells where pumps have been operating for several years, the water level is now perhaps 5 or 6 meters (16 to 20 feet) lower than when pumping was started: But no measurement, no record, not even identification of a specific well or specific locality. The absence of basic data and the need for observing fluctuations in wells and monitoring the effects of pumping as well as of rainfall, flood runoff and drought, have been pointed out (Bannerman, 1972a). Especially where a rather large community obtains its water from several boreholes, an observation well suitably located could provide data as to whether the

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groundwater is being depleted - and the forewarning may lead to timely planning for additional or supplemental or alternative supplies. In addition, water levels should be measured, perhaps monthly, in observation wells in a network planned to include various geologic formations and rates of rainfall and distances from rivers and lakes. Some boreholes would need be drilled for the special scientific purpose, and some might be wells abandoned for one reason or another.

When I say Ghana should find out what is happening in ground-water reservoirs, I do not mean to play the part of Jeremiah, warning of impending doom - because I doubt that any doom is impending. Particularly in areas of abundant rainfall there is certainly sufficient water available for recharge; and considering the small rate of pumping from each borehole and the vast volume of rock around it, I would expect the ground-water resource in mostareas to hold up very well, not only under existing development but also with greatly increased development - always assuming that hydrologic talent will be available for locating and spacing the wells. But if all is well, that also is nice to know, and such reassurance can come only with basic data on the groundwater and its hydrology.

2.8. Ground-Water Research

Although Ghana does not yet have a nationwide program of ground-water studies (involving a network of observation wells, records of water-level fluctuation, and various pump tests and aquifer tests) some research is in progress in ground-water hydrology (Water Resources Research Unit, 1971). This research, still in a pilot-project stage, is chiefly in the Accra Plains underlain by the Dahomeyan Formation, which is generally recognized as one of the least permeable in the country. On these plains, wells of small yield would be sufficient for cattle or other stock, or small gardens. Natural vegetation patterns have been helpful in suggesting

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ground-water zones, although seismic and resistirity instruments are also important in site selection. Bailing tests are a very inexpensive method of determining the potential yield of the borehole. In the solid rocks the holes are well preserved without casing. also reducing the cost of producing water. So far eight boreholes have been completed, with yields in the 600 to 1,500 gph range, good for the Dahomeyan and perhaps enough for a tomato-egg - and cow farm. The measurements of water-levels in the wells will permit study of the form of the water table, and of the fluctuations during the rainy season.

This research, and other geohydrologic studies and activities, are deserving of increased support and coordination, if the full potential of ground water is to be realized.

3. APPRECIATION AND ACKNOWLEDGEMENTS

This paper was written during a mere two weeks in Ghana, during which my principal role was as a recording secretary, digesting available published data and some unpublished records, hearing of the experiences, the woes and hopes of my new-found Ghanaian friends and colleagues - and organizing the minutes of all these meetings and documents under two principal topic headings. In this job I realize I have not had prior knowledge or opinion. and thus hope to qualify as an unbiased observer. But my report is necessarily coloured somewhat by my experiences in other lands.

Mr. Nyame-Kumi desires that this report be stencilled so that it can be made available to all participants in our meetings and to others interested. I appreciate this, and believe it is the closest we can come at this time to the Smithsonian Institution's hope for workshops - in Accra or Washington or both - to discuss the findings of the individual scientists involved in the Environmental Case Study of Volta Lake.

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