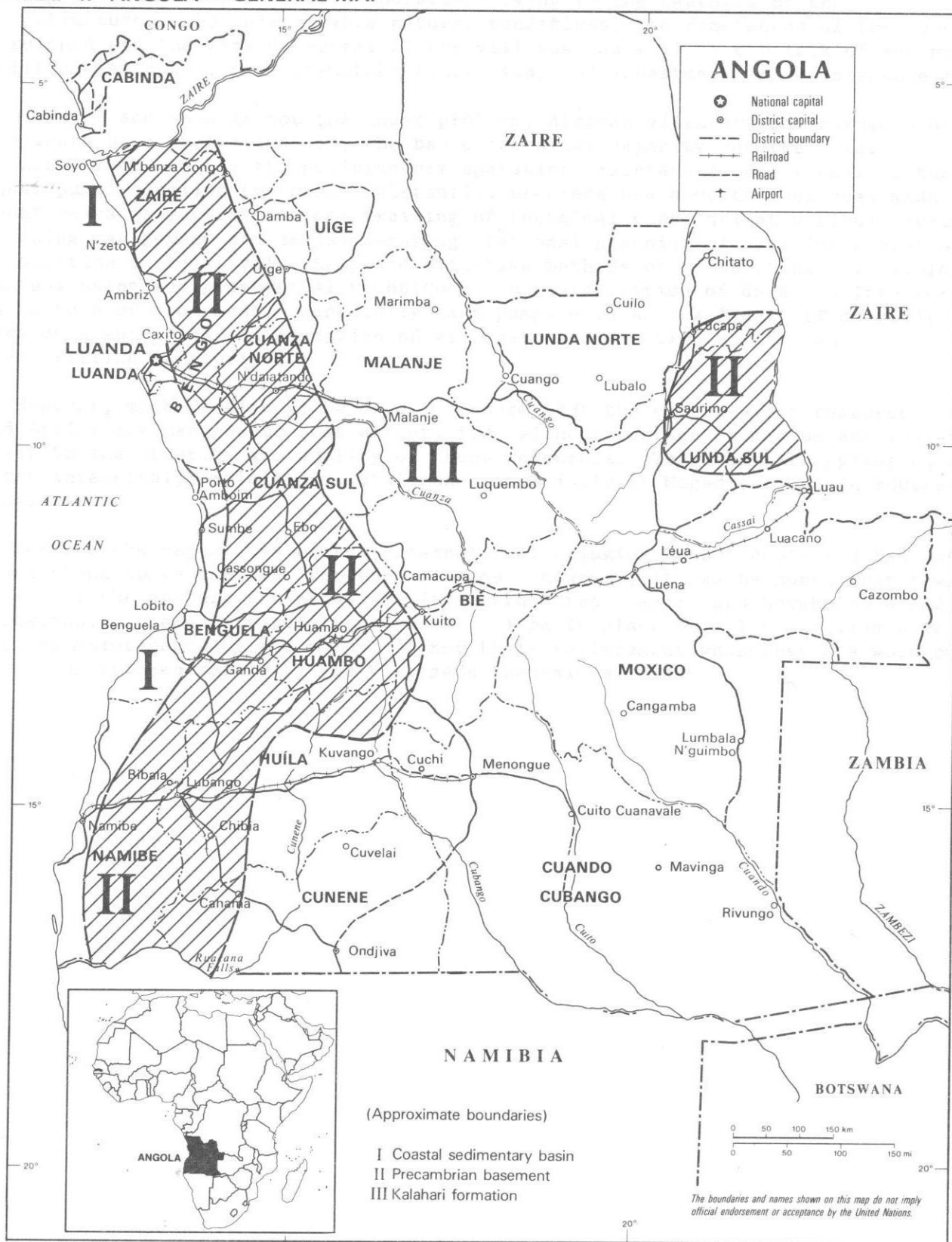


MAP 1. ANGOLA — GENERAL MAP



## PART TWO - COUNTRY PAPERS

### ANGOLA

Area: 1,246,700 km<sup>2</sup>  
Population: 8.4 million

#### I. BACKGROUND

The whole country is occupied by high plateaus and high peneplains from 1,000 to 1,500 m in altitude which include the upper basins of the Congo and the Zambesi. There are five types of terrain, with altitude increasing with the age of the formations.

Type V: The Prejurassic "Montanha Marginal" with flat-topped outliers which have escaped erosion, of which the following are examples: Bimbe: 1,830 m; Chicuma: 1,830 m; Humpata: 1,900 to 2,000 m. This terrain rises sharply (200-250 m) above the level of:

Type IV: The "Planalto Africano", monotonous, slightly undulating terrain cut by deep valleys, with poor soil and topped with a ferruginous crust which covers the whole of the interior of the country. The altitude is 1,600 to 1,700 m, and 1,350 m towards Kwanza.

Type III: The altitude is 1,500 m at Sanga, falling to 850-900 m at the foot of the Chela mountains. The land slopes westwards, and the boundary with the formations of type IV is very irregular, with the maximum loss of altitude in the Chela mountains, and a steep, well-preserved escarpment. These forms of relief probably date from the Lower Cretaceous.

Type II: This peneplain is the widest, at about 100 km. The boundary with type III is very indistinct and can even be undetectable.

Type I: This is the coastal zone. It is wide in the south (35 to 55 km) and up to 180 km wide in places north of Kwanza bay. It also varies in altitude: 500 m in the southern region, 300 m at Lobito and north of Kwanza, and 400 m at Cazengo.

On the ocean side this peneplain runs right down to the sea, level with Luanda. The first marine terrace, 40 to 60 m high, appears at Porto Amboim, and at Lobito and Namibia two terraces are formed: the upper "A" (80-130 m) and the lower "B" (25-40). The east, especially in the area of Mexico, is dominated by the typical formations of the Kalahari: polymorphic sandstones and sands deposited respectively on the erosion surfaces of the Cretaceous and the Middle Cenozoic.

In the west of the country there is a kind of rounded north-south massif, with some peaks over 2,000 m. The slopes are steep towards the west, especially in the Sierra de Chela, which forms an escarpment 1,000 m high.

The coastal desert of the Namib (Namibia) extends northwards along the coast of Angola to a point 100 km to the north of the town of Namibia (formerly Mossamedes), with even more intense aridity. Immediately inland and to the north of the Namib, the coastal region has a climate of the semi-arid type. The whole of the country to the east of the high ground receives 1 to 1.5 m of rainfall a year and sometimes more, in a climatic zone of the wet tropical type with a dry season (called "cacimbo") from May to August, and a rainy season from October to May.

The average temperatures in the hottest months are around 28 °C on the coast and 20 °C on the plateau. They are 22 °C and 14 °C respectively in the coldest month.

The annual potential evapotranspiration declines from 1,400 mm on the coast to 1,000 mm in the interior.

### Surface water

The centre and north of the country have many watercourses and perennial springs. In the south, Benguela, Haila, Nami and Cune, the watercourses dry up during the "cacimbo" season, entailing recourse to ground water to satisfy the needs of the population and livestock. There are only three permanent watercourses in this region: the Cunene, Kuando and Kubango.

The main hydrographic basins are those of the rivers Zaire (289,200 km<sup>2</sup>), Zambezi (148,400 km<sup>2</sup>), Cunene (94,000 km<sup>2</sup>), Kubango (156,000 km<sup>2</sup>) and Kuando (98,000 km<sup>2</sup>).

## II. GEOLOGY

The following are the main geological formations, grouped by geographical unit of the country.

1. Coastal zone - Located between the coast and the mountains which run along the big interior plateau: 200 km wide at Luanda, with a maximum altitude of 400 m. This zone is occupied by sedimentary formations of marine, littoral and lagoonal origin which have been deposited since the Mesozoic period.

On the coast, the Cretaceous seas have penetrated in two gulfs: Luanda and Namibia: the corresponding sediments are 150 m thick (Aptian-Maestrichtian). The extent of the Tertiary seas is largely the same (1,200 m of sediments dating from the Paleocene to the Pliocene).

2. Inland - The continental massif which includes all the high ground: a component of the African Precambrian crystalline basement rock which includes vast intrusions of eruptive rocks, with the granitogneiss base complex, the sandstone-quartzitic system of Oendolongo, which forms the highest mountains, and the Bembé system (terminal Precambrian or Lower Cambrian), with at the base a schist-limestone series and at the summit a sandstone-conglomeratic and quartzitic series. This system is overlaid with a discontinuous cover of continental deposits.

At the edge of the Zaire basin are found formations equivalent to those of the Karroo system of Southern Africa which extend beyond the actual limits of the river's hydrographic basin. The Karroo formations include argillaceous limestones, sandstones and shales, 500 m thick, traversed by intrusive dolerites.

The "sands zone" of the vast eastern part of the country is covered with Cenozoic formations of the Kalahari: sandstones and red sandy silts and Lower Quaternary deposits similar to those found in the People's Republic of Congo.

## III. GROUND WATER

It was in 1942 that Angolan hydrogeology took its first steps, with the creation of the Geology and Mines Services, whose functions included the study, research and development of ground water and its exploitation by borehole. The existing bodies were strengthened in 1963 in order to solve the increasingly acute problems of supplying water to rural dwellers. This resulted in the preparation of a

"co-ordination plan for the provision of water in the pastoral regions of southern Angola" in association with the Applied Geology Service of the Office of Geological Services and Mines, the body responsible for hydrogeology in Angola. Every year field crews have been constituted in order to carry out hydrogeological prospecting, while the drilling crew, likewise attached to the Mines Service is responsible for the drilling of exploitation wells.

The prospecting and drilling for ground water have been carried out for the most part in the formations of the Precambrian crystalline basement rock (gabbros and granites) and also in the Cretaceous sediments, the Kalahari formations and other Cenozoic sediments, and in the recent alluviums.

Operations begin by preference with a photogeological study, with the locations chosen close to watercourses or the geological accidents which traverse them. A large number of geophysical studies are also carried out (electrical and microseismic prospecting). The most favourable zones in the basement rock, with respect to water-bearing properties, are: the quartz veins and basic rocks, the contact zones between crystalline rocks of differing texture and composition, the zones of outcrops of fractured granitogneiss, and the zones of contact between the eruptive and the quartz-schist rocks.

The sands and sandstones of the Kalahari can be up to 600 m thick; in some cases the geophysical prospecting concentrates on the search for fossil valleys in the sandstone-limestone sedimentary formations covered by the Kalahari sandstones (Cunene River region).

In the coastal sedimentary basin the best - and virtually the only - aquifer is constituted by the white alluvial argillaceous sandstones which fill the fossil valleys. The water, which has a small dry residue, is sometimes tapped by means of underground dams.

Underneath certain flat sand-clay zones covered with savannah vegetation (the "chanas") the drilling has encountered artesian aquifers.

The Applied Geology Service operates mainly in rural areas in the southern and south-western provinces where the climate is arid, in particular south of Lobito, but its activities are also concerned with the supply of the big population centres: Porto Alexander, Namibe, Lubango, Ondjiva and Benguela.

About 1,200 exploitation boreholes have been drilled, with depths from 20 to 300 m; 55 % of the boreholes are 25 to 40 m deep.

A large number of boreholes have yields of between 1 and 7 m<sup>3</sup>/h. Some have higher yields: up to 30 m<sup>3</sup>/h at Catuiti in the fractured and tectonized gabbros. A structural study has shown that the size of the yield bears a direct relationship to the tectonic directions (direction of the fractures). For example, for a N-E/S-W direction, the yield is under 3 m<sup>3</sup>/h; for a E-W/N-W/S-E direction, it is 8.5 m<sup>3</sup>/h, and for a N-S direction, it is over 8.5 m<sup>3</sup>/h.



Since Independence the Applied Geology Service has acquired the status of a State enterprise - "Hidromina" - responsible to the Ministry of Industry, whose functions include the development of ground water for the whole country. At present (1983) this enterprise has about 15 drilling rigs, only a few of which are in operating order. Mention must also be made of the shortage of Angolan specialized technical personnel. In addition, the Ministry of Construction has established, with the support of UNICEF, a small technical unit for ground water which has two drilling rigs but is encountering some difficulties owing to lack of technical personnel and logistical support.