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MINERAL DEVELOPMENT IN SWAZILAND

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MINERAL discovery and exploitation have been among the major factors responsible for the economic emergence of Africa. Although the character of mining development has varied considerably from one territory to another, progress and distributional patterns have everywhere been determined by similar factors. Some of these factors are of world application, such as the distribution and relative abundance of mineral resources and their mode of occurrence. Others are comparatively unimportant in western countries with their long mineral and industrial histories, but of vital significance to Africa. Such are the influence of relief upon accessibility and upon climatic suitability of mineralized regions to European settlement, the extent of private prospecting and of official geological and mineral survey, the availability of cheap labor and of skilled technicians, distance from ports and means of communication. The remaining factors are peculiarly African, such as the existence of native lands and the complex, often unnecessarily complex, regulation of mineral ownership, prospecting, and mining. Moreover, there have been not only common factors but also common stages of development. Almost everywhere precious metals and stones were the first to be exploited, followed later by base metals, and only recently, if at all, by nonmetallic minerals. In most territories mining is still in its initial stages; only crude ore is exported, and few smelting and refining plants have so far been erected.

A territory such as Swaziland, whose mineral development and potentialities are both limited and varied, provides a concise example of African conditions. Factors and stages of development can be studied in detail. The selection of Swaziland for study is, in fact, timely. The South African Government has recently declared that Swaziland should be incorporated into the Union in order to facilitate railroad and industrial development within the territory. Yet, among the profound changes that have taken place in the territory's economy during the past decade, none has been more striking than the rapid expansion of mineral production. In the 1931 depression value of mineral output had fallen to £8,875, and the pre-war years witnessed a slow recovery to £42,164 in 1938. Ten years later production had exceeded a million pounds in value, nearly 11 times the highest figure recorded before World War II. But in 1937 Dorothy Doveton had stated: "it is difficult to forecast the future of minerals in the country, but it would appear that, unless any startling developments occur in gold, Swaziland will remain dependent upon her exports of tin."[1] Recently, tin mining has

become moribund. Although there has been a small, but by no means startling, increase in gold production, tin and gold together yielded only 3 per cent of the 1948 output. Apart from small quantities of barite, the remainder consisted entirely of asbestos. Other mineral resources are being systematically investigated by the Geological Survey Department established in 1942. Mineral production, which accounted for only one-third of the territory's exports during the thirties, now yields more than three-quarters of total exports, despite a substantially increased export of livestock products.

MINERAL REGIONS

With an area of 6704 square miles Swaziland exhibits sufficient variety and correlation of relief, geological structure, and mineral resources, for mineral regions to be clearly defined. In the west the mountainous edge of the high veld exceeds 6000 feet and averages 4500 feet above sea level. The northwestern mountains, built of Archean rocks of the Swaziland system, constitute the most highly mineralized zone of the territory. Apart from small intercalated masses of phyllite exposed by tin workings in the "older granite," which may be outliers of the main mass, the Swaziland system, represented by the Fig Tree, Moodies, and Jamestown series, is confined to a narrow strip about six miles wide along the Transvaal border. The Fig Tree series, composed of alternating shales and cherts with minor quantities of greywackes, grits, and schists, contains deposits of iron ore and manganese. It is overlain unconformably by the, Moodies series consisting of quartzites phyllites, conglomerates, grits, shales, and banded ironstones. These rocks have been extensively invaded by basic intrusions of the Jamestown series, so that schists, serpentine, and various unclassified igneous rocks also occur. Chrysotile asbestos, columbium, copper, gold, lead, silver, tin, and tungsten deposits all occur within the Jamestown schists and, except for chrysotile, owe their origin to granite intrusions. In places, notably surrounding Forbes Reef, the schists form relatively flat plateaus; otherwise, the region is characterized by a succession of ridge and valley. Narrow prominent ridges, that mainly follow the strike of rocks from northeast to southwest, mark the quartzites and other hard beds; intervening valleys, frequently so deep that a height of 3000 feet may separate mountain summits from valley floors, have been eroded in the softer shales and phyllites. The resultant outcropping of beds on the valley sides has facilitated mineral exploitation, but the deeply incised streams and dense vegetation of most valley floors have hindered prospecting and made communication difficult. There are still areas that have not been studied in detail, and the mineral resources are far from being fully known. Nevertheless, mineral development has been favored, not only by the presence of considerable mineral wealth and by landforms that facilitate mining, but also by an abundance of surface water, a comparative absence of malaria, and, for reasons described later, the limited extent of native settlement. The region was, in fact, the first to be developed by Europeans.

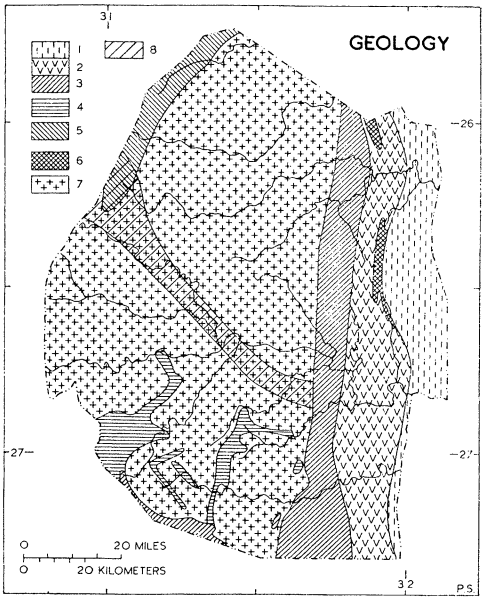
In the southwest the Pongola system, almost certainly the equivalent of the Witwatersrand system, represents the only other area of pre-Cambrian metamorphosed sediments in Swaziland. An official survey of the mountains between Mankaiana and Hlatikulu in 1946 confirmed the view that the Lower Pongola series, consisting of quartzitic sediments with volcanic rocks and some

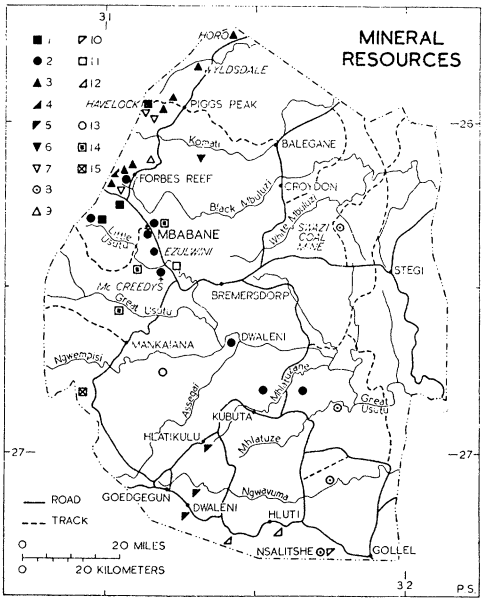
phyllite, is probably equivalent to the Dominion Reef series in the Klerksdorp district of the Transvaal.[2] Similarly, the Upper Pongola series, comprising quartzites, shales, and banded ironstones, and containing iron ore, gold, and kaolin, has been equated to the Hospital Hill series, the base of the Lower Witwatersrand system in the Johannesburg area. The Pongola rocks have produced a highly dissected landscape in sharp contrast to the more subdued forms of the surrounding granite. Whereas deep valleys have been eroded in the shales and phyllites, conspicuous northwest-southeast ranges, mostly approaching or exceeding 4000 feet, reveal the resistant quartzites and banded ironstones. The landforms and isolation of this region have deterred the prospector. Of the geology and mineral resources little is known. Communication, except for roads connecting the chief centers, remains restricted to rough tracks and bridle paths. Throughout most of the region malaria is prevalent in some years, but in river valleys, especially in the east, it occurs annually as a summer epidemic.

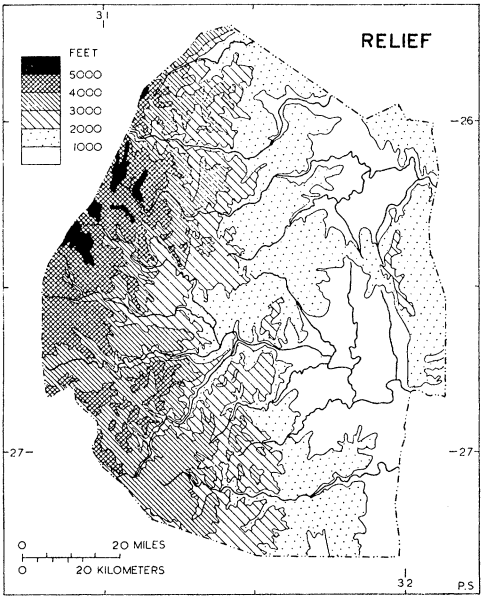
The older granite, an extensive granitic and in part gneissic complex, forms characteristically the rolling grass-covered hills of the middle veld. It also occupies portions of the high veld and bushveld, so that the formation covers nearly 60 per cent of the territory. The so-called "older granite," which includes both grey and red granites, gneisses, pegmatites, felsites, and porphyries, contributes columbium, corundum, euxenite, fluorite, monazite, talc, and tin, to the mineral resources. Development of the region, which dates from discoveries of tin in 1892, has been favored by physiographic and hydrographic factors. On the other hand, the concentration of native population in the middle veld, and the complex regulation of prospecting and mineral rights on native lands, have severely restricted the distributional pattern. Transportation has been a serious, but not insoluble, problem. In the eastern middle veld, especially in the southwestern section of the tin-bearing zone, malaria is invariably a summer epidemic.

The possibilities of mineralization in the southwest are closely associated with the relative ages of the Pongola system and the older granite. Recent work by the Swaziland Geological Survey Department indicates that granites of three different ages are present, but only one, probably the older granite, is older than the Pongola system. Of the two intrusives one is a red granite that does not contain pegmatite; the other is a grey granite that contains pegmatite and has little to distinguish it from the older granite. Identification of the granites is important because each is distinct in its mineral associations.

The rest of Swaziland, comprising the bush-covered plain of the low veld and the Lebombo range to the east, is formed by rocks of the Karroo system. The western portion of the bushveld is covered by Karroo sediments that consist of coarse grits, sandstones, shales, and coal seams. Correlation with the Karroo sediments in South Africa has not yet been definitely established, but the Ecca series in which calcite and coal deposits occur is known to be present throughout the area. Dwyka conglomerate and tillite rest unconformably on the granite floor in the south, but have not been observed in the north. Intrusions of post-Karroo dolerite have been so extensive that in some areas dikes and sills form at least 50 per cent of the rocks. The regular and gentle easterly dip of the Karroo beds has produced the slightly undulating terrain that characterizes the region north of







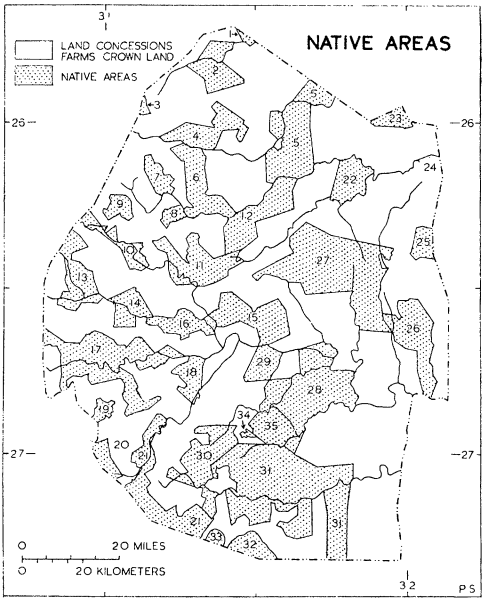


FIG. 1. The geology of Swaziland. Key: 1, Lebombo rhyolites; 2, Bushveld amygdaloid; 3, Karroo sediments; 4, Pongola systems; 5, Swaziland system; 6, porphyrites; 7, granite (mostly older); 8, tin-bearing zone. (After a provisional map by Dr. H. J. R. Way in the *Annual Report of the Government Geologist*, Swaziland, 1943.)

FIG. 2. Swaziland may be divided into four natural regions: the high veld above 4,000 feet in the west; the middle veld from 4,000 feet to approximately 1,500 feet; and the Lebombo range in the east.

FIG. 3. The mineral resources of Swaziland. Key: 1, asbestos; 2, tin; 3, gold; 4, barite; 5, corundum; 6, lead; 7, iron; 8, coal; 9, columbium; 10, calcite; 11, euxenite; 12, fluorite; 13, kaolin; 14, monazite; 15, talc.

FIG. 4. The 35 native areas in Swaziland today cover 40 per cent of the territory. In some areas, where mineral concessions are prior-dated to the land rights, mineral development by Europeans can proceed without interference by Government or Swazis; in others, where mineral rights have lapsed to the Crown or concessions are later-dated to surface ownership, prospecting is forbidden. (Compare with Figs. 6 and 7.)

the Usutu River; south of the Usutu the outcrop of the more resistant rocks, such as sandstone and dolerite, have yielded low, flat-topped hills. The region as a whole suffers from poor communications, malaria in summer, and drought in winter.

The Karroo sediments are overlain in the eastern bushveld by basic lavas that tend to be amygdaloidal. These are succeeded eastwards by a more acid series of volcanic flows ranging from porphyrites and andesites to rhyolites that together form the Lebombo monocline. They rise from the low velt by a well-defined escarpment, more pronounced in the south than in the north, to form a rugged plateau broken by three deeply-entrenched river valleys. Seawards the Lebombo range dips beneath the Cretaceous and Tertiary deposits of the coastal plain.

This region appears to lack economic mineral deposits. At Mananga Point and Stegi the Karroo shales, but not the overlying basalt, may have been receptive to mineralizers emanating from large dikes of porphyritic granophyre. If, however, the intrusive granophyre is genetically associated with the Lebombo acid volcanics, then the possibility of associated mineralization would appear to be slight. Before potential resources can be assessed, the relationship between the granophyre and the volcanics will have to be resolved.

MINERAL OWNERSHIP

A major deterrent to prospecting and mineral development has been the complicated regulation by Government of mineral rights, prospecting, and mining. Procedure necessary before prospecting varies greatly from one locality to another. During the last 60 years the position has become so confused that in some areas mineral ownership has been difficult to determine. To understand the present position a brief review of the historical background is necessary.

Gold discoveries in the high veld during the seventies, and the granting to Europeans of the first mineral concession in 1878 by Mbandeni, the Swazi king, promoted a concession-hunting boom that reached its climax between 1885 and 1889. During this period Mbandeni conceded more land than the total area of the territory and practically all the mineral rights. That he realized the significance of signing the concession documents is, of course, highly questionable. Suffice it that in 1902, when the territory came under British rule, the situation was so chaotic that a general survey of all concessions was immediately ordered. This was followed in 1904 by an examination of land titles, the cancellation of monopolies, the adjustment of disputed boundaries, and the settlement of conflicting rights.

In 1907 territorial segregation became official policy. About 38 per cent of the territory, divided into 31 separate areas, was allocated to the Swazis. A further 36 per cent was reserved for European concession-holders, and the remaining 26 per cent became Crown land. Where land had been reserved for concessionaires, the individual rights of landowners and mineral owners were defined. If the mineral rights had been conceded before the land rights, the mineral owner could, within certain limits, develop his minerals without regard to the landowner. If, however, the mineral rights were later-dated to the land rights, the mineral owner could prospect and mine only with the landowner's consent. In such cases landowners came to demand compensation for damage to arable land or pasture. Where land had been reserved for native settlement, holders of concessions prior-

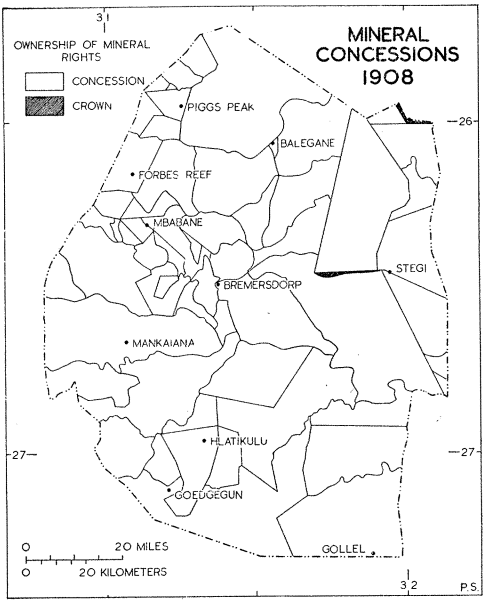


FIG. 5. The original 59 mineral concessions as demarcated by the boundary commission, 1908. Since 1908, many concessions have been subdivided or have lapsed to the Crown. Today, 71 concessions can be distinguished.

dated to native areas were entitled to develop mineral resources within those areas; but holders of later-dated concessions could neither prospect nor mine without permission from the Government. Permission was seldom given. Similarly, permission to develop those portions of native areas where the mineral rights had reverted to the Crown either by deed or purchase was consistently refused. But in areas where the Crown held both the mineral and land rights, prospecting and mining under Government license was permitted after 1912.

An early period of feverish prospecting and frequently disappointing development was followed by inactivity. Few concessionaires made use of their rights. The long-term nature of the original 59 mineral concessions, most of which had been granted for 50 or 99 years with a right of renewal and some for an indefinite or unlimited period, precluded other prospectors from developing the resources. Eventually, in 1927, the Government decreed that concessionaires who were not actively engaged in developing their concessions could either pay an undeveloped-mineral tax and retain full rights, or transfer their rights to the Crown, or declare their concessions open to prospecting and mining under Government control. Owners of mineral rights in native areas naturally retained their rights. Many concessions were subsequently either transferred to the Crown or opened to prospecting. Nevertheless, the total area where prospecting is now permitted covers only one-third of the territory. Most of this area is situated in the low veld and the Lebombo range where the discovery of extensive deposits of economic minerals is highly improbable.

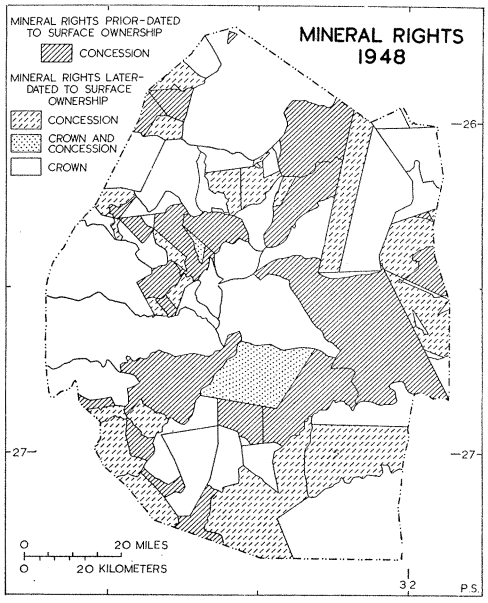


FIG. 6. Ownership of mineral rights with respect to surface ownership in Swaziland, 1948. Areas where mineral rights are *prior-dated* to surface rights may be developed without regard to landowners; they comprise 28 per cent of the territory. Areas where mineral rights are *later-dated* to surface rights may be developed only under Government license or upon payment of compensation to landowners; they cover 72 per cent of Swaziland. Licenses to develop resources in native areas are seldom granted.

None of the concessions in either the northwestern mineralized region or the tin-bearing zone has been opened to prospecting.

Since 1908 concessions have increased in number to 71, but have decreased in extent by half. For 48 per cent of the territory mineral rights are now vested in the Crown; overlapping Crown and concession rights, where base metal and precious metal ownership are separate, account for 3 per cent. Some areas may be developed only under Government license or upon compensation being paid to landowners; others may be exploited without regard to landowners, native inhabitants, or the Crown. The latter include prior-dated concessions covering the important mineralized region around Wyldsdale, Havelock, Piggs Peak, and Mbabane. Prior-dated concessions cover only 28 per cent of the territory. Crown and concession rights for the remaining 72 per cent are all later-dated. Moreover, areas open to prospecting comprise Crown areas covering 17 per cent, concessions 13 per cent, and overlapping areas 2 per cent; areas closed to prospecting consist of Crown areas covering 35 per cent, concessions 32 per cent, and overlapping areas 1 per cent. (Figs. 6 and 7. The writer wishes to thank Dr. H. J. R. Way, Chief Geologist of the Geological Survey Department in Swaziland, for kindly providing the mineral concession diagrams upon which these maps are based.) The complex position is being reviewed by Government, and presumably legislation will shortly be promulgated to regularize prospecting and mining. This should facilitate and encourage future development.

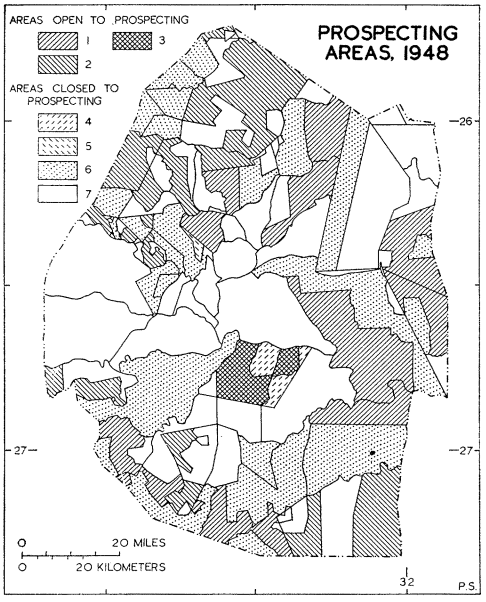


FIG. 7. Prospecting areas in Swaziland, 1948. Only 32 per cent of the territory is open to prospecting. Key: 1, concessions; 2, Crown mineral areas; 3, mixed areas (base metal rights vested in the Crown, precious metals in concessions); 4, mixed rights (division similar to 3); 5, mixed areas where mineral ownership is highly complex; 6, concessions; 7, Crown mineral areas.

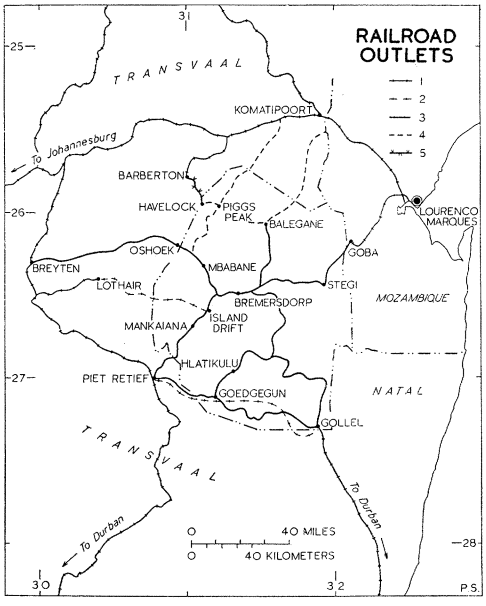


FIG. 8. Although Swaziland is surrounded by rail terminals, the absence of a railroad passing through the territory has been a major handicap to mineral development. Barberton and Breyten are the most important railheads. Key: 1, railroads; 2, proposed railroad extensions that have been surveyed; 3, S.A.R. motorbus routes; 4, other roads; 5, aerial railway.

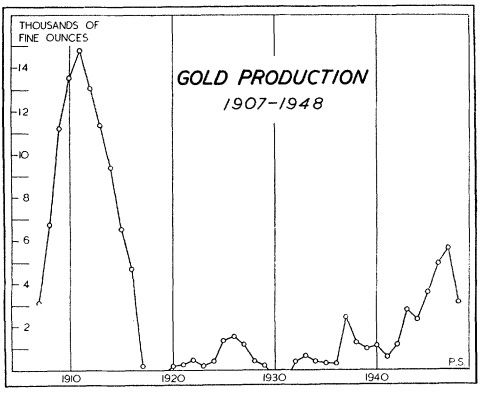


FIG. 9. Gold production in Swaziland, 1907–1948. (Data available only from 1907, and taken from Annual Colonial Reports for Swaziland 1907–1939, Annual Reports of the Government Geologist 1942–1947, and the *South African Mining and Engineering Journal.*)

THE GOLD PERIOD

Gold mining dominated mineral production in Swaziland from 1880, when the Forbes Reef mine began operations, until 1913, when tin mining assumed greater importance. During the nineties numerous gold mines, notably those at Piggs Peak and Horo, began producing. All were located along the eastern slopes of the northwestern mountains, for inaccessibility discouraged prospecting among the mountains. In 1911, the peak year in the history of gold mining in Swaziland, output reached 14,780 fine ounces. More than a dozen mines were producing. Yet, the first stage in the territory's mineral development had almost ended. By 1913 the value of tin production had surpassed that of gold, and whereas tin exports increased during World War I, gold output fell steadily. In 1918 gold mining ceased.

Subsequent production has been small. After 1920 output recovered to a small maximum of 1510 fine ounces in 1926; it was derived entirely from the Piggs Peak mine and disappeared during 1929. No production took place in the next two years. In 1937, owing to an increase in the price of gold, output reached 2410 fine ounces. Afterwards, production again declined. The recent recovery to 5637 fine ounces in 1947 may be attributed to favorable market conditions. Production comes mainly from the Piggs Peak and Wyldsdale mines.

The most important factor responsible for this erratic output has been the geological occurrence of the gold. Everywhere its occurrence consists of auriferous quartz veins intrusive at or near the contact between the older granite and the ancient metamorphosed sediments of the Swaziland system.[3] The lode deposits are dominantly replacements and fissure veins in which the gold is often associated with arsenical minerals that render treatment prohibitive under Swaziland conditions. Replacement has resulted from the occurrence of sheer zones and fissures that intersect congenial host rocks, notably crystalline schists. Sheer zones are, however, typical of all basement rocks within this region of metamorphism, traversing even the cherts and banded ironstones. Stockworks also occur in association with replacements. The fissure veins, though generally narrow, are often several hundred feet in length. Most of them are highly inclined and possess well-defined walls. Fissures and stringers are especially well developed near the contact of the schists with hard quartzites or cherts. Gold is normally irregular in distribution and for the most part visible; associated minerals, such as arsenopyrite, chalcopyrite, and galena, may occasionally be present. Everywhere, extensive faulting has hampered development.

The most important placer deposits have been those at Wyldsdale. They consist not only of terrace gravels deposited before the drainage system was rejuvenated but also of gold shed from nearby reefs. Stream gravels of

minor importance occur throughout the region.

Inaccessibility limited development. At most mines it merely retarded progress; at some it led to an early abandonment of workings. The Horo mine, situated in a densely wooded valley, had to close down through lack of transportation facilities. Wyldsdale was virtually inaccessible before the construction of a 5-mile track to the Piggs Peak road in 1946. In early days roads were not easily constructed owing to the rugged relief, the dense vegetation of the valleys, and the deeply incised streams. Bridle paths, often the only routes through the mountains, were impassable even to ox-wagons; and ox-wagons were the principal means of transportation until as late as 1930. Only the Forbes Reef and Piggs Peak mines came to be served with better roads. It is significant that Forbes Reef accounted for the largest output of any mine prior to 1912 and Piggs Peak for the largest subsequent output. The lack of railroad facilities in Swaziland has meant isolation and stunted development.

The gold reserves are unknown. The geology and mineral resources of the high veld are at present being investigated in detail by the Geological Survey Department. In the south, where ancient gold workings occur, the Upper Pongola quartzites that may be correlated with the Promise beds of the Government Reef series in the Lower Witwatersrand system have been found to contain conglomerate reefs. In the Transvaal the Promise quartzites have in places proved payable for small-scale mining, but in Swaziland preliminary sampling yielded disappointing results. Few exposures have, however, been sampled, and few of the streams draining the quartzite region have been systematically panned. Near Kubuta quartz veins have been observed in association with granitic intrusions into the Pongola rocks. Mineralization may have taken place along the contact, but the possibility of payable gold has yet to be investigated.

THE TIN PERIOD

The tin period may be regarded as extending from 1913 to 1938. Throughout this period the annual production of tin by value far exceeded the output of gold, and the aggregate production was five times more valuable. But ever since 1915, when production reached the peak figure of 618 short tons, tin mining has been declining. In 1948, despite the stimulus of high prices, output was only 23 tons. In the past, deposits at Makwanakop (due west of Mbabane), Forbes Reef, Mbabane, Ezulwini, McCreedys, Dwaleni, and north of Kubuta, have all been worked. Today, production comes mainly from Mbabane and McCreedys.

Most of the known alluvial and eluvial deposits, from which cassiterite has been extracted, are now almost exhausted. The deposits originated from the weathering and erosion of tin-bearing pegmatites occurring at or near the contact of the older granite with the ancient rocks of the Swaziland system.[4] The cassiterite-bearing zone, some 10 miles wide at Oshoek on the Transvaal border, extends southeastwards to the Mhlatuzane River where, some 2 miles in width, it disappears beneath the Karroo sediments (Figs. 1 and 3). The occurrence would thus appear to be remote from the contact, but investigations in this zone have revealed the older rocks as tongues of fine-grained schist or phyllite interbanded with gneiss. At Forbes Reef cassiterite occurs as veinlets in or near the walls of an aplite vein intrusive in a coarse schist.[5] Elsewhere, the only

source lodes that have been proved sufficiently productive to warrant mining occur at Mbabane and McCreedys.

The heavy rainfall, marked relief, and abundance of surface drainage, have concentrated alluvial deposits along the river valleys and facilitated the methods of working. In the east water resources are limited, so that only small-scale workings have been possible north of Kubuta. But the mountains around and to the south of Mbabane exhibit an intricate network of furrows, some of them 15 miles or more in length, that have been constructed to tap the headstreams of the drainage system. The utilization of all available water as a source of power for breaking ground as well as for sluicing has permitted the working of low-grade deposits. The overburden normally varies from 10 to 15 feet, but at McCreedys as much as 60 feet had to be removed. The marked relief has contributed by producing working heads of pressure. In many places, however, the presence of boulders has hindered operations. Unfortunately, most of the richer and more easily workable deposits, especially those served by water furrows, have been worked out. A few patches containing six pounds or more per cubic yard may still be found, but deposits now being exploited contain only about eight ounces per cubic yard.

Tin mining has recently been discouraged by the Government's attitude toward river pollution. Mining by monitor, but not sluicing, has had to be discontinued. Legislation fixing the maximum quantity of silt in tailings that may be discharged into a stream will probably be promulgated shortly.

Poor communications continued to handicap development throughout the tin period. Although in 1928 the South African Railways instituted a bus freight service which links the tin-mining region

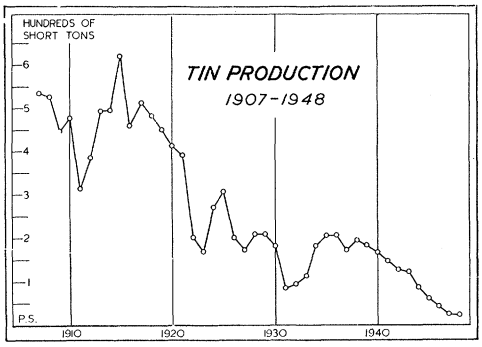


FIG. 10. Tin production in Swaziland, 1907–1948. (For sources of data see Fig. 9.)

with the Breyten rail terminal, areas away from main roads remained difficult to reach. Dwaleni, for example, is connected to the Mankaiana road by an almost impassable track, 15 miles long, that necessitates fording the Ngwempisi River and numerous smaller streams. Even Makwanakop remained extremely difficult to reach until a three-mile track was constructed to the Mbabane-Oshoek road in 1946.

Other factors have contributed to the decline in tin mining. The placer miner has almost always been refused permission to develop resources in native areas because of his utilization of water supplies, destruction of fertile soils, and undesired tailings disposal. Thus the tin-bearing gravels along the Mhlatuzane River in Native Area 28 have not been worked because the mineral rights are later-dated to surface rights. Moreover, important mining houses holding extensive concessions in Swaziland are not interested in operations that yield small profits. Prior to 1944 the returns from tin mining were particularly small: the price of tin in South Africa was controlled at a low figure; deposits were mostly low grade; and the costs of labor, of equipment, and of transportation, were high.

The small scale on which operations have been conducted and the fluctua-

tions in output have been responsible for a varying demand for labor, a highly unstable labor supply, and to some extent for the conditions prevailing in native compounds attached to the mines. Before World War II some 50 Europeans and nearly 800 Swazis were engaged in tin mining.[6] Most of the natives lived in temporary huts that lacked proper sanitary arrangements, were frequently overcrowded, and had become notorious for drunkenness and immorality.[7] Owing to the mines being located either near or within native areas, some of the workers were able to avoid the compounds and live at home. Today the scale of operations demands, perhaps fortunately, only a small labor force. Wages have risen but living conditions have shown little improvement.

THE ASBESTOS PERIOD

Since 1938 asbestos production has completely overshadowed all other mining activity. Output has risen from 4591 short tons in 1939 to a maximum of 32,660 short tons in 1944. This level was maintained for 1946 and 1948 (32,138 and 32,431 short tons respectively), but intervening years recorded a decrease in output. The promising recovery of gold production during this period and the development of corundum and barite deposits has been insufficient to compensate for the collapse of tin mining. Consequently asbestos has been steadily increasing in relative importance, contributing 69 per cent by value to mineral production in 1939 compared with 96 per cent in 1948.

Chrysotile, a fibrous variety of serpentine and the most valuable type of asbestos owing to its spinnability and resistance to heat, has been located in many areas of northwestern Swaziland. It occurs as narrow veins and stringers

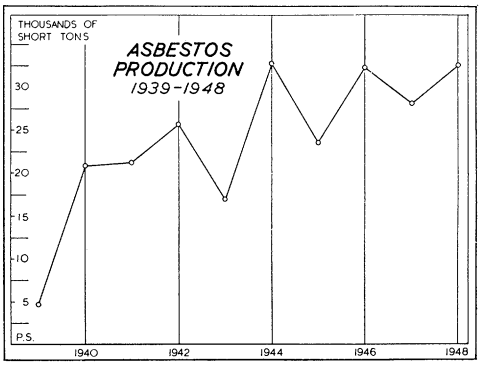


FIG. 11. Asbestos production in Swaziland, 1939–1948. (Data from Annual Reports of the Government Geologist 1945–1947 and the *South African Mining and Engineering Journal*.)

in bodies of serpentine forming a distinct horizon in the Jamestown schists. Most of the veins are not continuous over any distance and payable bodies are limited in extent. But at Havelock a large body is being worked by the New Amianthus Company. Here the occurrence consists of pale green serpentine carrying a stockwork of chrysotile veins about three-quarters of an inch wide. The deposit strikes approximately east-west and dips 50° to the south.[8] Situated on the southeastern slopes of Emlembe Mountain it can be worked both by open-cut methods and by adits driven into the slope to tap the deposits at depth. The veins are nowhere sharply defined, but grade into serpentine containing an uneconomic quantity of chrysotile. The limit of payable ore is reached when fiber recovery falls to 4 per cent of the rock mined. As yet neither the genesis nor geology of this deposit, which reveals some remarkable geological features, has been studied in detail. Other payable but smaller deposits probably occur in the Swaziland system, especially south of the Komati River.

The Havelock asbestos deposit was discovered in 1928, but lack of transportation facilities held up production for nearly ten years. Motor transport

was unable to reach the site until 1932 when a track was built connecting the mine with Piggs Peak. In that year operations began on a small scale, but were soon abandoned. Large-scale development awaited the completion of an aerial railway constructed to transport the asbestos 16 miles over rugged, mountainous country to Barberton, the nearest railhead in the Union. Mining started again in 1937. Exports date from 1939.

The Havelock mine employs over 80 per cent of the 150 Europeans and 3000 Swazis engaged in mining in the territory.[9] The company's policy has been to stabilize the native labor supply by providing good accommodation, modern sanitation facilities, adequate feeding arrangements, and married quarters. This presents a marked improvement upon conditions at tin mines where native workers are regarded as temporary. Probably the Havelock conditions reflect not only a more enlightened policy, but also the shortage of local labor in the high veld resulting from the sparse distribution of native population, the larger scale of operations, and their greater stability.

Corundum

During 1942 and 1943 a total of 172 short tons of corundum, valued at £1643, were produced. Since corundum was regarded as a strategic mineral during the war years, legislation was promulgated to facilitate the working of deposits in areas where the position regarding mineral rights had become so complex and obscure that development would otherwise have been impossible. Although corundum has been found in uneconomic quantities in alluvial tin-

FIG. 12. The Havelock asbestos mine. (Courtesy of South African Railways.)

stone deposits in central Swaziland, it occurs in payable quantities only in the south near Hlatikulu and Goedgegun where workable cassiterite is unknown. Corundum occurs in the border zone between extensive intrusions of pegmatite dikes and remnants of basic igneous rocks. The corundum-bearing rock, called plumasite, consists of porphyritic corundum crystals up to 12 inches long in a matrix of fine-grained felspar and biotite with some corundum.[10] Production has been derived from eluvial deposits and semi-decomposed rock in situ. Both the pegmatite and plumasite are so friable that blasting is unnecessary. The corundum individuals have been weakened by decomposition along cleavage planes and break up on extraction or during excavation to form hexagonal-shaped crystals rarely more than six inches long. Owing to the sporadic occurrence of corundum, its low grade, its low price on South African markets, and the high costs of transportation to the Union, large-scale development is improbable. During 1942–43 workings alongside the Hlatikulu-Goedgegun road reached a depth of 50 feet. Costs of deeper mining and of extraction from plumasite are prohibitive. Other deposits may, however, be discovered and developed as the territory becomes more intensively surveyed.

Barite

Barite occurs in the quartzites and cherts of the Moodies series. In 1943 a workable deposit was discovered at Londosi to the west of Forbes Reef. The veins which comprise an admixture of barite and quartz are fine-grained and pure white. Of the three barite-bearing zones that can be distinguished, only the lowest is of economic importance. This zone, which varies from seven to over 12 feet in width, contains at least seven lenses of barite from half an inch to over five feet in thickness. It has been traced along the strike from north to south for at least 1410 yards; it dips about 25° eastwards. The barium sulphate content of the veins averages about 85 per cent.[11] The deposit is situated on European land where Crown mineral rights are later-dated to surface rights.

Production began in 1945. Output for the first four years amounted to 632 tons valued at £3,968. This was derived entirely from surface workings, but inclined shafts have been sunk along the dip as a preliminary to underground mining. The construction of a track has enabled barite to be transported by motor truck to the Mbabane-Breyten motorbus route. Since bus freight rates are high, the additional costs of transportation by truck are probably too heavy to permit large-scale development of such a low-priced commodity. To reduce export costs an aerial railway is being built from Londosi to the bus route, and crushing machinery and an air separator unit have been installed at the mine. These improvements in processing and transportation should permit a greatly increased annual production. Ore reserves have been estimated at one million short tons with the possibility of an additional million tons.[12] The remarkable strike length of the main barite zone, the high barium sulphate content, the extensive reserves, the availability of water supplies, the relative ease of access—these are the chief factors favoring large-scale mining in the near future.

COAL AND IRON

Coal

In the low veld the lack of railroads, the presence of malaria in summer, and the absence of surface water supplies over extensive areas in winter, have

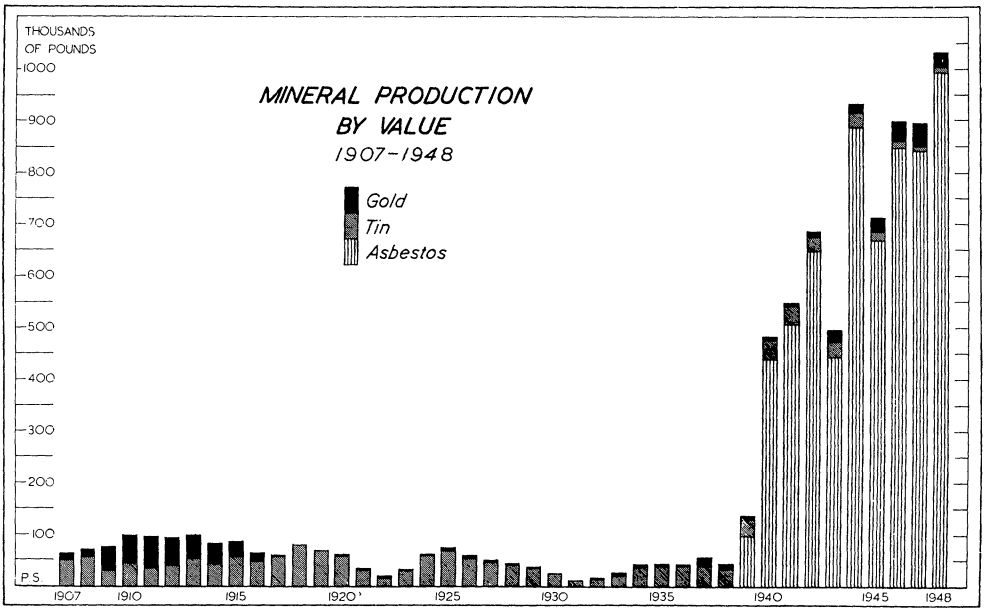


FIG. 13. Swaziland mineral production by value, 1907–1948. Comparison with Fig. 11 shows that the quantity of asbestos produced in 1948 did not exceed the 1944 output, despite 1948 being the first year in which mineral production exceeded one million pounds in value. Production of corundum and barite have been too small to be indicated. (For sources of data see Fig. 9.)

been the major obstacles to prospecting. During the seventies coal was discovered near the confluence of the Black and White Mbuluzi Rivers. Later, a shaft was sunk at the Swazi coal mine near the White Mbuluzi River and an adit driven into Nsalitshe Hill in the south; although some mining took place, neither systematic exploitation nor detailed assessment of resources has yet been attempted. Analyses of coal taken from deposits formerly worked indicate that the seams include semi-bituminous, semi-anthracitic, and anthracitic coals with about 9 per cent ash content at the Swazi coal mine[13] and 12 per cent at Nsalitshe.[14] The seams have limited value owing to their marked discontinuity, their variable thickness, and local metamorphism resulting from dolerite intrusions. Both deposits are situated on European farms with the mineral rights later-dated to surface ownership; the Swazi coal mine is held by concession and prospecting is not allowed; at Nsalitshe the mineral rights are vested in the Crown and prospecting is permitted.

Iron

Old Bantu iron pits occur in ferruginous Pongola shales near Kubuta.[15] Although iron ore is known to occur in several southern localities, no prospecting has been undertaken. Recently, however, payable ores have been discovered in the Swaziland system. A few deposits, notably at Iron Hill southwest of Havelock, at Nottingham Hill southeast of Havelock, and at Darkton southwest of Forbes Reef, have been surveyed. According to official estimates they contain 215 million short tons of hematite of the Lake Superior type, but larger reserves undoubtedly exist in the region. The deposits consist of secondarily enriched sedimentary ores in the shales and cherts of the Fig Tree series. The Darkton deposit, which in 1947 was provisionally esti-

mated to contain 160 million short tons of hematite averaging 45 per cent iron, is still being examined. At Nottingham Hill the reserves were provisionally estimated in 1946 to be 30 million tons carrying 50 per cent iron. At Iron Hill, the only deposit examined in detail to date, there are 15 million short tons of 45–62 per cent iron ore, low in phosphorus and sulphur but high in silica.[16] The high silica content may present a major problem in its utilization, but the silica is so friable that the problem might be solved by beneficiation processes. The ore body, intruded by several decomposed porphyritic dikes, is 900 yards long with a maximum width of 180 yards. Outcrops on the mountain slope indicate a minimum depth of 125 feet, but much greater depth is probable. The deposit is situated in Native Area 3, but mineral rights are held by private concession prior-dated to surface ownership. The area is remote, but not inaccessible. Nevertheless, neither the Iron Hill deposit, nor the Swazi coalfield 50 miles to the east, nor the Nsalitshe limestone occurrence 90 miles to the southeast, which together provide the basis for a potential iron and steel industry, can be developed without railroad connections to existing railheads.

OTHER MINERAL RESOURCES

Deposits of vermiculite and of copper, mercury, manganese, and tungsten ores have been reported from various localities, but upon detailed investigation none has been found to be of economic significance. Other mineral resources are being surveyed by the geological department, but most of them are low-priced commodities requiring railroad facilities for profitable exploitation. The complex ownership of mineral and surface rights has again been a factor hampering development.

Calcite

At Nsalitshe Hill calcite veins, formed probably by the leaching of post-Karroo dolerite, occupy fissures at or near the contact of Karroo sandstones with an overlying dolerite sill. The veins outcrop on the northern slopes, and contain coarsely-crystalline calcite with a calcium carbonate content exceeding 97 per cent.[17] Such high-grade lime would be excellent for agricultural, if not for industrial, purposes. In the middle veld the acid soils of the mixed farming areas are in urgent need of lime application. It is probable that crushed calcite could be marketed in Mbabane at a lower price than that ruling at present. But a limited demand and the high freight rates charged by S.A.R. buses are the major obstacles to development.

Columbium

In 1944 columbite, which yields the rare metals columbium and tantalum, was found to occur in pegmatite dikes in the older granite northeast of Forbes Reef.[18] The occurrence is situated on a European farm where mineral rights are later-dated to surface ownership and have lapsed to the Crown. Prospecting is permitted. The dikes are, however, too small, and alluvial deposits too erratic in distribution, to justify extraction. Moreover, the columbite contains only 20 per cent tantalum, a far more valuable metal than columbium. Associated with columbite in alluvial deposits are magnetite, cassiterite, and monazite. It is not improbable that workable eluvial or pegmatite deposits may be found in the future.

Euxenite

Euxenite consists of mixed columbates and titanates of yttrium, cerium, uranium, iron, and calcium.[19] Ever since 1898 rounded grains of this complex mineral have been found in alluvial tin

concentrates, but never in sufficient quantity to be payable.[20] In 1913 a kaolinized pegmatite containing euxenite, beryl, and muscovite, was located at McCreedys. Despite recent interest in the occurrence, its extent and workability have not been assessed.

Fluorite

Although two separate occurrences of high-grade fluorite have recently been found in southern Swaziland, they appear to form part of an extensive region of fluorite mineralization.[21] The mineral occurs in the older granite as veins, lenses, and single crystals, in silicified zones. Deposits near Hluti, situated on Native Area 31 where mineral rights are held by the Crown, are by no means so large as those further to the west, where mineral rights are held by private concession and prospecting is permitted.

Kaolin

In 1946 extensive bodies of high-quality kaolin, presumably derived from the decomposition of felspar, were located in the Upper Pongola sediments between the Ngwempisi and Assegai Rivers. An adequate water supply for processing the china clay is insured by the presence nearby of perennial streams. The kaolin occurs on European land where the mineral concession is prior-dated to surface ownership. Prospecting is not allowed. A rough track 12 miles long connects the area with the main Piet Retief–Mankaiana road.

Lead

Galena is known to occur in Native Area 6, but the occurrence has not been investigated. The original mineral concession has lapsed to the Crown and the area is closed to prospecting. Near Darkton crocoite (lead chromate) occurs as small, well-developed crystals in vugs in quartz stringers concentrated at the contact between the Jamestown schists and the quartzites of the Moodies series.[22] Since crocoite is a mineral of secondary origin resulting from the reaction of chromic acid solutions on lead sulphide ores, the crocoite probably passes into economic deposits of galena at depth. Mineral rights are, however, held by private concession later-dated to European land rights, and the area is not open to prospecting. Crocoite also occurs in gold mines near Forbes Reef.

Monazite

Monazite is sparsely distributed throughout the granite, gneiss, and pegmatite, of the tin-bearing zone. Small, worn crystals are found in alluvial tin deposits, but workable quantities probably exist only at Ezulwini and Mbabane.

Talc

Veins of fine-grained talc admixed with dolomite occur in serpentine at the Havelock mine. Other deposits have been located in basic schists within the older granite, notably northeast of Kubuta and in southwestern Swaziland. The latter occurrence promises to be the only one of potential value. The deposit is situated on European land where the mineral rights are held by private concession later-dated to surface ownership. Prospecting is not permitted.

TRANSPORTATION

Because the mineral resources mainly comprise low-priced commodities of which the entire production is exported, the lack of railroad facilities, the high freight rates charged by the S.A.R. motorbuses, and the extensive areas without means of communication, have been major handicaps to development. In 1902 the South African Government

in agreement with the Portuguese Government undertook to construct a railroad through Swaziland to Lourenço Marques; the Portuguese built a line to Goba, but the Union failed to fulfill its obligation. In 1911 South African policy was defined in the Mozambique Convention: "if and when Swaziland becomes a portion of the Union, the construction of a railway will be considered." Later, the proposed construction of privately-owned railroads was strongly opposed by the Union Government. Transportation difficulties were to some extent relieved by the introduction of motorbus services in 1928, but they favored agricultural rather than mineral exports. Only the southern fringe of the northwestern mineralized region has been served by buses. Freight charges for combined road and rail transportation are in any case higher than those for rail transportation alone, although bus freight rates appear to be lower than the corresponding cost of private truck transportation.

Swaziland is served by six railheads situated within 50 miles of her borders. As far as the northwestern region is concerned, Barberton and Komatipoort provide outlets to Lourenço Marques, while Barberton and Breyten serve the Johannesburg market. Lothair, though nearer Swaziland than Breyten, lacks road connections with the territory. Piet Retief and Gollel provide outlets to Durban, but are remote from mining activity. Goba provides a potential outlet for the northern bushveld.

Proposals for rail connections or extensions have envisaged agricultural rather than mineral development. Among the suggested routes those from Lothair to Island Drift and from Piet Retief to Gollel have recently been surveyed by the Union Railway Administration.[23] Although neither was selected primarily to facilitate mineral exports, any extension from Lothair to the border could have a branch line to tap the northwestern region. Nevertheless, there seems little likelihood of railroad construction taking place in the near future, and much of the territory's mineral wealth must perforce remain unexploited.

CONCLUSIONS AND FUTURE

In Swaziland the complex ownership and regulation of mineral rights, which are divorced from surface rights and complicated by the existence of native areas, have had a profound influence on prospecting and mining. Development before 1939 was carried out entirely by individual prospectors and small enterprise. Activity was limited not only because known mineral resources consisted mainly of scattered, low-grade deposits of gold and tin, but also because the mineral rights for much of the territory were held by concessionaires who neither developed their property nor permitted prospecting. Such concession-holders were mainly large mining houses discouraged by the limited potentiality and lack of transportation facilities. Legislation promulgated by the Government to facilitate prospecting on undeveloped concessions served to increase the complexity of prospecting regulations and deterred the independent prospector.

Development since 1939 has been concerned largely with asbestos mining. Although reserves have been sufficient to warrant the construction of an aerial railway from Havelock to Barberton, distance from market has necessitated the export of only best-grade fiber. Apart from asbestos, development has remained in the hands of individual prospectors and small enterprise. But only one-third of the territory is open

to prospecting. Of the known mineral resources awaiting development, only limited deposits of calcite, coal, columbium, and fluorite occur in areas where prospecting is permitted. Other coal and fluorite deposits, together with euxenite, iron, kaolin, lead, monazite, and talc, all occur in areas closed to the prospector.

The Geological Survey Department, instituted as late as 1942, is making a significant contribution to future development. It has already undertaken a provisional survey of the geology of Swaziland, investigated in detail most of the known resources, and made important discoveries. That the complex regulations regarding prospecting and mineral rights will shortly be simplified is almost certain. This should encourage development by individual prospectors. At present transportation costs render the exploitation of such low-priced deposits as coal unremunerative. But the coal deposits in the low veld, together with the water resources of the Komati, Mbuluzi, and Usutu Rivers, provide potential raw materials for the production of oil from coal—an industry that is likely to become important in South Africa in the near future. Meanwhile, the large mining houses will probably continue to be disinterested in mining activity in Swaziland until such time as railroad facilities become available.

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