

lowered state of the system, or whether they have any direct tendency to combine with fat and carry off a portion of superfluous adipose tissue. Their excess of carbonic acid, through its action on the stomach, favours the operation of alkaline waters. They have been classed as follows:—(I.) simple alkalines, where carbonate of soda is the main agent; (II.) waters containing in addition some chloride of sodium; (III.) waters containing sulphates of soda or of magnesia. All these classes may be said to be used in gout, lithiasis, affections of the liver, catarrh, and obstructions of the gall ducts, in dyspepsia, chronic catarrh of the stomach, and diarrhoea, in obesity, and in diabetes. Some of the waters of the second class are supposed to influence bronchial catarrhs and incipient phthisis, while the more powerful sulphated waters of the third class are especially useful in catarrh of the stomach, and in affections of the biliary organs; of these only one of importance (Carlsbad) is thermal. The rival cold waters of Tarasp contain twice as much carbonate of soda. The cold ones are chiefly used internally, the thermal ones both internally and externally. The latter, besides acting as warm water, slightly stimulate the skin when the carbonic acid is abundant, and the carbonate of soda has some slight detergent effect on the cutaneous surface like soap. These waters are unknown in England. They are most abundant in countries of extinct volcanoes.

Classes I. and II. of alkaline waters may be said to have a subvariety in acidulated springs or carbonated waters, in which the quantity of salts is very small, that of carbonic acid large. These table waters are readily drunk at meals. They have of late years been so widely exported as to be within the reach almost of every one. Their practical importance in aiding digestion is in reality much greater than one could expect from their scanty mineralization. They are drunk by the country people, and also largely exported and imitated. They are very abundant on the Continent, and, although some of the best-known ones enumerated below are German and French, they are common in Italy and elsewhere:—Heppingen, Roisdorf, Landskro, Apollinaris, Selters, Brückenaun, Gieshübel, all German; St Galmier, Pougues, Chateldon, French.

Associated with Class III. is that of the strongly sulphated waters known in Germany as bitter or purging waters, which have of late deservedly come into use as purgative agents. They are almost wanting in France and in America, and there are no very good ones in England. The chief supply is from Bohemia and Hungary. The numerous waters of Ofen are the best-known, and some of them are stronger than the Hunyadi, of which an analysis has been given in Table I. They are easily imitated. Some of the best-known are Ofen, Püllna, Saidschütz, Friedrichshall, Birmerstoff, Kissingen.

Two other classes of waters demand a few words of notice. The French have much faith in the presence of minute quantities of arsenic in some of their springs, and trace arsenical effects in those who drink them, and some French authors have established a class of arsenical waters. Bourboule in Auvergne is the strongest of them, and is said to contain $\frac{1}{16}$ th of a grain of arseniate of soda in 7 ounces of water. Baden-Baden, according to Bunsen's latest analysis, has a right to be considered an arsenical water. It is, however, extremely doubtful whether the small amounts of arseniate of soda which have been detected, accompanied as they are by preponderating amounts of other salts, have any actual operation on the system. The following are among the most noted springs:—Bourboule, Mont Dore, Royat, Salies (Bigorres), Plombières, Baden-Baden.

Of late years lithium has been discovered in the waters of Baden-Baden; and various other places boast of the amount of that substance in their springs. Indeed a new bath has been established at Asmannshausen on the Rhine in consequence of the discovery of a weak alkaline spring containing some lithium. Not very much is known of the action of lithium in ordinary medicine, and it undoubtedly does not exist in medicinal doses even in the strongest springs. Among these springs are those of Baden-Baden, Asmannshausen, Elster, Royat, Ballston Spa, and Saratoga (U.S.).

AMERICAN MINERAL WATERS.—The number of springs in the United States and Canada to which public attention has been called on account of their supposed therapeutic virtues is very large, amounting in all to more than three hundred. Of this number comparatively few are in Canada, and of these not more than six (St Catharines, Caledonia, Plantagenet, Caxton, Charlottesville, and Sandwich) have attained general celebrity. The first three belong to the saline class, the Caxton is alkaline-saline, and the last two are sulphur waters. The St Catharines is remarkable for the very large amounts of sodium, calcium, and magnesium chlorides which it contains, its total salts (450 grains in the pint) being more than three times the quantity contained in the brine-baths of Kreuznach in Prussia. The Charlottesville and Sandwich springs likewise surpass the noted sulphur-waters of Europe in their excessive percentages of sulphuretted hydrogen, the former containing more than 3 and the latter 4.72 cubic inches of this gas in the pint.

The mineral springs in the United States are very unequally distributed, by far the larger number of those which are in high medical repute occurring along the Appalachian chain of mountains,

and more especially on or near this chain where it passes through the States of Virginia, West Virginia, and New York. The Devonian and Silurian formations which overlie the Eozoic rocks along the course of the Appalachian chain have been greatly fissured—the faulting of the strata being in some places of enormous magnitude—by the series of upheavals which gave rise to the many parallel mountain ridges of the Appalachians. In many places the springs occur directly along the lines of fault. The various classes of mineral waters are likewise very unequally represented, the alkaline springs, and those containing Glauber and Epsom salts, being much inferior to their European representatives. On the other hand, the very numerous and abundant springs of Saratoga compare very favourably with the Selters and similar saline waters, and among the many American chalybeate springs the subclass represented by the Rockbridge Alum is unequalled in regard to the very large percentages of alumina and sulphuric acid which it contains. Besides its greater amount of mineral constituents (135 grains per pint), the Ballston spring surpasses the similar saline waters of Homburg, Kissingen, Wiesbaden, and Selters in its percentage of carbonic acid (53 cubic inches). It is also remarkable for the very large proportion of carbonate of lithia, amounting to 0.701 grains. Thermal springs are specially numerous in the territories west of the Mississippi and in California. Those in the east mostly occur in Virginia along the southern portion of the Appalachian chain; in the middle and New England States Lebanon is the only important thermal spring. Subjoined is a list of thirty American springs, the design being to represent as many of the more noted spas as possible, while at the same time enumerating the best representatives of the classes and subclasses into which mineral waters are divided according to the German method of classification.

	Designation and Locality.	Therapeutic Application
Indifferent (Thermal).	Lebanon, Columbia Co., N.Y. (73° F.).....	(Scrofulous ulcers and ophthalmia, ozaena, chronic diarrhoea and dysentery, secondary and tertiary syphilis.
	Healing, Bath Co., Va. (88° F.).....	Chronic and subacute rheumatism, gout, neuralgia, nephritic and calculous diseases.
	Warm, Bath Co., Va. (98° F.).....	Chronic rheumatism, gout, diseases of liver, neuralgia, contractions of joints.
Calcareous and Earthy.	Hot, Bath Co., Va. (110° F.).....	Dartrous diseases of skin, functional diseases of uterus, chronic mercurial and lead poisoning.
	Paso Robles, San Luis, Obispo Co., Cal. (122° F.).....	Calculus, gravel, catarrh of stomach or bladder, dyspepsia.
	Hot, Garland Co., Ark. (93°-150° F.).....	Gravel, dyspepsia (diuretic, diaphoretic).
	Gottysburg, Adams Co., Penn.....	Neuralgia (restorative).
	Sweet, Monroe Co., W. Va. (74° F.).....	Purgative, diuretic.
	Berkeley, Morgan Co., W. Va. (74° F.).....	Diabetes mellitus, gravel, inflammation of bladder, dropsy, albuminuria (diuretic).
	Alleghany, Montgomery Co., Va.....	Apertient and alterative.
	Bethesda, Waukesha Co., Wis.....	Do. do.
	Lower Blue Lick, Nicholas Co., Ky.....	Dartrous skin diseases, diseases of the bladder, jaundice, dyspepsia.
	Sharon, Schoharie Co., N.Y.....	Do.; scrofula and syphilis.
Epsom Salt.	White Sulphur, Greenbrier Co., Va.....	Anæmia, gravel, calculus (strongly diuretic).
	Salt Sulphur, Monroe Co., W. Va.....	Rheumatism, gout, scrofula, neuralgia.
Common Salt.	Bedford, Bedford Co., Penn.....	Rheumatism, gout.
	St Catharines, Ontario, Canada.....	Dyspepsia, jaundice, abdominal pletthora.
	Caledonia, Ontario, Canada.....	Do. do. do.
	Hathorne, Saratoga, N.Y.....	Ulcers, diseases of the skin, passive hemorrhages, atonic diarrhoea (has 10 grains of free sulphuric acid in the pint).
Iron.	Ballston, Saratoga Co., N.Y.....	Chlorosis and anæmia generally; tonic.
	Oak-Orchard Acid, Genesee Co., N.Y.....	Do. do. do.
	Rawley, Rockingham Co., Va.....	Scrofula, chronic diarrhoea.
Glauber Salt.	Sweet Chalybeate, Alleghany Co., Va.....	Anæmia, chlorosis, chronic diarrhoea, dropsy.
	Rockbridge Alum, Rockbridge Co., Va.....	Do. do. do.
Alkaline.	Cooper's Well, Hinds Co., Miss.....	
	Crab Orchard, Lincoln Co., Ky.....	
	Midland, Midland Co., Mich.....	
	Bladon, Choctaw Co., Ala. (carbonated alkaline).....	
	Congress, Santa Clara Co., Cal. (saline alkaline).....	
	St Louis, Gratiot Co., Mich. (simple alkaline).....	Dyspepsia, neuralgia, chronic and subacute rheumatism.

Bibliography.—I. German: E. Osann, *Darstellung der Heilquellen Europas*, 3 vols., Berlin, 1839-43; J. Seegen, *Handbuch der Heilquellenlehre*, Vienna, 1862; B. M. Lersch, *Hydrochemie*, 1870, and many other works; Helfft, *Handbuch d. Balneotherapie*, 8th ed., Berlin, 1874; Valentiner, *Handbuch d. Balneotherapie*, Berlin, 1876; L. Lehmann, *Bäder u. Brunnen Lehre*, Bonn, 1877; J. Braun, *System. Lehrbuch d. Balneotherapie*, 4th ed., by Fromm, Berlin, 1880; O. Leichtenstern, *Balneotherapie*, Leipzig, 1880. 2. French: *Dictionnaire des Eaux minerales*, &c., by MM. Durand-Fardel, &c., 2 vols., Paris, 1860; J. Lefort, *Traité de Chimie Hydrologique*, 2d ed., Paris, 1873; C. James, *Guide Pratique aux Eaux*

minerales, Paris (many editions); Macé, *Guide aux Villes d'Eaux*, &c., Paris, 1881; Joanne and Le Pileur, *Les Bains d'Europe*, Paris. 3. Swiss: Meyer Ahrens, *Heilquellen der Schweiz*, Zürich, 1867; Gsell Fels, *Die Bäder und Kurorte der Schweiz*, Zürich, 1880. 4. Italian: G. Jervis, *Guida alle Acque Minerali d'Italia*, Turin, 1876, &c.; E. F. Harless, *Die Heilquellen und Kurörter Italiens*, Berlin, 1848. 5. Spanish: Rubio, *Tratado de las Fuentes Minerales de España*, Madrid, 1833; Don J. de Antelo y Sanchez has recently published a work on Spanish waters. 6. English: T. Short, *History of the Mineral Waters*, London, 1794; J. Rutt, *Methodical Synopsis of Mineral Waters*, London, 1767; Granville, *Spas of England*, 1841; E. Lee, *Mineral Springs of England*, London, 1841; J. Macpherson, *Our Baths and Wells*, 1871; Id., *Baths and Wells of Europe*, 1873; and H. Weber's English edition of Braun, London, 1875. A great portion of the literature is to be found in monographs on particular places. 7. American: J. Bell, *The Mineral and Thermal Springs of the United States and Canada*, 1855; Moorman, *The Mineral Waters of the United States and Canada*, 1857; Chandler, *Lecture on Water*, 1871; Walton, *The Mineral Springs of the United States and Canada*, (J. M.—A. R. L.)

MINERVA (*i.e.*, *menes-va*, endowed with mind) was the Roman goddess who presided over all handicrafts, inventions, arts, and sciences. She was probably an Etruscan deity, but her character was modified on Roman soil through her identification with the Greek Pallas Athena. (see ATHENA). No legend of her birth is recorded; the Roman deities were abstractions, not distinct persons with an individual history. Her chief worship in Rome was in the temple built by Tarquin on the Capitol, where she was worshipped side by side with Jupiter and Juno. This foundation may be assigned to Etruscan influence. She had also an old temple on the Aventine, which was a regular meeting-place for dramatic poets and actors. The dedication day of the temple and birthday of the goddess was March 19, and this day was the great festival of Minerva, called *quinquatrus* because it fell on the fifth day after the Ides. The number five was sacred to the goddess. All the schools had holidays at this time, and the pupils on reassembling brought a fee (*minerval*) to the teachers. In every house also the *quinquatrus* was a holiday, for Minerva was patron of the women's weaving and spinning and the workmen's craft. At a later time the festival was extended over five days, and games were celebrated. This feature is evidently due to the Græcizing conception of Minerva as the goddess of war. To this same Græcizing tendency we must attribute the *lectisternium* to Minerva and Neptune conjointly after the battle of the Trasimene Lake. The 23d had always been the day of the *tubilustrium*, or purification of the trumpets, so that the ceremony came to be on the last day of Minerva's festival. Trumpets were used in many religious ceremonies; and it is very doubtful whether the *tubilustrium* was really connected with Minerva. There was another temple of Minerva on the Cælian Hill, and a festival called the lesser *quinquatrus* was celebrated there on June 13-15, chiefly by the flute-players.

Minerva of the Cælian temple was called *Capta*; June 19 was the foundation day of this temple and the birthday of the goddess. The *palladium*, an archaic image of Pallas, was brought from Troy to Lavinium, and thence to Rome by the family of the Nautii; it was preserved in the temple of Vesta as a pledge of the safety of the city. There are some traces of an identification of Minerva with the Italian goddess Nerio, wife of Mars; it is probable that March 19 was originally a feast of Mars.

Besides Preller, *Röm. Myth. and Hartung, Relig. d. Römer*, &c., see Jordan, *Ephem. Epigraph.*, 1. 238; Mommsen, *C. I. L.*, 1. 888; Usener, *Rhein. Mus.*, xxx. 222.

MINGRELIA, a former principality of Transcaucasia, which became subject to Russia in 1804, and since 1867 has constituted three circles of the government of Kutais—Letchgum, Senakh, and Zugdidi. The country corresponds to the ancient Colchis; and Izgaur or Iskuriah on the Black Sea coast, which was the capital during the period of Mingrelian independence under the Dadian dynasty, is to be identified with the ancient Dioscurias, a colony of Miletus. The Mingrelians (still almost exclusively confined to the Mingrelian territory, and numbering 197,000) are closely akin to the Georgians. See CAUCASUS, vol. v. p. 257, and GEORGIA.

MINIATURE is a term which by common usage has come to be applied to two different branches of painting.

Derived from the Latin word *minium*, the red pigment used in the primitive decoration of MSS., in the first place it is the technical word employed to describe a painting in a MS.; and, from the fact of such pictures being executed on a reduced scale, it has its secondary and modern signification of a small, or miniature, portrait. In the latter sense it belongs to the general subject of painting. Here it is proposed to trace the development of the miniature in MSS. of the different schools of Europe.

The rise of the art of ILLUMINATION, in which the miniature plays so important a part, has been described under that heading; and something has been said in that place about the earliest extant specimens of miniature painting. Unfortunately we cannot with any certainty reach farther back than the 4th century for the most ancient of them; and all remaining examples between that period and the 7th century in Greek and Latin MSS. can be counted on the fingers. The two famous codices of Virgil in the Vatican Library stand pre-eminent as the most ancient Latin MSS. decorated with paintings. The miniatures in the first of them, the *Codex Romanus*, are large and roughly yet boldly executed paintings, which have no pretension to beauty, and are simply illustrations; but they are as old as the 4th century, and are of the highest value in enabling us to appreciate the debased style to which classical art had descended, and which no doubt was more largely employed than we might think. The second MS., the *Schedæ Vaticana*, which may also be assigned to the 4th century, is far more artistic and retains a good deal of the grace of classic art. Of the same kind, but of rather later date, are the fragments of the *Iliad* in the Ambrosian Library at Milan, the miniatures of which are generally of excellent design. Next comes the Dioscorides of the Imperial Library at Vienna, with its semiclassical portrait-miniatures executed at the beginning of the 6th century. Of a rather later period are the paintings which illustrate the Greek MS. of Genesis in the same library. A far finer and older MS. of the same book of the Pentateuch once existed in the Cottonian Library, but was almost totally destroyed by fire. The few fragments of the miniatures which once filled this volume, and which were of the 5th century, are sufficient to show what excellent work could be done in the capital of the eastern empire, from whence the MSS. most probably came. The late interesting discovery of an illustrated MS. of the Gospels in Greek, of the latter part of the 6th century, at Rossano in southern Italy, adds another number to our scanty list of early volumes of this class, which is closed by the Latin Pentateuch in the library of the earl of Ashburnham. This last MS., however, is not older than the 7th century. It was executed in Italy, and is adorned with many large miniatures, not of high artistic merit, but of great interest for the history of painting and of costume.

Coeval with the MSS. which have just been enumerated are the beautiful mosaics and wall-paintings which are seen at Rome, Ravenna, and in other parts of Italy, serving as standards of comparison and carrying on the history of art where MSS. fail us. The strong and ever-increasing Byzantine element which appears in these works prepares us to find the predominance of the same influence when we again pick up the broken thread of the history of miniature painting. We may then, at this point, turn for a moment to the east of Europe and state briefly what remains of Greek art in MSS. Of Greek miniatures there are still many fine examples extant, but, excepting those which have been noticed above, there are few which are earlier than the 11th century. At this period the miniature appears in the set form which it retained for the next two or three hundred years; and the connexion between its

style and that of the mosaics is too evident for us to be at a loss to explain the course of development. The figure drawing is delicate, but rather exaggerated in length; the colours are brilliant; and the whole effect is heightened by glittering backgrounds of gold. In some few instances, however, the Greek artist breaks away from conventionalism, and, especially when portraying the divine features of the Saviour or some subject which deeply stirs his feelings, he surprises us with the noble dignity with which he invests his figures. Minuteness also caught the fancy of these Byzantine miniaturists; and there still remain MSS., such as Psalters and saints' lives, adorned throughout with delicate little drawings of great symmetry and beauty. The ornamentation which was employed in Greek MSS. in the period of which we are speaking, either as frames for miniatures or as borders or head-pieces, is designed evidently after Eastern types, and has more than an accidental likeness to the patterns which are seen in the tapestries and prayer-carpets of Persia. After the 13th century decadence sets in, and we need not follow the course of Byzantine art in MSS. farther than to notice that immediately from it sprang such national styles as those of Russia, Bulgaria, and modern Greece.

Meanwhile, in the West, under the fostering care of Charlemagne, arose a great school of decoration in MSS., which at the close of the 8th and beginning of the 9th century were multiplied and enriched with all the splendour that colours and gilding could give to them. But the books thus ornamented were almost always copies of the Gospels, or Bibles, or church service books, which afforded little scope for invention. Hence among the miniatures of this period we have an endless repetition of portraits of the evangelists, drawn, for the most part, in a lifeless way after Byzantine traditions, and degenerating, as time passes, into positive ugliness. The few miniatures of other descriptions, such as Biblical illustrations, show no great merit, and a half-barbaric splendour was generally preferred to artistic effect. But an exception must be made in regard to the style of drawing found in the MS. known, on account of its present resting-place, as the Utrecht Psalter. This volume is filled from beginning to end with delicately drawn pen illustrations, designed and executed with a facility which, compared with the mechanical and clumsy drawing of other Continental MSS. of the period, is astonishing. And these drawings are of particular interest for us, as they are of the style which was adopted in England and which gives to Anglo-Saxon art its distinctive aspect. Executed about the year 800 or early in the 9th century, and probably in the north of France, the volume was soon brought to England, where, however, MSS. of the same kind, it may be assumed, had long before been introduced. The light "fluttering" outlines of the drapery and other details of the drawings seem to suggest that the original models were derived directly from Roman life, and perhaps partly copied from sculpture; but those models must have gone through many modifications before passing into the style of the drawings of the Psalter. That the MS. was copied from an older one there can be scarcely a doubt; and it is not impossible that the original archetype may date back some centuries earlier. May not MSS. which St Augustine and his successors brought from Rome have contained drawings of the same kind? This style of drawing was, at all events, adopted and became nationalized in England; but it had there a rival in the Irish school of ornamentation, introduced from the north of the island. The early civilization of Ireland placed her in the van of art development in these islands. The wonderfully intricate interlaced designs which render Irish MSS. of the 7th and 8th centuries such marvels of exact workmanship derive their origin, in all probability, from the metal-work

of earlier ages. But, apart from ornamentation, the Irish miniatures of saints and evangelists are extraordinary and grotesque instances of purely mechanical drawing, which cause us to wonder how the same eyes and hands which assisted in the creation of such beautiful specimens of pure ornament could tolerate such caricatures of the human shape. The explanation is perhaps to be found in superstitious regard for tradition. This style of art was carried by the monks to Iona and thence to Lindisfarne, where was founded the school which produced, in the 8th and 9th centuries, the richly ornamented codices of Durham. While, then, Byzantine models were copied on the Continent, the free drawing introduced from the south and the intricate ornamentation brought in from the north were practised in England; but the free drawing, with its accompanying decoration copied from foliage, and gradually developing into beautiful borders harmoniously coloured, gained the day, and lasted down to the time of the Norman Conquest. The one great fault of this latter style of drawing strikes the eye at the first glance. This is the inordinate length of limb with which the human figures are endowed. But this blemish is forgotten when one comes to appreciate the many points of merit in the designs.

In Italy, after a long period of inactivity, two very different styles of decoration of MSS. sprang into existence. The first of these was that of the Lombardic school, which is distinguished by intricate patterns and bright colouring. The large initial letters which are found in the MSS. of the 11th and 12th centuries, the best period of this style, are often a perfect maze of interlaced bands and animal forms, and are extremely handsome and effective. Figure drawing, however, seems to have been but little practised by the Lombardic artists, but such as there is appears on a broad scale and well executed. In the collections of Monte Cassino are some of the best examples of this school. In the second style which developed in Italy the Byzantine influence is at first most marked. Indeed, among its early specimens of the 13th century are some which might pass for the work of Greek artists. But the genius of the Italians soon assimilated the foreign element, and produced a national school which spread throughout the peninsula and afterwards extended its influence to southern France and Spain. It is, however, remarkable that in a country which produced such fine pictures and wall-paintings at an early date there is comparatively little miniature painting in contemporary MSS. A curious and early instance of this kind of art occurs in a MS. in the British Museum, written and ornamented with a series of miniatures at Winchester, in the 12th century, in which are two paintings which are purely Italian and of more than ordinary excellence.

In the majority of the extant Italian miniatures of the 14th century the influence of the great artists of the Florentine school is manifest. The peculiar treatment of flesh tints, painted in body colour over a foundation of olive-green, and the peculiar vermilion and other colours which need be but once seen to be ever afterwards recognized as belonging to this school, are constantly present. The figures are generally rather shortened and the drapery carried in straight folds, very different characteristics from the swaying figures and flowing drapery of the English and French artists of the same period. The ornamentation which accompanied this style of miniature generally consists of heavy scrolls and foliated or feather-like pendants from the initial letters, with spots of gold set here and there in the border. There are also extant some examples of a most beautiful kind of ornamentation which appears to have originated in central Italy, and which seems to partake of the qualities of both the styles of Italian art of which we have been speaking, combining

the drawing of the Florentine school with a lighter colouring which may have been suggested by the Lombardic.

Of native Spanish miniature art little can be said. In the Visigothic MSS. of the early Middle Ages there is no ornament beyond roughly coloured initial letters and some barbaric figure drawing. A little later, however, we get some indication of national peculiarities in the MSS. of the 10th, 11th, and 12th centuries. Here there appear miniatures, stiff and rude in their drawing, but exhibiting the unmistakable Spanish predilection for sombre colours, — dusky reds and yellows and even black entering largely into the compositions.

The materials at our disposal of the 10th, 11th, and 12th centuries show the gradual development in France and western Germany of a fine free-hand drawing which was encouraged by the proportionately increasing size of books. Both in outline and colour the fully developed miniatures of the 12th century are on a grand scale; and initial letters formed of scrolls and interlacings assume the same proportions. The figure drawing of this time is frequently of great excellence, the limbs being well-proportioned; care is also bestowed upon the arrangement of the drapery, which is made to follow the shape and, as it were, to cling to the body.

But the great revulsion from the broad effects and bold grandeur of the 12th century to the exact details and careful finish of the 13th century is nowhere more striking than in miniature painting in MSS. With the opening of the new period we enter on a new world of ideas. Large books generally disappear to give place to smaller ones; minute writing supersedes the large hand; and miniatures appear in circumscribed spaces in the interior of initial letters. The combination of the miniature with the initial brings it into close connexion with the ornamental border, which develops *pari passu* with the growth of the miniature and by degrees assumes the same national and distinctive characteristics. Burnished gold was now also freely used, tending to give the miniature a more decorative character than formerly. In England, northern France, and the Netherlands the style of miniature painting of this period was much the same in character; and it is often difficult to decide from which of these countries a MS. is derived. English work, however, may be often distinguished by its lighter colouring, while deeper and more brilliant hues and a peculiar reddish or copper tinge in the gold marks French origin. The drawing of the Flemish artists was scarcely so good, the outlines being frequently heavy and the colours rather dull. Of the Rhenish or Cologne school examples are more scarce; but they generally show greater contrasts in the colours, which, though brilliant, are not so pleasing. As the century advanced, and particularly at its close, national distinctions became more defined. English artists paid more attention to graceful drawing and depended less upon colour. In some of their best productions they are satisfied with slightly tinting the figures, finding room in the backgrounds for display of brilliant colours and gilding. In France the drawing, though exact, is hardly so graceful, and colour plays a more important part. From the 13th to the middle of the 15th century great decorative effect is obtained by the introduction of diapered or other highly ornamented backgrounds. Of landscape, properly so called, there is but little, a conventional hill or tree being often taken as sufficient indication. Borders begin in the 13th century in the form of simple pendants from the initial letters, terminating in simple buds or cusps. But once arrived fairly in the 14th century, a rapid development in all parts of the decoration of MSS. takes place. There is greater freedom in the drawing; the borders begin to throw out branches and the bud expands into leaf. This is the best

period of English miniature painting, many of the fine MSS. of this century which are preserved in the public libraries bearing witness to the skill and delicate touch of native artists. In France the decoration of MSS. received a great impetus from the patronage of King John and Charles V., of whose famous libraries many handsome volumes are still to be seen; and later in the century the duke of Berri carried on the same good work.

With regard to miniature art in Germany there are so few examples to guide us that little can be said. Most of them are rough in both drawing and colouring; and in the few remaining specimens of really good work foreign influence is distinctly seen. In the west the art of France and Flanders, and in the south that of Italy, are predominant. Perhaps the finest MS. of this southern style to be seen in England is a Psalter belonging to Lord Ashburnham, which was probably executed in the 14th century at Prague, and is full of miniatures which in drawing and colouring follow the Italian school.

When we enter the 15th century we find great changes in both the great English and French schools. In England the graceful drawing of the previous century has disappeared. At first, however, some beautiful examples of purely native work were produced, and still remain to excite our admiration. Probably the most perfect of these MSS. are the Sherborne Missal belonging to the duke of Northumberland, and a very beautiful volume, a Book of Hours, in the library of Lord Ashburnham. The care bestowed upon the modelling of the features is particularly noticeable in English work of this period. In decoration the border of the 14th century had by this time grown to a solid frame surrounding the page; but now another form of most effective ornament was also used, consisting of twisted feather-like scrolls brightly coloured and gilt. As the century advanced native English work died out, and French and then Flemish influence stepped in.

In France immense activity was shown all through the 15th century in the illumination and illustration of books of all kinds, sacred and profane; and it is in the MSS. of that country, and, a little later, in those of the Low Countries, that we can most exactly watch the transition from mediæval to modern painting. Early in the century there were executed in France some of the most famous MSS. which have descended to us. In these the colouring is most brilliant, the figure drawing fairly exact; and the landscape begins to develop. The border has grown from the branching pendant to a framework of golden sprays or of conventional and realistic leafage and flowers. Towards the middle of the century the diaper disappears for ever, and the landscape is a recognized part of the miniature; but perspective is still at fault, and the mystery of the horizon is not solved until the century is well advanced. And now Flemish art, which had long lain dormant, sprang into rivalry with its French sister, under the stimulus given to it by the Van Eycks, and the struggle was carried on, but unequally, through the rest of the century. French art gradually deteriorates; the miniatures become flat and hard; nor are these defects compensated for by the meretricious practice of heightening the colours by profusely touching them with gold. The Flemish artists, on the other hand, went on improving in depth and softness of colouring, and brought miniature painting to rare perfection. The borders also which they introduced gave scope for the study of natural objects. Flowers, insects, birds, and jewels were painted in detached groups on a solid framework of colour surrounding the page.

But if, as the 15th century drew to its close, the Flemings had outstripped their French rivals, they had now more powerful antagonists to contend with. The Italians had been advancing with rapid strides towards the glories of

the Renaissance. Early in the century there arose a taste for older models. As, for their writing and afterwards for their printing, they went back to the 11th and 12th centuries for their standards, so they adopted again the interlacing designs of the Lombardic school for their ornament, and produced beautiful borders of twining patterns relieved by colour; or they took natural objects for their models, and painted borders of delicate flowers made still more brilliant with clustering stars of gold. Later, they drew from the ancient classical designs inspiration for the wonderful borders of arabesques, medallions, griffins, human forms, antique objects, &c., which they brought to such perfection early in the next century. Their miniatures rose to the rank of exquisitely finished pictures, and were executed by some of the best artists working under the patronage of such great houses as those of Sforza and Medici.

Here then, having advanced to the threshold of the domain of modern painting, we leave these two great schools of miniaturists in possession of the west of Europe. The Flemings had the wider field; they were wanderers

from home; and their works are scattered through many lands, from England in the north to Spain in the south. But Italian art had greater inherent strength, and will always hold the first rank. To instance a few of the more famous MSS. of this closing period of miniature painting, the Breviary of Isabella the Catholic in the British Museum, is a masterpiece of Flemish art produced in Spain; the Grimani Breviary at Venice is another fine example of the same school. Some beautiful Italian miniatures (executed for Leo X. and others) were in the collection lately sold by the duke of Hamilton. The earl of Ashburnham possesses a most delicately illuminated Book of Hours written for Lorenzo dei Medici by the famous scribe Sinibaldo in 1485, as well as a MS. to which Perugino and his contemporaries contributed paintings. And in one MS., a Book of Hours belonging to Mr Malcolm of Poltalloch, are gathered some of the best miniatures of both schools, viz., a series of exquisite paintings by Milanese artists supplemented by later ones of the finest Flemish type. (E. M. T.)

MINIMS. See FRANCIS (St) OF PAOLA, vol. ix. p. 695.

MINING

THE art of mining consists of those processes by which useful minerals are obtained from the earth's crust. This definition is wider than what is popularly known as mining, for it includes not only underground excavations but also open workings; at the same time it excludes underground workings which are simply used for passages, such as railway tunnels and sewers, and galleries for military purposes. We must remark also that the word "miné," or its equivalent in other languages, varies in signification in different countries on account of legal enactments or decisions which define it. Thus, in France and Belgium, the workings for mineral are classified by the law of 1810, according to the nature of the substance wrought, into *mines, minières, et carrières*. In the United Kingdom, on the contrary, it is the nature of the excavation which decides the question for certain legislative purposes, and the term mine is restricted to workings which are carried on underground by artificial light. The consequence is that what is merely an underground stone quarry in France becomes a true mine in England, whilst the open workings for iron ore, such as exist in Northamptonshire, would be true mines under the French law. It is necessary, therefore, in an article on mining, to go beyond the English legal definition of a mine, and include the methods of working minerals in excavations open to daylight as well as in those which are purely subterranean. Furthermore, as it is customary for the miner to cleanse his ore to a greater or less extent before selling it to the smelter, we shall treat, under the head of mining, those processes which are commonly known as the dressing or mechanical preparation of ores; and, finally, a few remarks will be made concerning legislation affecting mines in the United Kingdom, accidents in mines, and the production of the useful minerals in various parts of the globe.

The subject therefore will be dealt with as follows:—

1. Manner in which the useful minerals occur in the earth's crust, viz., tabular deposits and masses; faults or dislocations.
2. Prospecting, or search for mineral.
3. Boring with rods and ropes; diamond drill.
4. Breaking ground; tools employed; blasting by various methods; machine drills; driving levels and sinking shafts.
5. Principles of employment of mining labour.
6. Means of securing excavations by timber or masonry.

7. Exploitation, or the working away of strata or veins.

8. Carriage or transport of minerals through underground roads.

9. Winding, or raising in the shafts, with the machinery and apparatus required.

10. Drainage of mines, adit-levels, pumps, pumping engines.

11. Ventilation and lighting of mines.

12. Means of descending into and ascending from mines.

13. Dressing or mechanical preparation of minerals.

14. Recent legislation affecting mines in the United Kingdom.

15. Accidents in mines.

16. Useful minerals produced in various parts of the globe.

1. *Manner in which the Useful Minerals Occur.*—The repositories of the useful minerals may be classified according to their shape as (A) tabular deposits, and (B) masses. A. *Tabular Deposits.*—These are deposits which have a more or less flattened or sheet-like form. They may be divided, according to their origin, into (1) beds or strata, and (2) mineral veins or lodes.

(1) *Beds.*—Geology teaches us that a large proportion of the rocks met with at the surface of the earth consist of substances arranged in distinct layers, owing to the fact that these rocks have been formed at the bottom of seas, lakes, or rivers by the gradual deposition of sediment, by precipitation from solutions, and by the growth or accumulation of animal and vegetable organisms. If any one of these layers consists of a useful mineral, or contains enough to make it valuable, we say that we have a deposit in the form of a bed, stratum, or seam. Of course the most important of all bedded or stratified deposits is coal, but, in addition, we have beds of anthracite, lignite, iron ore, especially in the Oolitic rocks, cupiferous shale, lead-bearing sandstone, silver-bearing sandstone, diamond, gold, and tin-bearing gravels, to say nothing of sulphur, rock-salt, clays, various kinds of stone, such as limestone and gypsum, oil-shale, alum-shale, and slate.

The characteristic feature of a bed is that it is a member of a series of stratified rocks; the layer above it is called the *roof* of the deposit, and the one below it is the *floor*. Its *thickness* is the distance from the roof to the floor at right angles to the planes of stratification; its *dip* is the

inclination downwards measured from the horizontal; its *strike* is the direction of a horizontal line drawn in the middle plane.

The thickness of beds that are worked varies within very wide limits. Whilst the thickness of certain workable beds of coal is only 1 foot, and that of the Mansfeld cupiferous shale only 10 to 20 inches, we find on the other hand one of the beds of lead-bearing sandstone at Mechnich no less than 85 feet thick, and beds of slate far exceeding that thickness. It must not be supposed, however, that the thickness of a bed necessarily remains uniform. Occasionally this is the case over a very large area; but frequently the thickness varies, and the bed may dwindle away gradually, or increase in size, or become divided into two owing to the appearance of a parting of valueless rock. Fig. 1 shows beds of shale, limestone, iron ore, and sandstone. Any one of these beds may be valuable enough to be worked.



Fig. 1.

Mineral veins.

(2) *Mineral Veins or Lodes.*—Veins or lodes are tabular or sheet-like deposits of mineral which have been formed since the rocks by which they are surrounded; they differ, therefore, by their subsequent origin from beds, which, as just stated, are of contemporaneous origin with the enclosing rocks (although of course cases occur in which the deposit is lying unconformably upon very much older strata, or is covered unconformably by very much younger strata). It is necessary to explain that the term "vein" in this definition is used in a more restricted sense than is sometimes customary among miners, who speak of veins of coal, clay-ironstone, and slate, which geologically are true beds. They see a band of valuable mineral or rock, and, careless of its origin, call it metaphorically a vein or seam. On the other hand, the definition is broader than that which prevails among some geologists, who would confine the term vein to deposits occupying spaces formed by fissures.

The term "lode" was defined in 1877 by Mr Justice Field in the celebrated Eureka v. Richmond case as follows:—"We are of opinion, therefore, that the term, as used in the Acts of Congress, is applicable to any zone or belt of mineralized rock lying within boundaries clearly separating it from the neighbouring rocks." This interpretation seems suitable for the peculiar mining tenure of the United States, where the discoverer of a vein or lode can obtain a mining claim of 500 yards in length along the lode. It protects the prospector, whose object is to obtain a secure title, the mode of origin of the deposit being a matter of small importance to him so long as it is worth working. In many cases also it would be impossible to decide upon the mode of origin until workings had progressed considerably, and even then there would be room for disputes.

No doubt a very large number of mineral veins are simply the contents of fissures; others are bands of rock impregnated with ore adjacent to fissures or planes of separation; others, again, have been formed by the more or less complete replacement of the constituents of the original rock by particles of ore.

Veins may occur in igneous or in sedimentary rocks, and in the latter they frequently cut across the planes of stratification.

Like a bed, a vein has its dip and strike; but, as the dip of veins is generally great, the inclination is usually measured from the vertical, and is then spoken of as the *underdip* or *hade*. The bounding planes of a vein are called the *walls* or *cheeks*, and they are frequently smooth and striated, showing that one side must have slid against the other. The upper wall is known as the *hanging wall*, the lower one as the *foot wall*. The width of a vein is measured at right angles to the walls.

A typical example of a fissure-vein is shown in fig. 2, representing a lead lode in slate at Wheal Mary Ann mine¹ in Cornwall.

¹ C. Le Neve Foster, "Remarks on the Lode at Wheal Mary Ann, Menheniot," *Trans. Roy. Geol. Soc. Cornwall*, vol. ix. p. 153.

It is evident that a fissure in the surrounding slate has here been filled up by the successive deposition of bands of mineral on both sides.

A large proportion of the contents of a lode may consist of fragments of the walls that have fallen into the original fissure, and these are often tightly cemented together by minerals that have been introduced subsequently. The horizontal section of part of the Comstock lode² (Plate IV.) shows much "country" rock enclosed within the walls.

Where a lode consists of rock impregnated with ore, the mineralized part may fade away gradually into the surrounding rock (*country*) without there being any distinct wall, as shown in fig. 3, which is an illustration taken from the Great Flat Lode³ near Redruth in Cornwall.

The celebrated Ruby Hill deposit in the Eureka district, Nevada, is a mineralized zone of dolomitic limestone varying in width from a few inches to 450 feet, and having a mean width of 250 feet. It contains numerous irregular ore-bodies, which consist mainly of highly ferruginous carbonate of lead, rich in silver and gold. This mineralized limestone band, long called a lode by miners, has been determined by the decision just mentioned to be a lode in the eyes of the law.

Veins often continue for a great distance along their strike. The Van lode in Montgomeryshire is known for a length of 9 miles, whilst the Great Quartz Vein in California has been traced for a distance of no less than 80 miles. Veins are of less uniform productiveness than beds, and are rarely worth working throughout. Rich portions alternate with poor or worthless portions. The rich parts have received various names according to the forms they assume: fig. 4 represents a longitudinal section along the strike (*course*) of a lode, and the stippled parts are ore-bodies; B, B, Bare bunches; A is a large bunch or *course* of ore; when an ore-body forms a sort of continuous column we have a *shoot*, and ore-bodies which on being excavated leave chimney-like openings are called *pipes* (fig. 4, C). In the United States the Spanish word *bonanza*, literally meaning "fair weather" or "prosperity," is frequently used for a rich body of ore.

The richness of veins is dependent in many cases upon the nature of the adjacent rock (*country*), upon the underlie, and upon the strike, variations in any one of these three elements being often sufficient to cause a decided change of productiveness.

Various theories have been formed concerning the origin of mineral veins. Some geologists suppose that the minerals now constituting the veins have been dissolved out of the adjacent rocks and re-deposited in the vein cavity; others, on the contrary, believe that the ores have been brought up from great depths by mineral springs. In all probability both theories are correct, some lodes having been formed by the former process and some by the latter; and, furthermore, other lodes appear to owe their origin to a gradual substitution of valuable minerals in the place of some of the constituents of a worthless rock. One of the most important contributions to the science of ore-deposits of late years has been the discovery by Professor F. Sandberger of small quantities of silver, lead, copper, nickel, cobalt, bismuth, arsenic, antimony, and tin in silicates, such as olivine, augite, hornblende, and mica, which are constituents of igneous rocks. He therefore regards these rocks as the sources from which lodes have derived their riches.

B. *Masses.*—These are deposits of mineral, often of irregular shapes, which cannot be distinctly recognized as beds or veins. Such, for instance, are the red hematite

² James D. Hague, in *United States Geological Exploration of the Fortieth Parallel*, vol. iii., "Mining Industry," Washington, 1870, Atlas, plate 11.

³ C. Le Neve Foster, "On the Great Flat Lode south of Redruth and Camborne, and on some other Tin Deposits formed by the Alteration of Granite," *Quart. Jour. Geol. Soc.*, vol. xxxiv. p. 644.

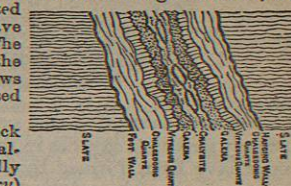


Fig. 2.

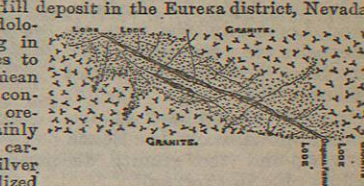


Fig. 3.

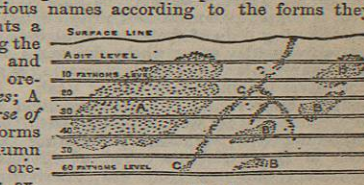


Fig. 4.