

REPORT

ON A VISIT TO

SOME SALT WORKINGS IN THE SHWEBO AND SAGAING DISTRICTS, UPPER BURMA.

BY

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INTRODUCTION.

IN April last I was deputed to visit the salt workings in the Shwebo and Sagaing Districts. At present the majority of the salt consumed in Burma is imported, so that if it could be produced in the country, the revenue derived from a tax on such would be considerable, besides providing occupation for the inhabitants and keeping money in the country. Salt works have been established in the Amherst and Arakan Districts and have proved to be a complete success. Mr. E. G. Robertson, Superintendent of Excise (Salt), was prominent in starting these experimental plants. He also visited the areas to which this report refers and has issued a report thereon to which I am indebted for the analyses contained therein. Mr. Robertson advanced the theory of a salt stratum in these districts and with a view to reporting on this, I was requested by the Burma Government to visit these salt workings. The places are situated close to the Mu Valley branch, Burma Railways, between Sagaing and Shwebo, so far easily accessible. I was fortunate to have with me Mr. Robertson, whom I wish to thank for the trouble he took in showing me round and for making the necessary arrangements. With his intimate knowledge of Burmese it was possible to obtain all available local knowledge, which is very essential for such a problem as this.

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Previous Work.

Previous work on this subject will be found in *Records, Geological Survey of India*, Volume VI, where Theobald gives an account of the brine springs in Pegu; Yule's *Mission to Ava*, Appendix A, in which Oldham mentions the salt lake at Yega; *Gazetteer of Upper Burma*, Volume II, where the Halin Salt workings are described; *Memoris Geological Survey of India*, Volume XL, in which Pascoe gives a short account of salt occurrences in the Tertiary beds of Burma.

Workings Described.

The workings visited occur at four different places, of which I propose to give short accounts.

In the Shwebo District the largest workings are at Halin, which comprises the villages of Yebugonyat, Twinmayat, Taunguguyat and Taungboyat. Several hot springs also occur here, but from the analysis (paragraph 4) it will be seen that they are of little value as a source of salt supply. They are used for medicinal and bathing purposes. In this area the brine seems to come up through the soil by capillary attraction and the salt crystallises out on the surface. One family works several plots of ground in rotation which allows the salt time to get to the surface. The salt soil is scraped into heaps, at the side of which crude filters are erected. These consist of bowl-shaped moulds of mud lined with bamboo splits and straw. A pipe is let into the bottom through which the filtrate drains off into an earthen pot placed below. The salt soil is placed in the filter and brine from shallow wells is poured on top. As this soaks down through the salt-soil, it takes up into solution the salt from the soil and the filtrate thus obtained may have up to 20 per cent. salt in it. The filtrate is then evaporated in rectangular pans over a wooden fire. The resulting product is very impure and dirty, no attempt being made to keep cattle, goats, etc., from wandering over the plots. The earth from the filters is spread over the plot from which it was taken and the process is repeated. The workings here are extensive and from some mounds of earth, which contain broken pieces of pottery and thus seem to have been the location of old workings, it looks as if the industry is a very old one.

This place is situated on the east side of the railway at mile 43 $\frac{1}{2}$ and is a centre where a large proportion of the population are engaged in salt production. Here the salt occurs in the form of brine which is obtained by digging wells to depths varying from 20 to 40 feet and a diameter of about $3\frac{1}{2}$ feet. The brine is drawn to the surface by means of a rope and bucket and is then emptied into a conduit. Plots have been previously prepared, the soil loosened and small irrigation channels about 2 feet apart are made in them. The brine is led from this conduit into the irrigation channels from which it soaks into the soil; the water evaporates and the salt crystallises out in the soil. Owing to the large surface exposed to the atmosphere by loosening the soil, the evaporation takes place rapidly. The irrigation is repeated two or three times before the soil is gathered into heaps,

ready for the filtration process. The latter is similar to that at Halin. The wells here are situated close to each other, about 10 were seen in a space of 150 yards square. There seems to be no diminution in the supply of brine after the wells have been heavily drawn on.

Sadaung is situated 9 miles due west of Katha railway station, mile 413 of the Mu Valley Railway. A new road between the place and Katha is at present in course of construction. As at Thakuttaw the salt occurs here in the form of brine which is obtained by sinking wells. The brine, when raised, is stored in sumps from which it is carried by hand and scattered over the surface of a plot. When the soil begins to congeal it is loosened by harrowing. Further brine is then sprinkled over the surface and the harrowing repeated. This exposes a fresh surface to the atmosphere and so evaporation proceeds with greater rapidity. At this place cattle are used to drag the harrows and this does not add to the purity of the product obtained. Judging from the pagodas, temples and houses at Sadaung the salt industry, on which practically the whole village subsists, must be a profitable one. The rate of evaporation here seems to be better than at the other centres, due to winds as well as temperature. In the low-lying parts of Sadaung the brine seems to be less dense and the evaporated products contains a greater percentage of mixed salts. This may be due to the accumulation of surface water.

Yega is situated 3 miles south-east of Saye railway station which is at mile 402 on the Mu Valley Railway. Here the brine is obtained from a lake (which is three-fourth mile long (north and south) and one fourth mile broad. Its eastern side is flanked by the range of gneiss hills which form the west bank of the Irrawaddy and run parallel to it. The brine is led by small channels from the lake to sump holes from which it is taken and scattered by hand over the sandy soil. The salts crystallises out on the surface and looks like an efflorescence. Inverted pyramid shaped filters of bamboo-matting and straw are used, the salt soil being placed in them and brine added as in the other centers. This lake contains a greater proportion of mixed salts, the quantity of sodium sulphate being noticeable. This mixture lessens its value as a source of common salt and if the manufacture of sodium sulphate were tried, I do not think it could compete with the existing sources of this salt. The industry at Yega is a very small one and I consider the place of little economic value.

Although no work is at present being done at this lake, as I had occasion to cross it, a note may be in order. The area varies with the season, an average of 40 square miles might be taken. It adjoins the railway on the west side between miles 404 and 408. As the brine here only contains 12.4 per cent. of Na Cl, it is of little importance. The lake is very shallow, reeds and grass being seen over the whole area.

Analyses.

From Mr. Robertson's report I append a list of analyses of brines, products and of sea water for comparison. From these the variable composition of the brine is seen :

(a) Brines.

(1)	Halin hot springs. (2)	Thakuttaw (3)	Sadaung. (1) (4)	Sadaung. (2) (5)	Yega. (6)	Bay of Bengal. (7)
Sodium chloride ...	0.68	1.636	1.520	1.065	0.69	0.606
Magnesium chloride ...	0.02	...	0.178	0.010	...	0.281
Potassium chloride ...	...	...	...	...	...	0.130
Magnesium sulphate ...	...	0.287	0.098	0.089	0.08	0.188
Calcium sulphate ...	0.01	0.168	0.141	0.028	0.05	0.136
Calcium chloride ...	0.09	...	...	...	...	...
Sodium sulphate ...	...	...	...	...	0.91	...
Organic matter ...	trace	0.001	0.007	0.003	0.01	...
Insoluble inorganic matter	trace	0.017	0.013	0.001	0.03	...
Ferric oxide and alumina	trace	0.006	0.073	...	trace.	...
Water ...	99.90	97.945	97.975	98.809	98.25	96.675

(b) Products.

(1)	Halin.	Sadaung.	Yega.	Sea water (boiled.)
	(2)	(3)	(4)	(5)
Sodium chloride	76.57	82.69	19.72	96.90
Magnesium chloride	0.40	1.6	...	...
Magnesium sulphate ... ..	...	1.05	3.91	0.06
Calcium sulphate	1.71	2.76	0.31	1.05
Calcium chloride	3.26	...	...	...
Sodium sulphate ... ..	...	...	55.81	...
Organic matter	trace.	0.04	0.02	...
Insoluble inorganic matter	0.09	0.32	0.70	0.08
Ferric oxide and alumina	0.17	...	0.07	0.09
Water	17.64	11.47	19.46	1.82

None of the brines, in salinity approach that of sea-water. The great advantages of working any of the centres visited, are the local supply of fuel which can be obtained and the providing of employment in what would otherwise be a barren track of country. The variable composition of the salts produced besides being due to changing conditions which will be mentioned in paragraph 5 may be due in part to variation in the solutions from which the salts were deposited. Taking the conditions believed to have prevailed when the Burma tertiaries—the source of the salts in my opinion—were being formed, as the water began to decrease in the basins or lakes the salinity would increase. This would continue until the point of saturation of the salt constituents were reached. In a solution of gypsum and sodium chloride the gypsum would begin to be deposited when 37 per cent. of the water had been evaporated, and the sodium chloride at 93 per cent. evaporation. We would thus get a stratum of gypsum overlain by a stratum of rock salt. If a fresh influx of water into the basin took place, we should get a repetition of the process. Should the brine contain a fair proportion of other salts, e.g., carbonate of soda, magnesium chloride, the deposition would be considerably altered. On this subject Geikie says: "The presence of sodium carbonate causes the decomposition of lime salts accompanied with a slight admixture of magnesium carbonate, while by further addition of the sodium carbonate a hydrated magnesium carbonate may be eventually precipitated. Temperature and climate play an important part also on the variability of composition in the brines as would present underground conditions, which must vary in different parts.

Geological Features.

The geological features of the areas in which the salt wells occur are similar; those at Yega Lake are different and will be treated later on. A large alluvial plain through which the Mu River runs, extends from the hill range on the west bank of the Irrawaddy to the range which runs parallel to and about 3 miles to the west of the Mu River. All the wells visited are situated in this alluvial plain. Along the western edge of the hill range which form the eastern boundary of the alluvium is a narrow belt of tertiary deposits which overlie gneissic rocks of Archaean age. The western boundary of the alluvium is again Tertiary beds, which form the hill range between the Chindwin and Mu Rivers. It is thus reasonable to suppose that these Tertiary beds continue under the alluvium. The tertiary beds of Burma are believed to have been deposited under basinal conditions. When evaporation took place we should have salts deposited around the edges or, if the concentration was sufficient, layers of salts would be deposited on the bottom. Apparently the concentration did not develop sufficiently as no definite layers of the gypsum or salts have been found up to the present. With the increase of water supply into the lake or basin we should expect to find the salts getting intermingled with the sediments during the latter's formation. Dr. Pascoe, *Memoirs Geological Survey of India*, Volume XL, mentions the occurrence of brine at many places in the tertiaries. Gypsum has been found in the form of selenite, disseminated among the clayey beds of the Pegu or lower beds of the Tertiary deposits. Theories of chemical formation have been advanced, but Dr. Pascoe thinks that the origin is from sea water. Brine occurs almost

universally over the greater part of Burma, but no stratum of rock salt has so far been found. Efflorescent salt of an alkaline character has been found in the vicinity of Pegu outcrops. This may be produced by the interaction between indigenous brine and soil salts. It occurs throughout the whole Tertiary series. Between Ywathit and Sadaung I found a little calcareous tufa. The presence of this in one place and absence in another would affect the composition of under ground waters. Between Thakkataw and Halin small mud vents occur but there is no perceptible motion. Calcareous nodules were found in their vicinity.

As I have said in paragraph 3 Yega lake is bounded on the eastern side by gneiss hills. On the north western corner I found a Tertiary outcrop, but owing to the absence of fossils, I could not determine to which horizon it belongs. We have thus one of the salt occurrences resting in part at least—directly on the tertiary beds. The difference in composition of the brine here can be accounted for by different conditions, *e.g.* exposure to the atmosphere, and the greater proportion of sodium sulphate may be derived from surface water which would naturally drain into this lake.

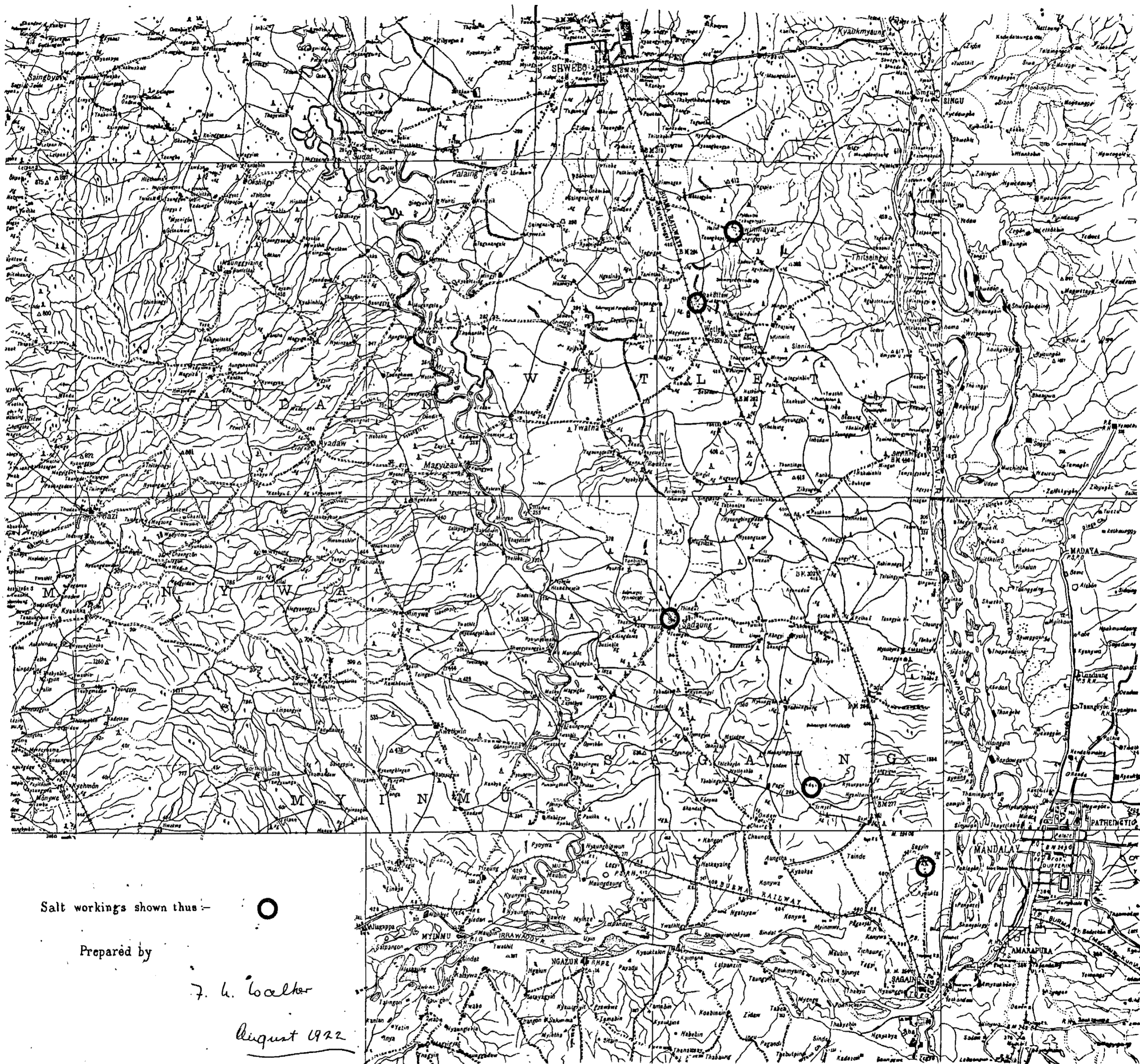
Conclusion.

I am of opinion that the tertiary beds are the origin of the salts found in these districts. The salts which these beds contain would be dissolved out and taken into solution by underground waters, which exist almost universally, and these in places would find conditions suitable for rising to the surface. The rainfall in this area, it may be noted is about 30 inches. Between Thakuttaw and Halin there are numerous small mud vents, which seem to indicate a fault line in the beds beneath, and it is highly probable that the brines rise to the surface along such lines. The alluvium itself is very porous and would offer little resistance to percolating waters. This is seen in wells which have not been lagged. No borings or wells have been sunk deep enough to enable one to form any estimate of the depth of the alluvium. As to the possible existence of a salt stratum I found no evidence in support of it. Judging from the known outcropping tertiary beds, in which no trace of a salt stratum has up to the present been found, I think it highly improbable that one exists here. Considerable quantities of salt are undoubtedly obtained, but there is no necessity for a salt stratum to exist as their source. They can easily be obtained from the salts which the tertiary beds are known to contain: The quantity and quality of brine is sufficient to warrant the encouragement of the industry. Mr. Robertson's suggestion of a trial boring, I consider a very sound one. It would help to determine what underground conditions are and I should anticipate striking a richer brine at greater depths than those to which it is possible to sink wells. If the borehole failed in other points, it could be used as a source for obtaining brine. The cost of such an experiment should not make it prohibitive. It would also if continued to a sufficient depth definitely settle the question of a salt stratum. As the industry stands at present it could be greatly improved by a little supervision. A cleaner product would be sure to find a better market than salt of the quality of that at present produced. Assessing the tax by the size of the evaporating pan seems to lead to much abuse; thus in one place a duplicate pan was found for which no tax was paid. This must lead to a great loss in revenue.

F. W. WALKER,

Assistant Superintendent, Geological Survey of India.

August 1922.



Salt workings shown thus: ○

Prepared by

F. L. Coaker

August 1922

Comments by Dr. G. DE P. COTTER, Superintendent, Geological Survey of India, Burma Party.

I have read Mr. F. W. Walker's report. It appears to me that the salt water of the areas reported on is very comparable to that found in the oilfields. The analyses given on page 221 of Pascoe's Memoir (Memoirs Geological Survey of India, Volume XL, Part I) are of a similar type to those given on page 7 of Mr. Walker's report.

Moreover, the tertiary rocks of Burma generally are characterised by feebly saline water, and by efflorescent salt. The efflorescent salt in Yenangyat, which is the only sample yet analysed, is mainly sulphate of soda, while the brackish water from Yenangyat wells is a mixture of carbonate and chloride, chloride being strongly predominant. Sulphate is either totally absent or present in small quantity in this water.

The amount of sodium chloride in all these waters is only 1 to $1\frac{1}{2}$ per cent. *i.e.* about half or less the strength of sea water. The product obtained from the Sagaing and Shwebo workings is not so pure as that obtained from sea-water. The only advantage that these waters have over sea-water is their situation in the dry zone where the monsoon rain does not greatly interfere with the processes of evaporation and recovery. Whether this advantage is sufficient compensation for the disadvantages above noted is a matter for the consideration of the Excise Department. It seems to me however that there are grave objections against any attempt to develop these workings on an extensive scale.

Mr. Robertson's suggestion that the salt of these waters may be derived from a subterranean stratum of rocky salt may be dismissed as unsound, the salinity being a characteristic feature of the Burma tertiaries, and being found in most deep water from the oilfields.

Are there then any strong brines in the dry zone of Burma? I know of no really strong brine except that of Bawgyo in Northern Shan States ($22^{\circ}35'$, $97^{\circ}17'$). A spring of saline water about the strength of sea-water is said by Theobald to occur at Sanywagyi in Pegu $18^{\circ}2'$, $95^{\circ}9'$. Other so-called brine springs occur, but all seem to be weak solutions.

The Geological Survey of India has however only mapped a small portion of Burma as yet. It is possible that some of the oil companies' geologists may know of the existence of strong brines in country which we have not yet visited.

G. DE P. COTTER,

20th September 1922.

Superintendent, Geological Survey of India, Burma Party.

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