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KOYAT

MEDICAL GUIDE

BY

G H BRANDT M

AND

J EGERTON BRANDT

With the author's compliments.

Royat

MEDICAL GUIDE

BY

G. H. BRANDT, M. D.

AND

J. Egerton BRANDT, M. D.

Fourth Edition.

CONTENTS

Royat

I. — INTRODUCTION

Twelve years of practical experience in the treatment of cases sent to me at Royat enabled me a few years ago to fulfil a promise made to many of my colleagues, who had kindly entrusted and still entrust their patients to my care.

The result was a small book supplying them with exact information on the climate, mineral waters, therapeutic means at our disposal, and further giving my clinical experience of those cases in which treatment at Royat gives the best results.

A few brief extracts from my casebook have seemed to me useful, as many medical men are misguided by the numerous pamphlets addressed to the general public, these, promising too much, prove not only misleading in practice, but are a sure means of discrediting that which is really beneficial if properly used.

I have been induced to rewrite parts of this little handbook and to enlarge it, as I find that although the composition of the waters and the climate remain the same, there is an advance in the therapeutic means at our disposal here, which should be brought before the profession. I have also added some photographic illustrations of the neighbourhood, giving a fair idea of the country and of the appearance of Royat itself.

In the appendix the reader will find a most interesting and exhaustive paper on the geological aspect of Royat and is neighbourhood, which Professor Etheridge F. R. S. has very

kindly written for us. We take this opportunity of thanking him for the time and trouble which he has devoted to us and our readers, especially as so few are competent to handle the subject and no one more so than the distinguished writer.

The object of this little book is to give to the profession as accurate an idea of Royat as possible from the point of view of a health resort; we have therefore only touched on the general surroundings as far as we have thought necessary for this purpose. An excellent English Guide book has existed for several years giving all information required by visitors.

II. — ROYAT

The mineral springs of Royat are situated in a valley running east and west and which ascends gradually from the town of Clermont-Ferrand, capital of the department of the Puy-de-Dôme, to the mountain from which the name of the department has been taken.

Clermont-Ferrand lies in the fertile plain of the Limagne, one of the vast granaries of France, and by following the valley for a mile and a half one reaches the hotels, gardens and bathing establishment of Royat-les-Bains at an altitude of 1480 feet; half a mile further up one comes upon the village of Royat with its picturesque church.

All the country is richly wooded with chestnut-trees, walnut-trees and orchards. Vines are extensively grown, wine, wheat and fruit being the staple produce of the region. As one ascends the winding valley still further, pine covered hills predominate, so that the country abounds in fine scenery and excursions, which can be undertaken either in carriages, on horseback or on foot.

An electric tramway runs every few minutes between Royat and Clermont, where the shops are very good and where the archeologist finds ample fields to explore.

Historically this part of the country is interesting, as it was the scene of Roman invasion and occupation under Caesar, numerous remains testifying to the fact; of these, the most noteworthy from a medical point of view are the excavated baths which clearly show how very largely the springs were utilized at that period.

Potable water is in great abundance and within a walk or drive of Royat one can see the large supply of spring water bubbling out of the soil and rushing down the valley in all directions. It is extremely pure and soft, and is used for drinking and domestic purposes as well as for irrigation of the fields and orchards, the remainder forming the Tiretaine stream which flows through the public garden of Royat.

The soil is almost entirely volcanic and loose, which fact negatives any tendency to dampness or mud, as the rain is either quickly absorbed or is carried off by the prevailing incline.

From a geological point of view this region is very remarkable, as is also the fact that an English scientist, Poulett Scrope, was the first to give a complete description of it.

III. — THE CLIMATE

Situated, as we have stated, in the centre of France, at an altitude of 1.480 feet, the climate is temperate, dry, bracing during the summer months. The moderate altitude ensures visitors against the excessive sultry heat prevalent during July and August on the plain, and also against cold, wet and mist, which so often spoil the early and late months of the summer season at more elevated health resorts.

Although the days in the height of summer are warm, the nights are always cool, owing to a mild breeze, which blows down from the hills every evening at about 7 p. m.

Dryness is the dominating feature of the climate, and there is no sudden change after sunset, indeed, one can sit out until late at night without fear of dampness. It is hardly necessary to point out the advantage of this feature to patients, who require fresh air and who often cannot take sufficient bodily exercise.

What we advise during July and August is rest in the middle of the day, whilst baths, drinking the waters and exercise are got through in the morning and after about 4 p. m. It is hardly necessary to say that warm, dry weather is most desirable for patients taking the waters and baths for obvious reasons.

As a general indication of the healthiness of the prevailing climate we may mention that we have been unable to discover the record of any epidemic in the village of Royat (situated half a mile from the baths), a result probably of the freely circulating air, the abundance of good water and the porous soil.

The Puy de Dôme belongs to the subalpine region and the rain therefore which falls at Royat during the summer months is mostly in the form of heavy thunderstorms, which do not last long and freshen the atmosphere, preventing any long spell of heat.

To give a more accurate idea of the temperature we publish a table giving the averages of the maximum and minimum temperatures, along with the resulting average temperature during the summer months for the last eight years.

We take the opportunity of thanking Mr. Weyer, the director of the thermal establishment, for his kindness in placing his accurate observations at our disposal.

TABLE OF AVERAGE TEMPERATURES DURING THE SUMMER MONTHS AT ROYAT

	Years	Average of maximum temperatures	Average of minimum temperatures	Average temperature
May.	1896	66.2 F	41.9 F	54 F
	1895	71.6	49.1	60.3
	1894	66.4	48	57.2
	1893	65.4	41.9	53.7
	1892	61.4	45.3	53.4
	1891	60.4	46.2	53.3
	1890	63.5	48.4	55.8
	1889	66	49.8	57.9
June.	1896	77.8	50.2	64
	1895	78.6	55	66.8
	1894	76.8	56.6	66.7
	1893	73	48	60.5
	1892	70.2	54	62.1
	1891	68	52.6	60.3
	1890	72.9	54	63.5
	1889	71.6	56.2	63.8
July.	1896	87.8	55.1	71.5
	1895	90	59.6	74.8
	1894	80.8	59.8	70.3
	1893	80.8	52	66.4
	1892	77.9	55.6	66.8
	1891	71.4	55.8	63.6
	1890	73.6	56.5	65
	1889	73.2	56.5	64.8

	Years	Average of maximum temperatures	Average of minimum temperatures	Average temperature
August	1896	75.4	49	62.2
	1895	83	57.6	70.3
	1894	80.8	59	69.9
	1893	80.6	54.4	67.5
	1892	77.9	56.2	67
	1891	71.4	53.6	62.5
	1890	73.6	56.8	65.2
	1889	71.6	55.6	63.6
September . . .	1896	73.2	47.2	60.2
	1895	77.9	57.4	67.7
	1894	67.8	55	61.4
	1893	66.4	46	56.2
	1892	66.6	51.3	58.9
	1891	66.6	51	58.8
	1890	65	50.8	57.9
	1889	65.3	49.8	57.6

IV. — ROYAT SPRINGS

The four mineral springs at Royat, although of the same type — chloro-alkaline — differ as to their mineralisation, and their temperature: the presence of chloride of sodium and other salts show a marked difference from the purely alkaline waters, of which we might quote as types, Vals and Vichy.

The salts of soda, potash, lime and lithia, represent in these waters the alkaline elements, the depressing effects of which are counteracted by the tonifying properties of the salts of iron, and arsenic, which combined with the stimulating effects of their carbonic acid, renders them so powerful, active and easily assimilated.

The four springs bear the name of Eugénie, César, Saint-Mart, and Saint-Victor. The tables of analysis recently made by Mons. Willm, a distinguished chemist attached to the Laboratory of the School of Medicine at Paris, will show at a glance the composition of each of the springs, with their temperature and quantity (1). The result of another analysis of these springs made by Mons. A. Carnot, Director of the Laboratory of the School of Mines at Paris, so as to obtain the correct amount of arsenic contained in them will be seen in Table II.

V. — EUGÉNIE SPRING

This spring is the largest, hottest, and most mineralised of the four springs; it throws up in huge bubbles 1.000 litres *(Quarts)* of water per minute, and constitutes the main supply to the swimming and still baths, the steam for inhalation, the spray for aspiration, and the different douches.

This water is clear, gaseous, and odourless, or nearly so, the numerous glasses which are placed after drinking on the circular slab which surrounds the spring, are lined with incrustations of the salts left after evaporation. This water, from the large percentage of lithia it contains, in combination with the soda and potash salts, is most valuable in all cases where gouty manifestations are present; it is easily borne by the stomach, and patients soon overcome

(1) Page 27.

the slight nauseating effect of its temperature; in fact almost all, after three or four days enjoy the drink, and find it soothing and pleasant, its high state of mineralisation — about 40 grains of solids in each litre, and its temperature 35°,5 cent. (96° Fah.) renders it a most valuable and agreeable water for bathing purposes, and has certainly contributed largely to give Royat its reputation as a Thermal Bathing Station.

VI. — CÉSAR SPRING

This abundant spring, next to Eugénie in thermality, marks 29° cent. — 84°,2 Fah. The large quantity lately discovered allows of its being used also for bathing purposes. This water is less mineralised than the preceding; it contains a much larger amount of free carbonic acid gas, and is therefore one of the most appreciated waters for drinking, either alone at the spring, or at table mixed with the country wine. It thus becomes a pleasant beverage, and will bear keeping in bottle for a considerable time without losing its properties. I have recently tasted some that had been in bottle for sixteen months (as an experiment) which I found still to contain some carbonic acid, and not at all unpleasant to drink. The amount of deposit was small.

VII. — SAINT-MART SPRING

This spring has been known for many years, and is mentioned by some of the old writers. It was lost for about forty years; having been covered up by an inundation in 1835.

Twenty years ago it was found again, and is at present in full play. Its mineralisation resembles somewhat that of Eugénie; its temperature differs, not exceeding 30° cent. (86° Fah.) It is wrongly called an intermittent spring. The amount of water is the same, but it occasionally throws out large bubbles of carbonic acid gas, which last for a minute or two and then subside. This phenomenon is, no doubt, the result of accumulated gas in the upper part of the irregular channel through which it runs; the gas goes on collecting until the quantity becomes so great, that in order to find an escape it forces itself through the column of water, thus causing this curious phenomenon.

This valuable water is very clear and rich in carbonic acid, which accounts for the perfect solubility of its various salts. It is largely used as a drink mixed with wine, and can be easily exported, keeping good for a long time. It is much frequented by persons who, though not under treatment, take an occasional glass, which sharpens their appetite, and prepares their stomach for an easy digestion.

VIII. — SAINT-VICTOR SPRING

This constitutes one of the most valuable springs of this group of waters. The last analysis made by Mons. Willm, and repeated by Professor Carnot of the Paris School of Mines, shows that its temperature is 20° cent., or 68° Fah. It contains more salts of lime and potash than the other waters. It possesses also a larger percentage of iron, and contains 4 1/2 *milligrammes* of arseniate of soda per litre. It is enclosed in a well-constructed Roman grotto, with a flat roof formed by small stones and cement. One Roman column in a perfect state of preservation, shows that the Romans attached considerable importance to this spring.

During the winter of 1881 to 1882 some excavations were being made over this so-called Grotto, when the workmen discovered extensive Roman works, the excavations were continued and a series of Roman baths were found, consisting of three large Piscinae, or swimming baths, lined with pure white marble — Roman ovens for heating air and water, with channels leading to the surrounding galleries. These Roman Piscinae were admirably constructed, and showed how extensive must have been the knowledge of their builders, and what importance this great nation attached to the mineral waters; they evidently took advantage of the fact that air is a bad conductor of heat, and as they wished to preserve the waters with their natural heat as they emerged from the spring, they surrounded the Piscinae by air chambers, and constructed one under each bath occupying the whole sub-surface of it, the so-called Grotto of St. Victor is nothing more nor less than a huge air chamber under one of these baths. The discovery of such extensive, and carefully arranged work, naturally enhances the value of these waters; it is natural to presume that should further investigations be made, extensive Roman remains would be discovered. It is to be hoped that the French Government will take up this very important subject.

We will draw particular attention to the value of this spring when treating of the diseases in which these waters are employed.

IX. — THE BATHING ESTABLISHMENT

The baths, and all the other modes of applying the mineral waters, are enclosed in a building 80 metres long. The part which occupies the centre of the building, has three wide entrances, leading into the vestibule. In front, at the entrance, is the office where tickets are

obtained for the different kinds of appliances, ordered by the physician; on either side of the vestibule are galleries, one to the right for ladies, the other on the left for men, each gallery containing 26 bath rooms, with baths made either of volvic stone, or enamelled iron. At the end of each gallery, a special portion is arranged for the spray-producing machines, or pulverisers; and the carbonic acid gas bath and douches. A dressing-room is attached to this department. On each side of the vestibule a staircase leads up to the aspiratory rooms, where the patients sit in an amphitheatre at different heights round a large tube, like the funnel of a steamer, out of which the mineralised steam is ejected in clouds. Another stair leads down to other galleries to the right containing 26 baths and hot douches. At the end of this there is a large swimming bath also of running mineral water called the *Piscine*. This large basin has the shape of a parallelogram presenting a surface of 130 square metres of thermal water. The depth is graduated by an inclined plane, so that children can enter without fear. At the further extremity of this bath, the depth is about 6 feet, so that one can easily plunge and swim. A swimming master is attached to this department which is open in the morning to ladies, and in the afternoon for gentlemen. On leaving the Piscine, the bather is supplied with a warm peignoir and towel before entering his dressing room.

Leading off from the bath galleries are the douching rooms, the " doucheur " and " doucheuse " being throughly competent and trained to carry out the physician's directions as to duration, strength and temperature of the douche or showerbath.

Two spacious and well-furnished ante rooms opening into the gallery on either side of the principal entrance are used by bathers who are waiting for the preparation of their bath, or getting cool before going out into the open air.

A smaller bathing establishment has been formed since the discovery of a large supply of water from the César spring; the temperature being much less than the Eugénie, and the water

highly charged with carbonic acid gas, renders it a most invigorating and delightful bath. A comfortable couch for massage or kneading process is fitted up in a room close at hand where the patient can be submitted to that treatment on leaving the bath.

X. — THE CÉSAR BATH

The César spring is one of the oldest of this region, if we may judge from the Roman Basin, with its iron grating and clasps which are still preserved over it. Like most of the Royat valley springs it appears intermittent, i. e. the bubbles of carbonic acid gas rise at certain periods, varying beween a few minutes to fifteen, twenty, or more. The analysis shows it to be a muriated alkaline water at a temperature of 84°,2 Fah. the carbonic acid is estimated at over 20 grains per litre; at one time the rush of gas was so great as to make the column of water overflow the basin which stood 2 feet above the surface of the water, when in a still state. The gas which emanates from this spring is warmer than the water through which it passes, the difference of temperature is so manifest, that if one holds an open hand a few inches above the surface of the water, it will feel quite warm; if one plunges the hand into the water, the coldness of the water is perceived immediately. The effect of this bath on the skin is very remarkable; on entering the bath one feels a sensation of chill, this sensation will be continued if the body is kept in motion whilst under water; but if the body is kept perfectly still, in less than one minute the gas begins to collect in fine globules all over the skin; after 10 minutes the body gets red, and the patient feels a tingling sensation all over, which, in some people, goes so far as to resemble burning.

This effect, which amongst French people is always expected, fails frequently amongst English, and hardly ever fails with Americans. We have often found rapid results of reaction after the bath in American men, whilst in delicate English girls with fine skins the result has only been obtained after several baths. Why this should be so, was for some time a puzzle : it remained to be ascertained what difference there was between an American and an English skin, and what was the cause of that difference. We discovered, first, that Americans as a rule wash in tepid water, whereas English people use the cold tub. Secondly, american skins perspire more freely than English. The question was then easily solved. On a skin that perspired freely, the carbonic acid gas contained in the baths acts more readily. In those which do not perspire, the action of the gas is slower.

This is so positive, than when prescribing that particular bath to English patients, we always ask them if they wash in warm water and if they perspire; if so, their skin will react to the bath from the beginning; if not, we remedy the defect by giving a few warm Eugénie baths first, which open the pores of the skin and we find that the patient then reacts to the César bath perfectly.

The cases most adapted for treatment by these baths, are the chlorotic and anœmic, who suffer from cold extremities, torpid liver, constipation, headaches, hœmorrhoids, and general malaise. The anœsthetic effect of the carbonic acid is very marked in cases of neuralgia, particularly in those where the affected nerves are superficial.

The remarkable, and numerous cures effected by these baths in appropriate cases, are a valuable testimony of their usefulness, any one desirous of making an experiment on a small scale, can easily do so, by filling a wine glass with soda water and placing his finger in it for a few minutes, the glass representing the bath and the finger the naked body, in a short time the finger, if kept still, will get covered with fine bubbles of gas, which as they dilate by the

heat of the finger, burst and make room for others to form; if the operator has a fine and easily perspiring skin, the surface will redden and tingle.

XI. — RESPIRATORY FUNCTION

One of the most distressing and not unfrequent symptoms which some gouty patients suffer from is dyspnœa. They generally complain of wheezing at night, which interferes with sleep, and is a source of great discomfort. This symptom ceases after a few days treatment at Royat. Some men of experience pretend that it is owing to the carbonic acid gas which is being constantly evolved from the waters, and the surrounding ground. Others say it is to the peculiar equability of the temperature, and mildness of the climate. Others again attribute it to the effect of the waters. I fancy that there is some truth in all these assertions, and all contribute to the benefit derived.

Cases of bronchial catarrh, accompanied or not by asthma, also derive considérable benefit by the aspiration of mineralised steam, these inhalations are carried out in a room in the shape of an amphitheatre, surrounded by benches placed in rows one above the other up to near the ceiling; in the centre of the room, a metal tube like the funnel of a steamer, rises above the ground for about seven or eight feet, throwing out clouds of mineralised steam; the patient sits down, inhaling from a quarter of an hour to an hour according as the case may be; and of course the higher he is placed, the more steam he gets; the patient during this process is deprived of his coat, waistcoat, and trousers, and is wrapped up in a flannel dressing gown. On leaving the inhaling room, he passes into an outer room warmed by steam or hot water, and there dresses slowly. Should there be any headache, the patient is ordered to take a hot foot

bath for a few minutes before dressing. The inhalation followed by a hot bath is often most useful. From the establishment he goes home, either on foot or in a sedan chair, and rests for an hour until breakfast time.

Throat cases are treated locally by pulverised mineral water. This is accomplished in a special room, surroundel by different kinds of silver plated pulverisers which are put in action by a force pump. The patient puts on an india rubber apron which fits round the neck, and hangs down the front of the body, protecting him from the spray. He then sits down opposite the apparatus and receives with open mouth the pulverised water.

XII. — STOMACH DOUCHE AND THE WASHING OUT PROCESS

This most useful operation ought to be practised early in the morning and on an empty stomach. The Saint Mart water is well adapted for this operation and if properly carried out gives excellent results in catarrhal affections of the stomach, flatulent dyspepsia with dilatation of that organ.

CARBONIC ACID DOUCHES AND BATHS

As the Eugénie water flows from the spring to the thermal establishment, there is a certain amount of free Carbonic acid gas which escapes during the transit; this is collected in order to be used in a pure state when required. The amount at our disposal is considerable ($2^{lit},671$ per sec., making $9615^{lit},6$ an hour at a pressure of 38^{mm} of mercury (1/20 atmosphere).

The pure carbonic acid gas is used in the form of baths, douches and vaginal injections for neuralgic complaints; in the case of douches the size of the jet and the pressure varies according to circumstances. We have had good results in cases of ovarian pains, frontal neuralgia, in chronic metritis with or without erosions of the cervix, leucorrhœa (1). The action of the pure gas either on the skin or mucous membrane is at first exciting, producing tingling, redness and a sensation of warmth. (V. César baths p. 16). After a time the gas acts as an anaesthetic, lessening the sensibility of the surface thus removing or diminishing pain.

We have thus in the application of carbonic acid gas a well defined gradation at our disposal.

For patients whom we want merely to put under the influence of warm mineralised baths, we prescribe the Eugénie bath and, instead of having the water constantly renewed during the bath, we allow only a small stream to go on flowing, so as to keep up the temperature of the water. This is necessary in many forms of skin eruptions, where any stimulation by free carbonic acid gas aggravates the symptoms. Mild stimulation of the skin is afforded by the Eugénie bath with the full jet of water coming in at the bottom of the bath and running off at the top, the patient thus gets the benefit of all the carbonic acid given off by the spring water.

A stronger stimulant, aided by its lower temperature, we have in the César bath, which we have already described in detail.

Should we want to produce a greater effect on the peripheral circulation, and not expose the patient to a lower temperature, we have the Eugénie bath which is provided with a finely perforated tube running along the bottom, which tube is connected with the reservoir of carbonic acid, so that besides the gas dissolved in the constantly flowing water, we can subject the

(1) The subject of neuralgia is touched on later on where we speak of the nervous manifestations of gouty origin.

patient to as much carbonic acid as we think necessary, as the gas bubbles up through the water and is prevented from interfering with the patients breathing by a simple device.

This bath presents the essential features for the treatment of certain cardiac cases, which along with regulated exercices has given such good results.

Lastly we will but refer to the applications of pure carbonic acid gas, which we have found most useful in certain cases already specified.

XIII. — THERAPEUTICS

The study of the chemical composition of the four mineral springs at Royat, shows that we have several powerful agents at our command.

We will briefly recapitulate these, and mention the class of cases to which we have found them applicable.

The waters belong to the muriated alkaline variety; the soda, potash and lithia represent the alkaline element, the chloride of sodium, the carbonate of calcium and the iron salts relieve and neutralize the depressing effects of the purely alkaline waters like Vichy and Vals.

The large amount of free carbonic acid gas ensures the easy digestion of the waters, and plays an important part in the action of the baths.

1) A distinguishing feature in these waters is the large amount of lithia which they contain, compared to other mineral springs (v. p. 29).

2) The large amount of free carbonic acid gas over which we have control.

3) The valuable St. Victor Spring containing both bicarbonate of iron (.056 p. mille) and arseniate of sodium (.0045 p. mille).

Besides the bathing and drinking, physical exercise in encouraged in appropriate cases, and where walking or riding is not suitable, we make use of an excellent gymnasium personally superintended by an able master; a regimental fencing-master is in attendance every day for patients who are able to take more severe exercise.

Experienced "masseurs" and "masseuses" are of great use in cases who are temporarily unable to get about.

Clinically we find that two great groups of cases derive benefit at Royat.

The first, and more important one, is that class of patients which exhibit any gouty manifestations.

The second includes general debility, anaemia, chlorosis: patients, in short, for whom iron, arsenic and climatic advantages are indicated, needless to say, many of these are gouty as well.

XIV. — GOUT AND ITS MANIFESTATIONS

A good deal of scepticism used to be prevalent among some members of our profession with regard to the efficacy of mineral waters, on looking over the long list of complaints for which any particular watering place was a panacea.

This might have been true in some instances, when advertisements were addressed to the public, but was hardly legitimate when men practising at various health resorts had been for years giving the result of their clinical experience along with the chemical composition of the waters and their various applications.

Modern medecine has, it seems to us, furnished an explanation of the apparent contradic-

tion; for the tendency now adays is to minimize the number of independant diseases, to classify the existing entities according to their causes, and thus to change the aspect of those clinical observations treated on the same lines, from a mere list of unconnected ailments to a series of expressions or symptoms of the same pathological cause; thus we can reconcile in the light of modern science many apparent discrepancies which seemed due to errors of clinical insight.

With reference to gout, this evolution has been made very apparent during the last few years ever since Bouchard, Burney Yeo and other distinguished clinicians have attributed the cause of the last surviving "diathesis" primarily to an imperfect nutritive metabolism and imperfect nutritive excretion of the results of retrogade metamorphosis, especially albuminous substances, in short referred the primary cause to a disturbed retrograde metamorphosis.

It is also frequently forgotten that other factors, besides the actual chemical analysis of the mineral waters play important parts in the modification of disease. We have heard the argument adduced that such minute and diluted doses of mineral salts can have little or no effect as compared to the large and concentrated doses which we are able to introduce into the organism; but one is apt to lose sight of the fact that the assimilation of the therapeutic agent is the important factor and that this assimilation depends largely on the intimate admixture of the active principles with the vehicle and which we find so perfect in nature.

Further, in considering how we modify the various manifestations of the gouty diathesis we must take into consideration that the surroundings, the air, the climate, the modified diet and the change in the habits and hours of the patient enter for a large part into any modifications of symptoms which we observe.

It would serve little purpose to detail the various morbid conditions dependant on gout, how besides the articular and unmistakable symptoms of both the acute and chronic forms, we so frequently meet with affections of the various systems, which will not yield to any re-

medies until we have traced their origin may be to a hereditary tendency and find until then our treatment had been directed against a mere symptom and not against the disease.

What we wish to make clear by the preceding lines is that when speaking of the action of the Royat treatment on affections of the heart as on those of the respiratory, renal, nervous systems we do not expect the waters to cure or alleviate widely different affections, but that underlying those we presuppose a tendency, hereditary or acquired, to the gouty diathesis of which those affections are the manifestations.

XV. — NERVOUS MANIFESTATIONS OF GOUTY ORIGIN AND THEIR TREATMENT AT ROYAT

Ever since it has been proved that the chemical element plays such an important part in the gouty diathesis, authorities on the subject such the late Sir Russell Reynolds, Bouchard, Charcot, Lancereaux, Sir Dyce Duckworth etc. have brought into prominence the frequent coincidence or alternation of gouty and nervous phenomena in the same patient or in his descendants. Charcot graphically illustrated this near relation by likening the arthritic condition and the allied nervous diseases to two trees, whose branches interlace, and whose roots are certainly very close if not actually connected.

It is very interesting therefore to find in practice that not unfrequently neuralgia, headache, migraine, vertigo, cramps, gastralgia, pseudo angina pectoris etc., are clearly traceable to a purely gouty cause.

Further, amongst gouty patients the character is frequently affected giving rise to irritability or to melancholic tendencies, a constant anxiety about their health and a train of subjective

phenomena which have been grouped, but hardly classified under the comprehensive head of neurasthenia.

The frequent recurrence of such subjects, the alternating character of their complaints led us to examine the urine with a view of comparing that of the purely gouty patient with that of the patient whose nervous system was affected and whose antecedents were arthritic. In both cases we observed marked hyperacidity, diminution of normal constituents and an increase of deficient oxydation — in other words, in both classes of patients assimilation is incomplete, the excretion is insufficient, and there is retention of abnormal products in the system, which keep up the pathological condition.

To combat these we had important factors at our command, fine air and climate, change of scene, food and surroundings, the appropriate treatment of the gouty element by the waters, but in certain neurotic cases some other treatment was required, especially at the beginning of the cure, to soothe the nervous system and strengthen it before the different agents already mentioned had had time to act. We have found that the electrical treatment in one of two forms is most efficient; i. e. the static bath with or without local applications (souffle, sparks, etc.) and secondly the electric water bath with a galvanic current.

It was in view of these considerations and of the treatment carried out by the late Prof. Charcot that we began a few years ago to combine pure hydrotherapeutics with treatment by electricity in suitable cases.

The two forms of electricity employed by us are as we have mentioned galvanoelectric water bath, and the statical bath.

We will first briefly describe the two apparatus and then mention the cases in which they seem most applicable.

In the *galvanic bath* the power is supplied by a battery of fifty elements of the Leclanché

type, modified by Dr Bergonié, professor at the Bordeaux school of medecine. The current is brought to the bath room where the wires communicate with.

1) A graphite rheostat (invented by Dr Bergonié);
2) A milliampèremetre;
3) A voltmetre;
4) Two interruptors.

Thus all danger is eliminated and the wires pass on to the bathelectrodes. If one wants to act on part of the body only (one limb or a joint) we use differently sized vessels and their electrodes and immerse the part to be treated in mineral water to which, if needed, other ingredients may be added.

The *statical* bath consists of an isolated chair on which the patient sits; the chair is connected by a metal rod to a Wimshurst machine. Two of these machines are necesssary, one whose revolvnig plates are of large diameter, another whose plates are more numerous but of smaller diameter. From the first named the quantity of electricity is less and the tension very large, from the second machine the reverse takes place. The therapeutic application of these two forms of electricity have proved to be of great value in the nervous disorders allied to or dependant on a gouty diathesis. In the various symptoms of neurasthenia, of which the most prominent are insomnia, headache, dyspepsia and constipation, we have found that the application of statical electricity along with topical application by brushdischarge, drawing sparks, etc., aid the general dietetic and hydropathic treatment very materially. In the hydro-electrical bath with mineral water containing both chloride of sodium and lithia we have seen gouty joints and limbs recover their free movement in a short time. It would carry us too far to discuss here the various opinions on the introduction of drugs into the tissues by galvanism, it has been asserted and denied by observers since the beginning of the century, but as this particular treatment

was only instituted in the summer of 1896, we have not had time to state positively our opinion on the subject. Great alleviation of symptoms followed in several cases where the bony structures were not involved, but where tophi and cellular induration had rendered a joint or extremity painful and practically useless. We hope in due course to be able to publish our personal clinical experiences of this treatment when a sufficient number of cases warrant the assertion either, that the lithium acts directly on the affected part as we are inclined to think, or that the result is due to the galvanic current alone as in some cases of subacute and chronic rheumatism.

XVI. — TABLES OF ANALYSIS OF THE VARIOUS SPRINGS

TABLE N° I.

ANALYSIS PER MILLE OF THE WATERS BY ED. WILLM

Barometric Height, 728 millimètres.

	Eugénie		Saint-Mart		Saint-Victor		César	
	Cent.	Fahr.	Cent.	Fahr.	Cent.	Fahr.	Cent.	Fahr.
Temperature	35.5	96	30	86	20	68	29	84.2
Free Carbonic Acid	1 grm., 3955		1 grm., 5524		1 grm., 7508		1 grm., 8188	
Silica	0.1026		0.0958		0.1050		0.0815	
Alumina	»		0.0027		»		»	
Carbonate of Lime	0.7706		0.6172		0.7058		0.4540	
— Magnesia	0.3497		0.4359		0.4519		0.2560	
— Iron	0.0518		0.0141		0.0420		0.0340	
Arseniate of Iron	0.0008		0.0010		0.0021		0.0008	
Carbonate of Soda	0.7374		6.6611		0.6777		0.3371	
— Potash	0.1423		0.1560		0.1564		0.0984	
— Lithia	0.0322		0.0229		0.0246		0.0191	
Sulphate of Soda	0.1643		0.1482		0.1612		0.0893	
Chloride of Sodium	1.6728		1.5930		1.6479		0.6528	
TOTAL	4.0297		3.7480		3.9746		2.0249	

In the form of bicarbonate	Eugénie	Saint-Mart	Saint-Victor	César
Bicarbonate of Lime. . . .	1.1183	0.8888	0.9164	0.6538
— Magnesia . .	0.4996	0.6226	0.6456	0.3657
— Iron	0.0740	0.0194	1.0580	0.0462
— Sodium . .	1.1687	0.0478	1.0732	0.5343
— Potassium .	0.2070	0.2260	0.2269	0.1484
— Lithium . .	0.0592	0.0421	0.0453	0.0351

School of Mines Essaying Department.

TABLE N° II.

Research for Arsenic in the Mineral Waters of Royat

	Saint-Victor	César	Saint-Mart
Arsenic.	0.0011 p. m.	0.0002 p. m.	0.0004 p. m.
or			
Arsenious Acid	0.0017	0.0003	0.0006
or			
Arseniate of Soda	0.00457	0.00083	0.00166

The Director of the Essaying Department,

A. Carnot.

XVII. — COMPARATIVE TABLE OF THE AMOUNT OF LITHIUM IN VARIOUS SPRINGS

		Chloride of Lithium per Litre.	
Chateldon			Traces
Chaudes Aigues			—
Mont Dore		8	milligrammes.
Vic sur Cère		8	—
Royat (Source César)		9	—
Clermont	Source des Salins	14	—
	Source de Jande	15	—
	Puits Loiselot	18	—
	Puits Arlésien Boyer	20	—
La Bourboule		18	—
Saint-Nectaire		22	—
Chatel Guyon		28	—
Medague (Eau de l'Ours)		30	—
Sainte-Alyre		31	—
Les Roches		33	—
Chateauneuf		35	—
Royat (St. Mart)		35	—
Royat (Grande Source)		35	—

Comparing the quantity of Lithia contained in the Auvergne springs and that of other regions in France and Germany, we find that those of Royat stand at the head of the list.

Eaux de Vals	Source St. Jean	15	milligrammes.
	Pauline	15	—
	Des Convalescents	18	—
	Juliette	20	—
Eaux de Vichy	Source St. Marie	18	—
	Hopital	18	—
	Grande Grille	20	—
	Hautrive	20	—
	Lardy	22	—
	Des Célestins	22	—
Ems	Augustaquelle	1/2	—
	Victoriaquelle	1 1/2	—
Carlsbad		1 1/2	—
Baden Murquelle		29	—

XVIII. — CLINICAL CASES

I

Eczema of Arthritic Nature.

Miss S—, English, of a gouty family, suffered for three years, from severe eczema on both feet, affecting chiefly the toes; was under treatment during the whole of the time for skin

disease, took arsenic, iron, iodide of potassium, cod liver oil, etc. without any permanent result. The last physician she consulted suspected gout might be at the bottom of the ailment, and sent her to Royat; she entered my room, supported by her father and sister, and was suffering from great soreness and pain; on the 10th day after treatment, the skin was all but healed; itchiness soreness, and pain had disappeared, and she walked from the base, almost to the top of the Puy-de-Dome; on the 21st day of treatment she went to a ball, and was able to dance until 2 o'clock in the morning. This improvement lasted until the month of May in the following year, when a small spot appeared on one toe, she returned to Royat and went through another cure, and has been since perfectly well.

II

Acnea Rosacea with obstruction of nasal passages and granulated Pharynx. — Gouty origin.

Mr. M—, aged 36, of spare and temperate habits, had been under various treatments for disease supposed to be of specific character; in spite of a mercurial and non-mercurial treatment, his symptoms persisted, and at last he came to Royat, simply to see Auvergne, and breathe pure mountain air; it was with some difficulty that I could persuade him to undergo a small cure, his unbelief in anything that could be done for him, was almost invincible, having lost all faith in everyone, and everything; he, however, at last consented, on condition, that if he were not better in a week, he would leave the place; by the use of the waters taken internally, and in baths, and with the daily use of the spray in the shape of nasal and pharyngeal douches, improvement began on the third day and continued steadily until he left, having only submitted to

fifteen days treatment. On leaving he could breathe freely through his nose, his throat was smooth and healthy looking, and his nose was, as he said, quite handsome again.

III

Psoriasis palmaris of gouty origin.

Mrs. M—, English, of a gouty family, lives in the country and has been suffering from psoriasis of the hands for the last five years; divers treatments had been used without any success; latterly she has been using an ointment containing chrysophanic acid (a drachm to the ounce of vaseline). She complained of her underlinen and even the lining of her boots being destroyed; in spite of this severe treatment, the disease was still present and according to the patient, if anything slightly aggravated. After three weeks treatment at Royat, the skin became clear, the dark appareance of the nails still persisting to a small extent; all pains and soreness had gone. The palms of the hands were somewhat shrivelled, but no sores or scales were visible.

IV

Chronic Bronchial Catarrh.

Mrs. L—, English, proceeds from a gouty family, and has had for the last two years bronchial catarrh accompanied by distressing dyspnœa. Went to Madeira for one winter, where she improved slightly; came afterwards to Royat and underwent a complete cure of thirty days.

The treatment consisted chiefly in the use of the flowing bath, and aspirations of mineralized steam, at the same time drinking the mineral water at the spring; after a few days' treatment the quantity of uric acid expelled was very great. Cough, expectoration and dyspnœa, almost entirely disappeared on the twentieth day, by the end of the cure, dyspnœa had entirely left her, and the only symptoms which existed were slight morning cough, with frothy expectoration.

V

Bronchial Asthma.

Mr. D—, a Frenchman, aged 49, has lived in Havana for many years, suffered from bronchitic asthma and anæmia.

Arrived at Royat on his way from Mont-Dore, where he underwent a cure of twenty-five days; no result as regards his bronchitis and asthma; anæmia more pronounced, and feels much prostrated; came with the intention of only drinking the waters to combat his anæmic condition, and get up his strength; was persuaded to undergo a short cure by aspirations; at the end of ten days, chest symptoms had almost entirely disappeared, better colour, feels stronger. Went out on a cold wet night, and had a slight relapse, continued aspirations for another ten days, feels quite well, no rales in chest, breathes freely, appetite excellent, can take exercise without tiring. This case illustrates the advantage of undergoing a treatment of hot baths and aspirations at Royat, where the climate is much milder than at Mont-Dore; patients are not so liable to take cold besides which the tonifying effects of the ferro-arsenical spring greatly assist the internal treatment, where anæmia and general debility are concomittant symptoms. Met this patient at Cannes two years after, and found him quite well.

VI

1880. — *Gout and Diabetes Mellitus* (1).

Mr. W—, aged 64, large build, unhealthy and bloated appearance, pulse weak, superficial circulation stagnant, laboured breathing on taking exercise. Urine contains 87 grammes of sugar per 1.000 grammes, three weeks treatment; after which 1.000 grammes of urine gave 47 grammes of sugar. Four months after, the patient writes, — " Royat, great success, feel better than I have done for the last twenty years. Hunt as I did when a youth, shall return next summer. " 1881. Returned in much better condition than last year, though urine still contained 64 grammes of sugar per 1.000, three weeks' treatment, sugar descended to 35 grammes; patient indulges too much in forbidden food, and therefore has not derived all the benefit he ought to have done; feels well, can take exercise without fatigue, breathes freely, flesh harder. 1882. Returned to Royat, general health better than last year. Sugar in urine 54 grammes, ten days after treatment sugar descended to 10 grammes per litre; on the twenty first day 12 grammes. Graduated gymnastic exercises did much good in this case by improving the general tone of the body.

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(1) The relation of gout and diabetes is uncontestible, the alternate appearance of the symptoms both in the same individual as in members of the same family were noted by Bence Jones, Garrod, Rayer, Charcot, Claude Bernard and others.

VII

Diabetes mellitus, profound Anæmia, extreme Debility, Dyspepsia, Albuminuria.

Mrs. L—, aged 58, arrived at Royat in a semi-collapsed state; the people at the hotel were afraid of admitting her, thinking she might die during the night. After forty-eight hours repose, she revived, urine contained 54 grammes of sugar, began treatment; at the end of ten days the quantity of sugar went down to 10 grammes 1/2 per 1.000. General health much improved, could walk short distances without fatigue, colour appearing on skin, appetite good.

Twenty-first days of treatment, sugar disappeared altogether, albumen only traces, stomach digests well, feels much stronger, colour much improved; this lady went by the name of " *La Ressuscitée.* "

VIII

Arthritic Eczema of Legs, Arms and Feet.

Mr. S—, English, of gouty parents, has suffered from eczema for the last two years, occasionally getting better, but no lasting improvement. Soreness of feet prevented his taking exercise, began mending after the seventh bath and water drinking, could already walk two miles without feeling his feet, voided large quantities of uric acid for about a fortnight, after which it began to diminish. All patches disappeared with the exception of one on the calf of

left leg. Sent him for an after cure to La Bourboule, where he made a short cure of ten days; on his return the patch had entirely disappeared.

IX

Severe Eczema of entire Hands, Fore-arms, and Legs—Of decided gouty origin.

Sir W. D—, has been suffering for several years from this disease, has tried internal and external treatment at home, and has been to many watering places abroad; latterly at Gastein which aggravated the disease to a considerable degree; despairing of being able to find relief by mineral waters, was at last with great reluctance induced to try Royat. At first this case resisted most tenaciously, but improvement showed itself slowly and at the end of three weeks a decided change for the better took place; all sores healed up, the red and angry appearance of the skin disappeared, the agonising burning and itchiness ceased, and new tissue began to form; an after cure of a fortnight at la Bourboule seemed to have consolidated this improvement. I have no doubt that a regular regime this winter at home, and a renewal of the treatment next year will complete the cure.

I might add numerous other cases of the same description, amongst others two cases of very tenacious pruritus *vulvæ et ani*, which had baffled all treatment at home, and which entirely disappeared at Royat; they were evidently of gouty origin. I think however that these observations are sufficient proofs of the efficacy of these waters, in a variety of chronic cases, where a gouty diathesis is present, though at times it is not manifested in any other way, and is therefore most difficult to diagnose.

X

Neurasthenia with gouty antecedents.

Mr. G. R—,English, arrived at Royat having suffered from severe nervous depression for some months, he showed several of the cardinal symptoms of neurasthenia, as it is generally termed. General depression, utter want of self confidence, impossibility of sustaining a train of thought, sleeplessness, muscular fatigue after very exertion. The patient's family history was distinctly gouty.

The treatment consisted in drinking Saint-Mart water with César baths and daily application of statical electricity, the duration of which was increased gradually to half an hour. Insomnia was the first symptom to disappear and with it the exhausted condition principally complained of in the morning even after a fair night.

By the end of a month's steady treatment, the patient was bright, conversed with ease, could take long walks, and went back to resume his work, without a relapse all winter. The next summer, though feeling in want of a holiday, he was not in the wretched condition of the year before; he underwent however a second course of treatment and has, since then, been able to resume his ordinary way of living without difficulty.

PARIS-LYONS AND MEDITERRANEAN RAILWAY COMPANY

TERMINUS AND OFFICES — 20, BOULEVARD DIDEROT, 20 — PARIS

The shortest and quickest route from Paris to Royat via Nevers and Clermont-Ferrand : from this last station visitors can reach Royat sither by Electric Tram or by the Royat Hotel omnibuses.

LONDON TO ROYAT *viâ* PARIS

Single Tickets

Viâ **CALAIS** *viâ* **BOULOGNE**

1st 123frs — 2nd 86.55 | 1st 116.90 — 2nd 82.05

These prices include Port dues

RETURN TICKETS

Viâ **DIEPPE**

1st class : **143.30** — 2nd class : **103.55**

Supplement for prolonged time.

1st class : **37.30** — 2nd class : **23.95**

These fares include Port dues

ROYAT AND CLERMONT-FERRAND TO LYONS AND TO GENEVA

By Roanne-Tarare — By Roanne-Saint-Étienne
By Thiers

		1st class	2nd class
Clermont-Ferrand (Royat)	Lyons to Geneva	21.85	14.75
		40.65	27.45

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FROM LONDON TO CLERMONT-FERRAND

Viâ **Calais or Boulogne Paris and Nevers**

1st Class : **182.35**cent | 2nd Class : **136.05**cent

These fares include the Port dues

These tickets give the right of stoppage at all the stations on the P.-L.-M. line, and are valid for 45 days. This period however may be prolonged for another period of 45 days by an extra payment of 57frs 50cent 1st class and 32.90cent 2nd class.

The prices of single tickets 1st class include the journey from one station to another by the Girdle line.

The use of these tickets is recommended to travellers who wish to go from London to Royat, returning by the same line.

USEFUL INFORMATION

I. — *Registration of Luggage.* Passengers wishing to go from London, or from Paris to Royat can register their luggage direct for that place.

II. — *Breakfast at Montargis* (Buffet). Passengers leaving Paris by the 9h 10m a. m. Express, have a stoppage of 25 minutes for breakfast at Montargis, arriving at 11h 19m and leaving at 11h 44m a. m.

III. — *Special carriages* (Voitures de luxe). The trains leaving Paris at 9h 10m a. m. and 8h 05m p. m. will, during the summer season be provided with fauteuils-lits between Paris and Clermont-Ferrand.

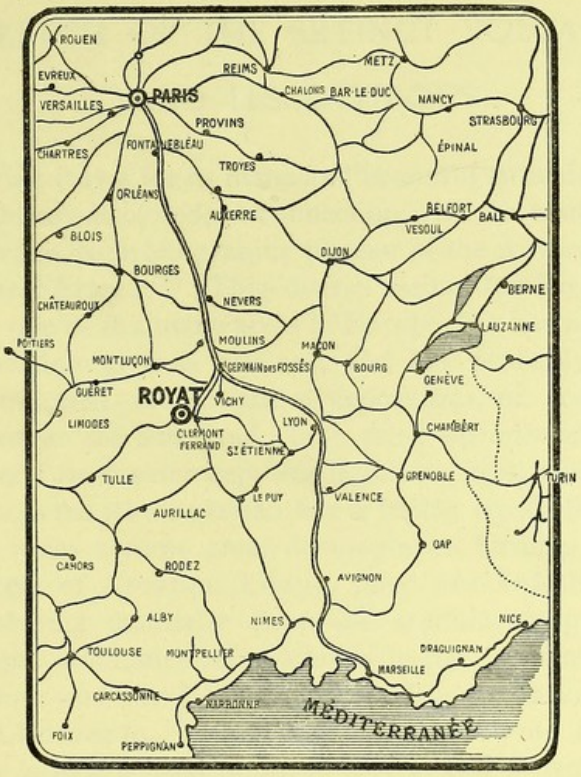
The trains leaving Clermont-Ferrand for Paris at 9h 10m a. m. and 9h 05m p. m. are provided with carriages of same description.

The supplementary charge made for occupying such carriages in the above trains, between Paris and Clermont-Ferrand, is 12 frs. in addition to the ordinary 1st class fare.

IV. — *Change trains at Clermont-Ferrand* or *take omnibus to Royat.* Passengers booking for Royat have to change trains at Clermont-Ferrand, which entails a delay of from 15 to 20 minutes, it is preferable to book for Clermont-Ferrand; where the Royat Hotel Omnibuses meet every train, and convey passengers and their luggage to Royat.

V. — *Information office at Royat.* The P.-L.-M. railway Company have established an office in the Royat Park, where every information will be supplied to travellers free of any charge, single and return tickets can be obtained, also circular tickets, luggage can be registered, and special carriages can be ordered, this office also issues tickets from Clermont-Ferrand to London-Paris-Vichy-Lyons and Geneva.

VI. — *Excursions to Switzerland.* Invalids who have finished their cure at Royat, and are recommended an air cure in Switzerland will find trains from Clermont-Ferrand to Geneva, and from Pontarlier to Paris and London, this being the most convenient and quickest route to Paris and London.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FONTAINEBLEAU
TROYES
ORLÉANS
AUXERRE
BELFORT
BALE
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BLOIS
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BOURGES
BERNE
NEVERS
CHÂTEAUROUX
LAUZANNE
POITIERS
MOULINS
MACON
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ST GERMAIN des FOSSÉS
BOURG
GENÈVE
GUÉRET
ROYAT
VICHY
LIMOGES
LYON
CHAMBÉRY
CLERMONT FERRAND
ST ÉTIENNE
TULLE
GRENOBLE
TURIN
LE PUY
VALENCE
AURILLAC
GAP
CAHORS
RODEZ
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NIMES
NICE
DRAGUIGNAN
TOULOUSE
MONTPELLIER
MARSEILLE
CARCASSONNE
NARBONNE
MÉDITERRANÉE
FOIX
PERPIGNAN

GEOLOGICAL SKETCH OF THE EXTINCT VOLCANOES OF ROYAT AND ITS ENVIRONS

Probably few who visit Royat for its many and beautiful attractions have any conception of the many interesting problems disclosed, in connection with the history and study of the extinct volcanoes, that rise upon the extended granitic plateau of the Auvergne in the " department of the Puy-de-Dôme in central France. " This district claims for itself, a region of the highest geological interest, being one of the many areas in Europe that has witnessed fewer geographical changes of level with relation to land and sea; and has probably never undergone marine submergence. The complicated stratigraphical depositions, or accumulations due to alternate changes of level between sea and land, have piled up *around or outside* this island like granitic plateau, marine and freshwater deposits of various ages. The marine strata belonging to the jurassic group, embraces the whole plateau like a frame, especially on its southern border, where these calcareous rocks assume great development, forming a large proportion of the surface of the departments of Aveyron, Lozère, Gard and Ardèche, which constitute a vast and elevated platform sloping gradually from the granitic or primary range towards the Southwest. The Auvergne mountains occur chiefly in the departments of the Puy-de-Dôme, the Cantal, the Mont Dore and the Le Puy, separating the basins of the Allier, Cher and Creuse from the Lot and Dordogne. These mountains occupy an area of about 1.000 square miles, or nearly 70 miles in length from South to North, and 15 from East to West, and more or less consist of extinct volcanic remains composed chiefly of basalts, trachytes and scoriæ poured over a more or less irregular granitic floor; so there appears to be three great volcanic centres.

That to the North comprises the Puy de Dôme, the granitic plateaux being about 1.600 feet above the sea, the Mont Dore district embracing the pic de Sancy, the summit being 6.185 feet above the sea, and still more southerly, the Cantal, or group of rocks containing the basaltic Plomb de Cantal which reaches the elevation of 6.258 feet, these three districts constitute the extinct volcanic region of the Auvergne.

EXTINCT VOLCANIC PHENOMENA IN THE VICINITY OF ROYAT

From the ancient granitic plateau of the Auvergne, and at an elevation of about 1.600 feet above the sea, rises a group of volcanic mountains, surpassing in variety of form, and structure, any similar group in Europe, and which commenced their geological history, from the miocene or middle tertiary age, and were active nearly down to the present day; a similar but no less wonderful series of extinct volcanoes, occur in the Velay and Vivarais between the sources of the Loire and Allier. But of these, although most intimately connected, and associated, it is not our purpose, to do more than name or refer to. The extinct volcanic phenomena in the vicinity of Royat is in itself so extensive and complete that it would be almost impossible to investigate the physical history of the northern area of the Auvergne plateau without much detailed research; doubtless the great southern extinct volcanic district of Mont Dore, or the Cantal, will be especialy examined when, or after the area of Royat has been investigated. We are presented in the Auvergne district with complete evidence of a series of events, of astonishing magnitude and grandeur, by which the original form and features of the country have been greatly modified, and changed, yet never so far obliterated, but they may still in part be recognised; and more than one long period in Tertiary times have followed each other in succession, yet this region

of central France has from first to last, preserved its geographical identity. There was a period when the spacious lakes of the Limagne, whose ancient boundaries may still be traced North, South, and East of Royat, Clermont-Ferrand, and Riom, across to the western edge of the Forez, and the course of the Loire. This remarkable area exhibits no signs of the sea ever having intervened, nor of any denudation which *may not have* been accomplished by atmospheric agencies, or by rivers and floods accompained by subterranean and other movements, during which the levels of the Auvergne have been in some places modified, and the whole granitic area upraised relatively to the surrounding part of France. In regions where eruptions of volcanic matter have taken place in the open air, and where the surface has *never been subject to marine* denudation, as in the case of the Auvergne area — cones and craters constitute the most striking peculiarities of this class of phenomena, and many hundreds of these cones are to be seen in this ancient province, as well as in the Velay, and Vivarais, where they mostly occur as linear chains of hills, strikingly exemplified by the line of puys, with their extinct craters ranging from South to North, or from Mont Dore, to the Monts Dôme, with *Royat as the central station,* from *whence all the volcanic phenomena* of the district may be realized and studied, and probably no other region, or district in Europe of equal dimensions exhibits so great and varied a series of extinct volcanic phenomena, as the region we have the privilege to examine. The entire series presents a marvellous succession of varied eruptions within a limited region, and during what was probably a single volcanic period. The *first eruptions* appear to have been basalts, and rocks of similar character which appeared again and again, in later stages of their history, the intervening eruptions in places consisting of phonolites, clinkstones, nepheline trachytes or andesites. The latest lavas would appear to have been scoriaceous basalts.

We are naturally led from the consideration of the active volcanoes of Europe generally, to those which are either dormant, or extinct in the same or adjacent regions, and such among

many others, are those of central France and the Eifel district of the Moselle and Rhenish provinces, where the volcanic phenomena and features like those of the Auvergne, are as recent or modern, as to have preserved their present external characters or outward form and structure, almost intact. We can scarcely however expect to find cones of very great antiquity often preserved, for even modern volcanic mountains become reduced and wasted away by subaerial denudation, and this action long continued, wears down and away, those loose materials, of which the greater part of volcanoes, both ancient and modern consist, but which if submerged below the sea, would sweep away all evidence of their past existence and history. In the Eifel and Rhine districts not only are these great sheets of solid lava, and enormous beds of fragmental ejections, still extant, but almost innumerable cones with extinct craters, some quite perfect, are still standing with flows of lava, scoriæ, and ashes piled up around their once active vents. The whole of these especially in the Auvergne area, still retain enough of their original and characteristic structure to convince the most casual observer that they owe their origin to the same igneous phenomena, or processes which are now piling up their ejected matter from modern, or active volcanoes, in every quarter of the globe. The extinct volcanoes of Auvergne seem *never* to have undergone this marine denudation, indeed all evidence tends to confirm the fact, that this portion of central France has remained for ages an elevated plateau, largely composed of granitoid, and gneissose rocks, on which now stand the remains of these once active volcanoes of central France. The Velay and Vivarais illustrated by the three great mountain masses of the Mont Dore, the Cantal and the Mezen, all rise or have their colossal masses placed upon the far extended South, and North granitic floor, some attaining to an elevation over 6.000 feet above the sea. The fundamental rocks of the Auvergne consist of granite and gneiss of great antiquity, constituting an extended plateau rising from the South, or source of the Loire and the Allier, in the departments of the Haute-Loire, Lozère and Ardèche — and on

this extended granitic plain or floor, rises the whole of the once active volcanic mountains, so finely seen in the extended chain of puys ranging from Mont Dore, on the South to the Puy de Dôme, and its attendant and once active neighbouring puys to the North, Royat being near the centre of these now extinct forces.

The question of the successive stages of volcanic action, and intensity, is of extreme interest to those physical and dynamical geologists and others, who may visit Royat. It is questionable whether the area extending over nearly 100 square miles, ranging, from Mont Dore or from South to North, was *at one, and* the same period of time the theatre of volcanic action, all research seems to show or tend to the belief, that it commenced at the elevated southern end or region of the Cantal, and Mont Dore, thence extending northwards, manifesting itself among the domes, puys, and craters of the " Mont Dôme " region which chiefly lie to the West of Royat — but from the extinct craters of the Auvergne mountains and those of the Vivarais no eruption has been known to have occurred " during the times of human history and tradition ".

Mr. Poulett scrope considered that the crater cones of the Haute-Loire gave evidence of an earlier epoch of activity, than those of the Puy de Dôme, from having undergone a greater amount of denudation or reduction in size, by long continued subaerial erosion; beyond this, we have no historical record of the period of active volcanic action, amongst the Monts Dôme group, but no one who has examined them can doubt, that these weird and dead volcanoes are comparatively extremely recent, based upon the well preserved forms of their original craters, generally composed of loose materials, such as ashes, slag, or scoriæ and lapilli; and also by reason of the freshness of their lava streams — which have invaded in many place channels previously occupied by earlier flows, or those which had been eroded since the northern extension of the great basaltic sheets from Mont Dore; and of the lava currents from the prolific puys of Lassolas, la Vache, Vichatel, de la Rodde and de Montenard (the most southerly of the Mont

Dôme range) have coalesced with those streams from Mont Dore, to about the latitude of Montenard and Saudoux 10 miles south of Royat.

The volcanic eruptions of the Auvergne and the Cantal appear to have commenced in the oligocene period, but to have been most active during the miocene, or middle tertiary period, continuing without interruption through pliocene and pleistocene or even prehistoric times; and *many* of the *cones* or puys of the later date (of which there are nearly 300) still look as fresh and perfect as though they had been in eruption during the present century — many of the craters are still entire, except here and there where breached at their sides, from whence extensive lava streams have issued, many of which may be traced from 1 to 10 miles, and are as bare, rugged and barren, as those of Etna and Vesuvius. The comparatively recent age of some of these streams is however indicated by the fact, that where they have found their way to the lower levels on the West, or East sides of the granitic plateau; they cover up valley gravels and alcustrine beds continuing extinct pleistocene mammalia and other vertebrata, and mollusca, the latter consisting chiefly, if not entirely, of land and fresh water forms.

Two classes of structural volcanic eminencies occur in the chain of Puys, one indicated by the name itself, from being entirely composed of the trachytic lava termed *Domite*. To *this class* belong *five* Puys viz the *Puy de Dôme*, the *Petit-Souchet Cherson*, the *Grand-Sarcouï* and *Puy de Chopine;* the Puys de Dôme, Sarcouï and Chopine are the most striking examples of the five *Domite masses*, while no less than 60 belong to the class of "crater or scoriæ cones"; and all are volcanic *cones* and craters of eruption; or from which the scoriæ and other fragmentary matters have been projected into the air, by explosive discharges, etc. The height of these cones varies from 500 to 1.000 feet above *their bases*, or about 1.700 feet above the granitic table land. The five named Puys therefore come under the class of *Domite*, or *Domitic cones*, which consist almost entirely of that variety of *earthy trachyte* termed *Domite*.

In the middle of the line of Puys rises the famous Mont Dôme *the giant of the chain*, being far superior both in bulk and elevation, to the numerous cones, which range upon the granitic plateau. The four puys above named, although much less in size than the Puy de Dôme, are nevertheless so closely connected in structure with some of the eruptive cones " notwithstanding their totally distinct composition ", left no doubt on the mind of Mr. Poulett Scrope of their " being likewise connected in origin with them ", having in short " been produced at the same time, and by a modification of the same volcanic agency and condition ".

With the exception of the remarkable Puy de Chopine, the remaining four consist entirely of this highly porous *Felspathic Domite*, each being literally one enormous mass of this mineral. The Puy de Dôme occupies nearly the centre of the extinct line, or chain of Puys and is conspicuously higher than the rest rising 4.844 feet above the sea, and about 1.700 feet above the granitic floor or the average level of the surrounding plateau; its base is surrounded by, and burried on all sides in the scoriæ, puzzolana, sandy and ashey debris, ejecta or *waste, from the adjoining* and surrounding craters and cones of other puys. The central position and magnitude of the « Dome *affordsa clue* to the position of many far more structurally, géolocally interesting puys, and it must be remembered that about 60 occupy the plateau, and may readily be examined.

The summit of Mont Dôme commands an horizon ranging to the Puys de Beauny, Thiolet and la Bannière, and the high granitic land to the North. To the South, the distant rugged summits of Mont Dore, with the intervening puys of de Montchie, de Barme, Laschamp, de Lassolas, de la Vache and Montenard, are all of extreme structural interest, thence across the great plain of the Limagne on the East, to the distant mountains of the Forez, with Clermont-Ferrand, Royat, Gravenoire and the far famed Gergovia at its south eastern foot. In close proximity to and on the immediate N. of the Dôme, rises le Grand-Souchet, and the Puy de Pariou,

sought out by all for its wonderful *crater* and the Puy de *Come with two*; la Goutte, the puys de Coquille, the mysterious Chopine, Louchardière and the dark Nugère, to the N. East. All these cones, and others to the East stand upon the central line of the plateau, or near the meridian of the Puy de Dôme commanding a scene, scarcely surpassed either by association, interest, or wonder. Again to the East and close to the foot of *the Dôme*, rises the puy de Colière, *which with* Gravenoire a little to the S. E.; completely burried the area upon which Royat now stands with their united lava streams scoriæ and Puzzolana. That of Colière threaded and filled the narrow and deep valley of Enval and Fontanas, accompanying the then existing rivulet of the Tiretaine to the western side of Royat, there meeting with the greater and overwhelming lava current from the puys of Charade and Gravenoire, whose united streams of lava, poured their contents over and upon the slopes of Royat and on and into the freshwater or lacustrine valley of the Limagne, six miles from their craters, ejecting enough lava and ashes to occupy an area of 10 square miles, and 4, from the eastern edge of the well-defined North and South line of the granitic escarpment, into and over the lacustrine marls of the Limagne. Associated with its more robust and immediate neighbour, the petit Puy de Dôme must here be noticed, although almost a part of the great Domite Puy, is invertheless a true *volcanic "scoriæ cone"*, resting against the northern Flank of the greater "Domite" puy, its mineral constituent consisting of basalt scoriæ, sand and ashes; although termed the "Petit", the cone reaches to the height of 4.186 feet, being only 656 lower than its colossal neighbour; the bowl shaped crater both in *diameter* and *depth* are nearly equal, being 300 feet at its northern edge. — The deep cuplike form of the crater, has given rise to the name " le Nid de la Poule " or " Hens Nest ".

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(1) Royat and its district with the puys in the immediate neighbourhood will be noticed later on...

West of the meridian of the Puy de Dôme rises the regularly formed conical and double *cratered puy* de Côme rising 900 feet from the surrounding plain; this puy should be noticed as being famous for the dimensions of its great lava current which cannot be much less than 10 square miles, the length of the current from the crater to the river Sioule, and Pontgibaud, exceeds 5 miles, and that of Louchardière at its junction with the De Côme, at Pontgibaud the same, and where the average united thickness of the lava is about 30 feet, and also as being closely associated with the equally prolific flow from the Puy de Louchardière, which renders them probably the most interesting of the whole chain. The large scoria cone of Louchardière, the summit of which reaches 3.956 feet, and 1.300 feet above the level of the plateau is breached on the west side by a flow of basalt, but an older and earlier flow of andesite lava may be traced away due West to Pontgibaud, and the Sioule, being probably a portion of the same ancient current which occurs at Tournebise South of Pontgibaud; again the rugged slopes of the great flow which descends from the cone of the puy de Côme (four miles South of Louchardière) meets and unites with the tongue shaped Louchardière lava at Pontgibaud where the Sioule subsequently cut its way through the united flow thus revealing the columnar structure of its basal or lower layers; indeed the craters of de Louchardière, de Côme, le Grand Souchet, de Basace, de Barme, and others along the Sioule or western side of the plateau have poured over the granitic floor nearly twice the amount of lava and scoriæ that would appear to have occurred on the Limagne or eastern side, or from the region of Nugère and Volvic, to Clermont-Ferrand, Gravenoire, and Royat, probably this *western accumulation* is due to the more regular and gentler slope or inclination of the granitic floor, which has allowed the numerous and *extensive* flows from the western puys to spread more equally and widely over the inclined plane; indeed much of the basalt, on the more precipitous and irregular slope of the *eastern escarpment* fills many of the deep valleys and water courses, thus apparently

producing deeper and thicker beds of lava, and more extensive tongue-like flows to the East, many extending from five to eight miles into, and over the Limagne plain; notably those of Nugère and Volvic, Châteaugay, derived from the puys de Raviole and de Jume, the Plateau of Pradelle, and the Royat fan-shaped flow from Gravenoire occupying an area of 10 square miles. Thence continued South to Lassolas, and de la Vache with their six miles flow, and to Vichatel, with part of the la Vache, eight miles. These extensive lava currents, are manifest to all who would follow and examine the fine exposures of granite, gneiss, and lava streams along the eastern slopes, and steeper escarpments overlooking the great lacustrine eastern plain. It is important to name, if not trace, this extended eastern edge and outcrop of the granite and its accompanying volcanic rocks, so accessible by rail or road from Royat to Volvic and Tournoel; and then southwards, from Royat across the *three*, East and West invasions, or rugged flows extending many miles into and over the lacustrine marls to the West of the Allier, terminating with the Puy de Saudoux the most southerly of the eastern puys from Royat.

The steep and winding road, and railway from Royat to Volvic or Riom follows this north-eastern escarpment, passing the plateau of Pradelle, thence by Étang, Sayat, Argnat, to the great basaltic quarries of Nugère and Volvic, situated on the elevated Northern granitic plateau. The return to Royat should be by the finely engineered road, which skirts the precipitous face of the escarpment from Volvic, descending near Nohanent, and Durtol, near the plateau de Pradelle to Clermont or Royat. The physical conditions of the two sides of the central plateau thus clearly enables us to realize how great is the difference of level between the expanded lava flows, over the western or Sioule side, and those on the eastern and steeper slopes, overlooking the plain of the Limagne.

We cannot pass over one of the most mysterious volcanic productions in the entire range of puys refer to the *puy Chopine*, the most northerly of the 5 *Domite* puys, situated 5 miles due

north of, and on the meridian of the Puy de Dôme, indeed from some unknown, or unexplained cause, *three of the five* " Domitic " puys lie *immediately* upon this line, viz. the Mont Dôme, le Petit-Souchet, and Clerson; the fourth or le Grand-Sarcouï lies half a mile to the east of this line, and the fifth or mysterious Chopine which *has been, still is, and will long remain*, a perplexing study to every geologist, and vulcanologist, who may visit Royat, or this part of the Auvergne. " D'Aubrisson declared to Mr. Poulett Scrope that after three visits to puy Chopine he had not acquired any insight whatever into its probable mode of formation, nor any positive idea of its structure and composition ", the puy *Chopine* is evidently a confused medley or mass of heterogenous substances, Massive and vertical beds of Domite occur on the North side, the basalt is dull in colour, cellular in structure, highly scoriaceous, containing much augite and olivine. The irregularly conical and steep sides of the cone, are covered with débris or fragments of various rocks, " two wide east and west fissures, or vents lay bare its upper half, which is a mixed assemblage of *various crystalline and volcanic* rocks, in different stages of alternation, due to or from volcanic heat, acid vapours, and atmospheric injury " clearly showing that the whole has been traversed and affected by *volcanic exhalations;* and as stated by Mr. Scrope, le puy Chopine consists of various primary, or granitoidal rocks showing signs of great disturbance. The whole mountain rises out of the semi-crater of the puy de la Goutte, which *closely embraces* two thirds of the southern half, or from the N. W. round to the East. Each rent above the talus, *which* conceals the base of the puy Chopine is a conglomerate of scoriæ, ashes, and massive blocks of olivine and augitic basalt. The general features are unparalleled in the Auvergne, and leave little doubt that the whole mass was raised to its present position, by the eruptions which threw up the scoriæ, that built up the puy de la Goutte, which immediately surrounds the southernside of Chopine. " The basalt which underlies the primary crystalline rocks (granite and gneiss) dates from this eruption, and is

the outcropping or outpouring of this subterranean lava, whence the aeriform explosions proceeded ". The *scene* from the summit of the double crater of the Puy de Côme, two miles south of Chopine with its huge western lava current, and also from the summit of the centrally situated Puy de Pariou, looking north, is indeed wonderful and never to be forgotten. The masses of Chopine, Louchardière, de Côme, with the *numerous puys*, closely surrounding la Coquille and de Jume, north of Chopine, creates with the prolific puy de Nugère, to the East an ardent desire to examine each individual cone — well indeed may it be said that of all the departments of France, the Auvergne is the richest in volcanic remains — and most easily examined from Royat, being situated midway, and amidst all the eastern puys and their expanded lava flows, both upon the eastern edge of the granitic floor, and embracing even the more mysterious past history of the Limagne plain — with its *once gigantic vertebrate fauna.*

The great volcanic cone of the northern and eastern puy de la Nugère exhibits traces of several craters, being situated nearly 3 miles West of Volvic, and the most *easterly* puy de la Bonnière; the principal or southern crater of Nugère originally consisted of a large, deep and oblong basin, which poured forth an immense volume of lava towards the east, having flowed far beyond the escarpment, on the edge of the granitic plateau, into the lacustrine plain of the Allier reaching fully 3 miles to Saint-Genest, and within a short distance of the plateau of Châteaugay but this extensive flow was also probably aided by the lava of la Bannière, which is immediately north of, and overlies Volvic — the old town of Volvic is built upon the augitic basaltic lava flow of la Bannière. — Indeed the craters of Nugère and Bannière and those of Raviole and la Jume, deluged the plain of the Allier with a vast current of lava 10 miles square, extending from Argnat-Féligonde, Sayat and Saint-Vincent, to Blanzat and *Châteaugay*, there forming an extensive, and expanded fan shaped lava flow. The lava of Nugère contains a large proportion of highly trachytic feldspar, scarcely distinguishable from some of the trachytes of the Mont

Dore, being indeed almost identical. The Volvic lava also bears considerable resemblance to the " *Neidermendig* mill-stone lava " near the " Laacher see " in the northern Eifel, and the Nugère and la Bannière lavas, are both rich in hornblende, granular augite and plagioclase feldspars; apart from the great interest attached to the geology and mineralogy of Nugère, Bannière and Volvic, all lovers of fine scenery will be amply repaid by the contemplation of the vast expanse of country overlooked from the escarpment of the granitic table land, on which, for four centuries, the grey basaltic lava of the great Nugère or Volvic quarries have been excavated, the enormous blocks, occasionally 20 feet long are sent down by tram road to the extensive works at Volvic, for manipulation into works of art, etc. The scene from the tortuous or winding carriage road descending from the high granitic plateau, and escarpment from Volvic, by Argnat, Féligonde, Sayat, Nohanent and Chamalière to Royat, will never be effaced from memory, either for its physical or geological aspects, or the varying local, as well as distant scenes across the vast plain of the Limagne, to the eastern mountains of the Forez.

Probably, the most remarkable of the breached or scoriæ cones are the Puys de Lassolas, or de Gravouse, and de la Vache, which lie near the hamlet of Nébouzat, and Fontfreide; five miles South of Royat; these are two bare, red scoriæ cones, completely broken down or breached on the South side, having sent forth a vast torrent of lava, and black and crumbling scoriæ. The united flow from these two cones, have descended about 600 feet into the valley of the Veyre, damming up the river, and thus forming the picturesque lake of Aydat, nearly one mile in length. The semicircular crater of de la Rodde has one orifice the current from which reaches the village of Aydat, at the South-West side of the lake; the scoriæ and basalt of la Rodde near Aydat and Saint-Julien, is remarkably rich in perfect crystals of augite and olivine. Beneath the basaltic lava stream an earlier flow appears to have passed down the narrow and tortuous valley to Saint-Amand, and Tallende, extending nearly 8 miles to the East, and 2 miles of the 8

descend to, and overly the marls and limestones of the Limagne valley, this after flowing over the steep eastern edge or escarpment of the granitic plateau; near to and partly surrounding the puy Saint-Saturnin on the North side, the Veyre has partly worn, or cut its channel in this great lava flow and at " Ponteix wanders through its crevices ". Within the breached craters of Lassolas, and de la Vache the bended scoriæ is distinctly seen. These remarkable and breached cones form one of the most characteristic and instructive features of the whole chain of the Monts Dôme, they stand alone, as mysterious witnesses of the destructive agency of fire.

THE VICINITY OF ROYAT

The *immediate vicinity of Royat* is surrounded on all sides by the most instructive and interesting examples of extinct volcanic phenomena in the Auvergne, situated on *the south*-eastern side of the granitic plateau, is written with unmistakable evidence the physical history of some of the once active volcanoes of the central plateaux of France. This has in no small degree rendered Royat so justly celebrated for its famous mineral springs, and waters, which rise amidst the wonderful Puys, or extinct volcanic mountains of the department of the " Puy de Dôme ", and to which so many yearly flock *for therapeutic treatment.* Setting aside the charm and beauty of its site, and surrounding physical features, to say nothing of the absorbing interest afforded to those who visit the Auvergne, the region of central France, made classic through the history of the recent extinction of its once remarkable volcanic phenomena, and now rendered especially attractive by the accessibility of Royat and Clermont-Ferrand to every

locality of interest, over the extended area, occupied by these once active volcanoes and puys must commend itself to all whether sought for an account of their remarkable scenery, or for scientific research, and of all the deparments of France, the Puy de Dôme offers every facility for investigating extinct volcanic phenomena. There also history claims a high place for the Roman colonization and occupation in this remarkable province, attested by the remains of their mineral baths, and intimate knowledge of the virtues of the same springs, which then rose, and still rise, through the interstices of these volcanic rocks, and their associated minerals, which led the way to the establishment of numerous and special mineral baths, not only over this area, but half Europe.

The proximity of the double coned summit of Gravenoire, to Royat and Clermont-Ferrand has doubtless rendered it attractive to visitors, especially to those interested in and visiting the Auvergne for the purpose of investigating the extinct volcanic phenomena of this remarkable department of central France, and which for the combined researches of the geologist and mineralogist is probably unequalled, and rendered famous and accessible through the researches, and almost complete history of the *Geological features and volcanic phenomena of the extinct volcanoes of central France*, by the late Mr. G. Poulett Scrope.

The eruption to which the magnificent Puy de Gravenoire probably owes its origin has burs through a bed of earlier basalt, derived from the Puy de Charade, one of the highest points of the Gravenoire plateau, and which largely covers the eastern granitic slope, two miles South and South East Royat. The scoriæ of Charade is still observable on its summit, but now only marking it as the site of a former and older eruption, the crater having been probably obliterated, by the newer eruption of Gravenoire; the basalt of Charade has a dull and leaden aspect, much decomposde, and assuming spheroidal exfoliation in concentric laminæ. The lava being rich in crystals of augite and nodular olivine.

The conspicuous cone of Gravenoire rises upon the eastern margin of the elevated and extensive granitic plateau, overhanging Royat and the Limagne plain, and was probably the *one great exhibition* of *igneous,* or *volcanic forces,* within the radius of 3 miles from Royat, no true crater is visible at the summit of the cone, having been probably destroyed during the emission of the later currents of lava, and scoriæ, which can now be traced where they descended towards the North, from the summit, or remains of the extinct crater cone, *into the heart of Royat*, which is indeed *entirely built upon*, the northern and eastern extensions of the great *fan-shaped flow,* which extends 5 miles from West to East, or from the granitic eminence of Charade, and Gravenoire, covering on its way the bituminous, and calcareous freshwater sandstones, that fringe, or border the western edge of the Limagne plain, and reaching nearly to the " Peperino " hill of the Puy de Coronal 2 miles East of Clermont-Ferrand *and five from* Royat; this great flow covers a continuous area of 10 square miles, how thick, it is difficult to say. Two other lava streams descended from the summit, or eastern side of Gravenoire towards the East. The former can be seen to have been diverted from its flow or course by the now *craterless calcareous eminence* of *Mont Rodex*, situated one mile S.-East of Royat, in the centre of the fan-shaped or expanded lava flow previously named. It is necessary and important to notice and specially refer here, to the Puy de Colière now a small cone, situated close to the eastern side of the Puy de Dôme. This Puy de Colière lava stream considerably affected the vicinity and west side of Royat; after a flow of nearly four miles from its crater, the current filled the narrow Enval and Fontanas valley, joining the greater Gravenoire flow west of, or above the bridge at Royat. This de Colière lava is well seen on each side of the deep excavation, cut through by the Tiretaine rivulet, at old and new Royat, and conspicuously so, on the right hand side of the main road, to the Puy de Dôme, immediately West of Royat, and below the road leading to the Granite or observatory Quarry, which is so well shown on

the elevated granitoid plateau immediately North of, and overlooking Royat. This is one of the many easily recognised basaltic masses, in new Royat; but at the steep road leading to the railway station, below the southern arch-way of the viaduct, is a fine exhibition of the dense and thick lava flow from Gravenoire. Adjoining this on the higher ground overlooking Clermont-Ferrand, and the Allier, are several exposures of olivine and augitic lavas, portions of the Gravenoire flow where the lava and scoriæ can readily be examined, indeed the whole of old and new Royat stands upon the ejected lava, scoriæ and puzzolana, from the craters of Gravenoire, Charade, and de Colière, but the great volume of these volcanic products which constitutes the mass of the Gravenoire flow is exhibited in the grandly developed and expanded fan-shaped flow previously named, which occupies the valley of the Allier reaching nearly to the Peperino hills of Clermont, and the Puy de Coronal four miles East of Royat, and five from the summit of the cone of Gravenoire.

This extended lava flow can be examined continuously to the South, reaching the Puy de Roulade, and the villages of Boisséjour and Beaumont to Aubières, and round to the Puy de Cronal. The proximity of this great accumulation, to and round Royat, enables us to examine the most extensive, and illustrative sections, of the volcanic products, of Gravenoire, as exhibited in the numerous openings, or quarries, which abound over this well defined area. To appreciate the history of the vast amount of the varied mineral products ejected from the craters of Gravenoire, de Colière, de Berge, Pasredon, Saint-Genest and de Jussat, all within the radius of 3 miles South of Royat must be seen to be realized. The cone of the lofty Gravenoire is surrounded on all sides by masses of vesicular augitic scoriæ, cinders and olivine lavas, and puzzulana, in varied mineral conditions, especially so on its eastern, and northern slopes. In fact the site of Royat *was buried in*, and the fair town *is now built upon*, and surrounded *on all sides by alternating beds of scoriæ and lava*, which have issued from the

crater of the closely situated and elevated Gravenoire. I must not forget to mention the singular puys Mont Rodex, Roulade and Montrognon, which are respectively about one, two, and three miles south of Royat, the two former situated upon the great fan shaped flow and probably constructed from the more recent or later lavas of Gravenoire, in its mineral constituents, however the lava of Roulade differs essentially from the last mentioned, being rich in crystals of augite, and nodules of olivine. The conical and crowned eminence of Montrognon 1.980 feet above the sea, is probably the sole remains of a plateau, originally formed by the flow of a large lava current from Gergovia and is one of the most perfectly conical cones of columnar basalt in the Auvergne being crowned by the ruins of a once feudal fortress; the base of the cone rests entirely upon the freshwater marls, and limestones, of the Limagne plain 1.890 feet above the sea. The villages of Clémensat, and Romagnat lie to the South-East of Montrognon, and between the famous plateau of Gergovia and the Puys de Jussat and Guron.

To the West of Montrognon and on the elevated granitic plateau rise the puys de Berge, and Pasredon, with the older basaltic flow of Saint-Genest de Champanelle. The first named cone being 3.120 feet above the sea, and site of one of the older volcanic apertures, its summit being strewn over with cellular basalt, scoriæ and bombs. In addition to the above, rises the solitary basalt capped puy of Chatrat, based on granite and 3.372 feet above the sea. The current of Saint-Genest de Champanelle is remarkable and of much interest to the mineralogist arising from the amount of quartz in its composition, being according to Mr. Scrope " a granitoidal mixture of quartz, feldspar and augite, and probably the only example of a quartzose basalt in the Auvergne " but each of the numerous Puys and " Cheires " upon either side (West or East) of the plateau, or *granite floor* have their special history.

And we may infer that this floor, although hidden by the overlying freshwater deposits

of the Limagne, is continuous under, but deeply seated, and ranging East to the distant mountains of the Forez.

This portion of the eastern escarpment and western side of the Limagne with the seven eminences, and close to Royat should claim the attention of all interested in dynamical and physical geology, the Puys de Berge, Gravenoire, Roulade, Montrognon, Jussat, Girou, Saint-Genest, de Champanelle, and Gergovia, with the extensive « cheires », or rugged lava flows, of la Serre de la Vache, and Vichatel, many exhibiting flows from seven to eight miles in extent, one half, upon the granite, the other or remaning half. Extending to and flowing over the scarpment into the Limagne plain, clearly demonstrating the relative age or superposition of the lava flows upon and over the freshwater or lacustrine marls. There can be little doubt that the cones of Puy Girou, de Jussat Gergovia and Chanonat, all based upon the lacustrine beds of the eastern plain; originally formed a single plateau, capped by a current of basaltic lava which probably proceeded from the granitic heights, occupied by the Puys de Berge, and Pasredon but subsequently separated by atmospheric denudation. The flattened table land of the historical Gergovia, five miles South-East of Royat exhibits two beds of basalt nearly 40 feet thick, with stratified beds of tufa-like Peperino between them.

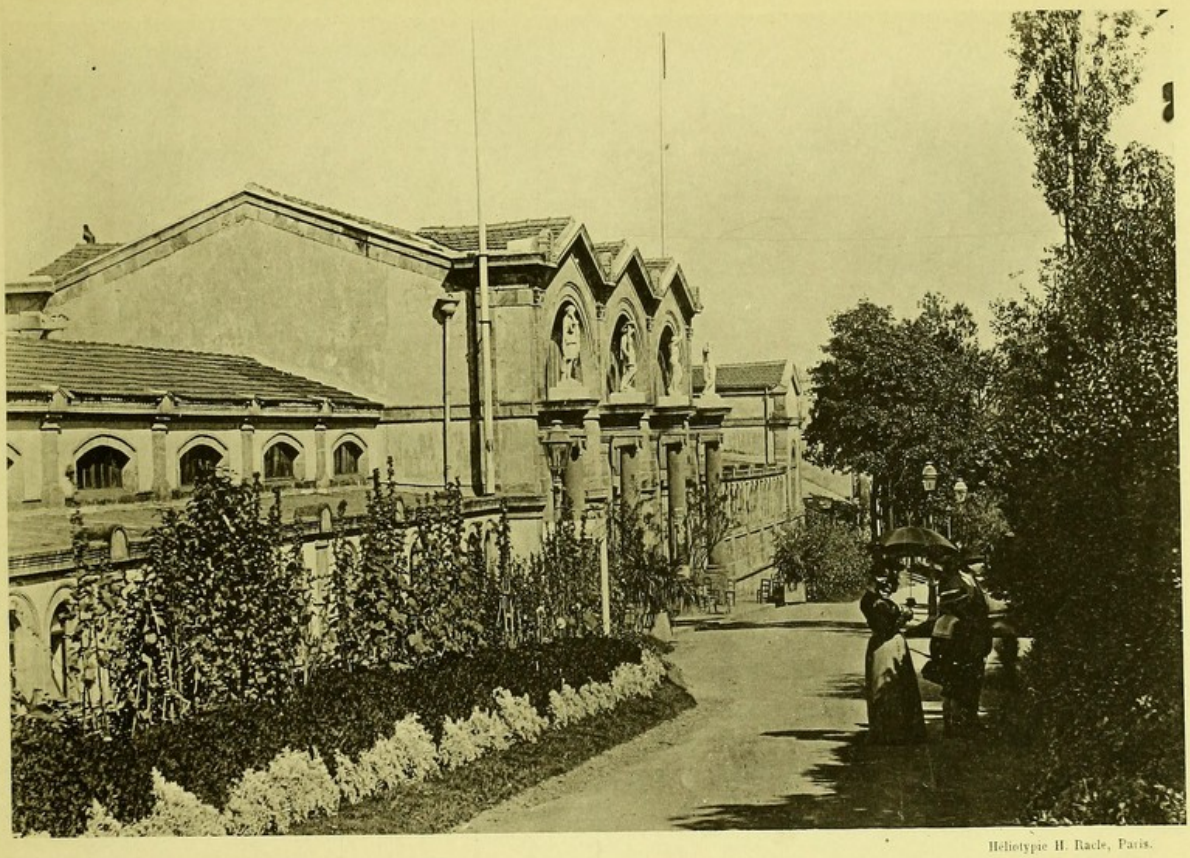
Mr. Scrope believed that in all probability it was the volcanic aperture of the Puy de Berge, that supplied the lava currents of Gergovia, Montrognon and Saint-Genest de Champanelle; their comparative elevation allowing for denudation, favours this opinion; the Puy de Berge is 3.210 feet, the Puy Girou 2.792 and the western summit of Gergovia 2.496 feet above the sea.

These three eminences are all based upon the limestones and marls of the Limagne valley, and all three have ejected their basaltic flows since the great freshwater *plain on wich they stand was under* water, and the successive deposits of the calcareous strata of Puy Girou, reached the great thickness of 2.500 feet. Probably next to the Puy de Dôme, Pariou, and the myste-

rious Chopine in point of interest, both to the geologist and historian, is the hill of Gergovia, the Puy Chopine being yet structurally undetermined, and Gergovia beyond its stratigraphical peculiarities, being famous for having been successfully defended by Vercingetorix against the Romans under Julius Cæsar.

R. E.

IMPRIMERIE CHAIX, RUE BERGÈRE, 20, PARIS. — 5104-3-97. — Encre Lorilleux).



Heliotypie H. Racle, Paris.

THE BATHING ESTABLISHMENT

Héliotypie H. Racle, Paris.

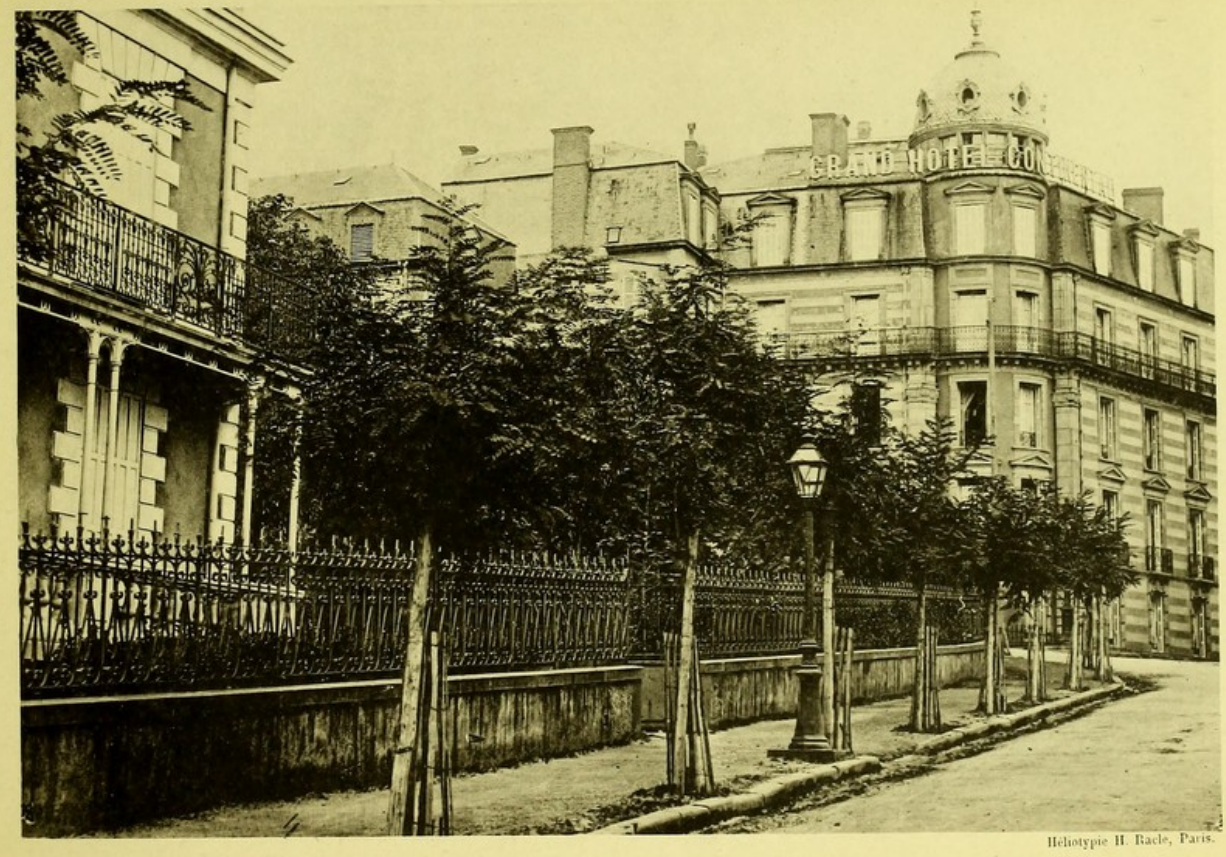
THE OLD CASINO

Héliotypie H. Racle, Paris.

ROYAT SQUARE

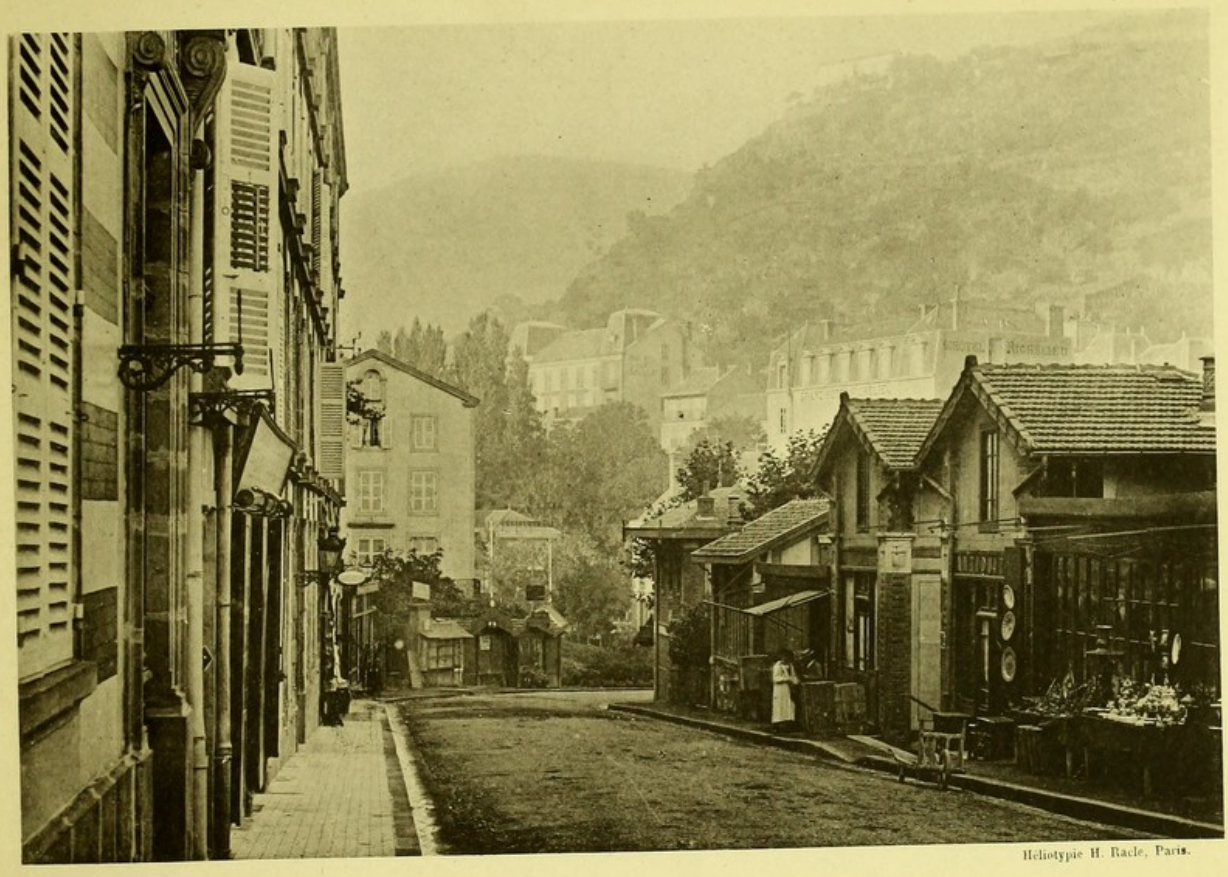
Héliotypie H. Racle, Paris.

BOULEVARD BAZIN



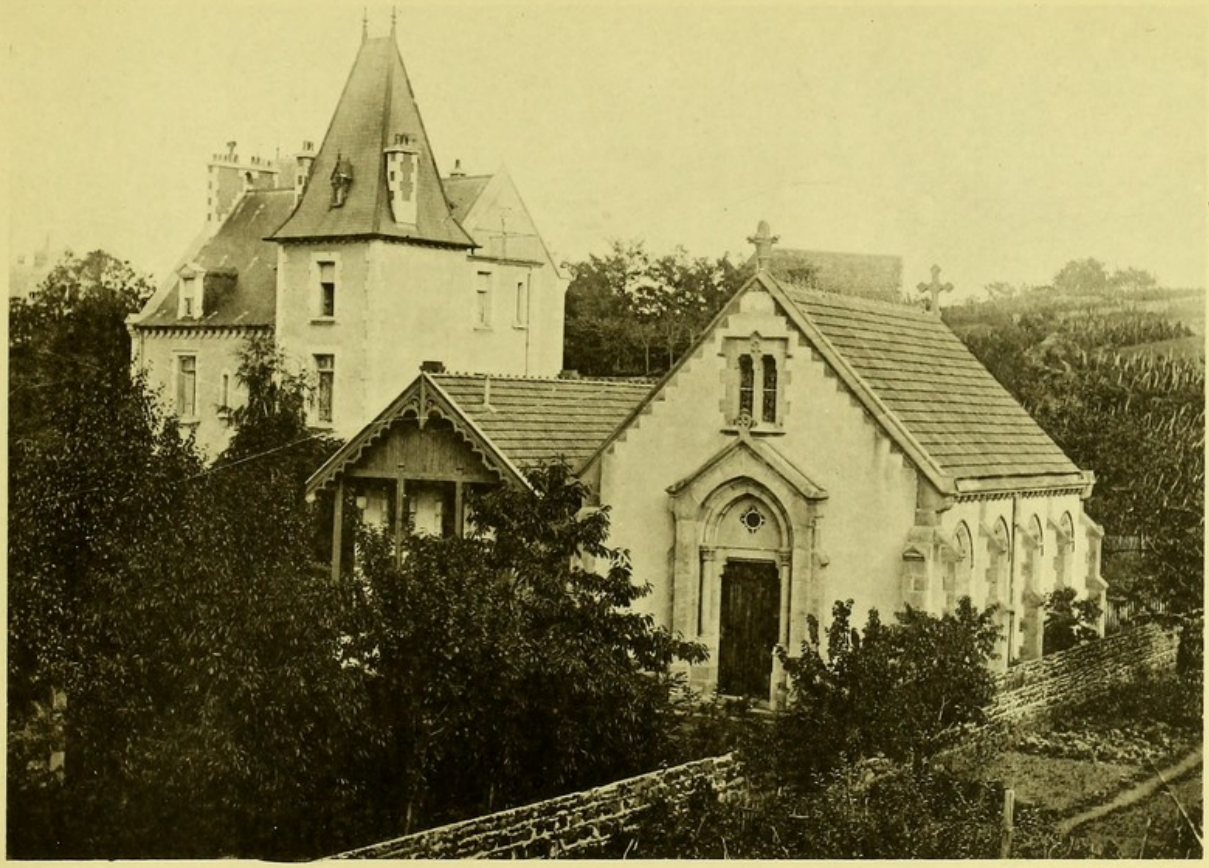
Héliotypie H. Racle, Paris.

ROAD LEADING TO THE RAILWAY STATION



Heliotypie H. Racle, Paris.

THE MAIN STREET

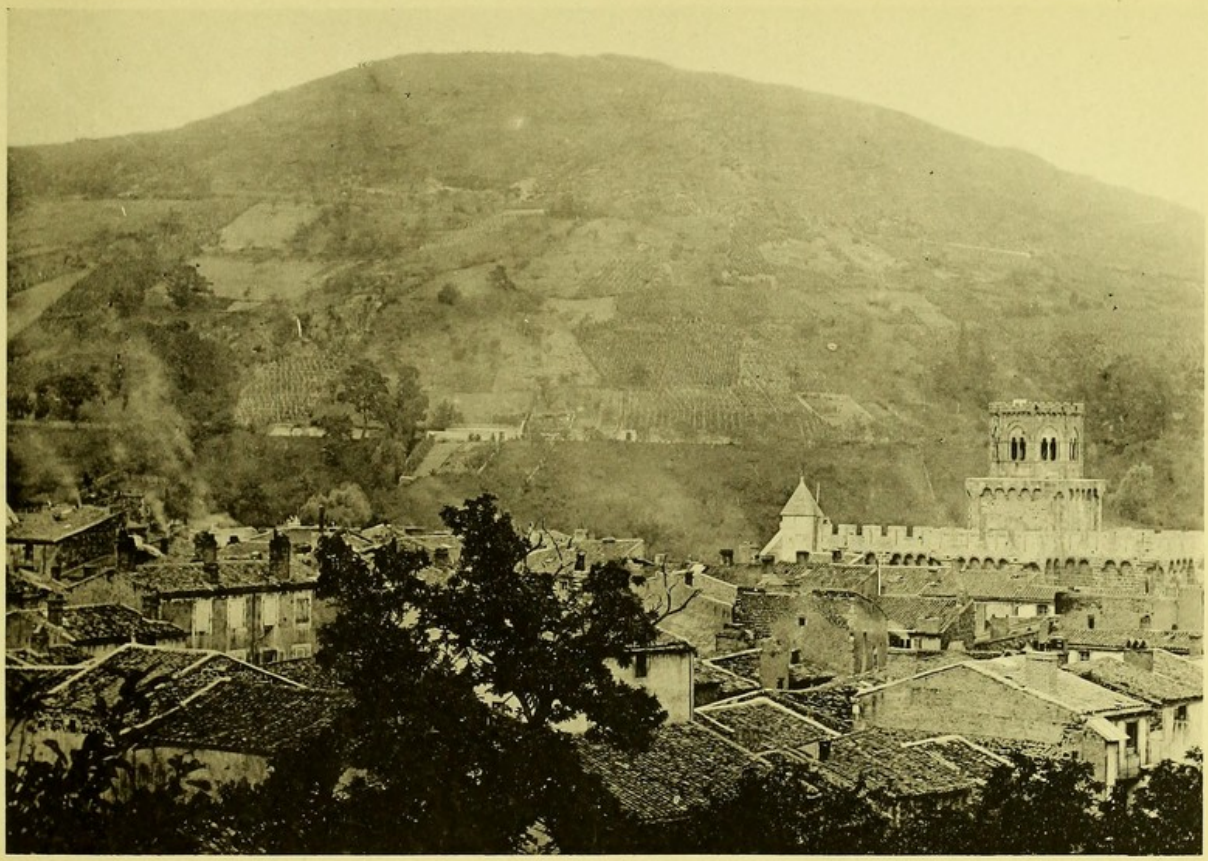


Heliotypie H. Racle, Paris.

THE ENGLISH CHAPEL

Héliotypie H. Racle, Paris.

ROAD FROM THE TRAMWAY



Heliotypie H. Bacle, Paris.

THE VILLAGE OF ROYAT AND ITS FORTIFIED CHURCH

Héliotypie H. Rigole, Paris.

THE VALLEY OF ROYAT

LES ENVIRONS DE ROYAT

Extrait de la Carte d'Etat Major au 80.000e

Imp. Lemercier et Cie, rue de Seine St. Remi.