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east of the river the Arabian Desert. Modern usage speaks simply of the Eastern and Western Deserts, a practice followed in this paper.

That part of the desert immediately adjacent to the Nile on the west is known as the west bank; that on the other side the east bank. A glance at the map of Nubia (fig. 2) will show the reader that for a short stretch of Lower Nubia, the region of the Korosko bend, the east bank is in fact the more westerly. This does not confuse the river dweller, to whom Nile direction is a more significant datum than compass direction. In the present study west bank and east bank refer to the Nile shore on the left and right respectively, when one faces in the direction of Nile flow.

Most altitudes of geomorphic features and Pleistocene sediments are expressed in meters above flood plain, a datum more critical to a study of Nile history than is absolute altitude. Absolute dates, except where otherwise specified, are expressed in C^{14} years before the present (B.P.).

Color notations following the Munsell system have been determined from dry samples.

(AB)

GENERAL PHYSIOGRAPHY

NILE SYSTEM

Through the 6,650 kilometers from its source in Rwanda-Burundi to its mingling with the Mediterranean at the Delta, the Nile traverses a number of different climatic zones, from the rain forests in the highlands of central Africa through progressively less humid regions to the arid Sahara. At its mouth the Nile briefly enters a semi-arid Mediterranean climate. Although the longest river in the world with the fourth largest drainage basin, the Nile ranks only

32nd in average total discharge (Leopold, 1962).

Throughout its length the Nile does not exhibit the classic long profile of a well-developed river system, but seems to comprise at least four segments, each with different characteristics. This suggests that the Nile system as a whole has had a complicated history. (For the following discussion, refer to figures 3 and 4.)

From its numerous East and Central African sources to Juba, the White Nile crosses many rapids and falls, includes major lakes along its course, and is never free from the influence of late tectonic activity associated with the development of the African Rift System. The integrated gradient of this stretch of the Nile is 1 in 1216 (Ball, 1939). However, segments such as Lakes Victoria and Kyoga have a very low gradient, while at Ripon and Murchison Falls the gradient is considerably steeper than 1:1,216. Analyses of the geomorphic history of the upper Nile have been published by, among others, Gregory (1921), Wayland (1930, 1934), Shackleton (1955), Pallister (1954, 1960), and Bishop (1965). The evidence suggests that the complex profile of the upper Nile is of late origin, and there is every reason to expect that this present metastable configuration will not long be maintained. Without the intervention represented by numerous hydrologic development projects currently under way, the tapping of Lakes Victoria and Kyoga by headward migration of falls not far down their outlets would seem geologically imminent.

Below Juba, the Nile undergoes a marked change in regimen. From Juba to Malakal the measured gradient is 1 in 13,900, and the river flows on what is thought to be a thick fill of alluvium (Ball, 1939). This is the region of the Sudd, where floating masses of vegetation not only hinder river navigation but also extract as much as fifty percent of the river's total volume through transpiration (Hurst, 1952). Several of the early schemes for utilization of the entire Nile called for cutting a canal around the Sudd to minimize discharge losses from this factor. Below Malakal the river falls only eight meters in the 809 kilometers above the junction with the Blue Nile at Khartoum, representing a phenomenally low gradient of 1 in 101,000. In times of flood, when the Blue Nile rises an average of 7 m, the White Nile is ponded above Khartoum, and there is no discernible flow in the White Nile almost as far upstream as Malakal.

No doubt this annual ponding has contributed, by deposition of sediment, to the extremely low gradient in the Malakal-Khartoum reach, but it seems unlikely that the gradient could ever have been very much steeper, as the White Nile flows on bedrock at the latitude of Khartoum.

Below Khartoum the Nile enters the cataract segment, and in the 1,847 km above Aswan falls 287 m, much of which is achieved in the relatively short stretches of the six cataracts. The gradient in the cataract segment is 1 in 6,440.

Three-hundred-twenty-two kilometers downstream of Khartoum the Atbara River enters the Nile, and from this point to the sea the Nile receives no additional discharge from adjacent land. Some water is lost through infiltration and evaporation, and, since irrigation began, a great deal more is removed to support an agricultural economy.

Below Aswan the Nile flows once again on alluvium; here the bed-rock valley has been deeply excavated in response to lower sea levels at times of Pleistocene glacial maxima. The gradient of this segment of the Nile is 1 in 13,200.

Examination of figure 4 leads to the conclusion that the history of the Nile has been complex. Ball (1939) discussed the theory that the low-gradient segment of the river between Juba and Khartoum had once been an extensive lake that received all the drainage of the Blue and Victoria Niles, as well as the discharges of a number of smaller streams that drain the highlands of the southern Sudan and southwestern Ethiopia. Under that theory, the Nile that enters the Mediterranean would have consisted of a river system extending into the Sudan and terminating in the headwaters of the Atbara. A head-ward-growing tributary of that system presumably tapped the waters of Lake Sudd, captured the upper Nile drainage, and made available to the lower Nile the life-giving silt of the Blue Nile. The evidence provided by the long profile of the Nile lends credence to this hypothesis. Ball calculated the inflow of water from all sources into Lake Sudd, and compared this figure with an estimated evaporation rate of a hypothetical lake the size of the basin in the central Sudan. The similarity of the two values convinced him that such a lake might have existed.

Although arguments in its favor are persuasive, no concrete evidence supporting the Lake Sudd hypothesis has come to light.

STUDY AREA

The segment of the Nile considered here lies between the Second