Mines, metals, and gems.

MINES, METALS, AND GEMS.

Through dark retreats pursue the winding ore,
Search nature's depths, and view her boundless store;
The secret cause in tuneful numbers sing,
How metals first were framed, and whence they spring:
Whether the active sun, with chymic flames,
Through porous earth transmits his genial beams;
With heat impregnating the womb of night,
The offspring shines with his paternal light:—
Or whether, urged by subterraneous flames,
The earth ferments, and flows in liquid streams;
Purged from their dross, the nobler parts refine,
Receive new forms, and with fresh beauty shine:—
Or whether by creation first they sprung,
When yet unpoised the world's great fabric hung:
Metals the basis of the earth were made,
The bars on which its fixed foundation's laid—
All second causes they disdain to own,
And from th' Almighty's fiat sprung alone.

YALDEN.

THOSE excavations in which metals, minerals, and precious stones are dug, are called MINES, and receive, from the substances they yield, various denominations. The richest and most celebrated gold and silver mines are those of Mexico and Peru, in South America. Iron mines are more abundant in Europe than elsewhere. Copper mines are chiefly found in England, Sweden, and Denmark; and lead and tin mines in England: the latter, more particularly in the county of Cornwall. Quicksilver mines abound principally in Hungary, Spain, Friuli, in the Venetian territory, and Peru; diamond mines, in the East Indies, and in the Brazils; and salt mines in Poland.

To explain the structure of mines, it should be observed that the internal parts of the earth, as far as they have yet been investigated, do not consist of one uniform substance, but of various strata, or beds, of substances, extremely different in their appearances, specific gravities, and chemical qualities, from one another. Neither are these strata similar to each other, either in their nature or appearance, in different countries; insomuch that, even in the short extent of half a mile, the strata will be found quite different from what they are in another place. As

little are they the same either in depth or solidity. Innumerable cracks and fissures are found in all of them; but these are so entirely different in size and shape, that it is impossible to form any inference from what may have been met with, relative to that which remains to be explored. In these fissures the metallic ore is contained.

In Cornwall, the most common opinion entertained by the miners is, that crude immature minerals nourish and feed the ores with which they are intermixed in the mines; and that the minerals themselves will, in process of time, be converted into ores productive of those metals to which they have the nearest affinity, and with which they have the greatest intercourse. In his mineralogy of Cornwall, Mr. Price thinks it most reasonable to conclude, that metals were made and planted in veins, at, or very soon after, the creation of the world: but that, in common with all other matter, they are subject to a degree of fluctuation, approaching to, or receding from, their ultimate degree of perfection, either quicker or slower, as they are of greater or less solid and durable frame and constitution. He supposes in every metal a peculiar magnetism, and an approximation of particles of the same specific nature, by which its component principles are drawn and united together; more particularly the matters left by the decomposition of the waters passing through the contiguous earths or strata, and deposited in their proper *nidus* or receptacle, until, by the accretion of more or less of its homogeneous particles, the metallic vein may be denominated either rich or barren.

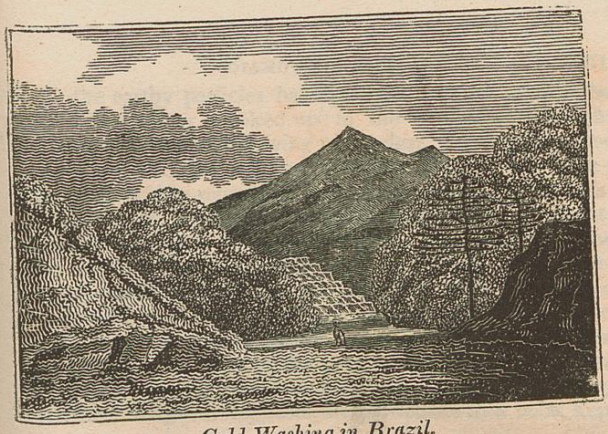
DIAMOND MINES.

The high value attached to diamonds does not depend so much on their beauty and hardness, as on their great scarcity, and the labour and expense necessary in procuring them. Hitherto they have been observed in the torrid zone alone; and Brazil is the only part of the Americas in which they have been found. The historical account of their discovery in that country is as follows. Near the capital of the territory of Serro do Frio flows the river Milho Verde, where it was the custom to dig for gold, or rather to extract it from the alluvial soil. The miners, during their search for gold, found several diamonds, which they

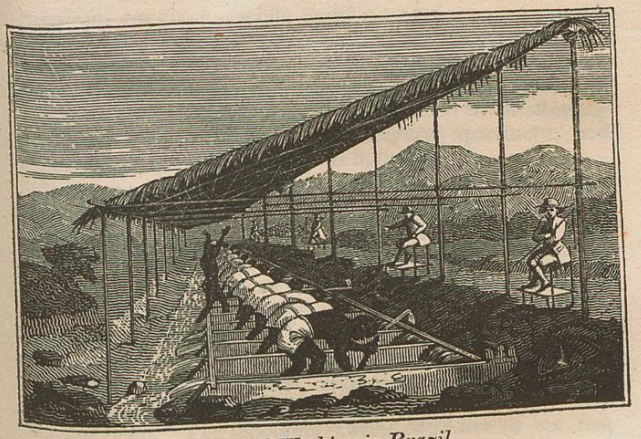
were induced to lay aside in consequence of their particular shape and great beauty, although they were ignorant of their intrinsic value.

The diamond works on the river Jigitonhonha are described by Mr. Mawe as the most important in the Brazilian territory. The river, in depth from three to nine feet, is intersected by a canal, beneath the head of which it is stopped by an embankment of several thousand bogs of sand, its deeper parts being laid dry by chain-pumps. The mud is now washed away, and the *cascalhao*, or earth which contains the diamonds, dug up, and removed to a convenient place for washing. The process is as follows. A shed, consisting of upright posts, which support a thatched roof, is erected in the form of a parallelogram, in length about ninety feet, and in width forty-five. Down the middle of its area a current of water is conveyed through a canal covered with strong planks, on which the earth is laid to the thickness of two or three feet. On the other side of the area is a flooring of planks, from twelve to fifteen feet in length, imbedded in clay, extending the whole length of the shed, and having a gentle slope from the canal. This flooring is divided into about twenty compartments, or troughs, each about three feet wide, by means of planks placed on their edge; and the upper end of these troughs communicate with the canal, being so formed that water is admitted into them between two planks about an inch separate from each other. Through this opening the current falls about six inches into the trough, and may be directed to any part of it, or stopped at pleasure, by means of a small quantity of clay. Along the lower ends of the troughs a small channel is dug, to carry off the water.

On the heap of earth, at equal distances, three high chairs are placed for the overseers, who are no sooner seated than the negroes enter the troughs, each provided with a rake of a peculiar form, and having a short handle, with which he rakes into the trough from fifty to eighty pounds weight of the earth. The water being then allowed to pass in by degrees, the earth is spread abroad, and continually raked up to the head of the trough, so as to be kept in constant motion. This operation is continued for a quarter of an hour, when the water begins to run clearer;



Gold Washing in Brazil.



Diamond Washing in Brazil.

and, the earthy particles having been washed away, the gravel-like matter is raked up to the end of the trough. At length the current flowing quite clear, the largest stones are thrown out, and afterwards those of an inferior size: the whole is then examined with great care for diamonds. When a negro finds one, he immediately stands upright, and claps his hands: he then extends them, holding the gem between the fore finger and the thumb. An overseer receives it from him, and deposits it in a bowl, suspended from the centre of the structure, and half filled with water. In this vessel all the diamonds found in the course of the day are deposited, and at the close of the work are taken out and delivered to the principal overseer, who, after they have been weighed, registers the particulars in a book kept for that purpose.

When a negro is so fortunate as to find a diamond of the weight of seventeen carats and a half, the following ceremony takes place: he is crowned with a wreath of flowers, and carried in procession to the administrator, who gives him his freedom by paying his owner for it. He also receives a present of new clothes, and is permitted to work on his own account. For smaller stones proportionate premiums are given; while many precautions are taken to prevent the negroes from stealing the diamonds, with which view they are frequently changed by the overseers, least these precious gems should be concealed in the corners of the troughs. When a negro is suspected of swallowing a diamond, he is confined in a solitary apartment, and means taken to bring the gem to light.

In the EAST INDIES, THE KINGDOM OF GOLCONDA, extending two hundred and sixty miles along the bay of Bengal, and having a breadth of two hundred miles from east to west, abounds in DIAMOND MINES. They are chiefly in the vicinity of the rocky hills and mountains which intersect the country, and in the whole of which diamonds are supposed to be contained. In several of the mines they are found scattered in the earth, within two or three fathoms of the surface, and in others are met with in a mineral substance in the body of the rocks, forty or fifty fathoms deep. The labourers having dug five or six feet into the rock, soften the stone by fire, and proceed till they find the vein, which often runs two or three furlongs under

the rock. The earth being brought out, and carefully searched, affords stones of various shapes, and of a good water. This earth is of a yellowish, and sometimes of a reddish colour, frequently adhering to the diamond with so strong a crust that the separation becomes difficult.

To find the diamonds, the workmen form a cistern of a kind of clay, with a small vent on one side, a little above the bottom: in this vent they place a plug, and throwing into the cistern the earth they have dug, pour in water to dissolve it. They then break the clods, and stir the wet earth in the cistern, allowing the lighter part to be carried off in the form of mud, when the vent-hole is opened to let out the water. They thus continue washing until what remains in the cistern is pretty clean; and then, in the middle of the day, when the sun shines bright, carefully look over all the sand, at which practice they are so expert, that the smallest stone cannot escape them. The brightness of the sun being reflected by the diamonds, aids them in their research, which would be foiled if a cloud were to intervene.

The specific gravity of the diamond is to that of water in the proportion of somewhat more than three and a half to one. It is the hardest of all precious stones, and can only be cut and ground *by itself and its own substance*. To bring it to the perfection by which its price is so greatly augmented, the lapidary begins by rubbing several of these stones against each other, while rough, having first glued them to the ends of two wooden blocks, thick enough to be held in the hand. The powder thus rubbed off the stones, and received in a small box for the purpose, serves to grind and polish them.

The greatest known diamond was found in Brazil, and belongs to the King of Portugal. It weighs 1680 carats; and, although uncut, is estimated by Romé de l'Isle at the enormous sum of two hundred and twenty-four millions sterling, which gives an estimate of nearly eighty pounds sterling for each carat, the multiplicand of the square of its whole weight being taken. The one next in magnitude and value is that purchased in 1772 by the late Empress of Russia: it weighs seven hundred and seventy-nine carats, and has been estimated at nearly five millions sterling. It ought, however, to be observed, that these estimates, founded on the magnitude and brilliancy of the gems, are

very different from the prices which the most princely fortunes can afford to pay for them. The diamond in question cost about one hundred and thirty-five thousand pounds sterling; and the one called the PITT or REGENT, although it weighed one hundred and thirty-six carats only, was, on account of its greater brilliancy, purchased of a Greek merchant for one hundred thousand pounds sterling. Several other large diamonds are preserved in the cabinets of the Sovereigns and Princes of Europe.

GOLD AND SILVER MINES.

The mines of LA PLATA, so denominated on account of the abundance of silver it contains, are chiefly situated in the provinces which were strictly considered as Peruvian, before the new partition of territory in 1778; Charcas, Tucuman, and even Buenos Ayres, being then considered as dependencies of Peru. With the exception of New Spain, the upper part of the Viceroyalty of La Plata is the richest country in silver which has yet been discovered, and contains innumerable mines both of that metal and of gold. All its northern provinces teem with mineral opulence; and those of Laricaja and Carabaya are distinguished by the production of the latter, and still nobler metal, in its virgin state.

The mountain of Potosi alone produces weekly about five thousand marks of silver, that is, from thirty to forty thousand dollars—a surprising produce, when it is considered that it has been wrought since 1545, at which time it was accidentally discovered by an Indian. At the commencement it was still more abundant, and the metal was dug up in a purer state; but it is still considered as the most sure and permanent mine. The silver is often found in shoots imbedded in the earth. Six thousand Indians are sent, every eighteen months, from the provinces of the Viceroyalty, to work this mine. The expedition is called *mita*; and these Indians, having been enrolled and formed into parties, are distributed by the governor of Potosi, and receive a small daily stipend, (equal to about eighteen pence English) until the period of their labour is completed. They are thus condemned to a forced service, which is nothing less than slavery, so long as it lasts, and which the Spaniards endeavour to justify by the plea that labourers

could not otherwise be procured. The mita having thus, according to them, been rendered indispensable, they observe that it is conducted with all possible humanity; which those may believe who have never heard of the cruelties they have exercised, it may be said habitually, on the wretched Indians, since the conquest.

Lumps of pure gold and silver, called *papas*, from their resemblance to the potatoe, are often found in the sands. The poor likewise occupy themselves in *lavederos*, or in washing the sands of the rivers and rivulets, in order to find particles of the precious metals.

To compensate for the mines which are rendered useless by the irruption of water, or other accidents, rich and new ones are daily discovered. They are all found in the chains of mountains, commonly in dry and barren spots, and sometimes in the sides of the *quebredas*, or astonishing precipitous breaks in the ridges. However certain this rule may be in the Viceroyalty of Buenos Ayres, it is contradicted in that of Lima, where, at three leagues distance from the Pacific Ocean, not far from Tagna, in the province of Africa, there was discovered not many years ago the famous mine of Huantajaya, in a sandy plain at a distance from the mountains, of such exuberant wealth that the pure metal was cut out with a chisel. From this mine a large specimen of virgin silver is preserved in the royal cabinet of natural history at Madrid. It attracted a considerable population, although neither water nor the common conveniencies for labour could be found on the spot, nor was there any pasturage for the cattle.

In the mint of Potosi about six millions of dollars are annually coined; and the mines of the viceroyalty of La Plata, taken collectively, are reckoned to yield about sixteen millions. The new viceroyalty of Buenos Ayres contains thirty gold mines, twenty-seven silver mines, and sixteen of other metals.

The mines of Mexico, or New Spain, have been more celebrated for their riches than those of La Plata, notwithstanding which they are remarkable for the poverty of the mineral they contain. A quintal, or one thousand six hundred ounces of silver ore, affords, at a medium, not more than three or four ounces of pure silver, about one third of what is yielded by the same quantity of mineral in Saxony. It

is not, therefore, owing to the richness of the ore, but to its abundance, and the facility of working it, that the mines of New Spain are so much superior to those of Europe.

The fact of the small number of persons employed in working them, is not less contrary to the commonly received opinion on this subject. The mines of Guanaxuato, infinitely richer than those of Potosi ever were, afforded from 1796 to 1803, nearly forty millions of dollars in gold and silver, or very nearly five millions of dollars annually, being somewhat less than one fourth of the whole quantity of gold and silver from New Spain; notwithstanding which, these mines, productive as they were, did not employ more than five thousand workmen of every description. In Mexico, the labour of the mines is perfectly free, and better paid than any other kind of industry, a miner earning from five to five dollars and a half weekly, while the wages of the common labourer do not exceed a dollar and a half. The *tenateros*, or persons who carry the ore on their backs, from the spot where it is dug out of the mine, to that where it is collected in heaps, receive a sum equal to five English shillings for a day's work of six hours. Neither slaves, criminals, nor forced labourers, are employed in the Mexican mines.

In consequence of the clumsy, imperfect, and expensive mode of clearing them from water, several of the richest of these mines have been overflowed and abandoned; while the want of method in the arrangement of the galleries, and the absence of lateral communications, add to the uncertainty, and greatly increase the expense of working them. Labour is not, as in the working of the European mines, abridged, nor the transport of materials facilitated. When new works are undertaken, a due consideration is not bestowed on the preliminary arrangements; and they are always conducted on too large and expensive a scale.

More than three-fourths of the silver obtained from America is extricated from the ore by the means of quicksilver, the loss of which, in the process of amalgamation, is immense. The quantity consumed annually in New Spain alone is about sixteen thousand quintals; and, in the whole of America, about twenty-five thousand quintals are annually expended, the cost of which, in the colonies, has

been estimated at one-fourth of a million sterling. The greater part of this quicksilver has been lately furnished by the mine of Almaden in Spain, and that of Istria in Carniola, the celebrated quicksilver mine of Huancavelica in Peru having greatly fallen off in its produce, since the sixteenth century, when it was highly flourishing. The prosperity of the silver mines, both in Mexico and Peru, therefore greatly depends on the supplies of quicksilver from Spain, Germany, and Italy; for such is the abundance of the ore in those kingdoms, that the only limit to the quantity of silver obtained there, is the want of mercury for amalgamation.

In taking a general view of the riches of the other provinces of America, Mr. Humboldt, who has supplied these details, remarks that, in Peru, silver ore exists in as great abundance as in Mexico, the mines of Lauricocha being capable of yielding as great a produce as those of Guanaxuato; but that the art of mining, and the methods of separating the silver from its ore, are still more defective than in New Spain. Notwithstanding this imperfect system, the total amount of the precious metals annually furnished by America, is estimated at upwards of nine millions and a half sterling—the gold being in proportion to the silver as one to forty-six. From 1492 to 1803, the quantity of gold and silver extracted from the American mines has been equal in value to 5,706,700,000 dollars; of which immense sum, the portion brought into Europe, including the booty made by the conquerors of America, is estimated at 5,445,000,000, giving an average of seventeen million and a half of dollars yearly. The annual importation being divided into six periods, appears to have been constantly augmenting, and in the following progressive ratio. From 1792 to 1500, it did not exceed 250,000 dollars. From 1500 to 1545, it amounted to three millions of dollars. From 1545 to 1600, to eleven millions. From 1600 to 1700, to sixteen millions. From 1700 to 1750, to twenty-two millions and a half. And, lastly, from 1750 to 1803, to the prodigious sum of thirty-five millions three hundred thousand dollars, nearly equal to eight millions sterling.

The first period was that of exchange with the natives, or of mere rapine. The second was distinguished by the conquest and plunder of Mexico, Peru, and New

Granada, and by the opening of the first mines. The third began with the discovery of the rich mines of Potosi; and in the course of it the conquest of Chili was completed, and various mines opened in New Spain. At the commencement of the fourth period, the mines of Potosi began to be exhausted; but those of Lauricocha were discovered, and the produce of New Spain rose from two millions to five millions of dollars annually. The fifth period began with the discovery of gold in Brazil; and the sixth is distinguished by the prodigious increase of the mines of New Spain, while those of every other part of America, with the exception of the Brazils, have been constantly improving.

The GOLD MINES of BRAZIL are very productive. Those called GENERAL are distant about seventy-five leagues from Rio Janeiro, which is the staple and principal outlet of the riches of the Brazilian territory. They yield to the king, annually, for his right of fifths, at least one hundred and twelve arrobas [weighing twenty-five pounds each] of gold. Their yearly produce may, therefore, be estimated at upwards of eight hundred thousand pounds sterling; and that of the more distant mines at about one third the sum.

The gold drawn from them cannot be carried to Rio Janeiro, without being first brought to the smelting houses established in each district, where the right of the crown is received. What belongs to private persons is remitted in bars, with their weight, number, and an impression of the royal arms. The gold is then assayed, and its standard imprinted on each bar. When these bars are carried to the mint, their value is paid to the possessor in coin, commonly in half-doubloons, each worth eight Spanish dollars. Upon each of these half-doubloons the king gains a dollar, by the alloy and right of coinage. The mint of Rio Janeiro is one of the most beautiful in existence, and is furnished with every convenience for working with the greatest celerity. As the gold arrives from the mines at the same time that the fleets arrive from Portugal, it is necessary to accelerate the operations of the mint, and the coinage proceeds with surprising quickness.

In AFRICA, the kingdom of MOZAMBIC abounds in gold, which is washed down by the rivers, and forms a

chief part of the commerce of the country. The kingdoms of MONOMOTAPA and SOFALA likewise furnish considerable quantities of gold; and the Portuguese who reside in the latter territory, report that it yields annually two millions of *metigals*, equal to somewhat more than a million sterling. The merchants export from Mecca, and other parts, about the same quantity of gold. The soldiers are paid in gold dust, in the state in which it is collected; and this is so pure, and of so fine a yellow, as not to be exceeded, when wrought, by any other gold beside that of Japan. Gold is likewise found on the island of Madagascar. The gold coast is so denominated from the abundance of gold found among the sands: it is not, however, so productive as has been generally supposed, owing to the intense heats, which, in a great measure, prevent the natives from prosecuting their researches.

In ASIA, the ISLAND OF JAPAN is most productive of gold, which is found in several of its provinces, and is, in by far the greater proportion, melted from its ore. It is likewise procured by washing the sands, and a small quantity is likewise found in the ore of copper. The emperor claims a supreme jurisdiction, not only over the gold mines, but over all the mines of the empire, which are not allowed to be worked without a licence from him. Two thirds of their produce belong to him, and the other third is left to the governor of the province in which the mines are situated. But the richest gold ore, and that which yields the finest gold, is dug in one of the northern provinces of the island of Niphon, a dependency of Japan, where the gold mines have been highly productive until latterly, that they have much fallen off. In the Japanese province of Tsckungo, a rich gold mine, having been filled with water, was no longer worked: as it was, however, so situated, that, by cutting the rock, and making an opening beneath the mine, the water could be easily drawn off, this was attempted. At the moment of commencing the operation, so violent a storm of thunder and lightning arose, that the workmen were obliged to seek shelter elsewhere; and these superstitious people, imagining that the tutelar god and protector of the spot, unwilling to have the bowels of the earth thus rifled, had raised the storm to make them sensible of his great displeasure at such

an undertaking, desisted from all further attempts, through the fear of incurring his displeasure.

THIBET, a mountainous country of India, contains a great abundance of gold, which is traced in the rivers flowing from that territory into the Ganges. In Hindostan there are not any mines of gold; but in the Irnada district gold is collected in the river which passes Nelambur in the Mangery Talui, a Nair having the exclusive privilege of this collection, for which he pays a small annual tribute. Silver is in general rare throughout the oriental regions, and there is not any indication of this metal in India; but in Japan there are several silver mines, more particularly in the northern provinces, and the metal extracted from them is very pure and fine.

Turning to EUROPE, DALMATIA is said in ancient times to have produced an abundance of gold. Pliny reports that in the reign of the emperor Nero, fifty pounds of this precious metal were daily taken from the mines of that province; and that it was found on the surface of the ground. It is added that Vibius, who was sent by Augustus to subdue the Dalmatians, obliged that hardy and warlike people to work in the mines, and to separate the gold from the ore.

BOSSINA, in SCLAVONIA, contains many mineral mountains, and has rich mines of gold and silver. The district in which the latter are found is named *Srebrarniza*, being derived from the word *srebr*, which signifies silver in all the Sclavonian dialects. Their produce resembles the native silver of Potosi, and is found, combined with pure quartz, in small, thin leaves, resembling moss.

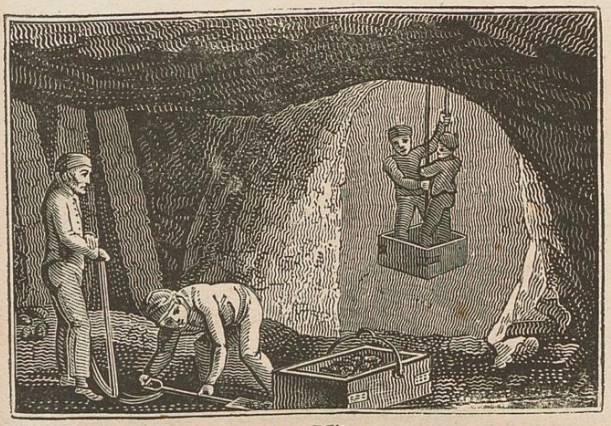
The kingdom of NORWAY formerly produced gold; but the expense of working the mines, and procuring the pure ore, being greater than the profit, these have been neglected. There are, however, silver mines, which are extremely valuable, and give employment to several thousands of persons. The principal of these is at Konigsberg, and was discovered in 1623, when the town was immediately built, and peopled with German miners. In 1751, forty-one shafts, and twelve veins, were wrought in this mine, and gave employment to three thousand five hundred officers, artificers, and labourers.

The silver ore is not, as was at first imagined, confined to

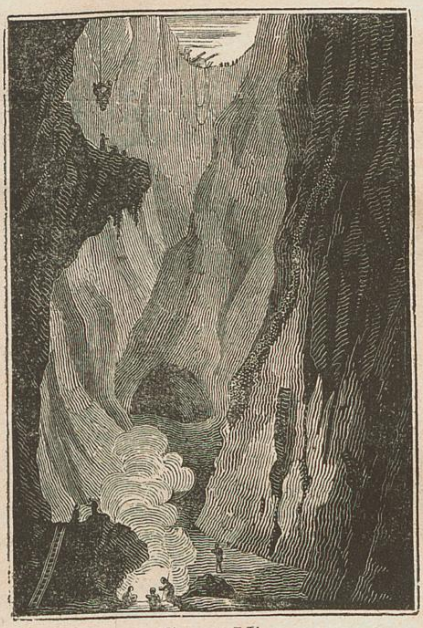
the mountain between Konigsberg and the river Jordal, but extends its veins for several miles throughout the adjacent districts, in consequence of which new mines have been undertaken in several places, and prosperously carried on. One of the richest and most ancient of the mines, named "Old God's blessing," has sometimes, in the space of a week, yielded several hundred pounds weight of rich ore. The astonishing depth of this mine, which is not less than a hundred and eighty fathoms perpendicular, fills the mind of the beholder with amazement; and the circumference at the bottom forms a clear space of several hundreds of fathoms. Here the sight of thirty or forty piles, burning on all sides in this gloomy cavern, and continually fed to soften the stone in the prosecution of the labours, seems, according to the notions commonly entertained, an apt image of hell; and the swarms of miners, covered with soot, and bustling about in habits according to their several employments, may well pass for so many infernal spirits; more especially when, at a given signal when the mine is to be sprung in this or that direction, they exclaim aloud: "Berg-livet, berg-livet!" Take care of your lives.

The gold mines of CREMNITZ lie forty miles south of the Carpathian hills; and twenty miles farther to the south, are the silver mines of SHEMNITZ. These are called mining towns; and the former is the principal, its rich ores being found in what is styled metallic rock. Its mines also produce a certain proportion of silver. Hungary is beside enriched by a mineral peculiar to itself, or one, at least, which has not hitherto been discovered elsewhere, namely, the opal—a gem preferred to all others by the oriental nations. The opal mines are situated at Ozerwiniza, where they are found in a hill consisting of decomposed porphyry, a few fathoms beneath the surface. Their produce is of various qualities, from the opake-white, or semi-opal, to the utmost refulgence of the lively colours by which this noble gem is distinguished.

TRANSYLVANIA and THE BANNAT contain numerous and valuable mines, consisting chiefly of grey gold ore, and white gold ore. The finest gold is found at Olapian, not far from Zalathna, intermixed with gravel and sand. The



Silver Mine.



Copper Mine.

sands of the Rhine, on the shores near Germerscheim and Sels, also contain gold.

The mountains of SPAIN were, according to ancient writers, very rich in gold and silver; and accordingly Gibbon calls that kingdom "the Peru and Mexico of the old world." He adds that "the discovery of the rich west-"ern continent by the Phenicians, and the oppression of "the simple natives, who were compelled to labour in their "own mines for the benefit of strangers, form an exact type "of the more recent history of Spanish America." The Phenicians were simply acquainted with the sea-coasts of Spain; but avarice as well as ambition carried the arms of Rome and Carthage into the heart of the country, and almost every part of the soil was found pregnant with gold, silver, and copper. A mine near Carthagena is said to have yielded daily twenty-five thousand drachms of silver, or three hundred thousand pounds sterling a year. The provinces of Asturia, Gallicia, and Lusitania, yielded twenty thousand pounds weight of gold annually: the modern Spaniards have, however, chosen rather to import the precious metals from America, than to seek them at home.

PORTUGAL is in many parts mountainous, and these mountains contain, beside others, rich ores of silver; but the Portuguese, like the Spaniards, being supplied with metals from their transatlantic possessions, and particularly with an abundance of gold and silver from Brazil, do not work the mines in their own country. Gems of all kinds, as turquoises and hyacinths, are also found in the above mountains, together with a beautifully variegated marble, and many curious fossils.

QUICKSILVER MINES.

THE quicksilver mines of IDRIA are the most interesting of these, and demand a particular description, as they have been celebrated in natural history, poetry, and romance. The ban of Idria is a district immediately subject to the Chamber of Inner Austria, and lies westward of Carniola. The town, which is small, is seated in a deep valley, amid high mountains, on the river of the same name, and at the bottom of so steep a descent, that its approach is a task of great difficulty, and sometimes of danger.

The mines were discovered in 1497, before which time that part of the country was inhabited by a few coopers

only, and other artificers in wood, with which the territory abounds. One evening, a cooper having placed a new ub under a dropping spring, to try if it would hold water, on returning next morning, found it so heavy that he could scarcely move it. He at first was led by his superstition to suspect that the tub was bewitched; but perceiving at length a shining fluid at the bottom, with the nature of which he was unacquainted, he collected it, and proceeded to an apothecary at Laubach, who, being an artful man, dismissed him with a small recompense, requesting that he would not fail to bring him further supplies.

The subterraneous passages of the great mine are so extensive, that it would require several hours to pass through them. The greatest perpendicular depth, computing from the entrance of the shaft, is 840 feet; but as these passages advance horizontally under a high mountain, the depth would be much greater if the measure were taken from the surface. One mode of descending the shaft is by a bucket; but as the entrance is narrow, the bucket is liable to strike against the sides, or to be stopped by some obstacle, so that it may be readily overset. A second mode of descending is safer, by the means of a great number of ladders, placed obliquely, in a kind of zig-zag: as the ladders, however, are wet and narrow, a person must be very cautious how he steps to prevent his falling. In the course of the descent, there are several resting places, which are extremely welcome to the wearied traveller. In some of the subterraneous passages the heat is so intense, as to occasion a profuse sweat; and in several of the shafts the air was formerly so confined, that several miners were suffocated by an igneous vapour, or gaseous exhalation, called the fire-damp. This has been prevented by sinking the main shaft deeper. Near to it is a large wheel, and an hydraulic machine, by which the mine is cleared of water

To these pernicious and deadly caverns criminals are occasionally banished by the Austrian government; and it has sometimes happened that this punishment has been allotted to persons of considerable rank and family. An incident of this nature, in the person of Count Alberti, laid the foundation of Mr. Sargent's elegant dramatic poem entitled "THE MINE."

The Count having fought a duel with an Austrian general, against the Emperor's command, and having left him

for dead, was obliged to seek refuge in one of the forests of Istria, where he was apprehended, and afterwards rescued by a band of robbers who had long infested that quarter. With these banditti he spent nine months, until, by a close investiture of the place in which they were concealed, and after a very obstinate resistance, in which the greater part of them were killed, he was taken and carried to Vienna, to be broken alive on the wheel. This punishment was, by the intercession of his friends, changed into that of perpetual confinement and labour in the mines of Idria—a sentence which, to a noble mind, was worse than death. To these mines he was accompanied by the Countess, his lady, who belonged to one of the first families in Germany, and who, having tried every means to procure her husband's pardon without effect, resolved at length to share his miseries, as she could not relieve them. They were terminated, however, by his pardon being procured by the general with whom he had fought the duel, on the latter being recovered from his wounds; and this nobleman, on his return to Vienna, was again taken into favour, and restored to his fortune and rank.

IRON MINES.

Native iron, the existence of which was formerly questioned, has been found in several places: it is, however, far from being common, and occurs in several mines. A mass of this description of iron was discovered in the district of Santiago del Estero, in South America, by a party of Indians, in the midst of a wide extended plain. It projected about a foot above the ground, nearly the whole of its upper surface being visible; and the news of its having been found in a country where there are not any mountains, nor even the smallest stone, within the circumference of a hundred leagues, was considered as truly surprising. Although the journey was attended with great danger, on account of the want of water, and abundance of wild beasts in these deserts, several individuals, in the hope of gain, undertook to visit this mass; and, having accomplished their journey, sent a specimen of the metal to Lima and Madrid, where it was found to be very pure soft iron.

As it was reported that this mass was the extremity of

an immense vein of the metal, a metallurgist was sent to examine the spot, and by him it was found buried in pure clay and ashes. Externally it had the appearance of very compact iron, but was internally full of cavities, as if the whole had been formerly in a liquid state. This idea was confirmed by its having, on its surface, the impression of human feet and hands of a large size, as well as that of the feet of a description of large birds, very common in South America. Although these impressions seemed very perfect, it was concluded, either that they were *lusus naturæ*, or that impressions of this kind were previously on the ground, and that the liquid mass of iron, in falling on it, received them. It had the greatest resemblance to a mass of dough; which, having been stamped with impressions of hands and feet, and marked with a finger, had afterwards been converted into iron.

On digging round the mass, the under surface was found covered with a coat of scoriæ from four to six inches thick, undoubtedly occasioned by the moisture of the earth, the upper surface being clean. Not any appearance of generation was observed in the earth below or round it for a great distance. About two leagues to the eastward was a brackish mineral spring, and a very gentle ascent of from four to six feet in height, running from north to south: with this exception, the adjacent territory was a perfect level. About the spring, as well as near the mass, the earth was very light, loose, and greatly resembling ashes, even in colour. The grass in the vicinity, was very short, small, and extremely unpalatable to the cattle; but that at a distance was long, and extremely grateful to them. From these concurrent circumstances it was concluded, that this mass of native iron, which was estimated to weigh about three hundred quintals, was produced by a volcanic explosion. It is stated as an undoubted fact, that in one of the forests of the above district of Santiago del Estero, there exists a mass of pure native iron, in the shape of a tree with its branches. At a little depth in the earth are found stones of quartz of a beautiful red colour, which the honey gatherers, the only persons who frequent this rude territory, employ as flints to light their fires. Several of these were selected on account of their peculiar beauty, they being spotted and studded, as it were, with gold: one of them,

weighing about an ounce, was ground by the governor of the district, who extracted from it a drachm of gold.

A fibrous kind of native iron has been found at Eibenstock in Saxony, and also in Siberia, where one particular mass weighed 1600 pounds. It resembled forged iron in its composition, and was malleable when cold, but brittle when red hot. In Senegal, where it is most common, it is of a cubical form, and is employed by the natives in the manufacture of different kinds of vessels.

Iron, although one of the imperfect metals, is susceptible of a very high polish, and more capable than any other metal of having its hardness increased or diminished by certain chemical processes. It is often manufactured in such a way as to be *one hundred and fifty times*, and, as will now be seen, even above *six hundred and thirty times*, more valuable than gold. On weighing several common watch-pendulum springs, such as are sold, for ordinary work, by the London artists, at half a crown, ten of them were found to weigh but one single grain. Hence one pound avoirdupois, equal to seven thousand grains, contains ten times that number of these springs, which amount, at half a crown each, to 8750 pounds sterling. Reckoning the troy ounce of gold at four pounds sterling, and the pound, equal to 5760 grains, at 48 pounds sterling, the value of an averdupois pound of gold is 58.33, or 58l. 6s. 7d. The above amount of the value of the watch springs weighing an avoirdupois pound, being divided by that sum, will give a ratio of somewhat more than 150 to 1. But the pendulum-springs of the best kind of watches sell at half a guinea each; and at this price the abovementioned value is increased in the ratio of four and one fifth to one; which gives an amount of 36,750l. sterling. This sum being divided by the value of the avoirdupois pound of gold, gives a quotient of more than 630 to 1.

It is the valuable property of iron, after it is reduced into the state of steel, that, although it is sufficiently soft when hot, or when gradually cooled, to be formed without difficulty into various tools and utensils, still it may be afterwards rendered more or less hard, even to an extreme degree, by simply plunging it, when red hot, into cold water. This is called *tempering*, the hardness produced being greater in proportion as the steel is hotter, and the

water colder. Hence arises the superiority of this metal for making mechanic instruments or tools, by which all other metals, and even itself, are filed, drilled, and cut. The various degrees of hardness given to iron, depend on the quantity of ignition it possesses at the moment of being tempered, which is manifested by the succession of colours exhibited on the surface of the metal, in the progress of its receiving the increasing heat. These are, the yellowish white, yellow, gold-colour, purple, violet, and deep blue;—after the exhibition of which the complete ignition takes place. These colours proceed from a kind of scorification on the surface of the heated metal.

The largest iron works in England are carried on in Colebrook Dale, in Shropshire. This spot, which is situated between two towering and variegated hills, covered with wood, possesses peculiar advantages, the ore being obtained from the adjacent hills, the coals from the vale, and abundance of limestone from the quarries in the vicinity. The romantic scenery which nature here exhibits, and the works which are carrying on, seem to realize the ancient fable of the Cyclops. "The noise of the forges, mills, &c." Mr. Young observes, "with all their vast machinery, the flames bursting from the furnaces, with the burning of coal, and the smoke of the lime-kilns, are altogether horridly sublime." To complete the peculiarities of this spot, a bridge, entirely constructed of iron, is here thrown over the Severn. In one place it has parted, and a chasm is formed; but such is its firm basis, that the fissure has neither injured its strength nor utility.

The great superiority of Swedish iron over that of all other countries, for the manufacture of steel, is well known, and is ascribed to the great purity of the ore from which the iron is smelted. Hitherto the British steel makers have not been able to employ British iron in their processes, it having been found too brittle to bear cementation; but attempts are now making by some very spirited steel makers at Sheffield; and from the products already obtained, great hopes are entertained of ultimate success. One of the most remarkable of the Swedish mines, if the name can with propriety be applied to it, is Tabern, a mountain of a considerable size, composed entirely of pure iron ore, and occurring in a large tract of sand over which it seems to

have been deposited. This mountain has been wrought for nearly three centuries, notwithstanding which its size is scarcely diminished.

But the richest iron mine of Sweden is that of Danmora, in the province of Upland. It is in depth eighty fathoms; occupies a considerable extent of territory; and its ore is conveyed to the surface of the earth, through several pits or openings made for that purpose, by means of casks fixed to large cables, which are put in motion by horses. The workmen, standing on the edges of these casks, and having their arms clasped round the cable, descend and ascend with the utmost composure. The water is drawn from the bottom by a wheel sixty-six feet in diameter, and is afterwards conveyed along an aqueduct nearly a mile and half in length. At certain distances from Danmora, are several furnaces, with large and populous villages exclusively inhabited by the miners.

In Wraxall's tour through the north of Europe, the mine of Danmora is described as yielding the finest iron ore in Europe, its produce being exported to every country, and constituting one of the most important sources of national wealth and royal revenue. The ore is not dug, as is usual in other mines, but is torn up by the force of gunpowder—an operation which is performed every day at noon, and is one of the most awful and tremendous that can possibly be conceived. "We arrived," observes the tourist, "at the mouth of the great mine, which is "nearly half an English mile in circumference, in time "to be present at it. Soon after twelve the first explosion "took place, and could not be so aptly compared to any "thing as to subterraneous thunder, or rather vollies of "artillery discharged under ground. The stones were "thrown up, by the violence of the gunpowder, to a vast "height above the surface of the ground, and the con-"cussion was so great as to shake the surrounding earth or "rock on every side.

"As soon as the explosions had ceased, I determined "to descend into the mine, to effect which I had to seat "myself in a large deep bucket, capable of containing "three persons, and fastened by chains to a rope. When "I found myself thus suspended between heaven and "earth by a rope, and looked down into the dark and

" deep abyss beneath me, to which I could see no
" termination, I shuddered with apprehension, and half
" repented my curiosity. This was, however, only a
" momentary sensation, and before I had descended a
" hundred feet, I looked round on the scene with very
" tolerable composure. It was nearly nine minutes before
" I reached the bottom; and when I set my foot on the
" earth, the view of the mine was awful and sublime in
" the highest degree. Whether, as I surveyed it, terror
" or pleasure formed the predominant feeling, is hard to
" say. The light of the day was very faintly admitted
" into these subterraneous caverns: in many places it was
" absolutely lost, and flambeaux were kindled in its stead.
" Beams of wood were laid across some parts, from one
" side of the rock to the other; and on these the miners sat,
" employed in boring holes for the admission of gun-
" powder, with the most perfect unconcern, although
" the least dizziness, or even a failure in preserving their
" equilibrium, must have made them lose their seat, and
" have dashed them against the rugged surface of the
" rock beneath. The fragments torn up by the explosion,
" previously to my descent, lay in vast heaps on all sides,
" and the whole scene was calculated to inspire a gloomy
" admiration.

" I remained three quarters of an hour in these frightful
" and gloomy caverns, which find employment for not
" less than one thousand three hundred workmen, and
" traversed every part of them which was accessible,
" conducted by my guides. The weather above was very
" warm, but here the ice covered the whole surface of
" the ground, and I found myself surrounded with the
" colds of the most rigorous winter, amid darkness and
" caves of iron. In one of these, which ran a consi-
" derable way beneath the rock, were eight wretched
" beings warming themselves round a charcoal fire, and
" eating the little scanty subsistence arising from their
" miserable occupation. They rose with surprise at seeing
" so unexpected a guest among them, and I was not a
" little pleased to dry my feet, which were wet with tread-
" ing on the melted ice, at their fire.

" Having gratified my curiosity with a view of these
" subterraneous apartments, I made the signal for being

" drawn up, and felt so little terror while re-ascending, " compared with that of being let down, that I am " convinced, after five or six repetitions, I should have " been perfectly indifferent to the undertaking. So strong " is the effect of custom on the human mind, and so " contemptible does danger or horror become, when " familiarized by continual trials!"

Throughout the whole extent of Sweden, the iron mines at present wrought, employ upwards of twenty-five thousand persons, and yield annually upwards of fifty-seven thousand tons of metal. It has been calculated that the furnaces and forges, which give to the iron the degree of perfection requisite before it can be used, consume annually two millions four hundred thousand loads of charcoal.

MINES OF COPPER, TIN, LEAD, &c.

THE purest copper obtained in Europe is the produce of the mines of the Swedish province of Dalecarlia. The following is a brief description of the principal of these immense and gloomy caverns, all of which boast a high antiquity.

The traveller's curiosity is first attracted by the hydraulic machines which are destined to convey the water to the different quarters, and the power of which is such, that one of the wheels has a diameter of not less than forty-four feet. Another wheel, of proportionate magnitude, is employed to raise the ore from the mine to the surface of the earth, and is admirably constructed. Regular circles are placed on each side, and round these the chain rises, taking a larger or smaller circumference, in proportion to the necessary circle to be made, so as to counterbalance the weight, and consequently the increased motion of the bucket.

Exteriorly, a vast chasm of a tremendous depth presents itself to the view. This being the part of the mine which was first opened, either through the ignorance or neglect of those who had then the management of the works, the excavations so weakened the foundations of the hill, that the whole fell in, leaving a most chaotic scene of precipitated rocks, and a gaping gulf resembling the mouth of a volcano. Great care has been since taken that no such disaster should again occur. Plans and sections are drawn of all the galleries, &c; and, where the prosecution of the

works, in the same direction, might be dangerous, orders are issued for the miners to stop, and AN IRON CROWN is fixed on the spot, as a prohibition ever to proceed further. The workmen then explore in a different direction, while every subterraneous excavation is nicely watched.

The traveller passes into the great chasm by a range of wooden steps, which cross, in a variety of directions, the rough masses of fallen rocks, of gravel, and of the ancient machinery. Ere he reaches the entrance of the cavern, he has to descend thirty toises; and this being accomplished, proceeds horizontally to a considerable distance within. He now loses the pure air of day, and gradually breathes an oppressive vapour, which rolls towards him, in volumes, from the mouths of a hundred caves leading into the main passage. He now feels as if he were inhaling the atmosphere of Tartarus. The Swedish iron mines which are described above, are mere purgatories when compared with this Satanic dwelling. The descent is performed entirely by steps laid in the winding rock; and, in following the subterraneous declivity, the traveller reaches the tremendous depths of these truly Stygian dominions.

The pestilential vapours which environ him with increasing clouds, and the style of the entrance, remind him of Virgil's description of the descent of Æneas to the infernal regions. Here are to be seen the same caverned portico, the rocky, rough descent, the steaming sulphur, and all the deadly stenches of Avernus. The wretched inmates of this gloomy cavern appear to him like so many spectres, as poetic fiction has described them; and he is induced by the length of the way, joined to the excessive heat and its suffocating quality, to fancy that he will be made to pay dearly for his curiosity. In one part the steam is so excessively hot as to scorch at the distance of twelve paces, at the same time that the sulphureous smell is intolerable. Near this spot a volcanic fire broke out some years ago, in consequence of which, strong walls were constructed, as barriers to its power, and several contiguous passages, which, had it spread, would have proved dangerous to the mine, closed up.

The visitor has now to traverse many long and winding galleries, as well as large vaulted caverns, where the workmen are dispersed on all sides, employed in hewing vast

masses of the rock, and preparing other parts for explosion. Others wheel the brazen ore toward the black abyss where the suspended buckets hang ready to draw it upward. From the effect of such violent exercise, combined with the heat, they are obliged to work almost naked. Their groupes, occupations, and primitive appearance, scantily lighted by the trembling rays of torches, form a curious and interesting scene.

The depth of the mine being at least twelve hundred feet, a full hour is required to reach the bottom. The mass of copper lies in the form of an inverted cone. Five hundred men are employed daily: but females are not admitted, on account of the deleterious quality of the vapours.

This mine was anciently a state prison, in which criminals, slaves, and prisoners of war toiled out their wretched existence. Near the bottom is a rocky saloon furnished with benches. It is called the HALL OF THE SENATE, on account of its having been the resting place of several Swedish Kings, who came, attended by the senators, to examine the works, and here took refreshments. It was in this mine that the immortal GUSTAVUS VASA, disguised as a peasant, laboured for his bread, in the course of a long concealment, after having been robbed by the peasant who served him as a guide.

In the year 1751, a very rich copper mine was wrought in the county of WICKLOW, IRELAND. From this mine ran a stream of blue-coloured water, of so deleterious a nature as to destroy all the fish in the river Arklow, into which it flowed. One of the workmen, having left an iron shovel in this stream, found it some days after encrusted with copper. This led one of the proprietors of the mine to institute a set of experiments, from which he concluded that the blue water contained an acid holding copper in solution; that iron had a stronger affinity for the acid than copper; and that the consequence of this affinity was the precipitation of the copper, and the solution of the iron, when pieces of that metal were thrown into the blue water. These ideas induced the miners to dig several pits for the reception of this water, and to put bars of iron into them. The result was, that they obtained an abun-

dance of copper, much purer and more valuable than that which they procured from the ore itself by smelting.

On the island of ANGLESEA, near Dulas bay, on the north coast, is PARYS MOUNTAIN, which contains the most considerable quantity of copper ore perhaps ever known. The external aspect of the hill is extremely rude, and it is surrounded by enormous rocks of coarse white quartz. The ore is lodged in a basin, or hollow, and has on one side a small lake, over the waters of which, as over those of Avernus, fatal to the feathered tribe, birds are never known to pass. The effect of the mineral operations has been, that the whole of this tract has assumed a most savage appearance. Suffocating fumes of the burning heaps of copper arise in all parts, and extend their baneful influence for miles around. That the ore was worked in a very remote period, appears by vestiges of the ancient operations, which were carried on by trenching, and by heating the rocks intensely, when water was suddenly poured on them, so as to cause them to crack or scale. In the year 1768, after a long search, which was so little profitable that it was on the eve of being abandoned, a large body of copper ore was found; and this has ever since been worked to great advantage, still promising a vast supply. The water lodged in the bottom of the bed of ore, being strongly impregnated with the metal, is drawn up, and distributed in pits, where the same process is employed as in the Wicklow mine. The copper thus procured differs little from native copper, and is very highly prized.

In the Parys mine eight tons of gunpowder are annually expended in blasting the rock. Nature has here been profuse in bestowing her mineral favours; for, above the copper ore, and not more than two feet beneath the soil, is a bed of yellowish greasy clay, from three to twelve feet in thickness, containing lead ore, from a ton of which metal upwards of fifty ounces of silver are generally obtained. These works have added greatly to the population of the country, since they find employment for about fifteen hundred persons, who, with their families, are supposed to amount to eight thousand souls, all of them deriving subsistence from the mines

The copper mines of CORNWALL are very numerous,

and several of them large and rich in ore. It is remarkable that in various parts of this county the earth has produced such an exuberance of this metal, as to afford it in large massy lumps of malleable copper, several pieces of which are shewn in very curious vegetable forms. The particular ore named *mundic*, found in the tin mines, was for many ages considered of no other use but to nourish that metal while in the mine. In the reign of Queen Elizabeth, a laudable curiosity tempted several private individuals to examine into its nature; but the design miscarried, and the mundic was thrown, as useless, into the old pits in which the rubbish was collected. However, about a century ago, this purpose was effected by degrees; and the copper extracted from the ore now produces, on an average, upwards of one hundred and fifty thousand pounds annually, equalling in goodness the best Swedish copper, while the ore itself yields a proportionate quantity of *lapis calaminaris* for the making of brass.

At ECTON HILL, near the river Dove, in Derbyshire, a valuable copper mine was discovered some years ago, and has since been worked to great advantage. In its position, situation, and inclination, it differs from any mine yet discovered in Europe, Asia, Africa, or America; the wonderful mass of copper ore not running in regular veins or courses, but sinking perpendicularly down, widening and swelling out at the bottom in the form of a bell. The works are four hundred and fifty feet beneath the river Dove, it being the deepest mine in Great Britain. On the opposite side of Ecton hill is a valuable lead mine, the veins of which approach very nearly to the copper mine.

Copper is converted into brass by the agency of Calamine, an oxide of zinc. It occurs frequently in beds, and in some places exists in great abundance. The Mendip hills, in Somersetshire, were once celebrated for their mines of calamine, which are now in a great measure exhausted. It is dug out of the earth, and, being broken into small pieces, is exposed to the action of a current of water, which washes away the light earthy matter, and leaves the calamine. The whole is then thrown into deep wooden vessels filled with water, and agitated for a considerable time. The galena sinks to the bottom, the calamine is deposited in the centre, and the earthy matter lies

on the surface. The calamine, thus separated from its impurities, is ground to powder, and becomes fit for use.

HUNGARY abounds in valuable ores and minerals, and is most celebrated for its vast copper works, at a town called Herrengrund, built on the summit of a mountain, and exclusively inhabited by miners. Here the process, noticed above, of apparently converting iron into copper, is pursued with great success, several hundreds weight of iron being thus transmuted every year. The vitriol with which the blue water is strongly impregnated, cannot be strictly said to convert the iron into copper, but insinuates into it the copper particles with which it is saturated; and this seeming transmutation requires a fortnight or three weeks only: but if the iron be suffered to lie too long in this vitriolic solution, it becomes at length reduced to powder.

In JAPAN, copper is the most common of all the metals, and is considered as the finest and most malleable any where to be found. Much of this copper is not only of the purest quality, but is blended with a considerable proportion of gold, which the Japanese separate and refine. The whole is brought to Saccin, one of the five principal cities of Japan; and it is there purified, and cast into small cylinders, about a span and a half in length, and a finger's breadth in thickness. Brass is there very scarce, and much dearer than copper, the calamine employed in making it being imported from Tonquin in flat cakes, and sold at a very high price.

CORNWALL has been, in all ages, famous for its numerous mines of tin, which are in general very large, and rich in ore. The tin-works are of different kinds, dependent on the various forms in which the metal appears. In many places its ore so nearly resembles common stones, that it can only be distinguished from them by its superior weight. In other parts, the ore is a compound of tin and earth, concreted into a substance almost as hard as stone, of a blueish or greyish colour, and to which the mundic, impregnated with copper, frequently gives a yellowish cast. This ore is always found in a continued stratum, which the miners call *load*; and this, for the greater part, is found running through the solid substance of the hardest rocks, beginning in small veins near the surface, perhaps not above half an inch or an inch wide, and increasing, as

they proceed, into large dimensions, branching out into several ramifications, and bending downward in a direction which is, generally, nearly east and west. These loads, or veins, are sometimes white, very wide, and so thick, that large lumps of the ore are frequently drawn up of more than twenty pounds weight. The loads of tin-ore are not always contiguous, but sometimes break off so entirely, that they seem to terminate; but the sagacious miner knows by experience, that, by digging at a small distance on one side, he shall meet with a separated part of the load, apparently tallying with the other end, as nicely as if it had been broken off by some sudden shock of the rock.

The miners of Cornwall follow the load, or vein, in all its rich and meandering curves through the bowels of the flinty earth. The waters are sometimes drained from the mines, by subterraneous passages, formed from the body of the mountain to the level country. These passages are called *adits*, and are occasionally the labour of many years; but when effected, they save the constant expense of large water-works and fire-engines. From the surface of the earth the workmen sink a passage to the mine, which they call a shaft, and place over it a large winch, or, in works of greater magnitude, a wheel and axle, by which means they draw up large quantities of ore at a time, in vessels called *kibbuls*. This ore is thrown into heaps, which great numbers of poor people are employed in breaking to pieces, and fitting the ore for the stamping mills.

A third form in which tin appears is that of crystals; for this metal will, under proper circumstances, readily crystallize. Hence, in many parts of the mineral rocks, are found the most perfectly transparent and beautiful crystals of pure tin. Beside these crystals, in many of the cavernous parts of the rocks, are found those transparent crystals, called CORNISH DIAMONDS, they being extremely brilliant when well polished. Their form is that of a six-sided prism pointed on the top, and they are sometimes four or five inches in length.

Among the most remarkable LEAD MINES, may be cited those of UPPER LOUISIANA, in NORTH AMERICA, which have for many years been highly productive. That called

Burton's mine is so extensive, that the mineral is calculated to cover two thousand acres of land. It is of two kinds, the gravel and fossil. The gravel mineral is found immediately under the soil, intermixed with gravel, in pieces of solid mineral weighing from one to fifty pounds. Beneath the gravel is a sand rock, which being broken, crumbles to a fine sand, and contains mineral nearly of the same quality as that of the gravel. But the mineral of the first quality is found in a bed of red clay, under the sand rock, in pieces of from ten to five hundred pounds weight, on the outside of which is a spar, or fossil, of a bright glittering appearance, resembling spangles of gold and silver, as solid as the mineral itself, and of a greater specific gravity. This being taken off, the mineral is solid, unconnected with any other substance, of a broad grain, and what mineralogists call potters' ore.

In other mines, in the vicinity of the above, the lead is found in regular veins, from two to four feet in thickness, containing about fifty ounces of silver in a ton; but at the depth of twenty-five feet the operations are impeded by water. The whole of this mineral tract is very rich and extensive.

In GREAT BRITAIN there are numerous lead mines, among which may be cited that of Arkingdale, in Yorkshire, and those with which Shropshire abounds. In the south of Lanerkshire, and in the vicinity of Wanlock-head, Scotland, are two celebrated lead mines, which yield annually above two thousand tons of metal. The Susannah-vein Lead-hills, has been worked for many years, and has been productive of great wealth. The above are considered as the richest lead mines of Europe.

Several of the Irish lead mines have yielded a considerable proportion of silver; and mention is made of one, in the county of Antrim, which afforded, in thirty pounds of lead, a pound of that metal. Another, less productive of silver, was found at Ballysadare, near the harbour of Sligo in Connaught; and a third in the county of Tipperary, thirty miles from Limerick. The ores of this last were of two kinds, most usually of a reddish colour, hard and glistering; the other, which was the richest in silver, resembled a blue marl. The works were destroyed in the Irish insurrections in the reign of Charles I. The mine, however, is still wrought on account of the lead it contains.

The following is the enumeration of the different substances in which metals are found. In granitic mountains, tin, lead, iron, zinc, bismuth, cobalt; and in gneifs, or schistose granite, silver, copper, lead, tin, and zinc. In micaceous schist are found copper, tin, lead, and antimony. In hornblende slate, copper ore; and under argillate, or common slate, silver, copper, lead, and zinc. In steatite sulphureous pyrites, and magnet. In primitive lime-stone copper, lead, and zinc appear; and even in strata of coal, native silver, galena, and manganese, have been discovered.

COAL MINES.

Coals are scattered, with a more or less sparing hand, over every continent, and almost over every kingdom of the globe; but there is not any country where coal mines are so rich and so frequent as in Great Britain, the opulence of which has been principally ascribed to this valuable mineral.

It is, in truth, the very soul of her manufactures, and consequently of her commerce, every manufacturing town being established in the midst of a coal country. Of this striking instances are afforded by Bristol, Birmingham, Wolverhampton, Sheffield, Newcastle, and Glasgow.

The coals of Whitehaven and Wigan are esteemed the purest; and the cannel and peacock coals of Lancashire are so beautiful, that they are suspected by some to have constituted the *gagates*, or jet, which the ancients ascribed to Great Britain. In Somersetshire, the Mendip coal-mines are distinguished by their productiveness: they occur there, as indeed in every other part, in the low country, and are not to be found in the hills. The beds of coal are not horizontal, but sloping, dipping to the south-east at the rate of about twenty-two inches per fathom. Hence they would speedily sink so deep that it would not be possible to work them, were it not that they are intersected at intervals by perpendicular dykes or veins, of a different kind of mineral, on the other side of which these beds are found considerably raised up. They are seven in number, lying at regular distances beneath each other, and separated by beds of a different kind of substance, the deepest being placed more than two hundred feet beneath the surface of the earth.

The town of Newcastle, in Northumberland, has been

celebrated during several centuries for its very extensive trade in coals. It was first made a borough by William the Conqueror, and the earliest charter for digging coals, granted to the inhabitants, was in the reign of Henry III. in 1239; but in 1306, the use of coal for fuel was prohibited in London, by Royal proclamation, chiefly because it injured the sale of wood, with which the environs of the Capital were then overspread. This interdict did not, however, continue long in force; and coals may be considered as having been dug for exportation at Newcastle for more than four centuries. It has been estimated that there are twenty-four considerable collieries lying at different distances from the river, from five to eighteen miles; and that they produced, or an average of six years, up to the close of 1776, an annual consumption of three hundred and eighty thousand chaldrons, Newcastle measure, (equal to seven hundred and seventeen thousand, six hundred and fifteen chaldrons, London measure) of which about thirty thousand chaldrons were exported to foreign parts. The boats employed in the colliery are called keels, and are described as strong, clumsy, and oval, each carrying about twenty tons; and of these four hundred and fifty are kept constantly employed. In the year 1776 an estimate was made of the shipping employed in the Newcastle coal trade; and from this estimate it appears, that three thousand, five hundred, and eighty-five ships, were during that year engaged in the coasting trade, and three hundred and sixty-three in the trade to foreign ports, their joint tonnage amounting to seven hundred and thirty-eight thousand, two hundred and fourteen tons.

It is a common opinion among geologists, that pit coal is of vegetable origin, and that it has been brought to its present state by the means of some chemical process, not at this time understood. However extravagant this opinion may at first sight appear, it is supported by the existence of vast depositions of matter, half way, as it were, between perfect wood and perfect pit coal; which, while it obviously betrays its vegetable nature, has in several respects so near an approximation to pit coal, as to have been generally distinguished by the name of coal. One of the most remarkable of these depositions exists in Devonshire, about thirteen miles south-west of Exeter, and is well

known under the name of Bovey coal. Its vegetable nature has been ascertained by Mr. Hatchet, in a set of experiments in which he found both extractive matter and resin—substances which belong to the vegetable kingdom.

The beds of this coal are seventy feet in thickness, and are interspersed by beds of clay. On the north side they lie within a foot of the surface, and dip south at the rate of about twenty inches per fathom. The deepest beds are the blackest and heaviest, and have the closest resemblance to pit coal, while the upper ones strongly resemble wood, and are considered as such by those who dig them. They are brown, and become extremely friable when dry, burning with a flame similar to that of wood, and assuming the appearance of wood which has been rendered soft by some unknown cause, and, while in that state, has been crushed flat by the weight of the incumbent earth. This is the case, not only with the Bovey coal, but also with all the beds of wood coal which have been hitherto examined in different parts of Europe.

The coal mines of Whitehaven may be considered as the most extraordinary in the known world. They are excavations which have, in their structure, a considerable resemblance to the gypsum quarries of Paris, and are of such a magnitude and extent, that in one of them alone, a sum exceeding half a million sterling, was, in the course of a century, expended by the proprietors. Their principal entrance is by an opening at the bottom of a hill, through a long passage, hewn in the rock, leading to the lowest vein of coal. The greater part of this descent is through spacious galleries, which continually intersect other galleries, all the coal being cut away, with the exception of large pillars, which, where the mine runs to a considerable depth, are nine feet in height, and about thirty-six feet square at the base. Such is the strength there required to support the ponderous roof.

The mines are sunk to the depth of one hundred and thirty fathoms, and are extended under the sea to places where there is, above them, sufficient depth of water for ships of large burden. These are the deepest coal mines which have hitherto been wrought; and perhaps the miners have not in any other part of the globe penetrated to so great a depth beneath the surface of the sea, the very deep

mines in Hungary, Peru, and elsewhere, being situated in mountainous countries, where the surface of the earth is elevated to a great height above the level of the ocean.

In these mines there are three strata of coal, which lie at a considerable distance one above the other, and are made to communicate by pits; but the vein is not always continued in the same regularly-inclined plane, the miners frequently meeting with hard rock, by which their further progress is interrupted. At such places there seem to have been breaks in the earth, from the surface downward, one portion appearing to have sunk down, while the adjoining part has preserved its ancient situation. In some of these places the earth has sunk ten, twenty fathoms, and even more; while in others the depression has been less than one fathom. These breaks the miners call dykes; and when they reach one of them, their first care is to discover whether the strata in the adjoining part are higher or lower than in the part where they had been working; or, according to their own phrase, whether the coal be cast down or cast up. In the former case they sink a pit; but if it be cast up to any considerable height, they are frequently obliged, with great labour and expense, to carry forward a level, or long gallery, through the rock, until they again reach the stratum of coal.

Coal, the chief mineral of Scotland, has been there worked for a succession of ages. Pope Pius II. in his description of Europe, written about 1450, mentions that he beheld with wonder black stones given as alms to the poor of Scotland. This mineral may, however, be traced to the twelfth century; and a very early account of the Scottish coal mines, explains, with great precision, the manner of working the coal, not neglecting to mention the subterraneous walls of whin which intersect the strata, particularly a remarkable one, visible from the river Tyne, where it forms a cataract, and passes by Prestonpans, to the shore of Fife. The Lothians and Fifeshire, particularly abound with this useful mineral, which also extends into Ayrshire; and near Irwin is found a curious variety, named ribbon coal. A singular coal, in veins of mineral, has been found at Castle Leod, in the east of Rosshire; and it is conjectured that the largest untouched field of coal in Europe, exists in a barren tract of country in Lanerkshire.

In North America, coal has been discovered in great

abundance on both sides of James river, and is said to have been first observed by a boy in pursuit of cray fish. This valuable mineral also abounds towards the Mississippi and the Ohio, that of Pittsburgh being of a superior quality; but it is chiefly worked in Virginia, where the beds are very extensive. One of these beds, about twenty-four feet in thickness, was found to repose on granite, and is cited as a great singularity. In the territory south of the Ohio, what is called stone coal is found in the Cumberland mountains; and in 1804 a coal mine was discovered on the river Juniata, in the vicinity of the Apalachian mountains. The bed is horizontal, on which account it is wrought with considerable advantage, and the mineral is upwards of ten feet in thickness. Notwithstanding these supplies at particular points of the extensive territory of the United States, coals are imported from Great Britain in very considerable quantities. In the space of one year, reckoning from the first of October, 1801, the importation amounted to not less than 18,473 chaldrons.

The process of mining is a combination of boring and digging. Shafts are sunk, levels are driven, and drains are carried off, by the help of picks or pick-axes, wedges, and hammers, the rocks being also sometimes loosened by blasting with gunpowder. In searching for coal, a shaft is sunk through the uppermost soft stratum, and the rock is then bored, by striking it continually with an iron borer terminating in an edge of steel, which is in the mean time turned partly round; and, at proper intervals, a scoop is let down, to draw up the loose fragments. In this manner a perforation is sometimes made for more than a hundred fathoms, the borer being lengthened by pieces screwed on: it is then partly supported by a counterpoise, and worked by machinery. Should it happen to break, the piece is raised by a rod furnished with a hollow cone, as an extinguisher, which is driven down on it. The borer is sometimes furnished with knives, which are made to act on any part at pleasure, and to scrape off a portion of the surrounding substance, which is collected in a proper receptacle.

Those who have the direction of deep and extensive coal mines, are obliged, with great art and care, to keep them ventilated with perpetual currents of fresh air, which afford the miners a constant supply of that vital fluid, and expel

from the mines damps and other noxious exhalations, together with such other burnt and foul air, as is become deleterious and unfit for respiration. In the deserted mines, which are not thus ventilated with currents of fresh air, large quantities of these damps are frequently collected; and, in such works, they often remain for a long time without doing any mischief. But when, by some accident they are set on fire, they then produce dreadful explosions, and, bursting out of the pits with great impetuosity, like the fiery eruptions from burning mountains, force along with them ponderous bodies to a great height in the air.

Various instances have occured in which the coal has been set on fire by the fulminating damp, and has continued burning for several months, until large streams of water were conducted into the mine, so as to inundate the parts where the conflagration existed. By such fires several collieries have been entirely destroyed, in the vicinity of Newcastle, and in other parts of England, as well as in Fifeshire in Scotland. In some of these places the fire has continued to burn for ages. To prevent, therefore, as much as possible, the collieries from being filled with these pernicious damps, it has been found necessary carefully to search for the crevices in the coal whence they issue, and, at those places, to confine them within a narrow space, conducting them through long pipes into the open air, where, being set on fire, they consume in perpetual flame as they continually arise out of the earth.

The late Mr. Spelling, engineer of the Whitehaven coal mines, having observed that the fulminating damp could only be kindled by flame, and that it was not liable to be set on fire by red-hot iron, nor by the sparks produced by the collision of flint and steel, invented a machine called a steel-mill, in which a wheel of that metal is turned round with a very rapid motion, and, by the application of flints, great plenty of sparks are emitted, which afford the miners such a light as enables them to carry on their work in close places, where the flame of a candle, or of a lamp, would, as has already happened in various instances, occasion violent explosions. In that dreadful catastrophe, the explosion of the Felling Colliery, the particulars of which will be hereafter detailed, it will be seen that mills of this description were employed, in searching for the remains of

the sad victims of the disaster; but this event happened before the invention of Sir Humphrey Davy's safety lamp, a discovery which, while it affords a more certain light, holds out every security to the miner against accidents which, without such a resource, might still be superadded to those already recorded, as arising from the flame of a candle or lamp.

A greater number of mines have, however, been ruined by inundations than by fires; and here that noble invention the fire-engine displays its beneficial effects. It appears, from nice calculations, that it would require about 550 men, or a power equal to that of 110 horses, to work the pumps of one of the largest fire engines, having a cylinder of seventy inches diameter, now in use, and thrice that number of men to keep an engine of that size constantly at work. It also appears that as much water may be raised by such an engine, as can be drawn, within the same spaoe of time, by 2520 men with rollers and buckets, after the manner now daily practised in many mines; or as much as can be borne on the shoulders of twice that number of men, as is said to be done in several of the mines of Peru. So great is the power of the elastic steam of the boiling water in those engines, and of the outward atmosphere, which, by their alternate actions, give force and motion to the beam, and, through it, to the pump rods which elevate the water through tubes, and discharge it from the mine!

There are four fire engines belonging to the Whitehaven colliery, which, when all at work, discharge from it about 1228 gallons of water every minute, at thirteen strokes; and, at the same rate, 1,768,320 gallons, upwards of 7000 tons, every twenty four hours. By these engines nearly twice the above-mentioned quantity of water might be discharged from mines which are not above sixty or seventy fathoms deep, which depth is rarely exceeded in the Newcastle collieries, or in any other English collieries, with the exception of the above.

Coal pits have sometimes taken fire by accident, and have continued to burn for a considerable length of time. About the year 1648, a coal mine at Benwell, a village near Newcastle-upon-Tyne, was accidentally kindled by a candle: at first, the fire was so feeble, that the reward of half a crown, which was asked by a person who offered to

extinguish it, was refused. It gradually increased, however, and had continued burning for thirty years, when the account was drawn up and published in the Philosophical Transactions: it was not finally extinguished until all the fuel was consumed. Examples of a similar kind have happened in Scotland and in Germany.

FELLING COLLIERY.

But of all the recorded accidents relative to coal mines, that of Felling Colliery, near Sunderland, a concise narrative of which here follows, was the most disastrous.

Felling is a manor about a mile and a half east of Gateshead. It contains several strata of coal, the uppermost of which were extensively wrought in the beginning of the last century. The stratum called the High-main, was won in 1779, and continued to be wrought till the 19th January, 1811, when it was entirely excavated. The present colliery is in the seam called the Low-main. It commenced in October, 1810, and was at full work in May, 1812. This mine was considered by the workmen as a model of perfection in the purity of its air, and orderly arrangements—Its inclined plane was saving the daily expense of at least 13 horses—the concern wore the features of the greatest possible prosperity, and no accident, except a trifling explosion of fire-damp slightly burning two or three workmen, had occurred. Two *shifts* or sets of men were constantly employed, except on Sundays. Twenty five acres of coal had been excavated. The first shift entered the mine at four o'clock A. M. and were relieved at their working posts by the next at 11 o'clock in the morning. The establishment it employed under-ground, consisted of about 128 persons, who, in the fortnight from the 11th to the 25th of May, 1812, wrought 624 scores of coal, equal to 1300 Newastle chaldrons, or 2455 London chaldrons.

About half past eleven o'clock on the morning of the 25th of May, 1812, the neighbouring villages were alarmed by a tremendous explosion in this colliery. The subterraneous fire broke forth with two heavy discharges from the Low-main, which were almost instantaneously followed by one from the High-main. A slight trembling as from an earthquake, was felt for about half a mile around the workings; and the noise of the explosion, though dull, was heard to three or

four miles distance, and much resembled an unsteady fire of infantry.

Immense quantities of dust and small coal accompanied these blasts, and rose high into the air, in the form of an inverted cone. The heaviest part of the ejected matter, such as corves, pieces of wood, and small coal, fell near the pits; but the dust, borne away by a strong west wind, fell in a continued shower from the pit to the distance of a mile and a half. As soon as the explosion was heard, the wives and children of the workmen ran to the pit; the scene was distressing beyond the power of description.

Of one hundred and twenty-eight persons in the mine at the time of the explosion, only thirty-two were brought to day-light, twenty-nine survived the fatal combustion, the rest were destroyed. Nor from the time of the explosion till the 8th of July, could any person descend. But after many unsuccessful attempts to explore the burning mine, it was re-closed, to prevent the atmospheric air from entering it; this being done, no attempt was afterwards made to explore it, till the morning of the last-mentioned day; from which time to the 19th of September, the heart-rending scene of mothers and widows examining the putrid bodies of their sons and husbands, for marks by which to identify them, was almost daily renewed; but very few of them were known by any personal mark,—they were too much mangled and scorched to retain any of their features. Their clothes, tobacco-boxes, shoes, and the like, were, therefore, the only indexes by which they could be recognised.

At the crane twenty-one bodies lay in ghastly confusion: some like mummies, scorched as dry as if they were baked. One wanted its head, another an arm. The scene was truly frightful. The power of fire was visible upon them all; but its effects were extremely variable: while some were almost torn to pieces, there were others who appeared as if they had sunk down overpowered by sleep.

The ventilation concluded on Saturday the 19th of September, when the ninety-first body was dug from under a heap of stones. At six o'clock in the morning the pit was visited by candle-light, which had not been used in it for the space of one hundred and seventeen days; and at eleven o'clock in the morning the tube-furnace was lighted. From

this time the colliery has been regularly at work; but the ninety-second body has never yet been found. All these persons, except four, who were buried in single graves, were interred in Heworth Chapel-yard, in a trench, side by side, two coffins deep, with a partition of brick and lime between every four coffins.

MISCELLANEOUS SUBJECTS CONNECTED WITH MINERALOGY.

CLIFTON HOT-WELL.

THE warm spring, or fountain, called THE HOT-WELL, in the parish of Clifton, is said to be so copious as to discharge sixty gallons of water in a minute. It rises forcibly from an aperture in the solid rock, at about twenty-six feet below high-water mark, and ten feet above low-water. On its immediate influx from the rock, the water is much warmer than when it is pumped up for drinking; and it also feels and tastes warmer in winter than in summer, and in very cold days heats the glass into which it falls from the cock. In 1695, this celebrated spring, after having fallen into neglect, was recovered, and the Hotwell-house erected, proper foundations being made for the pumps, by which the water is raised to the height of thirty feet: pipes are contrived, through which the waste water runs into the river; and in these pipes are valves, which open to let out the water, but shut when the tide is coming in.

With respect to the qualities of this mineral water, it is natural to suppose that, in its subterraneous passage through the rocks, over different strata, and among such variety of mineral and other substances, it must be impregnated with their several virtues. In the common spring water of the neighbouring rock-house, on a trial being made, the mercury in Fahrenheit's thermometer stood at fifty degrees, while that of the Hotwell, taken immediately from the pump, raised it to seventy-six degrees; and as the heat of a person in health seldom exceeds the ninety-sixth degree, it follows, that the Bristol water possesses somewhat more than three-fourths of the human heat.

Below the Hotwell-house rises a magnificent range of

rocks, which are not more remarkable for their height, than for their being equally so on both sides the river, the strata in some places answering on each side for about a mile and a half in a serpentine course. These constitute one of the greatest natural curiosities in England. The rock beyond the Hotwell, and on the same side, is named St. Vincent's, a chapel dedicated to that saint having been formerly built on its summit. It is in height three hundred feet, and has a very majestic appearance. It supplies the naturalist with many curious fossils; the botanist with a variety of scarce plants; the antiquary with the remains of a Roman camp; and the less curious enquirer with a view of a most dreadful and surprising precipice.

The rocks in general, when broken up, are of a dusky red, brown, or chocolate colour marble, very hard and close grained, and which, on being struck with a hammer, emits a strong sulphureous smell. It will bear a polish equal to any foreign marble; and, when sawed into slabs and polished, appears beautifully variegated with veins of white, blueish grey, or yellow. It is often employed for chimney-pieces; but is principally used for making lime, for which purpose there is not any stone in England so well calculated, nor is there any lime so strong, fine, and white, which excellent qualities occasion a great demand for foreign consumption.

Here, and in the vicinity, labourers are daily employed in blowing up the rocks with gunpowder, by which process vast fragments are frequently thrown down, and repeatedly strike the precipice with a dreadful crash, which, combined with the loud report of the explosion, re-echoed from side to side by the lofty cliffs, makes a grand and awful noise, resembling thunder, for which it is frequently mistaken by strangers. It is the opinion of the greater part of those who have viewed these rocks, that they were once united, and were separated by some terrible convulsion of nature. A bridge of one arch, from rock to rock, over the Avon, has long been in contemplation; but if the blowing up of these rocks should still be persisted in, the design will be rendered impracticable. This is the more to be regretted, because stone of the same quality is to be procured on Durdham-down, or lower down the river.

In the fissures and cavities of these rocks are found those

fine crystals called BRISTOL STONES, or DIAMONDS, some of which are so hard as to cut glass, and are exceedingly clear, colourless, and brilliant. When set in rings, in their natural state, these have appeared of as high a polish and lustre as if they had been wrought by the most skilful lapidary.

Bristol is surrounded by coal-pits, those of Gloucestershire being at Kingswood, and those of Somerset at Bedminster, Ashton, Nailsea, and Brislington. But the most copious supply is from Kingswood, where there are a great number of pits and colliers' houses, which last are so frequent, that Kingswood, viewed from the neighbouring hills, has the appearance of being one vast rural suburb of Bristol.

DIAMONDS AND PRECIOUS STONES.

IN addition to the information relative to DIAMOND MINES, at p. 259, *et seq.* of this work, the reader will not fail to be gratified by some curious particulars relative to these and the other more precious gems, drawn from the valuable treatise of Mr. Mawe, on this interesting subject.

In the history of the human race, there are few things which at first sight appear so remarkable, as the prodigious value which, by common consent, in all ages, and in all civilized countries, has been attached to the diamond. That a house with a large estate, the means of living, not only at ease but in splendour, should be set in competition with, and even be deemed inadequate to the purchase of a transparent crystallized stone, not half the size of a hen's egg, seems almost a kind of insanity. It would, indeed, truly deserve this name, if the purchaser were to part with what the seller would acquire by such a transfer. If, for the consciousness of possessing a diamond of nearly three-quarters of an ounce weight, a country gentleman were to pay ninety thousand pounds in ready money, and an annuity of four thousand pounds besides, he would, very deservedly, incur some risk of a statute of lunacy; yet, not only the above sum was given, but a patent of nobility into the bargain, by the Empress Catharine of Russia, for the famous diamond of Nadir Shah. In this case, however, although the seller acquired much, the purchaser did not undergo any personal privation; and, in reality, notwith-

standing the costliness and high estimation of diamonds, they are not put in competition with the substantial comforts and conveniencies of life. Among ornaments and luxuries, they, however, unquestionably occupy, and have ever occupied, the highest rank. Even fashion, proverbially capricious as she is, has remained steady in this, one of her earliest attachments, during, probably, three or four thousand years. There must be, therefore, in the nature of things, some adequate reason for this universal consent, which becomes a curious object of enquiry.

The utility of the diamond, great as it is in some respects, enters for little or nothing into the calculation of its price; at least all that portion of its value which constitutes the difference between the cost of an entire diamond and an equal weight of diamond powder, must be attributed to other causes.

The beauty of this gem, depending on its unrivalled lustre, is, no doubt, the circumstance which originally brought it into notice, and still continues to uphold it in the public estimation; and certainly, notwithstanding the smallness of its bulk, there is not any substance, natural or artificial, which can sustain any comparison with it in this respect. The vivid and various refractions of the opal, the refreshing tints of the emerald, the singular and beautiful light which streams from the six-rayed star of the girasol, the various colours, combined with high lustre, which distinguish the ruby, the sapphire, and the topaz, beautiful as they are on a near inspection, are almost entirely lost to a distant beholder; whereas the diamond, without any essential colour of its own, imbibes the pure solar ray, and then reflects it, either with undiminished intensity, too white and too vivid to be sustained for more than an instant by the most insensible eye, or decomposed by refraction into those prismatic colours which paint the rainbow, and the morning and evening clouds, combined with a brilliancy which yields, and hardly yields, to that of the meridian sun. Other gems, inserted into rings and bracelets, are best seen by the wearer; and, if they attract the notice of the bystanders, divide their attention, and withdraw those regards which ought to be concentred on the person, to the merely accessary ornaments. The dia-

mond, on the contrary, whether blazing on the crown of state, or diffusing its starry radiance from the breast of titled merit, or "in courts and feasts and high solemnities," wreathing itself with the hair, illustrating the shape and colour of the neck, and entering ambitiously into contest with the lively lustre of those eyes that "rain influence" on all beholders, blends harmoniously with the general effect, and proclaims to the most distant ring of the surrounding crowd, the person of the monarch, of the knight, or of the beauty.

Another circumstance tending to enhance the value of the diamond is, that although small stones are sufficiently abundant to be within the reach of moderate expenditure, and therefore afford, to all those who are in easy circumstances, an opportunity to acquire a taste for diamonds, yet those of a larger size are, and ever have been, rather rare; and of those which are celebrated for their size and beauty, the whole number, at least in Europe, scarcely amounts to half a dozen, all of them being in possession of sovereign princes. Hence, the acquisition even of a moderately large diamond, is what mere money cannot always command; and many are the favours, both political and of other kinds, for which a diamond of a large size, or of uncommon beauty, may be offered as a compensation, where its commercial price, in money, neither can be tendered, nor would be received. In many circumstances also, it is a matter of no small importance for a person to have a considerable part of his property in the most portable form possible; and in this respect what is there that can be compared to diamonds, which possess the portability, without the risk, of bills of exchange? It may further be remarked, in favour of this species of property, that it is but little liable to fluctuation, and has gone on pretty regularly increasing in value, insomuch that the price of stones of good quality is considerably higher than it was some years ago.

THE ART OF CUTTING AND POLISHING DIAMONDS has a twofold object: first, to divide the natural surface of the stone in a symmetrical manner, by means of highly-polished polygonal planes, and thus to bring out, to the best advantage, the wonderful refulgence of this beautiful gem; and, secondly, by cutting out such flaws as may happen to be near

the surface, to remove those blemishes which materially detract from its beauty, and consequently from its value.

The removal of flaws is a matter of great importance, for, owing to the form in which the diamond is cut, and its high degree of refrangibility, the smallest fault is magnified, and becomes obtrusively visible in every face. For this reason also, it is by no means an easy matter, at all times, to ascertian whether a flaw is, or is not, superficial; and a person with a correct and well-practised eye, may often purchase to great advantage stones which appear to be flawed quite through, but are, in fact, only superficially blemished.

The most esteemed, and, at the same time, nearest colour of the ORIENTAL RUBY, is pure carmine, or blood red of considerable intensity, forming, when well polished, a blaze of the most exquisite and unrivalled tint. It is, however, more or less pale, and mixed with blue in various proportions: hence it occurs rose-red and reddish-white, crimson, peach-blossom-red, and lilac-blue, the latter variety being named ORIENTAL AMETHYST. It is a native of Pegu, and is said to be found in the sand of certain streams near the town of Sirian, the capital of that country: it also occurs, with sapphire, in the sands of the rivers of Ceylon. A ruby perfect both in colour and transparency, is much less common than a good diamond, and when of the weight of three or four carats, is even more valuable than that gem. The King of Pegu, and the monarchs of Ava and Siam, monopolize the finest rubies, in the same way as the Sovereigns of India make a monopoly of diamonds. The finest ruby in the world is in possession of the first of these Kings: its purity has passed into a proverb, and its worth, when compared with gold, is inestimable. The Subah of the Decan, also, is in possession of a prodigiously fine one, a full inch in diameter. The princes of Europe cannot boast of any of a first rate magnitude.

The ORIENTAL SAPPHIRE ranks next in value to the ruby: when perfect, its colour is a clear and bright Prussian blue, united to a high degree of transparency. The ASTERIAS, or STAR-STONE, is a remarkable variety of this beautiful gem: it is semi-transparent, with a reddish purple tinge.

The view of a silver mine, facing p. 202, accompanied by

that of a natural road under the mountain of Filifeld, Norway, situated in a territory which abounds with mineral productions. This natural curiosity is so well exhibited in the plate, as not to need a particular description.

SALT MINES.

Hence with diffusive salt old ocean steeps
His emerald shallows, and his sapphire deeps.
Oft in wide lakes, around their warmer brim,
In hollow pyramids the crystals swim;
Or, fused by earth-born fires, in cubic blocks
Shoot their wide forms, and harden into rocks.

DARWIN.

CULINARY salt, or, as it is termed in chemistry, muriat of soda, exists abundantly in a native state, both in a solid form, and dissolved in water. It occurs, in solution, not only throughout the wide range of the ocean, but in various springs, rivers, and lakes; and is known, in its solid form, as a peculiar mineral, under the names of *rock-salt*, *fossil-salt*, and *salt-gem*. Its beds are mostly beneath the surface of the ground, but sometimes rise into hills of considerable elevation. At Cordova, in Spain, a hill, between four and five hundred feet in height, is entirely composed of this mineral. But the most celebrated salt mines are those of Wielicza in Gallicia, commonly called the salt mines of Cracow, those of Tyrol, of Poland, of Castille in Spain, and of Cheshire in England. In the province of Lahor, in Hindostan, is a hill of rock-salt of equal magnitude with that near Cordova. The mines of Iletski, in Russia, yield vast quantities of this substance. It is so plentiful in the desert of Caramania, and the air so dry, that it is there used as a material for building. It forms the surface of a large part of the northern desert of Lybia; and is found in great abundance in the mountains of Peru. It has a pure saline taste, without any mixture of bitterness; and crystalizes in cubes when obtained by slow evaporation from its solution. In Germany the mines of this kind are numerous: one of the largest is that of Hallein, near Saltzburg, in which the salt is hewn out from subterraneous caverns of a considerable range, and exhibits almost every diversity of colour, as yellow, red, blue, and white; in consequence of which it is dissolved in water, to be liberated from its impurities, and after-

wards re-crystalized. The salt mines of Cracow, and those of Cheshire, merit a particular description.

SALT MINES OF CRACOW.

Thus, cavern'd round, in Cracow's mighty mines,
With crystal walls a gorgeous city shines;
Scoop'd in the briny rock long streets extend
Their hoary course, and glittering domes ascend:
Down their bright steeps, emerging into day,
Impetuous fountains burst their headlong way,
O'er milk-white vales in ivory channels spread,
And wondering seek their subterraneous bed.
Form'd in pellucid salt, with chissel nice,
The pale lamp glittering through the sculptur'd ice.
With wild reverted eyes fair Lotta stands,
And spreads to heaven, in vain, her glassy hands:
Cold dews condense upon her pearly breast,
And the big tear rolls lucid down her vest.
Far gleaming o'er the town, transparent fanes
Rear their white towers, and wave their golden vanes;
Long lines of lustres pour their trembling rays,
And the bright vault resounds with mingled blaze.

DARWIN.

THESE celebrated excavations are about five miles distant from the city of Cracow, in a small town named Wielicza, which is entirely undermined, the cavities reaching to a considerable extent beyond its limits. The length of the great mine, from east to west, is six thousand feet; its breadth, from north to south, two thousand; and its greatest depth eight hundred: but the veins of salt are not limited to this extent, the depth and length of them, from east to west, being yet unknown, and their breadth only hitherto determined. There are at present ten shafts, but not a single spring has been discovered throughout the extent of the mine.

In descending to the bottom, the visitor is surprised to find a kind of subterraneous commonwealth, consisting of many families, who have their peculiar laws and polity. Here are likewise public roads and carriages, horses being employed to draw the salt to the mouths of the mine, where it is taken up by engines. These horses, when once arrived at their destination, never more see the light of the sun; and many of the people seem buried alive in this strange abyss, having been born there, and never stirring out; while others are not denied frequent oppor-

tunities of breathing the fresh air in the fields, and enjoying the surrounding prospects. The subterraneous passages, or galleries, are very spacious, and in many of them chapels are hewn out of the rock-salt. In these passages crucifixes are set up, together with the images of saints, before which a light is kept constantly burning. The places where the salt is hewn out, and the empty cavities whence it has been removed, are called chambers, in several of which, where the water has stagnated, the bottoms and sides are covered with very thick incrustations of thousands of salt crystals, lying one on the other, and many of them weighing half a pound and upwards. When candles are placed before them, the numerous rays of light reflected by these crystals emit a surprising lustre.

In several parts of the mine huge columns of salt are left standing, to support the rock; and these are very fancifully ornamented. But the most curious object in the inhabited part, or subterraneous town, is a statue which is considered by the immured inhabitants as the actual transmutation of Lot's wife into a pillar of salt; and, in proportion as this statue appears either dry or moist, the state of the weather above ground is inferred. The windings in this mine are so numerous and intricate, that the workmen have frequently lost their way; and several, whose lights have been extinguished, have thus perished. The number of miners to whom it gives employment, is computed at between four and five hundred; but the whole amount of the men employed in it is about seven hundred.

The salt lies near the surface, in large shapeless masses out of which blocks of sixty, eighty, or a hundred feet square, may be hewn; but at a considerable depth it is found in smaller lumps. About six hundred thousand quintals of salt are annually dug out of the mines of Cracow. The worst and cheapest is called green salt, from its greenish colour, occasioned by an heterogeneous mixture of a greyish mineral, or clay, and entirely consists of salt crystals of different dimensions. A finer sort is dug out in large blocks; and the third kind is the *sal gemmæ*, or crystal salt, which is found in small pieces interspersed in the rock, and, when detached from it, breaks into cubes or rectangular prisms. This is usually sold unprepared.

The colour of the salt stone is a dark grey mixed with yellow.

SALT MINES AND SALT SPRINGS OF CHESHIRE.

The Cheshire rock-salt, with very few exceptions, has hitherto been ascertained to exist only in the vallies bordering on the river Weaver and its tributary streams; in some places manifesting its presence by springs impregnated with salt, and in others being known by mines actually carried down into the substance of the salt strata Between the source of the Weaver and Nantwich, many brine springs make their appearance; and occur again at several places, in proceeding down the stream. At Moulton, a mine has been sunk into the body of rock-salt, and a similar mine is wrought near Middlewich. At Northwich, brine springs are very abundant; and there also many mines have been sunk for the purpose of working out the fossil salt. In that vicinity a body of rock salt has been met with in searching for coal.

The brines in this district are formed by the penetration of spring or rain waters to the upper surface of the rock salt, in passing over which they acquire such a degree of strength, that one hundred parts have yielded twenty-sever of pure salt, thus nearly approaching to the perfect saturation of brine. Their strength is therefore much greater than that of the salt springs met with in Hungary, Germany, and France. The brine having been pumped out of the pits, is first conveyed into large reservoirs, and afterwards drawn off as it is needed, into pans made of wrought iron. Here heat is applied in a degree determined by the nature of the salt to be manufactured, and various additions are made to the brine, with a view either to assist the crystalization of the salt, or to promote the separation of the earthy particles, which exist in a very small proportion. The importance of the manufacture of Cheshire salt will be sufficiently obvious from the statement, that, besides the salt made for home consumption, the annual amount of which exceeds 16,000 tons, the average of the quantity sent yearly to Liverpool for exportation, has not been less than 140,000 tons.

The mine of rock-salt first worked was discovered by accident at Marbury, near Northwich, about a century and

a half ago; and this bed had been wrought for more than a century, when, in the same neighbourhood, a second and inferior stratum was fallen in with, separated from the former by a bed of indurated clay. This lower stratum was ascertained to possess a very great degree of purity, and freedom from earthy admixture; on which account, and from the local advantages of Northwich for exportation, the fossil salt is worked in the vicinity of that place only. It occurs in two great strata or beds, lying nearly horizontally, and separated, the superincumbent from the subjacent stratum, by several layers of indurated clay, or argillaceous stone. These intervening beds possess in conjunction a very uniform thickness of from thirty to thirty-five feet, and are irregularly penetrated by veins of fossil salt. There is every reason to believe that the beds of rock-salt at Northwich, are perfectly distinct from any others in the salt district, and form what are termed by mineralogists *incumbent bodies* or *masses of mineral*.

These enormous masses stretch a mile and a half in a longitudinal direction from north-east to south-west; but their transverse extent, as measured by a line at right angles from the former, does not exceed 4,200 feet, somewhat more than three quarters of a mile. Without this area, the brine which is met with is of a very weak and inferior quality, and at a short distance disappears altogether. The thickness of the upper bed varies from sixty to ninety feet; and a general estimate made from its level, shows that its upper surface, which is ninety feet beneath that of the earth, is at least thirty-six feet beneath the low-water mark of the sea at Liverpool—a fact not unimportant in determining the nature of the formation of this mineral. The thickness of the lower bed has not hitherto been ascertained; but the workings are usually begun at the depth of from sixty to seventy-five feet, and are carried down for the space of fifteen or eighteen feet, through what forms the purest portion of the bed. In one of the mines a shaft has been sunk to a level of forty-two feet still lower, without passing through the body of rock-salt. There is thus an ascertained thickness of this bed of about a hundred and twenty feet, and without any direct evidence that it may not extend to a considerably greater depth.

Although two distinct beds only of fossil salt have been

met with at Northwich, it has been ascertained that the same limitations do not exist throughout the whole of the salt district. At Lawton, near the source of the river Wheelock, three distinct beds have been found, separated by strata of indurated clay: one at the depth of 126 feet, four feet in thickness; a second, thirty feet lower, twelve feet in thickness; and a third, forty-five feet farther down, which was sunk into seventy-two feet, without passing through its substance. The intervening clay, the structure of which is very peculiar, is called the SHAGGY METAL, and the fresh water which passes through its pores has the expressive appellation of ROARING MEG. This epithet will not appear too strong, when it is mentioned that in a mine in which the section of strata was taken, and where the shaggy metal was found at the depth of about eighty feet, the quantity of water ascertained to issue from its pores in one minute, was not less than three hundred and sixty gallons; a circumstance greatly enhancing the difficulties of passing a shaft down to the body of rock-salt.

In many of these beds of argillaceous stone, a portion of salt, sufficiently strong to affect the taste, is found to exist; and this saltness increases, as might be expected, in proportion as the body of rock-salt is approached: in the strata or layers immediately above the rock, which in all the mines are perfectly uniform in their appearance and structure, it is particularly remarkable, notwithstanding there are not, in these strata, any veins of rock-salt connected with the great mass below. On the contrary, the line between the clay and rock-salt is drawn with great distinctness in every instance, without presenting any of those inequalities which would arise from a mutual penetration of the strata. Not any marine exuviæ, or organic remains, are found in the strata above the rock-salt; and the almost universal occurrence of gypsum, in connexion with beds of fossil salt, is a fact still more deserving of observation, because it appears, not only in these mines, but also in the salt mines of Hungary, Poland, and Transylvania, on which account Werner, in his geognostic system, assigns to the rock-salt and floetz gypsum a conjunct situation.

The fossil salt extracted from the Northwich mines is of

different degrees of purity, and more or less olended with earthy and metallic substances. The purer portion of the lower bed yields a rock-salt, which, being principally exported to the Baltic, obtains the name of Prussian rock. The extent of the cavity formed by the workings varies in different mines, the average depth being about sixteen feet. In some of the pits, where pillars from eighteen to twenty-four feet square form the supports of the mine, the appearance of the cavity is singularly striking, and the brilliancy of the effect is greatly increased when the mine is illuminated by candles fixed to the side of the rock. The scene thus formed almost appears to realize the magic palaces of the eastern poets. Some of the pits are worked in aisles or streets, but the choice here is wholly arbitrary. Among the methods employed in working out the rock-salt, the operation of blasting is applied to the separation of large masses from the body of the rock, and these are afterwards broken down by the mechanical implements in common use. The present number of mines is eleven or twelve, from which there are raised, on an annual average, fifty or sixty thousand tons of rock-salt. The greater part of this quantity is exported to Ireland and the Baltic, the remainder being employed in the Cheshire district, in the manufacture of white salt by solution and subsequent evaporation.

The general situation occupied by the rock-salt in Cheshire is very similar to that of the Transylvanian and Polish mines, the beds of this mineral being disposed in small plains, bounded by hills of inconsiderable height, forming a kind of basin or hollow, from which there is usually only a narrow egress for the waters. The situation of the Austrian salt mines near Saltzburg is, however, very different. The mineral there appears to be disposed in beds of great thickness, which occur near the summits of limestone hills, at a great elevation above the adjoining country. This is a singular fact; and if the hypothesis be allowed that rock-salt is formed from the waters of the sea, it is necessary to suppose the occurrence on this spot of the most vast and surprising changes!

The theory of the formation of rock-salt presents some difficulties, at the same time that little doubt can exist of the general fact, that the beds of this mineral have been

formed by deposition from the waters of the sea. Such an opinion acquires much probability from the situation in which these beds usually occur; occupying the vallies and lower parts of the plains which are so surrounded by hills of secondary formation, as to leave only a narrow egress for the waters collected on their surface. The structure of the plain which constitutes the salt district of Cheshire, regarded in its general character, leads strongly to the conclusion that the waters of the sea must, at some former period, have occupied the lower parts at least of the basin thus formed, which at that time had a level lower by two hundred and fifty or three hundred feet than the one now appearing. To account for the great depositions of salt in the lower parts of this basin, it is necessary to suppose that some barrier must have been afterwards interposed to prevent the free communication of the waters of the sea with those thus collected; and the general course of the streams, the position of the beds of rock-salt, and the contractions in the valley of the Weaver, which appear below Northwich at Anderton and Frodsham, point out with some distinctness the place where these obstructions may probably have occurred.

The principal objection to this theory undoubtedly is, the non-existence of marine exuviæ, either in the rock-salt, or in the adjacent strata of clay; a fact very difficult to connect with the idea of a deposition from the waters of the sea. Other objections, though perhaps of less moment, arise from the appearance of the earthy salts in smaller proportion in the rock-salt than in sea water; from the apparently partial deposition of the beds; and from the difficulty of explaining the formation of certain figured appearances which occur in the substance of the rock. These circumstances, however, by no means authorize the rejection of the general idea which has been given of the origin of this mineral, strengthened as it is by the situation and appearances observed in the foreign salt mines, where the proofs of marine deposition are still stronger than those presented in the Cheshire district.