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GEOLOGICAL RECONNAISSANCE OF THE TOWANOKOKO RIVER HYDRO-ELECTRIC SCHEME

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INTRODUCTION

Preliminary plans for a hydroelectric scheme on the Towanokoko and Pondo rivers on the west coast of Gazelle Peninsula have been drawn up by the Department of Works. A geological reconnaissance of the area was made on August 6th. The writer was accompanied by Mr. R. Gruber and G. Edwards of the Department of Works.

The scheme proposed is to divert the water of the Towanokoko river at an elevation of about 1850 feet into the valley of the Pondo river by means of a tunnel, add the water of the right hand branch of the Pondo river and generate power from the combined output of the two at one of three alternative power house sites.

Access to the operating area would be either from Pondo, where a reasonably good all-weather anchorage exists, but no wharf, or from the Keravat-Malabunga area, which is connected by road to Rabaul. From Pondo, construction of a road for about six miles would be necessary, from the north-eastern corner of Pondo Plantation, over rugged limestone terrain which rises steeply from the coastal plain. From the east, which would also be the route of the transmission line, probably more than thirty miles of new road would be necessary from the Malabunga area. This would be for the greater part of its length on comparatively subdued topography, following gentle slopes up from the Keravat river into or skirting the east-west valley of the upper Toriu river, then up the limestone escarpment of the main divide. The final five or six miles to the tunnel site would be over rough limestone terrain. Between the limestone of the western part and the alluvium of the Keravat River valley, the route would be mainly over sediments - limestone, shale and conglomerate, with some volcanic beds - of the Neogene sequence.

GEOLOGY OF THE TOWANOKOKO RIVER AREA

The whole of the area of the proposed scheme, in fact practically the whole catchment area of the Towanokoko and Pondo Rivers, consists of Tertiary limestone. Fossiliferous samples from near the mouths of the gorges of the Towanokoko and Pondo rivers have been determined as Upper Miocene to Pliocene so that they probably belong to the "Lamogai Series" of Plio-Pleistocene age. A sample from the junction of the two arms of the Towanokoko river, however, at elevation 1920 feet, contained Lepidocyclina and is referred to the Middle Miocene or "Neogene Series" (Noakes, 1942). Relationships between the two formations could not be observed, but are probably conformable. The limestone is generally white, cream, or buff, pitted with numerous solution cavities and fairly uniform in appearance. In very few places can any structure be seen, but near the mouths of the Towanokoko and Pondo Rivers a well-defined dip to the north is clearly visible in several places, the angle of dip ranging from 5 to 35 degrees. Those dips are most probably depositional. Near the mouth of the Towanokoko river a bed of marly mudstone is interbedded in the limestone.

Cliff faces exposed by landslip along the Towanokoko River and on the high east-facing escarpment at the head of the Batonga river show fairly well-defined bedding that is seldom apparent in normal outcrop. The beds appear from the air to consist of shale, marl and limestone and to lie almost horizontal. In the area three to four miles north of the Towanokoko River are well-defined linear ridges trending north-west, that probably represent original reef formations. The limestone mass, which extends several miles north, east, and south of the scheme area, is bounded by high steep escarpments on all sides except the west, and especially on the east. These appear to be fault scarps, particularly on the east, where faulting has undoubtedly occurred, but examination of air photos suggests that the escarpments may represent, in part at least, the outer edge of an original barrier reef. These limestone escarpments reach heights exceeding 5,000 feet above sea-level, according to the military 1-mile maps.

On the air photographs the area between the Towanokoko and Pondo Rivers from 2 to 7 miles east of the coast, can be seen to have a comparatively subdued topography, in contrast to the highly developed karst topography of the adjacent areas, with its masses of pinnacles and sinkholes. This less severe surface may be caused by the presence of underlying shale or marl beds, such as those seen in the landslips, that have inhibited the maximum development of the karst topography.

In the Pondo river a very few well-worn pebbles of volcanic rocks were seen, and the outcrop on which the house of the manger of Pondo plantation is situated consists of an andesitic volcanic rock.

A conspicuous feature of both of the main streams, and of their tributaries is the copious amounts of travertine deposited by the stream waters on the boulders and bedrock of the stream courses, so that in many places a series of calcareous terraces has been formed. This secondary deposit has the effect of sealing the bed of the streams and no doubt has an important influence in stabilizing water flow.

It is possible that the water may contain sufficient lime for deposits to form in pipes and machinery under favourable conditions. Analyses will need to be made of the stream waters.

HYDROLOGY

Rainfall at Pondo is of the order of 170 inches per annum, falling mainly in the north-west season. Limited experience in the area, and native reports, indicate that the rainfall in the upper courses of the rivers is heavier, or at least more evenly distributed during the year, with frequent falls during the south-east season.

The fact that the streams flow (according to local native reports) fairly constantly throughout the year indicates that the country is moderately well saturated, and that, despite the apparent high permeability of the limestone, the accession of water from rainfall is enough to keep the water table well above the level of the main stream valleys. Some of the small tributaries are dry, and run only in times of excessive downpours, but others maintain a constant flow. It is expected, apart from the sealing of the beds by the travertinous material referred to above, that the stream water is in general in contact with the ground water and fluctuations in flow governed mainly by topography might be expected to occur along the course of the stream, according to whether the stream is losing water to or gaining it from the formation.

Any attempt to dam the stream could result in excessive water loss, and diversion weirs will need to be designed to cope with this situation. It is possible that further information on the water-table could be obtained by detailed mapping of the valleys of the two rivers during the drier season. The position of the water table relative to the level of the stream at the proposed diversion weir site will determine whether it will be possible to dam the stream effectively.

Exact positions for tunnels and power stations have not yet been located, and in fact the whole scheme may be subject to considerable review when larger-scale aerial photographs, accurate surveys, and results of stream gauging tests are available. The problems, however, are common to the whole area. Driving tunnels inthe limestone will be relatively easy. The rock is comparatively soft but should stand up well. Water will be abundant throughout and tunnels will need to be driven with good drainage and due regard to the possibility of encountering large bodies of water. Another possible hazard is open cavities, and it would be necessary to avoid locating the tunnel under obvious sinkholes, but the risk of running into such cavities cannot be entirely obviated.

ENGINEERING GEOLOGY

The powerhouse site would presumably be situated on limestone, and foundation conditions would be satisfactory, but the site would need to be bored to ensure that no open cavities lay below.

The rock formation and terrain (except in cliff faces) are suitable for foundations for penstock lines.

The only aggregate available in the area is the Tertiary limestone, which is probably not suitable for high-strength concrete. Tests of its engineering properties will need to be carried out.

The andesitic (?) rock upon which Pondo Plantation house is situated would almost certainly make good aggregate.

Supply of suitable sand in the area is going to be difficult. The sand in the lower reaches of the Pondo and Towanokoko Rivers, and even the ocean beaches, consists almost entirely of rounded small pebbles and grains of limestone, unsuitable both chemically and mechanically for use in concrete. Supplies of suitable sand may be obtainable from the Tongaliekanei River at Stockholm, 16 miles north of Pondo, or from the Toriu river 11 miles south. Both of these rivers drain from areas that contain other rocks as well as limestone. The Sambei river 8 miles south of Pondo, is another possibility.

With regard to road construction, the Tertiary limestone would provide very satisfactory road surfacing material.

SEISMICITY

Earthquake epicentres have not been plotted with sufficient accuracy to give precise information about the seismicity of the Pondo area. One epicentre from which severe shocks have originated, including that of January 14th, 1941, the heaviest shock that Malabunga area has known, lies about 25 miles east. Another centre which has produced major earthquakes is 80 miles to the south.

It must be assumed that earthquakes reaching an intensity of 7 to 8 on the Modified Mercalli scale will be experienced from time to time. Ground acceleration produced by a shock of intensity 8 is .15 g, according to Benioff and Richter, so it would be reasonable to design structures for accelerations of .2 g.

CONCLUSIONS

Geological conditions are not unfavourable for the construction of tunnel, penstocks and powerhouse, but are probably unsuitable for provision of pondage.

Sand is lacking and aggregate not readily available so that it may be desirable to keep the use of concrete to a minimum, e.g. steel pipe rather than concrete lining for the tunnel. Road surfacing material is abundant. Structures should be designed to withstand ground accelerations of .2 g.

Further geological work required includes traverses up both Pondo and Towanokoko rivers to plot the geological section in detail, and to attempt to determine the position of the water table. This should be done at the end of the dry season: a search for suitable sand will be required, and further investigation of supplies of aggregate. Traverses along proposed tunnel and pipe lines and examination of powerhouse sites should be made when these have been more exactly located. Chemical analyses should be made of the water of the two rivers.

REFERENCES

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