
**THE GYPSUM DEPOSITS OF THE
LACHHIPURA, BAGNA, ISLAMABAD,
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NALAS, URI TEHSIL,
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The GYPSUM DEPOSITS of the LACHHIPURA, BAGNA, ISLAMABAD, LIMBAR, and KATHA NALAS, URI TEHSIL, KASHMIR. By C. S. MIDDLEMISS. C.I.E., F.R.S., F.G.S. *Superintendent, Mineral Survey of Jammu and Kashmir State.*

THIS report should be considered as a companion report to those on the graphite of Braripura and the ochres of Nur Khwah and Rata Sar issued by this department. This is because the general area over which the three minerals, gypsum, graphite and ochre are found is the same, and because those minerals are intimately associated together in the field. In particular, the outcrops of the graphitic series, which have been described as extending for long distances in a double band intersecting at right angles the Lachhipura, Bagna, Islamabad, Limbar and Katha (Bambyar) nalas, are practically everywhere accompanied by the gypsum (and its genetically connected limestone bands) as a parallel and neighbour formation, the two being always in actual juxtaposition. These localities can all be found on the Survey of India sheet 43 J|4 on the scale of 1 inch = 1 mile.

Whereas in the case of the graphite and ochre reports particular local developments were described in great detail in the neighbourhood of Braripura, Nur Khwah and Rata Sar, there is no necessity at present to do this in the case of the gypsum, for the reason that many of the economic uses to which gypsum can be put are not so easily realisable as those relating to the graphite and ochre ; also because the gypsum occurs in such vast masses and of such average purity that it is scarcely necessary to do more than specify some of the chief places where by means of the simplest quarrying operations any amount of the mineral can be easily won. I have thought it well to issue this

Brief treatment of subject.

brief report as a statement of mineral fact that can afterwards be amplified as desired should any novel uses be found for the mineral or any of the already known uses become commercially applicable in Kashmir.

That gypsum (locally known as "gutch") occurs in the neighbourhood described has long been known, a quarry in the Katha (Bambyar) nala having been opened for many years and the mineral extracted in a desultory way for white-washing and possibly other purposes. Specimens of gypsum from Udhampur district from the neighbourhood of Batote were likewise extracted some years ago for experimental purposes by Lala Joti Parshad (the then Mining and Prospecting Officer) and have been reported on to the Durbar from the point of view of their qualities for the making of a quicksetting mortar for interiors and for use in surgery and the arts as plaster-of-Paris. The conclusion come to, after some correspondence, was that the value of the Udhampur gypsum might be regarded as negligible, considering the small demand for it at the time and the competition it would suffer down country with other more easily accessible sources of the mineral. The Udhampur locality has not yet been surveyed in detail, and I am unable to say how it compares with the vast stores of excellent quality material described in this report.

The deposits here treated of are situated north of, and within a few miles of the Jhelum river and cart-road in the neighbourhood of Mahura power station and Rampur. Those in the eastern part of the area may be typified by the old quarry in the Katha nala about 1 mile above Bambyar village. Here is exposed a quarry face, 20 feet high by 30 feet across, and there are other indications making it probable that the northern band crosses the Katha nala and has a thickness of at least 30 feet, the apparent dip being 40° N. Poor exposures and landslips in the steep valley hide the certainty of this. The southern band is also equally vague in places and has not been followed all along its course. The succeeding valley to the west, namely, the Limbar valley, suffers in the same way from imperfect exposures, from landslips, and from covering by surface soil, so that one can only say that the two bands cross it in conjunction with the graphite bands in a way rendered somewhat indefinite by lack of clear exposures.

Known for many years in Kashmir as "gutch."

. Description of the deposits: Katha and Limbar nalas.

In the Islamabad valley, the gypsum in the northern band is either very thin or not properly exposed, but the southern band is more developed, being about 85 feet thick. The apparent dip is as usual northwards at moderately steep angles.

In the next, the Bagna valley, we for the first time begin to see well exposed masses of the gypsum in continuous cliffs of considerable thickness and extent. The band on the north lies parallel to the graphite band and may be followed in a steeply dipping outcrop (60° — 70° N.) forming a distinct little cliff 40—60 feet in thickness. In an easterly direction this band can be followed uphill, to cross over to the Islamabad valley, and in a westerly direction it can similarly be followed across into the Lachhipura valley $\frac{1}{2}$ mile south of Lachhipura village.

The southern band in the Bagna valley exposes a vast array of cliffs and landslipped masses 200—300 feet in thickness. This outcrop mounts up and across the hill-spur north of Nur Khwah, where it forms a conspicuous object from the Jhelum valley road, and thence on into the Lachhipura valley, where again the thickness decreases to two beds, one of 30 feet and one of 60 feet respectively. In this Bagna locality, alone, the southern band is capable of yielding an enormous supply of gypsum.

Finally in the Lachhipura valley S. W. and S. of Bijhama and on the hill-slopes round about Goashar the outcrops of the gypsum attain colossal dimensions though much hidden by vegetation. One may in fact say that the greater part of the summit ridge of the Goashar hill, most of the slopes 2,000 feet down towards Braripura, on the one hand, and Bijhama on the other, as well as much of the scarped face to the south in the direction of Dhanni Saiydan are built of, or modelled out of gypsum.

The northern side of Goashar hill in fact is a dip slope, the gypsum beds being inclined at 35° to the north and continuing at least as far as a line joining the villages of Khairawala and Bijhama. At the Bijhama end of this line the junction of the gypsum and the phyllites to the north appears to be a fault.

The path from Braripura to Goashar and the steep nala alongside show much faulting or slipping in step-faults. The Gujar huts at

Goashar are situated on the remains of old slips of this kind, which have subsided from the ridge above.

Allowing for some folding and much more mixture with limestone and phyllite than is anywhere visible at the surface, the gypsum must total many hundreds of feet in thickness at this locality.

West-south-west of this the outcrop of gypsum descends into the deep nala between Zambur Patan and Dhanni Saiydan and passes on by the village of Kalsan into country recently surveyed by Pandit Labhu Ram of the Mineral Survey.

In the preceding remarks on its geographical distribution over the described area, I have not attempted to estimate the contents of each or any portion of the deposit in cubic feet or tons. There is much evidence to show that the gypsum is of secondary origin by the alteration of certain limestones. Hence variations in its development naturally occur from place to place according as the alteration has progressed more or less completely. The softness of the mineral (which can be scratched by the finger-nail), renders its disintegration by meteoric agencies and ground water a very simple affair, so that landslips on almost every slope where the gypsum is exposed are common and at the same time there is often a tendency for the outcrops to be obscured by a covering of talus, soil-cap, and by rain wash, to say nothing of crops and vegetation. This is especially the case where the graphitic series lies exposed above it on the hill-side: the dazzling snow-white appearance of the gypsum only needs a very thin coating of graphitic debris above it to hide it entirely from view. Considering these disturbing factors, the process of measuring the length, breadth and thickness of the deposit is clearly out of the question. One must be content to say, that in a walk from Braripura to Goashar or round the foot of the hills S. W. of Bijhama one encounters some hundreds of millions of tons.

It may be assumed then that extraordinarily large amounts of gypsum exist within the described area, and especially in the western part. What is of more immediate importance from the point of view of getting the mineral, is the fact that it is available to simple quarrying operations in numberless clean rock faces laid bare by denudation in the form of scarped cliffs of convenient heights for working, such as 60—100 feet. Almost anywhere at the foot of

Rough estimate of amount of gypsum available.

Available by simple quarrying at numberless rock faces.

the Goashar hill round the margin of the Bijhama plain, or up the slopes south of Braripura, the torn and dissected country-side is littered with enormous blocks of the gypsum which have fallen from the bare precipices, where quarries could be opened and the material obtained by the simplest processes. Gravity and the softness of the rock would assist the excavation of such a hillside deposit and the accumulation of it in the plain below preparatory to any utilisation of it for economic purposes.

Similar remarks may be made with reference to the southern outcrops in the Bagna and Islamabad valleys. But here and further east the confined outlets of these valleys renders the further transport of the mineral somewhat more difficult than in the case of the wide and open Lachhipura valley.

Taking it as proved that the amount available is extremely large, it is now necessary to enter a little into lithological details. Abundant examples can be met with in the Lachhipura valley and surrounding slopes pointing to the origin of the gypsum by alteration of the limestone which occurs associated with it.

This limestone is a crystalline or microcrystalline rock of grey, drab or yellow colours; and nearly everywhere there can be detected embedded in it quantities of small cubes of pyrite and a little magnetite in layers and streaks. A very good example of the grey variety, or white and grey streaky variety, is from the gypsum layer $\frac{1}{2}$ mile south of the main village of Bagna. From this by crushing and panning a heavy residue of pyrite was obtained with only a very little (5 per cent.) of magnetite. Where the residual limestone is yellow, or reddish yellow, the iron ore is mostly magnetite with only very little of the sulphide as in the Lachhipura nala near Nalusa and on the ridge west of Goashar.

Occasionally the limestone occurs in considerable amount aggregating beds of 80—100 feet, as for instance, near the bridge at Nalusa, where it is of a drab colour and streaky, but more usually it is in more irregular patches scattered about among the gypsum.

On general grounds, it is concluded that the gypsum is an alteration product of the accompanying limestone masses due to the action of decomposing pyrite grains in the presence of the usual agents of metamorphic change. This conclusion is strengthened by evidence

Origin of the gypsum from limestone.

Associated limestone beds.

Gypsum formed from the limestone.

afforded by contact specimens, in which the gypsum appears among the limestone, ramifying through it in veins and lumps. That it is not on the other hand a case of interbedding of the two rocks, as a result of original deposition, is rendered very probable by numerous examples where the gypsum veins are not only parallel with the bedding of the limestone, but also sometimes pervade joints at right angles to the bedding, thus cutting up the rock into residual patches of limestone entirely isolated and surrounded by gypsum (like bricks set in mortar). In other cases these patches become reduced to narrow tongues of limestone appearing here and there in the gypsum and each retaining its original stratification layers, which also remain parallel. Besides limestone, residual patches of phyllite also are sometimes prominent among the gypsum.

The theory of origin here adopted for the mineral agrees with that advocated by Dana for the deposits of western New York,* where "they do not form continuous layers in the strata but lie in embedded, sometimes nodular, masses." In all such cases, this authority says, "the gypsum was formed after the beds were deposited, and * * * is the product of the action of sulphuric acid from springs on limestone." In the case of the Kashmir deposits here described the sulphuric acid, instead of being brought from a distance by springs, must be considered to have been derived from the limestone *in situ* by decomposition of the sulphides locally present.

With the exception of particular local sections, it is impossible to say what proportion of the original limestone or phyllite remains in any given gypsum mass. These residual masses are met with here and there in the various sections of the complicatedly faulted and slipped masses of the gypsum and are more plentiful at one place and less at another in an apparently entirely random way. It may be accepted, however, that their volume as a whole in the areas here described is less than that of the gypsum. The latter is the dominant rock and most in evidence everywhere.

The gypsum is practically always present as a grey or white (never pink), compact microcrystalline mass that frequently is sufficiently fine grained, strong, and durable to be called alabaster. Only very occa-

* "The Non-Metallic Minerals" by G. P. Merrill, 2nd edition, 1910, p. 338, quoting from "Manual of Geology" by Dana. p. 234. Dr. F. J. H. Merrill, however regards a portion at least of the New York beds as chemically precipitated from sea-water.

sionally along very narrow fissures has the sulphate of lime taken on the transparent coarsely crystalline form of selenite.

In thin sections under the microscope there appear among the uniform mosaic of gypsum grains a very few grains having a high refractive index and strong double refraction which may be anhydrite.

Microscopic appearance.

Chemical character.

Treated in powder with boiling dilute hydrochloric acid all dissolves with the exception of a very minute residue about 1.2 per cent. of what is chiefly silica. Besides silica there is as impurity in the gypsum a trace of iron as would be expected. Mr. Wadia has tested the gypsum in the laboratory of the Prince of Wales' College, Jammu, and reports on its good quality and freedom from any noticeable impurities.

Obscurely visible here and there, as irregular slender patches and dykes in the gypsum and associated limestone, comes a greenish grey basic trap. Examples may be quoted from the section in the Lachhipura nala near Nalusa and from the ridge west of Goashar. The rock is hardly ever seen except in weathered, or fallen pieces. Under the microscope, it shows a confused and much altered compact ground-mass with some dark green amphibole or pyroxene (likewise altered). It possesses no special interest and will not affect the supply of gypsum or the working of it.

As already mentioned the present-day uses of gypsum in Kashmir and India, generally are as yet problematical. This is not because its uses are really of a doubtful character in a sufficiently advanced community, but simply because of the backward condition of India in respect of such industries, for the supply of gypsum for which at present it relies largely on importation.

The simply ground gypsum, without any other treatment, is chiefly used as a fertilizer, when it is known as "land-plaster" in some countries. It is possible that a good deal might be made of it from this point of view in Kashmir and India at no distant date, since recent developments in 1919, have shown its use in agriculture to be extremely beneficial, inasmuch as sulphur is not only an exceedingly important plant food, but the gypsum itself greatly increases the growth of the nitrogen-fixing bacteria in the soil (Mineral Industry for 1919). In its calcined form (after raising it to a temperature between 222°

and 400° F.) gypsum becomes dehydrated and is known as *Plaster-of-Paris*, and has the following uses dependent on its property of hardening or setting after mixture with water : stucco, plastering for walls, plaster-board, gypsum wall-board, whitewash, pottery moulds, statuary, gypsum-blocks to replace terra cotta, and for dental and surgical purposes. It is also used for making black-board crayons, and, together with the ochres of Nur Khwah, coloured varieties could be produced, as has been verified by experiments made in this office. It is also used as a retarder in Portland cement and as a bed for rolling hot glass. Millions of buttons used on military uniforms during the war had raw gypsum as their base.

Of all these uses to which it can be put the manufacturing of plaster-board and gypsum wall-board and its use in agriculture seem the most important. They could be reckoned on to absorb a considerable amount of the raw gypsum.

Gypsum during the war was utilised in Germany for the production of sulphuric acid and sulphur by roasting a mixture of gypsum and coke in a rotatory generator, slightly modified for the purpose. 22,300 tons of sulphur were produced by this process by the end of 1919, at the Bernburg and Walbeck works. It is rather doubtful if this method would pay in ordinary peace-time conditions.