

The Director,  
Geological Survey,  
P R E T O R I A.

HYDROLOGICAL INVESTIGATION OF NAHOON BASIN

This investigation was conducted with the purpose of determining the origin of the salt contained by the water of the Nahoon river. The basin of the Nahoon consists of a strip of country bounded by the main road from East London to Kei Road, via Berlin, and that from East London to Kei Road via Macleantown, this area falling between the  $27^{\circ}30'$  to  $28^{\circ}$  longitude and  $32^{\circ}45'$  to  $33^{\circ}$  latitude.

In contrast to the Buffalo river which has its origin in mountains, the Nahoon river with all its tributaries rises in a series of low-lying hills.

Excepting for the Newlands location, the basin is partially bushy and affords a suitable catchment with little pollution.

Geology.

The basin lies wholly on Beaufort beds which consist of layers of quartzitic sandstone alternating with layers of shale which are generally broken, and therefore pervious excepting in the vicinity of dolerite intrusions where they are baked and compact. The dolerite intruding these Beaufort beds occurs as sills and occasional dykes. These sills give rise to the hills forming the watersheds on the north-east and south-west boundaries of the basin. Thin sheets also occur in the basin itself.

Possible Origin of Salt.

The salt could have originated in one of three ways:-

1. It may have been introduced during the period of deposition of the material now constituting the Beaufort beds.

2. It may have been introduced into the Beaufort

rocks ....

rocks during the period of their submergence, either in Cretaceous times when the Needs camp beds were deposited or still more recently when the raised beach deposits were formed. In the latter case, however, only a very narrow coastal strip was submerged.

3. The salt may be of the nature of cyclic salt atmospherically transported from the ocean in the form of mist or spray and precipitated by rain.

#### Methods of Investigation.

To determine the mode of origin of the salt the following tests were carried out.

##### 1. Rock Analyses.

Different kinds of rocks were sampled and crushed. A known weight of the pulverised material was then treated with distilled water at 20°C for 24 hours and the weight of the salt extracted in this way was determined. In the table below the material investigated is arranged as far as it is possible to judge in the order of increasing perviousness and the salt extracted is expressed in percentages of the samples treated:-

<u>Rock</u>	<u>% Soluble salts</u>	<u>% Chlorides</u>	<u>Locality</u>
Sandstone (compact)	0.08	0.003	Fort Murray.
Solid dolerite	0.08	0.004	" "
Sandstone	0.18	0.004	" "
Sandstone	0.20	0.005	" "
Sandstone	0.16	0.0052	Umgotcho.
Sandstone	0.10	0.0056	"
Shale	0.09	0.005	Fort Murray.
Shale	0.11	0.006	" "
Shale	0.35	0.006	" "
Shale	1.13	0.0072	Umgotcho.
Decomposed dolerite	0.48	0.007	Fort Murray.
Soil	0.19	0.0076	Umgotcho.

The results prove that the salt-content increases with the perviousness of the rock.

2. Investigations with the Siemen's Bridge Apparatus.

The investigations were further extended by following up the different streams and testing them at regular intervals for their salt-content by means of the Siemen's bridge apparatus. Also the water of boreholes was tested in this way. The results may be summarised as follows:-

(a) The salinity of the water at the head of a ravine, that is at the origin of the stream, is comparatively low but increases lower down as the flow of the stream increases. On account of the low salt-content of the rocks the increased salinity cannot be accounted for by the extraction of salt by surface running water, but must be due to seepage springs which cause the increased flow and are fed by water which circulates in confining crevices under relatively higher pressure. The salinity of springs is therefore indirectly proportional to their relative height.

In the table averages of the salinities of boreholes are given, the highly exceptional figures being left out of the calculations. The localities are arranged in the order of decreasing altitude.

<u>Locality</u>	<u>Total No. of Boreholes</u>	<u>No. Boreholes considered</u>	<u>Salinity.</u>
Kei Road	7	5	51
Peelton	2	2	52
Berlin	9	8	70.5
Blaney	8	8	64.0
Woodbrook	12	8	75
Amalinda	8	8	152

With one exception therefore the salinity of boreholes is indirectly proportional to the altitude of the locality at which they occur.

(b) On page 2 it was established that the salt-content of rocks increases with their permeability. Whereas the other tributaries .....

tributaries of the Quengwe river contained water with a salinity of about 13, one stream was found to yield water with a salinity of 48. Investigations proved that this stream had its origin in shale while the others had theirs in sandstone.

Again in Woodbrook village, although only about two miles from the sea, two boreholes were found to yield water with a salinity of only 42. According to the owners these waters were struck in solid dolerite. Another borehole in the same village and in the same sheet of dolerite was found to yield water with a salinity of 250. Information as regards the nature of the rock in this borehole could not be obtained but there is no doubt that the water was struck while still in the dolerite. This water is most probably derived from decomposed dolerite.

Another example is afforded by the waters of Berlin which are in most cases pumped from wells sunk in decomposed dolerite. Although these wells are higher than the boreholes classified under Blaney, they yield water of a higher salinity.

#### Facts Summarised

1. The salinity of the waters of springs and boreholes increases as their distance from the sea decreases.
2. Where springs and boreholes are situated at the same distance from the sea the water of those situated lower is more saline than that of the higher ones.
3. The salinity of the water in a borehole or spring increases with the perviousness of the rocks from which it originates.
4. At Umgotcho the soil contains more chloride than the rocks underlying it which points to the fact that this salt could not have been derived from the underlying rocks since climatic conditions prevailing in this area do not allow for the large scale deposition of salt through capillary action.

5. Investigations carried out by the staff of the City Engineer's Office in East London brought to light that in the Buffalo river after a period ranging from 1 to 7 days after a flood the salinity of the water in the river increases rapidly and reaches in many cases a very high peak. There may be two reasons for this phenomenon. Many of the springs situated at the heads of ravines are very weak in dry seasons. The result is that many stagnant pools are formed, the stream finally disappears in the ground thus saturating the soil with brack water. On evaporation this solution gets more saline. In the event of rain this water is displaced by rain water and the highly saline solution flows into the river.

Another possibility is that during a storm rain water seeps into the soil and collects the soluble matter. This water then emerges again in the form of springs which last for only a few days during which they increase the salinity of the river water.

6. It is universally agreed that the Beaufort beds are fresh water deposits and this does not allow for the presence of salt-masses or layers. Even if such masses or layers did occur it would be expected that the salinity of the water from these localities will be very much higher than that of others irrespective of their relative height or distance from the sea. This, however, is not the case.

7. Of the deposits formed during the submergence in the Cretaceous period only the small occurrence of the Need's camp beds has remained while the rest has all been eroded away. During this erosion fresh water deposits were formed, namely, the surface quartzites at Fort Grey, Mount Coke, etc. Even these were again eroded away leaving only a few small patches. From this it is evident that the salt introduced into the rocks during the first submergence must have been leached out.

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The second submergence resulted in the raised beach deposits. As these deposits occur only at a height of about 70 ft. above sea-level it is obvious that this submergence could not have affected the rocks very far inland.

8. It has been proved in many parts that large quantities of sodium chloride are yearly transported from the sea and deposited inland by the wind. In South Africa it was found by Dr. Juritz that at Bloemfontein the precipitation of chlorine from the atmosphere was about 2.543 lbs. per acre per annum. At Johannesburg it was 1.863 lbs. per acre for a period of three months (Union Geological Survey, Memoir No.20 p.107). It is therefore evident that these cyclic salts will constitute a major factor in the Nahoon basin which is so near to the sea.

Conclusion.

From the above facts it must be concluded that the salt was and is still being introduced into the basin as cyclic salts. These salts are deposited on the surface, dissolved by rain water and thus introduced into the rocks.

To eliminate saline water altogether from this basin will be impossible. The only way out of this difficulty will be to fill storage reservoirs at times when the salinity of the river water is at a minimum—that is in times of flood.

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