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**THE GRAPHITE DEPOSIT OF  
BRARIPURA, URI TEHSIL, KASHMIR**

**BY**

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SUPERINTENDENT, MINERAL SURVEY OF JAMMU AND KASHMIR STATE**

**(With Plates I to V.)**

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TEHSIL, KASHMIR, by C. S. MIDDLEMISS,  
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I to V.)***

**I. GENERAL DESCRIPTION.**

**T**HE graphite of this deposit is of the amorphous variety, and it impregnates the phyllite of the area, forming a band of richly graphitic schist, 400 feet thick.

**Geographical distribution.** Besides the Braripura occurrences, here described in special detail, the same band of graphitic rock continues westwards beyond Kathal into tracts recently surveyed by Pandit Labhu Ram. Eastwards also it continues across the Lachhipura nala, over the ridge into the Bagna nala and thence over the next ridge into the Islamabad nala. (See Survey of India, sheet 43 J|4 1" = 1 mile). Throughout this length of over 4 miles, although it is interrupted here and there by river alluvium and by talus slopes, the graphitic schist, as regards quality and quantity, has been ascertained by my survey to be fairly uniform. The outcrop is known to extend even beyond this, and to pass (still striking due east) into the Limbar, Bambyar and Ijara nalas, and then to appear for the last time on the north (right) bank of the Jhelum river between Zainpur and Khadanyar, a further total distance of some 7 miles. This further extension of the band, although it has been traced and mapped on the 1" = 1 mile maps, has not been exhaustively explored as yet, so that I am unable to assert that it continues of the same thickness and richness as it is known to possess in the Braripura, Lachhipura, Bagna and Islamabad nalas. This northern band altogether therefore, is known to have a total length of at least 11 miles.

But not even here do these graphite-impregnated deposits cease, for another southern band (though poorer in quality and quantity) takes a parallel direction E. and W. from the hillside north of Chulan and Dhanni Saiyidan into the Lachhipura nala at Nalusa, across the

lower part of the Bagna valley, and thence *via.*, Lagama and Bujathala into the Limbar and Bambyar nalas, after which it disappears from view—a total further distance of 9 miles. The parallel arrangement of the two bands is due to their constituting the two outcrops of a synclinal fold which is inverted or recumbent along the northern limb.

Whilst there is not much reason to expect the outcrop to extend further east than the places mentioned above, it certainly continues for some few miles further west into areas recently surveyed by Pandit Labhu Ram in Survey of India Sheet 43 F|16.

Of the known uniformly rich and thick band lying between Braripura and Islamabad, the outcrops as found at Braripura outcrops plans and sections. three separate places near Braripura (lat. 34° 10'—long. 74° 4') are here taken for special description, because they all lie in the open and easily accessible valley system of the Braripura and Lachhipura streams, at a distance of only a few miles north from the point where the Lachhipura stream joins the Jhelum at Nur Khwah (the ochre locality of a separate report). These three outcrops occur along a length of 1½ miles, with the large villages of Braripura and Mugam Piran in the centre, and Kathal village on the west, whilst the eastern outcrop composes the lower end of the hill-spur between the Braripura and Malangan or Dachhawar streams. All these three localities will be seen marked on the Key Map (Plate I) which is the 4—times enlarged 1" = 1 mile Survey of India, sheet 43 J|4, whilst separate plans of each reduced from plans specially made by my survey on a scale of 1" = 150 ft. with sketched contours of 50 feet, (Plates II, III, IV.) exhibit the outcrop of the graphitic rock and associated rock systems in detail, together with the position of the trenches made during our exploration work. In addition to these large-scale plans, there have been drawn sections on the same scale, namely sections AA, BB, and CC, (Plate V.) through typical parts of the central area of Braripura.

## II. THE CENTRAL BRARIPURA OUTCROP.

This is the largest and most conveniently situated of the three outcrops as at present explored; although the Kathal outcrop on the west may perhaps rival it in size after further exploration has been done in a westerly direction.

The largest of the three deposits as at present described.

As shown by the 4" = 1 mile enlarged key map (Plate I.), and by the detailed plan (Plate II.) the graphitic schist of this central area occupies a limited, but well defined, arc-shaped belt of rough hill-side, extending from the hamlet of Mugam Piran on the west to the Forest Ranger's hut on the east ; throughout which area it is a conspicuous feature of the landscape by reason of its remarkably black sooty appearance, and especially when contrasted with the brilliantly white hills of gypsum in the surrounding country. In length this belt is about  $\frac{1}{2}$  mile, being 2,500 feet along the chord of the arc at its widest point ; whilst its breadth, measured down the sloping surface, is about 400 feet. This crescent-shaped outcrop sweeps across the lower parts of the hill-spurs, its lowest point being situated at an elevation of 6,200 feet above sea-level and its highest just below the 6,700 feet contour.

Exposures of the natural rock are numerous, but owing to the steep slopes (which sometimes lie at an angle of  $42^\circ$ ) surface flexure has seriously modified the true dip so that for many feet below the actual surface the thin-bedded graphitic schist has an apparent dip down-hill. The same cause has carried the loose debris down-hill far beyond the proper limits of the formation and over the edges of the gypsum and limestone series. That the actual dip is in towards the hill is proved by the behaviour of the outcrop as a whole with regard to the inequalities of the slope ; whilst the amount of the dip is similarly seen to be about  $45^\circ$ , but probably steepening slightly downwards. The detailed mapping of the course taken by a well-marked richer band with reference to the contoured surface enables one to estimate this angle with accuracy to within a few degrees. Notwithstanding this steady real dip of the graphitic series towards the hill (and which probably continues thus to considerable depths below the present surface), it is practically certain that the whole series is inverted along this line of country, so that beds of higher horizon apparently underlie beds of lower horizon.

The band of graphitic rock is followed to the south by a series of gypseous limestones and by ordinary phyllites to the north. The gypseous series extends down to the alluvium of the Braripura valley where it becomes covered by the latter, whilst the phyllite series extends upwards

**Associated formations.**

in great thickness, with the single interruption of another less well defined and less important graphitic series occurring some 200 or 300 feet above the main band. This subsidiary band is associated with some beds of crystalline marble. The phyllite series in this great extension to the north becomes more mineralised as it approaches the intrusive mass of the Kaz-i-Nag granite, which appears in force 2½ miles away. The subsidiary graphitic band to the north has been shown only on the small-scale key map. It has not been estimated or mapped in detail because it would naturally not attract the attention of any one exploiting these deposits so long as the richer, thicker and more conveniently situated bed below remains unworked.

The hill-side occupied by the main band, though rough and steep, is traversed by numerous winding tracks, the one going to Danna being the most used. These enable one to traverse the area from end to end without much difficulty. The section exposed round the base of the hill following the edge of the Braripura fields, and also those in the small side ravines, serve well in elucidating the geological structure. There is no difficulty (though some discomfort from the scrub-jungle) in finding one's way to any point of the area mapped in detail. ● ●

The main mass of the deposit consists of very soft and friable, thin-bedded, graphitic phyllite, alternating with about an equal amount of a more indurated rock. The latter, though appearing to be more arenaceous, is not so to any great extent, as is proved by triturating the harder variety in a mortar. It then appears that this variety requires more pulverising and more grinding, but ultimately yields a fine black paste not much differing from that afforded by the thin-bedded softer bands; though undoubtedly yielding as a whole a greater percentage of extremely fine gritty residue that probably consists of both quartz and felspar.

The appearance of the main mass of the formation, though generally dark and sooty in places, does not at first suggest a large percentage of graphite as compared with the richer band next to be described. It is however, richer than it appears to be as will be detailed presently.

Some 50 to 100 feet within the northern boundary of the deposit there appears a more noticeably dark and sometimes vividly coal-black bed, generally fissile and

**Accessibility of the formation.**

**Petrological features of the graphitic band.**

**Rich bed.**

thin-bedded. It is occasionally dull and earthy, but in some places breaks up into lenticular lumps with a glossy shining black surface. This band is 10 to 20 feet thick, and it contains within this thickness a number of irregularly occurring lenticular patches of richer rock, that, from numerous pits and trenches dug, I estimate at totalling 3 feet as a minimum. This constitutes the richest material in the field, and the continuity of the band throughout the outcrop has been proved by numerous natural and other artificial exposures. The same band in the same relative position also occurs in the other outcrops to west and east, namely, at Kathal and at the spur dividing the Braripura and Lachhipura streams.

The proving of this central Braripura outcrop was effected by means of a series of trenches, pits and excavations across the strike.

**Trenches excavated.** The positions of the rich bed struck by these excavations at different intervals along the  $\frac{1}{2}$  mile outcrop and at vertical altitudes of 6,200, 6,400, 6,550, 6,625 and 6,650 feet, respectively, afford conclusive proof as to the continuity of the deposit, not only laterally along the strike, but also downwards with the dip, within the limits next mentioned. At the same time they definitely localise the actual outcrop of the bed on the map and so indirectly prove its lie and dip.

**Estimation of amount of graphite material in rich bed.** If we graphically plot the rich bed of this area from its irregular surface boundary along the direction of dip down to valley or water-level, we get an irregularly bounded bed, which may be reduced to a symmetrical rectangular rock slice, 2,500 feet long by 375 feet deep and by 3 feet thick. The slice is only reckoned down to water-level in the valley, *i.e.*, down to a line between the altitudes of 6,400 feet at Mugam Piran end and 6,200 feet at the forest hut end; so that it is well within the limits of what may be regarded as rigorously proved.

This rock slice contains

$$2,500 \times 375 \times 3 = 2,812,500 \text{ cubic feet of the richer rock.}$$

The specific gravity of the material whether taken in the lump or in powder form varies between rather wide limits. Taking 2.35 as a fair average specific gravity, then 1 cubic foot contains 146 lbs. and the total contents of the bed work out at

$$\frac{2,500 \times 375 \times 3 \times 146}{28 \times 4 \times 20} = 183,315 \text{ tons.}$$

After purifying by grinding, sieving and washing, the amount of graphite material obtained from this is about  $\frac{3}{4}$  of the above, or 137,486 tons of purified graphite material ready for economic purposes.

It may be well to explain exactly how these experimental operations of grinding, sieving and washing were conducted. In the absence of any machinery for the purpose, all these operations had to be done by hand, and they have probably suffered in efficiency in consequence. After hand-picking, the lumps of the rich bed were pounded in an iron mortar and passed through a 90 mesh sieve. The residue that failed at first to pass through was reground until the whole passed the 90 mesh sieve. (The decision to pass the whole through the sieve was arrived at after many trials which showed that the coarser stuff, which at first refused the sieve, still had a large graphite content). The elutriation of the powder was done as follows. All the powder was thoroughly stirred in water and drawn off in glass vessels, allowed to stand for 2 minutes, and then decanted into another vessel. The residue that remained was again stirred thoroughly, allowed to stand again for 2 minutes, and then decanted. This was repeated some dozen times until the colour of the decanted liquid showed the practical absence of carbon. Finally the whole of the decanted material was allowed to settle for 24 hours and then collected, dried, weighed and compared with the original rock powder. (The arbitrary time period of 2 minutes for settling was arrived at after numerous trials, which showed that it was a suitable period to allow separation of the greater part of the more quickly settling sediment; but it is clear that a more elaborate system of settling troughs arranged in a series might result in grading the washed material into several qualities of varying richness in carbon).

The poorer, second quality, graphitic schist of this area to the same depth may, by similar methods of calculation, be estimated as a block of strata, 2,000 feet long by 400 feet thick and 300 feet deep (roughly) or 240,000,000 cubic feet. From these figures, taking the specific gravity of the material as 2.4, the total is arrived at of 16,052,000 tons of poorer graphite rock. One half of this may be rejected as coming below 2nd quality, and again, after grinding, sieving and washing, this becomes reduced to one half again (as

**Method used in purifying and concentration.**

shown by experiments). There is thus left  $\frac{1}{4}$  of the above or

|             |                                                    |
|-------------|----------------------------------------------------|
|             | 4,013,00 tons of graphite material                 |
| add to this | 133,719 tons from the rich bed                     |
| and we get  | 4,146,719 or roughly 4 $\frac{1}{7}$ million tons. |

of graphite material in the whole hill between Mugam Piran and the forest hut down to water-level. This weight of graphite material, in the form of a fine, sooty-black powder, represents the amount available for economic use, refined and purified as far as could be done with the simple mechanical methods at our disposal.

Although a smaller percentage of graphitic material is realisable by washing from this poorer bed than from the rich bed, there is no reason to suppose that the material itself falls far short of that obtained from the rich bed in its carbon content. Detailed analyses of it are not yet received.

From the occurrence of the deposit in the form of a hill slope, it is evident that so far as the poorer material goes, it is only necessary to quarry it away down to ground-water level. If it is found desirable to work the band of richer rock by itself, this can be done by adits and levels in the usual way for such a bed. Timbering in this case would be necessary; and for this purpose wood in abundance is obtainable locally at short distances of a few miles only from the spot. For grinding and washing, water-power and labour are available in any quantity all the year round, and electric power from Mahura could also be transmitted to a convenient place near the deposit. These matters, as well as the opening up of cart-road communication with the main Rawalpindi-Srinagar cart-road, would present no difficulties to the engineer; and it is therefore unnecessary at this stage to enlarge further on this aspect of the question.

### III. THE WESTERN AND EASTERN OUTCROPS.

The western of the three outcrops at Kathal village is separated by a short interval of alluvium and boulder-strewn river-bed from the central Braripura area. As shown in detail in Plan 3. (Plate IV) it comprises a straight strip of steeply rising hill-side, bounded on the east by the water-channel at the margin of the Kathal fields, having a width of a little over 200 feet, and continuing in a west-by-south direction into unsurveyed



tracts. Only the lower eastern end of this outcrop between the 6,500 and 6,750 level has been as yet proved by two trenches the positions of which can be seen on the plan. Other natural outcrops occur locally on the slopes ; and from these taken together it is a simple matter to calculate the cubic contents of the graphitic band, as far as explored, by methods similar to those used in the case of the central or Braripura outcrop. It is unnecessary to give these in detail, as any one can go through the process for himself. The total arrived at amounts to 11,880,000 cubic feet or about 800,000 tons. The general composition of the material and the position of the rich bed, as revealed by the two trenches, demonstrate that the Kathal outcrop is simply a continuation of that at Braripura and is in all essentials identical with it.

The eastern outcrop, as shown on Plan 2. (Plate III.) is also similar and an obvious continuation of the Braripura band. It is, however, of limited size and cubic content down to valley level owing to alluvium and river deposits of the Braripura and Dachhwar streams, which cover it in all round. Two trenches and an open quarry have laid bare the rich bed at three places. The cubic contents of the band as exposed down to water-level may readily be calculated to be about 5,000,000 cubic feet or about 350,000 tons.

#### IV. CHEMICAL COMPOSITION OF THE CRUDE AND WASHED MATERIAL.

At the outset it must be remarked that the chemical examinations reveal a composition that might be expected in an amorphous deposit of such great thickness and extent as this of Braripura, that is to say, they show a carbon percentage that is not high. Even in the richer lenticular band the percentage of carbon in the unrefined crude material is so low that, without washing or other concentration process, it is unlikely that it could be directly used for any but the roughest economic purposes. In the case of a small deposit, this (what one may designate) "borderland" carbon percentage would perhaps, discourage further proceedings ; in the present case, where the fate of millions of tons to the half-mile of outcrop is in decision, it becomes obviously urgent to carefully consider this question of its chemical composition ; and especially so with a view to devising means for increasing the carbon content by some form of concentration.

The chemical analyses were made on samples of the crude rock from the richer lenticular band and on those of the same material roughly ground, sieved and washed, as described in a previous section of this report.

I am indebted to the Director of the Geological Survey of India and to the Principal of the Sri Pratap College, Srinagar, for some analyses. For others, the professional assistance of Mr. C. S. Fawcitt of Bangalore was requisitioned. The following tabular statement embodies the results received up to date as regards the most important element, carbon.

From analyses made by

|                                                          | Geological Survey of India. | Sri Pratap College Srinagar.  | C. S. Fawcitt Bangalore.                                                           |
|----------------------------------------------------------|-----------------------------|-------------------------------|------------------------------------------------------------------------------------|
| Carbon % crude rock richer variety Trench No. 2.         | 22.15                       | .....                         | 22.95 combustible in air at red heat.<br>3.23 do. in oxygen<br><u>26.18</u> Total. |
| Carbon % Crude rock richer variety Trench No. 5.         | ...                         | ...                           | 18.48 in air<br>2.08 in oxygen<br><u>20.56</u> Total.                              |
| Carbon % ground and washed, richer variety Trench No. 2. | .....                       | Two Samples<br>30.89<br>30.44 | 25.60 in air<br>7.04 in oxygen<br><u>32.64</u> Total.                              |
| Carbon % ground and washed, richer variety Trench No. 5. | .....                       | .....                         | 23.53 in air<br>2.47 in oxygen<br><u>26.00</u> Total.                              |

On contemplating these carbon percentages it cannot be denied that the first impression is one of disappointment, especially in view of the expressed opinion of an authority on graphite, which states that :—

Low carbon percentage in amorphous graphite.

“ While perhaps, five per cent. flake ore might under certain conditions pay to work, owing to the comparative ease of extraction of the graphite flakes, it is problematical whether an amorphous ore containing 30 per cent. of the graphite would pay to work,

on account of the most difficult problem of concentration and attendant loss of graphite in the tailings."<sup>1</sup>

It is clear from this pronouncement that our graphite material, as roughly concentrated by hand-washing is, as already remarked, a border-land ore, about which there may well be doubts as to its successful utilisation for economic purposes.

It is worthy of note, however, that the analyses also show that our roughly washed material has already had its carbon percentage increased by from 5.5 to 6.5 per cent. as compared with that of the crude ore ; and it is, therefore, allowable to suppose that a more perfect method of mechanical washing by a system of settling tanks might give a further increase.

Some hints of possibilities in this direction are afforded by the specific gravities of the rock and its powder in various stages of its preparation. The Mugam and Piran crude rock and rock powder have given values for the specific gravity between the rather wide limits of 2.28 and 2.47. After powdering, that which passed through a 30 mesh sieve but failed to pass through a 60 mesh sieve gave the high value of 2.54, and this is nearly equalled by the residue from the powder which has passed the 90 mesh sieve and been washed in the manner already indicated, which gave a specific gravity of 2.52. From this it is clear that sieving and washing enable us to get rid of a considerable amount of higher specific gravity material, probably fine grit and clay. Similarly the specific gravity of the finer powder that passed the 60 mesh, but refused the 90 mesh (not washed) was 2.187. Here of course, all that refused the 30 and 60 mesh had been rejected and removed. The result shows a lowering of the specific gravity considerably below the lowest for the crude rock, and indicate partial purification. Finally the powder that passed the 90 mesh after washing and separation of the heavier material gave the lowest specific gravity of any attained, namely, 2.106 in one case and 2.14 in another, the average being 2.123. Whether purification can be effected beyond this by differential washing in settling tanks, remains at present uncertain, but is distinctly possible.

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(1) Fritz Cirkel "Graphite its properties, occurrence refining and uses." Ottawa. Canada, 1907, p. 97.

There appears to be, however, a limit with regard to such  
**Concentration of amorphous ores limited.** amorphous graphite as ours, beyond which separation by flowing water is powerless to effect any further concentration. The same authority quoted above remarks (*loc. cit.* p. 206) :—

“Substances which are intimately associated with the mineral in a very fine state of division, for instance, oxide of iron and the silicates, cannot be separated by a current of water.”  
 and again :—

“The ash of the graphite, that is the quantity of those non-combustible substances which are intimately associated with the mineral in an extremely fine state of division cannot be reduced by the most intricate washing processes.” \* \* \* \* \*” but it is well-known that for the finer purposes of manufacture chemical processes are employed for refining the mineral in some of the larger Bohemian and Bavarian works.”

Assuming these statements to be well-founded, there still remains the possibility that some method of “flotation”  
**“Flotation”** might be used to effect a more complete separation in the case of amorphous ores like ours, such as that of some of the pioneers of flotation, E. B. Kirby and H. Futz (*loc. cit.* p. 219), where bitumen in kerosene, or crude petroleum is made use of together with agitation of the mixture and the injection of a current of gas. the light hydro-carbons being afterwards recovered. Among graphites thus treated those of Kropfmuchle and Germansdorf (brown

All the above quoted methods of concentration, namely, washing earth) only boasted 31.72 and 34.54 per cent. of carbon respectively.

**Pure graphite not used for many economic purposes.** and flotation have as their object to obtain from the crude rock a graphite as pure as possible, that is to say, one with as large a percentage of carbon as possible. But it is significant that for some purposes, such as for instance, the making of pencil lead, the modern practice is not to use the pure or very rich graphite of 80 or 90 per cent. carbon content, (such as was originally sawn from the block into pencils at Borrowdale, Keswick), but to use clay in combination with graphite in proportions that some authorities put at 2 of graphite to 3 of clay or equal quantities of both in the case of ordinary pencils.

For the production of graphite paints, also, no great degree of richness in carbon is necessary, Hence it seems to me to be of the

very greatest importance for us to discover whether it might not be possible to utilize for these purposes a graphite material such, as the Braripura graphitic schist which in its original state already consists of just such an intimate mixture of clayey material, or at all events to use such material slightly enriched, perhaps, by the addition of a little pure graphite.

The decision of questions such as these ultimately rests with specialists in graphite and paint making. But in the meantime, and in spite of the borderland chemical composition accredited to it, I propose in the next section of this report to describe the results of some practical experiments made with the object of testing it myself in the manufacture of certain articles. Some of these experiments seem to me to be of such promise that they may well outweigh theoretical objections based on the borderland composition of the crude material. At all events I give them for what they are worth, and in doing so trust that I have stated the results as impartially as possible.

## V. PRACTICAL TESTS OF THE GRAPHITE MATERIAL.

During the time occupied in mapping the Braripura area I was constantly subjecting the graphite material to a number of practical tests, and these were further increased and amplified, whilst in recess in Srinagar head-quarters. I was greatly assisted by Lala Joti Parshad and Pandits Labhu Ram and Sohani Ram in improvising and carrying out what frequently became rather tedious and lengthy experiments. The aim of these tests was not to work out and conclusively prove the adaptability of the material to certain purposes. This could only be effectually done by practical experts in their own particular lines of business. But it did seem to me necessary to get some idea of the uses to which that material could best be put by making tentative experiments on our own account, even though they might be somewhat crude. In no other way could one judge of its possibilities, and so learn at the outset whether the material was likely to be worth the time and energy, we were spending on the detailed survey of it. It also seemed likely, that even a modicum of success with the poor appliances at our command, ought to be taken as an encouragement ; for it is certain that, in matters of grinding and purifying, better

results must accrue when modern machinery takes the place of rough hand-work.

There are many important uses to which graphite can be put.

**Uses of graphite.** These may be grouped as follows :—

- (1) The manufacture of various forms of writing and drawing materials, such as pencils, crayons and certain inks.
- (2) As paints, varnishes and stove polish.
- (3) For foundry facings.
- (4) As a dry lubricant.
- (5) For crucible making.

For the production of pencil lead, it is now generally admitted that the finest varieties of scaly graphite, or even some kinds of amorphous graphite, mixed with clay and other ingredients, are used at the present day. It was important, therefore, to make an attempt to see if we could produce any thing like a 'lead' or crayon from the Braripura amorphous variety.

As I was unable to grind the substance to a very fine state of powder or to bring it under high compression I had to find "binders" that would hold the particles together. Ordinary water was of no use. Gum was found to set the lead too firmly. Weak starch (washed from rice) gave a very soft and black crayon-like result, or one-something between a pencil and crayon, but without the smoothness and shine of a good pencil lead. Gelatine in weak solutions gave much the same results. The addition of linseed oil to the starch seemed to assist the smoothness of working, and a number of other substances such as kerosene, tallow *etc.*, were tried in various combinations. The starch was made by boiling rice in plenty of water for half an hour and then pouring off the liquid. This can be obtained in various degrees of strength by varying the quantity of water or by stirring actively during the boiling. According to the strength the results (when used as a binder with the graphite powder) were found to vary in hardness from such as resembled a very hard pencil to those which resembled a very soft crayon. Starch on the whole appeared to be the most suitable binder. The addition of linseed oil was made by making an emulsion of oil and starch water in the proportions of 10 of starch water to 1 of linseed oil. The effect of the addition of oil was to give a certain smoothness to the working of the "lead" and at the same time to slightly reduce the blackness. The combined starch,

or starch and oil, with the graphite powder were ground for some hours in a porcelain mortar to the consistency of dough, which was then kneaded into sticks of the thickness of a  $\frac{1}{6}$  inch and dried in the sun or on a hot plate.

In all cases the line produced by the "lead" on paper was without any noticeable shine and more so in the case of the softer varieties.

In the end, the conclusion come to was that we might roughly imitate a pencil lead, but the result lacked smoothness of working and evenness of line—defects that may be mainly due to the difficulty found in getting the grain fine enough. The experiments were sufficiently promising to indicate the direction to be taken in further exhaustive treatment of the material by those who make graphite a special article of trade.

On the other hand the softer varieties of crayon produced showed some admirable qualities. For bold drawings it worked freely and more smoothly than ordinary black chalk, and when shaded with the "stump" gave effects as soft as charcoal.

Steps have been taken to have the material examined by one or two experts in pencil lead, manufacture in India. **Expert opinion.** Even should it fail (after adequate grinding by machinery) to prove a satisfactory pencil lead by itself, I have very little doubt that the resources of modern methods of pencil manufacture would find a way by enrichment (with perhaps, some pure Ceylon graphite or lampblack) to obtain all the effects and qualities desirable in the manufacture of the various grades of pencils for all uses. The results of these enquiries will be communicated in due course.<sup>1</sup>

By mixing the powdered and washed graphite material with gum or glue and water, grinding the whole together and drying it in a mould, a hard solid stick of **Water-paints and drawing ink.** quasi-Indian ink was produced.

For these purposes, ordinary gum as supplied by the stationery depôt, and also country gum were used in a fairly strong solution. The glue (ordinary fish glue shavings as sold in the Srinagar bazar) was placed in boiling water and kept at this temperature for half an hour or until the whole was dissolved. The mixing with the graphite powder was done in a porcelain mortar and the whole ground for 10—12 hours to a stiff paste, which was then moulded into slabs and sticks and dried thoroughly for some days in the sun or artificially.

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1. Pencils and pencil leads received later all suffer from being hard and lacking smoothness of working.

On the whole glue gave the better results, as it seems to carry the particles of carbon in more complete suspension, and so yields a finer ink less liable to deposit sediment quickly.

These slabs and sticks when ground again on a palette with water yielded a fair imitation of Indian or Chinese ink, but on the whole this was more like the lampblack of artists' colourmen. In colour it is a black or rather slightly greyish black, of perfectly neutral qualities, not brownish like Indian ink, but almost identical with lampblack in hue. It works well when laid on in washes as a water paint for monochrome sketching and designing, and equally well as a drawing-ink for line-work with the pen.

Having had much personal experience of monochrome sketching and line-drawing, I made a number of trials of this material, and also obtained outside opinions of artists, with favourable results. Original drawings and copies of photographs have been made that lack nothing in technique. As regards line-drawing and tracing work on cloth of plans, etc., I have had it in constant use in my office in the preparation of maps and sections to illustrate my official reports during the last half-year and with the best results. I subjoin a few remarks by specialists in art matters and in process photography to whom I have submitted sample sticks of this Braripura ink. Such criticisms generally lean to the side of pointing out defects, and it is but fair to say that the comments therein were based on rather crude material, and did not include results of an extended trial of it in the practical production of drawings.

Mr. Andrews, Principal of the Amar Singh Technical College, Srinagar, remarked that the pigment was a grey and not a black, coming nearest to a colour known to artists as "charcoal grey," but he thinks that treated with modern appliances such as artists' colourmen use, it might be remedied in this respect. Any desire to question this expert opinion is tempered by the satisfaction felt that anything as *grey* as charcoal must be black enough for ordinary purposes.

An objection lodged against it as a drawing ink by Mr. Watkinson, Artist to the Geological Survey of India, who has had much experience of such matters, is that the pigment does not remain in suspension in water, for more than 24 hours, whereas Indian ink remains so for months, while manufactured liquid Indian ink and waterproof ink only deposit slightly after years. As regards this objection, the defect alluded to may partly be remedied by finer grinding and certainly



so by more thorough mixing with gum or glue in larger proportions. Experiments subsequently made by me show that the tendency to flocculent separation of the particles in suspension was very markedly arrested in sticks made with glue as compared with those made with gelatine or weak gum. In any case the tendency to deposit does not seem to affect adversely washes laid on paper, which, even of the palest tint, remain perfectly flat and uniform and of a beautiful silvery grey tint. Very many of the paints in a Winsor and Newton water-colour box deposit far more readily than this Braripura water paint.

Later opinions by Mr. Watkinson were much more favourable.

Mixed with other water-colours, such as the stronger blues, reds and greens, it forms delicate art shades that are very pleasing. It would consequently with little doubt prove of great service in distemper work—but adequate experiments in this direction have not yet been made by me.

**Mixture with other colours.**

**As an oil-paint for iron work structure: for black-boards, etc.**

A very important use for the graphite will undoubtedly be the manufacture of oil-paints. From experiments made by us with linseed oil, which is available locally in Kashmir in large quantities (see Nur Khwah ochre report), it has been found to give a slightly greyish black oil-paint, that possesses good body and excellent covering power. Mixed with copal varnish as well, the effect of course, is much blacker and more brilliant. These mixtures were made and ground just the same as any oil-paints and need no further remark. I think without any further words, we can assume that as a protective paint for iron-work structures the Braripura graphite will play a most important rôle, whilst it will enjoy some minor spheres of usefulness for coating black-boards, and writing slates. Quoting from Mr. Watkinson's remarks again:—

“There are several uses to which such a material could be put, such as a paint for coating school black-boards or artificial slates. The modern school slate is a card-board with graphite incorporated or coated which is waterproof and will stand wear.”

This last suggestion has already been acted on by us and a fair result obtained, which we hope to improve upon.

In another report on the Nur Khwah ochres recently issued, I have already mentioned the use of graphite along with those ochres. Later experiments show that the Braripura graphite is invaluable in building up

**Shades when used with Nur Khwah ochres.**

a series of shades of these yellow, orange, red and pink hues. Its perfectly neutral-black tone makes it particularly suitable for mixing with any colour with the object of producing greys, khakis and browns of any depth of shade. Many such have been produced and tried practically on wooden panels and other wooden articles during experiments. It is worthy of remark that, in all those shades produced, the graphite, of course, has the quality of absolute chemical inertness and also adds greatly to the effective covering power of the mixture and to the smoothness, tenacity and adhesion of the film of paint.

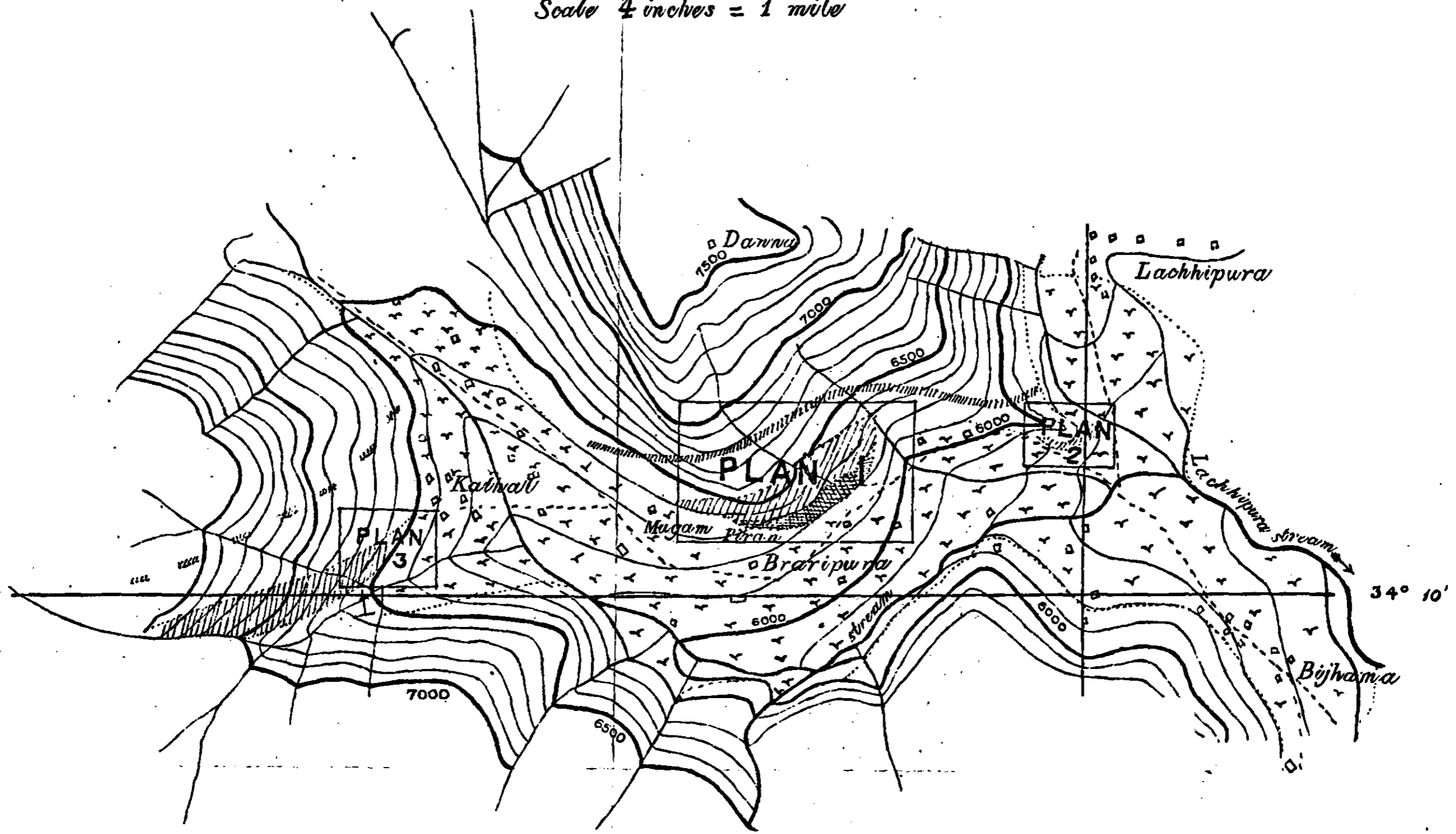
I have not so far been able to make experiments with the graphite as a stove polish, for foundry facings, as a dry lubricant or for crucibles. In the last two it seems generally admitted that the very purest scaly graphite is preferred though amorphous varieties are used for crucibles in some cases, where cheapness is of more importance than durability.

**GRAPHITE DEPOSIT OF BRARIPURA  
KEY MAP**

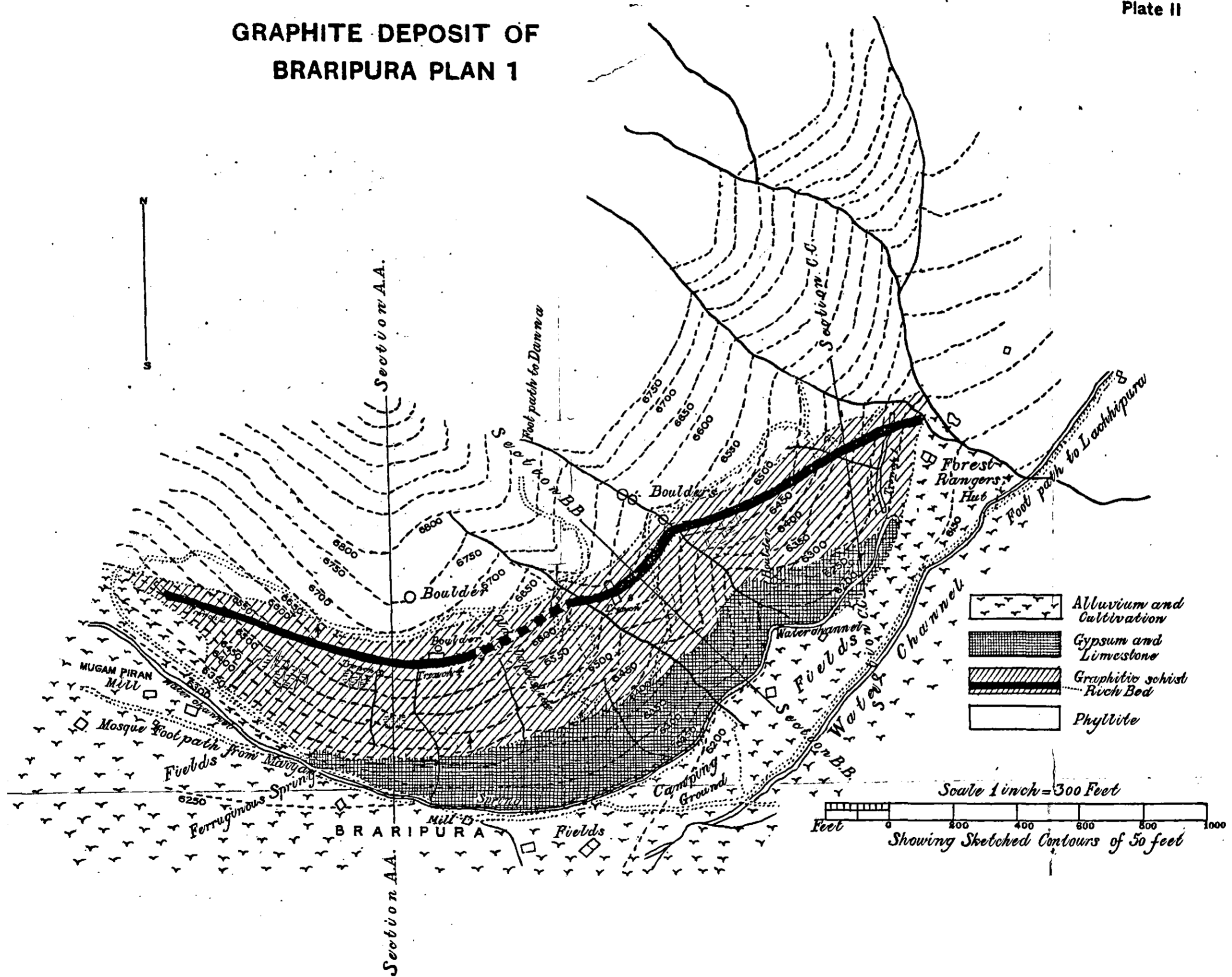
Plate I

Scale 4 inches = 1 mile

74° 5'

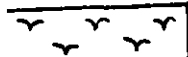

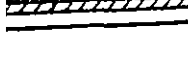


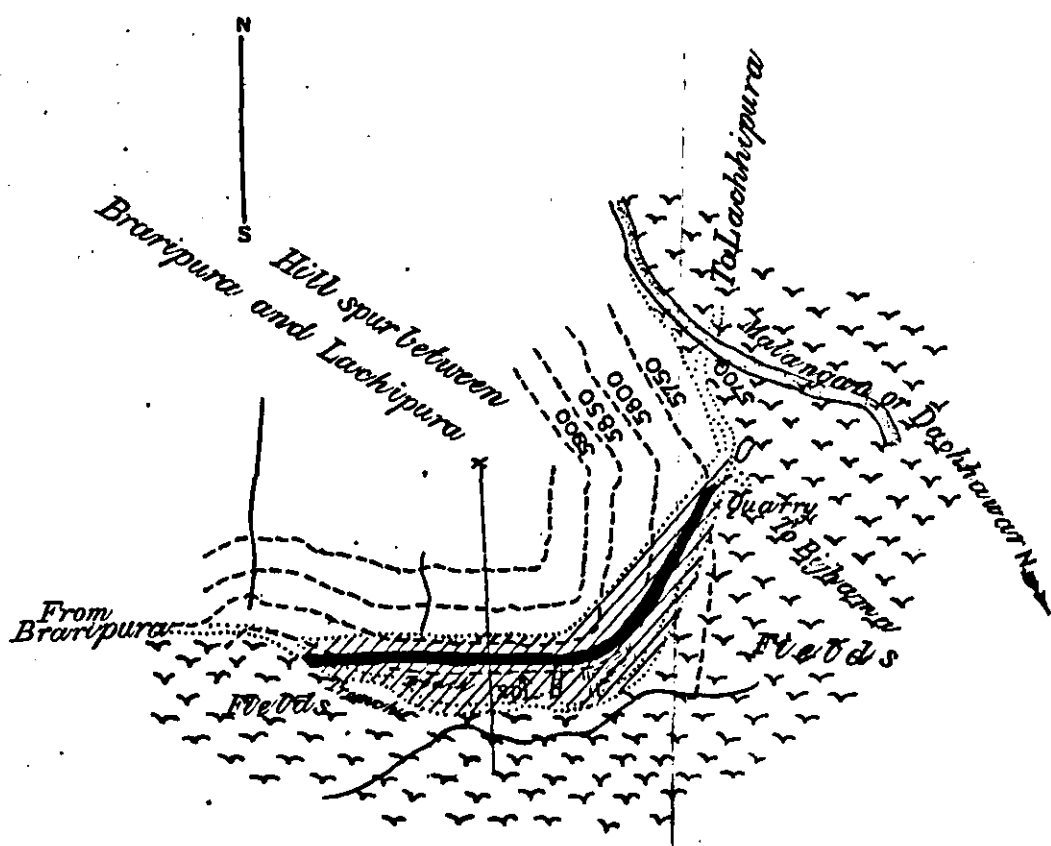
GRAPHITE DEPOSIT OF  
BRARIPURA PLAN 1



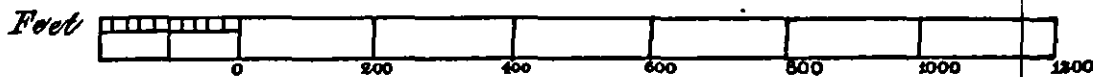
# GRAPHITE DEPOSIT OF BRARIPURA PLAN 2

## INDEX

-  Alluvium and Cultivation
-  Graphitic Schist Rich Bed
-  Phyllite

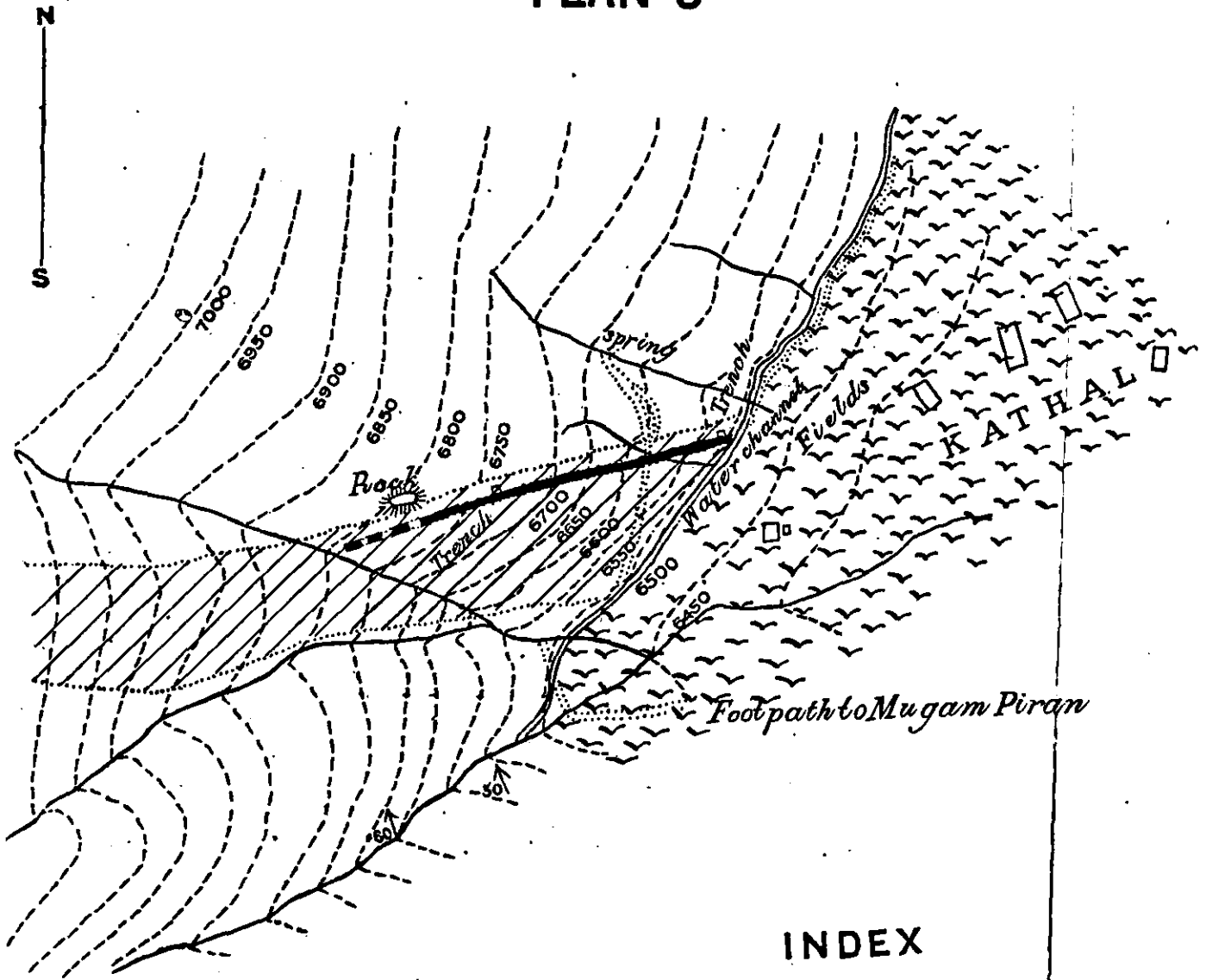


Scale 1 inch 300 Feet


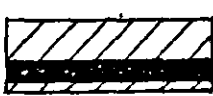




Showing Sketched Contours of 50 feet.

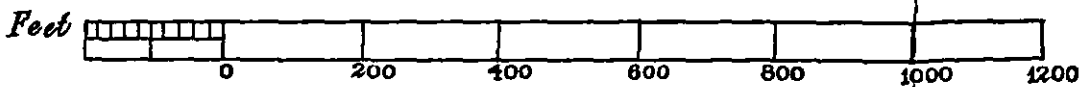
# GRAPHITE DEPOSIT OF BRARIPURA PLAN 3



## INDEX

-  Alluvium and cultivation
-  Graphitic schist
-  Rich bed
-  Phyllite

Scale 1 inch = 300 Feet



Showing Sketched Contours of 50 feet.

# GRAPHITE DEPOSIT OF BRARIPURA SECTIONS (PLAN 1)

*Horizontal and vertical scales the same, viz.  
1 inch = 300 feet*

