

mountain region. The hotel is a comfortable, well-kept establishment, having a capacity of one hundred guests. Lawn tennis, croquet, bowling, riding, and driving are among the amusements offered. The Wallawhatoola River, half a mile distant, furnishes excellent bass fishing. There are several mineral springs here, the most important being the Sulphur and the Alkaline Springs. The following analysis of the former was made in 1891 by G. B. M. Zerr, chemist, of Staunton, Va.:

SULPHUR SPRING (MILLBORO'S SPRINGS).  
ONE UNITED STATES GALLON CONTAINS:

Solids.	Grains.
Sodium hydrosulphate.....	3.34
Calcium sulphate.....	1.55
Potassium sulphate.....	.11
Sodium bicarbonate.....	4.27
Magnesium bicarbonate.....	1.65
Calcium bicarbonate.....	.54
Iron bicarbonate.....	Trace.
Alumina.....	.26
Sodium silicate.....	.89
Sodium chloride.....	.47
Aluminum phosphate.....	Trace.
Organic matter.....	.35
Total.....	13.43
Gases.	Cu. in.
Sulphureted hydrogen.....	1.08
Carbonic acid.....	6.94

This is an excellent water of the alkaline sulpho-carbonated variety. It possesses antacid, tonic, and mild diuretic properties, and will be found useful in the class of cases to which such waters are applicable. The alkaline spring was analyzed by Dr. Zerr in 1895. It is somewhat milder than the sulphur spring, but is also a very useful water in acid dyspepsia, enfeebled states of the digestion, etc.

James K. Crook.

**MINERAL ACIDS, TOXICOLOGY OF.** See *Acids*, etc.

**MINERAL ALKALIES, TOXICOLOGY OF.**—The alkaline carbonates and hydrates of potassium and sodium act as corrosive poisons.

Potassium carbonate is a white, crystalline salt, alkaline and deliquescent. It dissolves readily in water, its solution effervescing readily on the addition of acids. It is used in commerce under the names of pearl ash and salt of tartar.

The pure sodium carbonate is crystalline, colorless, odorless, and transparent. It has a sharp, alkaline taste and an alkaline reaction. On exposure to dry air the crystals effloresce and fall into a white, opaque powder. This compound is met with in commerce as washing soda or sal soda and is much used in the household for cleaning purposes.

Both these carbonates are much less poisonous than the hydrates of the same elements and they are of no great interest to the toxicologist. Their poisonous dose is large and their effect like that of the hydrates though much less intense.

The hydrates of both sodium and potassium are found in commerce in the form of irregular lumps, a more or less fine powder, or in the form of sticks, yellowish-white or pure white in color, crystalline, and bitter. All forms of these hydrates absorb moisture readily to such an extent as to become liquid. They dissolve in water very quickly with the evolution of great heat, producing if pure a clear liquid. A solution of each containing about five per cent. of the hydrate is official in the United States Pharmacopœia.

In strong solution the hydrates act energetically on cotton or woollen fibre and on animal or vegetable tissues in general, causing them to soften and disintegrate. On metals also they act corrosively and so insoluble a material as glass is after a time affected by them.

Poisoning by these substances is the result of accident or from suicidal intent, their sharp and biting taste serving to protect from their homicidal administration.

this residue consists of sodium and potassium sulphate. After weighing, the residue is dissolved in water, platinum chloride solution is added in excess, and the mixture is evaporated to dryness on the water-bath. The residue is treated with eighty-per-cent. alcohol and the insoluble potassio-platinic chloride filtered out, and after thorough washing with alcohol it is dried and weighed. The weight of the platinum salt multiplied by 0.2809 represents the weight of caustic potash. The difference between the potash, calculated to sulphate, and the weight of the mixed residue of sulphates represents the sodium sulphate.

Herbert M. Hill.

**MINERAL HILL SPRINGS.**—Grainger County, Tennessee.

**POST-OFFICE.**—Bean's Station. Hotel and sanitarium. These springs are located in the Bean's Station Valley, near the foot of Clinch Mountain, ten miles from Morris-town. The peculiar arrangement of the valleys, hills, and mountains gives rise to a cool, refreshing air current, always passing from north to south in the morning and from south to north in the afternoon. We are informed by Dr. W. J. Heacker, of Bean's Station, that as many as twelve varieties of mineral water are found near the hotel, among which are mentioned red, white, and black sulphur chalybeate, Epsom, and alum waters. No analyses appear to have been made. The accommodations of this resort appear to have been largely extended and improved. It is stated that many varieties of ills are benefited by the genial climate and a free use of the waters.

James K. Crook.

**MINERAL SPRINGS AND WATERS.**—Geologically, all the waters which issue from the earth might be designated as mineral, but in the common acceptance the term refers only to those waters which are used for internal or external medical purposes in virtue of their chemical contents, or on account of their natural temperature. Such waters have been employed in the healing art through all ages from the earliest dawn of history to the present day. Like many other medicinal agents, mineral waters in former times, before their proper constitution was understood, were superstitiously invested with powers which we now know they never could have possessed. Some of the ancient notions regarding their healing virtues are still retained by credulous or ignorant persons, and this fact is duly utilized by enterprising promoters of certain springs to their own commercial advantage, but not to the benefit of enlightened and progressive therapeutics. Aside from disappointing the expectations of invalids, the absurd claims published in their circulars by unscrupulous proprietors of mineral springs have served to prejudice the minds of medical men, some of whom in our own country ignore this subject altogether, and are content to leave the whole matter of mineral hydrotherapeutics in the hands of persons having nothing more than a commercial interest in its extension. In Europe, however, these agents are justly regarded as a valuable addition to the armamentarium medicorum, and a study of their uses is held as an essential part of materia medica and therapeutics. The students of all the chief universities are instructed in their rational uses, and the status of mineral waters is altogether dignified and satisfactory. Even on this side of the Atlantic there are evidences that the regular profession is awakening to a proper appreciation of the potential value of these remedial adjuncts, which in our own fair land are found in greater profusion and variety than anywhere else on the globe. A spirit of scientific inquiry and investigation is superseding the lethargy and indifference of American practitioners. Many of our spas are already provided with properly equipped sanatoria and bath-houses, and the writer learns from a recent visit to some of our well-known mineral spring resorts that an increasing number of the valetudinarian visitors are taking the waters under medical supervision.

The writer is convinced by his own continued observations that American medical men of to-day are far better

acquainted with the chemical composition and therapeutical possibilities of our own mineral waters than they were fifteen or twenty years ago. The alert Yankee will not forever allow the fruitful fields which surround him to lie fallow and undeveloped. The veil of ignorance and superstition which has shrouded the medicinal operation of mineral waters having been brushed aside, the plain fact is revealed that these substances exert their physiological action and therapeutical effects precisely as do other internal remedial agents. It is known to all that a mineral water containing the sulphate of soda or magnesia will act on the bowels. A bicarbonated alkaline water will quickly remove the symptoms of acid dyspepsia, while it requires no argument to show that a potent chalybeate will influence the manifestations of anæmia, at least as readily as will one of the artificial preparations of iron. These are examples of what we know about the therapeutics of mineral waters. But we have not yet learned why a very few grains of sulphate, magnesia, or sodic salt will give a laxative influence to a natural mineral water, and that the physiological effects of arsenic can be readily secured by the daily imbibition of a water containing far less than the usual pharmaceutical dosage. Nor are we at present able to explain why we cannot gain these same effects by artificially adding these substances to ordinary potable water. The progressive practitioner, however, while desirous of further light regarding these matters, will not deprive his patient of the advantage of knowledge well attested by clinical experience while awaiting an exact explanation of the *modus operandi* of his remedial agents. We are equally ignorant as to the precise action of a majority of our most highly prized artificial preparations.

Certain European mineral springs were known to be useful in the treatment of syphilis and its sequelæ many years before a chemical analysis showed them to possess a minute quantity of the iodides of potassium and sodium. Similarly, quinine was known to be useful in malarial affections a very long time before it was learned that malaria was a specific infectious disease, and that quinine was destructive of its pathogenic microbe. We are often obliged to avail ourselves of empirical knowledge until the scrutinizing eye of the experimental chemist or physiologist supplies us with rational explanations.

With the possible exception of the sulphated-saline group, mineral waters find their chief application in chronic diseases. The very fact of the ease with which they may be introduced into the system gives them a vast advantage in many obstinate and long-continued affections in which the gamut of pharmaceutical remedies has been run and the stomach of the weary patient rebels at more drugs. Waters have a very much better influence when consumed at their original source at the spa than when used from bottles, demijohns, etc., in the city. At the spring the patient has the added advantages of a change of scenery, surroundings, climate and food, and a temporary absence from the worries and cares of home and business. Many a long-standing and well-nigh hopeless case of chronic rheumatism, anæmia, dyspepsia, or hepatic disorder has been restored to a state of perfect or comparative good health by a timely sojourn at a proper mineral spring resort. There are numerous excellent commercial mineral waters which may be used advantageously at home, but the effects obtained cannot compare with those derived at the fountain-head.

The employment of baths or the external use of water belongs more properly to the domain of general hydrotherapeutics (*vide p. 788, Vol. IV.*). In this place we can only briefly refer to the action of mineral waters on the economy through the medium of the skin and to balneological procedures employed at mineral springs. The time was when special virtues were attributed to the external application of water the temperature of which had been raised by the interior heat of the earth. More advanced reasoning, however, has led to the conclusion that terrestrial heat imparts no more value to water as a bathing medium than heat secured through the art of

man, unless indeed we make allowance for the somewhat ambiguous influence of suggestion which may operate in occasional cases. Mineral waters, however, do acquire increased influence on the cutaneous investment of the body by reason of their impregnation with certain chemical ingredients—sulphureted hydrogen, chloride of sodium, etc. In recent years it has been taught that these ingredients affect the economy merely by their local stimulating or sedative action on the skin, and that under the ordinary circumstances of the bath there is very little if any interchange of constituents between the animal fluids and the water of the bath—in other words, that none of the contents of the water is absorbed into the blood. This view is set forth in all the late works on this subject. However, clinicians and physiologists like Wittich, Gutman, Cheruszewsky, and Walkenstein maintain that the skin is permeable to watery as well as to alcoholic solutions. It is claimed that absorption is carried on by the cutaneous blood-vessels and lymphatics, supplemented by the natural law of diffusion. The fact that the presence of iodine and bromine is speedily detected in the urine after bathing in certain waters, notably those of Mount Clemens, Mich., lends strong support to this view. It cannot be gainsaid that when the body is immersed in a mineral bath the skin separates two saline solutions of unequal density, *i.e.*, the blood serum and the water composing the bath. Thus, according to the physical law of osmosis and the ionic action and properties of molecules, equalization of the two fluids will be brought about, or at least attempted. Aside from this question, which we may regard as being still in abeyance, the fact must be borne in mind that water is a much more rapid conductor of heat than air, and it is well known that the human system tolerates changes of temperature in the latter to a much greater extent than in the former. While the air at 75° F. is too warm for comfort for most persons, a continued bath at that temperature becomes cold and depressing. Again, a bath at from 98° F. to 102° F. acts far more energetically than the atmosphere at the same temperature.

**CLASSIFICATION OF MINERAL WATERS.**—The need of a satisfactory scheme of tabulation of the different varieties of mineral springs, both for descriptive and for therapeutical purposes, has long been felt by medical men, and various methods of classification have been proposed by writers on the subject. The author is convinced that the following scheme suggested originally by Dr. Albert C. Peale of the United States Geological Survey and elaborated and modified by himself is all that is needful for the purpose, and is sufficiently elastic to cover the analysis of any mineral water, whatever its source. Under this method the writer has classified all the mineral springs of the United States that have been subjected to analysis and has found it to meet the requirements in every case. All mineral waters are divided primarily into two great groups and are then treated precisely alike with reference to their chemical contents.

Group A. Cold (non-thermal) springs.  
Group B. Thermal springs.

- Class I. Alkaline..... { Sulphated.  
                                  { Muriated.
- Class II. Alkaline-saline..... { Sulphated.  
                                  { Muriated.
- Class III. Saline..... { Sulphated.  
                                  { Muriated.
- Class IV. Chalybeate..... { Saline.  
                                  { Sulphated.  
                                  { Muriated.

Class V. Neutral or indifferent waters.  
The existence or non-existence of gaseous contents may be shown thus:

1. Non-gaseous.
2. Carbonated or acidulous—containing carbonic acid gas.
3. Sulphureted—containing hydrogen sulphide, etc. A combined solid and gaseous water may be referred to as alkaline-carbonated, saline-sulphureted, etc. Any

classification must, from the nature of the case, be somewhat arbitrary. Nature herself is an evolution. Many analyses so shade into each other that it is difficult to draw hard-and-fast lines. But the above classification admits of a ready subdivision according to the predominant or most important constituents, as follows: Sodid, magnesic, bromic, arsenical, acid, aluminous, etc.

Under the alkaline springs are included all those which are characterized by the predominance of the alkaline carbonates; as the carbonates of the alkalis, the alkaline earths, and the alkaline metals. There are no absolutely pure alkaline springs; all contain saline ingredients just as all saline springs contain alkaline. Many also contain iron, and a large majority of the most celebrated alkaline springs contain also carbonic acid gas. This substance not only greatly increases the solvent power of water, but imparts to it a bright and piquant sparkle, a grateful, somewhat acidulous, pungent taste, and furthermore enhances its therapeutical properties in certain states. Nearly half the alkaline springs of the United States are calcic-alkaline, *i.e.*, they contain calcium carbonate or bicarbonate as a predominant ingredient. But nearly all contain also the carbonate or bicarbonate of sodium, potassium, magnesium, iron, and many also lithium.

**Physiological Action.**—The alkaline carbonated waters stimulate the action of the stomach, render the urine alkaline, increase its flow, and are to some extent diaphoretic. They are not purgative unless strongly combined with salines, and they have a tendency to lessen catarrhal discharges.

**Therapeutics.**—These waters form a very efficacious and speedy remedy in the treatment of acid dyspepsia and flatulence. Given before meals they stimulate the peptic glands, thus promoting the flow of gastric juice and aiding the appetite and digestion. Though not curative, they are useful in ameliorating some of the symptoms of chronic catarrh or gastritis and cancer of the stomach. Their diuretic tendency gives them a useful application in fevers, rheumatism, gout, diabetes, vesical irritation, etc. The habitual use of these waters tends to render the urine alkaline, and it is believed by many eminent medical authorities that those containing lithium arrest the formation and favor the disintegration and expulsion of uric-acid calculi, concretions, etc. When combined with salines, iron, etc., these waters acquire new virtues which will be later referred to. The following analysis of one of the Manitou Springs of Colorado, the Navajo, presents a good example of an alkaline-carbonated water:

ONE UNITED STATES GALLON CONTAINS:

Solids.	Grains.
Sodium chloride.....	23.79
Potassium sulphate.....	15.35
Sodium sulphate.....	10.93
Magnesium carbonate.....	16.04
Iron oxide.....	.02
Sodium carbonate.....	42.60
Lithium carbonate.....	.61
Calcium carbonate.....	69.33
Alumina.....	.10
Silica.....	2.46
Total solids.....	181.23
Free carbonic acid gas.	

Among the better-known American alkaline springs are the following:

Bladon Springs, Alabama; Highland Springs, California; Perry Springs, Illinois; St. Louis Spring, Michigan; Londonderry Lithia Spring, New Hampshire; Glen Springs, New York; Buffalo Lithia Springs, Virginia; Waukesha Mineral Springs, Wisconsin.

Well-known European alkaline springs are as follows: Apollinaris Springs (Neuenahr), Rhenish Prussia; Fachingen, Germany; Weilbach, Hesse, Germany; Ems-on-the-Lahn (Kesselbrunnen), Germany; Obersalzbrunn, Silesia; and Holy-Well, North Wales.

**ALKALINE-SALINE WATERS.**—This class includes all those waters in which the purely alkaline ingredients and the salines are present in anything like equal quantities. For example, a water whose predominant constituents

are the carbonate of sodium and the chloride of sodium, the other ingredients being in smaller proportions, or comparatively unimportant, would be properly ranked as an alkaline-saline. If the sulphate of sodium or potassium were present in considerable quantities the water might properly be referred to as a sulphated alkaline-saline. The waters of the alkaline-saline class are among the most richly impregnated known. Many of the best in the world are found in the United States.

**Physiological Action and Therapeutics.**—The therapeutical effects of these waters are brought about by the simultaneous introduction into the system of a double or triple group of compounds somewhat differing in their individual influence, and each to some extent supplementing the action of the others. These waters are in the first place antacid *par excellence*. Their prime ingredients are essential to the processes of osmosis, combustion, digestion, and secretion. With the chloride of sodium the alkalis contribute to maintain the blood in the degree of viscosity necessary for the process of endosmosis and exosmosis. These waters thus possess all the virtues separately set forth as attaching to the alkaline and saline classes. Many of the muriated alkaline-salines exert a certain laxative influence, but those containing the sulphate of sodium or magnesium possess the advantage of more directly stimulating the emunctory action of the intestines, thus promoting the easy and painless removal of waste products from the system. These waters thus become useful in the various chronic disorders of the alimentary tract characterized by the symptoms of catarrh of the stomach, intestinal sluggishness, hepatic torpor, and constipation. They may also be expected to render good service in cases of biliary and urinary calculi, in uric acid sand and gravel, in chronic bladder and urinary disorders, and in gout and rheumatism. While perhaps not properly denominated curative, they undoubtedly in many cases favorably influence the course of chronic albuminuria and saccharine diabetes. Owing to their active influence on tissue metamorphosis, the stronger waters of this group must be used with great caution by cachectic and debilitated persons. It is especially with these waters that misguided laymen in the United States are in the habit of experimenting on their own persons, often converting an ordinary case of dyspepsia or debility into one of gravity and seriousness. Their habitual use should never be undertaken except on the advice of a physician. As a rule these waters are contraindicated in acute inflammatory disorders and in chronic inflammations having a tendency to acute exacerbations. They must be used guardedly in cases of atheromatous degeneration of the arteries, in aneurism of the greater vessels, and in all weakened or enfeebled states of the myocardium or great aorta. Following is an analysis of the Saratoga Vichy Spring, a good example of the alkaline-saline class of waters:

ONE UNITED STATES GALLON CONTAINS

Solids.	Grains.
Sodium bicarbonate.....	82.87
Calcium bicarbonate.....	95.52
Magnesium bicarbonate.....	41.50
Strontium bicarbonate.....	Trace.
Lithium bicarbonate.....	1.76
Iron bicarbonate.....	.05
Barium bicarbonate.....	.59
Potassium sulphate.....	Trace.
Sodium phosphate.....	Trace.
Sodium bborate.....	Trace.
Sodium chloride.....	128.09
Potassium chloride.....	14.11
Sodium bromide.....	.99
Calcium fluoride.....	Trace.
Sodium iodide.....	Trace.
Alumina.....	.46
Silica.....	.76
Organic matter.....	Trace.
Total solids.....	367.32

Carbonic acid gas, 388.07 cubic inches.

Many of the other Saratoga Springs belong to this class. There are so many excellent springs of the alka-

line-saline group in the United States that it seems almost invidious to mention examples of them. The following are fair representations: Allen Springs, El Paso de Rabbo Springs, and Litton Seltzer Springs, California; Bowden Lithia Springs, Georgia; the Idanha Spring at Soda Springs, Idaho; West Baden Springs, Indiana; Fry's Mineral Springs, Iowa; Waconda Mineral Springs, Kansas; Americanus Well, Michigan; Ballston Spa, New York; Wilhoit's Soda Spring, Oregon; Dixie Springs, Tennessee, and the Borland Mineral Well of West Virginia. The following are celebrated European alkaline-saline springs: Bilin, Bohemia (Josephs-Quelle); Contrexéville, Pavillon, France; Vals, France; Luhatschowitz, Moravia, and Selters, Nassau, Germany.

**SALINE MINERAL WATERS.**—The chlorides and sulphates give character to the saline class of waters and often coexist in the same spring. As a rule, however, one or the other group of salts is so preponderant as to overshadow all other ingredients. These waters may therefore be further subdivided into (1) the muriated salines and (2) the sulphated salines.

The muriated salines gain their character from the presence of the chlorides, *viz.*: the chlorides of sodium, potassium, magnesium, lithium, and iron. The chloride of sodium is by far the most important as well as the most universal of these salts, being found in almost every mineral water, from mere traces to many thousand grains in the gallon.

**Physiological Action.**—We cannot in this place undertake an account of the various functions of the chloride of sodium in the system. Suffice it to say that it is one of the essential components of the body, being present in every structure except the teeth. It is one of the most-important factors in the process of nutrition, and its withdrawal is at once keenly felt. In mineral waters the remaining chlorides are not as a rule present in large quantities and are relatively unimportant. The chloride of lithium is found in a few springs, but its quantity is usually too small to influence the properties of the water. The chloride of magnesium occurs frequently in muriated waters. It forms the bitter of salt waters, and occurs in great quantities in the waters of the Dead Sea and in some of the brines of New York and Michigan. It acts mildly as a purgative, promoting the flow of bile and increasing the appetite. The chloride of potassium coexists in many springs with common salt, though in much smaller quantity. Its functions and distribution in the body appear to be quite similar to those of its sodium congener. The chloride of calcium, like the carbonate of calcium, is not evacuant, but in large doses may cause constipation. Its influence in uric-acid states is probably identical with that of the carbonate. The chloride of iron is often a valuable ingredient of chalybeate waters.

When taken into the stomach in therapeutic doses the muriated saline or chloride of sodium waters cause an increase in the flow of gastric juice, bile, pancreatic juice, and intestinal fluid, promote the appetite, and aid in the process of digestion. They have a mildly aperient effect and exert an antiseptic influence on the intestinal mucous membrane, tending to prevent putrefactive changes. The increased quantity of urea excreted shows that they promote tissue metamorphosis. The bronchial mucous secretion is also increased.

**Therapeutics.**—In virtue of their physiological action the muriated sodic waters possess a valuable application in gastric, hepatic, and intestinal disorders. It would be difficult to mention a chronic affection involving the stomach, liver, or intestinal tract in which one of the chlorinated salines could not at some stage be beneficially exhibited, and their good effects are often greatly enhanced by the presence of valuable alkaline ingredients as well as iron. Herman Weber prefers them even to the bitter or sulphated saline waters in the portal congestion of thin or spare persons, in whom further reduction of weight is to be avoided. Their special application, however, is to be found in atonic dyspepsia, insufficiency of the digestive fluids giving rise to dry scybalous stools, a furred tongue, disagreeable taste in the mouth, loss of